



HELLENIC REPUBLIC
Ministry of Environment and
Energy

This document is an automatic machine translation to English and may not precisely depict facts or figures as they were intended in the original language.



NATIONAL ENERGY AND CLIMATE PLAN —

REVISED EDITION

**ATHENS, AVGHOSTOS
2024**

TABLE OF CONTENTS

Περιεχόμενα Πινάκων, Σχημάτων και Εικόνων	8
ΣΥΝΟΠΤΙΚΗ ΠΑΡΟΥΣΙΑΣΗ	14
I. Εισαγωγικές παρατηρήσεις	14
II. Μεθοδολογική προσέγγιση	15
III. Τεχνολογίες μετάβασης προς την κλιματική ουδετερότητα (net zero) ανά τομέα	19
IV. Εξέλιξη της μετάβασης προς την κλιματική ουδετερότητα (net zero) και προτεραιότητες ανά χρονική περίοδο	26
V. Ποσοτικά αποτελέσματα ΕΣΕΚ	36
Προεκτιμώμενο κόστος ενεργειακής μετάβασης (επενδύσεις)	59
Προεκτιμώμενη εξέλιξη του κόστους ηλεκτρικής ενέργειας	60
VI. Κατακλείδα	62
ΚΕΦΑΛΑΙΟ 1: Επισκόπηση και διαδικασία κατάρτισης του σχεδίου	63
1.1 Εισαγωγή και σημείο εκκίνησης	63
1.2 Πολιτικό, οικονομικό, περιβαλλοντικό και κοινωνικό πλαίσιο του σχεδίου	66
1.3 Στρατηγικές προτεραιότητες του Εθνικού Σχεδίου για την Ενέργεια και το Κλίμα	69
1.4 Στόχοι που θέτει η Ευρωπαϊκή Ένωση	74
1.5 Μεθοδολογική προσέγγιση κατάρτισης του ΕΣΕΚ	76
1.6 Διαβουλεύσεις και συμμετοχή φορέων	78
1.6.1 Δομή διακυβέρνησης	78
1.6.2 Συμμετοχή εθνικών φορέων	79
1.6.3 Διαβουλεύσεις με άλλα κράτη	84
Κεφάλαιο 2: Εθνικοί στόχοι και επιδιώξεις	97
2.1 Επισκόπηση γενικού πλαισίου καθορισμού στόχων	97
2.2 Κλιματική Αλλαγή, εκπομπές και απορροφήσεις αερίων του θερμοκηπίου	101
2.2.1 Μείωση των εκπομπών αερίων του θερμοκηπίου	101
2.2.2 Οι εκπομπές και απορροφήσεις του τομέα χρήσης γης, αλλαγής χρήσης γης και δασοπονίας (LULUCF)	106
2.2.3 Μείωση εκπομπών από τις μεταφορές.....	116
2.3 Διείσδυση Ανανεώσιμων Πηγών Ενέργειας (ΑΠΕ)	135
2.3.1 Σύνοψη στόχων και προτεραιοτήτων	135
2.3.2 Διείσδυση ΑΠΕ στην παραγωγή ηλεκτρικής ενέργειας	138
2.3.3 Χερσαία αιολικά και φωτοβολταϊκά πάρκα	138

2.3.4	Υπεράκτια αιολικά πάρκα.....	140
2.3.5	Υδροηλεκτρικά έργα	140
2.3.6	Λοιπές ΑΠΕ	143
2.3.7	Αποθήκευση – Μπαταρίες	143
2.3.8	Αποθήκευση – Αντλησιοταμίευση	144
2.4	Εναλλακτικά και κλιματικά ουδέτερα αέρια και υγρά καυσίμα.....	148
2.4.1	Βασικοί στόχοι	148
2.4.2	Ανάπτυξη βιομεθανίου	151
2.4.3	Ανάπτυξη πράσινου υδρογόνου	153
2.4.4	Δέσμευση και Χρήση ή Αποθήκευση Διοξειδίου του Άνθρακα (CCUS- CarbonCapture and Usage or Storage)	157
2.4.5	Προώθηση Ανανεώσιμων Υγρών Καυσίμων	158
2.5	Βελτίωση ενεργειακής απόδοσης	161
2.5.1	Βελτίωση της ενεργειακής απόδοσης στο σύνολο των τομέων τελικής κατανάλωσης ενέργειας	161
2.5.2	Βελτίωση της ενεργειακής απόδοσης στον κτηριακό τομέα	164
2.5.3	Αντιμετώπιση της ενεργειακής ένδειας	166
2.6	Στόχοι και επιδιώξεις στον τομέα της ασφάλειας ενεργειακού εφοδιασμού	169
2.6.1	Σύνοψη στόχων και προτεραιοτήτων	169
2.6.2	Ενίσχυση διεθνών ηλεκτρικών διασυνδέσεων	173
2.6.3	Ηλεκτρική διασύνδεση νησιών	175
2.6.4	Ενίσχυση εσωτερικών δικτύων	177
2.6.5	Τεχνολογίες που ενισχύουν την αξιοπιστία και ασφάλεια του ηλεκτρικού δικτύου	178
2.6.6	Κυβερνοασφάλεια και Κλιματική ανθεκτικότητα των κρίσιμων ενεργειακών υποδομών και Κυβερνοασφάλεια.....	181
2.6.7	Μείωση της εξάρτησης από εισαγωγές ενέργειας υδρογονανθράκων από τρίτες χώρες, ανάδειξη χώρας ως διαμετακομιστικού κόμβου για φυσικό αέριο και πράσινη ενέργεια, με στόχο την αύξηση της ανθεκτικότητας των περιφερειακών και Ευρωπαϊκών ενεργειακών συστημάτων	185
2.6.8	Αποθήκευση πετρελαίου και πετρελαιοειδών.....	187
2.7	Στόχοι και επιδιώξεις στον τομέα εσωτερικής αγοράς ηλεκτρικής ενέργειας	188
2.7.1	Εφαρμογή του “Μοντέλου Στόχου”	188
2.7.2	Εξέλιξη διάρθρωσης κόστους και μέση τιμή ηλεκτρικής ενέργειας	192
2.7.3	Ενίσχυση του ανταγωνισμού στην αγορά ενέργειας και ο ρόλος του ενεργού καταναλωτή....	192
2.7.4	Participation of demand response and storage in markets electricity... 194	
2.7.5	Strengthening green bilateral contracts and developing new environmental products; and αγορών	195

2.7.6	Ενίσχυση της ανθεκτικότητας των δικτύων ενέργειας	197
2.8	Κρίσιμες Πρώτες ύλες	200
2.8.1	Το ζήτημα των κρίσιμων (ΚΟΠΥ) και στρατηγικών (ΣΟΠΥ) ορυκτών πρώτων υλών	200
2.8.2	Το υφιστάμενο δυναμικό της Χώρας σε Κρίσιμες (ΚΟΠΥ) και Στρατηγικές (ΣΟΠΥ) Ορυκτές Πρώτες Ύλες 201	
2.8.3	Ενέργειες-δράσεις προς την κατεύθυνση της στρατηγικής αυτονομίας της Χώρας και της Ευρωπαϊκής Ένωσης για τις ΚΟΠΥ και ΣΟΠΥ	202
2.9	Προσαρμογή στη κλιματική αλλαγή	205
2.10	Έρευνα, καινοτομία και ανταγωνιστικότητα	208
2.10.1	Στόχοι	208
Κεφάλαιο 3: Μέτρα και πολιτικές		213
3.1	Κλιματική αλλαγή, εκπομπές και απορροφήσεις αερίων του θερμοκηπίου	213
3.1.1	Μέτρα και πολιτικές για την επίτευξη του στόχου της απολιγνιτοποίησης και της Δίκαιης Αναπτυξιακής Μετάβασης	214
3.1.2	Μέτρα και πολιτικές για τη μείωση των εκπομπών στον αγροτικό τομέα	220
3.1.3	Μέτρα και πολιτικές για την αύξηση της συμβολής του τομέα LULUCF στην κλιματική ουδετερότητα 224	
3.1.4	Μέτρα και πολιτικές για τον τομέα των μεταφορών	230
3.1.5	Μέτρα και πολιτικές για τη διαχείριση των αποβλήτων	241
3.1.6	Μέτρα και πολιτικές για την Κυκλική Οικονομία	244
3.1.7	Μέτρα και πολιτικές για τις αστικές βιοκλιματικές αναπλάσεις και τις έξυπνες πόλεις	248
3.1.8	Μέτρα και πολιτικές για τη βιομηχανία	251
3.1.9	Πολιτικές και μέτρα που έχουν προγραμματιστεί για τη σταδιακή κατάργηση των επιδοτήσεων για τα ορυκτά καύσιμα	255
3.1.10	Αξιολόγηση της κλιματικής τρωτότητας πολιτικών και μέτρων μετριασμού των αερίων του θερμοκηπίου	259
3.1.11	Σύνοψη μέτρων και πολιτικών για τη διάσταση της μείωσης εκπομπών αερίων του θερμοκηπίου	273
3.2	Μέτρα και πολιτικές για τις Ανανεώσιμες Πηγές Ενέργειας	281
3.2.1	Μέτρα και πολιτικές για αναμόρφωση του πλαισίου αδειοδότησης και επικαιροποίηση του ειδικού χωροταξικού πλαισίου για τις ΑΠΕ – Επιτάχυνση, ψηφιοποίηση και αποτελεσματικότητα αδειοδότησης . 282	
3.2.2	Μέτρα και πολιτικές για τη διασφάλιση υλοποίησης επενδύσεων ΑΠΕ και Αποθήκευσης - Προώθηση διμερών συμβάσεων, ανάπτυξη υβριδικών συστημάτων στα νησιά	284
3.2.3	Μέτρα και πολιτικές για την προώθηση διεσπαρμένων συστημάτων ΑΠΕ, ενδυνάμωση συμμετοχικού ρόλου τοπικών κοινωνιών – καταναλωτών	287
3.2.4	Μέτρα και πολιτικές για τη διασφάλιση βιωσιμότητας και ρευστότητας του μηχανισμού χορήγησης λειτουργικής ενίσχυσης στις μονάδες ηλεκτροπαραγωγής από ΑΠΕ καθώς και στους σταθμούς αποθήκευσης	290

3.2.5	Μέτρα και πολιτικές για την ανάπτυξη και ενίσχυση ενεργειακών δικτύων και βέλτιστη ένταξη και λειτουργία μονάδων ΑΠΕ - Αποθήκευση ενέργειας	290
3.2.6	Μέτρα και πολιτικές για τη διασφάλιση συμμετοχής ΑΠΕ στην κάλυψη ενεργειακών αναγκών στον κτηριακό τομέα - προσαρμογές στον κτηριοδομικό κανονισμό - προώθηση του διαμοιρασμού ενέργειας	296
3.2.7	Μέτρα και πολιτικές για την προώθηση της χρήσης συστημάτων ΑΠΕ για κάλυψη θερμικών και ψυκτικών αναγκών	297
3.2.8	Μέτρα και πολιτικές για την προώθηση νέων τεχνολογιών και σύζευξη ενεργειακών τομέων με έμφαση στον εξηλεκτρισμό για μέγιστη αξιοποίηση του εγχώριου δυναμικού από τις ΑΠΕ	298
3.2.9	Αξιολόγηση της κλιματικής τρωτότητας πολιτικών και μέτρων για τις ΑΠΕ	302
3.2.10	Σύνοψη μέτρων και πολιτικών για τη διάσταση των ΑΠΕ	307
3.3	Πολιτικές και μέτρα για τα εναλλακτικά και κλιματικά ουδέτερα αέρια και υγρά καυσίμα	315
3.3.1	Μέτρα και πολιτικές για την ανάπτυξη βιομεθανίου	315
3.3.2	Μέτρα και πολιτικές για την ανάπτυξη πράσινου υδρογόνου	320
3.3.3	Μέτρα και πολιτικές για την προώθηση των ανανεώσιμων υγρών καυσίμων	322
3.3.4	Αξιολόγηση της κλιματικής τρωτότητας πολιτικών και μέτρων για τα ανανεώσιμα υγρά και αέρια καύσιμα	323
3.4	Βελτίωση ενεργειακής απόδοσης	328
3.4.1	Μέτρα και πολιτικές για τη βελτίωση της ενεργειακής απόδοσης στον κτηριακό τομέα - Μακροπρόθεσμη στρατηγική ανακαίνισης του εθνικού κτηριακού αποθέματος	329
3.4.2	Μέτρα και πολιτικές για τη βελτίωση της ενεργειακής απόδοσης στον βιομηχανικό τομέα	334
3.4.3	Μηχανισμοί της αγοράς	336
3.4.4	Οριζόντια μέτρα και πολιτικές	337
3.4.5	Μέτρα και πολιτικές για την επίτευξη του στόχου του άρθρου 8 της Οδηγίας (ΕΕ) 2023/1791	338
3.4.6	Μέτρα και πολιτικές για την αντιμετώπιση της ενεργειακής ένδειας	342
3.4.7	Αξιολόγηση της κλιματικής τρωτότητας πολιτικών και μέτρων βελτίωσης της ενεργειακής απόδοσης	352
3.4.9	Σύνοψη μέτρων και πολιτικών για τη διάσταση της βελτίωσης της ενεργειακής απόδοσης	358
3.5	Μέτρα και πολιτικές για την ενεργειακή ασφάλεια	365
3.5.1	Μέτρα και πολιτικές για την ενίσχυση της διαφοροποίησης των ενεργειακών πηγών και οδεύσεων εισαγωγής ενέργειας	366
3.5.2	Μέτρα και πολιτικές για την ανάδειξη της χώρας ως περιφερειακού ενεργειακού κόμβου	368
3.5.3	Μέτρα και πολιτικές για την προώθηση συστημάτων παροχής ευελιξίας, συστημάτων αποθήκευσης και απόκρισης της ζήτησης και διασφάλιση της επάρκειας ισχύος της χώρας	378
3.5.4	Μέτρα και πολιτικές για την αντιμετώπιση του περιορισμού ή της διακοπής παροχής ενεργειακής τροφοδοσίας	378
3.5.5	Μέτρα και πολιτικές για την αύξηση ανθεκτικότητας των κρίσιμων ενεργειακών υποδομών ..	379
3.5.6	Αξιολόγηση της κλιματικής τρωτότητας πολιτικών και μέτρων για την ενεργειακή ασφάλεια ..	382

3.5.7	Σύνοψη μέτρων και πολιτικών για τη διάσταση της ενεργειακής ασφάλειας	383
3.6	Μέτρα και πολιτικές για την εσωτερική αγορά ενέργειας	388
3.6.1	Μέτρα και πολιτικές για την ενίσχυση του ανταγωνισμού στην λιανική αγορά και την προώθηση της δυναμικής τιμολόγησης - ολοκλήρωση της ψηφιοποίησης του δικτύου	389
3.6.2	Μέτρα και πολιτικές για την ανάπτυξη στρατηγικών για την αντιμετώπιση ενεργειακών κρίσεων και την προστασία των τελικών καταναλωτών	394
3.6.3	Μέτρα και πολιτικές για την προώθηση μεταρρυθμίσεων για τη βελτίωση της λειτουργίας της αγοράς ηλεκτρικής ενέργειας	396
3.6.4	Μέτρα και πολιτικές για την τυποποίηση και την ενίσχυση των διμερών συμβάσεων (PPA's) και την ανάπτυξη νέων περιβαλλοντικών αγορών	398
3.6.5	Μέτρα και πολιτικές για την προώθηση των συστημάτων παροχής ευελιξίας, των συστημάτων αποθήκευσης ενέργειας και απόκρισης της ζήτησης στις αγορές	399
3.6.6	Σύνοψη μέτρων και πολιτικών για τη διάσταση της εσωτερικής αγοράς ενέργειας	402
3.7	Μέτρα και πολιτικές για την αξιοποίηση των κρίσιμων ορυκτών πρώτων υλών	406
3.7.1	Μέτρα και πολιτικές για την ασφάλεια εφοδιασμού κρίσιμων ορυκτών πρώτων υλών	406
3.7.2	Προώθηση της έρευνας	407
3.7.3	Προώθηση της εκμετάλλευσης	408
3.7.4	Αξιολόγηση της κλιματικής τρωτότητας πολιτικών και μέτρων για την αξιοποίηση των κρίσιμων ορυκτών πρώτων υλών	409
3.8	Μέτρα και πολιτικές προσαρμογής στην κλιματική αλλαγή στο πλαίσιο υλοποίησης του ΕΣΕΚ	411
3.9	Μέτρα και πολιτικές για την Έρευνα, Καινοτομία και Ανταγωνιστικότητα	424
3.9.1	Μέτρα και πολιτικές για την προώθηση της έρευνας και καινοτομίας	425
3.9.2	Μέτρα και πολιτικές για την προώθηση της ανταγωνιστικότητας	435
3.9.3	Συνεργασία με άλλα κράτη μέλη στον εν λόγω τομέα	436
3.9.4	Σύνοψη μέτρων και πολιτικών για τη διάσταση της έρευνας, καινοτομίας και ανταγωνιστικότητας	437
Κεφάλαιο 4: Αποτελέσματα εξέλιξης ενεργειακού συστήματος έως το έτος 2050		441
4.1	Συνοπτική παρουσίαση υφιστάμενης κατάστασης	441
4.2	Προβλεπόμενη εξέλιξη των κύριων εξωγενών παραγόντων που επηρεάζουν το ενεργειακό σύστημα και τις εκπομπές αερίων θερμοκηπίου	449
4.2.1	Μακροοικονομικές και δημογραφικές προβλέψεις	449
4.2.2	Παγκόσμιες ενεργειακές τάσεις, διεθνείς τιμές ορυκτών καυσίμων, τιμή δικαιωμάτων εκπομπών βάσει του ΣΕΔΕ της ΕΕ	451
4.3	Προβλέψεις για την ανάπτυξη του ενεργειακού συστήματος και των εκπομπών και απορροφήσεων ΑτΘ	453
4.3.1	Διαμόρφωση σεναρίου επιπρόσθετων πολιτικών και μέτρων	453
4.3.2	Κύρια χαρακτηριστικά του ενεργειακού συστήματος έως το έτος 2050	455

4.3.3	Εξέλιξη της ηλεκτροπαραγωγής	475
4.3.4	Εξέλιξη της κατανάλωσης ενέργειας στους τομείς τελικής χρήσης	486
4.3.5	Εξέλιξη της κατανάλωσης ενέργειας στον οικιακό τομέα	489
4.3.6	Εξέλιξη της κατανάλωσης ενέργειας στον τριτογενή τομέα	492
4.3.7	Εξέλιξη της κατανάλωσης ενέργειας στον τομέα των μεταφορών	494
	Δείκτης Εκπομπές CO ₂ /Καταναλησόμενη Ενέργεια [kton/ktOE]	505
4.3.8	Εξέλιξη της κατανάλωσης ενέργειας στη βιομηχανία	505
4.3.9	Εξέλιξη της κατανάλωσης ενέργειας στον αγροτικό τομέα	507
Κεφάλαιο 5: Επισκόπηση επιπτώσεων και επενδυτικών αναγκών		509
5.1	Εκτιμώμενη εξέλιξη κόστους ηλεκτρικής ενέργειας.....	509
5.2	Εκτίμηση προβλεπόμενων επενδύσεων των προγραμματιζόμενων μέτρων πολιτικής	513
5.3	Επιπτώσεις των επενδύσεων του Εθνικού Σχεδίου για την Ενέργεια και το Κλίμα (ΕΣΕΚ) στην ελληνική οικονομία	519
5.4	Ο δημοσιονομικός αντίκτυπος της πράσινης μετάβασης	525
5.5	Υφιστάμενες επενδυτικές ροές και πηγές χρηματοδότησης	528
5.6	Παράγοντες κινδύνου και προκλήσεις	541
ΠΑΡΑΡΤΗΜΑ		545
ΠΑΡΑΡΤΗΜΑ – Επιπτώσεις κλιματικής αλλαγής στις ΑΠΕ		545

Contents of Tables, Figures and Figures

TABLE OF TABLES

N/A 1 MAND EVOLUTION OF TECHNOLOGY, METHODS AND APPROACHES FOR THE PERIOD UP TO 2050, WITH

ΑΦΕΤΗΡΙΑ ΤΗ ΣΗΜΕΡΙΝΗ ΚΑΤΑΣΤΑΣΗ	20
ΠΙΝΑΚΑΣ-ΕΣ 2 ΠΟΣΟΤΙΚΟΠΟΙΗΣΗ ΣΤΟΧΩΝ ΕΣΕΚ ΚΑΙ ΔΕΙΚΤΩΝ	36
ΠΙΝΑΚΑΣ-ΕΣ 3 ΕΓΚΑΤΕΣΤΗΜΕΝΗ ΙΣΧΥΣ ΜΟΝΑΔΩΝ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗΣ ΑΝΑ ΤΕΧΝΟΛΟΓΙΑ (MW)	41
ΠΙΝΑΚΑΣ-ΕΣ 4 ΕΞΕΛΙΞΗ ΑΠΟΘΗΚΕΥΣΗΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΑΝΑ ΤΕΧΝΟΛΟΓΙΑ – ΙΣΧΥΣ (MW) ΚΑΙ ΧΩΡΗΤΙΚΟΤΗΤΑ (MWh)	42
ΠΙΝΑΚΑΣ-ΕΣ 5 ΚΑΘΑΡΗ ΠΑΡΑΓΩΓΗ & ΕΙΣΑΓΩΓΕΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ (TWh/ΕΤΟΣ)	44
ΠΙΝΑΚΑΣ-ΕΣ 6 ΑΚΑΘΑΡΙΣΤΗ ΚΑΤΑΝΑΛΩΣΗ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ (TWh/ΕΤΟΣ)	46
ΠΙΝΑΚΑΣ-ΕΣ 7 ΠΡΟΒΛΕΠΟΜΕΝΗ ΔΕΣΜΕΥΣΗ ΚΑΙ ΧΡΗΣΗ CO2 (MTN CO2/ΕΤΟΣ)	48
ΠΙΝΑΚΑΣ-ΕΣ 8 ΠΡΟΒΛΕΠΟΜΕΝΗ ΠΑΡΑΓΩΓΗ ΚΑΙ ΧΡΗΣΕΙΣ ΥΔΡΟΓΟΝΟΥ (TWh/ΕΤΟΣ), ΙΣΧΥΣ ΜΟΝΑΔΩΝ ΗΛΕΚΤΡΟΛΥΣΗΣ (MW), ΕΓΧΥΣΗ ΥΔΡΟΓΟΝΟΥ ΣΤΑ ΔΙΚΤΥΑ Φ.Α. (ΜΕΣΟΣ ΟΡΟΣ % Κ.Ο.)	49
ΠΙΝΑΚΑΣ-ΕΣ 9 ΠΑΡΑΓΩΓΗ ΒΙΟΜΕΘΑΝΙΟΥ (TWh/ΕΤΟΣ)	50
ΠΙΝΑΚΑΣ-ΕΣ 10 ΧΡΗΣΗ ΠΡΟΗΓΜΕΝΩΝ ΒΙΟΚΑΥΣΙΜΩΝ	50
ΠΙΝΑΚΑΣ-ΕΣ 11 ΠΟΣΟΤΗΤΕΣ ΣΥΝΘΕΚΤΙΚΩΝ ΑΝΘΡΑΚΟΥΧΩΝ ΚΑΥΣΙΜΩΝ ΚΑΙ ΣΥΝΘΕΤΙΚΗΣ ΑΜΜΩΝΙΑΣ, ΕΓΧΩΡΙΑ ΠΑΡΑΓΩΓΗ ΚΑΙ ΕΙΣΑΓΩΓΕΣ (TWh)	51
ΠΙΝΑΚΑΣ-ΕΣ 12 ΠΡΟΒΛΕΠΟΜΕΝΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΟΝ ΑΓΡΟΤΙΚΟ ΤΟΜΕΑ (TWh/ΕΤΟΣ)	52
ΠΙΝΑΚΑΣ-ΕΣ 13 ΠΡΟΒΛΕΠΟΜΕΝΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΟ ΒΙΟΜΗΧΑΝΙΚΟ ΤΟΜΕΑ (TWh/ΕΤΟΣ)	53
ΠΙΝΑΚΑΣ-ΕΣ 14 ΠΡΟΒΛΕΠΟΜΕΝΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΟΝ ΕΜΠΟΡΙΚΟ/ΔΗΜΟΣΙΟ ΤΟΜΕΑ (TWh/ΕΤΟΣ)	54
ΠΙΝΑΚΑΣ-ΕΣ 15 ΠΡΟΒΛΕΠΟΜΕΝΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΟΝ ΟΙΚΙΑΚΟ ΤΟΜΕΑ (TWh/ΕΤΟΣ)	55
ΠΙΝΑΚΑΣ-ΕΣ 16 ΣΥΝΟΛΟ ΕΚΤΙΜΩΜΕΝΩΝ ΕΠΕΝΔΥΣΕΩΝ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2030 (ΕΚΑΤ. €)	59
ΠΙΝΑΚΑΣ-ΕΣ 17 ΣΥΝΟΛΟ ΕΚΤΙΜΩΜΕΝΩΝ ΕΠΕΝΔΥΣΕΩΝ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2031-2050 (ΕΚΑΤ. €)	59
ΠΙΝΑΚΑΣ-ΕΣ 18 ΕΚΤΙΜΗΣΗ ΕΞΕΛΙΞΗΣ ΜΕΣΟΥ ΚΟΣΤΟΥΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2050 (€/MWh)	60
ΠΙΝΑΚΑΣ 1 ΠΡΟΒΟΛΗ ΤΩΝ ΔΥΝΑΤΟΤΗΤΩΝ ΤΟΥ ΤΟΜΕΑ LULUCF (ΜΕ ΕΦΑΡΜΟΓΗ ΥΦΙΣΤΑΜΕΝΩΝ ΜΕΤΡΩΝ – ΣΕΝΑΡΙΟ WEM)	111
ΠΙΝΑΚΑΣ 2 ΠΡΟΒΟΛΗ ΤΩΝ ΔΥΝΑΤΟΤΗΤΩΝ ΤΟΥ ΤΟΜΕΑ LULUCF (ΜΕ ΕΦΑΡΜΟΓΗ ΕΠΙΠΡΟΣΘΕΤΩΝ ΜΕΤΡΩΝ – ΣΕΝΑΡΙΟ WAM). ..	112
ΠΙΝΑΚΑΣ 3 ΕΤΗΣΙΟΙ ΣΤΟΧΟΙ ΔΙΕΙΣΔΥΣΗΣ ΝΕΩΝ ΗΛΕΚΤΡΙΚΩΝ ΕΠΙΒΑΤΙΚΩΝ ΟΧΗΜΑΤΩΝ ΕΠΙ ΣΥΝΟΛΟΥ ΤΑΞΙΝΟΜΗΣΕΩΝ ΣΤΗΝ ΕΛΛΗΝΙΚΗ ΑΓΟΡΑ ΕΩΣ ΤΟ ΕΤΟΣ 2030 (ΣΕΝΑΡΙΟ Α – ΣΕΝΑΡΙΟ ΒΑΣΗΣ, ΣΕΝΑΡΙΟ Β – ΑΙΣΙΟΔΟΞΟ ΣΕΝΑΡΙΟ)	122
ΠΙΝΑΚΑΣ 4 ΕΤΗΣΙΟΙ ΣΤΟΧΟΙ ΔΙΕΙΣΔΥΣΗΣ ΝΕΩΝ ΗΛΕΚΤΡΙΚΩΝ ΕΛΑΦΡΩΝ ΦΟΡΤΗΓΩΝ (LCVs) ΕΠΙ ΣΥΝΟΛΟΥ ΤΑΞΙΝΟΜΗΣΕΩΝ ΣΤΗΝ ΕΛΛΗΝΙΚΗ ΑΓΟΡΑ ΕΩΣ ΤΟ ΕΤΟΣ 2030 (ΣΕΝΑΡΙΟ Α – ΣΕΝΑΡΙΟ ΒΑΣΗΣ, ΣΕΝΑΡΙΟ Β – ΑΙΣΙΟΔΟΞΟ ΣΕΝΑΡΙΟ)	123
ΠΙΝΑΚΑΣ 5 ΣΥΓΚΡΙΣΗ ΠΡΟΒΛΕΨΕΩΝ ΤΟΥ ΠΡΟΗΓΟΥΜΕΝΟΥ ΕΣΕΚ ΚΑΙ ΠΡΑΓΜΑΤΙΚΩΝ ΣΤΟΙΧΕΙΩΝ ΤΑΞΙΝΟΜΗΣΕΩΝ ΗΛΕΚΤΡΙΚΩΝ ΕΠΙΒΑΤΙΚΩΝ ΟΧΗΜΑΤΩΝ	126
ΠΙΝΑΚΑΣ 6 ΣΥΝΟΨΗ ΑΠΟΤΕΛΕΣΜΑΤΩΝ ΓΙΑ ΤΟΥΣ ΔΕΙΚΤΕΣ-ΣΤΟΧΟΥΣ ΤΩΝ ΑΠΕ	137
ΠΙΝΑΚΑΣ 7 ΠΡΟΣΔΙΟΡΙΣΜΟΣ ΣΤΟΧΟΥ ΕΞΟΙΚΟΝΟΜΗΣΗΣ ΕΝΕΡΓΕΙΑΣ ΤΟΥ ΆΡΘΡΟΥ 8 ΤΗΣ ΟΔΗΓΙΑΣ (ΕΕ) 2023/1791	163
ΠΙΝΑΚΑΣ 8 ΥΠΟΛΟΓΙΣΜΟΣ ΕΠΙΠΕΔΩΝ ΕΝΕΡΓΕΙΑΚΗΣ ΕΝΔΕΙΑΣ	168

ΠΙΝΑΚΑΣ	9	ΧΡΟΝΟΔΙΑΓΡΑΜΜΑ ΑΠΟΣΥΡΣΗΣ ΛΙΓΝΙΤΙΚΩΝ ΜΟΝΑΔΩΝ	215
ΠΙΝΑΚΑΣ	10	ΠΟΣΟΤΙΚΟΠΟΙΗΣΗ ΤΗΣ ΕΠΙΔΡΑΣΗΣ ΤΩΝ ΠΟΛΙΤΙΚΩΝ ΚΑΙ ΜΕΤΡΩΝ ΣΤΟΝ ΑΓΡΟΤΙΚΟ ΤΟΜΕΑ	224
ΠΙΝΑΚΑΣ	11	ΕΞΕΛΙΞΗ ΤΩΝ ΕΚΠΟΜΠΩΝ ΑΘ ΕΩΣ ΤΟ 2050 ΑΠΟ ΤΟΝ ΑΓΡΟΤΙΚΟ ΤΟΜΕΑ	224
ΠΙΝΑΚΑΣ	12	ΚΑΝΟΝΕΣ (ΥΠΟΧΡΕΩΤΙΚΕΣ ΔΕΣΜΕΥΣΕΙΣ) ΕΝΙΣΧΥΜΕΝΗΣ ΑΙΡΕΣΙΜΟΤΗΤΑΣ ΤΟΥ ΣΤΡΑΤΗΓΙΚΟΥ ΣΧΕΔΙΟΥ ΚΑΠ	227
ΠΙΝΑΚΑΣ	13	ΠΟΣΟΤΙΚΟΠΟΙΗΣΗ ΤΗΣ ΕΠΙΔΡΑΣΗΣ ΤΩΝ ΠΑΡΕΜΒΑΣΕΩΝ ΤΟΥ ΣΣ ΚΑΠ ΣΤΟΝ ΤΟΜΕΑ LULUCF (ΥΨΟΣ ΑΠΟΡΡΟΦΗΣΕΩΝ ΕΤΟΥΣ, ΣΕ ΚΤ CO ₂ EQ)	228
ΠΙΝΑΚΑΣ	14	ΠΟΣΟΤΙΚΟΠΟΙΗΣΗ ΤΗΣ ΕΠΙΔΡΑΣΗΣ ΤΩΝ ΠΟΛΙΤΙΚΩΝ ΚΑΙ ΜΕΤΡΩΝ ΣΤΟΝ ΤΟΜΕΑ ΔΙΑΧΕΙΡΙΣΗΣ ΑΠΟΒΛΗΤΩΝ	243
ΠΙΝΑΚΑΣ	15	ΕΞΕΛΙΞΗ ΤΩΝ ΕΚΠΟΜΠΩΝ ΑΘ ΕΩΣ ΤΟ 2050 ΑΠΟ ΤΟΝ ΤΟΜΕΑ ΔΙΑΧΕΙΡΙΣΗΣ ΑΠΟΒΛΗΤΩΝ	243
ΠΙΝΑΚΑΣ	16	ΜΕΤΡΑ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗ ΔΙΑΣΤΑΣΗ ΤΗΣ ΜΕΙΩΣΗΣ ΕΚΠΟΜΠΩΝ ΑΕΡΙΩΝ ΤΟΥ ΘΕΡΜΟΚΗΠΙΟΥ	274
ΠΙΝΑΚΑΣ	17	ΜΕΤΡΑ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗ ΔΙΑΣΤΑΣΗ ΤΩΝ ΑΠΕ	308
ΠΙΝΑΚΑΣ	18	ΜΕΤΡΑ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗΝ ΑΝΑΠΤΥΞΗ ΤΟΥ ΒΙΟΜΕΘΑΝΙΟΥ	318
ΠΙΝΑΚΑΣ	19	ΜΕΤΡΑ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗΝ ΑΝΑΠΤΥΞΗ ΤΟΥ ΠΡΑΣΙΝΟΥ ΥΔΡΟΓΟΝΟΥ ΚΑΙ ΤΗΝ ΠΡΟΩΘΗΣΗ ΤΩΝ ΑΝΑΝΕΩΣΙΜΩΝ ΥΓΡΩΝ ΚΑΥΣΙΜΩΝ	326
ΠΙΝΑΚΑΣ	20	ΜΕΙΓΜΑ ΜΕΤΡΩΝ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗΝ ΕΠΙΤΕΥΞΗ ΤΟΥ ΣΤΟΧΟΥ ΤΟΥ ΑΡΘΡΟΥ 8 ΤΗΣ ΟΔΗΓΙΑΣ (ΕΕ) 2023/1791	340
ΠΙΝΑΚΑΣ	21	ΜΕΤΡΑ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗ ΔΙΑΣΤΑΣΗ ΤΗΣ ΒΕΛΤΙΩΣΗΣ ΤΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ	359
ΠΙΝΑΚΑΣ	22	ΜΕΤΡΑ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗ ΔΙΑΣΤΑΣΗ ΤΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΑΣΦΑΛΕΙΑΣ	384
ΠΙΝΑΚΑΣ	23	ΛΙΣΤΑ ΧΩΡΩΝ ΜΕ ΤΙΣ ΟΠΟΙΕΣ ΑΝΑΠΤΥΣΣΕΤΑΙ ΣΥΝΕΡΓΑΣΙΑ ΣΧΕΤΙΚΑ ΜΕ ΔΙΕΘΝΕΙΣ ΔΙΑΣΥΝΔΕΣΕΙΣ	398
ΠΙΝΑΚΑΣ	24	ΜΕΤΡΑ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗ ΔΙΑΣΤΑΣΗ ΤΗΣ ΕΣΩΤΕΡΙΚΗΣ ΑΓΟΡΑΣ ΕΝΕΡΓΕΙΑΣ	403
ΠΙΝΑΚΑΣ	25	ΣΥΝΔΕΣΗ ΔΡΑΣΕΩΝ ΚΑΙ ΜΕΤΡΩΝ ΠΡΟΣΑΡΜΟΓΗΣ ΜΕ ΤΟΥΣ ΣΤΟΧΟΥΣ ΚΑΙ ΤΙΣ ΠΟΛΙΤΙΚΕΣ ΠΡΟΤΕΡΑΙΟΤΗΤΕΣ ΤΟΥ ΕΣΕΚ (,).414	414
ΠΙΝΑΚΑΣ	26	ΜΕΤΡΑ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗ ΔΙΑΣΤΑΣΗ ΤΗΣ ΕΡΕΥΝΑΣ, ΚΑΙΝΟΤΟΜΙΑΣ ΚΑΙ ΑΝΤΑΓΩΝΙΣΤΙΚΟΤΗΤΑΣ	438
ΠΙΝΑΚΑΣ	27	ΚΟΙΝΕΣ ΜΑΚΡΟΟΙΚΟΝΟΜΙΚΕΣ ΚΑΙ ΔΗΜΟΓΡΑΦΙΚΕΣ ΠΡΟΒΛΕΨΕΙΣ ΓΙΑ ΤΗΝ ΕΚΠΟΝΗΣΗ ΤΟΥ ΕΣΕΚ	450
ΠΙΝΑΚΑΣ	28	ΤΙΜΕΣ ΓΙΑ ΤΗΝ ΕΞΕΛΙΞΗ ΤΩΝ ΔΙΕΘΝΩΝ ΤΙΜΩΝ ΚΑΥΣΙΜΩΝ ΚΑΙ ΤΩΝ ΔΙΚΑΙΩΜΑΤΩΝ ΕΚΠΟΜΠΩΝ	452
ΠΙΝΑΚΑΣ	29	ΣΥΝΟΠΤΙΚΟ ΕΝΕΡΓΕΙΑΚΟ ΙΣΟΖΥΓΙΟ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2022 (ΙΣΤΟΡΙΚΑ) -2050	455
ΠΙΝΑΚΑΣ	30	ΕΞΕΛΙΞΗ ΕΝΕΡΓΕΙΑΚΩΝ ΚΑΙ ΚΛΙΜΑΤΙΚΩΝ ΔΕΙΚΤΩΝ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2022 (ΙΣΤΟΡΙΚΑ) – 2050	457
ΠΙΝΑΚΑΣ	31	ΒΑΣΙΚΑ ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ ΣΥΣΤΗΜΑΤΟΣ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗΣ ΜΕΧΡΙ ΤΟ ΕΤΟΣ 2050	475
ΠΙΝΑΚΑΣ	32	ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΟΙΚΙΑΚΟΥ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	489
ΠΙΝΑΚΑΣ	33	ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΤΡΙΤΟΓΕΝΗ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	492
ΠΙΝΑΚΑΣ	34	ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΟ ΤΟΜΕΑ ΤΩΝ ΜΕΤΑΦΟΡΩΝ ΕΩΣ ΤΟ ΕΤΟΣ 2050	495
ΠΙΝΑΚΑΣ	35	ΕΚΤΙΜΩΜΕΝΕΣ ΕΚΠΟΜΠΕΣ CO ₂ ΑΝΑ ΚΛΑΔΟ ΜΕΤΑΦΟΡΩΝ, ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2022 (ΙΣΤΟΡΙΚΑ) – 2050	504
ΠΙΝΑΚΑΣ	36	ΔΕΙΚΤΗΣ ΕΚΠΟΜΠΩΝ ΑΝΑ ΜΟΝΑΔΑ ΚΑΤΑΝΑΛΙΣΚΟΜΕΝΗΣ ΕΝΕΡΓΕΙΑΣ (ΚΤΟΝ CO ₂ /ΚΤΟΕ)	505
ΠΙΝΑΚΑΣ	37	ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΟ ΒΙΟΜΗΧΑΝΙΚΟ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	505
ΠΙΝΑΚΑΣ	38	ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΟΝ ΑΓΡΟΤΙΚΟ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	507
ΠΙΝΑΚΑΣ	39	ΕΞΕΛΙΞΗ ΚΟΣΤΟΥΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050	509
ΠΙΝΑΚΑΣ	40	ΕΚΤΙΜΗΣΗ ΕΠΕΝΔΥΣΕΩΝ ΣΤΟΥΣ ΒΑΣΙΚΟΥΣ ΤΟΜΕΙΣ ΤΟΥ ΑΝΑΘΕΩΡΗΜΕΝΟΥ ΕΣΕΚ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2050	513
ΠΙΝΑΚΑΣ	41	ΕΠΙΣΚΟΠΗΣΗ ΔΙΑΘΕΣΙΜΩΝ ΠΟΡΩΝ ΔΗΜΟΣΙΑΣ ΧΡΗΜΑΤΟΔΟΤΗΣΗΣ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2025 -2030	533

ΣΧΗΜΑΤΑ

ΣΧΗΜΑ-ΕΣ 1 ΠΟΣΟΣΤΙΑΙΑ ΚΑΤΑΝΟΜΗ ΕΤΗΣΙΩΝ ΕΚΠΟΜΠΩΝ ΑτΘ ΓΙΑ ΤΟ ΕΤΟΣ 2022	15
ΣΧΗΜΑ-ΕΣ 2 ΚΛΙΜΑΚΩΣΗ ΚΟΣΤΟΥΣ ΤΕΧΝΟΛΟΓΙΩΝ ΕΝΕΡΓΕΙΑΚΗΣ ΜΕΤΑΒΑΣΗΣ	16
ΣΧΗΜΑ-ΕΣ 3 ΣΧΗΜΑΤΙΚΗ ΠΑΡΟΥΣΙΑΣΗ ΡΟΗΣ ΥΠΟΛΟΓΙΣΜΩΝ ΕΣΕΚ ΜΕ ΤΟ ΕΝΕΡΓΕΙΑΚΟ ΜΟΝΤΕΛΟ TIMES.....	18
ΣΧΗΜΑ-ΕΣ 4 ΣΧΗΜΑΤΙΚΗ ΠΑΡΟΥΣΙΑΣΗ ΡΟΗΣ ΥΠΟΛΟΓΙΣΜΩΝ ΠΡΟΣΔΙΟΡΙΣΜΟΥ ΜΟΝΑΔΩΝ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗΣ ΚΑΙ ΑΠΟΘΗΚΕΥΣΗΣ ΕΝΕΡΓΕΙΑΣ.....	19
ΣΧΗΜΑ-ΕΣ 5 ΕΚΠΟΜΠΕΣ ΑτΘ (ΣΥΜΠΕΡΙΛ. LULUCF) ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2022 (ΙΣΤΟΡΙΚΑ) ΕΩΣ 2050	38
ΣΧΗΜΑ-ΕΣ 6 ΠΡΩΤΟΓΕΝΗΣ ΔΙΑΘΕΣΗ ΕΝΕΡΓΕΙΑΣ ΚΑΤΑ ΤΑ ΕΤΗ 2030 ΚΑΙ 2050 (ΤΩΗ/ΕΤΟΣ)	40
ΣΧΗΜΑ-ΕΣ 7 ΕΓΚΑΤΕΣΤΗΜΕΝΗ ΙΣΧΥΣ ΜΟΝΑΔΩΝ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗΣ, ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2022 (ΙΣΤΟΡΙΚΑ) ΕΩΣ 2050	42
ΣΧΗΜΑ-ΕΣ 8 ΕΞΕΛΙΞΗ ΑΠΟΘΗΚΕΥΣΗΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ (ΙΣΧΥΣ ΚΑΙ ΧΩΡΗΤΙΚΟΤΗΤΑ ΜΟΝΑΔΩΝ) ΓΙΑ ΤΑ ΕΤΗ 2022 (ΙΣΤΟΡΙΚΑ), 2030 ΚΑΙ 2050	43
ΣΧΗΜΑ-ΕΣ 9 ΕΚΤΙΜΩΜΕΝΗ ΑΥΞΗΣΗ ΠΡΟΣΦΕΡΟΜΕΝΗΣ (ΚΑΘΑΡΗ ΠΑΡΑΓΩΓΗ ΚΑΙ ΕΙΣΑΓΩΓΕΣ) ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΟ ΕΓΧΩΡΙΟ ΗΛΕΚΤΡΙΚΟ ΣΥΣΤΗΜΑ	45
ΣΧΗΜΑ-ΕΣ 10 ΕΞΕΛΙΞΗ ΤΗΣ ΚΑΘΑΡΗΣ ΠΑΡΑΓΩΓΗΣ ΚΑΙ ΤΩΝ ΕΙΣΑΓΩΓΩΝ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050, ΩΣ ΠΟΣΟΣΤΟ ΕΠΙ ΣΥΝΟΛΟΥ	45
ΣΧΗΜΑ-ΕΣ 11 ΚΑΛΥΨΗ ΑΝΑΓΚΩΝ ΓΙΑ ΔΕΣΜΕΥΣΗ ΚΑΙ ΑΠΟΘΗΚΕΥΣΗ ΔΙΟΞΕΙΔΙΟΥ ΤΟΥ ΑΝΘΡΑΚΑ ΤΩΝ ΚΑΥΣΑΕΡΙΩΝ (CCUS), ΕΩΣ ΤΟ ΕΤΟΣ 2050	48
ΣΧΗΜΑ-ΕΣ 12 ΕΞΕΛΙΞΗ ΠΑΡΑΓΩΓΗΣ ΑΝΑΝΕΩΣΙΜΩΝ ΑΕΡΙΩΝ ΕΩΣ ΤΟ ΕΤΟΣ 2050	50
ΣΧΗΜΑ-ΕΣ 13 ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΑΝΑ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	52
ΣΧΗΜΑ-ΕΣ 14 ΕΞΕΛΙΞΗ ΣΥΝΟΛΙΚΩΝ ΠΑΡΕΜΒΑΣΕΩΝ ΑΝΑ ΠΕΡΙΟΔΟ ΣΤΟΝ ΟΙΚΙΑΚΟ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	56
ΣΧΗΜΑ-ΕΣ 15 ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΙΣ ΧΕΡΣΑΙΕΣ ΜΕΤΑΦΟΡΕΣ ΑΝΑ ΤΥΠΟ ΚΑΥΣΙΜΟΥ (ΚΤΟΕ).....	57
ΣΧΗΜΑ-ΕΣ 16 ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΙΣ ΑΕΡΟΠΟΡΙΚΕΣ ΜΕΤΑΦΟΡΕΣ ΑΝΑ ΤΥΠΟ ΚΑΥΣΙΜΟΥ (ΚΤΟΕ)	57
ΣΧΗΜΑ-ΕΣ 17 ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΗΝ ΕΓΧΩΡΙΑ ΑΚΤΟΠΛΟΪΑ ΑΝΑ ΤΥΠΟ ΚΑΥΣΙΜΟΥ (ΚΤΟΕ).....	58
ΣΧΗΜΑ-ΕΣ 18 ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΣΤΗΝ ΠΟΝΤΟΠΟΡΟ ΝΑΥΤΙΛΙΑ ΑΝΑ ΤΥΠΟ ΚΑΥΣΙΜΟΥ (ΚΤΟΕ)	58
ΣΧΗΜΑ-ΕΣ 19 ΕΚΤΙΜΩΜΕΝΗ ΕΞΕΛΙΞΗ ΜΕΣΟΥ ΚΟΣΤΟΥΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ (€/MWh)	61
ΣΧΗΜΑ 1 ΜΕΘΟΔΟΛΟΓΙΑ ΓΙΑ ΤΟ ΣΧΕΔΙΑΣΜΟ ΤΩΝ ΠΟΛΙΤΙΚΩΝ ΚΑΙ ΜΕΤΡΩΝ ΤΟΥ ΕΣΕΚ ΤΗΝ ΠΕΡΙΟΔΟ 2021-2030	76
ΣΧΗΜΑ 2 ΕΠΙΣΚΟΠΗΣΗ ΤΗΣ ΔΟΜΗΣ ΔΙΑΚΥΒΕΡΝΗΣΗΣ	79
ΣΧΗΜΑ 3 ΕΠΙΣΚΟΠΗΣΗ ΤΗΣ ΔΙΑΒΟΥΛΕΥΣΗΣ ΕΠΙ ΤΟΥ ΠΡΟΣΧΕΔΙΟΥ ΑΠΟ ΤΗ ΔΙΥΠΟΥΡΓΙΚΗ ΕΠΙΤΡΟΠΗ	81
ΣΧΗΜΑ 4 ΙΔΙΟΤΗΤΑ ΣΥΜΜΕΤΕΧΟΝΤΩΝ ΣΤΗ ΔΗΜΟΣΙΑ ΔΙΑΒΟΥΛΕΥΣΗ	82
ΣΧΗΜΑ 5 ΠΟΣΟΣΤΙΑΙΑ ΚΑΤΑΝΟΜΗ ΣΧΟΛΙΩΝ ΔΗΜΟΣΙΑΣ ΔΙΑΒΟΥΛΕΥΣΗΣ ΑΝΑ ΘΕΜΑΤΙΚΗ ΕΝΟΤΗΤΑ ΣΧΕΔΙΟΥ 83 ΣΧΗΜΑ 6 ΒΑΣΙΚΕΣ ΘΕΜΑΤΙΚΕΣ ΚΑΤΗΓΟΡΙΕΣ ΣΧΟΛΙΩΝ ΠΟΥ ΥΠΕΒΛΗΘΗΣΑΝ ΣΤΗ ΔΗΜΟΣΙΑ ΔΙΑΒΟΥΛΕΥΣΗ ΩΣ ΠΟΣΟΣΤΟ ΕΠΙ ΣΥΝΟΛΟΥ ...	83
G 7 SGREENHOUSE GAS EMISSION REDUCTION LIMIT (INCLUDING LULUCF), for ΠΕΡΙΟΔΟ 2025-2050	102
ΣΧΗΜΑ 8 ΕΚΠΟΜΠΕΣ ΚΑΙ ΑΠΟΡΡΟΦΗΣΕΙΣ (ΣΕ ΚΤCO2EQ) ΑΝΑ ΚΑΤΗΓΟΡΙΑ ΧΡΗΣΗΣ ΓΗΣ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 1990 – 2022 (ΠΗΓΗ: ΕΤΗΣΙΑ	

ΕΘΝΙΚΗ ΑΠΟΓΡΑΦΗ ΕΚΠΟΜΠΩΝ ΑΕΡΙΩΝ ΤΟΥ ΘΕΡΜΟΚΗΠΙΟΥ ΠΡΟΣ ΤΗΝ UNFCCC, 2024)	107
ΣΧΗΜΑ 9 ΕΝΕΡΓΕΙΑΚΗ ΚΑΤΑΝΑΛΩΣΗ (ΣΕ 000 ΤΙΠ) ΑΝΑ ΚΛΑΔΟ ΜΕΤΑΦΟΡΩΝ ΚΑΙ ΤΥΠΟ ΚΑΥΣΙΜΟΥ, ΓΙΑ ΤΑ ΕΤΗ 2022 (ΙΣΤΟΡΙΚΑ) ΚΑΙ ΤΟ 2030 (ΠΡΟΒΛΕΨΕΙΣ).....	117
ΣΧΗΜΑ 10 ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ (ΚΤΟΕ) ΑΝΑ ΚΛΑΔΟ ΜΕΤΑΦΟΡΩΝ, ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2022 (ΙΣΤΟΡΙΚΑ) ΕΩΣ 2050 (ΠΡΟΒΛΕΨΕΙΣ).	118
ΣΧΗΜΑ 11 ΕΞΕΛΙΞΗ ΔΕΙΚΤΗ ΕΚΠΟΜΠΩΝ CO2 ΑΝΑ ΜΟΝΑΔΑ ΚΑΤΑΝΑΛΙΣΚΟΜΕΝΗΣ ΕΝΕΡΓΕΙΑΣ (ΚΤΟΝ CO2/ΚΤΟΕ), ΜΕΣΟΣ ΟΡΟΣ ΤΟΜΕΑ ΚΑΙ ΑΝΑ ΚΛΑΔΟ ΜΕΤΑΦΟΡΩΝ.....	119
ΣΧΗΜΑ 12 ΣΥΓΚΡΙΣΗ ΕΤΗΣΙΩΝ ΣΤΟΧΩΝ ΕΣΕΚ ΚΑΙ ΠΡΑΓΜΑΤΙΚΩΝ ΤΑΞΙΝΟΜΗΣΕΩΝ Η/Ο (ΕΠΙΒΑΤΙΚΩΝ) ΓΙΑ ΤΑ ΕΤΗ 2020 ΕΩΣ 2022.	127
ΣΧΗΜΑ 13 ΕΚΤΙΜΩΜΕΝΗ ΕΞΕΛΙΞΗ ΣΤΟΛΟΥ ΒΑΡΕΩΝ ΟΧΗΜΑΤΩΝ ΩΣ ΠΟΣΟΣΤΟ (%) ΚΑΘΕ ΤΥΠΟΥ ΚΙΝΗΤΗΡΑ (ΚΑΥΣΙΜΟΥ) ΕΠΙ ΤΟΥ ΣΥΝΟΛΟΥ, ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2050.....	129
ΣΧΗΜΑ 14 ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΙ ΠΡΩΤΟΓΕΝΟΥΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	162
ΣΧΗΜΑ 15 ΕΞΕΛΙΞΗ ΕΚΠΟΜΠΩΝ ΑΕΡΙΩΝ ΤΟΥ ΘΕΡΜΟΚΗΠΙΟΥ ΑΝΑ ΤΟΜΕΑ ΣΥΝΕΙΣΦΟΡΑΣ (ΠΗΓΗ: EUROSTAT).....	442
ΣΧΗΜΑ 16 ΕΞΕΛΙΞΗ ΤΩΝ ΜΕΡΙΔΙΩΝ ΚΑΥΣΙΜΩΝ ΣΤΗΝ ΑΚΑΘΑΡΙΣΤΗ ΕΓΧΩΡΙΑ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2010-2022 (ΠΗΓΗ: EUROSTAT).....	443
ΣΧΗΜΑ 17 ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΑΝΑ ΤΟΜΕΑ ΤΕΛΙΚΗΣ ΧΡΗΣΗΣ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2010 2022 (ΠΗΓΗ: EUROSTAT)	444
ΣΧΗΜΑ 18 ΕΞΕΛΙΞΗ ΤΩΝ ΜΕΡΙΔΙΩΝ ΚΑΥΣΙΜΩΝ ΣΤΗΝ ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2010-2022 (ΠΗΓΗ: EUROSTAT)	445
ΣΧΗΜΑ 19 ΕΙΔΙΚΑ ΜΕΡΙΔΙΑ ΣΥΜΜΕΤΟΧΗΣ ΤΩΝ ΑΠΕ ΣΤΟ ΕΓΧΩΡΙΟ ΕΝΕΡΓΕΙΑΚΟ ΣΥΣΤΗΜΑ ΣΤΗ ΒΑΣΗ ΜΕΘΟΔΟΛΟΓΙΑΣ ΤΗΣ ΕΥΡΩΠΑΪΚΗΣ ΈΝΩΣΗΣ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2010-2022 (ΠΗΓΗ: EUROSTAT)	446
ΣΧΗΜΑ 20 ΑΚΑΘΑΡΙΣΤΗ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2010-2022 (ΠΗΓΗ: EUROSTAT)	447
ΣΧΗΜΑ 21 ΕΓΚΑΤΕΣΤΗΜΕΝΗ ΙΣΧΥΣ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗΣ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2010-2022 (ΠΗΓΗ: EUROSTAT)	448
ΣΧΗΜΑ 22 ΕΞΕΛΙΞΗ ΑΕΠ ΚΑΙ ΠΛΗΘΥΣΜΟΥ	451
ΣΧΗΜΑ 23 ΚΑΛΥΨΗ ΑΝΑΓΚΩΝ ΓΙΑ CCUS ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	459
ΣΧΗΜΑ 24 ΕΙΔΙΚΑ ΜΕΡΙΔΙΑ ΣΥΜΜΕΤΟΧΗΣ ΤΩΝ ΑΠΕ ΣΤΟ ΕΓΧΩΡΙΟ ΕΝΕΡΓΕΙΑΚΟ ΣΥΣΤΗΜΑ ΣΤΗ ΒΑΣΗ ΜΕΘΟΔΟΛΟΓΙΑΣ ΤΗΣ ΕΥΡΩΠΑΪΚΗΣ ΈΝΩΣΗΣ.....	461
ΣΧΗΜΑ 25 ΜΕΡΙΔΙΟ ΣΥΜΜΕΤΟΧΗΣ ΑΠΕ ΑΝΑ ΤΟΜΕΑ ΤΑ ΕΤΗ 2030 ΚΑΙ 2050	462
ΣΧΗΜΑ 26 ΕΞΕΛΙΞΗ ΔΙΕΙΣΔΥΣΗΣ ΑΠΕ ΣΤΗΝ ΑΚΑΘΑΡΙΣΤΗ ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050	463
ΣΧΗΜΑ 27 ΕΞΕΛΙΞΗ ΔΙΕΙΣΔΥΣΗΣ ΑΠΕ ΣΤΗΝ ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΓΙΑ ΘΕΡΜΑΝΣΗ ΚΑΙ ΨΥΞΗ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	464
ΣΧΗΜΑ 28 ΕΞΕΛΙΞΗ ΔΙΕΙΣΔΥΣΗΣ ΑΠΕ ΣΤΗΝ ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΓΙΑ ΚΤΗΡΙΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	465
ΣΧΗΜΑ 29 ΕΞΕΛΙΞΗ ΔΙΕΙΣΔΥΣΗΣ ΑΠΕ ΣΤΗΝ ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΓΙΑ ΒΙΟΜΗΧΑΝΙΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	466
ΣΧΗΜΑ 30 ΕΞΕΛΙΞΗ ΔΙΕΙΣΔΥΣΗΣ ΑΠΕ ΣΤΗΝ ΤΕΛΙΚΗ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΓΙΑ ΜΕΤΑΦΟΡΕΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	466
ΣΧΗΜΑ 31 ΕΞΕΛΙΞΗ ΠΡΩΤΟΓΕΝΟΥΣ ΚΑΙ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	467
ΣΧΗΜΑ 32 ΕΞΕΛΙΞΗ ΤΩΝ ΜΕΡΙΔΙΩΝ ΚΑΥΣΙΜΩΝ ΣΤΗΝ ΑΚΑΘΑΡΙΣΤΗ ΕΓΧΩΡΙΑ ΚΑΤΑΝΑΛΩΣΗ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050 (ΣΕ ΚΤΟΕ, ΚΑΙ ΩΣ ΠΟΣΟΣΤΟ)	469

ΣΧΗΜΑ 33	ΕΞΕΛΙΞΗ ΤΩΝ ΜΕΡΙΔΙΩΝ ΚΑΥΣΙΜΩΝ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050	470
ΣΧΗΜΑ 34	ΕΞΕΛΙΞΗ ΤΩΝ ΜΕΡΙΔΙΩΝ ΚΑΥΣΙΜΩΝ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ, ΜΕ ΘΕΡΜΟΤΗΤΑ ΠΕΡΙΒΑΛΛΟΝΤΟΣ, ΤΑ ΕΤΗ 2030 ΚΑΙ 2050.....	472
ΣΧΗΜΑ 35	ΕΞΕΛΙΞΗ ΕΝΕΡΓΕΙΑΚΗΣ ΕΞΑΡΤΗΣΗΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050	473
ΣΧΗΜΑ 36	ΕΞΕΛΙΞΗ ΚΑΤΑΝΑΛΩΣΗΣ ΣΥΝΘΕΤΙΚΩΝ ΚΑΥΣΙΜΩΝ ΚΑΙ ΠΟΣΟΣΤΟ ΕΙΣΑΓΩΓΩΝ ΑΥΤΩΝ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	474
ΣΧΗΜΑ 37	ΕΞΕΛΙΞΗ ΠΑΡΑΓΩΓΗΣ ΑΝΑΝΕΩΣΙΜΩΝ ΑΕΡΙΩΝ ΕΩΣ ΤΟ ΕΤΟΣ 2050	475
ΣΧΗΜΑ 38	ΕΞΕΛΙΞΗ ΤΗΣ ΕΓΚΑΤΕΣΤΗΜΕΝΗΣ ΙΣΧΥΟΣ ΤΩΝ ΜΟΝΑΔΩΝ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050	479
ΣΧΗΜΑ 39	ΕΞΕΛΙΞΗ ΤΗΣ ΕΓΚΑΤΕΣΤΗΜΕΝΗΣ ΙΣΧΥΟΣ ΑΠΕ ΓΙΑ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗ ΕΩΣ ΤΟ ΕΤΟΣ 2050	480
ΣΧΗΜΑ 40	ΕΞΕΛΙΞΗ ΤΗΣ ΚΑΘΑΡΗΣ ΠΑΡΑΓΩΓΗΣ ΚΑΙ ΤΩΝ ΕΙΣΑΓΩΓΩΝ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050, (ΣΕΤΩΗ ΚΑΙ ΩΣ ΠΟΣΟΣΤΟ).....	482
ΣΧΗΜΑ 41	ΕΞΕΛΙΞΗ ΤΗΣ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗΣ ΑΠΟ ΑΠΕ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	483
ΣΧΗΜΑ 42	ΜΕΡΙΔΙΟ ΗΛΕΚΤΡΟΠΑΡΑΓΩΓΗΣ ΑΠΟ ΑΙΟΛΙΚΟΥΣ ΚΑΙ ΦΩΤΟΒΟΛΤΑΪΚΟΥΣ ΣΤΑΘΜΟΥΣ ΣΤΟ ΣΥΝΟΛΟ ΤΗΣ ΔΙΑΘΕΣΗΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	484
ΣΧΗΜΑ 43	ΕΞΕΛΙΞΗ ΤΗΣ ΙΣΧΥΟΣ ΜΟΝΑΔΩΝ ΑΠΟΘΗΚΕΥΣΗΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	485
ΣΧΗΜΑ 44	ΕΞΕΛΙΞΗ ΤΗΣ ΧΩΡΗΤΙΚΟΤΗΤΑΣ ΜΟΝΑΔΩΝ ΑΠΟΘΗΚΕΥΣΗΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050	486
ΣΧΗΜΑ 45	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΑΝΑ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	487
ΣΧΗΜΑ 46	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΑΝΑ ΤΟΜΕΑ ΣΕ ΠΟΣΟΣΤΙΑΙΑ ΒΑΣΗ ΤΑ ΕΤΗ 2030 ΚΑΙ 2050.....	488
ΣΧΗΜΑ 47	ΕΞΕΛΙΞΗ ΣΥΝΟΛΙΚΩΝ ΠΑΡΕΜΒΑΣΕΩΝ ΑΝΑ ΠΕΡΙΟΔΟ ΣΤΟΝ ΟΙΚΙΑΚΟ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	490
ΣΧΗΜΑ 48	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΟΝ ΟΙΚΙΑΚΟ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	491
ΣΧΗΜΑ 49	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΟΝ ΤΡΙΤΟΓΕΝΗ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	494
ΣΧΗΜΑ 50	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΟΝ ΤΟΜΕΑ ΤΩΝ ΜΕΤΑΦΟΡΩΝ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	496
ΣΧΗΜΑ 51	ΕΚΤΙΜΩΜΕΝΗ ΕΞΕΛΙΞΗ ΣΤΟΛΟΥ ΕΛΑΦΡΩΝ ΟΧΗΜΑΤΩΝ (ΕΠΙΒΑΤΙΚΩΝ ΚΑΙ ΕΛΑΦΡΩΝ ΦΟΡΤΗΓΩΝ) ΑΝΑ ΤΥΠΟ ΚΑΥΣΙΜΟΥ, ΓΙΑ ΤΗ ΧΡΟΝΙΚΗ ΠΕΡΙΟΔΟ 2025-2050.....	498
ΣΧΗΜΑ 52	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΑ ΕΠΙΒΑΤΙΚΑ ΚΑΙ ΕΛΑΦΡΙΑ ΟΧΗΜΑΤΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	499
ΣΧΗΜΑ 53	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΑ ΒΑΡΕΑ ΟΧΗΜΑΤΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	500
ΣΧΗΜΑ 54	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΑ ΛΕΩΦΟΡΕΙΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	501
ΣΧΗΜΑ 55	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΑ ΤΡΕΝΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	502
ΣΧΗΜΑ 56	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΗΝ ΕΓΧΩΡΙΑ ΝΑΥΣΙΠΛΟΪΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	503
ΣΧΗΜΑ 57	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΙΣ ΑΕΡΟΜΕΤΑΦΟΡΕΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050	503
ΣΧΗΜΑ 58	ΕΚΤΙΜΩΜΕΝΕΣ ΕΚΠΟΜΠΕΣ ΑΝΑ ΚΛΑΔΟ ΜΕΤΑΦΟΡΩΝ, ΑΝΑ 5-ΕΤΙΑ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2050.....	504
ΣΧΗΜΑ 59	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΟΝ ΤΟΜΕΑ ΤΗΣ ΒΙΟΜΗΧΑΝΙΑΣ ΕΩΣ ΤΟ ΕΤΟΣ 2050.....	506
ΣΧΗΜΑ 60	ΕΞΕΛΙΞΗ ΤΕΛΙΚΗΣ ΚΑΤΑΝΑΛΩΣΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΟΝ ΑΓΡΟΤΙΚΟ ΤΟΜΕΑ ΕΩΣ ΤΟ ΕΤΟΣ 2050	508
ΣΧΗΜΑ 61	ΚΑΤΑΝΟΜΗ ΕΚΤΙΜΩΜΕΝΩΝ ΕΠΕΝΔΥΣΕΩΝ ΣΤΟΥΣ ΒΑΣΙΚΟΥΣ ΤΟΜΕΙΣ ΤΟΥ ΑΝΑΘΕΩΡΗΜΕΝΟΥ ΕΣΕΚ, ΓΙΑ ΤΗ ΧΡΟΝΙΚΗ ΠΕΡΙΟΔΟ 2025-2030	515
ΣΧΗΜΑ 62	ΚΑΤΑΝΟΜΗ ΕΚΤΙΜΩΜΕΝΩΝ ΕΠΕΝΔΥΣΕΩΝ ΣΤΟΥΣ ΒΑΣΙΚΟΥΣ ΤΟΜΕΙΣ ΤΟΥ ΑΝΑΘΕΩΡΗΜΕΝΟΥ ΕΣΕΚ, ΓΙΑ ΤΗ ΧΡΟΝΙΚΗ ΠΕΡΙΟΔΟ 2031-2050	516
ΣΧΗΜΑ 63	ΕΚΤΙΜΩΜΕΝΗ ΜΕΣΗ ΕΤΗΣΙΑ ΣΥΝΕΙΣΦΟΡΑ ΣΤΗΝ ΑΚΑΘΑΡΙΣΤΗ ΠΡΟΣΤΙΘΕΜΕΝΗ ΑΞΙΑ (ΑΠΑ) ΓΙΑ ΤΗ ΧΡΟΝΙΚΗ ΠΕΡΙΟΔΟ 2025-2050	522
ΣΧΗΜΑ 64	ΕΚΤΙΜΩΜΕΝΗ ΜΕΣΗ ΕΤΗΣΙΑ ΣΥΝΕΙΣΦΟΡΑ ΣΤΗΝ ΑΠΑΣΧΟΛΗΣΗ ΓΙΑ ΤΗ ΧΡΟΝΙΚΗ ΠΕΡΙΟΔΟ 2025-2050	523

ΕΙΚΟΝΕΣ

ΕΙΚΟΝΑ 1 ΤΟ ΕΛΛΗΝΙΚΟ ΣΥΣΤΗΜΑ ΜΕΤΑΦΟΡΑΣ ΦΥΣΙΚΟΥ ΑΕΡΙΟΥ	148
ΕΙΚΟΝΑ 2 ΘΕΩΡΗΤΙΚΟ ΔΥΝΑΜΙΚΟ ΒΙΟΜΑΖΑΣ ΚΑΙ ΕΝΕΡΓΕΙΑΚΟ ΠΕΡΙΕΧΟΜΕΝΟ ΒΙΟΜΕΘΑΝΙΟΥ ΑΝΑ ΠΡΩΤΗ ΥΛΗ ΣΤΗΝ ΕΛΛΑΔΑ	153
ΕΙΚΟΝΑ 3 ΠΡΟΓΡΑΜΜΑΤΙΣΜΕΝΑ ΔΙΚΤΥΑ ΜΕΤΑΦΟΡΑΣ ΥΔΡΟΓΟΝΟΥ ΣΤΗΝ ΕΛΛΑΔΑ ΚΑΙ ΤΗΝ ΕΥΡΩΠΗ	156
ΕΙΚΟΝΑ 4 ΕΠΙΠΕΔΟ ΚΑΙ ΔΕΙΚΤΕΣ ΔΙΑΣΥΝΔΕΣΙΜΟΤΗΤΑΣ ΕΛΛΗΝΙΚΟΥ ΗΛΕΚΤΡΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ (ΠΗΓΗ: ΔΙΑΧΕΙΡΙΣΤΗΣ ΤΟΥ ΕΛΛΗΝΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ ΜΕΤΑΦΟΡΑΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ (ΕΣΜΗΕ))	174
ΕΙΚΟΝΑ 5 ΧΑΡΤΗΣ ΤΩΝ ΔΙΑΣΥΝΔΕΣΕΩΝ ΤΟΥ ΕΛΛΗΝΙΚΟΥ ΗΛΕΚΤΡΙΚΟΥ ΣΥΣΤΗΜΑΤΟΣ	175
ΕΙΚΟΝΑ 6 ΕΞΕΛΙΞΕΙΣ ΣΤΟΝ ΤΟΜΕΑ ΤΗΣ ΑΓΟΡΑΣ ΚΑΤΑ ΤΗΝ ΠΕΡΙΟΔΟ 2019-2023	188
ΕΙΚΟΝΑ 7 ΕΞΕΛΙΞΗ ΣΤΙΣ ΚΑΘΑΡΕΣ ΕΙΣΑΓΩΓΕΣ (ΘΕΤΙΚΕΣ ΤΙΜΕΣ) ΚΑΙ ΕΞΑΓΩΓΕΣ (ΑΡΝΗΤΙΚΕΣ ΤΙΜΕΣ) ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΣΤΟ ΣΥΣΤΗΜΑ.	190
ΕΙΚΟΝΑ 8 ΠΟΛΙΤΙΚΕΣ ΠΡΟΤΕΡΑΙΟΤΗΤΕΣ ΜΕΤΡΩΝ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗ ΜΕΙΩΣΗ ΤΩΝ ΕΚΠΟΜΠΩΝ ΑΕΡΙΩΝ ΤΟΥ ΘΕΡΜΟΚΗΠΙΟΥ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2030	213
ΕΙΚΟΝΑ 9 ΠΡΟΤΕΡΑΙΟΤΗΤΕΣ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗΝ ΠΡΩΘΩΣΗ ΤΩΝ ΑΠΕ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2030	282
ΕΙΚΟΝΑ 10 ΠΡΟΤΕΡΑΙΟΤΗΤΕΣ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗ ΒΕΛΤΙΩΣΗ ΤΗΣ ΕΝΕΡΓΕΙΑΚΗΣ ΑΠΟΔΟΣΗΣ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2030	329
ΕΙΚΟΝΑ 11 ΠΡΟΤΕΡΑΙΟΤΗΤΕΣ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗΝ ΑΣΦΑΛΕΙΑ ΕΦΟΔΙΑΣΜΟΥ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2030.....	365
ΕΙΚΟΝΑ 12 ΟΙΚΟΠΕΔΑ ΕΡΕΥΝΩΝ ΓΙΑ ΥΔΡΟΓΟΝΑΝΘΡΑΚΕΣ	367
ΕΙΚΟΝΑ 13 ΔΙΑΣΥΝΔΕΣΗ ΕΛΛΑΔΑΣ - ΑΛΒΑΝΙΑΣ	370
ΕΙΚΟΝΑ 14 ΔΙΑΣΥΝΔΕΣΗ ΕΛΛΑΔΑΣ - ΚΥΠΡΟΥ - ΙΣΡΑΗΛ	371
ΕΙΚΟΝΑ 15 ΔΕΥΤΕΡΗ ΔΙΑΣΥΝΔΕΣΗ ΕΛΛΑΔΑΣ - ΤΟΥΡΚΙΑΣ	372
ΕΙΚΟΝΑ 16 ΔΙΑΣΥΝΔΕΣΗ ΕΛΛΑΔΑΣ - ΑΙΓΥΠΤΟΥ	374
ΕΙΚΟΝΑ 17 ΔΙΑΣΥΝΔΕΣΗ ΕΛΛΑΔΑΣ - ΓΕΡΜΑΝΙΑΣ (GREEN AEGEAN INTERCONNECTOR).....	375
ΕΙΚΟΝΑ 18 ΠΡΟΤΕΡΑΙΟΤΗΤΕΣ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗΝ ΑΓΟΡΑ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2030.....	388
ΕΙΚΟΝΑ 19 ΠΟΛΙΤΙΚΕΣ ΠΡΟΤΕΡΑΙΟΤΗΤΕΣ ΜΕΤΡΩΝ ΠΟΛΙΤΙΚΗΣ ΓΙΑ ΤΗΝ ΠΡΩΘΩΣΗ ΤΗΣ ΈΡΕΥΝΑΣ, ΚΑΙΝΟΤΟΜΙΑΣ ΚΑΙ ΑΝΤΑΓΩΝΙΣΤΙΚΟΤΗΤΑΣ ΤΗΝ ΠΕΡΙΟΔΟ 2025-2030.....	425

EXECUTIVE SUMMARY

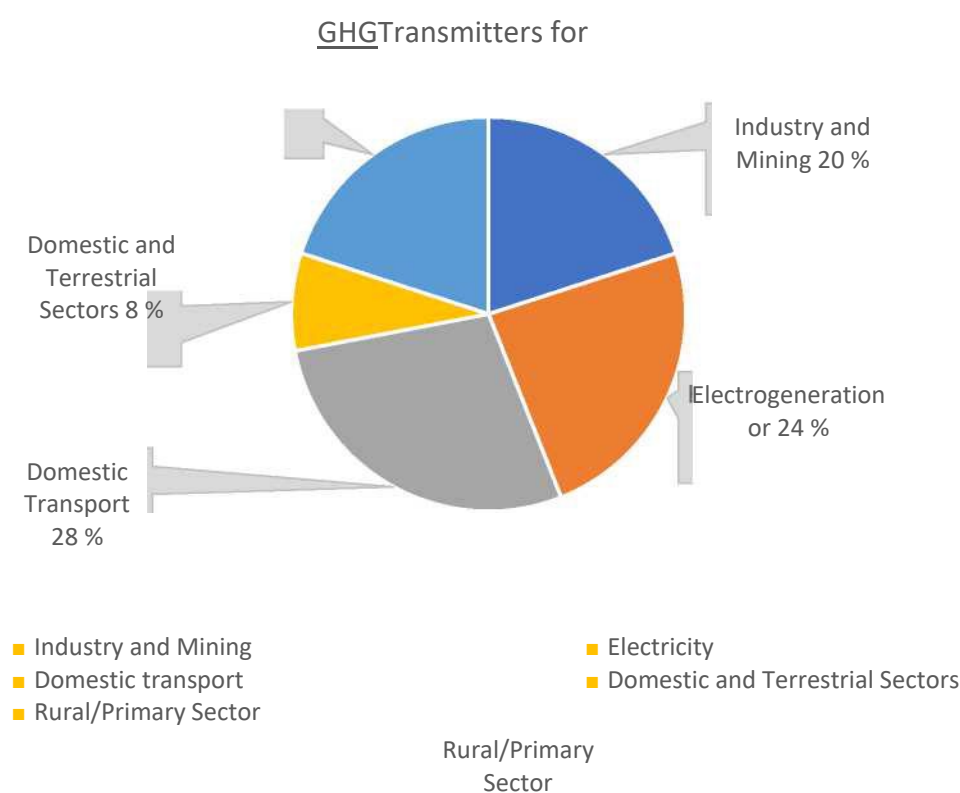
I. Introductory observations

Tackling climate change through a strategy that will lead to a 55 % reduction in greenhouse gas (GHG) emissions by 2030 compared to 1990, and ultimately to net zero emissions by 2050, has been identified as a key priority by the European Union (EU). This EU option is dictated by the existential risk to humanity of climate change. The EU's climate change target, as the Nationally Determined Contribution (NDC) of Member States (MS) under the Paris Agreement recognises the need for immediate action against climate change and sets out what this action should achieve collectively for the EU.

What is shaped by each National Energy and Climate Plan (NECP), as described in Regulation (EU) 2018/1999 on the governance of the Energy Union and Climate Action, is how each MS will contribute to achieving this common European climate target, while contributing to the achievement of the EU's individual targets for renewable energy, energy efficiency, energy

security, completion of the common energy market and enhancing innovation and competitiveness. In this context, each Member State draws up its own NECP, given that the conditions are not the same in all Member States, both in terms of size and sector distribution of energy consumption and the existing poles of energycover, as well as in terms of the exploitation potential of Renewable Energy Sources (RES) and geographical or climatic specificities (islands, prevailing temperatures, etc.). The main focus is therefore on reducing GHG emissions in each of the Member States' NECPs, thus contributing to the synthesis and crystallisation of the image of the common European energy and climate strategy for the decades to come. Bearing in mind that this picture is not (and cannot be) static, Regulation (EU) 2018/1999 provides for a procedure for the re-submission of the NECPs by the Member States every ten years (Article 3 (1)) and for updating the latest NECP submitted (Article 14 (1)) and for a continuous reporting and monitoring mechanism. This version constitutes an update, in accordance with Article 14 (1) of Regulation (EU) 2018/1999, of the latest consolidated NECP of the Hellenic Republic notified to the EU, which has been ratified by Decision No 4/23.12.2019 of the Government Council of Codified Policy (Government Gazette, Series II, No 4893).

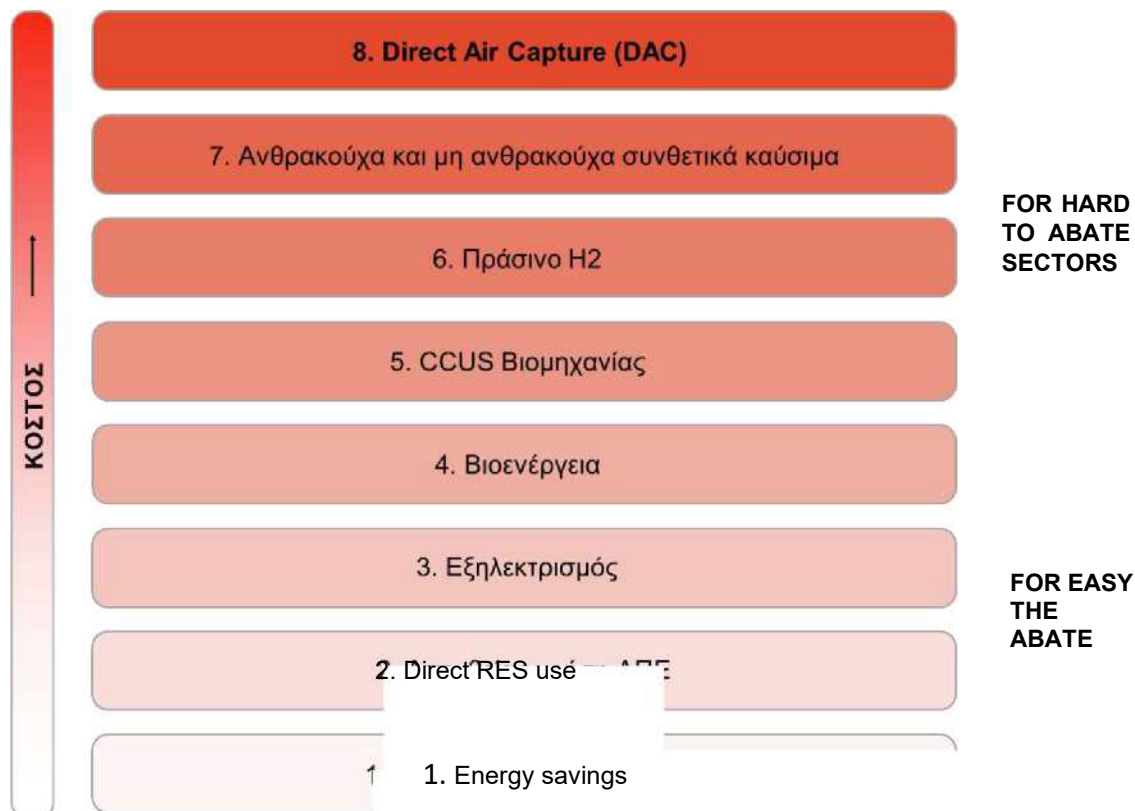
In Greece, GHG emissions in 2022 amounted to 76.9 Mt (taking into account also carbon emissions and removals in the land use, land use change and forestry (LULUCF) sector, which in 2022 amounted to 5.5 Mt). Emissions in 2022 were 26.2 % lower than in 1990. Emissions for 2022 were, in summary, accounted for 20 % by industry and mining, 24 % by electricity generation, 28 % by domestic transport, 8 % by the residential and tertiary sectors and 20 % by the agricultural/primary sector, waste management and non-CO2 GHG emissions (most of which come from the latter sectors).



Graph – HS 1 Quantitative breakdown of annual GHG emissions for the year 2022.

II. Methodological approach

This NECP is in principle Greece’s strategic plan to achieve its GHG emission reduction targets. It has been based both on current data and on plausible projections for the evolution of the maturity and cost of green earth artefacts andhas been developed with the basic principle of *minimising the cost of the energy transition for the intended result*. This principle is reflected in the prioritisation of interventions according to the figure below so that, where equivalent narcoticsexist, the most mature and cheapest interventions are prioritised in order toachieve the objectives.



Schoke-EE 2 Cost cost of energy transition technologies.

1. Through investments (cost-effective), energy management, behavioural measures.
2. E.g. solar thermal for water heating.
3. All sectors except shipping and medium-/long-haul aviation and certain industrial processes.
4. The restriction of raw materials creates competition and the need to prioritise uses.
5. For industries without alternative solution. The use of the captured CO₂ industry for the production of carbon synthetic fuels shall be allowed at least until the year 2040.
6. For industry (steel, ammonia, refineries) and hard to Abate sectors. Possibly also for a segment of aviation and heavy road transport (technology in progress).
7. For medium-/long-haul shipping and aviation.
8. The most accurate solution. Captured CO₂ shall be stored or used for the production of carbon synthetic fuels.

For the preparation of the NECP, account has also been taken of:

- **Macroeconomic forecasts and price developments of international energy products as well as GHG emission allowances, as projected by the Commission.** According to these, wholesale gas prices will be relatively stable at the level of EUR 38/MWh by 2050, but CO₂ emission allowance prices will be at a level of EUR 80/tonne until 2030 and then drastically increase to EUR 290/tonne by 2040 and EUR 490/tonne by 2050, while from 2027 the other sectors (wholesale, transport, etc.) will be integrated into the

pollutant market system, initially with transitional (reduced) prices and from 2031 in full. The escalation of emission allowance prices is seen as a forceful way to incentivise the energy transition and to finance the measures to achieve it.

- **Realistically illustrating the potential of RES in line with the existing leus potential** (biomethane, hydroelectric, pumped storage, offshore wind).
- **Ongoing decarbonisation projects for certain industrial sectors, from which they have been included in Community programmes for co-financing- (refineries, cement industries).**
- **Adopting as sustainable solutions as possible in the long term.** This requires a strategic design leading to the ultimate removal of fossil fuel dependency, as solutions such as the preservation of fossil fuels by capturing and storing exhaust carbon dioxide (CCS) or the capture and discouraging of carbon dioxide from the air (DAC) are not viable in perpetuity due to finite storage capacities. Thus, carbon capture and discouraging is primarily favoured (and without prejudice to the following point) as a transitional solution for sectors that have no other realistic alternative (such as cement and refineries up to the stage of development of alternative products). At the same time, in order to achieve the net zero target in the shortest period of time (only 26 years) and until 2050, the use of Air Carbon Capture (DAC) is also being saved after 2045. This is because the available technologies are not sufficiently mature within this timeframe to fully eliminate the use of fossil fuels (especially in transport). This option is combined with a reasonable expectation of de-escalation of DAC costs until then.
- **The need to maintain a high level of energy security and supply adequacy.** The complexity of the energy transition and the replacement of fossil fuels with renewable fuels must go hand in hand with – at the same time – maintaining and increasing uninterrupted access to energy

resources. This need imposes some transitional options that, depending on the progress in achieving individual decarbonisation targets, will be continuously revived for the period covered by the NECP.

The NECP was prepared using the International Energy Agency (IEA) model for simulating energy systems TIMES and a model for simulating the operation of the electrical system of the National Technical University of Technology (NPM).

In schematic form, the analysis made is shown in the figures below.

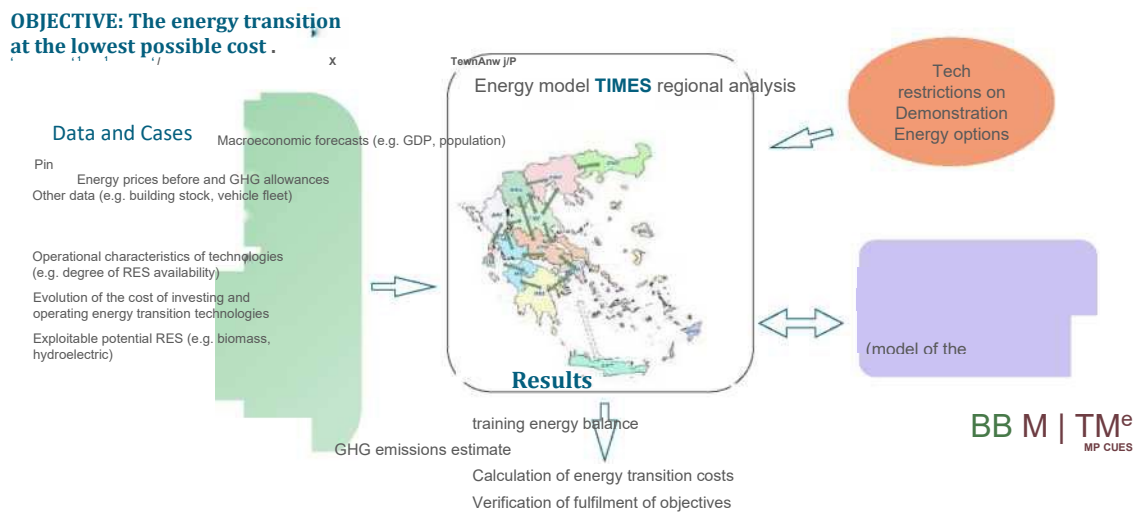


Figure – HS 3 schematic presentation of the NECP calculations with the TIMES energy model.

ΥΠΟΣΥΣΤΗΜΑ ΠΡΟΣΔΙΟΡΙΣΜΟΥ ΜΟΝΑΔΩΝ ΠΑΡΑΓΩΓΗΣ ΗΛΕΚΤΡΙΚΗΣ ΕΝΕΡΓΕΙΑΣ

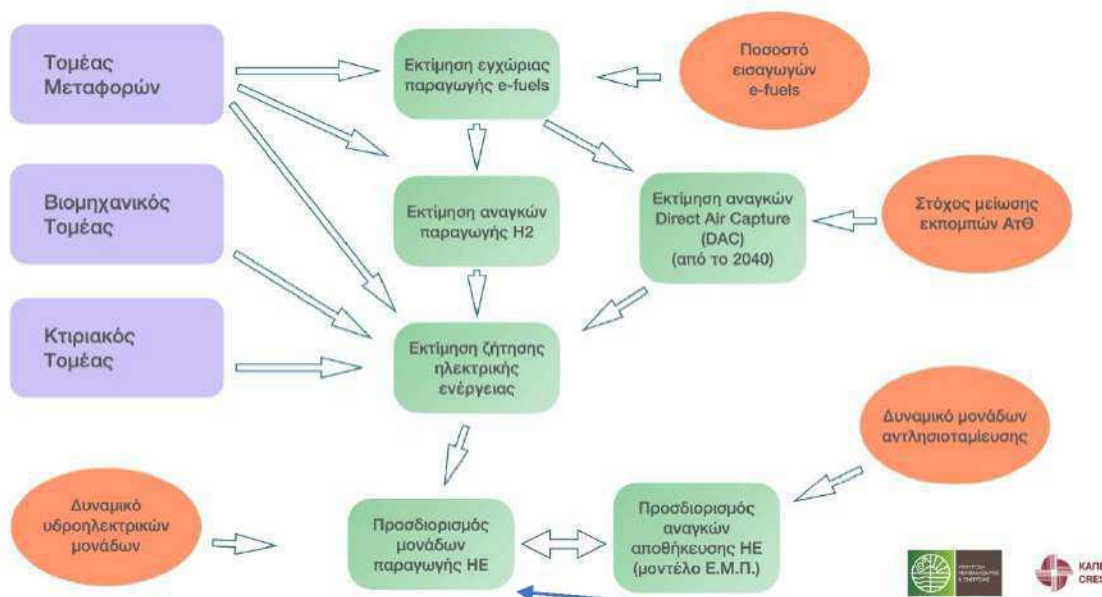


Figure – HS 4 Figure presentation of a flow of calculations for the identification of electricity generators and energy storage units.

III. Technologies for transition to climate neutrality (net zero) by sector

The pathway towards net zero per energy consumption sector involves a number of artefacts, methods and approaches ('transition technologies'), each of which currently has varying degrees of technological maturity and cost, per unit of GHG emitted avoided. In drawing up the strategy towards net zero, all known and technically sufficient alternatives have been identified and taken into account, from the most mature to some which have not yet become commercially applicable and expansionary, but may evolve rapidly internationally in the coming period, mainly through policy measures, both positive (incentives and subsidies) and negative (increase in emission allowance prices and inclusion of new sectors in the Roma tradingsystem).

The tables below summarise the mix and evolution of technologies, methods and approaches that are projected to lead to climate neutrality by consumption sector, starting with their current situation (year 2022).

Table – HS 1 Mixture and evolution of technologies, methods and approaches for the period up to 2050, starting with the current situation.

MEMO	
— @@	maintenance/existence
I.V.	increase
ITINE RANT	rapid growth
I.V.	reduction
ITINE RANT	rapid reduction
ITINE RANT	Increase shortterm and decrease
(?)	Uncertainty

ELECTRO-PRODUCTION

	Year 2022	Transitional		Net Zero (year 2050)
Lignite coal	—@@	—@@	ITINERANT	—
Oil	—@@	—@@	ITINERANT	SB (islands)
Natural gas	—@@	—@@	I.V.	(?)/SB
NATURAL GAS HECHP	—@@	—@@	ITINERANT	*
Biogas	—@@	—@@	I.V.	—@@

Hydroelectric	—@@	—@@	I.V.	—@@
Wind onshore	—@@	—@@	ITINERANT	—@@
Offshore wind		—@@	ITINERANT	—@@
Photovoltaic	—@@	—@@	ITINERANT	—@@
Pumped storage hydroelectric	—@@	—@@	ITINERANT	—@@
Batteries	—@@	—@@	ITINERANT	—@@
Electrical interconnections of-islands * *	—@@	—@@	ITINERANT	—@@
UN Imports/Exports	—@@	—@@	ITINERANT	—@@

SB: Step By (emergency reserve)

** Agricultural (capture and use of CO2 in agricultural production).*

***on the few remaining islands until/after 2030 non-interconnected islands are promoted, as a transitional or even permanent solution, the penetration of RES through the development of hybrid productionstations with a combination of RES and energy storage systems.*

INDUSTRY

	Year 2022	Transitional		Net Zero (year 2050)
Oil	—@@	—@@	I.V.	NZ
Natural gas	—@@	—@@	I.V.	NZ

Electrics	—@@	—@@	ITINERANT	—@@
Demand response	—@@	—@@	ITINERANT	—@@
Saving energy	—@@	—@@	ITINERANT	—@@
Biofuel	—@@	—@@	I.V.	—@@
Solar thermal/facialheat *		—@@	I.V.	—@@
CCUS		—@@	ITINERANT	—@@
Green hydrogen		—@@	ITINERANT	—@@

NZ: Early Zero

** For low temperature processes, steam support.*

BUILDINGS

	Year 2022	Transitional		Net Zero (year 2050)
Diesel	—@@	—@@	ITINERANT	—
Natural gas	—@@	—@@	ITINERANT	NZ
Bio-diesel		—@@	ITINERANT	—
Biomethane		—@@	ITINERANT	—@@
Biomass (wood) *	—@@	—@@	I.V.	—@@

Electrics	—@@	—@@	ITINERANT	—@@
Ambient heat	—@@	—@@	ITINERANT	—@@
Solar Thermal	—@@	—@@	ITINERANT	—@@
Energy savings * *	—@@	—@@	ITINERANT	—@@
Demand response		—@@	ITINERANT	—@@
Geothermal fields		—@@	I.V.	—@@
Cogenerated heat	—@@	—@@	I.V.	* * *

NZ: Early zero

** Use outside densely built urban areas.*

** * mainly from insulations, double jackets, bioclimatic buildings, high-efficiency fireplaces, media-management.*

** * * from non-fossil fuels (e.g. burning waste, biogas).*

INLAND TRANSPORT

	Year 2022	Transitional		Net Zero (year 2050)
Diesel (petrol, diesel)	—@@	—@@	I.V.	NZ
Natural gas (CNG, LNG)	—@@	—@@	COMPLETEN ESS *	NZ

Liquid biofuels (bio-diesel, bio-LNG)	—@@	—@@	I.V.	—@@
Electricity (batteries) * *	—@@	—@@	ITINERANT	—@@
Green hydrogen * * *		(?)	□ (?)	(?)
Energy savings * * * *	—@@	—@@	ITINERANT	—@@

NZ: Early Zero

** Increase in use for short/medium term heavy-duty vehicles, after reduction.*

** * for passenger cars, light commercial vehicles, trains and medium/long term for heavy-duty vehicles (technology under development)*

** * * for heavy-duty vehicles (maturing technology).*

** * * * mainly from behavioural measures (MMM, micro-mobility, shared mobility).*

SHIPPING

	Year 2022	Transitional		Net Zero (year 2050)
Diesel	—@@	—@@	I.V.	NZ
Natural gas (LNG)		—@@	I.V.	NZ
Liquid Biofuels		—@@	I.V.	—@@
Electricity (batteries) *		—@@	I.V.	—@@

Wind/solar (aided)		—@@	I.V.	—@@
Online Carbon Capture (OCC-incorporation of CO ₂ into chemical compounds)		—@@	I.V.	—@@
Green hydrogen * *		(?)	□ (?)	(?)
Carbon synthetic burnt(e-CH ₃ OH, s-LNG) * * *		—@@	I.V.	—@@
Synthetic ammonia (NH ₃) * * * *		—@@	I.V.	—@@

NZ: Early Zero

** For cold ironing and short sea shipping.*

** * for small/medium distances*

** * * with carbon from CO₂ capture and recycling*

** * * * engines using this technology are under research and development.*

AIRCRAFT

	Year 2022	Transitional		Net Zero (year 2050)
Oil (kerosene)	—@@	—@@	I.V.	NZ
Liquid Biofuels (bio-SAF)	—@@	—@@	I.V.	—@@
Electricity (batteries) *		—@@	I.V.	—@@

Green hydrogen * *		(?)	□ (?)	(?)
Synthetic kerosene (e-SAF) * * *		—@@	I.V.	—@@

NZ: Early Zero

** For short-haul flights*

** * engines using this technology are under research and development, for medium-haul flights*

** * * with carbon from CO2 capture and recycling.*

IV. Evolution of the transition towards net zero and time-period priorities

Greece's trajectory towards the objective of climate neutrality in 2050 is divided into three main periods of energy transition, each focusing on a different key aspect of the energy transition: first of all, the decarbonisation of electricity generation, then electrification of more energy end-use and the widespread decarbonisation of hard to Abate sectors through alternative fuels. Although the boundaries between these periods are not completely distinct, this gradual development results from the modelling of the energy system as the most rational and cost-effective transition solution as it makes the best use of the de-escalation (already in some but also expected in others) of the transition by technology.

Priority has also been given to the required climate change adaptation actions in line with the requirements of the United Nations Framework Convention on Climate Change (UNFCCC). Targeted climate adaptation measures have been envisaged in the updated NECP, which concern both natural and human systems, and are developed on the basis of vulnerability assessments for ecosystems, economic sectors and population groups. The aim of the planned policies and measures is to reduce climate vulnerability for each dimension of the updated NECP separately. The implementation of these policies and measures is imperative because climate change will have a significant impact on the entire energy system. By way of example, the reduced availability of water makes the operation of thermoelectric units very difficult. In addition, transmission and legal electricity networks, high-voltage plants and other energy networks and situations are vulnerable to extreme weather events, while coastal energy substructures are threatened by rising sea levels. The increase in average hot wine is expected to reduce the energy needs for heating during winter turbulence and increase the need for cooling during the summer season. Finally, climate change is expected to affect the efficiency of RES systems, creating uncertainty in achieving the targets set.

These periods are in particular as follows:

First Period (2025-2030): Rapid penetration of RES in electricity generation and construction of infrastructure for the electrification of final energy consumption.

This period is predicted to rapidly develop RES generation (mainly solar and wind power), i.e. technologies that have already matured and generate electricity at competitive costs vis-à-vis fossil fuels. Due to the targeting of RES, however, hydropower and energy storage systems (batteries, pumped storage) are also being developed and the capacity of interconnections with neighbouring countries is being expanded to ensure an excellent diversified generation mix that does not depend on disruptions (whether immediate or exceptional) to the production capacity of individual technologies. At the same time, internal electricity transmission and distribution networks are being built and strengthened with a view to speeding up the connection of new RES. The development of offshore oil as well as the development of infrastructure (ports) and supply chain are also starting, focusing on the creation and strengthening of the domestic value chain (shipyards, cables, etc.), let me see the current high cost of this technology to be offset by the creation of domestic added value. During this period, the electricity interconnections of most islands are being completed and the energy autonomy with RES of the non-interconnected small islands is being developed. The combination of RES with water desalination conjugates is also encouraged in order to solve the problem of water supply to the islands.

By the end of 2028, as expressly provided for in Article 11 of the National Law (Law 4936/2022, Government Gazette, Series I, No 105), the use of lignite for electricity generation shall cease. Particular attention shall be paid to the successor to district heating of former lignite-fired areas by implementing equivalent solutions for beneficiaries by other means:

- in a transitional phase, district heating with high-efficiency cogeneration with natural gas. At the same time, measures (and funding for related interventions) will be sought to reduce losses of district heating networks with a view to reducing them to at least half.
- In parallel, with a view to achieving a climate-neutral solution in the medium to long term — an institutional horizon will be used to promote, by means of investment cost subsidies, the display of buildings with heat pumps appropriate to the climatic conditions of the area.

During this period, smart meters are also being installed in all electricity tankers to enable demand response in line with the time fluctuation of electricity prices, effectively shifting demand to RES production hours and reducing overall costs for the system. There is also energy upgrading of buildings (insulations, energy-efficient fittings, heat pumps and self-generation RES systems). For energy costing programmes, the aim is to optimise the value for money (valorisation in climate zones C and D and in buildings with a high degree of use).

In addition, production of biomethane to replace part of the natural gas (mainly injected into the distribution networks due to the small size of aluminium plants), the production of liquid biofuels for the transport sector with a phase in the production of advanced biofuels for aviation in refineries and the installation of the first

commercial units producing green hydrogen, mainly for the production of renewable synthetic fuels in refineries (synthetic kerosene, synthetic methanol), are starting during this period.

At the same time, the increase in the rate of electrification of light road metaphors is maintained, with the extension of electric vehicle charging infrastructure, as well as the development of cold ironing infrastructure for ships at berth in ports and the electric mobility of trains. In the heavy road transport sector and ships, the penetration of LNG as a transitional fuel and of bio-LNG is sought.

In the light of the electrification of the above consumption sectors, the rapid penetration of RES in electricity generation is the spearhead in order to achieve the target of reducing GHG emissions by at least 55 % by 2030. In this context, an important component is the implementation of network development and reinforcement projects as presented in the relevant Managers' Development Programmes.

In industry, especially in sectors which do not have an alternative (cement industry, refineries), CO₂ capture and storage or use programmes, for which Community funding has also been approved, are encouraged and facilitated. The discouragement of CO₂ is planned to take place in the Prinos peat deposits under sea (there is a maturing project), while the identification and development of other appropriate geological formations in CO₂ depots or storage in other geological formations in neighbouring countries is being considered.

The role of natural gas remains important in this period. In particular, the use of natural gas in electricity generation is decreasing but natural gas continues to play a role in the stability of the electricity system. Similarly, the use of fossil fuels in the non-power sectors is decreasing, but at a comparable pace. The development of natural gas networks during this period is measured, looking at their long-term viability, mainly taking into account factors such as the next phases of the energy transition, climatic conditions/zones, etc. The development of new networks and infrastructure needs to be considered in the context of the evolution of demand both domestically and regionally, in particular taking into account – also taking into account – the speed of deployment of alternative technologies that can operate either inhibitory (e.g. heat pumps as an alternative source of heating in buildings) or supportive (e.g. de-scaling costs and higher capacity for biomethane or green hydrogen) in new investments in gas grids and substances.

In addition to the domestic market, the natural gas sector also has the possibility to develop transit in the Balkan and northerly markets (Vertical GasCSA Corridor). Greece has already invested in this perspective (Greece – Bulgaria Interconnector, New Symbiosis Station in Komotini, FSRU Alexandroupoli, under construction Interconnector Ellada – North Macedonia) and is supporting it with action (Vertical Corridor). Further investments to develop or strengthen the transmission system's after-market capacity are justified only in the light of the year – cessation of export capacity and on the basis of medium to long term coverage of fierce demand for gas, provided that demand from the market is recorded.

In full connection with the above, it is also decided during this period to develop natural gas pipelines from

domestic deposits, if it is finally confirmed that they are commercially exploitable following the investigations that have taken place or are underway. Such a possibility increases the security of gas supply for the whole of Europe throughout the period of the energy transition and contributes to revenues to the Greek State, which can be partly used to implement the energy transition, while also drastically affecting the planning and financing of investments in new gas infrastructure and networks.

Finally, the development of the exploitation of critical oaths in accordance with the stocks identified or to be found in the country is also encouraged within the period, always in accordance with the state-of-the-art methods of art and science and fully based on environmental protection.

Second Period (2030-2040): Fast electrification of final energy consumption

At the beginning of the next decade, it is estimated that significant cost reductions and improvements in the technical characteristics of electric vehicles batteries and heat pumps will have been achieved, allowing for their rapid penetration without State aid, which is expected to be fully confirmed during the next periodic review of the NECP.

As a result, together with the roll-out of vehicle charging infrastructure already achieved in the first period, in this decade we will see a dramatic increase in electrification in road transport, also taking into account the lack of new light-duty vehicles that do not achieve zero emissions in the EU since 2035.

A dramatic increase in the electrification of heating of buildings (heat pumps) is also expected, in particular taking into account:

- the ban on the sale of new oil burners from 2025, in accordance with the National Climate Law (Law 4936/2022, Government Gazette, Series I, No 105) and Directive 2024/1275/EU on the energy efficiency of buildings (Government Gazette, Series I, No), prohibiting the granting of incentives for new gas boilers after 2025.
- the obligation to blend heating oil with bio-diesel by at least 30 %, as from 2030, in accordance with the National Climate Law (Law 4936/2022, Government Gazette, Series I, No 105), as well as the inclusion of the building sector in the system of GHG emission rights, which will increase the cost of using fossil fuels.

In phase II, the electrification of the bio engine is also expected to proceed at an increased rate due to the increase in GHG emission allowance prices.

Technology development and cost reductions are expected to have been achieved also for offshore wind, in particular waterborne vessels, so that a significant increase in their abandoned power is planned in this period. A significant increase will also be observed in energy storage systems as a necessary component in an

environment of very high RES penetration.

In the above context, in order to implement electrification and absorb the additional energy produced, an important parameter remains the extension and reinforcement of electricity transmission and distribution channels, which will already have started in the first period, as mentioned above.

The use of advanced bio-fuels (such as bio-SAF and bio-diesel, whose production costs are lower than that of synthetic fuels) is foreseen in aviation and shipping due to the obligations set by EU legislation.

This will result in a steady reduction in fossil fuel consumption across all sectors of the economy.

Low electricity prices are a prerequisite for the successful nature of electrification.

Electricity prices to the final consumer will be reduced by actions:

- development of RES in a balanced way by category (photovoltaic, wind, hydropower) and on the basis of planning based on needs, with a view to minimising curtailment, while developing energy storage systems;
- demand response (shift) to the hours of oversupply of RES;
- maintaining the cost of regulated tariffs related to network development at reasonable levels, together with the gradual reduction, until definitive elimination, of regulated RES charges (ETMEAR – once contracts with high subsidies have expired) and subsidisation of consumption on the islands (SGI – once the interconnections have been implemented);
- transport of low RES costs to the final consumer by PPAS and through the application of energy offsetting from self-consumption systems. Specific actions are already planned around local government.

In phase II, RES will start to exceed 75 % as a share of electricity generation, reaching more than 99 % at the end of the period. However, natural gas plants (which will also be affected by the increased cost of GHG emission allowances) will continue to maintain a measurable share in the total mix for this decade.

In view of the above, and given that an even larger reduction in the operating hours of conventional power plants in the energy mix is estimated in the period 2030-2040, their participation in the market is to take place with even higher offers to ensure the recovery of their costs, tending to increase wholesale prices especially during peak hours. One of the measures to be considered is therefore the creation of an availability remuneration mechanism. The presence of gas-fired power plants is essential to ensure stability and security of supply to the electricity system in all cases throughout the period of energy transition up to 2050. It is

understandable that natural gas networks will remain active in supplying (inter alia) the above plants, as well as for the handling of biomethane. At the same time, oil plants in cold reserve will need to remain active also for islands in case of emergencies (e.g. due to failure of electrical interconnections).

With this market transformation, the objective is, inter alia, that lower production costs due to increased RES penetration are reflected in the final costs for consumers. Appropriate reforms are therefore needed at European level to ensure that the fixed costs of RES are transferred to the final consumer in all circumstances by redesigning the market model.

It should also be noted that the emerging expectation of a reduction in the production costs of green hydrogen (due to improvements in technology efficiency and a parallel decrease in electricity prices), in particular when compared to the increase in the prices of GHG emissions, will allow quantities of green hydrogen to be injected into the natural gas networks as of 2035, within the limits applicable to cross-border trade and the technical capacity of combustion plants.

With the above actions, the reduction of GHG emissions (compared to 1990) that can be achieved in 2040 is estimated at 80 %. This target for Greece has also been established through the National Climate Law (Law 4936/2022, Government Gazette, Series I, No 105).

Period C (2040-2050): Rapid development of production of green hydrogen and synthetic fuels.

By 2040, it is assumed that the production, and in particular the use, of hydrogen and synthetic fuels will have developed technically and economically, which will allow their penetration in hard-to-decarbonise sectors, such as heavy road transport and certain industrial sectors.

As regards hard to abate sectors, the heavy industry in Greece does not currently include steel or glass production plants and, if the situation persists in the coming years, the penetration of electricity in the industry at the same time will reduce the need for hydrogen as a fuel. By way of illustration, there is now only a need for one ammonia plant (which under the NECP assumptions will use green hydrogen from 2035). At the same time, the two existing refineries are already advancing investments that will allow the transformation of the grey hydrogen they produce, into 'blue' (i.e. by capturing and storing CO₂).

In heavy road transport, intensive applied automotive research is underway for electrification of the sector with the development of new batteries with high energy density and ultra-fast high voltage charging infrastructure, while research on hydrogen traffic (e.g. Japan) is also underway. The NECP assumes that heavy road transport is partially hydrogen-driven since 2040, with electromobility being the main reason, because hydrogen traffic, despite having technical advantages, has the problem of low overall energy efficiency and high cost of developing refuelling stations. This case would be reviewed during periodic reviews of the NECP depending on the state of the art.

However, the maritime and aviation sectors are more difficult to decarbonise. Biofuels have an upper limit determined by the availability of the raw material, while electromobility can only be used for short haul.

At present, the decarbonisation of **shipping** and **aviation** is projected to be achieved mainly through the use of renewable synthetic fuels. This will require large quantities of green hydrogen and industrial synthesis facilities, which are expected to be installed in the refineries, which already have experience in handling hydrogen and in chemical fuel processing processes. It is estimated that green hydrogen will be produced on site by RES, either installed specifically for this purpose, or through PPAS. Moreover, from 2035, RES will have a share of more than 90 % in electricity generation, so that hydrogen produced using electricity absorbed by the grids throughout Greece will be allowed to be considered as renewable.

Synthetic fuels can be separated into carbon and non-carbon fuels. The first category includes e.g. synthetic kerosene, synthetic methanol and plus positive methane/LNG. The origin of carbon can be biological or from CO₂ capture of industrial emissions or from air. In the latter case, however, the ash is launched on the basis of the current development values of the relevant technology due to the low CO₂ content of the air. In the NECP, synthetic carbon fuels are expected to be produced mainly with CO₂ captured by industry emissions, and from 2045 and by DAC.

The production of synthetic kerosene and synthetic methanol are already mature artefacts and their use, although important cost issues remain to be resolved. CO₂ emitted by carbon synthetic fuels shall be considered not to contribute to GHG emissions (carbon recycling) in accordance with Union legislation.

Ammonia has the advantage that it does not need coal to produce, nor does it produce CO₂ when burning. Synthetic ammonia can be produced using green hydrogen and atmospheric nitrogen and is already a mature technology. However, its energy use is not yet mature (engines, for which intensive research is ongoing, ammonia management protocols, etc.).

Research is also ongoing on the use of green hydrogen directly in shipping and aviation. However, both the difficulty of storing it and issues of clarity, due to the physico-chemical characteristics of hydrogen, make its final adoption uncertain. Even if the safety and security problems are overcome, the on-board storage restrictions mean that it is used only for short/medium haul.

In conclusion, renewable synthetic fuels made from green hydrogen still face significant challenges, mainly production costs and usage technology. An improvement in both areas shall be made by 2040. The NECP assumes that synthetic methanol will be used in shipping, and from 2045 there will be a significant commercial development of synthetic ammonia. For aviation it is considered an extension of synthetic kerosene. These cases will be checked during the periodic reviews of the NECP.

The development of synthetic fuels is considered in the NECP to be domestically produced for the most part,

and where necessary as a component and hydrogen the assumption is that it will also be produced within the country. This creates a commensurate increase in demand for electricity from RES and, consequently, in energy storage (batteries, pump-storage). Indigenous CO₂ will be used for carbon synthetic fuels.

In view of the above, it does not appear that there is at present a volume of imports of hydrogen per volume of hydrogen. There may be business export flows for hydrogen produced in Greece, but this remains to be clarified in the future subject to appropriate trade conditions and commitments.

The relative modelling of the possibility of hydrogen extraction, due to its uncertainty, goes beyond the current modelling and is referred to a subsequent revision, when data (technical, economic, geopolitical as well as business) will have crystallised to a greater extent. The same applies to large, mainly transit (to central Europe) projects for the transport of electricity from RES to countries in North Africa and the Middle East, which are currently in the process of exploratory feasibility studies.

V. Quantitative results of the NECP

The elements listed above are the product of extensive modelling and simulation of the operation of the energy system through the TIMES model, and also the modelling and hourly simulation of the individual electricity grid through a dedicated NPM model. To further deepen, the main results of the calculations and simulations, which can also be found in the tables included in the main text of the NECP, are set out below.

A. Objectives

Table – HS 2 Quantification of NECP targets and indicators.

	Year 2030		Year 2035	Year 2040	Year 2050	
	EU objective	NECP forecast	E- DGS forecast	NECP forecast	EU objective	E- DGS forecast
ACHIEVEMENT OF OBJECTIVES						
Reduction of GHG emissions by 1990 * (with LULUCF)	— 55, %	— 58 %	— 69 %	— 80 %	— 100 %	— 98 %
RES in gross French consumption Enr earth * *	42.5 %	43.0 %	60.6 %	77.2 %		95.8 %
RES in gross electricity consumption * * *	69.0 %	75.7 %	96.2 %	102.8 %	100.0 %	100.8 %
RES in heating and cooling * *		52.6 %	60.6 %	75.2 %		84.1 %

RES in buildings * *	49.0 %	72.2 %	86.0 %	93.3 %		95.1 %
RES in industry * *		34.0 %	43.0 %	57.3 %		65.8 %
RES in transport * *	29.0 %	13.4 %	43.2 %	69.0 %		96.1 %

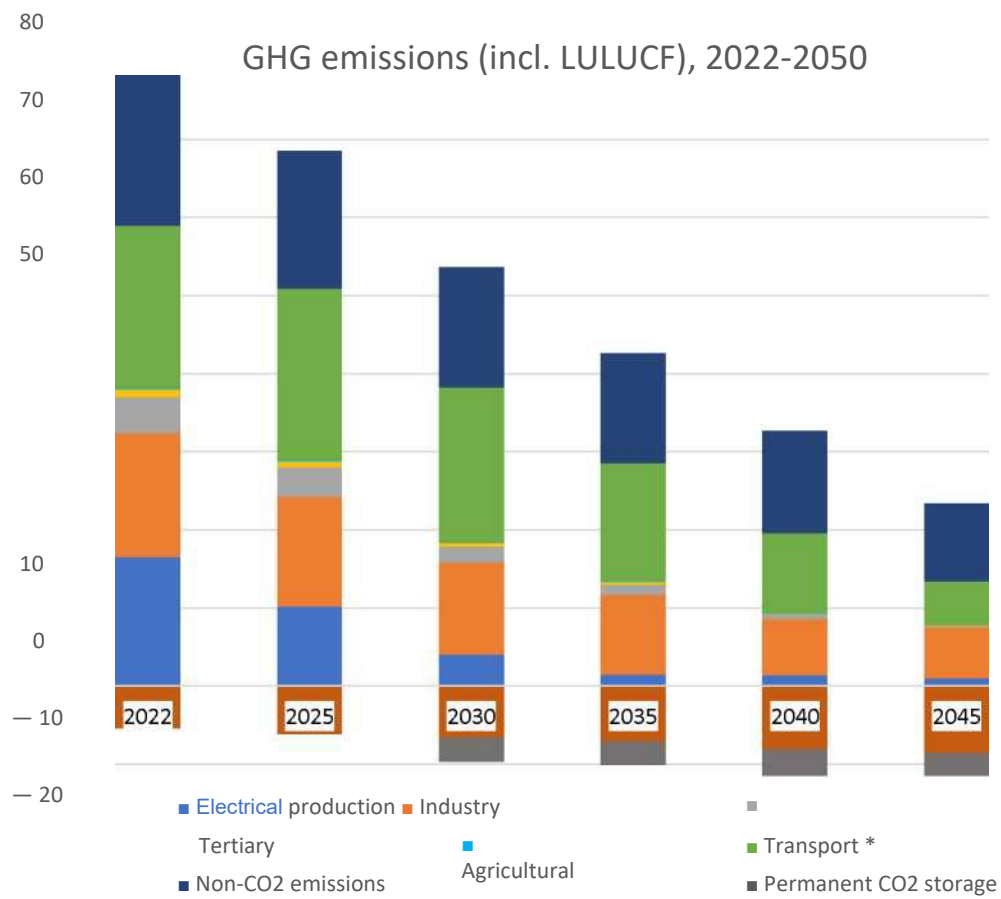
Advanced Biofuels + RFNBO (% FuelMeans) * *	5.5 %	4.6 %	11.2 %	14.2 %		13.2 %
RFNBO (% fuelmeter) * *	1.0 %	0.9 %	5.4 %	11.5 %		30.9 %
SAF (Sustainable Aviation Fuel) of biologicalorigin	6 %	5.0 %	16.2 %	25.3 %		38.0 %
SAF (Sustainable Aviation Fuel) non-biologicaldirt		1.0 %	4.1 %	8.1 %		43.9 %
Final consumption of blood (ktoe)	14,6	15,2	14,1	13,4		12,2
Primary energyconsumption (ktoe)	17,1	17,8	16,8	16,3		16,9

** Domestic energy consumption and international aviation*

** * calculation according to RED III projections, using Eurostat Sharestool Draft_version 5*

** * * (RES mill – Storage losses)/(Net production + Net Imports + Production Own Consumptions)*

B. Estimated greenhouse gas emissions (GHG)



** Domestic and International Air Transport*

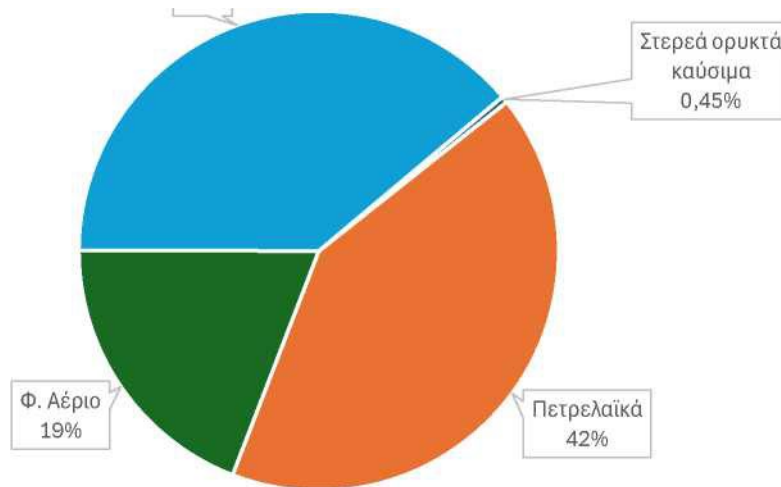
School-EE 5 GHG emissions (incl. LULUCF) for the period 2022 (historical) to 2050.

C. Estimated primary energy disposal

Primary disposal of media (TWh/year KHD)	2022	2030	2035	2040	2045	2050
Solid fossil fuels	18	1	0	0	0	0
Petroleum products	138	93	72	47	28	11
F. Gas	51	43	27	20	16	16
EOM	43	87	120	149	173	195
TOTAL	250	224	219	216	217	223

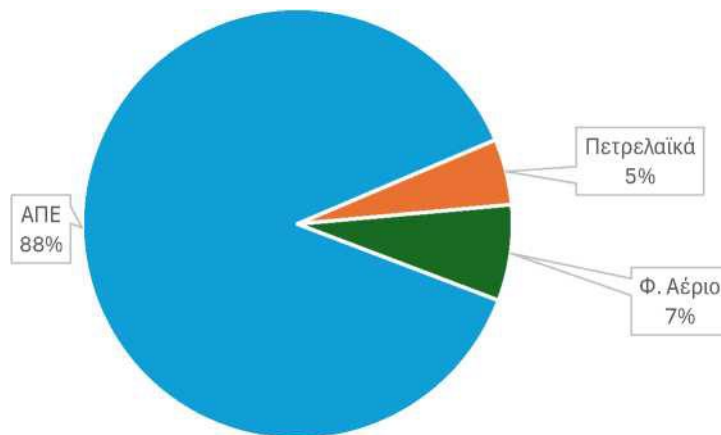
Primary energy consumption (TWh/year) 2030

RES 39 %



■ Solid fossil fuels ■ Petroleum ■ F.Gas ■ RES

Primary energy supply (TWh/year) 2050



■ Solid fossil fuels ■ Petroleum ■ F.Gas ■ RES

Figure – ES 6 Primary energy supply in 2030 and 2050 (TWh/year).

D. Estimated production and consumption of electricity

Table – EE 3 Power plants installed by technology (MW).

Electric power (MW installed)	Year 2022	Year 2025	Year 2030	Year 2035	Year 2040	Year 2045	Year 2050
Photovoltaic	5.430	8.500	13.500	18.500	26.000	30.619	35.051
Wind onshore	4.702	7.000	8.900	9.500	11.000	13.000	13.000
Offshore wind	0	0	1.900	3.900	5.787	8.230	11.805
Large Hydroelectric	3.171	3.171	3.458	3.893	4.023	4.488	4.678
Small HPP	250	302	350	391	429	461	490
Biomass Biogas	161	118	77	70	69	45	42
Lignites	1.625	1.280	—	—	—	—	—
NATURAL GAS*, †	6.296	7.045	7.885	6.300	5.900	5.900	5.900
HECHP NATURAL GAS	127	127	205	205	205	205	156
Petroleum‡	846	815	148	124	100	75	51
TOTAL	22.608	28.357	36.423	42.884	53.912	63.423	71.573

**Large natural gas units. Includes 'Aluminium' HECHP.*

† The sizes are indicative of maximum and are based on existing plants. The actual power of single natural gas needed either in hot or cold reserve after 2030 to ensure security of supply shall be determined by the security of supply studies.

they are prepared on a regular basis by the competent Operator (as well as from the operation of competition in the case of natural gas plants).

* * * the sizes are not indicative. The remaining power of the oil units on the islands in a cold reserve for reasons of security of supply shall be determined by the safety studies for donorfood.

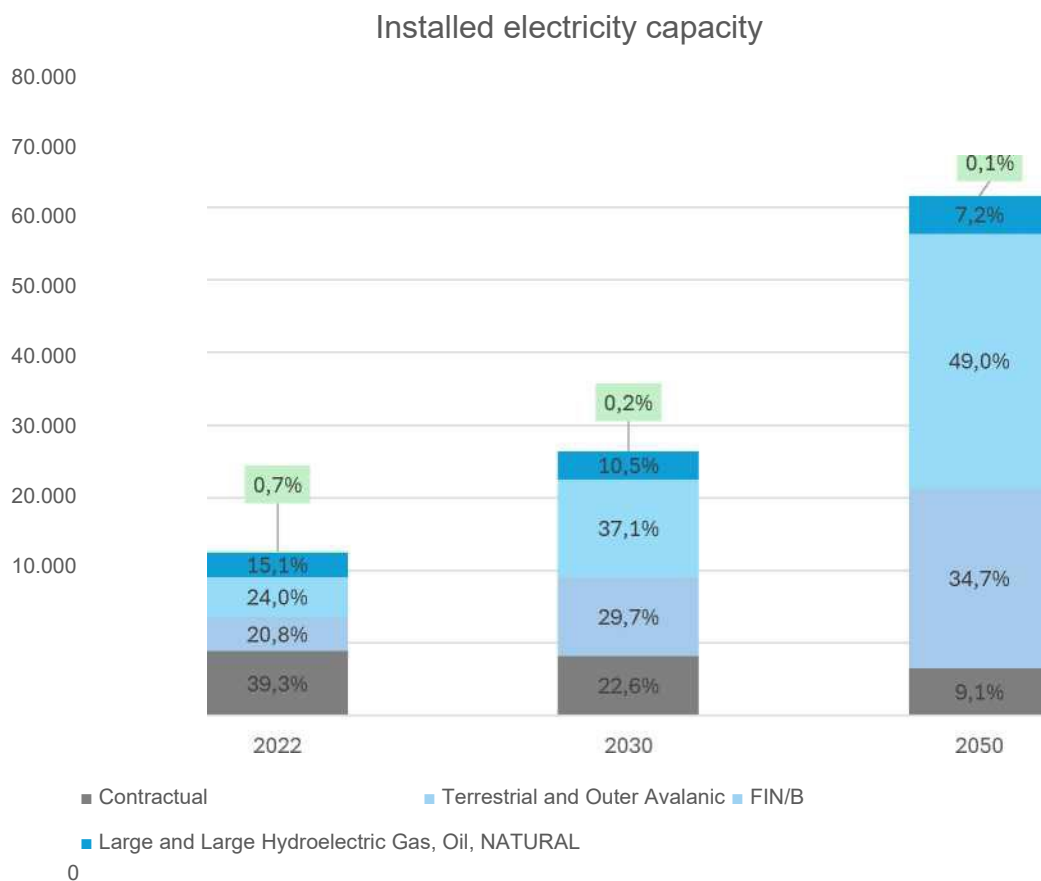


Figure – HS 7 Power plants installed, for the period 2022 (historical) to 2050.

Table – HS 4 Evolution of electrical energy storage by technology – power (MW) andspatial capacity (MWh).

UN storage (abandoned MW)	Year 2022	Year 2025	Year 2030	Year 2035	Year 2040	Year 2045	Year 2050
Pumped storage hydroelectric	699	699	1.928	2.949	4.464	5.251	5.453
Batteries	0	0	4.325	6.850	8.725	10.375	12.025
TOTAL	699	699	6.253	9.799	13.189	15.626	17.478

UN storage (installed capacity MWh)		Year 2022	Year 2025	Year 2030	Year 2035	Year 2040	Year 2045	Year 2050
Pumped storage hydroelectric		5.592	5.592	16.517	30.609	52.484	63.813	66.781
Batteries			0	10.996	17.479	22.457	26.978	31.252
TOTAL		5.592	5.592	27.513	48.088	74.941	90.791	98.032

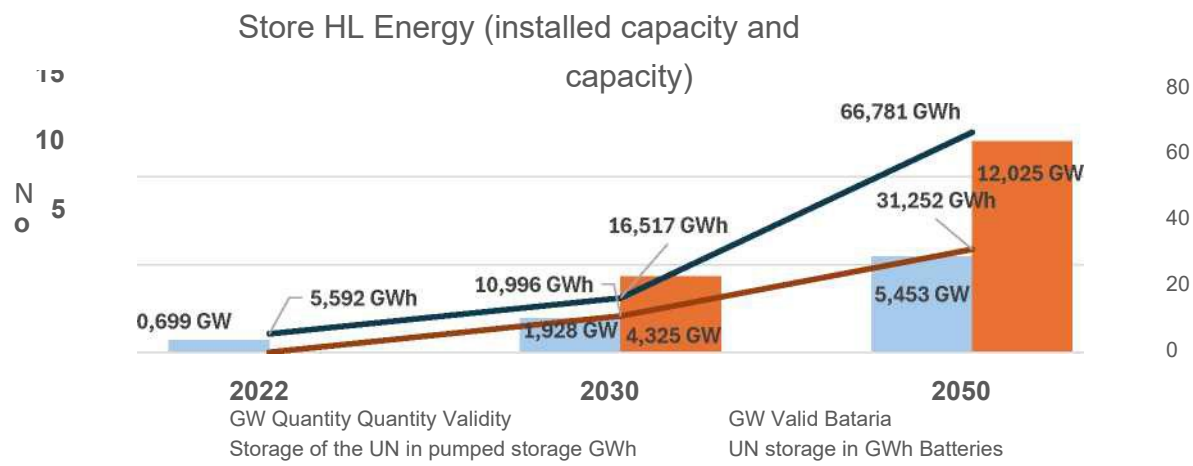


Figure – HS 8 Evolution of electricity storage (power and capacity of units) for 2022 (historical), 2030 and 2050.

