The Greek Energy Sector

Annual Report 2024

IENE

INSTITUTE OF ENERGY
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The Greek Energy Sector – Annual Report 2024

IENE Study (M77)

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Disclaimer

The present study is the product of collective work by the researchers at IENE. The opinions expressed are a synthesis of the various views. Further, the opinions presented here do not necessarily reflect the opinions of the organisations that support, finance or collaborate with the Institute.

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Units of Measurement

bcm	billion cubic meter
bcma	billion cubic meter per annum
bbl	barrel of crude oil
bpd	barrel per day
toe	tonne of oil equivalent
MJ	megajoule
GJ	gigajoule
kWp	kilowatt peak
kVA	kilovolt-ampere
MW	megawatt
GW	gigawatt
TW	terawatt
kWh	kilowatt hour
MWh	megawatt hour
GWh	gigawatt hour
TWh	terawatt hour
°C	degrees of Celsius
m	meter
cm	cubic meter
km	kilometer

Abbreviations

IPTO	Independent Power Transmission Operator
GDP	Gross Domestic Production
RES	Renewable Energy Sources
INGS	Independent Natural Gas System
DAPEEP	Renewable Energy Sources Operator & Guarantees of Origin
DEDA	Public Gas Distribution Networks
HEDNO	Hellenic Electricity Distribution Network Operator
PPC	Public Power Corporation
DEPA	Public Gas Company
DESFA	National Natural Gas System Operator
IMF	International Monetary Fund
EDA Attikis	Attiki Natural Gas Distribution Company
HEREMA	Hellenic Hydrocarbons and Energy Resources Management Company
ELAPE	RES Special Account
HWEA	Hellenic Wind Energy Association
EPA Attikis	Attiki Gas Provider Company (Natural Gas – Hellenic Energy Company)
Aerio Thessaloniki-Thessalia	Thessaloniki-Thessalia Gas Provider Company (ZeniΘ)
NECP	National Energy and Climate Plan
NGS	National Gas System
ETMEAR	RES sector-supporting surcharge imposed on electricity bills
HEnEx	Hellenic Energy Exchange
IEA	International Energy Agency
IOBE	Foundation for Economic & Industrial Research
JMD	Joint Ministerial Decision
NII	Non Interconnected Islands
AVCTP	Average Variable Cost of Thermal Plants
MSP	Marginal System Price
ALC	Act of Legislative Content
RAAEY	Regulatory Authority for Energy, Waste and Water
SEEPE	Hellenic Petroleum Marketing Companies Association
HELAPCO	Hellenic Association of Photovoltaic Companies
CHP	Combined Heat and Power
HRADF	Hellenic Republic Asset Development Fund

LNG	Liquified Natural Gas
EBRD	European Bank for Reconstruction and Development
EIB	European Investment Bank
FID	Final Investment Decision
FiP	Feed-in Premium
FiT	Feed-in Tariff
FSRU	Floating Storage and Regasification Unit
IAP	Ionian Adriatic Pipeline
IGB	Interconnector Greece-Bulgaria
IGNM	Interconnector Greece-North Macedonia
IGTI	Interconnector Greece-Türkiye-Italy
PCI	Projects of Common Interest
TAP	Trans Adriatic Pipeline

Preface

This is the fourth edition of the IENE Annual Report on the Greek Energy Sector. The previous editions were published in 2019, 2020 and 2023. The regular publication of analytical reports on the energy sector in Greece and SE Europe is a key concern of the Institute in its effort to provide broader information on energy issues.

It may sound redundant and unnecessary to state that an updated edition such as this one contributes positively to a better understanding of the structure and operation of the energy sector in Greece, which undoubtedly constitutes the backbone of the economy and a key development pillar. The energy sector may contribute in absolute terms to a much lower percentage of the country's GDP, which is estimated at 4.0%, compared to other sectors such as tourism, which contributes at the level of 15.0%, but it is a sector of high strategic importance, since the progress of the rest of the economy and society in general depends on uninterrupted supply of energy with competitive prices.

Like the previous editions, this year's Report covers all the individual sectors such as oil, natural gas, solid fossil fuels, electricity, Renewable Energy Sources (RES), cogeneration and Energy Efficiency. In addition, it refers to energy investments in all the above sectors as well as forecasts for energy demand and supply with reference to the Greek and European targets. It also covers issues concerning the country's energy security in relation to those foreseen at European level and refers to the national energy policy. Moreover, the latest developments in the legislative and regulatory framework are presented, while the promoted energy technologies are highlighted. The energy position of Greece is also examined in relation to developments and prospects in SE Europe, where Greece has returned to the regional energy scene, claiming an increasingly larger role.

This Report, which is published a few months after the government's National Energy and Climate Plan (NECP), does not aim to be a confrontational study. In contrast to the NECP, it is exclusively a source of information and an analysis tool, while it does not focus on forecasts and analytical scenarios, and in this sense does not constitute an energy policy proposal. Without completely avoiding criticism of the current energy policy, I believe that this Report facilitates the understanding of the domestic energy system.

The Report, which was mainly financed by the Institute's own resources, was prepared by the scientific staff of IENE and was based on data and analyses extracted from both the IENE database and official sources from Greece and internationally. The significant research activity that the Institute has developed in recent years and the continuous and systematic monitoring of the Greek, regional and international energy markets provided the necessary background on which the entire project was based.

Finally, I believe that this year's IENE Report on the Greek Energy Sector and the free access to it will be useful to the State but also to all professionals and companies active in the energy sector.

Costis Stambolis

Chairman and Executive Director
Institute of Energy for SE Europe (IENE)
Athens, February 2025

1. Introduction

Energy has always been and remains a central pillar of human activity and progress. It is also increasingly an integral part of human survival itself. The energy sector is of key importance for the development of the European and Greek economy, since it essentially supports it, ensuring the necessary energy flows for its operation, while creating added value, jobs and attracting investments and strong multiplier benefits.

On the one hand, the impacts of climate change and on the other hand, the increasing geopolitical tensions in our wider region have contributed to the creation of a climate of insecurity in the energy market. Humanity has experienced and is experiencing the effects of geopolitical tensions on energy markets and economies. In 2023 and 2024, the global energy system faced successive challenges related to the increasing interaction between economic, climate and geopolitical risks. In 2023 and 2024, geopolitical events took place, with the escalation of tensions in the Middle East affecting the flows of raw materials and energy products, while the direct impact on supply is related to longer routes for goods as well as higher transportation costs.

The impact on the international and regional natural gas market is significant, where prices increased substantially in the last quarter of 2024. Trading in the Dutch TTF, which is the European benchmark, is now typical, with the price for December deliveries reaching €48/MWh, i.e. a 28% increase compared to prices in September of the same year. On the contrary, the impact on the oil market is much milder, since despite the increasing tension in the Middle East, which is a key source for global oil supply (S. Arabia, Iraq, UAE, Iran), prices have been held at lower levels in the $70-$75 per barrel for Brent, the international benchmark, compared to the first half of 2024, where prices moved above $85 per barrel.

At the same time, Greece, like other countries in the Mediterranean (e.g. Spain, Italy, Türkiye), has been affected by a series of extreme weather phenomena in the last 18 months that, according to some analyses, are attributed to climate change. Typical phenomena are the prolonged heatwaves in the summer of 2023 and 2024 and the unprecedented floods in Thessaly in September 2023. Also, the extensive fires that occurred in Evros, Rhodes, Peloponnese and Attica, which, while having little relation to climate change, nevertheless intensified concerns and the feeling of insecurity and highlighted the need for timely forecasting, organization and adequate funding to deal with extraordinary weather phenomena. With long-term forecasting and planning of the necessary infrastructure projects, including in the energy sector, they should be a priority for the country. The impacts of extreme weather events highlight the urgent need for transition, ensuring the resilience of the European and Greek society and economy.

The 28th United Nations Climate Change Conference (COP28), held from 30 November to 13 December 2023 in Dubai, United Arab Emirates, was a milestone for global energy policy, with more than 130 countries committing to phase out fossil fuels by 2050, tripling global renewable energy capacity to at least 11 TW by 2030, and doubling the rate of energy efficiency improvements by 2030, adopting IRENA's 1.5°C recommendation.

This year, with a central focus on climate finance, the 29th United Nations Climate Change Conference (COP29) held last November brought together nearly 200 countries in Baku, Azerbaijan, and reached a landmark agreement to triple financing for developing countries, from the previous target of $100 billion per year, to $300 billion per year by 2035.

According to the International Energy Agency's report, titled "Electricity 2024 – Analysis and forecast to 2026", a significant development for 2023 was the very large increase in electricity generation from RES globally, which is expected to continue until 2026. In 2023, wind and solar energy recorded the highest combined annual increases in both production and installed capacity worldwide - at 90 TWh and 73 GW respectively. Production from the two RES technologies reached a record 27% of EU electricity.

In 2023, the Greek energy market presented important milestones related mainly to the increase in the participation of RES and the reduction of the contribution of fossil fuels to the energy balance and electricity mix and the shift of consumers towards self-generation solutions. Despite the de-escalation of energy prices in 2023, Greece continued to reduce both electricity and natural gas consumption. This trend, combined with the upward trajectory of RES and the change in citizens' energy behavior that began during the crisis, is indicative of the financial difficulties faced by consumers as the energy transformation intensifies.

In an energy environment that has changed since 2019, with the main characteristics of greater liquidity and uncertainty due to the ongoing crisis between Russia and Ukraine, but also in the Middle East, priorities at a pan-European level are being rearranged, affecting also the design of the National Energy and Climate Plans (NECPs). These new rearrangements in the European and Greek energy markets created a new starting point for the 2019 NECP, resulting in its revision in August 2024, based on the new data set by the European Climate Law and the legislative package "Fit for 55", in particular the adjustment with the obligation to reduce emissions by 55% (net reduction) by 2030, 80% by 2040 and net neutrality in emissions by 2050.

The NECP (Revised Edition, October 2024) looks forward to the development of RES in all sectors, so that they become the main pillar of the green transition through their direct use for energy production and indirectly for the production of green hydrogen and climate-neutral fuels. Indicatively, the target set for RES as a share in gross final energy consumption for 2030 is 43.0%. A very optimistic target, given that in 2023 the participation of RES in final energy consumption did not exceed 20%, despite the fact that the increased penetration of RES in the electricity system has led to higher consumer prices. In any case, the participation of RES in electricity consumption is the main policy priority for achieving this goal. Therefore, priority is given to the transformation of the electricity generation sector, for which the target is set for the share of RES generation units in gross electricity consumption to reach 75.7% in 2030.

The present 4th IENE Report on the Greek Energy Sector aims to provide comprehensive information on the main developments in all individual energy sectors for the past year. In addition, the Report aims to provide information on the current important issues that concern the energy sector of Greece, but also at the European and global level, as well as on how the energy agenda is expected to be shaped in the coming years.

An issue that is of particular concern to this year's Report is energy security, given the developments on the front of hostilities in the Middle East, but also between Russia and Ukraine and the EU's decision to completely abandon Russian energy imports. This Report highlights the need to diversify Greece's sources of supply and the best possible development and utilization of domestic sources of energy wealth (RES and conventional fuels), with emphasis on the creation of appropriate energy infrastructure and the acceleration of hydrocarbon exploration.

In summary, it would be useful to refer to the individual Chapters of this Report. Chapter 2 describes the framework within which the global and Greek economy operates, as well as their prospects, Chapter 3 focuses on the current situation and trends of the global and European energy market, while Chapter 4 briefly describes the European and national energy goals, emphasizing the issue of energy security.

Chapter 5 makes extensive reference to the energy market and energy infrastructure in Greece, while in the individual sections 5.1-5.7 the domestic energy market is thoroughly analyzed per energy fuel and sector, essentially constituting the backbone of the Annual Report, providing a variety of updated data.

Chapter 6 presents recent legislative and regulatory developments in the energy sector in Greece, with emphasis on the restructuring of the domestic wholesale electricity market and the effort to modernize the RES licensing process. Chapter 7 describes the energy market in

SE Europe and focuses on the critical role of Greece, while Chapter 8 presents the energy technologies expected to shape the future, with emphasis on hydrogen and energy storage technology.

Accordingly, Chapter 9 summarizes the energy investments required in Greece by 2030, in the context of its attempt to stop relying on Russian gas and oil imports, seeking alternative sources of energy supply, enhancing energy efficiency and increasing the share of RES in the energy mix. Finally, Chapter 10 refers to the prospects for the further development of the Greek energy market, while Chapter 11 summarizes the main conclusions of the Report.

2. Global and Greek Economy: Trends and Prospects[1]

2.1. The Global Economy: Trends and Prospects

The global economy continued to expand in the second quarter of 2024, at a steady but low pace, as a result of high inflation and monetary tightening. OECD economies grew at an annual rate of 1.7% in the second quarter of 2024, unchanged from the previous quarter and slightly lower than the corresponding quarter of 2023 (1.8%). The annual rate of change in GDP in the most developed economies (G7) strengthened slightly to 1.6%, from 1.5% in the previous quarter, while the corresponding quarter of 2023 was 1.9%. The 20 largest OECD economies grew at a rate of 3.1% in the second quarter of the year, from 3.2% in the previous quarter, and following growth of 3.8% in the corresponding quarter of 2023.

Inflation remains at higher than desired levels, despite a significant slowdown, while inflation is proving persistent in many economies. In August, inflation in the 38 OECD countries fell to 4.74%, while inflation (excluding energy and food) fell to 5.18%. At the same time, energy prices fell by 0.13% and food prices rose by 3.68% in the same month.

Central banks in many major economies are cutting interest rates only gradually, as they continue to maintain a restrictive monetary stance to address persistent inflation. Inflation rates have declined, but remain above the desired level, with the impact of tighter financial conditions evident, weighing on both inflation and economic activity. As inflation continues to exceed their targets, central banks are keeping interest rates high, gradually reducing them as price pressures continue to decrease. A key challenge for monetary policymakers will be to successfully manage the convergence of inflation towards the target, tailoring monetary policy to the underlying inflation dynamics and developments in economic activity.

[1] The majority of this Chapter came from the latest IOBE Report entitled: "The Greek Economy - Quarterly Report - 3rd Quarter 2024", https://iobe.gr/docs/economy/ECO_Q3_2024_REP_GR.pdf

According to the latest OECD report, growth is forecast at 3.2% in 2024, up from 3.1% in the May report. The growth rate of global trade volume is forecast at 2.3% this year, while an acceleration to 3.3% is forecast for 2025. Table 1 shows the annual changes in GDP in 2023 and the most recent OECD forecasts (September 2024) for its annual changes in 2024 and 2025, in the global economy and in selected developed and developing countries.

Table 1: Global Economic Environment (Annual % Change in GDP at Constant Prices, Unless Otherwise Stated), 2023-2025

Economy	2023	2024		2025	
		Projection	Difference from previous forecast*	Projection	Difference from previous forecast*
Global	3.1	3.2	0.1	3.2	0.0
US	2.5	2.6	0.0	1.6	-0.2
Japan	1.9	-0.1	-0.6	1.4	0.3
Canada	1.1	1.1	0.1	1.8	0.0
United Kingdom	0.1	1.1	0.7	1.2	0.2
Eurozone	0.5	0.7	0.0	1.3	-0.2
Germany	*-0.1*	*0.1*	*-0.1*	*1.0*	*-0.1*
France	*0.9*	*1.1*	*0.4*	*1.2*	*-0.1*
Italy	*1.0*	*0.8*	*0.1*	*1.1*	*-0.1*
Türkiye	4.5	3.2	-0.2	3.1	-0.1
China	5.2	4.9	0.0	4.5	0.0
India	7.8	6.7	0.1	6.8	0.2
Brazil	2.9	2.9	1.0	2.6	0.5
World Trade	1.0	2.3	-	3.3	-

* Difference in percentage points compared to previous OECD estimates (OECD Economic Outlook, May 2024).

Source: OECD Economic Outlook, Interim Report, ΟΟΣΑ, September 2024

The recent and expected trends in the economies of the most important countries for 2024 and 2025 are analysed as follows.

Among the most **developed countries**, the United States recorded strong growth in the second quarter of 2024, with GDP growing by 3.0% year-on-year, accelerating from 1.6% in the first quarter. This rise reflects an increase in consumer spending, inventory investment and non-residential fixed investment. Inflation decelerated for the sixth consecutive month to 2.4% in September, making it easier for the country’s central bank to proceed with a reduction in its key interest rate. More specifically, the FED reduced its key interest rate by 50 basis points to a range of 4.75%-5.00% at its September meeting, for the first time since March 2020. In addition, almost all FED members expressed confidence that inflation is moving steadily towards the 2% target. Two more reductions of 25 basis points are now expected by the end of the year. For the whole of this year, the US economy is expected to grow at a rate of 2.6%, while a slowdown to 1.6% is expected for 2025.

The **eurozone** economy grew at an annual rate of 0.6% in the second quarter of 2024, marginally higher than in the previous quarter (0.5%), and compared to a rate of 0.5% in the same quarter of 2023. Compared with the previous quarter, economic activity strengthened by 0.3% on a seasonally adjusted basis, recovering from a contraction of 0.1% in each of the previous two quarters. Among the expenditure components, exports (+1.7% from -0.8% in the previous quarter), government spending (+2.1% from +1.7%) and imports (-1.1% from -1.9%) accelerated, while consumer spending (+0.5% from +0.9%) and fixed investment (-3.0% from -1.0%) slowed down.

Among the bloc's largest economies, GDP increased year-on-year in the second quarter of 2024 in Spain (+3.1%), France (+1.0%), the Netherlands (+0.8%) and Italy (+0.6%), while it remained unchanged in Germany. Inflation fell to 1.8% in September in the Eurozone from 2.2% the previous month, while inflation also fell to 2.7% from 2.8%. The ECB cut its key interest rate for the third time in October by 25 basis points to 3.25%, following the decline in inflation to levels close to its 2% target.

Policymakers insisted that they would continue to take a data-driven approach from meeting to meeting and would not commit in advance to a specific path for interest rates. The Eurosystem's latest inflation forecasts have remained unchanged for 2024 and 2025, with staff projecting inflation to average 2.5% in 2024, 2.2% in 2025 and 1.9% in 2026.

China's economy also slowed to an annual growth rate of 4.7% in the second quarter of 2024, from 5.3% in the previous quarter. It was the weakest annual rate since the first quarter of 2023, amid a persistent housing market downturn, weak domestic demand, a falling yuan and trade tensions with the West. Overall, the economy grew by 5.0% in the first half, in line with the government's target for the full year. Economic indicators in June mostly showed a slowdown, with retail sales posting the smallest increase in nearly 1.5 years and industrial production growth at a three-month low.

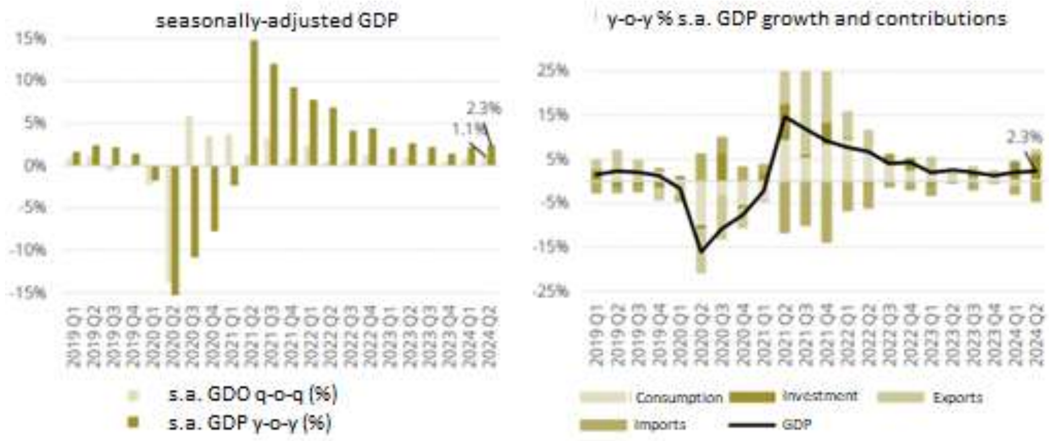
Meanwhile, the urban unemployment rate remained unchanged at 5.0% for a third month. In terms of trade, exports rose more than expected last month, but imports contracted unexpectedly. In late September and early October 2024, China launched a series of stimulus measures to boost its sluggish economy. These included monetary policies such as cutting interest rates, increasing liquidity for banks, and strengthening support for the troubled real estate sector. The government also announced plans to accelerate public spending through the issuance of special bonds.

The measures are aimed at reviving consumer spending and stabilizing key industries, although concerns remain about their long-term impact, given challenges such as weak consumer demand and high debt levels. For 2024, growth is forecast to slow slightly to 4.9%, according to the OECD, and to slow further in 2025 to 4.5%.

2.2. The Greek Economy: Trends and Prospects

In the second quarter of 2024, the annual growth rate of the Greek economy is estimated at +2.3%, continuing the upward trend of the previous quarter (+2.1% annually) and significantly exceeding the corresponding rate of the Eurozone (+0.2% annually) for the same period. It is noteworthy that the strong annual GDP growth continues for the 13th consecutive quarter after the economy recovered from the pandemic. The main factors of this growth are the increase in private consumption, which traditionally supports the GDP trend, as well as the large increase in total investments, mainly due to inventories. In contrast, general government consumer spending recorded a significant decrease, while the external balance deteriorated, as the significant increase in exports was offset by the larger increase in imports (see Figure 1).

Figure 1: GDP Evolution and Contribution of its Components for Greece



Sources: ELSTAT and IOBE

Regarding developments in GDP components in the second quarter of this year, the annual growth rate of total domestic consumption increased by +0.9% (from 0.6% in the previous quarter). Private consumption maintained its upward trend for the 13th consecutive quarter, as did GDP, recording an annual increase of +2.0% (compared to +2.1% in the previous quarter), thanks to the increase in employment and part of nominal wages, as well as the decrease in savings.

In contrast, public consumption continued its downward trend, with its annual growth rate decreasing by -3.6%, compared to -5.1% in the previous quarter. Supported by the resources of the Recovery and Resilience Fund, fixed capital investment managed to maintain its momentum, growing by +3.9% annually, compared to +3.1% in the previous quarter. The strong momentum of total investment (+29.7%) is mainly based on the significant increase in inventories, which in the corresponding quarter of the previous year had almost no change.

Specifically, the increase in fixed capital investment was primarily contributed by investments in Mechanical and transport equipment, which increased annually by +12.2% (from +5.2% in the previous quarter), followed by investments in other products, with an annual increase of +1.3% (from +0.6% in the previous quarter), while conversely, investments in Housing and construction experienced a decline, decreasing by -2.1% annually (from +0.6% in the previous quarter). In detail, in the individual categories of fixed capital investment, the annual rate of change was positive in five of the seven sectors, as annual increases were recorded in investments in Mechanical Equipment and Weapons Systems (+16.3% compared to 7.4% in the previous quarter), Transport Equipment (+13.4% compared to 8.0% in the previous quarter), Information and Communication Technology Equipment (2.1% compared to -1.6% in the previous quarter), Other Products (+1.4% compared to +0.7% in the previous quarter), and Other Construction (+0.7% compared to +9.4% in the previous quarter). In contrast, annual decreases were recorded in investments in Agricultural Products (-5.5%), and in Housing (-7.1%).

Table 2: Evolution of Key Macroeconomic Indicators – National Accounts (Seasonally Adjusted Data, Constant 2015 Prices), Provisional Data

Quarter	GDP		Final Consumption		Investment		Exports		Imports	
	€million	Annual rate of change	€million	Annual rate of change	€million	Annual rate of change	€million	Annual rate of change	€million	Annual rate of change
2012	**180484**	**-7,2%**	**163337**	**-7,0%**	**20220**	**-21,0%**	**48968**	**2,0%**	**52765**	**-5,7%**
2013	**175920**	**-2,5%**	**156834**	**-4,0%**	**19580**	**-3,2%**	**49843**	**1,8%**	**50682**	**-3,9%**
2014	**176882**	**0,5%**	**156657**	**-0,1%**	**20431**	**4,3%**	**53954**	**8,2%**	**54107**	**6,8%**
2015	**176462**	**-0,2%**	**156611**	**0,0%**	**21369**	**4,6%**	**56661**	**5,0%**	**58360**	**7,9%**
2016	**175612**	**-0,5%**	**156023**	**-0,4%**	**22767**	**6,5%**	**56426**	**-0,4%**	**59868**	**2,6%**
2017	**177461**	**1,1%**	**158863**	**1,8%**	**21627**	**-5,0%**	**61229**	**8,5%**	**64371**	**7,5%**
1’ 2018	44946	1,8%	40272	2,3%	5318	-10,5%	16246	9,4%	16677	4,7%
2’ 2018	45057	1,7%	39723	0,1%	6234	16,4%	16500	7,8%	17221	8,4%

3’ 2018	44945	0,5%	39865	0,2%	5308	-1,4%	16614	7,1%	17636	8,9%
4’ 2018	45270	2,2%	39833	-0,5%	6430	30,0%	17451	12,2%	17677	8,0%
2018	**180217**	**1,6%**	**159693**	**0,5%**	**23289**	**7,7%**	**66812**	**9,1%**	**69210**	**7,5%**
1’ 2019	45625	1,5%	40350	0,2%	6317	18,8%	17110	5,3%	17711	6,2%
2’ 2019	46110	2,3%	40744	2,6%	5559	-10,8%	18457	11,9%	17716	2,9%
3’ 2019	45877	2,1%	40142	0,7%	4819	-9,2%	18347	10,4%	18230	3,4%
4’ 2019	45849	1,3%	40948	2,8%	5607	-12,8%	16163	-7,4%	17565	-0,6%
2019	**183461**	**1,8%**	**162184**	**1,6%**	**22302**	**-4,2%**	**70076**	**4,9%**	**71222**	**2,9%**
1’ 2020	44878	-1,6%	40699	0,9%	6392	1,2%	15381	-10,1%	18147	2,5%
2’ 2020	38716	-16,0%	36346	-10,8%	5245	-5,7%	13100	-29,0%	14907	-15,9%
3’ 2020	40958	-10,7%	38747	-3,5%	6739	39,8%	12408	-32,4%	16750	-8,1%
4’ 2020	42343	-7,6%	38418	-6,2%	5338	-4,8%	14107	-12,7%	16114	-8,3%
2020	**166894**	**-9,0%**	**154210**	**-4,9%**	**23713**	**6,3%**	**54996**	**-21,5%**	**65918**	**-7,4%**
1’ 2021	43878	-2,2%	38735	-4,8%	7238	13,2%	15252	-0,8%	17436	-3,9%
2΄ 2021	44412	14,7%	40200	10,6%	7714	47,1%	16406	25,2%	18948	27,1%
3’ 2021	45842	11,9%	41180	6,3%	7001	3,9%	18388	48,2%	20460	22,2%
4’ 2021	46220	9,2%	42039	9,4%	7061	32,3%	18248	29,4%	20979	30,2%
2021	**180351**	**8,1%**	**162155**	**5,2%**	**29014**	**22,4%**	**68293**	**24,2%**	**77823**	**18,1%**
1’ 2022	47261	7,7%	42926	10,8%	7328	1,2%	17608	15,5%	20105	15,3%
2’ 2022	47442	6,8%	43034	7,0%	7290	-5,5%	18564	13,2%	21113	11,4%
3’ 2022	47689	4,0%	43063	4,6%	7813	11,6%	18179	-1,1%	20795	1,6%
4’ 2022	48194	4,3%	43302	3,0%	8168	15,7%	18208	-0,2%	21805	3,9%
2022	**190586**	**5,7%**	**172326**	**6,3%**	**30600**	**5,5%**	**72560**	**6,2%**	**83819**	**7,7%**
1’ 2023	48206	2,0%	43689	1,8%	6581	-10,2%	18885	7,2%	20760	3,3%
2’ 2023	48724	2,7%	43723	1,6%	7092	-2,7%	18611	0,3%	20981	-0,6%
3’ 2023	48681	2,1%	43520	1,1%	8493	8,7%	18519	1,9%	21405	2,9%
4’ 2023	48756	1,2%	44062	1,8%	8069	-1,2%	18585	2,1%	21811	0,0%
2023	**194367**	**2,0%**	**174994**	**1,5%**	**30235**	**-1,2%**	**74600**	**2,8%**	**84956**	**1,4%**
1’ 2024	49190	2,1%	44171	1,1%	8229	22,3%	18095	-5,7%	21683	3,1%

Sources: Quarterly National Accounts, ELSTAT, March 2024

Medium- and Long-Term Prospects

Private consumption is expected to maintain its momentum in the second half of this year, thanks to the increase in employment and wages, and the gradual de-escalation of inflation. In addition, if we take into account the expected reduction in interest rates and the implementation of the Greek Recovery and Resilience Plan, this positive trend is expected to continue in 2025.

However, the slower de-escalation of the unemployment rate, the ongoing credit contraction to households combined with the high cost of borrowing and their negative savings rate, as well as a possible large increase in international energy prices with consequent negative impacts on production costs and the de-escalation of interest rates will act as a brake on further strengthening of consumption. Regarding public consumption, the targets for achieving fiscal surpluses will lead to its contraction both this year and next year. For 2024, the annual change in private and public consumption is estimated at +2.2% and -2.7% respectively, while for 2025 at +1.7% and -0.4%. Total consumption is expected to be +1.3% (2024) and +1.2% (2025).

Table 3: Comparison of Forecasts for Selected Economic Indicators for the Years 2024 and 2025 (at Constant Market Prices, Annual % Changes)

	Ministry of Economy		European Commission		IOBE		IMF		OECD	
	2024	2025	2024	2025	2024	2025	2024	2025	2024	2025
GDP	2,2%	2,3%	2,2%	2,3%	2,3%	2,4%	2,0%	1,9%	2,0%	2,5%
Consumption	:	:	:	:	1,3%	1,2%	:	:	:	:
Private Consumption	1,7%	1,6%	:	:	2,2%	1,7%	:	:	1,7%	0,9%
Public Consumption	0,4%	0,0%	:	:	-2,7%	-0,4%	:	:	1,4%	0,7%
Gross Fixed Capital Investment	6,7%	8,4%	6,7%	:	8,8%	11,0%	:	:	2,8%	9,1%
Exports	4,2%	4,0%	:	:	1,8%	4,0%	:	:	1,3%	2,9%
Imports	3,8%	3,6%	:	:	5,8%	2,9%	:	:	3,4%	1,6%
Inflation (%)	2,8%	2,1%	2,8%	2,1%	3,0%	2,4%	2,7%	2,1%	3,0%	2,3%
Unemployment (% labor force)	10,3%	9,7%	10,3%	9,7%	10,1%	9,3%	9,4%	8,7%	9,8%	9,7%
General Government Primary Balance (% GDP)	2,4%	2,5%	:	-0,8%	:	:	2,1%	2,1%	1,8%	:
Current Account Balance (% GDP)	:	:	-5,2%	-4,8%	:	:	-6,5%	-5,3%	-6,0%	-4,0%

Sources: Medium-Term Fiscal-Structural Plan 2025-2028 – October 2024 – Ministry of National Economy and Finance, European Economic Forecast Spring 2024 – May 2024 – European Commission (EC), The Greek Economy 03/24 – October 2024 – IOBE (FEIR), IMF World Economic Outlook, Fiscal Monitor April 2024 – April 2024 – IMF, Economic Outlook 115 – May 2024 – OECD

Fixed capital investment is expected to maintain its upward trend in both the second half of 2024 and 2025. The drivers of this growth include the expected further easing of monetary policy, the acceleration of the implementation of the Greek Recovery and Resilience Plan, as well as the improvement in the economic climate following the upgrade of the country's credit rating. Furthermore, the faster de-escalation of interest rates is expected to strengthen the low credit expansion to businesses. More specifically, for 2024, fixed capital investment is expected to increase by +8.8% compared to the previous year, while for 2025 the growth rate is expected to reach +11.0%.

The external balance is expected to deteriorate compared to 2023, as the increase in total imports more than offset the positive impact of the increase in exports in the second quarter of 2024, with the Greek economy, however, maintaining its high degree of extroversion. For 2025, the projected increase in domestic demand, driven by accelerating investment, is estimated to lead to a strengthening of both total imports and exports, with exports recording a faster increase thanks to the increasing export capacity and strengthening competitiveness, combined with the gradual recovery of external demand. In addition, the upward trend in export market shares and the steady increase in receipts from tourism will contribute to the gradual further reduction of the current account deficit. We consider that the annual rate of change of exports and imports will be +1.8% and +5.8%, respectively, in 2024, and +4.0% and +2.9% in 2025.

Taking into account all the above, IOBE revises upwards its forecast for the recovery of the domestic economy, estimating a growth rate of +2.3% in 2024 (from +2.1% in the previous forecast of July 2024) and +2.4% in 2025, with some negative prospects, due to the low growth rate of the eurozone economy, the deterioration of the external balance and the persistence of inflation and uncertainty at the regional and global level.

3. The Global and European Energy Market

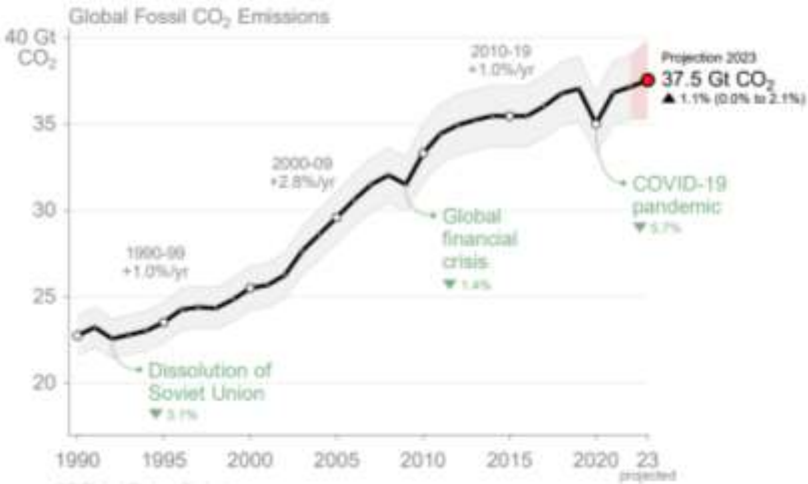
3.1 Global Energy Market

The energy market volatility that began in mid-2021 and dominated 2022 after Russia's invasion of Ukraine, with the energy crisis dominating, subsided in 2023 with energy prices falling, but the situation in view of hostilities in the Middle East remains fragile. The need for the transformation of the global energy system is now taking place in a more complex and fluid macroeconomic and geopolitical context. The vulnerability of the fossil fuel era and the risks associated with it are now more clearly visible, while at the same time the opportunities for emerging clean energy technologies are increasing at a rapid pace. However, many uncertainties remain related to the resilience of energy supply chains, the risks to security and affordability of the energy transition and whether the process of change will be rapid enough to avoid very severe impacts from a changing climate. The energy transition is based on electromobility and technologies such as wind, solar, photovoltaics, battery storage as well as on electricity security and diversified supply for clean technologies and critical minerals.

From mid-2021 to late 2022, Europe was caught in an energy crisis caused by soaring oil, gas and coal prices, which in some cases reached record highs, forcing households and businesses to rapidly reduce their consumption. Russia's invasion of Ukraine and the sanctions imposed in response by the United States and its allies disrupted energy supplies, which were already under pressure from the recovery in industrial production after the coronavirus pandemic. 2023 was the year in which energy prices fell, but carbon dioxide (CO2) emissions rose.

As shown in Figure 2, global carbon dioxide emissions from fossil fuels and cement increased by 1.1% in 2023, reaching a new record high of 36.8 billion tonnes of CO2 (GtCO2), according to the 2023 Global Carbon Budget report from the Global Carbon Project [1]. While CO2 emissions from fossil fuels in 2023 fell in some regions, including Europe and the US, the report records an increase in emissions globally, with this increase largely due to increased emissions from China – without which the global total would have remained roughly stable at 2022 levels.

Figure 2: Evolution of Global CO_2 Emissions, 1959-2023



Source: Carbon Brief

The study of the International Energy Agency (IEA) entitled: "World Energy Outlook 2024 (WEO 2024)" [2] is particularly important as it is a key tool for global energy developments. This year's Report focuses on the escalating risks in the Middle East and increased geopolitical tensions at global level and explores a range of energy security issues that decision-makers face as they move forward with clean energy transition. With increased investment in clean technologies and rapid growth in electricity demand, the WEO 2024 study examines how far the world has come on its path towards a more secure and sustainable energy system and what more needs to be done to achieve climate goals.

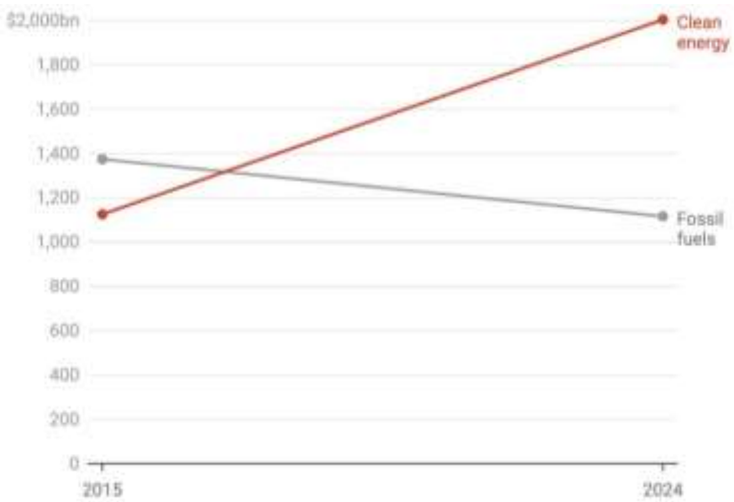
In particular, the new report highlights that current geopolitical tensions and fragmentation pose significant risks to both energy security and global action to reduce greenhouse gas emissions. The increasingly visible impacts of climate change, the dynamics behind clean energy transition and the characteristics of clean technologies are all changing what it means to have secure energy systems. A comprehensive approach to energy security must therefore extend beyond traditional fuels to cover the secure transformation of the electricity sector and the resilience of clean energy supply chains. Energy security and climate action are inextricably linked: extreme weather events, exacerbated by decades of high emissions, already pose significant risks to energy security. [2].

Clean energy transition has accelerated significantly in recent years, shaped by government policies and industry strategies, but there is more uncertainty in the near term than usual about how these policies and strategies will play out. The report's projections based on current policies suggest that the world is set to enter a new energy market context in the coming years, one characterized by ongoing geopolitical risks but also by relatively abundant supplies of fuels and technologies. This new energy situation will include a surplus of oil and liquefied natural gas (LNG) that will emerge in the second half of the 2020s, alongside a large production surplus in clean energy technologies, particularly solar photovoltaics and batteries.

The next phase towards a more secure and sustainable energy system will take place in a new energy market context, characterised by ongoing geopolitical risks but also by relatively abundant fuel and technology production. Our detailed analysis of market balances and supply chains highlights an oversupply of oil and LNG in the second half of the 2020s, alongside a large oversupply of capacity in some key clean energy technologies, notably photovoltaics and batteries. This provides a measure of security against further market disruptions, but it also implies downward pressure on prices and a period of increased competition among suppliers. The rapid growth of clean energy in recent years has come at a time of volatile fossil fuel prices. The cost of clean technologies is falling, but maintaining and accelerating their momentum in a world of lower fuel prices is another matter [2].

In this complex global landscape, the emergence and strengthening of the clean energy sector in recent years, with solar photovoltaics and electric vehicles (EVs) at the forefront, provides hope for the future. Investment in clean energy has increased by 40% since 2020, driven primarily by the push to reduce greenhouse gas emissions, but also by the economic incentive for mature clean energy technologies (Figure 3).

Figure 3: Annual investments in fossil fuels and clean energy, 2015-2024 (trillion USD)



Source: IEA

Clean energy is entering the energy system at an unprecedented pace, with more than 560 GW of new renewable capacity added by 2023, but its growth is far from the same across technologies and countries. Investment flows into clean energy projects are approaching $2 trillion each year, nearly double the combined amount spent on new oil, gas and coal generation – and costs for most clean technologies continue to fall after rising in the aftermath of the Covid-19 pandemic. This helps installed renewable capacity grow from 4,250 GW today to almost 10,000 GW in 2030 in the STEPS scenario, which falls short of the tripling target set at the UN Climate Change Conference (COP28), but is enough, overall, to meet the increase in global electricity demand and drive coal-fired electricity generation down. Along with nuclear power, which is the subject of renewed interest from many countries, low-emission sources of electricity generation are set to generate more than half of the world's electricity before 2030. China stands out: it accounts for 60% of the new installed renewable energy capacity added worldwide by 2023 – and China's photovoltaic electricity generation alone is set to exceed the total US electricity demand today by the early 2030s.

Specifically, IEA's World Energy Outlook 2024 explores three scenarios that provide the framework for how the future of energy will shape up and explore the impacts of various policy choices, investment and technology trends.

The **Stated Policies Scenario (STEPS)** provides a sense of where the energy sector is headed today, based on the latest market data, technology costs, and an in-depth analysis of current policy frameworks around the world. The STEPS scenario also provides the basis for optimistic and pessimistic sensitivity analyses.

The **Announced Pledges Scenario (APS)** examines what would happen if all national energy and climate targets set by governments, including net zero emissions targets, were fully and timely achieved.

The **Net Zero Emissions by 2050 Scenario (NZE)** maps an increasingly narrow path to achieving net zero emissions by mid-century in a way that limits global warming to 1.5°C.

Reflecting today's uncertainties, the three main scenarios are complemented by sensitivity analyses for renewables, electrification, liquefied natural gas (LNG) and how heatwaves, energy efficiency policies and the rise of artificial intelligence (AI) could affect electricity demand. The scenarios and sensitivity analyses illustrate different pathways that the energy sector could follow, the levers that policymakers can use to achieve them, and the impacts of these pathways on energy markets, security and emissions, as well as on people's lives and incomes.

The IEA notes that coal will be the only fossil fuel whose use will decline over the next decade, according to its Step-by-Step Policy Scenario (STEPS). The IEA's projections are based on the assumption that there will be impressive growth in renewable energy sources and electric vehicle penetration by 2030. Although global energy demand will grow by 7% by 2030, the first step before 2050 and the goal of achieving net zero conditions, demand will shift largely towards renewables and nuclear power. However, fossil fuels will remain in the spotlight as they will continue to represent more than 70% of supply, compared to an 82% share in 2022, according to the same scenario.

Solar and wind power will continue to grow rapidly, becoming the main source of electricity generation by 2025. The study says that investment in clean energy has increased by 40% since 2020, which has a positive impact on the creation of new jobs in the sector. More than $1 billion is spent on solar power development every day, while more than 500 GW of renewable energy capacity is expected to be added worldwide this year. However, it should be noted that their growth still falls short of the goal of net zero emissions by 2050. Global electricity demand is expected to grow rapidly in all scenarios, as a result of population and income growth, as well as the electrification of an increasing number of energy end-users. By 2050, electricity demand will increase by 80% from its current level in the STEPS scenario, by 120% in the APS scenario and by 150% in the NZE scenario. This additional demand will be met mainly by low-emission electricity sources, such as renewables, nuclear, fossil fuels with carbon capture, hydrogen and ammonia, increasing their share of electricity supply in each scenario. In contrast, the share of fossil fuels in electricity demand is expected to decline sharply from 2022 to 2050, with the decline reaching more than a third in the STEPS scenario, three quarters in the APS scenario and almost 100% in the NZE scenario.

Despite record clean energy growth, two-thirds of the growth in global energy demand through 2023 was met by fossil fuels, pushing energy-related carbon emissions to another high. In the STEPS scenario, the largest sources of energy demand growth are, in descending order, India, Southeast Asia, the Middle East, and Africa. However, clean energy growth and structural changes in the global economy, particularly in China, are starting to moderate overall energy demand growth, not least because a system with more electricity and rich in renewables is inherently more efficient than a system dominated by fossil fuel combustion (in which much of the energy produced is lost as heat). Individual year outcomes may vary in practice depending on broader economic or weather conditions or hydropower generation, but the direction under current policy frameworks is clear. The continued growth in global energy demand after 2030 can be met exclusively with clean energy.