Net PRODUCTION * HEADING-PRODUCTS (TWh/year)							
	2022	2025	2030	2035	2040	2045	2050
Photovoltaic	7,1	12,5	20,4	27,1	36,6	42,6	49,3
Wind onshore	10,9	15,8	20,8	21,9	25,3	29,7	30,3
Offshore wind	0,0	0,0	0,6	14,8	21,6	30,4	43,7
Large Hydroelectric	3,2	4,7	5,3	6,0	6,3	7,1	7,5
Small HPP	0,7	0,7	0,9	1,0	1,1	1,1	1,2
Biomass Biogas	0,1	0,6	0,4	0,0	0,0	0,1	0,0
Lignite	5,8	4,5					
NATURAL GAS	19,1	12,2	10,9	4,7	4,1	2,9	3,8
Petroleum	5,1	1,8	0,3	0,3	0,2	0,0	0,0
Total NetFork	52,0	52,8	59,5	75,8	95,1	104,7	135,8
Plus: NET IMPORTS/ (EXPORTS)	3,4	3,0	1,8	— 2,7	— 6,7	— 9,3	— 4,9
Total NetProduction for Net Imports	55,4	55,8	61,3	73,1	88,4	104,6	130,9

** after own consumption of production and RES cuts*

Table – HS 5 Net production of electricity imports (TWh/year).



Figure – EE 9 Estimated increase in electricity supply (net production and imports) energy in the domestic electric system

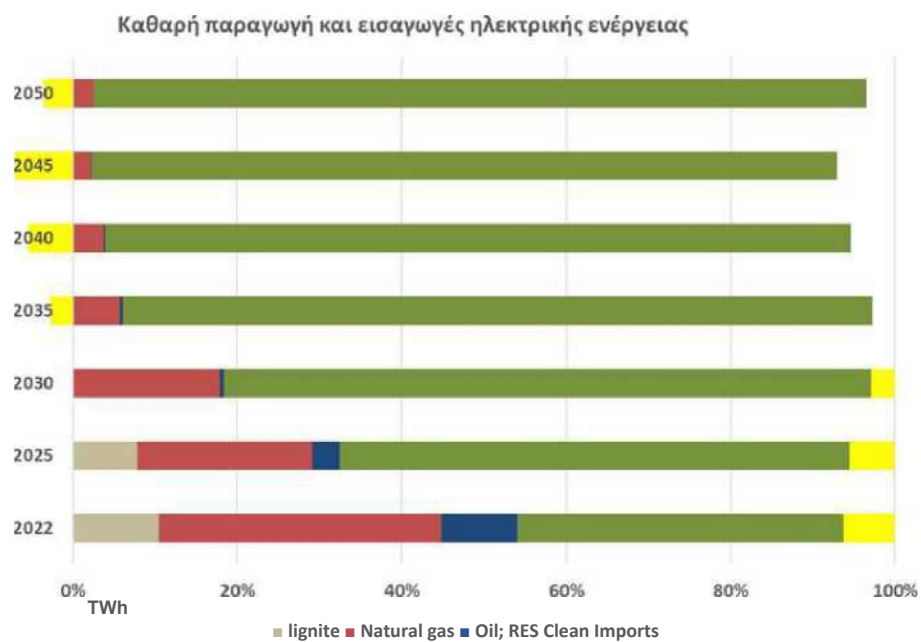


Figure – HS 10 Evolution of clean electricity production and imports by 2050, as a percentage of total.

Table – HS 6 Gross electricity consumption (TWh/year).

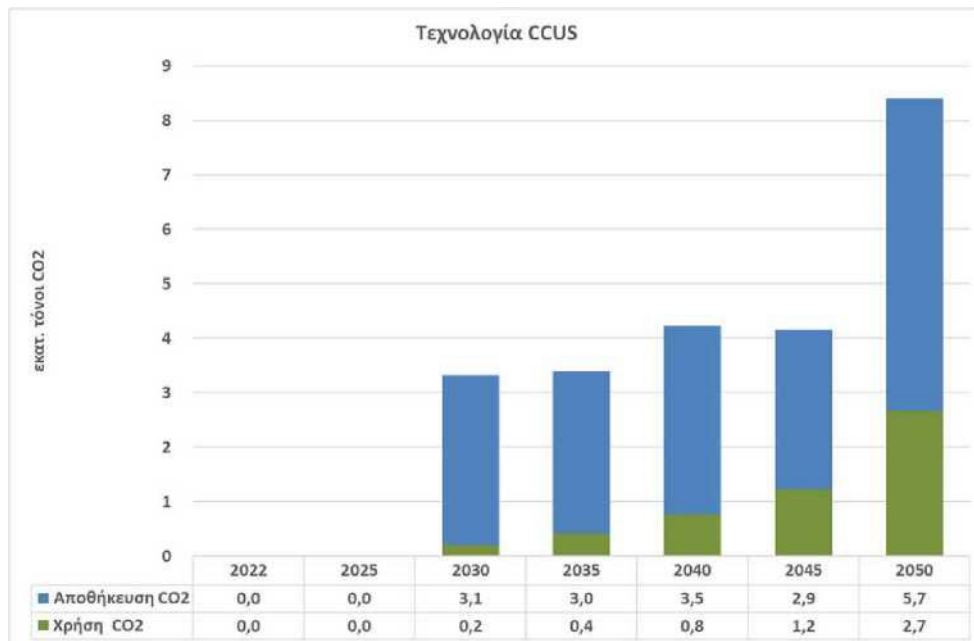
UNCLEANED CONSUMPTION UN (TWh/year)	2022	2025	2030	2035	2040	2045	2050
UN consumption in industrial- industry	11,9	10,6	11,7	12,9	15,9	15,9	16,0
UN consumption in the household sector	16,6	18,6	19,4	19,5	20,3	20,7	20,5
UN consumption in theradical sector	17,2	18,2	17,9	18,6	19,5	20,0	20,1
UN consumption in the agricultural/primary sector	2,2	2,8	2,9	2,8	2,7	2,7	2,7
UN consumption in metaherds	0,2	0,4	1,6	7,1	13,7	20,3	24,0
UN consumption inrefineries	0,8	0,8	0,8	0,7	0,5	0,4	0,4
UN consumption for propulsionof H2 transport	0,0	0,0	0,0	0,0	0,8	1,5	2,1
UN consumption forH2 component of syntheticexhaust	0,0	0,0	1,6	4,6	7,2	14,4	26,5
UN consumption fordispersing H2	0,0	0,0	0,0	0,1	0,1	0,2	0,3
UN consumption forsynthetic fuel components	0,0	0,0	0,0	0,1	0,1	0,4	0,5
UN consumption for DAC	0,0	0,0	0,0	0,0	0,0	0,0	8,8

UN consumption for- discouraging CO2	0,0	0,0	0,3	0,2	0,3	0,2	0,5
Other consumptions	0,8	0,2	0,2	0,2	0,2	0,2	0,2
Net UN consumption	49,7	51,7	56,3	66,9	81,4	97,1	122,5
Network losses	3,8	3,6	3,7	4,0	4,5	4,8	4,9
Loss of UN storage	0,0	0,4	1,2	2,0	2,3	2,6	2,9
Own consumption of produce	1,2	1,3	0,6	0,2	0,2	0,1	0,2
Gross domestic impregnation of the UN	56,6	57,1	61,8	73,1	88,4	104,6	130,5
Old ironing	0,0	0,0	0,1	0,3	0,4	0,5	0,6
Gross consumption of the UN without own consumption	55,4	55,8	61,3	73,1	88,4	104,7	130,9

E. Estimated capture and use of CO2

Table – EE 7 Forected capture and use of CO2 (MTN CO2/έτος).

CCUS (mil. tn CO2/έτος)	2022	2030	2035	2040	2045	2050
Industry commitment	0,0	3,3	3,4	4,2	4,1	3,9
Commitment by DAC	0,0	0,0	0,0	0,0	0,0	4,5
TOTAL COMMITTED CO2	0,0	3,3	3,4	4,2	4,1	8,4
Use of CO2	0,0	0,2	0,4	0,8	1,2	2,7
Storage of CO2	0,0	3,1	3,0	3,5	2,9	5,7



Graph – HS 11 Coverage of Carbon Capture and Storage (CCUS) needs, up to 2050.

F. Projected alternative fuels

Table – HS 8 Estimated production and uses of hydrogen (TWh/year), power of hydrolysis units (MW), injection of hydrogen into the natural gas networks (average% v/v).

GREEN HYDROGEN (TWh/year)	2022	2030	2035	2040	2045	2050
Consumption of H2 ingood transport	0,0	0,0	0,0	0,6	1,1	1,5
Consumption of H2 for the carboninput of eachof the fuels	0,0	1,2	2,3	4,1	6,7	15,0
Consumption of H2for synthetic ammonia	0,0	0,0	0,7	0,8	3,4	3,7
Injection of H2 into the natural gas network	0,0	0,0	0,1	0,1	0,1	0,1
TOTAL INPUT H2	0,0	1,2	3,2	5,6	11,3	20,2
Power of electrolysis units [MW]	0,0	231	638	1.099	2.135	5.123
H2 injection into natural gas networks (average% v/v)		0.0 %	1.8 %	2.5 %	3.1 %	2.8 %

Table – HS 9 Biomethane production (TWh/year).

Biomethane (TWh/year)	2022	2030	2035	2040	2045	2050
TOTAL PRODUCED BIOMETHANE	0,0	2,1	3,3	3,6	4,0	4,6

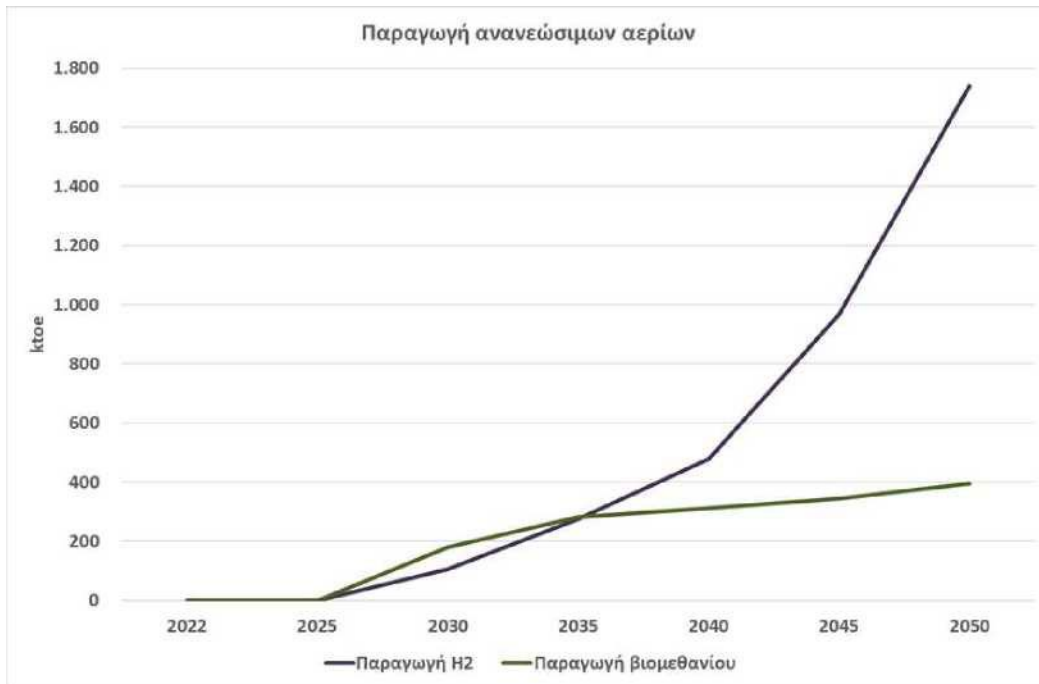


Figure – HS 12 Evolution of production of renewable gases by 2050.

Table – EE 10 Use of advanced biofuels.

Advanced Biofuel (TWh/year)	2022	2030	2035	2040	2045	2050
Land transport (Biodiesel and Bioetha-Nol)	0,0	1,1	1,8	1,6	0,6	0,0
Aviation (Bio-SAF)	0,0	0,8	2,9	4,5	5,9	6,9
Coastal shipping (Bio-LNG)	0,0	0,2	0,3	0,9	1,7	2,2

Sea-going (Bio-LNG) Shipping	0,0	0,1	1,3	1,6	1,4	1,5
TOTAL	0,0	2,2	6,2	8,7	9,5	10,7

Table – HS 11 Quantities of co-resilient carbon fuels and synthetic ammonia, injection of production and imports (TWh).

Synthetic carbon fuels (TWh)	Year 2022	Year 2030	Year 2035	Year 2040	Year 2045	Year 2050
Generation	0,0	0,8	1,6	3,0	4,7	10,9
Imports	0,0	— 0,5	0,4	1,6	2,5	3,9
TOTAL CONSUMPTION	0,0	0,3	2,0	4,6	7,3	14,8

Synthetic ammonia (TWh)	Year 2022	Year 2030	Year 2035	Year 2040	Year 2045	Year 2050
Generation	0,0	0,0	0,6	0,7	2,9	3,1
Imports	0,0	0,0	0,0	0,0	1,2	1,3
TOTAL CONSUMPTION	0,0	0,0	0,6	0,7	4,1	4,5

G. Estimated energy consumption by consumption sector

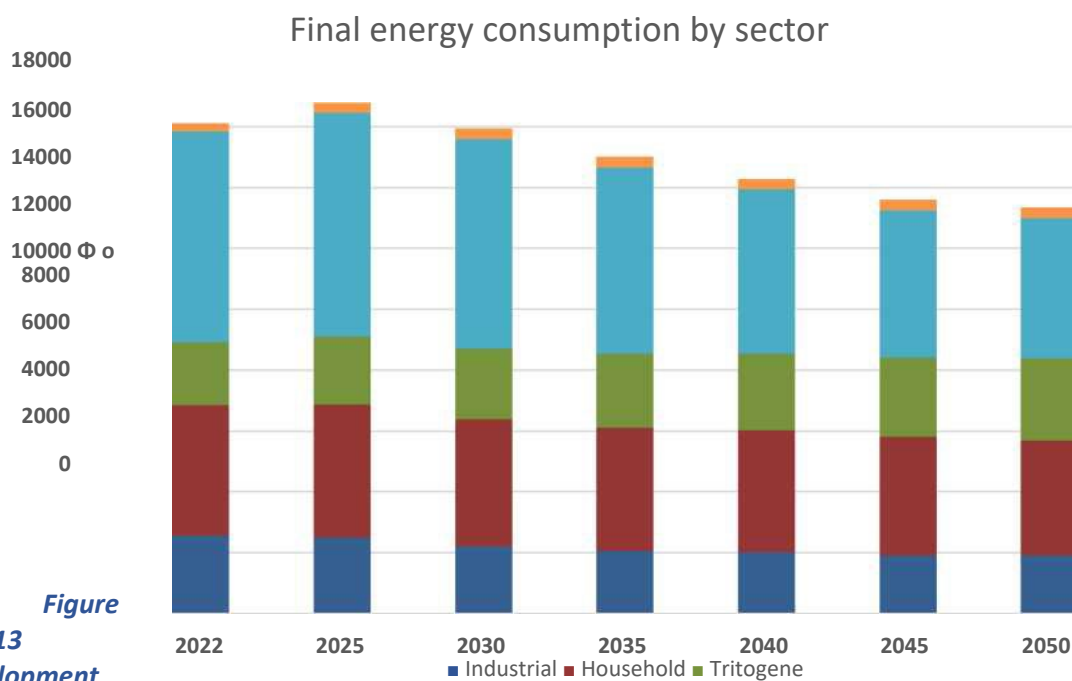


Table – EE 12 Estimated energy consumption in the agricultural sector (TWh/year).

Rural Sector (TWh/year)	2022	2030	2035	2040	2050
Petroleum fuels	0,5	0,6	0,5	0,4	0,3
Natural gas	0,1	0,0	0,0	0,0	0,0
Bio-energy	0,3	0,5	0,6	0,7	0,9
Electrics	2,2	2,9	2,8	2,7	2,7
Other forms	0,0	0,1	0,1	0,1	0,1
TOTAL	3,1	4,1	4,0	4,0	4,0

Table – EE 13 Estimated energy consumption in the industrial sector (TWh/year).

Industrial Sector (TWh/year)	2022	2030	2035	2040	2050
Liquid fuels	0,8	1,1	0,1	0,0	0,0
Petroleum fuels	9,2	5,4	4,2	3,3	2,5
Natural gas	6,6	4,9	4,2	1,6	1,0
Bio-energy	1,4	2,5	2,5	2,6	2,7
Electrics	11,9	11,7	12,9	15,9	16,0
TOTAL	29,8	25,5	24,0	23,4	22,1

Table – EE 14 Estimated energy consumption in the commercial/public sector (TWh/year).

Commercial/PublicMeat (TWh/year)				2022	0,3	0,4	0,4	0,3
Petroleum fuels				1,4	0,3	0,2	0,1	0,0
Natural gas				1,3	0,2	0,3	0,2	0,4
Bio-energy				0,1	5,8	6,9	7,7	9,2
Bionide (blended with pineoil)				0,0	17,9	18,6	19,5	20,1
Biomethane (gasroute networks)				0,0	0,5	0,7	0,8	1,2
Ambient heat (heat pumps)				4,1	27,1	28,3	29,2	31,4
Electricity (thrustpumps, electricsuppressors)				17,2				
Solar energy (solar thermal)				0,1				
TOTAL				24,2				
2030	2035	2040	2050					
0,7	0,5	0,2	0,0					
1,4	0,7	0,1	0,2					

Table – EE 15 Estimated energy consumption in the residential sector (TWh/year).

Household sector (TWh/year)	2022	2030	2035	2040	2050
Petroleum fuels	14,9	3,4	2,4	0,8	0,0
Lignite (district heating)	0,3	0,5	0,4	0,4	0,4
Natural gas	5,4	5,8	3,4	1,6	0,8
Bio-energy	7,8	9,8	9,6	11,4	11,5
Biodiesel (mixed with petroleumoil)	0,0	1,3	1,0	0,3	0,0
Biomethane (gas distribution networks)	0,0	1,0	2,1	2,1	1,9
Heat ambient (heat pumps)	1,1	4,0	4,7	5,6	4,4
Electricity (hotpumps, electrical resistors)	16,6	19,4	19,5	20,3	20,5
Solar energy (solar thermal)	3,6	3,5	3,8	4,1	4,6
TOTAL	49,8	48,6	46,9	46,6	44,0

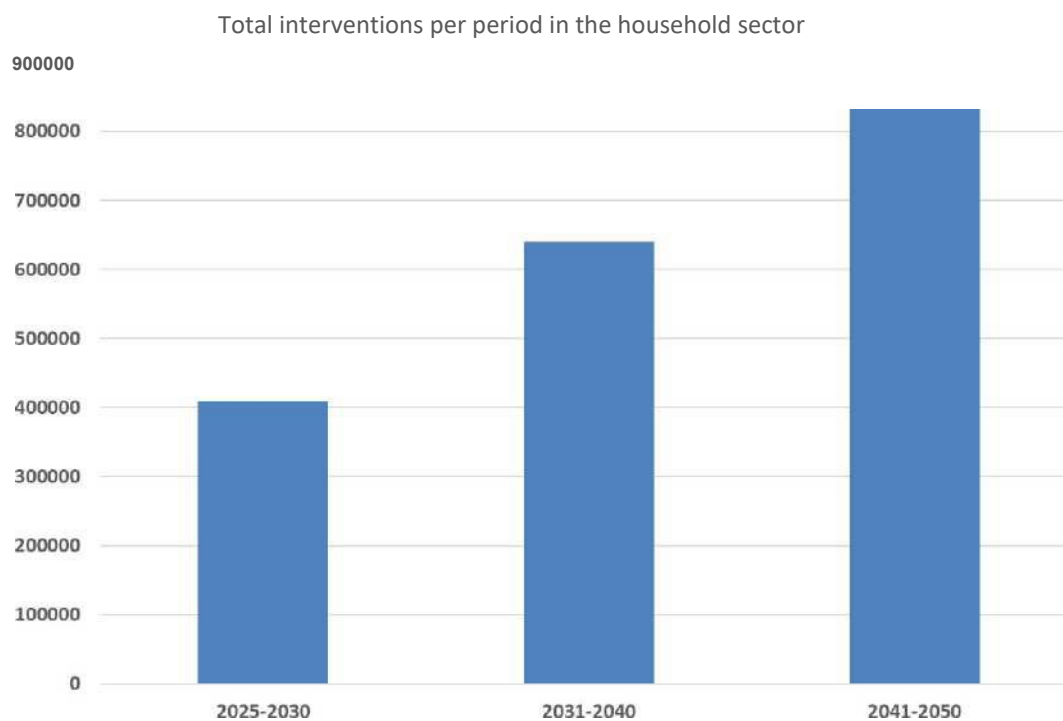
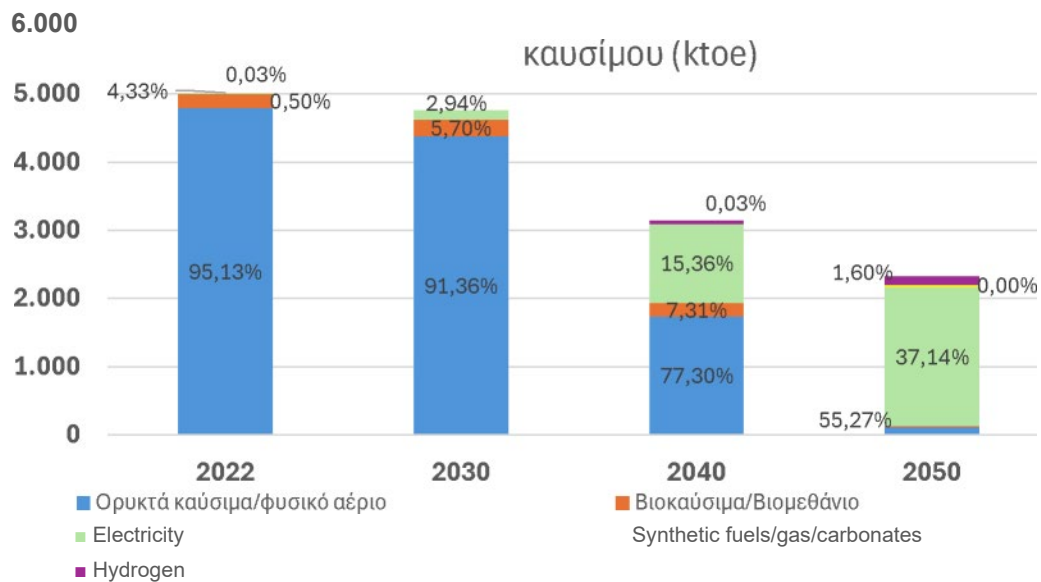


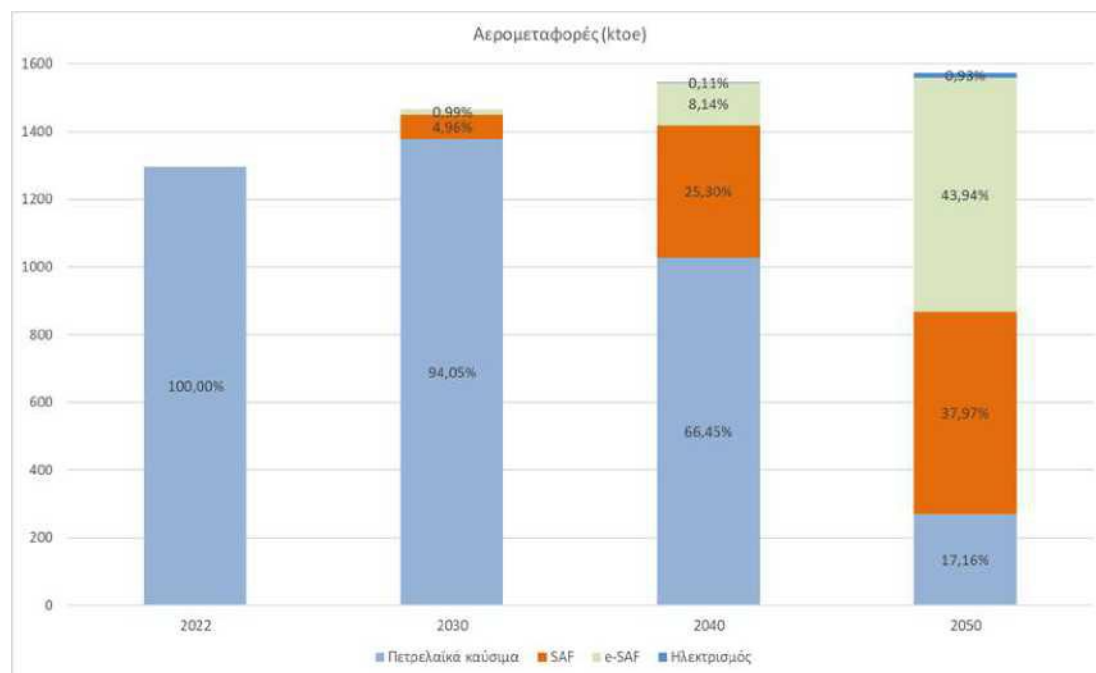
Figure – EE 14 Evolution of total interventions per period in the residential sector up to 2050.

TRANSPORT

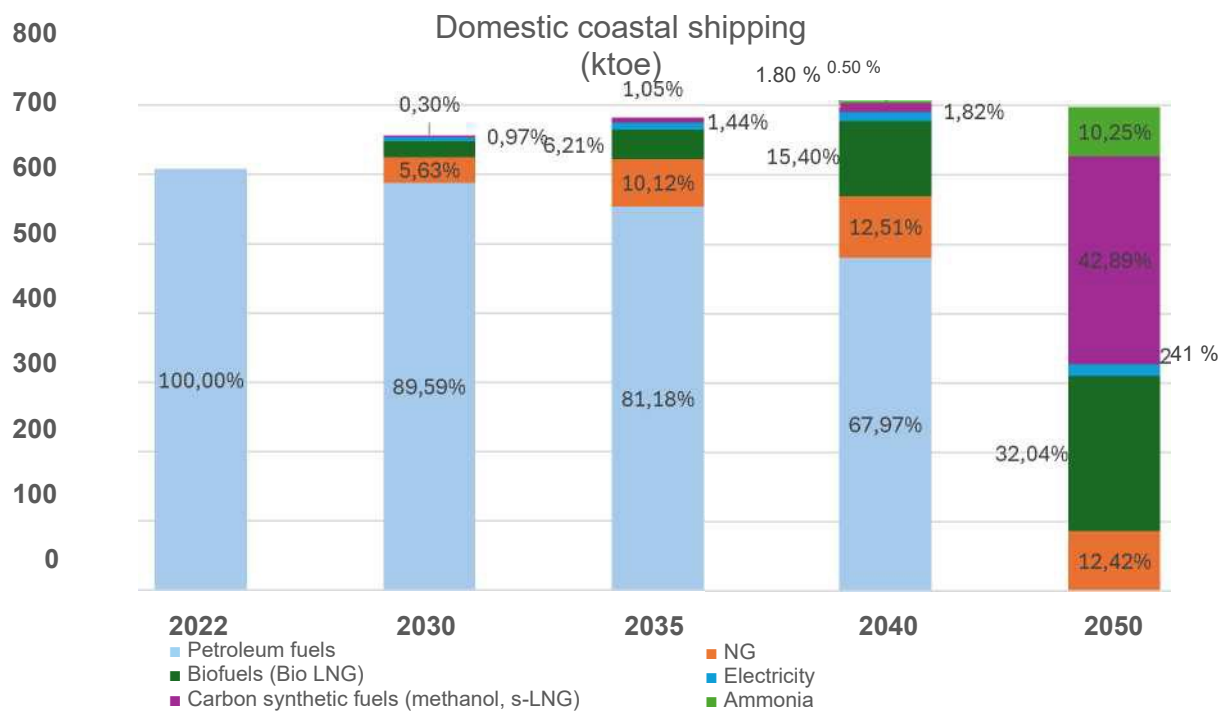


Energy consumption in land transport by type

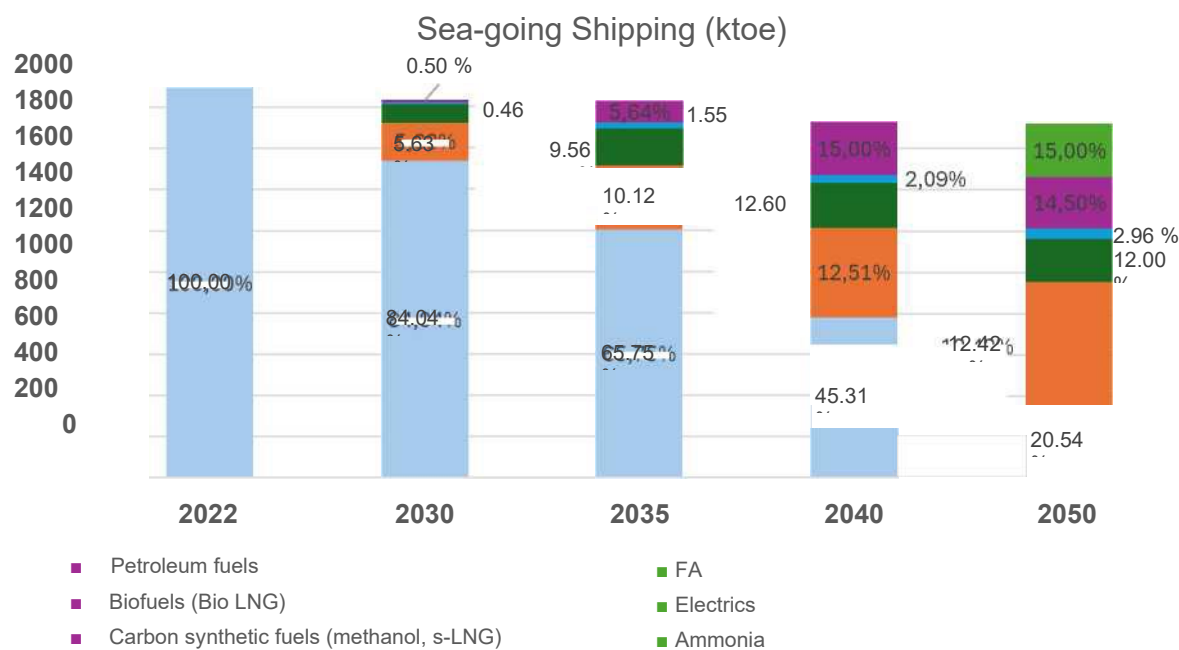
Figure – EE 15 Energy consumption in land transport by fuel type (ktoe).



Comment – EE 16 Energy consumption in aviation by type of fuel (ktoe).



Comment – EE 17 Energy consumption on domestic coastal shipping by fuel type (ktoe).



School-EE 18 Energy consumption in seagoing shipping by fuel type (ktoe).

Estimated costs of energy transition (investments)

Below is the approximate estimate of the investment costs for the implementation of the NECP (2024 values).

For 2025-2030:

Table – SO 16 Total estimated investments 2025-2030 (EUR million).

	Total energy sector investments 2025-2030 (EUR million)
Total – Action demand	65.106
Total – Energy production	30.829
Total	95.935

For the subsequent 20-year period up to the year 2050 (2031-2050):

Table – SO 17 Total estimated investments 2031-2050 (EUR million).

	Total investments in energy heading 2031-2050 (EUR million)
Total – Action demand	242.105
Total – Energy production	98.354
Total	340.460

It should be noted that the estimated costs of the energy transition include both private and public investments, while excluding the costs of adapting to climate change that has already begun (natural disasters caused by droughts, fires, floods and storms and the impact on agricultural production).

Preestimated evolution of electricity costs

As regards the preliminary estimated electricity costs, this is shown in the table below.

Table – RU 18 Estimate of the evolution of average electricity costs for the period 2025-2050 (EUR/MWh).

Estimated average UN costs [EUR/MWh] *	Year 2025	Year 2030	Year 2035	Year 2040	Year 2045	Year 2050
Recovery and return on capital of electricity-generation units	31	47	50	49	48	40
Fixed costs for operating and maintaining-power generating modules	14	17	17	17	16	14
Variable operating costs of units or vertebral-production	24	13	5	4	2	2
Pollutant costs	16	6	3	5	4	5
Cost of imports/exports of electricity	5	3	— 3	— 5	— 6	— 3
Cost of electricity injected§	90	86	73	69	64	59
Transport and Distribution	55	53	52	48	44	37
	----	---	---	----	----	----
Total UN Cost [EUR/MWh]	145	139	125	117	108	95

* 2024 prices,

§Cost of injected UN = (Cost of production + purchases/sales from international market)/(UN net consumption)

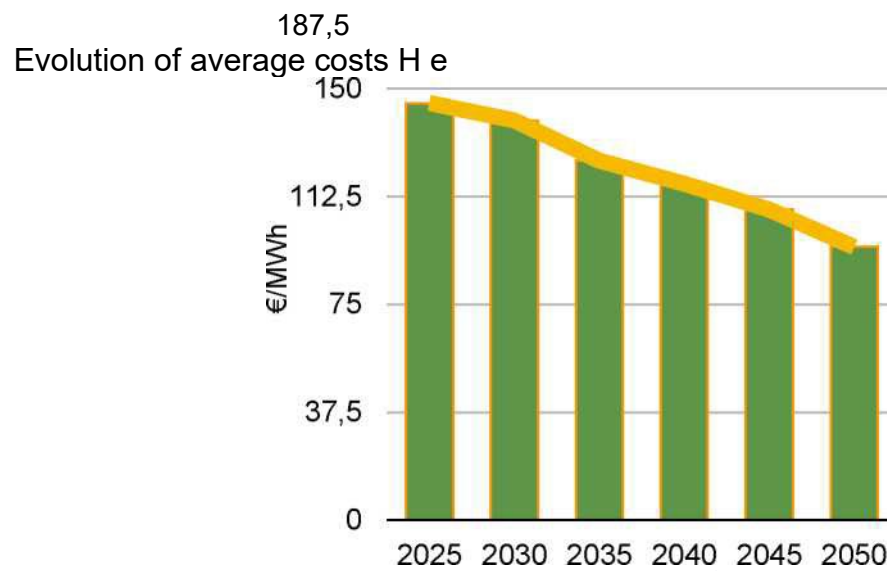


Figure – EE 19 Estimated evolution of average electricity costs (EUR/MWh)

It is clear that the average cost of electricity will decrease as RES pass and the related investments will be amortised. However, due to the energy efficiency of RES, there will be strong fluctuations in both seasonal and intra-day prices.

VI. Conclusion

Updating the NECP is a process required by the current EU framework, with clear parameters and timelines. Beyond this, however, it is necessary and necessary to ensure that the NECP responds dynamically and effectively to the huge changes that are taking place at a rapid pace in the field of active transition.

In this light, the procedure imposed by Regulation (EU) 2018/1999 itself on the governance of the energy union and climate action, and fully embraced by Greece in the updating process, makes the NECP a STRATE text alive, dynamic, modern and capable of providing a roadmap for the measures and actions that will lead Greece to the ultimate objective, both at national and EU level: climate neutrality.

This dynamic nature of the NECP, together with clear forecasts of follow-up to progress in its implementation, makes it perfectly parallel to form the basis for long-standing policy and measures, not only in the context of Energy but also in a number of related policy areas (town and country, transport, infrastructure, industry and trade, development and even education). Thus, the NECP is a fully updated development plan for Greek society and economy, with implications for each household, in each enterprise, in every sector of activity within Greece.

This particular importance of the NECP is reflected in the very broad composition of the Interministerial Committee, which was originally responsible for drafting and updating it. This is illustrated by the variety of issues it contains, which the Interministerial Committee was invited to update, and is demonstrated by the involvement of bodies, organisations, services and structures in the different types of consultation, discussion and conciliation culminating in the large open consultation of the final draft revision in the summer of 2024.

CHAPTER 1: Overview and drafting process

1.1 Introduction and starting point

The National Energy and Climate Plan (NECP) is the country's roadmap for the energy transition. This project serves three purposes. First, it is the overarching strategy on how the country will achieve climate neutrality by 2050. Secondly, it sets out the policies that will facilitate the achievement of the tenth birthday, focusing on the intermediate stage of achieving the targets in 2030. And thirdly, it quantifies policy, thus giving an insight into the main trends and size classes of the different variables.

This text is an update of the draft revised NECP, which was submitted in October 2023 to the European Commission. Awarding the NECP is an obligation to European legislation. But it is also a long-time to adapt the national strategy to the new situation that has emerged in recent years. **Since 2019,**

when the NECP was first drafted, huge changes have taken place in the world – changes that the new NECP is called upon to join.

In 2018, the Intergovernmental Panel on Climate Change (IPCC) adopted the first detailed analysis of the global impact of an increase in average temperatures of 1.5 degrees Celsius compared to the pre-industrial era. The text concluded that such a change would have a huge impact on life on the planet. The report prompted states to try to limit temperature rise as close as possible to ^{1.5} °C.

Since then, a number of agencies, mainly the International Energy Agency (IEA), have presented detailed scenarios for achieving climate fairness in 2050. Today, the roadmaps at our disposal are clearer and more detailed than those that existed a few years ago. The new NECP is therefore based on a more robust basis because international literature has been considerably enriched.

Developments in recent years have fundamentally changed the economy and the media markets. The pandemic was a global shock that greatly reduced demand and prices, but at the same time triggered an ambitious response from the EU, a response that created new resources (the Recovery and Resilience Fund (RRF)), which our country is using to accelerate the energy transition. Many of the actions mentioned in the NECP are possible because of the TAA, which did not exist in 2019.

The gradual exit from the pandemic also led to rising energy prices – for natural gas and carbon dioxide (CO₂) emissions prices, the rise was unprecedented. At the beginning of 2022, Russia's invasion of Ukraine followed by new price heights – especially for natural gas. The energy crisis that followed is the outline in which the NECP was written. Three main trends are worth noting:

First, the price spike completely changes the inertia or non-transition scenario. In 2022, Greece spent more than EUR 7 billion on gas imports – compared with EUR 1 billion on average in the years before the crisis. The State channelled almost EUR 10 billion to protect households and businesses from the impact of accuracy, an amount equal to 4.8 % of Gross Domestic Product (GDP) for that year. The cost of CO₂ emissions has also risen. As a result, the scenario of a slow transition – with more natural gas and more pollutants – is higher today than at the time when the 2019 NECP was designed. The logical consequence is that investments in alternative fuels and technologies are now more profitable.

Second, the energy crisis led to a significant drop in natural gas demand in 2022 (19 %) and electricity (6.7 %) for the whole territory. These new developments create a new starting point for the NECP, while recognising the difficulty of integrating the latest data into the energy simulation model. In addition, these trends were also confirmed in 2023 as an indication that the changes we observed in 2022 might be permanent and not temporary.

Third, the energy crisis has changed Europe's strategy, with the main objectives of ending dependence on Russian fossil fuels and accelerating energy with a tide. New targets are set for alternative fuels (e.g. hydrogen, biomethane, etc.), with a strong emphasis on production chains and boosting Europe's resilience.

The price increase **brought about by the crisis is affecting a number of policies I have awarded an explicit NECP.** It creates a need to reduce energy prices, protect vulnerable households, but also limit cost increases for specific actions and infrastructure. At the level of the economy, the rise in interest rates is changing economic realities, increasing the cost of borrowing and thus the cost of new investment.

It is evident that the changes brought about by the energy crisis interact with other trends, both structural and long-lasting. Globally, there is a continuous decrease in the cost of photovoltaics, wind farms and batteries, despite the inflation pressures observed. In Greece, installed capacity from photovoltaic and wind power increased significantly, and renewable energy sources (RES) now account for almost half of the production of the country's interconnected system.

The changes in energy coincide with a new situation for our country. The acquisition of the investment grade thanks to a positive assessment of the Greek economy closes a cycle that lasted more than a decade. Greece now has new funds that can be channelled into the energy transition. Rapid economic growth also creates a positive momentum for investment – but also leads to an increase in fuel consumption (mainly for road transport and aviation) – which is a challenge for the elaboration of an NECP.

At the same time, Greece is already experiencing the consequences of the climate crisis. The heat wave of July 2023 was the longest in history, with similar phenomena having the same intensity as in 2024. The intense fires in the country – especially Evros, Rhodes and Attica – spread more than 1 % of the country, four times more than the annual average, over the last 15 years. The unprecedented floods in Thessaly have caused incalculable disasters. These impacts underline the imperative need for a transition. On the other hand, they put the necessary and urgent emphasis on ensuring the resilience of the Greek society and economy.

In this context, this revised NECP has been drafted – adapted to trends and dynamics, focusing on the policies needed to reduce emissions by 2030, but also taking into account the strong picture of climate neutrality towards 2050.

1.2 Political, economic, environmental and social context

The national energy and climate strategy is the result of an interaction of three variables:

- **First, international trends define the contours to which Greece can move.**

RES costs continue to decrease. This is an international trend that creates weather for our country because it can harness its excellent solar and wind energy. The gradual maturation of floating offshore wind farms is another example that opens a new horizon for Greece – the production of energy in Aegean and Ionian waters. The progressive convergence of the costs of new electric cars with conventional cars creates another window of opportunity to speed up e-mobility. **On the other hand, there are a number of new technologies that are not yet mature and require significant State aid.** Hydrogen, synthetic fuels and batteries, as energy storage media, are included in this category. In shipping, oil alternatives are still at an early stage. In these markets, Greece must define the optimal mix of targets for the speed and nature of the transition – it may not abstain, but it obviously does not have unlimited resources to be able to grow everywhere at the same speed.

- **The second variable influencing the formulation of a national strategy is the status quo. Greece has already made some breakthroughs in the installation of RES involved in the electricity market.**

In 2022, Greece recorded the highest share in^{the} world in 7 of sun and wind in electricity generation, while RES penetration for the production of electricity continues at a similar pace. Production from lignite has already decreased by 80 %. Therefore, the mix of electricity strategies starts from a completely different basis in 2023 compared to 2019.

In sectors other than generation, we have the following starting points. In buildings, 60 % of the country's building stock belongs to the lowest energy classes (E-G) and more than half was built before 1980, and therefore lacks thermal insulation. There is also a significant discrepancy between the National Environmental Structure and the EU average, as shown in the shares of low-yield buildings. These buildings usually have significantly lower resilience against rising energy costs as well as extreme weather events due to climate change already taking place in Greece (e.g. floods, heatwaves). At the same time, the effects of the economic crisis with significant energy poverty are still being observed. Tertiary buildings, by contrast, are based on electricity already, so the need for intervention is different. However, with regard to energy intensity in the commercial and public buildings sector, since 2017, Greece has exceeded the EU-27 average, highlighting the high scope for improving energy efficiency in commercial buildings. In transport, the fleet of vehicles of all categories in Greece is older than the European average (with an average age of passenger cars in EL for 17 years significantly higher than the European average of 12 years), which creates the need but at the same time provides an opportunity for a rapid renewal of the fleet in the coming decade. In industry we have a high rate of electrification, while heavy industries that do not have an alternative source of energy to fossil fuels are limited in number, at least in relation to the rest of Europe.

- **The third variable is the resources available for the transition.**

On the one hand, the continuous fall in costs for RES deployment reduces the need for state subsidies, while at the same time there are a number of technologies that will be leveraged by public money.

The NECP is called upon to align available resources with the objectives, aiming at an optimal mix that does not merely reduce emissions, but also harmonises the national strategy with the achievement of other objectives such as reducing energy poverty, a just transition in lignite-fired areas, interconnecting islands with the mainland electricity system, creating production and goodwill chains in Greece, etc.

The question of resources has a given uncertainty. The resources from the TAF have contributed as a catalyst to the significant saving wave in the country, have enabled strategic investments in energy storage (pumped storage and batteries) and in the promotion of electromobility (charging infrastructure and zero-emission vehicles), as well as in other flagship projects. In 2019, this source of funding did not exist. There are currently a number of debates at European level that can drastically influence the availability of the resources that Greece can channel into the energy transition.

A second uncertainty relates to the Emissions Trading System (ETS) which provides significant resources for our country – but flows depend on a market that we can only predict approximately. A higher price scenario increases the competitiveness of RES but also affects the state's revenues from emissions – raising them in the near future but reducing them over time, as fossil fuels are replaced by new solutions.

Greece also has access to financial tools, which are constantly configured. The Innovation Fund, for example, in its third round of funding – has selected two Greek projects for actions related to the Carbon Commitment and Storage – which will speed up the evolution of this market in our country. The Islands Decarbonisation Fund is a new tool embedded in the national strategy, while the country is now gaining access to the Modernisation Fund and will prepare a plan for the use of Social Climate Fund resources. In parallel, resources for the Just Transition are already being used.

In conclusion, the NECP makes some assumptions about the potential resources that Greece will be able to mobilise, but there is a self-evident uncertainty that can have a positive or negative impact on the achievement of the targets. There is also uncertainty in international dynamics (e.g. costs of new technologies), energy prices (which may lead to increased needs to support vulnerable consumers), the size and cost of natural disasters, and others.

1.3 Strategic priorities of the National Energy Plan and the Climate

The revised NECP emphasises the reduction of emissions from electricity generation as more than 2/3 of the reduction of greenhouse gas emissions between 2020 and 2030 come from the electricity generation sector. It is an option in line with international experience, as in most countries the reduction of emissions in electricity production is faster than other sectors (buildings, industry, transport, etc.). Electricity generation is also responsible for most of the emissions in Greece, so naturally the NECP places a strong emphasis on electricity generation.

There is also an economic logic. The cost of RES has fallen and RES are now ripping with fossil fuels. Greece also has excellent wind and solar potential – it is therefore perfectly reasonable to make the most of it. Electricity generation is therefore a sector in which a large reduction in costs can be achieved by relying on energy sources available in abundance and thereby reducing energy prices for consumers, without the need for excessive subsidies.

The policy axes for electricity generation are as follows:

- A continuous reduction in lignite production, with the aim of reducing it to zero after 2028.
- Connection of the non-interconnected islands to the interconnected system by 2030.
- RES cover a slightly lower share than 80 % of electricity generation by 2030 (or earlier) – with a relatively balanced mix between solar and wind energy.
- A strong focus on the development of offshore wind farms – where Greece's potential is excellent – with the aim for the first projects to be operational in 2030.
- Development of sufficient power and capacity of energy storage systems (batteries and pumped storage).
- Security of energy supply and functioning of competitive electricity markets for the benefit of consumers and the national economy.
- Consumers' active participation in the market through, inter alia, the maturity of the demand response framework.
- Further electrification in final energy consumption with a focus on buildings and transport, as well as the promotion of RES self-generation systems.
- Use of electricity from RES for the production of renewable fuels.
- New international interconnections, with a focus on electricity exports to the EU to absorb the surrounding energy and make it easier to balance the national system.
- Digitalisation of the network.

The objectives of the NECP reflect these policies. The figures presented in the NECP are, of course, a forecast with specific assumptions. Real sizes tend to diverge at different points. However, these are the main axes on which the state will move and these objectives will strive to achieve through its

policies.

It can be expected that the quantitatively and qualitatively significant transition to the spot energy sector also causes some uncertainties about the stability of the spot. When RES reach such a high percentage (at levels around 80 %), the balancing ranges will multiply. This is obviously an issue that all developed countries stand up. It is partly a technical challenge (electricity adequacy and system stability) and partly economic (not to alternate the value between zero, at one end, and high levels, in the other). The practices of electricity system operation (production, distribution, marketing) with both French RES penetration slightly below 80 % are not fully specified. The NECP promotes policies that encourage and favour technical and cost-optimal adaptation.

We know from numerous scientific analyses that the balancing of a system dominated by RES is based on a combination of technologies and practices. Zero-pollutant technologies with (more or less) flexibility (e.g. nuclear, hydroelectric, geothermal, etc.), demand response (from buildings, cars, industry), storage technologies (pumped storage, batteries), taxing the system (e.g. maintaining natural gas plants) so that production from a technology or geographical area is not used, international interactions (which can transport energy from one place to another) and occasional energy disposal (because it is more economical than absorbing all energy at all times) play an important role.

In Greece, the system will be balanced by a combination of the above technological solutions, including batteries and pumped storage, hydroelectric and distributed RES, demand response and production of renewables, as well as gas interconnections and plants.

At the same time, the State will take the necessary measures to safeguard security of supply in the light of technological neutrality and the reduction of costs to consumers.

Emissions reductions in the remaining sectors (apart from electricity generation) will be more limited in the first period until 2030. This partly follows the tendencies where the power sector is changing faster. Here, however, the starting point for our country also plays a role. The economic crisis has significantly reduced energy demand in recent years: from 2007 to 2013, energy consumption decreased by 39 % in industry, 28 % in transport and 30 % in housing. By 2021, there had been little recovery in most sectors. **Economic growth will lead to an expected and fair increase in consumption. Therefore, in the coming years, Greece will have to balance two trends: the increase in consumption that the development will bring, and the energy savings (and coking) required by our energy policy.** The final effect on emission reduction levels may seem limited, but this reflects the momentum created by the recovery of an economy that only now leaves behind the years of the crisis.

In dwellings, and in buildings in general, the primary objective is to save livelihood and combat energy poverty. A significant proportion of the Recovery Fund resources, in conjunction with the Corporate Regional Development Pact (NSRF) and other European funds, support multiple cycles of the 'Save' programme, the 'Recycling Packaging' programme, the 'Electra' programme for public buildings, the programme for solar heaters in homes, and the 'Photovoltaic on the roof' profile in combination with batteries. Common axes are to develop and increase the energy efficiency of the

country's building potential, to improve the quality of life, to protect against the high cost of meeting the needs of the labour market, with additional targeted actions for specific vulnerable groups in need of support.

The transport sector is showing significant upward dynamics in recent times, as a result of the economic growth of our country. Greece has the lowest penetration rate of RES in the transport sector, as a result of the use of trucks (instead of rail) for the transport of goods, as well as the low share of biofuel in the blend. The primary objective of the NECP is the convergence of Greece with the European average in the electrification of transport, especially cars and taxis. This is, in part, already the case with a significant increase in electric cars in the total number of new car registrations in Greece. Greece benefits from international trends that make electric cars increasingly competitive in terms of cost and reliability than conventional cars. At the same time, the state is supporting the electrification of transport with specific incentives for private cars, corporate fleets, including light lorries (vans), taxis, and public transport.

In the coming years, the State's priority will be to develop a more dense network of publicly accessible electric vehicle chargers (electric vehicle chargers). Comparators show that our country is lagging behind the other European countries in their charging networks. The programme for the installation of chargers is supported by the TAA and is a key pillar of the country's electro-mobility strategy – with the development of this infrastructure being a prerequisite for the additional penetration of electric vehicles in the entire vehicle fleet, reinforcing the already positive trend. In all transport sectors, international experience suggests some possible solutions, which, however, are expected to mature after 2030. The aim of the NECP is therefore to create conditions for the development of these new technologies at the right time.

Industry is an important source of emissions for the country. Than in other European countries, domestic industry uses electricity and oil to a greater extent, and less natural gas and RES. This creates a positive dynamic, especially as regards the use of electricity and the limited need for thermal energy at very high temperatures. The short-term objective of the NECP is to create a carbon capture and storage value chain in the country that will mainly help industry in hard-to-abate industries and processes. This chain is also supported by European funds available to the country (TAA, REPowerEU) and European funds based on tenders (such as the Innovation Fund).

Electricity grids are becoming crucial in achieving the energy targets as they are at the heart of the energy transition and the delivery of environmental and energy measures and policies. For these reasons, the distribution network should evolve into a distributed, decentralised, digitised and flexible system that supports the energy transition and the purification of energy uses.

In this context, it is necessary to significantly increase and accelerate investment and project implementation based on long-term network development planning: to ensure increased RES penetration, meet demand by expanding electricity use in new sectors such as transport, etc., improve the resilience and digitalisation of the network and support market operations. In order to achieve this,

it is necessary to introduce parallel regulatory incentives aimed at the steady development and evolution of networks, to meet needs such as digitalisation, strengthening resilience, cyber-security needs and extensive data processing.

At the same time, the key objective is to optimise the use of network infrastructure by applying innovative technological solutions to energy management and flexibility systems, making use of intelligent metering systems, improving network capacity and making optimum technological use of the available infrastructure, achieving the expansion of dispersed generation, from storage and dynamic demand response. The Network Operators and in particular the Distribution Network Operator will be required to carry out a huge amount of investments. Their size and the need for rapid implementation should be supported through a range of levers and measures, together with ensuring access to financial products and tools designed to support Network investments, develop new skills and introduce innovation.

1.4 Objectives set by the European Union

In the period from 2020 to today, the EU set more ambitious targets for the year 2030 and incorporated the objective of climate neutrality by 2050 into the National Energy and Climate Plans of all Member States.

On this objective, the Greek government submitted a Long-term Energy and Climate Strategy, as a separate study under the National Energy and Climate Plan. Today, however, the long-term targets and the plan to achieve them are integrated into the main National Energy and Climate Plan, which therefore covers the whole period from now to 2050, **providing more details on the plan to achieve the 2030 targets.**

The EU set ambitious targets in its fight against climate change and the transition towards a more sustainable energy system. These objectives were discussed in the framework of the EU's Clean Energy for All Europeans package, which includes the Renewable Energy Directive, the Energy Efficiency Directive and the Governance Regulation.

Some of the main targets set for EU Member States in the NECPs are presented below:

- **Reducing net greenhouse gas emissions: A 55 % reduction by 2030 compared to the emission level of the year 1990, and climate neutrality by 2050.** In the context of the European Green Deal, the European Climate Law was adopted (Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) 2009/401 and (EU) 2018/1999) which increases the greenhouse gas emission reduction target for the year 2030, including emissions and removals/removals, by at least 55% compared to the year 1990. In addition, it is envisaged, inter alia, to extend the application of the trading scheme to emissions from maritime transport, as well as to implement a carbon offsetting and reduction scheme for international aviation. There is a new autonomous emissions trading system for buildings, road transport and fuels for additional sectors. This includes an increase in the overall emission reduction ambition by 2030 in the sectors covered by the EU Emissions Trading System (ETS) to 62 %.

The Effort Sharing Regulation sets binding annual greenhouse gas emission targets for Member States in sectors not covered by the EU Emissions Trading System (EU ETS) or the Land Use, Land Use Change and Forestry (LULUCF) Regulation, such as road and inland maritime transport, buildings, agriculture, waste and small industries.

- **The Land Use, Land Use Change and Forestry (LULUCF) Regulation establishes a binding obligation for the EU to reduce emissions and increase removals in the land use, land use change and forestry sectors.** The new rules set an increased EU-wide target of at least 310 million CO₂ equivalent greenhouse gas removals by 2030.
- **RES penetration: The RES indicator as a percentage of gross final energy tanks in 2030 will be**

at least 42.5 % (which may be increased to 45 %), accompanied by sub-targets per sector and tanker (electricity, heating/cooling and transport).

- **Improvement in energy efficiency in 2030 of 11,7%**, measured as a percentage change in final energy consumption compared to the forecast version of the 2020 Reference Scenario for 2030.
- **Promotion of advanced biofuels and renewable gases of non-biological origin** as a minimum share in transport fuels (5.5 % in 2030 reaching a minimum penetration of renewable gases of non-biological origin of 1 %).

Following the European Climate Law (Regulation (EU) 2021/1119 of the European Parliament and of the Council of 30 June 2021 establishing the framework for achieving climate neutrality and amending Regulations (EC) No 2009/401 and (EU) 2018/1999), Greece adopted for the first time the National Climate Law (Law 4936/2022, Government Gazette, Series I, No 105), which sets out specific targets, including reducing net greenhouse gas emissions by 55 % by 2030 and by 80 % by 2040 (compared to 1990 levels), and achieving climate neutrality (i.e. net zero greenhouse gas emissions) by 2050. Therefore, the current NECP incorporates the objectives of the National Law (Law 4936/2022, Government Gazette, Series I, No 105), the objectives under EU policy (Re-industrialisation and Fit-for-55 under the Green Deal) and the EU Directives on RES, energy efficiency, etc.

1.5 Methodological approach to drafting the NECP

The priority of the NECP at the level of planned policies and the implementation of specific measures is to achieve specific objectives relating to the security of energy supply, the functioning of energy markets and the role of cleaners, the strengthening of the competitiveness of the economy, as well as the promotion of research and innovation actions.

A key parameter for achieving the objectives set in the NECP is the understanding that the trajectory of the individual sectors automatically influences the trajectory of the others and, therefore, the measures finally designed and implemented do not have unambiguous impacts that concern only one thematic dimension and module of the NECP, but instead co-shape the overall evolution of the energy system and demonstrate that the NECP is also directly related to other national policies such as waste management, circular economy and climate change adaptation.

Chapter 3 presents the Policy Priorities and Policy Measures selected in order to achieve the ambitious targets set in a consistent and effective manner. The preparation of policy priorities and measures was carried out by applying the process illustrated in Figure 1.



Figure 1 Methodology for the design of the NECP policies and measures in 2030.

More specifically, in order to achieve the National Objectives, specific Policy Priorities have been identified, to be fulfilled in 2021-2030 through the development of targeted Policies and Measures.

At the same time, there is also a procedure for assessing the performance and assessing the impact of policy measures in order to provide feedback on political priorities and a possible revision and redefinition of those priorities in order to achieve the objectives set.

The objective is therefore to fulfil these Policy Priorities more efficiently, which can be achieved by designing and implementing Policy Measures for each Priority separately.

Priorities and policies are defined for both the five dimensions of the Energy Union and distinct for RES:

- **Climate Change, Greenhouse Gas Emissions and removals**
- **Renewable energy sources**
- **Improving energy efficiency**
- **Security of energy supply**
- **Energy market**
- **Research, innovation and competitiveness**

1.6 Consultation and involvement of stakeholders

1.6.1 Governance structure

The revision and update of the NECP in Greece is based on a comprehensive and comprehensive governance structure. More specifically, the '**Interministerial Committee for the Environment and Climate**' is the main body for updating the NECP, established by Council of Ministers Act No 31/30.9.2019 (Government Gazette, Series I, No 147). The Commission was also supported in the preparation of the original NECP and its structure was amended by Council of Ministers Act No 31/18.7.2021 (Government Gazette, Series I, No 127) and Council of Ministers Act No 29/27.11.2023 (GG I 197). The Interministerial Committee has the following powers:

- Formulation of national priorities, methodology and guidelines for the country's energy planning, as well as for the preparation of the NECP.
- Drafting, presenting and submitting the final draft of the NECP to the Minister for the Environment and Energy.
- Assisting the Minister for the Environment and Energy on the relevant requests with the competent committees of the Parliament and the services of the European Commission.
- Analysing and updating the scenarios to be investigated for the development of the country's urban system.
- Designing and promoting proposals for energy policies and actions, as well as proposing corrective measures in the event of discrepancies.
- Provide guidance to institutional actors.
- Coordination and consultation at national and regional level.

In particular, the Commission is also responsible for drawing up long-term energy planning, as provided for in Regulation (EU) 2018/1999 of the European Parliament and of the Council of¹¹ December 2018. The Commission prepares and submits the final draft of the NECP to the Minister for the Environment and Energy. The NECP shall be ratified by decision of the Government Council for Economic Policy, following a recommendation from the Minister for the Environment and Energy.

The Ministry of the Environment and Energy has also set up a **Working Group on Monitoring the Objectives of the National Energy and Climate Plan** (Decision No ΥΠΕΝ/Δ- ΠΕΑ/36803/264/9.4.2024 of the Minister for the Environment and Energy, Internet ref. No: Ψ76Ω4653Π8-PPE), which is divided into two Technical Groups: (i) Project Administration and Management Group and (ii) Composition and Finalisation Group.

In addition, in accordance with Article 29 of the National Climate Law (Law 4936/2022, Government Gazette, Series I, No 105), a **Scientific Committee on Change** is set up at the Ministry of the Environment and Energy, consisting of the President and eight (8) members with recognised prestige and high scientific training with academic or professional expertise in the field of climate change, environmental protection or related disciplines. The EEKA cooperates with the Interministerial Committee on Energy and Climate, the Directorate for Climate Change and Air Quality of the Ministry of Environment and Energy and the competent body of the Ministry of Climate Crisis and Civil Protection.

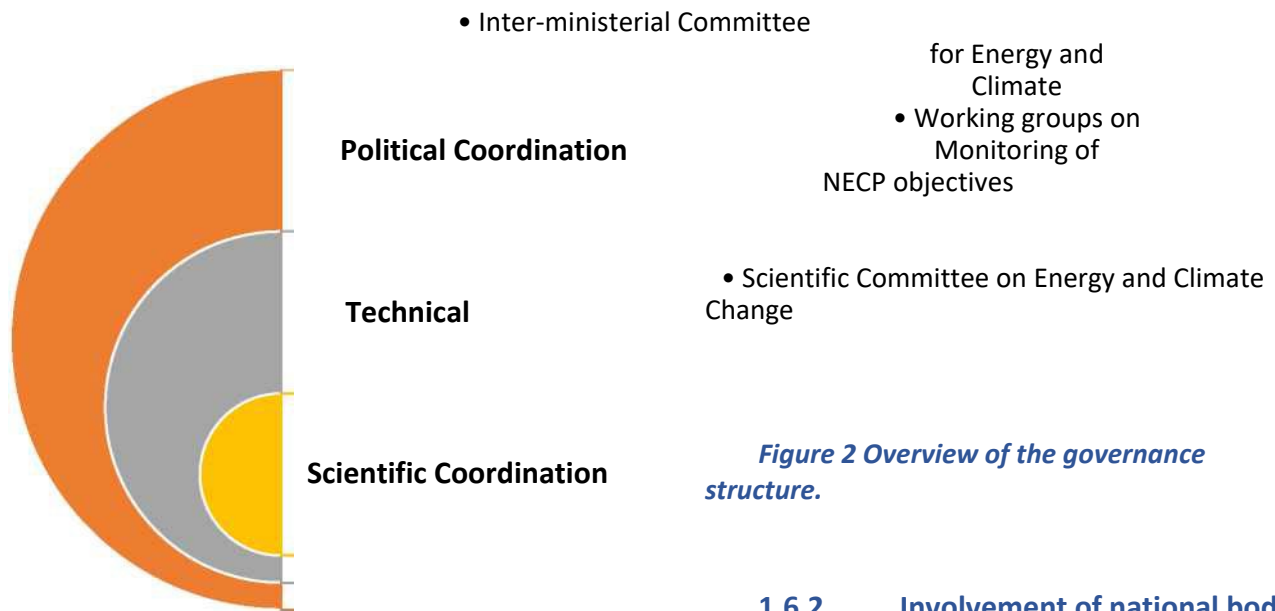


Figure 2 Overview of the governance structure.

1.6.2 Involvement of national bodies

Stakeholder and civil society consultations are an essential process that unfolds throughout the preparation of the revised NECP.

I. A detailed presentation of the draft updated NECP and its quantitative targets⁵ took place on 18 January 2023 to all members of the Interministerial Committee on Energy and Climate as well as to additional bodies that participated, upon invitation, in the Interministerial Committee. The aim was to present the proposal to update the NECP, detailing the energy and climate policy objectives for 2030, the evolution of the energy balance by sector and the level of investment needed to achieve the targets. At the same time, the presentation was published in all media, thus triggering a wider disclosure and consultation of the proposals for the implementation of the NECP.

II. Stakeholders participating on invitation to the NECP Interministerial Committee put forward proposals between January and February 2023 for the proposed policy objectives and priorities as well as recommendations on the measures and policies planned to achieve these objectives. In particular, comments were submitted by five (5) bodies, including the Bank of Greece, the Hellenic Hydrocarbons and Energy Resources Management Company (EDEYEP), the National Gas System Operator (DESFA), the Renewable Energy Centre (KEPE), as well as representatives of non-governmental organisations (NGOs), such as Greenpeace and WWF.

III. A presentation of the preliminary draft for the timely implementation of the NECP to the members of the ESC took place on 4 April 2023. The purpose of the presentation was to inform and give an opinion to the Commission on the draft update of the NECP.

IV. During the period August – September 2023, the RIS conducted a closed preliminary process for the draft updated NECP with specific national bodies and stakeholders. In particular, the draft updated NECP (resulting from comments from the bodies during the first consultation stage) was sent back to the stakeholders, accompanied by a questionnaire developed by the Ministry of the Environment and Energy in order to facilitate the structuring and collection of responses/comments. The purpose of the questionnaire was firstly to assess qualitatively the degree of agreement or disagreement of the bodies involved with the direction of the NECP and, secondly, to prioritise the comments/observations of the bodies, based on their frequency, **so that they can be taken into account in the final updated NECP.**

A total of 36 stakeholders submitted replies and comments, and the participation of 60 stakeholders was requested (60 % response rate). The bodies that provided feedback included ministries and public authorities, businesses and industry associations, electricity and gas network operators, members of the ESC, NGOs, as well as other stakeholders.

The figure below summarises the degree of agreement with the direction of the NECP by type of body involved.

#of % response Top respondents Draft NECP assessment

⁵<https://ypen.gov.gr/kostas-skrekas-me-to-neo-proteinomeno-esek-dinoume-yperaxia-stin-elliniki-oikonomia-dimiourgoume-nees-theseis- apascholis-kai-epitychanoume-antagonistikes-times-energeias/>.

NECP. Similarly, the aim of the presentation was to inform NGOs of therevised version of the NECP, and to express their views on it in an open debate, before the Plan is put to public consultation.

An open public consultation with civil society took place from 22 August to 16 September 2024. The number of participants passed 350 and a total of more than 1.780 comments were received via the opingov website (<http://www.opengov.gr/minenv/?p=13352>) as well as via letters from organisations. The following Figures present a qualitative analysis of the comments submitted in the context of the public consultation on the basis of the thematic categories they werein.

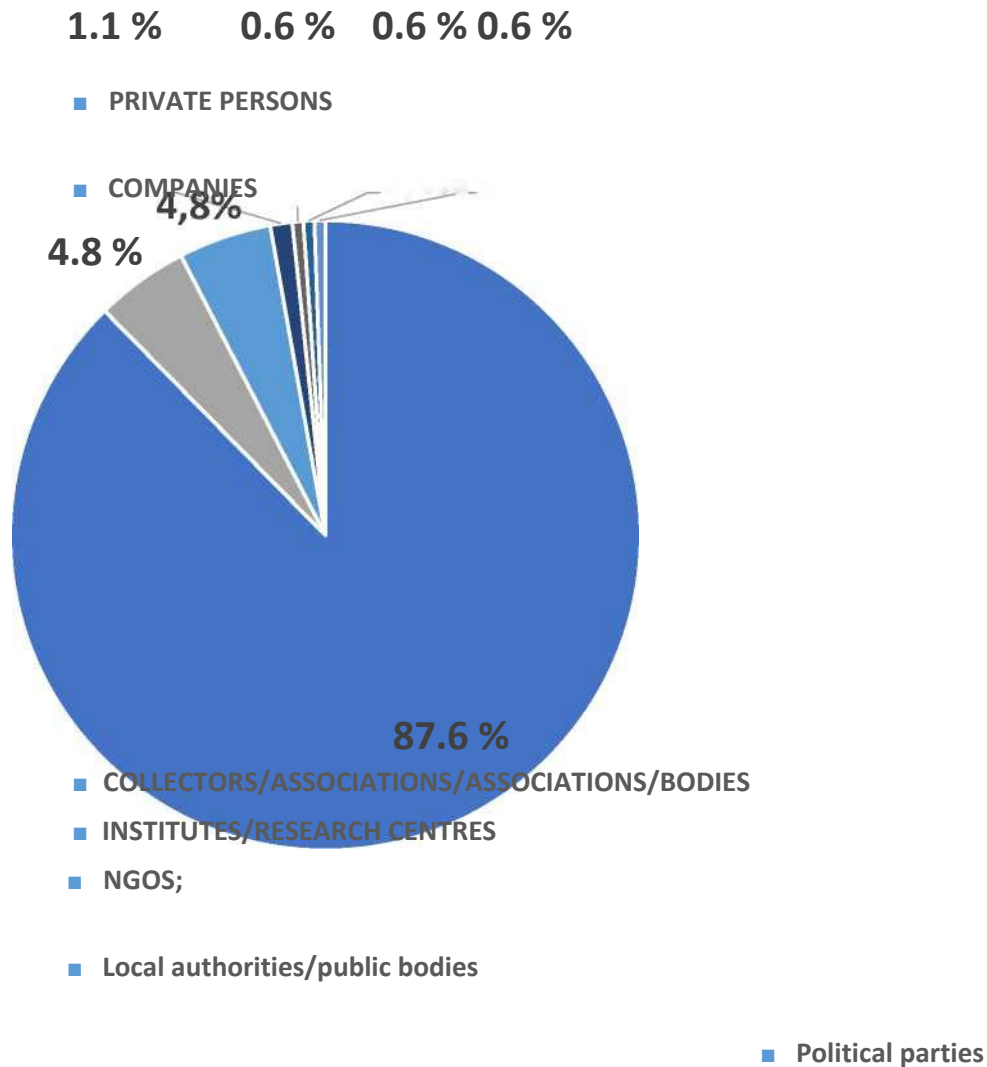


Figure 4 Status of respondents to the public consultation

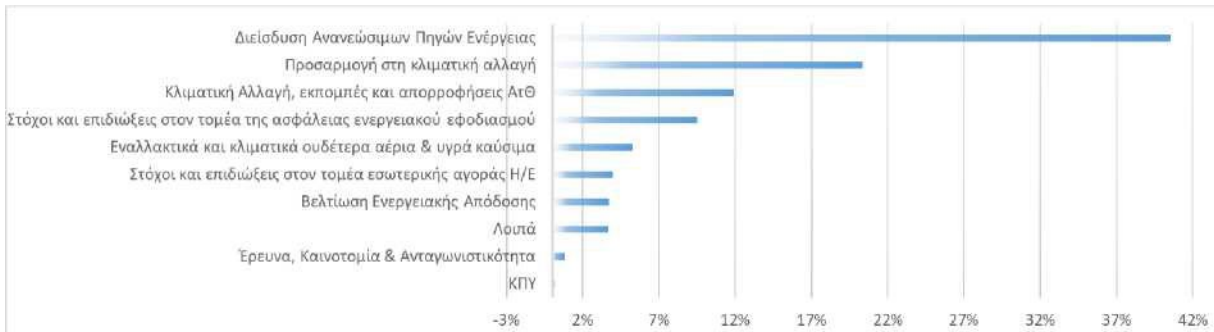


Figure 5 Percentage of public consultation comments by project module

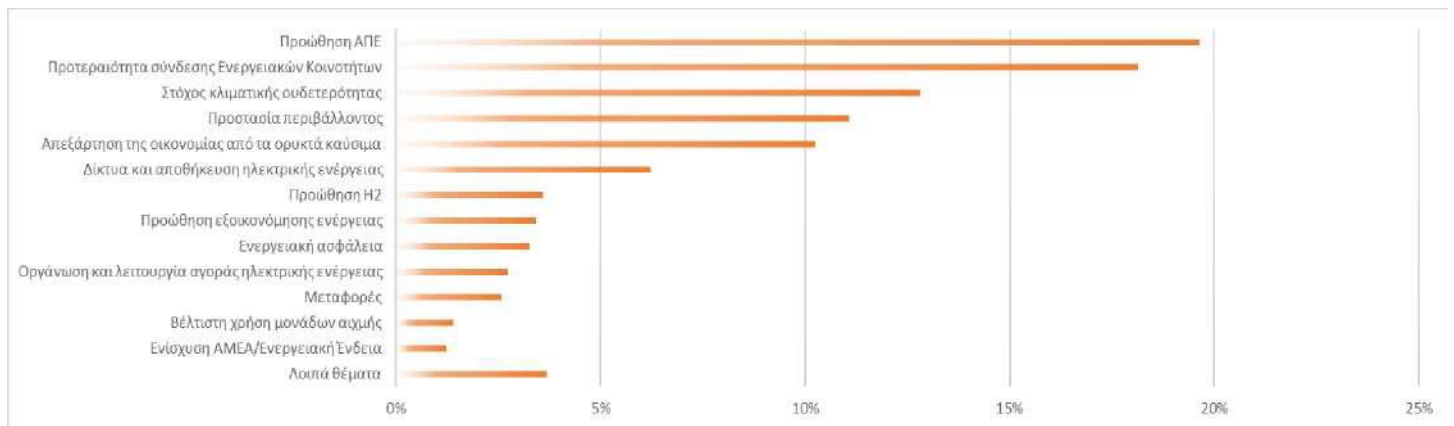


Figure 6 Key thematic categories of comments submitted to the public consultation as a percentage of total

Following the conclusion of the consultation, a re-presentation of the revised version of the NECP to the members of the Interministerial Committee on Energy and Climate took place on 19 September 2024.

Furthermore, on 16 October 2024, a joint meeting of the competent committees (Standing Committee on Production and Trade and Special Standing Committee on Environmental Protection) took place in the Greek Parliament, where the final objectives, priorities and policy measures of the revised NECP were presented, followed by an extensive discussion and comment from the members of the committees, referring to the objectives, priorities and measures of the NECP.

This draft is the final version of the revised NECP, taking into account all the comments submitted in the context of the open public consultation with civil society. This final version has also received all comments and views received in consultations with stakeholders, including central government bodies, French partners, civil society and the general public, which took place at different stages of the process of drafting the revised NECP.

1.6.3 consultations with other States

In the process of preparing the NECP, existing international and regional energy and climate partnerships were taken into account in order to assess any synergies and specific actions that can

contribute to the achievement of the national energy, environmental and other objectives of the NECP.

This includes the following relevant information:

I. Regional cooperation

Greece remains stable in its strategy to be an energy hub in the region of South East Europe, due to its geographical location and climatic conditions, providing diversification of supply sources and routes. Energy cooperation, at international and regional level, is of paramount importance for both energy security and the resilience of energy systems in order to respond to crises.

In the energy sector in particular, important international and regional thinking for the implementation of national policy is:

1. The Energy Community: the 'Energy Community' process aims to extend the European internal energy market to south-eastern Europe. Greece participates in the Energy Community bodies with each of the "participating country" with the right to speak but not vote, as it is covered by the EU Common Position.

2. Central and South-Eastern European Energy Interconnection (CESEC: Central and South-Eastern Europe Energy Connectivity): the Central and South-Eastern Europe Energy Interconnection Initiative (CESEC) aims to accelerate the integration of the gas and electricity market in the region. Since 2017, cooperation has been extended to RES and energy efficiency and, since 2020, to energy transition.

More specifically, in the context of CESEC meetings, steps were taken to complete the project of the second electricity connection between Greece and Bulgaria with the 1.7 GW N Santa – Maritsa line, which was completed in July 2023, at the level of the fellow leadership. As a sign of further cooperation, in the margins of the Ministerial Conference of the CESEC countries held in Athens in January 2024, a Memorandum of Understanding between Energy Ministers of Greece and Bulgaria reflecting the common objectives and priorities of CESEC, and between Greece, Bulgaria and Romania, Declaration of Intent to cooperate on future Cross-Border RES projects, covering the offshore wind energy delivery sectors, electricity interconnection and green hydrogen, were signed. Finally, at the same Ministerial Conference, reference was made to the signing of a Memorandum of Cooperation between the gas transmission operators of the countries of central and south-eastern Europe to enhance security of supply in the region through the vertical road.

3. Energy Charter: The Energy Charter Treaty is a legally binding multilateral agreement covering the promotion and protection of investment, trade, transit, energy efficiency and dispute settlement. It was signed, together with the Energy Charter Protocol on Energy Efficiency and related environmental issues, in Lisbon in December 1994 and both entered into force legally in April 1998. A modernisation of the Energy Charter was launched in November 2018 at the initiative of the EU and its Member States, focusing mainly on investment protection standards, limiting protection for fossil fuels and promoting sustainable development. Negotiations were concluded in 2022 but, so far, the modernisation of the Energy Charter has not been ratified.

4. Transatlantic Partnership for Energy and Cluster Cooperation (P-TECC): The Office for International

Affairs of the US Department of Energy cooperates with the Transatlantic Energy and Climate Partnership (P-TECC), which is an international platform designed to provide policy-makers and civil society actors in Eastern and Central Europe with the resources and technical tools to create a secure, resilient and climate-friendly energy system. The overarching objective of P-TECC is to support European energy security efforts, including in the context of the EU Energy Union and the Three Seas Initiative. (detailed below)

5. EU Strategy for the Adriatic and Ionian Region (EUSAIR): The main objective of the EUSAIR Strategy is to promote economic growth and prosperity in the Adriatic-Ionian region by improving its attractiveness, competitiveness and interdependence. Italy, San Marino, Croatia, Slovenia and the Western Balkan countries also participate.

6. The Eastern Mediterranean Gas Forum (EMGF): On 22 September 2020, in Cairo, Cyprus, Egypt, Greece, Israel, Italy, Jordan and the Palestinian Authority signed the Statute establishing the Eastern-Mediterranean Gas Forum (EMGF).

The establishment of the EMGF is based on the joint recognition that major offshore gas discoveries in the Eastern Mediterranean will have a substantial impact on the energy and economic development of the region while promoting prosperity and economic prosperity through synergies. The Articles of Association were ratified by Greece by Law 4769/2021 (Government Gazette, Series I, No 14).

7. Organisation for Black Sea Economic Cooperation (BSEC): Cooperation within the OSE is, in the current period, focused on strengthening Price Development in the Black Sea region, as BSEC countries are now more geared towards increasing the use of RES and tackling climate change by reducing greenhouse gas emissions, which are now a global challenge.

The issue of Green Growth, i.e. integrating environmental issues and taxing energy use, is now on the agenda of the Agency's meetings and is now an overarching strategy introduced by Greece during its Presidency in 2010. The priority given to the Green Growth is also reflected in the "Green Energy Strategy for the Member States of the BSEC" prepared at the meeting of the OSEC Council of Ministers for Foreign Affairs in Yerevan on 27 June 2018 and its implementation is a key priority for the countries from now on.

8. Union for the Mediterranean (UfM): The Union for the Mediterranean acts as a unique platform to facilitate and promote regional dialogue and cooperation in the Mediterranean region, as well as concrete projects and initiatives in the areas of Energy and Climate Action, in order to address the challenges of energy and climate change in the region, while supporting more secure and sustainable energy models.

9. International Renewable Energy Agency (IRENA): IRENA was officially established in Bonn on 26 January 2009. During the founding conference, seventy-five (75) states from all over the world, including Greece, signed its Statute, which was ratified by the Greek Parliament by Law 4017/2011 (Government Gazette, Series I, No 212). The Agency currently consists of 169 Member States (the European Union is also a member of the International Union). IRENA's central objective is to rapidly

disseminate the use of RES worldwide.

10. The International Solar Alliance (ISA)

The launch of the International Solar Alliance (ISA) was announced by Indian Prime Minister Narendra Modi and former French President Francois Hollande on 30 November 2015. ISA was designed as a coalition of solar resource-rich countries to address their specific energy needs. At the same time, it provides a dedicated platform for cooperation between countries through which global audiences, including governments, bilateral and multilateral organisations, companies, industry and other stakeholders, can contribute to the shared goal of increasing the use of solar energy to meet the energy needs of ISA member countries in a safe, accessible, fair and sustainable way, thereby contributing to enhancing energy security, sustainable development and improved access to energy in developing country Members. ISA currently has 97 member countries. Each year, the Ministerial Meeting of the ISA member countries takes place at a high level, the most recent being the 7th Ministerial Meeting (03.11.2024 in N. Delhi).

11. Clean Energy Marine Hubs (CEM-Hubs)

This initiative belongs to the International Chamber of Shipping (ICS). ICS represents over 80 % of the world's merchant fleet worldwide. The member countries of the Initiative are: Brazil, Canada, Greece (2024), Norway, Panama, HAE and Uruguay, with potential new members expected to be: Australia, Belgium, Chile, European Commission, France, Germany, Japan, Republic of Korea, India, Indonesia, Italy, Mexico, the Netherlands, Portugal, Spain, Singapore, USA and the United Kingdom.

The initiative aims to support governments and shipping in the city of "natural" maritime hubs, Clean Energy Marine Hubs (CEM-Hubs) through public and private know-how.

The work of the Clean Energy Marine Hubs initiative for the period 2024-25 will be concentrated on the following three main pillars to promote energy and maritime interaction through low carbon emissions: (1) developing the Alliance of CEM Energy and Shipping Hubs, (2) Activating Hubs' workflows and (3) Cross-sectoral cooperation and knowledge exchange.

12. International Energy Agency (IEA)

The International Energy Agency (IEA) is an autonomous International Agency established in 1974, which brings together thirty (30) countries, including Greece. The work of the DOE in its groups over recent years has been intense with discussions on the following issues: the enlargement of the Tax Office and the exploration of institutional ways of cooperation with Association Countries;

the modernisation of the emergency oil stock system;

C. the solidarity of the Member States with Ukraine, in particular with regard to the restoration of the damage caused to the country's energy infrastructure by the Russian attacks; and

D. The link between energy security and energy transition.

During the recent energy crisis in 2022, the DOE coordinated the countries at global level with

important initiatives to ensure the countries' energy shock.

Finally, the 'In-Depth Review' of the energy policy of its Member States, carried out by the Tax Office, is also important, showing the key elements of each country's energy policy. The most recent 'Examination' for Elada took place in 2022, in which the Tax Office congratulated Greece on its planning and significant achievements in energy policy in recent years.

13. Southern Gas Corridor Advisory Council

At the end of 2014, at the initiative of the President of Azerbaijan Ilham Aliyev and with the agreement of the Heads of State (Azerbaijan, Georgia, Türkiye, Greece, Bulgaria, Albania, Italy), related to the implementation of the Southern Gas Corridor (SGC), it was proposed to create an Advisory Council to effectively coordinate the measures for the implementation of this project, this included the development of the Shah Deniz II gas field in Azerbaijan, the development/extension of the South-Caucasus Pipeline in Azerbaijan and Georgia, the construction of the TANAP pipeline in Türkiye and the TAP pipeline in Greece, Albania and Italy. The European Commission, as well as the KPCs of the SCP, TAANAP and TAP deposit and pipeline companies, also participate at a high level in this Council. The first meeting took place in Baku, Azerbaijan, on 12 February 2015, and nine more meetings were called up until 2024 at an annual frequency.

14. The Three Seas Initiative

The Three Seas Initiative is an initiative bringing together 13 EU Member States between the Baltic Sea, the Black Sea and the Adriatic, namely: Austria, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia and most recently (September 2023) Greece. Ukraine and Moldova were granted partner status (September 2023).

The 'Three Seas Initiative' was created in 2014 and has since been attracting more and more senior players and leaders from business and politics. The countries of the Initiative meet at the level of the Trilateral and Business Forums. To date, eight Initiative Summits and Business Forums have been held. The 8th Session and Business Forum took place in Bucharest, Romania, on 6-7 September 2023.

15. MED9 cooperation

EU Med or MED9 is an alliance of nine Member States of the European Union in the Mediterranean: Croatia, Cyprus, France, Greece, Italy, Malta, Portugal, Slovenia and Spain. The Working Party was set up informally in Brussels on 17 December 2013 at the initiative of the Foreign Ministers of Cyprus and Spain, in order to coordinate issues of common interest to the countries of the Mediterranean region within the EU. At the 8th Summit, held in Athens on 17 September 2021, I wrote with the youngest members, namely Croatia and Slovenia. The Athens Declaration on Climate Change was also written at the same meeting.

In the same context and focusing on the energy sector, the MED 9^{Ministerial} Conference took place in Valletta in May 1, while the corresponding 2^{took} place in Larnaca in September 2024.

II. Tripartite and Multilateral Cooperation Arrangements:

1. Greece – Cyprus – Jordan

On 16 January 2018, a Memorandum of Understanding was signed in Nicosia between the Ministry of the Environment and Energy of the Hellenic Republic, the Ministry of Energy, Commerce, Industry and Tourism of the Republic of Cyprus and the Sub-Office for Energy and Mineral Resources of the Hashemite Kingdom of Jordan for the energy sector. The purpose of cooperation on the basis of the signed Memorandum of Understanding is the exchange of information and know-how, policy making, screening and actions for RES, Energy Efficiency, Innovation and Research, as well as the exchange of knowledge, best practices and pilot projects in buildings, with a particular focus on the promotion of nearly zero-energy buildings and the development of RES systems and technologies. Since 2018, 3 Kory Summits have taken place between the three countries and cooperation focuses mainly on RES and energy efficiency, in line with the relevant declarations.

2. Greece – Cyprus – Israel – Italy

A Memorandum of Understanding between the Republic of Israel, the Government of the Republic of Cyprus, the Government of the Hellenic Republic and the Government of the Italian Republic concerning cooperation on the EastMed gas pipeline was signed in Nicosia on 5 December 2017.

The purpose of this Memorandum of Understanding is to confirm from the parties involved their intention to cooperate in order to enable the development and implementation of the EastMed pipeline as a viable and strategic choice for gas producing states, to ensure an immediate and long-term export route for gas to Greece, Italy and other European markets, and to enhance the security of EU energy supply, while at the same time promoting competition between gas suppliers.

The Intergovernmental Agreement for the EastMed pipeline project was signed on 2 January 2020 by Greece, Cyprus and Israel. However, the Italian Government has not signed the agreement to date. Greece has ratified the Agreement with Law 4687/2020 (Government Gazette, Series I, No 98).

3. Greece – Cyprus – Israel

A Joint Declaration on Greece-Cyprus-Israel at the 5th Summit was signed in Israel on 20 December 2018, which, inter alia, focused on the completion of the Intergovernmental Cooperation on the EastMed Gas Pipeline. In addition, support for the Euro-Asia Interconnector project was mentioned, as well as the extension of cooperation in the field of RES, fuel alternators and electric vehicles, the enhancement of innovation as well as the implementation of joint pilot projects. Following the decision to implement the Helpline Interconnection of Crete as a national project (Ariadne Interconnection), with a view to ensuring the timely energy adequacy of Crete, Greece is supporting the implementation of the Crete – Cyprus – Israel electricity interconnection project for which a Memorandum of Understanding was adopted on 8 March 2021.

At the last 9th Summit held in Nicosia on 4 November 2023, the main points discussed concerned security, security, energy, civil protection, the climate crisis and tourism issues. During the meeting, the added value of the tripartite format and the efforts that work in the interests of stability and security in the region was highlighted, while the conditions for building an energy corridor from the Eastern

Mediterranean to Europe are in place. This includes the energy interconnection projects “Great sea Interconnector” (formerly EuroAsia Interconnector) and “East Med”. Finally, ways to promote the 3 + 1 cooperation scheme (Greece – Cyprus – Israel + USA) were discussed.

4. Greece – Cyprus – Egypt

The Joint Declaration of the 9th Tripartite Summit of Greece – Cyprus – Egypt (19/10/2021) explicitly mentioned once again the intention of the three countries to continue their cooperation through a series of agreements on the exploitation and transport of gas, as the discovery of deposits in the region can act as a catalyst for regional stability and prosperity. At the same meeting, the three countries also agreed that climate change should be a key element of the cooperation agenda.

In addition to the above mentioned trilateral cooperation in the gas sector, the three countries cooperate both through the joint exploitation of deposits and their participation in the EMGF.

For the interconnection of the electricity transmission networks of Greece, Cyprus and Egypt, a Memorandum of Understanding has been signed between the competent ministries of the three countries in the framework of the 9th Summit of 19 October 2021 setting out a general framework for cooperation for the implementation of the planning, licensing, development and implementation of the cross-border interconnection project.

III. Bilateral Cooperation

Greece is developing, bilaterally, more and more cooperation in the energy sector with many countries within and, in particular, outside the European Union, with a view to enhancing security of supply, using natural resources and facilitating the development of energy sources and routes. This gives it key strategic partners in the energy sector.

More generally, bilateral relations and areas of interest for cooperation between the people are defined and established, in addition to bilateral meetings and dialogues, in the framework of the holding of Joint Inter-Ministerial Committees (JITs) on economic labour, which take place on a regular basis (usually on an annual or biennial basis), under the coordination of the Ministry of Foreign Affairs and the participation of the relevant sectoral ministries. Finally, the Supreme Councils for Strategic Cooperation conducted bilaterally with the Ministry of Foreign Affairs constitute an important step in bilateral cooperation in all areas.

Below, we set out the most important developments in Greece’s bilateral relations with the main energy partners:

1. Greece – Israel

Energy relations with Israel have been institutionally strengthened by the signing of Joint Declarations between the two countries. On 8 August 2013, the 1st Joint Declaration on Energy Cooperation between Greece and Israel was signed in Nicosia. The continuation of the promotion of cooperation at bilateral level is carried out through the holding of senior Cooperation Councils (IACs). The last ASC between the two countries took place in Thessaloniki on 15 June 2017, at the end of which a Joint

Declaration describing the content of the bilateral cooperation was signed. This includes promoting energy security to adequately meet the growing demand for energy resources in the region, increasing energy supplies to enhance economic growth and prosperity, optimising the management of energy resources for the uninterrupted supply of energy goods in a sustainable manner, protecting the burden and reducing the impact of climate change. In July 2023, an Intergovernmental Agreement on Energy was proposed by the Greek side, which has been completed and is about to be formally signed.

2. Greece – Egypt

Enhanced cooperation between the two countries was stamped by the signature of two Electricity and Gas Interconnection Memoranda. More specifically, the 'Ell-Egypt Electricity Interconnection Project' (signed on 14 October 2021) includes onshore/offshore infrastructure, including electric submarine cables, providing a direct connection for the bi-directional transmission of electricity between the Hellenic Republic and the Arab Republic of Egypt as well as in the rest of the EU interconnected market. This project seeks to strengthen – strengthen the security and reliability of energy supply, promote fertile cooperation, peace and prosperity, and foster the further development and penetration of electricity produced from renewable energy sources in national, regional and European electricity mixes, building on the excess electricity that has been or will be further maintained. In addition, the Memorandum of Understanding on "Interconnection of natural gas" (signed on 25 November 2021) by the two countries aims at establishing a general framework that promotes cooperation in the gas sector (industry) which includes, inter alia, the strengthening of LNG trading, the creation of bi-directional gas pipeline connection and cooperation in the field of natural gas exploration.

3. Greece – Saudi Arabia

In 2022, the Greek – Saudi Arabia Business Forum (30 May) and the 5th Joint Ministerial Committee (31 May) took place in Athens. These declarations have given concrete impetus to further strengthen cooperation between the two countries in important sectors such as tourism, energy, innovation, investment, construction and the agri-food industry.

The partnership of the two countries has developed strongly in recent years and the need to consolidate and build on this work for the mutual benefit of their respective crowds has led to the signing, between the Government of the Hellenic Republic and the Government of the Kingdom of Saudi Arabia, of a Memorandum of Understanding (26 July 2022) for their cooperation in the field of energy. This Memorandum reflects their desire to strengthen their cooperation in various energy sectors such as oil, gas, electricity, renewable energy, energy efficiency, petrochemicals, as well as the circular coal economy and its concepts, in order to reduce the causes and impacts of climate change. In September 2023, transmission system operators (TSOs) of the two countries signed a Meta Agreement to promote electricity interconnection.

4. Greece – United Arab Emirates

Cooperation between the two countries in the field of energy and climate change is reflected in the signature of three Memoranda of Understanding as follows:

Initially, a “Memorandum of Understanding on cooperation on energy” between the two countries was signed on 4 May 2017 at the 3th meeting of the Joint Ministerial Cooperation Committee between the Hellenic Republic and the United Arab Emirates held in Athens on 3-4 May 2017.

A ‘Memorandum of Understanding on Climate Action’ was subsequently signed on 9 May 2022. The aim of this Memorandum of Understanding is to lay the foundations for facilitating and enhancing bilateral cooperation on climate action and provides the framework within which concrete cooperation projects and initiatives can be proposed and implemented by the participants.

Finally, Abu Dhabi Future Energy Company PJSC- Masdar and the Government of the Hellenic Republic signed a “Memorandum of Understanding on the GR-eco Islands Initiative” on 9 May 2022. The aim of this Memorandum of Understanding is to create a path to facilitate and strengthen bilateral cooperation on the GR-eco Islands initiative – a strategic government initiative of the Hellenic Republic in the fight against climate change that aims to transform the Greek islands into pioneers of green, sustainable and digital development through a just and socially inclusive energy transition.

5. Greece – North Macedonia

The two countries’ cooperation in the field of energy is implemented by the signing of a Symposium on the Development of the Natural Gas Interconnection between Greece and North Macedonia signed on 9 July 2021. The main objective of the Agreement is to declare support for the project to interconnect the gas systems of the two countries to be carried out by their competent gas companies and to decide that each company will construct, in coordination but independently of the other, the part of the project on the respective national territory.

6. Greece – Bulgaria

In the field of gas storage, a “Memorandum of Understanding on Gas Security” was signed on 16 February 2023 between Greece and Bulgaria. The aim of the Memorandum is, inter alia, to facilitate the possibility for Greek companies to store gas in the Bulgarian facilities in Chiren, ensuring similar access to Bulgarian companies in Revithoussa. This agreement increases the resilience of their security system for both countries, while at the same time consolidating their energy solidarity and work.

For cooperation in the field of crude oil Greece and Bulgaria decided to jointly explore the possibility of constructing a crude oil pipeline to connect the port of Alexandroupoli in the Hellenic Republic with the Burgas region of the Republic of Bulgaria (Alexandroupoli – Burgas oil project). For this reason, the two countries signed a ‘Memorandum of Understanding on the construction of the Alexandroupoli-Burgas oil pipeline’ on 16 February 2023.

Finally, as mentioned above, in the margins of the CESEC Ministerial Conference on 19 January 2024, a Memorandum of Cooperation was signed between the Energy Ministers of Greece and Bulgaria for cooperation in the energy sector, focusing on the promotion of new interconnection infrastructure.

7. Greece – Germany

The cooperation of the two countries is implemented by the holding of the EL-Lada-Germany Consultations, most recently in the 6th round, which took place in Athens on 30-31 May 2024. In the Action Plan, drawn up following the 6th round consultations, the two sides decided to reduce their dependence on Russian energy, in particular gas, as soon as possible, in compliance with EU measures such as diversification of supply, higher LNG imports and storage obligations. The common long-term objective is a fossil-free, climate-neutral, renewables-based energy system as part of their 2050 energy and climate strategy. In the framework of TARES4 (Technical support for clean energy divers in Greece), TARES5 (Technical support for clean electricity in Greece), TARES6 (Technical support for the implementation of investments and energy in the framework of the Greek Recovery and Resilience Plan) and H2Greece (Technical support for the implementation of the Greek National Hydrogen Strategy), supported by the Commission's Directorate-General for Reform (DG-Reform), cooperation in the field of renewable energy, energy efficiency and electromobility in Greece has intensified, in particular in the context of the national recovery and resilience plans. Both sides commit to further cooperation on innovative technologies and knowledge sharing in the field of RES and green hydrogen integration, as part of the DEU-GRC Clean Energy Construction Strategy.

8. Greece – Italy

On cooperation between the two countries in the field of energy, a joint declaration was signed in Corfu on 14 September 2017 between the Minister for the Environment and Energy of the Hellenic Republic and the Minister for Economic Development of the Republic of Italy, in the context of the First Bilateral Meeting of Greece – Italy.

Following the above Joint Declaration, the Ministry responsible for strengthening energy labour between the two countries was signed in Rome on 26 November 2019.

Finally, on 9 September 2022, the Ministry of the Environment and Energy of the Hellenic Republic and the Ministry of the Ecological Transition of the Italian Republic signed a 'Memorandum of Understanding on the Security of Gas Supply and Storage'. The Memorandum of Understanding aims to create a framework to enhance cooperation between the Parties to ensure that storage capacity is tied to underground storage facilities (UGS) located in the Italian Republic.

9. Greece – USA

Greece and the United States of America (US) have been working closely together through the exchange of Strategic Dialogues since 2018. In the context of the 5th Strategic Dialogue between the two countries held in Washington on 9 February 2024, the main topics for cooperation in the field of energy were Regional Energy Cooperation and Resilience and the Energy Transition, and the Dialogue also addressed climate change. In addition, cooperation between the two countries is strengthened to achieve energy security and regional stability, through multilateral cooperation schemes such as the Greece – Cyprus – Israel and the US (3 + 1) and the Eastern Mediterranean Gas Forum (see above), in which the US has an observer role. Finally, a bilateral Memorandum of Understanding between Greece and the USA (USAID) on energy cooperation in the Western Balkans was signed in Athens on 13/11/2023.

10. Greece – Azerbaijan

A Memorandum of Cooperation between Greece and Azerbaijan in the gas and oil sectors has been signed at institutional level (Baku, 2/8/2007). This Memorandum has been ratified by Law 3638/2008 (Government Gazette, Series I, No 15). In addition, on 16 February 2009, as part of the official visit of the President of Azerbaijan to Athens, a Memorandum of Understanding on cooperation between the two countries in the fields of RES and energy saving and energy was signed by the Greek Minister of Development and the Minister for Industry and Energy of Azerbaijan. This Memorandum has been ratified by Law 4462/2017 (Government Gazette, Series I, No 39).

In the current period, energy relations with Azerbaijan focus on the consolidation and expansion of the Southern Gas Corridor, to which the TAP gas pipeline, which starts from Azerbaijan and through our country, is part of Italy.

11. Greece-Türkiye

Cooperation between the two countries focuses on the topics of the “positive agenda” and, at the level of thematic energy and environment, the expansion of electricity interconnection capacity and the promotion of a Memorandum of Understanding in the field of civilian management.

IV. Other collaborations

- Participation in CA-EED (Concept Action Energy Efficiency Directive), CA-EPBD (Concept Action Energy Performance of Buildings Directive), CA-RES (Concept Action Renewable Energy Sources), on RES and energy extraction.
- Participation in ENTSO-E meetings on market and infrastructure issues.
- Participation in ENTSO-G meetings on gas market and infrastructure issues
- Participation/cooperation of the KPE as the National Centre for RES and Energy Savings in the European Network of Energy Centres (ENR) and the Medium-Ground Energy Centres Network (MEDENER).

Chapter 2: National objectives and targets

2.1 Overview of the general framework for setting targets

The Greek government intends to use the NECP as the main tool for developing the national energy and climate policy for the next decade, taking into account the recommendations of the European Commission and the UN Sustainable Development Goals.

The NECP highlights the priorities and development opportunities that our country has in terms of energy and climate change, and provides a concrete roadmap for achieving specific quantitative targets and which targets, describing policy priorities and measures, in a wide range of development and economic activities for the benefit of society.

The main objective of the National Energy and Climate Plan is to design, plan and implement the more socially, environmentally and cost-effective policy measures that will contribute to achieving the

medium and tough national energy and climate objectives, contribute to the country's economic development, while at the same time meeting the challenge of reducing energy costs and protecting end consumers from high prices of energy products and services in general. The national energy and climate targets for 2030 are determined taking into account specific quantitative charges assumed by Greece as a Member State, the characteristics and specificities of our national energy system, the domestic potential for the development of technologies and applications, the possibilities for adaptation, as well as the social, economic and legal characteristics of Greece. This process leads to the adjustment of national targets on the basis of corresponding central European targets (i.e. targets for sectors included in the Emissions Trading System, for RES, for energy efficiency) and which are finally proposed under this national plan.

In addition, under the National Plan, the key quantitative policy targets set for the period up to 2030 are also 'intermediate' targets for reducing greenhouse gas emissions by 2050, where the Greek Government's objective is to participate in the commitment to a climate-neutral household at European Union level.

The green energy transition aims at a climate-neutral energy system, i.e. close to zero CO₂ emissions from fossil fuel combustion and non-energy climate neutral processes. The target is the net sum of positive and negative greenhouse gas emissions taking into account the additional removal of CO₂ from soil, forests and the sea equal to zero in 2050 and thus persist.

The road to this target starts with the milestone of the year 2030 for which the EU legislation provides for a broad set of targets across all energy sectors in order to drastically reduce greenhouse gas emissions. The sector-specific targets for the year 2030, as well as the regulations on specifications, infrastructure and technologies, aim to guide all sectors in the choice of investments and changes so that the ambitious emission reduction trajectory is tempered and accelerated in the period from 2030 to 2050. An interim milestone is the year 2040 for which the National Climate Law provides for a concomitant emission reduction target and for which EU legislation has not yet come to an end.

The government supports the long-term strategic pathway for a climate-neutral economy, with a view to improving the competitiveness of the economy and manoeuvres, creating new jobs, strengthening its role to speak and comprehensively in the functioning of competitive energy markets for the benefit of Cyprus.

The main priorities of the NECP include inter alia:

- **Rapid RES growth:** Development of photovoltaics and wind (and speeding up the development of offshore wind) adding, in addition to the current approximately 12.5 GW, a further 12 GW by 2030 and, in addition, exploiting the country's remaining hydraulic capacity. Expansion of energy communities based on local self-government and focusing on photovoltaic developments in industrial and commercial roofs. Strategic importance in offshore wind development and ensuring siting and grid infrastructure.
- **Energy storage:** The high penetration of RES should be accompanied by the development of the

required storage (mainly battery and pumped storage technology) to shift excess RES over time, the provision of balancing/flexibility services (e.g. surge/download services) and system stabilisation, contribution to capacity adequacy and grid de-congestion services. Additionally, part of the above services will also be provided by demand response entities.

- **Energy Efficiency:** Energy upgrading of buildings (speeding up, significantly increasing the pace and depth of renovations, facilitating financing), re-establishing energy consumption management systems and changing the scope of energy to reduce the energy required and/or the demand profile. These actions can have significant added value and development of employment. Specific agreements with the industry sector on commitments to improve energy efficiency and reduce carbon footprint. Specific programme for heat pumps, replacement of appliances, burning and public sector buildings.
- **Digitalisation, resilience building and optimal use of electricity grids:** Electricity grids are becoming crucial in achieving energy and climate objectives and should accordingly be designed and developed so that they can best manage and respond to energy and climate challenges. In this context, capturing them, new investments and new planning for improving their resilience and optimum reception of increased RES penetration, as well as for the participation of flexible demand loads, are strategic priorities, contributing significantly beyond the achievement of specific quantitative energy and climate objectives, both to the security of energy supply and to the proper and competitive functioning of the electricity market.
- **Electrification of road transport:** Electrification in passenger and light/medium goods vehicles (possibly also in heavy vehicles) while developing charging infrastructure and systems to interact with the electricity grid. A large part of the required investments will be directed to zero-CO₂ vehicles but also to the deployment of smart charging infrastructure, ensuring that the delivered power can be managed using physiological systems. Electrification of trains and electrification of mooring boats and stationary aircraft.
- **Climate-neutral alternative fuels:** Support the development of a domestic industry producing climate-neutral alternative fuels for transport sectors that are not technically feasible or in interest to electrify, such as navy, aviation and possibly heavy long-distance road transport.
- **Gaseous fuel system:** Maintenance of the gas transmission and distribution system in the country and extension to areas or sectors that are not fed, provided that there is no independent investment and the progressive and targeted use of renewable gases so that the distributed mix becomes soon a low carbon footprint.
- **Bio-economy:** Investment and leverage for the development of national industrial and agricultural production of advanced biofuels and biogas formed into biomethane and injected into the gas network.
- **Creating a green hydrogen economy:** Progressive development of infrastructure and production of RES hydrogen, with priority being given to its use either as a clean fuel or as synthetic liquid fuels in aviation, shipping and heavy vehicles. There is already considerable mobility in this area that can develop a value chain in the country.
- **Innovation and systemic solutions in Carbon Capture and Storage (CCUS)** for the energy

transition of the country's industry (mainly tipping, oil refining). Development of investments in the capture of CO₂ from industrial processes, its use in the production of synthetic fuels and the development of infrastructure for geological storage of CO₂.

- **Support for new industries and business activities that break a domestic value chain for green energy technologies with a tie:** The aim is to maximise the benefits for domestic development and to engage with investments in the green transition and to support industries in reducing their carbon footprint and energy costs.
- **Adaptation to climate change:** Maintain the effectiveness of policies to reduce emissions and increase greenhouse gas removals in future climate conditions and develop a new neighbourhood system with increased adaptability and high resilience to climate change.

2.2 Climate Change, GHG emissions and removals

Piou

2.2.1 Reduction of greenhouse gas emissions

With a view to mitigating climate change, Greece is fully in line with the European Union's policy and commitments. In this context, the target of reducing net greenhouse gas emissions by 2030 is -55 % compared to 1990 emissions at European level.

The revised NECP foresees that this target for the year 2030 will be met – (~ 51 %) without taking into account the absorption of CO₂ by the Land Use, Land Use Change and Forestry (LULUCF) sector and that it can reach -58 % if a higher contribution from LULUCF is achieved.

This target is significantly higher than the current NECP. The NECP target for reducing greenhouse gas emissions in 2040 is set at -72 % without LULUCF and can reach -80 % taking into account the LULUCF sector. The corresponding target for the year 2050 is, according to the simulated scenario, set at -89 % without LULUCF and -98 % with LULUCF, which is marginally close to the 2050 climate neutrality target.

As mentioned below, low emissions remain in the year 2050 in some sectors where it is difficult to eliminate completely. These emissions need to be offset through negative emissions (i.e. removal of CO₂ from the atmosphere) mainly through removal, in the context of LULUCF.

Figure 7 shows the greenhouse gas emissions reduction trajectory inline with the climate neutrality objective in 2050.

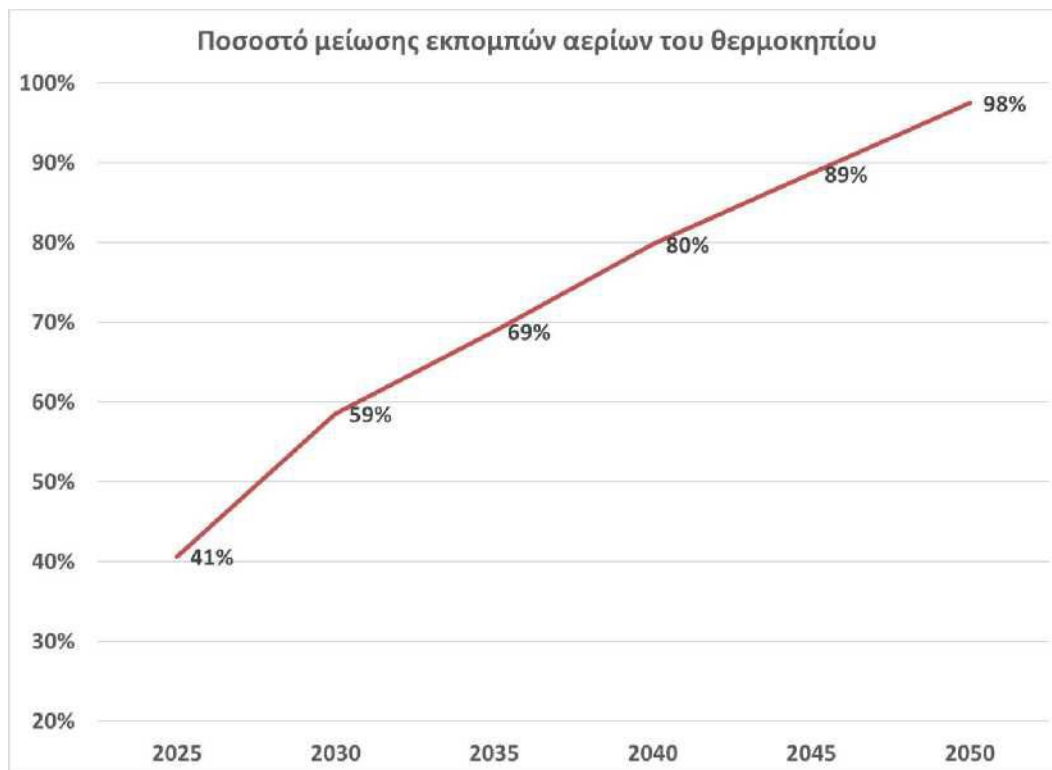


Figure 7 Path to reduce greenhouse gas emissions (including the LULUCF component) for the period 2025-2050.

The NECP seeks as a matter of priority to close to zero CO₂ emissions from energy production, already immediately after 2035, so that electricity can help reduce emissions in the transport and buildings sectors through electrification. In energy uses where electrification is difficult or asymmetric, electricity with an almost zero carbon footprint will produce green hydrogen that will either be used directly or serve to produce synthesised and climate-neutral gaseous and liquid fuels. To this end, CO₂ captured by biomass and the atmosphere will also be used. This strategy is expected to be fully underway immediately after 2035.

This, as well as through the major energy efficiency improvement foreseen in the NECP, will bring to zero CO₂ emissions in the building sectors, industry and transport. It is estimated that the complete elimination of emissions in the transport sector, notably in maritime and air transport, is likely to be difficult.

It should be noted that the large reduction in emissions already from 2023 comes from the withdrawal of lignite-fired power plants. De-lignification is a deep cut in the national energy map and is at the same time an enormous opportunity for the country. The spirit of innovation brought about by the exploitation of lignite will be translated into clean energy and the new energy mix of the 21st century.

For the transport sector, gradual decarbonisation is foreseen by the year 2030 mainly due to the penetration of biofuels and electricity in road transport. Electromobility contributes to this objective, contributing to a growing contribution thanks to a corresponding increase in the share of RES in electricity production, and secondly by biofuels and renewable fuels of non-biological origin. For the

latter, a binding target is set for the year 2030 to cover 1 % of all fuels in the transport sector. The plan envisages a significant expansion of advanced biofuels from suitable biomass feedstocks and in the future mainly from ligno-cellulosic biomass. In the long term, one third of fuel needs can come from advanced biofuels and at least 50 % come from climate-neutral synthetic fuels.

Reducing CO₂ emissions from industrial processes, where 2/3 is due to the production of building materials, is facilitated in the medium term by the capture of emitted CO₂, its use for the production of synthetic fuels (until 2040) and geological storage. However, the complete elimination of these emissions by 2050 seems difficult and needs to be further analysed.

There is a greater difficulty in reducing non-CO₂ greenhouse gas emissions, such as/most importantly methane from the livestock sector. Due to the specificity of the sector, further analysis of the policy measures and technologies needed to reduce emissions in this sector is foreseen.

A fundamental principle of national waste management policy is the promotion of the waste hierarchy, which achieves the gradual reduction of by-waste landfilled.

The main axes/actions are:

- Strengthening sorting at source, with particular emphasis on separate collection and treatment of bio-waste (urban and agro-livestock).
- The extension of the network of waste treatment plants (Waste Treatment Units – NPE, Recycling Recovery Units – RRF), Biowaste Treatment Plant (MSY).
- The production of alternative secondary fuels from the treatment of sub-urban municipal waste for its energy recovery (recovery).

In particular, the target has been set at national level to limit the disposal of waste from vegetation to landfill sites to 10 % of the total municipal waste generated in 2030, while specifically for biodegradable municipal waste destined for disposal, the Joint Ministerial Decision under Ministerial Decision Y-ΠEN/ΔΔΑ/90439/1846/29.9.2021 (Government Gazette, Series II, No 4514) sets a target of reducing to 35 % the total amount (by weight) of biodegradable municipal waste produced in 1995 (or the nearest reference year), and lays down a series of measures in accordance with the provisions of Law 4819/2021 (GG I 129). In addition, the National Waste Management Plan (ECHR) and the National Waste Prevention Programme, which refer mainly to the promotion of the waste hierarchy with priority to prevention, including reuse, and preparation for re-use and recycling, contribute to the achievement of the national target.

It should be noted that, as a general principle, since 2030, all waste suitable for recycling or other recovery, in particular municipal waste, shall not be accepted in landfills, with the exception of waste for which landfilling produces the best environmental results, in accordance with Article 4 of Law 4819/2021 (GG I 129).

Fluorinated gases (F-gases)

F-gases, which are very powerful greenhouse gases, with an overheating potential often thousands

times higher than that of CO₂ amount to 2.5 % of total greenhouse gases in the EU, and are used in everyday products as well as in industrial appliances. Hydrofluorocarbons (HFCs) are the most significant environmental harming F-gases, from a climate change perspective, even though they have a short lifespan. Also perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆) can remain in the steam ball for thousands of years. F-gases have adverse effects on climate change and measures are therefore taken to eliminate and reduce climate change. Between 1990 and 2014, fluorinated gases had doubled, unlike other greenhouse gases, which show a decreasing trend.

Regulation (EU) No 517/2014 of the European Parliament and of the Council of 16 April 2014 on fluorinated greenhouse gases and repealing Regulation (EC) 842/2006 was adopted to reverse the increase in fluorinated gases in the EU. On the basis of an evaluation carried out by the European Commission, the implementation of the Regulation has indeed led to a reduction in F-gases of horticulture. In particular, the supply of hydrofluorocarbons from the year 2015 to the year 2019 has been reduced by 37 % in metric tonnes and by 47 % in tonnes of CO₂ equivalent. In addition, there has already been a shift towards the use of alternative substances with a low global warming potential (GWP), including natural environments such as air, CO₂, ammonia, water, etc. in equipment traditionally using F-gases.

This Regulation provided for measures to prevent emissions and control leaks, control of by-products, end-of-life management of products and equipment, training and certification and control of the use of fluorinated gases. A quota system has now been introduced to implement a timetable for the continuous reduction of the quantity of hydrofluorocarbons, which importers and producers can place on the market every year, with a view to phasing them out and restrictions on their use have been introduced in several sectors.

Furthermore, to limit fluorinated gases from mobile air-conditioning systems under Directive 2006/40/EC on emissions of air conditioning systems in motor vehicles, the use of F-gases with a global warming potential of more than 150 is prohibited in all new cars and trucks since 2017.

In implementation of the Green Deal and the European Climate Law, emissions of fluorinated greenhouse gases need to be further reduced with a view to contributing to achieving 55 % emission reductions by 2030 and climate neutrality by 2050. In this context, the new Regulation (EU) 2024/573 was adopted to further limit emissions of fluorinated gases where the use of hydrofluorocarbons (HFCs) in heat pumps and air conditioning (AC) and cooling systems is planned to be phased out as early as 2025.

In particular, the new Regulation includes stricter provisions for the quota system and provides for a greater reduction in the quantities of hydrofluorocarbons (HFCs) placed on the market with a view to their consumption being phased out by 2050. In addition, hydrofluorocarbons used in fuelled appliances are included in the quota system. In addition, in the above Regulation more stringent provisions are added to prevent emissions from F-gases and more categories of F-gas equipment have been included. For the implementation of the Regulation in Greece, the Joint Ministerial Decision

under Ministry of the Environment, Energy and Energy (Ministry of the Environment, Energy and Energy)/ΔΔΕΔ/85858/2124/16.9.2021 (Government Gazette, Series II, No 6777) has been issued, which provides for the necessary services and the necessary measures and procedures for the implementation of European legislation. The competent authorities on the basis of the above Joint Ministerial Decision (in particular the regional authorities and the customs authorities) control the movement of fluorinated gases and impose penalties under Article 15 thereof. A Technical Interministerial Committee has also been set up to support the coordination work carried out by the Ministry of Environment and Energy. The inspection shall be carried out by the competent authorities, in particular the regional services and the customs authorities, and in the event of failure to comply, the relevant penalties shall be applied on the basis of the above joint ministerial decision. For the proper implementation of the new Regulation, it is expected to be revised.

In order to better supervise the implementation of Regulation (EU) No 517/2014, the Directorate for Air Change and Quality of the Ministry of the Environment and Energy has set up and maintained from 2019 an electronic database called the 'F-GASES DATA Database'. The purpose of this database is to: (a) recording equipment installed in the Greek system and operating with fluorinated gases and (b) recording the movement of refrigerant fluids on the domestic market (with the exception of very small quantities). This facilitates the implementation of the prescribed controls and ensures that work on fluorinated gases is carried out by certified personnel.

The functioning of this base is a supervisory tool for in-country auditing and it complements the supervisory tools used by the EU.

Finally, Directive 91/676/EEC on nitrogen oxides from pollution caused by nitrates from agricultural sources must be implemented, submitting to the EU every 4 years the relevant report on the state of nitrate pollution in surface waters and groundwater, with the corresponding processed data in tables posted on the EIONET.

2.2.2 Emissions and removals in the land use, land use change and forestry (LULUCF) sector

The Land Use, Land Use Change and Forestry (LULUCF) sector plays one of the main roles in the carbon cycle, constituting a CO₂ sink and contributing significantly to the reduction of Greece's total net emissions. In the period 1990 – 2022, the net runoff in LULUCF land accounting categories ranged from -2 Mt CO₂eq to -5.5 Mt CO₂eq. In 2022, based on the latest inventory in 2024, Greece carried out removals amounting to 5.391 Mt CO₂eq.

The majority of CO₂ removals come mainly from managed Greek forests, while the contribution of cropland as well as grassland is significant. On the other hand, the activities of the land use, land use change and forestry sector also cause emissions, mainly from fires or land-use changes. The greenhouse gases emitted in these cases mainly include carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O).

The contribution of the different land use categories to Greece's LULUCF emissions and removals is shown in Figure 8.

In order to increase the accuracy and completeness of the calculations, Greece has prioritised the upgrading of the monitoring, reporting and verification system of removals from the LULUCF sector (MRV), in compliance with Regulations (EU) 2018/841 and (EU) 2018/1999, and the protection and management of natural resources to increase future runoff, as the benefits of LULUCF related interventions are usually several years to deliver.

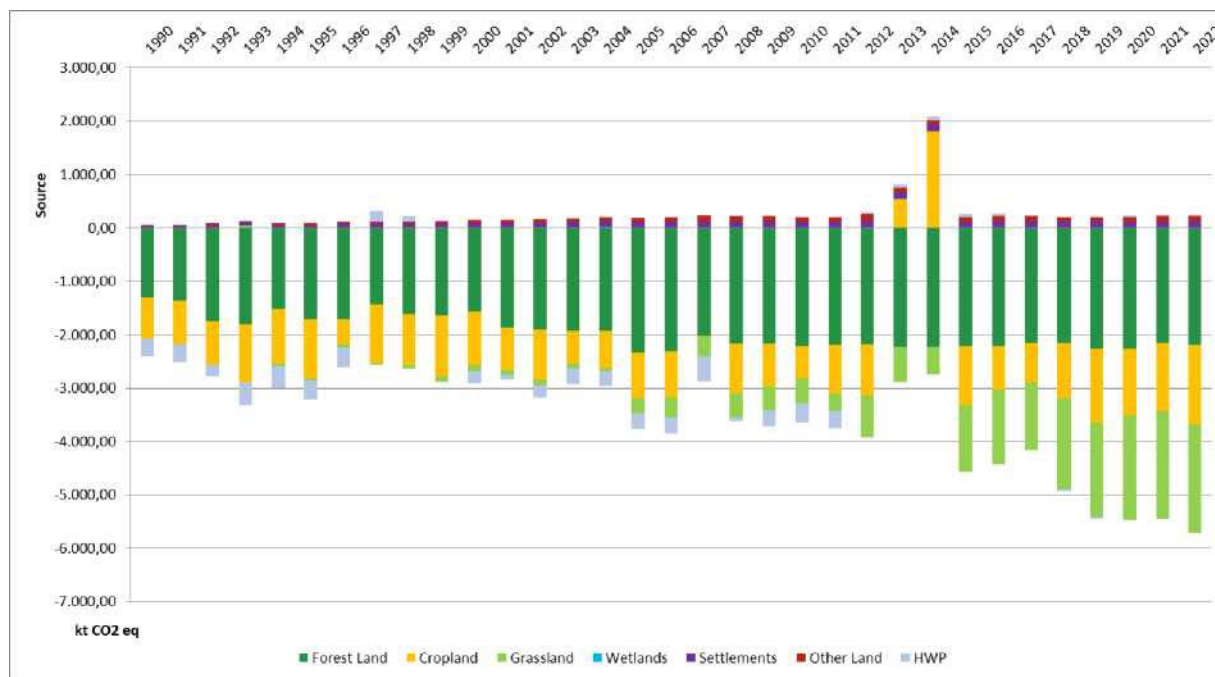


Figure 8 Emissions and removals (in ktCO₂eq) by land use category for the period 1990 – 2022 (source: Annual National Greenhouse Gas Emission Inventory to the UNFCCC, 2024).

As regards the monitoring system (MRV), the Ministry of the Environment and Energy is currently implementing the project for the installation and first operation of a compilation of the inventory and monitoring of forests and wooded land in Greece through the project ‘System for the installation and first operation of an inventory system and for the follow-up of forests and wooded land to meet the obligations of the country and to formulate a strategy for adapting to and mitigating climate change’. The project will produce, gradually from the year 2025, data necessary to estimate the carbon balance in the above-ground and underground biomass of forests. Due to its permanent nature, the network will have the possibility to exert carbon stock changes for the aforementioned reservoirs, by carrying out periodic measurements. In the future, the network may be used to measure elements necessary to calculate CO₂ emissions and removals from other carbon pools (deadwood, foliage, soil).

At the same time, national and European programmes (HORIZON et al.) are being carried out to improve scientific knowledge of LU-LUCF parameters, and new research programmes are planned. For example, the programme ‘Creation of a monitoring network for sustainable and multifunctional Mediterranean forest ecosystems to draw up a strategy for the mitigation and adaptation of the effects of potential climate change’, which will be proposed by the Ministry of the Environment and Energy (Directorate-General for Forestry and the Forestry Environment) for inclusion in a Green Fund funding

programme. In addition, in order to improve the MRV system in the sector, the National Technical University (Technical Adviser to the Ministry of Environment and Energy) has prepared a plan of required actions as a project proposal, for which it is seeking funding through the European LIFE programme or other resources. All this is expected to contribute to the methodological upgrade of the sector's emissions and removals estimates.

It should be noted that improvements have already been made in Greece's greenhouse gas inventories, in accordance with the relevant European regulations, such as the calculation of changes in organic carbon stocks in farmland soils and the recording of land-use changes using geospatial data. These improvements have already helped to improve the accuracy of emissions and removals calculations in the LULUCF sector.

As regards existing land uses, with the completion of the project to post and ratify the country's forest maps, the country's forests and land were mapped, with the aim of protecting them from arbitrary EPEm bases and unregulated construction, helping to prepare the right spatial planning and safeguarding private and public property. Forest maps were posted in 2021 and cover 95 % of the country. The remaining 5 % relates to areas excluded from posting as areas of town plans and demarcated land areas in Greece, as indicated by the competent services. Following the expiry of the award of forest maps, the areas of the forest maps that have not been challenged have been ratified in accordance with Articles 17 and 19 of Law 3889/2010 (GG I 182). The area covered by the ratified forest maps amounts to around 90 % of the country. The remaining 5 % of the posted maps relate mainly to areas that have been challenged in terms of their thematic content and, at this stage, are being reviewed by the competent Objections Review Committees (PSEQs).

A necessary future improvement is the inclusion of emissions and run-off from "unmanaged" forests, i.e. forests for which there are currently no management studies. To this end, 19 pilot studies are already being carried out in four Greek regions covering an area of 1 395 ha, while legislation is planned for the future to extend management to all public forests, as well as the operation of a digital platform for the registration of studies. The inclusion of these areas in the 'managed forests' category of the greenhouse gas inventory is estimated to be implemented in 2028 (with the reference year 2026, i.e. once the WPC project for the forest inventory has been completed). In addition, Law 5106/2024 (Government Gazette, Series I, No 63) established hybrid labour schemes for the management and exploitation of public forests in accordance with approved management and other studies on the protection of forest systems. The above steps are part of the public forest management reform implemented by the Ministry of Environment and Energy.

The new voluntary carbon credit market scheme expected to operate in 2025 will also contribute towards increasing managed forest land. Carbon credits or credits allow companies and other organisations to offset greenhouse gas emissions by financing projects that remove CO₂ from the atmosphere. These include temporary carbon storage projects from afforestation, but also from forest restoration.

Estimates for carbon removal in soils and woody biomass in the grassland category are also to be

incorporated. Until now, the greenhouse gas inventories have included quantitative data on the areas of land, as well as on the land of “unmanaged” forests, but not estimates of their waste.

The upgrades that will be carried out in the national gas inventories of the Greek heat range also include methodological changes in accordance with Regulations (EU) 2018/841 and (EU) 2018/1999, such as the upgrading of tiers (levels of methodological complexity) and the further use of geospatial data to account for areas by land use category and to monitor the development of these uses. The changes to be made will reshape the golden line and historical removals in the inventory.

In conclusion, the inclusion of new carbon pools and managed land, the upgrading of methodologies with new removals modelling and the use of geospatial land-use data, in accordance with Regulations (EU) 2018/841 and 2018/1999, will contribute to a more accurate and complete mapping of the carbon balance in the LULUCF component. This will further highlight the contribution of forests and other land sinks to Greece’s path towards climate neutrality.

For LULUCF, based on Article 4 of Regulation (EU) 2018/841, the targets for Greece are:

- ⑩ for the period 2021-2025, GHG emissions from the LULUCF sector must not exceed removals in all land accounting categories.
- ⑩ for the year 2030, Greece needs to achieve 1.154 Mt CO₂eq additional net removals from the average removals of the years 2016, 2017 and 2018, as calculated in year 2032. As indicated in Annex IIa to the Regulation, the target for Greece for 2030 was 4.373 Mt CO₂eq removals based on the 2020 inventory. Due to time series recalculations based on the latest 2024 inventory, this target is now 5.372 Mt CO₂eq removals.
- ⑩ for the period 2026-2029, Greece’s net removals must remain within a ‘national budget’, which will be calculated in 2025 on the basis of the greenhouse gas inventory submitted that year and on the basis of the parameters set out in Article 5 (4) of the above Regulation. Compliance with the budget will be examined on the basis of the census submitted in 2032.

Greece is set to meet the 2025 target and is expected to reach the 2030 target with great pressure, taking into account, as already mentioned, that removals in 2022, based on the latest national inventory, are estimated at 5.391 Mt CO₂eq.

According to new projections of LULUCF emissions and removals, Greece’s removals are expected to increase in the coming years. The projected increase is due to the increase in the carbon storage capacity of the LULUCF sector as a result of the implementation of measures and policies. In addition, due to the inclusion of additional data in the greenhouse gas inventory, as part of the necessary methodological upgrades in accordance with Regulations (EU) 2018/841 and 2018/1999, and as part of the improvement of the MRV system, the recorded removals will also increase for the historical years of the time series.