Some 270 billion cubic meters of new LNG capacity per year has been approved and, if delivered on schedule, is due to be commissioned by 2030, will be a huge addition to global production. In the STEPS scenario, LNG demand grows by more than 2.5% per year to 2035, an upward revision from last year's forecast, and the growth is faster than the growth in total gas demand. Europe and China have the infrastructure to absorb significantly more gas, but the scope is constrained by their investments in clean energy. IEA. CC BY 4.0. Executive

Summary 9 Emerging and developing economies that import natural gas generally need prices of around $3-5 per million British thermal units to make natural gas attractive as a large-scale alternative to renewables and coal, but delivery costs for most new export projects need to average around $8 per million British thermal units to cover investment and operation. If natural gas markets are to absorb all potential new LNG production and continue to grow beyond 2030, this would require some combination of even lower prices, higher electricity demand and slower energy transitions – with less wind and solar, lower rates of building efficiency improvements and fewer heat pumps – than is assumed in the STEPS scenario. However, any acceleration of global energy transitions towards the outcomes projected in the APS or NZE scenarios, or a new major Russia-China gas supply deal (which we do not include in the STEPS scenario), would exacerbate the LNG oversupply [2].

In the past five years, annual solar capacity additions have quadrupled to 425 GW, but annual PV capacity is set to increase sixfold to more than 1,100 GW, a level that – if fully deployed – would be very close to the quantities required in the NZE scenario. The story is similar for the abundant lithium battery capacity. The large-scale introduction of these technologies in developing economies would transform global trends, helping to meet growing demand in a sustainable way and allowing global emissions not only to peak in the coming years, as in the STEPS scenario, but also to enter a significant decline, which is not the case in the STEPS scenario. This requires concerted efforts to facilitate investment in developing economies, while addressing the risks that lead to rising capital costs.

The increasing use of electricity by data centres, which is partly linked to the increasing use of artificial intelligence, already has some strong local impact, but the potential impact of AI on energy are broader and include better coordination of systems in power generation and shorter innovation cycles. There are more than 11,000 registered data centres worldwide, and they are often concentrated in certain regions, so the local impact on electricity markets can be significant. However, globally, data centres represent a relatively small share of the total increase in electricity demand by 2030. More frequent and intense heat waves than we assume in the STEPS scenario, or better energy efficiency applied to new appliances – notably air conditioners – both produce significantly larger fluctuations in projected electricity demand than a case with increased data centre penetration. The combination of rising incomes and rising global temperatures creates over 1,200 TWh of additional global electricity demand for cooling by 2035 in the STEPS scenario, an amount greater than the current electricity consumption of the entire Middle East.

The study concludes that despite the growing momentum of transition, the world is still far from a path aligned with climate goals. Decisions by governments, investors and consumers too often entrench the flaws of the current energy system, rather than pushing it towards a cleaner and safer path. There are some positive developments in the STEPS scenario, but current policy frameworks still put the world on a trajectory for an average global temperature increase of 2.4 °C by 2100, which entails increasingly serious risks from climate change. Our scenario analysis highlights the prospect of buyers and consumers taking the lead in energy markets for a while, with suppliers competing as they make fuel and technology choices that have very different impacts on the energy sector and its emissions. All parties must recognize that there are consequences to continuing to use fossil fuels. There may be pressure to reduce fuel prices for a while, but history has shown that one day the cycle will reverse and prices will rise. And the cost of climate inaction, meanwhile, is growing by the day, as emissions pile up in the atmosphere and extreme weather events take their own unpredictable toll. In contrast, clean technologies that are increasingly cost-effective today are set to stay that way, with significantly reduced exposure to market volatility and lasting benefits for people and the planet. [2].

Table 4: Global Energy Supply by Fuel and Scenario (Mtoe), 2010-2050

				Stated Policies (EJ)				Shares (%)			CAAGR (%) 2023 to:	
	2010	2022	2023	2030	2035	2040	2050	2023	2030	2050	2030	2050
Total energy supply	536	629	642	676	682	691	722	100	100	100	0.7	0.4
Renewables	43	74	78	120	153	185	241	12	18	33	6.4	4.3
Solar	1	6	8	26	42	58	84	1	4	12	19	9.3
Wind	1	8	8	18	27	34	44	1	3	6	12	6.4
Hydro	12	16	15	17	19	20	23	2	3	3	1.9	1.5
Modern solid bioenergy	23	34	36	44	46	49	56	6	6	8	2.9	1.7
Modern liquid bioenergy	2	4	5	6	6	7	8	1	1	1	3.4	2.2
Modern gaseous bioenergy	1	1	1	2	3	5	8	0	0	1	7.7	7.2
Traditional use of biomass	21	19	19	15	13	12	10	3	2	1	-3.8	-2.5
Nuclear	30	29	30	36	41	45	49	5	5	7	2.5	1.8
Natural gas	115	144	145	153	153	152	152	23	23	21	0.8	0.2
Unabated	109	136	137	144	142	140	139	21	21	19	0.7	0.0
With CCUS	0	1	1	1	2	2	3	0	0	0	11	6.3
Oil	173	187	192	195	189	182	176	30	29	24	0.2	-0.3
Non-energy use	26	30	31	36	38	40	41	5	5	6	2.3	1.1
Coal	153	172	175	156	131	114	94	27	23	13	-1.7	-2.3
Unabated	151	169	172	151	126	109	89	27	22	12	-1.8	-2.4
With CCUS	-	0	0	0	0	0	1	0	0	0	46	15
Electricity and heat sectors	200	249	255	275	286	302	334	100	100	100	1.1	1.0
Renewables	20	41	43	78	108	136	182	17	28	54	8.8	5.5
Solar PV	0	5	6	23	38	54	78	2	8	23	22	10
Wind	1	8	8	18	27	34	44	3	7	13	12	6.4
Hydro	12	16	15	17	19	20	23	6	6	7	1.9	1.5
Bioenergy	4	9	10	14	16	17	21	4	5	6	5.1	3.0
Hydrogen	-	-	-	0	0	0	0	-	0	0	n.a.	n.a.
Ammonia	-	-	-	0	0	0	0	-	0	0	n.a.	n.a.
Nuclear	30	29	30	36	41	45	49	12	13	15	2.5	1.8
Unabated natural gas	47	56	57	58	56	54	52	22	21	16	0.1	-0.3
Natural gas with CCUS	-	-	-	0	0	0	1	-	0	0	n.a.	n.a.
Oil	11	9	8	4	3	3	2	3	2	0	-8.9	-6.1
Unabated coal	91	112	115	98	76	63	47	45	36	14	-2.2	-3.3
Coal with CCUS	-	0	0	0	0	0	0	0	0	0	32	16

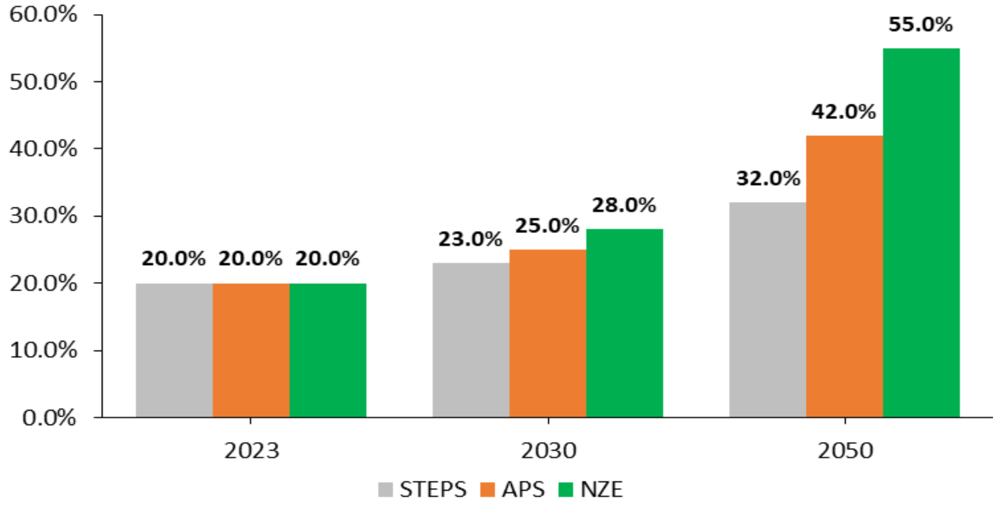
				Announced Pledges (EJ)				Shares (%)			CAAGR (%) 2023 to:	
	2010	2022	2023	2030	2035	2040	2050	2023	2030	2050	2030	2050
Total energy supply	536	629	642	641	624	620	635	100	100	100	-0.0	-0.0
Renewables	43	74	78	140	197	251	336	12	22	53	8.7	5.6
Solar	1	6	8	31	55	81	120	1	5	19	22	11
Wind	1	8	8	21	34	46	66	1	3	10	14	7.9
Hydro	12	16	15	18	20	22	25	2	3	4	2.4	1.9
Modern solid bioenergy	23	34	36	48	56	64	73	6	7	11	4.3	2.7
Modern liquid bioenergy	2	4	5	10	12	14	14	1	2	2	11	4.2
Modern gaseous bioenergy	1	1	1	4	6	8	12	0	1	2	17	8.6
Traditional use of biomass	21	19	19	6	5	3	2	3	1	0	-14	-7.7
Nuclear	30	29	30	39	49	59	69	5	6	11	3.6	3.1
Natural gas	115	144	145	138	121	106	86	23	22	14	-0.7	-1.9
Unabated	109	136	137	128	108	90	65	21	20	10	-1.0	-2.7
With CCUS	0	1	1	2	5	7	13	0	0	2	25	13
Oil	173	187	192	178	156	133	100	30	28	16	-1.1	-2.4
Non-energy use	26	30	31	34	35	35	34	5	5	5	1.6	0.3
Coal	153	172	175	138	95	66	40	27	22	6	-3.4	-5.3
Unabated	151	169	172	134	87	56	28	27	21	4	-3.5	-6.5
With CCUS	-	0	0	0	4	6	10	0	0	2	63	28
Electricity and heat sectors	200	249	255	271	285	314	378	100	100	100	0.9	1.5
Renewables	20	41	43	88	134	180	255	17	33	68	11	6.8
Solar PV	0	5	6	27	49	71	104	2	10	28	25	11
Wind	1	8	8	21	34	46	66	3	8	17	14	7.9
Hydro	12	16	15	18	20	22	25	6	7	7	2.4	1.9
Bioenergy	4	9	10	15	20	25	32	4	6	9	6.6	4.5
Hydrogen	-	-	-	0	1	2	2	-	0	1	n.a.	n.a.
Ammonia	-	-	-	0	0	0	2	-	0	0	n.a.	n.a.
Nuclear	30	29	30	39	49	59	69	12	14	18	3.6	3.1
Unabated natural gas	47	56	57	53	43	36	26	22	19	7	-1.1	-2.9
Natural gas with CCUS	-	-	-	0	0	1	1	-	0	0	n.a.	n.a.
Oil	11	9	8	4	2	2	1	3	1	0	-12	-8.1
Unabated coal	91	112	115	86	50	29	13	45	32	4	-4.0	-7.6
Coal with CCUS	-	0	0	0	3	4	7	0	0	2	60	30

				Net Zero Emissions by 2050 (EJ)				Shares (%)			CAAGR (%) 2023 to:	
	2010	2022	2023	2030	2035	2040	2050	2023	2030	2050	2030	2050
Total energy supply	536	629	642	588	544	538	564	100	100	100	-1.3	-0.5
Renewables	43	74	78	165	245	312	399	12	28	71	11	6.2
Solar	1	6	8	38	72	104	145	1	6	26	26	11
Wind	1	8	8	26	45	62	86	1	4	15	17	9.0
Hydro	12	16	15	19	22	25	28	2	3	5	3.5	2.2
Modern solid bioenergy	23	34	36	53	64	71	76	6	9	13	5.8	2.8
Modern liquid bioenergy	2	4	5	12	14	14	12	1	2	2	15	3.5
Modern gaseous bioenergy	1	1	1	6	9	11	12	0	1	2	26	8.8
Traditional use of biomass	21	19	19	-	-	-	-	3	-	-	n.a.	n.a.
Nuclear	30	29	30	44	59	70	78	5	7	14	5.5	3.6
Natural gas	115	144	145	126	79	53	31	23	21	5	-2.0	-5.6
Unabated	109	136	137	113	62	32	7	21	19	1	-2.7	-10
With CCUS	0	1	1	5	9	13	17	0	1	3	39	14
Oil	173	187	192	151	109	77	40	30	26	7	-3.4	-5.6
Non-energy use	26	30	31	33	32	31	28	5	6	5	0.9	-0.3
Coal	153	172	175	101	51	25	15	27	17	3	-7.6	-8.8
Unabated	151	169	172	95	41	13	2	27	16	0	-8.1	-15
With CCUS	-	0	0	2	7	9	11	0	0	2	106	28
Electricity and heat sectors	200	249	255	266	286	329	408	100	100	100	0.6	1.8
Renewables	20	41	43	104	172	232	311	17	39	76	13	7.6
Solar PV	0	5	6	33	64	89	123	2	12	30	28	12
Wind	1	8	8	26	45	62	86	3	10	21	17	9.0
Hydro	12	16	15	19	22	25	28	6	7	7	3.5	2.2
Bioenergy	4	9	10	16	24	30	36	4	6	9	7.2	5.0
Hydrogen	-	-	-	2	4	5	5	-	1	1	n.a.	n.a.
Ammonia	-	-	-	1	1	2	2	-	0	0	n.a.	n.a.
Nuclear	30	29	30	44	59	70	78	12	17	19	5.5	3.6
Unabated natural gas	47	56	57	53	26	11	2	22	20	0	-1.0	-12
Natural gas with CCUS	-	-	-	0	1	2	3	-	0	1	n.a.	n.a.
Oil	11	9	8	2	1	0	0	3	1	0	-17	-25
Unabated coal	91	112	115	58	17	0	0	45	22	0	-9.4	-35
Coal with CCUS	-	0	0	1	4	6	7	0	1	2	117	30

Source: IEA

The share of electricity in global final energy consumption has increased steadily in recent decades and amounted to 20% in 2023. By 2030, the share of electricity increases to 28%, while in 2050 electricity accounts for 55% of global final energy consumption in the NZE scenario (Figure 4).

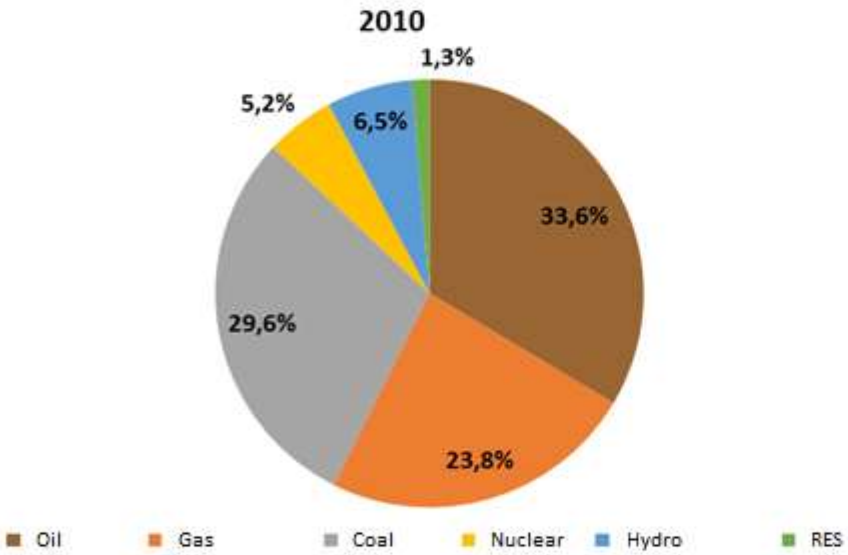
Figure 4: Share of electricity in global final energy consumption in 2023, 2030 and 2050, by scenario.

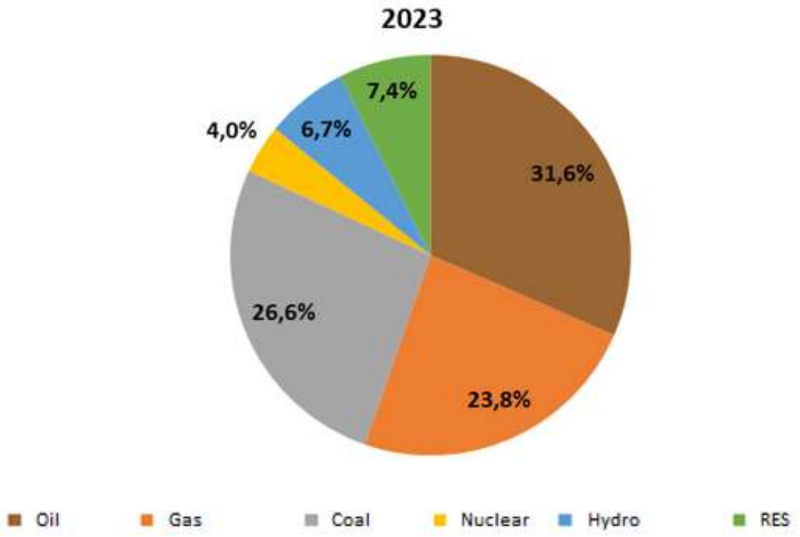


Source: IEA

Another important report on the global energy situation is the Energy Institute's "Statistical Review of World Energy 2024/73rd Edition" [3]. According to the Report, oil was the world's main energy source in 2023, followed by coal and natural gas, which together accounted for 82% of primary energy use (Figure 5). The share of renewable energy sources (excluding hydropower) in global electricity generation continued to rise, reaching 7.4%, up six percentage points from 2010 and driven by record solar and wind installations, surpassing the share of nuclear energy, which was 4%. Coal's share of electricity generation reached around 27%, down 3.0 percentage points, while natural gas's share remained stable at 24%.

Figure 5: Global Primary Energy Consumption, 2010 & 2023





Source: Energy Institute

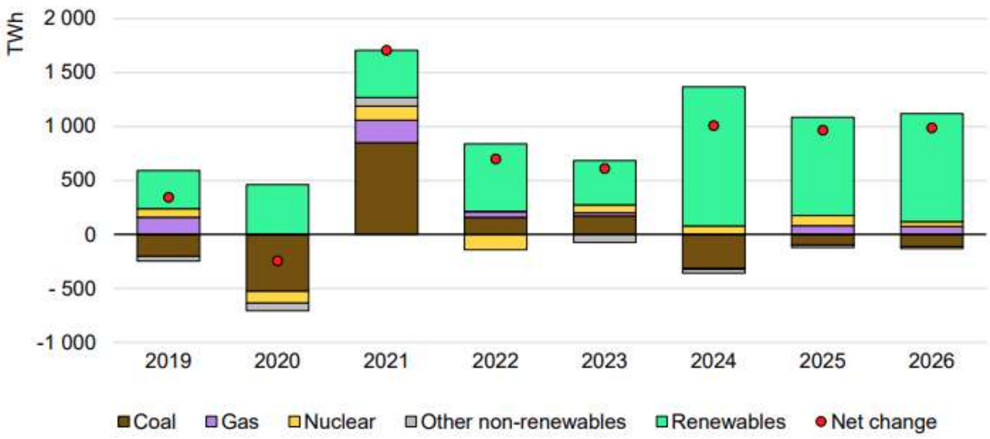
Furthermore, according to the International Energy Agency (IEA) study "Electricity 2024 – Analysis and Forecast to 2026" [4], global electricity demand is expected to grow moderately in 2023 by 2.2%, but at a slower pace than 2022, which was 2.4%. However, it is expected to grow at a faster pace in the next two years, with growth estimated to average 3.4% per year through 2026. This increase in global demand is driven by the improved economic outlook, which will contribute to faster growth in electricity demand in both advanced and emerging economies. In advanced economies and China in particular, electricity demand will be supported by continued electrification of the residential and transport sectors, as well as the notable expansion of the data center sector. The share of electricity in final energy consumption reached 20% in 2023, up from 18% in 2015.

Renewable energy sources are expected to provide more than a third of total global electricity generation by early 2025, surpassing coal. The share of renewable energy in electricity generation is projected to increase from 30% in 2023 to 37% in 2026, with growth largely supported by the expansion of increasingly affordable solar photovoltaics.

According to the IEA report, the rapid growth of renewable energy sources combined with increasing nuclear generation will displace global coal production, which is projected to decline by an average of 1.7% per year until 2026. This follows a 1.6% increase in coal production in 2023 amid droughts in India and China that reduced hydropower generation and increased coal-fired electricity generation, which offset sharp declines in coal production in the United States and the European Union.

Furthermore, in 2023, the sharp decline in gas-fired electricity generation in the European Union was more than offset by production in the United States, where natural gas, which is increasingly replacing coal, recorded its highest share of electricity generation. Global gas production grew by less than 1% in 2023, with an average annual growth rate of around 1% projected through 2026. While gas-fired production in Europe is expected to decline, global production will be supported by significant growth in Asia, the Middle East and Africa amid growing demand in these regions and the availability of additional liquefied natural gas (LNG).

Figure 6: Annual Change in Global Electricity Production by Source, 2019-2026



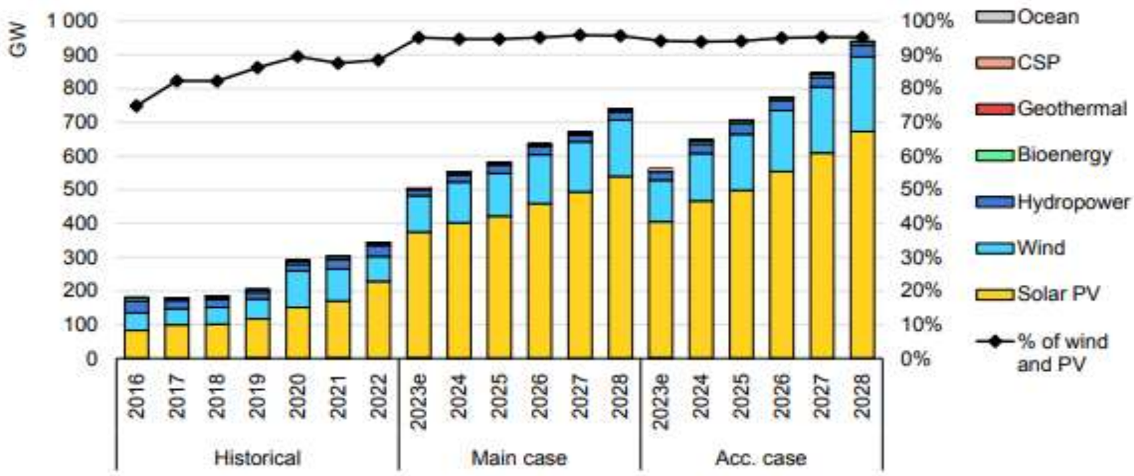
Source: IEA

In 2023, twice as much renewable energy capacity was installed compared to 2022, according to the IEA report "Renewables 2023 - Analysis and forecast to 2028" [5], which predicts an unprecedented rate of growth for these energy sources in the coming years, although it estimates that it will be insufficient to address climate change. According to the same report, the addition of installed capacity from renewable sources in 2023 worldwide was 507 GW, almost 50% higher than in 2022, as a result of continued policy support in more than 130 countries.

China was again the major driver of this growth (+116% in solar photovoltaics, +66% in wind turbines in one year), with Europe, the United States and Brazil also achieving unprecedented levels of growth.

According to the same report, the addition of new installed capacity of renewable energy sources worldwide will continue to increase over the next five years, until 2028, with solar photovoltaics and wind setting a record and projected to cover 96% of this new capacity, as their production costs are lower than fossil fuels and countries' policies continue to support these clean energy sources.

Figure 7: Renewable Electricity Capacity Additions by Technology And Segment

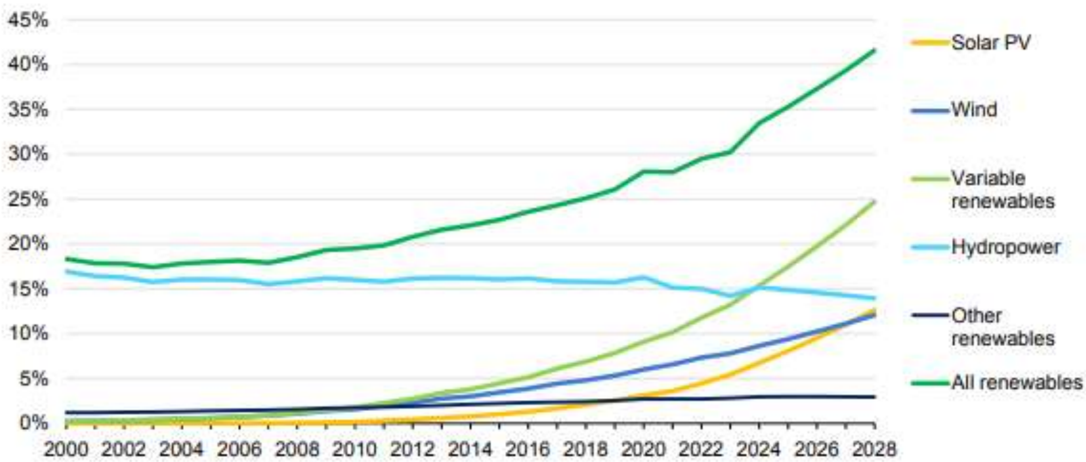


Source: IEA

By 2028, potential electricity production from renewable sources is expected to reach approximately 14,400 TWh, an increase of almost 70% compared to 2022. Over the coming five years, several renewable energy milestones are expected to be achieved:

- In 2024, wind and solar PV together generate more electricity than hydropower.
- In 2025, renewables surpass coal to become the largest source of electricity generation.
- Wind and solar PV each surpass nuclear electricity generation in 2025 and 2026 respectively
- In 2028, renewable energy sources account for over 42% of global electricity generation, with the share of wind and solar PV doubling to 25%.

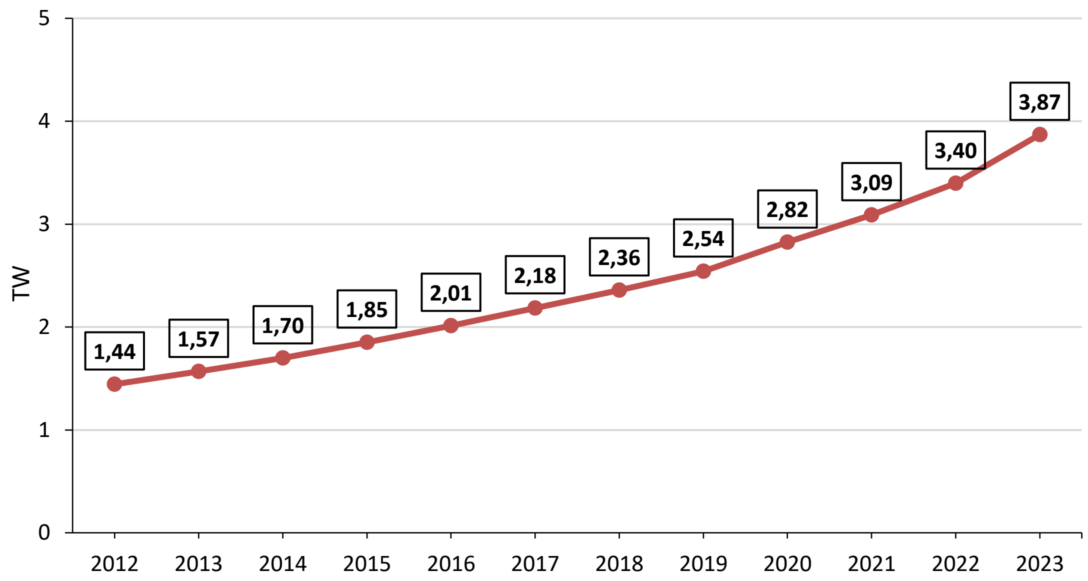
Figure 8: Electricity Generation by Technology Worldwide, 2000-2028



Source: IEA

Figure 9 depicts the growth trajectory of RES projects worldwide in terms of their installed capacity, presenting an Average Annual Change Rate 2013-2023 of 9.4%, according to data from the International Renewable Energy Agency (IRENA) [6].

Figure 9: Evolution of Installed Capacity of RES Units Worldwide

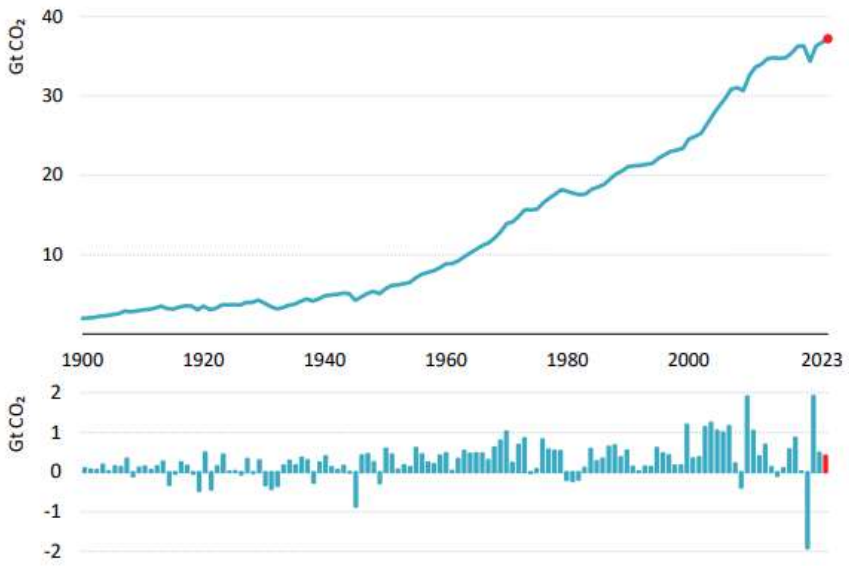


Source: IRENA

A common trend observed in 2023 across many regions worldwide was a significant reduction in hydropower generation due to weather conditions, particularly droughts, low rainfall and early snowmelt. As a result, global hydropower generation fell by more than 2% in 2023 compared to the previous year. The global hydropower capacity factor is estimated to have fallen below 40% in 2023, which is the lowest rate recorded in at least three decades and is well below the 2015-2022 average of 42% and the 2004-2014 average of 44%.

Despite the growing trend of renewables, global total energy-related CO2 emissions increased by 1.1% (410 million tonnes) in 2023, reaching a new record high of 37.4 billion tonnes, as recorded in the IEA report "CO2 Emissions in 2023" [7]. Most of this increase (65%) was due to lignite, while the global deficit in hydropower generation in 2023, due to drought, led to an increase in emissions by 170 million tonnes. Without the drought, global CO2 emissions would have fallen, according to the IEA.

Figure 10: Global Energy-related CO2 Emissions and Their Annual Change, 1900-2023



Source: IEA

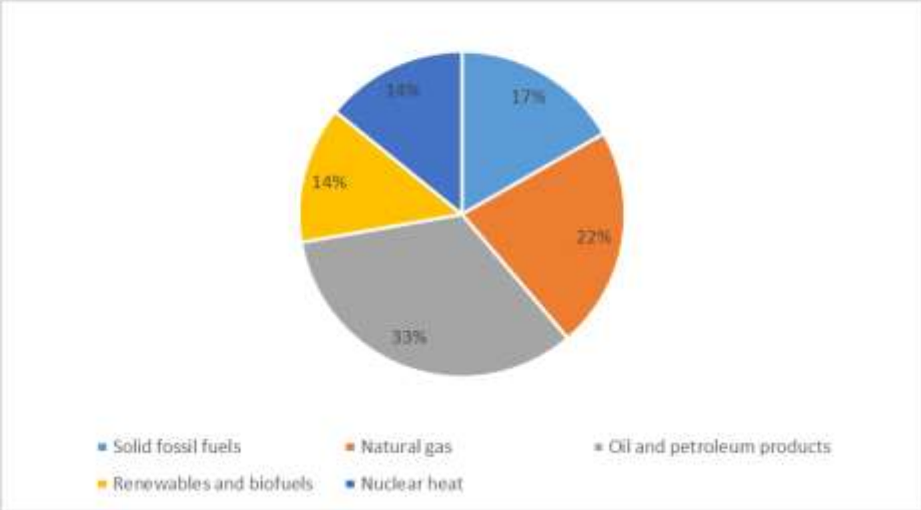
Wholesale electricity prices in various countries around the world fell in 2023 from the record prices seen in 2022, in line with declines in the prices of other energy products such as natural gas and coal. However, there were differences across geographical regions. Wholesale electricity prices in Europe fell on average by more than 50% in 2023 from their record levels in 2022. However, prices in Europe are still double their 2019 levels, while prices in the US in 2023 were only 15% higher than in 2019. The Nordic countries, with hydropower dominating the energy mix, remain the only markets in Europe with average electricity prices comparable to those in the United States and Australia. Wholesale prices in Japan and India in 2023 also remained above 2019 levels.

3.2 Europe's Energy Market

Following Russia's invasion of Ukraine in February 2022, the subsequent increase in energy prices and the energy crisis that Europe recently experienced, the continent is aiming for climate neutrality by 2050, investing in a "green" future. However, if we look at its energy mix, which in the following Figures is defined as gross inland consumption, we see that the energy transition is progressing more slowly than initially expected.

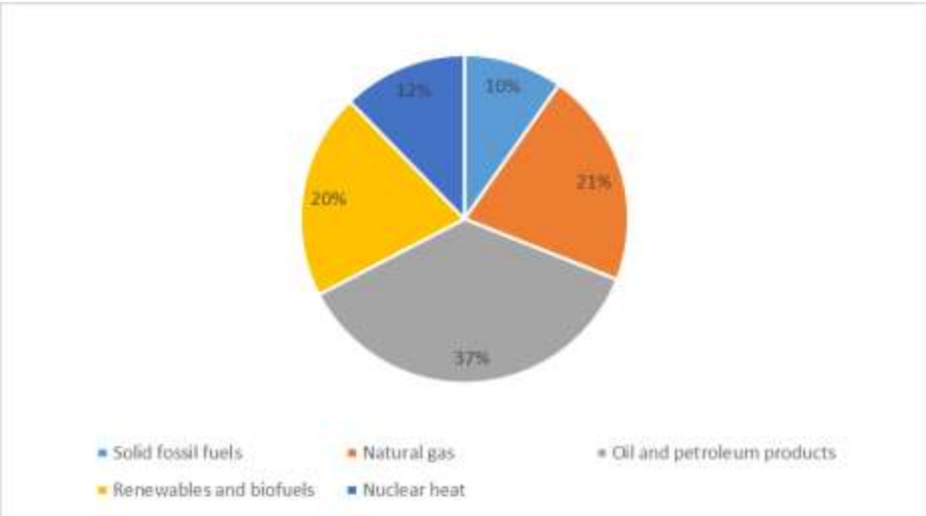
Although there is a higher penetration of RES and biofuels in Europe's gross inland consumption in 2023, compared to a decade ago, a slight decrease in the share of nuclear energy and a significant drop in solid fossil fuels, the contribution of natural gas and oil remains significant in the energy mix, with oil even increasing its share.

Figure 11: Gross Inland Consumption in EU-27, 2013



Source: Eurostat

Figure 12: Gross Inland Consumption in EU-27, 2023

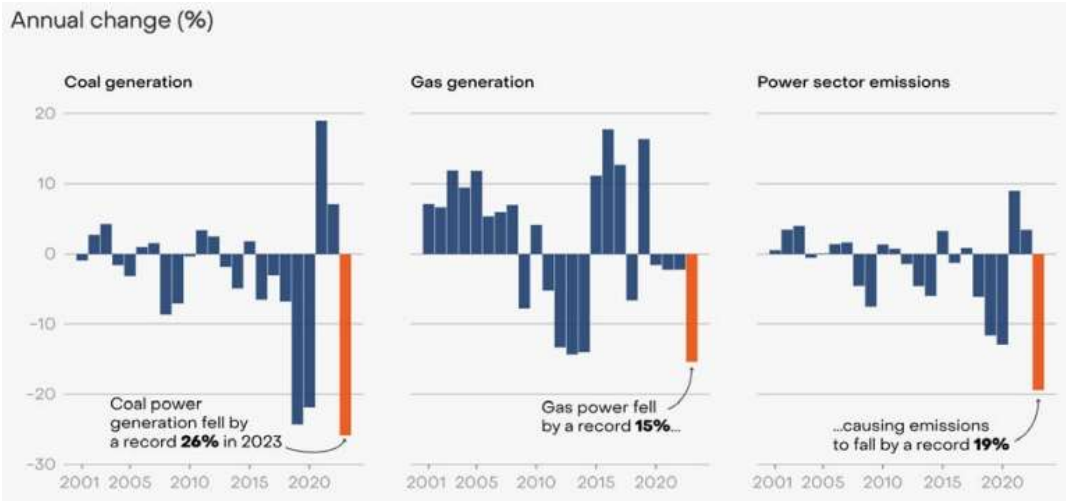


Source: Eurostat

Referring to electricity and according to the Ember's "European Electricity Review 2024" [8], the EU accelerated its transition away from fossil fuel-based electricity generation in 2023, with a sharp drop in the share of coal and gas and consequently in carbon dioxide emissions. Fossil fuels fell by 19%, reaching their lowest level ever, renewables grew by a record 44%, exceeding 40% for the first time, with wind and solar power leading this growth, generating 27% of the EU's electricity in 2023, thanks to large additions of installed capacity. In addition, wind power generation reached the important milestone of overtaking gas for the first time.

Record falls in coal, gas and CO_2 emissions in 2023 left the EU with a cleaner electricity generation mix as renewables take significant steps forward. The EU's transition to cleaner electricity generation is in full swing.

Figure 13: Record Falls in EU Coal and Gas Electricity Generation Push Power Sector Emissions Down 19%

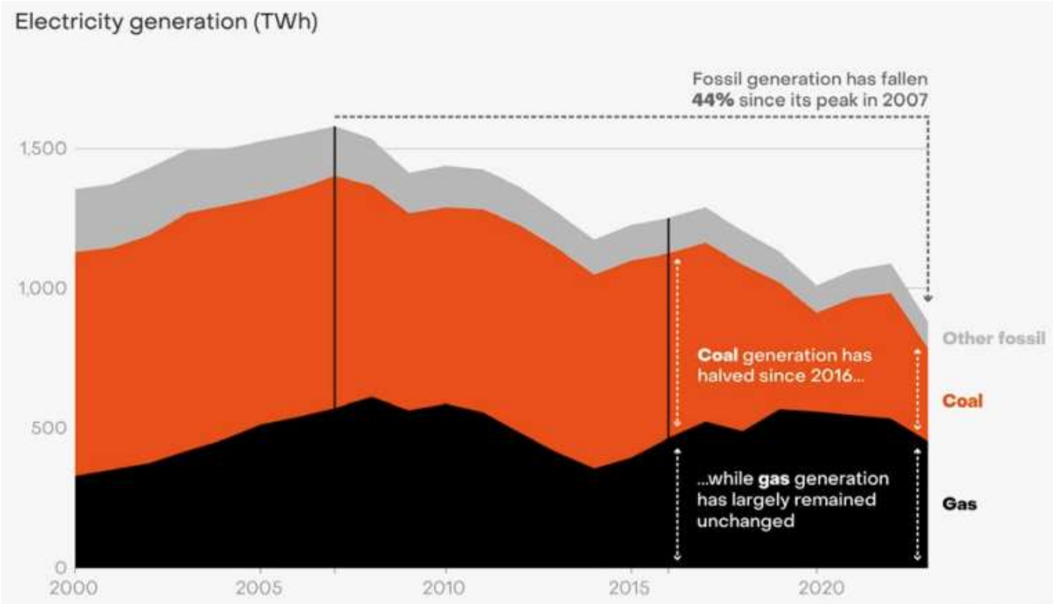


Source: Ember

Clean generation reached more than two-thirds of EU electricity, double fossil's share, as hydro rebounded and nuclear partially recovered from last year's lows alongside the increase in wind and solar. Coal was already in long-term decline, and that trend resumed in 2023. The temporary slowdown in coal plant closures during the energy crisis did not prevent a huge fall in coal generation this year, with a wave of plant closures imminent in 2024. Gas generation fell for the fourth consecutive year, and as coal nears phase-out in many countries, gas will be next to enter terminal decline.

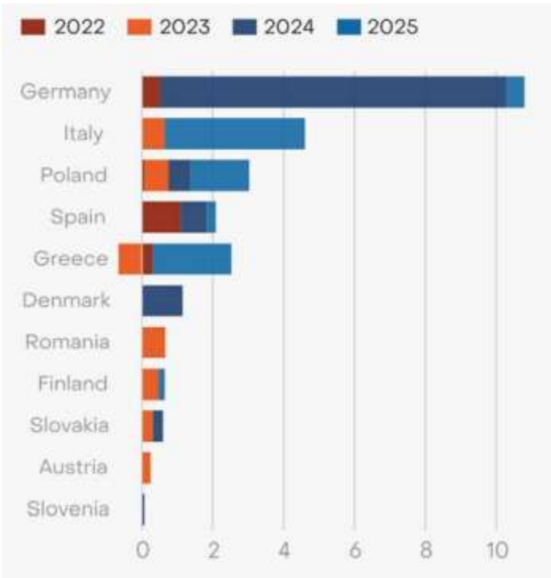
Fossil generation plummeted by a record 19% (-209 TWh) in 2023, to account for less than a third of the EU's electricity mix for the first time. Coal generation fell by 26% (-116 TWh) to its lowest level ever (333 TWh), making up just 12% of the EU electricity mix in 2023. Coal generation halved from 2016 to 2023 (-327 TWh) (Figure 14) due to a similar rise in wind and solar generation (+354 TWh). Coal plant closures slowed during the energy crisis, but coal's structural decline continues as a fifth of the EU's coal fleet will shut down in 2024 and 2025. This includes 10 GW of coal-fired power plants in Germany, most of which are scheduled to close by 2024. In 2025, large numbers of coal-fired power plants will close in Italy, Poland, Greece and Spain (Figure 15).

Figure 14: Coal Power Generation Has Halved Since 2016



Source: Ember

Figure 15: EU Coal Capacity Closures (GW)

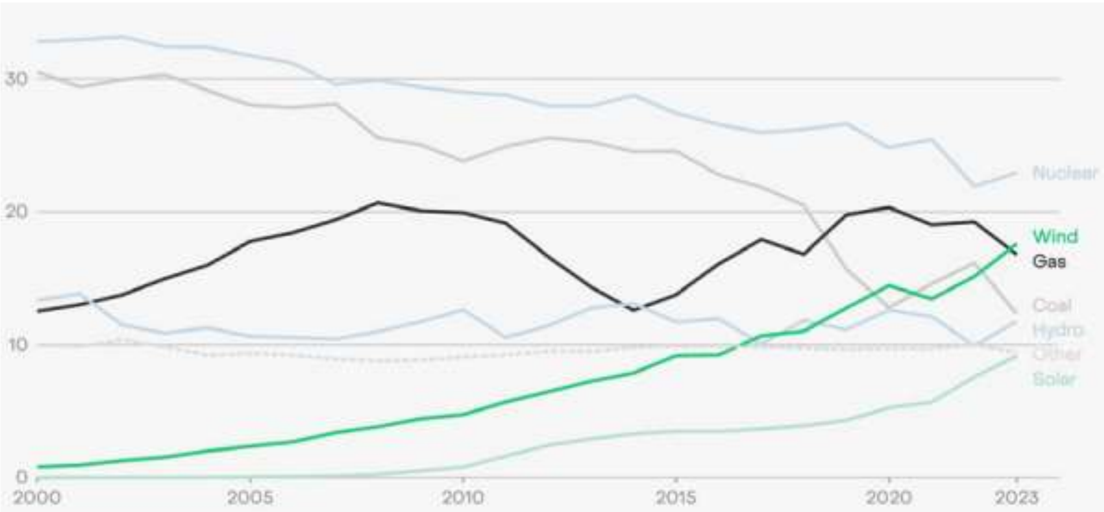


Source: Ember

It is important to highlight that the collapse in coal use was not offset by an increase in natural gas use. Natural gas production fell by 15% (-82 TWh) to 452 TWh, which was the largest annual decrease since 1990! It was the fourth consecutive year of decline in natural gas production, which represented 17% of total EU production in 2023. In addition to the growth of clean energy, the decline in electricity demand also contributed to the decline in fossil fuel production. Specifically, it fell by 3.4% (-94 TWh) in 2023 compared to 2022 and was 6.4% (-186 TWh) lower than the levels in 2021, when the energy crisis began. Of course, this trend is unlikely to continue. With the rise of electric mobility, the rate of decline in demand is not expected to repeat itself in the coming years. To reduce fossil fuels at the speed needed to meet EU climate targets, renewable energy sources will need to keep pace with demand growth.