Estimates of the evolution of LULUCF removals up to the year 2050 were made under two scenarios:

- ⑩ the With Existing Measures (WEM) baseline scenario, which builds on the implementation of existing or adopted policies and measures to be implemented. Table 1 shows the LULUCF sector emissions and removals projection based on the WEM scenario, by land use category inline with

Regulation (EU) 2018/841.

- ⑩ the With Additional Measures (WAM) scenario, which is based on the implementation of additional measures that may further contribute to increasing removals. Table 2 shows the LULUCF sector emissions and removals projection based on the WAM scenario, by land use category according to Regulation (EU) 2018/841.

It should be noted that the additional measures in the WAM scenario could potentially increase LULUCF removals from 0,6 to 1.8 Mt CO₂eq inclusive (price increase over the years). It is therefore important to include them in planning within the next few years, so as to provide a safeguard for Greece's commitment to achieving the 2050 climate neutrality target set in the National Climate Law (Law 4936/2022, Government Gazette, Series I, No 105).

Table 1 View the potential of the LULUCF sector (with existing measures in place –WEM Nar).

LUC Land Use Categories – LUCF 6	Baseline scenario projections (WEM) – Mt							
	2015	2020 ⁷	2025	2030	2035	2040	2045	2050
Total managed forests	– 3.1	– 3.1	– 3.3	– 3.5	– 3.6	– 3.7	– 3.7	– 3.8
Forests remaining forests	– 3	– 3.1	– 3.2	– 3.3	– 3.4	– 3.6	– 3.7	– 3.8
Afforested land	– 0.1	0.0	– 0.1	– 0.2	– 0.2	– 0.1	0	0
Deforested land	0	0	0	0	0	0	0	0
Sum managed cropland	– 1.1	– 1.3	– 1.3	– 1.4	– 1.5	– 1.6	– 1.7	– 1.8

In accordance with Regulation (EU) 2018/841.

The removals of the historical years 2015 and 2020 differ from those of the national greenhouse gas inventory projected in 2024, because they include a conservative estimate of the contribution of the entire forest area.

LUC Land Use Categories – LUCF ²	Baseline scenario projections (WEM) – Mt							
	2015	2020 ³	2025	2030	2035	2040	2045	2050
Cropland that remains cropland	– 1.1	– 1.3	– 1.3	– 1.4	– 1.5	– 1.6	– 1.7	– 1.8
Land converted to cropland	0	0	0	0	0	0	0	0
Sum managed grassland	– 1.2	– 1.9	– 1.8	– 1.8	– 1.8	– 1.7	– 1.7	– 1.7
Meadows on meadows	0	0	0	0	0	0	0	0
Land converted to grassland	– 1.2	– 1.9	– 1.8	– 1.8	– 1.8	– 1.7	– 1.7	– 1.7
Total managed wetlands	0	0	0	0	0	0	0	0
Total agglomerations	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total other areas	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Harvested wood products	0.1	0	0	– 0.1	– 0.1	– 0.2	– 0.2	– 0.2
Total LULUCF in million tonnes of risk CO₂	– 5.1	– 6.1	– 6.2	– 6.6	– 6.8	– 7.0	– 7.1	– 7.3

Table 2 View the potential of the LULUCF sector (with additional measures in place – WAM Scenario).

LULUCF Land Use Categories ⁸	Scenario <i>em&m</i> projections (WAM)							
	2015	2020	2025	2030	2035	2040	2045	2050
Total managed forests	– 3.1	– 3.1	– 3.3	– 3.8	– 3.9	– 4	– 4.1	– 4.3
Forests remaining forests	– 3	– 3.1	– 3.2	– 3.6	– 3.7	– 3.9	– 4.0	– 4.2
Afforested land	– 0.1	0.0	– 0.1	– 0.2	– 0.2	– 0.1	– 0.1	– 0.1
Deforested land	0	0	0	0	0	0	0	0

In accordance with Regulation (EU) 2018/841.

The removals of the historical years 2015 and 2020 differ from those of the national greenhouse gas inventory projected in 2024 because they include a conservative estimate of the contribution of the total forest area and additional carbon sinks.

LULUCF ⁴ Land Use Categories	Scenario <i>em&m</i> projections (WAM)							
	2015	2020 ⁵	2025	2030	2035	2040	2045	2050
Sum managed cropland	— 1.1	— 1.3	— 1.3	— 1.4	— 1.5	— 1.6	— 1.7	— 1.8
Cropland that remains cropland	— 1.1	— 1.3	— 1.3	— 1.4	— 1.5	— 1.6	— 1.7	— 1.8
Land converted to cropland	0	0	0	0	0	0	0	0
Sum managed grassland	— 1.2	— 1.9	— 2.4	— 2.4	— 2.5	— 2.4	— 2.5	— 2.6
Meadows on meadows	0	0	— 0.6	— 0.6	— 0.7	— 0.7	— 0.8	— 0.9
Land converted to grassland	— 1.2	— 1.9	— 1.8	— 1.8	— 1.8	— 1.7	— 1.7	— 1.7
Total managed wetlands	0	0	0	— 0.1	— 0.1	— 0.1	— 0.2	— 0.2
Total agglomerations	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total other areas	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Harvested wood products	0.1	0	0	— 0.1	— 0.1	— 0.2	— 0.3	— 0.4
Total LULUCF in million tonnes of risk CO₂	— 5.1	— 6.1	— 6.8	— 7.6	— 7.9	— 8.1	— 8.6	— 9.1

As regards **changes in carbon storage** due to measures, the projections of the With Existing Measures (WEM) baseline scenario were based on the following assumptions:

- From the reference year 2025 onwards, removals from all forests in the country are calculated (167 % increase in managed area). These calculations are conservative and are based on the data from the management studies of the Ministry of Energy, Energy and Energy, which include losses from fires and from the extraction of wood products. The current data is currently incomplete, so forecasts are subject to quite high uncertainty. Once the forest inventory has been completed, it will be possible to estimate forest removals more accurately, based on the results and tools obtained.
- The contribution of afforestation of agricultural land and other interventions by the agricultural sector relating to LULUCF and included in the CAP AA has been taken into account. The above estimates were based on the assumption that each input would be applied for 20 years, after which (2045) removals would gradually decrease by 50 % for Pillar 1 interventions, as well as 90 % for Pillar 3 interventions (afforestation).
- The category 'Forested land' has included removals from the restoration of lignite mines by PPC

with fake acacia plantations, based on the COFORMIT project data¹⁰. For the period after 2035, the absorption potential of existing plantations that have reached maturity is expected to decrease.

In the With Additional Measures (**WAM**) scenario, the assumptions of the baseline scenario and, in addition, the following assumptions, are valid:

- Systematic forest management – rectification of degraded forest ecosystems (coppice broadleaved – scrub in high forests), with an area of approximately 700 kha by 2050 (20 % of the country's forest area).
- Removals from the restoration of additional areas of lignite mines of approximately 5 000 ha or other disturbed areas have been included in the category 'Forested land', based on data from the COFORMIT project (conversion from another category to 'afforested land').
- Due to the mandatory transition to higher accuracy methodologies (Tier 2 or 3, according to IPCC guidance) based on the requirements of the LULUCF Regulation, the reservoirs of woody biomass and soil organic carbon shall be included in the reports to be submitted from 2028 onwards into land in the 'grasslands' (e.g. shrubs). These removals were estimated on the basis of corresponding carbon pools reduced by between 25 % (2030) and 40 % (2050), taking into account temporal variation, corresponding data from Italy's national greenhouse gas inventory¹¹.
- Return domestic production of long-lived wood products to floors in the period 1990 – 2011 (halting the continuously decreasing trend of wood products produced in recent years).

Taking into account emissions and removals from coastal ecosystems of the Posidonia meadows, the carbon removal potential of which is estimated at 68 kt CO₂ eq per year, based on research results from the ELKETHE for the South Aegean region (Apostolaki, etc., currently being published).

Note that the potential for carbon removal from the LULUCF sector is inherently uncertain, as it is endangered by natural disasters (fire, floods, insect or disease tree infestations, etc.). It is also affected by anthropogenic activities that can cause degradation of soil and coastal ecosystems or other significant impacts. These effects, in certain cases, are not immediately apparent in order to take appropriate action.

It is therefore important in the future that Greece achieves even higher decelerations than planned, both to further contribute to reducing its emissions on the path to climate neutrality and to resist uncertainties and any risks that may be introduced in the next period.

It is worth mentioning that consideration will be given to an increase in the potential for CO₂ capture

¹⁰Xanthopoulos G, Radoglou K, Derrien D, Spyroglou G, Angeli N, Tsioni G and Fotelli MN (2023) Carbon sequestration and soil nitrogen enrichment in Robinia pseudoacacia L. post-mining restoration plantations. Front. For. Glob. Change 6: 1190026. doi: 10.3389/ffgc.2023.1190026.

¹¹ Italian Greenhouse Gas Inventory 1990-2021 National Inventory Report 2023, Rapporti 383/2023, ISPRA, Rome (<https://unfccc.int/documents/627845>).

and storage due to biocarbon (Blochar), which results from the thermal conversion of organic matter with no (or minimal) oxygen. The untapped potential of untapped solid biomass in Greece can yield an annual biocarbon production of one million tonnes, leading to a CO₂ capture of around 2.5 million tonnes on an annual basis by 2050.

2.2.3 reduction of transport emissions

Reducing emissions of gaseous pollutants from the transport sector **is a key priority** on the country's path towards climate neutrality by 2050. The transport sector is the second largest source of total-greenhouse gas emissions in Greece, and is the only sector where GHG emissions have increased compared to 1990 levels (an increase of around 13 % between 1990 and 2021)¹². In fact, road transport is responsible for the largest share of these emissions (around 85 % of the sector's total emissions).

Against this background, the objective is to achieve a gradual decarbonisation of the transport sector by the year 2030, which is planned to be mainly supported (Figure 9):

- the further penetration of biofuels (almost doubling the volume compared to 2022), with a significant increase in the use and import of road transport and in aviation;
- electrification of land (road and rail) transport

The penetration of biofuels and electricity is driven by policies such as the revised targets of the RED Directive and policies imposing caps on the emissions of the fleet of new vehicles entering into circulation.

The revised NECP, especially for the road transport sector, **sets updated and more ambitious targets for reducing CO₂ emissions from new passenger cars than the existing ones, and sets sub-targets for light-duty trucks (LCVs) for the first time**¹³. For these two categories of vehicles, decarbonisation targets are mainly achieved through their electrification. **Targets are also set for the first time for the other sectors and categories of operations** (e.g. heavy road transport, maritime transport, etc.) with the **adoption of a combination of technologies and solutions**, such as the use of renewable liquid and gaseous exhaust gases and electric mobility.

¹² NATIONAL INVENTORY REPORT OF GREECE FOR GREENHOUSE AND OTHER GASES FOR THE YEARS 1990-2021 (2023 NIR).

¹³ Light lorries are defined as light commercial vehicles up to 3.5 tonnes (LCVs).

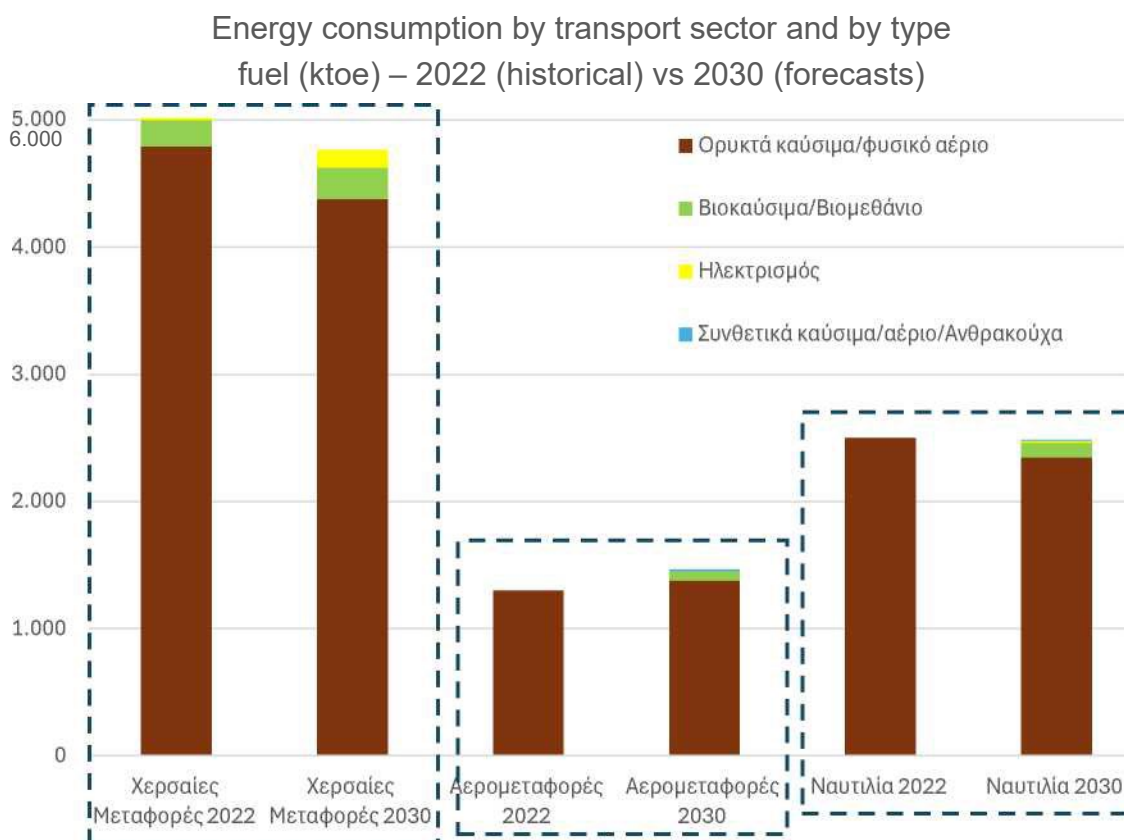


Figure 9 Energy consumption (in 000 pps) by transport sector and fuel type, for the years 2022 (historical) and 2030 (projections).

** In Figure 9 maritime transport includes coastal shipping and sea-going shipping.*

The gradual electrification of certain transport sectors makes it possible to couple energy sectors and achieves a greater contribution of RES to the energy allocation in transport. The share of RES in the transport sector is projected to increase significantly by 2030, reaching 13.9 %, with much higher figures-exceeding 35 % achieved in the coming years until 2035.

At the same time, there is demand for renewable fuels, due to their use in the regulated transport-sectors, with the demand for biofuels in this sector expected to almost double by 2030 compared to 2022 levels, which is a prerequisite for making the necessary investments to develop their production.

As a result, **emissions of carbon dioxide from the land transport sector are expected to be reduced by 10 % in 2030 compared to 2022** (Figure 11), thus offsetting the expected increase in carbondioxide emissions from the maritime and aviation sectors due to an increase in activity in these sectors and the resulting increase in consumption.

The sharp decrease in energy consumption in the transport sector is expected to occur in the period after 2030, and most importantly from 2035 to 2050, and will be mainly due to the decrease in consumption in land transport, asalso found in Figure 10.

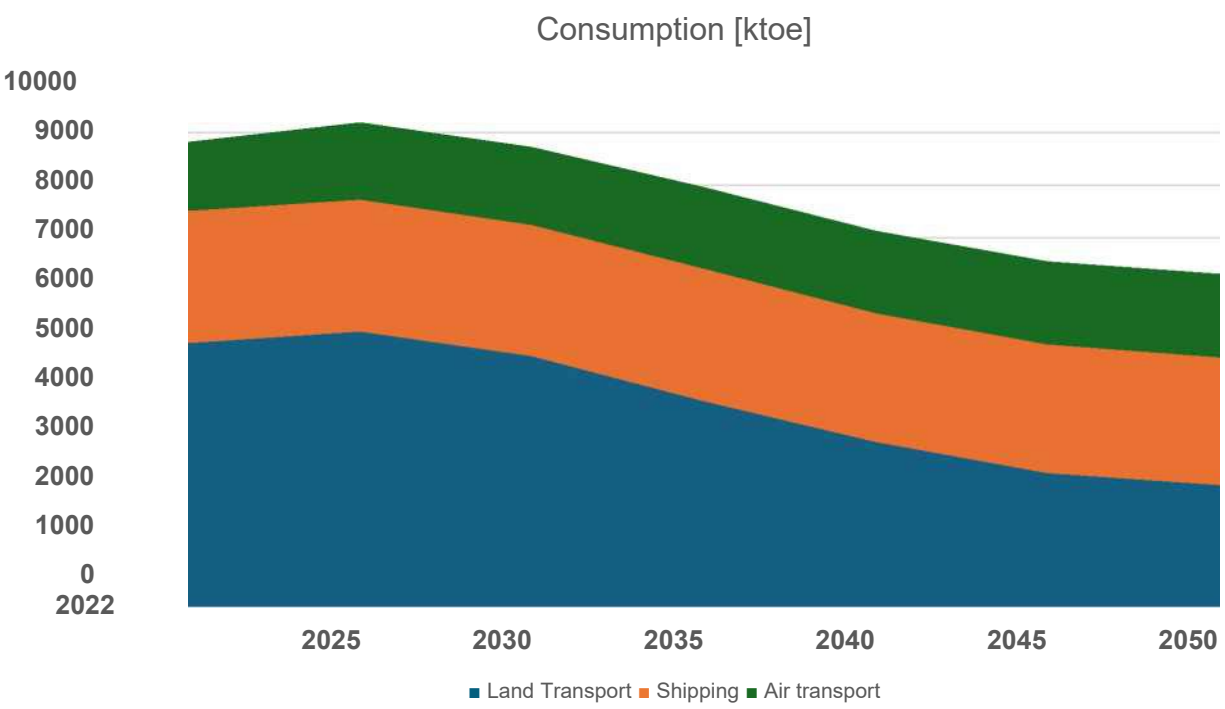


Figure 10 Energy consumption (ktoe) by transport sector, for the period 2022 (historical) up to 2050 (forecasts).

At the same time, due to the significant penetration of RES and greener transport, which is expected to occur during the same period, the ratio of CO₂ emissions to energy consumption (kton CO₂/ktoe) will also improve, both for the sector as a whole (average) and for individual clusters, with the land and aviation sectors showing the greatest decline, as shown in Figure 11.

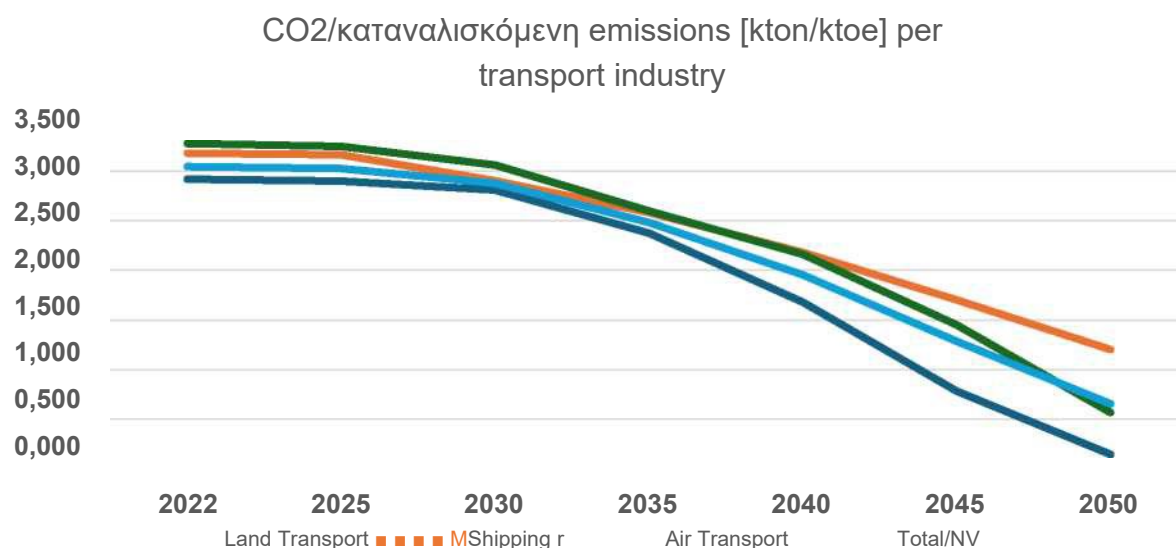


Figure 11 Evolution of CO₂ emissions per unit of energy consumed (kton CO₂/kt_{oe}), average sector and transport sector.

Road transport

The new targets set in the revised NECP for reducing the carbon footprint of road transport are ambitious as they are based on the successful path toward the NECP 2019 targets to date, but at the same time remain realistic, taking into account the starting point of this sector, with Greece having one of the oldest fleets of vehicles in Europe. In particular, the average age of cars and lorries in Greece is 17 years and 23 years respectively, while the average across the EU is 12 years and 14.2 years respectively¹⁴. In fact, especially for light lorries (LCVs), lorries and buses, the majority of registrations in Greece relate to imported used vehicles, which is taken into account when setting the relevant targets.

Light Road Transport

Electric vehicles in light road transport are expected to be the predominant way to reach the EU CO₂ emission standards.

Annual targets for electric mobility penetration of the light-duty vehicle fleet by 2030

Under the revised NECP, new CO₂ emission reduction targets are being updated and adopted by the new light vehicles that are expected to be registered in the country in the coming years, by 2030, also adopting the relevant provisions of European (Fit-for-55) and national legislation (Climate Law: law 4936/2022, Government Gazette, Series I, No 105).

In particular, Table 3 and Table 4 contain an update of the existing targets for new passenger cars and

¹⁴ Source ACEA (2023) Average age of the EU motor vehicle fleet, by vehicle type – ACEA – European Automobile Manufacturers' Association. Available at: <https://www.acea.auto/figure/average-age-of-eu-motor-vehicle-fleet-by-vehicle-type>.

¹⁵ Light duty vehicles are passenger cars (IX and taxis) of type M1, and light commercial vehicles up to 3.5 tonnes (LCVs), type N1.

the adoption for the first time of separate targets for light-duty vehicles respectively, each year until 2030. These two Tables provide two different scenarios setting specific annual quantitative targets for 2030 for these two categories of vehicles, both in terms of number of vehicles and market share of electric vehicles in relation to the total projected registrations of new vehicles. The two scenarios in the revised NECP are defined as follows:

- **Scenario A – Base Scenario:** A scenario in which, in order to achieve the objectives set, it is necessary to continue the existing measures (such as, for example, the subsidy programmes ‘Kinomi Electrics’, ‘Lotto Pantou’), without taking any additional measures.
- **Scenario B – Scenario B:** A scenario where a prerequisite for achieving the objectives set is the implementation of additional policy measures to promote electro-mobility¹⁶.

The annual targets for the share of electric passenger cars in total new registrations per year **until 2030 have been revised upwards**, in the optimistic scenario (Scenario B, Table 3), **while ambitious targets are also foreseen for the first time** for the share of electric light trucks in total new registrations (Table 4), with market shares of 50 % and 40 % respectively for these two sectors for 2030.

Regarding the estimated distribution between electric vehicle types (pure electric vehicles – BEVs and plug-in hybrid vehicles – PHEV¹⁷), this is estimated for autochthonous islands at a rate of 50 % -50 % immediately following years, with a gradual shift to 67 % -33 % in 2030 in favour of pure electric vehicles. Similarly for light vans, the amount of pure BEVs is projected to be more than 90-95 % compared to plug-in hybrid -PHEVs throughout the period up to 2030.

¹⁶ It should be noted that it has been assumed that the increased policy measures to be implemented will have a positive impact both on the electric vehicle market and on the total number of new passenger vehicles (all types of fuel) to be registered, as shown in Tables 3 and 4 respectively.

¹⁷ Plug-in hybrid -PHEV in the text means externally chargeable hybrid electric vehicles.

Table 3 Annual targets for the penetration of new electric passenger vehicles over total travel periods in the Greek market by 2030 (Scenario A – Base Scenario, Scenario B – Aisiodox Scenario).

Screenplay Year		Purchase of new passenger	Total passenger market change	Increase in total market	Passenger BEV-PHEVs	Year-on-year increase	Percentage of BEV-PHEVs year s
Scenario A – Base Scenario	2018 *	103.431	—	—	314	—	0.30 %
	2019 *	114.109	10.678	10 %	480	166	0.42 %
	2020 *	80.977	— 33.132	— 29 %	2.135	1655	2.64 %
	2021 *	100.911	19.934	25 %	6.961	4826	6.90 %
	2022 *	105.283	4.372	4 %	8.320	1359	7.90 %
	2023	130.000	24.717	23 %	12.740	4420	9.80 %
	2024	136.500	6.500	5 %	17.063	4323	12.50 %
	2025	143.325	6.825	5 %	21.499	4436	15.00 %
	2026	150.491	7.166	5 %	26.336	4837	17.50 %
	2027	158.016	7.525	5 %	31.603	5267	20.00 %
	2028	165.917	7.901	5 %	38.161	6558	23.00 %
Scenario B – Aisiodox Scenario	2018 *	103.431	—	—	314	—	0.30 %
	2019 *	114.109	10.678	10 %	480	166	0.42 %
	2020 *	80.977	— 33.132	— 29 %	2.135	1655	2.64 %
	2021 *	100.911	19.934	25 %	6.961	4826	6.90 %
	2022 *	105.283	4.372	4 %	8.320	1359	7.90 %
	2023	130.000	24.717	23 %	12.740	4420	9.80 %
	2024	136.500	6.500	5 %	20.475	7735	15.00 %
	2025	147.420	10.920	8 %	28.010	7535	19.00 %
	2026	159.214	11.794	8 %	38.211	10201	24.00 %
	2027	171.951	12.737	8 %	51.585	13374	30.00 %
	2028	185.707	13.756	8 %	66.854	15269	36.00 %
Scenario C – Aisiodox Scenario	2029	200.563	14.857	8 %	86.242	19388	43.00 %
	2030	216.608	16.045	8 %	108.304	22062	50.00 %

Table 4 Annual targets for the penetration of new electric light trucks (LCVs) out of all claims on the Greek market by 2030 (Scenario A – Base Scenario, Scenario B – Aisiodox Scenario).

Screenplay	Year	Purchase of new light trucks	Change in the combined market for light trucks	Increase in total market	BEV-PHEV light trucks	Year-on-year increase	BEV percentage — PHEV on annual
Scenario A	2018 *	6.905	—	—	13	—	0.2 %
	2019 *	7.972	1.067	15 %	11	— 2	0.1 %
	2020 *	6.865	— 1.107	— 14 %	14	3	0.2 %
	2021 *	10.426	3.561	52 %	106	92	1.0 %
	2022 *	9.660	— 766	— 7 %	169	63	1.7 %
	2023	10.400	740	8 %	730	561	7.0 %
	2024	10.920	520	5 %	1.092	362	10.0 %
	2025	11.466	546	5 %	1.433	341	12.5 %
	2026	12.039	573	5 %	1.806	373	15.0 %
	2027	12.641	602	5 %	2.212	406	17.5 %
	2028	13.273	632	5 %	2.655	442	20.0 %
Scenario B	2029	13.937	664	5 %	3.136	481	22.5 %
	2030	14.634	697	5 %	3.658	523	25.0 %
	2018 *	6.905	—	—	13	—	0.2 %
	2019 *	7.972	1.067	15 %	11	— 2	0.1 %
	2020 *	6.865	— 1.107	— 14 %	14	3	0.2 %
	2021 *	10.426	3.561	52 %	106	92	1.0 %
	2022 *	9.660	— 766	— 7 %	169	63	1.7 %
	2023	10.400	740	8 %	730	561	7.0 %
	2024	10.920	520	5 %	1.201	471	11.0 %
	2025	11.794	874	8 %	1.769	568	15.0 %
	2026	12.737	943	8 %	2.420	651	19.0 %
	2027	13.756	1.019	8 %	3.301	881	24.0 %
	2028	14.857	1.100	8 %	4.308	1007	29.0 %
	2029	16.045	1.189	8 %	5.455	1147	34.0 %
	2030	17.329	1.284	8 %	6.931	1476	40.0 %

* Classification statistics

The adoption of increased policy measures (in accordance with Scenario B of the above Tables) will lead to faster electrification of the passenger vehicle and light duty vehicle (LCVs) fleet in Greece,

with their circulating fleet expected¹⁸ to increase from around 30.600 vehicles¹⁹ to more than 460.000 vehicles in 2030.

Progress in decarbonising light road transport in 2020

The promotion of electromobility in Greece was identified as a key policy axis in the 2019 NECP, which highlighted the urgent need to complete the relevant regulatory framework and implement appropriate measures, incentives and policies for the development of the e-mobility market, taking into account the electric vehicle charging infrastructure network. The Plan has for the first time set specific quantitative annual targets for road transport, namely for the electrification of the passenger car fleet, according to which (frontloaded scenario) 30 % of the new vehicles to be operated in 2030 should be electric (BEV -PHEV).

The first and most important milestone towards the electrification of road transport was the adoption of the first legislative framework in Greece to promote electromobility (Law 4710/2020, Government Gazette, Series I, No 142), as a result of holistic pre-locking and ‘cross-sectoral’ cooperation. This legislative framework includes a nexus of fiscal, development and other incentives, measures and institutional interventions for both electric vehicles and charging infrastructure. In addition, the regulation of the electro-mobility market and the training of non-terrestrial electro-mobility infrastructure and market operators are also key points.

The basic legislative and regulatory framework was complemented by a series of measures and policies implemented, drawing on financial resources from various sources (for example: Recovery and Resilience Fund, Green Fund, Revenue of Unallocated greenhouse gas emission allowances, Ordinary Budget of the Ministry of Energy, etc.) with a view to developing the new e-mobility market.

More specifically, for the electrification of vehicles, programmes were activated to provide a total budget of more than EUR 160 million from August 2020 onwards, such as the ‘Most Electric’ programme (cycles A20 and 21 II), the Green Travel Action 22 and the ‘e-Astypalea²³’ programme.

In addition, the first National Climate Law introduced²⁴ specific provisions/targets for CO₂ emissions in the road transport sector both for the whole country and for individual transport/business sectors, such as new hire vehicles to third parties, taxi vehicles and company vehicles.

The figures¹⁸ refer only to the sum of all new annual classifications from the years 2013 to 2030 according to actual data and based on the forecasts in Tables 3 and 4. Second-hand vehicles are not included.

¹⁹ Data up to September 2023.

²⁰ Joint Ministerial Decision YΠEN/ΕΣΠΑΕΝ/77472/520/7.8.2020 (Government Gazette, Series II, No 3323) – Notice of the action ‘KINOUMI ELECTROIKI’. ²¹ 1 cycle remained open for applications from August 2020 until December 2021 inclusive.

²¹ Joint Ministerial Decision ref. YΠEN/ATH/70517/238/7.7.2022 (Government Gazette, Series II, No 3981) – Notice for the action ‘KINUMAI ELECTROIKI – Cycle II’. ²² 2 cycle was activated for applications in July 2022 and remained open until December 2023.

²² Joint Ministerial Decision under reference. Ministry of the Environment, Energy and Energy (YPEN/ATH/137582/646/27.12.2022) entitled ‘Green taxi, which is implemented with the support of the Recovery and Resilience Fund’ (Government Gazette, Series II, No 6789/28.12.2022).

²³ Joint Ministerial Decision YΠEN/ATH/78654/257/24.8.2021 ‘Notice of the e-Astypalea Action’ (Government Gazette, Series II, No 3961).

²⁴ Law 4936/2022 on the National Climate Change Transition to climate neutrality and adaptation to climate change, urgent provisions to tackle the energy crisis and protect the environment (Government Gazette, Series I, No 105).

As early as the first policy measures implemented, a particular focus has been on developing the necessary charging infrastructure for electric vehicles. One of the first steps was to carry out a specific strategic study on the needs for the deployment of a network of publicly accessible charging points in the country by 2030, which highlighted the need for a balanced development of an adequate network of publicly accessible charging points in Greece, while meeting geographic and population criteria, with a focus on urban areas where access to private parking spaces is more difficult. At the same time, the development of ultra-fast charging infrastructure of 150 kW and above along motorways and national roads became crucial for promoting electromobility. In addition, the study made the proposal that the majority of the necessary charging points should come from the allocation of areas under the responsibility of first-tier local authorities to private entities developing and operating this infrastructure by 2025. To this end, and as part of the 'implementation' of the relevant provision of Law 4710/2020 (Government Gazette, Series I, No 142), local authorities were drawn up by means of the charging of electric vehicles, resulting in the location of approximately 9.000 new public charging points throughout Greece, in areas within the competence of the first-tier local authorities.

In addition, with a view to the rapid development of publicly accessible charging stations, the action 'Lotto Pantou'²⁵, with a budget of EUR 80 million, was introduced, providing the cognitive incentives for the supply, installation and connection to the electricity grid, in particular accessible charging stations, powered by electricity produced from RES, with the aim of installing at least 4.500 publicly accessible electric vehicle charging stations throughout the country.

As a result of the above, the annual quantitative targets for the penetration of new registrations of heavy vehicles set in the NECP have been exceeded in all previous years (2020-2022), as shown in Table 5 and Figure 12, with the total number of electric passenger vehicles in circulation exceeding 2629.625, an increase of 24 times compared with 2019.

Table 5 Comparison of forecasts of the previous NECP and actual registration data of electric passenger vehicles.

YEAR	NECP OBJECTIVE	ACTUAL PROVISIONS LAWS OR REGULATIONS	TARGET COVERAGE E- DGS (%)	NECP MISCELLANEOUS FACTS TAXIS MOTIONS (IN- LARGE NUMBERS)
2020	1.265	2.135	169 %	870
2021	3.795	6.961	183 %	3.166
2022	7.589	8.320	110 %	731

²⁵ Joint Ministerial Decision ref. YΠEN/ATH/49144/468/4.5.2023 of the Action Notice entitled 'Lottery PANTO', supported by the Recovery and Resilience Fund, under Recovery Pillar 1 'Green Transition' Priority Axis 1.3 'Transition to a green and sustainable transport system' of the NRRP Greece 2.0. (GOVERNMENT GAZETTE, SERIES II, NO 2966).

²⁶ Data from SNCAs for the period from 2020 to September 2023 inclusive.

COMPARISON OF CLASSIFICATIONS BETWEEN THE NECPS AND THE FACTUAL SITUATION

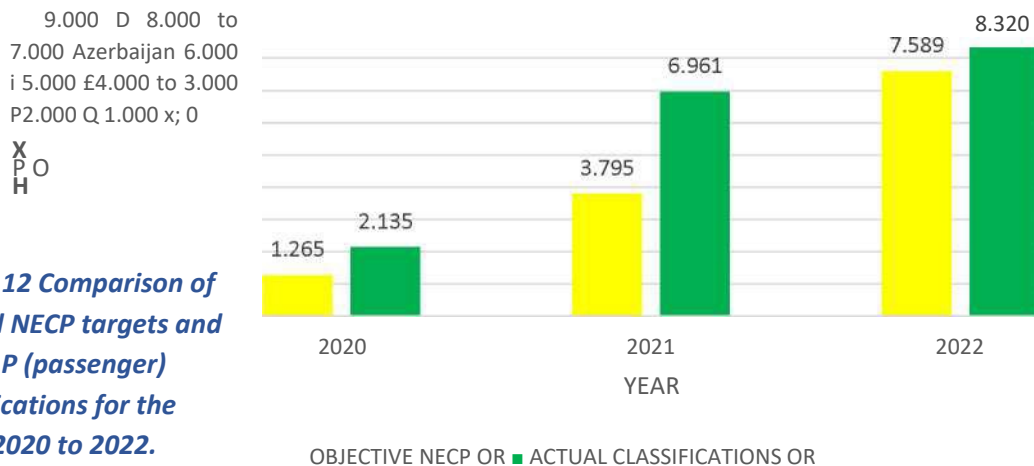


Figure 12 Comparison of annual NECP targets and actual P (passenger) classifications for the years 2020 to 2022.

In addition, by September 2023, 4.0127 publicly accessible charging points have been installed throughout the territory, i.e. 55 times more than in 2019.

Heavy Road Transport

As regards **heavy goods vehicles** in particular²⁸, it is important to mention that most of the travelling lengths of such vehicles, mainly trucks, in Greece concern second-hand vehicles

²⁷ According to data from the MYFAS on 13/10/23 (<https://electrokinisi.yme.gov.gr>).

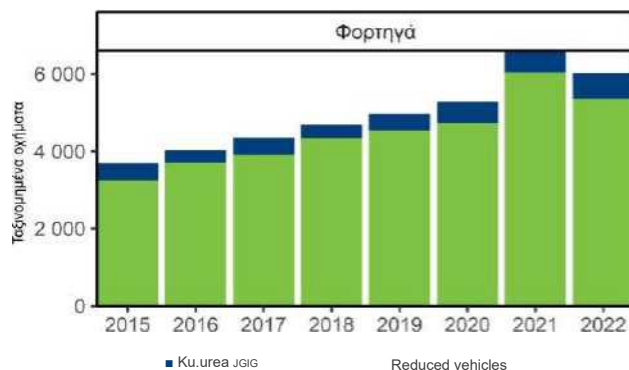
²⁸ Heavy-duty vehicles are vehicles for the carriage of goods with a maximum mass exceeding 3.5 tonnes.

imported into the soil²⁹. This significantly delays the reduction of carbon footprint in vehicles in circulation, despite the adoption of lower CO₂ emission limits imposed on new heavy-duty vehicles under the relevant European Directives.

With regard to the choice of technology and fuel for this category of vehicles, in the context of the long-term objective of climate neutrality, the following solutions are chosen per use, which will of course be considered in the coming years, depending on developments in technologies and their cost:

- *For short-haul lorries, electrification of the sector is preferred.*
- *For long-haul trucks, it is preferable to use solutions including electricity, gaseous fuels as a blend of carbon footprint as well as green hydrogen.*

As can be seen in Figure 13 below, the gradual use of other forms of energy compared to diesel, which is the main fuel in heavy road transport, is expected to start in 2030, while the replacement of oil to a dough grade is expected mainly from 2040 onwards.



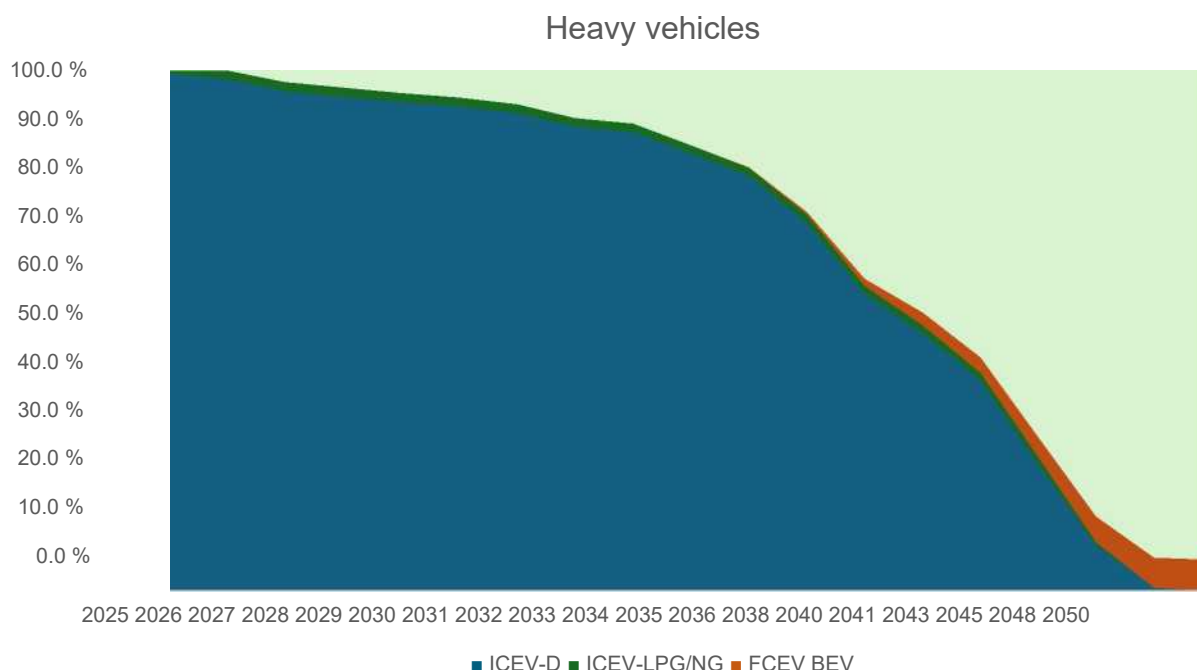


Figure 13 Estimated fleet evolution of heavy-duty vehicles as% of each engine type (fuel) out of the total, for the period 2025-2050.

Urban transport – use of STM

The revised NECP puts emphasis on reducing CO₂emissions especially in urban transport, including by replacing traditional forms and commuting methods with more modern and environmentally friendly forms. The aim is to **develop alternative forms of mobility such as** micro-mobility (e.g. cycling) and active mobility, as well as to **increase the use of MTMs**, where reduced carbon footprint solutions (electrification of bus fleet, development of Metro network, etc.) should be adopted.

In addition to contributing to the reduction of CO₂ emissions in urban centres, the above axes are also intended to help transform the congested Greek traffic cities into cities of sustainable mobility, i.e. to move away from the road and to transform them into people-oriented mild traffic. In this context, the target is to reduce the share of private motor vehicles as opposed to soft and collective mobility (walking – bicycle – STU).

Public Urban Transport

Public transport is always the main pillar of sustainable urban transport. Taking into account the guidance provided by the European and national institutional framework, the aim is to integrate into the design of the use of electric vehicles, as well as to progressively increase the number of low-emission vehicles to serve urban movements.

In particular, for road transport in the Athens metropolitan area, and by 2030, specific green mobility targets have been set³⁰:

- Strengthening the fleet with low-emission vehicles by 20 % by 2025, in line with 2019.
- Strengthening the fleet with low-emission vehicles by 40 % by 2028, in line with 2019.
- Reduce the value of the fleet vehicle emissions index (CO₂eq/km/passenger) by 8 % compared to the year 2019.

Electric vehicles charging infrastructure

The revised NECP addresses for **the first time alternative fuels infrastructure** that is needed to power vehicles, such as electric vehicle charging infrastructure and water supply infrastructure. The rapid and balanced development of this infrastructure is a prerequisite for achieving the objectives of achieving climate neutrality in transport by increasing the penetration of electric vehicles and the use of alternative fuels respectively.

The targets set for the deployment of publicly accessible charging infrastructure are intended to meet the national targets for the promotion of electro-mobility in road transport and make³¹ it possible to fulfil the obligations arising at European level from the new Alternative Fuels Infrastructure Regulation (AFIR) for each individual EU Member State. According to that regulation, publicly pre-stationary charging stations with a total power output of at least 1.3 kW for each pure electric vehicle (passenger or van) and 0.8 kW for each plug-in hybrid vehicle are to be installed in the country on an annual basis.

Based on this ratio, and on the basis of the forecasts for the fleet of new electric vehicles (passenger and light trucks) registered annually in Greece (Table 3 and Table 4 above), the estimated total installed power output in publicly accessible charging infrastructure exceeding 550 MW by 2030.

The total necessary number of publicly accessible charging points is estimated at 40.000 to 100.000 points for the year 2030³². Specifically for the Trans-European Road Network (TEN-T), with a distinction between the main network and the secondary network, the revised E-DGS, based on the new Alternative Fuels Infrastructure Regulation (AFIR), provides for a programme for the deployment of publicly accessible fast track infrastructure per specific distance, establishing the minimum required power output of each such facility. The demand for electricity from these fast moving infrastructure along the TEN-T, both for light-duty charging and for charging heavy-duty vehicles, and the impact on the electricity grid, based on a study, is³³ not expected to be significant by the years 2030-5 and is expected

³⁰ Project "Alignment Road Map of the OASA Group with the European Green Deal 2023-2028".

³¹ Publicly accessible charging infrastructure in this text means publicly accessible recharging points, providing electricity with non-discriminatory access to all users. Non-discriminatory access can include various means for identification, use and payment.

³² Based on a study carried out in 2021 with the support of the European Investment Bank's Technical Assistance Facility (JASPERS).

³³ ITF (2024), *Recharge and Refuel – Clean, smart and fair urban mobility for Greece Final report of the EV workstream*, OECD Publishing, Paris.

to increase significantly thereafter towards the year 2050.

Railway transport

In rail transport, a significant reduction in CO₂ emissions is expected thanks to the electro-mobility that will be further developed, based on two strategic axes:

- **Electrification of existing railway lines in the network**, with the aim of electrifying the largest proportion of the rail network in order to minimise the movement of polluting diesel-wagons. In particular, the length of the existing electrified railway line is projected to increase by 15 % by 2030.
- **Construction of new electrified railway lines** to move away from road traffic to rail, with the aim of adding new electrified lines with a length of 244 km by 2030.

Shipping

The revised NECP includes targets for an ambitious reduction of CO₂ emissions from shipping, a sector of major importance for the country due to its insular character and the country's international presence.

A sine qua non for a successful “green” transition of shipping to carbonisation is the availability of safe alternative fuels in sufficient quantities around the globe and technologies, low or no carbon footprint. As things stand, the choice of propulsion and fuel technology will be subject to further study and may be revised in the future taking into account developments in the technology concerned and its cost.

Recent decisions by the International Maritime Organisation (IMO/MEPC 80, July 2023) on binding absolute greenhouse gas (GHG) emission reduction targets pave the way for the use of biofuels in shipping and the calculation of their life cycle carbon footprint.

Biofuels blended with ‘drop-in’ fuels, such as biodiesel, renewable (advanced) diesel, bio-methanol, are fully blended with the corresponding fossil fuels and are compatible with the marine engines of existing seagoing ships, requiring minimal technical safety adjustments or no alterations to the marine engines using them and the fuel distribution network.

At the same time, Carbon Capture and Storage – CCS has been included in the IMO's sustainable pathways and is considered to be one of the options to train shipowners to achieve the objectives of decarbonising the sea.

However, in the meantime, the use of liquefied natural gas as a maritime fuel³⁴ is an immediately available solution to the decarbonisation path of shipping until new emission-free technologies are commercially

³⁴In this context, use will be made of the SSLNG Pier in Revithoussa, a project already approved for funding by the NSRF and expected to be operational in 2025, allowing the supply to Piraeus and other Greek ports for refuelling passenger/ferries, cruise ships and merchant ships.

available.

Coastal ferries

Based on data on line length and ship capacity in shipping³⁵, the following axes/guidelines are considered for the decarbonisation of the sector:

- Increasing the use of electricity, both through the application of electromobility to vessels operating mainly on ferry lines, and through the use of electric power to power ships at berth (by developing the necessary substructures in ports)
- Focus on the weak lines for a case-by-case examination of the appropriateness of specific options
- Use of alternative fuels on larger ships travelling longer and regular distances

Sea-going Shipping

Achieving climate neutrality in seagoing shipping has significant pre-calls. But this is a global problem, so the solutions chosen should be of the same scale. When certain categories of ships are at berth (e.g. containers, cruise ships), it is appropriate to use electric power to supply ships at berth (by developing the necessary infrastructure in ports).

Air transport

The revised NECP includes targets to reduce CO₂ emissions from air transport by promoting Sustainable Aviation Fuels (SAF) for fuelling aeroplanes. The new Refuel Aviation Regulation sets out this approach to pre-boost SAF, while maintaining a level playing field, with specific targets for the use of SAF fuels in aeroplanes.

The sustainable development of air transport requires the introduction of measures and incentives to boost biofuel production activity in Greece, involving both the agricultural and industrial sectors, including financial instruments for research and development in the sector. Targeted support and funding at national level, as well as public-private partnerships can improve the availability and financial sustainability of relevant fuels to further accelerate their procurement and dissemination.

At the same time, targeted actions should be implemented in relation to airports and the ground infrastructure of air transport, promoting both energy housing and the reduction of their carbon footprint, as well as the creation of electricity supply infrastructure through a standardised fixed or

³⁵ The majority of coastal shipping services are less than 50 nautical miles, with the largest line at 154 nautical miles. The capacity of the vessels on the routes (on the basis of information on uninterrupted routes) starts with 50 passengers and reaches up to 450 passengers.

mobile infrastructure for aircraft parked in airport gates or delineated parking areas.

2.3 penetration of Renewable Energy Sources (RES)

2.3.1 Summary of objectives and priorities

The greenhouse gas emission reduction target shall be specified and achieved through binding targets for the penetration of renewable energy sources (RES) in total gross energy consumption. The EU has put in place an unfavourable policy framework that ensures that, as a whole, it will ensure these important objectives, quantified through specific indicators and on the basis of formulas set by the EU.

The NECP looks forward to the deployment of RES in all sectors so that RES become the key pillar of the green transition through direct use for energy supply and indirectly for the production of green hydrogen and climate-neutral fuels.

The target set for RES as a share in gross final consumption for 2030 is 43.0 %.

The above objective is specified by sector for which individual binding targets are identified.

The participation of RES in electricity consumption is the main policy priority for achieving the target and it is necessary to implement the planned measures in a timely and timely manner.

Priority is therefore given to the energy transformation in the electricity supply sector, for which we aim for the share of RES turbines in gross electricity consumption to be 75.7 % in 2030.

The binding target for RES participation in the final energy consumption of the transport sector is set at 13.4 % for 2030, reflecting a realistic target given the current pace of electrification of transport.

Electromobility, biofuels and renewable fuels of non-biological origin contribute most to this target. More specifically, **what is a binding target for renewable fuels of non-biological origin to cover 0.9 % of all fuels in the transport sector in 2030**, also taking into account the production capacity of refineries. On top of this, the plan envisages a significant **development of advanced biofuels from other biomass feedstocks and in the future mainly from ligno-cellulosic biomass, which will account for 4.6 % of all transport fuels in 2030.**

The binding target for the development of RES specifically for heating and cooling is set at 52.6 % for 2030. In particular, heat pumps will contribute to this objective, as they use electricity and ambient heat and solar thermal systems. There is no extension of the use of biomass for combustion in city buildings to avoid a burden on air pollution of air from particulate matter. In any case, the use of biomass will remain at current levels, ensuring that it is used efficiently.

The development of the bio-economy is a priority for the NECP. In the short term, the aim is to 'green' the distributed gas, i.e. the use of renewable gases as a mixture with (fossil) natural gas, thus reducing the carbon footprint of gaseous fuels.

The strategic option of “greening” gaseous fuels, while keeping the use of gaseous fuels in addition to electrification, will require in the long term that climate-neutral gases cover all exhaustgases.

At the same time, a larger proportion of livestock, agriculturaland forest residues and waste are used to produce biogas andmethane by means of a reforming facility.

The aim is to tap the biogas production potential to inject around 2.1 TWh of biomethane into the gas grid in 2030.

The share of RES used for both energy and non-energy purposes in the industry sector will reach 34 % in 2030. I do not foresee penetration of renewable fuels of non-biological origin by 2030 in the energy and non-energy uses of the industrial sector.

Finally, the share of RES in the final energy consumption of the building sector in 2030 is expected to be equal to 72.2 %.

Table 6 summarises the calculations for RES target indicators as calculated according to EUROSTAT on the basis of the latest version of the SHARES tool (version v7– In November 2024) available when the NECP was drawn up, making the necessary adjustments in order to correctly integrate the energy data required.

Table 6 Summary of results for RES target indicators.

	2025	2026	2027	2028	2029	2030	2035	2040	2045	2050
Share of RES in gross finalenergy allocation [%]	30.9 %	34.1 %	36.3 %	38.9 %	41.4 %	43.0 %	60.6 %	77.2 %	88.6 %	95.8 %
Share of RES in gross electricity consumption [%]	58.6 %	64.5 %	67.8 %	71.8 %	75.3 %	75.7 %	96.2 %	102.8 %	106.9 %	100.8 %
Share of RES in gross finalenergy allocation for heating and cooling [%]	39.8 %	43.4 %	46.2 %	49.7 %	52.1 %	52.6 %	60.6 %	75.2 %	81.6 %	84.1 %
Share of RES in final energy consumption of the building sector [%]	51.2 %	55.5 %	59.7 %	63.1 %	65.7 %	72.2 %	86.0 %	93.3 %	95.3 %	95.1 %
Share of RES for energyand non-energy purposes in industry [%]	19.7 %	22.0 %	25.1 %	29.7 %	31.9 %	34.0 %	43.0 %	57.3 %	60.6 %	65.8 %
Share of RES in final energy consumption of the transport sector (%)	4.4 %	5.0 %	5.9 %	7.1 %	9.5 %	13.4 %	19.5 %	25.2 %	30.2 %	37.4 %
Share of advanced biofuels andbio-fuels in the transport sector (%)	0.8 %	1.2 %	1.5 %	1.8 %	2.9 %	4.6 %	7.6 %	8.7 %	9.9 %	10.5 %
Share of renewable fuels of non-biological origin in the transport sector (%)	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.9 %	1.6 %	2.3 %	3.0 %	3.6 %
Share of advanced biofuel – biogas and renewable fuelsof non-biological origin in the transport sector (%)	0.8 %	1.2 %	1.5 %	1.8 %	2.9 %	5.5 %	9.1 %	11.0 %	12.9 %	14.1 %
SAF (Sustainable Aviation Fuel) of biological origin	1.8 %	2.4 %	3.0 %	3.7 %	4.3 %	5.0 %	9.4 %	11.1 %	12.8 %	14.5 %
SAF (Sustainable Aviation Fuel) of non-biological origin	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.0 %	1.0 %	1.2 %	1.3 %	1.5 %

2.3.2 RES penetration in electricity generation

This section presents the main conditions for reaching RES penetration targets for electricity generation by 2030.

The targets set for the RES installed capacity mix are consistent with the connectivity possibilities offered by both the transmission system and the distribution network, based on the development programmes of the competent operators, which have been approved by the RAAEY.

It should be noted that, on the basis of the final connection offers to the system and the grid granted by July 2024 for the implementation of new RES projects (approximately 14.4 GW in the system and 1.6 GW in the network) and the applications submitted to the operators for the issuance of new connection offers (over 42.5 GW), the targets for the production of electricity from RES by 2030 are considered to be viable and achievable.

The planning to increase the capacity of the System and the Network and the physical execution of the necessary works to host new RES projects after 2030 will be studied in detail. This analysis will assess risk factors, how spatial and environmental constraints and the maturation times of the necessary system/network projects to support the NECP objectives.

With regard to RES technologies, provision is made for the development of both onshore wind and offshore wind, as well as a balanced development of photovoltaics, in order to diversify the production profile, with the aim of addressing issues of electricity system park and safety without the need to excessively increase electricity storage systems. **The target of electricity-storage by pumped storage and batteries totals around 6.2 GW in 2030. In addition to contributing to electricity system adequacy issues, either through individual systems or combined with RES stops, storage will contribute significantly to better production management and stability of the electrical system.**

At the same time, a geographical spread of RES should be achieved in order to reduce as far as possible problems of large amounts of generation capacity in the electricity system.

2.3.3 Onshore wind and photovoltaic farms

The installed capacity of onshore wind and photovoltaic farms is projected to increase by 10 GW by 2030 (from 12.5 GW in May 2024 to 22.4 GW in 2030).

The above objective will be achieved through:

- use of the operating aid scheme approved by the European Commission for RES plants up to 31.12.2025 (State aid SA.60064 (2021/N) – Greece Greek RES and heCHP scheme 2021-2025), which provides, for the period from 2021 to 2025 inclusive, for aid through competitive tendering procedures for the installation:
 - at least 3.250 MW of onshore wind and photovoltaic farms including small installed power plants;

- onshore wind and photovoltaic parks in combination with discouraging (batteries), onshore wind and photovoltaic parks in specific areas (Crete, Cyclades and Evia) with congestion;
- promoting dispersed production through self-consumption schemes to cover the energy consumption of electricity from household, wild, commercial and industrial consumers covering all sectors of economic activity;
- strengthening the role of Renewable Energy Communities and Citizen Energy Communities by actively involving both citizens and first- and second-tier local authorities in installing RES plants with storage systems to cover part or all of their members' energy consumption, the needs of first and second tier local authorities and energy vulnerable households;
- making use of long-term bilateral contracts, such as the bilateral power purchase agreements (PPAs), enhancing the ability to finance the installation of RES plants and guaranteeing end users stable electricity prices in the long term, so that they can act sustainably;
- updating the special spatial framework for RES and defining priority areas for the installation of RES stations, taking into account the need to penetrate RES stations, the nature and spatial characteristics of the continental, maritime and island area, as well as the protection and management needs of areas with specific environmental, ecological, cultural and topological interest and areas with high vulnerability to climate change. In this context, efforts will also be made to allocate these projects as rationally as possible to the geographical districts of the country.

An important parameter for achieving the RES penetration target in final electricity consumption is the implementation, as planned, of the plans for the development and reinforcement of the electricity grid and interconnection of the non-interconnected islands with the continental system.

2.3.4 Offshore wind farms

The development of offshore wind farms (OWFs) is a national strategic priority as it is expected to strengthen the energy transition plan and contribute to energy security by providing clean and affordable energy in our energy mix. The Greek maritime space is characterised by very good wind potential with little variability over the year, making it particularly attractive to investors for electricity generation, compared to other Mediterranean maritime regions, as it favours higher energy efficiency of LAGs.

The installed capacity of offshore wind farms is expected to reach 1.9 GW by 2030.

The LAG projects to be developed in the Greek seas will consist of both fixed bottom projects and floating projects.

HSE projects have a high energy efficiency (high utilisation factor) and the distribution of their

production throughout the day allows conventional production to be reduced during evening hours and ultimately to lower electricity costs.

2.3.5 Hydroelectric projects

Harnessing the **hydropower potential** is a high priority. To this end, the aim is to complete and operate the large hydropower projects under construction, to gradually exploit new sites with significant potential on the basis of environmental maturity, to exploit the potential in irrigation/water projects and reservoirs, and to further develop the category of small electric projects.

As a result of the above, the total installed capacity of hydroelectric power projects equipped with a reservoir (3.2 GW) is expected to increase particularly after 2030, reaching an installed capacity of 4.7 GW in 2050.

The further development of hydropower is mild and guided by the ethical principles:

1. Reducing the environmental footprint as far as possible, in which case projects already under construction or adjacent to existing projects shall be selected.
2. The construction of multi-purpose projects, thus combining irrigation and, as far as possible, flood protection and extending the lifespan of existing large reservoirs.
3. Avoiding the construction of projects in areas that are relatively virgin, as regards the existence of such projects.

In Greece, to a certain extent, hydropower has been developed since previous decades with the construction of large hydropower projects. It is estimated that the use of hydropower reaches 30 %. In European countries, on the other hand, this exploitation in many cases reaches 80 % and focuses on the large mountain ranges such as the Alps, the Pyrenees and others. The main utilisation in Greece with the construction of large projects mainly concerns four water bodies:

1. Acheloos (Mr Res)
2. Aliakonas
3. Arachthos
4. Nestos

Acheloos Basin

The completion of the construction and entry into operation of the Mesodos Ministry of Infrastructure, with a nominal capacity of 160 MW, is expected to take place immediately, as all the outstanding issues for the resumption of works to fill the reservoir have been settled. It is also envisaged that the Sykia project will be completed, which, although linked to the diversion of part of the Acheloos waters to Thessaly, may be constructed independently of the

project in question³⁶. Also located in the same basin is the Allaki (downstream of Sykia) IED with a nominal capacity of 83,6 – 100 MW, which has matured for authorisation purposes.

Arachthos catchment area

The Metsovitiko project is under construction and is expected to be completed and integrated into the system in the near future. An important project on the Arachthos River is the SIIE of Agios Nikolaos with an installed capacity of approximately 140 MW, but for which there is a need to redesign, as can be seen from the lack of maturity to date of its nival permit environment. The interesting position of the Strait of Kalaritiko is the annoyance of this project.

Water catchment area of Aliakonas

Many small hydropower projects affecting the design of larger projects have been authorised in this basin (e.g. at Eafi upstream of the operating project Ilarioa).

Furthermore, the possibility of upgrading existing ECS in order to make more efficient use of existing capacity is noted.

Finally, it should be noted that in the Pinios catchment area there is the possibility of carrying out projects that are described primarily as multi-purpose projects, with strong protection against flood and water protection provided by their reservoirs, and their implementation will depend more on other factors than on their energy production.

Nestos River Basin

In the position After, downstream of the two existing Nestos hydroelectric systems: Thesaurus and Platnovrysis is a relatively mature small project of 10 – 20 MW.

The design of the mentioned new large hydroelectric systems will take account of the effects associated with flooding of land with a view to minimising them, so that the net balance, taking into account the positive effects of hydroelectric power (such as flood protection, irrigation, flexible and “green” production with a long lifespan, high domestic added value of furnishings) will be positive in the long term.

³⁶ Completion of the Sykia dam must take place as soon as a severe flooding event similar to that of Thessaly in 2023 will result in a major environmental and general disaster in the downstream riverbed and in the operational downstream projects.

2.3.6 Other RES

For HRE technologies³⁷, with the exception of wind and photovoltaics and large HPP (hydroelectric powerstations), the weighted cost of production is still comparatively high, the implementation of the projects is cumbersome and time-consuming, and significant competition has not yet developed. Therefore, the further development of these technologies is expected to depend to a significant extent on government support.

In addition, taking into account both the new regulatory framework and the investment interest that has taken place over the past period in the exploration of thermal potential and the exploitation of geothermal fields of either national or local interest, the prospects for the penetration of geothermal energy in the national energy mix are positive both in terms of thermal energy production (85 MWth in 2021 mainly to meet the needs of the primary sector) and electricity generation, where there is still no corresponding plant in operation in Greece, although it is highly commercially mature technology implementation internationally. The aim is to broaden research into geothermal fields and to consider the development of potential electro-parks with maximum social acceptance in the regions concerned.

2.3.7 Storage – Batteries

The development of sufficient capacity and storage system capacity is an unavoidable condition for the further penetration of RES in the electricity generation mix.

Electricity storage stations, as stand alone storage plants, participating in the electricity markets, are expected to lead to a significant increase in the penetration rate of RES generation in the energy mix, as they are expected to replace the operation of conventional power plants during peak load hours, absorbing energy during lunch hours when the production of photovoltaic plants is maximised (i.e. RES likely to be discarded otherwise) while providing essential services to a system dominated by targeting and variable generation capacity.

In particular, storage units participate in the electricity markets by working towards smoothing the large fluctuations in daily electricity prices, absorbing RES energy when RES production is higher and/or higher than electricity demand and its efficiency during peak hours, subverting the production of expensive conventional gas plants, thus limiting wholesale electricity market prices.

In addition, electricity storage units participate in the balancing market, providing flexibility and ancillary services to the electricity system, which are essential for the successful integration of large power and different RES stochastic technologies into the system while at the same time strengthening the integrity of the market, in particular in the balancing market, supporting competitive and transparent price formation and leading to a reduction of balancing

Small hydroelectric are³⁷ also included.

prices.

Finally, storage systems (batteries) in combination with RES plants help to better manage the energy produced by RES plants, to ensure that injection restrictions are applied to these plants because of the imbalance – the production and demand balance of the national electricity system and ultimately to lower electricity prices.

The total power of battery storage systems is expected to reach **4.3 GW by 2030**.

2.3.8 Storage – pumped storage

Pumped storage has intrinsic advantages over other forms of large-scale storage. It is a mature technology, with a commercial function of many years, with no particular technological requirements and with an extremely high domestic premium value. The storage of electricity in pumped storage plants offers the advantages of the possibility of storing energy with a large capacity (up to 100 GWh), large power (up to 3 GW), which is able to provide electricity injection for a sufficient period of time, with a satisfactory overall efficiency (~ 70 %), while their basic infrastructure has a long lifetime (more than 80 years), well above what is known as the 'distillation accounting'³⁹. Furthermore, the dismantling of projects and the recycling of materials do not pose any environmental problems.

It also underlines the importance of generating energy from rotating machines (such as hydroelectric/pumped storage), with regard to the necessary inertia in an ultraviolet system dominated by wind and photovoltaic production.

In Greece, there are already two large hydropower plants, with the possibility of reversing operations, the Sifkia projects at Aliakonas and Thessauros in Nestos, with an installed capacity of 315 MW and 384 MW respectively. In addition, it can be seen that pumping systems with relatively small technical interventions can also be used in other existing hydroelectric projects with successive reservoirs, as demonstrated by a study carried out by the RAAEY. The installation of such pumping systems should improve the operation of existing hydropower systems and increase the guaranteed capacity they provide to the system.

In addition to the above category of projects, which are de facto subject to technical constraints, the storage of electricity already produced, in the form of dynamic energy, is also expected to develop through the construction of new assets, in addition to the main stream of larger rivers⁴⁰.

The approach of constructing pumped storage projects outside the main flow of rivers means that river flows are not interrupted, ferries are not transported, habitats etc. are not broken down, so that the environmental footprint is significantly depressed. Due to the exceptional

³⁸ Its supply chain is mainly steel and concrete.

³⁹ The lifespan of civil engineering works, such as dams and water tunnels, is longer than 100 years and is practically undefined.

⁴⁰ Greece is characterised by a rich and intense relief, which, in addition to its natural beauty, offers many solutions for pumped storage projects. It is a privilege that has no other lowland terrain, where the exclusive use of bats as energy storage is likely to be a one-way way.

advantages of electricity storage, these projects can be and are already widely accepted in society.

On this basis, **the total capacity of pumped storage systems is expected to be close to 1.9 GW by 2030 and to increase significantly to 5.4 GW by 2050. The total capacity of these systems is expected to be in the order of 17 GWh in 2030 and 67 GWh in 2050.**

This quantification was made taking into account, in particular, the already existing authorisations for storage projects through pumped storage issued by the RAAEY up to spring 2024⁴¹.

A prerequisite for achieving the 2030 target is the completion of the construction of the Amfilochia pumped storage plant, with a capacity of 680 MW,⁴² and the construction and operation of other pumped storage projects which are in a mature permitting phase, from a project pipeline with a total capacity of approximately 2.000 MW, mainly through the modification of existing hydropower plants with the addition of a reservoir.

Pumped storage projects that have production licences and are expected to help achieve the target for the year 2050 can technically be categorised into the following categories:

A. Projects located at the end of the river; These projects use already existing reservoirs and underneath reservoirs. Their construction improves the functioning of existing hydropower projects and increases the electricity they can provide. This is the case for the Sifkia projects already in operation on the River Aigake and Thesauros in the Nestos River. It is also planned to construct works between the Pournari II reservoirs – Pournari I on the River Arachthos and between the reservoirs Kremao – Kastraki on the River Acheloos.

B. Projects using an existing, artificial and/or natural reservoir as a lower reservoir. The operation of these works is conditional upon the operation of the pumping/silencing system or, within predefined limits, the variation of the level of the bottom reservoir. A large number of licences are concentrated in the area of the Casrki reservoir with an established power of 1.4 GW in the region of Western Greece. The same hill provides for projects of 100 MW with a lower reservoir of Kremmatias and 685 MW with Lake Trikonidas underneath. In the Region of Central Macedonia, projects with a capacity of 759 MW with a lower reservoir of Agia Varvara on the Aliakmona river are foreseen. In the Peloponnese region, projects with a capacity of 450 MW with a lower reservoir of the river Ladoon are foreseen. Projects with lower capacity

⁴¹ For modelling purposes, the time distribution of their construction integration and integration into the electrical system was based on information on the maturity stage of the investment projects on the one hand and the requirement for their smooth integration into the electrical system on the other hand.

⁴² The project will receive a total investment aid of EUR 250 million from the Recovery and Resilience Fund in line with the approved support scheme (SA 57473).

in other reservoirs are also foreseen.

C. Projects with provision for the construction of two new reservoirs. These projects are located outside the country's major rivers and reservoirs, and two new reservoirs are planned from the outset. The largest projects in this category are planned to be built in older lignite mines, based on their configuration, with a capacity of 368 MW in the region of Western Macedonia and 183 MW in the Peloponnese region. Projects with a capacity of less than 8-30 MW will also be built on other sites suitable for development.

2.4 alternative and climate-neutral gaseous and liquid fuels

2.4.1 Core objectives

The main strategic option of the NECP is to gradually reduce the carbon footprint of gaseous fuels. The penetration of RES in electricity generation as well as the substitution of natural gas by electricity in the heating of buildings and industry sectors is leading to a gradual reduction in total fuel consumption. At the same time, traded natural gas will be transformed into a mix of renewable gases.

According to the revised NECP, natural gas consumption in Greece will fall from 51.2 TWh KHD in 2022, to 42.5 TWh in 2030 and to 16.1 TWh by 2050.



Figure 1 The Greek gas transmission system.

However, the natural gas transported through the Greek gas transmission system is not only domestically consumed, but also the gas that transits to other Balkan and south-eastern European countries (Figure 1). In 2022, of the 7,5 bcm handled in the Greek Transmission System, 2,6 bcm (35 % of the total) concerned transit.

Gas transit is expected to increase further following the completion of the new LNG floating stations given the need for the decarbonization of energy systems in the South Eastern Europe region and the declared commitment to de-dependency on the Russian gas pathway. In this context, in order to safeguard the strategic objectives of regional security of supply, DESFA carries out upgrades of the transmission capacity of the system with the installation of new

compressor stations, with the aim of increasing the transit capacity by 2026 to 8,5 bcm/yr (from 3,1 bcm/yr today). A new interconnector is also under construction, which will connect the natural gas systems of Greece and North Macedonia, with the possibility of further expansion to the Somali coast and Serbia.

This is being completely reversed if the declared intention to fully phase out the EU's dependence on Russian gas is not materialised and the needs continue to be met mainly by Russian gas, which is channelled through Türkiye.

It should be noted that, in order to contain the increase in the tariff for the use of the gas transmission system, due to outright investments and at the same time a reduction in the volumes consumed, only the strictly necessary investments in the expansion of gas infrastructure, which will be needed during the energy transition, are promoted.

In the light of the above, the objective is to achieve at the same time:

1. Greece's full freedom to supply gas from any source depending on its commercial and strategic interests.
2. Safe supply to Greece in all cases of exceptional demand conditions or problems in an import infrastructure.
3. The transit of LNG to other Balkan (and/or more northerly) countries and Greece contributes to regional security of supply and independence from Russian gas supplies.
4. Balancing the electricity system and meeting spot energy needs in the event of extensive periods of low RES production.

For natural gas distribution networks, taking into account that natural gas infrastructure is no longer eligible for co-financing under Community programmes, and the fact that the uses currently covered by the gas distributed will gradually be electrified, there is a need to monitor and evaluate the extensions of distribution infrastructure in order not to lead to a disproportionate increase in tariffs for demand of distribution infrastructure. A disproportionate increase in usage tariffs will lead to an increase in the price of consumers of natural gas and an acceleration of the abandonment of natural gas, i.e. it will create precisions and ultimately stranded. In this context, the construction of networks in new remote areas, in which case the following conditions are met: (a) the procurement of distribution networks under already approved development programmes has not been signed to date, and (b) they cannot be fed by a future limited extension of existing natural gas transmission or distribution channels at the discretion of the RAAEY, only to the extent that there is a prospect that the distributed gas will be locally produced biomethane. An exception to this rule may be applied in the regions of Epirus, Western Macedonia, Central Macedonia, Eastern Macedonia and Thrace, due to local climatic conditions.

A particular use of natural gas that can be developed during the energy transition and

contribute to its objectives is the development of small-scale LNG deployments. The tanker refuelling station has already been completed and is in operation in Revithoussa, while the small-scale LNG pier for LNG refuelling (either for own use or for transport to other consumption centres) is currently under construction, with expected completion in the second half of 2025. LNG, transported on a small scale by road tanker vehicles or ships, can substitute oil with natural gas in the case of consumers far from the gas transmission network (industry, local service networks). Moreover, shipping (in particular coastal and cruise shipping) and heavy land transport can use LNG as a motor fuel until “green” fuels (electricity, hydrogen, synthetic fuels) are technically matured, reducing CO₂ and other pollutant emissions.

It is understandable that the majority of existing natural gas transmission networks will remain active in supplying at least gas power plants in compliance with all obligations to detect and repair channels from all fossil energy installations (LDARs), while existing nourished networks will remain active for the handling of biomethane.

It should be noted that, although the systematic substitution of green gas in its uses is currently not economically justified, as there are cheap alternatives (electrification), subject to a (and expected) reduction in green hydrogen production due to improved technology and lower electricity prices from RES (at least during the overproduction periods of RES), it is assumed in the NECP that some amounts of green hydrogen will be able to be injected into the natural gas networks from 2035, within the limits set by cross-border trade in natural gas.

In any case, as regards hydrogen transport infrastructure, it is true that pipeline transport is the safest and cheapest solution for large amounts or even long distances. There is already planning by DESFA to develop a dedicated hydrogen pipeline network, which will unite the estimated main demand centres in Greece, thus enabling imports and exports of green hydrogen to and from neighbouring countries.

This core hydrogen transport network in Greece has been integrated into the network of the European Hydrogen Backbone initiative of European Network Operators. With this in mind, Greece has the potential to act as a hub in the wider region for the import of green hydrogen from North Africa and the Middle East and its export to other European countries, provided that this need is confirmed by the markets.

2.4.2 Biomethane development

According to the revised NECP, total biomethane production is expected to reach 2.1 TWh in 2030, 3.6 TWh in 2040 and 4.6 TWh in 2050.

Biomethane is a renewable gas, mainly methane (like natural gas), which results from the anaerobic digestion of biological materials (agricultural, livestock, etc.) and the removal of carbon dioxide from the gas produced by this diaspora (biogas). The organic materials used are human or animal waste/effluent, food waste, food industry waste and tissue waste, or agricultural material. Because the coal of this material has just been taken from the first stone

and belongs to the short coal cycle, biogas and biomethane are considered to be renewable fuels. Biomethane has a similar composition and properties as natural gas and can therefore be transported through the available infrastructure. It can also be used as a fuel for vehicles and in general for all purposes also used for natural gas.

Biomethane can have a significant complementary effect on the achievement of the European Commission's environment. To achieve the European Commission's environmental targets for the year 2030 and the European Commission's goal of achieving a net-zero net economy by 2050, multiple decarbonisation solutions must be pursued in parallel. In addition, the treatment of biomethane in combination with the conversion of the residue into fertiliser gives an integrated method of bio-waste management in line with the principles of circular economy and sustainability.

The development of biomethane in recent years has increased significantly compared to biogas at European level, due to the better energy efficiency achieved by burning it for heating or traffic rather than converting biogas into electricity, where other RES can also be used.

Currently, 80 biogas power plants are in operation with a total abandoned capacity of 119,5 MWe and fuel energy of around 1.4 TWh/year. However, there is currently no biomethane production in the country. The biomass categories used are livestock farm waste (cattle, pig farms, sheep and goats, chickens), agricultural residues (from winter cereals, e.g. hard and soft soya, oats, rye, vetch, triticale), agro-industrial waste (whey), food waste (e.g. from restaurants) and organic municipal waste. The above materials may be used as raw materials for the production of biogas/biomethane and are in accordance with Annex XI of the amended Directive on injection and climate (RED II).

Of the existing biogas plants, it is estimated that 38 in the vicinity of natural gas networks can be converted relatively quickly into biomethane production with an energy content of around 0.9 TWh/year. The remaining biomethane production (in the order of 1.2 TWh/year) for the 2030 target is estimated to come mainly from new plants.

According to a study by the CCI, the total theoretical biomethane production potential from anaerobic biomass digestion is 7.0 TWh per year in Greece (Figure 2).

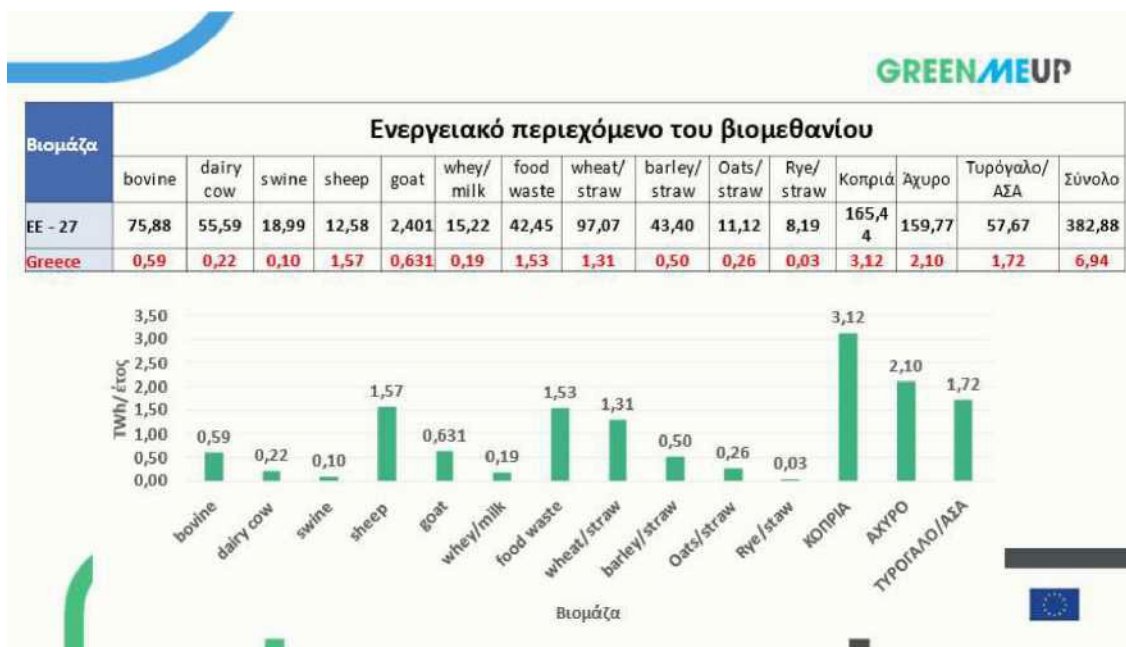


Figure 2 Theoretical biomass potential and biomethane energy content per feedstock in Greece.

Characteristic of Greek biomass production is that it results from small and scattered units compared to the rest of Europe. This creates difficulties in its conversion and leads to a low degree of actual exploitation of theoretical potential. It is estimated that the maximum degree of actual utilisation of theoretical potential cannot be considered to be higher than 50 %. Therefore, the maximum production of biomethane by anaerobic digestion is (optimistic) at the level of 3.5 TWh on an annual basis. With the addition of biomethane from gasification of ligneous residues (after the year 2040), a final maximum amount of 4.6 TWh per year is estimated for 2050.

It should be noted that the production of biomethane by gasification of ligneous residues (-waste) is still under exploration and maturation and has, for the time being, much higher production costs of biomethane.

In any case, the limited availability of the raw material creates an upper limit to the biomethane production potential.

2.4.3 Green hydrogen development

Production of green hydrogen

Hydrogen is currently produced from fossil fuels and used in the production process of refineries and ammonia/fertilisers.

The refineries currently produce 7.0 TWh per year grey hydrogen from the production process (naphtha reforming) and 4.7 TWh per year grey hydrogen from natural gas training, which is planned to be converted into blue by capture and use/storage of cogenerated CO₂.

Ammonia production in Greece is 100.00-150.000 t on an annual basis and is used for fertiliser

production. For the production of 100.000 t per year of ammonia, there are around 0.7 TWh of hydrogen on an annual basis. Today, this hydrogen is grey (from gas reforming).

As regards green hydrogen, two small research units and a small pilot plant for electrolytic hydrogen production have been built to date.

Although green hydrogen is not produced on a commercial scale, the production by 2030 of quantities of green hydrogen in the order of 1.2 TWh on an annual basis, to be used mainly for the production of synthetic kerosene and synthetic methanol, is considered. In addition, a small amount will be used for other uses, such as bus traffic (the pilot purchase of 50 hydrogen-powered buses is planned in Athens and Thessaloniki).

Refineries are projected to be the spearhead for the production of synthetic fuels and advanced biofuels, although for the latter there is a restriction of the raw material. The production of synthetic fuels is to be made from green hydrogen produced on site. The amount of hydrogen produced has an impact on RES electricity generation needs, as for every 1 TWh of green electricity, approximately 1.5 TWh of green electricity is required, which must be supplied continuously for the generation of synthetic fuels. In addition, the end uses of hydrogen (both for domestic consumption and for exports) are still in need of a stable supply profile. To achieve this, it is estimated that part of the production of green hydrogen should be based on RES diverging for hydrogen production.

The development of hydrogen in Greece by 2050 will be based on the following axes:

- The green hydrogen needs will be met by domestic production, given Greece's RES potential. In fact, as of 2035, RES penetration into electricity production will exceed 90 % and therefore hydrogen, which will come anywhere in Greece from grid electricity, will be considered green. This will be done in locations that ensure the optimisation of total costs, such as in refineries, where synthetic fuels are expected to be produced. Therefore, there does not seem to be a need for hydrogen imports or (as is currently the case) for extended transmission networks of hydrogen.
- Hydrogen, due to cost, will be directed to the use sectors that cannot be electrified directly. These are heavy road transport, shipping and aviation (subject to technical and economic maturity of the relevant technologies), and possibly in some industrial applications, as well as for the production of synthetic fuels. In particular:
 - (a) The use of renewable liquid synthetic fuels of biological or non-origin origin appears to prevail in shipping and aviation. There is research also for the use of clean hydrogen, but its storage restrictions lead to the conclusion that even if safety issues are resolved and the related artwork matures, this will only cover short and medium distance transport.
 - (b) In the heavy road transport sector, it is technically possible to apply the hydrogen

gas fuel cell solution. At the same time, the mushroom industry is conducting research to address the challenge of their heavy vehicles by competing with the hydrogen solution. In this context, hydrogen stations will be set up, in principle on a pilot basis to serve pilot projects such as H₂ in buses, and may be further extended after 2035, depending on technological developments.

(C) In the area of industrial applications that cannot be electrified directly, the need for hydrogen is only found in the refinery and ammonia sector, as there is no steel or glass manufacturing industry in Greece. As stated above, refineries are already producing blue feedstock by capturing and using/storing CO₂ (which is cheaper than pressed silos), and in ammonia production, the use of 'green' hydrogen depends on how to cover the extra costs.

(D) Finally, the current use of hydrogen as an electricity storage medium is not competitive with alternatives (battery stations, pumping stations).

It follows from the above that there is a high degree of uncertainty about future hydrogen production needs in terms of timing. The targets set by the EU even before the technology matures, although aimed at promoting the technologies concerned, are not certain that they will be achievable and will in any event require a reassessment in the future. In this NECP, a number of assumptions are made for the consumption of hydrogen in the transport sector (either as gas or in the form of positive fuels), assuming that the technical and economic maturity of the technologies instead of the enabling technologies will be achieved, in order to achieve the targets from 2040 onwards.

Green hydrogen transport infrastructure

It is estimated that no imports of hydrogen will be required, but there is a possibility of hydrogen pipelines, although, as is understandable, this depends on demand outside Greece and the relevant technical and economic data, as well as on the existence of contractual constraints on the purchase of hydrogen produced in Greece.

DESFA has already planned the development of a dedicated hydrogen pipeline network, which will bring together different locations in Greece, presuming imports and exports of green hydrogen from and to neighbouring countries (Figure 3).



Figure 3 Planned hydrogen transport networks in Greece and Evrop³⁹.

This core hydrogen transport network in Greece has been integrated into the network of the European Hydrogen Backbone initiative of European Network Operators.

According to this preliminary design of DESFA, the role that transmission infrastructure will play in the development of a hydrogen market in Greece as part of a wider integrated EU market, starting from the H₂ Valleys, could be significant. A wider integrated market will be implemented by the creation of a hydrogen supply corridor in the region of South East Europe, which, starting from Greece, will supply Central and Western Europe with the required quantities of green hydrogen either produced within the region or imported through Greece. As shown by recent developments in the evaluation of 1th projects

» DESFA, European Hydrogen Backbone. The list of projects of common interest under the revised TEN-E Regulation is compatible with the European Commission's design, which included the project 'Hydrogen interconnection pipeline between Greece and Bulgaria' in the above list by strengthening the potential for the supply of H₂ from Greece to the EU, via South-Eastern Europe.

The maturity of such infrastructure depends on the form in which hydrogen is used in end-uses, its topology for production and use, the evolution of demand both in Greece and at regional level, and the antagonism of hydrogen vis-à-vis alternatives.

2.4.4 Carbon Capture and Usage or Storage (CCUS- Carbon Capture and Usage or Storage)

Capturing CO₂ from industrial exhaust/waste gases is the only way to reduce the carbon footprint of certain industrial sectors, at least by developing alternative technologies based on redesign of production or products. Captured CO₂ may be used to synthesise synthetic fuels until at least the year 2040 in accordance with Union environmental legislation (to reduce the

use of new fossil fuels in transport). It can also be stored in impermeable geological formations. In this context, and given that industry is subject to international competition, investment-facilities are provided for the capture of CO₂ emitted by these industrial installations (refineries and cement plants in Greece).

Three projects have already been approved for co-financing by the Innovation Fund: (i) the IRIS project to capture about 0.5 Mt per year of CO₂ in the hydrogen production plant with untrained natural gas of a refinery in Korinthos, (ii) the IFESTOS project to freeze 1.9 Mt per year CO₂ in a cement plant in Kamari Viotia and (iii) the Olympus project to capture 1.0 Mt per year CO₂ in a cement plant in Myaki Evvoia.

At the same time, the first CO₂ storage facility in Prino, Kavala, with storage in the first phase of 1 Mt CO₂ and full operation of 3 – 4 Mt CO₂, has already been subject to the TAA for co-financing. The total storage capacity is estimated at 60-70 Mt CO₂. The first phase (for a capacity of approximately 1 Mt per year) is planned to be completed by the end of 2025 and the second phase (full capacity) by the end of 2027. The completion of the relevant token and regulatory framework for the capture, transport, use and discouraging of CO₂ is also progressing. The responsibility for supervising the construction and operation of storage projects has also been delegated to a specialised public company (ENEPP). In addition, through the RePower pillar of the TAA, the network for the transport of captured CO₂ from industrial installations has been included for funding. This network is intended to transport carbon dioxide for liquefaction to a central unit in Revithoussa.

It is worth noting that the storage facility in Prino in combination with the AGO network for transport and the CO₂ liquefaction and interim storage plant are a project of the 1st list of projects of common interest.

Finally, it is worth noting that small scale carbon capture technologies incorporating CO₂ captured into solid or liquid chemical compounds are also being used in the maritime sector. Recent decisions by the International Maritime Organisation (IMO/MEPC 80, July 2023) on binding GHG emission reduction targets, such as, inter alia, the 2050 net zero target and the indicative intermediate but ambitious absolute GHG emission reduction targets in 2030 and 2040 make CCS an important solution for shipping, at least until synthetic fuels mature. CCS has already been included in the IMO's sustainable pathways and it is estimated that it will be one of the shipowners' compliance options to achieve the objectives of decarbonising shipping.

2.4.5 Promotion of Renewable Liquid Fuels

Conventional liquid biofuels

The promotion of conventional liquids will continue with the current trend in the form of biodiesel with a mandatory mixing quota of 7 % v/v in road fuel oil with tumours, and bioethanol/bioethers with a mandatory mixing quota of 3.3 % innergic content in petrol,

equivalent to approximately 5 % v/v. Biodiesel is almost entirely produced in Greece in 18 factories with the raw material oil-energy crops (rapeseed, sunflower, soya, cotton seed) and oily waste (used fried oils) through the process of metesterification with methanol (Fatty Acid Methyl Esters, FAME). The share of bioliquids in diesel is expected to increase in line with EU legislation and new specifications for internal combustion engines.

Bioethanol is produced by fermentation of sugar/starch crops (sugar beet, cane, cereals, maize) and is imported. Before mixing, however, most of it is converted into ethers in the refineries in order to reduce the exhaust point.

The production of conventional liquid biofuels is not further developed in order not to create a problem in the supply of food and feed, in line with EU policy. The upper limit of conventional biofuels as a percentage of transport fuels is maintained in the existing frameworks (biodiesel to 7 %, etc.) throughout the energy transition, suggesting a gradual reduction in their production in absolute terms as the consumption of petroleum products will decrease.

Advanced Liquid Biofuels

Advanced biofuels produced by hydrogenation of vegetable oils or other biological fats, such as animal fat, used cooking oil and tall oil (extract from paper industries) are currently not produced in Greece. This chemical process first removes the oxygen content in the raw material and then decomposes and isomerisation of the organic molecules, with the final product being diesel (advanced biodiesel) or kerosene (SAF-Sustainable Aviation Fuel). These processes are usually carried out in refineries using hydrogen produced there.

Technologies for gasification of ligneous residues and synthesis of liquid fuels using hydrogen through the Fischer-Tropsch chemical process that achieves the catalytic conversion of a mixture of CO (produced by gasification) and H₂ into liquid fuels (diesel, gasoline, kerosene) (BtL- Biomass-to-Liquids) are also under investigation. One of the liquid fuels that is also considered as a substitute for petrol and can be produced by similar technologies is methanol (biomethanol).

According to the projections in the revised NECP, advanced biofuels will account for 4.6 % of transport fuels by 2030 and 13.2 % by 2050. The main restriction is the availability of raw material and the level of production, which, however, has a downward trend. Advanced liquid biofuels will be used in the transport sector.

The penetration of the bio-based advanced kerosene (SAF-Sustainable Aviation Fuel) is expected to reach 5 % of the total energy consumption of aeronauts in 2030 and 38 % in 2050.

RFNBO-Renewable Fuels of non-biological Origin

Renewable fuels of non-biological origin are not currently produced and used in Greece. According to the projections in the revised NECP, the diversion of renewable fuels of non-biological origin is expected to reach 0.9 % of transport fuels by 2030 and 30.9 % by 2050. The

main uncertainty is the technical, and above all economic, optimisation of the associated-
tennis.

SAF-Sustainable Aviation Fuel penetration is expected to reach 1 % of the total energy
consumption of aeroplanes in 2030 and 44 % in 2050.

Refineries are projected to be the spearhead for the production of synthetic fuels and
advanced biofuels, although for the latter there is a restriction of the raw material. The
production of synthetic fuels is to be made from 'green' hydrogen produced locally, covering
the largest share of domestic needs.

In particular, it is projected that around 2.7 % of net domestic consumption in 2030 and 20.6 %
in 2050 will be due to green hydrogen production needs.

2.5 Improving energy efficiency

2.5.1 Improving energy efficiency in all final energy consumption sectors

Improving energy efficiency is a key cross-cutting priority in the country's energy transition, while it is the fundamental axis on which all other energy policies must be designed to achieve ambitious climate and climate objectives. **In the context of this NECP, the objective of Article 4 of Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 is that final energy consumption should not exceed 15,2 Mtoe in 2030, showing a reduction of 8 % compared to the target of the former NECP for the same year (16,5 Mtoe).**

Accordingly, primary energy consumption is expected to reach 17,8 Mtoe in 2030, showing a decrease of 13 % compared to the corresponding target set in the previous NECP.

Please note that the final energy consumption and primary energy consumption figures that have been used to set energy efficiency improvement targets are compatible with EUROSTAT's 'Europe 2020-2030' standard.

Figure 14 shows the evolution of final and primary consumption up to 2050.

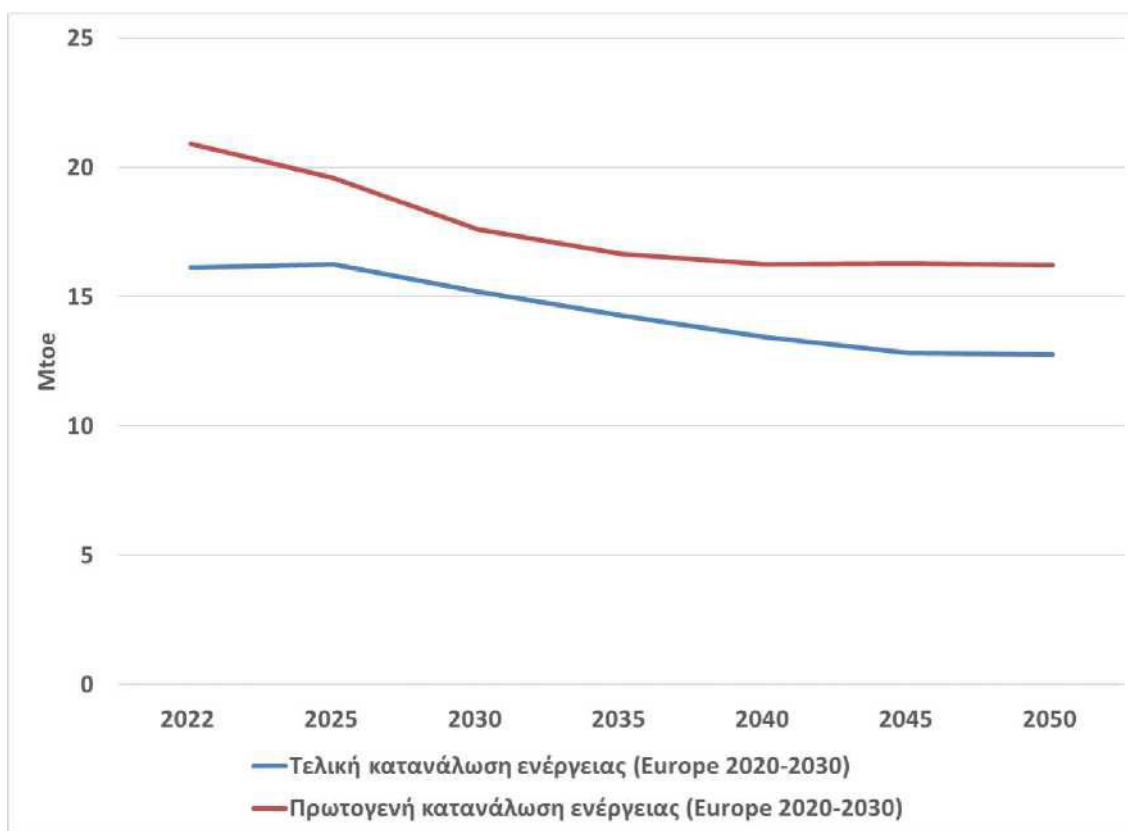


Figure 14 Evolution of final and primary energy consumption by 2050.

The achievement of energy savings, resulting from improved energy efficiency, has a direct impact on the way energy is consumed, on the artefacts used, on meeting consumers' energy needs, and has a key contribution to improving the competitiveness of each sector of economic activity.

The energy savings target under Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 in the period 2021-2030 is 11.251 ktoe of cumulative energy savings considering new savings:

- 0.8 % of annual final energy consumption from 1^{January} 2021^{to} 31 December 2023 on average compared to 2016-2018.
- 1.3 % of annual final energy consumption from 1^{January} 2024^{to} 31 December 2025 on average compared to 2016-2018.
- 1.5 % of annual final energy consumption from 1^{January} 2026^{to} 31 December 2027 on average compared to 2016-2018.
- 1.9 % of annual final energy consumption from 1^{January} 2028^{to} 31 December 2030 on average compared to 2016-2018.

The average final energy consumption in 2016-2018 is equal to 16.354 ktoe according to official data published in EUROSTAT. Please note that the 2014-2020 deviation (883 ktoe) is added to the energy savings target.

Table 7 shows the cumulative energy savings target established under Article 8 of Directive (EU) 2023/1791 of the European Parliament and of the Council of¹³ September 2023 on energy efficiency and amending Regulation (EU) 2023/955.

Table 7 Identification of an energy savings target in Article 8 of Directive (EU) 2023/1791.

Year	Annual energy savings (ktoe)										Cumulative-savings
2021	130,8										131
2022	130,8	130,8									262
2023	130,8	130,8	130,8								392
2024	130,8	130,8	130,8	212,6							605
2025	130,8	130,8	130,8	212,6	212,6						818
2026	130,8	130,8	130,8	212,6	212,6	245,3					1.063
2027	130,8	130,8	130,8	212,6	212,6	245,3	245,3				1.308
2028	130,8	130,8	130,8	212,6	212,6	245,3	245,3	310,7			1.619
2029	130,8	130,8	130,8	212,6	212,6	245,3	245,3	310,7	310,7		1.930
2030	130,8	130,8	130,8	212,6	212,6	245,3	245,3	310,7	310,7	310,7	2.240
2014-2020 add-on											883
Total liability 2021-2030											11.251

Finally, part of the cumulative energy savings target will be achieved by energy upgrading interventions in households affected by energy poverty, in accordance with Article 8 of Directive (EU) 2023/1791.

The key role of public bodies is expected to be in achieving energy saving objectives. **The exemplary role of the public sector is strengthened by setting a target to reduce the final energy consumption of all public bodies by at least 1.9 % per year compared to 2021. At the same time, the scope of the obligation to upgrade on an annual basis at least 3 % of the total floor area of heated and/or cooled buildings is extended to all public bodies.**

It is worth mentioning that local authorities draw up **municipal plans to reduce net greenhouse gas emissions in order to achieve a target of at least 10 % for 2025 and 30 % for 2030 compared to the base year 2019, in accordance with the** provisions of Article 16 of the Climate Law (Law 4936/2022, Government Gazette, Series I, No 105). This obligation relates to the existing initiative which contributed to tackling the energy crisis and concerned the entire public and local government as regards the obligation to reduce electricity consumption by 10 % in 2022 compared to 2019 for the same period (Joint Ministerial Decision ΥΠΕΝ/ΔΕΠΕΑ/68315/502/1.7.2022, GG II 3424).

It should be noted that the achievement of the above objectives is ensured by the application of the **Energy Efficiency First principle, by defining the choice** of the most efficient policy measures

while implementing cost/benefitsolutions over the entire life-cycle of the measure, as well as the long-term perspective, system efficiency and costs, thereby obtaining, in accordance with the requirements of Regulation (EU) No 1999/2018 (Article 18), what simplebenefits for all final consumption sectors, such as reducing localcosts, improving comfort conditions in buildings, increasing the productivityof workers, increasing domestic value added and employment and improving the competitiveness of businesses.

2.5.2 Improving energy efficiency in the building sector

The building sector may be the most critical sector to achieve energy efficiency improvements. The implementation of the envisaged policy measures should lead to the achievement of the objectives laid down in Directive (EU) 2024/1275 on the energy performance of buildings. Initially, **a target of reducing the average primary energy use in residential buildings by 16 % by 2030 and by 20-22 % by 2035 is determined/set**. At the same time, **the target for other buildings is redefined, whereby 16 % of the worst performing buildings are to be renovated by the year 2030 and 26 % of the worst-performing buildings have to be renovated by 2033**.

Given that the need for energy upgrading of the existing building is undeniable, it is necessary to set a **central target for the renovation of the building stock** by 2030, making a significant contribution to the radical upgrading of the obsolete building stock, while at the same time giving a significant boost to the construction sector through high value-added investments.

The annual renovation rate of residential buildings in 2025-2030 will amount to 68 thousand renovations. Accordingly, in 2031-2040 the annual renovation rate will decrease to 64 thousand renovations, while a significant increase is expected to be achieved in 2041-2050 to 83 thousand with a view to decarbonising the residential sector.

It is worth mentioning that renovation programmes for the building stock have already been implemented. In the residential sector, energy upgrading programmes contributed to an increase of 67 % in energy-upgraded dwellings compared to 2019. The number of applications approved in 2022 is 95.000 dwellings and the total interventions in residential buildings in 2023 amount to 86.545. The Housing Renovation Protocols in 2020-2022 provided the possibility to cover energy efficiency improvements for 126.000 potential beneficiaries. The total budget of the programme leveraged for the year 2021 alone is EUR 2 billion. The corresponding budget for the 2023 programme comes to EUR 973 million.

At the same time, the ELECTRA programme is being implemented, which aims to promote the exemplary role of the State in improving the energy efficiency of buildings, to meet the target of annual energy renovation of 3 % of the useful floor area of central government buildings, and to achieve the national energy efficiency target. To date, 86 applicants have been assigned with 172 buildings, which have a total funding budget of EUR 165 million. With this in mind, the programme for saving energy in the State (THERMEOSTAT) for monitoring the energy consumption of public bodies is already being implemented, which sets an annual target for achieving savings.

In addition, the design and implementation of financing programmes to improve energy efficiency in businesses has been launched in conjunction with any already established tax incentives to promote saving actions. By way of example, the 'Savings – Business' programme is mentioned, where there are initially 1.143 enterprises eligible. At the same time, it is a continuing measure to recoup costs associated with energy efficiency or water saving in accordance with the provisions of Law 4172/2013 (Government Gazette, Series I, No 167).

Finally, for each building or building unit offered for sale or rent from 1/6/2021, the energy performance index of the energy performance certificate shall be declared in all commercial advertisements.

In any event, **eliminating the carbon footprint of building waste** by 2050 is one of the main energy and climate targets. The **promotion of efficient heating and cooling systems** is a key priority to achieve this objective together with the upgrading of the building envelope.

In order to promote RES systems, initiatives have been developed and implemented in advance to replace old and energy-intensive devices with new ones, and to make the transition of households more economical, more efficient and more environmentally friendly. In more detail, the EUR 100 million 'I recycle changing water heaters' programme helped to purchase the product and **install** 13.589 solar thermal systems. Similarly, the 'Recycling – Changing Packaging' programme, with a budget of EUR 286, enabled 653.772 beneficiaries to replace active/northern appliances, such as air conditioners, refrigerators and freezers, achieving a reduction in electricity consumption of at least 43 % at household level.

At the same time, the promotion of RES technologies will contribute to increasing the share of RES in final consumption by facilitating **electrification and coupling of the remaining final consumption** targets of this NECP.

Finally, priority will be given to **phasing out fossil fuel boilers** by 2040 and increasing the contribution of buildings to the installation of electric vehicle charging infrastructure in line with the requirements of Directive (EU) 2024/1275.

2.5.3 Addressing energy poverty

All energy efficiency improvement programmes implemented in the residential sector are expected to play a key role in alleviating the inherent vulnerability of citizens and mitigating the energy supply phenomenon in the future. Targeted measures can effectively contribute to tackling energy poverty by limiting the social impact on Greek households.

In Greece, the phenomenon of energy poverty is a particularly important phenomenon, particularly since 2011, due to the economic downturn, with the result that the fight against this phenomenon is a priority and a major challenge until 2030.

The energy poverty target is maintained with the aim of reducing energy poverty by 50 % in 2025 and 75 % in 2030 compared to 2016. Achieving this objective requires the implementation of a coherent strategy, which aims to combat energy poverty permanently and in the long term,

rather than transient mitigation, through the adoption of temporary and short-term measures. However, direct support for the most vulnerable households who are experiencing a lack of access to essential energy services is also particularly important.

To this end, the Action Plan for Combating Energy Poverty was drawn up in September 2021, which includes the definition of the hotspots affected by energy poverty by means of specific quantitative criteria. At the same time, the focus was on exploring targeted policy measures to address energy poverty either through existing or new ones – while at the same time making use of both available funding programmes and market mechanisms.

In addition, a monitoring and control mechanism was set up to continuously evaluate the policies implemented, ensuring its smooth and effective implementation in accordance with the requirements and objectives of the NECP by 2030.

The monitoring and control mechanism provides for the preparation of progress on an annual basis, reflecting the evolution of the energy poverty phenomenon through the implementation of the proposed “top-down” monitoring procedures through the Energy Poverty Observatory as well as “bottom-up”. The objective of the progress report is to assess the achievement of the objective of reducing energy poverty levels compared to the previous year, to specify policy measures in cooperation with the bodies responsible for planning and implementing them, and to formulate proposals in the event of significant trends.

The main indicator for measuring and monitoring the phenomenon of endemic poverty was defined as the **Indicator I Dilleq**, which calculates the number of households, which meet the following two conditions at the same time:

1. The annual cost of each household’s total energy consumption should be less than 80 % of its annual cost to cover the minimum energy consumption of children (Treaty I).
2. The net income of each household on an annual basis is less than 60 % of the median of the corresponding discounted income based on the equivalent number of persons belonging to each household according to the OECD scale for all households according to the definition of relative poverty (Treaty II).

This indicator is determined on an annual basis using the data collected in the framework of the Family Budget Survey, which is carried out by the Hellenic Statistical Authority.

The share of households affected by severe poverty in 2021 is equal to 12.4 %, according to Index I, which showed an increase compared to 2020 (12 %). The value of Index I Azerbaijan for the year 2016, which is the year on which the target is monitored, was 13.8 %, leading to the conclusion that the level of energy poverty has decreased by 10 % over the period 2016-2021 (point 8).

Table 8 Calculation of energy poverty levels.

Year	Treaty I	Treaty II	Treaty II _{eq}	Index

2016	59 %	21 %	19 %	13.8 %
2017	57 %	22 %	18 %	12.5 %
2018	57 %	21 %	16 %	11.1 %
2019	55 %	21 %	17 %	11.2 %
2020	55 %	23 %	18 %	12.0 %
2021	62 %	23 %	18 %	12.4 %

The number of households affected by the energy poverty phenomenon in 2021 amounts to 513 thousand based on the performance of the I DublIleq Index. It should be noted that the number of households affected in 2016 was 573 thousand.

Therefore, the **Action Plan against Energy Poverty will be updated by strengthening and extending existing policy measures, taking into account the policy priorities that will be reflected in this NECP.** It should be noted that the focus will be on stepping up policy measures to achieve the 2025 target unexpectedly, covering the gap observed today.

Finally, the scope of the Action Plan is expected to be extended by promoting new technologies and implementing new mobility solutions to reduce the dependency of households affected by energy poverty on the use of private vehicles and to ensure access to quality, poor and affordable alternative modes of travel by facilitating the disruption and implementation of the Social Climate Fund Plan. To this end, the expansion of the phenomenon in enterprises will be studied.

It should be noted that securing the necessary financial resources on a permanent basis is the most important challenge in tackling energy poverty over the long term.

2.6 Objectives and targets in the field of security of energy supply

pitch

2.6.1 Summary of objectives and priorities

With regard to the dimensions of energy security and the energy market, it should be noted that their qualitative and quantitative targets are often complementary and interlinked and both policies and planned measures most often take into account both dimensions. The most prominent example is energy infrastructure, both international and secondary interconnections, which contribute to achieving objectives of both dimensions.

With regard to the security of energy supply dimension, the quality objectives developed under the NECP are broken down into the following main categories:

☐ increasing diversification of energy sources and suppliers from third countries

Enhancing the diversification of my energy sources and fuel supply countries so that there is no dependency on a single fuel or a single country is a key objective for the next period. This

differentiation, on the one hand, increases the tension between fuels and suppliers from third countries for the benefit of Greek consumers, on the other hand contributes decisively to enhancing security of supply and strengthens energy supply in the event of a regional crisis.

→ **optimal utilisation and use of indigenous energy sources**

Recognising the potential and making the best use of domestic energy sources is a key objective and aim for the evolution of the national energy system. In particular, the utilisation and use of RES potential, both for electric power supply and for immediate disposal and use for final consumption, contributes to energy security issues. However, the key role of improving energy efficiency and saving energy as a kind of indigenous energy source in energy security must also be highlighted in this pillar. Valuing and using this source is essentially the horizontal priority and the first action to implement policies and measures across the themes of the NECP. In addition, although with a different policy approach and planning, electricity for the extraction and exploitation of indigenous hydrocarbon deposits continues to be a focus of energy policy for the next period and is integrated into the wider framework for the exploitation of indigenous energy sources.

→ **promoting a country as an energy hub as well as an exporter of green energy**

Strengthening and exploiting Greece's geopolitical role is an objective at national level. It is therefore imperative to complete the emerging interconnections and to design new international electricity and gas interconnections with neighbouring countries. These actions will make a key contribution to ensuring security of supply.

As regards the electricity sector in particular, increasing the transmission capacity of interconnections is a strategic objective and to this end the implementation of a number of interconnection projects is promoted, which are discussed below. These projects contribute substantially to increasing the penetration of RES in the energy mix, but also to exporting excess 'green' energy to the countries of south-eastern and central Europe.

At the same time, Greece is promoting a large number of cross-border international gas projects by enhancing the diversification of energy sources and thus the energy security of the other European countries while at the same time becoming independent of Russian gas.

→ **reduction of the energy dependency rate**

Reducing the energy dependency rate is another important objective in the transformation of the national energy system. Moreover, high dependency is a matter of concern to the whole of the EU. Greece's high energy dependency is due to a particularly high use of petroleum products and secondary natural gas, which together account for more than 65 % of the sincere domestic energy consumption and are almost entirely imported from outside the European Economic Area. The aim under the NECP is to achieve a progressive reduction of the energy dependency rate by ensuring the security of supply of the national energy system. Quantitatively, this target

comes from a reduction in energy dependency on the high average rates that have been overwhelmed in recent years, around 75-78 %. The **initial target is to stabilise as a percentage at the level of 77 % and then by the year 2030 to reduce it in the region of 66 %**. In essence, there will be a visible decline in the dependency rate, despite the delignification of domestic electricity generation and a surge in the economy, due to the completion of the electricity interconnection of the islands, which are currently based on oil products, electrification in sectors currently based on fossil fuels, as well as through improved energy efficiency. In addition, in the period after 2030, the aim is to further and sharply de-escalate the energy dependency index, with the main focus being an even greater use and flexible use of RES potential, improving energy efficiency and an overall change in energy consumption patterns, by making greater use of new technologies and applications such as the storage of green energy and smart demand management systems.

→ **interconnection of autonomous island electricity systems**

There are currently 28 autonomous island electrical systems in Greece, each of which is supplied by one or more thermal power stations and consists of one or more islands connected to each other by seawater cables. These systems are served by oil plants (mainly in the small and medium systems), while *at Rhodes, Kos-Kalymnos, Thira and Lesvos* gas turbines (using light oil/diesel fuel) are also installed. The operation of these electrical systems requires increased financial resources and, moreover, the uninterrupted and vetoed supply of electricity to their consumers is not fully and independently guaranteed.

Before the end of this decade, the majority of these autonomous systems should be interconnected with the interconnected system, thus saving economic resources in the national economy, reducing energy dependency, providing equally high quality electricity and employment to all citizens, complying with environmental law requirements, and further exploiting the potential of domestic RES in these island systems. Even in cases where the interconnection of some helmets and remote electrical systems is not technically and economically efficient, innovative energy applications will be implemented in these systems as part of the development of hybrid systems (RES with storage) and policies for 'smart' islands. This objective translates into an interconnection of almost all autonomous electricity systems by 2029.

→ **system capacity assurance**

The objective is to ensure system capacity adequacy to ensure a high degree of reliability to meet the electricity demand in the system, taking into account the profound transformation of the electricity generation system in the next period. In order to ensure the operation of the necessary production resources to ensure the adequacy of the system, the requirement for appropriate capacity mechanisms or a capacity market will be assessed, following the updated study on the capacity adequacy of the system by the competent operator.

A key pillar of the NECP to achieve the above objectives is the high penetration of RES and the transformation of the electricity generation system by means of systems that provide flexibility for the efficient management of stochastic RES.

The factors influencing this evolution of the system are:

- The production/consumption balance, i.e. whether the energy produced at any time can be consumed, stored or exported in neighbouring systems and the energy consumption at any time can be shifted through demand response by giving flexibility to the system; and
- transmission and hosting capacity, with others for the available “electrical space”, ensuring all criteria for the safe operation and stability of transmission and distribution systems.

On the basis of the investment plan for the development of the transmission system, it is estimated that the electricity space for RES in 2030 will be in the order of 29 GW in total. At the same time, there is a huge investment interest in the further development of RES projects, which is highlighted by the fact that only ADMIE has RES requests for a connection offer totalling more than 42 GW. This dynamic may put the country in a position of energy independence and security earlier than foreseen in this draft NECP. Action is therefore needed to optimise the use of the existing electrical space and to increase it.

In this context, a new strategy is needed to create a new spot and to make the most of the existing space. In parallel with the development of networks, as it requires considerable licensing and ripening time, which is the case at international level, flexible artefacts such as storage (batteries and pumped storage) are needed to ensure a total of 6 GW, demand response (Demand Response) and optimum management of capacity cuts in RES projects are managed.

The management of stochastic production of RES plants during the operation of the conglomerate has a significant impact on the way conventional units operate, which are necessary to regulate the balance of production and load. There is a French range of challenges that need to be addressed, which has been explored for many years at pan-European level.

Finally, it should be noted that the mathematical model used applied an hourly simulation of electric system operation for all projection years in the future. The hourly simulation includes in the limitations the necessary back-up requirements and the reliability criteria applied by the Managers. Intrinsically, the tank develops flexibility systems for balancing RES, reserves for supra-day stochasticity and storage facilities to meet the criteria for reliable operation of the electrical system. As a result, this methodology, which has consistently been applied, ensures adequacy despite the high penetration of RES, with a system developed in an optimal financial way.

2.6.2 Strengthening international electricity interconnections

Since October 2004, the Greek Transmission System has been reoperating in parallel with the interconnected European Transmission System under the most general coordination of ENTSO-E (European Network of Transmission System Operators for Electricity). The parallel operation of the Greek transmission system with Europe is achieved through interconnector lines (GTs), mainly 400 kV, with the institutions of Albania, Bulgaria, North Macedonia and Türkiye. In addition, the Greek transmission system is connected asynchronously via a submarine connector with a voltage of 400 kV with Italy.

In June 2023, the new interconnection between Greece and Bulgaria became operational. The project concerned the implementation of a second interconnection line between the Greek and Bulgarian systems which was carried out with 400 kV aerial interconnector between the Santa hotspot and Maritsa East 1. The route has a mass-transport capacity of 2000 MVA and has a total length of approximately 151 km, of which approximately 30 km belong to Greek territory and approximately 121 km to the Bulgarian territory. The new 400 kV Greece – Bulgaria interconnector is a sign of European interest and is entitled 'PCI' with code 3.7.1 since 2013, with the ^{list} of Projects of Common Interest (PCI) from the EU of the NSI East Electricity Priority Corridor (North-South Electricity Interconnectors in Central Eastern and South-Eastern Europe) up to and including 4.

The results of Figure 4 show that, with the planned completion of future interconnection projects of neighbouring countries by the end of 2029, the Greek interconnected system will meet the target of an interconnectivity rate of 15 % in 2030.

YEAR	2025				2030				2035			
Interconnection	NTC (MW)		Nominal Transmission Capacity (MW)		NTC (MW)		Nominal Transmission Capacity (MW)		NTC (MW)		Nominal Transmission Capacity (MW)	
	From GR	To GR	EU	Total	From GR	To GR	EU	Total	From GR	To GR	EU	Total
GR-AL	450	450		1095	600	600		2085	600	600		2085
GR-BG	1000	1150	2430	2430	1400	1700	2430	2430	1400	1700	2430	2430
GR-MK	650	650		1548	1100	850		1548	1100	850		1548
GR-TR	218	166		1200	660	580		1200	1260	1180		2640
GR-ITS	500	500	500	500	500	500	500	500	1500	1500	1500	1500
GR-CY					1000	1000	1000	1000	1000	1000	1000	1000
GR-EG					3000	3000		3000	3000	3000		3000
GR-DE									3000	3000	3000	3000
GR-SAU									TBC	TBC	TBC	TBC
Installed Generation Capacity [GW]	28.9				40.3				49.9			
Peak Load [GW]	11.8				13.7				15.3			
Installed Renewable Generation Capacity [GW]	17.5				27.3				38.5			
	EU		Total		EU		Total		EU		Total	
Total NTC (Import)	1650		2916		3200		8230		7200		12830	
Total Nominal Transmission Capacity	2930		6773		3930		11763		7930		17203	
Interconnectivity Level	5.7 %		10.1 %		7.9 %		20.4 %		14.4 %		25.7 %	
Total Nominal Transmission Capacity/Peak Load	24.9 %		57.6 %		28.7 %		85.9 %		51.8 %		112.4 %	
Total Nominal Transmission Capacity/Total installed Renewable Generation Capacity	16.7 %		38.6 %		14.4 %		43.1 %		20.6 %		44.7 %	

Figure 4 Level and indicators of interconnectivity of the Hellenic Electricity System (source: Via — operator of the Hellenic Electricity Transmission System (ESMIE)).

In order to satisfy the planned interconnectivity rate in all cases, and given that the development of electrical interconnections with the electricity systems of neighbouring countries is a strategic priority for the Greek Electricity Medium System, the System Operator shall continue seamlessly to strengthen cooperation and joint actions with neighbouring managers for the planning and implementation of future interconnections, the feasibility of which is confirmed. In this context, the implementation horizon of the planned interconnection with neighbouring operators is within this decade and most of them with a view to completion earlier than 2030. The physical integration of each of the new interconnections is expected to contribute to a significant increase in the net transmission capacity of the Greek electricity system and to a consistent increase in the projected interconnectivity rate for 2030. The

map (Figure 5) shows both existing interconnections (black) and new interconnections based on future interconnectors (green).



Figure 5 Map of the interconnections of the Hellenic Electricity System.

2.6.3 Electricity interconnection of islands

The interconnection of the Aegean islands with the Continental System is an important priority. These connections address their electrical isolation, increase the reliability of the supply, reduce the cost of energy produced and consequently the costs of SGIs, protect the environment and exploit the high volume of RES in the non-interconnected islands (NII). In parallel with the abolition of the 'electrical isolation' of the Aegean Island, the size of the single electricity market is increasing. To date, all the Ionian Islands have been connected to the High Voltage System (HV). With regard to the Aegean Islands, Andros, Syros, Paros, Mykonos and Naxos are connected under the High Voltage (HV), while under the Middle Voltage (MT) they are interconnected via Paros, Antiparis, Ios, Sikinis and Folegandoros, and via Naxos Schinousa, Iraklida and Koufonisi. Also under Medium Voltage (MT), several islands are connected near the coast (Sporades,

Thasos, Samothraki, Kythira, etc.). Finally, several Aegean islands (mainly those located geographically close) have been interconnected under the Medium Voltage (MT).

More specifically, during the last three years, the following planned island interconnection projects were completed by the System Operator:

- Interconnection between Cyclades Phase B and C: Andros, Tinos, Naxos and reinforcement of Syros (Sept and Okt 2020)
- Phase I of the Crete interconnection: Crete – Peloponnese (beginning 2021)
- Upgrading of the Skiathos interconnection (July 2022)
- Functional replacement of the Aktio – Preveza interconnections (April 2023) and Zakynthos – Kallini (July 2023)

In parallel, the following projects are ongoing:

- Phase D of the Cyclades Interconnection: The project concerns the interconnection of the South Western Cyclades, in particular the islands of Thira, Milos, Folegan Drou and Serif with the ESMIE. The project is expected to be completed in 2025.
- Phase II of the interconnection between Crete (Crete – Attica): The project concerns the interconnection of Crete with Attica via a continuous stream link with a nominal capacity of 2 x 500 MW with VSC. The project is being implemented through ADMIE's daughter-company 'ARAADIS Interconnection AETE', with an estimated completion time in 2025 and commercial operations starting no later than 2026.

Today, the small and medium-scale 28 autonomous Aegean island electricity systems account for around 10 % of total energy consumption.

The next objectives of island interconnections are the projects to interconnect the Dodecanese and the islands of the north-east Aegean. The planning of these projects shall provide for:

- Interconnection of the Dodecanese with the Continental System: the project concerns the connection to the ESMUN of the South-East Aegean Islands Group, which includes the following six autonomous electrical systems: Karpathos (Kasos Diassis under MT), Rhodes (Halki interconnection under MT), Symi, Kos – Kalymnos (Psyrimos, Teldendos, Nilisos, Tilos, Leros, Leipzig, Galali interconnection under MT), Patmos and Aria-Kioi (Marathi interconnection under MT). The project will be implemented in two phases, with an estimated completion in 2029.
- Interconnection between the north-east Aegean islands and the Continental System: The North-East Aegean interconnection project concerns the interconnection with the ESMIE of the North East Aegean Islands Group, which includes the following eight autonomous electrical systems of the NIIIs of Limnos, Agios Efstratios, Skyros, Lesvos, Chios (Psaras), Samos (Fournes-Thymaina), Ikaria and Agathonisi. The project is a continuation of the project on the interconnection of the Dodecanese, and will be implemented in three phases, with an estimated completion in 2030.

2.6.4 Reinforcement of internal networks

At the same time as serving demand, which is a key parameter for each network development, the need to serve the highest level of RES penetration is of equal importance, in the context of fulfilling the national policy and the European policy rather than the corresponding European policy.

In order to achieve the ambitious RES penetration targets, appropriate reinforcement of transmission and distribution system infrastructure is planned to increase the available margins for connecting new RES stations. In this context, a series of projects to strengthen the transmission and distribution system have been carried out and are currently underway, which will help to absorb and distribute the energy produced by RES plants, so that the available electricity space in 2030 exceeds the tall, and new projects are planned after the 2030 horizon, in order to meet the RES penetration targets in the long term.

More specifically, over the last three years (in addition to the international and island interconnections already mentioned), the following critical projects have been completed:

- Interconnection between Rio-Antirio 400 kV (August 2019)
- Eastern Corridor 400 kV Peloponnese (Megalopoli – Korinthos) and Ko-Rinthos hotspot (December 2022).
- Western Corridor 400 kV Peloponnese (May 2023)
- Number of new substations for the connection of RES units

At the same time, a number of projects are underway (at various stages of implementation) with a view to completion by 2030, such as the completion of the Eastern Corridor 400 kV Peloponnese (Korinthos – Koumoundouros), the new GIS Koumoundouros hotspot (the largest in the country) which will replace the old open-air type, the new GM 400 kV Frilip– Nea Santa, System aid in the areas of Ioannina, Eastern Macedonia and Thrace, 150 kV pipeline replacements in the area of Trithiia, etc.

2.6.5 Technologies enhancing the reliability and security of the electric grid

Storage of electricity

The energy transition in the new era highlights the pivotal role of storage systems, as their integration into the electricity system offers multiple advantages that technically optimise its operation and contribute to the reliability and security of the electricity grid.

Traditionally, the main purpose of the use of storage systems, which has boosted the development of large pumped power plants in particular, has been to smoothen the large fluctuations in energy absorbing production prices during low night-time loads or the hours of high production of RES during the day and yield stored energy to peak conditions. Today, the incumbent power is in the order of 700 MW with the aim of adding new pumped storage projects with a capacity of **1.2 GW** by 2030.

However, the rapid development of renewable energy sources and their high penetration of electrical systems is leading to a greater need for energy storage. In combination with technological developments that have led to the development of new storage technologies, such as lithium-ion batteries, with the possibility of installation in the spotsystems and in parallel with the gradual reduction of their costs, theconditions for the development and operation of battery storage systems with different connectors (behind the meter or at the same connection node to the RES station, stand-alone) are being developed. The target set for battery storage is **4.3 GW** by 2030.

Depending on the characteristics of the different technologies available and the size, storage systems can provide multiple services in parallel. In particular, the most important storage applications for Transmission Systems are:

→ **upgrading of Transmission System Capacity**

The high penetration of RES sources in the electricity system requires significantly greater security and safety for the transmission of electricity to the electrical system. Today, often, the provision to maintain system safety in conditions of disruption necessarily leads to under-exploitation – not to be fully exploited under the conditions of operation of existing transmission lines. In addition, in which cases new transmission line projects are planned in order to ensure compliance with the criteria for safe operation of the system (loads, voltage levels, etc.) based on criterion N-1. Storage systems shall have characteristics that allow the system to operate more efficiently and may act in addition to transmission lines either as permanent solutions or as front points, taking into account the significant times required for the licensing and construction of new transmission lines, in particular when they are combined with and operate in cooperation with RES stations.

In general, the installation of storage systems with best practices can lead to a more efficient operation of existing transmission lines while maintaining the N-1 reliability criterion. Storage systems in such cases should be managed in a transparent and neutral manner with regard to electricity markets. By way of example and not restrictively, it is stated that there is no impact on the market by installing storage stations on either side of a transport corridor, where the two stations operate equivalent in terms of capacity but in the opposite direction in order to limit the flow on the runway with no overall change in the energy flow in the system.

→ **contributing to capacity adequacy in interconnected island systems with some capacity to interconnect and provide emergency reserves on fully interconnected islands**

Storage is of particular importance in islands with limited interconnection capacity as it enhances the capacity of the non-interconnected system. Even after the full interconnection of an island's electrical system, in the sense of full load coverage, security of supply requires that the poorly distributed generation units remain in order to provide emergency reserves in conditions of

major failure in the interconnection network. Part of the necessary emergency power may be generated by energy storage units, as is not limited to battery stations.

→ **demand response systems**

Because of the stochasticity of production, RES create a need for flexible power plants to serve the back-up and balance the system. Such services may be provided by Demand Response entities in an efficient and cost-oriented manner. Flexible demand response entities still have the potential to contribute to a shift in demand away from times when there is a lack of production and higher energy costs, to those where excess production occurs and energy costs are low.

Furthermore, adjusting the consumption profile by lowering peaks is expected to lead to a more efficient operation of the network in general, a reduction in its stress and, in the long term, a reduction in its operating and maintenance costs, in particular a reduction in regulated system and network charges. However, in order to strengthen demand response systems, it is assumed that external energy meters are installed. Demand response systems participated in the balancing market in 2023 with a total capacity of 162 MW. The increase in the participation of response systems in the system is expected to be rapid in line with the increased flexibility needs in the system by the year 2030.

Development and integration of offshore wind farms

In order to achieve the targets set in the National Energy and Climate Plan for 2030 and the long-term energy planning for 2050, it is necessary to speed up the procedures for the integration of new RES plants on a large scale. Projects for the installation of RES plants, which nevertheless require the implementation of major electricity transmission projects, are expected to contribute to this further development. A particular category of projects with these characteristics are projects that receive RES development on islands or offshore areas connected to the continental system.

The extension of the Interconnected Transmission System to the island area creates the conditions and makes it more possible to develop offshore and total parks as it significantly reduces the distances for the transmission of electricity from the source of production to grid connection points, making new areas economically viable for the development of offshore RES projects. The projected installed capacity of offshore wind farms is expected to reach 1.9 GW by 2030, with a significant increase also towards 2050.

Thermal plants with gaseous fuel and solid fossil fuel

Two new plants, a lignite-fired power plant with a capacity of 660 MW and a 826 MW combined gas, were completed and put into operation in 2023. In addition, two combined cycle gas plants with an installed capacity of 877 MW and 840 MW respectively are in the construction phase. These units have a high degree of energy efficiency, have a relatively small technical minimum and can operate at a very rapid rate of load rise and descent. In addition, they can use renewable gases as a fuel and as a percentage of green hydrogen.