The EU is steadily moving towards a transition from a fossil-based system to one where wind and solar power will be the mainstay of electricity generation. As this shift becomes more evident, the factors that will enable a clean electricity system are also becoming increasingly important. Alongside the development of wind and solar power, grids, storage and demand response will define the electricity system of the future. Wind power recorded a record annual growth rate in production in 2023 at 55 TWh (+13%). This meant that wind power production surpassed natural gas for the first time. Electricity generated from wind amounted to 475 TWh, equivalent to France's total electricity demand, compared to 452 TWh from natural gas. It was the only year that wind generation exceeded coal (333 TWh) other than 2020, when the effects of Covid-19 were present. Also, an additional 17 GW of wind power capacity was installed in 2023 compared to 16 GW in 2022. However, this rate needs to exceed 30 GW per year by 2030, if the EU is to meet its climate targets.

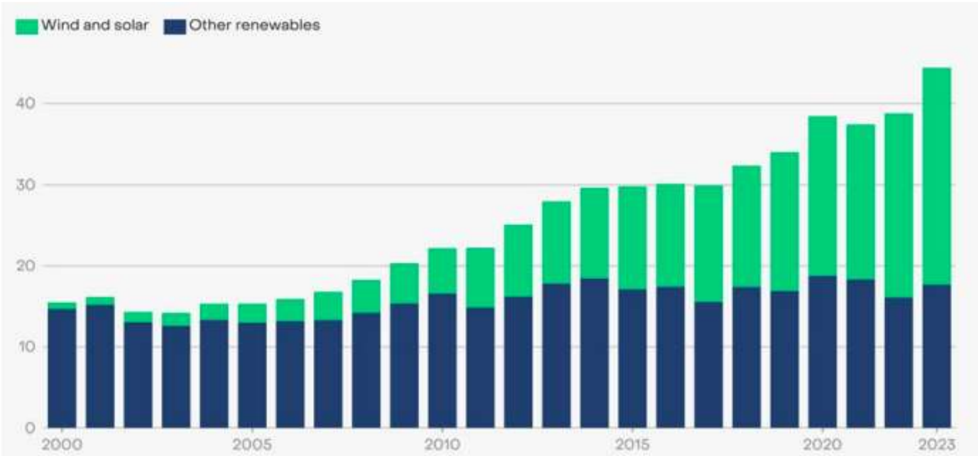
Figure 16: Share of EU Electricity Generation by Source (%)



Source: Ember

Ember data shows that for the first time ever, more than a quarter (27%) of the electricity generated in the EU in 2023 came from wind and solar, up from 23% in 2022. This pushed the share of electricity generated from renewables to a record high of 44%. Combined wind and solar generation increased by 90 TWh, also a record increase, while additional renewable capacity installed in 2023 reached 73 GW. Solar continued to grow rapidly, with 56 GW of new capacity added in 2023, compared to 41 GW in 2022 (up +37%). On the contrary, electricity production from solar parks failed to approach the annual increase in production recorded in 2022 (+36 TWh in 2023 compared to +48 TWh in 2022).

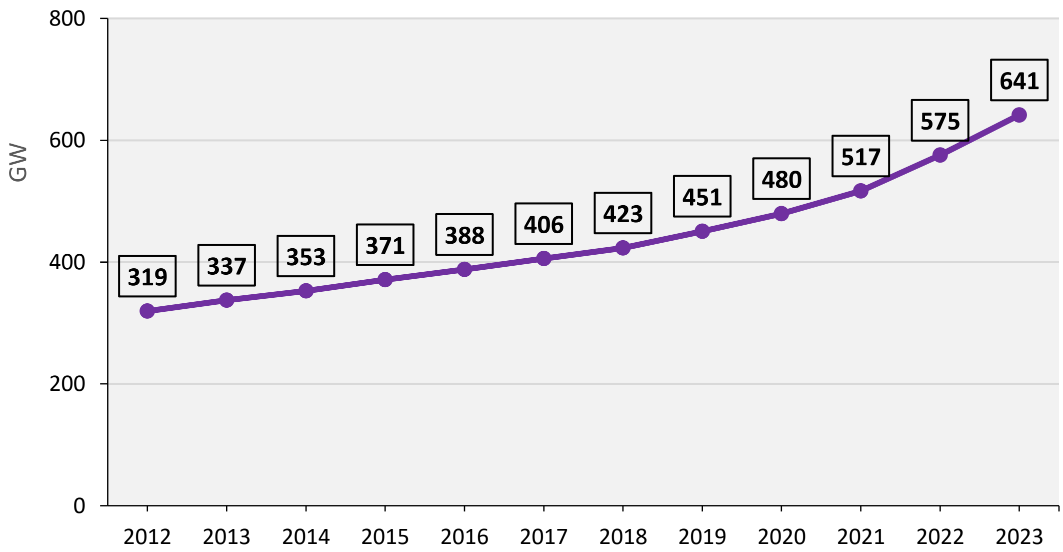
Figure 17: Share of EU RES Electricity Generation (%)



Source: Ember

Overall, electricity networks, energy storage and other factors contributing to system flexibility will become increasingly important in the future, as the share of wind and solar energy will continue to occupy a larger share in the electricity generation mix. Regarding the evolution of installed capacity of RES units in the European Union, it shows an increase from 2012 to 2023 with an Average Rate of Change of 6.5% (Figure 18) [6].

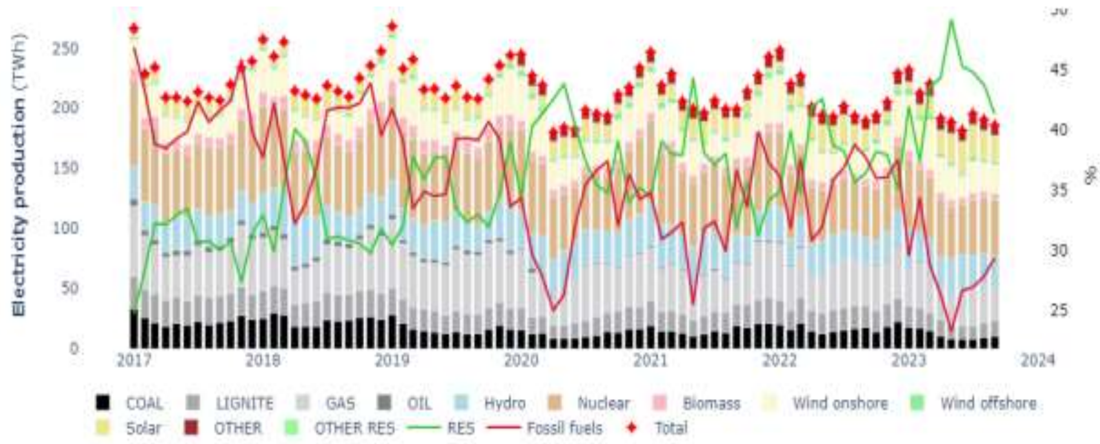
Figure 18: Evolution of Installed RES Capacity in the EU, 2012-2023



Source: IRENA

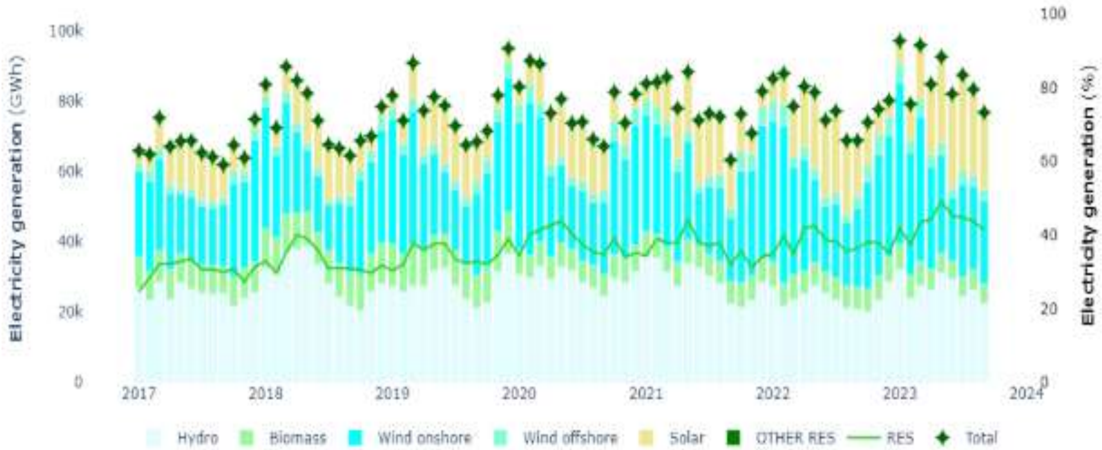
Figure 19 illustrates the evolution of the monthly electricity generation mix in the EU from 2017 to 2023, alongside the share of different energy sources in electricity generation, according to the European Commission's Quarterly Report on European Electricity Markets [9]. In the third quarter of 2023, reduced electricity demand combined with increased RES production contributed to a 23% reduction in fossil fuel production compared to the previous year. RES electricity production increased by 15% in the third quarter of 2023, while its share in the energy mix reached 43% (from 37% in the third quarter of 2022). According to Chart 18, this increase is mainly due to the notable increase in solar by 23% (+13 TWh) as well as onshore wind by 21% (+13 TWh). Hydroelectric generation also improved by 12% (+8 TWh), while offshore wind generated 14% more electricity (+1 TWh).

Figure 19: Monthly Electricity Generation Mix in the EU, 2017-2023



Source: European Commission

Figure 20: Monthly RES Production in the EU and Their Share in the Energy Mix



Source: European Commission

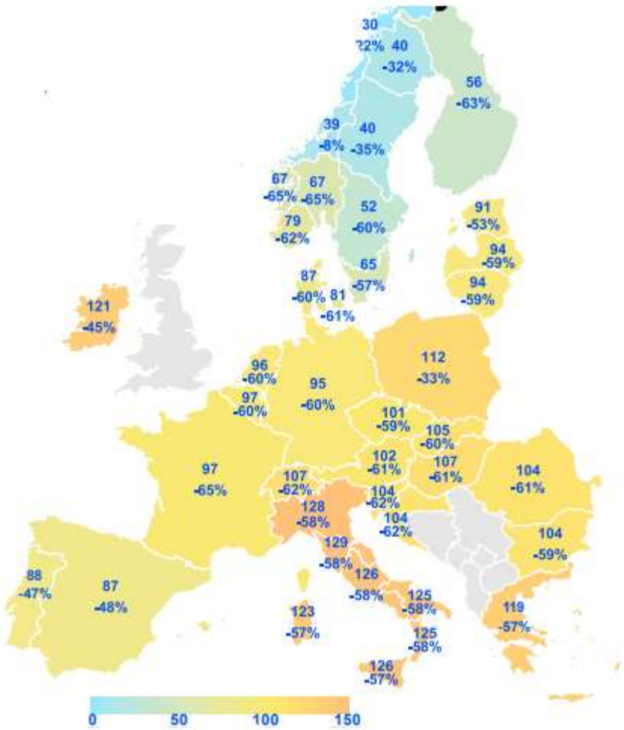
Meanwhile, total CO2 emissions from energy combustion activities in the European Union fell by almost 9% in 2023 (-220 million tonnes -Mt). The main driver behind this decline was the growth of renewable energy sources, with wind power surpassing both natural gas and coal in electricity generation for the first time, marking a historic milestone for the energy transition in the region. The reduction in industrial activity in Europe in 2023 also contributed significantly, accounting for 30% of the total annual CO2 emission reduction. High energy prices, interest rates, weak domestic demand and strong international competition pushed industrial production in the European Union to contract in 2023.

As for energy prices, Russia's military attack on Ukraine in 2022 disrupted energy markets and caused energy prices to rise. The EU's response focused on securing energy supplies and protecting citizens from higher energy prices. Energy prices stabilised in 2023 after a volatile 2022, but prices and day-ahead volatility remained higher than before the energy crisis.

Lower gas prices, in turn, contributed to lower day-ahead prices throughout 2023, complemented by a mild winter and energy conservation efforts. In 2023, the average day-ahead price was €93/MWh, less than half the average of €219/MWh from the previous year. However, the average day-ahead price was still more than double that of 2019. Similarly, price volatility remained higher than before the crisis. In 2022, Europe's high energy prices resulted from the global increase in gas prices. In 2023, the EU reduced its dependence on fossil fuels, thus contributing to lower electricity prices across the EU. However, price fluctuations still existed with countries that rely more on natural gas in their energy mix experiencing higher prices.

Average electricity prices fell in each Member State to below €130/MWh in 2023 compared to prices of €150 to €300/MWh in 2022, but remained above the €80/MWh threshold recorded in 2021 (Map 1). The highest prices were recorded in Ireland and Italy, while the lowest prices were recorded in the Scandinavian peninsula due to the abundance of hydraulic reservoirs.

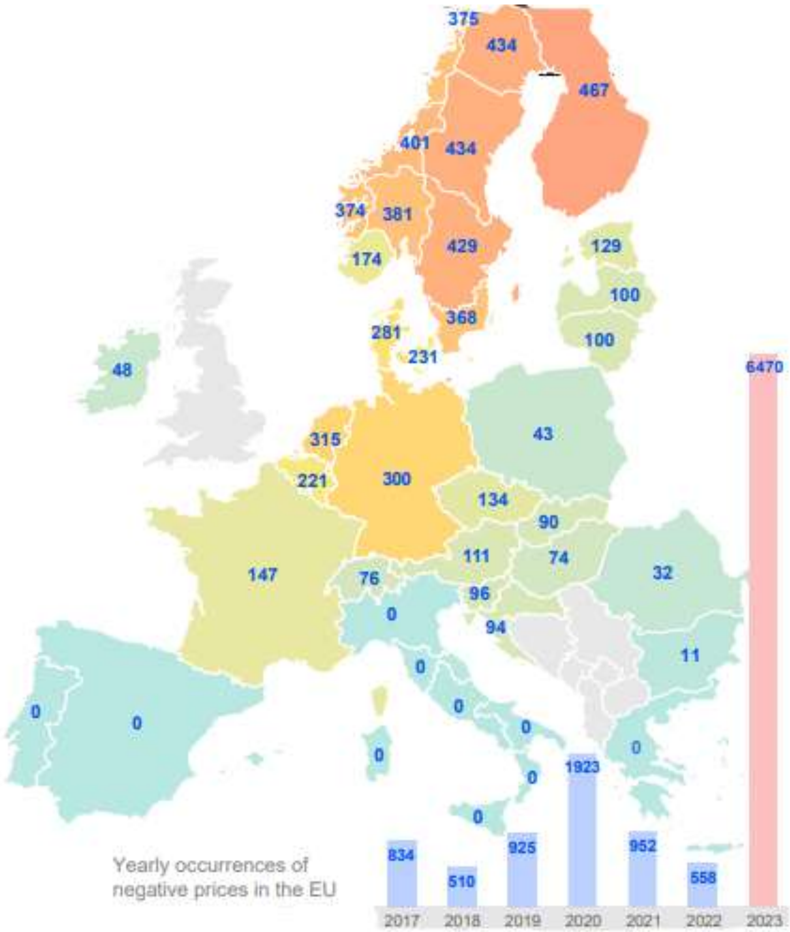
Map 1: Average Annual Electricity Prices and Annual Difference in EU-27/EEA (Norway), Switzerland - 2023 (€/MWh, %)



Source: ACER

A characteristic of the year 2023 was the explosive increase in negative electricity prices in European wholesale markets, as a result of the increased penetration of RES (Map 2). According to the 2024 Market Monitoring Report "Key developments in EU electricity wholesale markets - 2024 Market Monitoring Report" by the European regulator ACER, cases of negative prices shot up from 558 in 2022 to 6,470 in 2023 [10].

Map 2: Negative Electricity Prices in EU Member States in 2023 (Number of Events)

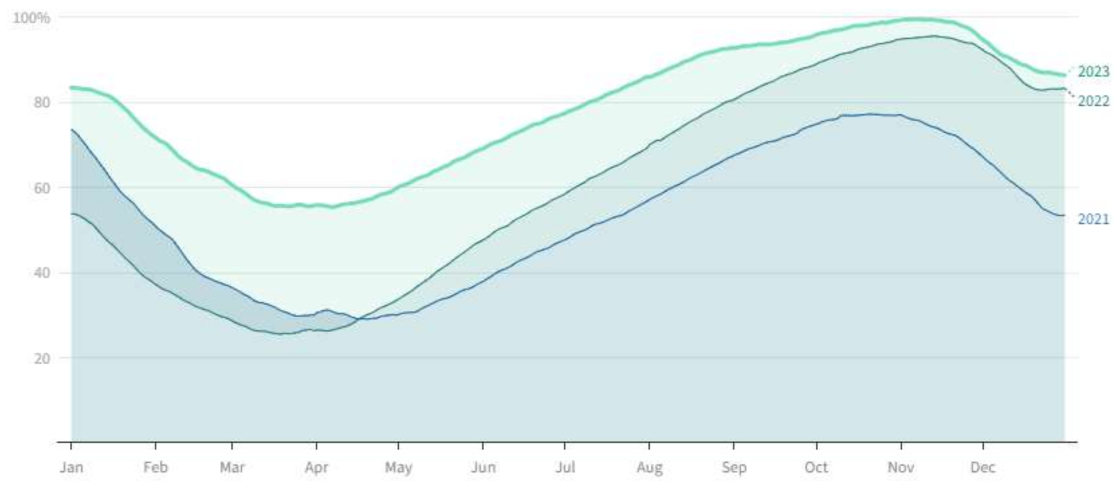


Source: ACER

One of the immediate measures agreed by EU countries was to increase gas reserves to ensure adequate supplies for Europeans and stable energy prices. To this end, EU countries, within the Council, adopted a regulation in June 2022 to ensure that storage capacities in the EU were filled before the colder months and could be shared across the EU in a spirit of solidarity.

The regulation provided that underground gas storage on the territory of the Member States had to be filled to at least 80% of capacity before the winter of 2022/2023 and to 90% before the following winter periods. The regulation was implemented quickly. In October 2022, the filling level reached 90%. Throughout 2023, the filling level was significantly higher than in previous years (Figure 21).

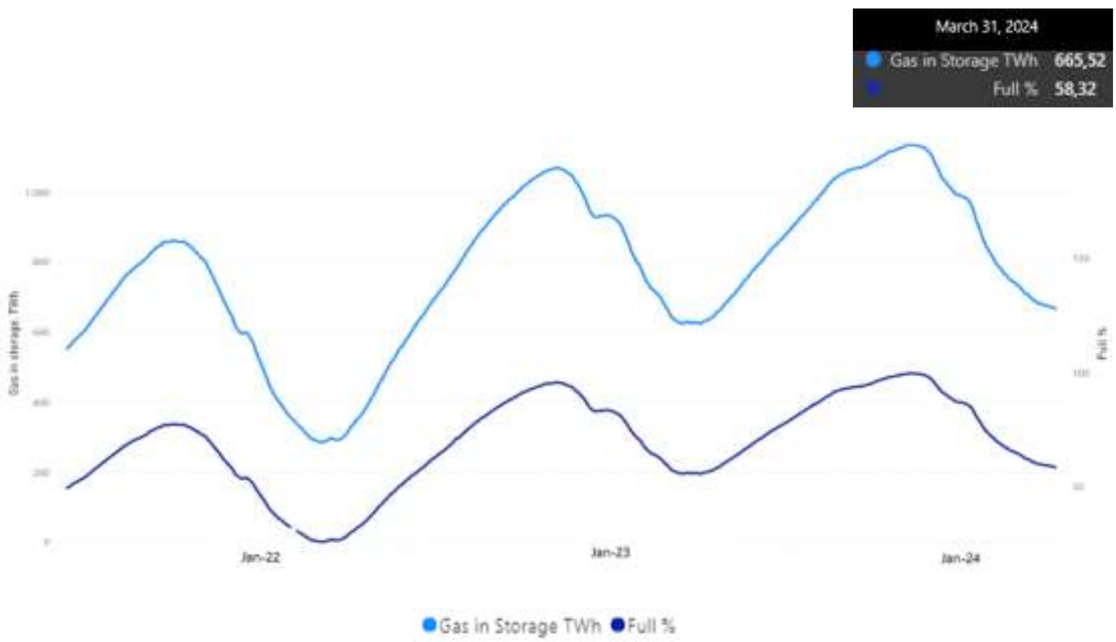
Figure 21: Filling Level of Natural Gas Storage Facilities in the EU, 2021-2023



Source: Gas Infrastructure Europe

EU natural gas storage at the end of March 2024, considered the end of the 2023/2024 winter season, stood at 58.32% full, according to data from the ENTSO-G platform. This is around 3 percentage points more than last year's filling rate.

Figure 22: Natural Gas Storage Filling Level at the End of the 2023/2024 Winter Season in the EU



Source: ENTSO-G

A generally mild winter across Europe, large LNG imports, weak economic activity and EU demand reduction targets have all contributed to limiting natural gas use. Demand was around 20% lower in February 2024 than the 2019-2021 average, according to data from the Bruegel think tank. Ahead of the 2023/2024 winter season, gas tanks were almost full in all

EU countries with storage facilities. Most EU Member States have gas storage facilities on their territory. Storage capacity in five countries (Germany, Italy, France, the Netherlands and Austria) accounts for two-thirds of the EU's total capacity.

Regulation (EU) 2022/1032 provides that underground gas storage on the territory of the Member States must reach at least 90% by 1 November each year. According to the regulation, countries without storage facilities should store 15% of their annual domestic gas consumption in reserves located in other Member States and thus have access to gas reserves. This mechanism strengthens the EU's security of gas supply and ensures a shared financial burden for filling the EU's storage capacity. Member States with lower storage capacity cooperate with those with larger facilities to secure their reserves.

In late February 2024, wholesale natural gas prices in Europe fell to their lowest point since the start of the war in Ukraine (February 24, 2022) due mainly to the mild autumn and winter in the northern hemisphere, which kept natural gas stocks at high levels for the season. European TTF natural gas prices on the Amsterdam Energy Exchange (Dutch TTF- Title Transfer Facility Natural gas futures) plunged to €22/MWh on February 24, the lowest level since May 2021. Prices have plunged by almost 95% from their highs of €351/MWh recorded in August 2022, despite increased geopolitical tension in the Middle East and the Red Sea.

Furthermore, while Houthi rebels in Yemen continued their attacks on shipping in the Red Sea into 2024, they have failed to significantly curtail natural gas supply, as LNG ships are heading from Qatar to Europe by circumnavigating Africa, albeit with delays and at greater cost. The sharp drop in natural gas prices reflects a broader trend driven by a mix of climatic and economic factors, including warmer-than-average temperatures in the Northern Hemisphere (North America, Europe, Far East), a notable decline in both industrial and residential demand for natural gas, and massive LNG imports.

4. Energy Policy Targets

4.1. Europe's Targets

Since 2020, the European Commission has set more ambitious targets for 2030 and has integrated the climate neutrality objective by 2050 into the National Energy and Climate Plans (NECPs) of all Member States. In relation to this objective, the Greek government has submitted a Long-Term Energy and Climate Strategy, as a separate study within the NECP.

Today, however, the long-term targets and the plan to achieve them are integrated into the main NECP, which therefore covers the entire period from now until 2050, providing more details on the plan to achieve the 2030 targets.

The European Union has set ambitious targets in its effort to tackle climate change and transition to a more sustainable energy system. These objectives were formulated within the framework of the "Clean Energy for All Europeans" package[2], which includes the Renewable Energy Directive[3], the Energy Efficiency Directive[4] and the Governance Regulation[5].

The main objectives set for EU Member States in the NECPs are the following:

- **Reducing greenhouse gas emissions:** A 55% reduction by 2030 compared to 1990 emissions, and achieving climate neutrality by 2050. As part of the European Green Plan, the Commission proposed in September 2020 to increase the 2030 greenhouse gas emission reduction target, including emissions and removals/absorptions, by at least 55% compared to 1990. In addition, it is envisaged, among other things, 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. A new stand-alone emissions trading scheme is being created for buildings, road transport and fuels for additional sectors. It foresees, among other things, an increase in the overall ambition for emission reductions 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 for net greenhouse gas removals of at least 310 million tonnes of CO2 equivalent by 2030.
- **RES penetration:** The indicator for RES as a percentage of gross final energy consumption in 2030 will amount to at least 42.5% (which may increase to 45%), accompanied by individual targets per consumption sector (electricity, heating-cooling and transport).
- **Energy efficiency in 2030 equal to -11.7%,** measured as a percentage change in final energy consumption compared to the 2030 version of the 2020 Reference Scenario[6].

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[2] https://ec.europa.eu/commission/presscorner/detail/el/IP_16_4009
[3] https://eur-lex.europa.eu/legal-content/EL/TXT/PDF/?uri=OJ:L_202302413
[4] https://eur-lex.europa.eu/legal-content/EL/TXT/PDF/?uri=CELEX:32023L1791
[5] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02018R1999-20231120
[6] https://energy.ec.europa.eu/data-and-analysis/energy-modelling/eu-reference-scenario-2020_en

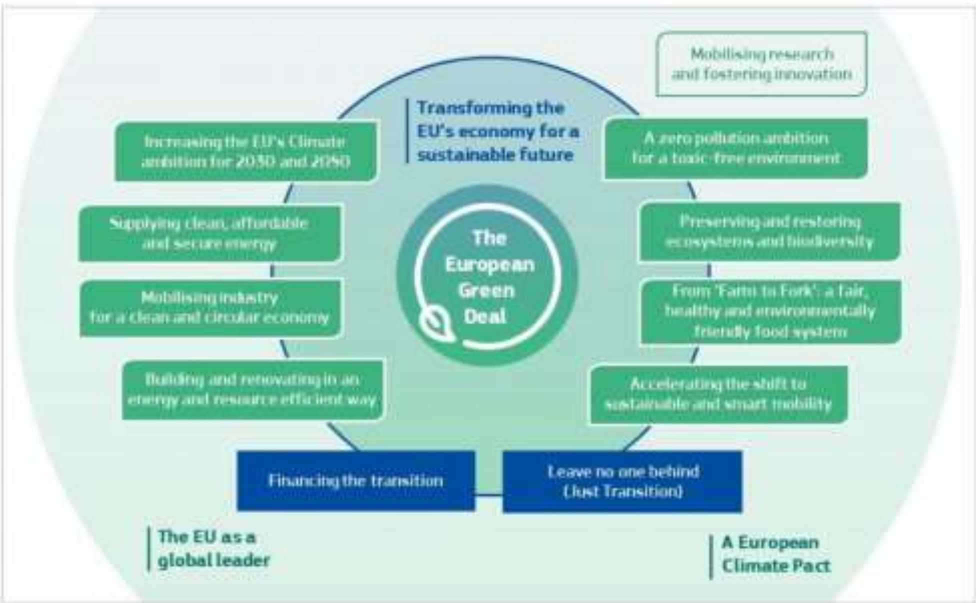
- **Blending of biofuels** (advanced and above the limit for conventional) and renewable gases of non-biological origin as a percentage of transport fuels.

Additionally, they are taken into account:

- • The **Social Climate Fund**[7], which aims to address the social and distributional impacts of the new emissions trading system for buildings and road transport. Based on social climate plans to be drawn up by Member States, the Fund aims to proceed with support measures and investments for the benefit of vulnerable households, very small businesses, transport users.
- The national emission reduction commitments set out in Directive 2016/2284/EU (NECD), which was incorporated into national law by J.Y.A. No. YPEN/DNEP/67467/3577 (Government Gazette 4740/B/23.10.2018), for the years from 2020 to 2029 and from 2030 onwards for the pollutants sulfur dioxide (SO2), nitrogen oxides (NOx), non-methane volatile organic compounds (NMVOC), ammonia (NH3) and suspended particulate matter.

Following the European Climate Law 2021/1119 establishing a framework aimed at achieving climate neutrality, Greece enacted for the first time the National Climate Law 4936/2022 (A' 105), which sets specific targets, including reducing greenhouse gas emissions by 55% by 2030 and by 80% by 2040 (compared to 1990 levels) and achieving climate neutrality (i.e. zero total greenhouse gas emissions) by 2050.

Figure 23: The European Green Deal



Source: European Commission

[7] https://eur-lex.europa.eu/EL/legal-content/summary/social-climate-fund.html

Therefore, the latest NECP incorporates the objectives of the National Climate Law, the objectives within the framework of the European Union policy (REPowerEU[8] and Fit-for-55 in the context of the European Green Deal[9]) and the final European Directives on RES, energy efficiency and others.

4.2 National Targets

The Greek government intends to utilize the National Energy and Climate Plan (NECP) as the main tool for shaping the national energy and climate policy until 2050. Through the NECP, the priorities and development potential of our country in energy and climate change issues are highlighted and a specific roadmap is provided for the achievement of specific quantitative and qualitative goals, which will describe priorities and policy measures in a wide range of development and economic activities for the benefit of society.

The main objective of the NECP is the design, programming and implementation of the most socially, environmentally and economically efficient policy measures that will contribute to the achievement of the medium-term and long-term national energy and climate objectives, will contribute to the economic development of the country, while at the same time responding to the challenge of reducing energy costs and generally protecting end consumers from high prices of energy products and services.

The national energy and climate objectives for 2030 are formulated taking into account specific quantitative obligations undertaken 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 adaptation capabilities, as well as the socio-economic characteristics of the country.

Through this process, the national targets are adjusted to the corresponding central European targets (i.e. the targets for the sectors included in the Emissions Trading System, for RES, for Energy Efficiency) and which are finally proposed within the framework of the NECP. In addition, the main quantitative policy targets set for the period up to 2030 are also "intermediate" targets for the reduction of greenhouse gas (GHG) emissions by the year 2050, where the goal of the Greek government is to participate in the commitment for a climate-neutral economy at EU level.

The green energy transition aims to make the country's energy system climate-neutral, i.e. to reduce carbon dioxide emissions from the combustion of fossil fuels to almost zero and to make processes that emit greenhouse gases that do not come from energy climate-neutral.

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[8] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/repowereu-affordable-secure-and-sustainable-energy-europe_en?prefLang=el
[9] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_el

The goal is for the net sum of positive and negative GHG emissions, taking into account the additional absorption of carbon dioxide by land, forests and the sea, to be equal to zero by 2050 and to continue in perpetuity.

The path towards this goal begins with the 2030 milestone for which EU legislation provides for a wide range of targets in all energy sectors in order to drastically reduce GHG emissions. The individual sectoral targets for 2030, as well as the regulations on specifications, infrastructure and technologies, are intended to guide all sectors in choosing the appropriate investments and changes so that the ambitious emission reduction path continues and accelerates during the period from 2030 to 2050. An intermediate milestone is 2040 for which the National Climate Law[10] provides for a specific emission reduction target and for which EU legislation has not yet been concluded.

The government supports in its long-term strategy a path towards a climate-neutral economy, aiming to improve the competitiveness of the economy and businesses, create new jobs, strengthen the role of the consumer and overall operate competitive energy markets for the benefit of society.

Table 5 summarizes the revised national targets in relation to the targets set in the initial NECP draft submitted in December 2019.

Table 5: Summary of National Targets and Indicators of the Revised NECP

Achievement of goals	Year 2030		Year 2035	Year 2040	Year 2050	
	EU target	NECP projection	NECP projection	NECP projection	EU target	NECP projection
Reduction in GHG emissions compared to 1990* (with LULUCF)	-55,0%	-58,0%	-69,0%	-80,0%	-100,0%	-98,0%
RES in gross final energy consumption**	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%

[10] https://www.elinyae.gr/sites/default/files/2022-05/105a_2022.pdf

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 (% of transport fuels)**	5,5%	4,6%	11,2%	14,2%		13,2%
RFNBO (% of transportation fuels)**	1,0%	0,9%	5,4%	11,5%		30,9%
SAF (Sustainable Aviation Fuel) of biological origin	6,0%	5,0%	16,2%	25,3%		38,0%
SAF (Sustainable Aviation Fuel) of non-biological origin		1,0%	4,1%	8,1%		43,9%
Final energy consumption (ktoe)	14,6	15,2	14,1	13,4		12,2
Primary energy consumption (ktoe)	17,1	17,8	16,8	16,3		16,9

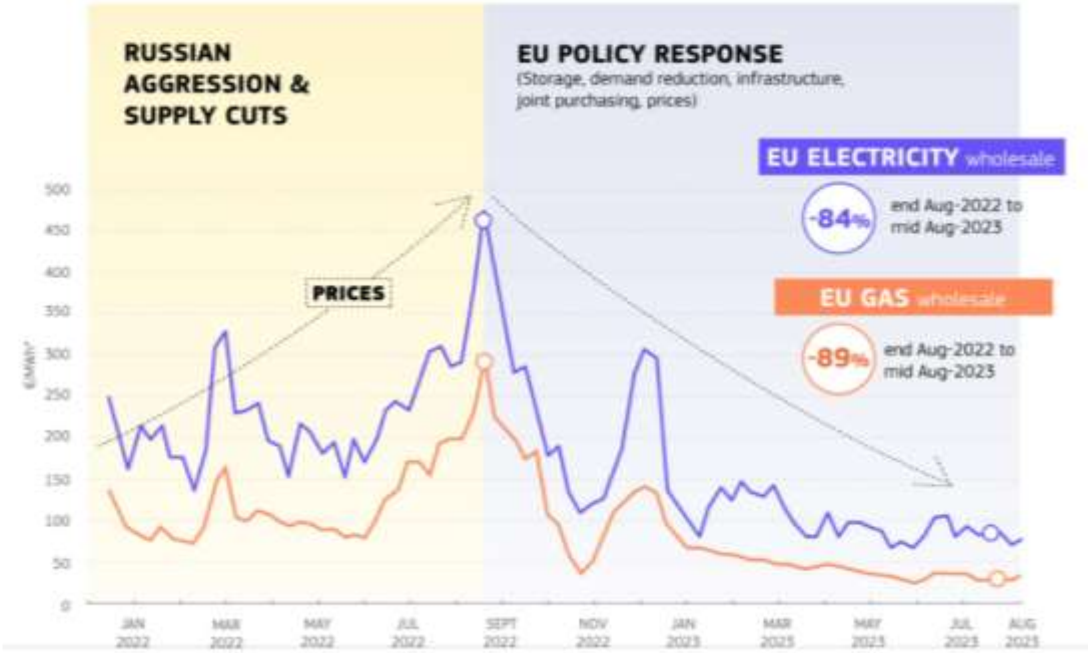
* Domestic energy consumption and international air transport
** Calculation according to RED III forecasts, through the tool "Eurostat Sharestool Draft_version 5"
*** (RES Injection - Storage Losses) / (Net Production + Net Imports + Own Production Consumption)

Source: NECP (2024)

4.3 Energy Security in Europe and Greece

The developments of recent years have radically changed the economy and energy markets. The pandemic was a global shock that temporarily reduced energy demand and prices, but at the same time triggered an ambitious response from the European Union – a response that created new resources (the Recovery and Resilience Fund - RRF), which our country is using to accelerate the energy transition. In addition, it led to a surge in inflation in the period that followed, after a sharp increase in demand was observed. Many of the actions described in the NECP are feasible because of the RRF, which did not exist in 2019. The gradual exit from the pandemic also led to an increase in energy prices – for natural gas and carbon dioxide (CO2) emission prices, the increase was unprecedented. In early 2022, Russia's invasion of Ukraine followed, which sent prices - especially of natural gas and, by extension, electricity - soaring to new heights.

Figure 24: Evolution of Natural Gas and Electricity Prices, 2022-2023



Source: European Commission

Overall, the energy crisis has led to five main trends. First, the price spike has completely changed the do-or-no-transition scenario. In 2022, Greece spent over €7 billion on natural gas imports – compared to the €1 billion it spent on average in the years before the crisis. The country has channeled almost €10 billion to protect households and businesses from the effects of precision – an amount equal to 4.8% of GDP for that year. The cost of CO2 emissions has also risen. Therefore, the scenario of a slow transition – with more natural gas and more pollutants – has a higher cost today, compared to the cost it had when the 2019 NECP was designed.

Second, the energy crisis brought about a significant drop in the demand for natural gas in 2022 (19%) and electricity (6.7%) for the entire territory. Third, the energy flows in SE Europe have changed. Our country imported much more LNG and increased natural gas exports to Bulgaria and other countries. The new landscape in the region creates significant opportunities for Greece to deepen the role it has already played as a pillar of energy security in the region.

Fourth, the energy crisis has changed Europe's strategy, with the main goals of de-reliance on Russian fossil fuels and accelerating the energy transition. New targets are set for alternative fuels (e.g. hydrogen, biomethane, etc.), while great emphasis is placed on production chains and on strengthening Europe's resilience.

Finally, the increase in prices brought about by the crisis affects a series of policies in the country's energy strategy. It creates a need to reduce energy prices, to protect vulnerable households, but also to limit cost increases for specific actions and infrastructure. At the economic level, the rise in interest rates changes financial data, increasing the cost of borrowing and therefore the cost of new investments. It is obvious that the changes brought about by the energy crisis interact with other trends, structural and long-term. Globally, we are seeing a continuous decrease in the cost of photovoltaics, wind farms and batteries, despite the inflationary pressures observed in 2022.

In Greece, the installed capacity of photovoltaics and wind farms doubled in four years, and RES cover almost 50% of the production of the country's interconnected system. The changes in energy coincide with a new juncture for our country. The recovery of investment grade, thanks to the positive assessment of the Greek economy, closes a cycle that lasted more than a decade. Our country now has access to new funds that can be channeled into the energy transition. Faster economic growth creates both a positive momentum for investments – but also leads to an increase in fuel consumption (mainly for road transport and air transport) – which is a challenge.

The Case of Europe

The European Union, over the past two decades, has shaped the regulatory framework for achieving energy security in its territory, with successive European regulatory rules and a series of mechanisms for managing domestic energy production and demand. However, its regulatory framework did not prevent the energy crisis in 2021 that was caused, initially due to the war between Russia and Ukraine and later, due to the significant chronic endogenous systemic problems facing the European energy sector.

More specifically, with its existing European regulatory legislation and regulatory mechanisms, the EU was unable to prevent the explosion of European gas and electricity prices in the period 2021-2022. Thus, from late 2021 to mid-2022, in order to safeguard energy sufficiency in Europe, the EU was forced to take successive emergency measures in the European electricity, gas and oil markets.

Initially, the EU took measures for 12 months, with the main goal of successfully managing the supply and demand of gas and electricity in the Union in the winter of 2022/2023. In the summer of 2023, the EU decided to extend the measures for the winter of 2023/2024.

The emergency measures, among others, concerned the reduction of natural gas consumption by 15% in all EU national markets, compared to their average domestic consumption over the last five years, the acceleration of natural gas storage in the Union's territory to meet demand in the winter of 2022/2023, common LNG markets with the organization of three European auctions for the purchase of natural gas from international markets, the demonstration of solidarity rules and procedures between states, the acceleration of the construction of new RES projects, the imposition of an upper ceiling on natural gas sales prices in European wholesale natural gas markets by establishing a mechanism for correcting market prices and the granting of free choice to Member States of the measures they can take to limit the explosion of electricity and natural gas prices in their territory.

In the case of the oil market, the European Union followed the decisions of the Group of 7 Developed Countries (G7) which focused on excluding Russian oil from their markets and imposing a ceiling on the maximum selling price of Russian oil to third countries.

The European Court of Auditors (ECA) recently warned that the European Union will have to overcome significant "obstacles" in order to address a possible new energy crisis[11]. In its report, it notes that while the EU has taken some emergency measures to address Moscow's "instrumentalisation" of natural gas, the benefits of this action "are not always clear". The ECA also highlights several new "challenges" that the EU will have to address in order to secure its long-term gas supply, such as greater reliance on imported LNG, as well as the need to decarbonise part of its natural gas consumption.

The report recalls that the gradual cessation of natural gas imports from Russia, which in 2021 represented 45% of EU natural gas imports, caused a supply crisis, which in turn caused prices to rise. Specifically, in August 2022, the wholesale price of natural gas peaked at €339/MWh (compared to €51/MWh in August 2021).

Member States started subsidising gas and electricity prices (costing around €390 billion in 2022 alone) in order to reduce the impact on households and businesses. By the end of 2023, the EU had successfully switched to sources other than Russia for its gas supply, and prices stabilised, reaching pre-crisis levels by early 2024. "The crisis triggered by Russia's full-scale invasion of Ukraine in 2022 tested the EU's resilience to a sudden gas shock. Prices may have increased sharply, putting significant costs on households and businesses, but fortunately we did not face a serious gas shortage," said ECA Member João Leão. "Given its dependence on foreign gas, the EU should not be complacent when it comes to security of supply. Moreover,

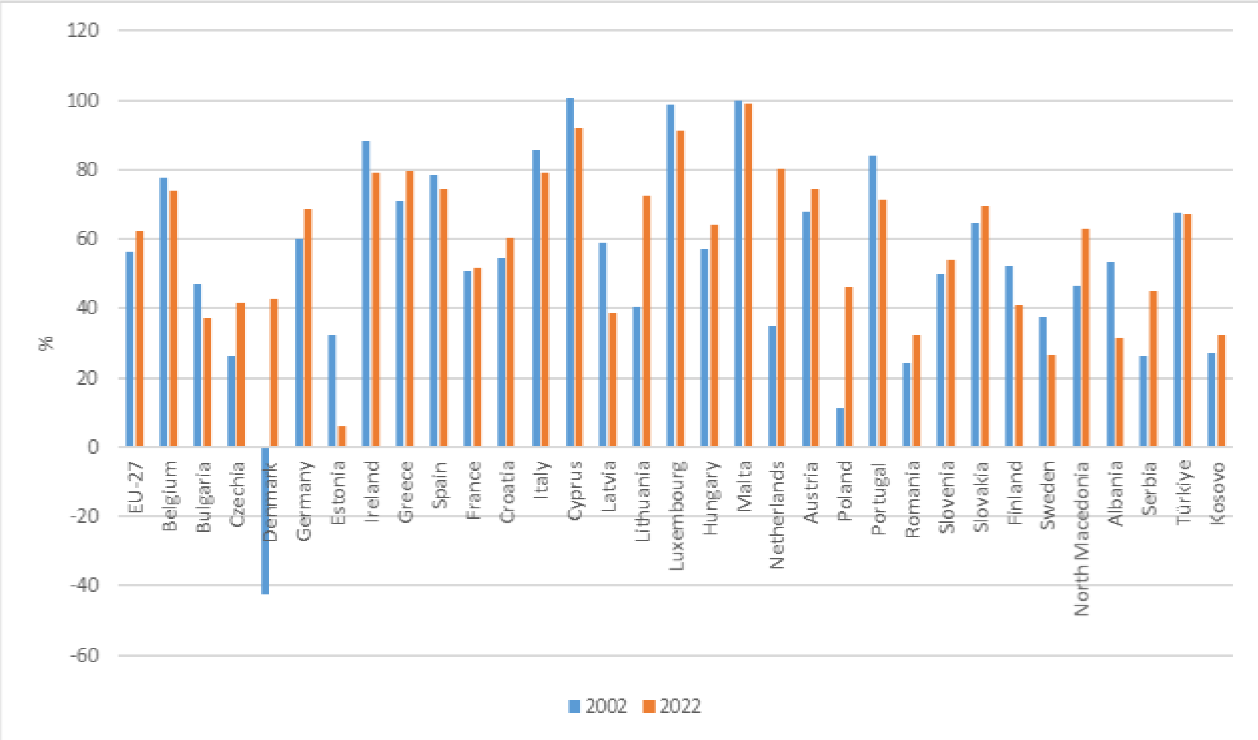
[11] https://www.capital.gr/diethni/3820877/europaiko-elegktiko-sunedrio-i-asfaleia-tou-efodiasmou-tis-e-e-me-fusiko-aerio-den-einai-egguimeni/

there are no guarantees for consumers that prices will be affordable in the event of a major supply crisis in the future," he noted.