The installed capacity of solid fuel thermal plants is expected to be reduced with the complete withdrawal of the old lignite plants.

De-lignification is a deep cut and priority in the national energy map and is at the same time an enormous opportunity for the country. On the basis of the planning (which is also part of the Just Development Transition Plan), the gap in the generation will be filled at most by RES plants, part of which will be deployed as a matter of priority in the geographical areas of the former lignite mines.

The next chapter presents the timetable for the scrapping of lignite plants, on the basis of which lignite-fuelled production will also cease after 31^{December} 2028 and the V plant in Ptolemais⁴³.

2.6.6 Cybersecurity and Climate Resilience of Critical Energy Infrastructure and Cybersecurity

Cybersecurity

The increasing electrification of our energy mix and the widening of the electricity mix combined with its parallel digitalisation increase both vulnerability and potential cyberattacks not only on transmission networks but also on electricity and gas distribution networks, on large decentralised RES power plants, on dispersed RES production from the Energy Capacities, and on individual producers and users of connected smart trains and devices (IoT-Internet of Things).

Targeted attacks on electricity networks with a state leader and an inoperable target have occurred on several occasions internationally since 2015, suggesting an overall increase in the resilience, adequacy and safe operation of the natural gas (DESFA, EDA) and electricity networks (ESMIE/ADMIE, DEDDIE) as a matter of national energy security, while it is noteworthy that DESFA's non-vital operating systems were the subject of a ransomware attack in August 2022.

Although comprehensive cybersecurity strategies have been developed at the level of network operators at corporate level, there is a need to establish a specialised energy cybersecurity strategy within the framework of the national and European Cybersecurity Strategy and the European Network and Information Systems (NIS) Directive 2 adopted in December 2022.

Climate resilience

The impacts of climate change are already present as an energy security factor. The increasing volatility of meteorological phenomena, as a result of the crisis, adds not only to the difficulty of predictability of the estimated efficiency of stochastic RES, but also to the duration and intensity of extreme weather barriers that threaten the structural integrity of critical energy infrastructure and affect its operation.

→ *impact on the structural integrity of energy infrastructure*

Strong winds, heavy hail and ice can cause significant damage to energy infrastructure, notably to above-ground energy transmission and distribution networks and wind turbines. Strong hail may also cause significant damage to panels of photovoltaic systems. High temperatures during

This⁴³ timetable is not definitive and is constantly assessed in the light of the circumstances prevailing at European, national and local levels.

heatwaves cause transformers to overheat, while forestfires can destroy infrastructure, especially wooden poles of overhead power grids.

Floods can also cause damage and damage to electricity substations and oil and gas transmission pipelines, as well as hydroelectric power plant reservoirs.

The disasters caused by the bad weather Daniel and Elias (September 2023) were indicative of the impact of floods on the security of the energy complex and of critical infrastructure related to climate and energy policies. Flood events caused significant damage and damage or even complete destruction of infrastructure, as well as the permanent or temporary cessation of operation or of the services provided. There have been damage and destruction both to important energy infrastructure such as power plants, substations and power transmission and distribution networks, and to critical infrastructure whose operation depends on electricity, such as water and irrigation networks and rail.

→ **impact on the operation and efficiency of energy infrastructure**

In addition to the structural integrity of energy infrastructure, extreme events may result in a temporary reduction in efficiency or even an interruption in the operation of power plants. High temperatures can lead to a reduction in the efficiency of thermal power plants (0.5 % per grade) and temporary shutdowns in the event of reduced availability of water resources for cooling or due to the risk of exceeding the maximum temperature limit for the water receiving water to which the cooling water is supplied. In addition, during heatwaves, network capacity may be reduced (1.5 % per grade).⁴⁴

Increased evaporation of water due to higher temperatures and longer periods of drought may cause significant falls in the level of reservoirs, reducing the efficiency of hydroelectric and pumped storage units. In addition, the predicted increase in wind speed outliers⁴⁵ ⁴⁶ may jeopardise the reliable operation of wind systems, while the efficiency of solar systems may be significantly affected by the increasing incidents of dust transfer from Sahara.⁴³ ⁴⁷

Electricity distribution networks, which are particularly exposed to weather events and their equipment usually has a long lifespan, are particularly pertinent to the effects of climate change. These effects can be divided into:

(a) acute hazards, such as heatwaves, forest fires, strong winds, floods, causing extensive damage to infrastructure and prolonged breaks;

⁴⁴ European Environment Agency, Adaptation challenges and opportunities for the European energy system – Building a climate-resilient low-carbon energy system, Publications Office, 2019, <https://data.europa.eu/doi/10.2800/227321>.

⁴⁵ Theodoros Katopodis, Iason Markantonis, Diamando Vlachogiannis, Nadia Politi, Athanasios Sfetsos, Assessing climate change impacts on wind characteristics in Greece through high resolution regional climate modelling, Renewable Energy, Volume 179, 2021, Pages 427-444, ISSN 0960-1481.

⁴⁶ <https://www.pv-magazine.com/2024/02/09/the-effect-of-extreme-dust-conditions-on-pv-system-performance>.

⁴⁷ Mirzabaev, A., L.C. Stringer, T.A. Benjaminsen, P. Gonzalez, R. Harris, M. Jafari, N. Stevens, C.M. Tirado, and S. Zakieldein, 2022: CrossChapter Paper 3: Deserts, Semiarid Areas and Desertification. In: Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegria, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)). Cambridge University Press, Cambridge, UK and New York, NY, USA, pp. 2195 – 2231, doi: <https://data.europa.eu/doi/10.2800/227321>.

(b) chronic risks, such as changing temperatures and rising sea levels that are likely to have detrimental effects on equipment performance, including degradation of transformers and lines.

Given these challenges, there is an urgent need for Distribution System Operators to strengthen the resilience of the network in order to be able to withstand potential disasters and minimise disruptions to energy supply.

In its National Strategy for Adaptation to Climate Change, Greece has identified the need to develop and implement Regional Adaptation Plans and has highlighted the vulnerability of distribution networks and the need to carry out further studies.

➔ ***impact on coastal, offshore and submarine energy infrastructure***

Important existing installations such as oil refineries and liquid fuel storage terminals are located in the coastal zone, while the energy infrastructure for the interconnection of Greek islands and international interconnections includes coastal installations (e.g. substations) and underwater networks. In future, submarine interconnections are expected to increase, while offshore wind farms are projected to be developed and floating platforms for the exploitation of marine gas fields will be installed.

Rising sea levels caused by climate change, rising storms and wave heights, acidifying and increasing the salinity of marine waters, together with increased coastal erosion, are expected to be major sources of risk for coastal, offshore and underwater energy infrastructure. For example, the average level of your Thalys is expected to increase by up to 20 cm south of the Peloponnese and in Crete by 2030, compared to the period 1950-2014, and by 10 cm in the rest of the country's sea areas, while by 2050 it is expected to increase to 20 cm in the North Aegean and to 30 cm in the other areas. In addition, the maximum sea level during extreme events is projected to increase by 0,4-0.9 m, with values increasing in the north direction.⁴⁵; 48 49

➔ ***demand effects***

As already mentioned in section '2.5 Improvement of energy efficiency', the increase in average temperature is expected to increase the need for cooling of buildings in 50 each perimeter, while the reduction in water availability may increase the heating of electricity for the operation of irrigation systems and desalination stops. Changes in demand will lead to a greater variation of loads and above all to very high peak loads during heatwaves, testing the electricity system. While increasing the climate resilience of energy infrastructure has been integrated into the operational planning of several energy producers and operators, there is a need to establish a

⁴⁸ European Climate Data Explorer- Relative sea level rise: <https://climate-adapt.eea.europa.eu/en/metadata/indicators/relative-sea-level-rise>.

⁴⁹ European Climate Data Explorer- Extreme sea level rise: <https://climate-adapt.eea.europa.eu/en/metadata/indicators/extreme-sea-level>.

⁵⁰ Konsta, D., Panagopoulou, G., Kyriakopoulos, G. L., Methenitis, K., Grigoriadou, E., Voudoui. A., Asimakopoulos, D., Setz, I. (2024) LIFE-IP AdaptInGR – Boosting the implementation of adaptation policy across Greece. Action Deliverable C.5 Analysis of synergies and synergies between the 2050 Long-term Strategy and the National Strategy for Adaptation to Climate Change covering all economic sectors and exploring the impacts of climate change and synergies with adaptation measures.

sectoral policy on the security of critical energy infrastructure in cooperation with the jointly responsible ministries under the relevant Directive (EU) 2022/2557 on the Resilience of Critical Entities adopted in December 2022.

2.6.7 Reducing dependence on hydrocarbon energy imports from third countries, making a country a transit hub for gas and green energy, with the aim of increasing the resilience of regional and European energy systems

As regards the diversification of oil imports, even before the second Russian invasion of Ukraine in February 2022, Greece was moving away from its dependence on Russian oil and gas exports. Since 2021, when Russian exports of crude oil accounted for around 21 % of our imports, they have gradually been reduced to zero by the end of 2022 in line with the EU-wide import restrictions on Russian crude oil and refined oil products.

As regards the diversification of natural gas imports, Greece is sufficiently diversified as it has 2 LNG stations (in Revythoussa and a new FSRU in Alexandroupolis), connection to the TAP pipeline from which Azeri gas is imported, connection to and via Bulgaria to the Trans-Balkan pipeline system and connection to the Turkish transmission system.

According to 2023 data, 42.2 % of natural gas imports were made as LNG via Revithoussa, 37.0 % via the connection to Bulgaria (Russian gas via Turk Stream), 17.6 % via TAP (Azeri gas) and 3.2 % via Türkiye (Azeri gas).

At the same time, the aim is to further develop Greece as a critical gas transit hub for the transport of non-Russian gas through non-Russian controlled routes and infrastructure both along the East West axis, which will be achieved through the ongoing further upgrade of the NNGS and the planned upgrade of the TAP (Trans Adriatic Pipeline) pipeline, and along the South-Vorian axis, which is achieved and will increase through the operation and the ongoing upgrade of the IGB interconnector with Bulgaria (IGB), the interconnector IGNM is expected to be operational in the new year and the IGNM project is under construction.

As regards the diversification of electricity imports, it is noteworthy that with the activation of the second electricity interconnector with Bulgaria (Nea Santa-Maritsa) launched in September 2023, Greece has already reached the 15 % interconnectivity target well before the 2030 target milestone. It is projected that as a result of the increase in RES in the medium to long term (starting in 2030) the country will reduce its electricity imports and gradually become a net exporter of green electricity. In particular, the share of electricity imports is projected to decrease from 6.7 % of final consumption in 2021 to 3 % by 2030.

The strategic aim of the revised NECP is to promote our country as a very important transit gateway for cheap green energy to the European electricity market, produced primarily by Greece but also by major potential North African RES exporting countries, such as Egypt and the Middle East, such as Saudi Arabia, and the strategic priority is the completion of the electricity interconnection between Greece, Cyprus and Israel, which will remove the energy isolation of

the Republic of Cyprus, the EU's last isolated neighbourhood system.

At the same time, the aim is to bring to maturity three new projects that will play a key role in achieving the above objective by implementing the country's interconnections to the south (interconnection with Egypt and Saudi Arabia) and to the north (interconnection with Demia).

2.6.8 Storage of oil and petroleum products

With regard to the storage of oil and petroleum products, Greece had large-scale oil storage facilities in 2021 10, with a total oil storage capacity of approximately 60 Evropaiki Vasilia (PMS) (20 DBs of crude oil and 40 DBs of petroleum products). The most crude oil and petroleum products are located close to the ports and refineries in Athens and Thessaloniki. The largest storage facilities are located in the Elefsina refinery (18,7 DMS), in Agios Theodorou (14,7 PMS) related to the Corinthos Refinery Motor Oil, at the Aspropyrgos refinery (approximately 8,7 DMS), in Megara (6,9 DMS), connected to pipelines with the Aspropyrgos and Elefsina refineries belonging to Helleniq Energy, and at the Thessaloniki refinery (6,8 PMS).

There are also large oil storage facilities in oil distribution strategies across the mainland and on the islands to support oil products. During most of the years following the year 2021, the strategic buffers were above the 90 day limit of imports of the previous year, fulfilling the country's relevant obligations resulting from its membership of the International Energy Agency and the relevant Directive 2009/119/EC.

It is noteworthy that the robustness of the country's strategic oil stocks allowed it to participate without any particular problem in the two collective actions by releasing the collective strategic stocks of IEA Member States, which took place in March and April 2022 with the aim of shielding the world oil market from the effects of the Russian invasion of Ukraine. IEA Member States released a total of 182.7 million barrels, the largest volume of emergency stocks ever released in the history of oil since 1974.

2.7 Objectives and objectives in the area of the internal market for electricity

earth

2.7.1 Implementation of the 'Objective Model'

The reorganisation of the domestic electricity market and its alignment with the corresponding European electricity market in line with the “Target Model” was completed in the MENA by November 2020 and fully by the end of 2022. Closer coupling of European electricity markets is implemented by strengthening interconnections with coupled countries, thereby enhancing competition and increasing overall economic benefits for consumers and businesses.

In order to increase the economic benefit of final consumers, it is important to further modernise the electricity system through its digitalisation and install smart meters to enable the real-time participation of consumption in the electricity market and the possibility for suppliers to offer dynamic electricity tariffs.

The evolution of the electricity market integration in Greece is described in the figure below (Figure 6).

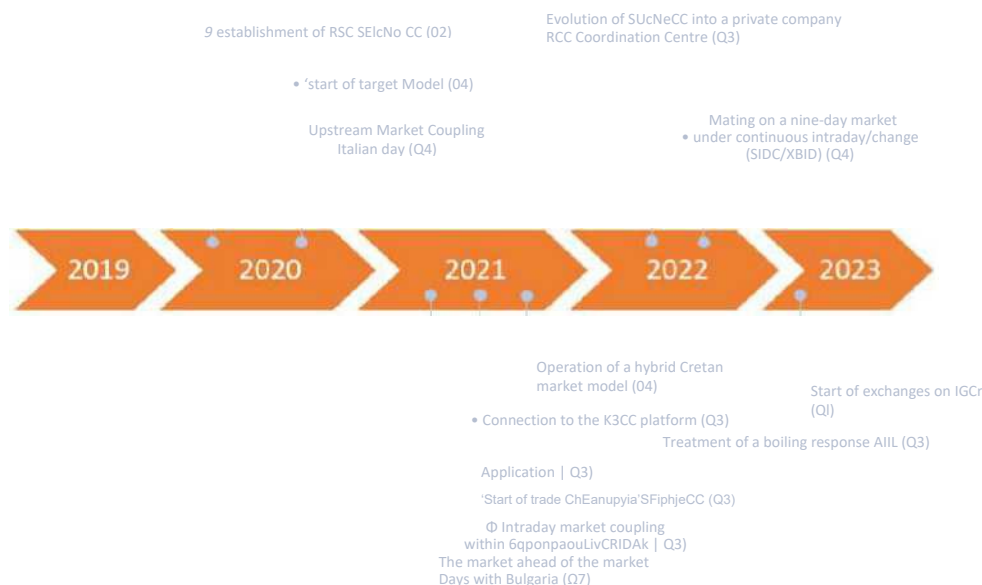


Figure 6 Market developments in 2019-2023.

The integration of the electricity market started in 2020 with the launch of the “Target Model” with the following markets:

- **The Day Ahead Market or Day-Ahead Market**
- **The Intra-Day Market**
- **The Balancing Market**

- **The Forward Market**

The application of the Target Model in conjunction with the coupling of the Greek electricity market with the European electricity market leads to:

- Increasing competition and transparency of markets
- Reduce potential market concentration and ensure fair and transparent conditions of access to more efficient management of interconnections with neighbouring countries by phasing in the flow based model
- Greater price convergence with European markets provided that connections are adequate. The adequacy of interconnections is a challenge for the good and Member States as the design of interconnections should call for emergency situations to avoid large price fluctuations between markets under the target model.
- Enhancing the depth and liquidity of the domestic market
- Expanding access to cheaper energy sources and increasing supply bottlenecks
- Facilitating the integration of RES into the energy mix through the introduction of new markets closer to real time of consumption (Intraday Market, Balancing Market) Fair and rational compensation of purification units through the Balancing Market

Greece has achieved a significant shift in the energy sector in defined periods. The country has become a net exporter in times such as the summer months with significant RES penetration. This development means that more energy is produced than consumed, with any impact on our energy independence and trade balance (Figure 7).

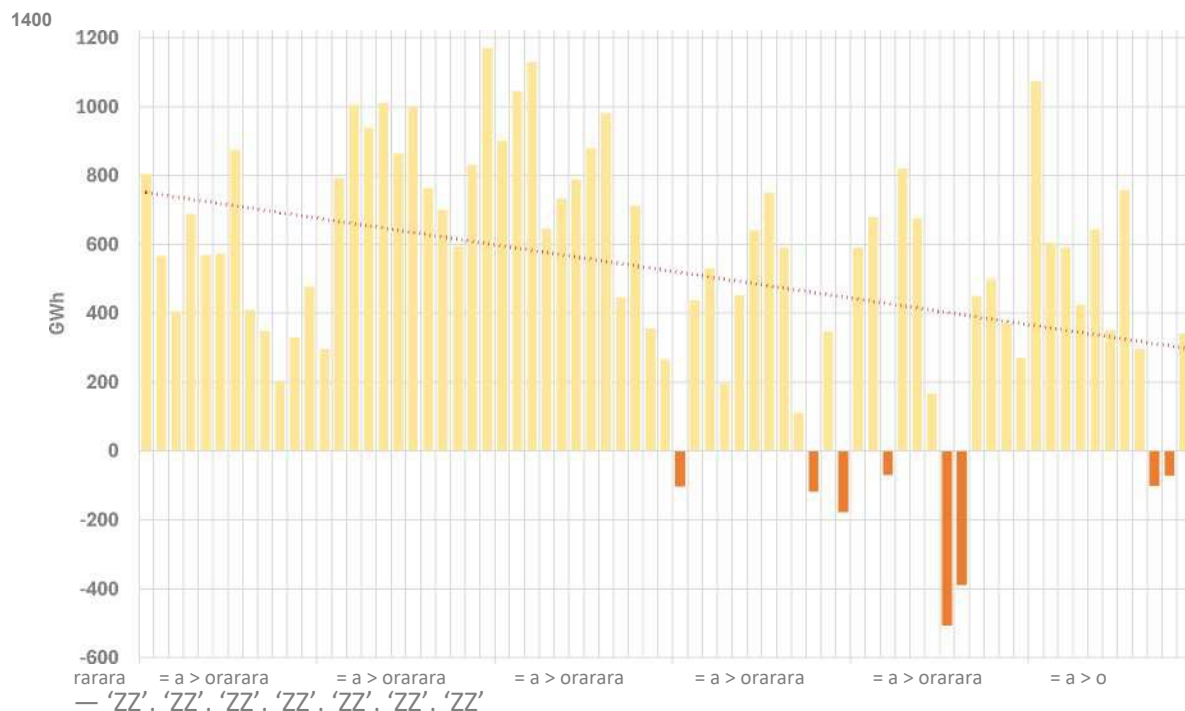


Figure 7 Evolution in net imports (positive prices) and exports (negative prices) of electricity in the system.

The two main reasons for this are:

- **Bundling of tenders:** Coupling between the different bidding zones has made it possible to manage energy production and tanking efficiently under normal conditions. This has allowed the optimum use of energy resources.
- **RES penetration:** The increasing use of RES such as wind and solar injection, combined with a more efficient use of hydroelectric resources, has increased the production of green energy.

The design of the energy market must be fundamentally linked to the structure of each production sector. Only in this way can energy markets function effectively: producers' remuneration should be cost-oriented but also signalling the need to expand capacity, i.e. investments. In light of the above, producers should be able to collect their long-term marginal costs. The ever-increasing penetration of RES, which is expected to be close to and above 80 % in the coming years (2030 onwards), poses challenges to the market by displacing the operation of conventional production units and making it difficult to recover their costs. As a result, prices on the market increase during peak hours with at the same time low production from RES.

To solve the problem of a persistent lack of peak capacity adequacy, consideration could be given to creating a market for long-term capacity availability and flexibility, providing sufficient incentives for the deployment of flexible technologies (e.g. energy storage, demand response and other distributed energy resources), enhancing the reliability of the electricity system and enhancing security of energy supply.

Key priorities and milestones and evolution of the electricity market

Milestones and evolution of the electricity market

Following the start of the implementation of the Target Model in Greece, the following important milestones for the integration of Greece with the European market and internal market restructuring, such as the introduction of demand response, were followed. At the same time, an important milestone was the connection of Crete to the interconnected system with the completion of Phase A of the interconnection ('small byconnection') and the entry into operation of Crete's market as a small connected system (Crete WAR) from 1^{November} 2021.

The milestones can be summarised as follows:

Linking the Greek electricity market with the European

- Connecting Day Ahead Market with Italy
- Day-ahead market coupling with Bulgaria

- Intraday coupling through CRIDAs auctions
- Intraday coupled via continuous intraday transaction (SIDC/XBID)
- Strengthening cooperation with neighbouring Administrators with the establishment of a SeleneCC Regional Security Commissioner (RSC)
- Opening of the commercial operation of the Selene CCC Regional Energy Centre and its transformation into a Regional Coordination Centre (RCC)
- Participation in the European divergence clearing platform IGCC
- Interconnection of Crete and operation of a new hybrid market model in Crete
- Integration of demand response and RES distributed into the energy market. The regulatory framework was completed on 30 June 2022 by Law 4986/2022 (Government Gazette, Series I, No 204), which added the relevant articles to Law 4001/2011 (Government Gazette, Series I, No 179) and was activated for the first time at the end of April 2023. Already in 2023, five distinct demand response entities participated in the energy market, with a total capacity of almost 162 MW.

Some of the next operational milestones of the electricity markets are:

- Participation in the functioning of coupled European markets (day-ahead market – DAM, regional intraday auctions – IDAS, continuous intragroup transaction) with 15-minute products (1 in^{semester} 2025)
- Full interconnection of Crete and integration into the electricity market (2 in^{the} half of 2025)
- Connection to the European platforms MARI (2026) and PICASSO (2 in^{half} 2026) for the exchange of balancing energy from manual reserves and frequency restoration respectively.

2.7.2 Cost structure evolution and average electricity price

From 2025 to 2030 inclusive, the average electricity price is projected to decrease, in particular due to increased RES penetration in combination with discouraging systems and the emphasis on energy efficiency, along with the gradual de-escalation of energy product prices as a result of the normalisation of the energy crisis. These projections are based on prices based on production costs that are burdened by a reasonable return on capital invested.

The estimated evolution of the average electricity price is shown in Table 39, which is included in Chapter 5 (Section 5.1).

2.7.3 Enhancing competition in the energy market and the role of a new consumer

The objectives for the electricity market, complementing the EU guidelines, relate to ensuring well-functioning and competitiveness for the benefit of final consumers. The role of consumers is now being upgraded, allowing them to provide the grid with energy from small scale RES units- and flexibility services through demand response schemes or smart charging of electric vehicles through the following priorities:

→ **smart meters**

Achieving the active participation of consumption in the energy market through demand response requires the deployment of smart meters. The Distribution Network Operator (DNO) plans to have an external meter for all consumers by 2030. Since 2021, 13.000 smart meters have been installed at medium voltage level and 70.000 at low voltage level, mainly in consumers with high electricity demand. In 2022, 100.000 smart meters were installed, with an estimated annual penetration rate of 800.000 and 1 cm in the period 2024-2030.

□ **dynamic pricing**

Gradually and in parallel with the roll-out of smart meters, dynamic electricity prices by suppliers are expected to be promoted, with variable tariffs adjusted in line with electricity market prices with a time window or hour bands. These tariffs will enable consumers to adjust their consumption profile by limiting their consumption during periods of high electricity prices and increasing it – by increasing periods of high RES generation.

This strategy has several objectives:

- **Adjusting consumption:** Using dynamic pricing, I will be able to keep track of changing electricity prices and adjust their consumption to save money.
- **Promoting green energy:** Dynamic billing encourages consumers to use renewable energy during high-production periods, promoting green consumption.
- **Participation in demand response programmes:** Consumers will be able to participate in demand response programmes, offering the hope of their consumption and helping the efficiency and optimum operation of the electricity system.
- **Enhancing the efficiency of the electrical system:** Dynamic pricing contributes to the efficiency of the electricity system by facilitating the adjustment of demand to fluctuations in renewable generation.

□ **self-consumption with identified energy compensation**

As energy has a different economic value within 24 hours of the day, the role of active consumer/self-producer (prosumer) is constantly gaining ground in all pan-European self-

consumption patterns. This new “net-billing” scheme provides for the offsetting of consumption against the energy produced by the photovoltaic system in real time and when energy is sold at the Day-Ahead Market price. Given that energy market prices for afternoon hours are higher today, the implementation of net-billing provides a strong incentive for storage (batteries) by maximising the economic benefit. In addition, storage contributes to the normalisation of daily wholesale energy prices by protecting the final energy supplier from exposure to price volatility.

strengthening the integrated energy market

Strengthening electricity interconnections with the coupled neighbouring countries applying the target model will allow for greater convergence of electricity prices under normal conditions, for a more efficient integrated electricity market with the ultimate aim of reducing electricity costs on an equal footing with all European citizens and businesses. As electricity generated by RES increases its share of the energy mix, EL will become increasingly exporting to the electricity sector as energy flows are shifted from the cheapest to the most expensive area and the contribution of interconnections to managing changing flows will prevent the curtailment of RES energy volumes. Congestion management of interconnectors implicitly through markets operating on the basis of the Target Model contributes to price convergence in the European electricity market and rational terminal power flows, based on clearing prices in neighbouring countries. An essential pre-condition for the smooth operation of interconnections is to address the problem of cross-border transfer of exchange-inflated prices during periods of local supply-demand imbalance.

2.7.4 Participation of demand response and storage in markets for verbal energy

demand response

Via the Demand Response Service, offers can now be made on the market by the Cumulative Representation Bodies (DSA). In the short term, the objective is to familiarise participants quickly with the new service, let me be able to make available at least several hundred megawatts on the demand side (already around 162 MW). The medium-term objective is to expand the demand response service so that it can also be applied to the management of demand for buildings or even household consumers through the digitalisation of networks. Demand-side response as a service will become increasingly important over the years, as RES production (production with a specific energy injection profile) will continue to grow.

storage in the electricity market

The inclusion of large-scale storage stations will improve the efficiency of the market and normalise the variation in daily electricity prices. Also, individual storage plants can allow maximum exploitation of excess green generation, i.e. when the total injection produced exceeds demand and export possibilities. By discouraging it, cuts in green energy are significantly reduced in conditions of high RES penetration and low consumption, which are now common,

and plays a crucial role in electricity price formation. In a context of black load and high RES production, the overwhelming share of the required production is covered by RES with stochastic production and there is therefore no scope to integrate several thermal plants (lignite and natural gas), which currently offer the necessary ancillary services to the spot energy system. These services could in the future be replaced by portfolios with storage systems or stand-alone long-term storage systems.

2.7.5 Strengthening green bilateral contracts and developing new product and market environments

Greece's strategy to promote green bilateral energy contracts (PPAs) through the development of a centralised platform has two main objectives:

- Promote the financing and development of renewable energy sources by adapting to wider European objectives for a faster energy transition.
- By providing a simpler and standardised framework for bilateral PPA meetings, Greece aims to attract both domestic and international poorer renewable energy. The PPA Platform will facilitate the conclusion of PPAs' s by reducing the risk of counterparties.

promoting bilateral energy procurement in energy-intensive sectors of the economy

The reduction of the energy costs of energy-intensive industrial consumers and agricultural supplies is pursued through the conclusion of bilateral contracts for the sale of electricity by financial arrangement or by physical delivery between pre-electricity suppliers and RES electricity producers with the aim of

the economic benefit of 'cheap' green energy is passed on to final industrial consumers and farmers.

Greece's effort to promote green bilateral contracts underlines its commitment to building a greener, secure and resilient energy future for the country and the wider region of South-East Europe.

invitations ♦ **tender for Guarantees of Origin**

An additional market that contributes to the further decarbonisation of energy consumption is the primary market for Guarantees of Origin for RES, which has been in operation since 1st half of 2024. The secondary market for **Guarantees of Origin** is being designed by the energy broker and is expected to start by 2026.

voluntary purchase of CO₂ emissions compensation ♦

At the same time, the integration of a Voluntary Carbon Credits Markets Market (VCMs) represents a crucial step towards accelerating green development objectives. This market will serve two main objectives:

- Initially, it promotes the active participation of businesses, individuals and organisations on a voluntary basis, allowing Greece to take important steps to tackle climate change. The market rewards solutions based on the development of the natural environment, such as reforestation, sustainable agriculture, as well as engineering projects that reduce or remove carbon emissions. These activities lead to the creation of verified carbon credits, with each credit representing the removal or flight of a metric tonne of CO₂ from the atmosphere.
- In addition, the Voluntary Market for Countervailing Credit provides a transparent and standardised platform for carbon credit trading, creating times for businesses to invest in projects that reduce or move away. Through this market, participants can take immediate action to reduce climate change and offset their own carbon footprint. This approach strengthens the role of individuals and their role as active participants in emission reduction, promoting individual and business responsibility to achieve zero carbon footprint by 2050.

2.7.6 Strengthening the resilience of energy networks

Strengthening the resilience of the electricity system has become a strategic priority, given the challenges of the climate crisis, the growing penetration of RES in the energy mix and the expansion of island and continental interconnections.

With a view to enhancing the reliable operation of the transmission system and safeguarding the social good of fixed electricity, the operator is already installing sophisticated real-time primary equipment monitoring systems (OLMS) and special equipment to improve systems for protecting high-voltage and ultra-high voltage components.

For the period 2025-2034, projects with a total budget of around 200 million are foreseen. EUR 500 000 for projects to enhance the resilience of the System.

The digitalisation of critical electricity transmission system infrastructure amid energy transition and climate crisis and preparing for cybersecurity challenges are critical parameters of the strategy for the coming years.

In terms of cybersecurity, systems and mechanisms of a high level of security have been developed with the aim of proofing the Transmission System, using cutting-edge techniques such as Artificial Intelligence and Machine Learning.

Similarly to the transmission system, the distribution network addresses the new challenges arising from the energy transition to ensure and strengthen the resilience of the existing distribution network and its extensions, in line with the new needs arising from the electrification of energy uses.

The main risks to the resilience and security of the distribution network are:

- Lack of electrical space and bottlenecks in electricity distribution hubs, as they result from

increased requests to connect new RES to the grid, but also in the near future due to increased demand

- The need to balance supply and demand in the electricity grid, requiring a wide range of short-, medium- and long-term actions to optimise resource and distribution network management, digitise the grid and ensure the smooth operation of the grid
- Ensure cybersecurity of energy infrastructure and protection of energy data, given the increasing level of digitalisation and centralisation of digital energy infrastructure, as well as the increase in the volume and complexity of energy data of network users to be collated, stored, managed and shared.

The electricity distribution system operator has launched and materialises a broad annual investment programme covering the full range of needs for strengthening and digitalising the grid, as well as integrating new network users, electrical loads and energy uses into an energy system, as well as the transformation of its functions to ensure the resilience and security of the distribution network.

As regards the digital infrastructure of the Electricity Distribution System Operator, the centralised structure for collecting and processing energy data with millions of users and metering points, using multiple information layers and interfaces, the possibility of a two-way flow of information to surveillance and remote control equipment, or beyond to consumer equipment, the free sharing of data through an information platform for posting data and information, and the classified provision of access creates simple challenges for the network operator, as the person responsible for collecting, processing and maintaining the data and managing the corresponding information structure.

At the same time, a high level of protection against data leakage and cyberattacks on the meter and its interfaces with the remote metering centre has been ensured, possibly the most critical point for the cybersecurity of the Network Manager's information infrastructure, by providing for DLMS protocol application to pollinators and Machine to Machine authentication.

With regard to the data protection of users of the Network, it is necessary to apply Union law, on the basis of the General Data Protection Regulation (GDPR) and the more specific provisions of European Regulation (EU) No 2019/943 and European Road (EU) 2019/944, in particular as regards the retention time of users and the procedures for their destruction. The Network Manager has set up and implements a corporate management and data protection policy in order to integrate and specify the provisions of the regulatory framework in its business operations and corporate governance.

As regards natural gas networks, it should be noted that they are among the youngest in Europe and are therefore designed with the most modern specifications. In addition, both transmission system and distribution system operators have devised and implemented emergency response plans and have provisions (e.g. relief screens) and procedures to withstand them and interrupt the flow in exceptional circumstances.

2.8 Critical Raw Materials

2.8.1 The issue of critical (CPM) and strategic (GPH) minerals ahead of materials

Speedy advancement of the energy transition, progress towards security of supply and energy storage and resilience of energy systems require a seamless and sustainable supply of fossil raw materials (CPM) and strategic fossil raw materials.^{48–53}

These raw materials concern minerals and metals that are essential for manufacturing the technologically advanced products of the green transition, such as hybrid and electric cars, electronic devices and circuits, magnets, wind turbines, photovoltaic systems, rechargeable appliance and vehicle batteries, catalysts, fibre optic cables, electrolyzers and fuel cells as well as heat pumps.

Sustainable and responsible sourcing and sufficiency of COP and SEPA are major European demands^{51 52 53 54 55 56 57} due to the very high dependence of European industry on third countries (EU imports for most metals range from 75 to 100 % of its needs), their economic importance, the high supply risk due to global competition, distortions in the international market, geopolitical developments and the continued reduction of their availability from domestic European sources.

In this context, the Critical Raw Materials Act (CRMA Act)⁵⁸ is the more specific institutional framework at European level to address the issues of safe and sustainable access to critical and strategic raw materials.

The individual quantitative objectives of the Regulation are: the annual consumption of strategic-critical raw materials within the EU is at least 10 % from extraction, 25 % from recycling and 40 % from primary material processing (for secondary production of final products). The time horizon set for the above targets is the year 2030, in line with the EU's climate and energy targets. In addition, in order to avoid monopolies scenarios, the Regulation provides that the maximum dependence of imports from a third country shall not exceed 65 % for each stratum of mineral raw material at any relevant stage of processing, by 2030.

European Commission⁵¹ Communication 2022/230 on REPowerEU Plan.

European Commission⁵² Communication 2023/62 on the Green Deal Industrial Plan for the Net-Zero Age.

⁵³ Regulation (EU) 2024/1735 of the European Parliament and of the Council of the European Union laying down steps to strengthen Europe's net-zero technology products manufacturing ecosystem and amending Regulation (EU) 2018/1724.

⁵⁴ Regulation (EU) 2023/1542 of the European Parliament and of the Council of 12 July 2023 concerning batteries and waste batteries, amending Directive 2008/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC.

⁵⁵ Regulation (EU) 2023/1781 of the European Parliament and of the Council of 13 September 2023 establishing a framework of measures for strengthening Europe's semiconductor ecosystem and amending Regulation (EU) 2021/694 (Chips Act).

European Commission⁵⁶ Communication 2022/221 on the EU Solar Energy Strategy.

⁵⁷ European Commission, Critical materials for strategic technologies and sectors in the EU – a foresight study, 2020.

⁵⁸ Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) 2013/168, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/1020.

2.8.2 Greece's existing capacity in critical (KOPY) and Strategic (SOPY) Mineral Raw Materials

On Greek territory and within Public Mining Countries (DCS), i.e. the sites in which the mining right belongs to the State, more than 15 raw materials included in the List of Strategic and Critical Raw Materials have been identified. In particular, the Critical Mineral Raw Materials (CRM) found within the CPM are: *bauxite, phosphite, gravity, antimony, nickel, cobalt, magnesium, silicon, tungsten, graphite, platinum group metals, arsenic, stars, gallium, germanium, manganese, copper and certain (light) rare earths*.

However, the existing inventory potential that has been recorded requires both updating and classifying in an international stockholding reporting system (UNFC, JORC, etc.) and new targeted research either to increase the added value of the already recorded targets within the CDM, or to discover new 'targets', both primary (deposits) and secondary (with reprocessing of metallised waste), of national and/or European strategic importance.

2.8.3 Actions towards the strategic autonomy of Greece and the European Union for KOPY and SOPY

With a view to ensuring the supply of the necessary fossil raw materials to feed the industry of the energy transition, Greece is preparing a roadmap with **two priorities and actions towards 2030: (a) mining exploration and (b) exploitation of mining potential and other actions**.

In particular, the targeted actions that will be the spearhead to ensure the sustainable exploitation, use and management of critical minerals in the context of the National Energy and Climate Plan relate, on the one hand, to the continuous activity to promote areas with exploration potential in the KPY and, on the other hand, to the exploitation of the already recorded mining potential of yeast by launching tendering procedures for the allocation of exploration and exploitation rights, as well as complementary political interventions.

In any case, the priorities are geared towards the sustainable transformation of deposits, the reduction of licensing time and bureaucracy, the attraction of investment, as well as the inclusion of benefits for local communities and the concept of social license to operate, while respecting national and European regulations to protect the environment.

mineral Research

The development of targeted national research programmes is **the first priority axis**, given the crucial contribution of mining research to the vibrant cycle of mining activity, but also the importance over time of the systematic identification of mineral deposits for the national economy. Furthermore, thorough and focused mining research to find stocks of critical and other mineral raw materials from intra-European topological targets is a well-established strategy within the EU, closely linked to both the energy transition and circular housing.

At national level, the mixed mining system applies. The investigation is carried out either by the State (through the Greek Geological and Mining Research Authority – EAGA) or by private

individuals. The areas which have been investigated by the State (IGME, now EAGME) and which have been designated or acquired by the State as a DNC, i.e. all sites in which the mining right belongs to the State, are rented out to private individuals in order to complete and complete the mining exploration and then start the exploitation phase, revising the results of the exploration work. This benefits both the State and the private investor, since, on the one hand, the preparation and completion of systematic research programmes confirms the economic value of the public funds, giving new revenue to the State and, on the other hand, the lessee – after a successful investigation – also acquires the right to exploit the mining deposit without any further tendering procedure.

Contrary to the investigation and despite the provision of the Mining Code (Legislative Decree 210/1973, Government Gazette, Series I, No 277) on direct labour, exploitation is carried out exclusively by private individuals (with the sole exception of Silida Naxos).

public Mining Survey

The first and absolutely necessary step in order to speed up the promotion of investment projects in CPPY is the development of research programmes targeting CPPIs.

Therefore, the provisions of the European Regulation on CRMs should be combined with the provisions of the national legislative framework so that national research proposals, which are in line with the EU guidelines and then be implemented, are first developed and developed. The central focus in the planning, implementation and implementation of the research programmes is the Hellenic Authority for Economic and Mining Research (EAGA), a body supervised by the Ministry of Energy and Climate Change. It should be noted that Law 5037/2023 (Government Gazette, Series I, No 78) updated the provisions of Legislative Decree 4433/1964 (GG I 219) on public mining exploration.

The areas that are currently being surveyed by the EAGA are within the Xanthi Regional Unit of Xanthi, while Decision No ΥΠΕΝ/ΔΑΠ/58343/821/19.6.2020 (Government Gazette, Series II, No 2896) of the Directorate-General for Mineral Raw Materials of the Ministry of the Environment and Energy ‘Declaration of an area to be researched by the State in the regional unit of Samos’, for a period of three (3) years, as extended for one year, has committed the area of western Samos for lithium exploration (Li).

private Mining Research

In addition to the search within a public sector by private individuals following the lease of the relevant right by the State following a tendering procedure, if the site is a free right of ownership and has not been classified as a PPA, the investor must have applied a Mineral Exploration Licence (AMS) in order to carry out any rational work. The procedure for AMS provides for a decision by the local competent authority. According to data from the Greek regions, there is currently only one AEI in force, while the competent services are also considering the granting of new VMEs.

Private research is carried out in the areas of Oitis Parnassos Gkonas for bauxite and in the Molata region of Lakonia for zinc, silver, Gallium and Germanium, within leased DMCs.

exploitation of mining potential and other actions

This **second pillar concerns the licensing of KOPY projects, with a** focus on launching new tenders for the exploitation of mineral deposits in aWFD, with a satisfactory degree of deposit maturity, combined with other policies and actions, which will complement and support the increase in investment activity.

tendering procedures

As regards the emergence of new areas for exploitation, the main task to be done is to update and complete the recording of the potential of the DNCs to be exploited and to prioritise them, so as to distinguish those who can be considered mature and be prioritised in competitive-dialogue. This is a specialised task involving the taking into account of technical, scientific, economic, legal and social criteria.

2.9 Adaptation to climate change

Following mitigation, the second pillar of international climate policy, as established by the United Nations Framework Convention on Climate Change (UNFCCC), is adaptation to climate change. Climate change adaptation measures concern both natural and human systems, and are developed on the basis of vulnerability assessments for ecosystems, economic sectors and population groups.

Climate change will significantly affect the energy system as a whole. The reduced availability of water endangers the operation of thermal power units. Electricity transmission and distribution networks, high-voltage stations, and other energy networks and facilities are vulnerable to extreme weather events, while coastal energy infrastructure is threatened by rising levels of sea level rise. The increase in average temperature is expected to reduce the energy needs for heating in the winter season and increase the need for cooling during the summer period. Changes in demand will lead to a greater variation of peak loads by pulling the electricity system. Climate change is also expected to reduce the efficiency of RES systems.

Climate change is expected to significantly affect both land use and forestry (LULUCF) and more generally soil, coastal and marine ecosystems, which play an important role in the carbon cycle and affect CO₂ concentration in the atmosphere. Coastal wetlands and ecosystems are expected to be negatively affected mainly by rising sea levels caused by climate change, while changes in marine environmental parameters (temperature, salinity, acidity) are expected to affect the geographical spread, composition and productivity of marine ecosystems.

The climate projections (temperature, rainfall, wind speed) recently produced in the LIFE-IP AdaptingR⁵⁶ project, 59 60 as well as the calculation of relevant climate indicators, such as the change in the number of days with strong cooling needs, the change in the number of days with strong heating needs, the change in the length of heatwaves and droughts, and the change in the fire risk indicator (FWI) are indicative of the magnitude of the impact of climate change on the country's energy system and on the CO₂ absorption capacity of domestic sinks. Regional climate projections have also emerged in the context of the Regional Climate Change Adaptation Plans.

More information on the effects of climate change can be found in the study 'The environmental, economic and social impacts of climate change in Greece' of the Bank of Greece's Climate Change Impact Study Committee⁶¹ and in the sectoral climate change adaptation analyses provided by the Ministry of Environment and Energy under the LIFE-IP AdaptingR project⁶².

⁵⁹ http://mapsportal.yopen.gr/thema_climatechange, <https://geo.adaptivegreecehub.gr>.

⁶⁰ LIFE-IP AdaptingR – Boosting the implementation of adaptation policy across Greece LIFE17 IPC/GR/000006: www.adaptivegreece.gr.

⁶¹ Committee on Climate Change Impact Assessment (EMKA) (2011).

The environmental, economic and social impacts of climate change in Greece: <https://www.bankofgreece.gr/Publications/%CE%A0%CE%BB%CE%B7%CF%95%CE%B7%CF%82%CE%CE%BA%CE%B8%CE%B5%CF%83%CE%B7.pdf>.

⁶² LIFE-IP AdaptingR (2022). Analysis of the state of play of the adaptation of the biodiversity and eco-systems sector to climate change. Project

Maintaining the effectiveness of mitigation policies in the new climate conditions and developing a new energy system with increased capacity and high resilience to climate change is a prerequisite for achieving the NECP's climate and energy objectives.

The relevant objectives and priorities of the NECP on adaptation to climate change include:

Recognising sources of climate risk, assessing climate vulnerability and enhancing the climate resilience of NECP measures and policies.

Maintaining the capacity to absorb greenhouse gases from the LU- LUCF sector in future climate conditions.

Prevention to limit the increase in N₂O, CH₄ and fluoride emissions.

- Improving knowledge of climate change caused by the shooting of RES potential and updating their spatial planning.
- Strengthening the link between climate, water, energy and energy policies (climate-water-energy-food nexus).

Enhancing the climate resilience of the production chains of alternative liquid and gaseous fuels to be developed.

Maintaining and enhancing the storage capacity of the system in black-nastic climatic conditions.

- Integrating the adaptation dimension into the programmes for the energy upgrading of the building stock and the regeneration of the urban surroundings.
- Mainstreaming adaptation into energy poverty policies.
- Ensuring the climate resilience of energy infrastructure.

To develop a new energy system of increased resilience and enhanced capacity to adapt to new climate conditions.

deliverable (code: LIFE17 IPC/GR/000006).

LIFE-IP AdaptInGR (2024) Analysis of the status quo for adaptation of the forestry sector to climate change.

Project deliverable (code: LIFE17 IPC/GR/000006).

LIFE-IP AdaptInGR (Under completion). Analysis of the current situation to adapt the Georgian and Livestock sectors to climate change.

Project deliverable (code: LIFE17 IPC/GR/000006).

LIFE-IP AdaptInGR (Under completion). Analysis of the status quo for the adaptation of the Structured Period to Climate Change sector.

Project deliverable (code: LIFE17 IPC/GR/000006).

2.10 Research, innovation and competitiveness

2.10.1 Objectives

The Greek Research and Innovation System is one of the important elements of the Greek economy with a view to contributing to the resolution of multiple problems and the general development of the country's economy. The aim is to link the region and innovation to entrepreneurship, with the aim of enhancing the competitiveness and openness of businesses towards international markets. In particular, the integration of new knowledge and innovation in both existing and new products, services, production systems and value chains contributes to increasing the resilience of Greek businesses and strengthening the export profile in international competition, as well as the employment of highly qualified and skilled scientists (Brain Gain) and the link between academia and the production sector.

The promotion of Research, Innovation and Competitiveness (REC) in the field of education continues to be a priority in the period up to 2030 and a long deadline until 2050, enhancing important technologies that will contribute to achieving all the energy and environmental objectives, the twin climate and digital transitions, but also to supporting economic growth and per circumvention through investments that enhance the cohesion and competitiveness of the economy. **To this end, the gross domestic expenditure on research and technological development is expected to reach 0.13 % of GDP for 2 030 in the energy and environment sector compared to 0.06 % in 2017.**

In line with the Net Zero Industry Act and the Strategic Energy Technology Plan (SET PLAN), the strategic objectives for net-zero technologies have been defined on the basis of three criteria:

1. Technology Readiness Level (TRL).
2. Contribution to decarbonisation, i.e. technologies that are expected to contribute significantly to the emission reduction target.
3. Contributing to the competitiveness of the industrial system and reducing security of supply;

this will strengthen sectors where Greece has a low specialisation index and increase manufacturing capacity in the value chain of zero-emission technologies.

The two timelines of this NECP lead to different but complementary targets for 2030 and 2050. By the year 2030, the outbreak shall be on net-zero technologies that are technologically mature in a national context, which are expected to significantly contribute to reducing net greenhouse gas emissions by at least 55 % below levels in the year 1990 by the year 2030. These objectives therefore relate to technologies that are now commercially available: heat pumps, smart energy management technologies, grid technologies (including smart and fast charging of electric vehicles), photo- electric and thermal solar systems, onshore and offshore wind technologies, batteries/storage, sustainable biogas/biomethane, carbon capture and discouraging in industry

and electrolysis plants and fuel cells.

By 2050, a significant part of the emission reduction needed to achieve climate neutrality requires the development of technologies that are still in the demonstration or prototype phase, especially in hard-to-decarbonised sectors, as well as in heavy transport applications. NRA activities in this case target different technology clusters with a wider range of maturity blocks, including original technologies.

At the same time, the Greek Energy Intensive Industries ⁽⁶⁰⁾ play an important role in achieving the energy transition to a non-coal economy, ^{63 64} as they consume a significant share of the country's total final energy consumption. Research and Innovation programmes in zero-footprint sectors and technologies will play a crucial role in strengthening the competitiveness of businesses in Greece, as well as supporting their after-reliance on a zero-emission circular economy.

Another objective of the R & I activities and those to develop competitiveness is to help overcome two problems of the current situation in Greece in various strategic technology groups: innovative activity in various strategic artefacts, as well as a lack of know-how. Technological innovation should therefore be accompanied by a roadmap aimed at increasing skills and new jobs with a greater focus on the sectors and workers most affected by the energy transition.

At the same time, digital technologies are supported, which have a profound impact on lifestyles and business, which are crucial for a more productive and greener economy.

In relation to **competitiveness**, the indicators chosen for achieving the targets are:

 improving energy efficiency – reducing greenhouse gas emissions

The essential objective is to accelerate the decoupling of economic growth with energy consumption and greenhouse gas emissions. Improving energy intensity and emission intensity indicators through the adoption of targeted measures will ensure that this is the result of the energy efficiency and self-consumption improvement measures to be implemented, which will contribute to both reducing energy costs and enhancing the competitiveness of different economic sectors. The penetration of RES in all final energy and tanker sectors, rational energy management, as well as the use of the most efficient appliances and processes are the main tools for achieving this objective.

 reduction of energy costs

Reducing energy costs is a key policy priority to make energy products more affordable for all consumers. The measures and policies implementing this objective shall take into account the market power of consumers and of these specific groups, as well as any particular features

⁶³ https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/net-zero-in-industry-act_el.

⁶⁴ Final energy consumption for the industrial sector in Greece for the year 2022 was 21 % of total final energy consumption.

related to local characteristics, such as those of remote people, with a view to keeping the average costs of energy products below **the European average**.

☐ **increase domestic value added of the energy sector**

Promoting innovative applications and services in the energy sector with high EU added value is a priority objective for the next period as it makes a positive contribution at gross national product level and enhances the sustainability of the energy sector. In addition, this objective also enables new direct and indirect jobs to be encouraged as a result of the activities of the urban sector. The use of specialised scientific and technical human resources is a central priority in energy planning.

☐ **development plans for the areas most affected by a net-zero economy**

The challenges faced by lignite-dependent industries from the transition towards a zero-emission economy are addressed with tailor-made solutions to support structural transformation and speed up the process of economic diversification and technological transition. The aim is to further implement a sustainable development strategy plan (as an extension of what is included in the Plan for the Just Development Transition – PLAP), focusing on sectors that can acquire dynamic characteristics in terms of output, employment and income indicators. In this case, local satellite businesses of all scales will continue to be activated and activated, so that every region or local community can reap the benefits of the clean energy transition while creating new jobs and promoting investment in new clean technologies.

☐ **reskilling and upskilling to build resilient supply chains of zero-footprint technologies**

Decarbonisation and the ongoing energy transition are set to lead to significant changes in employment, including a number of new opportunities in the clean energy sector. At the same time, employment opportunities in traditional energy sectors will be reduced. A smooth transition to a zero-carbon economy depends to a large extent on the retraining of workers in fossil fuel industries and the appropriate training of young people entering the labour force. At the same time, there is a demand for services from a workforce with appropriate skills in the field of innovative renewable energy (e.g. offshore wind and hydrogen leak production technologies). Another area in which the workforce needs to be upgraded is that of the building sector and innovative applications and infrastructure for the digitalisation of the network.

☐ **implementation of an action plan for the implementation of the National Industrial Fire and a governance model for its monitoring**

In order to increase the competitiveness of the Greek industry, a single strategy for priority sectors for industrial decarbonisation should be materialised. Working meetings with experts from the same industry and from other sectors, continuous analysis of client preferences and experience, and cooperation with academic and research institutions are important external-innovators to implement it effectively. At the same time, with internal factors, the emergence of

new technologies and trends, the support of the company's leadership, the integration of innovation into the enterprise's strategy and the management of the corporate culture are the most important ones – SGEIs – for the take-up of an innovative profile.

- ❑ **encouraging research and innovation, through cooperation between companies in the supply chain of innovative net-zero technologies with academic institutions in Greece and abroad**

At the same time, there is a need for uniform planning and coordination of the research work of research centres and universities and for this work to be aligned in line with the priorities of the National Industrial Strategy. In order to ensure such interconnection, the conversion of technological innovations into viable commercial products should be supported.

Chapter 3: Measures and policies

3.1 Climate change, GHG emissions and removals

Piou

The definition of policy measures on climate change and in particular the reduction of greenhouse gas emissions for the period 2025-2030 aims to cover nine different Policy Priorities (FP1.1-FP1.9), which are presented in KEP 8.

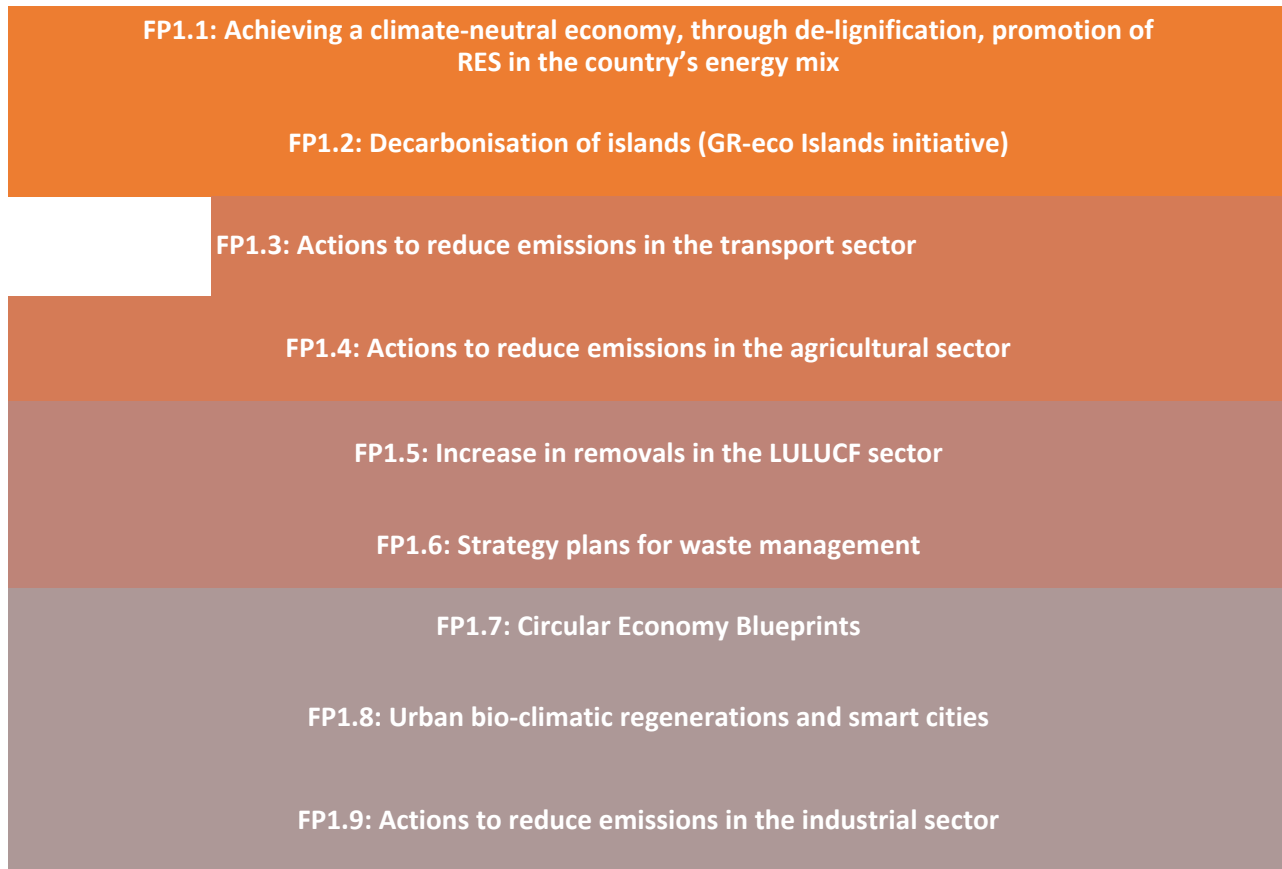


Figure 8 Policy priorities for policy measures to reduce horticultural emissions in the period 2025-2030.

The Policy Priorities aim to achieve the goal set in the Paris Agreement to limit the increase in the global average temperature to well below 2 °C and, if possible, 1.5 °C – compared to the pre-industrial era, and to deliver on the resulting EU commitment to reduce greenhouse gas emissions by at least 55 % by 2030 compared to 1990.

At the same time, the aim is to integrate into national planning the EU's long-term vision for a climate-neutral economy by 2050⁶⁵. The policy measures, which have been specified in the

⁶⁵ European Commission – A Clean Planet for all: A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy

<https://eur-lex.europa.eu/legal-content/EL/TXT/HTML/?uri=CELEX:52018DC0773&from=EN>.

context of the above policy priorities, are analysed separately in the following sections.

3.1.1 Measures and policies to achieve the objective of lignite-fired and the Just Development Transition

The elimination of the economy's dependence on polluting lignite fuel is a key priority for the Greek government.

The reasons for lignite-de-lignification are **also** environmental, due to the phenomenon of climate change, but also economic reasons, due to the rise in pollutant emission prices.

This transition away from lignite is feasible and can be supported due to Greece's strong renewable energy potential, which will be our main national energy resource in the energy mix of the future.

The withdrawal of all lignite units by 2028 will take place in an orderly and responsible manner. The government's absolute priority is to make the transition to the post-lignite era just for the regions of Western Macedonia and Megalopou. Special care will be taken to heat the lignite-fired areas, which is planned to continue by other means such as district heating with high-efficiency cogeneration with natural gas, heat pumps suitable for the climatic conditions of the area, etc.

The table below (Table 9) sets out in detail the timetable for the pulling of active lignite-fired power plants, which has been taken into account in the revised EC.

Table 9 Timeline for withdrawal of lignite-fired power plants.

Unit rhetoric	electronics Fuel	Polished power	abandoned	Withdrawal
Meliti	Lignite coal	289		2024
Megalopoli IV	Lignite coal	256		2024
Agios Dimitrios I	Lignite coal	274		2024 *
Agios Dimitrios II	Lignite coal	274		2024 *
Agios Dimitrios III	Lignite coal	283		2025
Agios Dimitrios IV	Lignite coal	283		2025
Agios Dimitrios V	Lignite coal	342		2025
Ptolemaida	Lignite coal	615		2028

*to 31/08/2024

Additional reductions in greenhouse gas emissions are also expected from the interconnectedness of the autonomous island systems with the continental system, where local, highly polluting, power plants will gradually cease to operate, as detailed in the following sections.

The Just Development Transition in Greece from 2020 to date

In 2020, the National Energy and Climate Plan (NECP) (Government Gazette, Series II, No 4893/2019) set specific energy and climate targets at national level by 2030, with the aim of moving to a climate-neutral and more competitive economy.

Among these objectives were:

- the complete removal of the use of lignite by the domestic electricity generation system by 2028, with a specific timetable for the withdrawal of operational lignite-fired power plants by 2023 (delignification); and
- (b) the gradual interconnection of the majority of island, autonomous, electrical systems with the continental electrical system by 2029, in order to enable the cessation of local electricity production using diesel or fuel oil as fuel (decarbonisation).

In this context, the Government Economic Policy Council, through the adoption of the NECP, announced at the end of 2019 a roadmap for a smooth and developmentally just transition of affected regions in Greece, entitled 'Just Development Transition Plan (JDP)'.

In addition, the Council of Ministers, through Act No 52/23.12.2019 (Government Gazette, Series I, No 213), defined the priorities, objectives and measures to be included in the Plan, its governance bodies (i.e. the DAM Government Committee and the SADAM Coordination Committee), their composition and tasks, and in 2020 it included the island regions of North Aegean, South Aegean and Crete by means of Act 49/7.12.2020 (Government Gazette, Series I, No 259).

The drafting of the DAFM started in 2020 and, in terms of content, was based on the following five development pillars, focusing on sustainable employment based on technological development and the production of high value-added products:

- (1) clean energy;
- (2) industry, crafts and commerce;
- (3) smart agricultural production;
- (4) sustainable tourism;
- (5) technology and education

An analysis of the intrinsic advantages of lignite-fired areas was carried out during the preparation of the DAP, so that it is based on real competitive advantages of the regions, always combined with the investment interest already expressed. IM Macedonia, with the main advantages of education and natural wealth, is becoming an innovative centre for clean energy production and research with a diversified economic model. Megalopolis, with the main advantages of natural wealth and structures, is modernising its energy and industrial profile, shifting to clean production and restarting heavy industry in the Peloponnese.

The DSAM was completed in December 2020, following extensive public clarification in accordance with the Governance of Transitions toolkit of the European Commission, and was presented to the Council of Ministers and the Standing Committee on Production and Trade of the Parliament.

In parallel to the drafting of the PLAP, the Government Committee for the TLD approved in March 2020 the preparation of a distinct and single Just Development Transition Programme, under the NSRF 2021-2027, co-financed by the JTF, with its resources from the Structural Funds being split. In this context, ~ EUR 1.629 billion of public expenditure has been committed in favour of the affected areas as follows: 830.0 million EUR from the JTF, transfer (leverage) of EUR 545 million from other structural funds (ERDF, ESF +) and EUR 254 million from the national strand of the Public Aid Programme.

The affected areas that fall under the Fair Follow-up Design and are related to the de-lignification and decarbonisation are common:

- **Region of Western Macedonia**
- **Greater Megalopolis**

- **Islands of the North Aegean, the South Aegean and Crete**

After an extensive period of public consultation of the content of the PAP and of the three ESDITS with local bodies and negotiations on programme texts with the competent services of the European Commission, Greece became the first Member State with an approved Just Development Transition Programme and ERN in June 2022 by means of EU Decision [HYPERLINK "https://www.sdam.gr/sites/default/files/2022-06/%ce%91%ce%a0%ce%9f%ce%a6%ce%91%ce%a3%ce%97%20%ce%95%ce%93%ce%9a%ce%a1%ce%99%ce%a3%ce%97%ce%a3%20%ce%a0%ce%a1%ce%9f%ce%93%ce%a1%ce%91%ce%9c%ce%9c%ce%91%ce%a4%ce%9f%ce%a3.pdf"](https://www.sdam.gr/sites/default/files/2022-06/%ce%91%ce%a0%ce%9f%ce%a6%ce%91%ce%a3%ce%97%20%ce%95%ce%93%ce%9a%ce%a1%ce%99%ce%a3%ce%97%ce%a3%20%ce%a0%ce%a1%ce%9f%ce%93%ce%a1%ce%91%ce%9c%ce%9c%ce%91%ce%a4%ce%9f%ce%a3.pdf) C (2022) 3943/16.6.2022.

Policy measures linked to the objective of Citizenship/Cooling, in the context of the Just Development Transition

The policy measures/actions included in the 2021-2027 LLP programme focus on the energy and climate objectives and priorities of the current NECP (2019) and the JTF projections and eligibility.

In particular, the JTF shall aim to provide support to people, economies and the environment of territories facing serious socio-economic challenges deriving from the transition process towards the Union's energy and climate objectives for the year 2030.

In this context, the following priorities, which are directly linked to the objectives of the NECP, were identified in the TCS Programme, including on the basis of an established analysis:

1. Boosting and Promoting Entrepreneurship

Under Priority 1, which focuses on strengthening and promoting entrepreneurship, among other things, investments of an active nature may also be financed, with a focus on new technologies such as greengeneration. In particular in Western Macedonia, flagship projects are included, which make the productive transformation and the region's shift to RTDI and the energy sector: (a) Innovation Zone, (b) Green Data Centre and super-generator SRM, (c) Innovation Hub for Green Hydrogen and Energy Storage in the SRM. For continental lignite regions (Western Macedonia and Megalopoli) priority 1 focuses on transforming and enhancing the competitiveness of existing businesses, which need support for their transition to the zero-pollutant economy, and on setting up and attracting new businesses, creating jobs and leading to economic diversification, modernisation and transformation of the existing production model. Finally, with regard to island transition regions, the focus is on implementing digital transformation and carbon footprint reduction plans.

2. Energy Transition – Climate Neutrality

Priority 2 is of purely energy interest, targeting the energy transition and climate neutrality through investments in energy efficiency, production and storage of clean energy, as well as its use/utilisation by local communities. It focuses on three main categories of actions/investments,

i.e. energy efficiency, clean energy and smart energy.

3. Land use repurposing – Circular economy

- Priority 3 aims at repurposing land use in the fields of lignite and the strengthening of the circular economy:

the projects/investments for the regeneration and reuse (Repurposing) of the restored-lignite land (Western Macedonia and Megalopoli) to host new economic activities, i.e. the construction of the necessary infrastructure (i.e. green infrastructure and technical land use repurposing projects) and/or superstructures for the implementation of the new land uses (e.g. business parks) aiming at the transition of the affected areas to a new economic model.

- Targeted investments in the circular economy, within the restored lignite land (Western Macedonia and Megalopoli), linked to recycling renewable co-products and discouraging energy (photovoltaic panels, batteries).

4. Fair Labour Transition

The main aim is to address the socio-economic consequences of the transition by means of interventions to adapt human resources to skills and to provide training in relation to new production activities. The aims are:

- Maintaining existing jobs and reducing unemployment
- The creation of new and highly skilled jobs in new specialisations with a positive impact on local income
- Ensuring equality, inclusion and non-discrimination

The main categories of actions include:

- Direct employment and social cohesion interventions in the affected regions
- Promotion of employment
- Upskilling and retraining of human resources
- Adaptability of workers and enterprises
- Socio-economic inclusion
- Vocational education and training infrastructure
- Social care and welfare infrastructure
- Familiarity – Awareness of the social and economic fabric

5. Small-scale Integrated Interventions – GR-eco islands

Priority 5 provides for projects and investments linked to the energy transition of the LLP regions

and highlighted through integrated territorial strategies such as ITI and the GR-eco Islands National Initiative. (P.1.2, Figure 8).

Actions to decarbonise islands (implementation of a GR-eco Islands initiative)

The country's energy transition is an excellent opportunity for the Greek islands to highlight the important role they can play in achieving the goals set to reduce dependence on fossil fuels, while exploiting the possibilities offered for this purpose in the context of the just development transition.

The initiative is a holistic approach to the green transition of the Greek islands and reflects, inter alia, the insular aspect of the NECP.

The initiative focuses on the successful transition of the Greek islands towards climate neutrality while stimulating local economies through a set of complementary actions in the light of sustainable development.

The initiative aims to implement interventions in a wide range of areas. The main areas of intervention relate to the four thematic axes below.

The energy transition axis, as the main one, is also broken down into individual sectors:

- Energy transition, where the main objective is to achieve Energy and Cycle Neutrality. This will be achieved by making maximum use of renewable sources, through hybrid systems of electricity generation, storage of electricity, hydrogen production, increased energy savings in the building sector, but also in all sectors of activity such as tourism, etc. In particular, the following sub-sectors can be distinguished:
 - Decommissioning of electricity from fossil fuels
 - Streamlining energy consumption
 - Provision of cheap energy to residents and businesses
 - Improving energy security
 - Reducing transport environmental footprint
- Sustainable resource management
- Environmental protection
- Entrepreneurship and innovation

Interventions in the above sectors are expected to have a significant positive impact on island tourism. Both green energy and efficiency improvements and sustainable mobility are expected to improve the image of islands, giving it a 'green' profile and thus making them more attractive to those who want to visit them.

The GR-eco Islands initiative mobilises resources from all the funds, programmes and more general sources of funding at our disposal, such as the NSRF 2021-2027, the Just Transition Fund, the TAA, the Cooling Fund (in the process of being set up), even those that meet the ESG criteria,

etc.

3.1.2 measures and policies to reduce emissions in rural part

The National Strategic Plan (NSP) of the Common Agricultural Policy (CAP) of Greece for 2023-2027, approved in November 2022, is the main tool for strategic planning for the implementation of the 2023-2027 CAP and the development of the country's primary sector and rural areas.

The main objective of the Strategic Plan is to support the sustainable development of the agricultural and food sectors by ensuring their sustainable rural income and enhancing competitiveness, as well as by strengthening the socio-economic fabric of rural areas, while contributing to the achievement of environmental and climate objectives, at national and European level. Through its incentives, it will help create a new production model for the wider agri-food sector in Greece with the aim, inter alia, of reducing its 'climate footprint' and adapting it to climate change. Reducing the 'climate footprint' is linked to the specific objective of contributing to climate change mitigation by reducing greenhouse gas emissions and enhancing CO₂ capture, as well as promoting sustainable energy.

The CAP Strategic Plan puts particular emphasis on achieving increased climate and environmental prominence. The environmental and climate ambition under the CAP will be achieved through the new "Green Architecture" of the CAP. The three key elements in the Green Architecture are:

1. enhanced conditionality;
2. the Green Schemes of Pillar 1 (interventions in Article 31 of Regulation (EU) 2021/2115) and
3. climate and environment-related interventions of Pillar 2 (Article 70 of Regulation (EU) 2021/2115, agri-environment-climate commitments).

The enhanced conditionality sets the baseline for farmers receiving CAP payments and consists of statutory management requirements (SMRs) and standards for maintaining land in good agricultural and environmental condition (GAEC). Greece will implement through the CAP a system of enhanced conditionality by improving already existing Good Agricultural and Environmental Condition (GAEC) practices, while integrating some existing 'Greening' requirements of the previous programming period into the enhanced conditionality. For binding commitments, those contributing to climate change are described in the LULUCF chapter.

Following the enhanced conditionality, new voluntary, annual agri-environment schemes, known as 'Green Schemes', will reinforce the environmental and cyclical results to be achieved by CAP Pillar 1 payments. EL will allocate 25 % of the CAP direct payments budget (Pillar 1) to the "Ecological Schemes", giving farmers a choice of simple, practical measures that they can apply to their farms each year, with the aim of maximising the participation of farmers in achieving climate and environmental values on all areas cultivated. The ecological schemes to be applied in the three agronomic regions (arable, tree, pasture) in Greece are:

- 1.1 Use of resilient and adapted species and varieties to climate change
- 1.2 Extension of the application of ecological focus areas
- 1.3 Implement improved vegetation cover practices while enhancing biodiversity.
- 1.4 Circular economy applications in agriculture
- 1.5 Improving landscape-rich agroforestry ecosystems
- 1.6 Aid to producers for the application of precision farming methods using the input management and environmental monitoring tool (s).
- 1.7 Environmental management of livestock systems
- 1.8 Maintenance and improvement of crops on terraced land
- 1.9 Maintenance of organic farming and livestock farming methods
- 1.10 Protection and conservation of landscapes and agricultural systems of High Environmental Value.

Pillar 2 interventions are grouped into the following distinct categories:

(a) Aid to producers to compensate for the additional costs and income foregone created by their increased commitments/farming practices, targeting the environment and the climate.

This category includes interventions for:

1. the protection of wildlife within protected areas (bird fauna, – wild mammals);
2. the protection of the rural landscape;
3. reduction of the use of plant protection products through the application of ninalactics with plant protection sulphur,
4. the protection of genetic resources in agriculture and livestock farming;
5. the transition to organic farming and farming practices;
6. afforestation of agricultural land;
7. enhance biodiversity and adaptation of forests to climate change.

(b) Granting aid to producers in mountain and less-favoured areas (ANCs), as well as areas with specific handicaps, with the aim of maintaining agricultural income in those areas and of continuing agricultural activity which contributes to protecting against soil erosion, protecting biodiversity and preserving the rural landscape and preventing biodiversity and adapting forests to climate change in the Special Protection Areas (SPAs) of NATURA 2000 areas.

(C) Public and private investment targeting environment and climate: This section includes:

I. Investments in agricultural holdings for:

- i) water saving
- ii) saving energy
- iii) energy production from RES
- iv) the acquisition of protective equipment against natural disasters and extreme weather events.

II. Public investment for rational water management (construction of reservoirs for water

retention, modernisation of irrigation networks to reduce losses) as well as investment to prevent and restore damage to forests against biotic and abiotic damaging causes, including forestfires.

III. Investments in the protection of wild mammals, triangle habitats and soil protection.

Aid to producers for agro-environmental commitments under Pillar 2 and the ecological schemes of Pillar 1 absorbs 19 % of the Community contribution under the Strategic Plan. In addition, the objectives of the Strategic Plan are to maintain agricultural activity in mountainous and less-favoured areas, which is very important to protect biodiversity and combat soil erosion. 26.6 % of the resources of the Strategic Plan are allocated to the environmental and climate objectives of the AA if the budget of the two specific interventions is taken into account.

Priority will also be given to reducing emissions, CH₄ and N₂O, which are greenhouse gases almost exclusively (> 99.9 %) emitted by the agricultural sector. Methane is emitted mainly from enteric fermentation and management of animals from mouse, while nitrous oxide mainly from fertiliser use and the wintering/disposal of animal waste.

The impact of GHG mitigation measures in the agricultural sector (related to methane and nitrous oxide gases) is shown in Table 10.

In particular, measures for the rational use of compost and organic crops (effect on N₂O emissions) and improved diet (effect on methane) have been quantified. The impact of measures to increase CO₂ removals is described in more detail in the LULUCF sector.

Table 10 Quantification of the impact of policies and measures on the agricultural sector.

Agricultural sector	2025	2030	2035	2040	2045	2050
Effect of measures on ktCO ₂ eq	415	638	766	891	1011	1127

The implementation of the planned measures and policies is expected to lead to a 24 % reduction in greenhouse gas emissions in 2030 compared to 2005, while in 2040 and 2050 the reduction is expected to be 30 % and 36 % by 2005 (Table 11).

Table 11 Evolution of GHG emissions by 2050 from the agricultural sector.

Agricultural sector	Historic emissions				Forecast					
	1990	2005	2020	2022	2025	2030	2035	2040	2045	2050
GHG emissions (kt CO ₂ eq)	10535	9337	8421	7980	7544	7139	6842	6558	6280	5994

3.1.3 measures and policies to increase the contribution of the LULUCF sector to climate neutrality

The Land Use, Land Use Change and Forestry (LULUCF) sector has the potential to contribute significantly to the path of Greece and the European Union towards climate neutrality. Policies developed to this end must be based on the principle of sustainability, be based on the principle of environmental protection and rational management, and ensure that ecosystem functions are widely shared. They must also be consistent with other national policies affecting natural resources and ecosystems, such as biodiversity protection, water conservation and sustainable development.

A systematic monitoring of the evolution of land use **and its characteristics is a necessary condition for a more complete and accurate recording** of the sector's contribution in order to ensure the protection of carbon stocks. To this end, the system for the installation and first operation of a forest and forest area inventory and monitoring system will continue to be established with a view to monitoring and recording these trends without hindrance.

Current policies and targeted measures, already implemented⁶⁶ under National or Strategic Plans or other national, European or international commitments of our country, will continue to be implemented with a view to **increasing net removals** and offsetting LULUCF greenhouse gas emissions through the following actions:

- Sustainable forest and forest land management
- Production of long life cycle wood products
- Strengthening the protection of forests against natural disasters
- Reforestation and restoration of degraded areas
- Afforestation of agricultural land.

Institutional measures, such as **the codification of forest legislation**, the updating **of forest management plans and studies** on sustainable forest management (currently underway) and the **preparation of definitive studies for the whole country** (with data entered on a digital platform), together with the staffing of the Forestry Service, will improve the current forest management framework, with a view to:

- the improvement of the production potential of forests through the recovery of subtracted and twofold forest ecosystems and an increase in the stock of shallow;
- the production of long life cycle wood products and the fight against logging and related trade (see FLEGT Timber Regulations No 2173/2005 and No 995/2010);
- improving the structure of forests to increase their resilience and pre-adaptation to climate change;
- protecting and promoting regeneration of forest vegetation;

⁶⁶ Sources: LIFE-IP AdaptInGR project, YPEN Directorate-General for Environmental Policy, Ministry of Rural Development and Food, Directorate-General for Forestry and Forestry Person, Ministry of Rural Development and Food.

- the provision of multiple ecosystem services (e.g. improving quality, protecting biodiversity).

Prevention and restoration of damage to forests against biotic and abiotic threats (natural fires, pathogens, floods and other natural disasters and catastrophic events) is also an important part of the measures and policies that will continue to be implemented. Prevention measures, which will continue, include vegetation cleanings (e.g. under the antiNERO programme, financed by the Recovery and Resilience Fund, etc.), but also the preparation of **fire protection plans** for the whole country. In addition, in order to maintain the health and vitality of forest ecosystems, appropriate specialised measures are taken to **combat diseases, insects and fungi**, as well as any pathogenic cause in forest trees (e.g. systematic monitoring by sampling), in compliance with the relevant obligations under Community legislation on plant health checks.

With regard to the **restoration of forest potential** damaged by fires, disasters and other catastrophic events or degraded by other phenomena such as soil erosion, actions will continue to be implemented, as is clear:

- **Reforestation** under the National Rehabilitation Plan (aimed at the condition of degraded forest ecosystems using mainly wetland species) and the 'Rehabilitation and Reforestation Contractor' (for forests affected by devastating fires and restoration work on mountain river beds).
- **Mountainous anti-erosion and flood prevention projects**, as a matter of priority in cases of widespread disasters such as those of Evia (2021) and Dadia in the PEREVOU (2022-2023).

All the measures mentioned, on which the WEM central scenario projections are based, aim both at maintaining and increasing the existing carbon storage. It should be noted that measures and policies concerning other areas of environmental housing (such as the agricultural sector, urban bio-climatic regenerations, water management, biodiversity, etc.) also have an impact on the carbon balance of the LULUCF sector.

In addition, the mitigation of emissions and the increase in removals from the LULUCF sector is expected to be enhanced by implementing policies and measures included in the 2023-2027 **Strategic Plan of the Greek Common Agricultural Policy (CAP SP)**, which relate mainly to the conservation and sustainable use of land and resources in general, as well as to agricultural land management practices.

As regards the enhanced conditionality rules (binding commitments) of the CAP Strategic Plan, those related to climate change are summarised below in Table 12:

Table 12 Enhanced conditionality rules (binding commitments) of the CFP Strategic ECT.

Good Agricultural and Environmental Standard Code	Description	Contribution to the sector LULUCF
GAEC 1	Maintenance of permanent grassland on the basis of the ratio of permanent grassland in relation to agricultural area at national, regional and sub-regional level and at member-group level or at farm level, compared to the reference year 2018 and the maximum acceptable reduction of 5 % compared to the year per year	General safeguard measure against conversion to all agricultural uses to maintain carbon stocks
GAEC 2	Protection of wetlands and peatlands	Protection of carbon-rich soils
GAEC 3	Ban on burning crop residues	Maintenance of the organic body of the soil

The **interventions** of the Strategic Plan for the CFP, related to the LULUCF sector and expected to help protect the existing carbon pool of woody biomass and soil or increase removals, concern:

- maintain and increase soil organic matter;
- improving agro-forestry ecosystems;
- soil protection against erosion,
- afforestation of agricultural land.

The impact of LULUCF related measures of the Strategic Plan of the CFP, which contribute to increasing CO₂ removals and is currently quantifiable, is presented in Table 13.

Table 13 Quantification of the impact of the CFP AA interventions on the LULUCF sector (year removal heat, kt CO₂eq).

INTERVENTION	Years of the period					
	2025	2030	2035	2040	2045	2050
P1-31.2 – Extension of-ecological focus	— 1,2	— 3,0	— 3,0	— 3,0	— 2,4	— 1,2
P1-31.3 – Adoptionof improved sewageplant practices, withparallel enhancement of biodiversity	— 0,3	— 0,7	— 0,7	— 0,7	— 0,6	— 0,3
P1-31.4 – Holdingsof a circularestates in agriculture	— 0,1	— 0,3	— 0,3	— 0,3	— 0,2	— 0,1
P1-31.5 – Improvement of agroforestryhabitat systems, floating in landscape elements	0,0	0,0	0,0	0,0	0,0	0,0
P3-70-4.1 – Afforestation and creationof land (second phase of afforestation covering maintenance costs and compensationfor no income)	0,0	— 131	— 131	— 131	— 131	— 65,6
Amount of removals per year (kt CO₂eq)	— 1,6	— 135	— 135	— 135	— 134,2	— 67,2

Greece's long-term planning also assessed the contribution of the implementation **of the additional measures** beyond the above and a second projection of future LULUCF emissions and removals by 2050. The additional measures included in the **WAM** scenario estimates include:

1. Systematic forest management – Correctionof degraded forest ecosystems (coppice broadleaf forests – shrubs in high forests) – Mainstreaming the climate dimension in management studies, monitoring the carbon balance, implementing measures to

increase removals in forests and enhancing their resilience. The estimated additional removals in relation to WEMnar, which this category of measures can offer, range from 0,3 to 0.4 Mt CO₂eq at country level per year.

2. Increased production of long-lived wood products. In recent years, there has been a continuously decreasing trend in the quantity of wood products produced based on official FAO statistics⁶⁷ for Greece. The estimated removals in relation to the WEM scenario, which have been included in the WAM forecast, range from 0,1 to 0.2 Mt CO₂eq at country level per year.
3. Rehabilitation of disturbed areas (such as lignite mines, quarries, etc.) following the cessation of human activities. The estimated additional removals relative to the WEM scenario, included in the WAM forecast, are between 0,05 and 0.1 Mt CO₂eq at country level per year.
4. Integration of additional carbon pools, which to date are not included in Greece's greenhouse gas emissions inventory as follows:

Woody biomass of scrubland and carbon storage in the soil of the 'Groundland remaining grassland'. The estimated additional removals relative to the WEM scenario, which have been included in the WAM forecast, range from 0,5 to 0.9 Mt CO₂eq scenario at country level per year.

B. Deductions from Posidonia's seagrass beds⁶⁸. The carbon removal potential of these ecosystems is estimated at 68 kt CO₂eq per year, based on research results from the ELKETHE for the South Aegean region (Apost- Laki, etc., currently being published). The estimated additional removals relative to the WEM scenario, which have been included in the WAM forecast, range from 0,1 to 0.2 Mt CO₂eq at country level per year. Please note that the inclusion of marine meadows in the greenhouse gas inventories may be carried out on a voluntary basis and provided that sufficient data and scientifically accepted methodology are available. The possibility of including these ecosystems in the national greenhouse gas inventory is currently being explored by Greece in the context of the upgrade of the MRV system for the Greek LULUCF sector.

3.1.4 transport measures and policies

The objective of climate neutrality of the transport sector is first served by electro-mobility, while the use of green hydrogen and other renewable liquid fuels of biological or non-biological origin are expected to contribute to a lesser or greater extent depending on the transport sector

⁶⁷ <https://www.fao.org/faostat/en/#data/FO>.

⁶⁸ https://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/#lang=EN;p=w;bkgd=5;theme=631:0.75;c=2693939.830479798,4685166.709327022;z=7.

under consideration.

Roadtransport 69

Light Road Transport

The policy launched since 2019, particularly for light-duty vehicles, and is gradually enriching and evolving, has made it possible to create a market for traffic and electric vehicles in the country. Achieving the revised targets for reducing CO₂ emissions in the light-duty vehicles sector is both the **continuation of existing** and the **adoption of new policies and measures** focusing on maintaining, improving **and, where necessary, extending an appropriate framework for the significant electrification** of this transport block.

Particular emphasis should be placed on electrification of light trucks (vans), as part of the “greening” of the supply chain. In particular, targeted measures and indirect and direct incentives to acquire and use such vehicles are envisaged.

By way of illustration, policy measures towards 2030 should include indirect and direct financial incentives for acquisition (in the form of tax incentives and subsidies to natural and legal persons). In addition, either in conjunction with the purchase incentives or independently, enhanced incentives should be introduced and measures should be taken to withdraw old polluting vehicles, together with strict roadworthiness tests for old vehicles (see KTEO and on-road checks). At the same time, incentives to reduce the cost of using these vehicles should continue to be implemented and strengthened.

As well as introducing new incentives, it is important to introduce new incentives for the use of old thermal motor vehicles, especially in urban centres. Various forms of disincentives will be examined in this regard, taking into account the degree of maturity of the electro-mobility market and the rate of renewal of vehicles in Greece.

Green supply chain: Reducing emissions of gaseous pollutants from the sector more closely along the supply chain is a key priority towards climate neutrality. Recording environmental performance in the supply chain, in particular greenhouse gas emissions in road transport and distribution, as well as energy consumption within the Storage and Distribution Centres should contribute to the decarbonisation of transport. In this context, both the implementation of Article 5 of Law 4302/2014 (Government Gazette, Series I, No 225) on the green supply chain and the measures for the electrification of light trucks used for the distribution of goods become particularly important. In this context, incentives and in particular disincentives for last mile

Road⁶⁹ transport means:

- (A) journeys made by light vehicles (passenger cars, light lorries LCV, i.e. M1 and N1 vehicles);
- (B) travel by light personal electric vehicles (EPHs) and by two-/three-wheel vehicles and small cars (CATEGORY L);
- (C) journeys made by heavy vehicles (heavy lorries of the type N2);
- (D) journeys made by collective transport (urban buses, track-based modes, etc.).

feeding will be considered (e.g. action to replace a two-chamber with E-cargo bike).

Heavy Road Transport

The framework set out in Chapter 2 (2.2.3) envisages the possibility and feasibility of adopting specific policy measures for heavy-duty vehicles, around technologies and which appear to be a solution, with a view to accelerating the reduction of their carbon footprint. Specific measures in specific sectors such as heavy vehicles used in urban transport (buses, catering cars) will also contribute to serving other objectives such as improving transport within urban centres.

Urban travel – Use of SMUs

Road passenger transport

Actions to decarbonise road passenger transport in Attica are:

- Drawing up a Strategic Transport Plan and an implementation plan.
- Implementation of a fleet renewal programme with new low-emission vehicles.
- Explore a scenario for retrofitting existing buses to use hydrogen using a total consumption forecasting system.
- Significantly increase the accessibility of stops from pedestrians.

For passenger transport by road outside Attica, as well as for interurban road transport, the adoption of measures for the use of different technological solutions, such as electromobility, the use of green hydrogen through pilot projects and scaling up if technically and economically approved, as well as the use of gaseous fuel as a blend of reduced carbon footprint, will be considered.

Track-based means

Actions for the development and extension of track-based instruments in Attica shall receive:

- Extension of line 2 of Metro from Anthoupolis to Ilion (creation of 3 new passenger stations) and extension of the Elathiou Elathiou.
- Construction of Metro Line 4.
- Supply of new tramway trains to service line 3 of the Metro.
- Exploring the possible extension of the existing tram operating network.

Sustainable urban and active mobility

Measures designed and implemented to promote sustainable urban mobility shall include:

- The overall design of sustainable transport systems by local self-government through the mandatory preparation of a Sustainable Urban Mobility Plan

(SUMP) by municipalities with a population of more than 30.000 inhabitants and those operating in the areas under the responsibility of OASA and OASTH, as well as from all the regions of Greece;

- support for sustainable mobility policies and measures by the Central Administration through the creation of an Electronic Platform for Sustainable Urban Mobility Plans (IDSUAK) to be kept by the Ministry of Infrastructure and Transport;
- the setting of lower speed limits on the urban web in the context of the amendment of the Road Traffic Code;
- promoting active mobility through the development of the National Action Plan for the promotion of cycling⁷⁰, the implementation of the National Strategy for the Periphery and the National Plan for Accessibility with a Step to Climate Change;
- promotion of Light Electric Vehicles Personnel (EPOC)⁷¹. The additional deployment of ELVs and L-category vehicles⁷² as means of travel requires both the continuation of existing policies and measures focusing on driving, improving and, where necessary, extending an appropriate framework for the electrification of this sector to a significant extent. Examples of new measures include incentives to switch a vehicle (from car to bicycle) such as tax relief for the acquisition of a bicycle/electric bicycle/e-van for corporate travel, and/or replacement of a conventional private car or MOTO with a bicycle.

In addition, new measures and policies will be considered such as:

- the development of private sustainable urban mobility plans by companies employing a large number of workers;
- the introduction of a mandatory parking space for the purchase of a new car; ⁷³
- measures to reshape the road environment to give space to alternating forms of travel instead of cars.

Improving road behaviour and promoting alternative forms of travel

- **Active human-powered mobility:** Promotion of provisions of the Road Code promoting alternative forms of travel (pedestrian, cycling, micromobility) with a view to ensuring safe traffic and the co-existence of all road users, which will help to increase the rate of travel by alternative means or on foot.
- **Economic-ecological Driving:** In the context of theoretical and practical expatriation

⁷⁰ In conjunction with the 'National Strategy for Cycling'.

According⁷¹ to the definition of the Road Traffic Code (Article 2 of Law 2696/1999, Government Gazette, Series I, No 57), a vehicle is defined as an electric motor vehicle which does not fall within the scope of Regulation 858/2018/EU, Regulation 168/2013/EU, Directive 2009/48/EC and Directive 2007/46/EC.

L-category⁷² vehicles (two-, three-wheel and quadricycle microcars) serve the objectives of micromobility and can be tools for urban transport and supplies of goods (last mile) in the supply chain.

The⁷³ urban centres of Greek cities are among the most densely populated in Europe and parking is the main brake to implement sustainable mobility policies in them.

candidate drivers and drivers should be trained and examined economically and in a safe and environmentally friendly manner. Particular emphasis should be placed on drivers of heavy-duty vehicles in the initial and periodic training process for obtaining a certificate of professional competence.

Electric vehicles charging infrastructure

The development of the necessary charging infrastructure throughout Greece is a prerequisite for further electrification of road transport in Greece. The development of such infrastructure, both publicly accessible on motorways and points inside and outside cities, as well as infrastructure for private access to homes or corporate spaces (in buildings), will be served through the continuation of existing policy measures (subsidy schemes and tax incentives) and the adoption of new countermeasures.

Publicly accessible charging infrastructure requires the continuation of existing and new measures, in the form of financial incentives for their deployment, with a focus on high power (fast charging) infrastructure outside urban centres as well as normal power infrastructure within urban centres.

At the same time, for both publicly accessible and privately used infrastructure, regulatory measures should be promoted with a view to further simplifying any licensing procedure needed for their installation, as well as the procedure for their connection to the electricity distribution network. A particular phase will be given to the increased use of RES to supply this infrastructure.

For charging infrastructure in buildings in particular, it is important to ensure the implementation of the provisions of Law 4710/2020 (GG I 142) for the installation of such infrastructure in new/nascent and existing buildings, both by taking measures to provide incentives and facilities and by introducing strict checks on compliance with the legislation.

At the same time, the development and use of intelligent systems relating to communication with charging infrastructure, their control and the possibilities available to PC users to use them more easily is being promoted. The aim is to achieve the highest levels of interoperability possible, both between different charging walls within the country and with networks and providers of charging services in other European or non-European countries. Intelligent charging systems will communicate with the management of the electricity grid and through tariff incentives and dynamic gearing will manage the exact charging time of each vehicle in order to avoid congestion in the electrical infrastructure, as well as to increase the use of RES for their power supply. They may also be able to support the conditional use of PC batteries for the provision of services to the electricity grid (smart charging, V2G), a measure related to the

promotion of RES and the development of sufficient capacity from cabin capacity.

Railway transport

In rail transport, electromobility is expected to be further developed, including and expanding the electrification of the railway network in the country.

In the context of reducing greenhouse gas emissions in the rail transport sector, OSE is moving towards electrification of the MEGA of a lower proportion of its rail network, in order to minimise the movement of polluting diesels.

The main projects relating to the electrification of existing railway lines are the following:

- Installation of Electromobility, Splifery – Teleadministration and ETCS L1 on the textile single railway line Palaofarsalos – Kalabaka. (Length of 80 km with estimated completion by year 2025)
- Signalling – Electromobility on the existing single Larissa – Volos railway line (Length 61 km with estimated completion by year 2025)
- Electrification of the new double railway line on the Kiato-Rododafni section (Length 71 km with estimated completion by year 2025)
- Electrification of the existing single sideline Thriasi-Ikonium (Length 18 km with estimated completion by year 2030)
- Installation of electric mobility on the existing Thessaloniki – Strymona-Promachonas Strait (Length of 143 km with estimated completion by 2030)
- Upgrading of an existing West Attiki Provincial Rail Line, section: Upper Liosia – New Unit of Megara – Megara (Length 34 km with estimated completion by 2025).

At the same time, it is planned to complete the following new projects on electrified railway lines:

- Construction of a single electrified standard gauge I railway line Samos – Loutraki (Length 6.4 km with estimated completion by year 2025)
- Construction of a new double railway line Rododafni – Psapopyrgos of length 21.5 km and Psaporgos – 10.5 km long with electric mobility (Length 32 km with estimated completion by year 2030)
- Construction of a new single railway line on the Thessaloniki – Toxes section, by electro-mobility and signalling (Length of 206 km with estimated completion by 2030)

Shipping

The choice of policy measures must be technologically neutral, subject to compliance with the

climate-neutrality objective, and it is a prerequisite for securing the necessary supply infrastructure.

- ✓ Incentivising the retrofitting of existing ships to have reduced emissions and the renewal of the old fleet, in particular coastal shipping and the construction/retrofitting and operation of hybrid ships
- ✓ Development of the necessary electricity infrastructure in ports (cold-ironing) ⁷⁴
- ✓ Strengthening research into the development of new technologies for the use of renewable energy and alternative fuels
- ✓ Encourage research into the development of equipment for carbon capture of marine exhaust gases

The transition of maritime transport requires changes in both ships and ports, the definition of standards and the interoperability of systems between ports. As a consequence, the transition to the maritime sector is based on 3 pillars, which are analysed below:

- Green transformation of ships,
- green transformation of ports, and
- green transformation of islands' interconnections.

Green transformation of vessels (coastal and sea-going shipping)

Coastal ferries

In the area of coastal shipping, the strategic objective is to set up the appropriate facilities to enable the Greek coastal shipping fleet to comply with the new requirements of European legislation (FuelEU Maritime) and the EU Emissions Trading System (ETS), as well as the related objectives and proposals set by the IMO worldwide, which aim to reduce the footprint of carbon dioxide emitted by maritime transport by means of an increasing demand of renewable energy sources or means that will emit reduced carbon emissions.

In this context, consideration will be given to the adoption of measures for the renewal of its fleet on the ground as well as for the operation of low-emission passenger ships when sailing. Studies on these issues have been commissioned as a first step in designing the appropriate framework. This is the case for short-haul ferries which may become electrically powered batteries with a primary energy source.

Sea-going Shipping

⁷⁴ On the basis of the provisions of the Alternative Fuels Infrastructure Regulation (AFIR) at least for the ports of the main and complementary Trans-European Maritime Transport Network.

- Research to identify the most advantageous solution
- Policy options aligned with the IMO and the EU.

Green transformation of ports

Ports

With regard to ports, the aim is to incentivise Port Administration and Exploitation Bodies (PFMPs) to integrate innovative programmes and actions leading to the transformation of ports into smart, self-propelled ports and energy hubs. Actions with regard to ports focus on:

- Encourage FLVs to adopt policies to protect air quality in ports against pollution through SO_x, NO_x and microparticle emissions.
- Taking initiatives to reduce greenhouse gas and carbon emissions from port operations. Promoting policies to keep abreast and reduce emissions to air associated with key activities: shipping, loading and unloading, handling of goods.
- Promoting continuous improvement and energy saving policies in ports, with a focus on operational efficiency and clean technologies.
- The development of monitoring mechanisms between the Ministry of Shipping and Island Policy and the NLVs to develop targets, monitor performance and report on progress towards the targets set to reduce the impact of climate change.

The actions to be taken in the coming period, with regard to the policy measures as included in the existing NECP, include:

- With regard to the **supply of electricity to ships during the period of elongation**, it is **necessary** to continue the electrification programme by carrying out studies for all the ports of the main and complementary transport network (TEN-T) in the next few years, and by **providing financing instruments with the help of EU financial instruments⁷⁵** for domestic legal aid/subsidies for the energy transformation/electrification of ports. **At the same time, an appropriate regulatory and regulatory framework is needed for the electricity market through transactions with ports and ships at berth.**
- With regard to the **planning and integration of RES and storage units in port areas in the form of self-generation**, care is needed to ensure that the regulatory framework developed in the case of maritime power (power supply for ships at berth) includes self-generation of electricity from RES and the installation of storage units in ports.

⁷⁵ Studies for electrification of ships at berth, with European funding, have been carried out in the following ports: Piraeus, Igoumenitsa, Rafina, Volos and Heraklion, while studies for the ports of Lavrio, Corfu and Kavala are expected to start in 2024. In addition, the ports of Igoumenitsa and Rafina have secured European funding for the implementation of electricity infrastructure.

- With regard to the **strengthening of local electricity networks and at the level of stations in the port area**, a study on how to consolidate the electricity needs of all ports for 2030 is required⁷⁶.

In addition, the adoption of measures such as:

- Development of an observatory for adaptation to the energy transmission and electrification policy of ports, through which there will be a continuous record of the electricity supply sites in Greece's ports.
- Drawing up a scientific training programme for the competent officers (technicians of the FEDs and officers of the Hellenic Coast Guard) on matters relating to the energy transformation and electrification of ports.

Green transformation of island interconnections (Port interconnections)

Strengthening the interconnectivity of the Greek islands is also essential for an integrated maritime transport transition policy. In this context, “rationalisation of the coastal and port network and promoting the renewal/modernisation of the fleet” is also addressed as a key intervention⁷⁷, including through the establishment⁷⁸ of the “Young” programme, which is a tool for financing projects of a similar nature.

Air transport

The revised NECP includes targets to reduce CO₂ emissions from air transport by gradually using renewable liquid fuels to feed aeroplanes. In particular, the use of biofuels and synthetic fuels will be considered, and the development of electrification infrastructure for aircraft during their stay at the airport will be envisaged⁷⁹.

Policy measures for this sector will include targeted support and financial support for the biofuel production activity, as well as public-private partnerships, to improve the availability and financial sustainability of biofuel production, and to further accelerate their supply and dissemination.

Furthermore, for Greece, it is important to ensure that the needs for the production of SAF and

⁷⁶ Due to the mandatory implementation of port electrification projects, in order to meet these needs, studies to strengthen the electricity networks in the port area should be completed and included with high priority in the Network Development Plans of DEDDIE and ADMIE.

⁷⁷ It is included in the final report of the National Strategic Transport Plan of Greece (nationaltransportplan.gr) and in particular in Pillar 5 ‘Strengthening the connectivity of the Greek islands’.

⁷⁸ Cf. Article 6 of Codification Law 4832/2021 (Government Gazette, Series I, No 172).

⁷⁹ Based on relevant objectives set out in the AFIR.

the use of technologies for the production of non-organic synthetic biofuels are met, as far as possible, by domestic production, given the country's potential for renewable energy sources (RES).

3.1.5 Waste management measures and policies

The waste management sector is an integral part of the National Energy and Climate Plan. Waste, which emits large amounts of greenhouse gases, needs appropriate treatment on the basis of the hierarchy of waste, prioritising preparation for re-use, recycling, followed by material/substance or energy recovery, thus helping to tackle climate change and promote the circular economy. Moreover, the National Waste Management Plan (ECHR), which was revised in 2020 and 2023, is the roadmap for moving from the existing waste management model to a modern, efficient, environmentally friendly and competitive circular economy by 2030, while contributing to achieving climate neutrality.

To this end, actions are promoted relating to (a) separate collection and aerobic or anaerobic treatment of biowaste (of urban and agro-livestock origin, including edible fats and oils), which is a priority stream, for compost production and/or energy recovery, (b) separate collection of waste materials (plastic, paper, glass and metals) for preparation for re-use, recycling/recovery of materials, and (c) production of alternative secondary fuels and energy recovery from the energy-intensive industry and from waste to energy units, contributing to the substitution of fossil fuels from biomass/biofuel and waste fuel.

In addition, with regard to food waste which has a significant impact on greenhouse gas emissions, measures to prevent their creation and proper management are provided for both in the Waste Framework Law (Law 4819/2021, GG I 129 and Law 5151/2024, GG I 153) and in the National Waste Prevention Programme, and food waste reduction targets have been established, contributing to the UN's sustainable development target of reducing food waste per capita by 50 % by 2030. In particular, by 2030 (a) a reduction in food losses along the production and supply chain, and (b) a reduction of thirty percent (30 %), relative to food waste generated in 2022, in food waste per chapter at retail and consumer levels is foreseen. At the same time, measures are being taken to encourage the donation and redistribution of food for pineapple consumption.

In addition, provision is made for strengthening and upgrading the waste treatment infrastructure in order to fully cover the country. In particular, the upgrading of Recyclable Materials Clearing Centres (RMPs) and the upgrading of Waste Treatment Units (NPE) to Recycling Recovery Units (RUs), where separately collected recyclable materials and biowaste will be treated, while the quantities of residual mixed waste will decrease over time. It is also important to reduce the number of uncontrolled waste disposal sites for which Greece pays a financial fine to the European Union, as waste treatment and waste disposal plants are gradually operating to serve neighbouring areas.

The central objectives of the national design are the preparation for re-use and recycling of

municipal waste generated by at least 60 % by 2030 and, upon completion of the projects, the reduction of municipal waste landfilled to 10 % of the total municipal waste generated in 2030 instead of 2 035 in accordance with Directive 2008/98/EC.

Please note that the production of energy from secondary RDF (Refused Derived Fuel) or SRF (Solid Recovered Fuel) fuels, recovered from mechanical biological units for the processing of residual mixed municipal waste (NPE and RRF), and possibly also from RDPs, is compatible with:

- waste management and recovery with modern circular and cost-based technologies
- the requirements of the Circular Economy, since the energy use of secondary fuel is higher in the waste hierarchy than its final disposal in a landfill.
- the European Commission's Guidelines on the diversion of waste disposed of in landfills by 90 % by 2035;

At the same time, CO₂ emissions from its use are lower than fossil fuels because the RDF/SRF contains a significant proportion of biomass.

Special management and specific measures will be taken to address the diversity of waste, with the aim of fully covering island regions during the tourist season.

The current ECHR for 2030 and the corresponding Regional Waste Plans (PESDA), which are under revision, provide for intensification of measures for integrated waste management in line with the principles of the circular economy. All of the above action plans are a realistic plan to bring together European legislation and develop a management model with 'more valuable waste', leading to a significant reduction in pollutant emissions (e.g. methane that almost exclusively (> 95 %) is emitted by the waste management sector, CO₂ from the burning of hospital and other industrial waste materials (e.g. solvents) and N₂O from waste water management).

The impact of measures to mitigate greenhouse gas emissions in the waste management sector (methane gas is concerned) is shown in Table 14, as follows from the quantification of the impact of measures to reduce biodegradable materials disposed of in landfills, energy recovery of methane from landfills and sewage sludge management.

Table 14 Quantification of the impact of policies and measures in the field of waste management.

Management sector	2025	2030	2035	2040	2045	2050
Effect of measures on ktCO ₂ eq	748	1171	1570	1913	2206	2477

The evolution of greenhouse gas emissions from the waste management sector, taking into account the measures and policies of this and the next chapter, is presented in Table 15. Emissions in 2030 are expected to be at 2005 levels, while in 2040 it is expected to be around 26 % lower and in 2050 about 45 % less than in 2005.

Table 15 Evolution of GHG emissions by 2050 from the waste management sector.

	Historical				Forecast					
Management sector	1990	2005	2020	2022	2025	2030	2035	2040	2045	2050
GHG emissions (kt CO ₂ eq)	5384	5256	5683	6240	6091	5262	4529	3909	3378	2916

3.1.6 Circular Economy Measures and Policies

A key tool for coordinating policies and actions towards a more circular economy is the ‘New Action Plan – Road Map of Circular Economy’, which was approved by Council of Ministers Act No 12/29.4.2022 (Government Gazette, Series I, No 84). This plan, which is a revision of the previous National Operational Plan 2018-2019, has a implementation deadline of 2022-2025, is in line with the objectives of the corresponding European Commission Action Plan and is compatible with national legislative developments.

The general actions contained therein have been divided into four groups:

- (a) sustainable production and industrial policy
- (b) sustainable consumption
- (C) fewer waste with higher value; and
- (D) horizontal actions

this includes specific actions for key products to be prioritised.

Actions relating to **sustainable production and industrial policy** will continue to be implemented, such as:

- **Tax incentives** for investments targeting green housing and energy carried out by small and medium-sized enterprises (Joint Ministerial Decision No 139818 EΞ/29.09.2022, Government Gazette, Series II, No 5083).
- **Correlation between sustainable production criteria** for products and the levies from pipelines, as part of extended producer responsibility schemes (Article 9 (3) (b) and Article 78 of Law 4819/2021 (Government Gazette, Series I, No 129)), which may award after the adoption of the proposal for a regulation on ecodesign.
- Laying down requirements for **recycled plastic content** in plastic containers and cups (Article 6 of Law 4736/2020, Government Gazette, Series I, No 200), which may be supplemented after the adoption of the proposal for a Regulation on packaging and packaging waste.

Also, in the context of LIFE IP GREECE for the Circular Economy, the Greek ESYF/ELOT standardisation organisation has carried out an overview of **standards for secondary materials**,

with a view to developing relevant technical specifications.

Of the actions related to sustainable consumption, the following will continue to be implemented:

- Development of **Centres for the Re-Use of Materials** (KJHA) (Article 18 of Law 4819/2021) and a supporting study has been completed for the creation of the own map including the identification of a framework for their operation and supply.
- Enforcement of the **obligation to inform consumers** of repairable and scalable products such as furniture, electrical and electronic equipment and products containing software (Article 17 of Law 4819/2021).
- Carrying out **information and training actions**, as also provided for in the National Waste Management Plan (Council of Ministers' Acts Nos 39/31.8.2020 (Government Gazette, Series I, No 185) and 5/18.4.2023 (Government Gazette, Series I, No 94), in the National Programme for the Prevention of Material Waste (Council of Ministers Act No 11/29.4.2022 (GG I 83) and in Regional Waste Management Plans.

On actions for **less waste with more value**, the bathing will be strengthened:

- Development and implementation of **'Pay-as-you-throw'** (Pay-as-you-throw) systems (see Article 37 of Law 4819/2021). Please note that a guide has been drafted in the framework of LIFE IP CEI GREECE on the circular economy and is awaiting its adoption.
- Creation of **new EPR schemes** (referred to in national legislation as 'alternative management systems – TAs') for streams such as textiles, vehicle spare parts, photovoltaic panels, wind turbines, pesticide packaging, medicines, mattresses, furniture, fishing gear, tobacco products, balloons and wet wipes. The relevant framework has already been laid down for tobacco products, fishing gear, wet wipes and balloons (Articles 9-11 of Law 4736/2020), and for textile products, agricultural plastics, pharmaceutical products for home use, sleeping mattresses and furniture (Article 10 of Law 4819/2021). In addition, a support study has been prepared for systems on textile light products and mattresses, and specific directives for pesticide packaging and agricultural plastics are under preparation.
- Promotion of the **use of secondary (refuse) fuels** in energy-intensive industries, as well as the creation of a network of thermal treatment facilities for the energy use of municipal waste and waste streams, which have been regulated by law (Article 63 of Law 4819/2021) and described in the National Waste Management Plan of the ECHR 2020-2030 (Ministerial Council Acts No 39/31.8.2020 (Government Gazette, Series I, No) 185) and 5/18.4.2023 (GG I 94). To this end, a preliminary assessment study has been carried out for alternative thermal waste treatment technologies and/or secondary fuels and a feasibility study has been carried out to establish a network of municipal waste energy recovery units. In addition, a voluntary cooperation agreement between the Ministry of the Environment and Energy and the Hellenic Cement Industries Association

(July 2019) has been signed for the value of secondary fuels by the cement industry in the context of industrial cohabitation and the circular economy.

- **Intensification of checks at all stages of waste management**, including the installation of an electronic positioning system (GPS) on all means of transport of waste by road (Article 43 (2) and (3) of Law 4819/2021, and Ministerial Decision ΥΠΕΝ/ΔΔΑ/107482/1848/3.11.2022, GG II 5584). Specific obligations have also been established for the management of hazardous waste generated by health facilities (Article 43 (5) of Law 4819/2021) and it is mandatory for waste treatment facilities to have an environmental management system (Article 51 of Law 4819/2021).
- Implementation of a **framework governing environmental inspections** (Law 4843/2021, Government Gazette, Series I, No 193) and adoption of the Compliance Actions Model (Ministerial Decision ΝοΥΠΕΝ/ΓΔΣΕΕ/16675/165/21.2.2022, Government Gazette, Series II, No 776), on the basis of Presidential Decree 39/2023 (Government Gazette, Series I, No 92) on the establishment and maintenance of the Register of Environmental Policies, which also allows the use of skills of executives outside the narrow public sector.

The New Circular Economy Action Plan also includes a number of **horizontal actions**, such as:

- Actions on **single-use plastics** pursuant to Law 4736/2020 (Government Gazette, Series I, No 200), including prohibitions on the placing on the market of certain single-use plastic products. They are also implemented in cooperation with the Inter-Service Market Control Unit (DMEA) of the Ministry of Development, which is responsible for monitoring the implementation of the obligations for retail, domestic catering and catering businesses (Article 29 of Law 4994/2022, Government Gazette, Series I, No 215).
- Define a **policy framework** for a) education, training, lifelong learning and social innovation in circular economy sectors and b) promote circular innovation in research, innovation, digital arts. It should be noted that the policy framework for promoting the circular economy in research and innovation has been set out in the National Strategy for Smart Specialisation 2021-2027, adopted in June 2022, as the Circular Economy is a distinct priority area in this strategy.
- Single State Aid Action “Research, Creation-Innovation”. This is the **‘Research Innovation’ action** for the period 2021-2027, which focuses on circular economy interventions.
- **A multiannual financial plan for research infrastructures**, reflecting the country’s priorities for long-term investment in large scale research infrastructures with the Secretariat-General for Research and Innovation (GGEK) accelerating the Secretariat-General for Research and Innovation, is under revision.
- Action to promote the **creation of a non-toxic environment**, initiated in 2022, with a duration of 5 years and the active participation of bodies such as the API at the university, the Benaki Phytopathological Institute and the General Chemical State Laboratory.

Finally, as regards **specific actions** as a matter of priority, the new Action Plan also includes excavation, construction and demolition waste and water. In the **case of excavation**,

construction and demolition waste, provision is made for:

- **To enhance the efficiency** of the alternative management of CACs. Issues such as selective demolition, separate closure, requirements for maximum possible utilisation, etc. (Article 30 of Law 4819/2021, Government Gazette, Series I, No 129) have already been addressed. In addition, evaluation criteria have been laid down by the Hellenic Agency for Recovery, with a view to promoting the standardisation of the drafting of the operational plans of the relevant management systems. Rules have also been laid down for determining the financial consideration paid by these systems to the processing units of the EAC (Article 30 (6) of Law 4819/2021). For the integrity of weighing, these units must have certified weighing systems and, from 1.1.2023, all vehicles transporting waste from excavation, construction and demolition must carry GPS (Article 30 (9) of Law 4819/2021).
- The **development of markets for secondary materials** resulting from the processing of SCOs. Relevant elements are examined in the context of the revision of the national standard specifications for public works (ELOT/Ministry of Infrastructure and Transport). The use of recovered aggregates from waste treatment plants in public works shall also be promoted in implementation of the National Green Public Procurement Plan, by means of relevant specifications.

For **water**, funding is foreseen for proposals relating to:

- I. Interventions to **reduce wasteful water** at the distribution and consumption stage.
- II. **Water use efficiency** of economic activities with a significant footprint.
- III. **Waste water treatment projects** of priority C and D, and
- IV. **Reuse of water and sludge** of plants for the treatment of liquids from grains for **collection and use of rainwater**.

In particular, they will be supported;

- V. Wastewater treatment and access to high-quality drinking water projects and pilot holistic programmes are included in the Operational Programme Environment and Climate Change 2021-2027 (C (2022) 6045).
- VI. Water resource management interventions (such as waste water treatment, rainwater collection and utilisation, sludge management, RES desalination, effluent reuse of wastewater treatment plants, digitalisation/smart metering/leakage, water saving, connectivity with networks, public awareness, water saving actions, etc.) are included in the GR-eco Islands initiative.
- VII. Actions to reduce the losses of irrigation networks, modernise water and promote investments in water saving and reuse on agricultural holdings are contained in the 2023-2027 CAP National Strategic Plan.

3.1.7 Measures and policies for urban bio-climate regenerations and smart cities

Cities can play an important role in developing and implementing many climate change measures

and measures, as they are places where local actions, national and international climate change mitigation commitments meet. Urban and industrial areas in Greece have a significant share innational energy tankers and greenhouse gas emissions. Improvements in urban planning, traffic organisation and energy management at local level will therefore play a major role in reducing cities' energy consumption as well as their carbon footprint.

In addition, "smart and sustainable cities" models, integrating energytechnologies and using new advanced information technologies and challenges, will be one of the key pillars of the restructuring of theenergy sector. A 'smart' city by investing in applied good practicesthat have managed to reduce their energy footprint by changing the travel model by reducing the private car, prudent management of natural resources and supporting participatory governance at the same time enhances sustainable economic growth and improves living standards. The use of "smart" instruments at city level improves people's living conditions, attracts businesses and investments at local level and increases real estate values.

The interventions that reshape the city are smart meters and the externalnetworks that help change, help with the findings, lead to reallocation and decisions, enabling the large amounts ofinformation needed for their harmonious operation to be monitored and managed, and I greatlyassist in the rational use of energy in cities by endusers. Together with the new regulatory framework of the demand response mechanism and energy communities, the role of cities and citizens in the transition and ultimately in the restructuring of the energy sector is expected to be significantly promoted. The use of 'intelligent' applications isnow also intertwined with urban regenerations, with the main aim of improving the living standards of residents and the operating conditions of businesses.

Urban bio-climate regeneration is related to prudent management of media consumption, the use of cold or photocatalytic coating materials in public spaces, proper water management in public spaces, control of electricenergy consumption to illuminate shared spaces, the use of renewable energy sources in thecity (in private and public spaces), smart waste management, green ceilings; green walls, promoting the construction of low-energy and near-zero-energy buildings, promoting the upgrading of the blanks of building elements and installations of existing buildings (so as not to burden their surroundings and making them less energy-intensive), creating neighbourhoods with motorless indoor roads, measures and actions to reduce urban noise from transport (note that urban noise from transportcannot exceed max Lden; Lnight), implementing infrastructure for bicycles, pavements, increasing open public spaces, promoting sustainable mobility and parkingsystems, equippingpublic spaces with technological information applications and implementing liverawareness and environmental awakening of citizens. In addition, good urban and architectural bioclimate planning and the use of sustainable materials in bioclimate planning (cool materials, shading structures, vegetation)-are key prerequisites for the sustainable development of cities. Individual actions to strengthen urban green, such as the creationof green routes and urban green canyons with appropriate tree planting of roads, urban gaps, whitepublic spaces and squares, the protection and promotion of

streams, rivers, beaks and the regeneration of appendices, tributaries, lakeside and beach areas; as well as the use of modern cold materials and technologies that are highly reflective of solar radiation and lead to energy savings in the built environment, in particular the reduction of noise and waste in water consumption, are structural components of the sustainable development of cities and reduce thermal sizes and energy and carbon footprints, making an important contribution to mitigating climate impacts and improving the quality of life of citizens. Selecting dry-resistant plants with low green requirements and promoting water loop collection or recycling/water-use systems to meet their irrigation needs will help to respect them in the new conditions created by climate change.

Especially with regard to the serious saturation problems faced by cities as a result of the increase in the number of vehicles in circulation, there will be a need for brave changes in order for Greece to meet the European objective of reducing the use of the car, with much more traffic being undertaken by public transport, walking and walking. It is not underestimated that the three above modes of mobility are the pillars of sustainable mobility and their importance is not only energetic, but also social, economic and environmental. It is nowadays that, due to the hostile environment in narrow roads, trapping pollutants and noise, and very narrow pavements, people with disabilities and people affected have been excluded. For these, several public open spaces are no longer accessible. Serious difficulties also encounter elderly people and children and those who are ganging to walk, such as public transport users. It should also be noted that due to the absence of relevant infrastructure, the proportion of cyclists is negligible. Pending – a major project to improve public transport and promote its demand through traffic restrictions and reduce road width. This will widen the pavements and draw strips for the bicycle.

At the same time, public spaces, streets and squares will become more attractive for pedestrians and this will significantly boost the general economy of cities and visitor turnout. Lowering the fast threshold from 50 to 30 km/h will play a major role for sustainable mobility. This will form low-circulation beehives, i.e. socialisation hotspots that will help improve the quality of life and defeat residents in the face of the climate crisis. At the same time, the need for urban equipment for MMMs (e.g. shadows at stops), an increase in urban cannons, and an increase in water permeability and concomitant/filtration capacity of urban run-off will contribute to a safer movement of citizens in alternative ways during all more intense heatwaves and rainfall.

As part of a holistic approach, smart governance systems contribute to streamlining city management processes, promoting effective communication, cooperation and citizen engagement, ultimately enhancing the successful adoption of policies, measures and mechanisms at local level. The aim is to support the respective integrated actions with the active involvement of local actors, both public and private, and to integrate the above strengths into urban planning.

The implementation of energy efficiency improvement measures, which were included in the policy priorities for improving energy efficiency in the building and industry, including electricity

and gas infrastructure, also contributes to reducing greenhouse gas emissions and thus slowing down climate change. In addition, the production of heat and cold from CHP units and the promotion of combined district heating/cooling (e.g. 5GDHC) to meet the thermal and cooling needs of buildings, as well as the use of waste heat to produce electricity, leads to a reduction in greenhouse gas emissions due to reduced sale of petroleum products and other conventional fuels.

Given the ever-increasing tourist flows and the expansion of the tourist season, which increases and differentiates energy volumes, as well as the environmental and carbon footprint of the sector, emphasis will be placed on establishing rules for controlling and mitigating impacts. A detailed description of all policies and measures for the energy transition of the tourism sector are described in the sixth section of this chapter.

3.1.8 Measures and policies for industry

Decarbonising industry is a challenge, as it is responsible for a significant share of emissions. Moreover, some industrial activities (cement industry, oil refining, chemical industry) are classified as Hard-to-abate, i.e. there is no technologically easy way to mitigate and ultimately avoid GHG emissions, as GHG emissions are fully linked to the industrial process itself. Greece has an unfinished industry in at least two such sectors (cement and refining), and is also active in other similar sectors (fertilisers, plastics), and it cannot be excluded that new industrial activities may be developed or those already existing in the following period. In this context, the carbonisation of industry can be divided into two main sub-categories: decarbonising sub-sectors of industry that can be electrified and managing emissions from industrial sub-sectors classified as Hard-to-abate.

For the first sub-category, where there are mature technologies equivalent for the use of electricity instead of a fuel material, these will be progressively preferred, encouraged and incentivised. The evolution of GHG emission allowance prices will also contribute to the gradual transformation of many industrial processes into pure (or mostly) electrical emissions, as the ever-increasing emission costs will increasingly burden the final product, making it ultimately uncompetitive. Therefore, the electrification of industry will occur gradually when the capital cost of converting an existing plant with fuel into electricity (appropriately discounted) will be more than the unit GHG emission cost per unit of output produced over time.

Therefore, in terms of policy measures leading to electrification, the SEDE is a sufficient incentive, but in any case relevant initiatives should be taken by means of regulatory measures. On the other hand, there is no doubt that measures are needed to ensure the competitiveness of industry on this path, as both high electrification costs (CAPEX) and high electricity costs after electrification (OPEX) jeopardise the economic viability of the EU industry, especially in view of international competition with industries in countries with much less ambitious GHG emission

reduction policies. For the predictability of costs, bilateral contracts with renewable energy plants will be regulated.

It should be noted that the risk of carbon leakage has been identified at both EU and national level and relevant measures and policies are in place, both for direct emissions and indirect emissions. In particular, this second component, the mechanism for offsetting the costs of industry from indirect emissions, should receive even greater attention and attention at the pan-European level. This is because, in addition to an existential risk to the competitiveness of the EU economy, this is also a significant risk of undermining the global pre-sophistication of GHG emission reductions. This is because, as long as third countries retain a competitive advantage from the lack of abatement measures (such as the introduction of a carbon tax) and are rewarded for it (by attracting investment in new industrial plants and relocating existing ones from economies receiving such measures, such as the EU), global climate action will not only be accelerated but will, on the contrary, be lagging behind and regressive.

At this point, it is envisaged that measures to compensate for the competitive advantage already present, and will continue to provide growth, for products and raw materials produced outside the EU and by states that have not applied any form of carbon tax, will be important. In this context, the newly introduced Carbon Border Adjustment Mechanism (CBAM) or equivalent measures seek to eliminate this unfair advantage of products produced in third countries without incurring costs equivalent to those imposed by the ETS in the United Europe, providing European industry with the “vital space” to survive and grow. However, while the measure fails to respond to the competitiveness challenges of European industry within the limits of the Union, it does hardly address reduced competitiveness in third countries and markets, where ‘pure’-products (i.e. produced without GHG emissions) have an inherent cost disadvantage compared to those from third countries, which are produced without additional cost burdens. In addition, domestic legal intermediaries imported from European industries are burdened.

In this context, the European Union appears to have identified the risk of potential (some claiming, evolving) deindustrialisation due to increased costs associated (inter alia) with increased costs due to GHG reduction measures in place and is taking a number of measures and policies to halt and address it. European policies such as the Net-Zero Industry Act (NZIA) and the Critical Raw Materials Act (CRM), while targeting specific categories of bio engineering and raw materials (in particular those related to the transition to net zero as such), show projections linked to increased competitiveness. The same is true of the projections in a number of policy texts which propose the inclusion of criteria in competitive procedures that assess, inter alia, the carbon footprint of the products, materials or works to be selected and not only the non-price criteria in auctions. At the same time, the announcement by the newly elected President of the European Commission Ursula von der Leyen of a New Clean Industrial Deal within the first

100 days of her second mandate, with a particular focus on the competitiveness of the European Union industry, is optimistic. The new network of measures and policies under development at European level to maintain and strengthen the competitiveness of European industry as electrification and decarbonisation evolves, Greece will be supported by proposals and new measures during the formulation phase, and compatible national policies during the implementation phase.

Having identified the correlation between electrification and industrial coking and maintaining the competitiveness of the industry, Greece has proposed to the European Commission a policy measure for its energy-intensive industry, which would make it possible to incentivise the supply of clean energy from new RES, within a market context, by subsidising part of the shaping cost of RES's stochastic production profile in the stable demand profile of the energy-intensive industry. Although the European Commission has raised some objections in principle to this innovative policy measure (known as "Green Pool"), Greece continues to monitor developments in this very important policy area and is considering the design of a new proposal, or the redesign of the above existing one, so that it can achieve its intended decarbonisation objective while maintaining the competitiveness of industry, within the framework of the Union's empathy, in particular in the coming period.

Furthermore, for those industries or industrial processes that are not a solution, which means that CO₂ is still released from them, measures are taken to promote carbon Capture and Storage (CCS) technologies. Greece is already developing the first geological formation for long-term storage of CO₂ in (almost) depleted underwater oil deposits in Prino, Kavala. The development of this infrastructure is supported by the Recovery and Resilience Fund and it is estimated that it can, in full deployment, allow up to 3 million tonnes of CO₂ to be injected per year. At the same time, and with corresponding funding from the TAA, the Midstream is also being developed in the CCS value chain, with DESFA implementing a project to transport carbon dioxide from the EMITTERS industrial plant to the selected storage sites. In addition, the need to establish an aid scheme based on CfDs in relation to current ETS prices is being explored. In this regard, a comprehensive regulatory framework is being developed for the entire carbon capture, use and/or storage value chain (as a reform of the REPower EU Chapter of the National Recovery and Resilience Plan), in full compliance with EU legislation, to ensure the transparency, equality and legal certainty deemed necessary for the necessary investments to take place.

However, industrial developments are also significant, since the development of a domestic CO₂ warehouse has incentivised the main Greek industries that are based on hard to Abate industrial sectors (two refineries and two cement factories) to draw up investment plans for the capture of GHG emissions and long-term storage. Three of the four industries have already received substantial grants from the European Innovation Fund, while the fourth application is pending. The practical support of Greece in this sector, together with the direct reflections of industry, leads to the conviction that, by 2030, over 3 million tonnes of CO₂ will be permanently reserved

and stored in Greece by hard to Abate industrial sectors. Investment projects (costs at an early stage) for the use of captured CO₂ are also interesting, especially in relation to the creation of a new type of renewable fuels, for which it may become more detailed in a subsequent update of this document.

Finally, the development of CCS technologies and their possible extension to other areas beyond the above increase the need for more storage sites. Indeed, while dozens of new such carbon stores are currently being developed in northern Europe, there are few new projects in the Mediterranean and are insufficient to cover only a small part of the carbon emitted by industries that cannot mitigate their emissions. Greece therefore emphasises the identification of new geological formations deemed suitable for the permanent storage of CO₂, with the competent Greek authorities, on the one hand, the Hellenic Hydrocarbons and Energy Resources Management Company (EDEYEP) and, on the other hand, the Hellenic Authority for Geological and Metal Exploration (EAGME) carrying out the relevant surveys. Given that numerous geological formations are also found in third countries in the region, Greece will propose to reform the relevant framework at European level to allow the development of warehouses in non-EU Member States, naturally ensuring the necessary safety, environmental protection, monitoring and certification.

3.1.9 Policies and measures planned to phase out fossil fuel subsidies

Phasing out fossil fuel subsidies, in a fair, orderly manner and always taking care of the economically weakest and vulnerable ones, is essential to reduce greenhouse gas emissions, increase energy efficiency and promote renewable energy sources.

In this light, phasing out fossil fuels and replacing them with clean energy solutions – including direct electrification, renewables, energy efficiency and demand flexibility, energy storage, as well as societal changes that reduce energy demand – is the primary requirement to achieve our climate and fairness goals.

This adaptation is designed to be implemented in a well-managed and socially sound way, with a focus on the clean energy transition. This includes parallel pricing for fossil fuels based on market trends, managing the potential social and economic impacts of such a reform and using revenues to support social protection.