During the energy crisis, the EU achieved its target of reducing gas demand by 15%, but the ECA could not verify whether this was due solely to the measures taken or to external factors (such as high gas prices and a warm winter).

Similarly, the EU-wide gas storage capacity requirement was met, exceeding the 90% target. This is, however, in line with normal storage levels before the crisis. The ECA was also unable to assess whether the implementation of a "cap" on gas prices in the EU ultimately paid off, as prices have remained at a much lower level since it was introduced.

Figure 25: Energy Dependence in Europe, 2000 and 2020



Source: Eurostat

Among the measures taken was the launch of the AggregateEU platform[12] to provide an alternative gas trading channel through common markets. Again, the ECA could not determine whether this platform provided added value compared to other existing ones, as the differences in gas prices between EU Member States caused by the crisis had already been significantly reduced when the AggregateEU platform was launched.

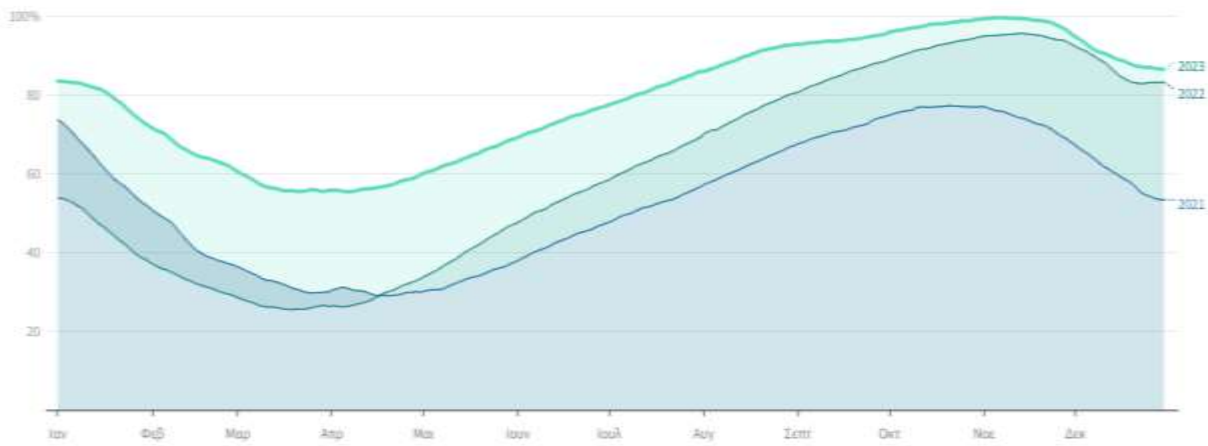
[12] AggregateEU είναι ο μηχανισμός της ΕΕ που επιτρέπει τη συγκέντρωση της ζήτησης και την από κοινού αγορά φυσικού αερίου σε ευρωπαϊκό επίπεδο. Δημιουργήθηκε μετά την έκδοση του κανονισμού (ΕΕ) 2022/2576 του Συμβουλίου (του λεγόμενου «κανονισμού για την αλληλεγγύη»), ο οποίος καθιέρωσε για πρώτη φορά τη συγκέντρωση της ζήτησης και την από κοινού αγορά φυσικού αερίου σε επίπεδο ΕΕ.

The reduction in dependence on Russian fossil fuels is a tangible reality. Pipeline gas imports from Russia have fallen sharply, while LNG import volumes from reliable partners such as the United States and Norway are increasing.

The share of Russian pipeline gas in EU imports fell from over 40% in 2021 to around 8% in 2023[13]. In terms of pipeline gas and LNG combined, Russia accounted for less than 15% of total EU gas imports. This decrease was mainly due to a sharp increase in LNG imports and an overall decrease in EU gas consumption. Norway and the United States were the top suppliers of natural gas in 2023. Norway supplied almost 30% of all natural gas imports. Other suppliers include North African countries, the United Kingdom and Qatar. In 2023, the EU imported over 120 billion cubic meters of LNG. In 2023, the United States was the largest supplier of LNG to the EU, accounting for almost 50% of total imports, while in the same year imports from the US almost tripled compared to 2021.

Chart 24 shows a comparison of the filling level of natural gas storage facilities during the period 2021-2023. In 2022 and 2023 the average filling level was much higher than in 2021. In 2022, the filling target of 80% was reached in August. In 2023, the filling level was above 80% since July and above 90% since August[14].

Figure 26: EU Natural Gas Storage Facility Filling Level, 2021-2023



Sources: Gas Infrastructure Europe, European Commission

Most EU Member States have gas storage facilities on their territory. The storage capacity of five countries (Germany, Italy, France, the Netherlands and Austria) represents 2/3 of the total EU capacity. According to the regulation, countries without storage facilities should store 15% of their annual domestic gas consumption in tanks located in other Member States and thus have access to gas stocks stored in other Member States. This mechanism strengthens the

[13] https://www.consilium.europa.eu/el/infographics/eu-gas-supply/#0
[14] https://www.consilium.europa.eu/el/infographics/gas-storage-capacity/#0

EU's security of gas supply and ensures a shared financial burden for filling the EU's storage capacity. Member States with smaller storage capacities cooperate with Member States with larger facilities to secure their stocks.

France, Germany, Italy and the Netherlands are the countries with the largest storage capacity. Greece, Estonia, Ireland, Cyprus, Lithuania, Luxembourg, Malta, Slovenia and Finland do not have any gas storage facilities. However, under the Gas Storage Regulation, they will have to make solidarity arrangements with other Member States to secure their own gas reserves. Importing LNG is a means of diversifying the suppliers and routes used by the EU to supply natural gas. Importing LNG has become particularly important following Russia's invasion of Ukraine and the EU's need to reduce its dependence on Russian gas imports. The EU is the world's largest importer of LNG, importing over 120 billion cubic metres in 2023, as previously mentioned. The largest LNG importers in the EU are France, Spain, the Netherlands, Belgium and Italy.

Russia's invasion of Ukraine and the use of gas supplies as a weapon have prompted EU Member States to further develop LNG infrastructure. Some planned investments are treated as EU projects of common interest, benefiting from simplified procedures and, in some cases, co-financing through the Connecting Europe Facility. Thanks to these investments, the EU's LNG import capacity increased by 40 billion cubic meters in 2023, and an additional 30 billion cubic meters are expected to be made available in 2024.

Spain, France, Italy, Portugal, Belgium, the Netherlands, Croatia, Poland, Greece, Finland and Lithuania have LNG terminals in operation. More than 12 LNG terminals are planned across the EU, with some already under construction.

The Case of Greece

The country's main priority is to increase the diversification of import sources and routes in order to strengthen the security of energy supply. At the same time, reducing energy dependence while developing domestic energy sources, compatible with the goals of achieving climate neutrality by 2050, is obviously the first and constant priority, especially in the context of a long-term energy plan. However, as long as this energy dependence remains at high levels and in order to avoid events such as the energy crisis that the country faced in the period 2008-2009 and more recently, at the end of 2016 to the beginning of 2017, as well as in 2022,

it is necessary to diversify energy sources and suppliers from third countries, so that there is no dependence on a single fuel or a single geographical area or a single pipeline, in parallel with promoting the penetration of RES but also, most importantly, promoting actions to improve energy efficiency, which are a top priority as previously stated in all dimensions of the country's energy planning.

However, in addition to measures to strengthen the country's position in the region, measures must be taken to ensure the readiness of the country and the stakeholders involved to deal with the limitation and/or interruption of energy resources and in this context, specific initiatives and the implementation of regulatory mechanisms should be foreseen.

Some of the measures and policies to strengthen the diversification of energy sources and energy import routes are the increase in the diversification of energy sources and suppliers coming from third countries. In particular, each country, in the context of securing its energy supply and preventing energy supply shortages that will lead to significant economic damage to many sectors of its economy, has as its main political priority the increase in the diversification of energy sources and the increase in the number of third countries supplying the country with oil, natural gas and electricity.

Important policy measures to meet the above priority are the promotion of natural gas transmission projects that will enable the supply of fuel from more countries, including the further strengthening of the country's electricity and natural gas interconnections with neighboring markets that will help in the uninterrupted flow of energy at a regional level.

Another measure is the development of domestic hydrocarbon deposits. Greece continues to be a growing market in the exploration and production of natural gas in the Eastern Mediterranean. Both the hydrocarbon exploration and exploitation programme in Greece, as well as the TAP (Trans-Adriatic) transnational pipelines, the Greece-Bulgaria Interconnection (IGB) and the East Med pipeline programme are important projects that enhance the diversification of the EU's energy supply and ensure security of supply in order to reduce energy dependence on third countries.

The Greek government has today awarded nine offshore and onshore concessions to consortiums of companies, including Prinos, where crude oil production has been ongoing (at a declining rate) for four decades. This is the first time that the country has had a large number of concessions, with major international and Greek companies as contractors. In light of the energy price crisis and security of supply, and taking into account the time pressure to exploit potential domestic natural gas deposits in view of the imposed energy transition, hydrocarbon exploration and exploitation projects were declared national priority projects by the Prime Minister himself in April 2022.

In the last two years, exploration has accelerated with the completion of all geophysical exploration programmes for active contracts and the decision to drill in the Ioannina onshore plot. Within the next two years, the decisions of the lessees are expected to conduct exploratory drilling on most of the plots, with the aim – in case of a positive decision and successful outcome of the research – of having domestic hydrocarbon production (beyond that of Prinos) within the current decade.

A conservative estimate of the potential and probable reserves of the said areas, in which however exploratory drilling has not yet been carried out, ranges, according to preliminary data from EDEYEP, at 24 trillion cubic feet or 680 billion cubic meters. The possible confirmation of these deposits exceeds both the present and future domestic demand for natural gas, making our country an exporter by the end of the decade.

Equally important from the point of view of energy security is the development of electricity interconnections and natural gas interconnection pipelines. The country's emergence as a regional energy hub is inextricably linked both to the strengthening of domestic electricity generation capacity and electricity storage systems and to the development of energy interconnections with neighboring countries.

Regarding the preparedness of the country and the stakeholders to address the limitation or interruption of the supply of an energy source, the following are foreseen, according to the draft of the revised version of the NECP: (a) development of a national energy security strategy within the framework of the sectoral strategies of the National Security Strategy until 2025, (b) development by 2025 of a National Strategy for the Cybersecurity of energy networks and infrastructures within the framework of the European Directive (EU) 2022/2555, concerning measures for a high common level of cybersecurity across the European Union (NIS 2 Directive), (c) development by 2025 of a National Strategy for the Protection and Climate Resilience of Critical Energy Infrastructures within the framework of the relevant European Directive (EU) 2022/2557 on the Resilience of Critical Entities, (d) preparation of a National Strategy for the exploration and exploitation of Critical Energy Minerals in Greece within the framework of the European Critical Raw Materials Act (CRMA).

4.4 Critique on the Current Energy Policy

With the completion of the new National Energy and Climate Plan (NECP) at the end of last October, Greece updated its energy planning, now being particularly detailed, with ambitious targets and with special reference to RES and energy efficiency.

Although the revised NECP is characterized by its large volume and the amount of information it includes, the in-depth research and processing of data and the ambitious targets for 2030 and 2050, many regulations and decisions by the state sector are needed in order to implement the adopted policy. In practice, however, the application of policy will face difficulties, so it is proposed to prepare a user-friendly manual that will include the "implementation plans", giving special emphasis to what needs to be done in a timely manner by the state sector in order to make the investments.

The new revised NECP is clearly more realistic than the previous one, having corrected exaggerations without however avoiding ambiguities and fragmentary references to important issues (e.g. hydrocarbon extraction). Despite the first impression it creates regarding the comprehensive treatment of all issues directly and indirectly related to the energy sector, however, upon completing its study one finds that some issues have not been investigated in depth and with the appropriate attention and correlation with related sectors.

It is not surprising that its main axis is only climate-centric, while several questions arise both about the economic viability of the entire strategic development framework (excessive development of RES) and about the insistence on new technologies (green hydrogen, synthetic ammonia, carbon-containing synthetic fuels biomethane), about which the NECP itself in some places speaks with reservation as untested on a large scale and in economies of scale.

Also, for the effective management and supervision of the NECP while it lasts, it will be necessary to form a team in the Ministry of Energy and Natural Resources of competent and experienced executives who will also contribute to the timely handling of bureaucracy for the successful achievement of the goals.

An important issue is the realism of the goals. Although increasing the share of RES in electricity generation to 82% is highly ambitious, achieving this target requires huge investments and immediate progress in the licensing and implementation of RES and energy storage projects. Greece has experienced significant delays in the licensing and implementation of infrastructure projects in the past, which may be an obstacle to achieving the targets.

Also, the gradual elimination of lignite production is crucial for the country's delignitization, but the social and economic impacts on post-lignite areas require special attention. The transition to other jobs and the development of new economic activities in these areas are considered necessary in order to avoid social destabilization and economic recession.

The emphasis on new technologies, such as green hydrogen and synthetic fuels, demonstrates Greece's ambition to lead the way in de-lignitization. However, the technological maturity of these solutions, as well as the required infrastructure, remain challenging. There is a risk that they will not be ready to contribute effectively to the 2030 targets, which could overturn the planning.

Regarding natural gas, the new NECP foresees the addition of two new natural gas units to the existing fleet without any retirement, raising the total installed capacity from 6.037 GW today to 7.885 GW. This development raises questions about the economic viability of natural gas units, which are likely to depend on subsidies, such as capacity adequacy mechanisms, increasing costs for consumers.

Regarding the development of installed RES capacity, the new NECP foresees an increase of 10 GW in wind and photovoltaics by 2030, from 12.5 GW in May 2024 to 22.4 GW in 2030, as well as in the budget for the necessary investments. Similar targets are set for RES and batteries by 2050. However, by 2030, a part of RES, especially those installed in the country before 2010, closing the limit of their technical and economic life, must be replaced, while by 2050 almost all RES operating today (12.5 GW) must be replaced. Regarding the batteries that will be installed by 2030, these must be replaced in the decade 2040-2050. Therefore, there is a need to adjust the targets upwards for new RES and batteries, so they should be included in the relevant budget, as well as for the relevant actions and financing.

Regarding offshore wind farms, the target of 1.9 GW by 2030, although completely feasible in terms of production, construction and installation of the necessary infrastructure, is called into question due to the non-extension of territorial waters up to 12 nautical miles, especially in Crete and the Aegean, and the failure of the state to declare an Exclusive Economic Zone (EEZ) in the Aegean and Eastern Mediterranean all these years. This is of enormous importance in the case of offshore marine farms in Greece because, based on analysis of wind data, high speeds and stable winds are found in the middle of the ocean.

The recent (August 2024) negative experience following the decisions to ban the installation of offshore wind farms in Crete and Gyaros limits the feasible installed capacity to just 500 MW. If Greece had proceeded with the extension of territorial waters in Crete and the islands to 12 nautical miles and had declared an EEZ, it could easily move the wind farm locations much further from land and thus achieve the 1.9 GW target.

It is also a serious omission of the NECP that it does not set targets for a much larger installed capacity of offshore wind farms, e.g. 20 and 30 GW by 2035 and 2040. Only if targets of this order are set will Greece be able to set up the necessary production chain, acquiring know-how and creating new jobs.

Regarding the development of hydroelectric power plants, the NECP foresees a significant increase in installed capacity (1.6 GW by 2050). For large hydroelectric power plants, although it is a critical sector for the country and with the looming water shortage in the coming years, no institutional and supportive measures are mentioned for their implementation and the

NECP is left to the "maturation" of projects that take decades (example: the Mesochora HPP and others). Therefore, substantial measures must be launched for their implementation.

For the islands, where the penetration of RES is disappointing and oil dominates with high costs and emissions, the NECP proposes the installation of so-called hybrids (RES and storage). This will be a good solution for the islands that are to be interconnected with the national transmission system in the coming years where an increase in production capacity is required for the increased summer peaks until their interconnection, instead of adding new oil units, as announced and with the corresponding cost. In addition, after the interconnection, RES and storage can constitute a system with the principles and techniques of microgrids to avoid blackouts in the event of a failure of the interconnection.

However, for the islands that are not to be interconnected, this solution proposed in the NECP will forever be subject to the dominance of the oil unit with limited penetration of RES (perhaps marginally at 40% on an annual basis). These islands need a new RES and storage system with innovative management technologies and RES penetration>90%, where the oil unit will be a backup and will operate as a supplement when needed. The energy transition on the islands, covering all energy needs with RES penetration of 90% and beyond for 2030, with a drastic reduction in production costs and security of energy supply, will be based on reforms and innovations, which the NECP must include.

Furthermore, in the NECP, regarding the high penetration of 76.8% RES in electricity in 2030, there is no mention of any rejection of excess RES production. It would be useful to mention it in order to follow up with research and search for solutions for the best response from now on.

At the same time, banking institutions are the main financier of a RES project and it is logical to seek to secure their capital by any means. In the past, state participation, in the guarantor role, created a sense of security in the market and easy financing conditions. Undoubtedly, bilateral contracts (PPAs) are a risk management mechanism, mainly for banking institutions. Through PPAs, guaranteed and stable revenues are ensured so that banking institutions can safely recover the cost of capital, while at the same time energy companies can build a diversified portfolio, with different technologies of production units, in order to minimize the risks arising from the energy stock market and the variability of the production of RES units.

The more consumers are bound to PPAs, the more the market will be deprived of consumer influence. The low prices to the end user, which appear through PPAs unfortunately contradict the fundamental principle of competition, while the regulatory role of the consumer is limited exclusively to a guarantor for the repayment of loans. Although PPAs are a useful tool for strengthening the industry and the economy in general, they should in no case replace competition in the energy market. Therefore, the expansion of the application of PPAs beyond large consumers causes a weakening of competition as the interaction produced by the dynamics of consumers in the entire energy market is reduced.

The increase in energy efficiency, in industry, in buildings and in land transport, which as we observe mainly from 2030 onwards is predicted to be very high, means that the demand for electricity and consequently for new RES will decrease. Therefore, the development of new RES should definitely be said in relation to increased energy efficiency. This is clearly seen from the projected final energy consumption, where while this is constantly decreasing until 2050, the development of RES continues at an unabated pace.

On the one hand, this is partly justified by the replacement of conventional fuels in transport (at least to a certain extent) and in the building sector by electricity (electrification) and partly by the use of RES for the production of green hydrogen, but again, the excess energy that is projected to be created from RES by 2050 (+60 GW) will more than cover the final energy demand, since compared to today, a more than fourfold increase in the installation of RES is projected.

It should be noted that for transport, energy consumption is projected to be lower by ¼ of current consumption by 2050, while for land transport, a reduction of up to 50% of current consumption is projected. Also, the electrolysis capacity is projected to reach 5,188 MW by 2050. Therefore, the percentage of RES that the country needs in relation to the reduction in final demand due to energy efficiency should be reassessed.

It is true that the new NECP sets more realistic bases for biomethane than the previous one, as according to our suggestions (participation in the IENE consultation) the previous plans were clearly modified, which set the unattainable and unrealistic, as we had mentioned, target of 9.7 TWh/year for 2050, reducing it to more realistic levels just above 4 TWh/year. However, the target of producing 2.1 TWh/year of biomethane for 2030 has remained the same and is also considered quite ambitious for the reasons that we analyze below.

According to RAAEY, the total annual quantity of biogas produced in 2022 was 1.28 TWh, and was used exclusively for electricity generation. This quantity is equivalent to 125 MNm3 of biomethane per year and corresponds to approximately 10% of the total natural gas consumption directed to the country's distribution networks mainly for small-scale (domestic and commercial) production consumption. The aim of the NEEK is therefore to exploit the biogas production potential in order to inject approximately 2.1 TWh of biomethane into the gas network in the year 2030. This means firstly that the currently existing 80 biogas units with a total installed capacity of around 120 MW would have to spend a total of €70 million within 5 years. in order to modify the technology for converting biogas into biomethane but also to lose the guaranteed prices, based on their contracts and secondly to create another 40-50 biomethane units within the same period.

This is considered to be leniently difficult to impossible and economically ineffective. In Greece, in fact, where 4/5 of the existing biogas units are between 100 KW and 999 KW, capacities that are considered very small compared to other countries (Germany, Spain, Great Britain), their conversion into biomethane units is considered not only problematic but also economically unviable.

Especially when a biogas unit of the order of 500 KW in Greece has a relative profitability that comes only from the favorable subsidized financial framework that applies to biogas today (existing feed-in tariff) it will be completely unprofitable for the entrepreneur to proceed with such an investment modification unless much higher feed-in tariffs are foreseen. In any case, with the above announcements of the National Energy and Natural Resources Development Plan and the forced conversion of biogas units to biomethane, a broader insecurity is also created among entrepreneurs as it seems that they will be surprised in the coming years regarding a new subsidy framework, completely changing the IRR of their investments.

Also, the extraction of domestic hydrocarbons and their exploitation is completely absent from the analysis, while it is briefly mentioned that it is a pillar of energy policy for the next period. However, it is not clarified how exactly it constitutes an energy axis since it is not analyzed at all, but also how it is ultimately integrated into the broader framework of the exploitation of domestic energy sources. It is particularly striking that the issue of hydrocarbons has not been included in the chapter on energy security, nor in that of the extraction of domestic minerals, but it is implied that in the event that these domestic resources become exploitable, they will not be directed to the Greek market but will be exportable goods. However, the research and extraction of hydrocarbons is not only an energy issue but also a geopolitical issue that strengthens the national diplomatic quiver but also ensures energy security. The issue of the country's energy security is completely downgraded in the National Energy and Power Development Strategy since the proposals submitted are considered inadequate and in the wrong direction. For example, the goal of making Greece an energy hub does not answer the fundamental question of improving energy security. The emergence of the country as an energy supply and transportation hub (oil, natural gas, electricity) does not mean that energy security automatically improves.

At the same time, although there is an assumption that, based on international literature, nuclear energy contributes to the balancing of a system based mainly on RES, such as the Greek one, there is no mention of a reassessment of this very important source of electricity which, among other things, could also help in the production of hydrogen on which this NECP is particularly based. The technology of small modular nuclear reactors (Small Modular Reactors – SMRs) is officially promoted by the EU, while there are quite a few countries in our region that are thinking of investing, such as Romania, which already has a long experience, and Serbia, which recently opened the issue and lifted the ban on nuclear energy.

These reactors are easily and quickly assembled and disassembled, they are built modularly and are considered, according to official EU data, as ideal power generation units that can provide security to the system for the development of more RES projects. They operate with the same technology as large nuclear reactors but are lower cost, for example requiring less water to cool the reactor, while they are flexible in moving. Regarding the issue of safety and causing an accident, due to their small size, operators can more easily shut down these units, while at the same time the safety systems they have operate faster and more effectively, essentially disconnecting critical parts of the equipment in the event of an accident. Perhaps the National Energy Strategy should make a reference to this technology, leaving open the possibility of including it in the energy strategy in a subsequent revision of the National Energy Strategy.

5. The Energy Market and Infrastructure in Greece

From the early 1990s until today, the energy system of Greece has been shaped according to the respective requirements of the national economy, the evolution of individual economic activities and the development of specific sectors, the consumer habits that have been adopted, but also the European policies on energy, the environment and development. Until recently (e.g. 2010) these largely influenced the energy policy followed in Greece.

To understand the country's energy system, the energy balance is used with Eurostat data. An energy balance is the structured way of depicting energy quantities and presents what and how much is produced, what and how much is consumed, where it is consumed, i.e. it depicts the balance between production and consumption. In addition, it helps to understand how products are transformed into each other, to highlight the various relationships between these products and how all types of energy are ultimately used. In a simplified way, we can say that an energy balance is a table, where the columns are the energy products (fuels) and the rows are energy flows (production - conversion - consumption).

The main elements of the energy balance analyzed in this Report include the total Gross Available Energy, the Gross Inland Consumption and the Final Energy Consumption. The relationships between the various energy quantities of the energy balance according to Eurostat are presented in Annex I, while the country's energy balance for the years 2022 and

2010 as well as the summary energy balance 2020 -2030 based on the NECP 2019 are presented in Annex II.

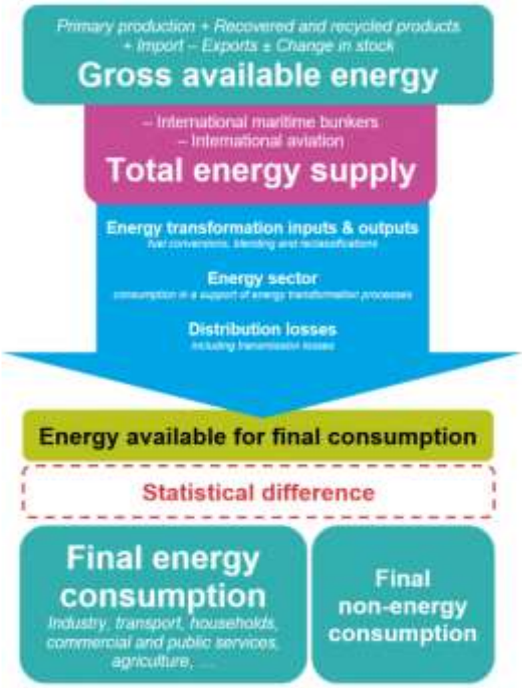
For a better understanding of the concepts used in this chapter, Table 6 is provided with useful definitions.

Table 6: Definitions of Key Energy Balance Concepts According to Eurostat

	Definitions
Gross Available Energy	It includes the primary energy sources (natural energy resources) used during the year (solid fuels, oil, natural gas and the equivalent electrical or thermal energy produced by RES plants), increased by recoverable or recyclable energy products, imports of primary energy sources and depleted reserves and reduced by the corresponding exports. ***Gross Available Energy = Primary Production + Recoverable and Recyclable Products + Imports - Exports ± Change in Inventories***
Gross Inland Consumption	It is the Gross Available Energy for all activities within the country's territory, excluding international marine fuels. It includes the needs for energy transformation, including electricity generation from conventional fuels, energy sector support functions, transmission and distribution losses, final energy consumption and the use of fossil fuel products for non-energy purposes (e.g. in the chemical industry). It excludes international marine fuels, but may include other fuels purchased within the country and used elsewhere (e.g. international aviation and "fuel tourism" in the case of road transport). ***Gross Domestic Energy Consumption = Primary Production + Recoverable and Recyclable Products + Imports - Exports ± Stock Change – International Marine Fuels***
Total Energy Supply	It is the Gross Available Energy for all activities within the country's territory, excluding international aviation and marine fuels. It includes energy needs for energy transformation (including electricity generation from fuels), the supporting functions of the energy sector itself, transmission and distribution losses, final energy consumption (industry, transport, households, services, agriculture, etc.) and the use of fossil fuel products for non-energy purposes (e.g. in the chemical industry). It excludes international aviation and marine fuels, but may include other fuels purchased within the country and used elsewhere (e.g. "fuel tourism" in the case of road transport). ***Total Energy Supply = Primary Production + Recoverable and Recyclable Products + Imports - Exports ± Stock Change – International Marine Fuels – International Aviation Fuels***
Final Energy Consumption	It concerns the total energy consumed by end users, such as households, industry and agriculture. It is the energy that reaches the final consumer and excludes that used by the energy sector, including deliveries and transformation.

Source: Eurostat

Figure 27: Simplified Scheme of Eurostat's Energy Balances



Source: Eurostat [11]

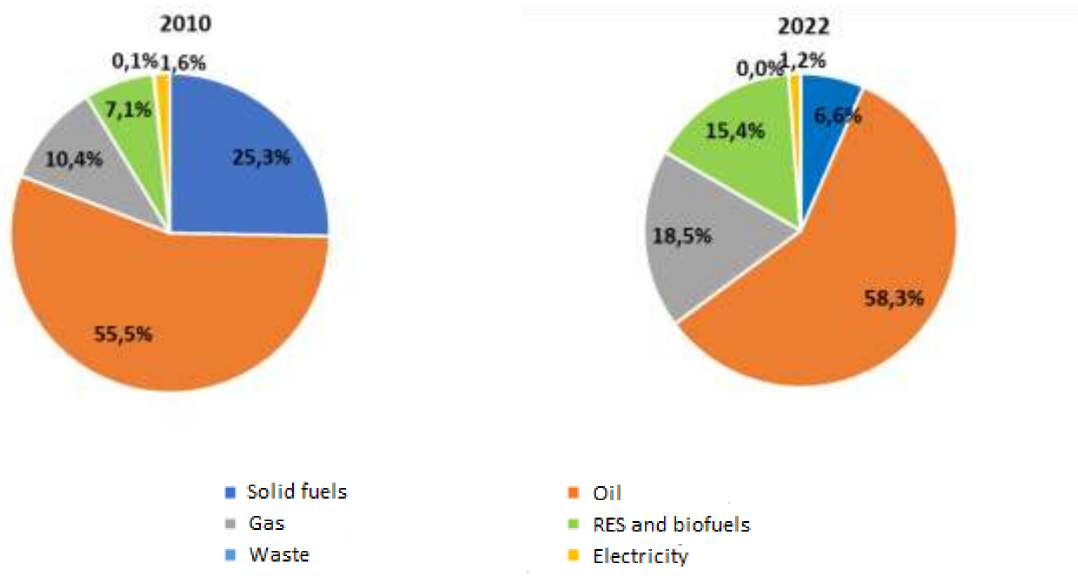
Note: The statistical difference is equal to the energy available for final consumption minus the final non-energy consumption minus the final energy consumption.

Regarding Gross Available Energy in Greece, as shown in Figure 28, it has a downward trend from 2010 to 2022, with the largest drop recorded in 2020 during the coronavirus pandemic. In 2022, a recovery is observed compared to both 2020 and 2021 by 7.7% and 1.9% respectively. Regarding the Gross Available Energy mix in 2022, oil and oil products accounted for 58.3%, with natural gas (18.5%), RES (15.4%) and fossil fuels (6.6%) following (Figure 29).

Figure 28: Gross Available Energy in Greece per Source, 2010-2022 (ktoe)

Source: Eurostat

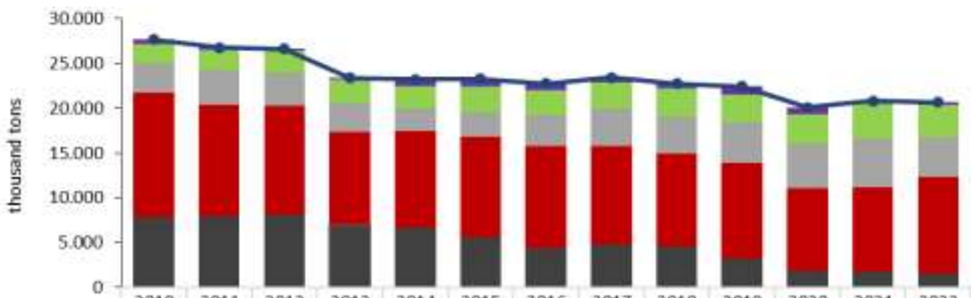
Figure 29: Fuel Share in Greece's Gross Available Energy, 2010 and 2022



Source: Eurostat

Total Energy Supply for all products is one of the key figures of the energy balance and represents the amount of energy required to meet domestic energy needs. In the entire energy system, Total Energy Supply ranged at 20,663 thousand tons (Ktoe) in 2022, showing a significant decrease of 25.3% compared to 2010 (Figure 30), while, compared to 2021, a marginal decrease of 0.7% was recorded. The trend of increasing the penetration of RES in gross domestic energy consumption continues and from 7.7% in 2010 reached 16.8% in 2022. At the same time, the share of solid fuels decreased from 27.7% in 2010 to 7.2% in 2022 (Figure 29) [12].

Figure 30: Evolution of Total Energy Supply in Greece by Source (ktoe), 2010-2022

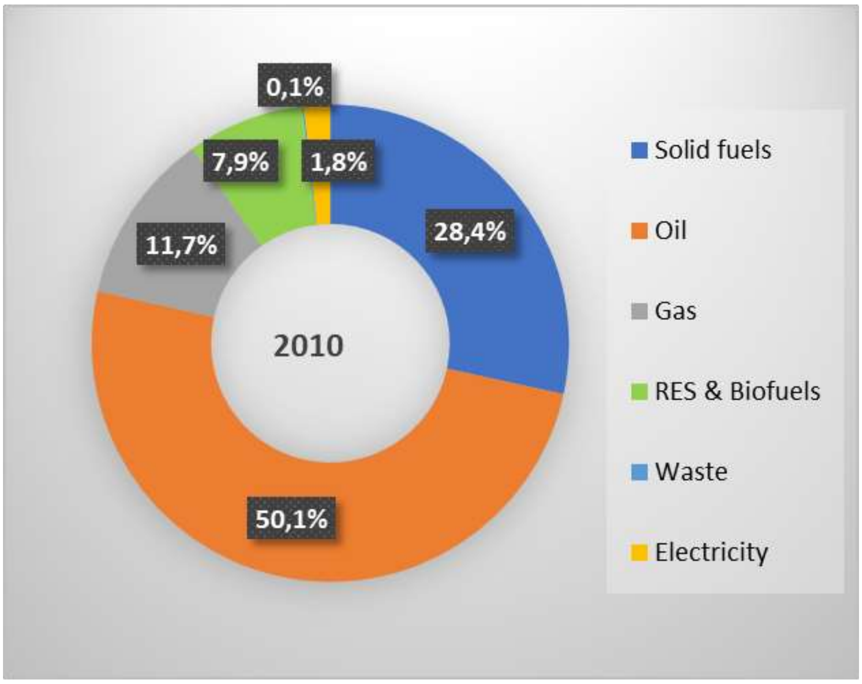


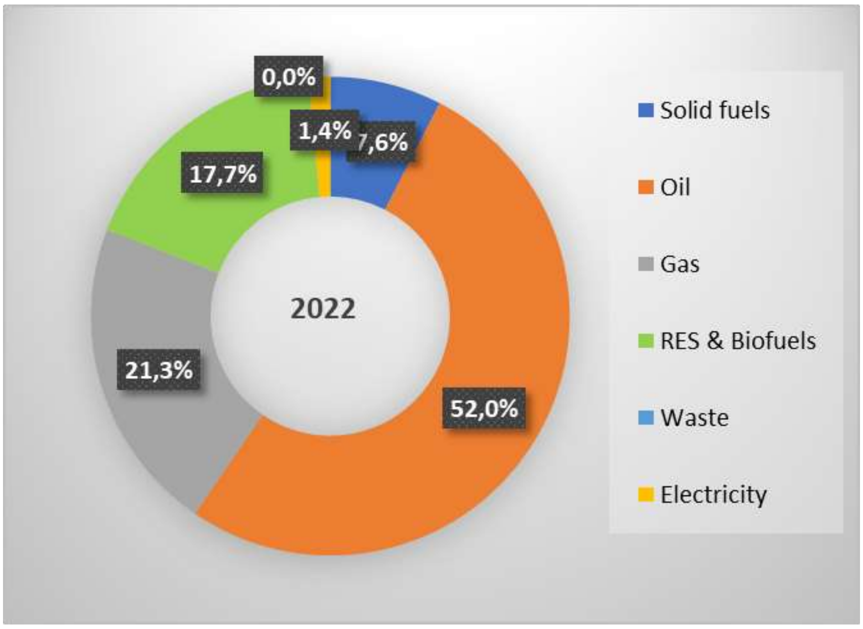
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Electricity	491	278	153	162	758	826	756	536	540	855	762	317	296
Waste	32	28	15	21	21	89	60	0	29	42	10	8	0
RES & Biofuels	2.191	2.199	2.507	2.676	2.506	2.840	2.704	2.915	3.141	3.172	3.350	3.838	3.658
Gas	3.234	3.972	3.662	3.236	2.484	2.677	3.490	4.204	4.117	4.489	4.928	5.449	4.404
Oil	13.854	12.434	12.132	10.318	10.760	11.226	11.396	10.936	10.358	10.669	9.212	9.492	10.743
Solid fuels	7.863	7.887	8.135	6.981	6.687	5.606	4.369	4.817	4.564	3.196	1.831	1.711	1.562
TOTAL	27.665	26.798	26.604	23.395	23.217	23.265	22.776	23.408	22.749	22.424	20.093	20.814	20.663

Source: Eurostat

Note: Electricity as part of Total Energy Supply refers to Primary Production + Recoverable and Recyclable Products + Imports - Exports ± Change in Inventories. Essentially it refers to Imports - Exports.

Figure 31: Fuel Share in Greece's Total Energy Supply, 2010 and 2022





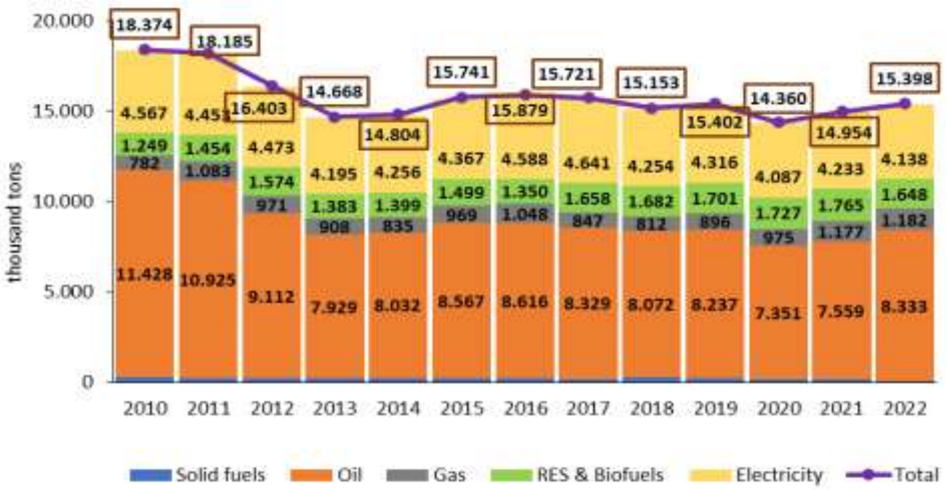
Source: Eurostat

Regarding Final Energy Consumption, after its sharp decrease in 2013 (-20% compared to 2010), Eurostat data show a mild upward trend in the period 2013-2022 (with the exception of 2018) with a sharp decrease in 2020 due to the coronavirus pandemic and an upward trend in the following two years. In 2022, total final energy consumption increased by 3.0% compared to 2021 and amounted to 15,398 thousand tons.

From Chart 30 it can be seen that the consumption of solid fuels and petroleum products decreased significantly in 2022, compared to the consumption levels of 2010 (a decrease of -76.0% and -27.0% respectively). This decrease was largely offset by the increase in the use of

RES and the consumption of natural gas, whose consumption increased by 31.9% and 51.3% respectively in 2022 compared to 2010. Electricity consumption decreased by -9.4% in the same period.

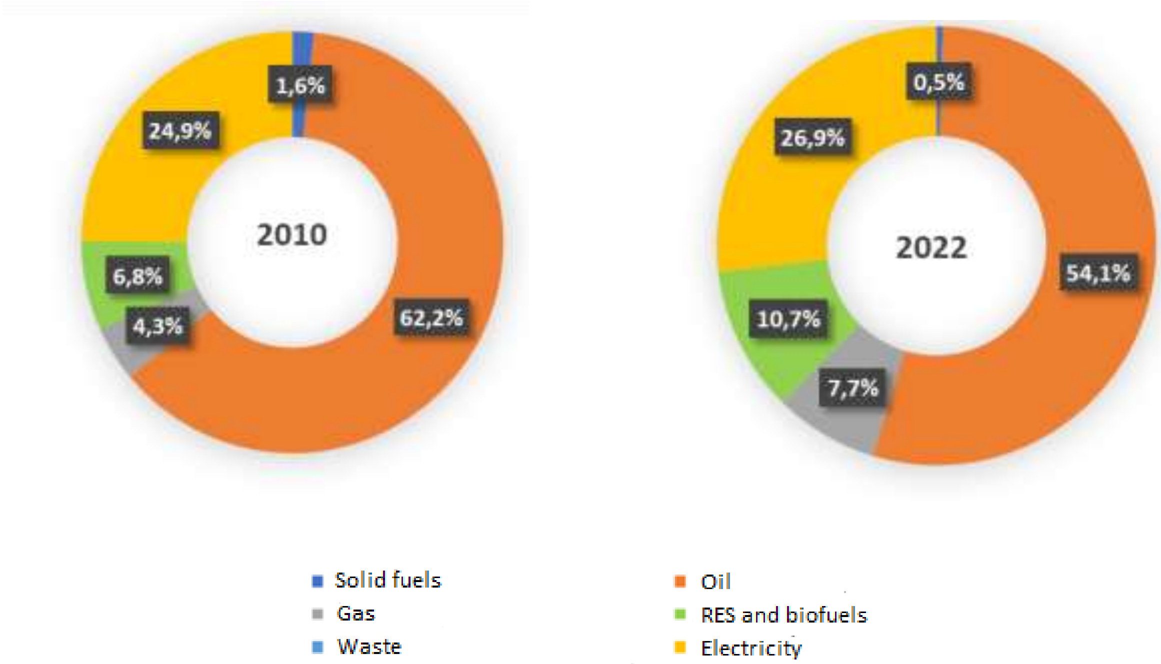
Figure 32: Final Energy Consumption per Fuel in Greece (thousands tons), 2010-2022



Source: Eurostat

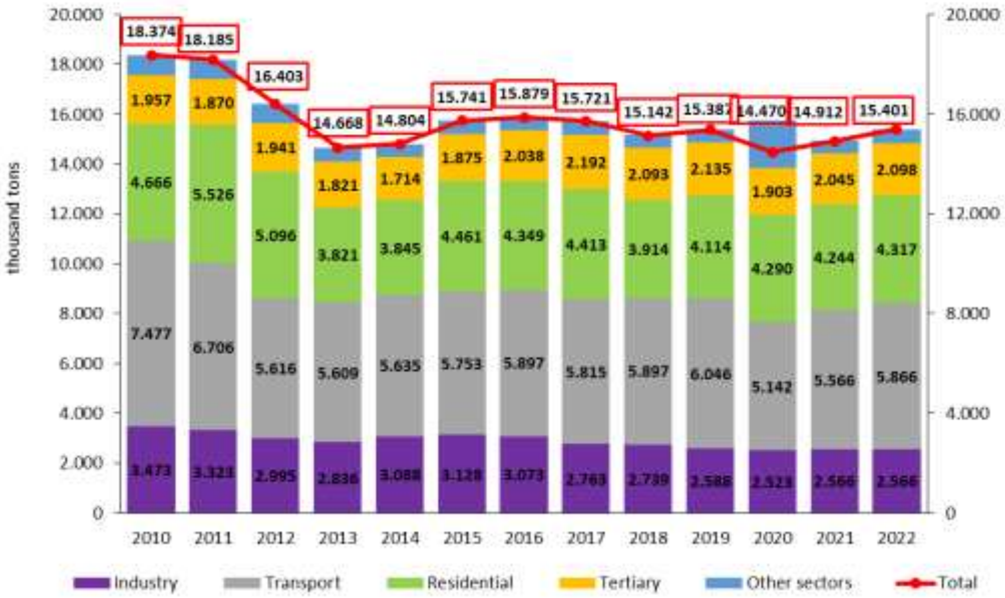
Figure 33 presents the contribution of different types of fuels to final energy consumption during the period 2010-2022. The largest share in the final consumption sector corresponds to the consumption of petroleum products (54.1% for 2022), with electricity following with a percentage of 26.9%, while the percentages of the use of RES and natural gas amounted to 10.7% and 7.7% respectively [12].