Mineral Fuel Subsidies

In general, there is no universally accepted definition of fossil fuel subsidies. According to the methodology used by EIGA⁸⁰, the fiscal impact of fossil fuel support measures in Greece was estimated at EUR 6.24 billion in 2022. 87 % of this amount was directed to final hairdressers and

⁸⁰ The Organisation for Economic Co-operation and Development (OECD) distinguishes seven types of subsidies in this area: (1) commercial tools such as ditches, (2) regulatory tools such as price control, (3) tax breaks for producers or consumers, (4) credits to producers, (5) direct transfer of funds aimed at reducing the final price or production costs, (6) participation in the risk of borrowing (guarantees) and (7) provision of government energy services at a price below cost.

12 % to businesses. Support was mainly provided in the form of direct subsidies (EUR 5.43 billion), representing 87 % of the total public finance costs of the support measures, while tax expenditure amounted to EUR 0.81 billion.

On the basis of the state budget, prepared by the Greek Ministry of National Legality and Finance, the largest budgetary cost came from subsidies on electricity consumption by households and businesses, with a total cost of EUR 9.1 billion.

It should be noted, however, that 2022 was the year of the Russian invasion of Ukraine, which triggered a price spike and forced the government to provide additional support due to the increase in energy prices in the country. During 2023, support to electricity prices for households and firms continued, but to a lesser extent than in 2022, as prices declassified.

As described in the NECP, electricity prices for the final consumer will decrease, while the need for subsidies will be limited through actions such as the balanced development of renewable energy sources (RES) by category, demand response to the hours of oversupply of RES, the cost containment of regulated tariffs and investments in energy storage systems. These actions will help secure stable and lower electricity prices, while at the same time strengthening the country's energy security and independence.

Two of the most significant budgetary expenditure that has been systematically implemented in Greece in recent years is the charges on electricity bills for 'public utilities' (SGI) for the non-interconnected islands and Crete, as well as the heating allowance. For these costs, although critical for energy accessibility, stabilising energy costs and ensuring energy efficiency, there is a phasing-out plan.

Charges on electricity bills for 'public utilities (SGI)'

The charges on the electricity bills for public utilities concerning, inter alia, the non-interconnected islands and Crete in Greece constitute an important intervention to support electricity supply in the island regions of Greece. The tariffs are imposed in order to supply electricity to consumers on the non-interconnected islands at the same prices as those of mainland consumers, despite the fact that the electricity production costs on the islands are much higher. The PSO covers the additional costs of producing electricity in these areas, where the electricity supply is based on diesel or fuel oil generators and therefore have increased production costs. The cost of this subsidy for the year 2023 was approximately EUR 539.1 million (the part of the SGI relating to the non-interconnected islands and to Crete which is partially connected).

The Hellenic Electricity Distribution Network Operator (EDDIE) has been appointed by the State as manager of the special public utilities account, which is the revenue from the related charges. In addition, the Regulatory Authority for Waste, Energy and Water (RAAEY) has a supervisory and regulatory role in matters relating to public utilities, ensuring that the measures taken are effective and in accordance with the legislative framework.

Although, according to the OECD, these subsidies are considered to be fossil fuel subsidies, the term “insularity subsidy” is proposed to be more precise. The per-capita for these subsidies will be abolished upon completion of the interconnections between the islands and the continental electricity network, which are expected to be completed by the end of this decade. An immediate significant reduction will occur with the completion of ongoing electricity interconnection projects, such as the one on Crete and the Cyclades Interconnection Phase D. For Crete in particular, its electrical interconnection with the continental system is expected to be completed at the end of 2024 with the beginning of 2025 and to be fully operational in 2026. In 2024, the part of the SGI charges corresponding to Crete is estimated at around EUR 350 million, which is expected to be saved on an annual basis with the completion of the island’s major interconnection.

Finally, the interconnections described above will allow the supply of energy from more efficient and environmentally friendly sources, reducing costs and CO₂ transmitters. This creates the necessary infrastructure to realise the significant potential of renewable energy sources on the islands.

Heating allowance

The heating subsidy in Greece is a necessary benefit, especially during the winter months, to ensure that households can maintain a decent level of heating. The rationale behind this subsidy is to support citizens, and in particular financially vulnerable households, who cannot afford to afford heating, especially in areas with low heating costs.

According to data from the Ministry of Economic Affairs and Finance, a total of EUR 269.2 million was granted in 2022 as a heating allowance, mainly to the primary consumers of heating oil, natural gas and other subsidised forms of fuel. The payment of the heating allowance was reduced to EUR 237 million for the winter period 2023-2024.

However, the heating allowance since 2024 is not only limited to oil and gas, but also extended to subsidies for electric heating. This strategy aims to reshape the framework for heating subsidies, making it more environmentally friendly and economically viable. For the first quarter of 2024, there was payment of a heating allowance to about 400,000 households using electricity as a means, with a total cost of EUR 38 million.

Under the NECP, Greece plans to gradually reduce fossil fuel subsidies and increase support for clean and efficient heating technologies.

With this approach, the heating allowance will continue to support vulnerable households, while promoting the use of green and sustainable sources of energy, aligning the country’s policy with the European objectives for key change and energy transition and meeting the requirements of the Employment Committee and Social Protection Committee recommendation. Finally, it is planned to expand programmes for the incremental upgrading of vulnerable households, in parallel with the use of green and sustainable energy sources, to improve the energy efficiency

of their homes. This will reduce the need for heating and cooling, thus reducing dependence on heating and cooling allowances. A key component of this design is the electrification of the household heating and cooling sector, promoting heat pumps.

3.1.10 Assessing the climate vulnerability of greenhouse gas policies and mitigation measures

amalgamation

Climate change is negatively affecting the operation of lignite-fired power stations. The reduction of rainfall and the increase in the intensity and duration of heatwaves and droughts are expected to cause interruptions in operation due to reduced positive water resources for cooling or the risk of exceeding the maximum temperature limit for the water recipient to which their cooling water is supplied. High temperatures are also expected to cause a decline in lignite-fired power stations' efficiency. ⁸¹

The withdrawal of lignite plants and their replacement with solar and wind energy systems (70 % of net electricity production in 2030 and 91 % in 2050), the operation of which is not affected by the availability of water resources, is therefore expected to reduce the vulnerability of the energy system to climate change.

The agricultural and tourism sectors, two most climate-sensitive sectors, are at the same time key pillars of the Fair Development Based Plans. Climate change is expected to have negative impacts on the agricultural sector and tourism, but at the same time it may create opportunities for new artists, expand the tourism season and develop alternative forms of tourism. A review of the Just Development Transition Plans in relation to the relevant Perspective Contingent Plans for Adaptation to Climate Change could contribute to improving their effectiveness.

decarbonisation of islands

The reduction in annual rainfall caused by climate change and the increase in the duration of drought periods are expected to cause further pressures on the islands' water resources, reducing the availability of water for the operation of fibre-brick stations and the production of green hydrogen.

In addition, the reduced availability of water resources is expected to increase the needs for desalination and thus the demand for energy. Summer energy demand is expected to increase further due to the projected increase in cooling scoring parts ⁸². Changes in demand will lead to very high peak loads during heatwaves, testing the electricity system.

Completing the interconnection of islands, developing storage systems, taking measures to

⁸¹ European Environment Agency, Adaptation challenges and opportunities for the European energy system – Building a climate-resilient low-carbon energy system, Publications Office, 2019, <https://data.europa.eu/doi/10.2800/227321>.

⁸² European Climate Data Explorer – Cooling Degree Days: <https://climate-adapt.eea.europa.eu/en/metadata/indicators/cooling-degree-days>.

rationalise energy consumption in homes and businesses, are expected to mitigate the effects of increasing energy demand, but for the effective transition of the Greek islands to climate neutrality, increased energy needs and more generally the effects of climate change should be taken into account in planning in a systematic manner.

The first phase of the implementation of the GRECO Islands initiative of the NSRF 2021-2027 has already started and the climate adaptation dimension has been integrated into the relevant documents and processes. Climate resilience/vulnerability was one of the criteria for the selection of islands, to be funded as a matter of priority, while climate risks and pressures on natural resources (e.g. water resources) are taken into account when assessing the status quo against the objectives of the GRECO Islands' primacy.

transport sector

Urban sustainable and active mobility

Outdoor climatic conditions also influence people's choice of travel. Increasing average temperatures and minimum winter temperatures in general favour the use of alternative modes of travel, but increased intensity and frequency of weather events (heatwaves, urban floods, unburnt concentration of African dust, etc.) can act as a deterrent.^{80, 83 84}

Climate change may therefore to some extent undermine efforts to promote urban sustainable and active mobility⁸⁵ and reduce greenhouse gas emissions. Measures to improve thermal comfort conditions in urban space, which is further detailed in sub-section '3.1.7 Measures and policies for urban bio-climatic regenerations and smart cities', should help mitigate the related impacts of climate change.

Electrification of transport

Climate change is not expected to affect transport electrification plans. Possible impacts are related to the safety and adequacy of the electric energy system, in particular during increased intensity and duration of extreme weather events, as well as the specifications for the proper functioning of the relevant infrastructure (e.g. charging infrastructure) in the new climate conditions, and discussed in chapter "3.5 Meters and energy security policies".

Uptake of zero-greenhouse gas emission fuels

Climate change may affect efforts to increase the uptake of hydrogen and bio-based fuels in transport. As I have already said, the possibility of producing hydrogen may be affected by a reduction in the availability of water resources, while bio-based biofuel production is acceptable

⁸³ Gössling, S., Neger, C., Steiger, R. et al. Weather, climate change, and transport: a review. *NAT Hazards* 118, 1341 – 1360 (2023). <https://doi.org/10.1007/s11069-023-06054-2>.

⁸⁴ Andrew M. Fraser, Mikhail V. Chester, Transit system design and vulnerability of riders to heat, *Journal of Transport Health*, Volume 4, 2017, Pages 216-225, ISSN 2214-1405, <https://doi.org/10.1016/j.jth.2016.07.005>.

⁸⁵ Konsta, D., Panagopoulou, G., Kyriakopoulos, G. L., Methenitis, K., Grigoriadou, E., Voudou, A., Asimakopoulos, D., Setz, I. (2024) LIFE-IP AdaptInGR – Boosting the implementation of adaptation policy across Greece. Action Deliverable C.5 Analysis of synergies and synergies between the 2050 Long-term Strategy and the National Strategy for Adaptation to Climate Change covering all economic sectors and exploring the impacts of climate change and synergies with adaptation measures.

to be affected by the projected reduction in yields of agricultural and limestone crops and the limitation of energy plantation crops⁸⁶. The impact of the scale of change on hydrogen and biofuel production is analysed in detail in ‘3.2 Renewable Energy Measures and Policies’ and ‘3.3 Policies and Measures on alternative and climate-neutral gaseous and liquid fuels’.

Temporary interruption in the provision of transport and transport services

Climate change may temporarily affect the achievement of targets to reduce greenhouse gas emissions from transport, in cases where low greenhouse gas emission modes of transport are stopped and their transport operations are temporarily taken over by means of transport with high greenhouse gas emissions. One example is the closure of the rail network for 3,5 months as a result of the catastrophes caused by the bad weather of Daniel (September 2023) and its replacement in passenger and transport work by means of transport using fossil fuels (e.g. passenger cars, buses, trucks). The implementation of Directive (EU) 2022/2557 on the resilience of critical entities and Article 18 of the National Climate Law on strengthening the climate change dimension in environmental licensing should help to shield transport infrastructure from climate risks.



agricultural sector

Agricultural crop emissions

Climate change is projected to lead to a reduction in annual rainfall and a sharp increase in the duration of droughts, negatively affecting agricultural crop productivity. As part of the effort to maintain productivity, dry crops may be transformed into irrigated crops. In Mediterranean arid systems irrigated areas receive significant inputs of nitrates and water, resulting in significantly higher emissions of N₂O than dry matter, depending on the type of fertilisation used and the irrigation system. Therefore, the increase in the total irrigated area is likely to lead to an increase in total emissions of N₂O from agricultural sectors^{87,88}.

Strengthening dry-resilient agricultural crops and promoting rational and efficient irrigation and smart agriculture under the National Strategic ECT for the CFP 2023-2027 and the National Strategy and Regional Plans for Adaptation to Climate Change (see Section 3.8), are expected to help contain the associated greenhouse gas emissions.

Livestock

Climate change is expected to have a negative impact on livestock as well. The increase in

⁸⁶ Drobinski P, Azzopardi B, Ben Janet Allal H, Bouchet V, Civel E, Creti A, Duic N, Fylaktos N, Mutale J, Pariente-David S, Ravetz J, Taliotis C, Vautard R 2020 Energy transition in the Mediterranean. In: Climate and Environmental Change in the Mediterranean Basin -Current Situation and Risks for the Future. First Mediterranean Assessment Report (Cramer W, Guiot J, Marini K (eds.)) Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 58pp, in press.

⁸⁷ MedECC (2020) Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report (Cramer, W., Guiot, J., Marini, K. (eds.)). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 632 pp., ISBN: 978-2-9577416-0-1, doi: 10.5281/zenodo.4768833.

⁸⁸ E. Karalis, I. Tsalacianidou, 2024. Analysis of the current situation for the adaptation of the Georgian sector and the climate change economy. Deliverable A1.D1 of LIFE-IP AdaptInGR (code: LIFE17 IPC/GR/000006).

temperature affects the biological processes of the animals by reducing their robustness. Climate change is also expected to negatively affect the feeding of feed and the vegetation of grasslands and pastures. The effects will be more pronounced in extensive livestock farming systems, as intensive systems can adapt more easily, regulating indoor climatic conditions in livestock installations⁸⁵. 89

However, livestock farming, and in particular intensive livestock farming systems, are influenced not only by local climatic conditions, but also by the prices of feed and trade prices for milk products and meat at international level. In this context, European herd and sheep and goat farming is expected to be restricted in terms of number of animals and production, mainly due to the climate change in the decline in grassland and the production of grass maize. On the contrary, it is expected that European pig and poultry farming will benefit from the best prices of the corresponding feed and will be strengthened. 90

Therefore, based on the studies so far at EU level, climate change is expected to result in reduced emissions from livestock.



LULUCF sector

Forest land and grassland

Climate change is expected to cause long-term changes in the boundaries of Atlantic forests and grassland, shifting them to higher altitudes and latitudes, changing forest species, tree death, increasing insect infestations and invasions by alien species. The impacts of climate change are already being felt by increasing the frequency and intensity of forest fires, which can lead to forest and forest land degradation, reducing their CO₂ absorption capacity. In the case of widespread fires, greenhouse gas emissions may exceed the corresponding removals in those years. It is indicative that the EU's forest carbon sinks have decreased over the past decade, mainly due to the above unfavourable and indirect effects of climate change, while in some cases forest land has been converted, at least temporarily, into CO₂ sources. 88; 91 92

Greece's sustainable forest land and grassland management model, together with the strengthening of prevention and restoration policies and measures against biotic and abiotic threats (fires, pathogens, floodplains and other catastrophic events and causes of degradation

⁸⁸ Katsoul P., Birzelis I., 2019, Climate Change and Animal Production, Periodic edition of the Agricultural University of Athens 'Tripous-Lemos', Issue 45, p. 8.

⁹⁰ J.C. Ciscar, D. Ibarreta, A. Soria, A. Dosio, A. Toreti, A. Ceglar, D. Fumagalli, F. Dentener, R. Lecerf, A. Zucchini, L. Panarello, S. Niemeyer, I. Pérez-Domínguez, T. Fellmann, A. Kitous, J. Després, A. Christodoulou, H. Demirel, L. Alfieri, F. Dottori, M.I. Voudoukas, L. Mentaschi, E. Voukouvalas, C. Cammalleri, P. Barbosa, F. Micale, J.V. Vogt, J.I. Barredo, G. Caudullo, A. Mauri, D. de Rigo, G. Libertà, T. Houston Durrant, T. Artés Vivancos, J. San-Miguel-Ayán, S.N. Gosling, J. Zaherpour, A. De Roo, B. Bisselink, J. Bernhard, L. Bianchi, M. Rozsai, W. Szewczyk, I. Mongelli and L. Feyen, Climate impacts in Europe: Final report of the JRC PESETA III project, EUR 29427 EN, Publications Office of the European Union, Luxembourg, 2018, ISBN 978-92-79-97218-8, doi: 10.2760/93257, JRC112769.

⁹¹ E. Karalis, I. Tsalakanidou, 2024, Analysis of the current situation in order to adapt the forestry sector to climate change. Deliverable A1.D1 of LIFE-IP AdaptInGR (code: LIFE17 IPC/GR/000006).

⁹² EEA (2024). European Climate Risk Assessment. Executive Summary. EEA Report No 1/202: <https://www.eea.europa.eu/publications/european-climate-risk-assessment>.

such as soil erosion) contributes to adapting them to climate change and maintaining their capacity to absorb greenhouse gases. Implementation of the relevant measures of the National Forest Strategy, the National Strategy and the Biodiversity Action Plan and the National Strategy and Regional Plan for Adaptation to Climate Change (see section 3.8), and the gradual integration of the climate adaptation dimension in the technical specifications of their management and protection plans, will also contribute to the implementation of forest land and grassland. In addition, strengthening the political leadership mechanism and improving its equipment and logistical infrastructure through the National Recovery and Resilience Plan Greece 2.0 and the Civil Protection Operational Programme 2021-2027 should contribute to improving the prevention and preparedness of forest fires and reducing their extent. 93 94

The inventory and monitoring system for forest land and grassland to be completed should provide valuable insights into the impact of climate change on the extent, their characteristics and greenhouse gas absorption capacity and in the future support more effective policies and concrete measures to adapt them.

Cropland

Climate change is expected to cause significant changes also in cropland. The increase in temperature and vegetation will have a positive impact on the productivity and growth rate of crops, while, on the contrary, a reduction in annual rainfall, an increase in the length of dry seasons and an increase in susceptibility and disease risks are expected to have a negative impact, especially in combination with heatwaves and rapid rainfall, which for EL is expected to be more frequent in the coming years. The type, sign and intensity of the effects of climate change depends on the type of crop and is highly geographically diverse. Climate change is also expected to indirectly affect agricultural crops, causing an increase in the risk of erosion, brining, salinisation and desertification of soil resources.^{91; 95}

Climate change is projected to cause a further reduction in organic matter in Mediterranean soils, and thus in soil organic carbon and its carbon storage capacity, a trend which will also be enhanced by the increase in erosion and soil degradation caused by climate change.^{96 97 98 95}

It is clear that climate change will lead to a major restructuring of farmers and thus changes in the

⁹³ E. Karalis, I. Tsalacianidou (2024). Analysis of the status quo to adapt the forestry sector to climate change. Deliverable A1.D1 of LIFE-IP AdaptInGR (code: LIFE17 IPC/GR/000006).

⁹⁴ E. Karalis, I. Tsalacianidou, 2024. Analysis of the current situation for the adaptation of the Georgian sector and the climate change economy. Deliverable A1.D1 of LIFE-IP AdaptInGR (code: LIFE17 IPC/GR/000006).

⁹⁵ Tsadilas, C.D. Impact of Climate Change on the Primary Agricultural Sector of Greece: Adaptation Policies and Measures. *Earth* 2023, 4, 758-775. [TTPs:// doi.org/10.3390/earth4040041](https://doi.org/10.3390/earth4040041).

⁹⁶ MedECC (2020) Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report (Cramer, W., Guiot, J., Marini, K. (eds.)). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 632 pp., ISBN: 978-2-9577416-0-1, doi: 10.5281/zenodo.4768833.

⁹⁷ Andrés, P., Doblas-Miranda, E., Rovira, P., Bonmatí, A., Ribas, Maria, Mattana, S., Romanyà, J. (2022) Research for AGRI Committee – Agricultural potential in carbon sequestration-Humus content of land used for agriculture and CO₂ storage. European Parliament, Policy Department for Structural and Cohesion Policies, Brussels. [https://www.europarl.europa.eu/thinktank/en/document/IPOL_STU\(2022\)_699655](https://www.europarl.europa.eu/thinktank/en/document/IPOL_STU(2022)_699655).

⁹⁸ Note: Soil is one of the carbon sinks of all land use categories of the LULUCF sector, in which in addition to wetlands it also concerns forest land, grassland and cropland.

vegetation cover and land use. However, since agricultural crops, unlike forest land and grassland, are essentially anthropogenic rather than natural activity, influenced by societal-economic factors such as changes in dietary habits, the demand for industrial and energy crops, and the volatility of the prices of agricultural crops at international level, it is difficult to predict the future structure of straw and the potential change in their capacity to store carbon in woody biomass and soil.

The use of geospatial data to calculate the areas per crop type and to monitor the evolution of these areas, as part of the LULUCF inventory of emissions and removals, will contribute to early detection of relevant trends and appropriate adaptation measures.

Wetlands

Climate change is expected to also affect wetland and marine eco-systems that play an important role in the carbon cycle and are still planned to be part of the LULUCF emissions and removals inventory. Changes in the hydrological cycle, in particular the increase in the duration and intensity of periods of drought and the increase in temperature and subsequent evaporative-vapours, may lead to a reduction in the area and even the drying of some wetlands. In the case of coastal wetlands, rising average sea levels and increasing coastal erosion will be additional sources of risk. Projections are even more bleak in the case of *Posidonia* marine meadows, which may lose up to 75 % of their habitats in the Mediterranean according to the most adverse climate scenarios. 99

The implementation of the measures of the National Strategy and Regional Plans for Adaptation to Climate Change for soil resources, coastal zone, biodiversity and ecosystems (see section 3.8) should help prevent soil erosion and desertification and preserve wetlands and grasslands. The extension of pre-existing regimes such as the creation of new marine protected areas also contributes to this.

Reducing the vulnerability of land

As already presented in subsection 3.1.3, a number of measures are being implemented or planned to help increase CO₂ removals from the LU- LUCF sector. At the same time, these measures contribute both to reducing the vulnerability of the land to the most acute and frequent natural disturbances caused by climate change and to reducing the vulnerability of the land to ecosystem disturbances caused by climate change.

In addition to these measures are those taken under other policies (such as water management and the protection of ecosystems), which will also contribute to increasing the resilience of the land. These measures wear different land use categories (see Forests: D, Lowlands: X, arable land: K, Wetlands: (H) and are summarised as follows:

⁹⁹ MedECC (2020) Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report (Cramer, W., Guiot, J., Marini, K. (eds.)). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 632 pp., ISBN: 978-2-9577416-0-1, doi: 10.5281/zenodo.4768833.

1. Fire protection, such as antiNERO programmes, fire prevention studies, vegetation cleanings, improvement and maintenance of forest roads and fire belts.
2. Pathogen monitoring system (Ministry of Rural Development and Food) – Surveys (DR).
3. Flood prevention projects – Revision of flood management plans (All CATEGORIES of land use).
4. Monitoring of water resources (M).
5. Grazing management plans (planned) (X).
6. Preparation of specific environmental studies and management plans for protected areas (D/X/Y).
7. Supervision projects at national level and individual actions of units for the management of areas in the regions (C/S).
8. Forest and forest area inventory and monitoring system to meet the country's obligations and formulate a strategy for climate change pre-adaptation and mitigation (N/A).
9. Framework for Priority Actions for the Natura 2000 2021-2027 Network (D/X/Y).
10. Measures of the Common Agricultural Policy Strategic Plan for the improvement of agroforestry ecosystems, soil protection against erosion and afforestation of agricultural land (D/C).

A detailed description of adaptation measures for the forestry, eco-systems and agriculture sectors are included in the respective sectoral analyses of the LIFE-IP AdaptInGR project, coordinated by the RIS.

waste management

Waste management facilities

The increase in temperature is expected to affect the rate of decomposition of organic waste at collection points and sorting plants, while the increase in the intensity and duration of heatwaves and droughts is expected to create ideal conditions for the ignition of waste and residues collected for burial in landfill and landfill facilities, leading to an increase in greenhouse gas emissions. ^(97, 100 101)

The above risks can easily be prevented by better organising the collection and sorting of organic waste and by taking measures to reduce the risk of fire and fire expansion in landfill/landfill facilities, on the planet and by applying Article 18 of the National Climate Law (Law 4936/2022, GG I 105).

¹⁰⁰ Konsta, D., Panagopoulou, G., Kyriakopoulos, G. L., Methenitis, K., Grigoriadou, E., Voudouli, A., Asimakopoulos, D., Setz, I. (2024) LIFE-IP AdaptInGR – Boosting the implementation of adaptation policy across Greece. Action Deliverable C.5 Analysis of synergies and synergies between the 2050 Long-term Strategy and the National Strategy for Adaptation to Climate Change covering all economic sectors and exploring the impacts of climate change and synergies with adaptation measures.

¹⁰¹ Ministry of Development and Investment (2022), Temporary Framework for assessing the climate resilience of infrastructure projects submitted for co-financing to NSRF programmes 2021-2027 – Examples of urban solid waste management projects. <https://adaptivegreecehub.gr/eleghos-klimatikis-anthektikotitas/>.

Synergies with other NECP policies and measures

In addition, measures and policies to reduce greenhouse gas emissions from the waste sector are expected to contribute to reducing the climate vulnerability of the policies and measures of the NECP to produce bioenergy and enhance removals in the LULUCF sector.

Indeed, strengthening the systems of separate collection of biowaste for anaerobic treatment for biogas/biomethane production and for the production of naphthalic fuels can compensate for the projected reduction in the area and yield of energy crops and in the production of residual forest and agricultural biomass for bioenergy production. The use of compost produced as a by-product of the anaerobic treatment of agricultural waste, as an e-doping agent, can contribute to an increase in soil organic matter, which plays an important role in the carbon cycle, increasing the soil's organic stock and its carbon storage capacity⁹⁹. 102 103

Food waste prevention policies can also compensate for a decline in the productivity of food crops by alleviating the pressures to increase irrigated crops (linked to an increase in N₂O-transmitters) and to reduce energy crop areas.

circular economy

Circular economy measures and policies are not expected to be affected by key change. However, as with policies and measures in the waste sector, they are expected to contribute to reducing the climate vulnerability of other policies and measures in the NECP. For example, policies to increase the use of municipal residues to meet the energy needs of industry, and policies for the use of biogas produced in waste water treatment plants for the production of methane, compensate to some extent for the decline in production of forest and agricultural biomass caused by climate change.

Also, policies and measures to increase the reuse of effluent water of wastewater treatment plants, the collection and use of rainwater, and the reduction of losses of hydraulic networks contribute to improving the availability of water resources to further increase hydropower and pumped storage capacity, as well as the development of green hydrogen production and the extraction of critical mineral raw materials.

urban bio-climatic regenerations and smart cities

Urban replacements

Greek cities have a high intensity of activity, dense and high construction, toughness of asphalts,

¹⁰² MedECC (2020) Climate and Environmental Change in the Mediterranean Basin – Current Situation and Risks for the Future. First Mediterranean Assessment Report (Cramer, W., Guiot, J., Marini, K. (eds.)). Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 632 pp., ISBN: 978-2-9577416-0-1, doi: 10.5281/zenodo.4768833.

¹⁰³ European Environment Agency, Climate change adaptation in the agriculture sector in Europe, Publications Office, 2019, <https://data.europa.eu/doi/10.2800/537176>.

high car traffic, low green density and more generally a limitation of the natural environment¹⁰⁴. It is indicative that the number of large Greek cities has a particularly low proportion of sinoon spaces (EUR 10 m² per inhabitant) compared to the other European cities, in particular Thessaloniki, Heraklion and Volos (EUR 5 m² per inhabitant)¹⁰⁵¹⁰⁶.

These factors weigh heavily on the microclimate in large cities and contribute to the emergence of the urban thermal island effect¹⁰³.¹⁰⁷ The intensity of the phenomenon in Athens was already 7-8°C during the summer, at the end of the previous Avia¹⁰⁸, and more recent research shows a further increase in the urban heat island phenomenon during the extreme heatwaves^{106, 107}.

Consequently, the increase in the number of days with high temperatures and in the number of tropical nights of¹⁰⁸ caused by climate change¹⁰⁹ ¹¹⁰ ¹¹¹ ¹¹² is expected to increase the phenomenon, affecting heating needs and, above all, cooling needs and related greenhouse gas emissions. Thermal comfort conditions vary widely within the urban fabric and depend both on factors such as building density and on factors such as the presence of vulnerable populations (e.g. elderly people, children, low-income households)¹¹³.

Urban bioclimatic regeneration measures, good urban planning and architectural planning and actions to strengthen urban green and gas corridors included in the NECP help to improve the urban thermal environment and reduce the urban heat island phenomenon, thereby reducing cooling. However, given the high cost and the long time horizon for the completion of the relevant actions, it is necessary to prioritise them on a spatial basis and to combine them with actions to upgrade the building stock and tackle energy poverty.¹¹⁴

Priority should be given to refurbishments and building energy upgrades/renovations in “thermally burdened urban areas” (e.g. on the basis of thermal dust) and areas where the

¹⁰⁴ https://www.adapt2climate.gr/wp-content/uploads/2023/03/Adapt2CC_Deliverable_1.1.1_v1.0.pdf.

¹⁰⁵ European Environment Agency, Kalmierczak, A., Unequal exposure and unequal impacts – Social vulnerability to air pollution, noise and extreme temperatures in Europe, Publications Office, 2018, <https://data.europa.eu/doi/10.2800/324183>.

¹⁰⁶ Agathangelidis I, Cartalis C, Santamouris M. Urban Morphological Controls on Surface Thermal Dynamics: A Comparative Assessment of Major European Cities with a Focus on Athens, Greece. CLIMATE. 2020; 8 (11): 131. <https://doi.org/10.3390/cli8110131>.

¹⁰⁷ Kolokotsa D, Lilli K, Gobakis K, Mavrigiannaki A, Haddad S, Garshasbi S, Mohajer HRH, Paolini R, Vasilakopoulou K, Bartesaghi C, et al. Analysing the Impact of Urban Planning and Building typologies in Urban Heat Island Mitigation. Buildings. 2022; 12 (5): 537. <https://doi.org/10.3390/buildings12050537>.

¹⁰⁸ Kapsomenakis J., Kolokotsa D., Nikolaou T., Santamouris M., d, Zerefos S.C.. Forty years increase of the air ambient temperature in Greece: The impact on buildings. *Energy Conversion and Management* 74 (2013) 353 – 365.

¹⁰⁹ Founda, D., Santamouris, M. Synergies between Urban Heat Island and Heat Waves in Athens (Greece), during an extremely hot summer (2012). SCI Rep 7, 10973 (2017). <https://doi.org/10.1038/s41598-017-11407-6>.

¹¹⁰ Roukounakis N, Varotsos KV, Katsanos D, Lemesios I, GIANNAKOPOULOS C, Retalis A. High Resolution WRF Modelling of Extreme Heat Events and Mapping of the Urban Heat Island Characteristics in Athens, Greece. Sustainability. 2023; 15 (23): 16509. <https://doi.org/10.3390/su152316509>.

¹¹¹ RIS geospatial information portal. ‘LIFE-IP AdaptInGR project. Change in the number of Very Heating Days per Year in the Near and Outer Future: <https://mapsportal.ypen.gr/maps/967>.

¹¹² RIS geospatial information portal. ‘LIFE-IP AdaptInGR project. Change in the number of tropical nails per year in the Near and Outer Future: <https://mapsportal.ypen.gr/maps/937>.

¹¹³ European Environment Agency, Kalmierczak, A., Urban adaptation in Europe – How cities and towns respond to climate change, Publications Office of the European Union, 2020, <https://data.europa.eu/doi/10.2800/324620>.

¹¹⁴ Konsta, D., Panagopoulou, G., Kyriakopoulos, G. L., Methenitis, K., Grigoriadou, E., Voudoui. A., Asimakopoulos, D., Setz, I. (2024) LIFE-IP AdaptInGR – Boosting the implementation of adaptation policy across Greece. Action Deliverable C.5 Analysis of synergies and synergies between the 2050 Long-term Strategy and the National Strategy for Adaptation to Climate Change covering all economic sectors and exploring the impacts of climate change and synergies with adaptation measures.

building potential is of low thermal profile and there is an increased risk of energy poverty.

Smart cities

Smart meters and grids also contribute to better demand management and grid adequacy and stability to cope with increased cooling volumes. The promotion of CHP and combined district heating and cooling networks (e.g. 5GDHC), in particular through the complete withdrawal of air-conditioning equipment and heat pumps enclosing or operating with high GWP fluorinated greenhouse gases, contributes to meeting the increasing climate change cooling needs by avoiding the same maladaptation.

Sustainable urban mobility

Outdoor climatic conditions also influence people's choice of travel. Increasing average temperatures and minimum winter temperatures in general favour the use of alternative modes of travel, but increased intensity and frequency of weather events (heatwaves, urban floods, unburnt concentration of African dust, etc.) can act as a deterrent.¹¹² 115 116

The improvement of the urban thermal environment and the recession of the urban heat island as a result of the implementation of the above measures in the NECP contribute to the creation of appropriate conditions for the use of alternative movement measures during high temperatures. Improved urban equipment (shadow, comfort points, public canyons, etc.) also contributes to this.

Also, increasing the water permeability and the ability to retain/filtrate the flow contributes to a safer movement of citizens in alternative ways during heavy rainfall.

3.1.11 Summary of measures and policies for the GHG emissions reduction dimension

Table 16 summarises the policy measures planned to reduce greenhouse gas emissions.

¹¹⁵ Gössling, S., Neger, C., Steiger, R. et al. Weather, climate change, and transport: a review. *NAT Hazards* 118, 1341 – 1360 (2023). <https://doi.org/10.1007/s11069-023-06054-2>.

¹¹⁶ Andrew M. Fraser, Mikhail V. Chester, Transit system design and vulnerability of riders to heat, *Journal of Transport Health*, Volume 4, 2017, Pages 216-225, ISSN 2214-1405, <https://doi.org/10.1016/j.jth.2016.07.005>.

Table 16 Policy measures for the GHG emission reduction dimension.

Numbering	Policy measure name	Correlation with policy priorities	Target	Sector affected	Category of Measure
M1	Withdrawal of lignite-fired power plants	PP1.1	Reduction of GHG emissions	Electricity generation	Regulatory, Technical Measure
M2	Removal of electricity from ocean fuels on the islands, through interlinking of autonomous island systems and development of hybrid systems	FP1.1, FP1.2, FP2.3	Reduction of GHG emissions	Electricity generation	Regulatory, Technical Measure
M3	Promotion of RES, storage systems and RES fuel production	FP1.1, FP1.2, FP2.1, FP2.2, FP2.3	Non-ETS GHG emissions reduction	Electricity generation Heating – Cooling transport sector	Regulatory, Technical, Economic Measure
M4	Reducing the quantities of biodegradable waste	FP1.6, FP1.7	Non-ETS GHG emissions reduction	Total final energy consumption sectors	Regulatory, Technical, Economic Measure
M5	Improving energy efficiency in buildings, industry and infrastructure	FP1.1, FP1.2, FP1.8	Non-ETS GHG emissions reduction	Total final energy consumption sectors	Regulatory, Technical, Economic Measure
M6	Incentivising the acquisition and use of a fleet of light vehicles (passenger cars, taxis and light vans)	PP1.3	Reduction of the pass on the part of the times	Light road transport	Financial measure
M7	Electrification of the L-type vehicle fleet	PP1.3	Reduction of the pass on the part of the times	Urban mobility – micro-mobility	Economy/ Regulatory measure

Numbering	Policy measure name	Correlation with policy priorities	Target	Sector affected	Category of Measure
M8	Introduction of disincentives for the use of conventional vehicle fleets	PP1.3	Reduction of the pass on the part of the times	Light road transport	Regulatory
M9	Putting in place measures to decarbonise the supply chain	PP1.3	Reduction of the pass on the part of the times	Light/heavy road transport	Economy/ Regulatory measure
M10	Incentivising the scrapping of old polluting conventional vehicles	PP1.3	Reduction of the pass on the part of the times	Light/heavy road transport	Economy/ Regulatory measure
M11	Adoption of measures to decarbonise heavy-duty vehicles	PP1.3	Reduction of the pass on the part of the times	Heavy road transport	Economy/ Regulatory measure
M12	Incentivising the deployment of 'smart' charging infrastructure for private use in buildings	PP1.3	Reduction of the pass on the part of the times	Light road transport	Economy/ Regulatory measure
M13	Replacement of old low-emission technology with low-emission vehicles (mainly electric) and creation of charging infrastructure to serve them	PP1.3	Reduction of the pass on the part of the times	Road passenger public transport	Financial measure

Numbering	Policy measure name	Correlation with policy priorities	Target	Sector affected	Category of Measure
M14	Implementation of a programme to make better use of the highway fleet by redesigning/rescheduling the routes by means of environmental criteria	PP1.3	Reduction of the pass on the part of the times	Road passenger public transport	Regulation/ Technical
M15	Adopt measures to promote sustainable urban mobility using alternative forms of mobility and active mobility	PP1.3	Reduction of the pass on the part of the times	Urban travel	Regulatory measure
M16	Development of a network of publicly accessible electric charging infrastructure for light-duty and heavy-duty vehicles	PP1.3	Reduction of the pass on the part of the times	Light road transport	Economy/ Regulatory measure
M17	Strengthening (local) electricity networks for the deployment of charging infrastructure in high load demand areas	PP1.3	Reduction of the pass on the part of the times	Light/heavy road transport	Financial, Technical
M18	Electrification of existing and equipment for new electrified railway lines in the OSE network, with a view to moving road traffic to rail	PP1.3	Reduction of the pass on the part of the times	Railway transport	Technical, financial measure
M19	Strengthening coastal shipping links with a public service by using 'green' low-gas-emitting ships	PP1.3	Reduction of the pass on the part of the times	Shipping	Technical, financial measure

Numbering	Policy measure name	Correlation with policy priorities	Target	Sector affected	Category of Measure
M15	Development of shore-side electricity infrastructure for ships during their berth	PP1.3	Reduction of the pass on the part of the times	Shipping	Technical, financial measure
M20	Integration of electric vessels on domestic voyages (ferry lines)	PP1.3	Reduction of the pass on the part of the times	Shipping	Technical, financial measure
M21	Planning and integration of RES units in port areas in the form of self-generation and electrification of key port consumption	FP1.3, FP2.3, FP2.8	Reduction of the pass on the part of the times	Shipping	Technical, financial measure
M22	Development of a regulatory and regulatory framework for the operation of ship signalling infrastructure in ports	FP1.3, FP2.8	Reduction of the pass on the part of the times	Shipping	Regulatory measure
M23	Strengthening local electricity networks and at substation level in the port area	FP1.3, FP2.8	Reduction of the pass on the part of the times	Shipping	Technical, financial measure
M24	Financial aid – subsidising the need for transformation – electrification of ports with the help of EU financial tools	PP1.3	Reduction of the pass on the part of the times	Shipping	Financial measure

Numbering	Policy measure name	Correlation with policy priorities	Target	Sector affected	Category of Measure
M25	Creation of electricity supply infrastructure through a standardised hot or mobile interface to aircraft parked at airport gates or delineated parking areas	FP1.3, FP2.8	Reduction of the pass on the part of the times	Air transport	Regulatory, financial measure
M26	Strengthening the connectivity of the Greek islands	PP1.3	Reduction of the pass on the part of the times	Shipping	Technical, financial, regulatory measure
M27	Creation of electricity supply infrastructure through a standardised hot or mobile interface to aircraft parked at airport gates or delineated parking areas	FP1.3, FP2.8	Reduction of the pass on the part of the times	Air transport	Regulatory, financial measure
M28	Reduce fluorinated gas emissions	FP1.1, FP1.2	Non-ETS GHG emissions reduction	Industrial processes Cooling, air-conditioning, fire protection systems	Regulatory measure
M29	Reducing emissions in the agricultural sector	FP1.1, FP1.4	Non-ETS GHG emissions reduction	Agricultural sector	Regulatory, Ecological Measure

Numbering	Policy measure name	Correlation with policy priorities	Target	Sector affected	Category of Measure
M30	Sustainable management and forest protection	FP1.1, FP1.5	Reduction of bad GHG emissions	Forestry sector	Regulatory, Ecological Measure
M31	Promoting a circular economy	FP1.1, FP1.2, FP1.6, FP1.7	Non-ETS GHG emissions reduction	Total utilities	Regulatory, Ecological Measure
M32	Emission reduction measures in the Turkish sector	FP1.1, FP1.2, FP1.8	Non-ETS GHG emissions reduction	Tertiary sector — Tourism	Regulatory, Ecological Measure
M33	Development of smart networks and promotion of smart models and sustainable cities	FP1.1, FP1.2, FP1.7, FP1.8	Non-ETS GHG emissions reduction	Total utilities	Technical, Financial Measure
M34	Urban bio-climatic regenerations	FP1.1, FP1.7, FP1.8	Non-ETS GHG emissions reduction	Building sector	Regulatory, Ecological Measure
M35	Development of smart governance systems	FP1.1, FP1.8	Non-ETS GHG emissions reduction	Total utilities	Technical, Financial Measure
M36	Thermal maps of urban orchards to identify 'priority areas'	FP1.1, FP1.2, FP1.8	Adaptation to climate change	Urban environment buildings	Technical measure
M37	Decarbonisation of industry through electrification	PP1.9	Reduction of bad emissions on the part of the industry	Industrial sector	Technical measure

Numbering	Policy measure name	Correlation with policy priorities	Target	Sector affected	Category of Measure
M38	Decarbonisation of industry through promotion of carbon capture and storage (CCS) technologies	PP1.9	Reducing emissions in the industry sector	Industrial sector	Technical/regulatory/financial measure

3.2 renewable Energy Measures and Policies

Achieving the 43.0 % target set for RES as a share of total gross final energy consumption for 2030 requires the development of regulatory and technological policies and measures, with a specific implementation chart.

These measures and policies aim at RES penetration in new uses and sectors, energy coupling of sectors and ultimately the electrification of final bunches.

The high investment interest in the development of new RES projects for the period 2025-2030, combined with the pace of development of the projects observed in recent years, ensures that the new higher targets set are met, but also demonstrates significant needs in supporting, expanding and upgrading the electricity transmission and distribution network in order to integrate the required projects into the system in a reliable and secure manner. To this end, policies and measures are now being put in place to optimise the management of energy leaks produced.

The policy measures for the promotion of RES in the period 2025-2030 aim to cover eight different Policy Priorities (FP2.1-FP2.8, Figure 9), which are presented in the following picture and which cover all the potential RES development.

All policy measures are detailed for each Policy Priority in the following sections.

FP2.1: Revamping the permitting framework and updating the specific spatial path for RES – Accelerating, digitalising and permitting efficiency
FP2.2: Ensuring the implementation of RES and Storage investments – Promoting bilateral contracts, Hybrid Islands Systems
FP2.3: Promoting dispersed RES systems, strengthening the participatory role of local communities and consumers
FP2.4: Ensuring the viability and liquidity of the operating injection mechanism for RES power plants as well as storage plants
FP2.5: Development and strengthening of energy networks and optimum integration and operation of RES plants – Energy storage
FP2.6: Ensuring RES participation in meeting energy needs in the building sector – adjustments to building regulation – promotion of energy sharing
FP2.7: Promote the use of RES systems to cover heating and cooling needs
FP2.8: Promoting new technologies and coupling energy sectors with a focus on attracting maximum domestic potential by RES

Figure 9 Policy priorities for the promotion of RES in 2025-2030.

3.2.1 Measures and policies to reform the permitting framework and update the specific spatial framework for RES –Accelerating, digitalising and permitting efficiency

The updating and more efficient implementation of both the token and the current renewable-energy framework are assessed on an ongoing basis, incorporating the provisions of the European Directives. The ultimate objective of this process is to permit and ultimately to implement the RES plants needed to meet the energy and national targets and to deliver the benefits of RES directly to society.

The aim is to further reduce permitting times for the installation of an RES plant, to accelerate investment and to strengthen the climate of e- pendan-state confidence, attracting even more investment in the future.

Simplified authorisation procedures and shortening the response times of the services, the setting of specific deadlines for implementing the various authorisation steps set for investors, the completion and full operation of the RES information system carried out by the Ministry of the Environment and Energy for the digitalisation of authorisation procedures, the supervision of the authorisation of an RES plant and the interoperability of individual systems, and the existence of a contact point – one stop service – where the investor can now address any licensing issues are expected to make a significant contribution in this respect.

At the same time, in the specific spatial framework, the categories of areas in which the installation of RES stations are permitted or partially excluded will be known in advance and

the conditions for installing such stations will be laid down, taking into account criteria such as physiology, environmental protection, carrying capacity and anthropogenic activities of each installation.

Particular attention will be paid to a balanced distribution and coverage of available land for the development of new RES plants. For both wind and photovoltaics, following an energy, environmental and strategic assessment of defined priority areas ('Go to areas') in which RES projects to be located will be assessed on the basis of a specific authorisation procedure and within a specified timeframe.

The focus will be on assessing the possibility of dual use of available grazed and arable land, which will allow the installation of photovoltaic stations and at the same time maintain and expand agricultural activity. In order to implement this measure, it will be necessary to establish a specific framework for the promotion of agro-photovoltaic plants, their installation in special structures and the type of crops that can be developed in parallel and the cooperative structures to be developed between RES producers and the agricultural sector.

In addition, a specific regulatory (licensing procedures and stove system) and spatial framework will be established for both marine wind farms and floating photovoltaic parks, as well as examining the possibility of installing two or more plots (wind with photovoltaic) on the same land, taking into account the difficult network capacities, making optimal use of the country's rich energy potential in combination with land – available land that either remains unexploited – without the development of any activity, whether it is highly profitable for the installation of RES plants, or land that is already being exploited for RES stations but not to the maximum extent.

Finally, the institutional framework for the dismantling and recycling of RES after the end of their lifetime will be developed, with emphasis on compliance with the applicable environmental requirements and the restoration of these environmental requirements.

3.2.2 Measures and policies to ensure the implementation of RES and Storage investments – Promotion of bilateral contracts, development of hybrid systems on islands

In order to achieve the ambitious RES penetration target for the electricity generation system, storage technology (either as individual plants or in combination with RES plants) will play a key role.

In particular, the combination of storage and RES projects for the release of electricity can be done in two ways. Either adding storage within RES projects behind the meter or creating collaborative RES and standalone energy storage schemes connected at the same point (same substation).

To this end, use will be made of existing projects in operation as well as projects that do not cut

electrical space and are under implementation, allowing these projects to add a storage system.

This could significantly increase the scope for receiving new RES projects. The release of electrical space will depend on the entire volume and capacity of storage systems that will be added through a framework and, respectively, on the way in which the energy produced by these plants is managed and injected.

The installation of these storage systems will be promoted through already approved support-schemes which may be extended, such as the approved scheme SA.64736 for the receipt of investment and operating aid for individual storage stops following participation in a competitive procedure for the submission of a candidate, and scheme SA.60064 for the granting of operating aid to RES power plants combined with an electricity storage unit behind the meter. In addition, indirect support schemes will also be useful to promote the deployment of such systems, such as speeding up their authorisation and approval, priority connection to the electricity system, the possibility of a guaranteed price for the energy produced by RES plants with a parallel share in the electricity markets for energy injected by the storage plant.

Based on the current support scheme, competitive bidding procedures were carried out in 2023 for a total capacity of 700 MW of individual storage stations, with a capacity of 2 hours, and it is expected that another competitive procedure will follow in the last four months of 2024, with an auction capacity of 300 MW and a capacity of 4 hours.

It should be noted that in order to achieve the objective of installing 4.3 GW of slurry stations by 2030, the extension of aid scheme SA.64736 is being considered¹¹⁷ by increasing the planned capacity in addition to 1 000 MW, as well as the extension of aid scheme SA.60064 by increasing the planned capacity in addition to 200 MW for RES plants combined with an electrical storage unit behind the meter.

In addition, by providing incentives for RES plant owners to connect to the grid or system, the framework for the participation of RES projects in the **electricity markets and the conclusion of bilateral contracts will be strengthened**, so that these plants, without receiving operating aid, participate in the energy market to recover part of the investment, and to ensure a stable flow of revenue and secure bank financing, enter into bilateral contracts with RES suppliers, consumers and bodies. These contracts will provide final consumers or suppliers with a tool to compensate for the risk of fluctuating electricity prices and ensure poor security for producers. Bilateral contracts will also be available via a digital platform where its administrator will be responsible for processing and clearing transactions. In any case, the aim is to create the

The scheme¹¹⁷ provides that electricity storage systems may receive investment and operating aid following their participation in a competitive bidding process. The selected projects will be obliged to join the electricity markets and conclude Contracts for Differences (CfDs) for a duration of 10 years ensuring their financial viability. According to the scheme, competitive procedures will be carried out for the granting of investment and operating aid to 1 000 MW of storage plants. The selected projects should be operational by the end of 2025.

necessary liquidity in the market, ensuring mutual benefits for the parties involved and competitive prices.

Priority will also be given to the development and integration of electricity storage with pumped storage technology. To date, the European Commission has approved aid for the implementation of the 680 MW pumping station in Amfilochia (SA 57473). In order to promote the installation of pumped storage stations and/or other long-term storage stations, consideration will be given to submitting a request to the Directorate-General for Competition of the European Commission for approval of an aid scheme (investment and/or operating aid) following the participation of interested parties in a competitive bidding process.

Development of hybrid systems in non-interconnected islands (GR-eco Islands Initiative)

Hybrid power plants¹¹⁸, combined with RES and storage stations, installed on the non-interconnected islands are expected to play a key role in the further decarbonisation of these islands, as part of the implementation of the GR-eco Islands initiative¹¹⁹.

The development of such systems is a solution to increase RES penetration in a state that is either not expected to be interconnected with the continental electrical system or their interconnection will be delayed. In particular, by means of hybrid power plants, more than 80 % of RES penetration can be achieved at stand-alone electricity system level.

The installation of hybrid production plants in the autonomous island systems and in the Crete system is promoted through approved scheme SA.58482120, with the aim, inter alia, of limiting the use of liquid fossil fuels in the electricity sector. On the basis of the above scheme, it is initially envisaged to classify hybrid plants with a guaranteed capacity of 240 MW in the coming years, half of the above capacity being for hybrid plants in Crete¹²¹, while the remaining capacity concerns hybrid plants to be installed on non-interconnected and connected islands, such as Rhodes, Lesvos, Kos, Megitis, Anticythira, Gavdos, Eri – Koussa, etc.

The first hybrid plant implemented under this aid scheme is the Astypalaia hybrid plant¹²², comprising a 3,5 MW PV plant and a battery with a capacity of 9.1 MWh. The RES penetration target is at least 50 % in Phase A of implementation of the project, while Phase II provides for an increase in the RES penetration level to at least 80 %, to be achieved by extending and upgrading the components of the HWB.

¹¹⁸ AS¹¹⁸ defined in Law 4414/2016, Government Gazette, Series I, No 149.

¹¹⁹ As established by Article 21 of the National Climate Law (Law 4936/2022, Government Gazette, Series I, No 105)

This scheme¹²⁰ sets out 3 Aid Measures for hybrid plants on the NII. The first Measure concerns the development of HWB on the following NIIs: Maximum, Anticythira, Gavdos, Ereikoussa and Othnoi, the second concerns the development of HVC in Crete, while Measure 3 concerns the development of HWW on all other NII.

These¹²¹ hybrid plants will include pumped storage systems with wind plants with a guaranteed capacity of up to 50 MW, hybrid plants consisting of batteries with a guaranteed capacity of up to 50 MW and plants with a guaranteed capacity of up to 50 MW.

AS¹²² a special pilot project of Astypalaia, in the context of the implementation of the wider project "Smart -Sustainable Island" on this island.

Other hybrid power plants on the NII are the live power plant in Tel123, as well as the hybrid plant in Agios Efstratios which is expected to be operational in 2024¹²⁴, with both plants combining wind and solar power generation with battery storage.

3.2.3 Measures and policies to promote dispersed RES systems, strengthening the participatory role of local communities –consumers

The multidimensional contribution of the dispersed production of RES systems is undeniable, with the result that it is imperative to implement and promote the patterns of self-consumption in accordance with the new institutional framework established by Law 5037/2023 (Government Gazette, Series I, No 78) when transposing Directives (EU) 2018/2001 and (EU) 2019/944.

This will be achieved by securing the electrical space available for the installation of RES plants for self-consumption, by financing for specific and categories of consumers part of the installation to make this feasible and feasible, as well as through simplified permitting procedures.

Programmes will be designed to promote self-consumption, such as the existing programmes ‘Photovoltaic at Home’ and ‘Photovoltaic in the field’, which have been funded from funds from the TAF, to subsidise the installation of battery photovoltaic plants, in order to protect specific groups of consumers, particularly vulnerable households in Greece, businesses and energy-intensive consumers from changes in energy costs.

It is a priority to create a positive environment for new investments that promote self-consumption for all domestic, agricultural and commercial consumers in the country, at all voltage levels, combined with new technologies such as storage and dynamic energy management, leveraging new digital solutions.

The promotion of dispersed RES systems for self-consumption is a key strategic axis since 2019 with the implementation of net metering and virtual net metering. By June 2024, 15.000 self-consumption plants are in operation with a total installed capacity close to 500 MW, and connection servers have been provided for 17000 plants with a capacity of 700 MW. Recognising the importance of self-consumption, and in order to further promote it, 10 MW of electricity space has been reserved in each substation of the Network Operator pursuant to Law 5037/2023 (Article 64).

This available margin shall be used for the development of RES plants exclusively to meet the energy needs of household consumers, professional farmers, the secondary/tertiary sector, the Renewable Energy Communities and Citizen Energy Communities, as well as legal persons of a welfare nature and first-and second-level local authorities.

¹²³ It has been operational since 2019 and has been implemented under the TILOS Project.
¹²⁴ It is implemented in the framework of the research project “Ai Strattis Green Islands”.

In particular, for household consumers and for plants up to 10.8 kW, a self-consumption programme is planned providing for compensation through the participation of the plants in the electricity markets, and any revenues will be offset directly in the electricity bills issued by suppliers, without incurring any tax obligations for consumers.

For companies, a targeted subsidy programme is being planned for the installation of battery photovoltaic plants exclusively for self-consumption, with a total of EUR 160 million pre-computed using resources from the TAF.

The promotion of dispersed production and self-consumption is further strengthened through the specific framework for offsetting the energy needs of valleys, either by installing photovoltaic plants that are electrically connected to the supply of consumption (self-consumption with identified compensation) or at the point in the interconnected system (Virtually) (self-consumption with near-identified compensation), while at the same time promoting collective consumption, while also exploiting the available electrical space in the urban web. The actions will be supported through a special register of self-consumers to be established by the Network Manager and the promotion of energy coaching to shape active consumers and optimise energy habits.

At the same time, Renewable Energy Communities and Citizens' Energy Communities will also play an active role in the implementation of policies to promote RES in final consumption.

With a view to strengthening the role of local communities and vulnerable users, the 'PLANTS' programme is being launched with the aim of meeting a significant part of the energy needs through the installation of RES plants with a storage station and the application of virtual identified compensation, and therefore to reduce the energy costs of first and second degree local authorities, local and general organisations for improvement, municipal water and sewerage enterprises, and vulnerable households can benefit from low electricity costs.

Through the "PLANTS" programme, local and regional authorities are expected to make significant savings that are currently channelled to cover their high energy bill, while they will have an incentive to implement energy-saving measures that will further reduce their energy costs. In addition, this programme will have a positive impact on the whole agricultural primary sector by reducing energy costs leading to increased competitiveness.

EUR 100 million from the TAF and other available financial instruments will be used to implement the Programme.

In any event, the contribution of the Renewable Energy Communities and the Citizens' Energy Communities in the context of promoting self-consumption is key, as they can bring together a large number of consumers from the same or a different region, manage their consumption comprehensively, and on the basis of their consumption profiles, meet their needs through virtual self-consumption from an RES plant, thus reducing their energy costs.

To this end, a specific technical assistance and advisory mechanism will be set up to support the Communities, to further promote them in the Gulf, to identify and remove obstacles to their development and to continuously simplify and update the institutional framework governing them.

3.2.4 Measures and policies to ensure the viability and liquidity of the mechanism for granting operational aid to RES plants and storage plants

Since 1^{January} 2016, RES power plants have cooperated on the electricity market and are included in a support scheme in the form of operating aid. The compensation of RES plants participating in an operational aid procedure shall be carried out by the Special Features for RES and HECHP. The account shall be credited with part of the revenue from the price of the CO₂ emission allowances, as well as revenues from their participation in the electricity market where the market price exceeds the price that RES plants closed through the competitive process for their operational reinforcement. Given that the competitive procedures for granting operational aid to RES plants lead to very competitive levels at prices well below the average Day-Ahead Market, the bill results in surplus for new RES projects. In any case, appropriate legislative and regulatory measures will be taken to support the account while ensuring its liquidity and sustainability. Surpluses in this account are also expected to cover the needs for operational aid to storage stations.

The aid scheme will be one of the main tools to support RES technologies for electricity generation as well as storage facilities. In this context, a specific frontloading mechanism and procedure is in place to adjust the reference value for each technology and category of RES plants for projects not yet in operation, depending on the developments in the financing and development and operation costs of the units. Furthermore, the development of environmental markets using Guarantees of Origin for RES electricity is expected to act as a complementary market mechanism, which will further contribute to the proper functioning of the Special Account. More specifically, the regulatory framework was completed in July 2022 and since June 2024 DAPEEP has launched auctions of guarantees of origin in the Greek system.

3.2.5 Measures and policies to develop and strengthen energy supplies and optimal integration and operation of RES plants – Storage of energy

Electricity transmission and distribution networks play a key role in the high penetration of RES units for electricity generation, and therefore the planning and development of new projects by the operators will consolidate forecasts for the penetration of new RES units and plan the necessary adjustments and actions so that it is implemented as seamlessly and as quickly as possible for the operation of the energy system. The operators of both the transmission systems and the distribution network shall design and ensure the networks with a view to the future development of RES stations, increasing geographical dispersion, strengthening and technologically modernising the high-voltage and ultra-high-voltage transmission system and

the distribution networks. Consequently, the grids should be scaled up to ensure that RES penetrates as much as possible by limiting any cut to the energy injected to a minimum.

Efficient management of high RES penetration requires coordinated planning for the development of infrastructure between the various energy carriers (electricity, renewable and non-renewable gases, and sub-system of carbon capture and storage). Electricity and gas networks are traditionally connected at transmission level through high-power gas-fired power plants. Due to the current energy transition and given the significant storage capacity of natural gas pipelines, the further connection of these networks should be considered so that their coupling allows for a more efficient integration of RES, better management and deceleration of grids, but also, in the future and if necessary, more efficient production, storage and use of green energy.

These requirements, especially for the electricity distribution network, are increasing, both because local and dispersed production of medium and small scale RES systems is expected to increase, and due to the specific requirements of new electricity loads that are expected to arise as a result of the spike in the transport sector (e.g. electricity supply to mobile vessels) and to meet heating needs in the building sector.

Planning and planning for the reinforcement and expansion of grids through nomination of electricity should take into account these challenges for the integration of RES and flexible demand and the related investments should be designed, planned and implemented in an optimal way, so that both overall and specifically at local level the above targets for RES penetration and electrification of final energy consumption are met.

In this context, the technically and economically optimal reinforcement and expansion of energy infrastructure both in the transmission system and in the distribution network to counter saturation phenomena that hinder the further development of RES plants in specific areas will also be a key measure for the optimal integration of RES into the energy networks in the next period.

By way of illustration, the potential to increase the power of the substations (addition of M/S) and to upgrade them more generally should be exploited. Prior to this, new regulatory models for the allocation of charges for new projects for the development of the Crown and System Development (in particular F/S) have been designed and implemented to facilitate the implementation of such projects to connect small producers.

Also, according to the results of the project being implemented, substations built by producers (mainly to connect wind farms) could now be used to serve distribution lines of the network, since in this case it would allow more RES plants to be connected to the deck, and the regulatory framework would also need to be modernised in these directions.

To this end, the distribution network operator has already drawn up members of the distribution network to determine the aid to the distribution network, at the level of the number of HV/MV units that will be saturated and will need to be increased, as well as the corresponding distribution lines which will exceed the possibility of absorbing RES and will therefore need aid. The aim of these studies is to develop a methodology for determining expected investment costs, to identify geographically critical areas of intervention in order to strengthen the distribution network and to co-finance augmentations in order to meet demand for the simultaneous reception of new RES projects. Within this framework, relevant projects have already been included and are being implemented in the TAA.

In addition, the development of new financing models for the rapid development of these infrastructures will be initiated, while management complexity and time delays due to exogenous factors will be reduced through better planning and transparent consultation procedures.

The rapid authorisation of projects for the expansion and enhancement of electrical infrastructure is a priority for achieving the energy targets and, in this context, provision is made for legislative measures, where necessary, to provide a clear framework for authorising such projects. Accordingly, the aim is to standardise the related costs of strengthening and/or extending the grid and their distribution with RES producers, as well as the corresponding connection contracts to incorporate all relevant parameters.

At planning level, cooperation between system operator and distribution network operator to identify and plan the needs for the development and enhancement of electrical infrastructure is self-evident, taking into account the dispersed effects of RES production in terms of overcharging the lines and substations of the network, reverse power flows and technical challenges in relation to system balancing.

A comprehensive legislative and regulatory framework for limiting the injection of electricity produced by RES plants into the grids is under way, with the aim of making better use of the grids and maximising the possibility of absorbing energy from RES plants in areas with limited absorption capacity.

The penetration of RES units into the energy mix, mainly uncontrolled (photovoltaic and wind power plants, NHUs without reservoirs) has led to an increased level of renewable production cuttings, increasing the risk of disruption of the supply of showers due to grid overload and other technical emergencies for the operation of energy grids, in the short term due to excess renewable generation over demand in the system, and in the long term due to bottlenecks.

In order to ensure the smooth operation of electricity grids and to avoid burdening individual RES plants by continuously imposing a curtailment of their renewable generation, a comprehensive legislative and regulatory framework for the injection into the grids of

electricity generated by RES plants is planned.

In this context, the ability of network operators to spread control of the controlled production from RES plants is enhanced through the installation of appropriate command allocation equipment. Recent legislation requires that, in 2024, the installation of appropriate infrastructure to limit the injection of all RES units with an installed capacity of more than 1 MW, with the ability to control injection by system and network operators, is required.

At the same time, consideration is already being given to the expansion of RES production units, with the possibility of installing appropriate remote control equipment in RES plants with an established capacity of 400 kW initially, and progressively to plants with abandoned capacity of up to 200 kW, provided that they are eligible for renewable production curtailment orders under EU and national legislation.

With a view to efficient control and distribution of RES production units, the necessary information and technical infrastructure shall be developed and the model for receiving allocation decisions between electricity distribution system operators and system operators shall be explored.

In particular, its regional control centres are being upgraded and integrated, with the aim of initially imposing injection limitation orders on RES units in a timely manner and, in future, expanding control and interface capabilities to provide additional energy services to the electricity grids (e.g. frequency and voltage regulation) by an expanding group of available dispersed RES and storage units.

The regional control centres of the electricity distribution network are expected to become the main network supervision infrastructure, as the widening digitalisation of network infrastructure will allow for the widening of the functions they will have to perform, as described in more detail in subsections 3.5.3, 3.6.1 and 3.6.5.

In order to make even greater use of the other networks, consideration will be given to the requirement for new plants not to become a burden on the electrical characteristics of the networks (e.g. short-circuit level), which must also be observed for existing plants which are carrying out a radical renewal of production equipment. To address the serious technical problem of short-circuit levels, DEDDIE is already preparing a plan for the implementation of short- and long-term measures.

With regard to the radical renewal of production equipment (repower), this will gradually become a priority, with the end of the lifetime of the existing plants, as it will have to maintain or increase the utilisation of this RES potential in the areas concerned, while taking into account the new environmental conditions, market participation obligations and the need to strengthen networks.

In the context of the new interconnections between the autonomous systems of the NII and

the continent, the exploitation of existing local RES potential will be optimised, while taking into account both technical and economic, environmental and social considerations. At the same time, the implementation of interconnections will favour both the achievement of RES penetration targets and the energy security of islands.

Special provision should also be made for the development and strengthening of the network also on the islands, as the development of new hybrid RES plants, along with the emergence of new local RES self-generation systems, requires specific planning and recognition of local needs in terms of strengthening the grid, both before and after their interconnection with the continental system.

Further penetration of non-controlled RES is expected to create new challenges for transmission and distribution system operators in terms of system operation, due to the targeting of the production of these plants.

In order to limit the cuts in renewable production to the economically minimum level while ensuring continuity of supply to consumers, increased system flexibility is needed and therefore the importance of flexibility sources, such as storage, is further increased. There is also a need to strengthen the telemetering and remote control systems in the distribution network. In addition, for producers with an obligation to participate in the electricity market- and to assume balancing obligations, the targeting of RES generation is an additional risk factor.

In this context, it is envisaged to reflect the evolution, in the form of digital bundles, of the possibilities for hosting new RES stations and local demand loads in a publicly accessible format, so that it can also be reflected in a greater level of detail than the current one.

Storage systems are expected to play an important role in limiting the occurrence and need of RES energy cuts in the system as a whole, in addressing local saturation problems, and in improving the capacity adequacy and flexibility of the system. The combination of RES units with energy storage systems, i.e. when they share the common connection point (the storage-system is installed behind the meter (behind-the-meter) or at a point in the distribution network downstream of the same connection point with the HV system), if there are no operational problems, may mitigate the impact of RES units on the operation of the system by smoothing out variations in production.

Among the benefits for system operators is the improvement of network stability through the provision of ancillary services (e.g. voltage control, frequency response and power quality), while increasing the ability of the network to host new RES units, through the provision of management services.

congestion. For producers, the combination of storage with RES leads to curtailment due to the inability to absorb the energy produced from the grid, while allowing the provision of Capacity Firming, giving the possibility of reducing deviations from planned production. This opens up

new prospects for participation in additional energy markets, such as the balancing market and the long-term capacity compensation mechanism, leading to increased profitability for investment and a reduction in the need to strengthen it.

3.2.6 Measures and policies to ensure RES participation in addressing energy needs in the building sector – adjustments to building regulation – promotion of energy sharing

The potential for further RES penetration in buildings remains high, requiring the adoption of specific policy measures for its efficient use. A key tool will be the implementation of a regulatory framework to include RES in meeting the energy needs of the building sector (fixing a minimum participation rate). In this context, the relevant forecasts for nearly zero-consumption buildings will contribute to further penetration of RES in the building sector, taking into account technological and sustainability criteria, contributing to the achievement of the objectives set in the context of improving the energy efficiency of the building sector.

In addition, the simplified procedure for installing renewable energy stations on buildings, as provided for in the revised European Directive (EU) 2018/2001 and which is expected to be directly incorporated into national legislation, will also be a key tool.

Targeted solutions and regulations to promote the collective autoclaving of 'green' energy in housing complexes and share it among tenants are key measures, with almost 60 % of the country's population living in housing complexes.

The above provisions of the regulatory framework will be incorporated into the Revised Energy Performance of Buildings Regulation, with particular emphasis on the exemplary role to be played by public buildings used by the public sector by setting thresholds for minimum RES participation taking into account the criteria of economic sustainability and energy benefit. Particular emphasis will also be placed on removing barriers to installing RES and storage systems in buildings through targeted adaptations of the Building Regulation.

In this context, maximising synergies will be sought both with the policy measure on the implementation and promotion of self-consumption schemes and with other policy measures concerning public and private buildings in the field of energy efficiency.

3.2.7 Measures and policies to promote the use of RES systems to meet thermal and cooling needs

Promoting efficient heating and cooling systems is a key policy priority to achieve this objective together with the refurbishment of the building envelope. In addition, support will be given to the coordinated promotion of RES systems, such as solar thermal systems, contributing both to the improvement of energy efficiency and to the further penetration of RES through technologies for the direct production of heating, cooling and hot water, to be carried out either on site or in the vicinity. A contribution from RES district heating networks using mainly geothermal energy, biomass and renewable gases is also envisaged, albeit with a small part.

An important contribution will be made under Article 17 of the Climate Law (Law 4936/2022, Government Gazette, Series I, No 105), which includes measures to reduce emissions in buildings, such as banning the sale and installation of heating oil burners.

In the same vein, schemes to install photovoltaic systems with a storage system for self-generation to produce renewable electricity to meet thermal/cooling needs through heat pumps and reduce energy costs for consumers will be strengthened.

In addition, the installation of hybrid RES systems (such as solar thermal with heat pumps, photovoltaic with heat pumps, biomass solar thermal, solar thermal with geothermal) will be encouraged, based on the principle of technological neutrality.

Promoting the use of bioenergy to meet the thermal and cooling needs of households and industries is an important step towards reducing dependence on conventional energy sources and reducing greenhouse gas emissions. Greece has a great potential for the development of bioenergy, as it spreads rich natural resources and alternative energy sources that can be valorised. In any case, the use of bioenergy will take place through modern and energy-efficient boilers and heating systems, ensuring compliance with the provisions of the applicable environmental legislation.

Please note that a study has been launched to assess the technical and legal potential of exploiting all available raw materials that will lead to the efficient use of bioenergy in all final energy consumption sectors.

In addition, measures for the use of local district heating networks within industrial areas that exploit waste heat from specific industries and crafts to meet the thermal needs of many other industries will be considered.

Finally, specialised support programmes will be developed both to develop efficient supply chains of residual biomass and biodegradable matter and to support and implement optimal environmental and energy from bioenergy applications. To this end, a plan is being developed to incentivise the collection and utilisation of forest biomass on the basis of management studies, which will include the technical specifications for its extraction. Forest biomass, after the necessary treatment, will be made available to certified operators for the purpose of producing energy or other products of the bioenergy chain.

It should be noted that all the above measures will be combined with the strengthening of the cognitive skills for the installation and operation of RES technologies through shedding and other measures, with a view to ensuring that there is a sufficient labour force with the appropriate level of skills.

3.2.8 Measures and policies to promote new technologies and coupling of energy sectors with a focus on electrification to maximise the domestic potential of RES

Maximising the domestic potential of RES and the promotion of new energy artefacts is a key

concern for policy measures up to 2030 to achieve the walls.

Promoting the implementation of Offshore Wind Parks (OCS) projects

The promotion of offshore wind farms will be carried out by means of Law 4964/2022, which specifies for the first time the framework for the development of LAGs in the Greek maritime space. The objective of the framework is to ensure rigorous litigation in the selection of HSE development areas with a view to protecting and preserving the environment. The careful design of the regulatory and legal framework is expected to benefit our country by ensuring a balance between local communities and the state, while creating the framework for ensuring the implementation of safe investments.

The regulatory model chosen attributes to the State, through the Hellenic Hydrocarbons and Energy Resources Management Company (EDEYEP) S.A., which is designated as the body responsible for the HSC, the primary role in planning and selecting the organised development of Offshore Wind Parks (POAYAP), while, at the same time, detailed procedures for the location of the areas have been developed, which to a high degree mitigates the risks and provides the necessary investment insurance, already at the initial planning stage. The granting of rights to investors and the subsequent development of LAG projects within the regions will be carried out following a specific evaluation process based on quality criteria, while the tender for the price of energy to be heard at a later stage will guarantee consumer protection. The design of the electricity transmission network and the cost of interconnection are constantly optimised and reformed thanks to the regulatory framework, with the necessary consideration of LAG projects in the plans of ADMIE for the interconnection of islands. To this end, the Liaison and Deployment Coordination Committee for LAG projects has been set up and operates, with the aim of speeding up procedures and effective cooperation and communication of all the competent bodies involved in the elaboration of LAG development projects.

In order to achieve the penetration target, it is necessary to adopt a series of regulatory decisions and policy measures, as described by way of illustration below:

- Drawing up the National Programme for the Development of Offshore Wind Parks (EPAYAP), which will determine the entire maritime space that is in principle open to exploitation. The EPAYAP project and the accompanying Strategic General Environmental Impact Study have been completed and are expected to be submitted to the competent Directorates of the Ministry of Energy and the Environment.
- The selection of the first Offshore Wind Park Organised Development Areas (POAYAP), through a pool of options of ten (10) potential with an estimated installed capacity of 4.9 GW, in which the first LAG projects will be installed. The first RFMOs will be framed by the adoption of corresponding Presidential Decrees, by the end of 2024, and will achieve the target of 1.9 GW set in the revised NECP. The pool of options for LAGs will be continuously extended with new areas in order to achieve the NECP hillside

objectives.

- Carrying out studies and surveys to assess the needs for strengthening the major-facilities and other necessary infrastructure in the areas where LAG projects are developed, the seabed morphology where the wind turbines of LAG projects will be installed.
- The approval by the European Commission of the scheme for strengthening LAG projects and its incorporation into the national legislative and regulatory framework. In particular, the aid scheme will provide for the granting of aid following the participation of interested parties in a competitive tendering procedure and the conclusion of Operational Aid Contracts (CfDs) with a duration of 20 years. The first tenders for the granting of aid are expected to be carried out by the RAAEY by the end of 2025, with the projects selected being completed by 2030.
- Submitting a request to the Directorate-General for Competition of the European-Commission for the granting of aid and speeding up the necessary authorisation procedures for the installation of the first pilot project for LAGs, with a total capacity of 600 MW, in the Alexandroupoli area.

Promotion of other innovative RES technologies

In this context, innovative RES and/or RES technologies that have not been sufficiently qualified and can help to further exploit this potential will be considered and promoted primarily in the form of pilot applications. **Wave energy** deployment projects, potential for floating photovoltaic development, **production of green hydrogen** are some of these applications for which there is a target to be further analysed in this light.

Particular reference should be made to the possibility of *using RES systems for blackening*. In particular, by carrying out the corresponding feasibility and cost/benefit studies, the use of small stand-alone RES desalination plants will be promoted for the production of drinking water or to meet irrigation needs in islands and depopulated areas, which remain without an electricity grid, or have a weak network and are characterised by severe water scarcity. Small standalone draught units will be combined to cover their energy consumption with RES systems. For example, small wind turbines and photovoltaic systems for the production of electricity can be installed in reverse osmosis units, while in the case of desalination thermal units both low enthalpy geothermal energy and solar thermal systems can be used. In addition, the requirement for constant capacity in desalination plants requires the use of an energy-storage facility in order to increase the operating hours of the plant regardless of the availability of RES. In any event, desalination plants will contribute to Planetary development, to reducing the use of bottled waters with high environmental costs due to the lack of recycling in most of these areas, to reducing the problems of large electricity grids, to the seasonality of water needs and to a reduction in GHG emissions due to the limitation of the operation of local power plants as long as these islands remain uninterconnected with the continental system.

With regard to geothermal energy, the regulatory framework for its exploitation has recently been completed and the call for interest for exploring geothermal potential in four regions of Central – Eastern Macedonia and Thrace is already ongoing. In this context, it is evident that the introduction of specific incentives for the development of high-temperature geothermal field exploration and exploitation projects and the implementation of an effective token system are a priority for the development of national geothermal policy. Accordingly, it is of the utmost importance to design and adopt support measures specifically aimed at informing local communities in areas with important geothermal fields.

To this end, the coupling of energy sectors to enhance optimal RES penetration is also a priority, as it helps to exploit the excess electricity generated from RES to meet the demand for heating and cooling and load taking in transport.

The gradual electrification of final consumption sectors enables the coupling of energy sectors and achieves a greater participation of RES at the level of final energy consumption. In particular, sector coupling refers to the possibility of interconnecting the power sector with different energy sectors, such as Power-to-Heat, Power-to-Gas and downstream- (Electromobility).

Energy sector coupling provides additional flexibility to the system, boosting the ability to absorb production from RES plants. In combination with storage systems and intelligent energy management systems, the consumption of flexible loads can be deferred in order to maximise RES energy sorption. The coupling of the electricity sector with the heating/cooling sector, through energy-efficient heat pumps, is already an economically integrated load-bearing approach, and there are other possibilities for converting electricity into thermal energy and its subsequent storage.

Equally important are the potential for the coupling of the electricity and gas sectors, through applications to convert electricity into renewable gas, through the production of **green hydrogen**.

Ultimately, achieving energy sector coupling provides the energy system with increased flexibility to cope with fluctuations in energy demand and before renewable energy, while at the same time exploiting costly investments (many of which exist) in the most appropriate and efficient way by reducing the likelihood of stranded assets¹²⁵.

3.2.9 Assessment of the climate vulnerability of RES policies and measures

Climate change causes changes in solar radiation, wind, and hydrological cycle and directly affects the available solar, wind and hydroelectric dynamic-muscular. In addition, it affects the photosynthesis process and thus plant growth and biomass production potential.

Of course, the¹²⁵ implementation of energy sector coupling requires very careful planning as well as fundamental changes in our energy system.

Solar and wind energy

According to existing studies, by 2050, the impact of climate change on electricity generation from photovoltaic systems in Greece is likely to be limited (EUR $\pm$ 5 %). Equally small (-1 % to + 2 %) is projected to be the change in onshore wind energy production. Conversely, significant changes are expected in the case of offshore wind. The average wind power density is projected to decrease by up to 20 %. However, significant increases of up to 30 % are foreseen in some regions, instead of corresponding decreases in others. Changes are also expected in the seasonal values of the mean wind power density as well as in its volatility. The changes vary between the climate scenarios and models used, but seem to converge in the case of the North Aegean, where climate change appears to have a very positive impact on the exploitation of offshore ^{diamonics,123, 124, 125, 126}

Currently, the number of climate projection studies on the effects of climate change on solar and wind energy production, and in particular offshore wind, is limited and small spatial analysis, which allows, to some extent, to draw conclusions on emerging trends, but does not provide sufficient information on the spatial planning of solar and oil-oil development programmes. Producing maps of climate projections of the solar and wind as a delta in appropriate spatial analysis and their subsequent use for the location of priority areas or their organised development will contribute to a greater efficiency of solar and wind units in future climatic conditions.

The promotion of dispersed systems and measures to increase the loss of electric space capacity is expected to compensate, to some extent, for changes in the available solar and onshore wind potential, where the influence of the climate is expected to be low. The focus is therefore on adapting to climate change offshore wind energy production.

Offshore wind will be a key pillar of the future energy system after 2030, with its contribution to net electricity production increasing from 1 % in 2030 to 32 % in 2050. The development of appropriate climate projections and the subsequent update of the spatial planning of overbuilding wind, which is at an early stage, will contribute to better aerial exploitation of offshore potential and provide better data for the mid-term revisions of the NECP.

Hydropower and pumped storage

¹²³ Georgopoulou E, Mirasgedis S, Sarafidis Y, GIANNAKOPOULOS C, Varotsos KV, Gakis N. Climate Change Impacts on the Energy System of

a Climate-Vulnerable Mediterranean Country (Greece). *ATMOSPHERE*. 2024; 15 (3): 286. <https://doi.org/10.3390/atmos15030286>.

¹²⁴ RIS geospatial information portal. Climate Change. Change in the Average Annual Advantage in the Near and the Lower Future.

¹²⁵ Georgopoulou E, Mirasgedis S, Sarafidis Y, GIANNAKOPOULOS C, Varotsos KV, Gakis N. Climate Change Impacts on the Energy System of a Climate-Vulnerable Mediterranean Country (Greece). *Atmosphere*. 2024; 15 (3): 286. <https://doi.org/10.3390/atmos15030286>.

¹²⁶ A. Martinez, G. Iglesias, Climate-change impacts on offshore wind resources in the Mediterranean Sea, *Energy Conversion and Manage*, Volume 291, 2023, 117231, ISSN 0196-8904, <https://doi.org/10.1016/j.enconman.2023.117231>.

The impacts of climate change on the hydrogen cycle are also projected to be significant. By 2060, total annual rainfall in the different regions of the country is projected to decrease by up to 15 % and the duration of drought periods to increase to 15 consecutivedays¹²⁶. At the same time, rainfall is projected to increase, which in some areas of Central and Northern Greece can reach up to 50 % by²⁰⁵¹²⁷.

Changes in the total quantity and temporal distribution of rainfall wouldcalm the flow of surface water on which hydropower production also depends. Hydropower plants equipped with reservoirs willbe less affected by the change in water flow, but they will be more affected by an increase in average temperature and a consequent increase in evaporation¹²⁸. At the same time, climate change is expected to lead to an expansion of irrigated land, which, together with the development of green hydrogen, will increase competition between different uses of water resources.

The hydropower generation potential in Greece, according to existing studies, is expected to decrease by up to 10 % by 2050, which can be up to 20 % in the case of more adverse climatescenarios¹²⁹. The changes show a significant spatial variation, with the estimated change inthe hydrological capacity of existing hydropower plants ranging from 2 % to 20%¹³⁰. Although relevant studies are missing, the effects on pumped cash units are expected to be of a similar scale.

Climate change therefore poses significant challenges to the achievement of the NECP objectives of increasing hydropower generation and increasing the storage capacity of pumped cash units, which can be affected through the implementation of appropriate measures.

Upgrading the electromechanical equipment of existing hydropower plants could increase their efficiency by 10 % and compensate for any reductions due to changes in water flow. Also, reducing demand and increasing water recycling and reuse, which will be achieved through the

¹²⁶ RIS geospatial information portal. Climate change: https://mapsportal.yopen.gr/thema_climatechange.

¹²⁷ RIS, 2019, Implementation of Directive 2007/60/EC — 1th revision of the Preliminary Flood Risk Assessment:

<https://floods.ypeka.gr/wp-content/uploads/2023/12/9efdfa4a-ae88-4965-b9b6-6d40ad458a3e.pdf>.

¹²⁸ European Environment Agency, Adaptation challenges and opportunities for the European energy system – Building a climate-resilient low-carbon energy system, Publications Office, 2019, <https://data.europa.eu/doi/10.2800/227321>.

¹²⁹ Drobinski P, Azzopardi B, Ben Janet Allal H, Bouchet V, Civel E, Creti A, Duic N, Fylaktos N, Mutale J, Pariente-David S, Ravetz J, Taliotis C, Vautard R 2020 Energy transition in the Mediterranean. In: *Climate and Environmental Change in the Mediterranean Basin -Current Situation and Risks for the Future*. First Mediterranean Assessment Report (Cramer W, Guiot J, Marini K (eds.)) Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 58pp, in press

https://www.medecc.org/wp-content/uploads/2020/11/MedECC_MAR1_3_3_Energy_transition_in_the_Mediterranean.pdf.

¹³⁰ Georgopoulou E, Mirasgedis S, Sarafidis Y, GIANNAKOPOULOS C, Varotsos KV, Gakis N. Climate Change Impacts on the Energy System of a Climate-Vulnerable Mediterranean Country (Greece). *ATMOSPHERE*. 2024; 15 (3): 286. <https://doi.org/10.3390/atmos15030286>.

implementation of the relevant measures of the National Strategy and Regional Plans for Adaptation to Climate Change (see Section 3.8), the National Strategic ECT for the new Common Agricultural Policy (CAP) 2023-2027, the River Basin Management Plans and Flood Risk Management, is expected to improve the availability of water resources for electricity production and pumped storage. Finally, promoting a more holistic model for managing flood phenomena that simultaneously ensures protection from and storage of flood water for use during periods of low rainfall, and the inclusion of hydroelectric and pumped water reservoirs, could help to better adapt their operation to the change in the temporal distribution of rainfall.

The impact of climate change on the achievement of hydropower generation and storage targets by 2030 is expected to be limited, especially in case of timely adaptation measures. However, it is expected to be more important after 2030 and a revision of the existing urban planning is likely to be needed. It is worth noting here that in 2050 the share of hydropower in total net electricity production is expected to be 6.4 %, so that a 20 % reduction due to climate change is only 1.3 % of the total electricity mix, which could be easily compensated by other RES or by the limitation of exogenous electricity.

However, hydroelectric potential plays an important role in the stability and security of the future energy system. The total installed capacity of pumped cash units is expected to reach 1.928 MW in 2030 and 5.453 MW in 2050. The aspects of energy system security related to the climate vulnerability of pumped pumping units are addressed in subsection 3.2.9.

Bio-energy

Climate change is expected to ultimately have a negative impact on the growth rate and productivity of Greek forests and many agricultural crops and lead to a reduction in the amount of agricultural and forest residues and waste available in the agri-food sector. Also, a decline in energy crops is expected, as larger areas will be needed to compensate for the productivity of food crops.^{132, 133}

Improving the efficiency of agricultural, livestock, agro-industrial and municipal organic waste collection systems is expected to overcome potential reductions in the amount of remaining agricultural and forest biomass. Moreover, any shortages could be filled through imports from Central and Northern European countries, where instead from Greece and other southern European countries, climate change is expected to contribute to increasing biomass potential. In any case, given that the contribution of bioenergy to the overall pre-electricity mix will be close to zero by the year 2050, the impact of any reductions in it on wider energy planning is expected to be very close.

More detailed information on the impact of climate change on RES production in Greece can be found in Annex I.

With a view to further strengthening the climate adaptation dimension in RES policies and

measures:

- Development of maps of climate projections of RES potential at high spatial resolution. Prioritising the development of maps for offshore wind energy and hydroelectric and hydro-pumped potential.
- Integration of climate change adaptation into the emitted and revising spatial plans of energy interest, in particular by selecting priority, fit and carrier areas

¹³² European Environment Agency, Adaptation challenges and opportunities for the European energy system – Building a climate-resilient low-carbon energy system, Publications Office, 2019, <https://data.europa.eu/doi/10.2800/227321>.

¹³³ Drobinski P, Azzopardi B, Ben Janet Allal H, Bouchet V, Civel E, Creti A, Duic N, Fylaktos N, Mutale J, Pariente-David S, Ravetz J, Taliotis C, Vautard R 2020, Energy transition in the Mediterranean. In: Climate and Environmental Change in the Mediterranean Basin -Current Situation and Risks for the Future. First Mediterranean Assessment Report (Cramer W, Guiot J, Marini K (eds.)) Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 58pp, in press

https://www.medecc.org/wp-content/uploads/2020/11/MedECC_MAR1_3_3_Energy_transition_in_the_Mediterranean.pdf.

capacity to install coastal wind and new hydroelectric and land-based power plants.
131

- Strengthening the interconnection of water management, flood protection and hydropower plans.
- Programme for the gradual upgrading of electromechanical equipment for hydroelectric units.

3.2.10 summary of RES dimension measures and policies

Table 17 summarises the set of policy measures for the RES dimension:

¹³¹ Konsta, D., Panagopoulou, G., Kyriakopoulos, G. L., Methenitis, K., Grigoriadou, E., Voudoui, A., Asimakopoulos, D., Setz, I. (2024) LIFE-IP AdaptInGR – Boosting the implementation of adaptation policy across Greece. Action Deliverable C.5 Analysis of synergies and trade-offs between the 2050 Long-term Strategy and the National Strategy for Adaptation to Climate Change covering all economic sectors and exploring the impacts of climate change and synergies with adaptation measures.

Table 17 Policy measures for the RES dimension.

Numbering	Policy measure name	Correlation with-policy priorities	Target	Sector affected	Category of Measure
M1	Implementation of support schemes and use of differential pre-growth contracts (CfDs) of mature RES technologies and combination of these with storage	FP1.1, FP2.2, FP2.4, FP2.5	Increase in-electricity generation from RES	Generation eu conical energy	Regulatory,- Financial
M2	Development of new RES projects (with- or without battery) without the need for clandestine aid, through market participation and bilateral contracts to ensure their viability	FP1.1, FP2.2	Increase in-electricity generation from RES	Generation eu conical energy	Regulatory measure
M3	Promotion of the installation of electricity storage systems – either individual systems or combined with RES technologies	FP1.1, FP2.2, FP2.5	Increase in-electricity generation from RES	Generation eu conical energy	Regulatory measure
M4	Developing and supporting innovative and pilot projects and offshore wind farms with high domestic added value	FP1.1; FP2.1; FP2.2; FP2.3; FP2.5, FP2.8	Increase in electricity-generation from RES	Generation eu conical energy	Financial measure

Numbering	Policy measure name	Correlation with-policy priorities	Target	Sector affected	Category of Measure
M5	Ensuring Sustainability of Specialist RES Account	FP1.1, FP2.4	Increase in electricity-generation from RES	Generation eu conical energy	Regulatory,- Financial
M6	Development of environmental markets by using guarantees for the production of RES projects	FP1.1, FP2.4	Increase in electricity generation from RES; RES increase for heating/cooling; RES increase in transport	Generation eu heating and cooling of the metafosector	Regulatory,- Financial
M7	Development of climate blade maps of RES potential in high spatial analysis	FP1.1, FP2.1	Adaptation to Climate Change Increase in electricity-generation from RES	Generation eu conical energy	Administrative/- Major measure
M8	Updating, simplifying and optimising the functioning of the specific spatial context, including taking into account the climate change adaptation dimension	FP1.1, FP2.1	Increase in electricity generation from RES	Generation eu conical energy	Regulatory measure
M9	Updating, simplifying and optimising its operation	FP1.1, FP2.1	Increase in electricity-generation from	Generation eu conical energy	Regulatory measure

Numbering	Policy measure name	Correlation with-policy priorities	Target	Sector affected	Category of Measure
	specific spatial context – also taking into account the climate change adaptation dimension		Adaptation to Climate Change		
M10	Token and spatial framework for marine wind farms, also taking into account the climate adaptation dimension	FP1.1, FP2.1	Increase in electricity generation from RES Adaptation to Climate Change	Generation of renewable energy	Regulatory measure
M11	Plan for the development of hydroelectric and pumped storage units in connection with the Water Management Plans (RBMPs), Flood Protection (FRMP) and Climate Change Adaptation (RAS)	FP1.1; FP2.1; FP2.5	Increasing electricity generation/storage from RES Adaptation to Climate Change	Electricity-generation/storage	Regulatory measure
M12	Promotion of dispersed RES production with integrated storage moulds through self-consumption schemes	FP1.1, FP2.3, FP2.6, FP2.7	Increase in electricity-generation from RES	Generation of renewable energy	Regulatory measure

Numbering	Policy measure name	Correlation with-policy priorities	Target	Sector affected	Category of Measure
M13	Support for the development of RES energy projects (with or without storage systems from renewable energy communities and citizens' energy communities, including through the use of specialised financial tools	FP1.1, FP2.2, FP2.3, FP2.6	Increase in electricity-generation from RES	Generation and heating/cooling in all sectors consume written	Regulatory measure
M14	Promotion of the installation of Hybrid Power Stations on the Non-Interconnected Islands (NII)	FP1.1, FP2.1, FP2.2	Increase in electricity-generation from RES	Generation and conical energy	Regulatory measure
M15	Strengthening energy infrastructure (transmission and distribution walls) to deal with saturation phenomena. Development of new financial modules for rapid implementation of relevant projects	FP1.1, FP2.5	Increase in electricity-generation from RES	Generation and conical energy	Technical measure

Numbering	Policy measure name	Correlation with-policy priorities	Target	Sector affected	Category of Measure
M16	Designing interconnections based on optimum utilisation of RES potential and boosting green electricity exports	FP1.1, FP2.1, PP2.3	Increase in electricity generation from RES; RES increase for heating and	Generation eu conical energy	Technical measure
M17	Application of technical procedures and rules for the release by a local location of electricity space for the connection of new RES stations, together with operators' cooperation on a per-incremental basis to capture future network ranges	FP1.1, FP2.5	Increase in electricity-generation from RES	Generation eu conical energy	Regulatory measure, Technical measure
M18	Designation of priority areas (go to areas), development of agricultural PVS (double use of land) and exploitation of greenfield sites for the development of RES, taking into account also the dimension of adaptation to climate change	FP1.1, FP2.1, FP2.3;	Increase in electricity-generation from RES	Generation eu conical energy	Regulatory measure
M19	Promotion of RES installation in buildings	FP1.1, FP2.3, PP2.7	Increase in electricity-generation from RES	Generation eu heating and cooling in buildings	Financial measure

Numbering	Policy measure name	Correlation with-policy priorities	Target	Sector affected	Category of Measure
			RES increase for heating – cooling		
M20	Setting minimum thresholds for RES and removing barriers to installing RES and storage systems in buildings	FP1.1, FP2.6, PP2.7	Increase in electricity generation from RES; RES increase for heating/cooling	Generation eu heating/cooling in buildings	Regulatory measure
M21	Promotion of efficient heating and cooling systems using RES	FP1.1, FP2.7	RES increase for heating/cooling	Heating/cooling in all areas consume written	Financial measure, Technical measure
M22	Support and implementation of best environmental and energy-efficient bioenergy applications	FP1.1, FP2.7	RES increase for heating/cooling	Heating/cooling in all areas consume written	Financial measure
M23	Developing supply chains to make best use of bioenergy	FP1.1, FP2.7	RES increase for heating/cooling	Heating/cooling in all consumption-sectors	Financial measure, Technical measure

Numbering	Policy measure name	Correlation with-policy priorities	Target	Sector affected	Category of Measure
M24	Training/retraining actions for installers of RES specialists	FP1.1, FP2.3, PP2.7	RES increase	Electricity generation Heating – Cooling	Regulatory measure

3.3 policies and measures for alternative and climate-neutral gases and liquid fuel

The penetration of RES in electricity generation as well as the substitution of natural gas by electricity in the heating of buildings and industry sectors is leading to a gradual reduction in the overall consumption of gaseous fuels. At the same time, traded natural gas will be transformed into a mix of renewable gases. The main strategic option of the NECP is to gradually reduce the consumption and carbon footprint of gaseous fuels.

3.3.1 Measures and policies for the development of biomethane

The coordinated and effective promotion of biomethane as renewable gas requires the implementation of a comprehensive and coherent framework of policy measures, based on the following axes:

- The upgrade of existing biogas plants to biomethane plants, at least those adjacent to natural gas distribution or transmission networks. It is estimated that about half of today's biogas plants can be transformed into biomethane plants.
- The establishment of new biomethane plants, especially in rural/livestock areas.
- The injection of the produced biomethane into natural gas distribution networks (or gas transmission pipelines where this is economic), with a view to transferring it to final consumption.
- The possibility to use the produced biomethane in transport.

To this end, appropriate adjustments to the regulatory framework will initially be introduced by the end of 2024, with a view to specifying different elements, such as, but not limited to, defining the raw materials eligible for biomethane production, regulating all authorisation phases of biomethane plants, establishing rules for the injection of produced biomethane into the National Gas Transmission System or Natural Gas Distribution Networks, providing for actions to manage the biomethane produced more efficiently, connecting biomethane plants to the Transmission System or Distribution Network, including the conditions to be met for the implementation and operation of the Gas Transmission System, and finally establishing the Gas Transmission System by the National Gas Transmission System.

In addition, a support scheme for biomethane plants will be designed to achieve the start and scaling up of the production and use of Biocarbon in the best way in terms of cost benefit. The support scheme shall be preceded by the granting of investment aid and/or annual operating aid, to biomethane production units or biogas to biomethane upgrading plants, which are connected to the National Gas Transmission System or the Natural Gas Transmission Networks, as well as to non-connected plants. With a view to operating aid more efficiently, provision will be made for the establishment of a Special Biodiesel Account. Please note that

support for the use of the digested residue as a soil improvement agent under the support scheme will be explored.

Renewable gas certificates for biomethane, to be made available through auctions by the competent body, and the construction of the relevant market should additionally contribute to the further enhancement of biomethane plants. The necessary regulatory framework will be put in place to make use of the certificates, laying down all the details for issuing and cancelling certificates.

The seamless and continuous collection of the required raw materials is a particularly critical parameter for the promotion of biomethane. The supply chain required can be developed through the implementation of specific measures resulting from a study, such as:

- Aid for crop rotation actions for the use of intermediate crops as raw materials.
- Intensifying the collection of agricultural residues from the cultivation of cereals, which are not exploited and burned.
- Accelerate the collection of bio-based waste both by increasing the use of brown bins and by imposing a collection obligation on specific high-potential economic activities such as food industries, hospitals and hotels.
- Development of an integrated system for the management and collection of raw materials for the production of biomethane by municipalities setting specific quantitative targets and providing for aid if they are achieved.

In addition, targeted pilot actions will be planned to promote forged and liquefied biomethane in areas not covered by the natural gas transmission system and natural gas distribution networks.

Finally, support will be given to the implementation of information and awareness-raising actions among all stakeholders regarding the further exploitation of biomethane and the overall benefits of using biomethane, including the promotion of the circular economy and the use of digested residue as a soil improvement, and the need to collect the required raw materials with all.

Table 18 Policy measures for the development of biomethane.

Numbering	Policy measure name	Correlation with-policy priorities	Target	Mouldaffected	Category of Measure
M1	Develop a regulatory framework for the promotion of biomethane	FP1.1, FP1.3, FP1.7	Reduction ofGHG emissions and-increased RES penetration	Total final-consumption sectors	Regulatory measure
M2	Implementation of a support scheme for biomethane plants	FP1.1, FP1.3, FP1.7	Reduction ofGHG emissions and-increased RES penetration	Total final-consumption sectors	Financial measure
M3	Promotion of certificatesfor fusible gas from biomethaneproduced	FP1.1, FP1.3, FP1.7	Reduction ofGHG emissions and-increased RES penetration	Total final-consumption sectors	Regulatory measure
M4	Creating a supply chain through the implementationof targeted actions to collect the required raw materials	FP1.1, FP1.3, FP1.7	Reduction ofGHG emissions and-increased RES penetration	Total final-consumption sectors	Normative; Financial measure
M5	Design pilot actions to promote compressed andwetted biomethane in areas not covered by natural gasdelivery and distribution systems	FP1.1, FP1.3, FP1.7	Reduction ofGHG emissions and-increased RES penetration	Total final-consumption sectors	Financial measure

Numbering	Policy measure name	Correlation with-policy priorities	Target	Mouldaffected	Category of Measure
M6	Implementation of information and awareness-raising actions to all interested benefits for the furtherpromotion of biomethane	FP1.1, FP1.3, FP1.7	Reduction ofGHG emissions and-increased RES penetration	Total final-consumption sectors	Information and awareness raising measure

3.3.2 Measures and policies for the development of green hydrogen

In order to acquire know-how on green hydrogen production, as well as to develop the national market for green hydrogen, the initial implementation of a limited number of small and medium-scale projects makes sense. The surrounding projects can, in a subsequent phase, be developed into green hydrogen projects with a French scale to meet domestic needs on the path of full carbonisation of the economy by 2050, and the possibility of exports in the long term will also be considered. However, in order to make these projects commercially viable, they need financial support. A support scheme for green hydrogen pilot projects, which will act as a solution for the development of local, regional and national green hydrogen value chains, is therefore envisaged. The financial support under this measure is expected to be provided in the form of investment aid for the installation costs of electrolysis systems, from which green hydrogen will be produced from renewable electricity, in compliance with the requirements established by European legislation. The implementation of alternative mechanisms, such as the introduction of tax incentives and the provision of low-interest loans to obtain the necessary financial resources, will also be explored.

It is estimated that hydrogen produced by 2030 will be used for the treatment of synthetic fuels (synthetic kerosene and synthetic methanol) as well as for pilot projects for hydrogen-powered buses (approximately 50 for Athens and Thessaloniki). The general principle is the use of hydrogen in hard-to-abate sectors.

In order to achieve the objectives outlined in the NECP for the post-2030 year, a drastic increase in the installed power of electrolysis systems used for green hydrogen production must take place. Depending on developments in technologies for the use of hydrogen and its derivatives, relevant investments in hydrogen production will be promoted and incentives will be considered in line with the funding programmes developed at Community level.

The financial support model of the European Hydrogen Bank is a good starting point and experience will be properly exploited. It is likely that the infrastructure of the European Hydrogen Bank will be used to highlight the projects that will benefit from State aid.

The financial support granted for the production of green hydrogen is estimated to reduce the costs of this hydrogen and thereby incentivise the replacement of fossil fuels. However, this support may not be sufficient to promote the large-scale roll-out of hydrogen, also due to unnecessary difficulties, such as the need to invest on the demand side. For this reason, the development of the green hydrogen market in Greece would also require the establishment of appropriate demand-side support tools.

The obligation of quotas for the consumption of green hydrogen is seen as an effective mechanism for the development of the market for green hydrogen, provided of course that the applications concerned are technically and economically mature. The measure of quota obligations will lead to significant increases in consumer prices while climate-neutral fuels are

still much more expensive than drinking fossil fuels. In order to avoid negative side effects, subsidising the price of climate-neutral fuels and/or exempting them from taxes may be considered appropriate. In addition, excise duties and the valuation of carbon dioxide emissions from fossil fuels should be maintained. It should be noted that, due to tourism accounting for 13 % of the country's GDP, a sudden increase in the cost of air and coastal shipping would have a significant negative impact on the Greek economy.

It is worth mentioning that the definition of criteria for prioritising green hydrogen investments to be strengthened is being considered. The criteria that will contribute to the selection of green hydrogen projects are briefly:

- The consumption destination of green hydrogen.
- The way in which the electricity needed to produce green hydrogen is produced.
- The current and future availability of water resources and the existence of water-grade hydrogen production in the area where the investment is located.
- The possibility of leveraging investments.
- The integration of production with supply chain infrastructure.
- The impact on employment and added value for the domestic economy.

Finally, other measures and policies considered are:

- Support the development of hydrogen equipment production (electrolysis systems, fuel cells, hydrogen storage cylinders, etc.).
- Support the transformation of users' facilities and equipment for the production, distribution and use of green hydrogen in place of fossil fuel (industry, transport).
- Reduction of environmental and energy taxes and levies for the production and use of green hydrogen and its derivatives.
- Establishment of an institutional framework for the licensing and construction of stops for the production and use of green hydrogen.
- Implementation of an organisation for the certification of renewable fuels.

3.3.3 Measures and policies to promote renewable liquid fuels

The development of renewable liquid fuels of non-biological origin (synthetic fuels) is expected to start already in 2030 and to rise after 2040, when technologies for the use of synthetic fuels are expected to mature further technically and economically. Synthetic fuels are intended for metropolitan sectors where the electro-mobility alternative (in particular shipping and aviation) cannot be applied.

In order to achieve the objectives set out in the NECP, the following measures and policies

have been selected:

- Adopt legislation providing for corresponding obligations on fuelsuppliers or other actors involved (airlines, etc.).
- Organisation of a scheme to certify the production or import of renewable fuels.
- Cover obligations through green certificates in line with practice to be developed in the EU.
- Encouraging the reduction of the consumption of liquid or gaseous fuels in the after-air by means of measures such as the use of NMMs, electrification and extension of means to the hot track, the promotion of electrification of passenger and other road transport (where technically possible) and the electrification of boat berths and cold ironing.
- Fiscal and/or other financial incentives, in order to contain the increase in unit transport costs resulting from the increased production costs of renewable fuels, with a particular focus on disproportionately affected vulnerable citizens and businesses.

As the production and penetration of renewable fuels in transport is currently in an embryonic phase, the measures will evolve in line with the good practices developed at EU level and the available financial means.

Finally, the implementation of the legislation on sustainable aviation (ReFuelEU Aviation) leads to the development of the production of sustainable aviation fuel (SAF) of biological or non-origin origin. Projects are already being developed by the Greek refineries and there is expected to be a financial contribution from EU funds (or national funds as far as possible).

3.3.4 Assessing the climate vulnerability of policies and measures on renewable liquid and gaseous fuels

Hydrogen

Hydrogen production facilities are particularly hydronorth as they require drainage of water not only as a raw material for its production, but also through cooling. Water consumption for hydrogen production by electrolysis is estimated at approximately 300 m³/GWh H₂.

Water consumption for hydrogen production can have a significant impact on the local water balance, especially in areas where water resources are limited and are projected to be subject to additional pressures due to climate change. Indeed, in the case of the RCP4.5 scenario, the average total rainfall in the period 2031-2060 is expected to decrease by up to 15 % compared to the reference period 1971-2000, which, in combination with an increase in evapotranspiration and surface run-off, is expected to cause a reduction in the available

waterdoor¹³⁵.

Reducing the availability of water resources and the consequent intensity of competition for water uses (e.g. agriculture, tourism, mining) at local or regional level can be a barrier to the development of hydrogen value chains.

By making the future availability of water resources and the existence of competing water uses a criterion for selecting 'hydrogen valleys' and siting single electrolysis blocks for green hydrogen production, the associated risks can be reduced and even avoided. The use of alternative water sources would also help to address the reduced availability of water. Seawater desalination could be used as an alternative source of water in the case of islands and coastal areas. The effluent water of the waste water treatment plants could be used¹³⁶. The size and quantity of waste water treatment plants are proportionate to the population they serve, with the largest plants located in the country's major urban centres, which are at the same time important industrial centres and important nodes of the supply chain and maritime and air transport. Therefore, this alternative puts hydrogen production plants closer to end users, making it a promising solution for further investigation. Under this NECP, pilot projects for the production of green hydrogen using effluent water from wastewater treatment plants will be developed.

Also, demand reduction, more rational management, recycling and re-utilisation of water resources, to be achieved through the implementation of the relevant measures of the National Strategy and Regional Plans for Adaptation to Climate Change (see Section 3.8), River Basin Management Plans, Flood Risk Management Plans and Circular Economy promotion policies (see subsection 3.1.6) are expected to further mitigate the effects of climate change and improve the availability of water resources for hydrogen production.

Finally, the dependence of the development of hydrogen value chains on the availability of water resources can be reduced through the selection of fewer water-choking technologies in its production facilities. As hydrogen is planned to match in the energy mix after the year 2030, it is expected to benefit from the or unreasonable developments in the efficiency of the electrolysis process and the reduction of water cooling needs. The introduction of appropriate financial incentives and the establishment of appropriate conditions and criteria in support schemes can contribute to the selection of less intensive and water-intensive technologies.

Biofuel – Biomethane

Climate change is expected to affect the productivity of Greek agricultural crops and despite variations by type of crop cause a decrease in the total amount of agricultural residues and

¹³⁵ RIS geospatial information portal. Climate change: https://mapsportal.yopen.gr/thema_climatechange.

¹³⁶ Philip Woods, Heriberto Bustamante, Kondo-Francois Aguey-Zinsou, The hydrogen economy – Where is the water? Energy Nexus, Volume 7, 2022, 100123, ISSN 2772-4271, <https://doi.org/10.1016/j.nexus.2022.100123>.

waste available in the agri-food sector for biomethane production. Improving the implementation and efficiency of waste management and circular economy systems is expected to compensate for losses, at least by the year 2030. Any significant reduction in biomass available for biofuel and biomethane production after the year 2030 could be considered in future NECP revisions taking into account technological developments and the availability and sustainability of other alternative fuels, as well as the possibility of imports from Northern and Central European countries whose agricultural production and more generally biomass production would benefit from climate change¹³⁷.

The table below summarises the policy measures envisaged for renewable hydrogen and renewable fuels of non-biological origin.

¹³⁷ Drobinski P, Azzopardi B, Ben Janet Allal H, Bouchet V, Civel E, Creti A, Duic N, Fylaktos N, Mutale J, Pariente-David S, Ravetz J, Taliotis C, Vautard R 2020, Energy transition in the Mediterranean. In: Climate and Environmental Change in the Mediterranean Basin -Current Situation and Risks for the Future. First Mediterranean Assessment Report (Cramer W, Guiot J, Marini K (eds.)) Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 58pp, in press
https://www.medecc.org/wp-content/uploads/2020/11/MedECC_MAR1_3_3_Energy_transition_in_the_Mediterranean.pdf.

Table 19 Policy measures for the development of green hydrogen and the promotion of renewable liquid fuels.

Numbering	Measure	Objectives	Sector affected	Category of Measure
M1	Development of an institutional framework for siting and licensing installations for the production of green hydrogen and synthetic fuels including safety regulations	Decarbonisation, energyindependent	Industry, transport	Regulatory
M2	Organisation of a green and synthetic fuel certification scheme	Decarbonisation, energyindependent	Industry, transport	Regulatory
M3	Development of a scheme to support the production of green hydrogen and synthetic fuels and implementation of pilot projects	Decarbonisation, energyindependent	Industry, transport	Regulatory, Financial, Technical
M4	Obligation of renewable energy quotas in transport fuels and industry (after Community legislation)	Decarbonisation, energyindependent	Industry, transport	Regulatory
M5	Development of a support scheme for the production of green hydrogen and synthetic fuels as part of more general legislation to support the production of green production equipment	Decarbonisation, energyindependent	Industry, transport	Regulatory, Financial
M6	Developing a tax regime for the use of renewable gases and liquid fuels as part of a more general revision of the energy taxation system	Decarbonisation, energyindependent	Industry, transport	Economic

Numbering	Measure	Objectives	Sector affected	Category of Measure
M7	Provide financial incentives for the development of sustainable aviation fuel production units including synthetic exhaust	Decarbonisation, energy independent	Industry, transport	Economic

3.4 energy efficiency improvement

The energy efficiency improvement target for 2030 implies significant energy savings in view of economic growth and the projected increase in national income.

Economic growth is accompanied by an increase in industrial production, with an increase in energy consumption, the mitigation of which is limited by industrial efficiency measures.

In addition, growth and income growth leads to increased mobility of passengers and goods and thus to an increase in final energy consumption, despite electromobility measures, which significantly reduces the energy consumption of a vehicle, and tightening standards for new vehicles.

Measures in the transport sector need time to deliver on all energy consumption as they apply to new vehicles. To achieve this energy efficiency improvement target, a coherent set of policy measures is envisaged, which are presented below with specific policy priorities.

The definition of policy measures to improve energy efficiency has actually been designed to cover eleven different Policy Priorities (FP3.1-FP3.11), illustrated in Figure 10.



Figure 10 Policy priorities for improving energy efficiency in 2025-2030.

3.4.1 Measures and policies to improve energy efficiency in the building sector – Long-term renovation strategy of the national building stock

The long-term renovation strategy for the building stock will be revised in line with the provisions of Directive (EU) 2024/1275 of the European Parliament and of the Council of 24^{April} 2024 on the energy performance of buildings, taking into account the increased renovation target of the building stock that has been established with a view to the full decarbonisation of buildings by 2050.

The objective of this strategy is the technical/economic analysis and demonstration of the best measures to fulfil the high rate of renovation and decarbonisation of the building stock. A critical aspect is the implementation of targeted policy measures to mobilise the investment needed to meet the strategy's objectives by capitalising on existing measures and

programmes.

In any case, the operating framework of the existing programmes will be improved, with the aim, by way of example, of increasing potential beneficiaries, promoting the most cost-effective and cost-effective interventions, reducing bureaucracy, reducing possible operational problems, involving domestic financial institutions more closely in financing the necessary interventions and promoting leadership in the domestic manufacturing and manufacturing industry. Priority will be given to implementing different interventions (e.g. upgrading the building envelope, draining heating, RES in buildings) with a view to optimising the available resources and maximising the benefits.

Successful funding programmes to improve the energy efficiency of residential buildings will continue seamlessly, and I will be amended accordingly to target more effectively the support of economically vulnerable and inactive vulnerable households. The focus is on adapting and improving the financing model in place with a view to increasing existing leverage levels by beneficiaries. At the same time, the possibility of shortening the framework of existing household tax exemptions will be explored with a view to speeding up the necessary energy renovation interventions with alternative financing routes.

The implementation of financing programmes to improve energy efficiency in enterprises will be intensified in conjunction with the already institutionalised tax incentives to promote energy and water saving actions in businesses. In addition, the aim is to remove barriers to access to the required financing by providing both soft loans and guarantees, while alternative supply mechanisms, such as Energy Efficiency Contracts, will be promoted. The role of energy audits and the development of integrated management systems in tertiary sector buildings through appropriate actions to promote them should be a catalyst. Please note that the framework for energy audits will be amended in line with the provisions of Article 11 of Directive (EU) 2023/1791 of the European Parliament and of the^{Council} of 13 September 2023 on energy efficiency.

In the case of public buildings, actions such as, for example, the promotion of the exemplary role of the State by improving the existing 'Ileectra' programme for the energy upgrading of public and municipal buildings or through similar programmes, and the continuous monitoring of the energy consumption of public buildings with the aim of reducing energy consumption annually in all public bodies will be maintained. In any case, the promotion of measures and programmes that are technically feasible and optimal in terms of societal costs and results, covering the overall use of energy consumption, will be a key priority for public buildings. In addition, the financing of energy grades in public buildings will be carried out on the basis of the municipal and regional energy efficiency action plans and municipal emission reduction plans. To this end, the digitalisation of the above projects will be pursued in order to monitor their implementation more efficiently. It is important that the role of energy managers in

public buildings should be improved, as it is already added as a condition to pre-financing the energy upgrading of public buildings. The electronic platform to follow the energy behaviour of public buildings aims to co-operate the work of energy managers.

Please note that the above policy measures are appropriately designed to encapsulate the provisions of Directive (EU) 2024/1275 of the European Parliament and of the Council of 24^{April} 2024 on the energy performance of buildings, such as the obligation that all new residential and non-residential buildings must have zero on-site fossil fuel emissions from 1^{January} 2028 for public buildings and from 1^{January} 2030 for all other new buildings, with the possibility of specific exemptions. In addition, provision is made for the imposition of minimum efficiency standards, the phasing out of fossil-fired boilers, the increase in RES energy in buildings (enhancing direct use) and the availability of infrastructure in buildings to accommodate RES.

Priority will be given to designing targeted measures for the most effective and transparent way to share the benefits arising from the implementation of energy efficiency improvement interventions between tenants and landlords to address existing barriers. At the same time, a more structural decision-making framework in multi-apartment buildings will be sought to ensure that energy efficiency improvement measures are seamlessly implemented.

In addition, as a horizontal measure, the energy upgrading of public and private buildings will also be linked with measures to improve their accessibility to people with disabilities.

At the same time, alternative financing mechanisms such as energy efficiency contracts in particular for public buildings are being promoted at an increasing rate. To this end, a central programme for the energy upgrading of public buildings through energy performance contracts is planned, based on the prioritisation and grouping of public buildings with a view to launching targeted sub-programmes based on the buildings to be included in each group. Specific financial instruments are intended to support energy service enterprises that will undertake the energy upgrading of buildings under the planned measure, such as the provision of low-interest loans and guarantees in line with the provisions of the State aid framework.

The promotion of energy services will be carried out in accordance with the provisions of Article 29 of Directive (EU) 2023/1791 of the European Parliament and of the Council of¹³ September 2023 on energy efficiency, while for the reduction of renovations of large non-residential buildings with a total useful floor area over 750^m 2 it will be ensured that public bodies assess the feasibility of using energy performance contracting and other performance-based energy services.

The use of RES systems for heating and cooling (mainly heat pumps and solar thermal systems) will be enhanced by combining different policy instruments in full compliance with the projections of the comprehensive assessment to promote efficient heating and cooling, which will be appropriately revised in the light of the new energy savings and RES targets. The

updated comprehensive heating and cooling assessment will be prepared in accordance with the provisions of Article 25 of Directive (EU) 2023/1791 of the European Parliament and of the Council of¹³ September 2023 on energy efficiency by applying the principle of 'minimum efficiency first'. In addition, local heating and cooling plans will be drawn up in municipalities with a total population of more than 45 thousand inhabitants, and specific financial tools and technical support actions will be provided for to promote efficient heating and cooling systems to be integrated into them.

Targeted programmes to promote specific RES systems for display and cooling will be implemented, while existing programmes will be strengthened. A phase will be given to the promotion of RES for the direct production of heating, cooling and hot water through technologies such as solar thermal systems, heat dishes and biomass. It will also seek to strengthen RES combinations (e.g. solar thermal with heat pumps, photovoltaics with heat-pumps, solar thermal with biomass, solar thermal with geothermal) and to promote energy produced on-site or nearby from RES. The planned financial programmes will contribute to the promotion of economically optimal RES systems by category of final consumer, while taking into account their contribution to the respective target.

The focus is on increasing nearly zero-energy and zero-carbon buildings, in line with the requirements of Directive (EU) 2024/1275 of the European Parliament and of the Council of 24^{April} 2024 on the energy performance of buildings. To this end, new regulatory and financial measures to create the right framework and create incentives for new and radically renovated buildings will contribute to maximising the number of buildings, with improved efficiency in relation to the minimum energy performance requirements.

In any case, synergies with policy measures to promote self-consumption of electricity will be maximised in the context of the above measures, facilitating greater penetration of RES into the building stock.

The implementation of information and training actions on energy efficiency will focus on raising awareness and ultimately encouraging final consumers to adopt more rational energy use practices in buildings. The upgrading of the role of Energy Performance Certificates is expected to contribute to this by exploring alternative ways of transforming them into customised energy upgrading road maps of buildings or showing buildings. The upgrading of the Energy Performance Certificates will be carried out in accordance with the provisions of Directive (EU) 2024/1275 of the European Parliament and of the Council of 24^{April} 2024 on the energy performance of buildings, making them a key tool for assessing the performance of buildings and increasing the penetration of RES by taking into account all life-cycle greenhouse gas emissions.

At the same time, the need to develop new schemes for the recognition of qualifications, accreditation and certification of installers has been recognised to ensure that energy-saving

interventions are properly implemented and that the maximum potential of technologies is exploited.

In the same context, the Single Stage Services may facilitate the implementation of energy efficiency improvements in the building sector. Targeted actions will be launched with a view to establishing One Stage Services in each region by providing support to all phases needed to decarbonise the building stock.

Finally, the focus will be on regulating the quality of the indoor environment and the indoor conditions that must be maintained in buildings in order to ensure healthy conditions in accordance with the provisions of the above EU Directive. The installation of metering and control devices to monitor and regulate indoor air quality, as well as the Energy Performance Certificates and the smart readiness indicator, will be launched to this end.

3.4.2 Measures and policies to improve energy efficiency in the industrial sector

Priority shall be given to targeted energy saving programmes in spillovers and in industry with a focus on production processes. More specifically, the implementation of the energy saving measures proposed by the energy audits under Article 11 of Directive (EU) 2023/1791 of the European Parliament and of the Council^{of} 13 September 2023 on energy efficiency is directly driven by the financing programmes for improving energy efficiency in tertiary SMEs in conjunction with the already established tax incentives.

The aim is to continue the financial incentives for SMEs as well as to introduce additional incentives for the implementation of energy saving measures proposed by the energy audits also to obligated large companies in the industrial sector. In addition, new measures will be designed to support the implementation of energy management systems in non-obligated SMEs with the aim of continuously improving their energy efficiency and promoting electrification in an orderly manner. It should be noted that these policies are expected to significantly enhance the competitiveness of businesses, while at the same time being shielded from the effects of future energy crises.

For the industrial sector in particular, priority shall be given to specific programmes for concluding programme agreements with industries and manufacturing enterprises to provide financial incentives to improve energy efficiency, provided that specific targets for both energy savings and greenhouse gas emission reductions are met. In addition, a package of measures is planned to provide financial incentives to promote efficient heating and cooling systems including RES technologies and the utilisation of waste heat in full compliance with the projections of the comprehensive assessment to promote efficient heating and cooling. In addition, further use of bioenergy to meet the thermal needs of manufacturing and industrial/craft enterprises will be sought.

Additional specific financial mechanisms will be designed to strengthen the material

implementation of energy efficiency improvement measures in the industrial sector through energy efficiency contracts, such as subsidising costs and facilitating access to finance for energy service companies.

It is worth mentioning the obligation to reduce emissions by at least 30 % by 2030 compared to 2019 for projects and activities in the public and private sector, the construction or operation of which may have an impact on the situation and do not fall within the scope of the European Emissions Trading System (ETS), in accordance with the provisions of Article 19 of the Climate Law (Law 4936/2022, Government Gazette, Series I, No 105).

Finally, the existing framework for mandatory energy audits in enterprises with high energy consumption will be significantly strengthened also in view of the new provisions of the Revised Directive (EU) 2023/1791 of the European Parliament and of the Council of 13^{September} 2023 on energy efficiency and amending Regulation (EU) 2023/955 (Article 11). More specifically, the existing electronic file of energy audits will be upgraded to constitute a single system for reporting and monitoring the energy consumption of those liable for operations in the tertiary sector, industry and transport in accordance with the above EU Directive. This system will integrate existing systems (ETMEAR roll-over system and tax – exemptions for manoeuvres) and enable the introduction and systematic monitoring, in a simpler and more comprehensive manner, of new reporting obligations, energy audits, agreements and action plans depending on the sector and the level of energy consumption, encouraging harmonisation and simplification of procedures. In addition, the development of this system will provide for the creation of an open database of energy efficiency measures in the industrial and tertiary sectors in order to increase the efficiency of energy audits, especially in the industrial sector (best practices). This unprecedented approach will be combined with the obligation to report on the implementation of energy audit recommendations by obligated undertakings in accordance with Directive (EU) 2023/959 of the European Parliament and of the Council of 10^{May} 2023 amending Directive 2003/87/EC establishing a system for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 concerning the establishment and operation of a market stability reserve for the Union-greenhouse gas emission trading system and the conditions for the free allocation of allowances.

3.4.3 Market mechanisms

The promotion of energy efficiency interventions will be facilitated by the activation of market mechanisms. In this respect, the scheme of the Energy Efficiency Obligation Scheme will maintain a key role, together with alternative policy measures in achieving the energy savings target. The allocation of the target to obligated parties will take into account the achievable techno-economic potential of energy savings in the sectors of activity of the obligated parties and the mix of alternative policy measures to be designed.

At the same time, possible support for obligated parties will be explored through the development of the institutional framework for the repayment of savings investments through on-bill financing and the exploitation of alternative policy measures.

Accordingly, consideration will be given to further extending the existing scheme through the operation of a mechanism analogous to white certificates, with energy token. The use of specialised innovative digital modelling as an incentive for the combined lifecycle of a building, starting from the design/construction phase to operating and adapting it to the ever-changing needs of the enterprises and organisations using it, can particularly contribute to the achievement of the objective.

Competitive processes for achieving energy savings are a rather promising market mechanism, which aims to promote energy efficiency improvement actions in specific sectors in an orderly and efficient manner, as it is the tertiary and industrial sectors. Competitive procedures will insure the implementation of energy efficiency improvement interventions in the most cost-effective and cost-effective way, as well as reducing the risk of third parties implementing interventions through the bundling of small projects.

3.4.4 Horizontal measures and policies

The achievement of the above objectives relating to the improvement of energy efficiency is ensured by applying the Energy Efficiency First principle by prioritising the selection of the most efficient liver measures and at the same time leading to multiple benefits across all final and tanker sectors, such as reducing energy costs, improving conditions in buildings, increasing workers' productivity, increasing domestic value added and employment and improving the competitiveness of manoeuvres. To this end, the framework for the application of this principle will be developed in accordance with the provisions of Article 3 of Directive (EU) 2023/1791, including the designation of the body responsible for monitoring implementation, the development of guidelines and tools, the provision of technical support, etc.

In addition, the implementation of the programme to replace old and energy-intensive electrical appliances with new more energy efficient appliances will be strengthened through the provision of a subsidy for the household sector. These programmes aim to counteract specific categories of energy-intensive household electrical appliances, with new, technologically advanced, environmentally friendly, more energy-efficient appliances, while ensuring the recycling of old electrical appliances that become resistant to them.

It should be noted that the political priority is to support final consumers in the purchase of durable, advanced and low-carbon goods in order to ensure that energy consumption is reduced.

Particular emphasis is expected to be placed on the installation of advanced light systems in the tertiary sector (including the public sector) and on walking, contributing to the

achievement of energy efficiency objectives. The special programme of the Deposits and Loans Fund for the upgrading of municipal streetlighting will continue with the aim of reducing energy consumption, while new tools will be designed for the energy upgrading of streetlighting through Energy Efficiency Contracts. Measures to modernise water/sewerage and irrigation infrastructure will be launched to this end, with the aim of saving water and energy at the same time.

A specific set of policy measures aimed at improving energy efficiency in the agricultural sector is being studied. Examples include both the planned measure to improve the energy efficiency of pumping stations and new measures such as the energy upgrading of agricultural machinery and the reduction of energy consumption in greenhouses and livestock farms.

As part of a holistic approach, the design and implementation of policy measures in the areas of buildings, transport and networks is strongly driven by the promotion of climate-neutral cities. In particular, both buildings and vehicles, as independent entities, will be able to communicate and interact, through support structures based on the use of advanced ICT technologies. Smart meters and smart grids will be a key part of these projects, allowing for the monitoring and management of the large volumes of charge needed for their harmonious operation. The completion of the smart meter development programme will significantly contribute to the rational use of energy by final consumers. In addition, combined with the new normal framework of the demand response mechanism, better electricity load scoring and peak load management are expected to be achieved. It is worth mentioning that the proposed holistic approach should include both the stimulation of climate-friendly urban planning and the promotion of new materials to reduce heating and cooling needs.

Targeted information and training actions on energy efficiency in sectors outside the buildings sector will be designed to raise awareness and ultimately encourage final consumers to adopt more rational energy use practices in all final consumption sectors. To this end, the establishment of networks with the active involvement of all stakeholders with a view to fruitful discussions and the participatory design of the necessary policy measures to achieve the objectives of improving efficiency will be launched.

Finally, information will be collected on the operation of data centres with a power demand of the installed information technology of at least 500 kW in line with the provisions of Article 12 of Directive (EU) 2023/1791, while pilot energy saving actions will be planned in the most energy-intensive data centres.

3.4.5 Measures and policies to achieve the objective of Article 8 of Directive (EU) 2023/1791

The achievement of this target under Article 8 of Directive (EU) 2023/1791 will be achieved by combining the Energy Efficiency Obligation Scheme with a mix of alternative policy measures (Table 20).

More specifically, the Energy Efficiency Obligation Schemes will consume 24% of the total cumulative target over the period 2021-2030, while a total of ten alternative policy measures will be implemented to cover the remaining one, reflecting the main policy priorities and the most important energy efficiency improvement measures.

Table 20 Mixture of policy measures to achieve the objective of Article 8 of Directive (EU) 2023/1791.