Figure 33: Fuel Share in Greece's Final Energy Consumption, 2010 and 2022



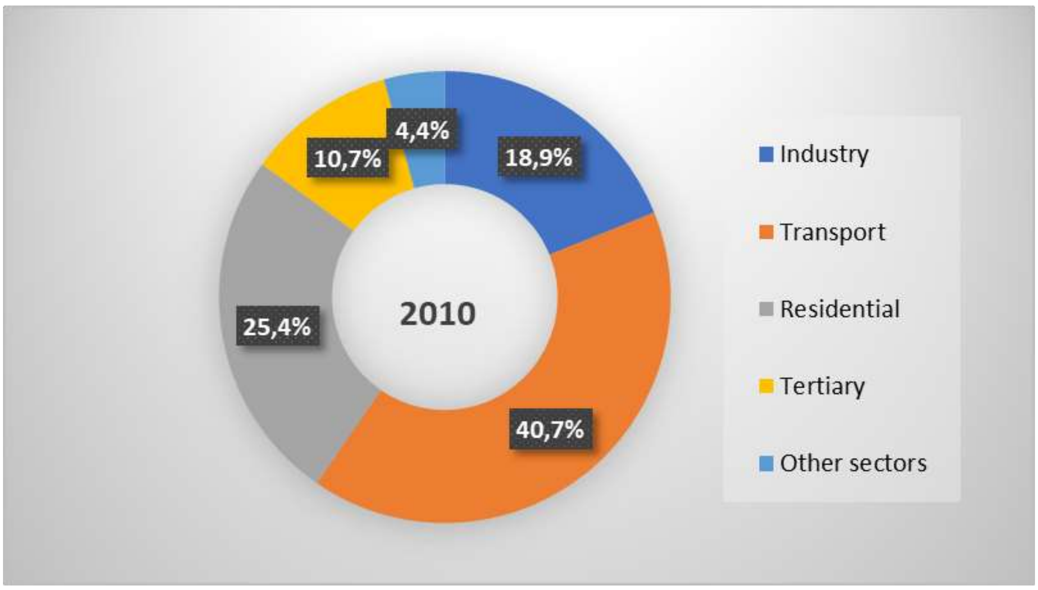
In 2022, a decrease in the participation of industry and transport in final energy consumption was observed by two and three percentage points, from 19% to 17% and from 41% to 38% respectively compared to 2010, while an increase in their shares was recorded by the residential and commercial-public sectors. It should be noted that for 2022, the transport sector had the largest contribution as a share in final energy consumption (share 38.1%), while the participation of both the residential and industrial sectors was also significant (share 28.0% and 16.7% respectively) (Figure 34) [12].

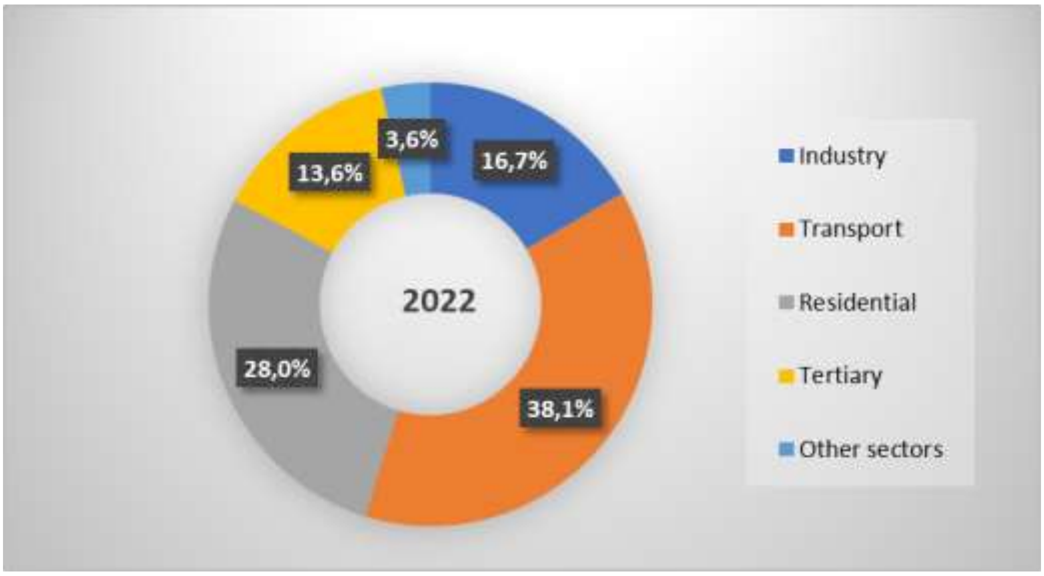
Figure 34: Final Energy Consumption by Sector in Greece (thousands tons), 2010-2022



Source: Eurostat

Figure 35: Share of Individual Sectors in Greece's Final Energy Consumption, 2010 and 2022

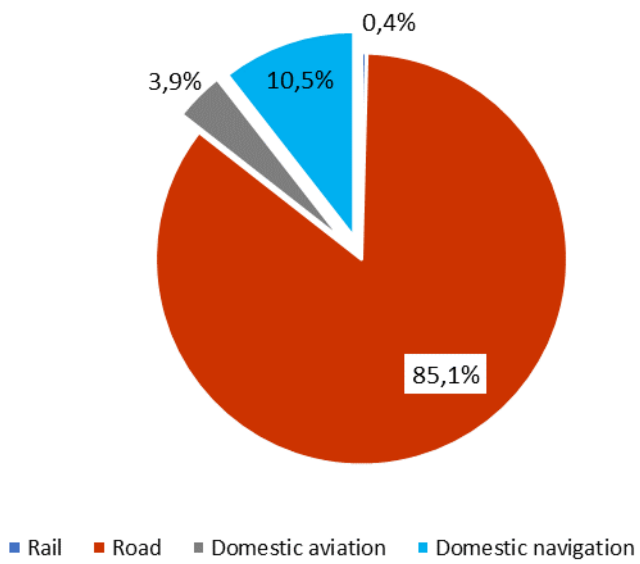




Source: Eurostat

In the transport sector, road transport dominated energy consumption, accounting for 85.1% of the sector in 2022 (Figure 36).

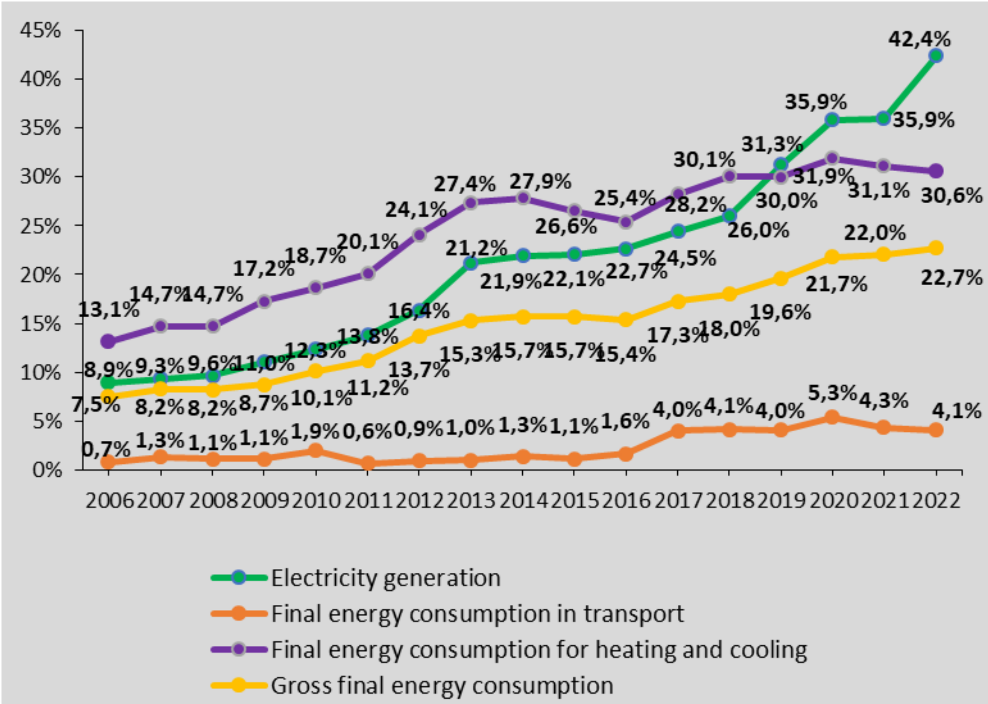
Figure 36: Share of Transport Type in Final Energy Consumption in the Transport Sector, 2022



Source: Eurostat

The contribution of RES to energy consumption in Greece shows a significant increase during the period 2006-2022, as its total contribution in 2022 as a share in gross energy consumption amounted to 22.7%, while its share in electricity production reached 42.4% in the same year. (Figure 37) [13].

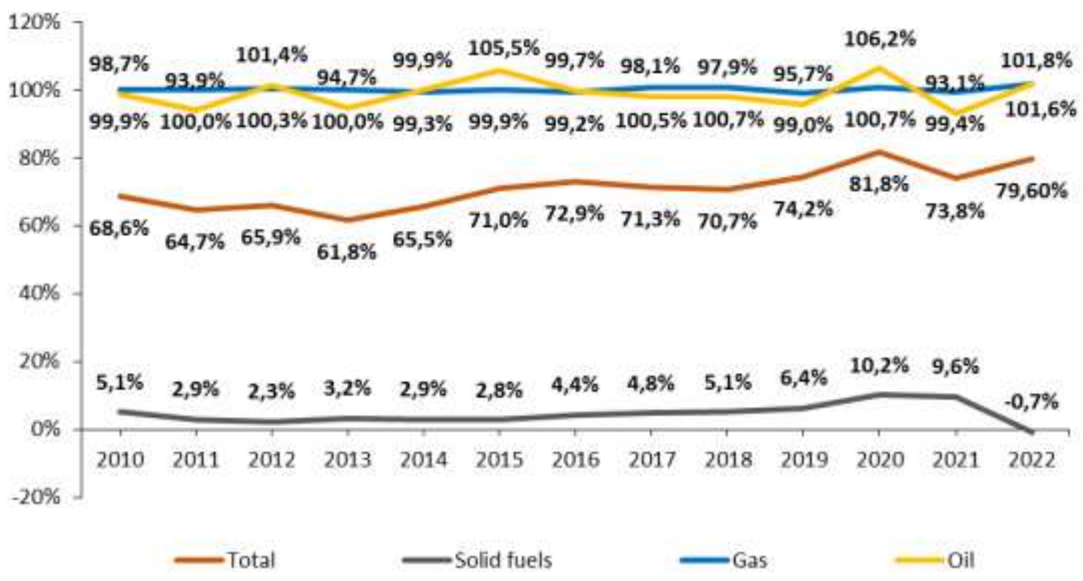
Figure 37: Total and Specific RES Shares in the Domestic Energy System Based on the European Union Methodology, 2006-2022



Source: Eurostat

With the exception of the transport sector, where the share of RES showed marginal fluctuations with a steady increase from 2016 to 2020 and a decline in 2021 and 2022, the contribution of RES to both gross electricity consumption and final energy consumption for heating and cooling during the period 2007-2022 showed a significant increase with an average annual growth rate of 8% and 7% respectively. The share of electricity from RES in 2022 stood at 42.4%, showing an impressive increase compared to 2006, when the corresponding share was 8.9%. In particular, with regard to the production of electricity from RES, with characteristics of uncontrolled production, i.e. electricity production from photovoltaic and wind plants (in the Transmission System), the percentage of wind plants amounted to 48.6% and photovoltaic plants to 25.0%. In addition, the share of hydroelectric plants accounted for 23.9% of electricity production from RES in 2022. Despite the steadily increasing penetration of RES in the national energy mix over the last decade, Greece's energy dependence index - which is defined as the ratio of energy imports to domestic gross available energy expressed as a percentage - moved in the opposite direction, recording a significant deterioration. In 2010, 68.6% of gross available energy in Greece came from imports, while in 2022 this share increased to 79.6%. More specifically, the share of oil and petroleum product imports in 2022 amounted to 101.8%, natural gas to 101.6%, remaining relatively stable since 2010, while fossil fuels show a negative index in 2022, meaning that exports were made for these products in 2022, so there was energy independence (Figure 38).

Figure 38: Greece's Energy Dependence, 2010-2022



Source: Eurostat

5.1 Oil and Petroleum Products

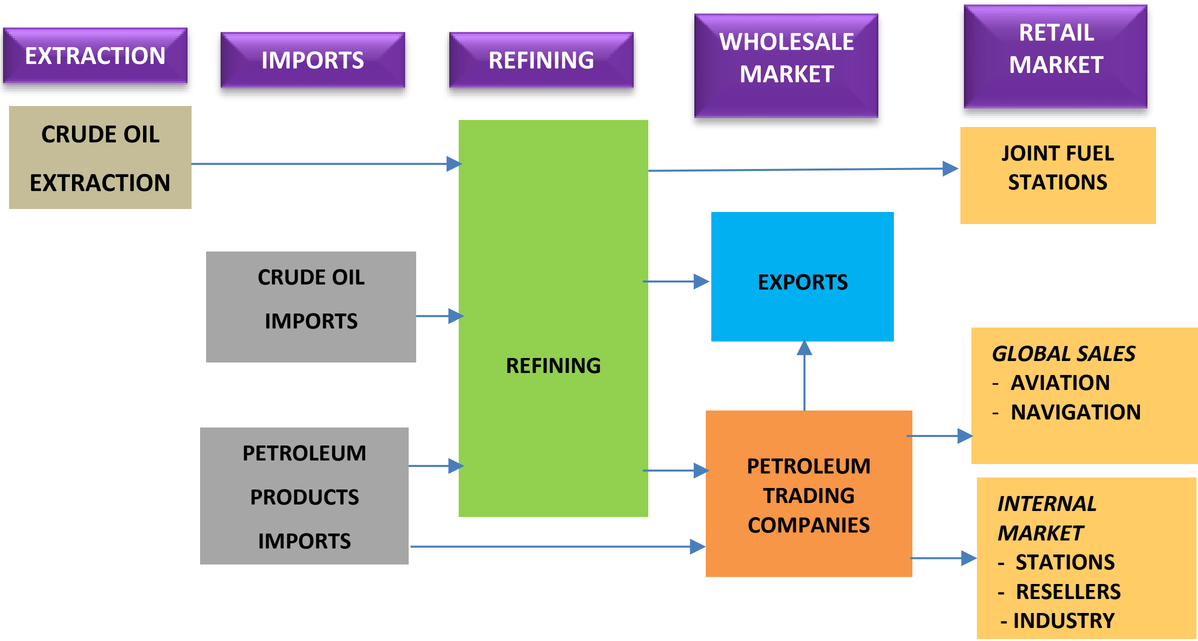
5.1.1 Structure of the domestic petroleum products market

The domestic petroleum products market, which has the largest share in both gross and final energy consumption, is composed of the following segments (Figure 39):

- crude oil extraction
- production of petroleum products by refining companies,
- wholesale market and
- retail market

The operation of the market is supported by appropriate transportation, production and storage infrastructure, such as refineries, pipelines, tankers, port facilities.

Figure 39: Domestic Petroleum Products Market



Sources: IENE, IOBE

The Greek petroleum market is regulated by Law 3054/2002 "Organization of the petroleum market and other provisions" (as amended) and the relevant Licensing Regulation.

In the market for the year 2023, there were [14]:

- 2 refinement companies with 4 refineries.
- 22 Petroleum Marketing companies holding a type A license, with storage and trading facilities throughout Greece.
- 22 companies holding a type B1 or/and B2 license for marine or/and jet fuels, with facilities for the replenishment of ships in harbours and with stations for the replenishment of aircrafts in almost 25 airports. 12 of them also hold a type A license.
- 21 companies holding a type C license – namely license to trade LPG, with installations or/and LPG bottling plants. 2 of them also hold a type A license.
- 11 companies holding a type D license – namely a license to trade Asphalt. 8 of them also hold a type A license.
- 1 company holding a License to Transport via Pipeline. The company is active in the transportation of Jet fuels from the Refineries at the E. Venizelos Airport.
- 5.900 active service stations.
- In Greece there is 1 service station for every 1,770 inhabitants, while the average equivalent in the EU is 1 service station for every 3,250 inhabitants.
- approximately 250 Heating Oil Resellers.

The following are used for the transportation and distribution of fuels [14]:

- a pipeline network
- approximately 1.400 Public fuel trucks
- approximately 180 Private fuel trucks of the Trading Companies
- approximately 8.000 Private small trucks for the distribution of heating oil

The Sales for 2023 were:

- Domestic Market: 6.603.431 tons
- International Market: 4.161.892 tons
- Both Markets: 10.765.323 tons

The study "Aggregate Data and Indicators of the Petroleum Products Trading Sector for the year 2022" by the IOBE [15], highlights the following regarding the prospects and challenges of the industry in the coming years:

- The petroleum trading sector will face a more unfavorable domestic and international environment in the coming years, as the Greek and European economies are expected to slow down in the next two years.
- The increase in financing costs strongly affects petroleum trading companies due to the high working capital needs for the acquisition of petroleum products, including the payment of excise duty.
- Many of the national Energy and Climate policy objectives directly affect the petroleum trading sector, as measures to limit petroleum consumption are required to achieve them.
- According to the National Energy and Climate Plan (NECP), the annual consumption of petroleum products for energy use will decrease by 8% in 2025 and by 23% in 2030 compared to 2015, creating serious pressures on trading companies.
- In the transport sector, the reduction of petroleum consumption will be based on substitution with electricity (electromobility), gaseous fuels (advanced and synthetic biofuels) and green hydrogen, as well as on enhancing energy efficiency.
- Petroleum trading companies have undertaken a large part of the obligation to improve energy efficiency (approximately 56% of the total or 815 ktoe). This implies high compliance costs if the companies do not take the necessary measures to improve energy efficiency in the sectors where petroleum products are used (except air transport).
- This cost creates an additional burden on the financial results of companies in the sector and more so for those that are experiencing losses or marginal profitability.

- For the period 2023-2030, Petroleum Trading Companies will be required to achieve energy savings in final consumption by implementing technical measures (in addition to horizontal/behavioral), which require high investments.
- The expected decline in sales will maintain the particularly weak profitable image of the sector or will make it loss-making, at least with regard to: a) products directed to the domestic market (mainly gasoline and diesel and heating oil) and b) the companies that base their sales on these products.
- The financial results of the sector in the coming years will depend on the course of the economy, the evolution of international oil prices, the tax treatment and the ability to obtain bank or other financing at an acceptable cost.
- At the same time, in the medium term, significant investments are required from the trading companies to adapt to the new data (electromobility, hydrogen stations, etc.). The financial results of the sector, as reflected in this Report, raise some doubts about the ability of mainly smaller companies to implement them.

5.1.2 Oil Production, Imports and Exports

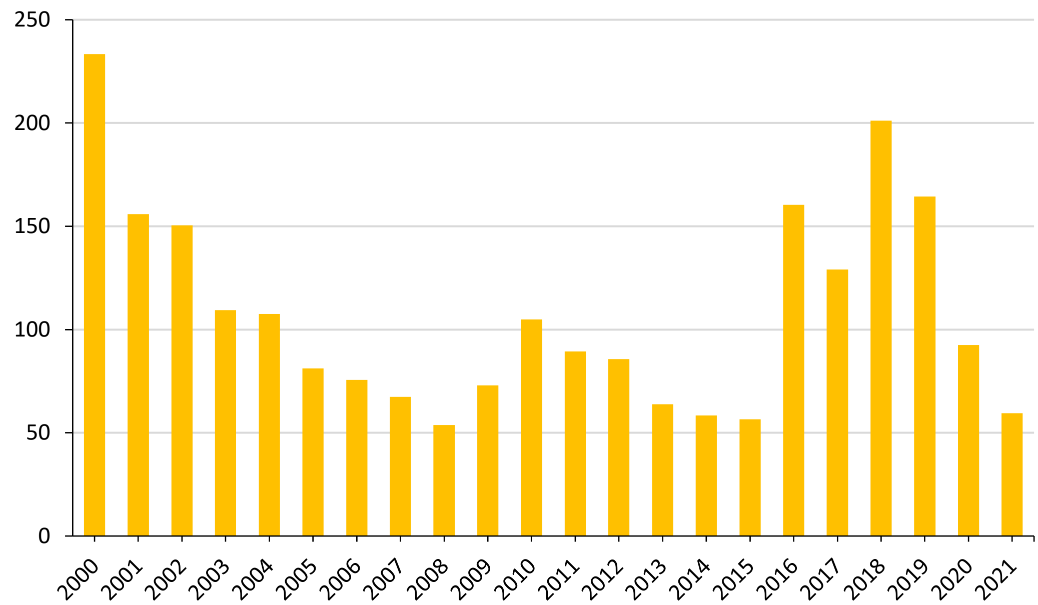
Crude oil production[15] in Greece, which began about 40 years ago in 1981, was interrupted in 2021 due to a series of technical problems, resulting in zero production in 2022 and 2023. The first oil loading from Prinos production for 2024 took place from Energean's facilities in Kavala in the first days of 2024, as Prinos production was fully restarted, which had been interrupted since September 2021, initially due to a scheduled shutdown for maintenance of the facilities and then due to the events with their occupation by the Union of former employees. In total, 220,000 barrels of crude oil were delivered to BP, including production from the Epsilon field, which restarted in November 2023.

Energean made significant investments in 2023 to boost production, most notably the internal cleaning of the coiled tubing of the wells on the Alpha platform in Prinos, including the EAH3 horizontal well in the Epsilon field. The process was carried out with absolute precision and safety in November 2023 by a specialized Italian company.

At the same time, a new platform is being prepared at the Epsilon field, in order to increase oil production by 2025. According to Energean's estimates, the Epsilon field has proven reserves of approximately 23 million barrels and by 2025 it can produce up to 5,000 barrels per day.

[15] Crude oil includes: crude oil, natural gas liquids, refinery feedstocks, additives as well as other hydrocarbons (including emulsified oils, synthetic crude oil, mineral oils derived from bituminous minerals such as oil shale, tar sands, etc. and oils from coal and natural gas liquefaction).

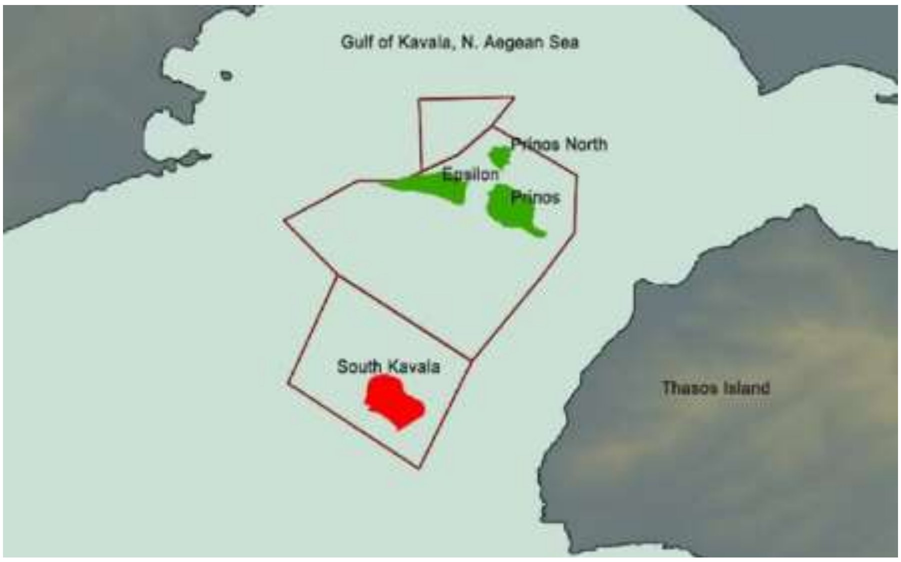
Figure 40: Crude Oil Production in Greece (thousands tons), 2000-2021



Source: Eurostat

Of the eight active licensed areas, the "Prinos" area was the only one in production phase in 2024. The marine sedimentary basin "Prinos-Kavala" is located in the northern Aegean Sea, 6 km. northwest of Thassos, with sea depths between 30-50 m. Production comes from three deposits: "Prinos", "Northern Prinos" and "Epsilon".

Map 3: Prinos, North Prinos and Epsilon Reserves in the Gulf of Kavala

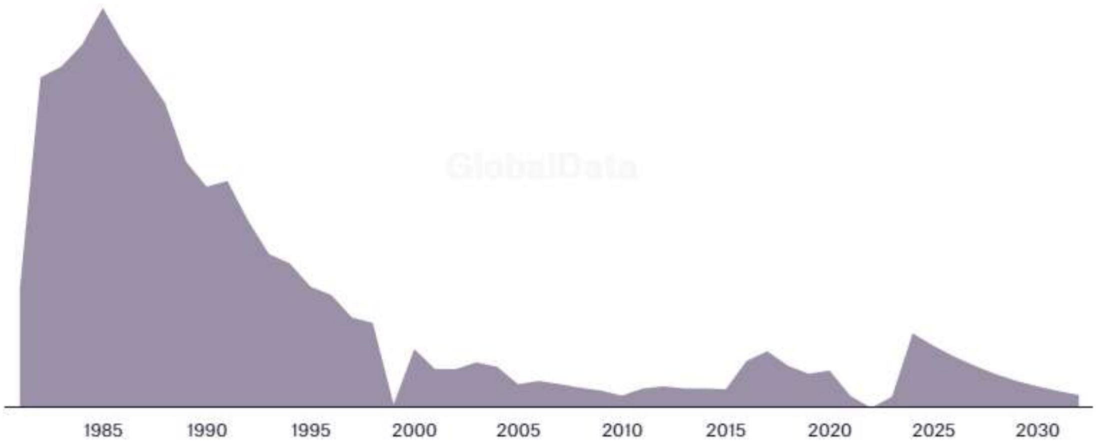


Source: Oil and Gas Journal

The Prinos Basin was explored in the 1970s and the Prinos field was discovered in 1974, with the drilling of the Prinos-1 well, the first exploration well in the area. The field was developed in the late 1970s and production began in 1981. Initial development of the field, following delineation drilling that confirmed the extent of the reservoir, took place from 1979 to 1981.

Crude oil production began in early 1981, with initial production ranging from 8,000 to 10,000 bpd. Production peaked in 1985 at 27,000 bpd, but has declined steadily since then (Figure 41) [16].

Figure 41: Evolution of Total Production of the North Prinos Field, barrels per day (bpd)



Source: Offshore Technology [17]

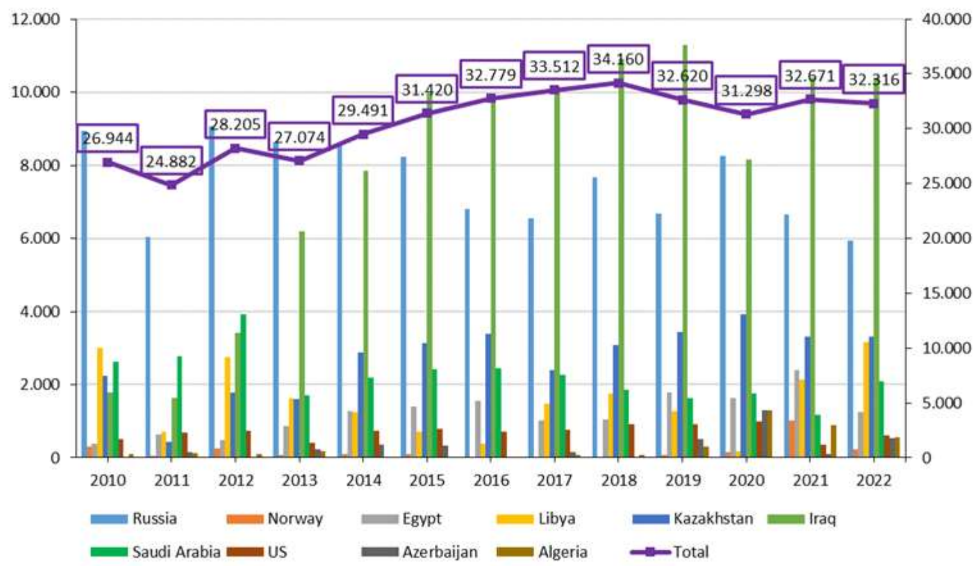
It should be noted that the Prinos field has proven to be incredibly productive, albeit geologically challenging, with a total of around 130 million barrels extracted to date, three times the initial estimate.

The depleted South Kavala field is suitable for conversion into underground gas storage (UGS) that will be connected to the TAP pipeline that will cross Greece 2 km from Energean's onshore facilities. UGS plays a significant role in minimising the need to import more natural gas during periods of high demand, while also helping to absorb sharp fluctuations in supply. In 2022, and as a result of a prolonged period of instability and high energy prices, the European Commission adopted the Gas Storage Regulation (EU/2022/1032), which establishes underground gas storage facilities as critical infrastructure.

Energean submitted on June 1, 2011 to the Regulatory Authority for Energy, Waste and Water (RAAEY) an application for a permit allowing the installation of the storage facility and the conversion of the almost depleted field into an underground natural gas storage facility, in accordance with Law 3428/2005 (regarding the liberalization of the natural gas market in Greece). Energean's Prinos CS project in Greece has been included by the European Commission as a Project of Common Interest [18]. According to preliminary technical studies, the South Kavala LNG facility will be able to contain an exploitable volume of gas (working gas) of approximately 530 million cubic meters (Nm3) and its operation will be in two cycles per year, where the maximum extraction rate will reach 9 million Nm3 per day [19].

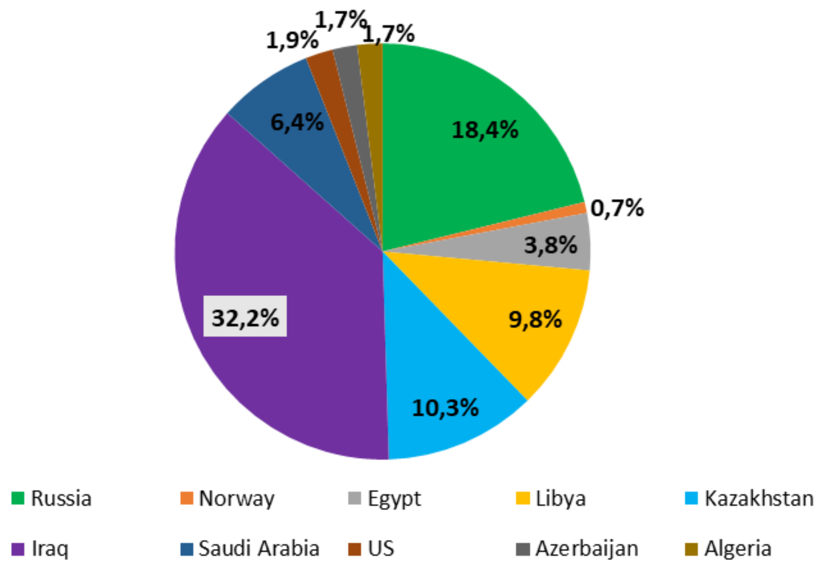
Therefore, Greece depends on imports of large quantities of crude oil and petroleum products to meet its needs. Iraq was Greece's largest supplier of crude oil in 2022, with 10.4 million tons, followed by Russia with 5.95 million tons and Kazakhstan with 3.13 million tons (Figure 42). Imports from Iraq alone accounted for 32.2% of Greece's total imports of crude oil and petroleum products in 2022, which amounted to 32.316 million tons (Figure 43) [20].

Figure 42: Imports of oil and petroleum products in Greece by Country (thousand tons), 2010-2022



Source: Eurostat

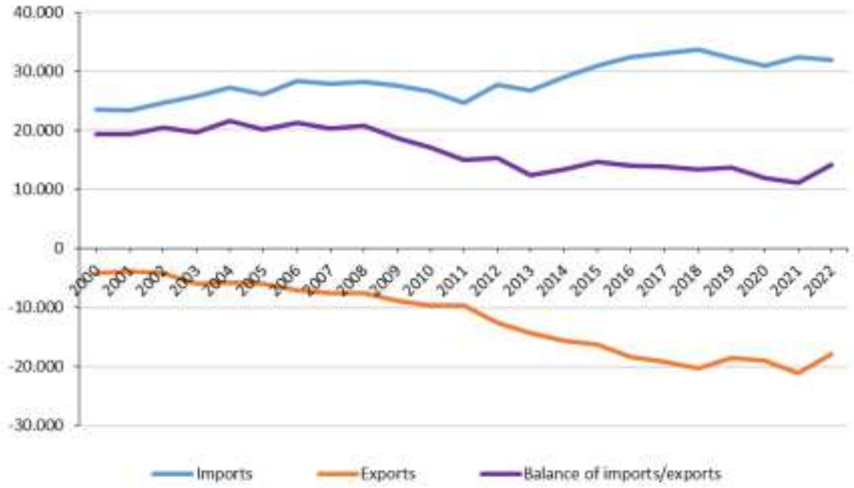
Figure 43: Share of Oil Imports in Greece by Country, 2022



Source: Eurostat

Since 2013, imports of petroleum products followed an upward trend until 2021, with the exception of 2019 and 2020 and stabilization in 2021 and 2022, in parallel with the increase in exports, however, Greece remained a net importer of petroleum products for the period 2000-2022 (Figure 44).

Figure 44: Imports, Exports and Balance of Petroleum Products in Greece, 2000-2022



Source: Eurostat

5.1.3 Oil Consumption

Following its decrease during the economic crisis (-30.6% in 2013 compared to 2010) and the recovery in the period that followed, the consumption of petroleum products in Greece decreased sharply in 2020, compared to 2019, by -10.8%, mainly due to the crisis caused by the Covid-19 pandemic, while in 2021 and 2022 it followed an upward trend [21].

Figure 45: Consumption of Oil and Petroleum Products by Sector (thousand tons), 2010-2022

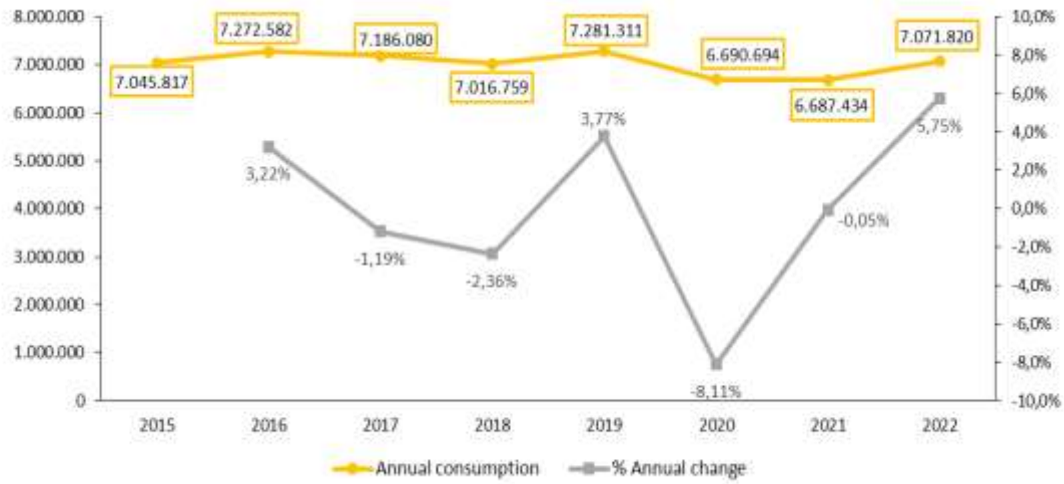
Source: Eurostat

The transport sector consumed 5.8 million tons of oil in 2022, representing 70.0% of total oil consumption. This is followed by the residential sector with 15.4% and industry with 9.5%.

Road transport accounted for 85.3% of oil consumption in transport, followed by domestic shipping with 10.6% and small shares of domestic aviation and rail transport (3.9% and 0.1% respectively). The transport sector for 2022 was mainly based on diesel and gasoline, which together represented 87.4% of total oil consumption in the transport sector in Greece, with kerosene and fuel oils following with 3.9% and 5.4% respectively.

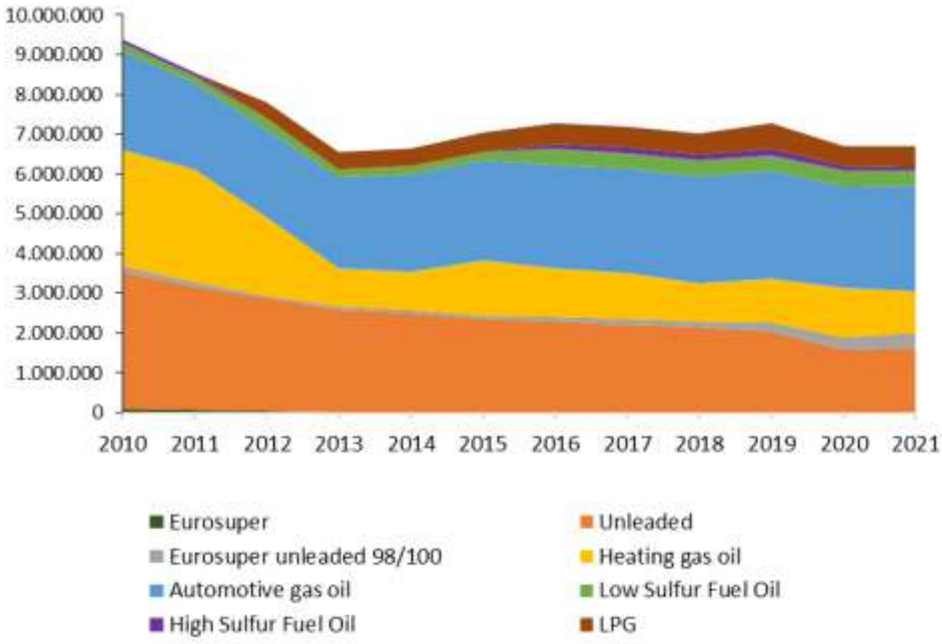
According to data published by the Hellenic Statistical Authority [22], there is an increase in the consumption of petroleum products in 2022 compared to 2021 of 5.7%, with the corresponding quantities amounting to 7,071,820 metric tons for the year 2022 and 6,687,434 metric tons for the year 2021 (Figure 46). More specifically, there is an increase in the annual consumption of heating oil by 12.6%, of LPG by 10.1%, of high-sulfur fuel oil by 7.5%, of diesel by 5.8%, of unleaded gasoline by 5.2% and of low-sulfur fuel oil by 3.1%. On the contrary, a decrease in the annual consumption by 15.2% is observed in super unleaded gasoline 98/100.

Figure 46: Annual Consumption of Petroleum Products in Metric Tons, 2015-2022



Source: ELSTAT

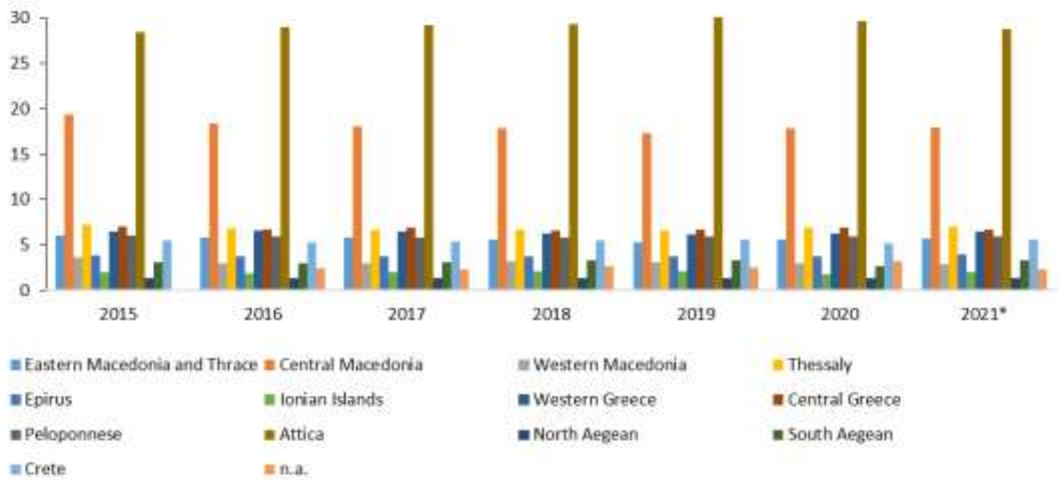
Figure 47: Consumption of Petroleum Products by Product Category in Greece (metric tons), 2010-2022



Source: ELSTAT

During 2015-2022, the Regions that presented the highest consumption of petroleum products were Attica and Central Macedonia, followed by the Regions of Thessaly, Central Greece, Western Greece, Peloponnese, Eastern Macedonia and Thrace, Crete, Epirus, South Aegean and Western Macedonia. The lowest consumption was observed in the Regions of the Ionian Islands and the North Aegean [22].

Figure 48: Percentage (%) of Petroleum Product Consumption by Region, 2015-2022

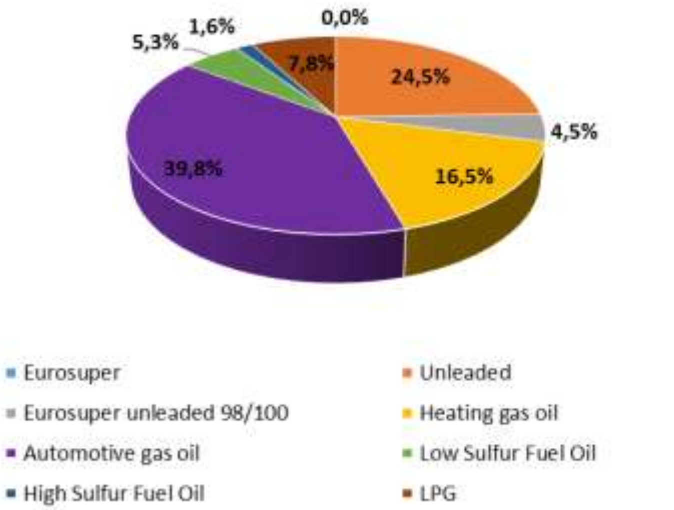


Preliminary data

Source: ELSTAT

For 2022, diesel fuel represented the largest category of petroleum product consumption (39.8%), followed by unleaded gasoline (24.5%) and heating oil (16.5%) (Figure 49).

Figure 49: Shares of Petroleum Product Consumption in Greece by Category, 2022

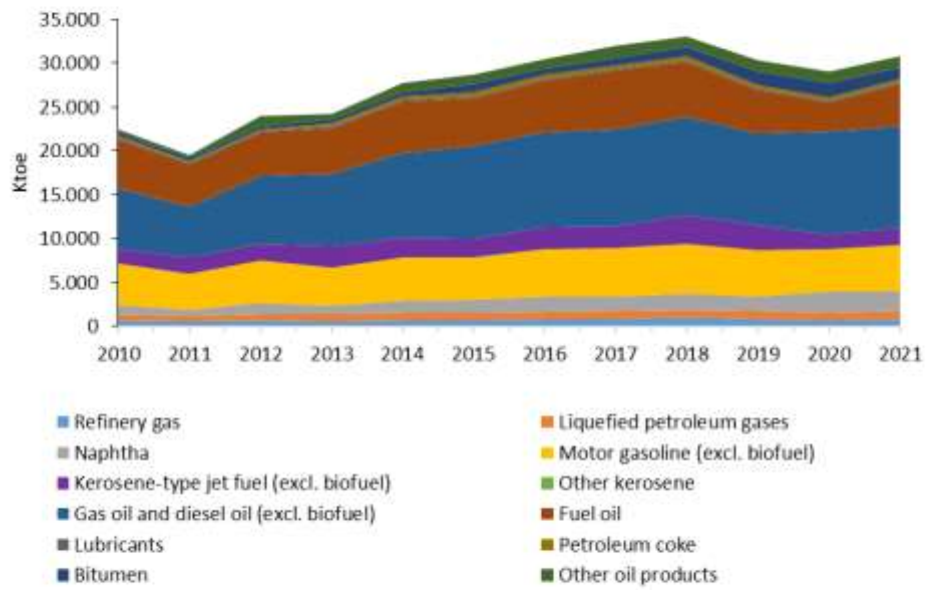


Source: ELSTAT

5.1.4 Refining Sector

Refining capacity in Greece increased by 6.0% in 2022 compared to 2020, in contrast to the downward trend observed in 2019-2020 (Figure 50). Total refining capacity in 2022 was 30.77 million tons.