N/A	Policy measure	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total young EU (ktoe)	Total EU heaths (ktoe)
1	Energy upgrading of residential buildings	31	44		50	243	243	243	243	243	243	1.581	6.154
2	Promotion of energypedal heating and cooling systems in residential buildings					24	21	12	5	6	6	74	331
3	Promotion of energysupplies in residential buildings		1									1	5
4	Energy upgrading of public buildings					34						34	204
5	Improving energy efficiency in the industrial and tertiary sectors					32	28	22	19	15	27	143	532
6	Energy managers in public buildings	0,2			47	46						93	607
7	Energy upgrade of the-bedrock	1				5	5	5				16	86
8	Improving energy efficiency in the transport sector					7	7	7	7	7	7	42	147
9	Promotion of electro-mobility in road transport	2	2	4	7	18	18	18	18	18	18	121	489
10	Energy efficiency charging schemes		299	299	300	300	300	300	300	300	300	2.698	2.698

N/A	Policy measure	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	Total young EU (ktoe)	Total EU heaths (ktoe)
Total young EU (ktoe)		34,2	346	303	404	708	621	606	591	589	601	4.803	
Total cumulative EU on an annual basis (ktoe)		346	720	331	1025	2750	1904	1523	1174	878	601	11.251	

3.4.6 Measures and policies to address energy poverty

The policy measures to be implemented to address energy poverty can be grouped into three different dimensions. Initially, the policy measures of the first dimension (**Dimension I: Consumer protection – Immediate impact on the most vulnerable households**) aim to protect affected households in the short term. The long-term response to the phenomenon can be achieved through policy measures in the second by way of action (**Dimension II: Development Perspective – Construction of Energy Governance: Actions to improve energy efficiency and increase the use of RES**), while the third dimension includes information and awareness-raising actions (**Dimension II: Information, training and coordination actions**).

The policy measures to be implemented to achieve the objective of tackling energy poverty for each of the dimensions of the respective Action Plan shall be:

DIMENSION I: CONSUMER PROTECTION – DIRECTORATE OF PROVISIONS WITH PROCEDURES IN THE FRAMEWORK OF VULNERABLE HOUSEHOLDS

○ M1: Social tariff scheme and mitigation of the impact of the energy cost crisis

Policy measure M1 aims to maintain and improve the shape of the French tariff for the supply of electricity to households affected by energy poverty.

This policy measure provides for the adoption of a preferential price for the sale of electricity in the case of affected households, which are experiencing energy poverty. The preferential tariff will concern the amount of electricity until the minimum thermal and cooling comfort conditions are met throughout the year, including the electricity consumption of other uses of affected households, which are included in this policy measure. This measure may be applied with the aim of (a) avoiding the transition of households with specific characteristics to the category of those affected by energy poverty due to adverse economic conditions and (b) alleviating the intensity of energy poverty in affected households by facilitating access to a minimum level of required energy services.

In any case, the design of the specific policy measure is proposed to comply with the conditions set out in Article 5 (4) and (5) of Directive (EU) 2019/944 on public interventions in the price setting for the supply of electricity.

This policy measure may be extended to other energy products, which may be subsidised as they have a decisive influence on the development of energy poverty.

○ M2: Regulatory package to protect affected households

Policy measure M2 envisages the continuation of the targeted regulatory and regulatory measures, which are already in force, and their possible reinforcement in order to better protect affected households from energy poverty.

Key regulatory and regulatory measures will include:

1. Maintaining the existing provision for the automatic transition of vulnerable household customers to the Universal Service regime in the event of delays in the payment of energy bills, provided that they call the criteria for determining the households affected.
2. Setting a threshold for minimum consumption of energy products on an annual basis below which disconnection of affected households is prohibited.
3. Facilitating repayment and adopting a more flexible and more favourable settlement of overdue debts of affected households in specific cases (e.g. the possibility of partial and interest-free repayment based on a percentage of the monthly expenditure of affected households). Examples of such cases may be periods with prolonged economic recession, periods with particularly low temperatures and severe weather phenomena that will be discovered by climatic zone in Greece, etc.
4. Redesigning energy bills to make them simple, accessible, understandable and comprehensive with regard to the information needed to tackle energy poverty.

The focus will be on adopting initiatives for the rapid promotion of smart meters, leading to the implementation of the regulatory measures envisaged and enabling self-control and management of consumption. In addition, ensuring the minimum guaranteed electricity supply of households affected by energy poverty through the installation of smart meters will be explored by providing planned and fully controlled minimum electricity to ensure the decent living of people and families affected by energy poverty. The development of smart meters may be promoted more strongly in conjunction with the implementation of policy measure M4 and the more active involvement of electricity and gas supply providers, ensuring that the participation of operators does not conflict with the regulatory provisions on the responsibility of distribution network operators in the installation of smart meters, but that personal data will be handled in accordance with the provisions of the legislation in force.

The forecasts for the above measures will be incorporated into the supply codes for natural gas and energy under the supervision of the RAE. In addition, RAE will be responsible for continuously evaluating and carrying out systematic audits of the regulatory and regulatory framework to be established.

DIMENSION II: DEVELOPMENT FORESIGHT – STRUCTURAL RESPONSE TO ENERGY IN THE-PIPELINE: ACTIONS TO IMPROVE ENERGY EFFICIENCY AND INCREASE THE NEED FOR RES

- **M3: Energy upgrading of residential buildings of affected households and promotion of the installation of RES stations to cover their energy needs**

Policy measure M3 aims to address energy poverty in the structural and long term by providing financial support to promote energy efficiency improvements and the installation of RES systems to meet the overall energy needs of affected households in the most efficient, technical and economic manner.

The maximum subsidy rate will be determined taking into account the real ease of equity contribution by affected households for their participation in this policy measure. In the case of just development transition regions and regions with special characteristics, a higher subsidy rate will be considered.

The implementation of policy measure M3 may be combined in addition to the pre-letters of refurbishment of the building stock, which will be applied to the shock of residential buildings at national level.

The main pillars of this policy measure will include aid, either in combination or individually, for the following energy saving and RES measures:

- Energy upgrading of the building envelope.
- Installation of energy-efficient heating, cooling and producing hot water systems.
- Installation of energy-efficient and smart appliances.
- Installation of RES systems for self-consumption of electricity in accordance with the provisions of Article 21 of Directive (EU) 2018/2001 for renewable self-consumers and Article 15 of Directive (EU) 2019/944 for active customers.

It should be noted that priority will be given to renovating residential buildings with the lowest energy efficiency (worst performing buildings), combining the implementation of ramps in the building envelope and the installation of energy-efficient heating, cooling and hot water systems.

In addition, the participation of affected households in resource and demand management schemes will be explored, as will the installation of storage systems with the aim of maximising self-consumption by identifying electricity generated from RES.

Excess electricity, which is produced and not self-consumed, may be sold by Cumulative Representation Bodies, giving an additional benefit to affected households.

Finally, the focus will be on tackling energy poverty in rented housing by ensuring a fair distribution of incentives and benefits between landlords and tenants, ultimately to ensure that energy efficiency investments are made in the residential buildings occupied by the affected households, and to avoid asymmetric increases in rents and calls for evictions as a consequence of the cost of interventions being passed on to the tenants.

The obligation to achieve cumulative end-use energy savings in households affected by energy poverty under Article 8 of Directive (EU) 2023/1791 will be met through measure M3 as an alternative policy measure to promote end-energy saving interventions. The share of households affected by energy poverty will be determined on the basis of Index I Azerbaijan IIeq according to the projections of the Action Plan to tackle poverty.

- **M4: Incentivising existing mechanisms for actions in affected households – Energy**

Efficiency Obligation Scheme

Policy measure M4 aims to support actions in households affected by the energy poverty phenomenon by the obligated parties under the Energy Efficiency Obligation Schemes for the period 2021-2030.

The promotion of interventions in affected households may be implemented through the following alternatives:

The **increase** in energy saving units by a factor of 1.4 in the case of technical measures in affected households for the most effective fulfilment of the energy savings target by the obligated parties.

The installation of efficient heating, cooling and water-producing systems under the Energy Efficiency Obligation Scheme in affected households living in worst performing buildings by means of a special letter due to the significant contribution of the Responsible Parties to the implementation of the actions.

In the case of Alternative I, the Responsible Parties will undertake to implement relatively low-cost technical measures in affected households, such as, but not limited to, the installation of smart meters, the provision of energy-efficient lamps and the introduction of efficient heating, cooling and hot water systems.

Finally, equal access to the identification process of households affected by the energy supply phenomenon will be ensured for all obligated parties.

- **M5: Using Renewable Energy Communities and Citizens' Communities to tackle energy poverty**

Policy measure M5 aims to revise the existing framework for the functioning of energy communities in accordance with the provisions of Directives (EU) 2019/944 and (EU) 2018/2001 with a view to maximising social benefits by tackling energy poverty. A specific set of initiatives will be designed to ensure that RES energy produced (electricity, heat and cooling) is used by both citizens' communities and renewable energy communities to meet the energy needs of households affected by the flood of energy poverty.

To this end, local and regional authorities are under way with a view to implementing social policy by using the energy capacity system in order to meet the energy needs of the households affected by energy poverty. To this end, the 'Apollon' programme, through the installation of new RES plants and the implementation of virtual compensation with identity, contributes to the strengthening of energy vulnerable households and to the beneficiaries of the A Social Invoice, covering 90 % of their own consumption.

The exemplary role of local and regional authorities in tackling energy poverty should be strengthened either through their participation as members in existing or new initiatives of Renewable Energy Communities and Citizens' Communities, or by supporting subdivided or

new initiatives without direct participation through, for example, the supply of land/roofs/facilities, the provision of know-how, the conclusion of contracts with common criteria, etc.

Please note that the actions planned under this measure may be combined with actions to improve energy efficiency, in order to address the phenomenon of energy poverty more radically.

In addition, the institutionalisation of regulatory incentives to further strengthen citizens' communities and renewable energy communities will be explored, while making use of the provisions of Article 21 of Directive (EU) 2018/2001 on renewable self-consumers and Article 15 of Directive (EU) 2019/944 for active customers, and facilitating their access to bank lending on favourable financing terms.

Finally, the institution of energy communities can be used to better design and implement targeted and innovative information and education actions at local level, making it imperative to maximise synergies with policy measure M8.

- **M6: Innovative financial tools to implement energy efficiency improvement actions in households affected by energy poverty**

Policy measure M6 aims to design and implement innovative public and/or blended/hybrid finance programmes to help households affected by energy poverty. Approved programmes may combine public and private funding or be exclusively public funding, and will be divergent for households affected by energy poverty.

Public funding will come from the massive energy renovation of similar housing and competitive processes to reduce the cost of implementation due to the economies of scale that will be created. Private money will initially come from energy providers through the on-bill financing scheme with the aim of paying them over a predetermined period of time by affected households. At the same time, a dedicated guarantee mechanism will be set up by the Greek State to harness the energy providers involved in cases of failure to repay the agreed repayment amounts.

In addition, consideration will be given to setting up one-stop shop services with a view to financing the necessary interventions to improve energy efficiency, while local and regional authorities will be more actively involved in financing the required investments through the on-tax financing scheme. It should be noted that tax incentives will be explored for those who will subsidise private financing of planned investments.

DIMENSION III: INFORMATION, EDUCATION AND COORDINATION ACTIONS

- **M7: Information and education of affected households in the context of Energy Efficiency Obligation Schemes**

Under the Energy Efficiency Obligation Schemes, the designated obligated parties will undertake targeted information and expatriationactions to provide specialised technical advice with a view to effectively combating energy poverty, which can be achieved through-better energy management.

The implementation of targeted information and awareness-raising actions for affected households will be governed by the restrictions and general specifications laid down under this scheme in the period 2021-2030 through the relevant operating rules.

In any case, preference will be given to tailor-made actions based on thespecific characteristics of affected households, focusing on advice on how to manage the energy consumed more effectively.

By way of example, it is recommended that energy tests be carried out to understand all aspects related to the phenomenon of energy poverty and to identify the most cost-effective measures to improve energy efficiency to address the phenomenon ofenergy poverty.

The implementation of these actions will be strengthened with a view to achieving more effectively the energy savings target by the obligated parties by increasing the energy saving units verified using a factorof 1,1.

- **M8: Carrying out targeted information and education actions**

This policy measure includes the design and implementation of targeted and innovative information and education actions at national, regional and local level, both for households affected by energy poverty and for individuals who will be involved in the implementation of the various technical measures in affected households.

These actions will be implemented with the involvement of all the actors that can contribute to the dissemination of existing know-how, such as local and regional authorities, regions, chambers, professional associations, consumer associations, educational bodies, renewable communities and citizens' communities, etc.

Specific actions may cover the provision of specialised energy saving advice, as well as information on energy tariffs that have been developed and are in force for all energy products.

In addition, the focus will be on informing affected householdsabout the available funding programmes and their protection measures, including the criteria and procedures for their inclusion.

Tackling energy poverty in rented housing will be facilitated by providing targeted information to all parties involved (tenants, owners and relevant policy bodies).

Information and education actions will be appropriately designed tominimise their interaction with the respective information and education actions,which will be implemented

under policy measure M7 by the obligated parties under the Enforcement Scheme.

The focus will be on the protection of personal data and the implementation of good practices to avoid the risk of stigmatisation of affected households through targeted actions involving all parties involved.

In addition, the operation and continuous updating of a reliable price approval tool for the various energy products under RAE monitoring and control is necessary to improve the current level of knowledge and understanding of energy tariffs by affected households.

Finally, the establishment of a network involving all stakeholders will be launched with the aim, inter alia, in accordance with the provisions of Article 24 of Directive (EU) 2023/1791, of developing policies to support local and national decision-makers in the implementation of energy efficiency improvement measures and of providing technical assistance and financial tools to address extreme poverty.

- **M9: Establishment of Single Stage Services**

Policy measure M9 aims to establish one-stop shops to tackle the phenomenon of energy poverty more effectively at local and regional level. The implementation of this measure will seek to actively involve all the parties involved, in particular local and regional authorities, both in the implementation of the services provided and in the identification of affected households.

The one-stop shop services to be established may provide indicatively in the first phase the following services:

- Information and education of affected households on the phenomenon of energy poverty.
- Support in understanding energy bills and providing contracts on reducing energy bills and making energy use more efficient.
- Awareness of the benefits of implementing energy efficiency improvement interventions and the use of RES.
- Provide information on all the steps needed to implement energy efficiency improvement interventions and the use of RES.
- Preliminary building analysis and quantification of the estimated renovation costs and expected impacts.
- Provide information on available programmes to deal with social poverty.
- Provide information and support for the preparation of all necessary documents for participation in existing programmes.
- Guidance on dispute resolution and claiming rights as a consumer.
- Conduct collective orders and negotiations to achieve lower prices for the purchase of

energy-efficient equipment.

the conclusion of voluntary agreements with professional and production associations with a view to centralising the necessary actions and maximising the benefits for affected households.

In any event, the ultimate objective of the one-stop shop services will be to provide and implement comprehensive packages of interventions to improve energy poverty for households affected by energy poverty, with guaranteed financial and energy outcomes.

3.4.7 assessing the climate vulnerability of energy efficiency policies and measures

Energy performance of buildings

The increase in the average annual minimum temperature¹³⁸ and the average annual maximum temperature¹³⁹ is expected to reduce the energy needs for heating in buildings during the winter season and increase the need for cooling¹⁴¹ or summer. For the intermediate mitigation scenario RCP4.5 heating degree days are expected to decrease by -13 % by 2040 for Greece as a whole, compared to historical data for the period 1981-2010 (average 1.028 heating degree days), by -23 % by 2070 and by -28 % by 2100¹⁴². In the West Dorian Region, one of the coldest in the country, heating degree days are expected to decrease by -38 % at the end of the century. For cooling degree days, for RCP4.5 and in relation to historical 0-2010 data (max. 267 cooling degree days), it is expected to increase by +37 % across the country by 2040, by +71 % by year 2070 and by +88 % by 2100¹⁴³.

In the case of urban centres, where the majority of the country's crowds are concentrated, the phenomenon of an urban thermal island causes further stiffening of the urban thermal environment and microclimate, affecting heating needs and, above all, cooling needs. Simulations in 4 urban centres in Greece show that the strengthening of the urban heat island effect in the period 1970-2010 led to a reduction in the demand for heating of 1.0 kWh/m² per decade and an increase in load demand for cooling at a rate of almost five times, i.e. about 5.0 kWh/m² per year¹⁴⁴. Similar data are obtained for the period 2020-2021, with the average energy consumption for air conditioning in Greece rising from 115 to 473 kWh/household¹⁴⁵.

According to existing studies, the projected reduction in annual climate change heating needs is expected to outweigh the increase in annual cooling ranges, ultimately contributing to a reduction in total annual energy demand from occupants¹⁴⁶. Possible changes in peak demand and any impact on the adequacy and operation of the electricity system, from the increase in cooling ranges, are dealt with in Chapter 3.5 on 'Energy security'.

¹³⁸ RIS geospatial information portal. LIFE-IP AdaptInGR project. Change in the Medium Annual Minimum Temperature in the Near and Outer Future: <https://mapsportal.ypen.gr/maps/1037>.

¹³⁹ RIS geospatial information portal. LIFE-IP AdaptInGR project. Change in the Average Annual Maximum Heat in the Near and Outer Future: <https://mapsportal.ypen.gr/maps/1029>.

¹⁴⁰ RIS geospatial information portal. LIFE-IP AdaptInGR project. Change in the number of days with strong needs for heating per year in the near and the lowest future: <https://mapsportal.ypen.gr/maps/951>.

¹⁴¹ RIS geospatial information portal. LIFE-IP AdaptInGR project. Change in the number of days with strong needs to be frozen per year in the near and last future: <https://mapsportal.ypen.gr/maps/901>.

¹⁴² European Climate Data Explorer- Heating Degree Days: <https://climate-adapt.eea.europa.eu/en/metadata/indicators/heating-degree-days-1>.

¹⁴³ European Climate Data Explorer- Cooling Degree Days: <https://climate-adapt.eea.europa.eu/en/metadata/indicators/cooling-degree-days>.

¹⁴⁴ Kapsomenakis J., Kolokotsa D., Nikolaou T., Santamouris M., d, Zerefos S.C.. Forty years increase of the air ambient temperature in Greece: The impact on buildings. *Energy Conversion and Management* 74 (2013) 353 – 365.

¹⁴⁵ <https://www.odyssee-mure.eu/publications/efficiency-by-sector/households/unit-consumption-air-conditioning.html>.

¹⁴⁶ Georgopoulou E., Mirasgedis S., Sarafidis Y., GIANNAKOPOULOS C., Varotsos K.V., Gakis N. Climate Change Impacts on the Energy System of a Climate-Vulnerable Mediterranean Country (Greece). *Atmosphere* 2024, 15, 286. <https://doi.org/10.3390/atmos15030286>.

Climate change is therefore not expected to reverse the achievement of the targets for improving the energy efficiency of the building sector. However, it is expected to worsen the thermal comfort conditions inside buildings during the summer period and affect the effectiveness of the existing Regulation on the Energy Efficiency of Buildings (KENAK) and existing policies to address energy poverty.

Measures to renovate and improve the energy efficiency of the building sector often involve interventions in the building envelope and contribute not only to improving thermal comfort conditions and reducing cooling and heating needs, but also to some extent adapting the building stock to climate change¹⁴⁷. The alignment of KENAK with the recent revision of the European Union Directive on the energy performance of buildings should contribute to adapting the building stock to climate change in an integrated and systematic manner. Directive (EU) 2024/1275 provides for Member States to address climate adaptation issues of new buildings and buildings undergoing major renovation, while taking into account the local climate in the methodology for calculating energy performance. In particular, the preamble to the Directive states that the calculation methodology takes into account ‘other actors that play an increasingly important role, such as the urban theory effect’.

Feedback on greenhouse gas emission reduction policies

The increase in cooling needs is expected to lead to an increase in the installation of air conditioning units and heat pumps and thus an increase in electricity consumption and the use of fluorinated gases, in particular HFCs. F-gases deliver powerful greenhouse gases and building abatement policies that increase them are considered ‘maladaptation’, as they indirectly enhance the effects of climate change and thus further increase cooling needs¹⁴⁸. In addition, the extensive use of air conditioners contributes to heat discharge into the external environment by reinforcing the urban heat island phenomenon.

The new Regulation (EU) 2024/57 on fluorinated greenhouse gases provides for auctions for the disposal of air-conditioning and heat pump equipment that they contain or whose operation relies on HFCs to help avoid grey “bad” climate adaptation. The Regulation sets 1 January 2025 as the prohibition date for single-split systems with less than 3 kg of fluorinated gases, while the ban on other types of air-conditioning and heat pump equipment containing or whose functioning relies on fluorinated gases with GWP of at least 750 enters into force gradually, with a final date of 1 January 2025.

The promotion in the building sector of technologically and economically feasible alternative air-conditioning systems and heat pumps, including solar cooling systems, through

¹⁴⁷ Konsta, D., Panagopoulou, G., Kyriakopoulos, G. L., Methenitis, K., Grigoriadou, E., Voudouli, A., Asimakopoulos, D., Setz, I. (2024) LIFE-IP AdaptInGR – Boosting the implementation of adaptation policy across Greece. Action Deliverable C.5 Analysis of synergies and trade-offs between the 2050 Long-term Strategy and the National Strategy for Adaptation to Climate Change covering all economic sectors and exploring the impacts of climate change and synergies with adaptation measures.

¹⁴⁸ <https://www.eea.europa.eu/publications/cooling-buildings-sustainably-in-europe>.

programmes for the replacement of electrical household appliances or other energy upgrading programmes, will help to mitigate or even avoid 'bad' climate adaptation, in the middle of time, until the disposal of equipment containing or operating with powerful greenhouse gases is completely phased out. The promotion of solar cooling in the context of measures to increase the installation of RES in buildings and district heating and cooling systems incorporating RES (5GDHC) elements in areas already existing or planned to develop heating systems could also contribute to this.

Tackling energy poverty

High temperatures cause increased morbidity and mortality, with age (elderly people, children), underlying diseases, social divergence and low socio-economic profile, important drivers of vulnerability. The increase in the average maximum temperature during the summer, combined with an ageing population and a further increase in urbanisation, are expected to increase the exposure and vulnerability of the population to climate change. Protection against high temperatures depends mainly on the ability to meet thermal comfort conditions inside buildings, and therefore in addition to their construction characteristics and the ability of their occupants to afford increased energy consumption bills for artificial air-conditioning.^{149, 149 150}

The prioritisation of vulnerable households/businesses in the energy upgrading programmes and the measures envisaged to address energy poverty should help address the impact of climate change on the cost of energy needs and on the health of residential occupants with low thermal comfort conditions. However, it will also require appropriate adaptation of relevant policies and measures, such as the creation of a dedicated programme to address increased cooling costs, the priority energy upgrading of housing of vulnerable groups within urban areas with strongly local beds of an urban heat island, etc.

Increasing energy demand for the operation of water and irrigation facilities and networks

National energy saving planning can also be affected by the impacts of climate change on the water balance. In the case of the RCP4.5 scenario, annual rainfall is expected to decrease by up to 15 % by the year 2050, and the duration of drought periods to increase by up to 11 days, especially in Crete and South Greece^{151, 151 152} reducing the availability of water resources and affecting agricultural crop productivity. At the same time, the rise in the average sea level (up to 20 cm by 2030 and up to 30 cm by 2050 compared to the period 1986-2005 under the

¹⁴⁹ European Environment Agency, Kalmierczak A., Unequal exposure and unequal impacts – Social vulnerability to air pollution, noise and extreme temperatures in Europe, Publications Office, 2018, <https://data.europa.eu/doi/10.2800/324183>.

¹⁵⁰ <https://www.eea.europa.eu/publications/cooling-buildings-sustainably-in-europe>.

¹⁵¹ RIS geospatial information portal. 'LIFE-IP AdaptInGR project. Change in total annual rainfall in the near and lower future: <https://mapsportal.ypen.gr/maps/998>.

¹⁵² RIS geospatial information portal. 'LIFE-IP AdaptInGR project. Change in the Maximum Annual Duration Period in the Near and Outer Future: <https://mapsportal.ypen.gr/maps/916>.

SSP5-8.5 scenario¹⁵³) is expected to reinforce the salting effects of coastal aquifers. In the context of adapting to these new conditions desalination plants may increase especially on islands and coastal zones, while irrigation systems may be extended to some harsh areas, further increasing the demand for energy from hydraulic grids during the summer.

The measures to adapt to climate change in the agricultural and tourism sectors and the sustainable water management measures of the National Strategy and the Regional Plans for Adaptation to Climate Change (see Section 3.8), the National Strategic Plan for the CAP 2023-2027 and the River Basin Management Plans, and in particular measures to reduce water consumption and streamline water/sanitation and irrigation infrastructure, are expected to mitigate the impact on national energy planning of increasing energy demand for desalination and irrigation.

In the light of the above and with a view to further strengthening the climate change relevance dimension of policies and measures to improve energy efficiency:

- Rapid alignment with Directive (EU) 2024/1275 on the energy efficiency of buildings, focusing on adapting the building to climate change from a subject (e.g. using climate projections for the revision of the TEE 20701-3/2010 'Climate Data of Greek Areas') and ensuring new conditions during both winter and summer periods.
- Revision of the Building Regulation and drafting of relevant specifications with a view to integrating more green building elements (e.g. green roofs), passive bioclimatic heating/cooling systems and heating/cooling systems using RES.
- Incorporate appropriate criteria in electrical appliance replacement programmes to support policies to reduce fluorinated gases in refrigeration equipment and heat pumps and promote RES cooling/heating systems.
- Strengthen the adaptation dimension in the building energy upgrading programmes and integrate appropriate criteria for prioritising support for vulnerable households, including citizens with disabilities, chronic diseases and their families, within a "heat affected" environment. ¹⁵⁴
- Strengthen the adaptation dimension in energy upgrading programmes of public buildings and prioritise buildings used by climate-vulnerable populations such as hospitals, elderly care facilities, and schools.
- Develop specific measures and programmes to address the increased cooling of vulnerable groups, including citizens with disabilities, chronic diseases and their families.

¹⁵³ European Climate Data Explorer- Relative Sea Level Rise: <https://climate-adapt.eea.europa.eu/en/metadata/indicators/relative-sea-level-rise>.

¹⁵⁴ Konsta, D., Panagopoulou, G., Kyriakopoulos, G. L., Methenitis, K., Grigoriadou, E., Voudouli, A., Asimakopoulos, D., Setz, I. (2024) LIFE-IP AdaptInGR – Boosting the implementation of adaptation policy across Greece. Action Deliverable C.5 Analysis of synergies and trade-offs between the 2050 Long-term Strategy and the National Strategy for Adaptation to Climate Change covering all economic sectors and exploring the impacts of climate change and synergies with adaptation measures.

- Wide implementation of remote control/remote control systems and installation of smart water meters in hydraulic grids to further save energy and water.

3.4.9 summary of measures and policies for the dimension of improving energy efficiency

Table 21 summarises the set of policy measures for the energy efficiency dimension:

Table 21 Policy measures for the energy efficiency improvement dimension.

Numbering	Policy measure name	Correlation with pre-polar priorities	Target based on road 2023/1791//EU	Sector affected	Category p.m. metre
M1	Financing programmes for the renovation of public sector buildings with energy performance contracting potential	FP4.1, FP4.5, FP4.9	Objective Article 3 Objective Article 8 Objective Article 5 and 6	Tertiary sector — Public Buildings	Financial measure
M2	Financing of upgrades of public buildings on the basis of the municipal and regional building performance action plans and municipal emission reduction plans	FP4.1, FP4.5, FP4.9	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Tertiary sector — Public Buildings	Financial measure
M3	Improving the regulatory framework and the role of energy managers of buildings	FP4.1, FP4.9	Objective Article 4 Objective Article 8	Tertiary sector — Public Buildings	Regulatory measure
M4	Financing programmes for the renovation of residential buildings	FP4.2, FP4.5, FP4.9, FP4.11	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Domestic sector	Financial measure
M5	Financing programmes for the renovation of tertiary sector buildings (except public)	FP4.2, FP4.5, FP4.9	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Tertiary sector — Buildings outside the public sector	Financial measure
M6	Use of tax and town planning moves to implement energy housing interventions in residential and tertiary buildings (outside the public sector)	FP4.2, FP4.9	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Domestic sector Terrestrial	Regulatory, Codified Measures

Numbering	Policy measure name	Correlation with pre-polar priorities	Target based on road 2023/1791//EU	Sector affected	Category p.m. metre
				sector – Buildings outside the public sector	
M7	Promotion of RES systems to meet thermal and cooling needs in the building sector	FP4.2, FP4.9, FP4.11	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Residential sector Terrestrial sector	Normative; Financial measure
M8	Replacement of old and energy-intensive or verbal devices with new energy footage	FP4.2, FP4.5, FP4.11	Objective Article 4 Objective Article 8	Domestic sector	Financial measure
M9	Regulatory measures to promote near-zero-energy and zero carbon capping buildings	FP4.1, FP4.2, FP4.9	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Total buildings	Regulatory measure
M10	Regulatory, fiscal and financial incentives to promote buildings above minimum energy requirements	FP4.1, FP4.2, FP4.5, FP4.9	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Total buildings	Normative; Financial measure
M11	Promotion of IGS through targeted financial-structural programmes for the energy upgrading of the building stock	FP4.1, FP4.3, FP4.5, FP4.9	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Tertiary sector	Financial measure
M12	Measures for a more efficient sharing of benefits between tenants and building owners	FP4.1, FP4.3, FP4.5;	Objective Article 4 Objective Article 8 Objective Article 5	Domestic sector Terrestrial	Regulatory, Financial

Numbering	Policy measure name	Correlation with pre-polar priorities	Target based on road 2023/1791//EU	Sector affected	Category p.m. metre
			and 6	sector	measure and Information – Awareness – Measure
M13	Strengthening the role and improving the regulatory framework of energy efficiency obligation schemes	FP4.4, FP4.11	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Total final allocation sectors	Regulatory measure
M14	Application of competitive procedures to achieve energy savings	FP4.4, FP4.11	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Total final consumption sectors	Financial measure
M15	Development of an institutional framework for on-bill financing from the payment of investments in energy savings	FP4.3, FP4.5, FP4.9, FP4.11	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Industrial, tertiary and household sectors	Regulatory measure
M16	Funding programmes through effective checks on obligated and non-liable undertakings	FP4.2, FP4.5, FP4.6, FP4.9	Objective Article 4 Objective Article 8	Industrial and tertiary sectors	Financial measure
M17	Actions retraining/retraining for installers of new systems, equipment and equipment in the buildings	PP4.10	Objective Article 4	Total final allocation sectors	Regulatory measure
M18	Implementation of information and esteem measures to improve efficiency	PP4.10	Objective Article 4	Total final allocation sectors	Day-to-day – sensitising – measure

Numbering	Policy measure name	Correlation with pre-polar priorities	Target based on road 2023/1791//EU	Sector affected	Category p.m. metre
M19	Financing programmes for energy upgrading of the streetlighting network	FP4.1, FP4.3, FP4.5	Objective Article 4 Objective Article 8	Public sector	Financial measure
M20	Promoting climate-neutral cities using ICT technologies	FP4.1, FP4.2, FP4.9	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Total final allocation sectors	Technical, financial measure
M21	Programmes for concluding programme agreements with industries and manufacturing companies	FP4.6, FP4.9	Objective Article 4 Objective Article 8	Industrial sector	Financial measure
M22	Financial programmes to improve the energy efficiency of industries and intermediate enterprises, including the promotion of IGS	FP4.3, FP4.5, FP4.6, FP4.9	Objective Article 4 Objective Article 8	Industrial sector	Financial measure
M23	Provision of financial and fiscal incentives for the promotion of RES technologies and the utilisation of waste heat in industrial plants	FP4.6, FP4.9	Objective Article 4	Industrial sector	Financial measure
M24	Promotion of modernisation of water/sewerage and irrigation infrastructure with a view to concomitantly housing water and energy	FP4.7	Objective Article 4 Objective Article 8	Water infrastructure	Technical, Financial Measure

Numbering	Policy measure name	Correlation with pre-polar priorities	Target based on road 2023/1791//EU	Sector affected	Category p.m. metre
M25	Review and implementation of policy measures in the context of the Action Plan to tackle energy poverty	FP4.2, FP4.4, FP4.8, FP4.10, PP4.11	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Domestic sector	Regulatory, Financial and Meaning/Weather Stunting Measures
M26	Establishment of Single Stase Services	FP4.2, FP4.5, FP4.10	Objective Article 4 Objective Article 8	Domestic sector	Financial and Consideration — Awareness — Measure
M27	Improvement of indoor environmental quality and indoor conditions	FP4.1, FP4.2	Objective Article 4 Objective Article 8	Residential and tertiary sectors	Regulatory, Financial and Information/Awareness Measures
M28	Development of an implementation framework for the Energy Efficiency First Authority	PP4.8	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Total final allocation sectors	Regulatory measure
M29	Promoting energy-efficient data centres	PP4.10	Objective Article 4 Objective Article 8	Tertiary sector	Financial and Consideration — Awareness — Measure

Numbering	Policy measure name	Correlation with pre-polar priorities	Target based on road 2023/1791//EU	Sector affected	Category p.m. metre
M30	Support the implementation of measures in local heating and cooling plans	FP4.8, FP4.9	Objective Article 4 Objective Article 8 Objective Article 5 and 6	Total final allocation sectors	Technical, Financial Measure

3.5 energy security measures and policies

The definition of the 2025-2030 security of supply policy measures aims to cover five different Policy Priorities (FP5.1-FP5.5), which are presented in Figure 11.

FP5.1: Enhancing diversification of energy sources and energy import routes
FP5.2: Reducing energy dependency and making the country a regional energy hub
FP5.3: Promote systems providing flexibility, and storage and demand response systems; ensure the country's output adequacy
FP5.4: Preparedness of the country and the actors involved in dealing with the limitation or disruption of energy supply
FP5.5: Increasing the resilience of critical energy infrastructure

Figure 11 Security of Supply Policy Priorities 2025-2030.

The main priority is to increase the diversification of energy supply sources and routes, thereby enhancing the security of energy supply. In parallel, reducing energy dependency while developing domestic energy sources, compatible with the objectives of achieving climate neutrality in 2050, is obviously the first and constant priority, especially in the context of long-term energy planning. However, as long as this energy evaporation remains at a high level and in order to avoid events such as the exceptional crisis faced by the country in 2008-2009 and more recently, at the end of 2016 up to and including the beginning of 2017, as well as in 2022, it is necessary to diversify energy sources and suppliers coming from third countries, so that there is no dependence on a single fuel or geographical area or on a single pipeline, while promoting the use of RES and energy efficiency improvement actions, which are the first priority, as stated above in all dimensions of energy planning.

However, in addition to measures to strengthen the country's position in the region, measures need to be taken to ensure that it and the actors involved are prepared to cope with the curtailment and/or disruption of energy resources, and that specific initiatives and regulatory mechanisms are envisaged in this context.

The policy measures, which have been specified in the context of the above policy priorities, are analysed separately in the following sections.

3.5.1 Measures and policies to enhance the diversification of energy sources and routes

□ increasing diversification of energy sources and suppliers from third countries

Each country, in the context of securing its energy supply and preventing the occurrence of a

lack of energy supply that will lead to significant domestic legal damage to many sectors of its economy, has as its main political priority to increase the diversification of energy sources and to increase the number of third countries supplying oil, gas and electricity to the country. Important policy measures to address the above priority are the strengthening of the country's electricity and gas interconnections with neighbouring markets, which will help ensure a seamless flow of energy at regional level.

development of indigenous hydrocarbon deposits

Greece continues to be a growing market in gas exploration and production in the Eastern Mediterranean. Both the programme for the exploration and exploitation of hydrocarbons in Greece and the programme for the trans-national TAP (Trans-Adriatic) pipelines, the Greece-Bulgaria Interconnector (IGB) and the East-Med pipeline are important projects that enhance the diversification of the EU's energy supply and ensure security of supply to reduce energy evaporation from third countries.

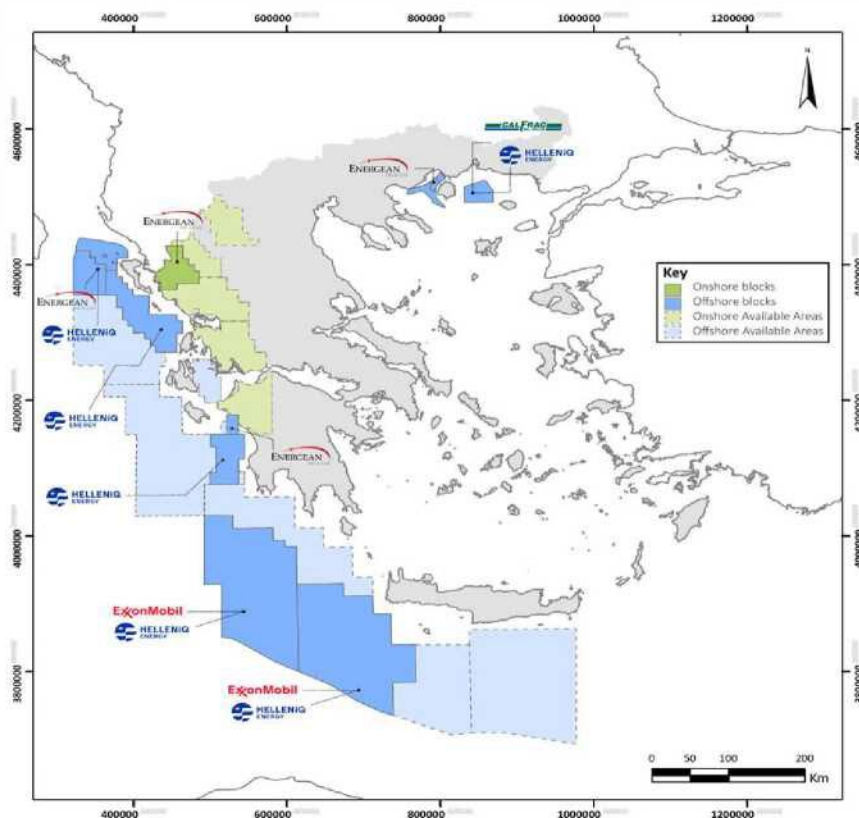


Figure 12 Hydrocarbon exploration sites.

The Hellenic Republic has now allocated nine sea and land areas to consortia of companies (Figure 12), including that of Prinos, where production of argon has continued (at a decreasing pace) for four decades. This is the first time that the country has a large number of concessions, with large international and Greek companies. In the light of the energy price and food security crisis, and taking into account the time pressure to exploit potential domestic natural gas deposits in view of the necessary energy transition, the projects for the exploration and exploitation of hydrocarbons were declared to be projects of national importance by the Prime Minister himself in April 2022. Over the past two years, research has been accelerated with the completion of all geophysical research letters for active contracts and the decision to drilling on Ioannina's land surface. Over the next two years, the employees' decisions to carry out exploratory drilling on most plots of land are expected, with the aim – in the event of a positive decision and a successful outcome of the investigations – of having a domestic hydrocarbon traction (beyond that of Prinos) within the current decade. The State shall pay particular attention to safety issues related to the exploration and exploitation of hydrocarbons and thus the protection of the surrounding environment. Environmental risks are examined by the competent services of the Ministry of the Environment and Energy, which defines the terms and conditions, and approves the implementation steps. As the competent authority, the Hellenic Hydrocarbon and Resource

Energy Company (EDEYEP) monitors, among other things, the implementation of these contractual obligations by the trustees and their partners and intervenes if there are derogations from either side. For the above reasons, the Ministry of the Environment and Energy draws up the National Plan A for Emergency Response in Offshore Facilities, with the coordination of all relevant public bodies.

The direct economic benefits of the possible production of natural gas for the Greek State on the basis of a period of 25 years from the start of production will come from income tax and from production dividends and other rewards. At the same time, the promotion of a system of redistribution of hydrocarbon resources to support local economies driven by the delignification of electricity generation, but also at national level through the possible allocation of resources to the energy transition, should mitigate the direct and indirect effects at local level by making the operation of this feedback loop a priority of public interest.

A conservative estimate of the potential and potential reserves of these areas, but in which exploratory drilling has not yet been carried out, is in line with preliminary data from the ISPA at 24 trillion cubic feet or 680 bcm. The possible confirmation of these deposits outweighs both the current and future domestic demand for natural gas, making our country export by the end of the decade.

3.5.2 Measures and policies to make the country a regional energy hub



development of electricity interconnections

The emergence of the country as a regional energy hub is inextricably linked to both the strengthening of domestic electricity generation capacity and the system of electricity storage and the development of energy interconnections with neighbouring countries.

In the case of electricity, it is envisaged to develop new interconnections and strengthen existing ones. The main projects of national and international interest are:

1. Second interconnection between Greece and Italy

According to the results of the studies to investigate the need for strengthening the European transmission network, in the long term price convergence between the two countries requires the strengthening of electricity interconnection between them¹⁵⁵.

In the context of the feasibility study carried out jointly by the Greek and Italian Transmission System Operators (ADMIE - Terna SPA), different technical alternatives for the development of a new subsea interconnection between the Greek and Italian systems to achieve an increase in capacity between the two systems by 500 to 1 000 MW were explored in detail.

In 2022, the joint working group of the competent authorities finalised the feasibility study for the implementation of a second interconnection between Greece and Italy, which included

¹⁵⁵ "CSE RgIP – Continental South – East Europe Regional Investment Plan) 2020", ENTSO-E, October 2020.

the preparation of market studies, network studies and cost-benefit analysis. On the basis of the results, it was decided that the most appropriate and best techno-economical solution for the implementation of the second interconnection between Greece and Italy was the implementation of a new bipolar continuous stream link of 1 000 MW with voltage converter and sea return technology (Bipolar VSC HVDC with sea-return) or alternatively via a metal return pipeline.

The project has been incorporated into the latest submitted ten-year development plan (DDP) of the System Operator (2024-2033) and the ten-year plan of ENTSO-E (TYNDP), while the time horizon for its completion is 2031.

2. Second interconnection between Greece and Albania



Figure 13 Interconnection between Greece and Albania.

In April 2020, ADMIE started cooperation with the Albanian System Operator (OST) on the possibility of implementing a new interconnecting line between Greece and Albania.

In this context, preliminary market, network and preliminary cost-benefit assessments were carried out, on the basis of which it was decided to implement a new 400 kV interconnector (GL) between Greece and Albania, with a view to completion by 2030. The new connecting aerial GM 400 kV of a single circuit between a new hotspot in Western Greece (Thesprotia hotspot) with a connection to the Arachthos hotspot and the Fier in Albania, will have a nominal transport capacity of 2000 MVA and is estimated to have a total length of around 170 km, of which 45 km are on Greek territory and 125 km on the territory of Albania.

A Memorandum of Cooperation between ADMIE and OST was signed in November 2022 for the implementation of the new interconnector. According to the current planning, the new

interconnection line is expected to be completed by the end of 2031.

The new interconnector GM is expected to increase capacity between the two countries by at least 200 MW in both directions. The project will facilitate the penetration of more RES in the two systems, enhance market convergence and help achieve the targets for the transition to a climate-neutral Europe.

3. Interconnection between Greece and Cyprus and Israel



Figure 14 Interconnection between Greece, Cyprus and Israel.

The project concerns the implementation of the interconnection of the transmission systems of Greece, manureand Israel with direct current links and includes sections 3.10.1 of the Israel-Cyprus interconnection and 3.10.2 of the Cyprus – Greece (Crete) interconnection. The project is estimated at a total length of 1 208 km, a capacity of 1 000 MW and an estimated budget of EUR 2.4 billion.

In October 2023, the System Operator was appointed as the Implementing Body and Project Promoter of the Electricity Interconnector between Greece, Cyprus and Israel, ensuring the technical and financial adequacy of the project and laying the foundations for its timely completion.

On 24 November 2023, the creation of the special purpose vehicle 'GREAT SEA Interconnector M.A.E.', which is responsible for the construction and financing of the PCI 2.6 electricity interconnection project, was completed. At present, the sole shareholder of GREAT SEA Interconnector M.A.E. is ADMIE.

In December 2023, EuroAsia Interconnector Ltd transferred the amount of EUR 55.2 million which it had received as pre-financing from the European Union's Climate, Infrastructure and Environment Executive Agency (CINEA) and CEF (Connecting Europe Facility) and with an additional EUR 109.2 million received in January 2024 the pre-financing received amounted to EUR 164.5 million – EUR million, representing 25 % of the total grant.

In addition, ADMIE issued an order to start works and the first instalment was paid to the contractor of the cable section. At this stage, the studies required for the contract are also being carried out for the section on conversion stations. The completion of this section is the year 2029.

The completion of the project will mark the electrical interconnection of Cyprus – the last non-interconnected EU Member State – with the European system byside, ensuring strong energy proofing of the island. Israel will implement its security of supply by enabling it to increase, further and faster, the participation of Renewable Energy Sources (RES) in its energy balance.

4. Second Greece – Türkiye interconnection

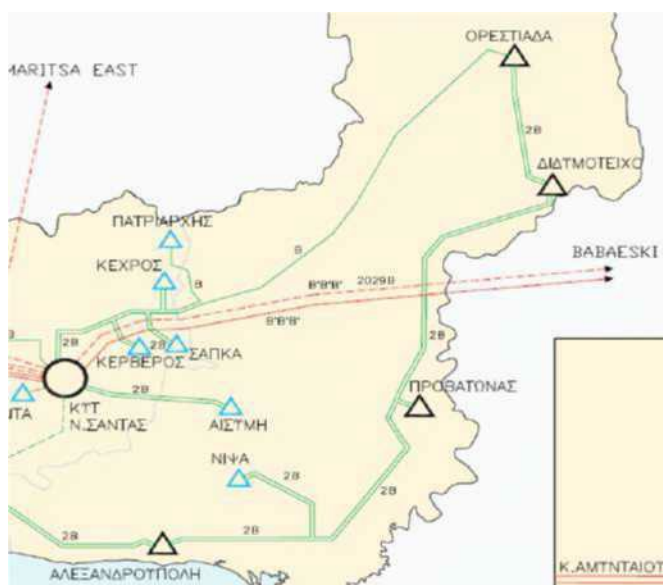


Figure 15 Second Greek – Türkiye interconnection.

A joint working group between the Transmission System Operators of Greece, Bulgaria and Türkiye (ADMIE, ESO-EAD -TEIAS) has been set up in an earlier period to explore alternative scenarios for the development of new interconnections perinstrument in the European and Turkish systems to increase transmission capacity at the border between Greece and Türkiye and Bulgaria – Türkiye.

At a tripartite meeting held in Izmir, it was decided to submit a new project entitled ‘EAST BALKAN Corridor’ to the ENTSO-E Pan-European Ten-Year Development Programme (TYNDP). The projects, a new interconnector GM 400 kV Greece – Türkiyeand a new interconnector GM 400 kV Bulgaria – Türkiye were submitted as projects under consideration to TYNDP 2020, while the results of the evaluation of TYNDP 2020 confirmed the need to increase capacity between these countries.

In March 2022, ADMIE and TEIAS agreed on the implementation of the new 400 kV interconnection GM between Greece and Türkiye, with a view to completion by 2029. The

new connecting aerial GM 400 kV of a single circuit between the Nea Sama hotspot and Babaeski in Türkiye will have a nominal transport capacity of 2000 MVA and is estimated to have a total length of around 130 km, of which 70 km are located on Greek territory and 60 km on Turkish territory, as it is planned to travel in parallel with the existing interconnection between the two legs.

A Memorandum of Cooperation between ADMIE and TEIAS was signed in December 2023 for the implementation of the new interconnector. Based on the new literacy timeline, the new interconnection line is expected to be completed by the end of 2031.

The new interconnector GM is expected to increase capacity between the two countries by 600 MW in both directions. The project will strengthen the connection of the European transmission system to the large extent of Türkiye, which is relatively weak as the two systems are connected through three interconnectors (one Greece – Türkiye and two Bulgarian-Türkiye interconnectors, it will improve stability between the interconnected systems of South-Eastern Europe with that of Türkiye, it will also allow the penetration of more RES into the Greek system, foster market convergence with those countries and help achieve the targets for the transition to a climate-neutral Europe.

5. Upgrading the interconnection between Greece and North Macedonia

In the context of ENTSO-E's Pan-European Ten-Year Development Programmes (TYNDP) 2018 and 2020, studies to investigate the needs of strengthening the European transmission network for 2040 identified the need to strengthen the capacity of transmission of electricity between Greece and the North Macedonia System for the scenarios examined. The project proposed by ADMIE and MEPSO to address this need was to upgrade the interconnector GM 400 kV Melite-Bitola. This project was initially included in TYNDP 2018 as a project under consideration, with a view to implementation after 2030. The project was again submitted to the next Pan-European Decade Development Programmes (TYNDP) 2020, 2022 and 2024 as a project under consideration, while the feasibility of implementing this interconnection will be examined in the next period.

6. Interconnection between Greece and Egypt



Figure 16 Interconnection between Greece and Egypt.

The GREGY Interconnector project has been proposed by the Project Promoter for inclusion in the PMI project list for Greece – Egypt, and both ADMIE and RAAEY have expressed their support. A Greek – Egypt Working Memorandum was signed in October 2021, setting up a high-level working group with the participation of representatives of the two Ministries, Transmission System Operators and Regulatory Authorities, which will examine the technical and financial parameters of the Greece-Egypt electricity interconnection project in cooperation with Project Promoter, facilitate licensing and support its qualification as a project of European interest.

An opening meeting between the managers of the two countries took place in May 2021 and a working group was set up to prepare the project. In this context, ADMIE and EETC (Egyptian Electricity Transmission Company) also signed a Memorandum of Understanding and a Cooperation Agreement.

ADMIE, in cooperation with Project Promoter Elica S.A. and the transmission system operator of EETC, is actively contributing to the maturity of the new interconnection with a next step in carrying out feasibility studies on the best technical solution. In addition, ADMIE also examines its investment participation in the project, on the basis of MoU signed in 2023 with Elica, regarding the launch of exclusive discussions to assess the Operator's entry into the equity capital of the SPV, which is detracting from the electricity interconnection project between Greece and Egypt.

In June 2023, the project was included in the list of shortlisted projects of Common/Mutual (European) Interest PCI/PMI, which was finalised in November 2023.

According to Project Promoter, the completion of the project is 2028.

7. Greece-Germany interconnection (Green Aegean Interconnector)

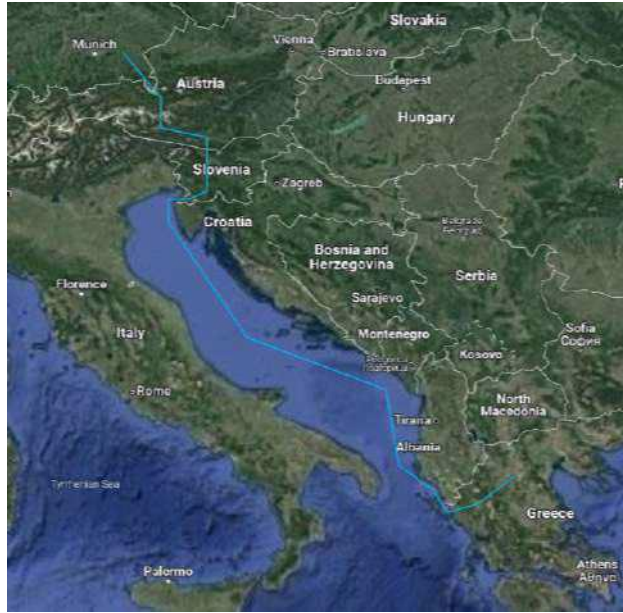


Figure 17 Greece-Germany (Green Aegean Interconnector).

The planning concerns a total transmission capacity of 3 GW of green energy and in a second year further development at 6-9 GW. This will be brought together from the Eastern Mediterranean and Egypt in southern Europe. The intended route concerns underwater crossing from Greece through the Adriatic Sea to Slovenia, followed by a land route to Austria and South Germany. The project, with an initial budget estimate of EUR 8.1 billion, has been included in the 10-year ENTSO-E plan (TYDP 2024). ADMIE is in close cooperation with the involved operators TenneT (Germany) and ELES (Slovenia) for its further maturity.

8. Greece – Saudi Greek Interconnection

The signing of a Shareholders Agreement (SHA) between ADMIE and National Grid S.A – Saudi Electricity Company for the establishment of the joint venture ‘SAUDI GREEK Interconnection S.A.’ to set up the special purpose company jointly owned by the two Transmission System Operators (ADMIE and National Grid S.A – Saudi Electricity Company) in September 2023 is the first step towards the maturity of the electricity interconnection between Greece and Saudi Arabia. In February 2024, the consortium “SAUDI GREEK Interconnection S.A.” was set up to deal with the preparation of the viability study for the electricity interconnection between Greece and Saudi Arabia by ADMIE and National Grid, which hold a 50 % share. The partnership is supervised by the Ministry of Environment and Energy of Greece and the Ministry of Energy of Saudi Arabia and specifies the strategic synergy between the two countries in the field of Energy. The statutory purpose of the SPV is to carry out the studies on the commercial viability of the clean energy interconnector project from North Africa and the Middle East to Europe. In April 2024, the consortium SAUDI GREEK Interconnection S.A. announced the relevant studies, which were to be completed in the first 3 months of 2025.

☐ **development of gas interconnections**

Similarly, in the case of natural gas, it is envisaged to develop new interconnections and strengthen existing interconnections with neighbouring systems, as well as to develop new gas import and transmission systems that strengthen the country's role as a regional energy hub and contribute to the removal of the region from Russian gas transmission pipelines.

In particular, the main projects of national, regional and international interest in natural gas concern:

1. Upgrading the TAP pipeline up to 10 bcm/yr through the installation of an additional compressor in the Serres area.
2. Increasing the capacity of the Greece-Bulgaria Interconnector (IGB) from 3 to 5 bcm/yr in 2026 (project under construction, with compressor installed in Komotini).
3. The commercialisation of the Alexandrou Poli LNG Vessel Plant project, which took place in October 2024.
4. The implementation of the LNG DiorigaGas floating station in Korinthos, which has been licensed and could be the third LNG import point in the southern part of the country (if the need is confirmed by the market in the wider area of South East Europe).
5. The design maturity of the East Med pipeline, the implementation of which is linked to developments in the discoveries and transport studies of the East Mediterranean gas fields.
6. The implementation of the interconnection between Greece and the Republic of North Macedonia in 2025 with an initial capacity of 1 bcm/yr (project under construction).
7. Projects under construction to strengthen and upgrade the DESFA transmission system (installation of compressors) in the context of the designation of Greece as a ferry energy hub.

☐ **development of green H2 interconnections**

European gas infrastructure managers have been planning green hydrogen transmission systems since now. In this context, the domestic hydrogen infrastructure (Greek H₂ Backbone) is the starting point of the South-East Europe Hydrogen Corridor, a collaboration of seven European gas structures companies from Greece, Bulgaria, Romania, Hungary, Czechia, and Germany, based on ensuring the supply of green hydrogen to South-East and Central Europe. The corridor, with a minimum capacity of 80 GWh/day, aims to connect the promising hydrogen production boars in Greece and Bulgaria via Romania, the UCO shrimp, Slovakia and the Czech Republic, with high hydrogen-demand areas up to and including Germany. The corridor will also contribute to the supply of hydrogen heating areas along its route and in the

future it can offer the possibility to import hydrogen from the Near and Middle East. The aim of the development of AGO is to exploit the high production potential of green hydrogen through RES intended solely for this purpose in Greece. The materialisation of such a project depends mainly on the commitments to take the hydrogen transported and is currently a plan of the managers¹⁵⁶.

3.5.3 Measures and policies to promote flexicurity systems, storage and demand response systems and tightening the country's capacity adequacy

The country's security of supply is linked to the construction or maintenance of secondary electricity generation, storage and interconnection capacity of the country in order to ensure a high degree of reliability for the energy system. Specific measures for flexibility schemes are detailed in subsection 3.6.5.

The optimal use and exploitation of ever-increasing dispersed energy resources in the electricity grid (in the form of dispersed generation, injection storage and flexible loads) is an important factor in achieving the national targets for 2030. The ultimate aim of this policy is to ensure capacity adequacy, make full use of domestic RES potential and new artefacts, and address saturation problems.

In order to make optimal use of electricity grids, a system of flexibility and flexibility providers in the active grids, such as electricity storage systems, aggregators and consumers capable of demand-side response, play an important role. To this end, the installation of electricity storage systems and the gradual roll-out of intelligent metering systems will allow a greater number of operators to offer heating response services and flexibility. Appropriate operational infrastructure planning for the integration of network flexibility sources in flexibility markets at both local and national level, setting specific specifications per source of flexibility and providing appropriate incentives to flexibility service providers are important tools that will enhance the uptake of dispersed energy resources. In this direction, electric pulling can also contribute to increasing electricity storage capacity. In particular, vehicle batteries can be a new tool – a tool to enhance the flexibility of the system, through an aggregation scheme and/or Virtual Power Plants (VPPs).

3.5.4 Measures and policies to address the limitation or disruption of energy supply

As the recent energy crisis has shown, security of supply is linked to the construction or maintenance of the country's sufficient electricity generation capacity and interconnectivity through international interconnection projects, as well as to the development of electricity storage units of sufficient capacity and capacity.

Similarly, in the case of natural gas, provision is made for the diversification of feedstocks,

¹⁵⁶If the project is implemented, a much larger RES power installation will be required. Such projects (like other energy transit projects) have not been taken into account in this NECP, as the purpose of the Plan is to describe how to achieve post-energy at national level.

through the development of new ones and the strengthening of existing interconnections with neighbouring systems, as well as the possibility of gas storage, both in existing storage infrastructure in neighbouring countries (e.g. Italy, Bulgaria), and in the context of the implementation of national and international projects of interest, pipelines and gas storage plants.

Finally, it is necessary to maintain a sufficient quantity of strategic stocks of oil.

3.5.5 Measures and policies to increase the resilience of critical energy infrastructure

Strengthening the resilience of existing energy infrastructure against climate change and developing a new energy system with self-resilience and enhanced capacity to adapt to new climate conditions is a necessary priority.

The implementation of Directive (EU) 2022/2557 is expected to play a key role in safeguarding existing energy infrastructure. This Directive provides for the carrying out of risk assessments of critical entities for all relevant natural risks, as well as measures to ensure their resilience, including measures necessary to prevent the occurrence of static hazards, with due consideration of disaster risk reduction and climate change response measures.

As regards new energy infrastructure, a number of national and European legal tools and policies are expected to contribute to their climate resilience:

- Article 18 of the National Climate Law (Law 4936/2022, Government Gazette, Series I, No 105) provides for the construction of climate risks and impacts and the adoption of measures to introduce the resilience of projects to existing and future climatic conditions, as part of their environmental authorisation. These projections are expected to contribute, inter alia, to the climate resilience and adaptation to climate change of energy and building infrastructure, as well as other critical infrastructure linked to energy and climate policies.
- Article 73 (2) (j) of Regulation (EU) 2021/1060 requires that investments in structures that have an expected lifespan of at least 5 years and receive funding from the NSRF 2021-2027 must be climate resilient. To this end, the European Commission has issued “Technical Guidelines on enhancing the resilience of infrastructure to climate change for the period 2021-2027” (2021/C 373/01)¹⁵⁷, on the basis of which the National Coordination Authority of the Ministry of Development and Investment, in cooperation with the Jaspers Group (Joint Assistance to Support projects in European Regions), and with the support of the Ministries of Environment and Energy and Infrastructure and Transport, developed a national interim climate resilience assessment framework¹⁵⁷.
- The European Commission has mandated the European Committee for Standardisation (CEN) and the European Committee for Electrotechnical

¹⁵⁷<https://adaptivegreecehub.gr/eleghos-klimatikis-anthektikotitas/>.

Standardisation (CENELEC) to adapt to climate change European standards, with a focus on adapting standards for energy and transport infrastructure, buildings and equipment and ICT infrastructure. A guide has already been issued¹⁵⁸ and the procedure for selecting the standards for energy structures to be revised has begun.

The implementation of the relevant measures of the National Strategy and the Regional Plans for Adaptation to Climate Change is also expected to contribute to this (see section 3.8).

As regards the readiness of the country and the bodies involved to counter the restriction or interruption of the supply of an energy source, the following provisions are provided:

- (a) Development of a national energy security strategy in the context of the sectors strategies of the National Security Strategy up to 2025.
- (b) Preparation of the National Cybersecurity Strategy by 2025 energy networks and infrastructure under the European Directive (EU) 2022/2555 on measures for a high common level of cybersecurity across the EU (NIS 2 Directive).
- (c) Preparation of the National Strategy for Protection and Resilience of Critical Energy Infrastructure by 2025 critical energy infrastructure resilience in the context of the European Directive (EU) 2022/2557 on the resilience of critical energy infrastructure.
- (d) Development of a National Strategy for the Exploration and Exploitation of Energy Mines in Greece under the European Critical Raw Materials Act (CRMA).

In addition, electricity grids, which are particularly exposed to and disruptive phenomena and their equipment usually has a long lifespan, are particularly vulnerable to the effects of climate change.

Δεδομένων αυτών των προκλήσεων, υπάρχει επιτακτική ανάγκη οι Διαχειριστές να ενισχύσουν την ανθεκτικότητα του δικτύου ώστε να είναι σε θέση να αντέξουν πιθανές καταστροφές και να ελαχιστοποιήσουν τις διαταραχές στον ενεργειακό εφοδιασμό. In addition, given the increase in RES (including dispersed injection), grid resilience is more important than ever, as it also affects energy generation flows.

Already, the National Strategy and Regional Plans for Climate Change Adaptation have highlighted the vulnerability of energy infrastructure and especially distribution networks to climate change and the need to carry out parallel studies to specify and prioritise adaptation measures.

In this context, managers need to take, first of all, preventive measures to strengthen resilience. These include the undergrounding of the aerial way (to protect it from strong winds or fires), the use of more durable materials (e.g. replacement of wooden poles with synthetic or concrete poles) and the upgrading of substations (e.g. replacement of old equipment) and

¹⁵⁸https://boss.cen.eu/media/BOSS%20CEN/ref/climate_adaptation_in_standards_guidance.pdf.

the specifications of existing infrastructure. In addition, MESH network systems could be developed, given their ability to operate seamlessly, even if parts of them are destroyed.

Additional investments in digitisation and automation are necessary in order to optimise and enhance its controllability and visibility, ensuring a faster response in the event of a crisis and better management of electric load.

Finally, it is necessary to ensure that the Managers are prepared for an immediate response to possible crises. In this context, the development of a preparedness mechanism, including the maintenance of a larger stock of specific critical materials and equipment and cooperation with third parties to strengthen their response to potential crises, will be considered, while at the same time relocating qualified and trained personnel is essential.

In the framework of the 'programmes to strengthen resilience to flood plains in Thessaly', specific measures are foreseen to reduce the energy backlash of households and businesses and to ensure the energy supply of construction and more generally the operation of critical elements of water and irrigation infrastructure. In particular, support is foreseen for:

- Households, public services and businesses to take measures to increase the climate resilience/flood protection of electromechanical installations (e.g. relocating a boiler, anchoring equipment, separating an electrical circuit of higher and lower floors, generator as a back-up).
- Farmers, businesses and municipal water and sanitation services to increase climate resilience/flood protection of water drilling and irrigation drilling (e.g. lifting of wells and construction of protective elements, emergency equipment such as rolling pump, generator).

3.5.6 Assessing the climate vulnerability of energy security policies and measures

The increase in temperature and all the more pronounced heat and drought phenomena lead to a reduction in the efficiency and operation of thermal power plants. The concentration of lignite and diesel plants and their replacement with solar and wind systems, the operation of which is not affected by the availability of water resources, is expected to reduce the vulnerability of the energy system to climate change.

In addition, the NECP policies and measures to promote dispersed energy systems, strengthen international and national interconnections and electricity transit networks, increase the storage capacity of the energy system and develop demand response systems, are expected to compensate for any local phenomena of curtailment or disruption of energy source during the more frequent and intense extreme weather events caused by climate change, as well as increased peak loads during the most intense heat seasons.

On the contrary, increasing reliance on pumped cash units⁽¹⁵⁹⁾ increases vulnerability to climate change. Better studying the effects of climate change on the water balance at

catchment level, and locating them in areas of low climate vulnerability, can significantly mitigate the risks involved.

Recent European and national legislation on infrastructure resilience is an enabling framework for climate proofing and adaptation of renewable and new energy infrastructure, but this should be reinforced by a number of additional tools to make them immediately effective¹⁵⁹¹⁶⁰, such as:

- Issue technical instructions/manuals for assessing the climate vulnerability of critical energy infrastructure and networks.
- Carry out specific studies assessing the climate vulnerability of energy infrastructure and develop appropriate investment programmes to strengthen their resilience.
- Assessment of future investment plans of network operators and consideration of the need to modify them.
- Revision of technical specifications for the operation of power plants and transmission and distribution networks.
- Development of specific power security plans for hydroelectric and pumped storage units to deal with drought phenomena.

3.5.7 Summary of measures and policies for the energy security dimension

Table 22 summarises the policy measures envisaged to meet the energy security dimension targets.

¹⁵⁹ The total installed capacity of the pumped storage units is expected to reach 1.745 MW in 2030 and 5.453 MW in 2050, providing 29 % and 31 % respectively of the total installed electricity storage capacity and 56 % and 68 % respectively of the total installed capacity of GWh for electricity storage.

¹⁶⁰ Konsta, D., Panagopoulou, G., Kyriakopoulos, G. L., Methenitis, K., Grigoriadou, E., Voudoui, A., Asimakopoulos, D., Setz, I. (2024) LIFE-IP AdaptInGR – Boosting the implementation of adaptation policy across Greece. Action Deliverable C.5 Analysis of synergies and trade-offs between the 2050 Long-term Strategy and the National Strategy for Adaptation to Climate Change covering all economic sectors and exploring the impacts of climate change and synergies with adaptation measures.

Table 22 Policy measures for the energy security dimension.

Numbering	Policy measure name	Correlation with policy priorities	Target	Affected sector	Category of Measure
M1	New interconnections with neighbouring electricity transmission and upgrading of existing ones	FP5.1, FP5.2,	Increasing Diversification, Storage and Readiness to respond to containment or interruption of provision; Development of domestic-energy sources	Electricity	Technical measure
M2	Extension of the demand response measure in electricity markets, applying to all consumers	FP5.3, FP5.4	Increase in demand response, Reduction of energy output	Electricity	Regulatory measure
M3	New interconnections with neighbouring gas transmission partners and upgrading of existing ones	FP5.1, FP5.2, PP5.4	Increase Diversification Preparedness for Reduction or Provision Breakdown	Natural gas	Technical measure
M4	Strengthening of gas demand management measures	FP5.3, FP5.4	Increase in demand response, Readiness to respond to Reduction or Prolongation	Natural gas	Regulatory measure

Numbering	Policy measure name	Correlation with-policy priorities	Target	Affected sector	Category of Measure
M5	Speeding up the implementation of storage projects (batteries and pumped storage) in the electricity sector	FP5.3, FP5.4,	Increase Diversification, Storage and Response of Demand Readiness to respond to Reduction or Prolongation	Natural gas	Technical measure
M6	NII electrical interconnections to reduce electricity from imported fossil fuels	FP5.1, FP5.3	Reduction of energy supply, increased security of supply to islands, development of domestic energy sources, decontamination of islands	Electricity	Technical measure
M7	Periodic update of the capacity assurance study by ADMIE, implementation of planned measures; integration of the Market Reform Plan and consideration of the need to implement powerful mechanisms to ensure capacity adequacy	FP5.3, FP5.4	Increase Diversification, Storage and Response of Demand Readiness to respond to Reduction or Prolongation	Electricity	Regulatory measure
M8	Improvement of network resilience through the implementation of appropriate measures (e.g. underground, use of durable materials and aerial network specifications), including the penetration of resilience of C/C infrastructure	PP5.5	Resilience of critical energy-subsystems	Electricity	Regulatory measure, technical-measure, financial measure

Numbering	Policy measure name	Correlation with policy priorities	Target	Affected sector	Category of Measure
	HV/MT and optimisation of network gas				
M9	Maintenance and updating of a national risk assessment for natural gas (including regional studies) whenever requested in accordance with Regulation (EU) 2017/1938	FP5.1, FP5.4	Readiness to respond to Reduction or Prolongation	Natural gas	Regulatory measure
M10	Implementation and updating of the Preventive Action Plan and the Emergency Plan in the gas sector and implementation of planned measures, including solidarity mechanisms	PP5.4	Readiness to respond to Reduction or Prolongation	Natural gas	Regulatory measure
M11	Maintenance and updating of emergency-management plans for electrification of the NII and implementation of planned measures	PP5.4	Readiness to respond to Reduction or Prolongation	Electricity	Regulatory, Technical Measure
M12	Maintenance of a Management Committee for Oil and/or Petroleum Products Supply Disorders	PP5.4	Readiness to respond to Reduction or Prolongation	Petroleum oils	Regulatory measure

Numbering	Policy measure name	Correlation with-policy priorities	Target	Affected sector	Category of Measure
M13	Maintenance and updating of National Extractive Energy Transmission System-Measures (Exceptional imports or verbal energy, load cut schemes, Defense Plan, Restoration Plan, etc.)	FP5.2, FP5.4	Readiness to respond to Reduction or Prolongation	Electricity	Regulatory measure
M14	Design and implementation of procedures, security and data protection mechanisms for network users	PP5.5			Regulatory measure
M15	Maintenance and Update of Reservation of Emergency Reserves of AnasGis Petroleum	PP5.4	Readiness to respond to Reduction or Prolongation	Petroleum oils	Regulatory measure
M16	Develop strategies and policies for: the security of critical energy infrastructure, b. the cybersecurity of energy infrastructure managers and the establishment of a framework for assessing the security of such infrastructure and c. The development of critical raw materials;	PP5.5	Resilience of critical energy-subsystems		Regulatory measure

3.6 measures and policies for the internal energy market

The energy market has experienced structural changes in its design and functioning in recent years, both at wholesale and retail level. The need for the additional reforms discussed below has been highlighted mainly by the recent energy crisis and their implementation requires the successful coordination of both the institutions involved and the market participants.

The seamless integration of high stochastic generation from RES stops and the effective management and participation of new technologies such as energy storage and demand response in the markets are an important challenge for the functioning of the electricity market in the downstream sectors.

Five main priority pillars (FP6.1-FP6.5) for the measures to be taken are presented below.

FP6.1: Enhancing competition in the retail market and promoting dynamic pricing – completing network digitalisation

FP6.2: Development of strategies to tackle the energy crisis and protect final consumers

FP6.3: Promoting reforms to improve the functioning of the electricity market

FP6.4: Standardisation and strengthening of bilateral PPA's contracts and development of new environmental markets

FP6.5: Promote systems providing flexibility, and storage and demand response systems; ensure the country's output adequacy

Figure 18 Electricity market policy priorities for 2025-2030.

Key institutional bodies for the implementation of new policies and the achievement of the electricity market are the Ministry of Energy and Energy (YPEN), the Regulatory Authority for Waste, Energy and Water (RAAEY), the Independent Transmission System Operator for Electricity (ADMIE), the Greek Energy Exchange ('ERA'), the Hellenic Energy Exchange ('ERA'), the Hellenic Electricity Prefecture Network Operator ('DEDDIE') and the Renewable Energy and Guarantees of Origin Operator (DAPEEP). Each of the above bodies, in accordance with the obligations and responsibilities specified in the European and national legal and regulatory framework, plays a catalytic role in the development of reforms and the achievement of the objectives set under the NECP.

3.6.1 Measures and policies to enhance competition in the single market and promote dynamic pricing – completing the digitalisation of the network

Measures to fully align with the EU guidelines on the retail electricity market will be promoted with a view to consumer empowerment and protection, transparency and competitiveness among electricity predecessors, as well as the promotion of dynamic and flexible tariffs. The

measure concerns the development by suppliers of a new type of variable pricing product, which will directly monitor price fluctuations on wholesale markets and also enable the consumer to match his load profile to this variation by means of appropriate brands received from the relevant market operators. Given that products with similar characteristics were in the past only supplied to medium and/or low voltage customers, who were apparently in a different position for the perception of a price-setting machine, it seems necessary to immediately establish uniform rules for all electricity consumers. The framework for the implementation of dynamic pricing, which is planned to be **implemented by the end of 2024** in the retail electricity market, aims to identify the necessary adaptation of the framework governing the operation, rights and obligations of operators, suppliers and consumers, taking into account the recording, study and analysis of the specific issues related to the effective implementation of dynamic pricing and current market conditions. The scope of the Invoicing Potential Framework covers in particular:

(a) General design issues

- Identification of the market (day-ahead, intraday) that can be taken into account in determining the reference price of the dynamic pricing leg.
- Standardising the tariff structure based on the transparency of the pricing method, the comparability of the supplier tariffs available and the feasibility of providing for separate tariffs for each category of consumers.
- Application of limits to the price variation of the dynamic part of the tariffs.
- Establishment of a clearance period to calculate the charge for the dynamic part of the invoice.

(b) Consumer information and protection issues:

- General and specific terms and conditions of dynamic pricing contracts, in particular the duration of the contract and the possibilities for unilateral termination by the customer for a loss on another invoice or supplier.
- Content of specific pre-contractual information on dynamic pricing contracts, including in particular information on the relevant market for the definition of the reference price, the precise way in which charges are calculated (the social and non-dynamic components of the tariff), the opportunities and risks of dynamic pricing, due to fluctuation in the reference price, etc.
- Content, timing and manner of contractual information: timely information on the price of the dynamic part of the tariff, system functionality requirements for the use of information from automatic load management systems for installations.

(C) Supervision and enforcement issues

- Content and procedure for informing the RAAEY of available fare products, the terms of dynamic pricing contracts and the dynamic price contracts concluded.

(D) Determination of the implementation of the new framework governing tariff contracts and division of responsibilities

- Identification of needs to complete a regulatory framework (such as laws, codes, regulations, manuals);
- Identification of implementation needs (procedures, systems, Arts), etc.

Targeted policy measures will be launched to **promote dynamic pricing, in line with a new framework described above**, in the supply of electricity to final consumers with the aim of promoting energy efficiency and achieving energy cost reductions. Dynamic price-setting will encourage the reduction of consumption during peak periods and promote the use of energy-efficient and smart devices. To achieve this goal, technological solutions allowing prices to be adjusted in line with energy demand and supply will be strengthened. The aim is to encourage the development of smart meters and devices that allow consumers to follow their consumption and to receive information on price fluctuations.

The implementation of these measures comprises two periods:

- In the short term, suppliers will offer dynamic pricing for the service groups that DEDDIE provides to market operators with truncated data per 15 minute (Medium and Low Voltage benefits). Then use of electro-mobility supplies should be integrated into the dynamic price as a priority for incentivising end-users through parallel price signals to achieve green charging.
- In the medium term, the gradual integration of new major groups of services into dynamic pricing as a matter of priority until smart meters are installed in all Low Voltage services.

Furthermore, in addition to dynamic pricing, **the development of competition in the retail market** will make it possible to avoid a high degree of concentration and low consumer mobility. The share of electricity supply in Xille Voltage represented by the dominant undertaking (PPC) has decreased from 91 % in 2016 to 63 % in 2023. This reduction goes in the desired direction, with the ultimate aim of strengthening the role of consumers and improving the conditions of domestic competition, through which a number of benefits will be generated for final consumers, such as lower costs in the bill of vendors, improved customer service, as well as new solutions and services to meet existing and future needs such as smart homes, traffic, energy clearing, demand response, etc.

The deployment of smart meters to all consumers is a key priority and is expected to be completed by the year 2030, based on the existing design and the state of play of installations and tendering procedures. Recorder meters will make it possible to complete the digitalisation of the network through the increased technical possibilities they are supposed to adopt. In particular, the ability to adjust the frequency of energy data collection will lead to the optimisation of the assessment of potential risks to the safety of the product and the

adoption of measures to address them, either by limiting the absorption rate and/or controlling the associated loads of consumers.

The installation of smart meters is also a prerequisite for the active participation of consumers in energy markets, such as through the implementation of the new self-consumption scheme by means of the identified netting and the use of demand response, and will allow optimisation of the functions of their plugs (electricity suppliers, RES and Demand Power Plants) by receiving, in real time, the energy measurements of the showers via an appropriate smart meter port; and the sharing by the network operator of consumers' energy data at a level of 15 meters, allowing the provision of dynamic and zonal prices and the offsetting in real time, on market terms, of electricity produced and consumed by self-consumers.

The possibility to obtain energy data directly from consumers and third parties via the access gateway will allow, in conjunction with the wider digitalisation of energy appliances and uses (e.g. cooling, heating, electric charging), the immediate adaptation of the energy absorbed by consumers, both in a nine-day horizon, in order to reap the full benefits of dynamic tariffs, but also at a hourly level, allowing commercial and household consumers to participate in a demand response market and allowing the full enjoyment of the benefits of this market, given that the critical mass of loads is at the low voltage.

Smart meters, with increased security standards and prevention of external interference with metering equipment for plug purposes, will result in a significant reduction of plugs. At the same time, the comprehensive mapping and supervision of the distribution network will allow appropriate diagnostics to be carried out for targeted plug detection and verification.

The central objective of the energy transition is the **active participation of citizens** in the energy market either directly or through an aggregator following the guidelines of the European Union. Self-consumption is therefore being promoted by selling excess energy on the energy markets to all riders in Greece, as well as at all voltage levels, notably by means of photovoltaic systems and new technologies such as energy storage.

Through the shape of the identified netting, the consumer participates in the energy market, sells the excess energy and adjusts its distribution profile to maximise the compensation benefit between the energy produced by the RES plant and the energy consumed in real time.

The new imputation scheme allows companies to install RES systems with or without storage on behalf of the self-consumer, so that their consumption can be offset at a much lower financial price than the cost of supplying electricity on the retail market, increasing competition in the energy market.

The main advantages of self-consumption in the form of identified need-to-work compensation promoted are the following:

1. If, in a dwelling or business, there is no available space (roof, roof, land) to install a photovoltaic system, it can now be installed anywhere in the country, with the application of the photovoltaic energy compensation indicator.
2. If an enterprise has several consumption supplies, then they can be combined for offsetting under the same self-consumption scheme.
3. The costs of electricity supply are reduced, while at the same time promoting the electrification of heating and transport, involving a dwelling or business, installing heat pumps and chargers. As a result, consumers are shielded both from an increase in the price of electricity, but also from increases in oil and petrol prices due to sudden international events.
4. The role of active self-generator/consumer is being enhanced, as new digital technologies and specialised energy counselling help them to organise their electricity needs so that they have the maximum benefit.
5. Each self-producer is involved in the active protection of one's surroundings and in order to achieve the maximum economic outcome minimises its environmental footprint.
6. Electricity grids are discharged thanks to dispersed production, which is burned locally.
7. The introduction of new electrification and smart spot energy management technologies:
 - ✓ They boost the electrification of households and businesses.
 - ✓ They create new jobs in the green and digital transitions.
 - ✓ They create the basis for further participatory growth in the green, digital transition.

3.6.2 measures and policies to develop strategies to tackle energy crises and protect final consumers

In response to the energy price crisis, a number of regular and temporary measures have been put in place to mitigate the consequences of the crisis and to set the cost increase faced by final consumers. These measures as a strategy to tackle an energy crisis can be summarised as follows:

- In accordance with Article 61 of Law 4839/2021 (GG I 181), the **Energy Transition Fund (TEM)** was established to address the consequences of the energy crash. Revenue from the EU Emissions Trading System, as well as revenue from the introduction of exceptional measures aimed at protecting consumers from any high prices on the market, flows to the TEM, among other things. The TEM's contribution to tackling the energy crisis has been extremely calm, with more than **EUR 10 billion** channelled to consumer bills from autumn 2021 to December 2023.

- In accordance with Article 12a of Law 4425/2016 (Government Gazette, Series I, No 185), a temporary non-return of part of day-ahead market revenue was introduced, which ran from July 2022 to December 2023, while Greece was one of the first countries in the EU to apply such a mechanism to automatically withhold so-called 'precipitated' profits of electricity producers. Under this Temporary Mechanism, a maximum compensation price for each category of production units was set for each month, the regulated Producer Revenue Price ('PTEP') and if the market price exceeds the PTEP for a given time, then revenue withheld in favour of TEM is generated for that time. The total revenue of the above mechanism for the 18 months of implementation was over **EUR 3.5 billion**, with the largest share coming from RES power generators.

In addition to the above measures to shape the framework for supporting consumers in the context of an energy crisis, measures will be taken to protect tanners and tackle energy poverty, such as amending the Electricity Supply Code as a whole, which has not been amended since its adoption (2013), and amending the framework for granting the Social Care Invoice (KOT) to its beneficiaries, so that it can be applied more effectively in the light of the new retail market conditions, to the benefit of vulnerable fathers.

As mentioned above, an important part of the completion and reform of the existing regulatory framework governing the electricity supply regime is undeniably the adoption of a new Supply Code in the first months of 2024, which will modernise/update the electricity supply regime so that it is in line with the current provisions of Regulation (EU) 2019/943 and Directive (EU) 2019/944, as well as with technological and digital developments in the market itself which require proportionate brave adjustments. Moreover, the Electricity Supply Code has been the main tool which has greatly helped to achieve the gradual liberalisation of the retail electricity market, while at the same time ensuring and largely pushing both the market and final consumers towards deepening the rules on transparency, cost-orientation and a well-functioning and organised market. However, the aim is not only to amend the existing Procurement Code on the basis of the changes that have already been made to the European and domestic legislative and regulatory framework, but also to inform and finally adopt a modern, coherent, complete and ambitious new Procurement Code, which will incorporate existing and upcoming technological developments, liberalise and strengthen relations between suppliers and end users, while at the same time continuing to protect and ensure the orderly and regulated functioning of the market and competition.

In addition, in addition to the reform of the framework of the Electricity Supply Code, suppliers will be incentivised to facilitate the conclusion of bilateral contracts for the purchase and sale of electricity with producers, with the aim of reducing consumers' energy costs, while by enhancing the liquidity of pre-institutional markets, suppliers are encouraged to

manage the risk more effectively than their exposure to markets by trading against risk. In addition to the above, the country's commitment to decoupling wholesale electricity market prices from that of natural gas and through increased RES penetration, which has a positive impact on the import/export trade balance, is consistent.

Finally, the focus will be on tackling the particularly acute problem of rheumatic thefts, by tightening the framework for offenders, in particular by adopting policies such as increasing the financial penalties for such cases, for the benefit of society as a whole.

3.6.3 Measures and policies to promote reforms for BiH to improve the functioning of the electricity market

□ import of 15 cm of products on the electricity markets

The Greek Energy Exchange, as electricity market operator ('NEMO'), has already begun the preparation of adapting and improving all its systems in order to achieve the introduction of 15 minutes of continuous transaction products on the Day Ahead Market and the continuous Intraday Exchange for the Greek Tender Zone. On the basis of Regulation (EU) 2019/943 of the European Parliament and of the Council on the internal market for electricity, operators allow market participants to carry out energy traders at intervals that are at least as short as the imbalance settlement type (i.e. 15 minutes). The aim is to make the products available in the Pan-European Intraday Auctions, the launch of which is planned for 2024, and then on a pan-European basis in 2025 to the Day Ahead Market. Similar interventions shall also be launched in the internal infrastructure of the Transmission System Operator for Electricity (ADMIE), as well as in the interconnections, to ensure their smooth operation under conditions that will lead to trade in 15 million products in the Day Ahead Market and the Intra-Term Market.

The implementation of the above is linked to progress in uncoupled markets. The Greek electricity market is bordered both by coupled European markets (see Bulgaria and Italy) and uncoupled, such as Albania, North Macedonia and Türkiye. Special care should therefore be taken to bring about the introduction of the 15-minute products/transactions also on the uncoupled markets, as otherwise the Greek market will be obliged to maintain 60-minute products, as is now the case, in order to trade electricity with the uncoupled markets.

□ measures for market monitoring and lifting restrictions

In the context of RAESE's ongoing market surveillance, the objective has been set to restore market conditions, which will increase competition and provide the necessary signals to attract the investments needed for the energy transition. A key step in this direction is the gradual lifting of the temporary measures adopted in the context of the energy crisis, thus restoring the free functioning of the markets in line with the European plan, while maintaining their endless monitoring and surveillance. It is also considered necessary to restore the functioning of the markets due to other definitions set since the launch of the

markets under the “Objective Model”, in order to regulate individual and temporary issues of the new markets.

the regional role of Greece and the achievement of interconnectivity

Taking measures to continue projects to build new interconnectors and strengthen existing ones is a key priority to strengthen Greece’s crucial role, with the aim of strengthening regional energy cooperation, making Greece a strong clean energy exporter and deepening the European electricity market. Examples include the complete completion of the new interconnector between Greece and Bulgaria (Maritsa – Nea Sada), but also the investigation to strengthen the interconnections between Greece and the Motoric of North Macedonia and between Greece and Türkiye. In addition, the interconnection with Crete supports the prospect of interconnecting Greece with Cyprus and, via Cyprus, with Israel. Finally, it is proposed to explore the possibility of improving the reliability of existing interconnections.

It is important for the efficient availability of interconnector capacity in a secure manner to calculate it through a common coordinated methodology to take into account at regional level the state of the grids, changing flows from RES and price volatility.

The successful operation of the Regional Security Coordinator of the South-East Euro (RSC) based in Thessaloniki, in which the Greek and Romanian System Operators participate jointly, is a very positive development within the above-mentioned framework. Promoting the acceptance of the European legislative framework by third countries such as those participating in the Energy Community and their participation in the RSC is essential to extend the harmonised management of interconnections and achieve interconnectivity.

Addressing the problems of public acceptance in the construction of new interconnector lines is crucial to address them early. Early involvement of local communities, as also provided for in the TYNDP guidelines, should be pursued.

In the context of international interconnections, cooperation has already been initiated at regional level with the following countries:

Table 23 Lists of countries with which cooperation on international cooperation is taking place.

Albania	Cyprus
Bulgaria	Republic of North Macedonia
Israel	Türkiye
Italy	Egyptian
Germany	Saudi Arabia

3.6.4 Measures and policies to standardise and strengthen two-way contracts (PPAs) and the development of new environmental markets

➔ promotion of bilateral contracts (PPA's)

The great interest in investment has highlighted the need to establish a bilateral RES PPAS Platform. The Basic Principles and Structure of the Platform aim to:

- Fostering the development of new RES projects on market terms, since their viability and their financing will be ensured – for the most part – free from State aid schemes.
- Enhancing the choice of smaller participants from both the seller and the off-taker side.

The RES PPAS Platform is expected to be operational towards the end of 2024.

☐ opening of invitations to tender for Guarantees of Origin

The Director of Renewable Energy Sources and Guarantees of Origin (DAPEEP) has already conducted the first auction for the award of guarantees of origin in mid-2024, following the successful completion of the interconnection of the Greek Non-Food Guarantees of Origin (OP) with the corresponding European registers. This has facilitated the participation of Greek 'green' certificates in all European herds, as their issuing bodies are also members of the European Guarantee of Origin (AEO) providers. This possibility is intended to increase the value of domestic Guarantees of Origin, as it will create possibilities for serving the large consumers and electricity suppliers targeted by the Greek green certificates.

At the same time, the Energy Exchange plans to create secondary guarantees of origin, thereby increasing the transparency and marketability of these certificates.

☐ voluntary Carbon Market (voluntary Carbon Market)

The development of the Voluntary Carbon Credits Markets (VCMs) market is being explored in Greece, as the measure will further support a number of objectives:

- It will provide private sector companies with further possibilities to reach the zero-emission target, in addition to what is set by the EU Emissions Trading System (EU ETS).
- It will create opportunities to support local efforts to reduce and remove carbon emissions, and will also enhance capital flows in programmes that allow offsetting carbon emissions.
- The voluntary market will strengthen addressing climate change issues and implementing policies to reduce and avoid greenhouse gas emissions.

With the completion of a voluntary CO₂ Reduction Credit Market, it will be possible for the first time within the EU to access products and services related to voluntary offsetting of CO₂

emissions, in addition to the mandatory Compliance Market in an EU Emissions Trading Scheme (EU-ETS).

3.6.5 Measures and policies to promote flexibility, energy storage and market-response systems

□ ൧൩൦൫■൧ □൩◆□□■◆൩ ൬□■◆□✕൩◆◆✕□■ ൫✕൧

In order to enhance the contribution of the Demand Response to market flexibility and system security, a number of combined actions are needed both in the retail and wholesale markets and in the networks. The actions so far and the measures that have been and will be strengthened/completed can be summarised as follows:

- Complete the take-up of smart meters to all consumers with the aim of fully replacing conventional meters with smartmeters by 2030.
- Establishment of a regulatory framework for all suppliers of dynamic tariffs to offer within one year (completion of the Energy Supply Code, new framework for implementing dynamic pricing).
- Strengthening cooperation and coordination between operators (TSO-DSO coordination) for the selection of common rules and procedures to ensure the safe and reliable operation of the electrical connector in realtime. DEDDIE has already recently started to provide suppliers with certified measurement data of 15 cm for low voltage supplies 5, 6 and 7.
- Continued granting of Demand Response (PSEAZ) authorisations. In 2025, the Licensing Regulation will be amended to provide for specific arrangements for the licensing of PPSEAZs, with the introduction of special charges.
- Complete the review of the regulatory framework for the participation of PPSCABs in wholesale markets, on the basis of their specific characteristics. As early as the end of 2022, the participation of PPSEAZs in the Balancing Market is possible. In addition, the rules for the operation of the day-ahead and intraday markets and the Balancing Market Regulation have already been amended in order to involve demand response in the Day Ahead Market and the Intraday Market. An update on the readiness of ERA and ADMIE for their implementation is expected, with the completion of the necessary changes to their information systems.

The basic empowerment of the consumer comes from the ability to control their consumption profile. Furthermore, the above measures are expected to have multiple benefits across the electricity market to the benefit of final consumers. First of all, the participation of as many entities as possible in the wholesale markets increases competition. As a result, the market participation of PPSEAZs is designed to reduce system load by reducing the need to activate costs and polluting thermal plants, and to increase competition between

participants by reducing the limit price, which will be transferred to the retail market. It should be noted that demand response is a non-capital intensive activity and can therefore also be offered by entities that do not have other forms of production, attracting also non-integrated companies active in the retail market, further intensifying competition in the internal market in favour of the final consumer.

In addition, consumers will benefit from financial incentives offered to them to contribute to demand response schemes. For example, in implemented countries, suppliers offer discounts or compensation for reducing consumption during peak hours.

In addition, the role of the Energy Communities in the field of energy flexibility will be explored, assessing the possibility of acting as flexibility entities through storage, smart consumption management and demand-response projects.

storage participation in electricity markets

The amendment of the regulatory and regulatory framework to support the full integration of storage systems into the Energy Markets is expected to have been completed in 2024. Based on current planning, Storage Systems are foreseen to participate as Balancing Service Entities, with the right to participate in all energy markets and all relevant energy and capacity products. Ensuring the full and equal participation of Storage Systems in the Energy Market is a crucial part of the country's energy transition and a milestone for the electricity market, thus improving market flexibility and liquidity.

In addition, a significant contribution to the provision of reserves is expected, especially given the capacity of storage systems to provide reserves without parallel energy supply, which is not possible in most balancing service technologies.

As a result of the participation of storage systems in the energy markets, not only the increase in the RES penetration margin in the energy mix, but also better congestion management, as well as improved operational security and the proper functioning of the transmission system, are being fostered.

participation of demand response in electricity markets

The regulatory framework for responding to a demand, which was completed on 30 June 2022 by Law 4986/2022 (Government Gazette, Series I, No 204), which added the relevant articles to Law 4001/2011 (Government Gazette, Series I, No 179) and was activated for the first time at the end of April 2023, will continue to be implemented with the necessary improvements where necessary.

In this context, the Regulations of the three electricity markets of the "Target Model", the Day Ahead Market, the Intraday Market and the Balancing Market were amended in order to integrate demand response into their operation, including high-efficiency cogeneration and

thermal power plants.

Now, the new entities, i.e. the Cumulative Demand Response Bodies and Consumers, will be able to operate in the markets and submit forms for each load block they represent. A prerequisite for greater penetration of the consumption response in electricity markets is the installation of smart meters in the grid.

As already pointed out, the installation and implementation of automation systems, through long real-time monitoring and monitoring of the network, will allow the Network Manager to better coordinate the dispersed active resources and to plan flexibility services.

Please note that the planned increase in RES penetration of electricity generation, based on current planning, is expected to continuously create new opportunities to develop demand response on the Greek market, with a view to providing both energy and reserves and ancillary services. The relative growth is expected to increase the liquidity of electricity markets with corresponding benefits in terms of their competitiveness.

participation in European Energy Balancing Platforms

Under Regulation (EU) 2017/2195 establishing a guideline on electricity balancing, common European layouts for the imbalance netting process (IGCC), the exchange of balancing energy from automatic frequency recovery reserves (PICASSO), manual frequency restoration drills (MARI) and replacement reserves (TERRE) shall be established to ensure optimal management and coordinated operation of the European electricity transmission system, while supporting the implementation of the Union RES penetration targets.

Greece's participation in the European platforms is an important milestone towards achieving the objectives of the plan, as it promotes increased competition, transparency and efficiency of the balancing market and the electricity transmission system, while supporting the implementation of the Union RES penetration targets. At the same time, it facilitates the efficient operation of the intraday market by offering participants the possibility to ensure their own balancing in time as close to real as possible.

3.6.6 Summary of measures and policies for the internal energy dimension

Table 24 summarises the policy measures envisaged to meet the targets within the internal energy market dimension.

Table 24 Policy measures for the internal energy market dimension.

Numbering	Policy measure name	Link to policy priorities	Target	We are-affected by the sector	Category of Measure
M1	Strengthening electricity interconnections with neighbouring countries to further connect and integrate with the wider electricity market	PP5.3	Electricity interconnectivity Electrical system adequacy Flexibility of the energy system Consumer protection Improvement of competition Energy poverty	Electricity	Technical measure
M2	Participation of storage systems, combined with RES or individually, in electricity grids	PP5.5	Electricity interconnectivity Electrical system adequacy Flexibility of the energy system Protection of consumers Improving competition	Electricity	Technical measure
M3	Extension and reinforcement of a distribution network (e.g. electrical/electrical power lines, medium-voltage/low voltage lines) to facilitate the connection of new RES and the increase in demand due to the electrification of the final consumption of others (e.g. ports, central vehicle loading stations)	FP5.1, FP5.5	Electricity interconnectivity Energy transmission and distribution infrastructure Electricity system adequacy Flexibility energy system	Electricity	Technical measure

Numbering	Policy measure name	Link to- policy priorities	Target	We are- affected by the sector	Category of Measure
			Protection of consumers Energy poverty		
M4	Installation of eff-top interface and control equipment in RES units and storage stations	FP5.1, FP5.5	Electricity interconnectivity Electrical system adequacy Flexibility of the energy system Consumer protection Improving competition	Electricity	Regulatory, Technical Measure
M5	Reforms for the optimal functioning of the electricity market	FP5.3, FP5.5	Protection of consumers Improving competition	Electricity	Regulatory measure
M6	Continue to take measures to link the electricity market with neighbouring markets.	PP5.3	Energy market integration Consumer protection Improvement of competition	Electricity	Regulatory measure
M7	Implementation of investments in the network, including the installation of external meters and infrastructure, telecommunications, remote control and management, telemetry and metering data management, with a view to optimising the integration of propeller loads	FP5.1, FP5.5	Flexibility of the energy system Protection of consumers Improving competition	Electricity	Regulatory, Technical Measure

Numbering	Policy measure name	Link to policy priorities	Target	We are affected by the sector	Category of Measure
M8	Interoperability of informationsystems of a distribution system operator and other marketparticipants and consumers	PP5.5	Protection of consumers Improving competition	Electricity	Regulatory, Technical Measure
M9	Enhancing the participation of thedemand response in electricity markets	PP5.5	Protection of consumers Improving competition	Electricity	Regulatory, Technical Measure
M10	Take measures, in case of exceptional-measures per volume, to protect consumers-from high electricity market prices	FP5.1, FP5.2	Protection of consumers	Total final energy-consumption sectors	Regulatory measure
M11	Creation of a market forenvironmental products (e.g. guarantees of origin,voluntary purchase of pollutants, etc.) and a toolfor pre-pushing bilateral contracts for thesale of offshore renewable energy	PP5.4	Protection of consumers Improving competition	Electricity	Financial measure
M12	Promoting self-consumption andbilling dynamics to enhance the active participation of consumers in the electricity market	PP5.5	Protection of consumers Improving competition	Electricity	Regulatory, Financial

3.7 measures and policies for the exploitation of critical mineral raw materials

3.7.1 Measures and policies for the security of supply of critical raw materials

In addition to the tendering procedures for the exploitation of mature CRM deposits, which will contribute to the security of supply of raw materials in the European Union, other policies and actions are needed, which can be summarised as follows:

- Complete the specific WFD spatial plan, which will ensure the accessibility of deposits of strategic interest over time and even improve the sector's social acceptance by reducing potential frictions with other competing land uses.
- Legislative and regulatory interventions in order to improve the existing regulatory framework for mining activity. There is a need to re-examine the existing mining legislation on three axes:
 - (a) to adapt the rules to the current socio-economic situation and investment needs, as well as to European imperatives, with a view to improving the mining investment climate; in conjunction with corresponding interventions in environmental and forestry legislation, permitted land uses, in particular within protected areas, the climate proofing of mining facilities and infrastructure, the licensing and management of extractive waste and post-mining uses of sites (Post mining).
 - (C) establishing a coherent framework that does not create uncertainty for those active and investing in the mining industry, but at the same time contributes to building public confidence in the management of rights by the State.
- Strengthening existing investments in the exploitation of Greek ferronickel-laterite deposits (laterites), bauxites, magnesium deposits and mixed sulphur-containing ores, with a concomitant routing of interventions to encourage the production of critical and strategic minerals contained therein.
- Promotion of circular economy projects: Development of systems and policies to encourage recycling, processing for final products and reuse of critical minerals and their waste, sustainable and socially responsible sourcing of raw materials in line with the quantitative targets of the European Regulation on Critical Raw Materials.
- Diversification of Supply Sources: Strive to find and develop new sources of critical minerals, as well as explore new innovative notions that will reduce the environmental footprint or dependence on them.
- International Cooperation: Collaborate with other Member States of the European Union and global partners to exchange know-how in the field of fluid, extraction and processing of CPMs. Approach new methods for the extraction and processing of KPH ores, concentrates and wastes through innovative enrichment and metallurgical processes (e.g. Ga, Ge, Sb, Ni, Co, etc.).

- Widening social cooperation: For a smooth transition from the current situation to a situation of at least 10 % increase in mining, significant interventions are also needed to improve civil society's perception of the mining sector. Interventions relating to the substance of mining in our collective value chapter and substantial initiatives aimed at improving the degree of social acceptance of mining projects and ultimately mitigating or removing the consolidated negative impact on these projects ('social permit'). Targeted collective programmes to inform and strengthen public opinion and to convey the right message to the right ones are therefore needed within the next 6-7 years. At the same time, in mining regions with limited water resources, specific cooperation programmes should be set up to reduce the development of different uses in the context of climate change.

3.7.2 Promoting research

1. Exploration:

Funding is a crucial point for the continuation and further development of CRM research (which is difficult and complex e.g. deep boreholes, with high risk and geological uncertainty). Therefore, in order to ensure that research can be done seamlessly, appropriate financial tools should be put in place both at national level and at Community level.

The predominant quality objective, i.e. the targeted geological survey and exploration/logical survey in areas of high interest, requires, according to the relevant estimates of the Association of Mining Enterprises (AIC), expenditure of around 100 million. EUR [...], until the year 2030.

2. Research Innovation:

It is proposed to support and encourage research programmes aimed at developing alternative materials and methods of metallurgical processing or SOL to reduce the recycling of critical minerals, as well as to reduce water use in the extraction and production process, with the collaboration of private individuals and research organisations in the country (e.g. HORIZON programme).

2.3.3 Promotion of exploitation

Increasing the European Union's degree of self-sufficiency from ~ 2 % today to 10 % with a view to 2030, an objective in line with the European Regulation on Critical Raw Materials, means an increase of at least 400-500 % in the mining industry, with regard to the exploitation of KOPs, within the next 6-7 years. **In order to achieve the target**, in the coming years up to 2030, the Ministry of the Environment and Energy plan to gradually launch international tenders for the lease of exploration and exploitation rights to DNCs, which will be judged positive on the basis of the above criteria. In particular, the planning shall include **annual**

international tendering procedures which should include at least one (1) of the poles of molten and critical mineral metals every year.

It should be noted that, according to data from the Ministry of the Environment and Energy, the number of PPPs under assessment exceeds one hundred and twenty, some of whom are of interest to KOPY-SOPY and are therefore being considered for the possibility of launching a tendering procedure for leasing and operating them. The evaluation of the FRM is carried out by the Ministry of the Environment and Energy in cooperation with the GFCM.

Any prospect of exploitation needs to be accelerated given the long period of time – ~ 8-10 years – required for the launch of a mining project, from exploration to licensing and the commencement of production for a mining project, so that the 10 % target for the production of critical mineral raw materials from European deposits, including in Greece, is hoped to be met. It goes without saying that CPPI projects should be able to access funding provided for by the EU funds (NSRF, Just Transition Fund, RePowerEU, InvestEU, Innovation Fund) and the ECB.

2.3.4 Assessing the climate vulnerability of policies and measures to harness critical mineral raw materials 161

KOPH extraction can be significantly affected by climate change and in particular by changes in the hydrological cycle. More heavy rainfall and floods mean that mining can be stopped either directly due to damage to the mines and installations or indirectly due to interruptions in the supply of energy. They can also increase the risk of leakage of hazardous substances from extraction facilities and pollution of water bodies and soil, causing damage to other domestic legal activities and thus increasing opposition from local communities.

In addition, the reduction of annual rainfall and the increase in drought periods due to climate change may cause pressure on water stocks in the CPPY extraction areas. Water is necessary both in surface mining, to suppress dust and washing equipment, and in underground mining for the transport of the ore. Water requirements are even particularly heavy in the case of rare earth extraction (0.63 m³/kg) and lithium (0.78 m³/kg). Water availability reduction will increase competition with other uses, causing – especially in cases of extreme drought – a decrease in production. More efficient water use in the extraction process, the use of alternative water sources (e.g. use of lower quality water, recycling of water used in extraction, reuse of effluent or desalted water treatment plants), and use of less water-intensive technologies can alleviate climate change pressures.

Climate change may affect global CUP chains, jeopardising global energy security. The disruption of rare-earth mining in DoWestern China in 2020 due to floods, the interruption of several weeks' exports of cobalt due to floods in the Durban port in the Democratic

161 International Energy Agency, (2022), Climate Resilience for Energy Security, p. 191.

Republic of Congo (DRC) in 2022 and the decline in copper production due to drought in Chile in the same year are some examples of the effects of climate change on the supply and prices of critical mineral raw materials worldwide.

Taking into account that most of the production of critical raw materials is concentrated in a small number of countries (e.g. the DRC produces 70 % of cobalt, China 60 % of rare earths, South Africa 70 % of platinum, and Australia and Chile 2/3 of lithium), which are predicted to face drier climate conditions and/or more intense rainfall and floods in the future, it is even more understood how the local impacts of climate change can influence energy policies globally.

The use of our country's critical mineral raw materials reduces to some extent the vulnerability of the NECP policies and measures to the disruptions caused by climate change in global supply and the consequent increase in CPPY prices. At the same time, however, it increases pressure on reduced climate water resources, increasing competition with other uses (e.g. agriculture, youth, tourism) at local or regional level.

More rational management, recycling and reuse of water, to be achieved through the implementation of the relevant measures of the National Strategy and the Regional Plans for Adaptation to Climate Change (see section 3.8), the River Basin Management Plans, the Forest Flood Management Plans and the Circular Economy promotion policies (see Section 3.1.6) should help mitigate the effects of climate change and improve the availability of water resources for the extractive industry. In any case, however, the future availability of water resources and the existence of antagonistic water uses should be taken into account when assessing KOPY extraction streams.

At the same time, it is necessary to take measures to increase the climate resilience of KOPY extraction facilities within Greek territory, also on the basis of the provisions of the National Strategy for Adaptation to Climate Change (see Section 2.9) for the mining sector. The application of the relevant provisions of Article 18 of National Climate Law 4936/2022 (Government Gazette, Series I, No 105) during the environmental licensing of mining activities contributes to this direction.

3.8 climate adaptation measures and policies in the context of implementation of the NECP

Under Article 45 of Law 4414/2016 (Government Gazette, Series I, No 149), Greece has already developed and approved the National Strategy for Adaptation to Climate Change. The NAFRP sets out the overall objectives, guiding principles and means of implementing a modern, effective and development strategy for adaptation to climate change within the framework defined by the United Nations Convention on Climate Change, European policies and international experience. The evaluation and revision of the NAFRP will be carried out in the framework of the LIFE-IP AdaptInGR project, coordinated by the Ministry of the Environment and Energy, and is expected to be completed in 2026.

The thirteen regions of Greece have already developed Regional Climate Change Assistance-Plans (Regional Climate Change Plan) on the basis of Law 4414/2016 (Article 43). The Regional Centres specify the guidelines of the NAFRP, assessing climate vulnerability and determining appropriate climate change adaptation actions and measures, also taking into account the specificities of each region. The process of approving the Regional Social Security Centres is in progress and is expected to be completed at the beginning of 2025. To date (October 2024), the Regional Centres of the North Aegean, Crete, Attica, Peloponnese, Western Greece, Western Macedonia and Central Macedonia have been approved. The RSACs shall cover a period of at least seven years.

In the context of the National Climate Law (Articles 9 and 10), the prevention of climate change resilience and adaptation action at sectoral level is further promoted, also on the basis of the relevant provisions of the European Climate Law. In particular, it introduces an obligation for central government bodies to integrate climate change adaptation into their strategic and operational planning, while enabling measures and policies to strengthen resilience and reduce vulnerability in all sectors of the economy and the natural environment. Adaptation to climate change is already embedded in European and national strategies on forests and biodiversity/eco-systems, and their integration into water and building environment policies is ongoing.

The NACR and the CSAPs launch actions and measures to maintain the absorption capacity of the land use, land use change and forestry (LULUCF) sector and improve actions and measures to maintain the good status of forest, agricultural, soil, coastal and marine ecosystems, which play an important role in the carbon cycle and affect the concentration of CO₂ in the atmosphere. These measures also contribute to maintaining the capacity of forests and crops to produce biomass for energy purposes.

¹⁶²https://ypen.gov.gr/wp-content/uploads/legacy/Files/Klimatiki%20Allagi/Prosarmogi/20160406_ESPKA_teliko.pdf.

In addition, the NACR and the RSACs provide for actions and measures to save energy from RES and generate energy from renewable sources to meet the projected increase in demand and peak cooling load during the summer period (due to an increase in the frequency, duration and intensity of the heatwaves), as well as actions and measures for the adaptation and climate resilience of renewable energy generation and storage sources and plants. Measures to boost the use of RES and energy saving in buildings, tourist facilities and utility networks also contribute to reducing greenhouse gas emissions.

The NAFS and the CSAPs also promote actions and measures for climate resilience and adaptation of the energy system to climate change with a view to ensuring its effective functioning. The NACA, purely for reasons of relaxation of this analysis, did not take into account the transformation of the energy system in the context of the implementation of policies to mitigate greenhouse gas emissions. It therefore includes adaptation actions and measures also for energy installations, such as lignite-fired plants, which may have disappeared before the need to protect them from the effects of climate change occurs. However, these actions can be applied proportionally to the energy launch of the new energy system. In addition, the NAFRP and the CSPCs include measures to manage the forecasted increase in demand and the peak in the summer period.

Finally, the NACR and the CSAPS include measures to protect public safety during heat seasons that contribute to fighting energy poverty, measures to adapt the extractive industries that contribute to domestic critical mineral raw materials, as well as measures to adapt the railway to maintain the capacity to provide transport and passenger services against alternative means of transport with a larger energy footprint and if they have a shallow footprint.

The NECP actions and measures and the RSPCs in relation to the objectives and political priorities of the NECP, which will be implemented in the coming years, are summarised in Table 25.

Table 25 Linking adaptation actions and measures to the objectives and policy priorities of the NECP ^(163, 164).

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
• Understanding the mechanisms of behaviour in water scarcity, heated wine and increased CO₂ concentration. • Changes in cultivation techniques and choice of crops and varieties due to an increase in hot wine and a change in rainfall. • Extension of organic farming systems. • Addressing desertification/Updating the National Action Plan to combat desertification. • Land Resource Management: cultivation manipulations to protect against erosion, protect against deterioration of the soil structure, maintain/post- increase the organic substance degraded more rapidly due to increased temperatures, avoid desalination.	Climate change, greenhouse gas emissions and removals	FP1.4: Actions to reduce losses in the agricultural sector

¹⁶³ On the basis of the preparation of the NAPR actions and measures by the Climate Change Department, Directorate for Climate Change and Air Quality of the Ministry of the Environment and Energy.

¹⁶⁴ Konsta, D., Panagopoulou, G., Kyriakopoulos, G. L., Methenitis, K., Grigoriadou, E., Voudouli, A., Asimakopoulos, D., Setz, I. (2024) LIFE-IP AdaptInGR – Boosting the implementation of adaptation policy across Greece. Action Deliverable C.5 Analysis of synergies and trade-offs between the 2050 Long-term Strategy and the National Climate Change Strategy covering all economic sectors and exploring the impacts of climate change and synergies with adaptation measures.

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
• Sustainable forest and forest land management: forest management plans, management of underground vegetation, rational grazing of forest silvicultural-systems.	Climate change, greenhouse gas emissions and removals	FP1.4: Actions to reduce bales in the agricultural sector FP1.5: Emission reduction in the LU sector — LUCF
• Improving the composition and architecture of forest ecosystems to increase their resilience to climate change (e.g. thermophilic and dry-resistant species, thinning of stands to define competition for soil moisture). • Limiting forest fires: modernising the legislative framework, strengthening prevention (improved accessibility, reduction of waste fuel), strengthening response mechanism (e.g. retrofitting equipment, warning systems, screening), accelerating the implementation of restoration/reforestation measures • Limiting soil erosion in forests and wooded land (management of land vegetation, anti-erosion measures on burnt land, water works). • Promotion of restoration measures for natural ecosystems (forests, hedgerows, wetlands, etc.) aimed at increasing CO₂ sequestration to minimise climate change impacts • Risk assessment of expected effects of climate change on marine eco-systems	Climate change, greenhouse gas emissions and removals	FP1.5: Increase in removals in the LULUCF sector

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
• Consideration of the need for further lifting of the rotary-line in order to protect it from high water levels in areas of high vulnerability while creating more frequent and maximum layers of openings. • Protection of outdoor railway infrastructure from winds (comfort fence). • Integration of different types of train movement related monitoring. • Hot wire monitoring/warning systems in underground railway infrastructure. • Planning of emergency routes or diversions for rail transport due to shuttle cut-off in areas or points of high vulnerability	Climate change, greenhouse gas emissions and removals	FP1.3: Actions to reduce emissions in the transport sector
• Assess the impact of climate change on hydropower generation. • Improving efficiency in the energy sector with water extraction and consumption of mine hydro power plants.	Renewable Sources Energy Energy security	FP2.4: Ensuring the viability and robustness of the mechanism for granting operational aid to RES power plants and storage stations FP2.5: Development and strengthening of energy networks and optimal integration and operation of RES plants – Energy Storage of FP5.4: Preparedness of the country and the actors involved in dealing with the limitation or disruption of energy supply

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
		FP5.5: Increasing the resilience of critical energy infrastructure
• Management of transboundary surface and groundwater bodies. • Integrating climate change into water planning and water management. • Assessment and quantification of impacts using specific models for differences in brown scenarios. • Identification of potential adaptation scenarios for activities using large quantities of water in areas already facing gaps. • Water saving/efficiency: housing measures in all sectors and uses, orthotic water use in agriculture and tourism, reduction of losses from water and irrigation networks. • Water reuse/recycling: irrigation with reused water, recycling of rainwater, waste water treatment and use of circular water. • Improvement/enhancement of water reserves: creation of artificial reservoirs, improvement of existing storage methods to replace low-flow pumping.	Renewable Sources Energy Alternative and climate-neutral gaseous and liquid fuels Energy security	FP2.2: Ensuring the implementation of RES and Storage investments – Extension of operating aid schemes – Promotion of two-way contracts, Hybrid Systems FP2.5: Development and strengthening of energy networks and optimal integration and operation of RES plants – Energy Storage of FP3: Measures and policies for the development of green hydrogen FP5.4: Preparedness of the country and of the actors involved in dealing with the restriction or interruption of the supply of input supplies FP5.5: Increasing the resilience of critical energy infrastructure

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
• Use of small desalination units. • Optimisation of existing meteorologicalwafers.		
• Examination of the need to updatethe Energy Performance of Buildings Regulation (KENAK).	Renewable Sources Energy Energy performance	FP2.6: Ensuring RES participation in meeting energy needs in thebuilding sector – adjustments to buildings – regulation – promotion of energy sharing FP2.7: Promote the use of RES systems to cover heating and cooling needs FP4.1: Improving the energy efficiency of public buildings andexemplary public sector FP4.2: Renovation strategy for residential and tertiary sector building stock FP4.9: Promote efficient heating and cooling
• The use of innovative and energy-friendly materials for the energy upgrading of buildings and the construction of new (zero energy consumption), as well as the use of RES and other saving techniques.	Climate change, greenhouse gas emissions and removals Renewable Energy sources Energy performance	FP1.8: Urban bio-climatic regenerations and smart cities FP2.6: Ensuring RES participation in meeting energy needs in thebuilding sector – adjustments to buildings – regulation, promotion of energy sharing

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
		FP2.7: Promoting the use of RES systems to cover heat and coldwater FP4.1: Energy efficiency improvement of-buildings and exemplary role of the public sector FP4.2: Renovation strategy for residential and tertiary sector building stock FP4.9: Promote efficient heating and cooling
• Reduction of the thermal and energy needs of buildings (saving technologies, energyfrom construction systems and equipment, savingtechniques, training/user information)	Energy performance	FP4.1: Improving the energy efficiency of public buildings andexemplary public sector FP4.2: Renovation strategy for residential and tertiary sector building stock FP4.9: Promote efficient heating and cooling FP4.10: Educate/inform professionals and consumers about energy efficient equipment and rational energy use
• Adaptation of urban planning to climatechange and improvement of the thermal environment in cities (redesign of free spaces, newplantations, bioclimate planning, urban green growth).	Climate change, greenhouse gas emissions and removals Energy performance	FP1.8: Urban bio-climatic regenerations and smart cities FP4.2: Renovation strategy for the residential and tertiary sector building stock

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
Examination of the need to improve the specifications of tourist facilities.	Energy performance	FP4.2: Renovation strategy for residential and tertiary sector building stock FP4.9: Promote efficient heating and cooling
Energy saving and efficient use in the final units combined with the transition of the tourism product to a lower carbon footprint.	Energy performance	FP4.2: Renovation strategy for residential and tertiary sector building stock FP4.9: Promote efficient heating and cooling
Informing/raising awareness of the influence of the key change on the factors supporting tourism activity related to the country's native reserves and the required actions.	Energy performance	FP4.10: Educate/inform professionals and consumers about energy efficient equipment and rational energy use
Incentives for tourism businesses to reduce energy consumption.	Energy performance	FP4.3: Promotion of energy performance contracting by ESCOs FP4.4: Promoting market mechanisms FP4.5: Promoting innovative financial tools to leverage private capital and financial sector engagement
- Creation of air-conditioned and green spaces for protection during heatwaves - Identification of vulnerable groups and development of support networks.	Energy performance	FP4.11: Addressing energy poverty

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
• Modernisation of water and irrigation networks. Perroll-out of smart grids and demand management systems.	Energy performance	FP4.7: Promotion of water/sewerage and irrigation infrastructure modernisation interventions
• Development of a broader active system protection plan. • Studies assessing the climate resilience of pneumatic energy infrastructure and installations. • Investment programmes in infrastructure and network-protection projects, including the relocation of network infrastructure. • Consider the need to modify programmes of new energy infrastructure and network projects. • Avoid locating energy infrastructure and walls in places of high climate vulnerability. • Amendment of a regulation of licences for electro-ducting units and existing licences. • Drawing up programmes for the protection of waterbodies from which electricity-generating units are cooled. • Research and development of high-efficiency hot shower cooling technologies on the use of water resources, modern methods of protecting networks against extreme weather events.	Energy security	FP5.5: Increasing the resilience of critical energy infrastructure

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
Investments in flexible production units with a low degree of use on an annual basis with the potential for fast rise and load-descent.	Energy security	FP5.3: Promote systems providing flexibility, and storage and demand response systems; ensure the country's output adequacy
Smart demand management grids to mitigate the impact of increased electricity demand.	Climate change, greenhouse gas emissions and removals Energy security	FP1.8: Urban bio-climatic regenerations and smart cities FP5.3: Promote systems providing flexibility, and storage and demand response systems; ensure the country's output adequacy
- Prepare reliable spatial and temporal parallel climate models for the assessment of impacts on the extractive industry –Risk assessment analyses. - Development of guidelines and standards for the recording, assessment and assessment of climate change in mining projects - Link to national policy on the uptake of WFD - Prepare plans to address climate change impacts in critical "inputs" (e.g. water) - Shielding/enhancing mining infrastructure during and after exploitation: further increase in safety factors	Critical mineral raw materials	Harnessing critical mineral raw materials

NSPR/CSPR measures	Link to Energy Union objectives	Link to Policy Priorities (PCP) NECP
when planning to increase the length of time of the analysis during the design phase, aid with maintenance-measures for restoration works due to the spread of the soil cover and increased drainage needs. • Improving preparedness: development of risk action plans, definition of pre-implementation measures and integrated management of the effects of climate change in strategic business planning. • Enhancing information for the sector on climate change		

3.9 measures and policies for Research, Innovation and Competitiveness

The Research, Innovation and Competitiveness **Policy Priorities** identify those energy technologies that have the potential to make it possible to achieve the decarbonisation targets for 2030, both because of their potential for penetration and in terms of making the transition technically and economically feasible, and of maintaining and strengthening the competitiveness of Greek industry. These include 11 distinct general objectives setting out policy measures, which are specified in the first development of Technology Priorities.

FP6.1: Innovative applications with high domestic added-value potential and empowerment business outward-looking

FP6.2: Develop innovative technologies for energy conservation

FP6.3: Development of innovative net-zero technologies

FP6.4: Digitalisation of the energy system; Smart grids

FP6.5: Development of innovative transport technologies and applications for micro-mobility

FP6.6: Development of innovative energy storage applications as well as technologies capture, storage and use of CO

FP6.7: Promoting innovative technologies to support circular economy actions

FP6.8: Implementation of horizontal measures to align the link between research and research and innovation with industrial decarbonisation priorities

FP6.9: Promoting entrepreneurship through research and innovation actions integrated into market functions

FP6.10: Optimising token and aid schemes to promote investments aimed at enhancing competitiveness

FP6.11: Enhancing competitiveness through reskilling and upskilling programmes skills for resilient and sustainable zero technology supply chains footprint

Figure 19 Policy priorities for promoting research, innovation and competitiveness in 2025-2030.

3.9.1 Measures and policies to promote research and innovation

Policy measures to promote Research, Innovation and Competitiveness are strongly related to the technologies promoted under the Energy Union, as expressed in the Strategic Energy Technology Plan (SET PLAN) and the Net Zero Industry Act, depending on the maturity of their integration into a national context. It should be noted that the objective of the planned actions is twofold, on the one hand to lead to applications with high domestic added value and, on the other hand, to strengthen the openness of businesses, as a proportion of these applications will be exported to other countries.

Major challenges emerge from the energy efficiency improvement targets set in all areas of final energy consumption. At the same time, it will facilitate the maturity and market integration of innovative energy saving technologies that make a significant contribution to improving energy efficiency.

In particular, research and innovation activities on **improving the efficiency of buildings** will include:

- New materials for buildings: Innovative materials and building technologies supporting a recycling process, innovative thermal insulation systems with improved thermal performance, innovative thermal insulation system without fossil-based materials.
- Prefabricated active parts for facades and roofs: Standard panels for aerated facades or roofs combining photovoltaic and thermal or fat systems, thermal insulation, phase switching materials, batteries.
- Cost-efficient, smart, flexible heat pumps and heat pumps for high temperatures: Smart heat pump adjustable to provide additional services to the grid, flexible heat pump (GHG) providing

a wider range of operation and operating control equipment, further per fold and disposal of absorption technologies and GHG adsorption systems.

Accordingly, in the industrial sector, support will be given to:

- Energy-efficient heating and cooling technologies: Heat pumps for the temperature of the cooling compression cycle with refrigerants with low global warming capacity for use in industrial medium-temperature applications and district cooling.
- Heat/cold recovery: Use of low waste heat for electricity generation in higher efficiencies, per acquisition of high temperature waste heat with SCO₂ cycle, hybrid plants for the upgrade of waste heat integrating RES in industrial installations and processes.
- System integration: Industrial symbiosis between energy-intensive Chania biota to harness energy losses and better manage energy globally, unconventional energy sources in the manufacturing industry, further integration of digitalisation into the governance of processes and facilities.

Achieving the objective of reducing greenhouse gas emissions in all sectors of economic activity is expected to lead to both the full and market integration of mature decarbonisation technologies into the penetration market and the gradual penetration of less competitive technologies. The imminent transition to a new model of production and demand presents significant challenges, requiring the development of know-how and the promotion of innovative technologies.

In the field of RES, it is envisaged to strengthen research and innovation in the following technologies:

Solar thermal energy

Aggregated thermal solar (CHP) systems for electricity generation: Implementation on a commercial scale of installation of CHP with storage, cost reduction and efficiency increase of Fresnel linear concentration technology, development of new materials and techniques to discourage heat suitable for CHP systems.

Heating and cooling applications of solar thermal systems: For each development, standardisation and implementation of hybrid RES systems in buildings with a high profile for THP, the digitalisation of THP and their integration into smart buildings, new materials, parts and new methods for the production of THP to reduce costs, the development of standardised HES specifically for the production of heat in industrial dishes, the development of integrated hybrid solar cooling technologies with inductive-costs, high efficiency and back-up system, easy standing, control and operation.

Bio-energy

The development of high-efficiency cogeneration of heat and power from large mass on a

large scale.

The development, demonstration and scaling up of solid, liquid and gaseous intermediate-bioenergy streams through biochemical/thermochemical/chemical transformation from sustainable biomass.

Wind energy (offshore wind and small wind turbines (M/F))

- Offshore wind farms: Pre-industrial seating standards of offshore type for depths 50-60 m, waterborne type for depths > 60 m, floating platforms with trains, A/C anchorage system for depths > 60 m.
- Wind farm electrical infrastructure: Equipment for coupling wind farms with network support services, submarine power cables for installation at depths > 60 m and connection to floating A/C.
- Operation and maintenance of wind farms: Collection-processing system for continuous operational control A/C, software for processing large amounts of data from wind farms and analysis of operational parameters, Drones or robotics for A/C control and maintenance, residual life assessment methodologies.
- New methodologies for assessing wind potential using remote sensing. Long-range scanning Lidars (Long-range scanning Lidars) measurements to correlate/evaluate satellite data in combination with mesoscale numerical models in coastal, offshore and complex topography areas.
- Holistic end-of-life management of wind farms and/or parts of wind turbines (reuse, recycling, disposal, remediation).
- Small A/C: Pre-industry standards with improved aerodynamic performance or low sound footprint, procedures for quality control infrastructure and certification of small A/C
- Development and integration of innovative design and noise reduction turbines in the urban environment (Quiet urban wind turbines).

Photovoltaic energy

- Integration of photovoltaic systems into buildings and other infrastructures: New high-efficiency photovoltaic cells of thin film, Hybrid systems associating various photovoltaic system technologies with other energy generation technologies, Innovative systems integrating photovoltaic systems into buildings and infrastructure to interconnect them with other applications, Methods to measure the performance and resilience of photovoltaic systems in pragmatic conditions and over time and in conditions of accelerated ageing.
- Development of multi-contact-technology photovoltaic cells with high incremental efficiency: Perovskite technology multi-contacting cells deposited on Si/CGIS, New methods and tools for deposition and transfer of the III/V reservoir, GaP deposition techniques on Si, High energy gap semiconductor manufacturing techniques as acoustic absorbers, Adaptation of Si/CGIS technology as sub-absorbers, Performance test in real

world conditions.

- Photovoltaic park monitoring and operation systems and installations: Development of advanced and automated functionalities for analysis of the various operating databases and early detection of falsification, Standardisation and self-checking of sensors, Communication of inverters of a photovoltaic module and between different photovoltaic installations.

Geothermal

- Development of materials, methods, techniques and equipment to improve the operation, efficiency and availability of geothermal units (plastic materials for piping and heat exchangers for the temperature range above 90°C, technology for replacing saline substances specialising in fluids in Greek geothermal fields).
- Improvement of the efficiency of conversion to electricity and direct use of heat (hybrid power plant from geothermal and biomass, geothermal cogeneration plant with cooling water supplying a district heating network).
- Development of methods and techniques to improve the productivity, penetrability and other characteristics of geothermal reservoirs, for geothermal fields of local interest.
- Development of methods and techniques to increase the efficiency of power supply units, production of thermal energy for direct uses, combined power and thermal energy, as well as hybrid geothermal stations with other RES (biomass, thermal solar, etc.).
- Development of new methods and techniques for research and capacity assessment of geothermal fields, including exploratory drilling.
- Development of methods and techniques for optimal integration of electricity from a geothermal unit into the energy system (development of a geothermal unit or variable load power plant complementing energy produced by wind and photovoltaic (PV)).
- Development of a zero-emission geothermal power plant.
- Development of thermal process plants using geothermal energy (e.g. drainage, drying of products, etc.) of zero emissions.
- Development of methods, techniques and equipment to continuously monitor the production of geothermal fields and implement weather intervention protocols for the sustainable use of the geothermal potential of each field.
- Development of technology, methods and production of geothermal fluid pumps and modular binary cycle power plants.
- Development of technology, methods, production and monitoring of geothermal fluid disposal networks for urban district heating and in thermal applications in the upstream-sector or manufacturing, such as greenhouses, dryers, other industrial-craft processes.

Hydrogen industry

Here, it is necessary to include a set of priority actions necessary to build a strong, efficient

and sustainable hydrogen industry in support of the country's objectives. As such priorities- (which are more or less the same as global priorities to support the development of the clean hydrogen industry), the following can be outlined:

Reducing the cost of production of clean hydrogen. (Scaling up to large earth, more efficient technical and cost-efficient electrolytes (improvements to equipment by increasing plant size, storage density as well as low-cost catalyst systems, material improvements through the use of lignite-terminal critical materials in the electrolyte stack and the creation of catalysts from non-rare materials, scaling up and improvement of production processes, lower cost projects and components "Balancing the Unit").