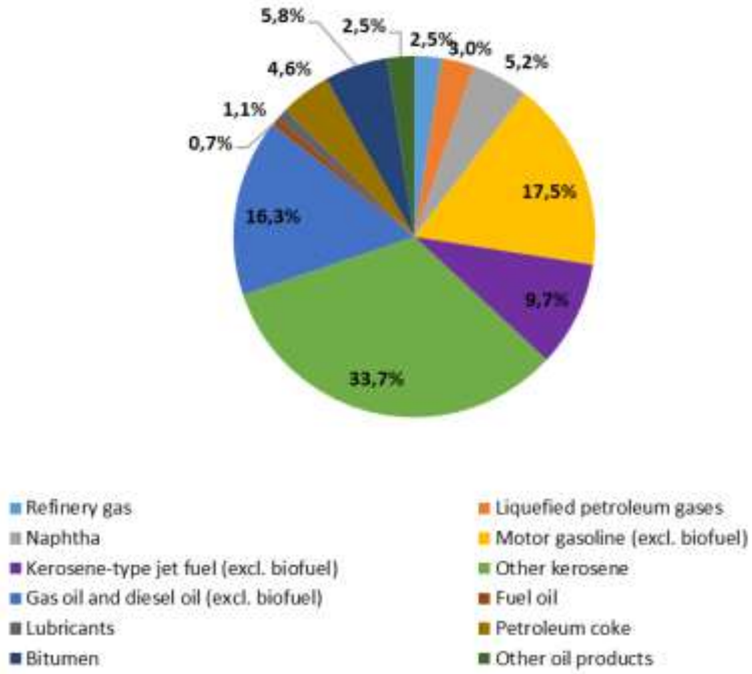
Figure 50: Refined Products in Greece (thousand tons), 2010-2022



Source: Eurostat

Diesel production amounted to 10.35 million tons in 2022, representing the largest share of refined products. Gasoline and fuel gases accounted for 17.5% and 16.3% respectively of refined products in Greece in 2022 (Figure 51).

Figure 51: Share of Refined Products in Greece, 2022



Source: Eurostat

HELLENiQ ENERGY's Refineries

Crude oil is refined into petroleum products at four domestic refineries. The three refineries, owned by HELLENIC PETROLEUM DEPPP S.A., a subsidiary of HELLENiQ ENERGY Group, are located in Aspropyrgos, Elefsina and Thessaloniki and represent approximately 65% of the country's total refining capacity and have a total storage capacity of crude oil and petroleum products of 6.65 million cubic meters.

Table 7: HELLENiQ ENERGY's Refineries

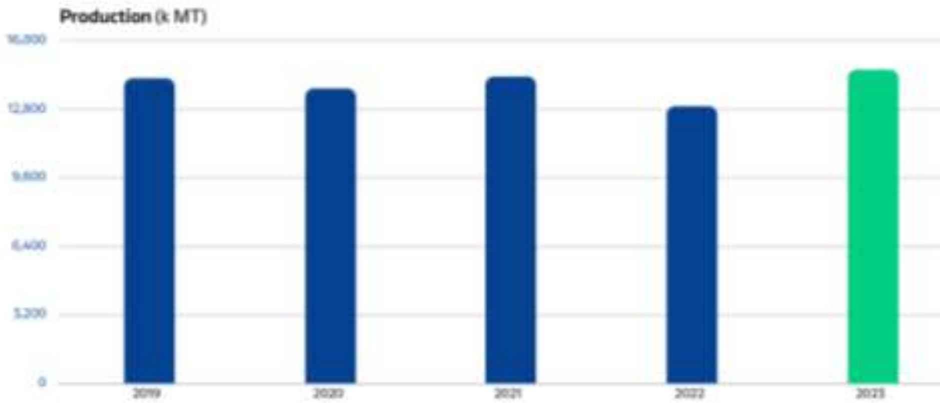
Refinery	Daily Refining Capacity (Kbpd)	Annual Refining Capacity (million MT)	Refining Configuration	Nelson Complexity Index
Aspropyrgos	146	7.6	Cracking (FCC)	9.7
Elefsina	106	5.3	Hydrocracking	12.0
Thessaloniki	90	4.5	Hydroskimming	5.8

Source: HELLENiQ ENERGY

The Group's three coastal refineries operate as a single system. Periodic crude purchases and production and sales planning are prepared as a whole for the refining system and aim to optimize profitability, taking into account prevailing regional crude oil and product prices, as well as domestic and international demand. A significant competitive advantage is the ability of the Group's refineries to process intermediate products (SRAR, VGO) and to adjust the blend and crude processing levels, depending on the respective economic data. Indicative margins for Mediterranean refineries declined compared to the historic highs reached in 2022, Brent prices in 2023 did not show major fluctuations, with the exception of increased prices in the September-October period, while natural gas and electricity prices decelerated during the year compared to the particularly high levels of 2022.

Against this backdrop, production in 2023 increased to 14.6 million metric tons from 13 million in 2022, according to the 2023 Annual Report [23].

Figure 52: HELLENiQ ENERGY's Refinery Production



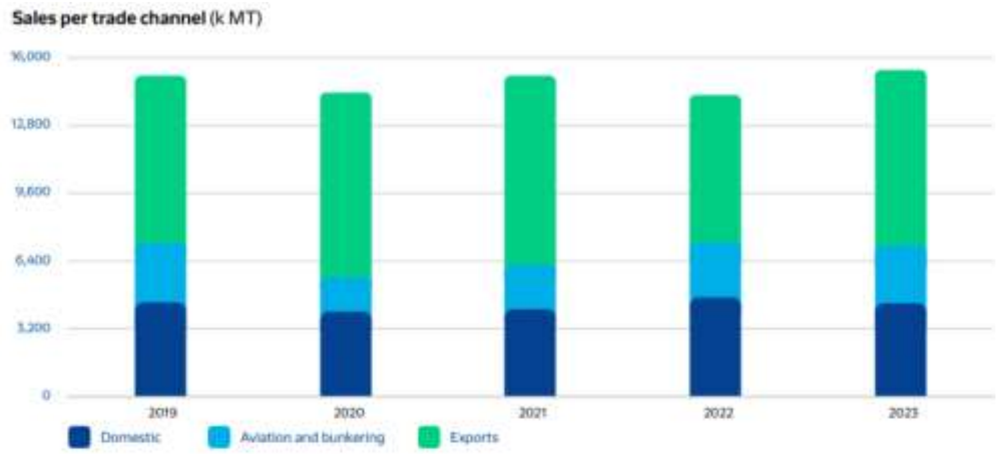
Source: HELLENiQ ENERGY

The production of mid-range fractions (jet, gasoil and diesel) in 2023 amounted to 55% of total production, higher than in 2022, mainly due to the increased utilization rate of the Elefsina refinery, while gasoline production amounted to 22%. Overall, the production rate of high value-added products amounted to 82%, one of the highest rates in the European refining industry, while fuel oil was limited to 7% (2022: 11%), reflecting the operational optimization of the Aspropyrgos refinery. In addition, the percentage of intermediate products and raw materials traded between the three facilities exceeded 14%, contributing to the optimization of the operation in the production, distribution and marketing sectors.

HELLENiQ ENERGY's Refining, Supply and Trading segment's production and sales increased in 2023, while profitability was positively affected by satisfactory refining margins.

Fuel sales are carried out by the subsidiary HELLENIC PETROLEUM S.A. to petroleum trading companies in Greece, including the Group's subsidiary, EKO S.A., as well as to specific special customers, such as the Armed Forces, while excess production (50-60%) is exported. All of the Group's refined products meet European standards (Euro VI). In 2023, sales in the domestic market decreased by 5% compared to 2022 and amounted to 4.4 million tons, due to reduced heating oil consumption. Excluding heating oil, sales increased by 1%. Aviation fuel sales amounted to 943 thousand tons, recording an increase of 9%, while marine fuel sales improved by 1.5%, reaching 1.8 million tons. Exports increased by 19% to 8.3 million tons, accounting for 54% of total sales in 2023 and maintaining the Group's position as one of the most extroverted in the region. As a result, in 2023, total sales of products and commodities of the Group's refineries increased by 8.1% to 15.4 million tons [23].

Figure 53: HELLENiQ ENERGY's Refinery Product Sales by Market



Source: HELLENiQ ENERGY

Motor Oil's Refinery

According to Motor Oil's Annual Financial Report 2023 [24], the total quantity of crude and other raw materials processed by the company in fiscal year 2023 compared to fiscal year 2022 is analyzed in Table 8.

Table 8: Motor Oil's Crude and Raw Material Process

	Metric Tons 2023	Metric Tons 2022
Crude	8,809,239	9,157,599
Fuel Oil raw material	1,128,452	1,432,526
Gas Oil	1,872,867	3,242,396
Other	853,867	409,728
Total	**12,664,425**	**14,242,249**

Source: Motor Oil

Data on the evolution of the refinery's production by product and the company's sales by product during the two-year period 2022-2023 are shown in Tables 9 and 10 respectively.

Table 9: Motor Oil's Refined Production, 2022 & 2023

Refinery Production per Product	Thousand M T 2023	Thousand M T 2022
Lubricants	226	200
LPG	191	180
Gasoline	2,568	1,824
Jet Fuel	1,501	1,550
Diesel (Automotive - Heating)	3,979	4,820
Naphtha	87	555
Semi-finished products	21	25
Special Products	1,453	1,103
Fuel Oil	1,944	3,249
Total	**11,970**	**13,506**

Source: Motor Oil

Table 10: Motor Oil's Refinery Product Sales

Sales per Product	Thousand M T 2023	Thousand M T 2022
Asphalt	1,336	996
Fuel Oil	2,085	3,202
Diesel (Automotive - Heating)	4,073	4,834
Jet Fuel	1,771	1,748
Gasoline	2,560	1,845
LPG	206	199
Lubricants	254	226
Other	477	792
Total (Products)	**12,762**	**13,842**
Crude Sales / Other Sales	476	83
Total	**13,238**	**13,925**

Source: Motor Oil

The lower quantity of crude & raw materials processed by the Company in 2023 compared to 2022 is due to the periodic maintenance work of the refinery units carried out between May-July 2023 [24].

Pump Prices

According to the Hellenic Petroleum Marketing Companies Association (SEEPE) [25] and regarding the issue of fuel price fluctuations, the following is clarified:

- Wholesale prices in Greece are influenced by the International Platts prices of finished petroleum products (Eastern Mediterranean) and not by the Platts prices of crude. The prices of products at the pump never change at the same rate as the international prices. Retail prices (gasoline, diesel, etc.) follow the prices of finished Refinery products and not the prices of crude (e.g. Brent).
- Refinery prices in Greece are set by the average of the last four days. Therefore, there is a relative lag in the appearance of any fluctuations in international prices in the market.
- Trading Companies set their prices every day based on the Refinery prices and any changes are immediately passed on to the gas stations.

- The retail prices of gasoline at the pumps consist of the Refinery price, Taxes & Duties (EFK, DETE, Special levy, RAAEY, VAT 24% and green fee ELAPE) the transportation cost, the gross profit margin of the Trading Company and the Station Owner.
- The pump prices are determined freely and exclusively by the station owners. The Trading Companies do not in any case determine – and are even prohibited from recommending – retail pump prices.

Retail prices of liquid fuels

Table 11 presents the average retail prices of liquid fuels (95 octane unleaded, 100 octane super unleaded, diesel and LPG), according to the Weekly Fuel Price Overview Bulletin of the Ministry of Development.

Table 11: Average Retail Fuel Prices in Greece, July 12, 2024 (€/lit, includ. VAT)

Product	Number of stations	Average price
Eurosuper 95	4.228	1,911
Eurosuper 100	2.695	2,101
Automotive gas oil	4.522	1,671
Autogas	1.160	0,874

Source: Ministry of Development

Retail fuel prices vary considerably across the EU-27, as shown in Table 11, mainly due to differences in national tax rates. The price of Eurosuper 95 in Greece stood at €1.908 per litre on 15 July 2024 – significantly higher than the EU-27 average of €1.747/lt. The price of Eurosuper 95 in Romania stood at €1.524/lt, significantly lower than the EU-27 average. Similarly, the price of Eurosuper 95 in Bulgaria stood at €1.332/lt, also significantly lower than the EU-27 average [26].

Table 12: Fuel Prices (Including Taxes) in Selected EU Countries, 15 July 2024

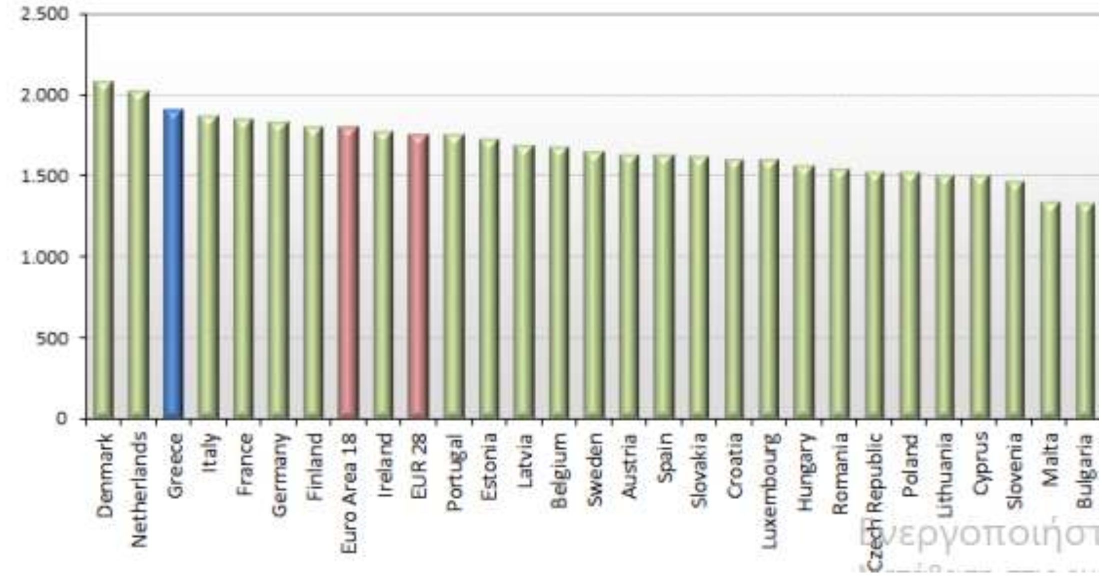
Country	Euro-super 95 RON (€/lt)	Gas Oil Automobile (€/lt)	Heating Gas Oil (€/lt)
Bulgaria	1,332	1,306	-
Croatia	1,603	1,609	0,990
Cyprus	1,515	1,572	1,108
Greece	1,908	1,668	-
Hungary	1,573	1,592	1,592
Italy	1,869	1,751	1,489
Romania	1,524	1,535	0,979
Slovakia	1,613	1,526	-
Slovenia	1,496	1,528	1,183
Spain	1,624	1,500	1,031

Source: European Commission

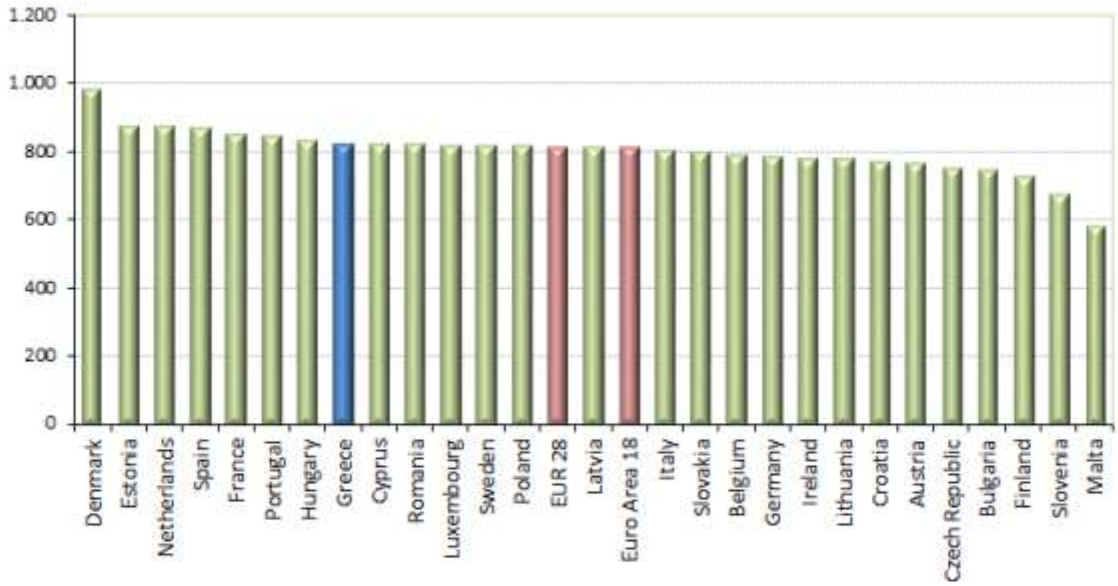
According to the Weekly Fuel Price Overview Bulletin of the Ministry of Development, concerning prices for the week of July 8, 2024, the retail prices of unleaded gasoline, diesel and heating oil with and before taxes in the 27 EU countries are presented in the Figures below [27]:

Figure 54: Weekly Retail Prices (€/1000 Lit) For Gasoline, Diesel and Heating Oil with and Without Taxes

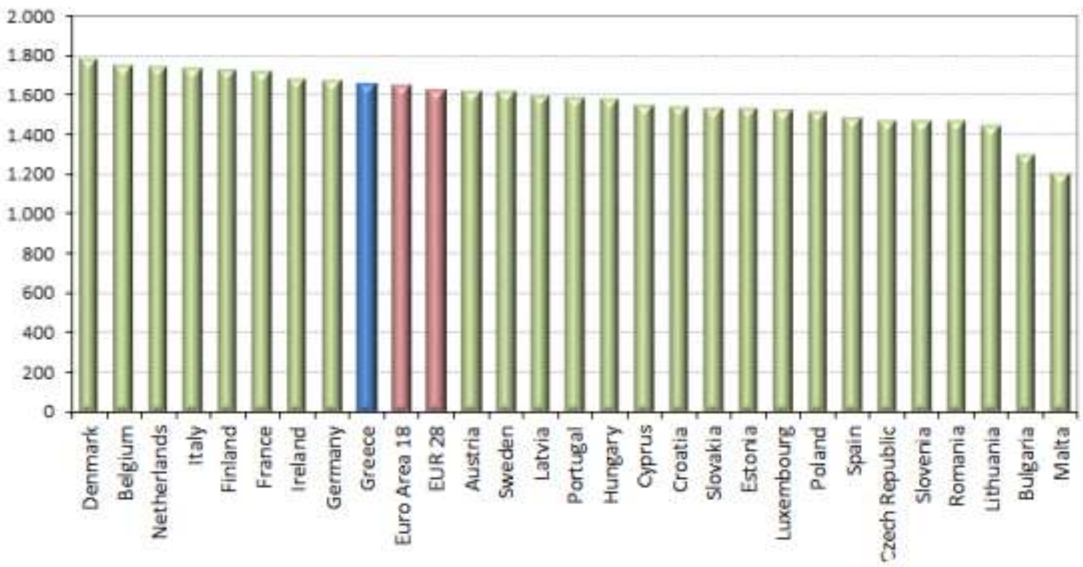
Euro-super 95 with taxes – weekly prices 08/07/2024



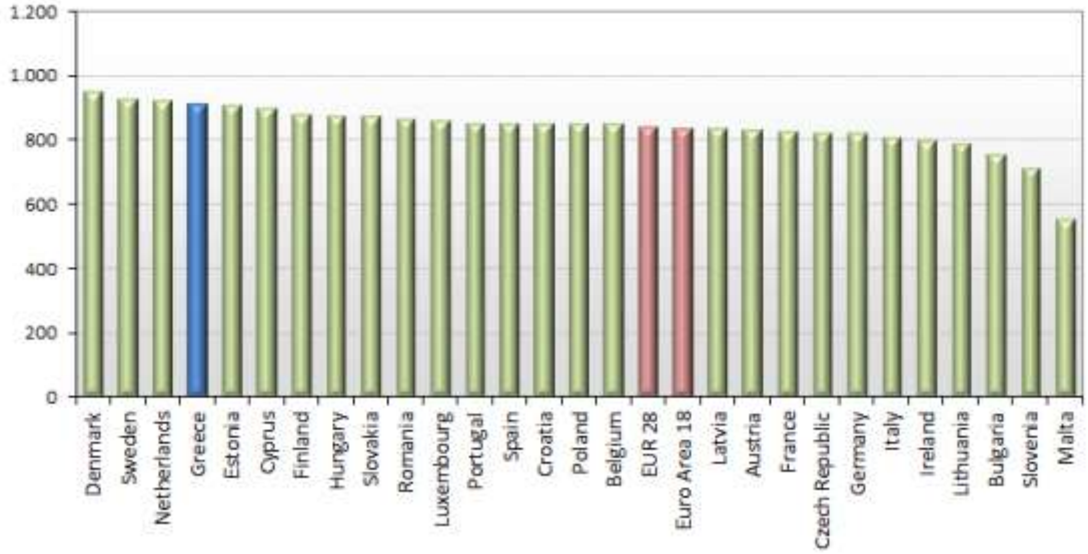
Euro-super 95 without taxes – weekly prices 08/07/2024



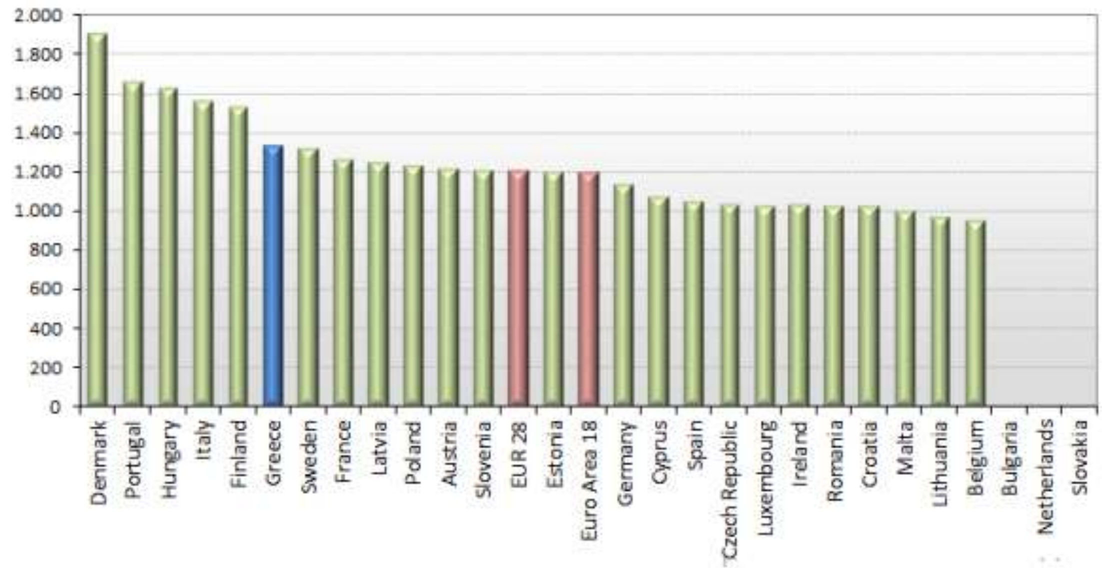
Gas Oil Automobile with taxes – weekly prices 08/07/2024



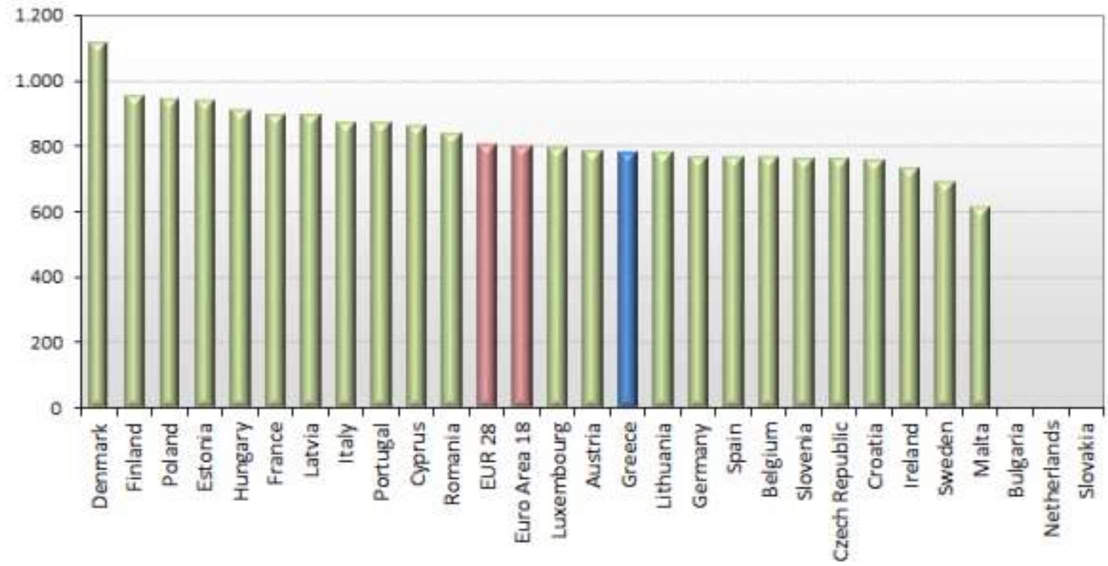
Gas Oil Automobile without taxes – weekly prices 08/07/2024



Heating Gas Oil with taxes – weekly prices 25/03/2024



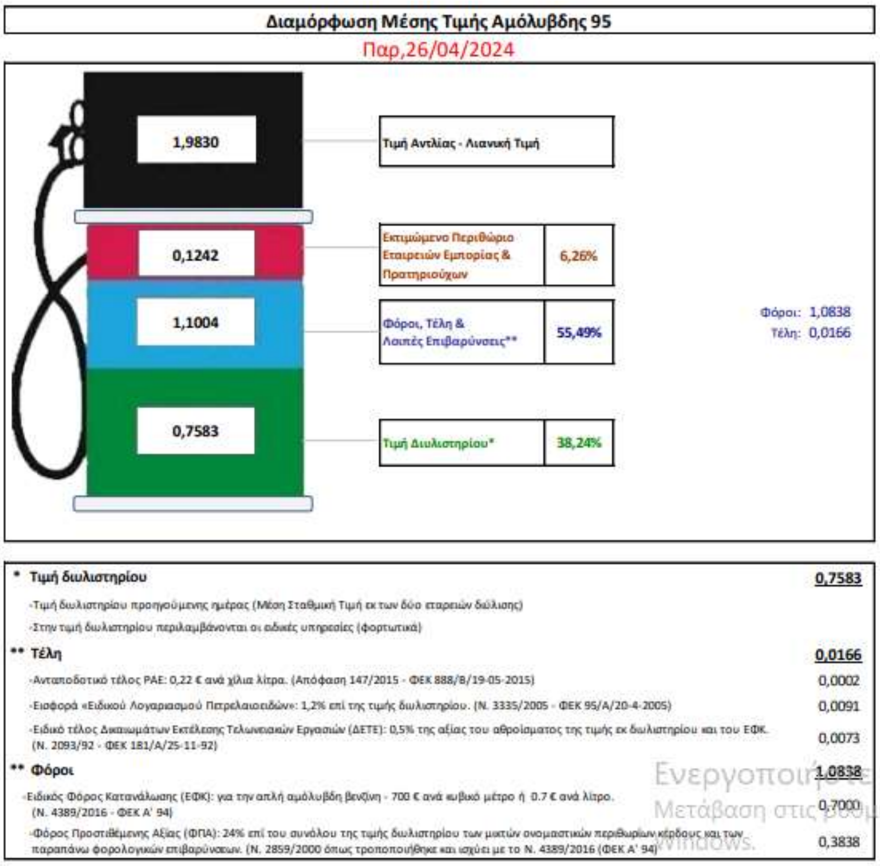
Heating Gas Oil without taxes – weekly prices 25/03/2024



Source: Ministry of Development

As an example regarding the retail price, the final retail price of gasoline on 26/04/2024 will be mentioned, which is formed by the refinery price by 38.24%, by taxes (fixed and variable) by 55.49%, and by the estimated margins of trading companies, liquid fuel transporters and gas stations by 6.26% [28].

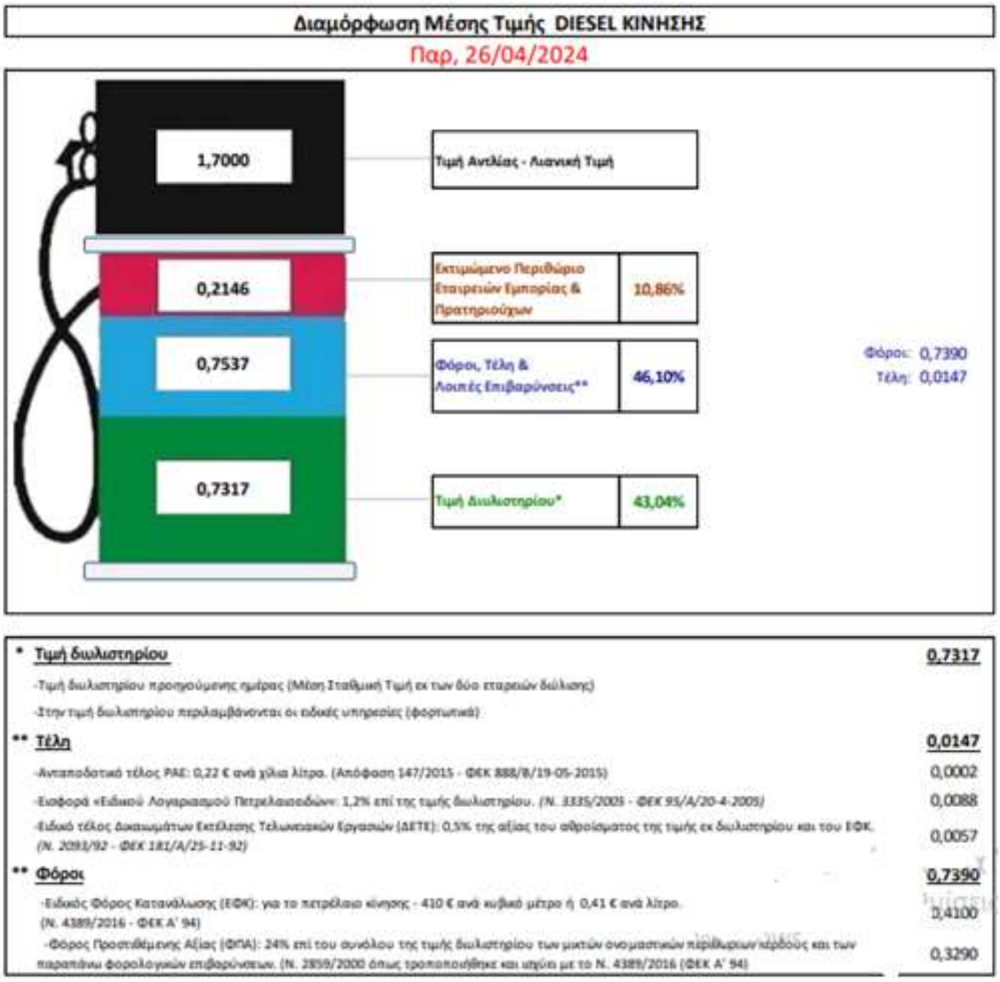
Figure 55: Formation of the Average Price of Euro-super 95 on 26/04/2024



Source: Ministry of Development

For April 26, 2024, the final retail price was formed by the refinery price by 43.04%, by fixed and variable taxes by 46.10%, and by the estimated margins of trading companies, liquid fuel transporters and gas stations by 10.86% [28].

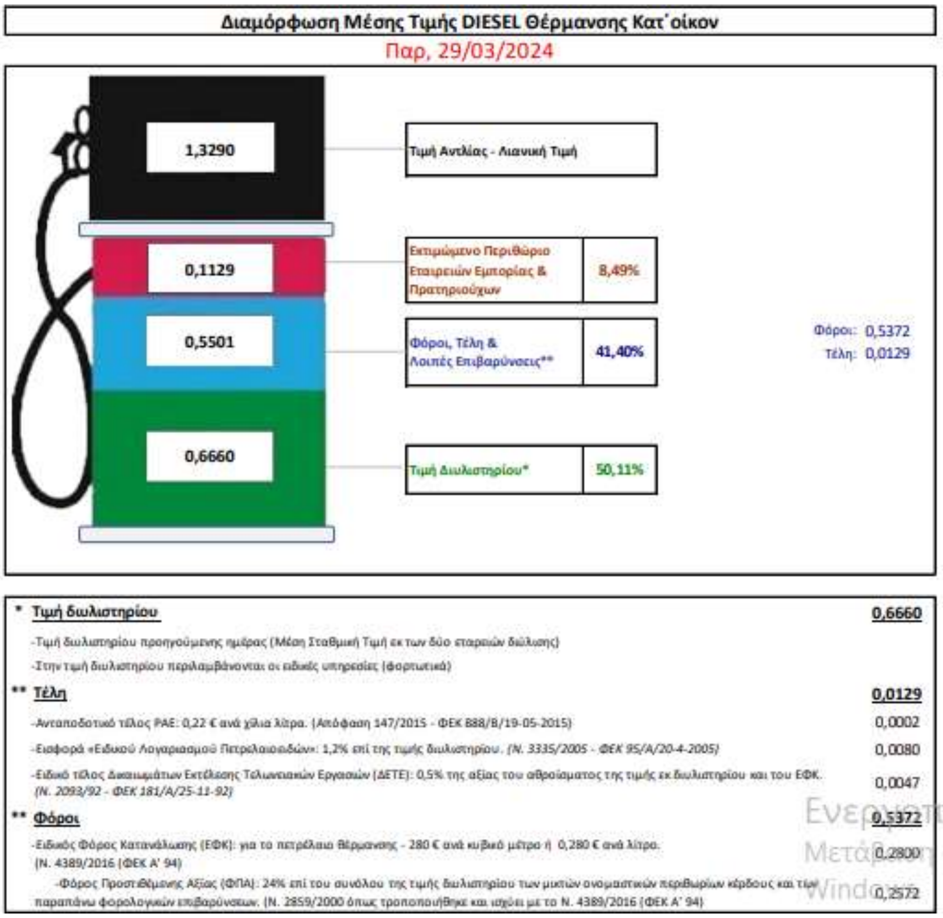
Figure 56: Formation of the Average Price of Gas Oil Automobile on 26/04/2024



Source: Ministry of Development

For 29/03/2024, the final retail price of heating oil was formed by the refinery price by 50.11%, by taxes (fixed and variable) by 41.40%, and by the estimated margins of trading companies, liquid fuel transporters and gas stations by 8.49%.[28].

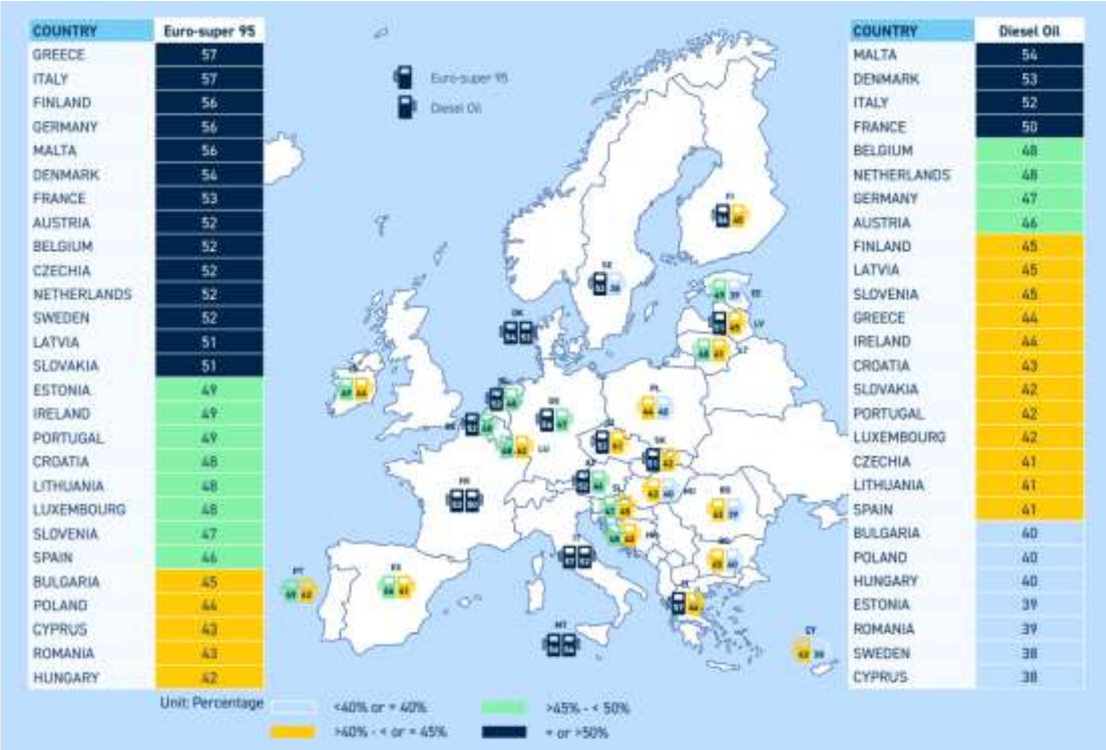
Figure 57: Formation of the Average Price of Heating Gas Oil on 29/3/2024



Source: Ministry of Development

It is interesting that in Greece taxes and fees in 2024 constituted 46.0% of the final price. Comparable to other EU countries for 2023, Greece leads in the level of taxes on gasoline, as shown in Map 4 [29].

Map 4: Share of Taxes in the Final Retail Price of Fuel in the EU, 2023



Source: Fuels Europe

Refining is a successful sector of the Greek economy and the country is one of the main exporters of petroleum products in SE Europe. The refining sector is easily affected by fluctuations in international oil prices and operates in a highly competitive global environment that relies heavily on countries with different environmental regulations.

5.1.5 Hydrocarbon Exploration and Exploitation in Greece

According to the Special Report of IENE's Hydrocarbons Committee (Upstream) [30], which was completed in April 2022, and according to numerous published analyses and studies by international institutes and companies, hydrocarbons have been, are and will continue to be for several more decades a key component of the energy mix of the global, European and Greek economy, with natural gas in particular being the transitional fuel.

The current international energy crisis that began in late 2021 and worsened with Russia's invasion of Ukraine (February 24, 2022) has brought the issue of energy self-sufficiency and security to the forefront of social and economic concern, without a reliable scientifically and economically acceptable solution having yet been provided. Day by day, it is becoming clear that in the complex and unstable geopolitical environment that it presents, the pursuit of energy self-sufficiency has once again been set as the main objective of any energy strategy. As has already become apparent, the crisis has prompted the EU to reorganize its energy policy, with the aim of de-dependence on Russian natural gas as quickly as possible. In the same context, several member states are reviewing their energy strategy, now seeing hydrocarbon exploration in their territory from a different perspective, as they successfully implement the complete de-dependence on Russian energy imports.

The “hydrocarbons” chapter is considered a priority for many European countries, while the classic producing countries in the Middle East – Asia – West Africa – America continue their current exploration activities with production maintained at levels that cover demand at relatively high prices. Norway, one of the main suppliers of natural gas to the European continent, continues exploration in new areas, in the Arctic, Denmark has declared that it will exploit its own oil deposits by 2050, while the government of Great Britain intends to exhaust all potential of its own deposits in the North Sea, which are economically exploitable. Also, the Netherlands continues to exploit its under-produced natural gas reserves until exhaustion, while Italy is securing its back through the energy giant ENI, with Spain following with Repsol and France with Total Energies spreading to the wider geographical area of the SE Mediterranean, the Middle East and North Africa. At the same time, in recent months we have been witnessing an explosion in the exploration and production of small natural gas deposits in Southern, Central and Eastern Europe as well as larger offshore deposits in the Black Sea (Hungary, Poland, Romania, Bulgaria and Türkiye).

On a global scale, the continued rise in investments in hydrocarbon exploration and production is confirmed (9% in 2023 and 7% in 2024) with an emphasis on the Middle East and Asia mainly by state-owned companies. Also of interest is the investments of oil companies in "clean technologies" which are limited to just USD 28 billion, corresponding to 4% of their total investments and 1% of their gross revenues.

Europe's strategic decision to rapidly stop relying on Russian natural gas and the need to find alternative sources of supply, together with the surge in oil prices to levels above $70 per barrel, which makes exploration for hydrocarbons in deep seas and complex geological environments commercially viable again, have reignited interest in potential deposits in Greece. This is an important development, because Greece is a country that is almost 100% dependent on oil and natural gas imports, with a huge contribution to its energy balance. Thus, the discovery of commercially exploitable hydrocarbon deposits is expected to be of enormous importance for both the economy and its national security.

Recent NECP shows that hydrocarbons, and in particular natural gas, will continue to contribute more than 50% to the country's energy mix, as they do worldwide, for several more decades. Since it is clear, based on many studies by energy analysts and institutes, that fossil fuels will NOT be fully replaced, at least until 2050, by other energy sources such as Renewable Energy Sources (RES) and green hydrogen, and RES will act complementary to fossil fuels, with natural gas playing the role of a transitional fuel, Greece must proceed without any delay towards strengthening and accelerating the programme of exploration and extraction of domestic hydrocarbons [30].

In fact, the NECP (August 2024) specifically refers that for the period 2025-2030 “the role of natural gas remains important. Specifically, the use of natural gas is decreasing in electricity generation but continues to play a role in the stability of the electricity generation system” to conclude “it is decided to develop natural gas production from domestic deposits, provided that it is finally confirmed that these are commercially exploitable following the research that has taken place or is in progress”.

Studies by the Hellenic Hydrocarbons and Energy Resources Management Company (HEREMA) and the Academy of Athens, as well as publications by reputable academics and companies, converge on the finding that there are high possibilities of the existence of very significant natural gas reserves in the country (west and south of Crete, Ionian Sea, Thermaikos, Thassos, Epirus, hydrates in the SE Mediterranean, biogenic gas in the NW Peloponnese, etc.) [30]. In fact, the above-mentioned IENE study estimates that the potential natural gas reserves in the country may amount to 70-90 trillion cubic feet (2-2.5 trillion cubic meters), given that more than 40 geological structures have been mapped from the existing seismic recordings, which require further geological and geophysical studies and, of course, drilling to certify natural gas deposits.

According to the annual financial report of HEREMA for 2023, a conservative estimate of the potential and probable reserves of the areas in question, in which, however, exploratory drilling has not yet been carried out, ranges, according to preliminary data from HEREMA, at 24 trillion cubic feet (trillion cubic feet) or 680 bcm (billion cubic meters) of natural gas (risked recoverable reserves). The possible confirmation of these deposits exceeds both the current and future domestic demand for natural gas, making our country an exporter by the end of the decade [31].