Further exploring green hydrogen production solutions in lower Technology Readiness Level technologies (emerging, higher efficiency and wider choice of raw materials or electrolyzers that remove the need for precious metals, hydrogen production through biomass conversion, direct solar/thermal water cleavage, permeable membranes that can improve hydrogen purity).

Improving the mass density of hydrogen through the use of hydrogen derivative carriers (such as ammonia and methanol) and improved compression and liquefaction technologies to reduce the cost of storage, transport and distribution of hydrogen.

Continuous development of fuel cell solutions for mobility applications and climate-reduction of refuelling infrastructure for road transport applications, especially in the market segments of heavy and/or long distance vehicles.

Better understanding and management of impacts on pipeline and wafer materials, household and commercial appliances and metering systems in case of blending of hydrogen in existing natural gas networks or use of existing pipeline systems in dedicated hydrogen transport infrastructure.

The development of hydrogen solutions in hard-to-decarbonise heavy industry and mobility applications, such as steel production, metal processing, maritime transport and aviation.

Further development of gas turbines, stationary fuel cells, and mobile and ammonia turbines, which support the potential of hydrogen as well as low carbon for cogeneration and to provide flexibility to power systems reaching high shares of variable RES energy.

'Cross-cutting' research to support standards and safety, regulatory reforms and domestic and international certification schemes for hydrogen production emissions, environmental impacts of projects, as well as studies of global supply chain business models.

A key priority of Research and Innovation for the next period in the area of energy networks are the challenges related to their digitalisation and the deployment of smart grids. The main actions to be supported **in the electricity distribution chain** are the following:

Creating an innovation environment for the development of smart services:

The market design for marketing heterogeneous flexibility products, cyber-security of critical energy infrastructure, innovation regulatory zones, process chain for interoperability of ICT systems, systemic and public-economic impacts of digitalisation on the energy system.

Planning and technical-economic assessment of the implementation of smart grid, metering, storage, demand response services and technologies individually or jointly, and of increasing RES penetration towards efficient, reliable and secure transmission and distribution systems.

- Applications of blockchain technology in energy, in particular dispersed production, storage and consumption. Platforms for clearing transactions and interfaces with markets.

Developing an optimised electricity grid:

Develop and implement solutions to increase observability and controllability in the energy system: Increased observability and controllability of medium and low voltage networks with high penetration of distributed energy resources, intelligent flexible planning, planning and operation of the network based on improved observability of the transmission network.

- Development and implementation of solutions and tools to manage the load profile through demand response and control, in order to optimise the use of the network and to postpone investments in networks: Participation of customers and new markets and business models, EV/PHEV charging infrastructure and patchwork in smart energy systems, mechanical demand response.
- Develop and implement solutions to increase the flexibility of all types of behaviour: Interactions between flexible generation and the electricity system, ancillary services in scenarios with very high RES penetration and low mechanical inertia, increasing flexible generation through the use of mapped storage in generation facilities.

In addition, support will be given to innovative actions relating to **electric receptions** and charging strategies, while emphasis will be placed on electricity consumed coming from RES and hydrogen produced from diffuse forms of energy.

Corresponding actions to develop innovative technologies will also be supported for the reduction of **biofuels as renewable fuels** for sustainable transport (fuels for road transport, aviation), divided into:

The development and demonstration of advanced liquid and gaseous biofuels through biochemical/thermochemical/chemical transformation from sustainable biomass and/or autotrophic microbes and primary RES energy.

The development and demonstration of other liquid and gaseous fuels (excluding hydrogen) through thermochemical/chemical/biochemical/electrochemical transformation of the gaseous neutral carriers with renewable energy.

The development, production and demonstration of renewable liquid and gaseous fuels of non-biological origin (RFNBOs) for transport.

For **energy storage**, the development of new or improved electricity or thermal storage technologies with higher efficiency, positivity, durability, safety and at the lowest possible cost will be fostered. Electrochemical energy storage technologies will be supported, mainly involving RES generators for use in a non-interconnected electricity grid or at remote points of the electricity grid, in particular:

- (i) Development of 5-4.5V high voltage lithium-ion batteries and fully solid status for all e-mobility applications (pre-shooting or material modifications to improve safety, determination of performance characteristics at low temperatures).
- (ii) Study the effect of fast/ultrafast loading of Li-ion batteries on materials and battery degradation (understanding the floods and measuring the effect of high C on existing and advanced lithium-ion cells, assessment of progress in fast-/ultra-fast chargers: from the current 120 kW to the future + 300 kW, proposals for measures to reduce cell degradation: straw in materials, thermal management, design of a component and hyphen shell incorporating optimised thermal management and safety mechanisms, design of appropriate charging stations to be cooled by cooling fluid).
- (iii) Batteries for static energy storage applications: Establish interfaces to extend the lifecycle and lifespan of the systems.
- (iv) Other battery technologies (after Li-ion) for electro-mobility: Development of parallel detection, monitoring, thermal management and security systems.
- (v) Recycling of Li-ion and then Li-ion batteries: Development of low-cost packaging for secure reverse logistics; development of an improved opaque model of reverse logistics.
- (vi) Recovery of lithium from geothermal brines and sustainable enrichment processes for indigenous lithium deposits in hard rocks: Mapping and identifying interests of geothermal resources from the point of view of lithium.
- (vii) Development of hybrid battery systems for static energy storage applications: Study of new materials for system hybridisation, design design of components and systems specific to hybrid systems, study of advanced battery management systems for hybrid systems.
- (viii) Second use and smart integration of batteries into the grid: A technical/ economic study to quantify the 2nd life criteria, create before test totals depending on the

final application of 2rd^{use}, applying tests to the most promising batteries, develop models to better understand and predict the performance of the current and those of the next generation of Li-ion batteries, study to identify a convergence roadmap from the current state of play, proposals to update and/or create a common set of standards, develop proposals for a set of demonstrative projects to gain more knowledge and inspire the use of batteries for EV applications in the Stationary Deduction Market, a standardised platform with the key characteristics of batteries and their components.

In addition to batteries, the following actions will be strengthened in terms of storage:

- Development of technologies and applications for local/small scale storage of spot or thermal energy;
- Development of distributed energy storage systems for autonomous and interconnected energy grids;
- Demonstration of innovative plug-and-play solutions for the storage of renewable energy in autonomous grids.
- Development of new or improved energy storage technologies with higher efficiency, availability, durability, efficiency, safety and lower costs (supercapacitors, etc.).

In the agricultural sector, the development of energy technologies for building value chains of locally available biomass to meet the energy needs of local communities will be promoted. These include the development and improvement of energy use technologies for agricultural residues and recovered material industries, bioliquids, biological resources, waste/waste (emphasis on improving system reliability, automated operation and environmental performance of these technologies), as well as the development of solid, liquid and gaseous bioenergy intermediaries for heat and large scale cogeneration from sustainable biomass.

Innovative applications that help **mitigate the environmental footprint of businesses and the impact of climate change** on the urban environment, as well as the promotion of the circular economy will also be fostered, with a focus on material recovery and waste energy recovery and reuse, as well as innovative techniques for capturing or reusing CO₂ in industry. Specifically for the energy-intensive industry, support will be given to the further development of R & I in industry and construction to develop and adopt advanced net-zero technologies and materials. Technologies to convert CO₂ to chemicals/fuels and the optimisation of existing transition processes to advanced CO₂ capture and storage technologies will be promoted, especially for energy-intensive industries and for the envisaged areas in energy transition.

Research on **techniques and processes for the production of products from non-electrical uses of lignite**, such as the production of methanol, synthetic exhaust, rare earths, activated carbon, carbon fibres, nanotubes, graphene, etc.

In the area of **smart cities/positive energy balance neighbourhoods**, green, energy

neighbourhoods, sustainable and cost-efficient buildings and building planning with renewable energy sources will be planned in conjunction with the establishment of urban service stops. In particular, the technologies, arrangements and methods of interconnection and interaction of final customers will be strengthened to jointly drive energy from RES (RES communities) or to co-produce electricity (citizen energy communities), smart management, storage, self-allocation and sale and/or charging services for electric vehicles.

The **horizontal actions** to be taken to improve the conditions for conducting research and innovation in Greece aim to further upgrade the country's public infrastructure, promote research funding, increase the internationalisation of the Greek research ecosystem and develop research collaborations.

In the specification and implementation of policies and measures there will be close synergy with the planning and implementation bodies of national and regional smart specialisation strands. Energy is already one of the priority areas of the National Smart Specialisation Strategy and some regional ones. The involvement of energy sector actors in the entrepreneurial discovery process is key to maximising the intended results.

3.9.2 Measures and policies to promote competitiveness

The Greek business community is very aware of the need to adopt a strategy that effectively integrates innovation and sustainability. By integrating innovative practices that prioritise environmental and social concerns, businesses can strengthen their competitiveness and at the same time contribute to a more sustainable and prosperous future. Furthermore, integrating innovation with sustainability also leads to many benefits for businesses, such as 'green profiles', cost savings, risk mitigation, enhanced worker engagement and long-term resilience. It allows businesses to align with social and environmental needs, contributing to a more sustainable future, while leading to monetary growth and profitability.

Promoting knowledge-based entrepreneurship is also a priority for the next period 2025-2030, contributing directly to the competitiveness component. To this end, provision is made for:

- Improve the existing permitting framework for clean non-tree emission technologies in the energy-intensive industry.
- The use of dedicated funds to promote research and innovation in SMEs, to collaborate with research centres and to strengthen the conditions for creating successful investments.
- Exploitation of patent rights, assignment of rights, etc.

In addition, the creation of innovative clusters of enterprises and thematic operators to promote healthy entrepreneurship, the establishment of knowledge-intensive enterprises for the commercialisation of mature research results and innovative ideas, and the development of structures supporting it will be further strengthened, such as incubators, technology parks, collaboration spaces, etc.

Enhancing competitiveness requires that the existing regulatory framework for the

implementation of investments for the uptake of net-zero technologies in industrial plants and SMEs be further improved to create a stable and transparent investment framework of rules, procedures and administrative structures for the seamless completion of large public and private net-zero projects and strategic net-zero projects in energy-intensive industry at national level, to ensure swift administrative processing, as well as faster permitting procedures, in accordance with national and Union legislation, with the aim of simplifying and speeding up their authorisation and permitting procedures.

In addition, with the aim of leveraging more private capital, promoters of net-zero strategic projects will benefit from actions to facilitate the provision of favourable financing to energy-intensive industries and SMEs and to take part of the business risk not taken up by financial institutions, while providing the necessary guarantees. The adoption of such measures will allow for faster market integration of the above mentioned technologies, maintaining and enhancing sustainable growth and the surge of businesses and industries in the country's energy transition. Επιπλέον νέα χρηματοδοτικά προγράμματα με στόχευση καινοτόμες τεχνολογίες καθαρών μηδενικών εκπομπών θα υποστηρίξουν νέα συνεργατικά έργα μεταξύ βιομηχανίας και ερευνητικών ομάδων, που προκύπτουν από τις ανάγκες της βιομηχανίας και στα οποία η βιομηχανία είναι ο φορέας αρωγός (business-led fundamental research).

The contribution of the circular economy to improving competitiveness is particularly important for the next period 2025-2030 and in the long term until 2050, and therefore concrete actions focusing on the development of innovative technologies to achieve the objectives of the National Circular Economy Strategy will continue to be promoted.

Finally, reskilling workers to develop new technical skills is of paramount importance for industries and businesses in general to adapt to new energy/climate realities. In addition, continuous professional training will facilitate the transfer of workers between different sectors in the phasing out of industrial activities in the energy sector. To this end, new vocational training and qualification certification programmes will be developed, in line with the new upskilling or reskilling/re-skilling initiatives, as reflected in the 5 key attitudes of this plan. These programmes will target the reskilling of workers and the specialisation of the unemployed in net-zero technologies at all stages of their supply chain.

3.9.3 Cooperation with other Member States in this area

Cooperation with other countries in the field of Research and Innovation is shaped by the transnational cooperation of the Secretariat-General for Research and Innovation (Secretariat-General for Research and Innovation), which exist as an integral part of its overall activity in shaping and strengthening research policies. These partnerships resolve a very wide range of bilateral, tripartite and multilateral actions as a result of the country's international policy and the joint will of the governments involved. With regard to the forms of multilateral cooperations, they may be at ministerial level (e.g. Black Sea Cooperation Organisation) or collaborations initially decided at ministerial level and implemented by researchers/scientists

(e.g. ERANETS). Cooperation with other Member States in the field of energy and climate will benefit from the Territorial Cooperation – Interreg programmes of the 2021-2027 programming period, as well as the other European Union programmes financing R & I-related actions in the fields of interest (HORIZON EUROPE, etc.).

3.9.4 Summary of measures and policies for the research, cross-section and competitiveness dimension

Table 26 summarises the policy measures envisaged to meet the targets under the research, innovation and angular dimension.

Table 26 Policy measures for the research, innovation and competitiveness dimension.

Numbering	Policy measure name	Link to policy-priorities	Target	Sector affected	Category of Measure
M1	Development of innovative energysaving technologies	FP6.1, FP6.2	Promoting research and a new one	Energy Efficiency Consumer focused intelligent energy system, RES	Financial measure
M2	Development of innovative technologies for CO ₂ capture and exploitation in industry	FP6.1, FP6.3	Promoting research and a new one Development of low-carbon technologies	Capture, Use and Storage of Coal	Financial measure
M3	Development of innovative applications for the digitalisation of the energy system	FP6.1, FP6.4	Promoting research and a new one	Consumer focused intelligent energy system	Financial measure
M4	Development and promotion of innovative RES energy production artefacts	FP6.1, FP6.3	Promoting research and a new one Development of low-carbon technologies	EOM	Financial measure
M5	Development of innovative technologies for the production and use of Hydrogen and climate-friendly fuels	FP6.1, FP6.3	Promoting research and a new one Development of low-carbon technologies	EOM	Financial measure
M6	Promoting innovative technologies and-breakthroughs for smart cities/neighbourhoods-for energy balance	FP6.1; FP6.3, FP6.4	Promoting research and a new one Development of low-carbon technologies	"Smart Smarter, Consumer Focused Intelligent Energy System, RES	Financial measure

Numbering	Policy measure name	Link to policy priorities	Target	Sector affected	Category of Measure
M7	Development of innovative technologies Energy and Smart Transport	FP6.1, FP6.5	Promoting research and a new one Development of low-carbon technologies	Sustainable Transport	Financial measure
M8	Development of innovative applications for carbonisation of the agricultural sector	FP6.1, FP6.2	Promoting research and a new one Development of low-carbon technologies	Competitive Agricultural Sector, Energy From Supply, RES	Financial measure
M9	Development of innovative energy discouraging applications	FP6.1, FP6.6	Promoting research and a new one	Sustainable transport Consumer focused intelligent energy system	Financial measure
M10	Promoting innovative circular economy technologies	FP6.1, FP6.7	Improving competitiveness	All topics of the NECP	Regulatory, Financial Measure
M11	Implementation of horizontal measures to tip the conditions of investigation	FP6.8	Promoting research and a new one	All topics of the NECP	A regulatory measure; Household
M12	Promoting entrepreneurship through research and innovation actions integrated into market functions	FP6.9	Improving competitiveness	All topics of the NECP	Financial measure
M13	Promoting a flexible financial and licensing framework to enhance competitiveness	FP6.10	Promoting research and-innovation, improving-competitiveness	All topics of the NECP	A regulatory measure; Household

Numbering	Policy measure name	Link to policy-priorities	Target	Sector affected	Category of Measure
M14	Implementation of programmes for reskilling and upgrading skills for all supply chains of non-tree technologies	FP6.9; PP6.11	Improving competitiveness	All topics of the NECP	Training-expatriation measure
M15	Incentives for the promotion of clean non-tree technologies in the energy industry	PP6.11	Improving competitiveness	Industrial sector	Regulatory, Codified Measures

Chapter 4: Energy system evolution results up to 2050

4.1 State of Play Summary

Total greenhouse gas (GHG) emissions in Greece showed a decrease of 30 % in 2022 compared to 2010¹⁶⁵. In 2017, there was a slight increase in GHG emissions of 6 % compared to 2016 emissions, mainly due to a higher share of fossil fuels in gross domestic electricity production. However, it was followed by a reduction in GHG emissions in the period 2019-2021, showing signs of stabilisation in the year 2022.

GHG emissions in 2022 amounted to 76.9 Mt, taking into account carbon emissions and removals in the land use, land use change and forestry (LULUCF) sector, which amounted in 2022 to 5.5 Mt. Emissions in 2022 were 26.2 % lower than in 1990 and 42.8 % lower than in 2005, where their peak was recorded.

As shown in Figure 15, the energy sector's contribution to total GHG emissions was the highest (57 %) in 2022 compared to the industrial and horticultural sectors (22 %), the agricultural sector (12 %) and the waste and water management sector (9 %).

¹⁶⁵ The mapping of the figures in this section is done specifically for the period 2010-2022 in order to correlate with the relevant policy objectives.

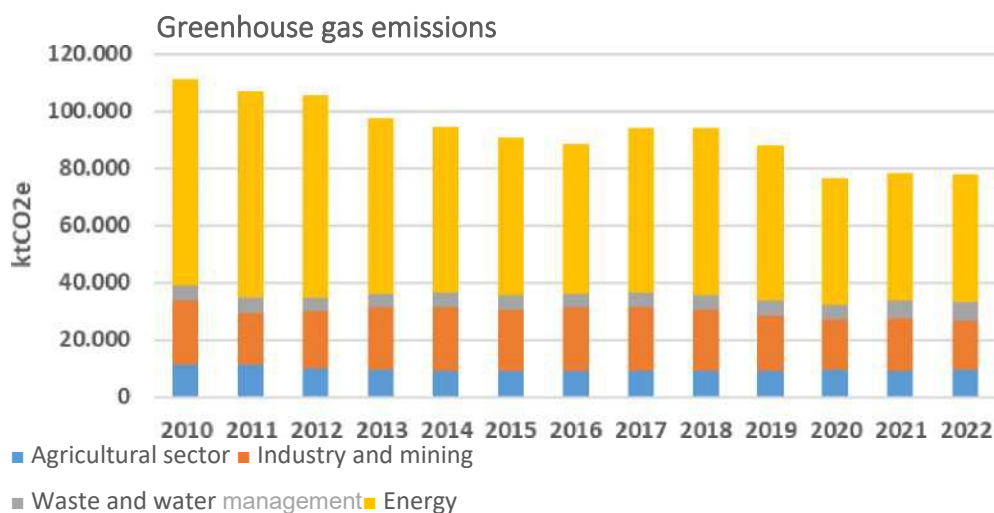


Figure 15 Evolution of GHG emissions by contribution sector (Source: Eurostat).

In particular, the combustion of fossil fuels for the production of electricity and heat is the main activity that contributes to the status quo. Gross inland energy consumption decreased by 23 % in 2022 compared to 2010 levels (Figure 16). The acidification of RES in gross energy consumption continues with minor exceptions (years 2014 and 2016), leading to an increase of 67 % in 2022 compared to 2010. At the same time, the share of solid fuels decreased by 80 % in 2022, compared to 2010.

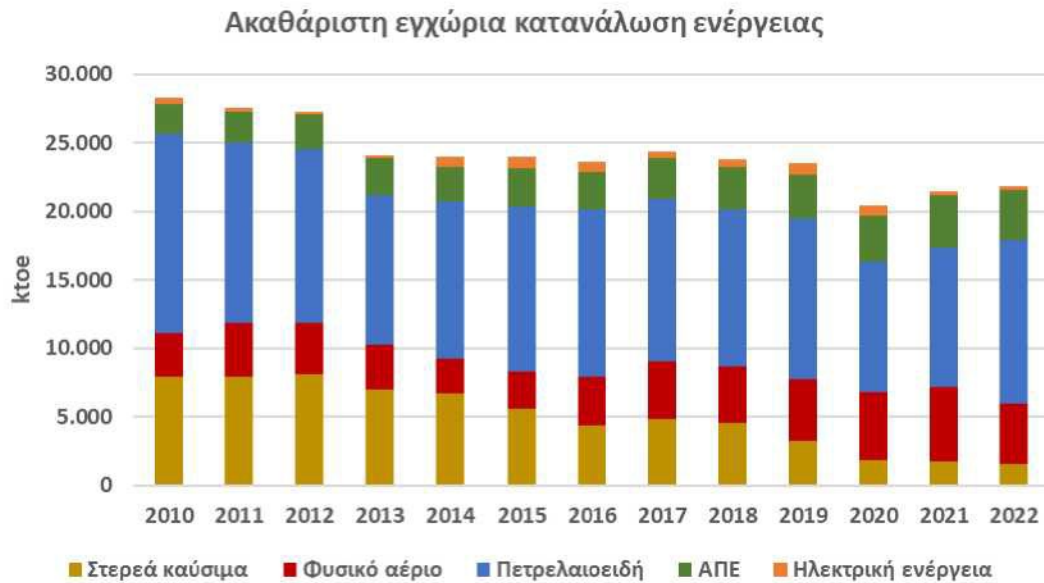


Figure 16 Evolution of fuel shares in gross inland energy consumption 2010-2022 (Source: Eurostat).

Final energy consumption recorded a decrease in all sectors of end-use, with the exception of the tertiary sector and fisheries, in the period 2010-2022. The biggest decrease was found in the agricultural sector (66 % reduction), followed by industry, transport and the household sector, with a decrease of 26 %, 22 % and 7 % respectively in the final total compared to 2010. The tertiary sector grew by 7 % over the same period (Figure 17), mainly due to an increase in its gross front-end value, while a significant increase was recorded in the fisheries sector.

For the year 2022, the transport sector recorded the largest contribution as a share of final energy consumption (39 % share), while the participation of the residential, industrial and tertiary sectors was also significant (shares of 29 %, 17 % and 14 % respectively).



Figure 17 Development of final energy consumption by end-use sector for the period 2010-2022
(Source: Eurostat).

Figure 18 shows the contribution of the different fuel types to the final energy tankers in the period 2010-2022. The largest share in the downstream sectors corresponds to the consumption of petroleum products (54 % for 2022), followed by electricity, direct use of RES and natural gas with 27 %, 11 % and 8 % respectively. The consumption of solid fuels, petroleum products and electricity in the end-use sectors decreased significantly in 2022 compared to consumption levels in 2010 (a decrease of 76 %, 27 % and 9 % instead of). This decrease is largely offset by the significant increase (51 %) of natural gas consumption and by the direct use of RES, whose consumption is increasing by 32 % over the period 2010-2022.

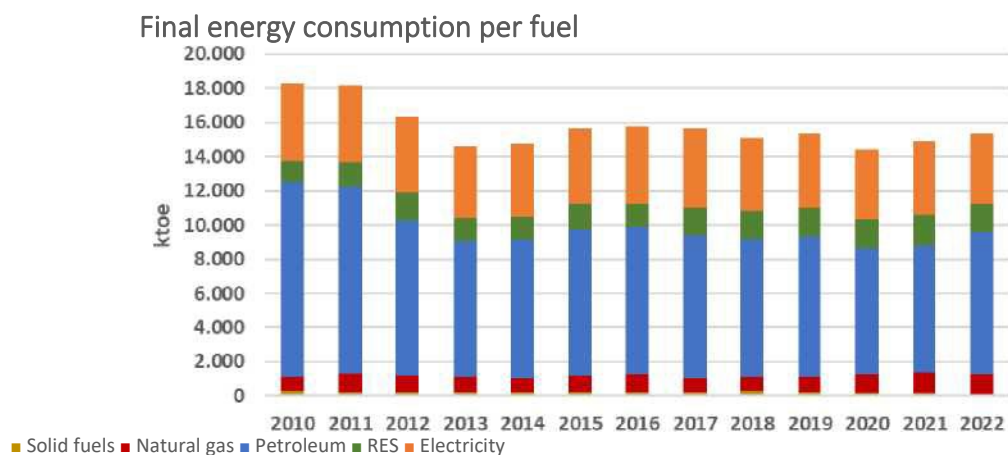


Figure 18 Evolution of fuel shares in final energy consumption for the period 2010-2022 (source: Eurostat).

In 2022, the contribution of RES to gross final consumption of energy (ATE), transport, electricity and heating and cooling was 22.7 %, 4.1 %, 42.4 % and 30.6 % respectively (Figure 19). The largest percentage increase in RES in 2022 compared to 2010 was recorded in electricity generation (30.1 %), while it was lower in gross final energy consumption (12.6 %), heating and cooling (12.0 %) and transport (2.2 %).

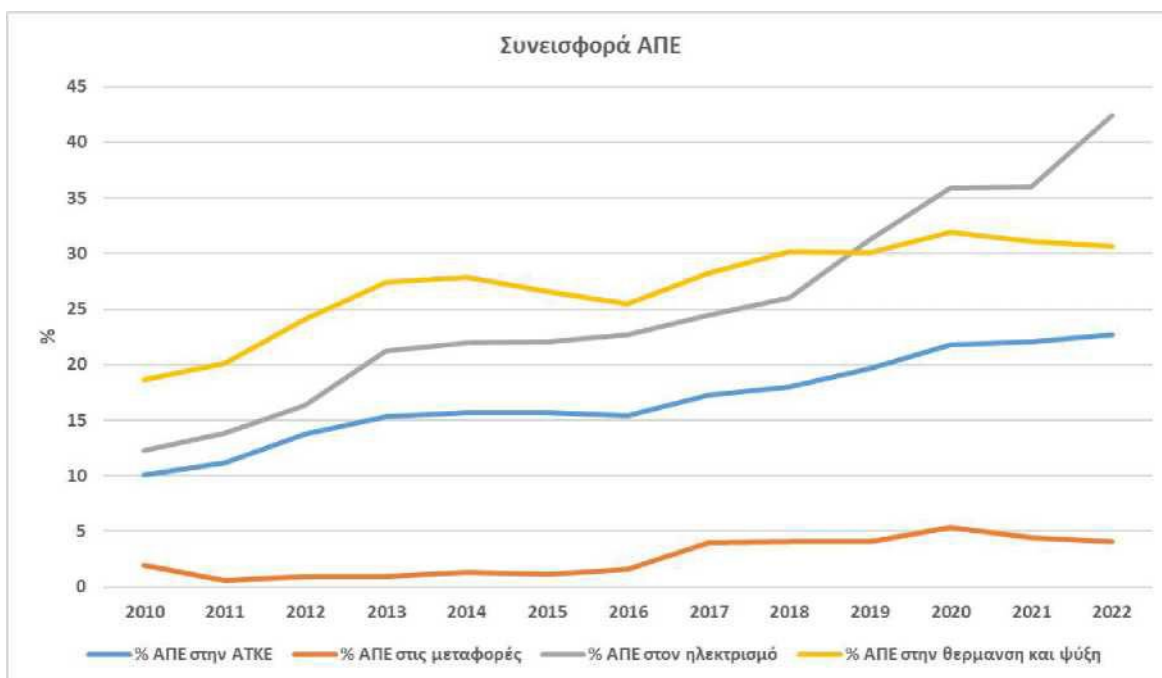


Figure 19 Special shares of RES in the domestic energy system based on a European Union methodology for 2010-2022 (Source: Eurostat).

Total gross electricity production was 4,5 Mtoe in 2022, down by 8 % compared to 2010. In 2010-2022, RES (43 %) recorded the largest percentage increase, followed by natural gas (36 %), stream fuels (11 %) and mineral oils (10 %). It is worth mentioning that the contribution of solid fuels to gross electricity generation has decreased over time (Figure 20).

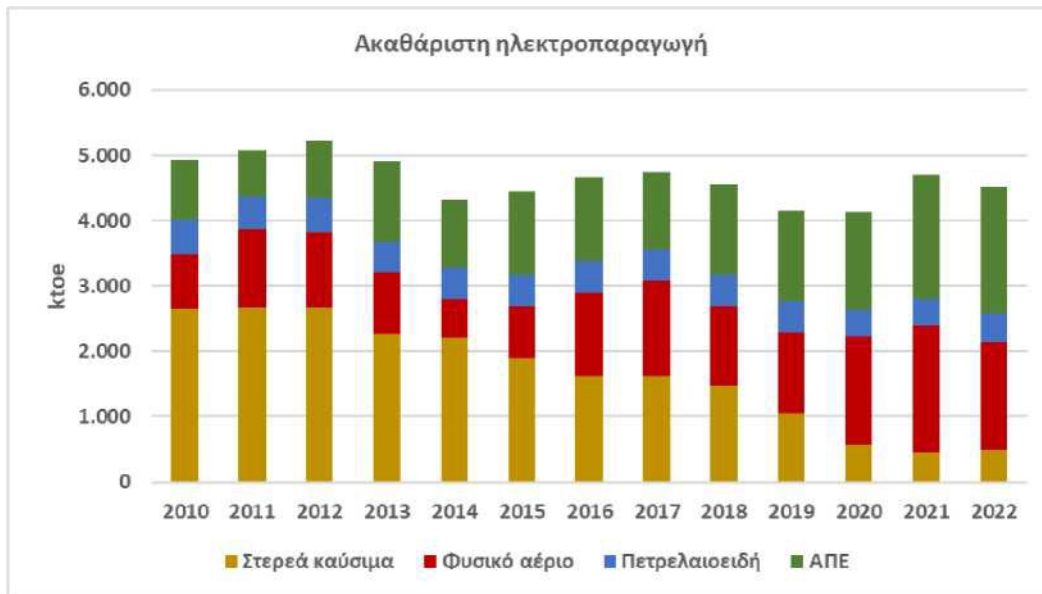


Figure 20 Gross electricity generation 2010-2022 (Source: Eurostat).

In 2022, installed electricity capacity was 23.4 GW, 58 % of which was compared to 2010, with conventional fuels accounting for 42 % of the total, followed by photovoltaic (23 %), wind (20 %) and hydroelectric (15 %) (Figure 21). The largest percentage increase in 2022 compared to 2010 was recorded in photovoltaics and wind, and the smallest in hydroxes, with conventional fuels decreasing in percentage terms.

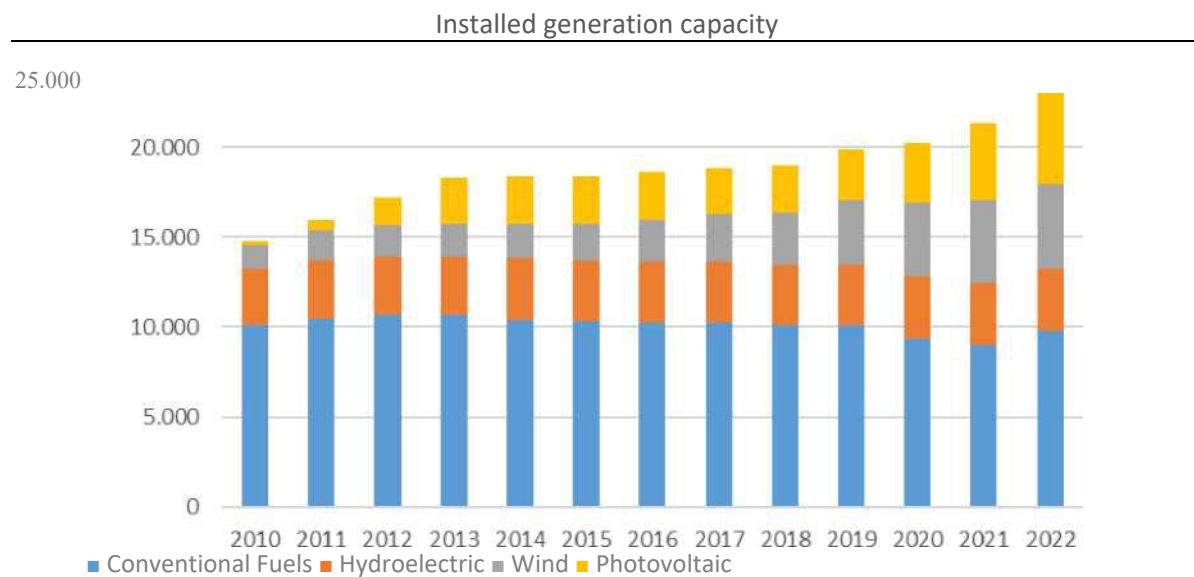


Figure 21 Power installed generation capacity for the period 2010-2022 (Source: Eurostat).

4.2 Projected evolution of the main exogenous factors affecting the energy system and greenhouse gas emissions

This chapter presents an update of key macro-economic trends, such as international fuel prices and emission allowance prices, as well as domestic macroeconomic indicators which have changed markedly.

The assumptions made for the individual parameters influencing the evolution of the energy system, which limit or enhance the development of individual aggregates, are summarised in the projections for the following figures for the period 2022-2050:

- i. Economic activity by industry
- ii. Population and number of households
- iii. International fuel prices
- iv. Greenhouse gas emission allowance prices
- v. Evolution of investment costs of energy technologies
- vi. Potential of RES technologies
- vii. Development of electricity infrastructure and natural gas

The evolution of the demand for useful energy in the final consumption sectors (buildings, at times, etc.) takes into account both the evolution of economic activity by sector and the evolution of the population, housing, household size, production capacity of individual industrial sectors and other macroeconomic and demographic parameters.

The reference year is 2022, as it is the most recent year for which there is an integrated official national energy balance.

viii. Macroeconomic and demographic forecasts

The main assumptions used in the TIMES simulation energy model of the Centre for Renewable Energy Sources and Energy Savings (KEPE), which were used during the preparation of the revised NECP, are set out in Chapter 4.3. The assumptions on the evolution of the country's macroeconomic and public aggregates have been taken from the European Commission's recommendations¹⁶⁶, in the context of an update of the NECP, and are summarised in Table 27 and Figure 22.

Table 27 Joint Macroeconomic and Demographic Forecast for the preparation of the NECP.

¹⁶⁶https://commission.europa.eu/publications/commission-recommendation-assessment-swd-and-factsheet-draft-updated-national-energy-and-climate-16_en.

	2022	2025	2030	2035	2040	2045	2050
Population [million]	10,5	10,3	10,1	9,9	9,7	9,5	9,3
GDP [EUR million]	190,7	205,9	216,1	225,8	236,0	245,4	255,2

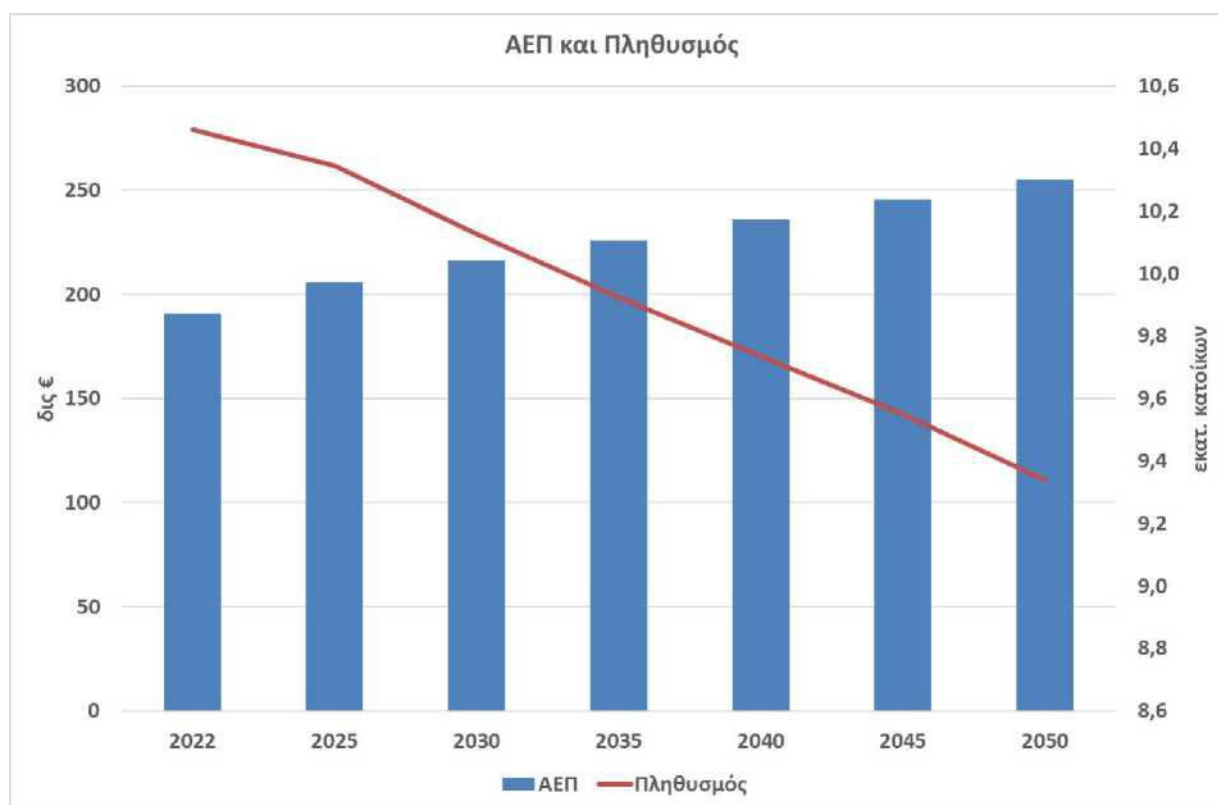


Figure 22 Evolution of GDP and population.

ix. .2 global energy trends, international fossil fuel prices, EU ETS emission allowance price

Table 28 summarises the updated assumptions on the evolution of international fuel prices and EU ETS emission allowances. Natural gas prices, as well as the price of ETS allowances, were derived – taking into account current prices, forecasts from market operators and international estimates for their future evolution in¹⁶⁷169 168 169.

¹⁶⁷ European Commission, 'Recommended parameters for reporting on GHG projections in 2025'.

¹⁶⁸ Annex II. GHG projection parameters 2025.

¹⁶⁹ European Commission, 'Recommended parameters to model ETS2 in the context of the update of NECP'.

Table 28 Prices for the evolution of international fuel prices and emission allowances.

	2022	2025	2030	2035	2040	2045	2050
Natural gas disposal price (EUR/MWh)	120	38	38	38	38	38	38
Crude Oil (EUR/barrel)	103	103	103	103	109	117	131
Emission allowance prices (EUR/t CO ₂ eq)	60	80	80	140	290	430	490

4.3 Projections for the development of the energy system and GHGtransmitters and removals

This section presents the assumptions and computational tools used to develop the baseline scenario to support the National Energy and Climate Plan. To develop the scenario, the energy simulation TIMES model of the CCI was used, with the main aim of achieving the walls for the period 2030-2050.

The price model follows a bottom-up approach, incorporating a detailed description of the production system and meeting the demand for energy at the minimum cost, while taking decisions on equipment scarcity and operation, sources of primary energy disposal and imports/exports of energy products between different regions.

In the sub-sections of Chapter 4.3, the main results from the Nergic TIMES model are presented. For reasons of comparability and continuity, the detailed results of Annex B (evolution of the energy system based on policies), the results of the initial draft NECP, as well as the more detailed temporal development step of the energy system, are presented as the main results from the TIMES energy model.

4.3.1 Developing a scenario for additional policies and measures

In order to prepare the NECP and achieve the relevant energy and climate targets set, an **energy policy scenario was drawn up with additional measures** to complement those already implemented or adopted (Scenario for achieving targets), taking into account the policy measures presented in the corresponding Chapter 3. The **Energy Policy Scenario with existing measures** is the scenario analysed in detail in the December 2011 NECP¹⁷⁰.

The formulation and analysis of the scenario with the additional policy measures aims to assess the parameters affecting the energy system and to adopt additional national policies, which will also meet both the challenges faced by the energy sector in Greece and the obligations arising from the harmonisation of the national framework with the European Energy and Climate Policy.

Taking into account the specific challenges, the energy policy scenario with the additional policy measures meets the following national objectives inline with European policy:

- i. **The share of RES in gross final energy consumption for 2030 and 2050 is 43.0 % and 95.8 % respectively.**

¹⁷⁰https://energy.ec.europa.eu/system/files/2020-01/el_final_necp_main_el_0.pdf

- ii. **Final energy consumption, without ambient heat, for the years 2030 and 2050 is estimated at 15,2 Mtoe and 12,2 Mtoe respectively, while primary energy consumption is 17,8 Mtoe and 16,9 Mtoe respectively¹⁷¹.**
- iii. **The reduction in greenhouse gas emissions is estimated at a level of 57.9 % in 2030, relative to the year 1990, higher than the European Union's 55.0 % GHG emission reduction target.**

Most of the key assumptions made for the individual parameters influencing the evolution of the energy system are the same as those of the CENA of existing policies and measures. However, the evolution of the cost of RES technologies varies and, in addition, it is assumed that the electricity infrastructure development programme is extended to include the interconnection of the Southern Cyclades, the Dodecanese and the North Aegean within the next decade. In addition, the scenario with the additional policy measures incorporates a set of new policies and measures, as detailed in Chapter 3 by thematic dimension, which are taken into account in the resolution process to reflect the evolution of the energy system from the simulation model.

4.3.2 Main features of the energy system by 2050

The future evolution of the energy system, as indicated in **the policy scenario with additional measures**, is reflected in the evolution of the baselines defining energy supply and demand for the period 2022-2050. From the results presented, it is clear that the evolution of the energy system differs significantly from the reference energy scenario with the existing measures, and the achievement of the relevant energy and neutral targets for 2030 is achieved both by changes in the electricity mix and by significant variations in fuel consumption in the final consumption sectors and in the degree to which energy efficiency is achieved.

Table 29 shows the evolution of energy baselines in the form of a summary balance for the period 2022-2050, while Table 30 shows the rise of specific energy and climate indicators for the same period.

Table 29 Summary energy balance for 2022 (historical) -2050.

Summary Energy Balance [ktoe]	2022	2025	2030	2035	2040	2045	2050
Net Imports	18416	16617	13977	10409	7266	5076	4349
Solid fuels	212	160	95	11	0	0	0
Petroleum products	12963	11839	9398	7260	4735	2798	1333
F. Gas	4626	3944	3838	2650	2141	1899	1985

¹⁷¹ Please note that the levels of final energy consumption and primary energy consumption, which have been used in setting energy efficiency improvement targets, are compatible with the standard set by EUROSTAT Europe 2020-2030.

Renewable Hydrogen	0	0	0	0	0	0	0
Electrics	302	254	156	— 233	— 577	— 796	— 424
Biomass/Biofuels	313	419	532	688	826	852	1002
Renewable Ammonia	0	0	0	0	1	104	115
Renewable Methanol	0	0	— 13	33	95	97	112
e-kerozine	0	0	— 28	0	44	122	179
Renewable Liquid Fuels	0	0	0	0	0	0	46
Sea-going Shipping	1894	1840	1830	1830	1730	1725	1721
Provision of primary media	21798	20965	19339	18477	17812	17598	18635
Solid fuels	1548	1106	95	12	0	0	0
Petroleum products	11866	10178	8039	6191	4041	2394	980
F. Gas	4385	3965	3654	2329	1709	1382	1383
Electrics	302	254	148	— 262	— 613	— 839	— 475

Summary Energy IBalance [ktoe]	2022	2025	2030	2035	2040	2045	2050
EOM	4269	5461	7453	10276	12795	14852	16802
Renewable Ammonia	0	0	0	0	1	— 155	— 143
Renewable Methanol	0	0	— 22	— 70	— 164	— 158	— 138
e-kerozine	0	0	— 28	0	44	122	179
Renewable Liquid Fuels	0	0	0	0	0	0	46
Gross domesticallocation	22141	20965	19368	18477	17768	17476	18410
Solid fuels	1683	1106	95	12	0	0	0
Petroleum products	11248	10178	8039	6191	4041	2394	980
F. Gas	4647	3965	3654	2329	1709	1382	1383
Hydrogen	0	0	0	0	0	0	0
Electrics	302	254	148	— 262	— 613	— 839	— 475
EOM	4260	5461	7453	10276	12795	14852	16802
Renewable Ammonia	0	0	0	0	1	— 155	— 143
Renewable Methanol	0	0	— 22	— 70	— 164	— 158	— 138
Final Energy Consumption	16111	16788	16007	15065	14332	13658	13412
Final consumption of the product, without heat treatment of the person inquestion	15666	16204	15161	14069	13180	12461	12208
Final Energy Consumption							
by sector							
Industry	2566	2492	2270	2126	2073	2001	1991
Residential	4278	4369	4178	4036	4011	3879	3784
Tertiary	2078	2242	2331	2436	2512	2607	2700
Transport	6918	7341	6878	6122	5395	4826	4595
Rural	271	344	350	345	340	345	342
by fuel							
Solid fuels	65	161	95	12	0	0	0
Petroleum products	8915	8646	7117	5373	3563	1979	615
F. Gas	1167	1288	1095	818	420	299	266
Electrics	4136	4355	4591	5236	6201	6847	7168
Heat	27	44	42	41	40	37	31
EOM	1355	1711	2026	2234	2471	2515	2602
Ambient heat	445	584	846	1005	1149	1181	1176
Hydrogen	0	0	0	10	57	102	135
Renewable Ammonia	0	0	0	0	4	39	72
Synthetic fuels	0	0	16	69	139	371	1022
Biomethane	0	0	178	277	287	273	297

Table 30 Evolution of energy and climate indicators for 2022 (historical) – 2050.

Indices	2022	2025	2030	2035	2040	2045	2050
Net GHG emissions incl. LULUCF (Mt CO₂eq)	76,9	62,3	43,9	32,5	21,1	11,8	2,6
Net GHG emissions by sector (Mt CO₂eq)							
Electricity	18,8	10,2	4,0	1,5	1,4	1,0	1,2
Energy Sector	5,9	5,6	4,7	4,2	2,3	2,0	1,7
Industry (with processes)	9,2	8,4	7,1	6,0	4,8	4,5	4,3
Residential	5,0	3,8	2,1	1,3	0,5	0,2	0,2
Tertiary	0,6	0,7	0,5	0,3	0,1	0,0	0,0
Rural	0,6	0,2	0,2	0,1	0,1	0,1	0,1
Transport (Domestic Transit and International Air Transport)	21,6	21,9	19,8	15,1	10,3	5,6	1,4
Non-CO ₂ GHG emissions	20,6	17,6	15,4	14,1	13,0	10,0	8,6
Carbon emissions and removals in the land use, land use change and forestry (LULUCF) sector	— 5,5	— 6,2	— 6,6	— 7,2	— 8,1	— 8,6	— 9,1
Industry and energy sector commitment	—	—	3,3	3,4	4,2	4,1	3,9
Commitment through DAC	—	—	—	—	—	0,0	4,5
Use of CO ₂ for the production of synthetic fuels	—	—	0,2	0,4	0,8	1,2	2,7
CO ₂ Storage	—	—	3,1	3,0	3,5	2,9	5,7
Energy Completion [%]	76.6 %	72.9 %	66.0 %	51.3 %	37.2 %	26.3 %	21.4 %
RES share in gross final energy consumption [%]		30.9 %	43.0 %	60.6 %	77.2 %	88.6 %	95.8 %
RES share in final consumption for heating and cooling [%]		39.8 %	52.6 %	60.6 %	75.2 %	81.6 %	84.1 %
Share of RES in gross electricity allocation [%]		58.6 %	75.7 %	96.2 %	102.8 %	106.9 %	100.8 %
RES share in buildings [%]		51.2 %	72.2 %	86.0 %	93.3 %	95.3 %	95.1 %
Share of RES in Industry [%]		19.7 %	34.0 %	43.0 %	57.3 %	60.6 %	65.8 %
Share of RES in Transport [%]		4.4 %	13.4 %	43.2 %	69.0 %	86.5 %	96.1 %
Share of Advanced Biofuels and Biogas in Transport (%)		0.8 %	4.6 %	11.2 %	14.2 %	13.5 %	13.2 %
Share of Renewable Fuels of Non-Organic Origin in Transport (%)		0.0 %	0.9 %	5.4 %	11.5 %	21.5 %	30.9 %

Share of Advanced Biofuels – Biofuels and Renewable Fuels of Non-Based Origin in Transport (%)	0.8 %	5.5 %	16.6 %	25.7 %	35.0 %	44.1 %
SAF (Sustainable Aviation Fuel) of biological origin	1.8 %	5.0 %	16.2 %	25.3 %	32.3 %	38.0 %
SAF (Sustainable Aviation Fuel) of non-organic origin	0.0 %	1.0 %	4.1 %	8.1 %	22.4 %	43.9 %

In particular, the total supply of primary energy is down by 12 % in 2030, reaching 19,3 Mtoe, compared to 2022, while in 2050 it stands at 18,6 Mtoe. The contribution of petroleum products and natural gas tends to decrease until 2050, while solid fuels cease to exist from 2040 onwards. There is a particularly significant contribution from RES, which reached 7,5 Mtoe in 2030 of 16,8 Mtoe in 2050. It is worth mentioning that the negative prices for electricity, renewable ammonia and renewable methanol are due to imports and sea-going shipping, while e-kerosene has appeared since 2030 and renewable liquid fuels since 2045.

For the year 2030, the **energy policy scenario with additional measures** achieves a **reduction of net GHG emissions of almost 57.9 % relative to the year 1990 and 67.7 % over the year 2005**, with net emissions falling to 43,9 MtCO_{2eq}, including horticultural emissions and removals due to land use, land-use change and forestry (LULUCF).

In particular, for GHG emissions in Greece in 2030 and 2050, compared to the year 2022, a reduction is achieved in the electricity sector, the non-power sector, industry, including industrial, residential, tertiary and rural processes, as well as the attitudes sector. In particular, net GHG emissions for the year 2030 (including LULUCF) are estimated at the level of 43.9 Mt CO_{2eq} and 2.6 Mt CO_{2eq} in 2050, relative to 76.9 Mt CO_{2eq} in 2022. The overall reduction in emissions is achieved by choosing cleaner forms of energy in all sectors, in particular in the power sector, where high-CO₂ emission technologies (i.e. lignite-fired and oil plants) are replaced by RES for electricity supply until 2030.

Carbon Capture Utilisation and Storage (CCUS) technology is expected to be applied in the coming years in Greece, as shown in Figure 23. The CO₂ commitment by domestic industry is expected to reach 3.3 million tonnes CO₂ in 2030, peaking in 2040 at 4.2 million tonnes CO₂ and falling to 3.9 million tonnes of CO₂ in 2050. Adding the direct air capture technology (DAC) commitment, which is expected to grow in the period 2045-2050, then results in the total amount of CO₂ captured, estimated to reach 8.4 million tonnes of CO₂ in 2050. It is expected that CO₂ storage will play in the period 2030-2050, which will reach 3.1 million tonnes of CO₂ in 2030 and 5.7 million tonnes of CO₂ in 2050. Finally, other technological solutions, the expensive current costs of which are projected to phase out over time, such as Air Carbon Capture and Storage

(DAC), are also expected to be implemented by the year 2050.

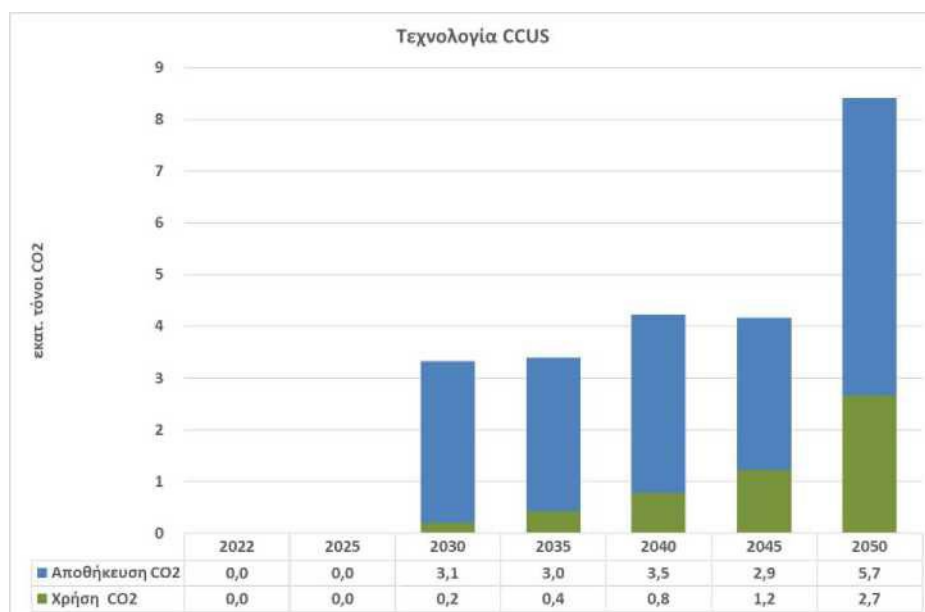


Figure 23 Coverage of CCUS needs up to 2050.

RES participation

The contribution of RES as a share of gross final energy consumption reached 43.0 % in 2030, before reaching 95.8 % in 2050 (Figure 24). The share of RES in gross electricity consumption, final energy allocation for heating, buildings, industry and transport in the period 2025-2050 shows a notable increase. The share of RES in gross electricity consumption in 2030 is expected to be 75.7 %, rising significantly from 2025 (58.6 %), while in 2050 it is estimated that it will reach 100.8 % (Figure 25).

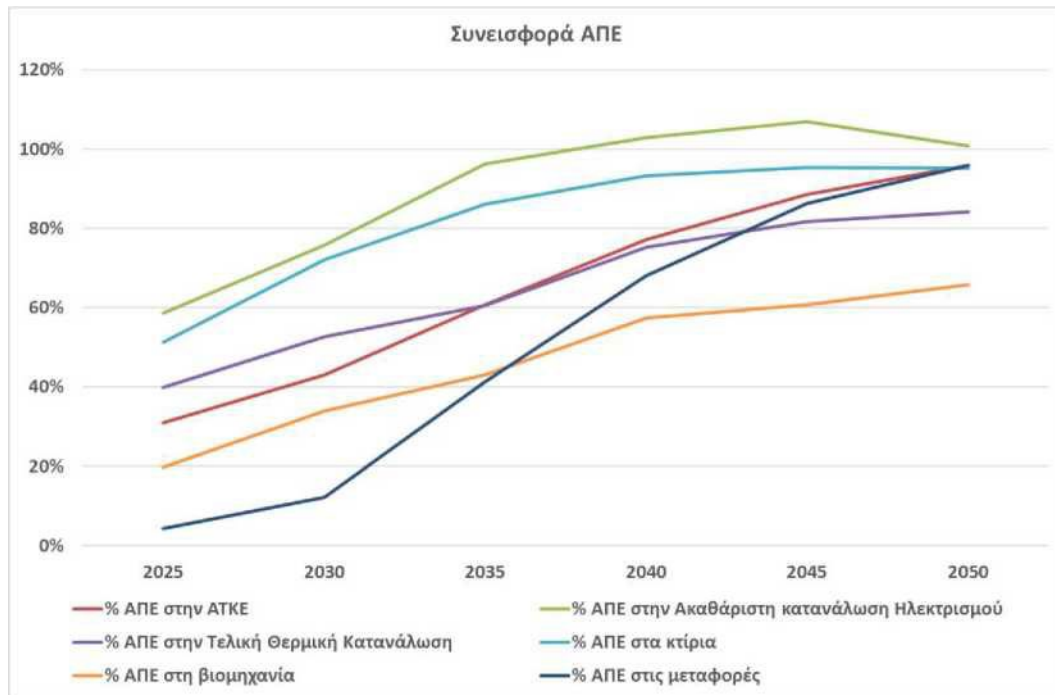


Figure 24 Specific shares of RES participation in the domestic energy system in the Method Base — European Union doctrine.

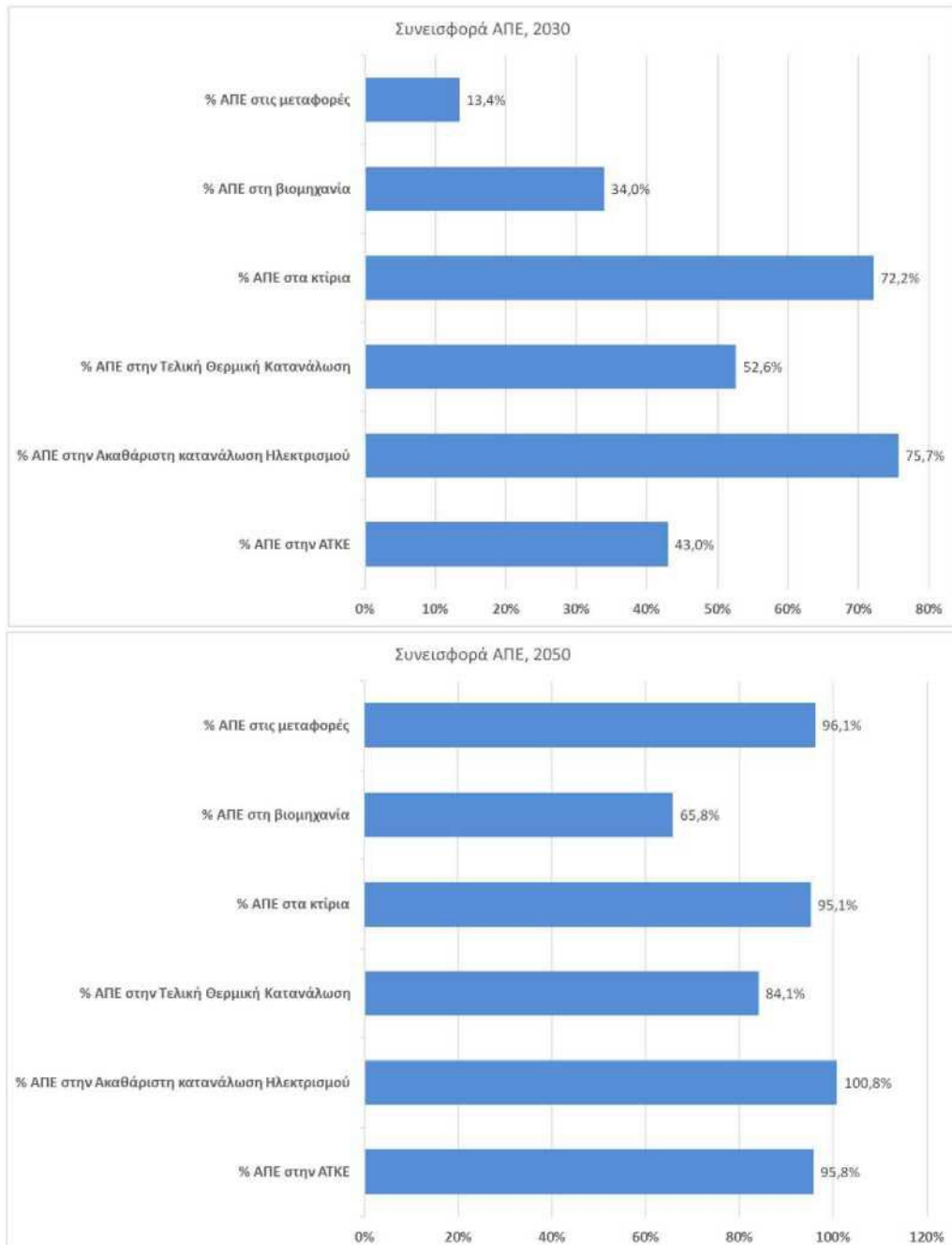


Figure 25 Share of RES participation by sector in 2030 and 2050.

The increase in the share of RES in gross final energy consumption hampers the radical change and shift of the national generation mix and the transition to an environment in which RES will play a leading role (Figure 26).

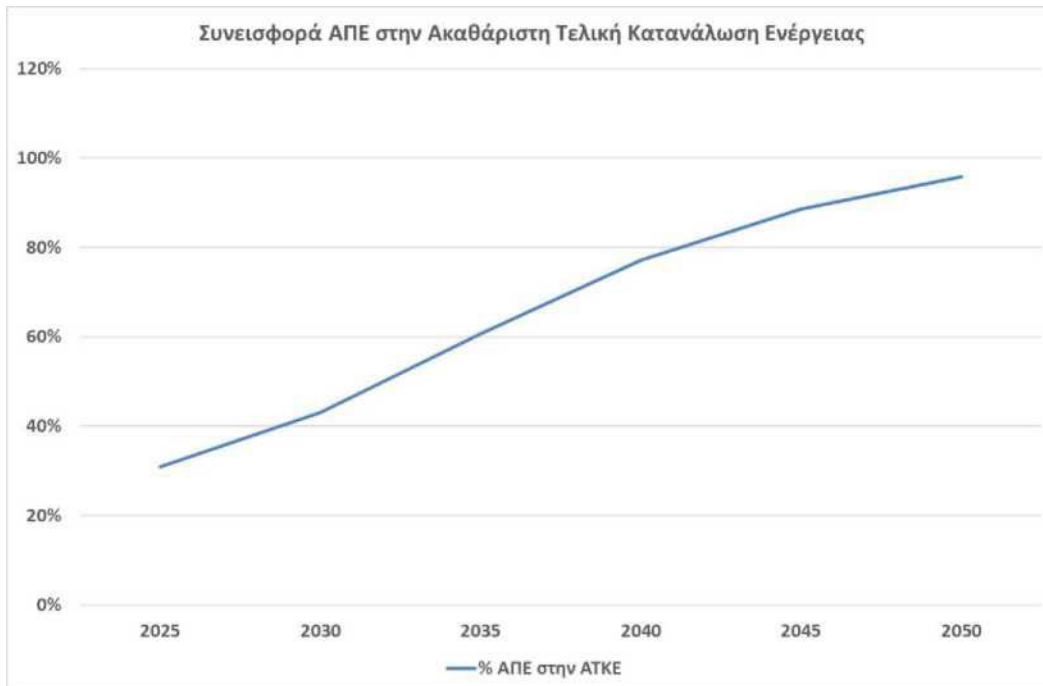


Figure 26 Evolution of RES penetration into gross final energy consumption by 2050.

RES penetration in final consumption for heating is increasing significantly from 2025 to 2050 (Figure 27), bringing the share to 52.6 % in 2030 and 84.1 % in 2050, from 39.8 % in 2025. This increase is mainly due to the increased penetration of heat pumps to meet heating needs in the tertiary and residential sectors, the maintenance of the use of biomass at high levels and the increased use of solar thermal systems to produce hot water in the domestic sector, which contribute to an increase in the RES contribution to the building sector as a whole (Figure 28).

Although the share of RES in district heating and cooling is relatively small, an increase in the relative share will be pursued by 2030 as it will facilitate the energy transition of the regions affected by the de-lignification.

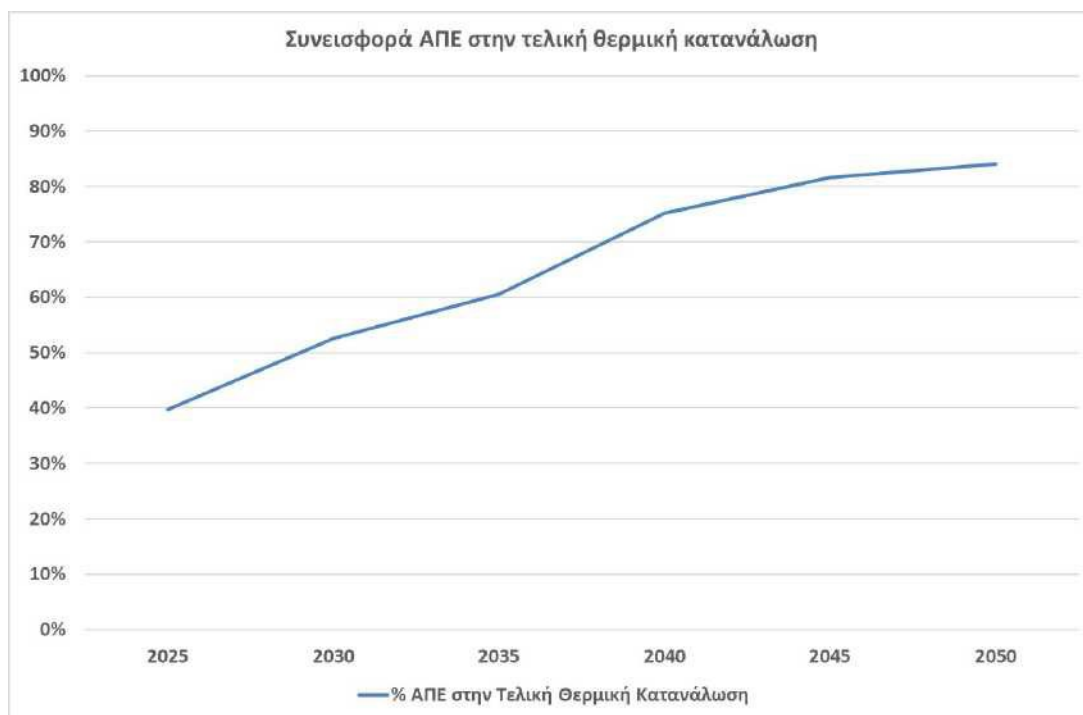


Figure 27 Evolution of RES penetration of final energy consumption for heating and cooling by the year 2050.

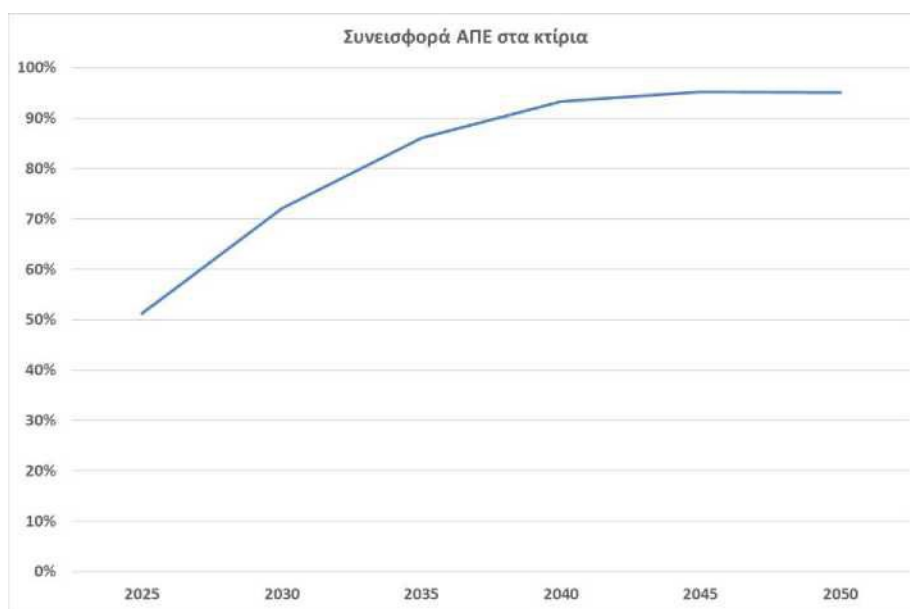


Figure 28 Evolution of RES penetration of final energy consumption for buildings by 2050.

In addition, bioenergy is expected to contribute significantly to the industrial sector by 2050, which is expected to reach 213,3 ktoe in 2030 and 227,9 ktoe in 2050, rising by 76 % and 88% instead of 2022 (121 ktoe).

Penetration of RES in industry is expected to be 34.0 % in 2030, before almost doubling in 2050 (65.8 %) (Figure 29). However, there is no projected penetration of renewable fuels of non-biological origin by 2030 in the energy and non-energy uses of the industrial sector. In addition, an important e-building is estimated to be the contribution of RES to buildings, where it is expected to rise from 72.2 % in 2030 to 95.1 % in 2050.

Finally, the transport sector is characterised by a sharp increase in the share of RES since 2030, mainly due to the penetration of biofuels, renewable fuels of non-biological origin and a significant increase in electromobility (Figure 30). RES penetration is 13.4 % in final energy consumption for transport in 2030 and 96.1 % in 2050. Furthermore, advanced biofuels and biogas, together with renewable fuels of non-biological origin, are estimated to cover 5.5 % of all fuels in the sector in 2030.

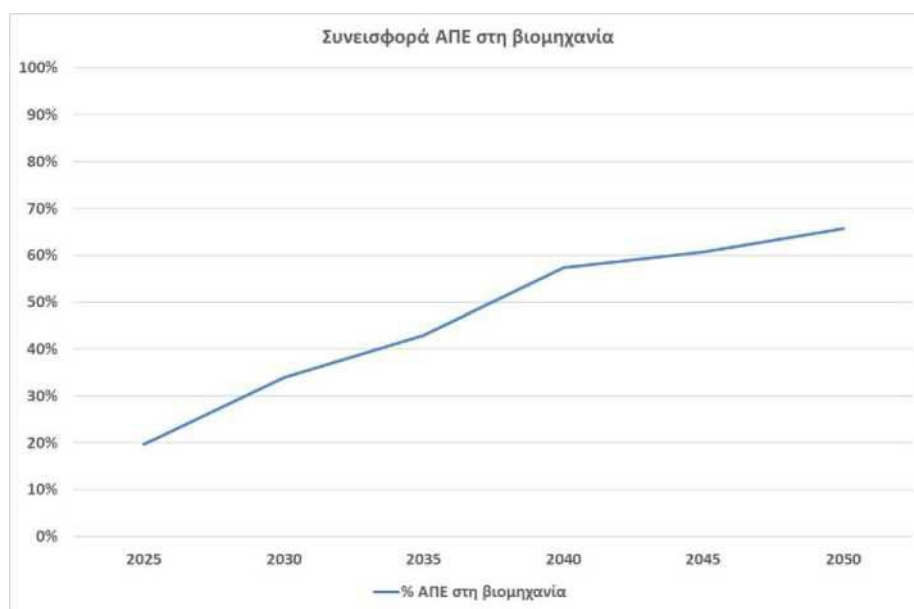


Figure 29 Evolution of RES penetration of final energy consumption for industry up to net — in 2050.

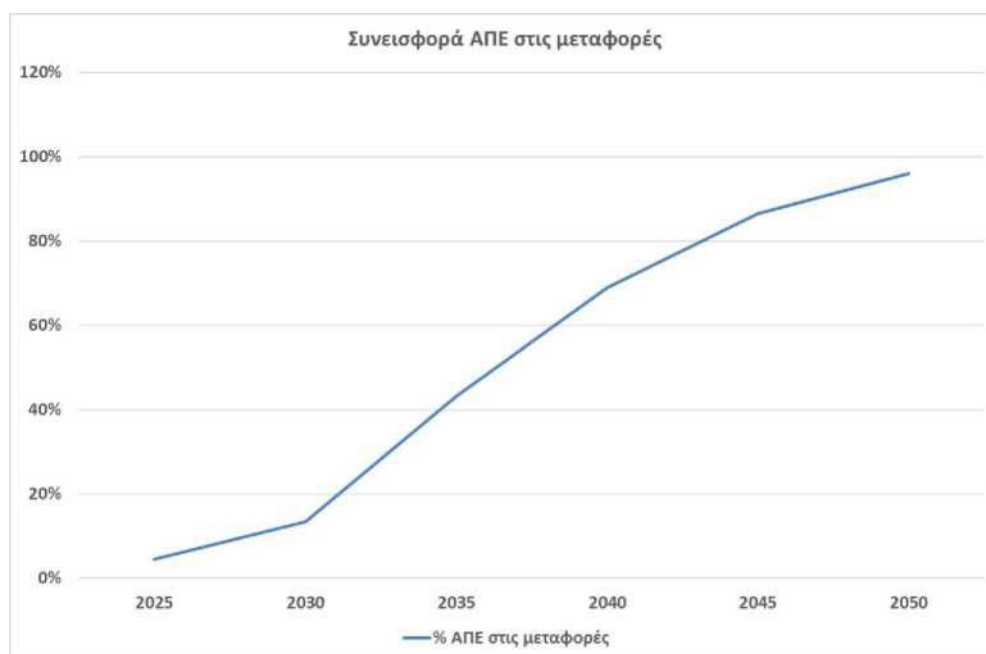
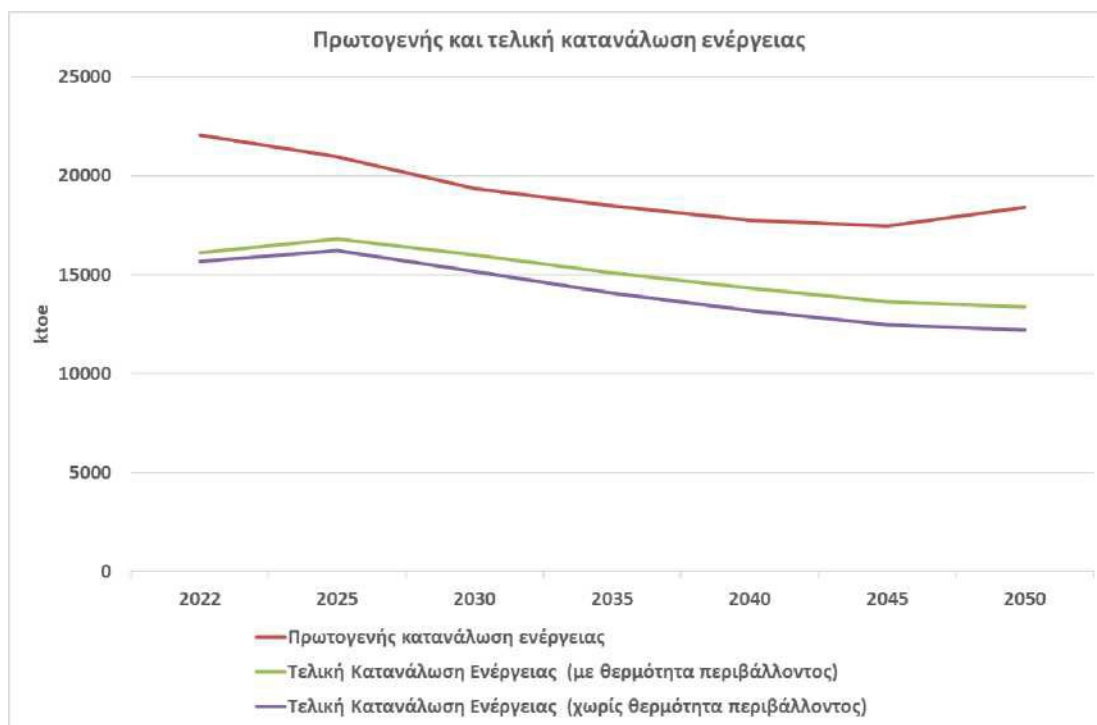


Figure 30 Evolution of RES penetration of final energy consumption for transport up to the year 2050.

Energy consumption

Total primary energy consumption shows a continued decline of 12 % until 2030 to 19,4 Mtoe and 19 % by 2040 compared to 2022, and then a relative stabilisation is achieved until 2050, as shown in Figure 31. Overall, primary energy consumption will be 17 % lower in 2050 compared to 2022 (22,1 Mtoe).



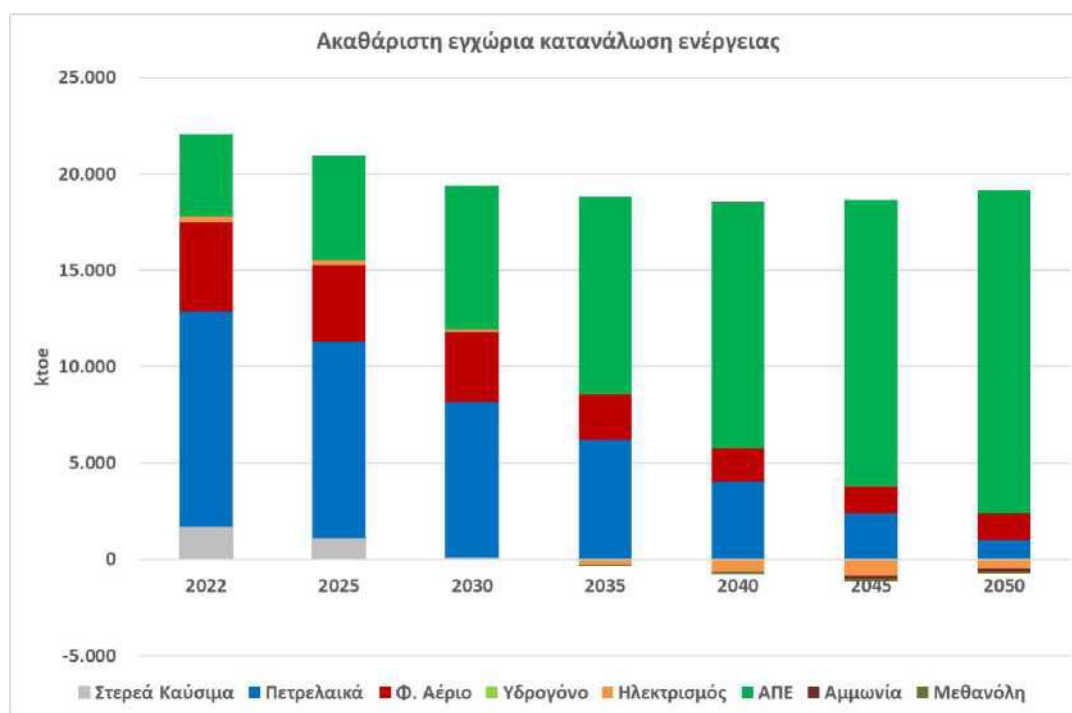
Σχήμα 31 Εξέλιξη πρωτογενούς και τελικής κατανάλωσης ενέργειας έως το έτος 2050.

There is a similar trend in the case of final energy consumption, with a warm environment, which in 2030 is estimated to be 16,0 Mtoe, which is lower than in 2022 (16,1 Mtoe), leading to higher energy efficiency through the adoption of strong measures and policies, mainly in the buildings sector but also in the post-school sector. Accordingly, total final energy consumption is expected to reach 13,4 Mtoe in 2050, a fall of 17 % compared to the 2022 peaks. Final energy consumption, without ambient heat, is 15,2 Mtoe in 2030 and 12,2 Mtoe in 2050.

Gross inland energy consumption has fallen by 12 % in 2030 (19,4 Mtoe) compared to 2022 (22,1 Mtoe), as shown in Figure 32, and will eventually reach 18,4 Mtoe in 2050, leading to an overall decrease of 17 % compared to 2022 levels.

At the same time, the highest penetration of RES is evident, which is almost doubling in the period 2022-2030, while the share of fuel streams is significantly reduced, mainly due to the

de-lignification of the power generation sector. At the same time, oil products show a noticeable decline, which is characterised by the withdrawal of the islands' oil power plants after their interconnection with the interconnected system and by resisting the use of petroleum products in the final energy consumption sectors (buildings, transport) from RES and natural gas.



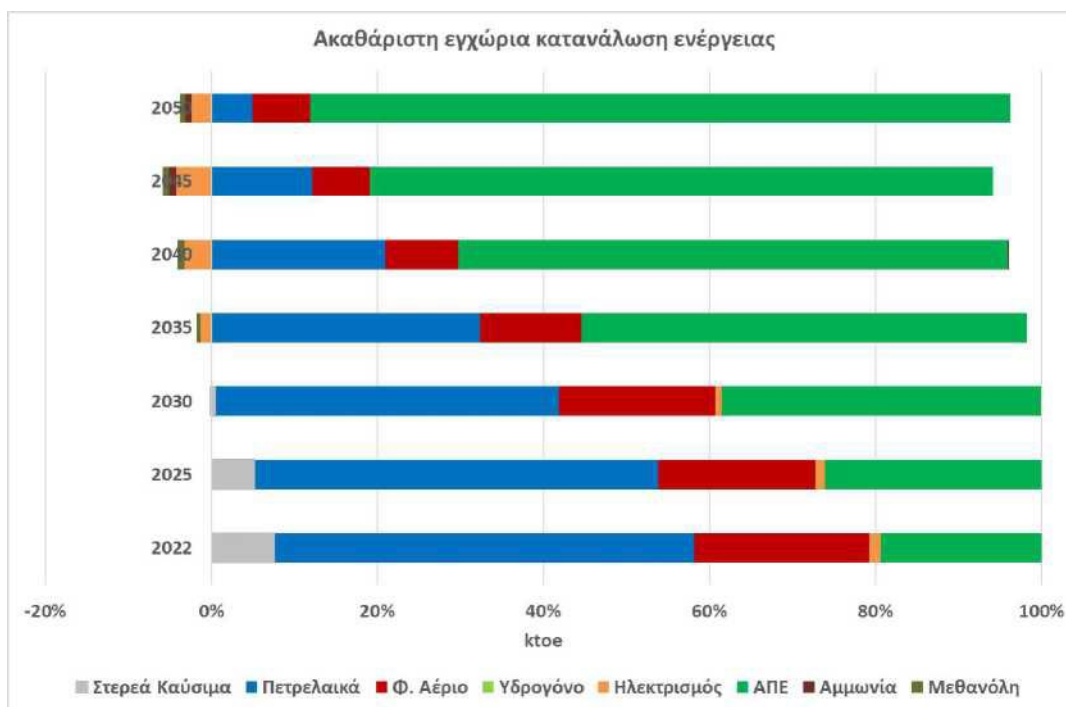


Figure 32 Evolution of fuel shares in gross inland energy consumption to year 2050 (in ktoe, and as a percentage).

Final energy consumption, including ambient heat for the use of heat pumps, shows a decrease of 1 % in 2030 compared to the estimate for the year 2022 (Figure 33). For 2050, final energy consumption is 13,4 Mtoe, a fall of 17 % compared with 2022.

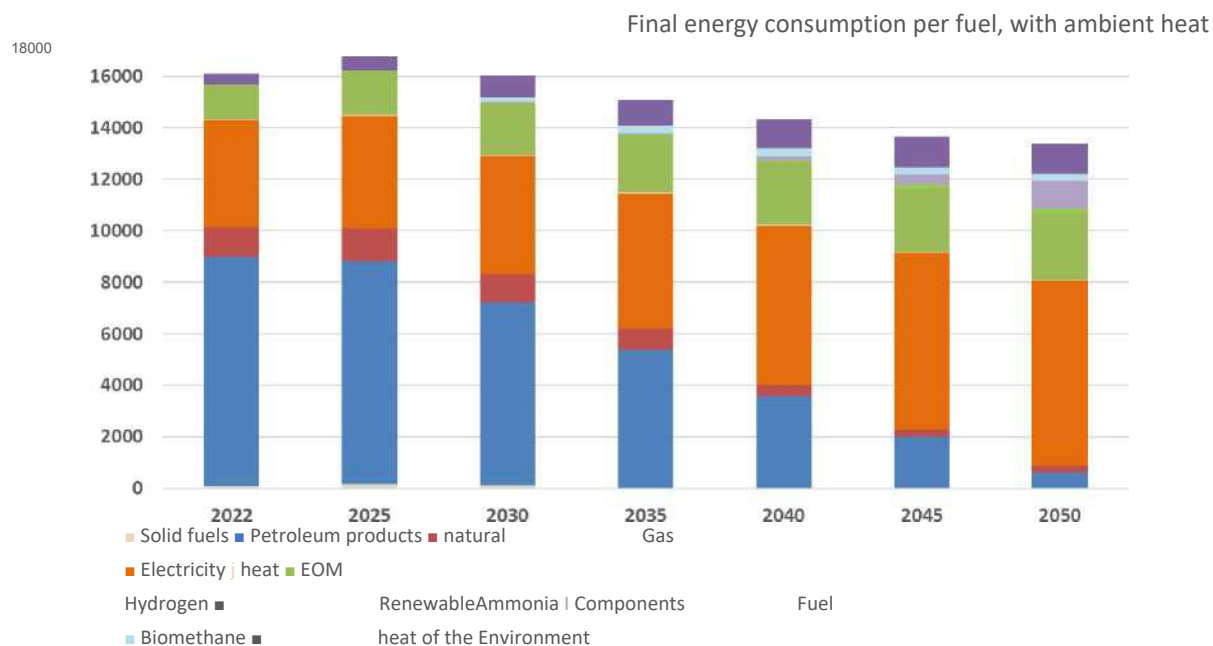
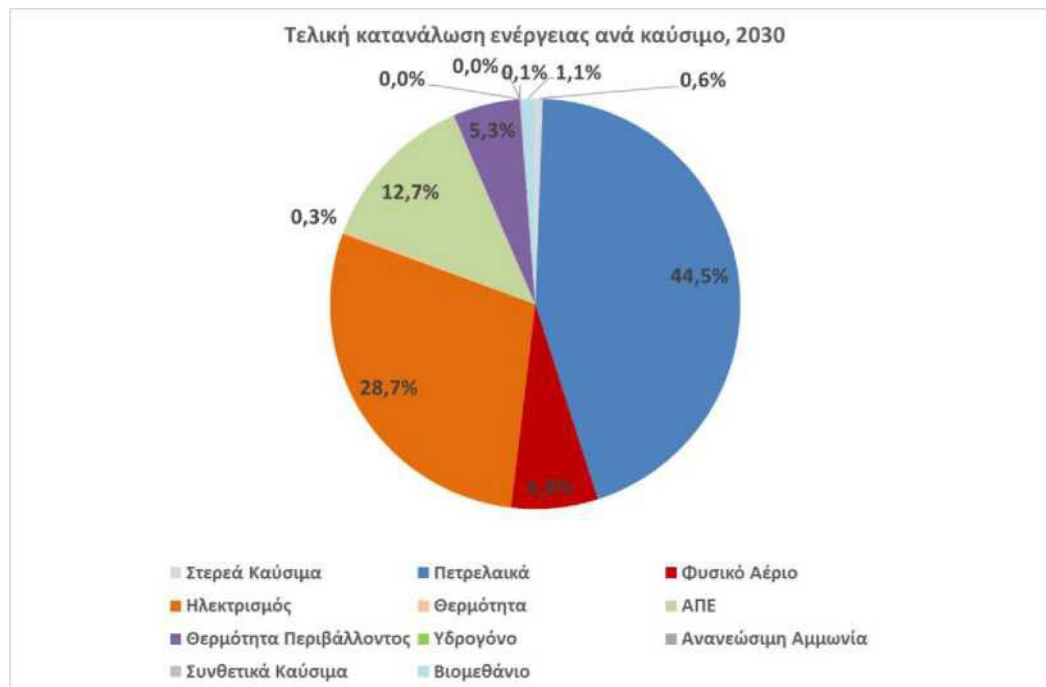


Figure 33 Evolution of the shares of final energy consumption fuels by the year 2050.

At the same time, there is a 50 % increase in the direct use of RES in the final energy allocation (i.e. from solar thermal, heat pumps, geothermal and biosink) in 2030 compared with 2022, with a notable drop in the direct use of petroleum products and a slight decrease in the direct use of natural gas.



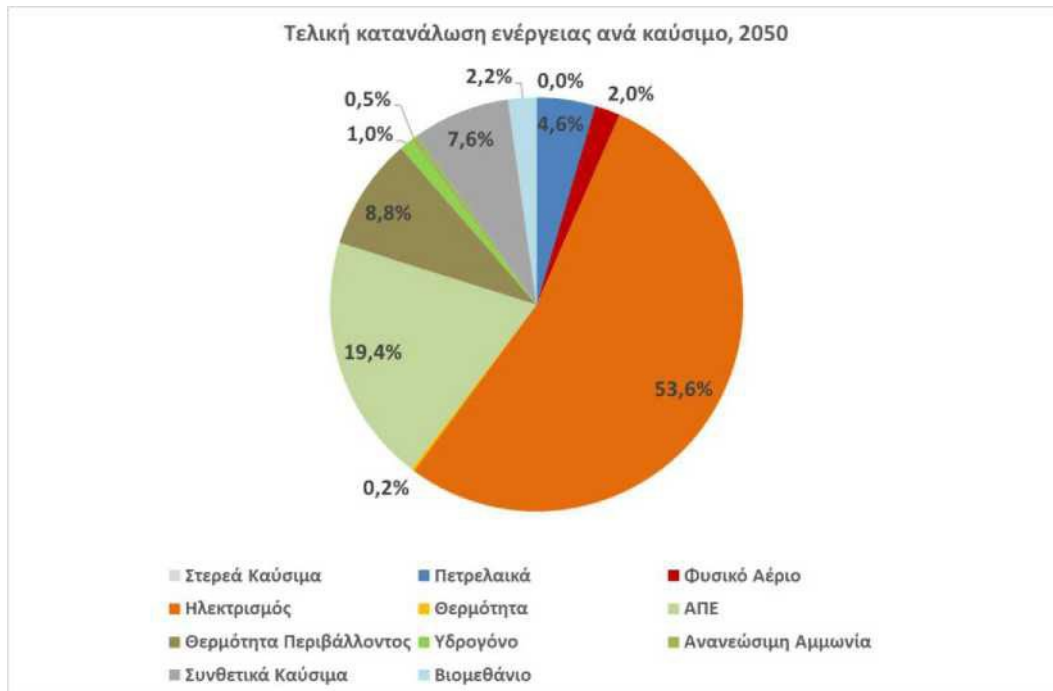


Figure 34 Evolution of the shares of final energy consumption fuels, with heat; complainant, in 2030 and 2050.

When comparing final energy consumption for 2030 and 2050, Figure 34 shows a dramatic drop in the use of oil products and natural gas (mainly in 2050), achieving high levels of electrification, while the use of new fuels such as hydrogen, biomethane and synthetic fuels is increasing.

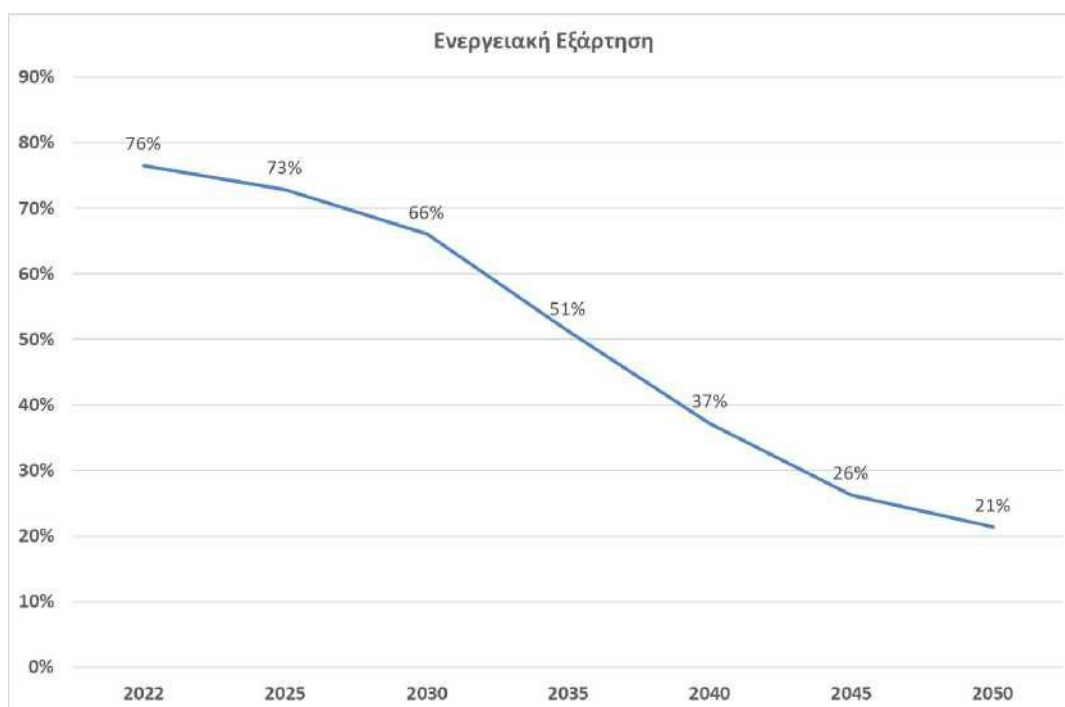


Figure 35 Evolution of energy dependency by 2050.

As regards the country's energy dependence on fuel imports, this indicator is significantly scaled down, with a decrease of around 10 percentage points in 2030 and 55 percentage points in 2050 compared with 2022 (Figure 35), which stands at 66 % and 21 % in 2030 and 2050 respectively. This result is all the more due to high RES penetration in the national energy mix and significant improvements in end-use energy efficiency, which together outweigh the cessation of the use of lignite in electricity generation.

As regards synthetic fuels, a significant increase in consumption is expected in 2030-2050 (Figure 36). In particular, synthetic fuel consumption is expected to increase from 25,6 ktoe in 2030 to 1,7 Mtoe in 2050. It is worth mentioning that the percentage of exports of synthetic fuels is expected to reach 161 % of total consumption in 2030, while imports are registered from 2035-2050, reaching 10 % in 2035 and remaining at 30 % in the period 2040-2050.

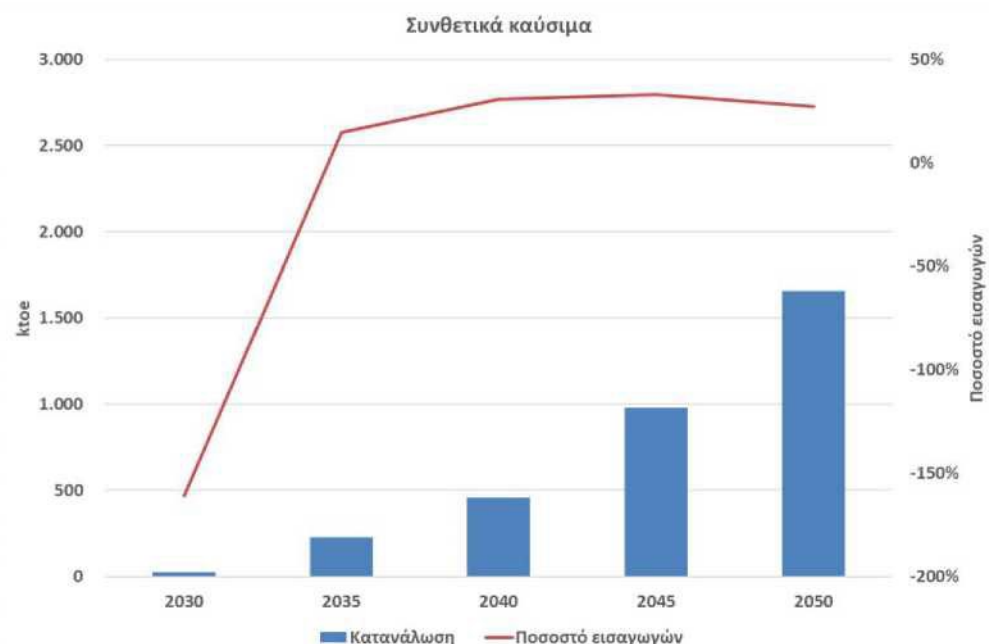


Figure 36 Evolution of consumption of synthetic fuels and percentage of imports thereof up to operational by 2050.

With regard to renewable gases, it is expected that production will emerge and increase in the period 2030-2050 (Figure 37). In particular, hydrogen production is expected to increase from 1.2 TWh in 2030 to 20.2 TWh in 2050, with biomethane production doubling in 2050 (4.6 TWh) compared to 2030 (2.1 TWh). Please note that in the period 2025-2030, biomethane production is expected to develop to replace part of the natural gas (mainly in the distribution networks due to the small size of Greek plants) and the installation of the first commercial green hydrogen production lines, mainly for the production of renewable synthetic fuels from refineries.

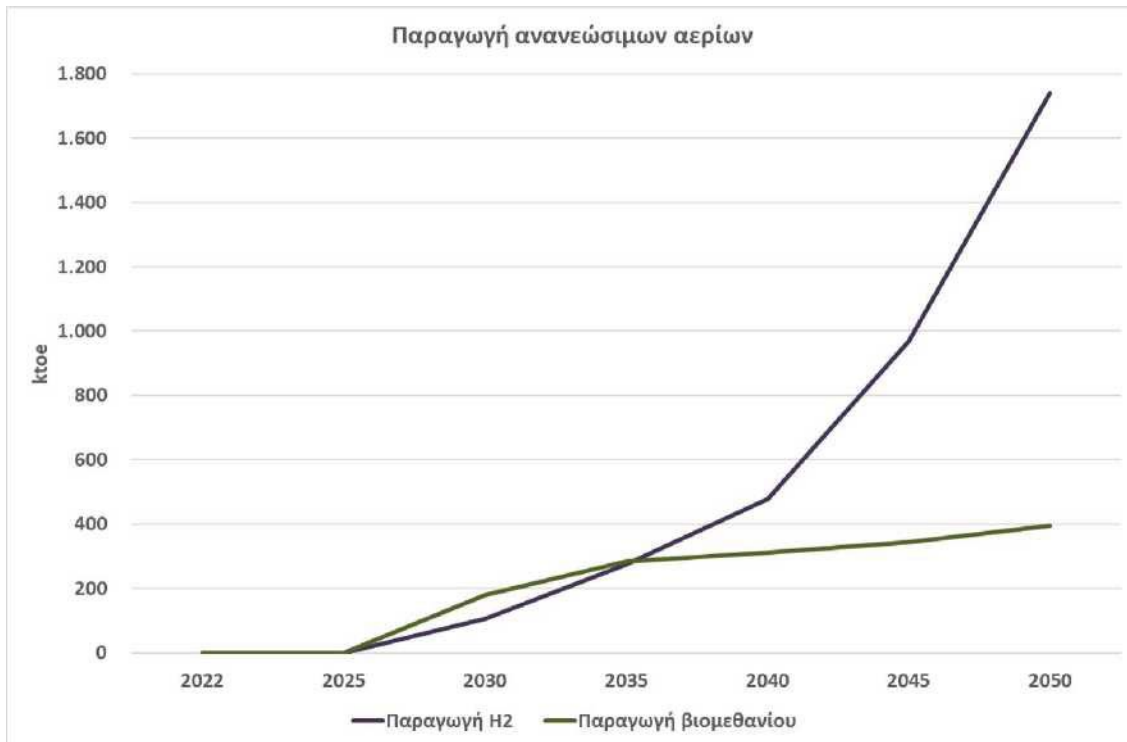


Figure 37 Evolution of production of renewable gases by 2050.

4.3.3 Evolution of electricity generation

The evolution of the electricity generation system up to 2050 is characterised by the high penetration of RES and the withdrawal of lignite-fired power plants by 2028, which is planned under the national policy for the de-lignification of the energy sector, as well as the reduction in the installed capacity of the three units, which are expected to be shut down, on the one hand due to the high emissions of gaseous pollutants and the age of these plants and afterwards due to the islands' imminent interconnections with the interconnected system during the period under review.

The main characteristics of the electricity generation system up to 2050, in line with the energy policy scenario with the additional policy measures, are presented in Table 31.

Table 31 Basic characteristics of a power-generating system until 2050.

Electricity	2022	2025	2030	2035	2040	2045	2050
Total Installed Power [GW]	22,5	27,5	35,5	42,0	53,0	62,5	70,7
Lignite coal	1,6	1,3	—	—	—	—	—

F. Gas	6,3	7,0	7,9	6,3	5,9	5,9	5,9
Petroleum products	0,8	0,8	0,1	0,1	0,1	0,1	0,1
Biomass Biogas	0,2	0,1	0,1	0,1	0,1	0,0	0,0
Photovoltaic	5,4	8,5	13,5	18,5	26,0	30,6	35,1
Wind onshore	4,7	7,0	8,9	9,5	11,0	13,0	13,0
Offshore wind	0,0	0,0	1,9	3,9	5,8	8,2	11,8
Hydroelectric	3,4	2,8	3,1	3,6	3,8	4,2	4,5
Total Net DeliveryElectro-Parts [TWh]	52,0	53,9	60,4	78,8	101,5	122,9	145,5
Lignite coal	5,8	4,5	—	—	—	—	—
Natural gas	19,1	12,2	10,9	4,7	4,1	2,9	3,8
Oil	5,1	1,8	0,3	0,3	0,2	0,0	0,0
Biomass Biogas	0,1	0,6	0,4	0,0	0,0	0,1	0,0
Photovoltaic	7,1	13,1	20,9	28,7	40,1	47,1	54,0
Wind onshore	10,9	16,3	21,1	22,9	27,0	32,0	32,5
Offshore wind	0,0	0,0	0,6	15,4	22,8	32,4	46,5
Hydroelectric	3,9	5,5	6,1	7,0	7,3	8,3	8,7
Net Imports of Electricity [TWh]	3,5	3,0	1,8	— 2,7	— 6,7	— 9,3	— 4,9
Total Electricity Supply [TWh]	55,5	55,8	61,3	73,1	88,4	104,7	130,9
Network losses [TWh]	3,8	3,6	3,7	4,0	4,5	4,8	4,9
Pumping losses [TWh]	0,0	0,4	1,2	2,0	2,3	2,6	2,9
Waste electricalenergy [TWh]	0,0	1,1	0,9	3,1	6,4	8,9	9,7

The installed capacity of natural gas is rising until 2030, to 7.9 GW, compared to 6.3 GW in 2022, before decelerating to 6.3 GW by 2035 and 5.9 GW in 2040, where it stagnates until 2050. The above size is indicative of maximum and is based on existing plants. The actual capacity of natural gas plants that will need either hot or verylow capacity to ensure security of supply will be determined by the security of supply studies carried out on a regular basis by ADMIE and by the functioning of competition.

The penetration of RES in the net domestic generation mix in 2030 is expected to reach almost 81 %, up from 42 % for 2022, due to the expected further reduction in the cost of RES technologies for electricity generation, in particular photovoltaic and wind power plants, and the withdrawal of lignite plants. The expected increasein output of the remaining conventional plants, due to the increase in the cost of acquiring emission allowances, makes RES particularly competitivewith co-production units for the period after 2020. For 2050, RES are expected to contribute 97 % to the net domestic generation mix, exceeding, as output, the levels of 141.6 TWh, which are comparatively higher than in 2030 (49.2 TWh) and 2022

(22.0 TWh).

The RES penetration target in gross final energy consumption was achieved in the most cost-effective way for the national economy by significantly increasing the contribution of wind and photovoltaic plants to power generation. This is because these are technologies that already have a particularly low levelised cost of electricity generation and in the short term that are directly competitive on the electricity market with conventional thermal plants.

It should be noted that part of the oil plants on the islands that will be interconnected will be subject to a cold reserve system. However, their operation will be drastically restricted, as the islands' loads will be mainly covered by the interconnected system, and the application of the Directives on Industrial Emission Transfers (IED¹⁷²)¹⁷³ and MCP D will be fluorescent to determine the maximum number of operating hours.

Overall, the installed capacity for electricity generation is 35.5 GW and 70.7 GW in 2030 and 2050, respectively, increasing by 58 % and 215 % instead of 2022. For 2030, the installed capacity of lignite-fired power plants is not taken into account, as the last year with lignite-fired electricity production is 2028, while the installed capacity of oil plants is expected to decrease by 82 % in 2030 compared to 2022, reaching a level of 0.15 GW. This figure does not include all the power that may be needed in cold reserves on the islands for reasons of urgency (e.g. breakdown of interconnections).

The installed capacity of RES increases by about 13.8 GW to 27.5 GW in 2030 compared with 2022, with 88 % of this increase in wind and photovoltaic parks (Figure 38). For photovoltaics in particular, the expansion of their use at distribution network level, in particular in urban and semi-urban areas, has also been incorporated through self-consumption schemes and projects by energy communities. Of particular interest is the 50 % reduction in installed capacity of biomass and biogas plants, which is expected to reach 76.6 MW by 2030, from the current 161.0 MW. For 2050, the installed capacity of RES stands at 64.4 GW, a significant increase from the 2022 levels (13.7 GW).

With regard to the shares and installed capacity of both thermal power units and RES technologies, it should be noted that these have prevailed in the context of the energy simulation, considering specific assumptions on reduced generation costs from these plants and should be considered as indicative and possible, but not binding per technology and category of assets. In particular for RES power plants and taking into account the scale of

¹⁷²https://environment.ec.europa.eu/topics/industrial-emissions-and-safety/industrial-emissions-directive_en.

¹⁷³https://environment.ec.europa.eu/topics/industrial-emissions-and-safety/medium-combustion-plant-directive_en.

competitive bidding procedures, the evolution of the reduction in generation costs and therefore the possibility of developing them outside any support, the final allocation of the capacity of these projects in terms of technology may vary significantly until 2050.

Therefore, more than all, the requirement for RES electricity generation should be seen as an objective and left to the market and the strong advantages between RES technologies for which projects and what capacity will ultimately contribute to this objective. Similarly, for thermal power parks this recording is also not binding as the operating margin of new units or not will arise in the context of the needs of the liberalised and astigmatic electricity market.

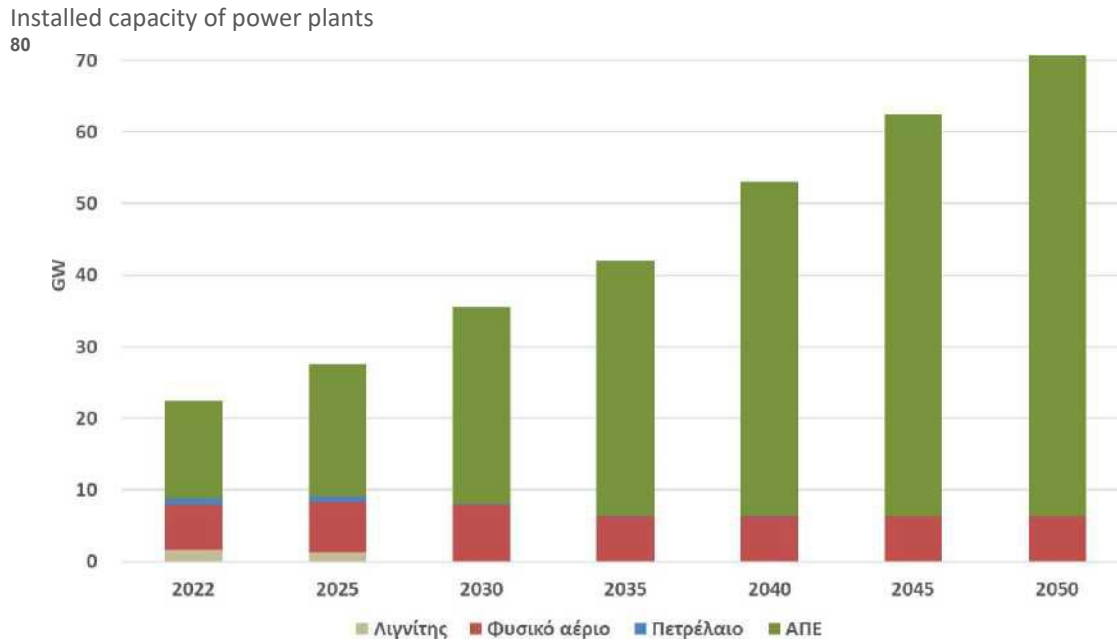


Figure 38 Evolution of installed capacity of power-generating modules by 2050.

In detail for the RES contribution to installed electricity capacity, uncontrolled RES (wind and photovoltaic plants) for 2022 are estimated to have reached 10.1 GW, while for 2030 and 2050 they are 24.3 GW and 59.8 GW respectively. As regards the installed capacity of hydroelectric power plants, it is projected to increase by around 1.0 GW in the period 2022-2050, due to the operation of large hydropower projects and through the renewal and operation of a number of new small hydroelectric projects (Figure 39).

There are already two large hydropower plants in Greece, with the possibility of reversing operations, the Sifkia projects at Aliakonas and Thesauros in Nestos, with an installed capacity of 315 MW and 384 MW respectively. In addition, it is possible to install pumping systems with relatively small technical interventions in other existing hydroelectric projects with successive reservoirs. The installation of such pumping systems should improve the operation of existing vertebrates and increase the guaranteed power they provide to the system.

Installed capacity of RES units for electricity production
70

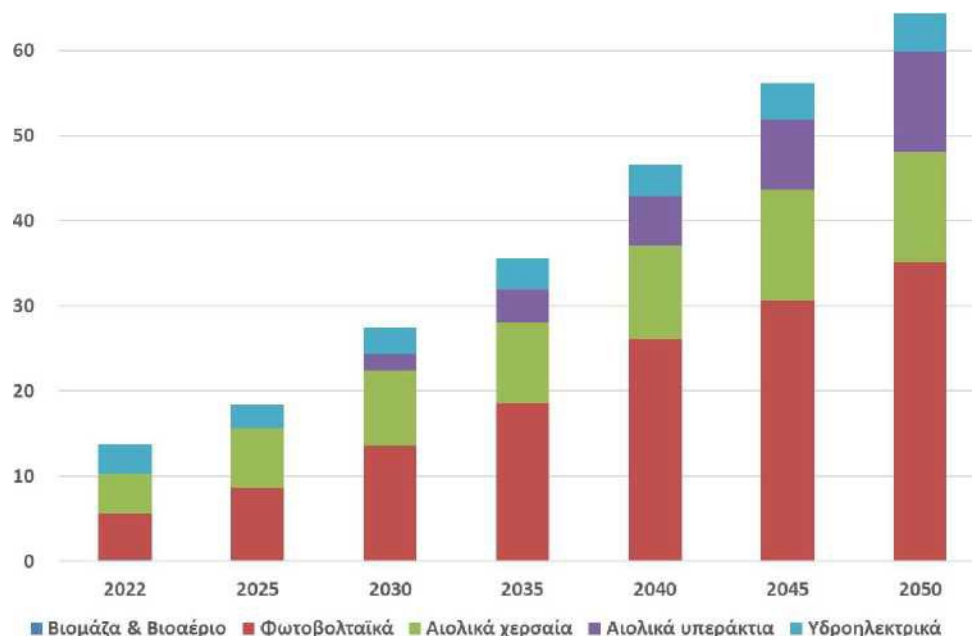


Figure 39 Evolution of installed RES capacity for electricity generation up to 2050.

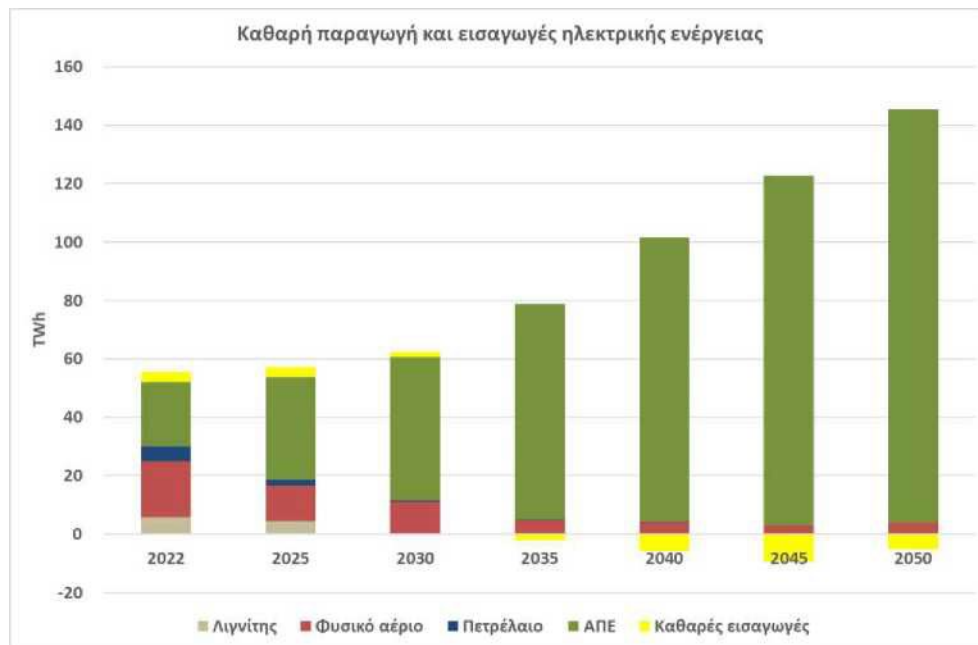
It should be noted that, in order to achieve the above new installed capacity from wind and photovoltaic farms and the maximum possible utilisation rate, it is necessary to gradually consider new possibilities in terms of technological applications (e.g. storage) and new categories of projects (e.g. marine wind farms), provided that it is considered that reducing the costs of these applications and projects is such that overall the new costs of generating electricity from them will be reduced to a low level and are directly competitive with electricity market rules.

There are similar challenges for the development of small hydropower projects, as their installed capacity is estimated to increase, on the basis of a stable growth rhythm, by 2050, making a significant contribution to such a high share of RES in gross electricity consumption. Especially for these projects that are exposed to multiannual permitting procedures, a clear and consistent framework is necessary to achieve these sizes of participation from this category of projects.

As shown in Figure 40, total net electricity production in Greece, including net imports, increases compared to 2022 by 11 % by 2030 and by 136 % by 2050, gradually relying on more environmentally friendly sources.

In particular, in 2030 there will be no share at all in the net lignite-fired power supply, whereas for 2022 it is estimated that around 10 % of the total production is still from lignite-fired power

stations.



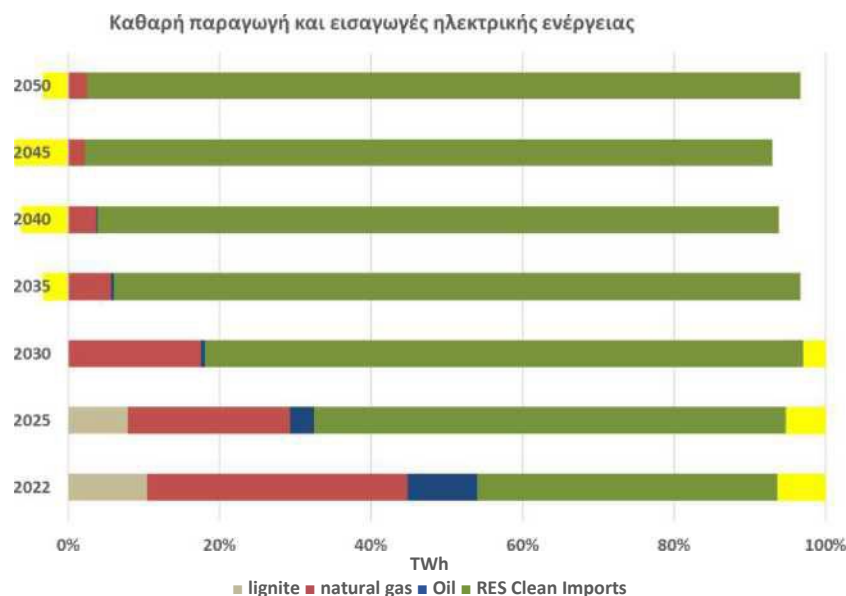


Figure 40 Evolution of net electricity production and imports by year 2050, (in TWh and as a percentage).

Similarly, the share of petroleum products in net electricity production has fallen by 94 % up to 2030 compared to 2022, mainly due to the withdrawal of oil plants currently located on non-interconnected islands, following their imminent interconnection with the continental system. A small proportion of petroleum products amounting to 1 % of total net production, still observed in 2030, is almost exclusively related to electricity production in refineries. It is worth mentioning that mineral oils have ceased to exist in the production of electricity from 2045 onwards.

Natural gas shows a decrease in net electricity production of almost 43 % in 2030 (10.9 TWh) compared to 2022 (19.1 TWh). In 2050, the share of natural gas in net electricity generation is expected to decrease by 80 %, in line with 2022 levels, reaching 3.8 TWh.

For RES in particular, as shown in Figure 41, electricity production from wind (onshore and offshore¹⁷⁴) and photovoltaic plants will more than double in 2030 compared to 2022, while the combined share of biomass and biogas in net electricity production will increase by 0.3 TWh. The increase in hydropower generation was 57 % in 2030 (6.1 TWh) compared with 2022, at 8.7 TWh in 2050.

¹⁷⁴ In the period 2025-2030, all precursors for the development of offshore wind (mainly sea) with as much domestic added value as possible are expected.

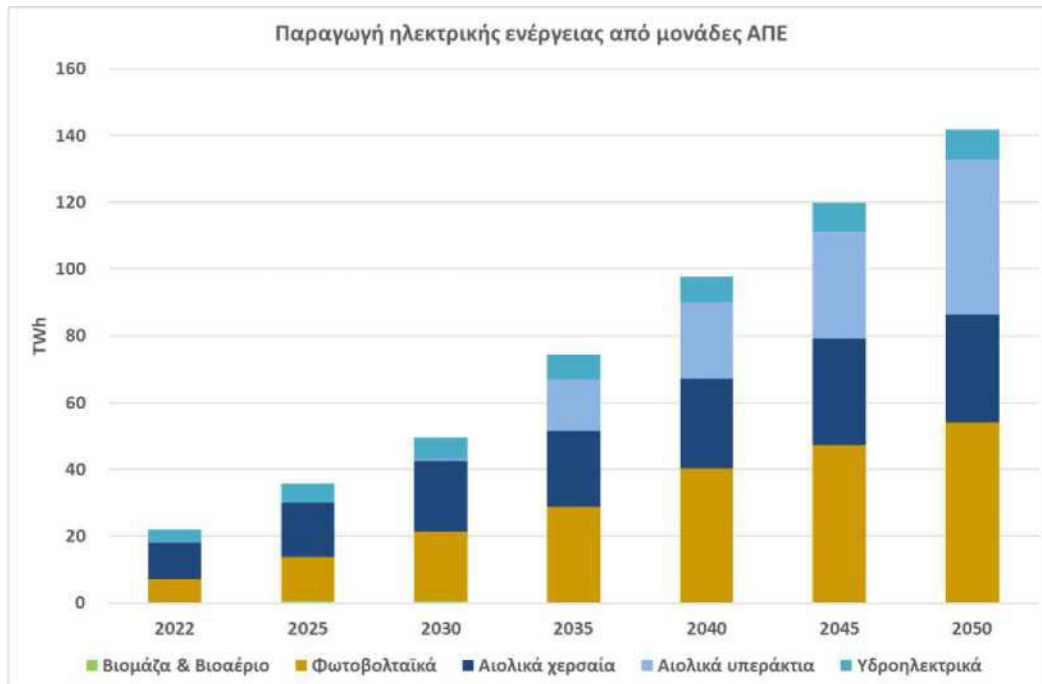


Figure 41 Evolution of RES generation by 2050.

Figure 42 shows the share of electricity generation from unclassified RES (wind and photovoltaic plants) in total electricity generation, which increases by 137 %, from 18.0 TWh in 2022 to 42.6 TWh in 2030, reaching 133.0 TWh in 2050, reflecting the technical, operational and market challenges that should be optimally addressed for market participants, consumers and the electricity system. The power supply of wind power plants (onshore and offshore) is expected to be higher than the generation of photovoltaic plants throughout the period 2022-2050. In particular, wind power plants will contribute 21.7 TWh in 2030 and 79.0 TWh in 2050, with photovoltaic plants contributing 20.9 TWh in 2030 and 54.0 TWh in 2050 respectively.

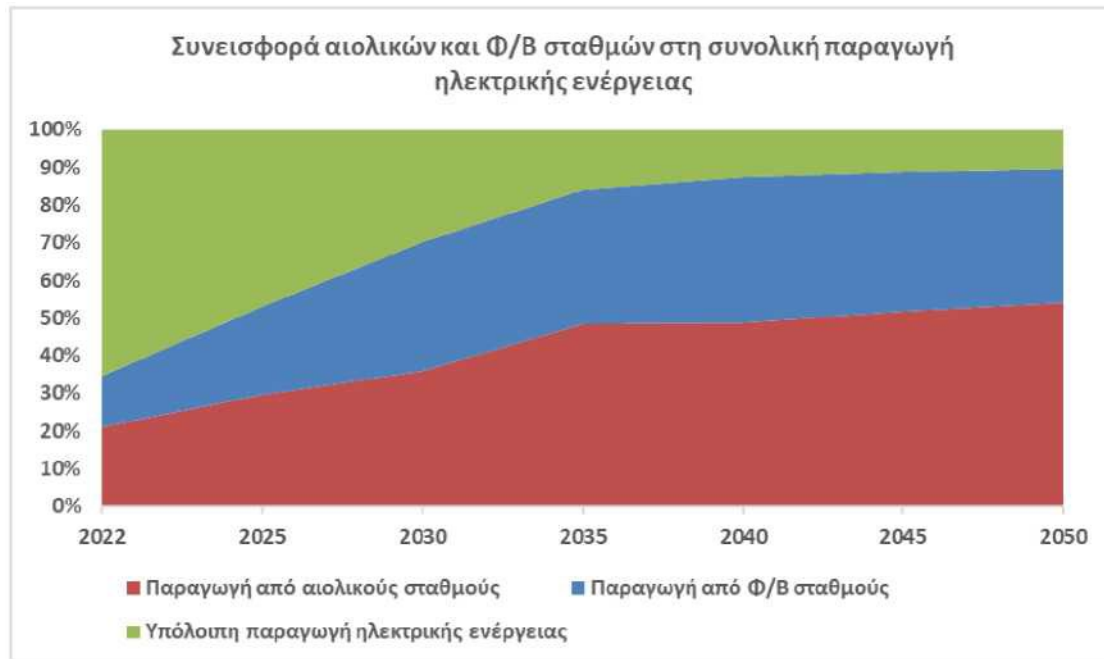


Figure 42 Share of electricity generation from wind and photovoltaic plants at the point of electricity supply by 2050.

In order to achieve such high levels of penetration of uncontrolled RES with an economic veil (sufficiently low cuts in their production), energy storage needs (pumped storage, batteries, gas conversion, etc.) arise.

In general, given that the electrical system needs storage facilities as soon as possible, pumped storage seems to have the intrinsic advantages of other forms of large-scale storage, such as batteries. It is a mature technology, with a commercial function of many years, with no particular technological requirements and materials, and an extremely high domestic added value and an extremely long life span.

More specifically, the total energy handled in storage systems for 2030 and 2050 is estimated at 9.0 TWh in 2030 and 26.0 TWh in 2050, with storage systems having a power of 6.3 GW and 17.5 GW (Figure 43) and a capacity of 27.5 GWh and 98.0 GWh (Figure 44) respectively. Of these, the capacity of pumps and batteries is expected to be 16.5 GWh and 11.0 GWh respectively in 2030, approaching 66.8 GWh and 31.3 GWh respectively in 2050.

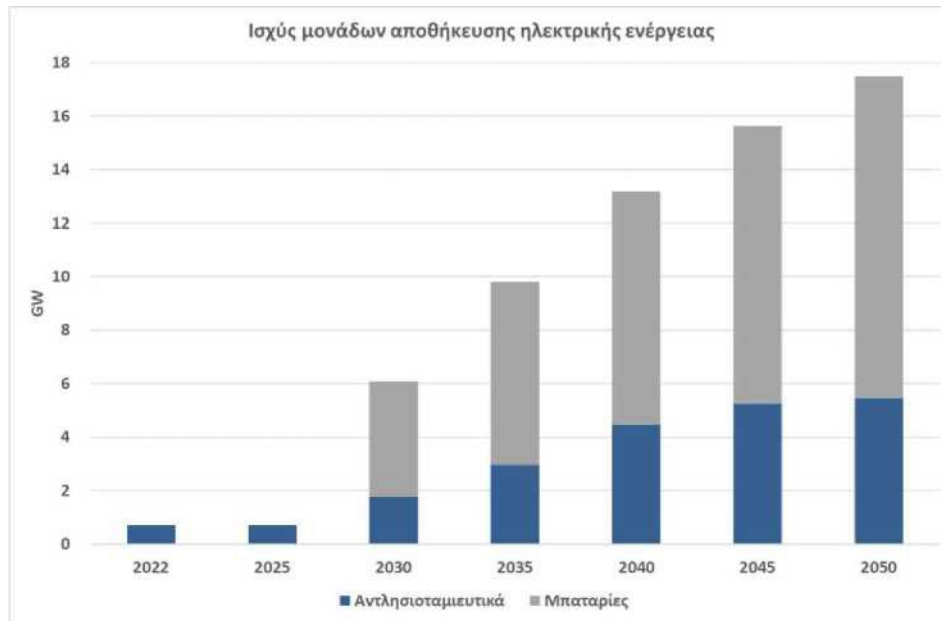


Figure 43 Evolution of power of electricity storage units by 2050.

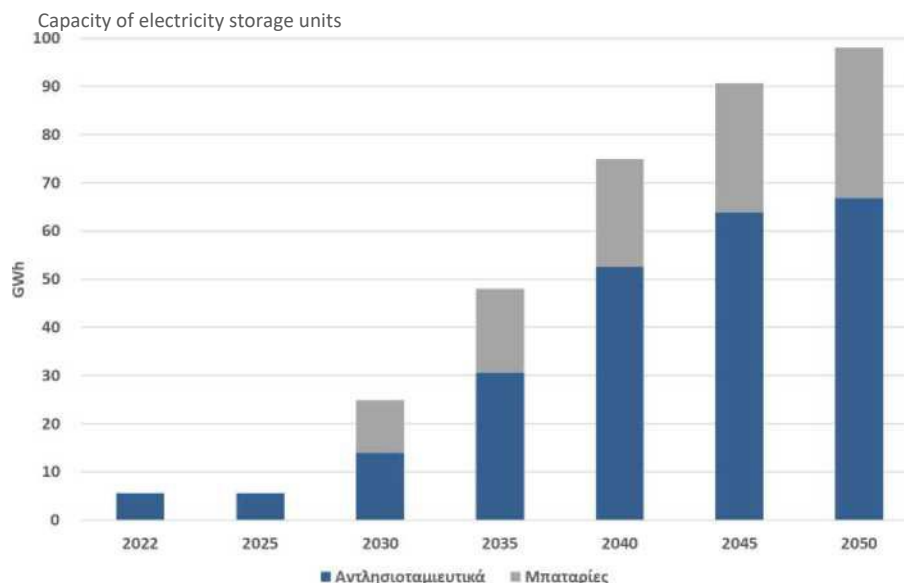


Figure 44 Evolution of the capacity of electricity storage units by 2050.

4.3.4 Evolution of energy consumption in end-use sectors

The graphs below show the evolution of final consumption in the different end-use sectors up to 2050. Final energy consumption tends to decline from 2022 to 2050 (see Figure 45), despite the growing evolution of economic aggregates, disposable income of households and the value added of economic sectors, which has an impact on demand depletion to a large extent.