Despite the long-standing efforts since 1975 of the Greek State and the joint ventures of public and private companies, both Greek and foreign, the Greek hydrocarbon Exploration and Production (E&P) industry, apart from the activity in the Prinos area in the North Aegean, has not managed to develop significantly. This was not due to negative technical results from the exploration work, but mainly due to the long delays and interruptions of the exploration work caused by the backlogs and the lack of continuity and consistency of the Greek State, which negatively affected the technical and business choices and decisions. Nevertheless, the estimates of business and academic circles regarding the existence of domestic hydrocarbon deposits were and continue to be optimistic, based on the results of geochemical, geological and geophysical studies and drilling, in comparison with discoveries in the wider region, especially in the last decade.

The current activity of energy groups, such as the US ExxonMobil, the Greek HELLENiQ ENERGY (formerly HELPE) and Energean, the recent presence of the French Total Energies, the Italian Edison and the Spanish Repsol, as well as the expressed interest of other important oil companies, in combination with the published positive results of the research work, strengthen the prospect of the existence of very significant hydrocarbon reserves, particularly in the maritime areas of the Ionian, Crete and Thermaikos and in the onshore area of Western Greece.

Therefore, it is necessary to provide guarantees and facilities to the contracting investors of the Greek concession areas, in order to accelerate the hydrocarbon exploration work. Greece must and can transform from an exporter of petroleum products and an importer of crude oil and natural gas into a hydrocarbon producer and exporter of natural gas, covering a large percentage of the needs of the EU countries. This development is estimated to create business opportunities in related industrial sectors (shipyards, chemical industry, pipe factories, etc.), with an increase in private investments, new jobs, with a parallel reduction in the total energy cost, an increase in energy security and diversification of supply, revitalization of the indebted economy, while it gives increased geopolitical and geostrategic value to our country.

The aim of the political leadership is to complete the processing and interpretation of the surveys carried out (especially the seismic surveys of 2022-2023) as soon as possible, in order to assess the potential of the potential deposits and to decide whether it is advantageous to carry out exploratory drilling and subsequently, if more positive results are obtained, to exploit them. This practically translates into the immediate implementation of the outstanding contractual obligations of the contracting companies with an initial programme costing several tens of millions of euros for seismic surveys and then exploratory drilling, lasting 2-4 years and given that the full exploitation of hydrocarbons, from the start of surveys to discovery and production, requires approximately 7-10 years.

In this context, the government decided to accelerate and intensify the hydrocarbon discovery processes. Thus, in early April 2022, a meeting was held between the political leadership of the Ministry of Economic Affairs and the administration of HEREMA, which aimed to reassess whether and how hydrocarbon exploration could be more effectively integrated into the field of movements made necessary by the war in Ukraine, to diversify sources of natural gas supply. The culmination was the Prime Minister's statements on measures to address the energy crisis, which stated that "for the country's energy self-sufficiency, in addition to investments in RES, transforming the country into a gateway for energy products and saving energy, the exploitation of national natural gas deposits with economic interest is certainly included".

History

After a deafening silence and indifference to hydrocarbon exploration for an extremely long period of time, which lasted 15 years (1996-2011), the Greek State woke up in the midst of the serious economic crisis and revised the legislative framework (2011), conducted geophysical and seismic surveys with new technology to attract investors (2012) and gradually proceeded with international tender announcements (2012-2015) with the ratification of eleven Lease Agreements in the Hellenic Parliament (2014-2019). In October 2019, 13 Lease Agreements were in force in corresponding marine and terrestrial areas of the Greek territory with 8 Greek and international oil companies and the country was now on the global energy map.

In addition, the necessary Strategic Environmental Impact Assessments were prepared and approved and the EU environmental directives were incorporated into Greek Law (2016). The presence of HELLENiQ ENERGY (shareholder: the Greek State with 35%) was decisive, with a comparative advantage in the in-depth knowledge of the Greek area by its high-level geoscientists, combined with its strong commercial and economic position, while the competitive presence of the constantly strengthening Energean was absolutely positive. In the 2010s, there was a cross-party will to give impetus to research for the discovery of hydrocarbons, which unfortunately is burdened by the well-known backbiting of the public administration.

Regarding hydrocarbon exploration in Greece, the climate became negative in the two years 2020-2021. In response to Climate Change and the policy to address it, despite their positive moves between 2012 and 2019, almost all political parties began to oppose research with obvious negative effects on the state apparatus (environmental permits, transit permits, etc.). Also, due to the spread of the coronavirus pandemic since early 2020 and the changing strategy of oil companies, which had a presence in the Greek upstream market, some of them decided to change strategy and direct part of their investments to green forms of energy.

At the same time, the objections of ecological organizations and collectives against hydrocarbon exploration in the country intensified, which were selectively expressed, either in the form of direct aggressive actions (e.g. obstruction of the execution of seismic recordings by Repsol in the Ioannina area, public consultations in Western Greece), or in the form of legal appeals to the Council of State (e.g. against the environmental permit for seismic surveys in the Ioannina area, against the Strategic Environmental Impact Study in the Crete area). While the final decisions of the Council of Europe rejected the complaints of the ecological organizations, the significant long-term delay in the trial and issuance of a decision (appeal for the Strategic Environmental Impact Study of Crete in November 2019, decision in October 2022) in combination with the corresponding approvals of environmental permits (see the Katakolo area where the approval of an environmental permit for the execution of production drilling has been pending since 2019) created a negative business climate for the continuation of research work.

The skepticism of political parties also affected individual local actors who reacted, rather mildly, while the majority of local government representatives (Regional Governors and Regional Councils of Peloponnese, Western Greece, Epirus, Crete) during the mandatory public consultations were positive about conducting the surveys. Of particular interest is that the broader public opinion and local communities, in their overwhelming majority (80%), recognize the expected economic and geopolitical benefits for the country and are positive, according to a survey conducted by HEREMA (ALCO, June 2021).

The government, since the beginning of 2020, initially seems embarrassed and then does not react positively to oil company contractors who request guarantees to protect their investments, especially in the case of drilling and discovery of deposits and development and production works where investments amount to tens of millions of dollars. At the same time, the advent of COVID-19 and the reduced energy demand in 2020-2021 temporarily "hit" the oil industry. Within this context, oil companies are forced to readjust their stance and some are preparing to either withdraw, returning the concessions to the Greek State, or freeze exploration investments, while the rest are in a state of waiting given the positive prospects of the areas under exploration. Consequently, HEREMA, which is mandated to supervise business activities and coordinate investigations, is now in an obviously difficult position and is forced to grant, within the limits of legality, extensions to the execution of contractually mandatory investigative work.

The business situation worsened with the statements of the Greek Minister of Foreign Affairs, who stated in April 2021[16], as in February 2022[17], that Greece is not going to become an oil and gas producing country. A typical example of the negative climate that had developed in 2021 in the Greek hydrocarbon market was the sending of an open

[16] https://www.capital.gr/oikonomia/3541093/klima-skeptikismou-gia-tis-exoruxeis-udrogonanthrakon
[17] https://e-mc2.gr/el/news/dendias-den-tha-kanoyme-aigaio-kolpo-toy-mexikoy

letter[18] to the Greek Prime Minister of a group of 47 young executives, who specialize in the sector and are employed in positions of responsibility in large companies, organizations and educational institutions, mainly abroad, in an effort to stimulate interest in the research and production of hydrocarbons in our country.

It is recalled that the Spanish Repsol, which participated, as a joint venture manager, in three hydrocarbon exploration and exploitation projects in the Ionian Sea, in Aitoloakarnania and in the Ioannina region, completely abandoned its activity in Greece. In January 2021, Repsol and its partner Energean returned the Exploration and Production rights in the Aitoloakarnania region before even starting the exploration. In March 2021, the Spanish group withdrew from the joint venture with Energean in the Ioannina region and then in December 2021 it also withdrew from the joint venture with HELLENiQ ENERGY in the Ionian region, where it had 50% and management, but fully fulfilling its contractual obligations arising from the Lease Agreements with the Greek State and by extension the Co-Management Agreements with the partners in the joint ventures.

The two Greek companies, however, continue their exploration work, Energean in the Ioannina region and HELLENiQ ENERGY UPSTREAM in the Ionian region. Repsol's withdrawal is officially related to the new global strategy announced by the company in October 2020, which, among other things, concerns the company's commitment to withdraw from 14 countries in which it was active in hydrocarbon exploration, and where Greece was one of these countries, but the negative business experiences during the conduct of exploration work contributed decisively to the business decision, mainly in terms of licensing and support from the state apparatus in combination with the tensions and delays in the work due to actions of ecological movements.

Also, in 2021, the French Total Energies initially withdrew from marine area 2 west of Corfu (Total Energies consortium 50% operator with Edison 25% and HELLENiQ ENERGY UPSTREAM 25%), transferring its rights to Energean and then in April 2022 from the areas W and SW of Crete (Total Energies consortium 40% operator with ExxonMobil 40% and HELLENiQ ENERGY UPSTREAM 20%), transferring its rights to the partners, but fully fulfilling its contractual obligations arising from the Lease Agreements with the Greek State and by extension the Co-Management Agreements with the partners in the joint ventures. Total Energies' business experience was similar to that of Repsol and negatively affected its continued presence in the country, while it was the company that actively participated in international tenders, demonstrating interest in the country.

[18] https://www.capital.gr/oikonomia/3611260/anoixti-epistoli-pros-ton-prothupourgo-xemplokarete-tis-ependuseis-stous-udrogonanthrakes

It is worth mentioning that, in parallel with the above business moves to withdraw from exploration in Greece by international oil companies, HELLENiQ ENERGY UPSTREAM proceeded with a partial divestment from the hydrocarbon exploration and production sector in August 2021, returning the relevant rights in the onshore areas "NW Peloponnese" and "Arta - Preveza" to the Greek State, before even carrying out the minimum geophysical exploration work provided for by the Lease Agreement, given that according to a statement by the management, the Group's strategy is to focus hydrocarbon exploration and production activities only in offshore areas.

Also, in 2021, the joint venture HELLENiQ ENERGY UPSTREAM (50%, operator) and Energean (50%) returned the exploration rights in the “West Patra Gulf” concession to the Greek State, while according to previously published data, 3D seismic recordings had been successfully performed and a geological structure with potential recoverable reserves of 140 million barrels of oil had been mapped. The joint venture cited a lack of adequate port infrastructure to conduct the conventional exploration drilling, which it was obliged to conduct during the current exploration phase.

Thus, at the end of 2021, hydrocarbon exploration was now at a critical juncture, even for the fulfillment of the minimum contractual obligations arising from the Lease Agreements between the contracting companies and the Greek State [46] and which had all been ratified by the Greek Parliament and now have the force of law. And all this background is evolving in the shadow of the energy crisis that is beginning to weigh on Europe as a result of the European Union’s strategic choices for an immediate and violent change in the energy mix, without the necessary technologies and infrastructure having been secured.

However, in 2022 there is a positive change of course from the government. In light of the negative developments of the war in Ukraine, the energy crisis and high energy prices, the EU is reviewing its energy policy and the Greek government is following suit. Characteristic is the speech, in February 2022, of the General Secretary for Energy and Mineral Resources at the Hellenic Ministry of Environment and Energy, Ms. Alexandra Sdoukou, at the annual conference of the hydrocarbon industry, within the framework of EGYPS 2022, in Cairo, Egypt, who emphasized the following: "We need more research and more natural gas production, as a tool to reduce our energy dependence on countries outside the EU. We remain open and willing to build stronger alliances with existing investors”[19].

[19] https://www.ot.gr/2022/02/17/energeia/se-anadiplosi-i-kyvernisi-gia-tis-ereynes-ydrogonanthrakon-stin-ellada/

In addition, in early March 2022, a meeting was held between the political leadership of the Ministry of Energy and Mineral Resources and the administration of HEREMA, which aimed to reassess whether and how hydrocarbon exploration could be more effectively integrated into the "quiver" of movements made necessary by the war in Ukraine, to diversify sources of natural gas supply. The culmination is the statements of Prime Minister Mr. K. Mitsotakis, who in his April 2022 address on measures to address the energy crisis, said that for the country's energy self-sufficiency, in addition to investments in RES, transforming the country into a gateway for energy products and saving energy, "certainly also includes the exploitation of national natural gas deposits with economic interest." Unfortunately, however, a few weeks later, the market was once again in turmoil after the Prime Minister stated in a speech in Katakolo that the government would not allow oil production and that no other areas would be granted for exploration.

In this climate, full of palindromes and controversial positions, the companies decide and proceed with the implementation of their contractual obligations and in 2022 seven seismic campaigns are carried out in all the maritime areas that have been granted. HEREMA fully supports the work, especially the recording of seismic events throughout the maritime area of the Ionian Sea and west of Crete. The next two years (2023-2024) will be decisive and decisive for the future of the research, given that the processing and interpretation of the seismic data will take place, the synthesis of existing studies with the new findings and important technical and business decisions will be made by the companies on whether or not to continue the research. For now, the official statements of the parties involved on the part of the Greek State (HEREMA, MoEE) are more than positive and create further optimism for the discovery of significant hydrocarbon deposits [32].

The result is that after an active seven-year period (2012-2019) in which the Greek State successfully held 4 international tenders for the concession of Hydrocarbon Exploration and Production rights, during which 11 new areas were gradually granted, today research work is active and being carried out in 8 areas in Epirus, the Ionian Sea and the offshore area of Crete, now of course in the research and production areas of the Prinos concession [33].

It is absolutely acceptable that 2023 was a year of particular activity in almost all the concessioned areas, which was rightly communicated by the Greek State (HEREMA, MoEE) to the global market in a prominent manner. The consortia carried out a multitude of geological and geochemical works but mainly proceeded to carry out geophysical seismic surveys, two and three dimensions in the marine areas, exceeding their contractual obligations and demonstrating in practice the technical and commercial interest of the energy market for the discovery of new hydrocarbon deposits in Greece and the wider geographical area of the SE Mediterranean. The processing and subsequent interpretation of the seismic images with their integration into the existing research data will allow the companies to carry out a full technical, environmental, commercial and business evaluation for the conduct of exploratory drilling to identify or not hydrocarbon deposits.

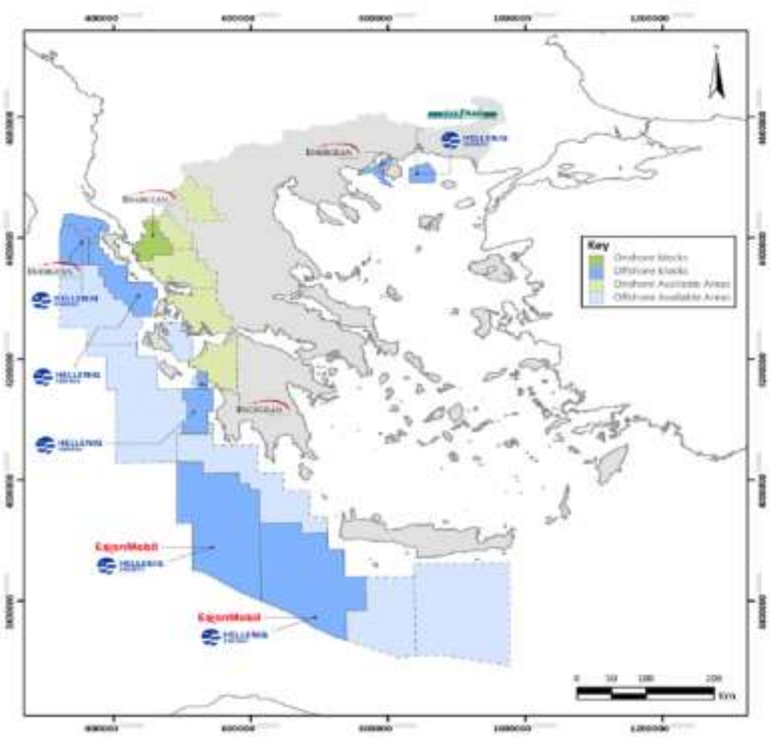
The contracting companies thus far appear to be fulfilling their contractual obligations and are seeking cooperation with HEREMA and the competent MoEE in order to overcome the inherent bureaucratic delays mainly at the licensing level (environmental studies, navigation NAVTEX, etc.). In the final business decisions of the companies, an important criterion will be the further stance and decisions of the Greek State, as expressed institutionally at the governmental, supervisory, licensing level (HEREMA, MoEE) but also judicial - legal (trial - issuance of decisions by the Court of Auditors, Council of State, etc.) and in combination with certain negative statements by government executives even at the highest level. At the same time, the international oil market saw the "explosion" of exploration in 2023 very positively and reacted positively. Based on the publications and the movements in the international market, it is clear and evident that several companies are seriously interested in entering the Greek market and investing in hydrocarbon research and production. Unfortunately, the Greek State is keeping a “silence” while, according to international practice in similar cases, it should take advantage of the exceptional situation to promote positive messages to the market (with presentations at conferences, articles in technical journals, etc.) and proceed immediately to new international competitions for the concession of other areas for research and production.

The international market is waiting in vain for the announcement of new marine areas in Crete and the Ionian Sea, as announced by HEREMA since 2019, even though the statements of State officials are positive about the results of the 2023 surveys. On the other hand, the statements of the Ministry of the Environemnt and Energy (Katakolo 2022) move in the opposite direction, stating that no new areas will be granted and returned areas will not be declared again, and are consistent with HEREMA's inaction. And within this conflicting climate, a map of concessions is published in the NECP (August 2024) in which "available areas" (5 offshore and 4 onshore) are shown. Similar – not the same – is the map of HEREMA, in which four appear as “open areas”, which are those that had been granted through international tenders and were recently returned.

At this point, we should recall that according to Law 4001/11, as it is in force, and the existing experience of four international tenders, in order for there to be "available areas" or "open areas" the "Minister of Environment, Energy and Climate Change, by means of a notice published in the Government Gazette and sent for publication in the Official Journal of the European Union, shall notify the available areas, as well as any specific information relating to them. For any significant change in this information, a supplementary notice shall be published", which is currently not publicly known to be happening.

In particular, according to Law 4001/11, the rights for hydrocarbon exploration and production in specific areas are always granted exclusively through international tenders announced by the Greek State. The areas to be granted are after the selection of new areas, either areas that had been granted and returned or had been included in previous tenders and were not granted (open door), or finally after companies expressed interest in specific areas and the State accepted the request. However, in the NECP's map, five new offshore and one onshore area (sic) appear as "available", as well as three onshore and one offshore area that were returned before the surveys were even completed. The latter are also shown as "open" on the HEREMA map (among other things, market rumors claim that a legal dispute is ongoing for one area between the State and the contracting companies).

Map 5: Conscession map



Source: NECP (August 2024, p. 348 Map 12)

In addition to the above, the market raises questions regarding the will and any support moves of the Greek State regarding the existence/creation of critical infrastructure for offshore drilling, given that the existing port infrastructure is either unsuitable or meets with the refusal of local actors to use it.

Last, but equally important, what concerns oil companies is the reaction of environmental organizations which hinder research work mainly through legal appeals and on a smaller scale with activist actions.

There are many reasonable and unanswered questions regarding the desire of the Greek State to explore and produce hydrocarbons, changing the status quo of the country on an economic, social and geopolitical level. The only thing certain is that while the positive potential of the existence of very large hydrocarbon deposits is gradually emerging through research, the state's image towards the energy market is not convincing enough to attract companies that will take risks and invest hundreds of millions of dollars.

<u>Current status of research work</u>

According to HEREMA, the works that have been carried out in the concessioned areas based on the existing Lease Agreements between the Greek State and the contracting companies are:

Map 6: Map of Active Exploration and Production Concession

Source: HEREMA

Ionian Region and Region 10

Area 3310 Lease Agreement: N 4630/19 (Government Gazette A'155/10.10.2019)

Ionian Area Lease Agreement: N 4629/19 (Government Gazette A'154/10.10.2019)

Stage: 2nd three-year Research Phase (09 July 2026)

Lessee: HELLENiQ ENERGY UPSTREAM (100%)

The Ionian block is located in the Northern Ionian Sea and covers part of the Apulian platform and the pre-Apulian zone. Offshore oil and gas discoveries in Albania and Italy are strong indications of a functioning petroleum system in the Ionian block.

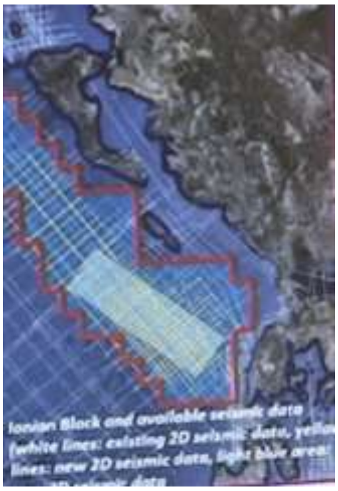
The area has proven to be capable of generating oil from Upper Triassic source rocks (Sabkha – lacustrine environments), deposits in basins within the Upper Liassian platform, as well as from organic-rich lacustrine phases offshore the Apulian platform.

“Block 10” is located in the Kyparissia Gulf, in the western Peloponnese. Water depths range from 500 m to 2,500 m. The proven petroleum system in the neighboring licensed area of West Katakolo, combined with the large number of surface natural oil and gas leaks in the wider area, make “Block 10” a particularly interesting area. (source EDEYEP)

The minimum contractual technical programme of the current exploration phase of both concessions has been completed, given that the Lessee has performed geological, geochemical and environmental studies, reprocessing a total of 3,000 km of existing seismic records, and acquiring 2,800 km of new 2D seismic data (1,200 km in area 10 and 1,600 km in the Ionian area in the 1st quarter of 2022).

The Lessee, after processing and interpreting the two-dimensional seismic data, proceeded immediately in the 4th quarter of 2022, in addition to its contractual obligations in the first research phase and essentially fulfilling the obligations of the next phase, to record three-dimensional seismic data of 2,430 sq. km. in area 10 and 1,150 sq. km. in the Ionian region.

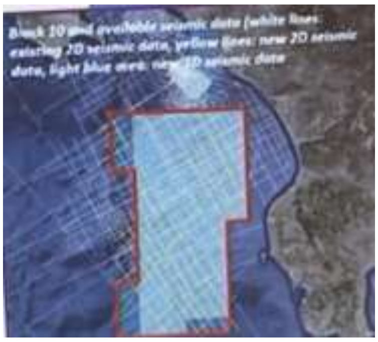
Map 7: Seismic Map 2D-3D in the Ionian Region



Source: HEREMA

The new seismic data is now in the processing stage, to be interpreted and combined with all existing geological, geophysical and drilling data, in order to more accurately identify areas and geological targets, before final business decisions are made to execute exploration drilling. It is noted that the current 2nd Exploration Phase, according to the Lease Agreement, does not include mandatory drilling which (one per area) are included in Phase 3 upon payment of a corresponding letter of guarantee [49]. It will now be interesting to see the business strategy that the Lessee will choose to follow in these extremely promising areas for the discovery of hydrocarbon deposits, i.e. will it wait and proceed with the execution of the mandatory drilling (at least one per area) in the next research phase after July 2026, when it will enter the 3rd Research Phase or will it proceed earlier during this phase, negotiating the contractual obligations of the existing Lease Agreement with the Greek State. Of course, other business moves, common in the industry, with a total sale of rights to another company or a partial sale and the creation of a joint venture and the maintenance or not of the role of the Operator should not be excluded by the Lessee.

Map 8: Seismic Map 2D-3D in the Region 2



Source: HEREMA

Ioannina Region

Start Date: 03/10/2014

Lease Agreement: N 4300/14 (Government Gazette A'222/03.10.2014)

Stage: 2nd Research Phase Tenant: Energean (100%)

This is the most mature concession in terms of research work, but with significant delays since the start of work. The area has proven oil and gas in Albania, Italy and Croatia. More than 10 million barrels of oil and 30 trillion cubic feet of natural gas have been discovered in areas related to the wider area.

The minimum technical programme with geological, geochemical and environmental studies as well as recording, processing and interpretation of 400 Km of 2D seismic data has been completed in the area and at least one research target has been identified. The company intends to conduct the “Epiros 1” drilling in the Jurganista area (Municipality of Zitsa) and the procedures for obtaining environmental study approvals have already been completed with the completion of the required public consultation and the company’s briefings with local communities. The drilling site has been selected in grassland areas at a great distance from Natura protected areas and the approved environmental studies cover in detail the entire range of work to be performed and are fully compatible with the legislation and the strictest industry standards.

At the same time, the Lessee continues to cooperate with HEREMA and MoEE to complete the licensing with the aim of carrying out the exploratory drilling as soon as possible, the first in the promising onshore area after many years of inactivity, to be precise, while the drilling will be the 17th carried out in the history of Epirus, it is the first after 22 years, after the unsuccessful drilling "Dimitra" in Kalpaki (drilling site - source Energean).

Map 9: Drilling Location "Epirus 1"

Source: Energean

The total impacts foreseen in the Strategic Environmental Impact Study are characterized as minor to negligible for the natural environment, anthropogenic activities as well as the atmospheric and acoustic environment and are limited to the construction site. Site preparation will require approximately 220 days, drilling approximately 130 days and road construction interventions 84 days. The total duration of the project implementation is approximately 12 months.

In the event of discovery and subsequent confirmation and valuation of exploitable deposits, Energean will declare the exploitability of the deposit and proceed with the preparation of a Development and Environmental Protection Plan, which will be submitted for approval to the Ministry of Environment and Energy. For all the work that will be required, separate Environmental and Social Impact Studies will then be prepared and submitted for consultation. In case of no discovery, the area will be fully restored to its current form (Source: Energean).

Western and Southwestern Crete Region

Start Date: 10/10/2019

Area W. Crete Lease Agreement: N 4631/19 (Government Gazette A'156/10.10.2019)

Area SW. Crete Lease Agreement: N 4628/19 (Government Gazette A'153/10.10.2019)

Stage: 1st Research Phase (two-year extension, end of phase October 10, 2024)

Lessee: Exxon Mobil (70%, operator) and HELLENiQ ENERGY UPSTREAM (30%)

The areas are located in the maritime area of Crete. According to the available geophysical data of 2012, there are indications of carbonate structures, similar to the recent natural gas discoveries made in the Eastern Mediterranean (Egypt and Cyprus).

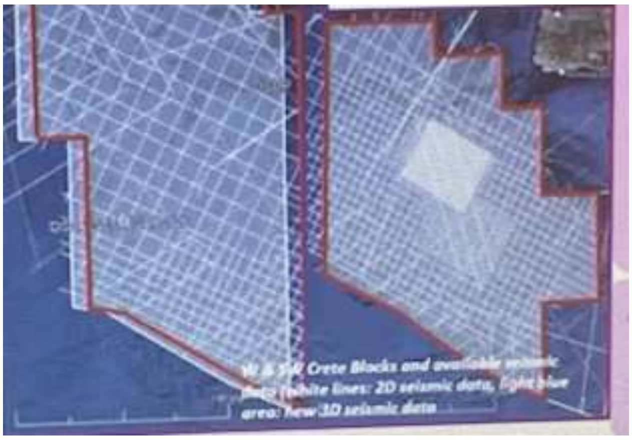
These are the most promising areas in Greece for the existence of large natural gas deposits, as shown by the initial seismic recordings, but at the same time they are among the least explored areas, which makes it imperative to acquire other seismic data (in a denser network of recordings) in combination with the preparation of geological and geochemical studies.

The consortium, after the withdrawal of Total Energies, which was the manager, continues the research with ExxonMobil as manager, which increased its participation from 40% to 70%, and HELLENiQ ENERGY UPSTREAM, which also continues to participate with 30% (from the 20% it initially held). The consortium proceeded, in direct cooperation with HEREMA, to record two-dimensional seismic data in the first quarter of 2023. During the recordings, based on the preliminary results of the initial on-board processing, the operator decided to densify the network by recording more seismic data than the contractual obligation of 3,250 km per area.

According to published data from HEREMA, almost twice as many kilometers were recorded as the contractual obligation (12,278 km), which is interpreted as indicating that there are positive indications for the mapping of geological targets. It is estimated that the consortium, based on the results of the seismic and geological and geochemical studies, will make business decisions to enter the next research phase within the time frame of the contractual obligations.

The consortium recently (2024) performed 3D seismic surveys (874 sq. km) in the SW area, so it is clear that this particular area is currently the focus of technical interest for the execution of exploratory drilling in the immediate future.

Map 10: Seismic Surveys 2D-3D in the SW Crete Region



Source: HEREMA

While the execution of the above seismic surveys, both quantitative (dense network of two-dimensional) and qualitative (three-dimensional), demonstrates in practice the technical and commercial interest of the consortium in specific parts of the areas, it also raises significant questions about the continuation or not of the surveys in the remaining area of the concessioned areas, which, in addition to its very large size, is estimated to have geological targets for further investigation.

The next three-year research phase has as a contractual obligation, per area, the acquisition of three-dimensional seismic data, with an obligation to conduct exploratory drilling during the Third Phase of the surveys. However, it is not excluded that the consortium, depending on the interpretation of the seismic and the size of the geological targets, may proceed with exploratory drilling during the next phase in order to confirm the existence of an “oil system” and, in case of success, to conduct further 3D seismic surveys during the trenching work of possible discoveries.

It is noted that the oil system of the area remains unknown and the drilling will provide important data mainly regarding the existence of source rocks and reservoirs. This means that at present there is no certainty as to the nature of the potential deposits (natural gas, oil, etc.) and whether the existing geochemical models and those from neighboring areas converge on the existence of natural gas. The statements of the political leadership (Katakolo 2022) that in the event of an oil discovery, business activities will not proceed if they do not act as deterrents, at least cause concern among companies that are required to spend many tens of millions of dollars to carry out exploratory drilling, assuming the technical risk of failure.

"Katakolo" Area

Commencement Date: October 2014

Lease Agreement: N 4298/14 (Government Gazette A'220/03.10.2014)

Stage: Development and Production (25 years from 2016)

Lessee: Energean (100%)

The Katakolo field, located on the west coast of the Peloponnese, was discovered in the early 1980s by the Hellenic Petroleum Exploration Company and is to date the only area in Western Greece with a proven oil and gas discovery. Recoverable reserves are estimated at 18 million boe. More specifically, the offshore area has confirmed oil and gas reserves, while the onshore area is very promising for shallow biogenic gas discoveries.

In August 2016, the Lessee proceeded to notify the exploitability of the “West Katakolo” field and entered into a 25-year exploitation license. Production is expected to begin following approval of the relevant Environmental Impact Study. The public consultation, however, while it has been completed since 2020, final approval is still pending, with the obvious result of creating questions about the effective operation of state licensing services.

Prinos Concession

Stage: Exploration and Exploitation (25 years) Lessee: Energean (100%)

Exploration in the Prinos basin began in the 1970s and the first discovery was made in 1974 in the Prinos field. Crude oil production began in 1981. Primary oil production in Greece is carried out in the Prinos, North Prinos and soon in Epsilon fields in the Gulf of Kavala (8 km west of Thassos and 18 km south of the coast of Kavala). Production began in early 1981, with initial rates of 9,000 barrels per day and peaked at approximately 28,000 barrels per day in the period 1982-1986. Since then, production has decreased significantly, falling below 1,500 barrels per day with signs of recovery since 2016. In particular, total domestic production amounted to 206 thousand. tons in 2018 (approximately 4,300 barrels per day), the highest level since 2000, while more than 2.3 million tons of crude oil have been produced since 2000.

The field has produced more than 125 million barrels since 1981. The oil from the Prinos field is moderately heavy (27-28° API), undersaturated and sour with a dissolved gas content of 674scf/bbl (120m3/m3). The latest 3D seismic survey conducted in 2015 in the Prinos area led to an increase in the field's 2P and 2C reserves and the identification of several other potential plays and prospects in the area. The field complex is eligible for funding through the RRF for the development of the first CCS facility in Greece.

The "North Prinos" field was developed as a satellite field of the "Prinos" field in 1996, with production starting the following year and with production quantities of 3,000 barrels per day. In 2009, a new inclined well with extended horizontal displacement was drilled, reaching a total depth of 4,370 m. The oil is relatively heavy (17-24°API), sour, with a dissolved gas content of 253 cu. ft/barrel (45 cu. m/cubic meter), 20-30% hydrogen sulfide (H_2S) and a high amount of resins and asphaltenes. The Epsilon field was discovered in the 1990s, when the E-1 well confirmed crude oil reserves at a depth of approximately 2,800 mTVDSS. The oil from "Epsilon" is light (36o API), with 8-14% hydrogen sulfide, and a dissolved gas content of 349 cubic feet/barrel (62.1 cubic meters/cubic meter).

The company that exploits the deposits in the Prinos area is Energean, the only company that produces oil in Greece, which estimates that the remaining reserves of these deposits are in the order of 100 million barrels (2P+2C).

It is noted that as a consequence of the COVID19 pandemic and the collapse of oil prices, in April and May 2020, the contractor Energean announced the cessation of its activities at the Prinos complex and applied to the Greek State for state aid under the European Union's Temporary Framework for State Aid. The proposed business plan concerns how Energean will use the state funding to implement the Epsilon field development plan, the exploitation of which would extend the life of the Prinos complex by 10 to 15 years. In the long term, the company plans to channel CO_2 to enhance oil recovery and provide multiple synergy opportunities for the future conversion of the depleted Prinos reservoirs into permanent storage facilities for captured CO_2.

According to a company update in early January 2022 [34], Energean has entered into a €90.5 million loan with the Black Sea Trade and Development Bank (BSTDB). The loan will finance Energean's investment plans, mainly for the development of the Epsilon field but also for the further development of the other Prinos fields, while supporting both working capital needs and investments in the infrastructure of the Prinos complex.

The first oil loading from the Prinos production was carried out with complete safety from Energean's facilities in Kavala in the first days of 2024. In total, 220,000 barrels of crude oil were delivered, with BP as the buyer, with the characteristic that this also includes production from the Epsilon field, which restarted in November 2023.

Energean has recently made significant investments to boost production, most notably carrying out the internal cleaning of the coiled tubing of the wells on the Alpha platform in Prinos, including the EAH3 horizontal well in the Epsilon field. The process was carried out with absolute precision and safety by a specialized Italian company in November 2023.

In September 2022, Energean obtained an exploration permit for the storage of carbon dioxide (CO_2) in Prinos, Kavala, in accordance with European and Greek legislation. Studies conducted by Energean as well as by other specialized companies showed that the field can operate in an initial phase with a storage capacity of 1 million tons of CO_2 in the first phase, while there is the prospect of upgrading to store up to 3 million tons of CO_2 per year for 25 years, if this is confirmed by the necessary studies. In addition, the prospect of greater storage for a shorter period of time is being examined in order to meet market demand and until additional capacity is confirmed.

The purpose of the Prinos CO_2 Storage project is to contribute to local and regional decarbonization by storing CO_2 captured from hard to abate industries, from the use of direct CO_2 capture technologies in the air, from bioenergy, from the shipping industry and other sources.

The project is now being carried out by EnEarth, a company of the Energean group, which will be active in the storage and transport of CO_2 as well as in the direct capture of CO_2 from the atmosphere. EnEarth recently submitted an application for a CO_2 Storage Permit in Prinos.

The project is a key part of the Mediterranean CCS Strategic Plan, which has been developed by France, Italy and Greece, with the aim of creating the first industrial/commercial CO_2 storage hub in the SE Mediterranean (see figure below – source Energean PLC).

Map 11: CO2 Transport and Storage Map

Source: Energean

At this point, it is worth mentioning the very strict environmental standards and protection measures contained in Greek legislation and Lease Agreements for the execution of exploration and production works. It is clear and amply demonstrated by the results that the contracting companies in all the concessioned areas meet all these measures, which are constantly monitored by HEREMA.

The obvious objective of the exploration works is to assess the size and prospects of the country's potential natural gas reserves. The recent geophysical surveys took place at a time when natural gas is at the top of Europe's energy agenda due to supply shortages that have led to a large increase in energy costs for industry and households. The next step in the process is the analysis and evaluation of the data. Previous studies by HEREMA and estimates by Greek and international analysts have shown that the potential value of Greece’s natural gas reserves exceeds €250 billion, supporting the process of replacing coal with natural gas in the wider region and accelerating the transition to a more sustainable, low-emission energy system.

It is worth noting that the reassessment of the hydrocarbon exploration and exploitation programme in Greece does not in any way constitute a shift from the basic energy priorities that have been set. However, what is being explored, in the shadow of the Ukrainian crisis, is to what extent (and with what “formula”) it would be possible to integrate it into the European energy transition plan, in which Greece aims to play a leading role. In this context, RES remain unwaveringly the "tip of the spear" of Greek energy policy, with the ultimate goal of transitioning to a climate-neutral economy.

Nevertheless, given that during this transition, natural gas will be a bridge fuel, supporting the further penetration of RES, it is being examined whether there is "space" for the upstream sector in the course of decarbonization, especially if it is combined with newly emerging "green" applications.

According to HEREMA [35], hydrocarbons are an essential component of a balanced energy transition, which will last for several decades (and beyond 2050) and in this interim period, natural gas should fill the energy "gap" but also provide solutions to society's needs for affordable energy. In this context, significant investment prospects are emerging that the natural gas market creates, and in which the Greek industry is going to be active in the near future, starting from Greece, towards the wider Balkan region.

The hydrocarbon industry is developing infrastructure and possesses the know-how for the "transition" to blue and green hydrogen, the development of CO2 storage capabilities as well as the development of offshore wind farms.

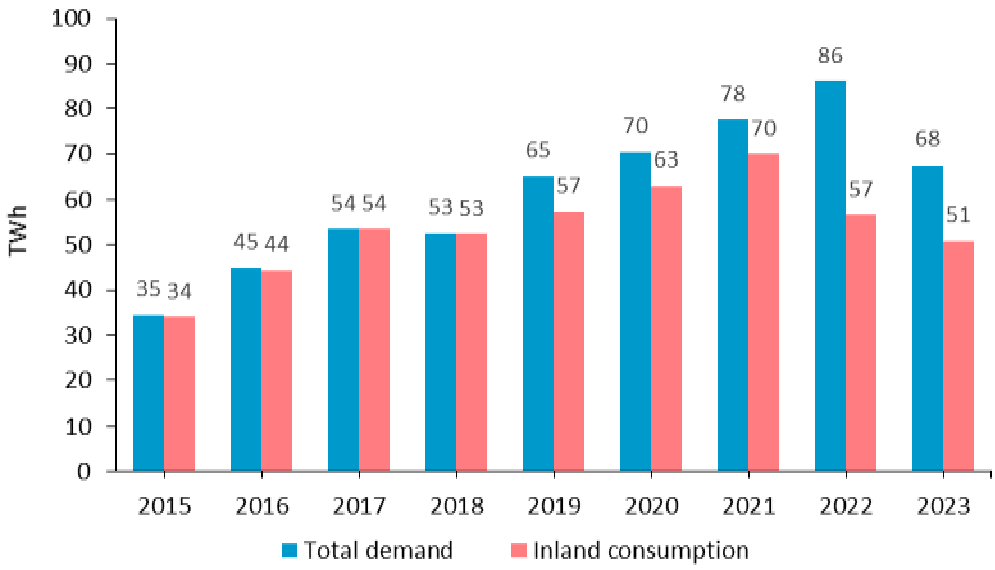
The development of a domestic hydrocarbon production industry, based mainly on natural gas, can contribute significantly to the Greek economy and to the broader climate and energy goals. Considering that the cost of fossil fuel imports in Greece over the past decade has amounted to around €150 billion, the development of the sector could have a transformative impact. Not only because it would reduce costly import dependencies, but also because the development of the Greek natural gas market would enhance security of supply, it would also potentially generate significant surplus revenue for the national economy and budget, strengthening the country’s strategic position as a regional and European energy hub. [36].

5.2 Natural Gas

5.2.1 Gas Demand and Consumption

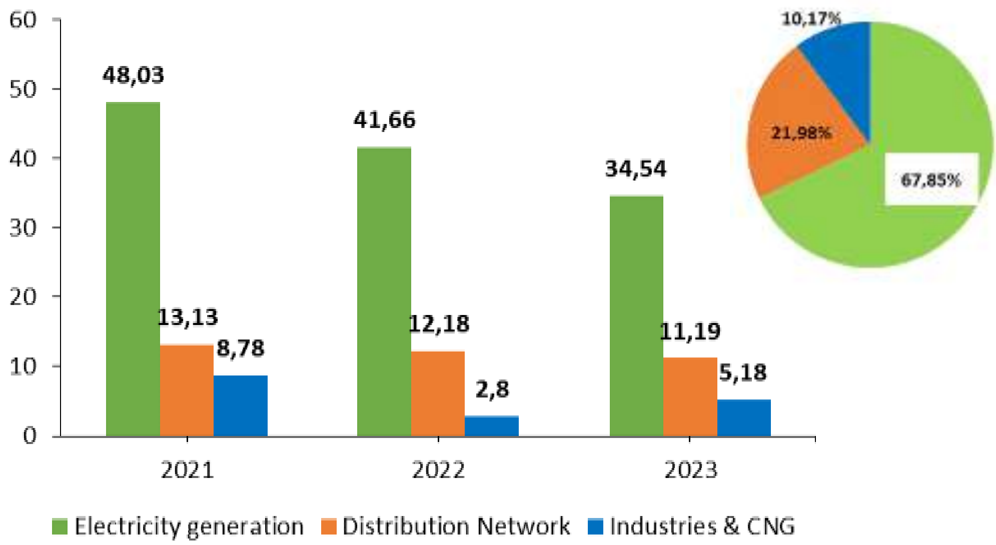
Total natural gas demand in Greece decreased by 21.56% compared to 2022, according to DESFA data for 2023 [37]. Specifically, total demand (domestic consumption & exports) of natural gas decreased by 21.56%, reaching 67.60 TWh from 86.18 TWh in 2022. A decrease of 10.13% was also recorded in domestic consumption from 56.65 TWh in 2022 to 50.91 TWh in 2023, while natural gas exports decreased by 43.48% from 29.53 TWh to 16.69 TWh (Figure 58).

Figure 58: Evolution of Gas Demand and Consumption, 2015-2023



Source: DESFA

Figure 59: Domestic Gas Consumption (TWh) and Share (%) by Customer Category, 2021-2023

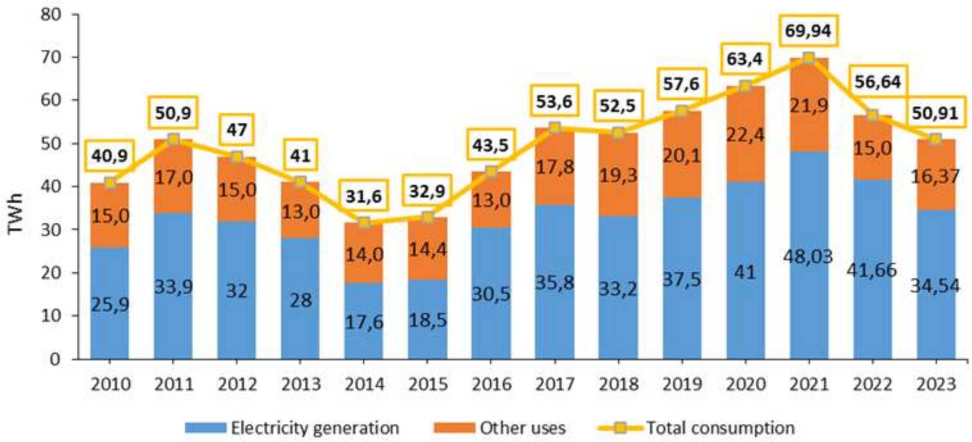


Source: DESFA

The above Figures show that natural gas consumption in Greece decreased by -10.1% in 2023 compared to 2022, in line with the EU's target of reducing consumption by 15% in the period from August 2022 to March 2023, compared to the average of the same period in the previous five years. The target was set as part of the effort to reduce the EU's dependence on Russian fossil fuels and enhance the EU's security of energy supply.