Final energy consumption by sector

18000

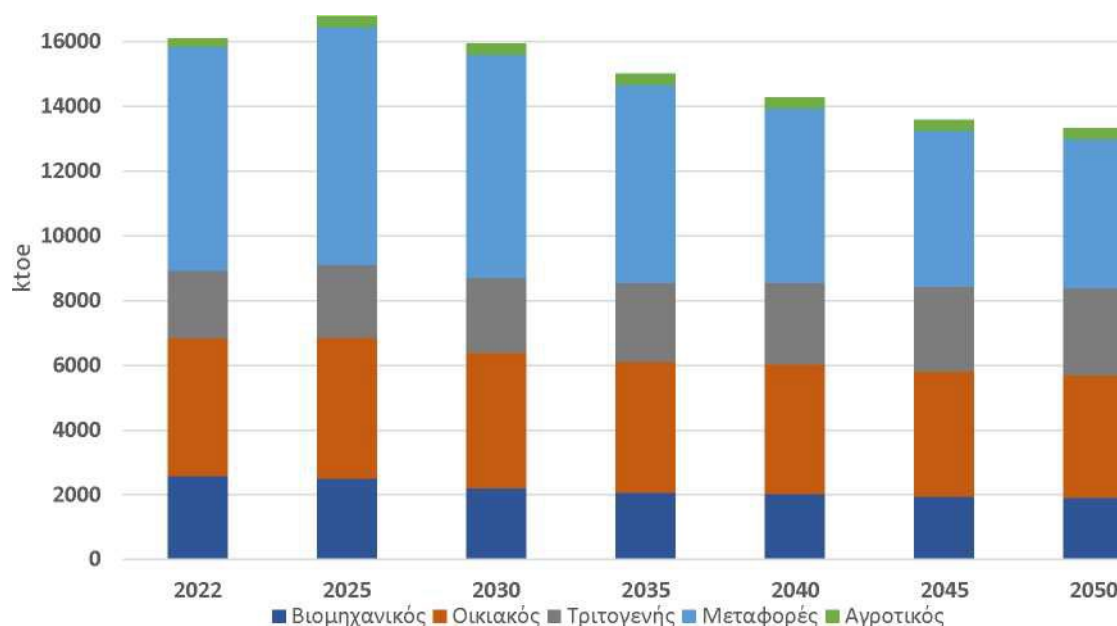


Figure 45 Development of final energy consumption by sector up to 2050.

At the level of final consumption sectors (Figure 46), the transport sector, which accounts for the largest share of final energy consumption, is steadily declining until 2050. Through the gradual replacement of the inefficient fleet of vehicles, the promotion of electromobility and the upgrading of public transport, final energy consumption fell from 6,9 Mtoe in 2030 to 4,6 Mtoe in 2050.

The contribution of the household sector to total final consumption in 2022 is 4,5 Mtoe, with a downward trend of 4,2 Mtoe in 2030 and 3,8 Mtoe in 2050. This shows that, in addition to the containment of final energy consumption, measures to improve energy efficiency and achieve energy savings are successful in reducing the consumption of energy in this sector as well. In percentage terms, the contribution of the household sector to total final consumption increases by 2 % between 2030 and 2050, with the tertiary sector increasing from 2,3 Mtoe in 2030 to 2,7 Mtoe in 2050. Accordingly, the final energy consumption of the industrial sector is expected to decrease from 2,3 Mtoe in 2030 to 2,0 Mtoe in 2050. The agricultural sector

will contribute less in terms of final energy consumption than the other sectors, by 350,1 ktoe in 2030 and 342,1 ktoe in 2050.

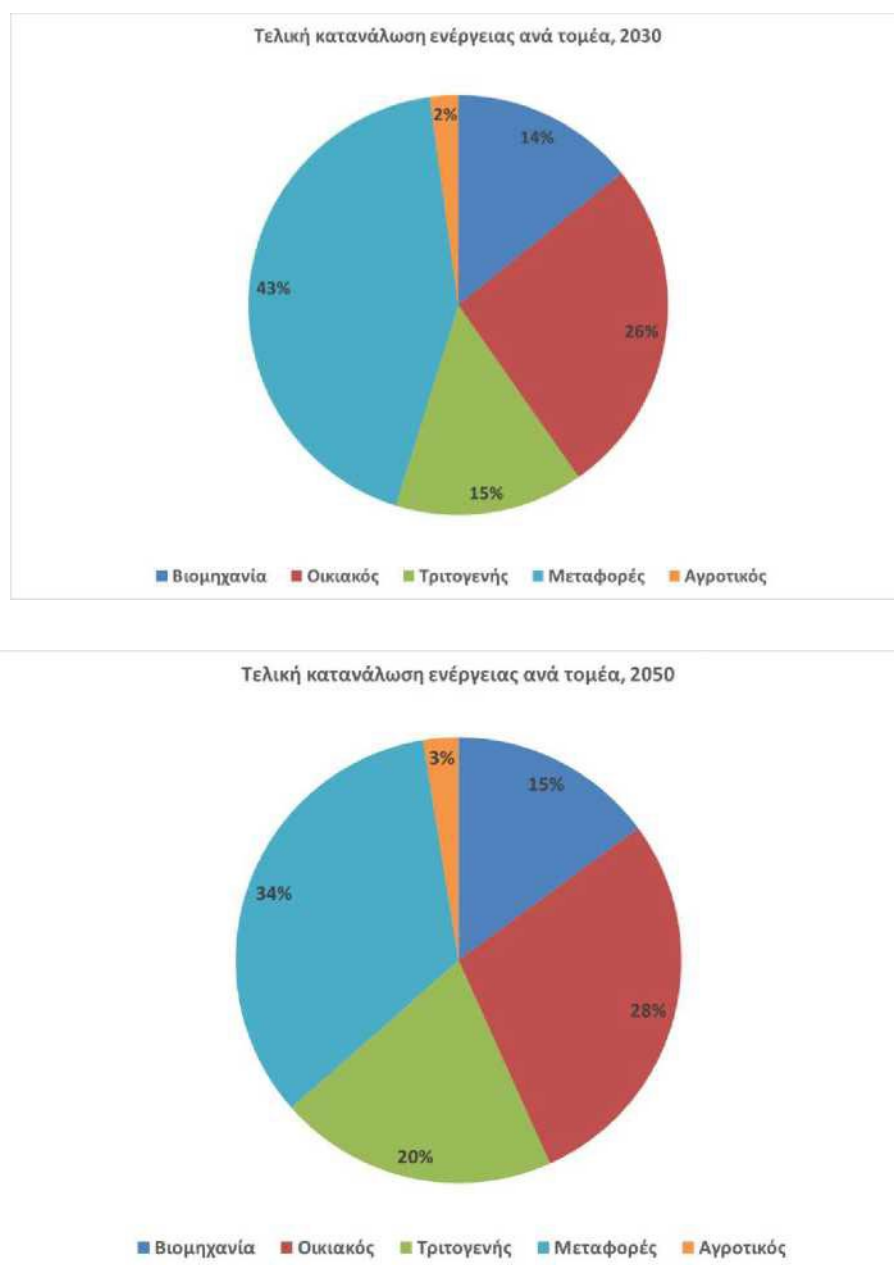


Figure 46 Development of final energy consumption by sector in percentage terms in 2030 and 2050.

4.3.5 Evolution of energy consumption in the residential sector

Final energy consumption in the residential sector decreased by 2 % in 2030 and by 12 % in 2050 compared to 2022 (Table 32 and Figure 48), reaching levels of 4,2 Mtoe in 2030 and 3,8 Mtoe in 2050. Electricity and bioenergy have the largest shares, with 40 % and 20 %

respectively, of the total final consumption of the household sector in 2030. The use of naturalgas is maintained at the same level (marginal increase to 12 % in 2030 from 11 % in 2022), replacing part of oil consumption for heating, leadingto a decrease in the share from 30 % in 2022 to 7 % in 2030. The increase in the use of heat pumps in 2030 compared to 2022 is also significant, as can be seen from the increase in ambient heat use (260 % increase in 2030 compared to 2022).

The same trend continues until 2050 as a result of the electrification of the residential sector with the elimination of heating oil and a significant reduction innatural gas.

Table 32 Final energy consumption of the residential sector by 2050.

Domestic sector	2022	2025	2030	2035	2040	2045	2050
Final Energy Consumption (ktoe)	4278	4369	4178	4035	4009	3879	3784
Consumption by fuel							
Petroleum products	1285	822	289	203	67	0	0
F. Gas	466	545	498	294	135	86	70
Bio-energy	672	848	841	826	981	1001	986
Biodiesel (blended with petroleum)	0	0	114	86	29	0	0
Biomethane (gas distribution	0	0	84	179	182	158	163
Ambient heat (dense heat)	96	220	347	407	485	448	382
District heating	27	41	39	37	35	34	31
Electricity (heatpumps, electrical resistors)	1426	1603	1664	1679	1747	1780	1759
Solar (solar thermal)	306	290	302	324	349	372	394
Synthetic fuels	0	0	0	0	0	0	0
CO2 emissions_{from the residential sector} (MtCO₂)	4,7	3,8	2,1	1,3	0,5	0,2	0,2

An increase in the rate of renovation of the building stock will play a key rolein the evolution of final energy consumption in the residential sector (Figure 47). More

specifically, the annual renovation rate of residential buildings in 2025-2030 will amount to 68 thousand renovations. Accordingly, in 2031-2040 the annual renovation rate will decrease to 64 thousand renovations, while a significant increase is expected in 2041-2050 to 83 thousand to decarbonise the residential sector.

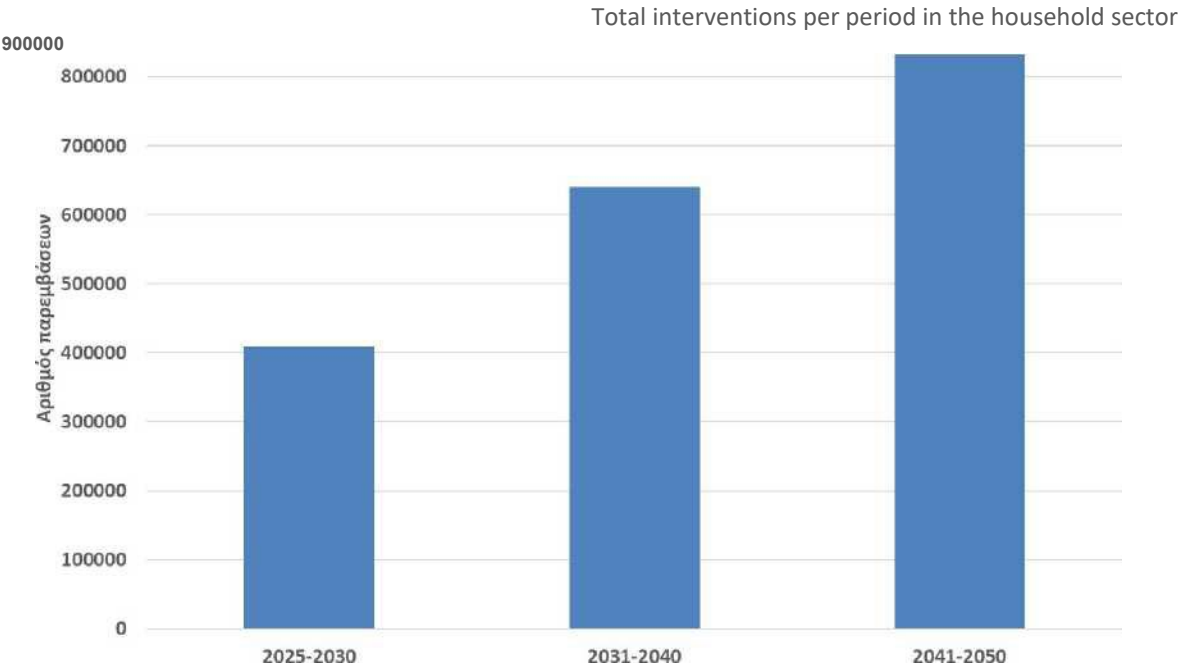


Figure 47 Evolution of total interventions per period in the residential sector up to 2050.

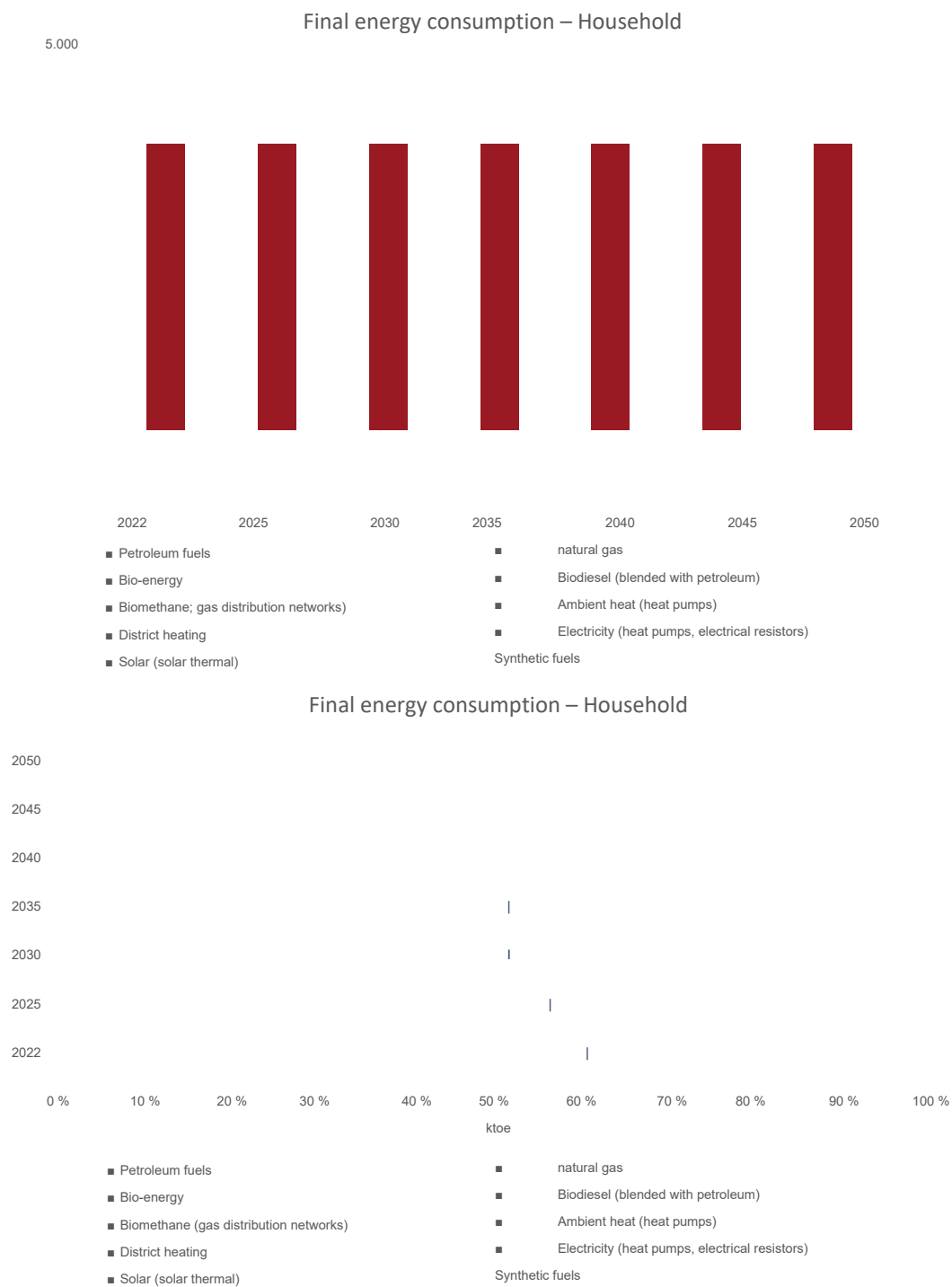


Figure 48 Development of final energy consumption in the residential sector by 2050.

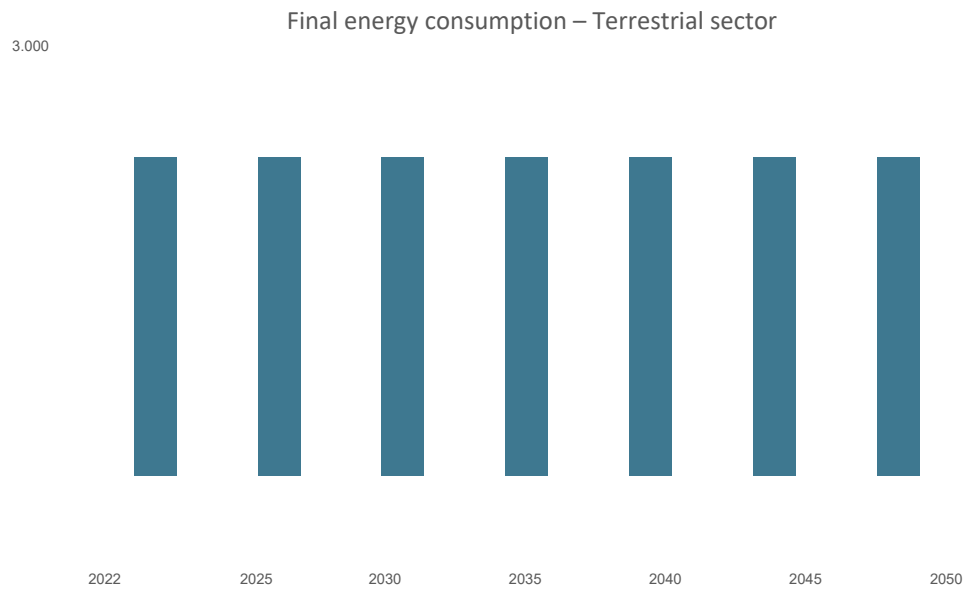
4.3.6 evolution of energy consumption in the tertiary sector

In the tertiary sector, there is an increase in final energy consumption of a range of 12 % in 2030 (2,33 Mtoe) and 30 % in 2050 (2,70 Mtoe), compared to 2022 (2,08 Mtoe) (Table 33 and Figure 49). Technology is dominated by the penetration of heat pumps with a share of 21 % in final consumption in 2030 compared to 17 % in 2022. Electricity consumption is also particularly high, which maintains a share of 66 % in 2030, slightly down from 2022 (71 %).

Finally, the contribution of natural gas remains unchanged at 5 % in 2022, while the significant increase in biodiesel, biomethane and bioenergy in turn leads to a reduction in the contribution of petroleum products from a share of 6 % in 2022 to 3 % in 2030 in terms of final energy consumption in the tertiary sector. The same trend is maintained until 2050, with electricity and ambient heat being the main energy products to solve the thermal needs of the tertiary sector.

Table 33 Final energy consumption of tertiary sector by 2050.

Tertiary sector	2022	2025	2030	2035	2040	2045	2050
Final Energy Consumption (ktoe)	2078	2242	2331	2436	2512	2607	2700
Consumption by fuel							
Petroleum products	121	113	62	40	20	0	0
F. Gas	109	146	117	61	12	10	16
Bio-energy	8	8	27	35	33	30	22
Biodiesel (mixed with petroleum-oil)	0	6	26	17	9	0	0
Biomethane (gas distribution networks)	0	0	15	24	17	19	37
Ambient heat (dense heat)	348	364	499	597	664	733	794
District heating	0	3	3	4	5	3	0
Electricity (heatpumps, electrical resistors)	1480	1563	1539	1598	1680	1723	1728
Solar (solar thermal)	12	29	44	58	73	88	102
Tertiary sector CO₂ emissions (MtCO₂)	0,9	0,7	0,5	0,3	0,1	0,0	0,0



- Petroleum fuels
- Bio-energy
- Biomethane (gas distribution networks)
- District heating
- Solar (solar thermal)
- Natural gas
- Diesel (blended with oil)
- Ambient heat (heat pumps)
- Electricity (heat pumps, electrical resistors)

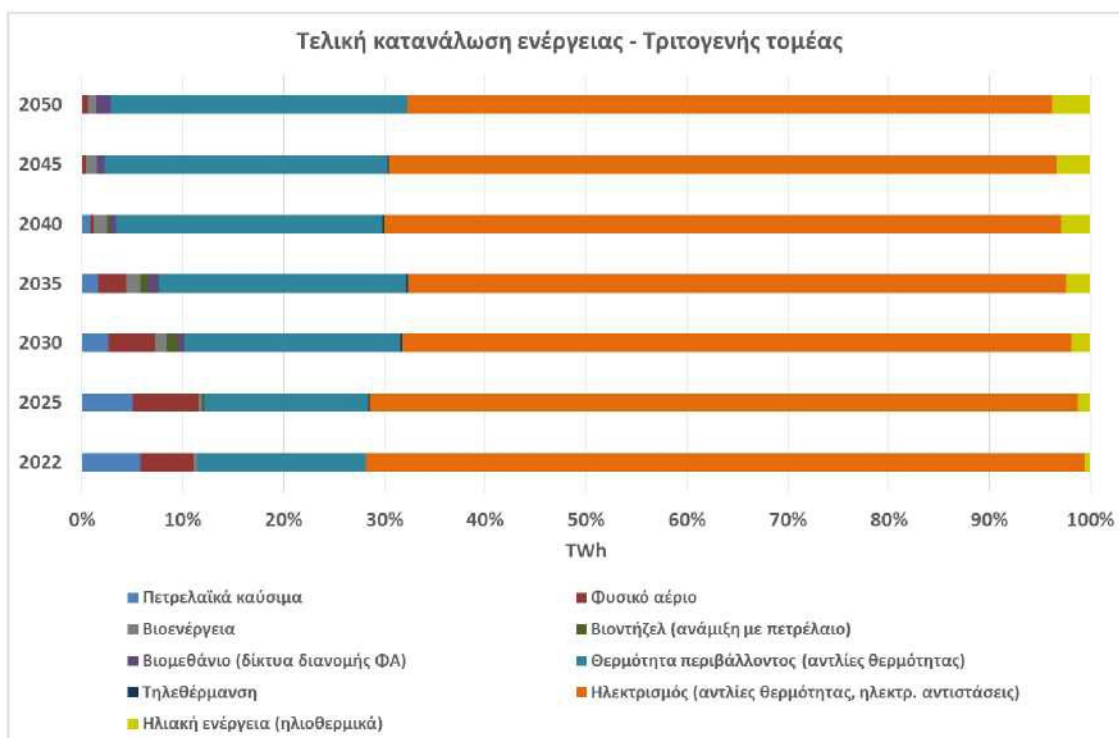


Figure 49 Development of final energy consumption in the tertiary sector by 2050.

4.3.7 evolution of energy consumption in the transport sector

The transport sector is characterised by a relatively high penetration of biofuels, synthetic fuels, including renewable methanol, electricity and a corresponding drop in petroleum products (Table 34 and Figure 50). Let alone, the reduction in the use of petroleum products in the transport sector is small in 2030, reaching a level of 6 % compared to 2022. In addition, their share falls to 91 % in 2030 compared to 97 % in 2022. The use of biofuels is slightly increasing, with a share of total consumption of 5 % in 2030 compared to 3 % in 2022. Electricity penetration increases in 2030, accounting for a share of 2 %, while consumption in absolute terms increases eight times in 2030 compared to 2022.

The decline in oil products is particularly significant in 2050 (a decrease of 94 % compared to 2022), with a share of 8 % in 2050, reflecting their substitution by electricity and renewable gases. More importantly, synthetic fuels are expected to penetrate from 2030 onwards, from 16,5 ktoe in 2030 to 1,0 Mtoe in 2050. Similarly, from 2030 onwards, biomethane and bio-LNG are forecast to emerge, amounting to 6,3 ktoe and 3,4 ktoe in 2030 respectively and 5,2 ktoe and 139,8 ktoe in 2050 respectively.

In 2030, 94 % of mineral oils will be used in terms of final energy consumption of aeroplanes, with a small contribution from biofuels and synthetic kerosene. However, in the period 2030-2050, a very large reduction is being achieved in petroleum products (from 1,4 Mtoe in 2030

to 270,0 ktoe in 2050), resulting in an increasing use of biofuels and synthetic kerosene. More specifically, the use of biofuels and synthetic kerosene will increase from 72,7 ktoe and 14,5 ktoe in 2030 to 597,6 ktoe and 691,5 ktoe respectively in 2050.

Table 34 Final energy consumption in the transport sector by 2050.

Transport Sector	2022	2025	2030	2035	2040	2045	2050
Final Energy Consumption (ktoe)	6920	7341	6878	6122	5395	4826	4595
Consumption by fuel							
Petroleum products	6684	7011	6251	4721	3156	1709	375
F. Gas	14	32	131	165	172	107	91
Biofuel	204	267	333	542	641	643	689
Electrics	18	32	138	609	1175	1744	2075
Biomethane	0	0	6	8	24	21	5
Bio-LNG	0	0	3	6	38	99	140
Hydrogen	0	0	0	1	48	93	126
Renewable Ammonia	0	0	0	0	4	39	72
Synthetic fuels (incl. adolescent methanol)	0	0	16	69	139	371	1022
CO2 emissions, domestic and international airborne) (MtCO₂)	20,8	21,9	19,8	15,1	10,3	5,6	1,4

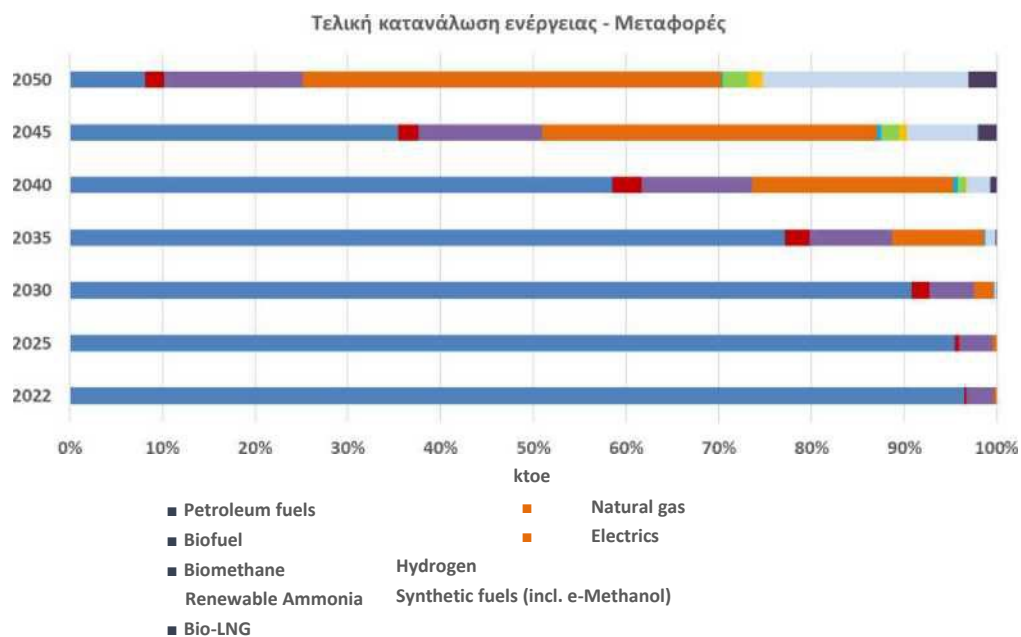
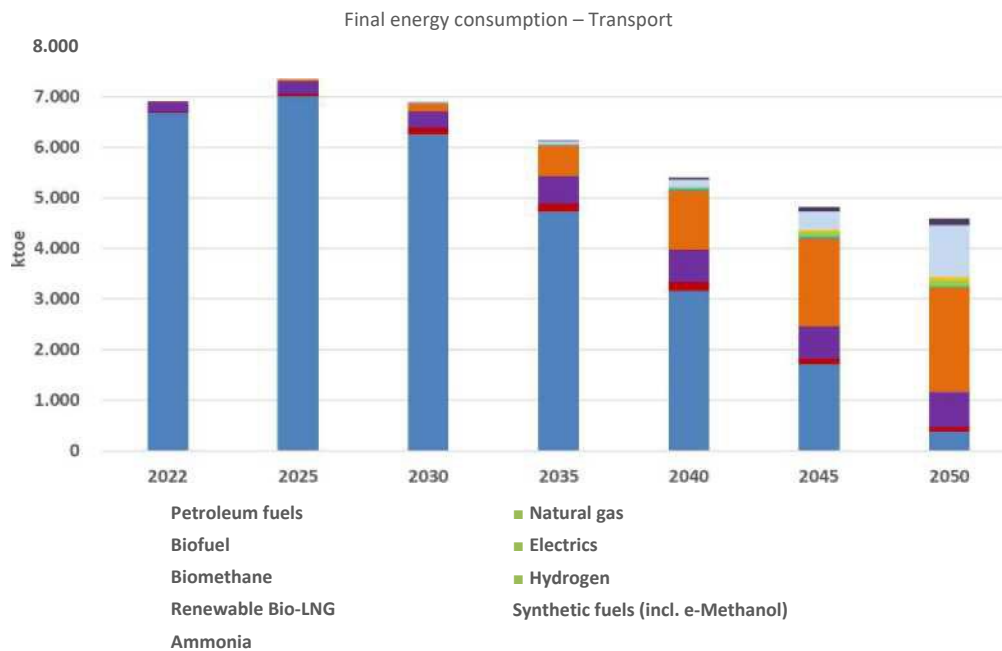
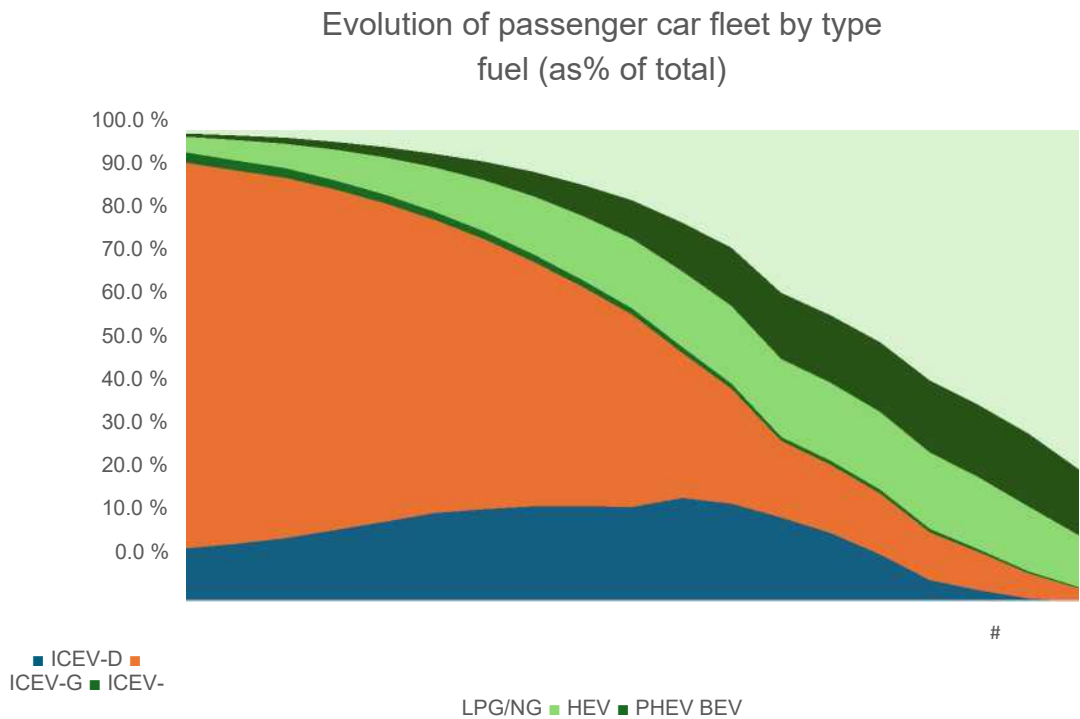


Figure 50 Evolution of final energy consumption in the transport sector by 2050.

The gradual renewal of the existing fleet of passenger vehicles and light-duty vehicles (Figure 51), with new higher energy efficiency (mainly electric vehicles), will lead to a 3 % reduction in the final energy consumption of passenger vehicles and light commercial vehicles in the period 2022-2030.



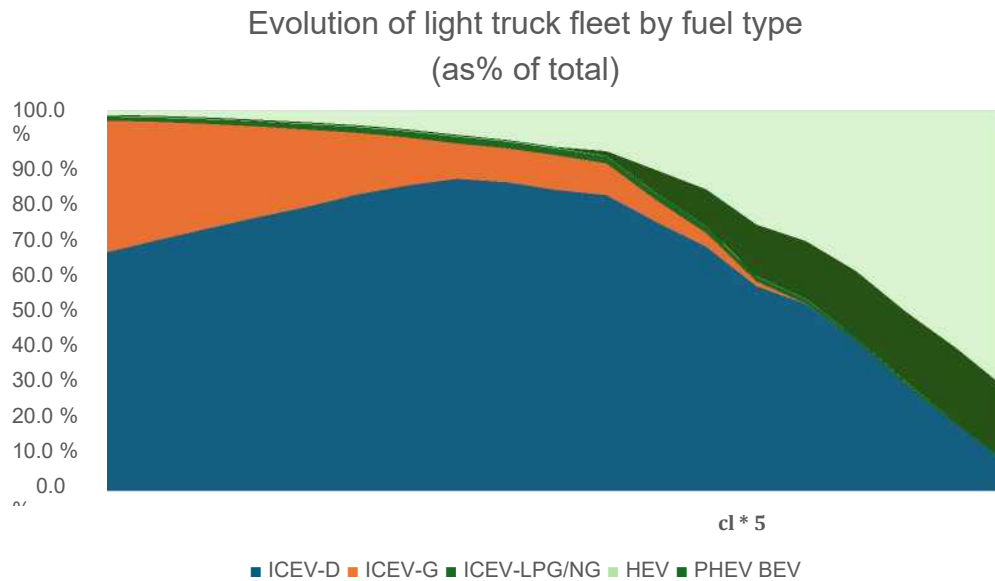


Figure 51 Estimated evolution of the light-duty vehicle fleet (passenger and light trucks) by fuel type, for the period 2025-2050.

Biofuels are expected to take a large share of their consumption of olive oil in the period 2022-2030, changing their participation in the passenger vehicle and light commercial subsector from 3 % to 5 %). The increased penetration of electric mobility of passenger vehicles and light commercial vehicles is expected to occur in the period 2030-2050, from 62,2 ktoe in 2030 to 1,3 Mtoe in 2050 (Figure 52).

Final energy consumption – Passenger vehicles and light duty vehicles 4.500

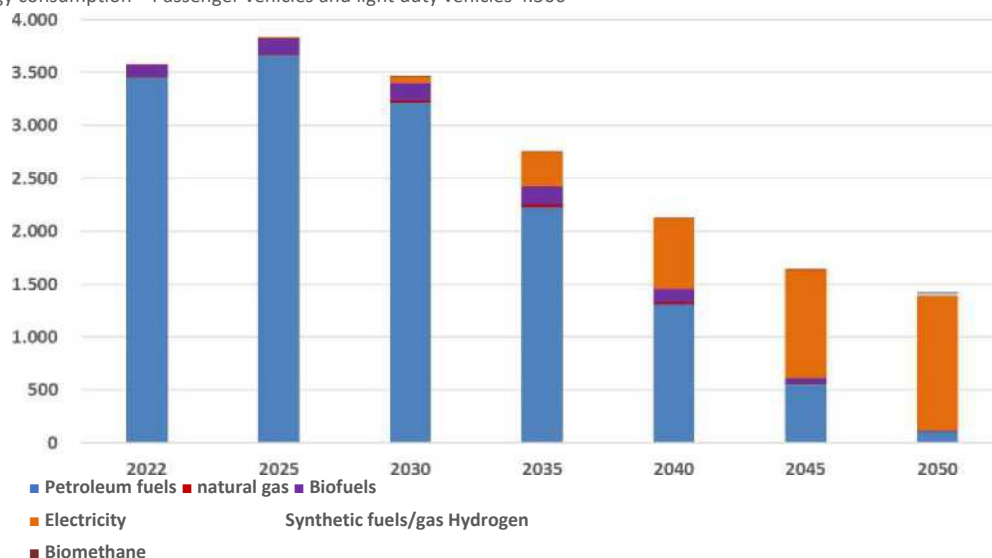


Figure 52 Evolution of final energy consumption in passenger and light duty vehicles up to operational by 2050.

In heavy commercial vehicles, the predominant fuels remain mineral oils (873,5 ktoe) until 2030, followed by approximately an equal contribution from natural gas (69,6 ktoe) and biofuels (60,7 ktoe) (Figure 53). Between 2030 and 2050, higher hydrogen penetration in heavy commercial vehicles is taking place, with a simultaneous reduction in petroleum products, natural gas and biofuels. The number of vehicles in question is largely achieved, rising from 17,9 ktoe in 2030 to 618,3 ktoe in 2050.

Final energy consumption – Heavy vehicles 1.200

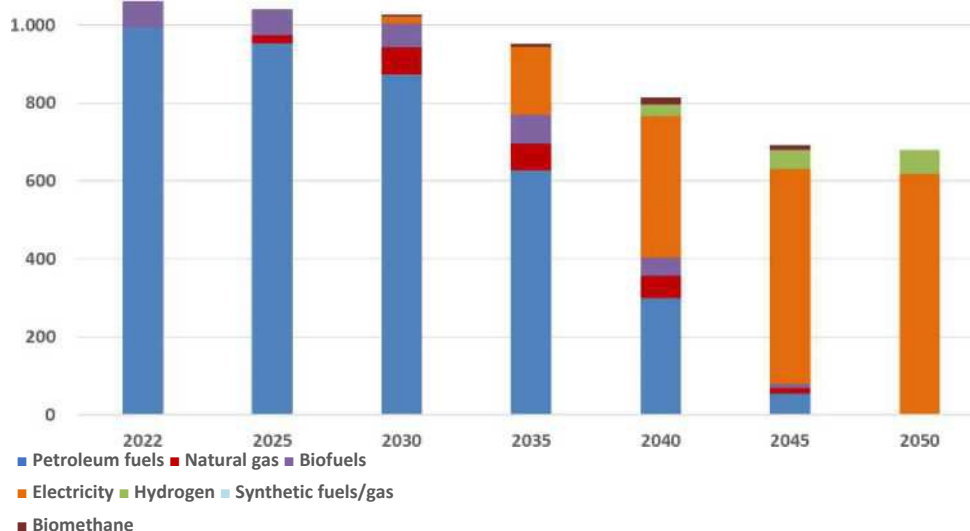


Figure 53 Evolution of final energy consumption in heavy-duty vehicles by the year 2050.

In buses, the contribution of petroleum products, natural gas and bioexhaustis expected to decrease over the period 2030-2050, as electrification and the parallel use of hydrogen will be promoted (Figure 54). In particular, petroleum products and biofuels will be eliminated in buses in 2050, from 193,6 ktoe and 13,5 ktoe respectively in 2030. Electricity penetration will continue, from 31,8 ktoe in 2030 to 122,9 ktoe in 2050, with the water gene entering after 2040 and reaching 65,0 ktoe in 2050. The contribution of biomethane to buses is small, with its appearance since 2030, just as in the case of passenger and lightweight vehicles and heavy vehicles.

Final energy consumption – Bus 400

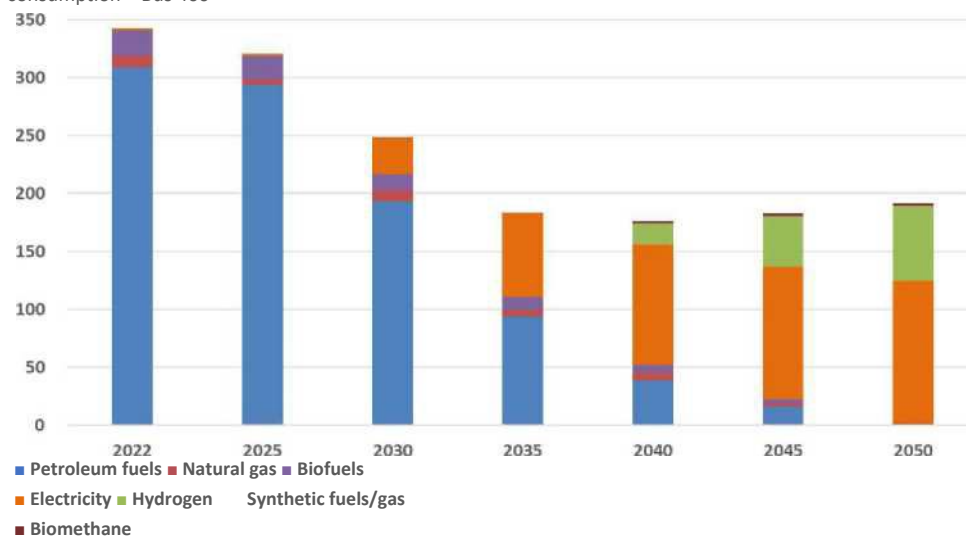


Figure 54 Evolution of final energy consumption in buses by 2050.

Full electrification of track-based media will also lead to a reduction in final energy consumption (Figure 55). More specifically, the share of electricity in rail transport will be 100 % (or 23,9 ktoe) in 2030 compared to 48 % (or 14,5 ktoe) in 2022 (Figure 55). In 2050, the contribution of electricity to rail transport, in terms of final energy consumption, is expected to reach 31,4 ktoe, an increase of 116 %, compared to 2022.

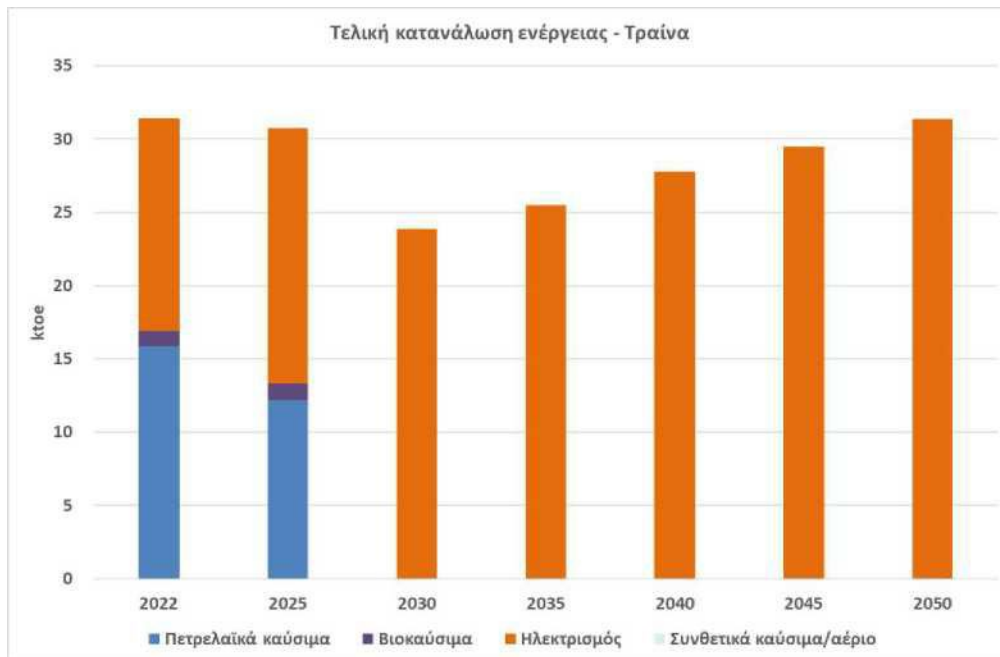


Figure 55 Evolution of final energy consumption on trains by the year 2050.

In maritime transport (domestic), mineral oils will remain the dominant ones until 2045, in terms of final energy consumption, reduced from 587,6 ktoe in 2030 to 382,5 ktoe in 2045, with a small contribution from natural gas, which is expected to increase from 36,9 ktoe in 2030 to 86,6 ktoe in 2050 (Figure 56). Biofuels are estimated to increase from 19,7 ktoe in 2030 to 83,7 ktoe in 2050. The electrification of maritime transport starts after 2030, from 6,3 ktoe to 16,8 ktoe in 2050. Since 2040, the use of renewable ammonia has also been introduced on board ships, with a contribution from 3,5 ktoe in 2040 to 71,5 ktoe in 2050. It is particularly important that bio-LNG's contribution in the period 2030-2050 is from 3,4 ktoe in 2030 to 139,8 ktoe in 2050.

800

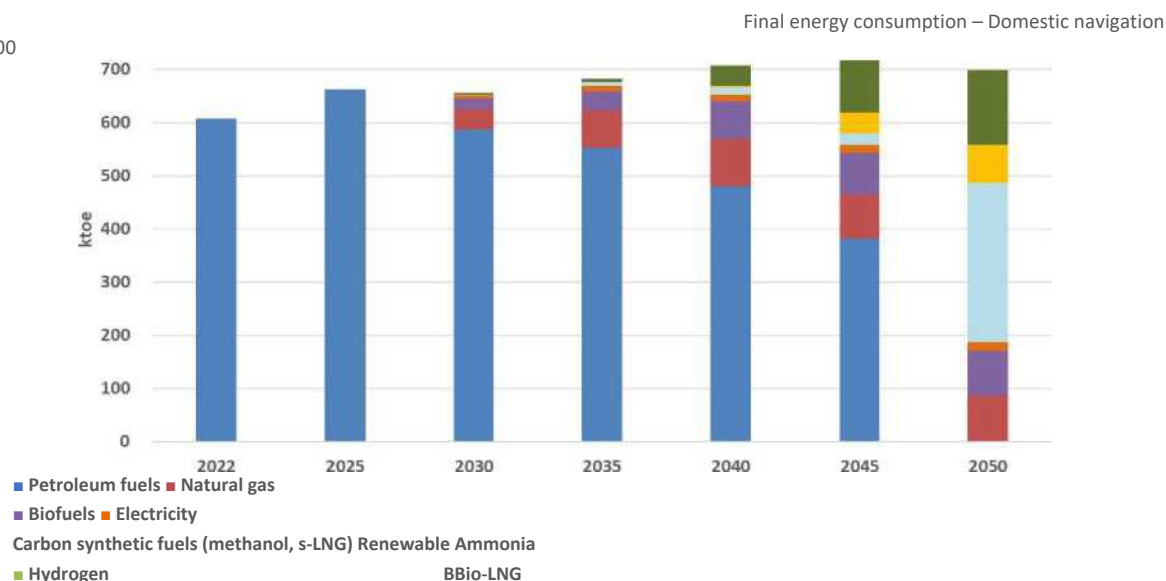


Figure 56 Evolution of final energy consumption in domestic navigation by 2050.

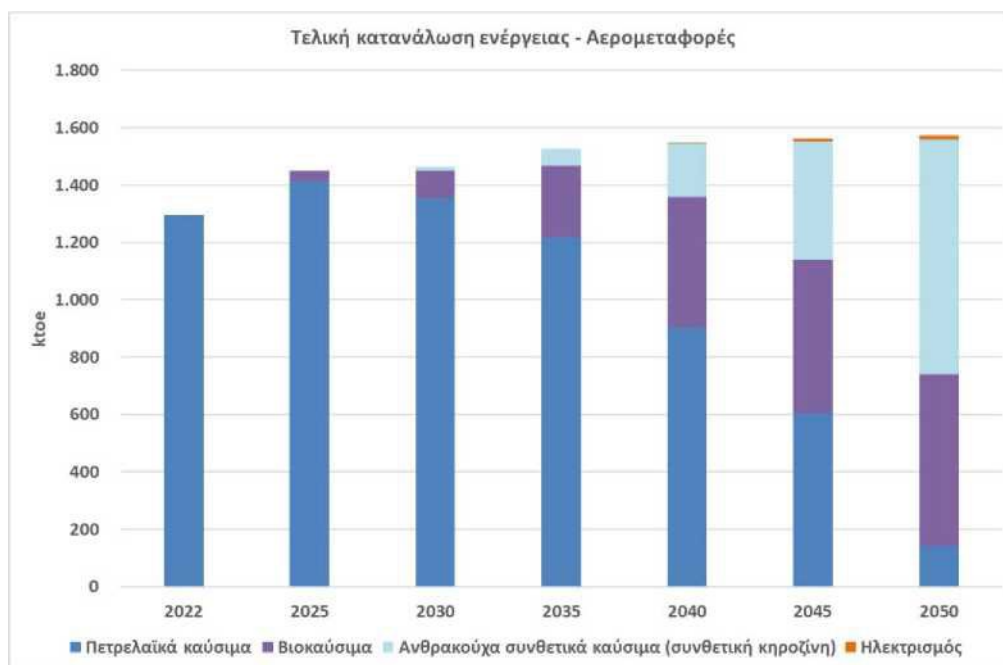


Figure 57 Development of final energy consumption in aviation up to the year 2050

The above trajectory for reducing energy consumption overall in the metropolitan sector, together with the introduction of alternative – greener – fuels in which sectors are leading to a reduction in CO₂ emissions gradually, starting in

2030 and, above all, from 2035 onwards. Table 35 and Figure 58 show the estimated reduction in emissions by sector and overall.

Table 35 Estimated CO2 emissions by transport sector, for the period 2022 (historical) – 2050.

Year	CO2 emissions [kton]						
	2022	2025	2030	2035	2040	2045	2050
Land Transport	14620	15147	13355	9285	5269	1991	334
Domestic Coastal Shipping	1894	2058	1902	1861	1686	1374	234
Air Transport	4246	4706	4482	3964	3336	2256	890
Total/NV	20760	21912	19740	15110	10291	5622	1458

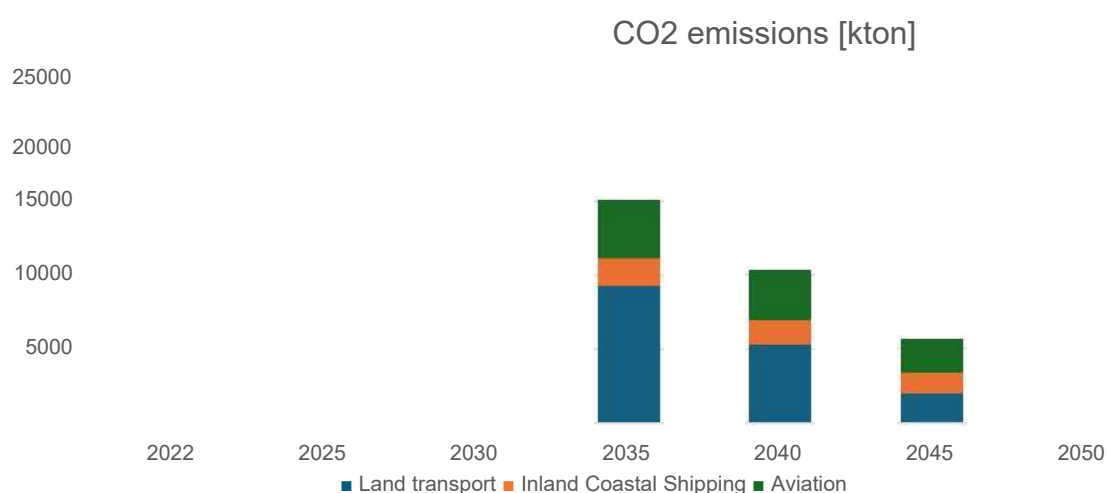


Figure 58 Estimated emissions by transport sector, every 5 years for the period 2025-2050.

The expected reduction in emissions can best be reflected in the emission ratio of the corresponding fuel energy consumption (kton/ktoe) shown in Table 36.

As the use of alternative fuels in aviation and shipping will start in the coming years, this indicator is expected to decrease by more than 8 % in aviation and almost 7 % in Shipping by 2030 compared to 2022.

Table 36 Emission index per unit of energy consumed (kton CO₂/ktoe).

Emission indicator CO ₂ /Καταναλησκόμενη Energy [kton/ktoe]							
Year	2022	2025	2030	2035	2040	2045	2050
Land Transport	2,916	2,896	2,805	2,373	1,677	0,782	0,144
Domestic Coastal Shipping	3,120	3,110	2,900	2,731	2,385	1,916	0,335
Air Transport	3,275	3,247	3,059	2,594	2,157	1,445	0,565
Total/NV	3,001	2,985	2,868	2,468	1,907	1,165	0,317

4.3.8 Evolution of energy consumption in industry

In industry, over the period 2022-2050, a mild decrease in final energy consumption is recorded (Table 37 and Figure 59). In particular, there is an overall decrease in energy consumption of 14 % in 2030 and 26 % in 2050, compared to 2022. The dominant energy product in the industrial sector is electricity, the contribution of which increases from a share of 40 % in 2022 to a share of 46 % in 2030 and a share of 72 % in 2050 of total final energy consumption. Oil products and natural gas make a relatively significant contribution, which is, however, constantly declining, while the use of bioenergy is increasing, as can be seen from the doubling of consumption in 2050 compared to 2022.

Table 37 Final energy consumption in the industrial sector up to 2050.

Industry	2022	2025	2030	2035	2040	2045	2050
Final Energy Consumption (ktoe)	2566	2492	2197	2066	2015	1931	1904
Consumption by fuel							
Solid fuels	65	161	95	12	0	0	0
Petroleum products	788	644	465	364	283	240	219
F. Gas	569	555	420	358	140	99	82
Bio-energy	121	219	213	218	223	227	228
Electrics	1023	913	1003	1110	1366	1363	1374
Hydrogen	0	0	0	4	3	1	0
Synthetic fuels	0	0	0	0	0	0	0
CO₂ emissions (MtCO₂)	9,5	8,4	7,1	6,0	4,8	4,5	4,3

Final Energy Consumption – Industry Sector

3.000

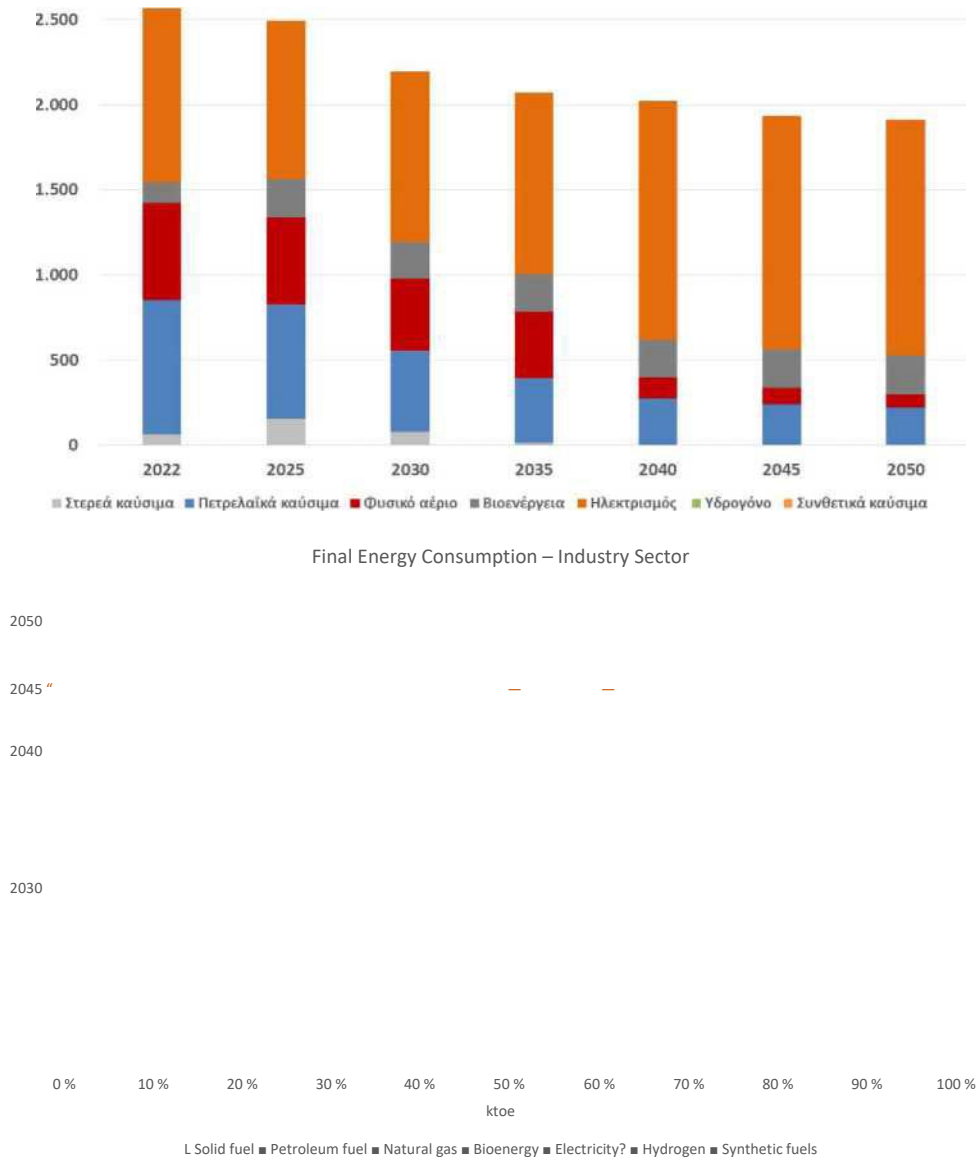


Figure 59 Development of final energy consumption in the industrial sector by 2050.

4.3.9 Evolution of energy consumption in the agricultural sector

In the agricultural sector, there is a significant increase in final energy consumption in 2022-2050 (29 % increase), mainly due to increased use of electricity and bioenergy. However, final energy consumption stabilises after 2025 at levels of 340-350 ktoe.

Electricity use decreases in 2030-2050 (5.8 % decrease in 2050 compared to 2030). Accordingly, the use of bioenergy increases significantly both in 2030 (an increase of 49 % compared to 2022) and in 2050 (an increase of 169 % compared to 2022). Finally, consumption of petroleum products is declining markedly over the period 2022-2050.

Table 38 Final energy consumption in the agricultural sector by 2050.

Agricultural sector	2022	2025	2030	2035	2040	2045	2050
Final consumption of energy (ktoe)	271	344	350	345	341	345	342
Consumption by fuel							
Petroleum	43	56	51	44	36	30	22
F. Gas	10	0	0	0	0	0	0
Bio-energy	28	34	42	51	59	68	76
Electrics	190	244	246	239	234	236	232
Other forms	0	10	10	11	11	12	12
CO2 emissions (MtCO₂)	0,2	0,2	0,2	0,1	0,1	0,1	0,1

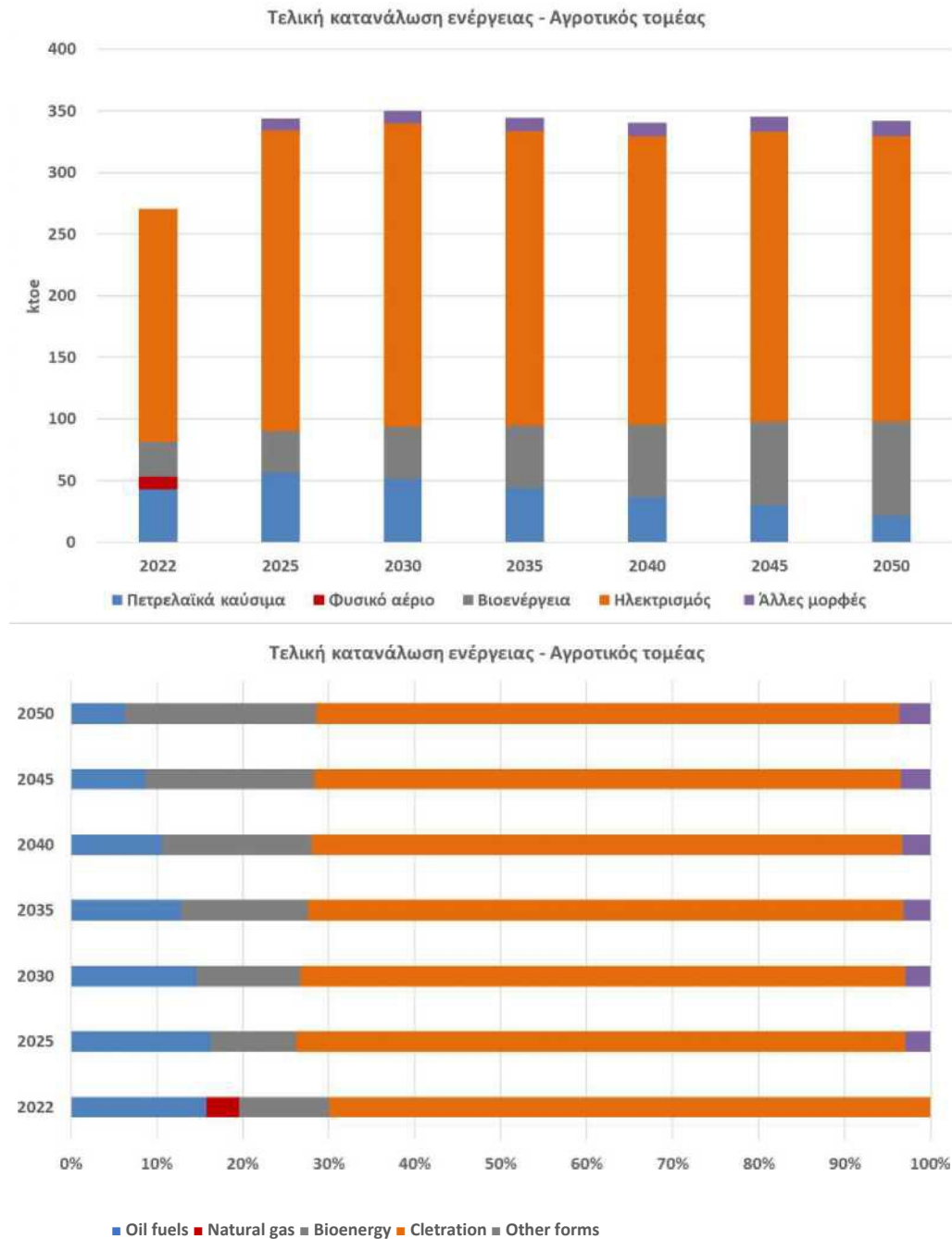


Figure 60 Development of final energy consumption in the agricultural sector by 2050.

Chapter 5: Overview of impacts and investment ranges

5.1 Estimated evolution of electricity costs

The green energy transition focuses on the significantly increased participation of RES in electricity generation in order to reduce the carbon footprint of spot energy and thus expand its use in the energy system. Electricity price formation in the future will be of great importance to the cost of the transition.

In this context, it is very important that the average cost of electricity is expected to decrease already in the period 2025-2030, while it is expected to be drastic in the period up to 2050, as shown by the result of the energy simulations.

The evolution of the different components of electricity costs is shown in Table 39, the estimated costs of which are highly diversified in the coming years. More specifically, the fixed cost of capital and maintenance of units is reduced over the medium term until 2035 (mainly due to the new RES power plants to be installed), the average network costs are gradually decreasing, while the variable cost of fuel and operation of power plants is falling significantly (mainly due to the replacement of conventional units by RES units).

Table 39 Evolution of electricity costs up to 2050.

Estimated UN COSTS [EUR/MWh] *	2025	2030	2035	2040	2045	2050
Recovery and efficiency of transmission units	31	47	50	49	48	40
Fixed costs for the operation and maintenance of power supply units	14	17	17	17	16	14
Variable costs of operating power plants	24	13	5	4	2	2
Cost of CO ₂ emissions	16	6	3	5	4	5
Cost of imports/exports of electricity	5	3	— 3	— 5	— 6	— 3
	----	----	---	----	----	---
Cost of electricity injected * *	90	86	73	69	64	59
Transmission and Distribution of Electricity	55	53	52	48	44	37
	----	----	---	----	----	---
Total UN Cost [EUR/MWh]	145	139	125	117	108	95

* 2024 prices						
* * cost of injected UN = (Cost of production + international purchases/sales)/(UN Net Consumption)						

Therefore, the average cost of electricity will decrease as RESpenetrate and the related investments are amortised. However, the development of RES leads to increased costs for networks and storage facilities, due to the necessarydifficulties in these sectors. However, unit costs for grids are decreasing due to increased energy flows. It is noteworthy that the cost structure of generation **is constantly shifting from variable costs to fixed costs** for capital employed and equipment maintenance, while variable costs tend towards a minimum percentage of the total over the long term.

Overall, a continuous trend in electricity costs is expected in the medium to long term.

A key conclusion from this analysis is that **downstream energy is achieved in the electricity-sector by reducing the generation costs**. The result of this simulation shows the economic competitiveness of the objectives and policies described, even in the short term and in the-medium term, where while significant environmental and disastrous benefits are achieved, there is no appreciation of the burden on consumers in the context of thisactive transition.

Organised wholesale energy markets, as in the target model, aredesigned to operate as competitive markets. The order in which the powerplants are included in the distribution plan follows the incremental order ofthe marginal one, i.e. minutes of fuel costs. All units receive at the price determined by the marginal units, therefore, when they are not the same as the market equilibrium price, they generate revenues higher than operating costs. It isfor all units to obtain from the margin over operating costs to cover the fixed operating and maintenance costs, the costs borrowed andthe remuneration of the own capital employed. This is the economic showcasethat has always prevailed in electrical systems and markets.

The successful recovery of fixed costs (maintenance and capital) depends on the diversity of the marginal cost structure (in practice of fuel costs) of electric-central production units, i.e. the difference in revenue betweenmy competitors' exhaust costs, as well as on the ability of units covering peaks (energy scarcity moments) to collect above operating costs, while setting the market equilibrium price. The high penetration of RES removes both factors on which the successful recovery of fixed costs by plants depends. Other power resources, such as storage and demand response, generateload shifting (e.g. from peaks to load valleys) to emit – market price differences between low and high loads. Theyaffect market prices downwards

because they contribute to reducing energy scarcity and therefore lower prices at peak moments and do not contribute to increasing the diversity of marginal costs. On the contrary, they tend to reduce diversity in periods of lack of power. They therefore reduce the availability of sufficient revenues from production plants and for the storage and demand-side metering units themselves. As a result, these plants, in order to recover costs in a market with high RES penetration, submit high prices to their energy supply.

The lack of sufficient total cost recovery security for high-capital investments in electricity generation is such that the creation of non-capacity availability facilities to provide stable revenues could be exaggerated, especially when the system with a high share of RES cannot inherently ensure the sustainability of RES balancing investments.

At the same time, investments in energy efficiency, mainly through the electrification of heat loads, in buildings and in industry, will be advantageous due to the relatively short recovery time of capital costs (in the medium term), as a result of lower purchase costs for energy products and equipment purchase costs. Furthermore, as long as the massive production of new technology accumulators and vehicles will continue at European and global level, electromobility is expected to become cost-effective compared to conventional vehicles over the past few years. By contrast, the costs of alternative fuels, such as green hydrogen and synthetic fuels, are expected to decrease in the longer term.

In conclusion, **the cost of energy services for consumers in all sectors is expected to decrease over the medium to long term.**

5.2 Estimate of projected investments of planned policy measures

Achieving the medium- and long-term national targets through policy measures in the key energy and climate dimensions, as captured and analysed above, will mobilise a number of significant investments in the country's increment, by enhancing the competitiveness of the economy and working away.

The forecast for investment costs for the energy demand and production sectors for the period 2025-2030 is shown in Table 40 and the corresponding Figure 61. The table and the corresponding Figure 62 also show the estimate for the entire subsequent period up to 2050 (2031-2050). These investments are expected to make a significant contribution both in terms of the national economy and in terms of protecting tanners from fluctuations in the prices of energy products, also through the opening up of competition in energy markets.

Table 40 Assessment of investments in the key sectors of the revised NECP for 2025-2050.

	Type of investments	Total investment in the energy sector (EUR million)	
		2025-2030	2031-2050
Energy demand	Agricultural sector	220	1.856
	Tertiary sector – Household housing	1.227	3.617
	Tertiary sector – Lighting	189	681
	Tertiary sector – Other uses	1.156	4.516
	Industrial sector	1.762	3.168
	Residential – Heat pumps	5.363	12.370
	Residential – Thermal solar	851	1.916
	Domestic sector – Other heating, cooling and hot water systems	1.652	9.423
	Residential sector – Building envelope	2.463	8.917
	Main sector – Lighting systems for furniture	2.756	10.657

	Light trucks, Passenger vehicles, Motor-Cycles – Electrical	8.691	109.524
	Light Freight Vehicles Passenger Vehicles – NG	324	194
	Light lorries, Passenger vehicles, Motor- Cycles – Other	24.283	13.668
	Busses Heavy lorries – Heavylorries	3.752	38.905
	Busses Heavy lorries – Gas	944	145
	Busses Heavy lorries – H2	30	5.286
	Busses Heavy lorries – Other	6.316	894
	Trains	2.266	9.399
	Road transport infrastructures	860	6.971
	Total – Action demand	65.106	242.105
Production of energy	Capture, storage and use of CO2	1.000	14.371
	CO2 storage infrastructure	1.248	1.575
	Investments in electricity networks	9.939	20.000
	Photovoltaic parks	3.532	14.012
	Wind parks	7.256	27.514
	Hydropowerplants	968	3.883
	Gas-fired powerstations	458	0
	Production, distribution and use of H2	349	2.048
	Renewable ammonia production technologies	0	339
	Natural gas transmission and distribution networks	2.000	0
	Biomethane production and distribution	250	463
	Electricity storage stations; Pumped storage hydroelectric	3.830	14.151
	Total – Energy production	30.829	98.354
	Total	95.935	340.460

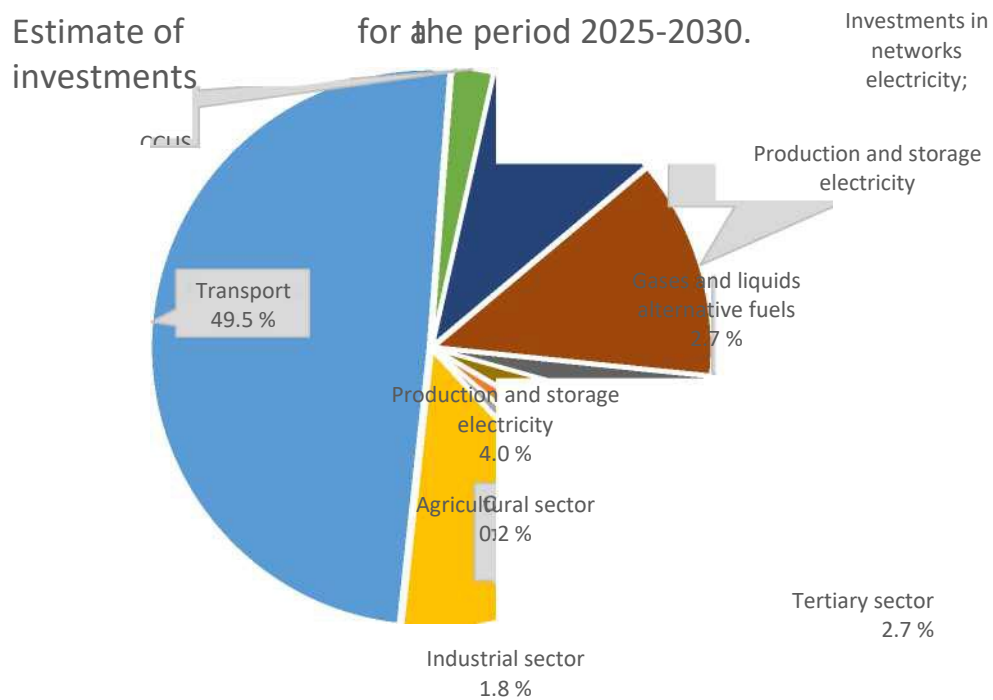


Figure 61 Breakdown of estimated investments in the key sectors of the revised NECP, for the period 2025-2030.

Estimated investments for 2031-2050

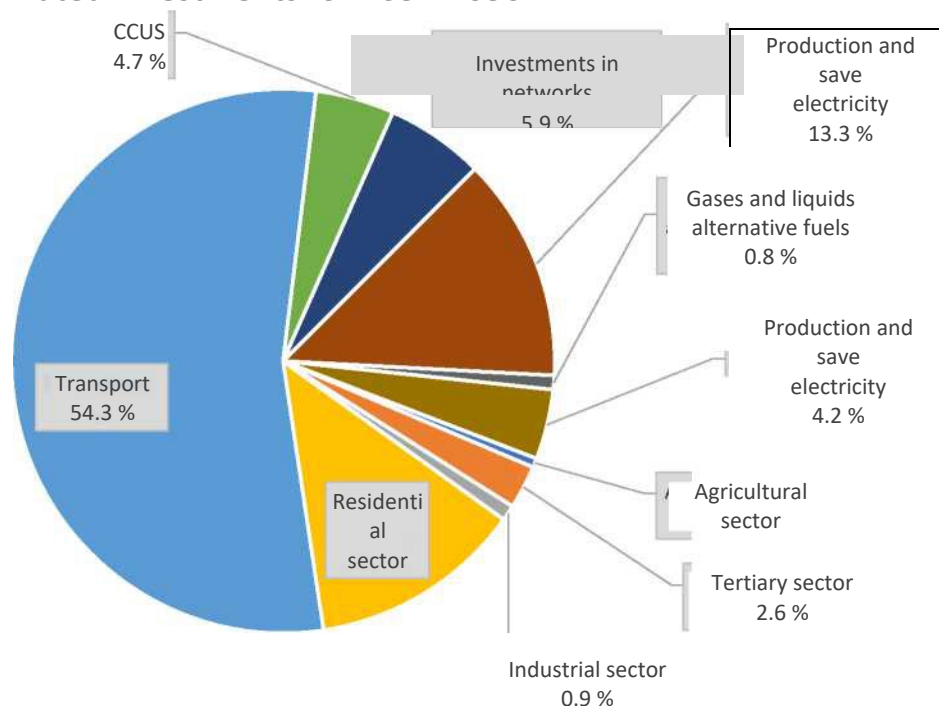


Figure 62 Breakdown of estimated investments in the key sectors of the revised NECP, for the period 2031-2050.

A total of EUR 95.9 billion of investment is estimated to be needed for energy after the Greek energy system by 2030. The majority of these (68 %) will be required to adopt significant energy efficiency upgrades across all end-use sectors of EUR 65.1 billion. For the deployment of RES technologies and alternative fuels in the energy sector, the expansion and reinforcement of wind and storage plants, the total investment to be made is EUR 30.8 billion over the same period.

These investment costs concern the implementation of investments required for the country's energy transition and the achievement of energy and climate targets, and contractual actions that would be carried out independently of the energy transition decision, such as, for example, the purchase of household furniture, cars, etc. The investment costs required for the energy base represent 58 % of total investments by 2030 and must be materialised in addition to contractual actions.

Achieving energy efficiency improvement requires a significant increase in household-spending on investments in energy upgrading of homes and more on upgrading heating and cooling systems for a total of EUR 13.1 billion by 2030. In order to implement the investments, it is necessary to implement a subsidy programme for vulnerable and low-income households with high energy costs, for the energy upgrading of waste water and for the replacement of heating systems for cooling and hot water. Subsidies will also be needed on a smaller scale in other sectors such as small businesses and innovative green investments. In the tertiary sector, the total energy efficiency improvement investments to be implemented are estimated at EUR 2.6 billion. Accordingly, EUR 1.8 billion of total investment is expected to materialise in energy saving actions in the industrial sector by the year 2030.

In transport, most of the investment, worth EUR 44.3 billion, will be implemented in both the passenger and freight road transport sector, of which EUR 12.4 billion will be spent on the electrification needs of the vehicle fleet. At the same time, charging infrastructure for road transport will be extended (with total costs estimated at EUR 860 million), infrastructure for the provision of electricity for ships at berth (cold ironing) will be developed and the electric trams will be completed.

The rest of the energy production sector, including infrastructure, will receive lower public investment support, as energy transition investments are implemented at a competitive cost compared to fossil fuels such as in the field of RES generation. Public support in these areas is expected to boost entrepreneurship and facilitate financing and leveraging investments in particular in innovative and less mature technologies. Due to the energy efficiency of RES, energy storage systems (pumps, pumped storage) with a total investment cost of EUR 3.8 billion will be further developed and electricity transmission and distribution networks will be extended to enable the connection of new RES. The installation of smart meters to all electricity consumers to enable demand response is also expected to be completed in 2025-2030. The total cost of investments in electricity networks is estimated at EUR 9.9 billion.

For the alternative and climate-neutral liquid and gaseous fuels sector for the period 2025-2030, total investments of EUR 599 million are expected and will include the production of biomethane, the first production of advanced liquid biofuels for the transport sector as well as the installation of the first pollutant green hydrogen production units, mainly for the production of renewable plus positive fuels in refineries (synthetic kerosene, synthetic methanol).

In industry, sectors that do not have an alternative (cement industry, refineries) will proceed with CO₂ capture and storage or utilisation programmes with a total investment cost of EUR

1 billion by 2030. Investments in CO₂ storage are estimated at EUR 1.2 billion and are planned to take place in the Prinos marine depleted oil fields or in other geological formations of neighbouring countries.

It should be noted that the above calculations include the cost of purchasing vehicles and means of transport of all kinds, the cost of acquiring appliances and equipment that consumes energy in all sectors and the cost of investments in energy efficiency in all sectors. The above investments therefore concern all investments in the energy sector and include investments in actions promoting the energy transition (technologies and net zero footprint interventions) as well as investments in conventional actions.

Please note that the calculated energy transition costs do not include the costs of adapting to climate change that are already underway (natural disasters from droughts, fires, floods and storms and impacts on agricultural production).

5.3 The impact of the investments of the National Energy Plan and climate (NECP) in the Greek economy

The growth in domestic activity resulting from the substitution of imported energy products and the resulting improvement in the current balance, combined with the expected reduction in energy costs for consumers in all sectors over the medium to long term as analysed above, lead to a benefit for the economy, with a positive drop in domestic value added and employment.

Within the economy, new energy investments are linked to a wide range of increased activities in the supply chain and in the provision of specialised construction, installation, support, digitalisation and innovation services. All the sectors involved make up a significant proportion of the domestic economy and of the new activities that will be developed to serve, directly or indirectly, technological change in the energy, industrial, building and transport sectors.

It is therefore necessary to assess and quantify the economic impact of the investments between 2025-2050 as a result of the NECP.

To calculate the economic impact, the input-output methodology ('Leontief model') was used taking into account sectoral investments as analysed in the NECP. On the basis of the input-output tables¹⁷⁵ for the Greek economy, which describe the interactions of the sector in an economy, even multipliers for variables such as gross value added (GVA) and jobs are calculated in order to quantify the relative impact of investments disseminated by one sector on the rest of the economy. Multipliers reflect the change in gross value added, in all industries, for each additional unit of value of gross production (e.g. sales or revenues) delivered to the end user by this industry. Similarly in the case of employment, multipliers reflect the jobs created in all sectors for each additional unit of value of gross production delivered to the end user by that industry.

Thus, specialised sectoral multipliers were calculated for 44 sectors of the Greek economy in terms of gross value added and positions at direct, indirect and induced levels. The direct contribution consists of the effect on employment and the full added value directly supported by the investment. Indirect is created by the supply chain supporting the investment. The contribution generated consists of the associated consumption of the workforce. Due to the long time horizon covered by the NECP (2025-50), different multipliers were calculated for pre- and post-2035. For the years prior to 2035, the latest available input-output tables of the OECD year 2019 were used, while for the 2035 multipliers new input-output tables were

¹⁷⁵OECD

created. They were used¹⁷⁶ to predict expected growth rates for key macroeconomic aggregates by industry. Subsequently, a 'Mixed Integer Linear Programming' (MILP) was created which includes the initial input-output table together with the projected growth rates, which is planned to adjust the sum of rows and columns again by ensuring that the new table maintains its fundamental balance and reflects the new economic realities that are checked for the reliability of forecasts (e.g. changes in productivity). In this case, I have not incorporated changes in the basic structure of the economy (e.g. changes in the imports of the household of one). Finally, the Leontief methodology for the development of multiple silencers was again applied.

Both investment and operational effects at the level of gross value added and project positions were estimated to capture the total contribution.

As a basis for the analysis, all the NECP investments planned on an annual basis up to the year 2050, as identified by the TIMES model and presented in section 5.2, were taken into account. The type of such investment expenditure was then analysed and quantitative assumptions were made for the sectors of the economy that I am going on and for the share of domestically supported investment (versus imports) for the affected industries.

The main sectors of the economy estimated to be affected in GVA terms (relative to base year 2023) by the domestic supported investment expenditure of the NECP are construction with + EUR 16 billion, machinery and equipment with + EUR 27 billion (e.g. electromechanical equipment (+ EUR 9 billion), metal products (+ EUR 3.5 billion), vehicles, (+ EUR 15 billion) and professional services with + EUR 6.5 billion (e.g. engineering and engineering services).

In addition to the investment effects, net operational effects were also calculated, i.e. the impact on gross value added and jobs that prevail due to changes in energy demand and production per sector and per fuel due to NECP investments. For the purpose of this analysis, it was assumed that energy prices remain stable given the uncertainties related to international markets and technological developments.

Based on the results of the analyses of the economic impact, the investments of the NECP supported investments as well as their operational effects on the economy contribute in terms of gross value added of EUR 6.0 billion on an annual basis throughout the period 2025-50. Of the EUR 6.0 billion of gross value added, around EUR 2.4 billion is due to direct effect and around EUR 3.6 billion to supply chain interactions and indirect and induced effects.

¹⁷⁶OECD, ILO, Savings Induced Effects + 3.6 %.

The NECP's contribution to the economy is estimated at around EUR 6.0 billion per year until 2050

Average annual contribution to Gross Value Added
EUR 2, at constant prices

■ MEDIUM Contribution
■ WITH A direct contribution generated
Percentage of IP

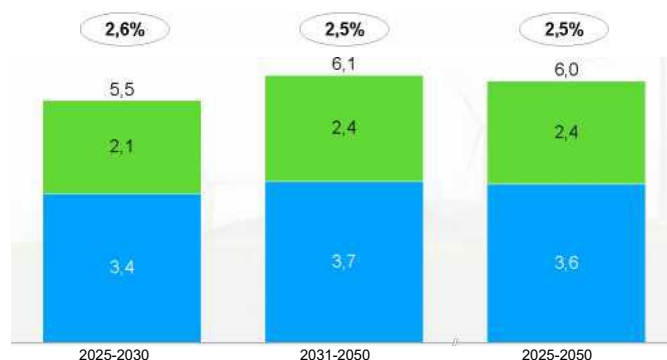


Figure 63 Estimated average annual contribution to Gross Value Added (GVA) for the period 2025-2050

Παράλληλα, οι εγχώριες επενδύσεις και οι λειτουργικές επιδράσεις λόγω της ενεργειακής μετάβασης αποτυπώνονται και στην απασχόληση, καθώς εκτιμάται ότι θα απαιτηθούν περίπου 210 χιλιάδες θέσεις εργασίας σε ετήσια βάση οι οποίες διατηρούνται καθ' όλη τη χρονική περίοδο 2025-50, μια αύξηση της τάξεως του 5% σε σχέση με το σύνολο του εργατικού δυναμικού. In particular, the mobilisation of large investment funds for 25 years and the fact that jobs are created in labour-intensive industries such as construction are leading to employment growth. Around 116 thousand jobs are directly due to the investment and operation of the projects (direct effect) and about 94 thousand jobs to supply chain interactions and indirect and induced effects.

It is therefore evident that the green transition will create new jobs in emerging economic activities in the coming years, which will serve as compensation for jobs lost in specific sectors, such as fossil fuels. In Greece, the implementation of the programme for the de-lignification of electricity generation until 2028 introduces at the same time integrated structural measures, including socio-economic and environmental restoration measures, to restructure the affected areas and industries, ensuring the Just Transition. The transition process thus

extends beyond the energy sector, as new jobs and forms of manual activity arise in sectors such as agriculture, construction, digital services, tourism and transport.

As the transition to the green economy demonstrates the need for new skills, policies aimed at skills development play an important role. A series of actions aim to retrain and support unemployed and socially vulnerable to enter the circular economy, with specific skills development per development. At the same time, programmes are being developed to help businesses that want to accelerate their transition to green housing to acquire the right workforce with the associated 'green right-hand' ones.

The NECP's contribution to jobs is estimated at around 210.000 maintained until 2050

Average annual contribution to employment

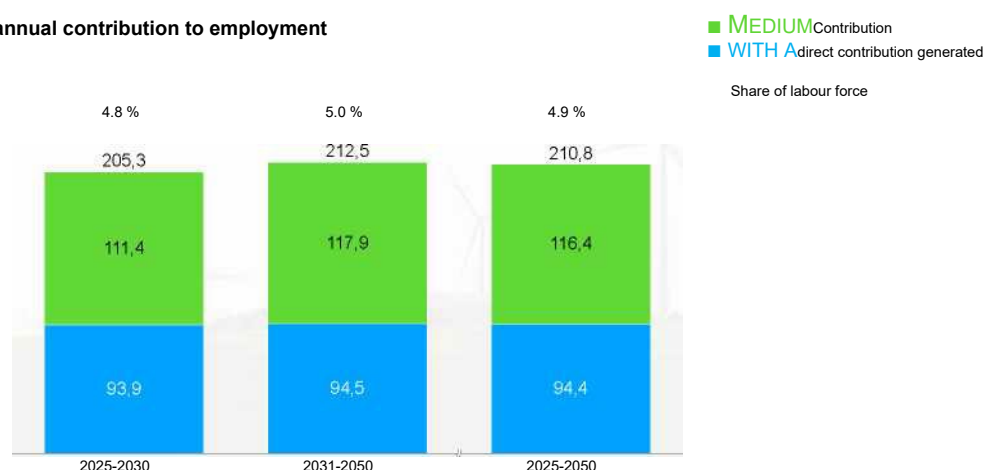


Figure 64 Estimated average annual contribution to employment for the period 2025-2050

It is worth noting at this point that all **NECP investments are not defacto new investments for the whole economy, but constitute a real reason for redirecting investments into different technologies.** International experience shows that around 15-20 % of corresponding investments are now incremental new investments at the level of the total economy.

The remaining amount of the investments will come from the change in the mix of western costs incurred and now (e.g., instead of purchasing a conjugated vehicle, an electric/hybrid vehicle will be purchased).

In conclusion, investments to fulfil net zero greenhouse emissions are expected to change Greece's economic model from an operational-expenditure-intensive economy to a capital-intensive economy. The transition to a zero-emission economy will bring cost savings, such as fuel costs for heating due to improved insulation in buildings and the use of more efficient heating technologies. I think that the mismatch between the timing of the investments in relation to the benefit of the investments (due to the time-shifted benefit of some actions), uncertainty and instability during the transition period and the lack of mature technologies in some cases may limit investment dynamics and lead to additional costs. Therefore, in order to mobilise the investments needed, there needs to be a coordinated framework for investment promotion and facilitation. New specialisations, the development of new businesses, their investment and support involved in the green transition represent a great challenge and opportunity for engagement, entrepreneurship and growth of economic activity. This is because the green transition essentially substitutes imported products, such as petroleum products and natural gas, with technologies with a greater leverage effect on the domestic economy. Renewables, energy efficiency and new clean fuels of the future, related digital services and distribution, can achieve a significant proportion of the costs corresponding to domestic added value.

The optimisation of this benefit for the economy depends largely on the economic capacity of the economy to leverage investment in new artefacts and the whole supply chain, thereby increasing opportunities for domestic added value. The growth of domestic value added is possible through a targeted industrial policy to support innovation and new clean technologies.

5.4 The budgetary impact of the green transition

The achievement of the objectives set out in this plan also includes a budgetary statement. **In this context, it is important to stress that the contribution of the public budget to the increased investment costs is expected to be small.**

Over the long term, beyond 2030, there will be a fiscal gap from lower tax revenues from fossil fuels (mainly in transport) which will be replaced over the long term by electricity and clean synthetic fuels and biofuels for which a lower tax burden will apply in order to be competitive. The country's tax system needs to be realigned in the long term by redesigning environmental taxes and developing an appropriate tax policy mix, taking into account the need to attract investment in areas that will further facilitate green and digital post-market- and related developments at EU level (extension of the scope of the EU ETS, revision of the Energy Taxation Directive, CBAM carbon pricing, etc.). At the same time, achieving energy

efficiency improvement requires a significant increase in household expenditure on investments in the energy upgrading of homes and in the purchase of durable goods (appliances and cars of advanced crafts).

The management of households' extra investment expenditure for cars and energy efficiency (buildings and appliances) has difficulties due not so much to costs, but above all to the relative inability to finance households and to ensure cheap borrowing costs. As a result, investments needed for energy efficiency are discouraged. Thus, in parallel with the implementation of a subsidy programme in the field of energy efficiency, **it is important to take action and adopt appropriate measures to facilitate access to finance for a large part of households.** This will also have the effect of limiting the need for subsidies available to a smaller part of households.

From a macroeconomic point of view, it is important that there is no real burden on energy-services, but will require a significant increase in investment and therefore its successful development depends on the ease of financing at the cost. High borrowing costs or difficulty in accessing the capital market will discourage operators from undertaking the investment resulting in delayed and increased costs. **Easy financing reduces the costs of the green transition for households and businesses** as it will mainly be the cost of capital service due to increased pedestrian intensity.

Subsidies will also be needed on a smaller scale in other sectors such as small businesses and innovative green investments. The other energy sector, energy supply and consumption, including infrastructure, will not need subsidies from the State because, under certain conditions, the energy transition is self-financed in these sectors, such as RES, grids, etc. The preconditions for these areas are **government policy** to foster entrepreneurship and **facilitate financing and leveraging investments and innovations.**

The financial sector is invited to develop and offer financial products related to Green Transition objectives. The use of masonry tools that include sustainability criteria can lead to an overhaul of economic resources between industries and accelerate innovation in fast-growing industries, but also in the financial system itself. In this transformation, it is important for the producers and the three main links of the system, i.e. lively, capital and insurance markets, to play a role.

In conclusion, in order to achieve the objectives of the NECP to align the Greek economy with a carbon neutrality and more resilient trajectory, the following points are highlighted:

- Make thorough use of the current Multiannual Financial Framework 2021-2027 and additional funding sources at EU level to steer the next funding cycle towards the decarbonisation of the economy and society in an energy transition, avoiding financing investments that are inconsistent with this objective.
- Align national public funds with the objectives set out in the NECP, integrating criteria related to its objectives in the different funding lines.
- Orient Foreign Direct Investments towards the Greek economy of the future, in line with the decarbonisation and nascent transition objectives.
- Aligning the financial system with the objectives of carbon-cutting, in line with the directives at EU and national level to integrate sustainable finance into the activity of financial institutions.
- Adapting tax policy to accommodate the needs of the energy transition and decarbonisation in the coming period.

5.5 Existing investment flows and sources of financing

The 2021-2027 programming period continues to be a key tool to support the expected investments of this project, at least in specific categories of investment interventions, on the basis of which the appropriate financial structural programmes are prioritised and drawn up at the level of the breakdown of available resources.

The main features of the 2021-2027 programming period are as follows:

- The existence of enabling conditions (replacing the former conditionalities), some of which concern the energy sector. The fulfilment of enabling conditions shall be monitored throughout the programming period and any delays in their fulfilment may cause difficulties in the financing of the respective projects.
- The increase in the importance of repayable assistance (provided through financial instruments) and the trend towards a reduction in grants. The increased use of financial tools will result in an increase in the resources available to implement certain categories of energy projects, due to leverage and resource recycling. In addition, it is possible to combine resources from the Funds with resources from other sources in order to facilitate the financing of projects.

The “Corporate Regional Development Pact 2021-2027” (“**NSRF 2021-2027**”) largely reflects the new priorities of the European Commission and Greece’s new development priorities for the coming years. The NSRF 2021-2027 e was approved by the European Commission on 29 July 2021, while Law 4914/2022 (GG I 61) provides for the arrangements for the management, control and implementation of development interventions for the 2021-2027 programming period. According to this, the total resources available to the country amount to EUR 26.2 billion over the next 7 years, of which EUR 20.9 billion relates to EU support and EUR 5.3 billion to the National Contribution. These resources concern the European Social Fund, the European Regional Development Fund (ERDF), the Cohesion Fund and the European ERN Cooperation.

The proposal for a regulation on the ERDF and the Cohesion Fund provides that in countries with a gross national income of less than 75 % of the EU average at least 30 % of the ERDF resources shall be allocated to the Funds’ Policy Objective 2, which concerns energy, climate and the environment. In addition, 6 % of ERDF resources will be allocated to sustainable urban development. Also, a significant part of the Cohesion Fund (37 %) will be directed towards Policy Objective 2.

According to the allocation of public funds (EU and national) for Policy Objective 2, as set out

in the programming of the NSRF 2021-2027, as well as data on the disbursement of funds up to 2023, the resources expected to be available for the period 2024-2030 amount to EUR 7.5 billion.

Actions/projects in the energy and climate change sector to be financed are, as a rule, included in Policy Objective 2, as already mentioned. The specific objectives supported by the ERDF and the Cohesion Fund (mainly investments in circular housing, sustainable development and RES) under this Policy Objective are the following:

- I. Promoting energy efficiency measures.
- II. Promotion of renewable energy sources.
- III. Development of smart energy systems, grids and storage equipment at local level.
- IV. Promoting climate change adaptation, risk prevention and disaster resilience.
- V. Promoting sustainable water management.
- VI. Promoting the transition to a circular economy.
- VII. Enhancing biodiversity, green infrastructure in the urban environment and reducing pollution.

Limitations on eligibility arise both from Article 7 of Regulation (EU) 2021/1058 of the European Parliament and of the Council of 24^{June} 2021 on the European Regional Development Fund and on the Cohesion Fund and from the intervention fields provided for in Regulation (EU) 2021/1060 of 24^{June} 2021 laying down common provisions on the Funds. In particular, the ERDF and the Cohesion Fund shall not, inter alia, invest in the production, processing, distribution, storage or combustion of fossil fuels.

The Common Provisions Regulation's fields of intervention relating to a low-carbon economy are as follows:

- ✓ Energy efficiency and demonstration projects in SMEs and supporting measures.
- ✓ Energy efficiency with renovation of the existing housing stock, demonstration projects and supporting measures.
- ✓ Energy efficiency with public infrastructure renovation, demonstration projects and supporting measures.
- ✓ Support companies specialised in the provision of services contributing to the low carbon economy and climate resilience.

- ✓ Renewable source energy: wind.
- ✓ Renewable source energy: solar.
- ✓ Renewable source energy: biomass.
- ✓ Renewable source energy: marine (wave, tidal).
- ✓ Other renewable energy sources (including geothermal energy).
- ✓ Smart energy distribution systems at medium and low voltage levels (including smart energy grids and ICT systems) and related storage systems.
- ✓ High-efficiency cogeneration, district heating and cooling.
- ✓ Support environmentally friendly production processes and resource efficiency in SMEs.
- ✓ Adaptation to climate change measures and prevention and management of climate-related risks: floods (including awareness-raising activities, civil protection and disaster management systems and infrastructures).
- ✓ Adaptation to climate change measures and prevention and management of climate-related risks: fires (including awareness-raising activities, civil protection and disaster management systems and infrastructures).
- ✓ Adaptation to climate change measures and prevention and management of climate-related risks: other risks, e.g. storms and drought (including sensitising activities, civil protection and disaster management systems and infrastructures).
- ✓ Water management and conservation of water resources (including river basin management, specific measures to adapt to climate change, reuse, leakage reduction).
- ✓ Household waste management: prevention, minimisation, sorting, cycling measures.
- ✓ Household waste management: mechanical biological treatment, heat treatment.
- ✓ Promoting the use of recycled materials as raw materials.

The above framework also finances electricity transmission infrastructure, with a focus on islands' interconnections, in order to facilitate further RES development, as well as interventions to promote the just transition of lignite-fired regions and promote the circular economy.

In addition, Policy Objective 3 promotes, inter alia, investments left in 'Clean Urban Transport Infrastructure', which may also include e-mobility infrastructure in urban environments.

In addition, under the sustainable infrastructure policy area of Invest EU set up by the

European Commission in order to integrate into its long-term budget (2021-2027) the financial envelopes for loans and guarantees, it is possible to also finance actions/projects related to the energy sector, which are estimated to continue to contribute significantly to leveraging resources also for the period 2025-2030.

Funding for actions in the energy sector may also be included in Objective 1, through which actions in the field of energy and climate change relating to research and innovation (e.g. actions involving new ones, advanced energy storage systems, new materials, etc.) can be financed, its relevance (e.g. measures for the energy upgrading of small and medium-sized enterprises) and information and communication technologies (ICT) (e.g. incentives for digital businesses or energy data, etc.), etc.

An additional source of funding under the NECP may be the national resources of the **Public Investment Programme** (PIP). In particular, in the National Development Programme (NDP), energy and climate-related actions/projects will be prioritised, in the context of the country's national development objectives, and I am mindful of the principle of complementarity with the EU co-financed interventions and the effectiveness of policies and commitments made by the country for specific periods of time.

Additional resources for energy and climate change related actions can be drawn in the 2021-2027 period from the Rural Policy Programme. The reform of the **Common Agricultural Policy (CAP)**, which applies to the 2023-2027 budget, entered into force on 1 January 2023, paving the way for a more and greener CAP, which seeks to ensure a sustainable future for European farmers, in line with the ambitions of the European Green Deal, the Farm to Fork Strategy and the Biodiversity Strategy. The new CAP approach, based on performance and results, is more flexible and responsive to local circumstances and needs, while increasing the EU's sustainability ambitions. The **National Strategic Plan for the new Common Agricultural Policy (CAP) 2023-2027** of Greece, adopted on 21 November 2022, is based on active coverage of the whole territory, based on innovative and sustainable agriculture and forestry production. This strategy implements the CAP instruments financed by the EU, through direct payments, sectoral measures and rural development instruments. The green architecture of the Plan includes the achievement of three specific environmental and climate objectives (a) contributing to climate mitigation and adaptation, (b) rational and effective management of natural resources, and (c) protection of biodiversity includes the following building blocks: The main contribution to the above objectives is the interventions that contribute to increasing carbon storage.

According to the measures of the Common Agricultural Policy (CAP) National Strategic Plan

(NSP) for climate change mitigation and adaptation objectives, a total of EUR 3.1 billion is to be made available for the period 2025-2030, with the main investment streams including measures for the rational use of fertilisers, the development of organic crops and the improvement of the diet.

Funds from the **Connecting Europe Facility (CEF)** are also being used to finance important energy infrastructure (Projects of Common Interest), which will be used in the next period by broadening energy eligibility, including in addition to projects of common interest and cross-border cooperation projects in the field of RES generation, as well as smart grid applications.

Tax policy is also expected to play a prominent role in the expected green transition, which should be designed to reflect cost savings, address core social and environmental costs internally – absorbing externalities and influencing behavioural change as a key determinant of fair and sustainable competition.

In addition to the above funding sources, important new European Deployment Mechanisms will be used to finance decarbonisation and energy transition requirements.

Table 41 Overview of public funding resources available for the period 2025 – 2030.

	Available resources (EUR)
Savings	4.198
Transport	2.208
RES-Renewable gases	2.686
Energy storage	1.476
Networks	842
CCU -CCS	150
Total	11.561

The table above summarises the available public funding resources that will be used to support investments in the energy transition of the underlying sectors of the energy system in Greece and correspond to the major sources of financing. Furthermore, the available resources expected to be made available also for the non-energy sectors for the period 2025-2030 are recorded. In particular, approximately EUR 3.8 billion is expected to be available for the circular economy and waste management sector by 2030, with key actions to ensure the promotion of sustainable production and industrial policy, sustainable drinking and programmes for the prioritisation, collection and treatment of waste and its reuse through processing and energy recovery plants. Similarly for climate change adaptation and environmental protection, available resources amount to EUR 2.6 billion and include measures to tackle climate change and prevent and manage climate-related risks, measures to protect nature and biodiversity as well as actions to protect, restore and sustainably use forests and

areas

Natura 2000. While for energy research and innovation actions, the available resources are estimated at EUR 0.7 billion for the period 2025-2030.

This summary is not exhaustive as additional sources of funding at European level are expected to exist or become more visible to further strengthen the next funding cycle towards the decarbonisation of Greek government and society in the energy transition.

Resilience and Recovery Fund – Repower EU

The Recovery and Resilience Fund (RRF) is the EU's largest financial front to date, designed to reduce the socio-economic impact caused by the COVID-19 pandemic health crisis. The RRF is planned to disburse up to EUR 723.8 billion in grants and loans to Member States by 2026. The RRF Regulation entered into force in February 2021, stipulating that each Member State will submit a National Recovery and Resilience Plan (NRRP) setting out the reforms and investments that the Member State commits to implement. The National Recovery and Resilience Plan Greece 2.0, adopted on 13 July 2021 by the Economic Financial Affairs Council of the European Union (Ecofin). 'Greece 2.0' covers 106 investments and 68 reforms, broken down into 4 pillars: Green Based, Digital Transition, Employment-Skills – Social Cohesion, Private challenges and transformation of the economy. It pools EUR 31.16 billion of which EUR 30.5 billion of European funds to be channelled through grants and loans, and is expected to mobilise EUR 60 billion of total investment in the country by the end of 2026, where all projects should have been implemented. The total funding for Greece for subsidies for the Green Pillar amounts to EUR 6.2 billion from the Recovery Fund and runs until 2026. For the Recovery Fund loan programme, 500 investment projects have already been submitted with a total of EUR 18.5 billion, with 60 % coming from small and land-based enterprises, thus widening the possibilities and scope of financing for diaspora. In particular, for the Green Pillar the total budget for investment loans is around 50 % (EUR 9 billion), while the TAA contribution amounts to EUR 3.7 billion.

The REPowerEU plan proposed by the EU in 2022 aims to rapidly reduce the European Union's dependence on Russian fossil fuels, with a budget of EUR 20 billion by 2027. The proposal for the revision of the National Recovery and Resilience ECT "Greece 2.0" was submitted on 31^{August} 2023 to the European Commission. At the heart of the revision is the new REPowerEU investment and reform package with EUR 795 million of European funding aimed at Europe's energy autonomy and the request for additional EUR 5 billion loans to be added to the existing Recovery Fund loan programme. The request for additional EUR 5 billion of loans to the private

economy responds to the high demand of the TAF loan programme.

The revised Recovery and Resilience Plan through REPowerEU financially strengthens energy efficiency actions for households, businesses and Posio and RES energy storage systems. It paves the way for biomethane and green hydrogen supply and CO₂ capture and storage technology through pilot projects and reforms shaping the permitting and operation framework. REPowerEU reforms also include optimising land use for RES development, increasing grid and energy storage capacity to promote related investments, etc.

Coking Fund for Islands

In the context of achieving Greece's ambitious targets by 2030 for tackling climate change, the energy transition and the decarbonisation of islands, the Ministry of Environment and Energy has set up in cooperation with the Directorate-General for Climate (DG Clima) and the European Investment Bank (EIB), the new financial mechanism "Maritime Coal Fund", drawing on the auctioning of 25 million tonnes of unallocated CO₂ emission allowances. The actions to be financed include changing the energy model in the non-interconnected islands with the continental electricity transmission system but also faster electrical interconnection as well as hybrid RES projects with storage, investments in multi-purpose dams/tanks, infrastructure for the supply of electricity for ships at berth and for charging electric vehicles. This new financial mechanism is a key tool for attaining the objectives of Article 21 'Transformation of the Islands' Development Model and their transition to climate neutrality' of the recently adopted National Climate Law (Law 4936/2022, Government Gazette, Series I, No 105). The amount of funding for the years 2024-2030 to be allocated to the decarbonisation of the June and Ayo islands in Greece from the decarbonisation fund is estimated at approximately 2.3 billion

EUR billion in current prices, while total expenditure is estimated at EUR 5.6 billion, depending on the price of emission allowances at monetary valuation.

The Just Transition Fund

The Just Transition Mechanism is part of the European Green Deal and aims at a just and fair green transition. It will mobilise investments of at least EUR 100 billion over the period 2021-2027 to support workers and citizens in the regions most affected by the transition, with funding from the EU budget, co-financing by Member States, as well as contributions from InvestEU and the European Investment Bank (EIB).

The Just Development Transition Plan (JDP) of the lignite-fired areas of Western Macedonia

and the Municipality of Megalopolis has been drawn up and is being implemented with a view to developing development opportunities for the regeneration of local security, labour-markets and the creation of new ones. The total amount of funding, including the obligation to leverage private resources, is estimated to exceed EUR 5 billion from EU and national resources.

Social climate fund

The Social Climate Fund will support the most vulnerable households, micro-enterprises and public transport users in view of the expected increase in energy and public transport prices following the extension of the ETS to the transport and buildings sector). The implementation of this fund will take place during the years 2026-2032, with Greece having access to around EUR 3.37 billion, submitting a social climate plan containing the measures and investments it intends to implement to mitigate the social impacts caused. This concerns measures and investments aimed at reducing dependence on fossil fuels by increasing the energy efficiency of buildings, decarbonising heating and cooling systems and promoting low or even zero-emission mobility solutions.

The Innovation Fund

The Innovation Fund is one of the largest funding programmes for demonstration projects for innovative low-carbon technologies. Funding and notional projects shall focus on:

—Innovative low-carbon technologies and processes in carbon-intensive industries, including substitution of carbon-intensive products.

Carbon Capture and Utilisation (CCU).

Manufacturing and maintenance of carbon capture and storage.

The innovative production of electricity from renewable sources.

Energy storage.

Net zero mobility (maritime, air, road) and buildings.

The revenues of this fund come from the auctioning of ETS allowances. It is estimated that the

Innovation Fund could reach up to EUR 38 billion, depending on the carbon price at the time of monetisation of emission allowances¹⁷⁷.

In 2023, the revision of the EU ETS Directive reinforced the Innovation Fund as follows:

- The total size of the Innovation Fund has increased from 450 million ETS allowances to around 530 million allowances in ETS.
- Changes in scope: new sectors (e.g. shipping, aviation)
- Introduction of medium-scale projects
- Application of the Do No Significant Harm (DNSH) principle since 2025
- Stronger reference to multiple environmental impacts
- The introduction of new financial instruments (“Competitive Tender”)
- Greater attention to geographical balance, including through technical assistance to Member States with low effective participation.

The Innovation Fund is a key element to achieve the goal of a carbon-neutral Europe by 2050 and to comply with the Paris Agreement.

Modernisation Fund

Following the revision of the EU ETS Directive as part of the Fit for 55 package, Greece is one of the new Member States benefitting from this fund to support the modernisation of energy systems and the improvement of energy efficiency in Member States with lower GDP per capita. This will allow investment in renewable energy, energy efficiency, discouraging and energy networks to be fostered and to promote a just transition in territories whose economy was previously based on high-carbon industrial or other activities. For this Fund to work, Greece will have to submit investment proposals to the European Investment Bank and an Investment Committee, which will be evaluated with a view to disbursing the revenues of this Fund, which will always be subject to State aid authorisation. In terms of support, Greece will receive 10.1 % of the total value of this fund between 2024 and 2030, corresponding to around EUR 1.85 billion.

Combining the above funding with national programmes, through which complementary actions are financed (e.g. the ‘Electra’ programme, the National Development Plan (Law 4635/2019, Government Gazette, Series I, No 167)), which contribute to the transition to a

The¹⁷⁷ total financing of the Innovation Fund depends on the carbon price and can reach around EUR 40 billion between 2020 and 2030, calculated with a carbon price of EUR 75/tCO₂.

low-carbon economy (energy efficiency, RES, energy infrastructure), as well as the use of market mechanisms (e.g. Green Pool, Bilateral Power Sales Contracts, on-bill financing, enforcement schemes, auctions for energy saving), will mobilise significant resources for the implementation of projects.

Ultimately, at the level of public funding, there are currently national resources aimed at supporting the decarbonisation of the economy and the active transition, offering some funding possibilities available to the public and private sectors. The implementation of the updated NECP entails speeding up the action of the funds identified with a focus on the objectives set, coupled with close links between different sources of supply and stimulating the use of European funds.

At the same time, mobilising additional private sector financing, including – taking into account the contribution from foreign investors and international financial institutions to new blended finance and lending mechanisms and models (Green Bonds, Green Loans) – in line with the Sustainable Development Goals is becoming crucial and is expected to widen significantly.

The design and development of new financial schemes and finance projects, as reflected in the revised NECP, and their optimum use through appropriate leveraging of available resources, while mobilising own funds, will lead to significantly more investment than the resources available through Community and national programmes, making a key contribution to achieving energy and climate policy objectives.

Finally, revenues from the auctioning of emission allowances from the Emissions Trading System in the stationary, aviation and maritime sectors (ETS 1) as well as the extension to the buildings and transport sectors (ETS 2) are expected to significantly enhance support for the above actions to achieve the energy transition for the period 2025-2030.

In particular, Directive 2003/87, as amended by EU Directive 2023/959 establishing a system for emissions trading within the Union, provides for timely and harmonised requirements for the use by Member States of revenues from auctioning of emissions from the stationary installations, aviation and maritime sectors (ETS 1). One of the key aspects is the provision that to make sure that money from pollutant pricing will lead to investments in the green transition, Member States must use 100 % of the revenues from the sales of allowances for climate and energy purposes.

Greece is one of the Member States that consistently allocates 100 % of its ETS revenues for climate and energy purposes. The main sectors financed through revenues from the auctioning

of emission allowances in Greece have remained stable in recent years. These areas concern:

- energy (RES, energy saving, promotion of electromobility),
- ecosystem management/adaptation to climate change;
- skills development and support for just development transition in regions affected by lignite-fired;
- support to companies at risk of carbon leakage as well as
- the administration of the ETS.

Total revenues from the auctioning of ETS 1 allowances are estimated at EUR 6.9 billion with an emission price of EUR 80/tCO_{2eq} on average over the whole period 2025-2030.

For the newly established emissions trading system for buildings, road transport and the sectors (ETS 2) expected to be operational in 2027, Directive 2023/959 stipulates that its revenues can be used for the same purposes as revenues generated by the auctioning of ETS 1 emission allowances. At the same time, the Directive specifies that priority should be given to activities that contribute to addressing social aspects arising from the implementation of ETS 2. Most importantly, the extension of ETS 2 to the buildings and transport sectors will lead to additional revenues being allocated. These are estimated at EUR 2.1 billion, while if ETS 2 becomes operational in 2028, revenues are expected to reach EUR 1.8 billion with an emissions price of EUR 45/tCO_{2eq} on average over the whole period 2027-2030. The distribution of revenues is expected to be further refined with the development of the National Social Climate Plan.

5.6 risk factors and challenges

In line with the structure of the above chapters, starting with the policy objectives, the policy orientations have been identified, which have been framed by a number of policy measures, which can be classified in regulatory and technical terms. Focusing on yesterday's measures, these usually concern the implementation of a technological intervention, which inevitably goes hand in hand with the mobilisation of investment expenditure, regardless of who will do so. Therefore, for each policy measure, there can be a variety of rational combinations of taking over the financial burden of the investment for the production of the same technological application.

The choice of the most appropriate financial mechanism and instrument as well as the sharing of the financial burden, each policy measure is an issue directly and managementally linked to the success of the implementation of the measure. Therefore, the basic planning principles for taking the financial burden of the various parties involved are a process that remains within the limits of energy planning.

Availability of resources over medium/long term horizon

The previous section 5.5 refers to more than any other period of time in the past, available European financial tools (in the form of Funds and/or other forms), which can finance the most (if not all) of the necessary areas of intervention in the context of the active transition and decarbonisation of the various sectors of the economy.

The availability of these tools and the resources they mobilise, aiming at maximising the mobilisation of private capital, both from the point of view of investors and from the point of view of the citizens or businesses concerned, ensures that the necessary investments can be realised in the short term and up to 2027-2028, in terms of the ability to obtain financing from private resources/banks.

It remains a matter of securing the necessary resources to (co-) finance the necessary investments around and especially after 2030. In fact, all planned measures and policies are **based on the underlying assumption that the financial tools involved will not only continue, but will also be expanded and increased in the future**, as related investments in green transition projects will need to be accelerated during this period, as also illustrated by the projections of the revised NECP model. In this context, there is a need for a concerted effort

to mobilise additional resources at European level in the medium/long term.

European resources available to finance actions related to the reduction of GHG emissions are needed in the first place because they allow all Member States to prioritise and accelerate such actions regardless of their own ultimate budgetary capacity. Secondly, because they give a clear signal to private capital about the EU's commitment and determination to work hard on climate change action in the long term. In the third place, because they significantly assist in the implementation of necessary investments, which, however, fall short of purely financial criteria than to substantiate the possibility of recovering the invested capital and to obtain the necessary funding and implementation (funding gap). Fourthly, because they play a key role in decoupling the costs of new transition technologies and enabling them to be massively adopted on market terms.

For the above reasons, maintaining and extending the existing financial tools beyond the decade horizon is considered necessary and necessary in order to achieve not only the objectives of the Greek NECP but also the EU's general objectives in the context of reducing GHG emissions, penetration of RES, achieving incremental savings but also maintaining energy security.

More effective measures to achieve the objective of improving energy efficiency

A major challenge is a more rational and efficient allocation of resources with a view to achieving the energy efficiency target set for the year 2030. The successful containment of final energy consumption to projected levels will multiply and maximise the benefit of meeting the remaining sub-targets in the field of RES, and electricity generation in general, as well as in the field of energy security.

In order to ensure that the energy consumption reduction target is met, the scale of the operation of existing energy efficiency improvement programmes in all sectors will be improved, with the aim, by way of example, of increasing existing levels of leverage from beneficiaries, increasing the number of potential beneficiaries, promoting the most cost-effective and effective interventions, involving domestic financial institutions more actively in financing the necessary interventions, and promoting pioneering in the domestic manufacturing and manufacturing industry.

In addition, emphasis will be placed on schemes leading to the implementation of energy saving projects through Energy Efficiency Contracts by Youth Service Enterprises and Public

Private Partnerships, and priority will be given to the implementation of targeted market mechanisms to improve energy efficiency.

In addition, the aim is to remove barriers to companies' access to the required financing by providing both soft loans and guarantees. The role of energy audits and the development of energy management systems in tertiary sector buildings through other actions to promote them is expected to be a catalyst.

Optimising the cost-effectiveness of policy measures

Key principles of energy planning include optimising the cost-effectiveness of policy measures, while upholding the shared roles of all parties involved while keeping the risk of failure to implement at the lowest levels. They are therefore designed and will be implemented through policy measures to manage available EU and national resources more effectively. However, in order to achieve this objective, a range of financial instruments and instruments will be used, with the ultimate aim of creating the right conditions for attracting investment, combining different cognitive sources and optimising the return on public capital.

In particular, the optimisation of the return on public funds will be achieved by reducing subsidies and instead granting a bonus that allows for the recycling of funds (repayable aid), through dedicated funds, as well as through the creation of financial instruments with appropriate blending of grants and loans and combining resources from different sources (structural funds, other European resources and instruments, national resources, market mechanisms, etc.).

Accordingly, the creation of conditions for attracting investment will be achieved, first through the right regulatory framework and secondly through the rational rules governing the implementation of each measure. Mechanisms to be put in place to strengthen this framework are: granting security for first losses in single schemes, increasing the scale of mainly small projects by aggregating them, standardising procedures and methodologies to reduce the risk of parties involved in cases of difficult to manage projects, setting up technical support structures at decentralised or central level, removing legislative and regulatory obstacles, respecting transparent and equitable procedures which may be angular or not, and applying tax incentives.

APPENDIX

Annex – Effects of climate change on RES

Solar energy

In the intermediate RCP4.5 mitigation scenario, the average annual input of short length-radiation is expected to increase slightly (4,8-8 Watt/m²), while cloud coverage is slightly decreasing (-3.6 %) in the period 2031-2060 in Greece, favouring increased efficiency of photovoltaic systems (PV). On the contrary, the increase in the number of days with very high temperatures and the decrease in wind speed in many areas of land negatively affect their performance.

The impact of climate change on electricity generation from light-power systems, in Greece in the period 2021-2050, is expected to be very limited (EUR ± 5 %), mainly due to a slight change in solar radiation and less to the compensatory effects of air temperature and fast wind.

Unlike photovoltaic systems, concentrated solar systems (CPS) are positively affected by the rise in temperature, but require a significant amount of water for their operation, limiting their growth on islands with limited water resources. Research in recent years has focused on reducing the water consumption of CPS systems by developing alternative technologies for cooling (e.g. dry or hybrid systems) and cleaning of mirrors.

The efficiency of solar systems is also strongly influenced by the dust-mead episodes, which have intensified in recent years. The presence of dust in the steam ball reduces solar radiation, while its application on photovoltaic panels and mirrors further reduces their performance. There is currently uncertainty about the impact of climate change on dust transfer episodes and further research is ongoing. However, it is certain that increased desertification, loss of soil cover and drying of water bodies in arid and semi-arid areas will contribute to the production of dust and the occurrence of related episodes.

¹⁷⁸ National Climate Change Adaptation Hub. Maps Displaying Climate Forecasts: <https://geo.adaptive-greecehub.gr>.

¹⁷⁹ RIS geospatial information portal. Climate change: https://mapsportal.ypen.gr/thema_climatechange.

¹⁸⁰ Georgopoulou E, Mirasgedis S, Sarafidis Y, GIANNAKOPOULOS C, Varotsos KV, Gakis N. Climate Change Impacts on the Energy System of a Climate-Vulnerable Mediterranean Country (Greece). *ATMOSPHERE*. 2024; 15 (3): 286. <https://doi.org/10.3390/atmos15030286>.

¹⁸¹ European Environment Agency, Adaptation challenges and opportunities for the European energy system – Building a climate-resilient low-carbon energy system, Publications Office, 2019, <https://data.europa.eu/doi/10.2800/227321>.

¹⁸² <https://projects.research-and-innovation.ec.europa.eu/en/projects/success-stories/all/water-consumption-solution-efficient-concentrated-solar-power>.

¹⁸³ <https://www.pv-magazine.com/2024/02/09/the-effect-of-extreme-dust-conditions-on-pv-system-performance>.

¹⁸⁴ Mirzabaev, A., L.C. Stringer, T.A. Benjaminsen, P. Gonzalez, R. Harris, M. Jafari, N. Stevens, C.M. Tirado, and S. Zakieldein, 2022: Cross-Chapter Paper 3: Deserts, Semiarid Areas and Desertification. In: *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegria, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, B. Rama (eds.)). Cambridge University Press, Cambridge, UK and New York, NY, USA, p. 2195 – 2231, doi: <https://data.europa.eu/doi/10.2800/227321>.

Wind power

In the case of RCPs, a slight change in wind speed (-0,2 to + 0.1 m/s) is expected in the period 2031-2060 compared to the reporting period of 1971-2000, in the areas of land¹⁸⁵. In most areas of land with high wind speeds during the reference period the average wind speed is predicted to increase slightly (EUR 1 %). The change in the yield of land-based wind production systems (-1 % to 2 %) is also projected to be small (to), but this varies according to the region and the climatic conditions used¹⁸⁶. In addition, some studies predict an increase in calm values of wind speed, which may endanger both reliable operation and the structural integrity of wind turbines¹⁸⁷.

In the case of marine areas, significant changes in wind potential are expected. The average wind power density is projected to decrease by up to 20 % in SSP1-1.9 and SSP2-4.5 in the periods 2030-2039 and 2060-2069. However, in the case of SENARiou SSP1-1.9, significant increases of up to 30 % are foreseen in some regions of the North Aegean and similar reductions in others. Changes are also expected in the seasonal values of the mean wind power density. SSP1-1.9 and SSP2-4.5 envisage increases in North Aegean and Ionian regions during winter, and decreases in South Aegean regions. As regards the volatility of wind energy, the SSP1-1.9 scenario envisages a reduction in the North Aegean and the Ionian Sea and an increase in the South Aegean for the periods 2030-2039 and 2060-2069. The SSP2-4.5 scenario projects a slight decrease in variability for almost all marine areas in 2030-2039 and an increase in the Ionian and maritime surroundings south of the Peloponnese in 2060-2069.
188

Hydropower

Climate change is expected to cause a reduction in atmospheric precipitation, as well as changes in their intensity and temporal distribution. In the case of the RCP4.5 scenario, a 15 % reduction in average total annual rainfall and an increase in the duration of drought periods of up to 15 consecutive days is expected in the period 2031-2060 compared to the reporting period 1971-2000, especially in Southern Ellada¹⁸⁹. The intensity of rainfall is projected to increase by up to 50 % by 2050 in areas of Thessaly, Western and Central Macedonia, Sterea Ellada and Eastern Macedonia and Thrace, while increases of up to 20%

¹⁸⁵ RIS geospatial information portal. Climate Change. Change in the Average Annual Advance Speed in the Near and the Outermost Future: <https://mapsportal.yopen.gr/maps/930>.

¹⁸⁶ Georgopoulou E, Mirasgedis S, Sarafidis Y, GIANNAKOPOULOS C, Varotsos KV, Gakis N. Climate Change Impacts on the Energy System of a Climate-Vulnerable Mediterranean Country (Greece). *Atmosphere*. 2024; 15 (3): 286. <https://doi.org/10.3390/atmos15030286>.

¹⁸⁷ Theodoros Katopodis, Iason Markantonis, Diamando Vlachogiannis, Nadia Politi, Athanasios Sfetsos, Assessing climate change impacts on wind characteristics in Greece through high resolution regional climate modelling, *Renewable Energy*, Volume 179, 2021, Pages 427444, ISSN 0960-1481, <https://doi.org/10.1016/j.renene.2021.07.061>.

¹⁸⁸ A. Martinez, G. Iglesias, Climate-change impacts on offshore wind resources in the Mediterranean Sea, *Energy Conversion and Manage*, Volume 291, 2023, 117231, ISSN 0196-8904, <https://doi.org/10.1016/j.enconman.2023.117231>.

¹⁸⁹ RIS geospatial information portal. Climate change: https://mapsportal.yopen.gr/thema_climatechange.

are expected in the rest of the country¹⁹⁰. Changes in rainfall are expected to affect the flow of surface water on which hydroelectric injection is also dependent.

Hydropower plants with reservoirs are less affected by riverbed rivers and can in many cases be associated with flood protection. However, they are more affected by the sharp increase in temperature, which leads to an increase in water evaporation. ^{191 192 193}

The hydropower generation capacity in Greece is expected to decrease by up to 10 % by 2050, in the case of the RCP2.6 and RCP 4.5 scenarios, while the reduction may amount to 20 % in the case of more adverse scenarios. The projections vary significantly between the different useful climate models and RCPs scenarios. According to simulations of moderate rainfall and surface run-off for the RCPs scenarios in the regions where the existing hydropower plants are located, hydropower capacity is expected to be reduced by 2-4 % in the Region of Western Greece around 2021-2050 compared to the period 1971-2000, 15-16 % in the regions of Ipiros, Western Macedonia and Central Macedonia, and 5-10 % in the regions of the Peloponnese, the island and eastern Macedonia and Thrace. In the case of simulations based on past performance data of hydropower plants in relation to the prevailing meteorological conditions, greater reductions are foreseen: 20 % in Perifera Peloponnese, 10-15 % in Epirus, Western Macedonia and Central Macedonia and up to 5-10 % in Western Greece and Eastern Macedonia Thrace.^{192, 193}

Bio-energy

The increased concentration of CO₂ in the atmosphere is expected to have a positive impact on forest robustness and growth rate. However, this positive effect is likely not to be visible due to the concurrent negative effects of climate change such as depopulation or loss of certain forest species, the shooting of productive forest areas, an increase in insect infestations and tree death, as well as an increase in the frequency, extent and intensity of forest fires. ¹⁹⁴

Climate change is expected to have a corresponding impact on agricultural crops. An increase in the concentration of CO₂ carbon in the atmosphere, an increase in average temperature and an increase in the length of the vegetative and growing season will have a positive impact on

¹⁹⁰ RIS, 2019, Implementation of Directive 2007/60/EC — 1st revision of the Preliminary Flood Risk Assessment:

<https://floods.ypeka.gr/wp-content/uploads/2023/12/9efdfa4a-ae8-4965-b9b6-6d40ad458a3e.pdf>.

¹⁹¹ European Environment Agency, Adaptation challenges and opportunities for the European energy system – Building a climate-resilient low-carbon energy system, Publications Office, 2019, <https://data.europa.eu/doi/10.2800/227321>.

¹⁹² Drobinski P, Azzopardi B, Ben Janet Allal H, Bouchet V, Civel E, Creti A, Duic N, Fylaktos N, Mutale J, Pariente-David S, Ravetz J, Taliotis C, Vautard R 2020 Energy transition in the Mediterranean. In: Climate and Environmental Change in the Mediterranean Basin -Current Situation and Risks for the Future. First Mediterranean Assessment Report (Cramer W, Guiot J, Marini K (eds.)) Union for the Mediterranean, Plan Bleu, UNEP/MAP, Marseille, France, 58pp, in press

https://www.medecc.org/wp-content/uploads/2020/11/MedECC_MAR1_3_3_Energy_transition_in_the_Mediterranean.pdf.

¹⁹³ Georgopoulou E, Mirasgedis S, Sarafidis Y, GIANNAKOPOULOS C, Varotsos KV, Gakis N. Climate Change Impacts on the Energy System of a Climate-Vulnerable Mediterranean Country (Greece). ATMOSPHERE. 2024; 15 (3): 286. <https://doi.org/10.3390/atmos15030286>.

¹⁹⁴ E. Karalis, I.Tsalakanidou, 2024, Analysis of the current situation to adapt the forestry sector to climate change. Deliverable A1.D1 of LIFE-IP AdaptInGR (code: LIFE17 IPC/GR/000006).

the productivity and growth rate of crops, while, conversely, a reduction in annual rainfall, an increase in the length of drought periods, an increase in disease and desertification of soils are expected to have an adverse effect on them. The type, sign and intensity of impacts are geographically different times and depend on the type of crop, and studies do not focus on the effects of climate change on agricultural biomass production for energy purposes. ¹⁹⁵

However, existing studies predict that energy crops will be declining in Mediterranean and southern European countries such as Greece, especially in regions with limited water resources, where larger areas will be needed to compensate for the decline in productivity. Similarly, they provide for a reduction in the amount of agricultural and forestry residues and waste available in the agri-food sector for bioenergy production.

¹⁹⁵ E. Karalis, I. Tsalacaniidou, 2024. Analysis of the current situation for the adaptation of the Georgian and Livestock sector climate change. Deliverable A1.D1 of LIFE-IP AdaptInGR (code: LIFE17 IPC/GR/000006).