In March 2024, the European Union submitted a recommendation to member states to continue the effort to reduce gas consumption by 15% for the period April 2024 - March 2025, compared to the reference period from April 1, 2017 to March 31, 2022. This recommendation is a follow-up to the August 2022 Regulation for a mandatory reduction of gas consumption by 15% in the eight-month period August 2022 - March 2023 compared to a reference period, as well as the March 2023 decision for a voluntary reduction in consumption in the period April 2023 - March 2024. The largest percentage of natural gas in 2023, as in all previous years, was consumed in the production of electricity by the thermal units of the Public Power Corporation and private power producers. However, the role of natural gas in electricity generation, although significant, declined in 2023, reaching 68% of total natural gas consumption from 74% in 2022 (Figure 60).

Figure 60: Evolution of Natural Gas Consumption in Greece (TWh), 2010-2022



Source: RAAEY, DESFA

Regarding the share of natural gas in gross electricity production, this stood at 36.4% in 2022 (Figure 61).

Figure 61: Fuel Shares in Gross Electricity Production, 2012-2022

Source: Eurostat

According to DESFA data for the first half of 2024 [38], an upward trend is recorded in domestic natural gas consumption, with an increase of 29.76%, reaching 30.78 TWh, from 23.72 TWh in the corresponding period last year. On the contrary, total natural gas demand is recorded as slightly reduced by 7.14% due to the decrease in exports. The Sidirokastro entry point was the main natural gas entry gateway of the country during this period, followed by the LNG Terminal in Revithoussa (Agia Triada entry point), which covered almost one third (29.74%) of total natural gas imports.

Natural gas imports amounted to 30.93 TWh, recording a slight decrease of 8.14% compared to 33.67 in the first half of 2023. The largest quantities entered from the Sidirokastro entry point (15.7 TWh), which covered 50.76% of imports. The contribution of the Revithoussa LNG Terminal remained significant, covering 29.74% of total natural gas imports with 9.2 TWh, while the Nea Mesimvria entry point, through the pipeline, covered 19.52% with 6.03 TWh.

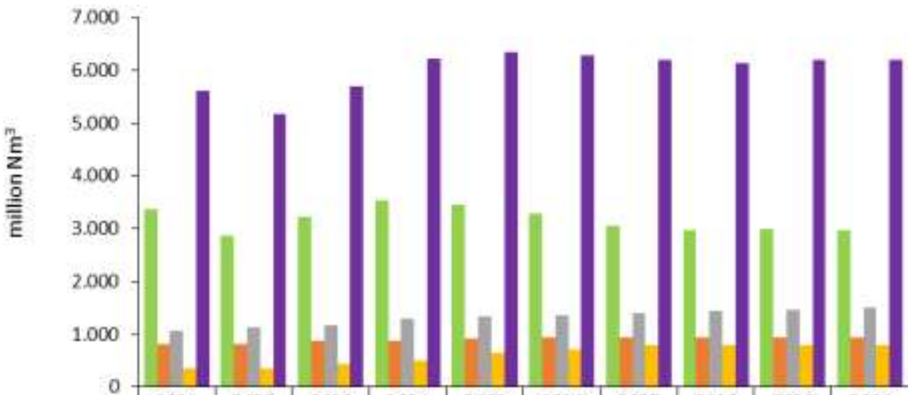
Regarding the LNG unloadings carried out at the Revithoussa Terminal during the period January-June 2024, these concerned approximately 8.96 TWh from 12 tankers compared to approximately 17.3 TWh from 26 tankers in the corresponding period of the previous year. 67.97% of these LNG quantities came from the USA, reaching 6.09 TWh. In second place were imports from Russia (1.91 TWh), followed by Algeria (0.48 TWh) and Norway (0.48 TWh). At the same time, regarding the operation of the LNG Truck Loading service, which offers a flexible solution for the road transport of significant quantities of LNG to areas and users outside the network, since its start of operation in November 2023, 104 LNG Trucks have been unloaded, transporting 4,675.00 m3 of LNG or 30,139 MWh of equivalent energy.

Regarding the categories of natural gas consumers, power generators continue to record the highest consumption, covering 63.97% of domestic demand with 19.69 TWh out of a total of 30.78 TWh, recording an increase of 30.92% compared to last year.

A significant increase of 141.36%, compared to the first half of 2023, was also recorded in the consumption of natural gas by industries and vehicle refueling stations directly connected to the NGV, which amounted to 4.61 TWh, a quantity corresponding to almost 14.97% of domestic demand. Consumption by distribution networks during the first half of 2024 was at the level of 6.48 TWh, covering 21.05% of the total demand of the previous year.

According to the 2021-2030 Development Study prepared by DESFA [39], natural gas demand, based on the baseline scenario, is expected to range from 5,602 bcm of natural gas in 2021 to 6,195 bcm of natural gas in 2030. It is worth noting that IENE, based on data it has processed and given the delignification, as well as the expansion of natural gas networks in urban centers and the region, estimates that by 2030 domestic natural gas demand will have exceeded 8.0 bcm and possibly reach up to 10.0 bcm.

Figure 62: Natural Gas Demand Estimate in Greece Baseline Scenario – NECP adjusted, 2021-2030



	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Electricity generation	3.371	2.868	3.213	3.544	3.459	3.284	3.060	2.962	3.001	2.967
Gas consumers connected to the high pressure network	816	817	874	878	924	928	928	932	929	929
Distribution networks	1.065	1.132	1.169	1.298	1.334	1.366	1.402	1.441	1.467	1.499
Reverse flow-exports	350	350	430	505	635	710	800	800	800	800
TOTAL	5.602	5.167	5.686	6.225	6.352	6.288	6.190	6.135	6.197	6.195

Source: DESFA

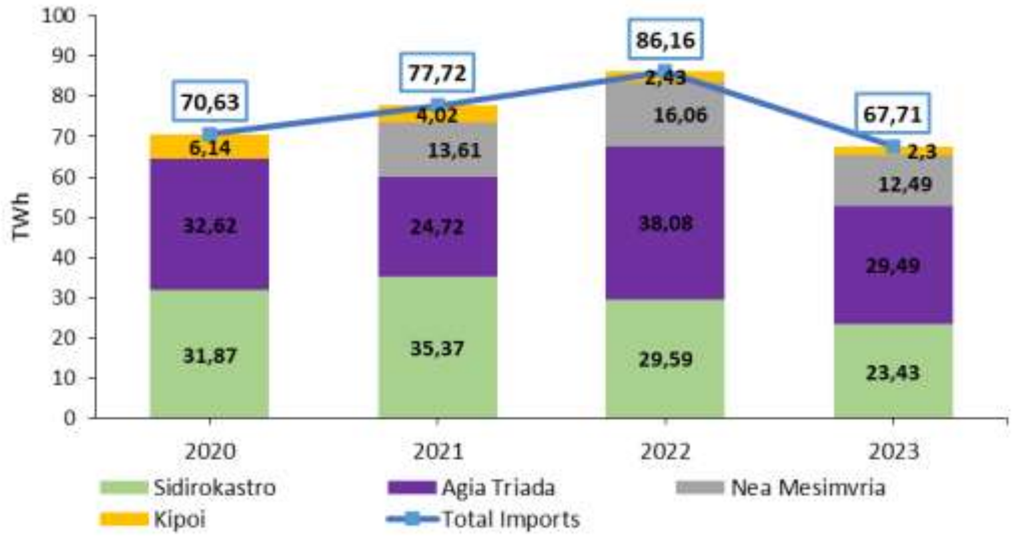
According to the August 2024 NECP revision proposal, natural gas consumption in Greece will decrease from 51.2 TWh in 2022, to 44.1 TWh in 2030 and to 16.2 TWh by 2050.

5.2.2 Natural Gas Supply Sources

The Revithoussa terminal was the main natural gas import gateway into the country during this period, followed by the Sidirokastro entry point, whose flows decreased by 20.82% compared to the same period last year [37].

Natural gas imports amounted to 67.71 TWh in 2023, recording a decrease of 21.41% compared to 86.16 TWh in 2022.

Figure 63: Distribution of Natural Gas Imports by Entry Point, 2020-2023

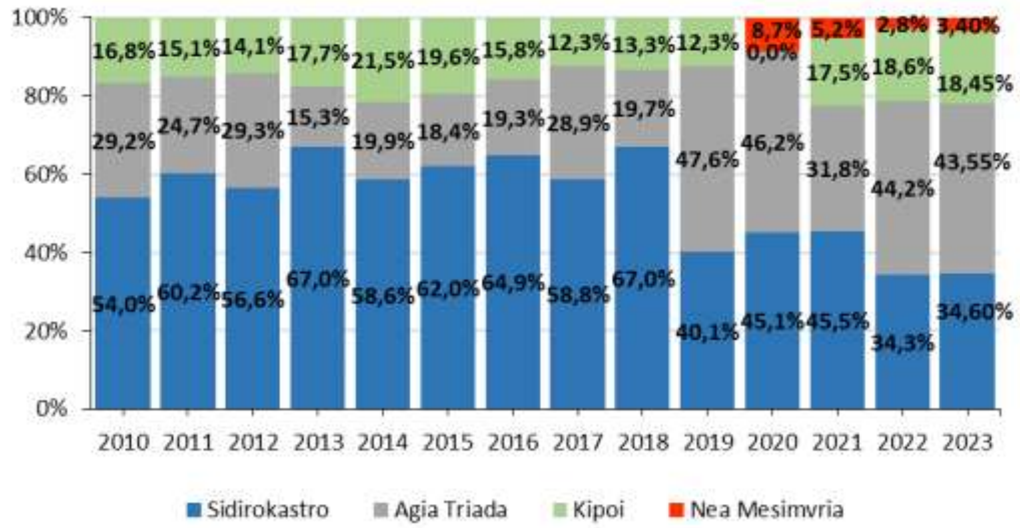


Source: DESFA

The largest quantities entered the country from the Revithoussa LNG terminal, which covered 43.55% of imports. In particular, approximately 28.52 TWh of LNG were unloaded from 41 tankers from 7 countries.

Regarding the contribution of the remaining entry points, the Sidirokastro entry point covered 34.6% of imports (23.43 TWh), followed by the Nea Mesimvria entry point, which, through the TAP pipeline, covered 18.45% of imports (12.49 TWh). Finally, Kipoi Evros covered 3.39% of imports (2.3 TWh).

Figure 64: Evolution of the Percentage Participation of Greece's Natural Gas Entry Points in Imports, 2010-2023



Sources: DESFA, IENE

According to DESFA’s data for 2023 [37], the US remained the largest LNG importer in Greece with 10.75 TWh and a share of 37.69%. In second place were imports from Russia with 8.38 TWh, followed by Egypt (3.5 TWh), Algeria (3.47 TWh), Norway (0.97 TWh), Nigeria (0.94 TWh) and Spain (0.51 TWh).

Figure 65: LNG Cargo Imports by Country (TWh), 2020-2023

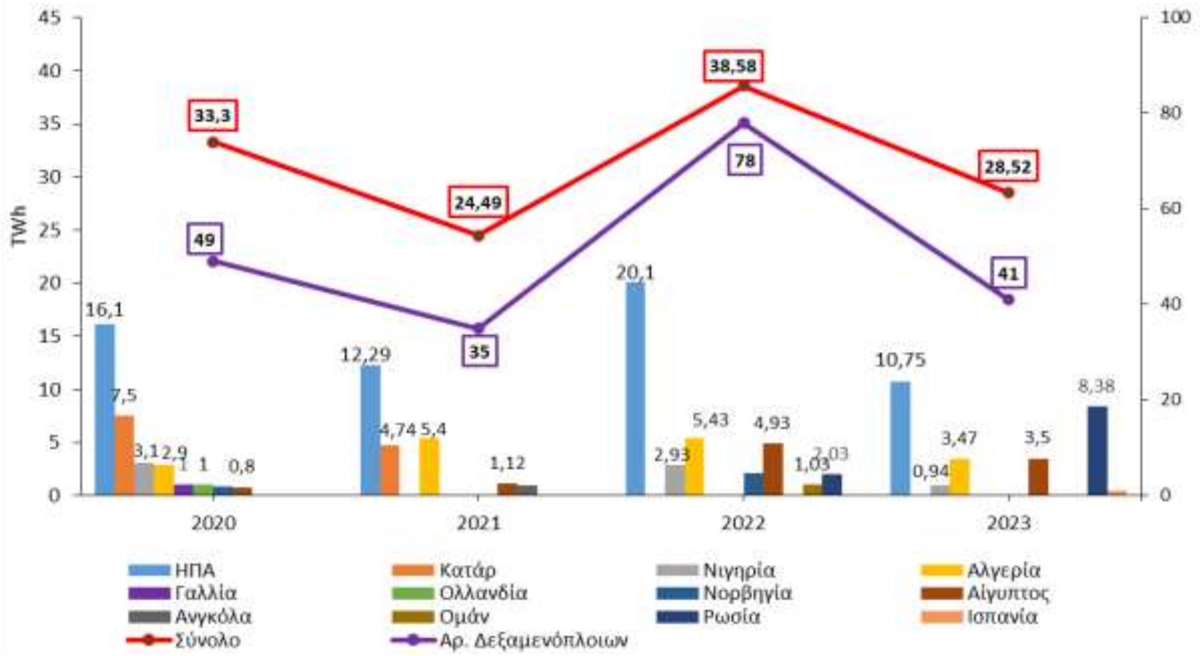


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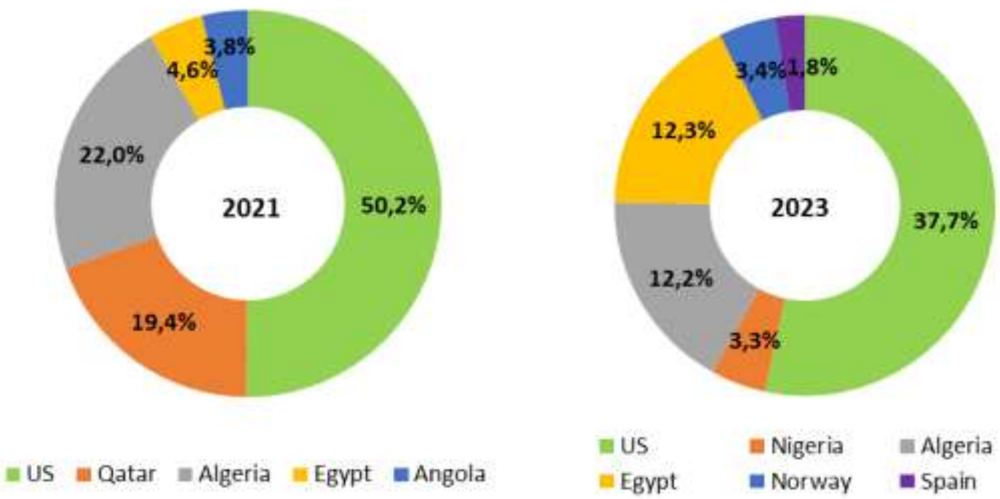
Figure 66: LNG Import Shares by Country, 2021 and 2023

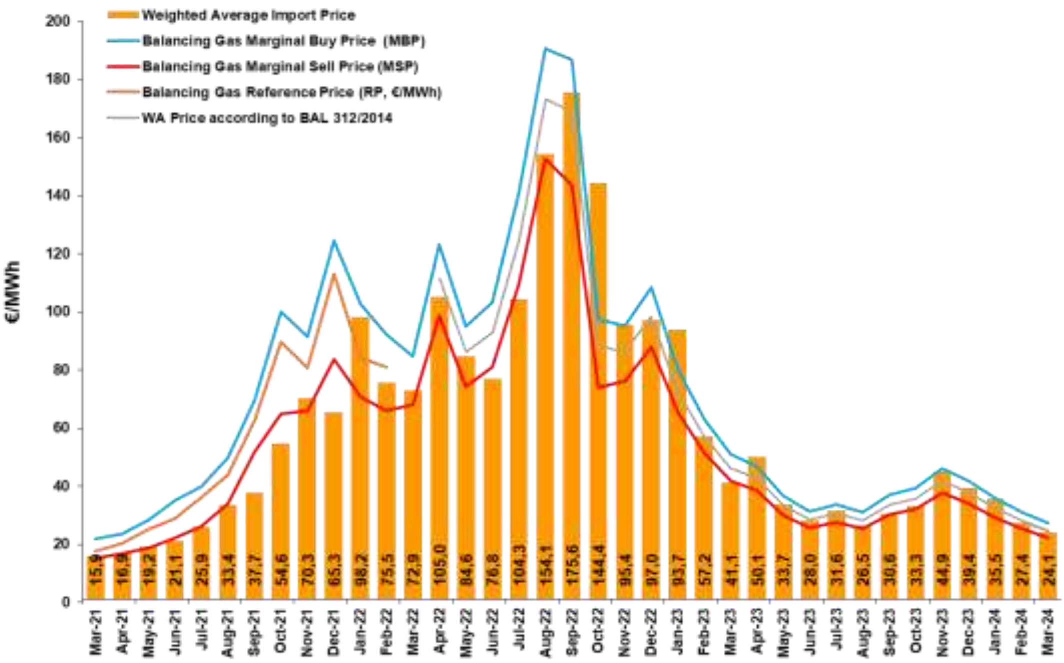


Source: DESFA

5.2.3 Gas Prices

Based on data provided by the Regulatory Authority for Energy, Waste and Water [40], Figure 67 presents the weighted average import price, per month, for the period March 2021 – March 2024 as well as the evolution of the monthly weighted average import price in relation to the balancing gas reference price, the balancing gas marginal buy price, the balancing gas marginal sale price and the weighted average price according to the Balancing Regulation 312/2014, for the same period.

Figure 67: Evolution of the Weighted Average Natural Gas Import Price in Greece, in the Time Period March 2021 – March 2024

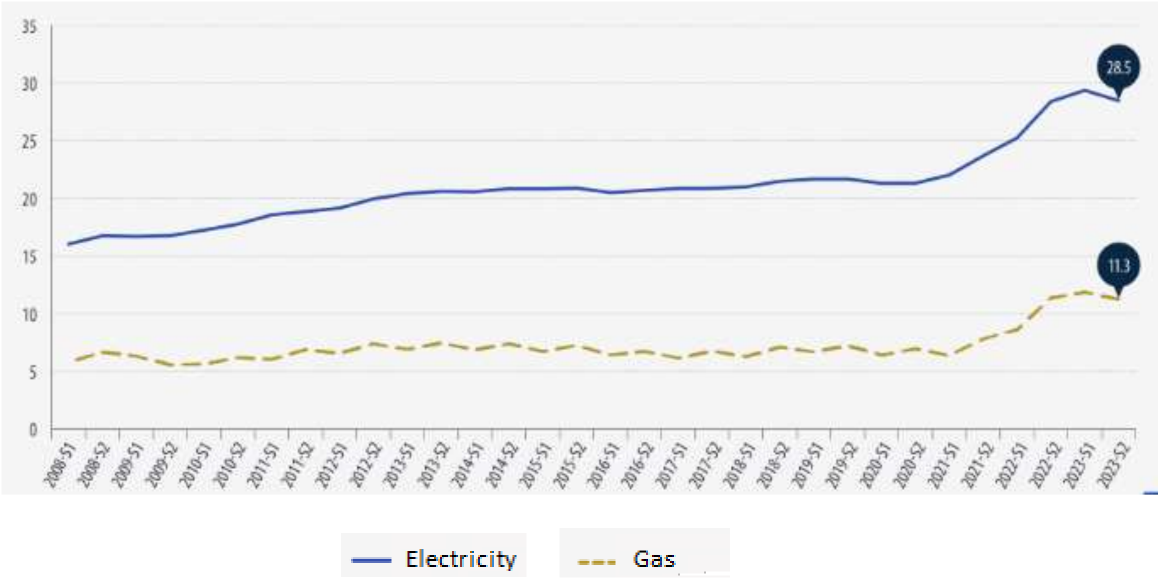


Source: RAAEY

During 2023, there is a de-escalation in natural gas import prices compared to 2022, with a slight recovery in November and December 2023, but with prices lower than €50/MWh.

According to Eurostat's data [41], natural gas prices for household consumers decreased in the second half of 2023, mainly as a result of lower energy costs and to a lesser extent lower taxes, which are gradually returning to pre-crisis levels after the reductions in 2022. For non-household consumers, natural gas price reductions were more evident in the second half of 2023.

Figure 68: Evolution of Electricity and Natural Gas Prices for Household Consumption in Europe, 2008-2023 (in €/100 KWh)



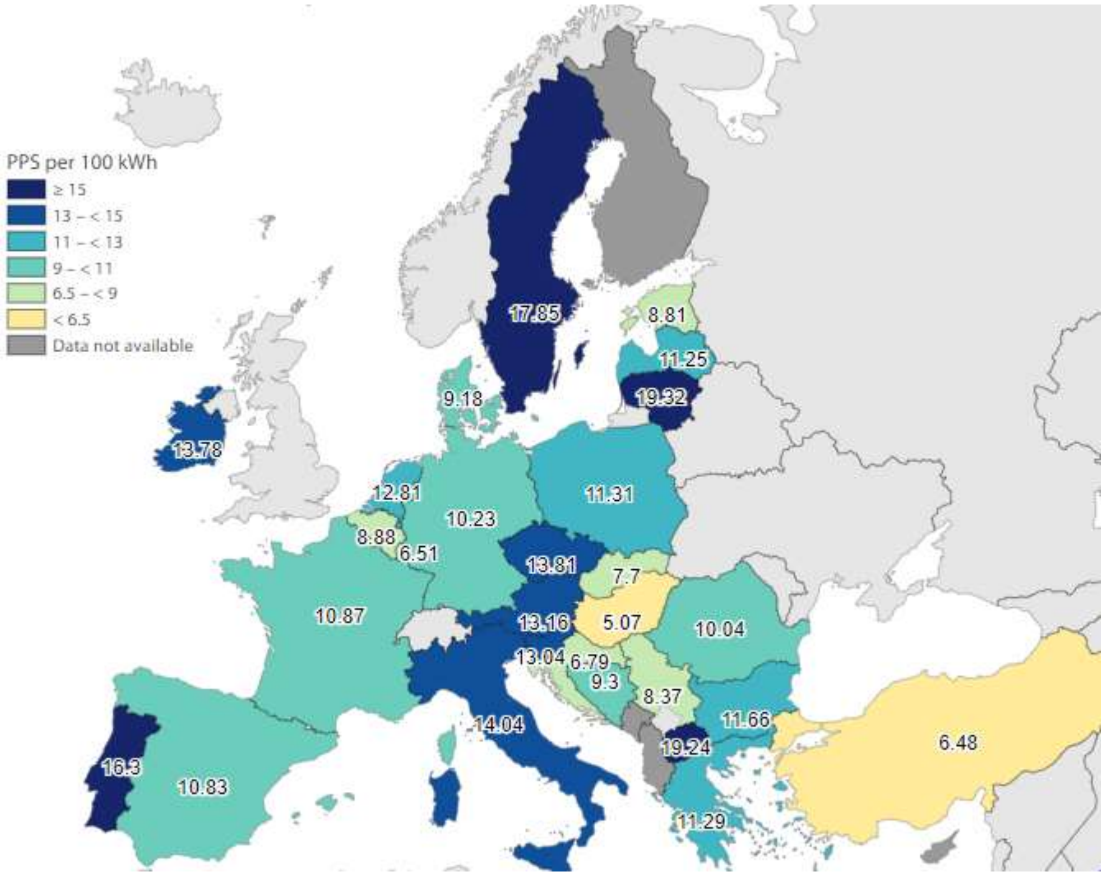
Note: The above prices include taxes and fees.

Source: Eurostat

Between the second half of 2022 and the second half of 2023, natural gas prices (in national currencies) increased the most in Lithuania (+68%) and decreased the most in Denmark (-39%). For household consumers, a total of 12 countries reported increases, while the other 12 using natural gas reported price decreases.

Poland (+32%), Slovakia and Germany (both +22%) followed Lithuania with the highest price increases, while Greece (-42%), Denmark (-41%) and Bulgaria (-40%) had the highest decreases [42].

Map 12: Natural Gas Prices for Residential Consumers, Second Half of 2023 (Purchasing Power Standards (PPS) per 100 KWh)



Source: Eurostat

5.2.4 Retail Market

In the retail natural gas market, the management of the country's distribution networks has been undertaken by two operators, the company HENGAS and the company ENAON EDA. Following the merger by absorption of EDA THESS and EDA ATTIKIS into DEDA, the company ENAON EDA was established, which replaced the three previous Gas Distribution Network Operators and undertook the management of the networks of Attica, Thessaloniki and Thessaly and the networks of the Rest of Greece (Peloponnese, Central Greece, Central Macedonia and Eastern Macedonia-Thrace) [43].

The ENAON EDA distribution network for Attica is supplied with natural gas from the DESFA transmission network from five (5) entry points in Attica. The movement of natural gas in the Attica region is carried out through the medium and low pressure networks [44].

The medium pressure network consists of approximately 343 kilometers of medium pressure pipelines, steel pipes with a nominal operating pressure of 19bar or 10bar, to which large industrial consumers are connected as well as the distribution stations that supply the low pressure networks. The low pressure network consists of approximately 3,632 kilometers of low pressure pipelines through which domestic, commercial and industrial uses are served. The low pressure network consists of approximately 3,112 kilometers with a nominal operating pressure of 4bar and polyethylene construction material as well as 520 kilometers of old network – with a nominal operating pressure of 23 mbar and polyethylene or cast iron construction material – which is mainly found in the area of the center of Athens and where it is gradually being replaced.

Through the low-pressure distribution network of Attica, EDA ATTICA supplied 194,545 delivery points (final gas consumption points) during 2023, serving a total of more than 430,000 final customers [44]:

- residential consumers (central heating or autonomous heating)
- commercial consumers (professional and large commercial e.g. hospitals, hotels)
- industrial customers and
- customers with natural gas air conditioning

The total distributed quantity of natural gas in the Attica distribution network for 2023 amounted to 3,649,991 MWh.During the month of January 2024, a total of 20 Suppliers were active in the retail natural gas market, representing at least one delivery point, according to data from RAAEY [43].

Table 13: Active Natural Gas Suppliers, January 2024

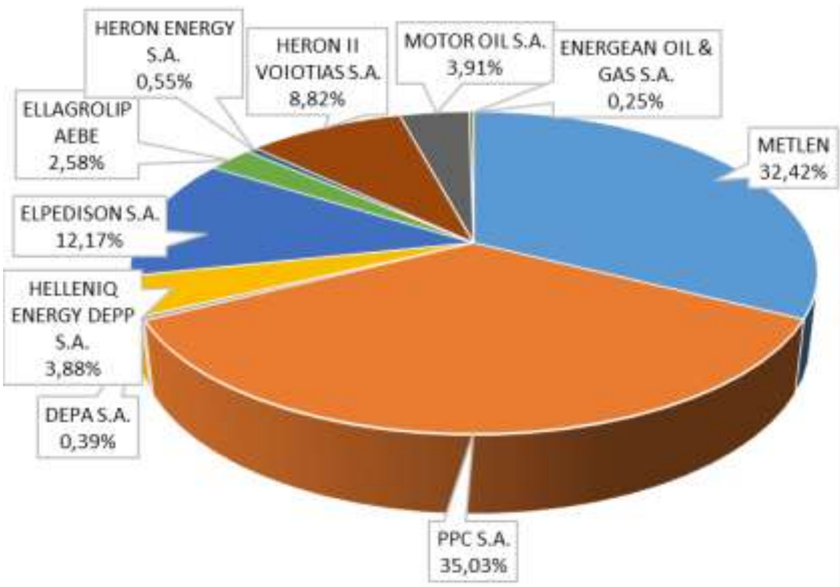
A/A	SUPPLIER'S NAME
1.	ELPEDISON COMMERCIAL S.A.
2.	FULGOR HELLENIC ELECTRIC CABLE COMPANY S.A.
3.	GREENSTEEL – CEDALION COMMODITIES S.A.
4.	NRG TRADING HOUSE S.A.
5.	SOVEL A.E. GREEK STEEL PROCESSING COMPANY
6.	VOLTERRA S.A.
7.	VOLTON HELLENIC ENERGY COMPANY S.A.
8.	ANOXAL S.A. METAL PROCESSING AND RECYCLING INDUSTRY
9.	PPC S.A.
10.	DEPA S.A.
11.	ELVALHALCOR S.A.
12.	ELINOIL HELLENIC PETROLEUM COMPANY S.A.

13.	**MYTILINEOS COMPANY - GROUP OF COMPANIES S.A.**
14.	**ATTICA GAS SUPPLY COMPANY S.A.**
15.	**THESSALONIKI-THESSALIA GAS SUPPLY COMPANY S.A.**
16.	**EFA ENERGY NATURAL GAS COMPANY S.A.**
17.	**HERON ENERGY S.A.**
18.	**MOTOROIL HELLAS CORINTH REFINERIES S.A.**
19.	**PROMETHEUS GAS S.A.**
20.	**SIDENOR INDUSTRIAL STEEL S.A.**

Source: RAAEY

According to DESFA's data [45], PPC held the largest percentage of energy consumed in the natural gas market for 2023 with a percentage of 35.03%, followed by Metlen with a percentage of 32.42% and then by Elpedison with 12.17%, while other companies with smaller percentages complete the list (Figure 69).

Figure 69: Natural Gas Market Shares per Transmission User 2023, % of Energy Consumed (Quarterly Average)

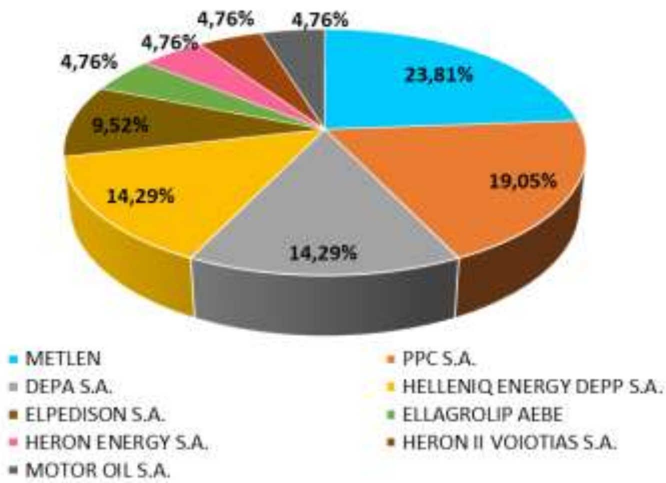


Note: Market shares only concern consumers directly connected to the National Natural Gas Transmission System

Source: DESFA

Regarding the share of suppliers in 2023 based on the number of active connection points to the National Natural Gas Transmission System, Metlen leads with a percentage of 23.81% followed by PPC S.A. with a share of 19.05%.

Figure 70: Market Shares of Natural Gas Suppliers Based on Active Connection Points, 2023



Source: DESFA

For the year 2023, the majority of consumption in medium pressure (MP) and low pressure (LP) is attributed to industrial use with a percentage of 43.6% and to residential use with a percentage of 41.6%. Consumption for residential and commercial customers decreased compared to the previous year, in contrast to the consumption of industrial customers and CNG. Overall, a decrease of 8.8% was recorded in total consumption in the retail market (Table 14) [46].

Table 14: Consumption in PM and CP (MWh by use category), Total Market, 2022 and 2023

USE CATEGORY	2023	2022	CHANGE
RESIDENTIAL	4.658.045	5.612.918	*-20,50%*
COMMERCIAL	1.584.025	1.883.677	*-18,90%*
CNG	73.952	66.955	*9,50%*
INDUSTRIAL	4.879.499	4.620.155	*5,30%*
TOTAL	**11.195.521**	**12.183.705**	**-8,80%**

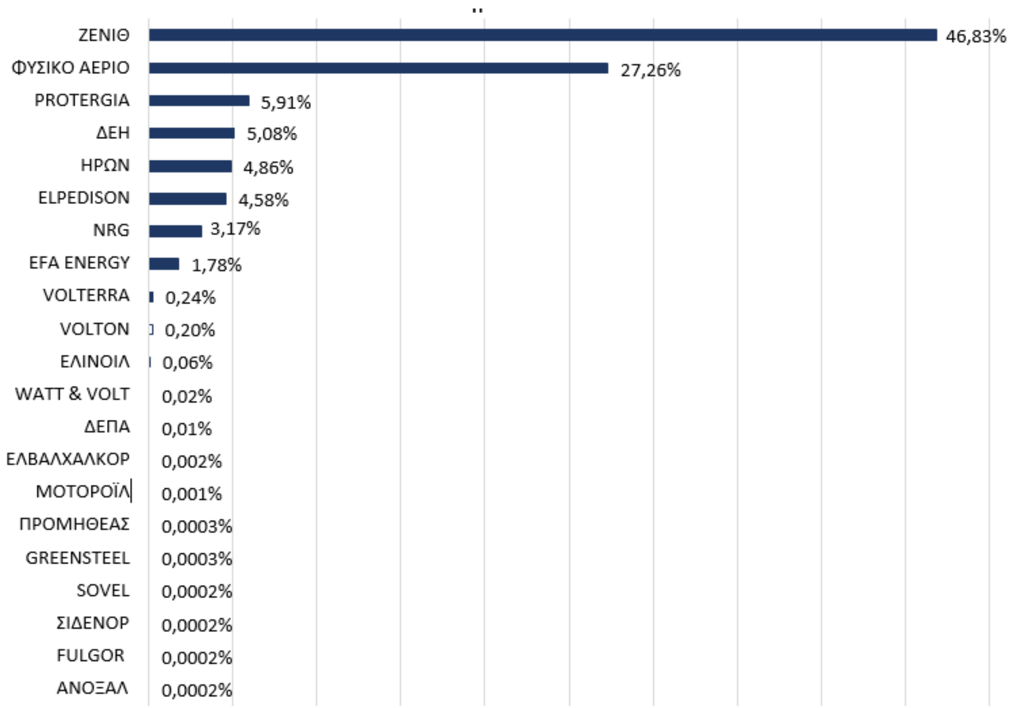
Source: RAAEY

Table 15: Consumption in MP and LP (MWh) Per Distribution Network and Per Month, 2023

Month	EDA Attikis	EDA Thessaloniki	DEDA	HENGAS	TOTAL
January	590.877	775.267	231.581	745	1.598.471
February	702.979	821.236	270.645	938	1.795.798
March	447.152	566.987	292.394	655	1.307.189
April	269.565	356.703	254.894	513	881.675
May	188.644	211.857	247.157	176	647.835
June	152.082	162.075	228.304	43	542.504
July	140.516	139.171	208.110	29	487.825
August	114.114	114.718	180.539	23	409.395
September	144.503	124.505	234.044	17	503.068
October	156.342	156.850	254.556	32	567.780
November	234.777	405.875	269.215	1.171	911.038
December	508.425	776.398	254.650	3.470	1.542.944
Total	**3.649.976**	**4.611.642**	**2.926.091**	**7.812**	**11.195.521**

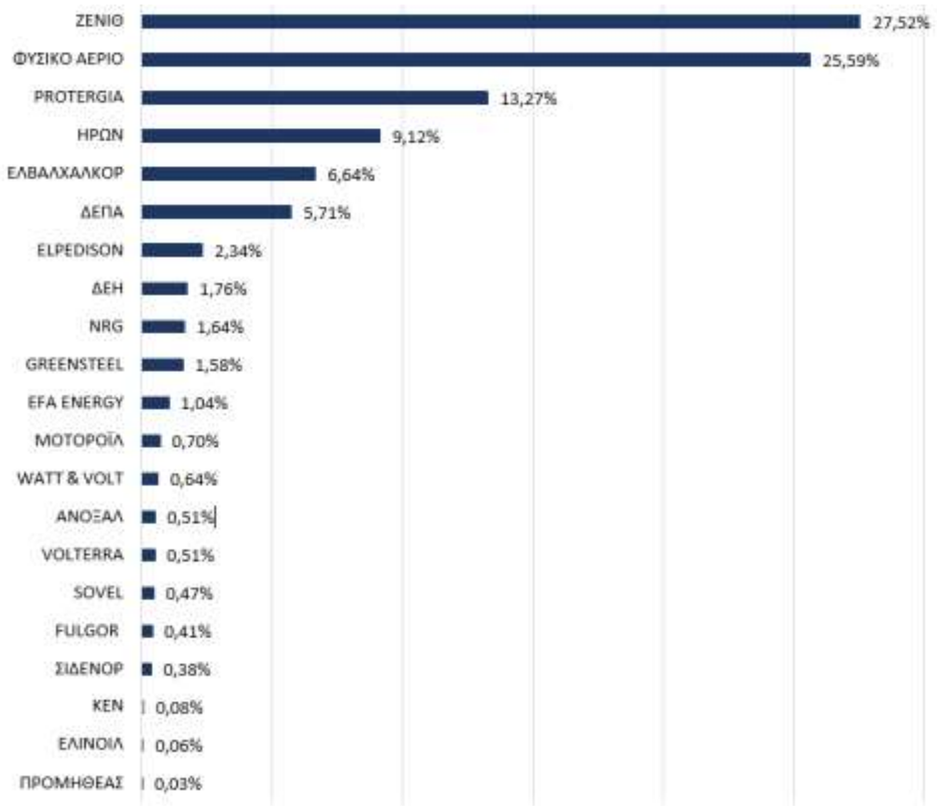
Source: RAAEY

Figure 71: Shares of Suppliers in the Retail Natural Gas Market (Based on Number of Delivery Points), Total Market, MP & LP, 2023



Source: RAAEY

FIgure 72: Shares of Suppliers in the Retail Natural Gas Market (Based on Consumption), Total Market, MP & LP, 2023



Source: RAAEY

5.2.5 Natural Gas Transmission Through Pipelines

National Natural Gas System (NNGS)

According to DESFA's data, the total length of natural gas transmission pipelines amounted to 1,466 kilometers. More specifically, 512 kilometers related to the central high-pressure gas transmission pipeline and 954 kilometers to the supply pipelines of the various regions of the country. The length of the network did not change compared to 2022 (Table 16) [47].

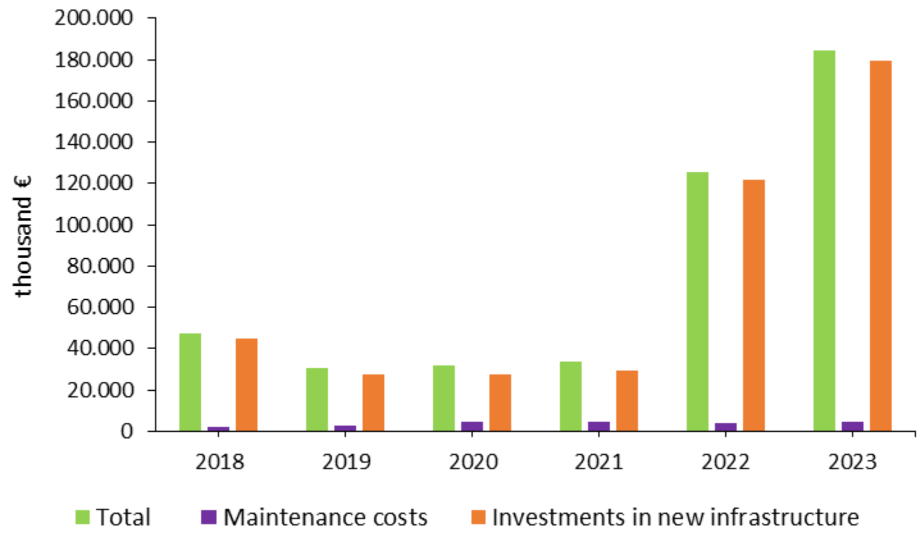
Table 16: Length of Natural Gas Transmission Pipelines (km)

	2018	2019	2020	2021	2022	2023
High-pressure main gas transmission pipeline	**512**	**512**	**512**	**512**	**512**	**512**
Supply pipelines of the country's regions	**952**	**954**	**954**	**954**	**954**	**954**
Total	**1.464**	**1.466**	**1.466**	**1.466**	**1.466**	**1.466**

Source: ELSTAT

The maintenance costs of natural gas transmission infrastructure amounted to €4,857,000 in 2023, an increase of 29.6% compared to 2022, where the corresponding costs amounted to €3,747,000. Investments in new infrastructure amounted to €179,393,000 in 2023, an increase of 47.6% compared to the corresponding investments in 2022, which amounted to €121,563,000 (Figure 73) [47].

Figure 73: Expenditures for Natural Gas Transmission Infrastructure, 2018-2023



Source: ELSTAT

Table 16 presents the movement of natural gas in the Greek territory. Regarding the total imported quantities (receipts) of natural gas at the entry points of the National Natural Gas System, in 2023 a decrease of 21.4% was observed compared to 2022. Similarly, the total exported quantities (deliveries) of natural gas from the exit points of the NNGS showed a decrease of 21.5% in 2023 compared to 2022.

Table 17: Natural Gas Transportation in the NNGS (MWh), 2019 -2023

	2019	2020	2021	2022	2023
Imported quantities of natural gas at entry points (MWh)	65.202.881	70.649.066	77.736.918	86.157.785	67.723.344
Exported quantities of natural gas from exit points (MWh)	65.109.198	70.474.183	77.562.806	86.176.038	67.606.113
in national transport	*57.407.326*	*63.104.605*	*69.960.612*	*56.639.902*	*50.914.754*
in international transport	*7.701.872*	*7.369.578*	*7.602.194*	*29.546.136*	*16.691.359*

Source: ELSTAT

Independent Natural Gas System (INGS)

In addition to the National Natural Gas System (NNGS), there is also the Independent Natural Gas System, which consists of the TAP (Trans Adriatic Pipeline) interconnector and the Greece-Bulgaria (IGB) interconnector. Through the TAP pipeline, natural gas is transported from the Caspian region to Europe and its length in Greek territory is 550.8 kilometers. The TAP pipeline began operation in December 2020. The Greece-Bulgaria Interconnector (IGB) has a length of

31.6 kilometers in Greek territory and the pipeline operation began in October 2022. Table 18 presents the imported quantities of natural gas through TAP and the deliveries of natural gas from TAP to the National Natural Gas System (NNGS) and to the Greece-Bulgaria Interconnector (IGB).

Table 18: Natural Gas Transmission Through TAP, 2021-2023

	2021	2022	2023	Μεταβολή % 2023/2022
Imported quantities of natural gas in Greece (MWh)	90.483.085	126.239.076	127.902.146	1,3%
Exported quantities of natural gas from Greece (MWh)	76.311.953	108.161.587	104.643.609	-3,3%
Deliveries to the NNGS in Nea Mesimvria (MWh)	13.617.600	12.596.353	7.436.839	-41,0%
Deliveries to IGB in Komotini (MWh)		4.872.894	15.422.089	216,5%
Transport project (MtKm)	3.118	4.272	4.086	-4,4%

Source: ELSTAT

Table 19 presents the imported and exported quantities of natural gas through the IGB pipeline since October 2022, when it began operation, as well as the technical capacity at the entry and exit points.

Table 19: Natural Gas Transmission Through IGB and Technical Capacity of Entry and Exit Points, 2022-2023

	2022	2023
Imported quantities of natural gas in Greece (MWh)	18.495	0
Exported quantities of natural gas from Greece (MWh)	4.875.908	15.540.771
Deliveries to the NNGS (MWh)	0	0
Transport project (MtKm)	10	32
Technical capacity of entry point in Greece (MWh/day)	124.762	124.762
Technical capacity of exit point from Greece (MWh/day)	124.762	124.762

Source: ELSTAT

According to data from 2023, 42.2% of natural gas imports were made as LNG through Revithoussa terminal, 37.0% through the connection with Bulgaria (Russian gas via Turk Stream), 17.6% through TAP (Azerbaijani gas) and 3.2% through Türkiye (also Azerbaijani gas) [48].

NNGS Development Programme

On 21 September 2023, the decision "Approval of the Development Programme of the National Natural Gas System (NSGS) for the period 2023-2032" was published in the Official Gazette 5595B, following approval by the RAAEY (No. E-68/2023). The new NNGS Development Programme includes projects with an estimated budget of €1.32 billion, of which €476 million correspond to new projects, while the rest correspond to those already approved in the 2022-2031 Development Programme or included in the List of Small Projects, updated in terms of schedule and budget. Of these new projects, €13 million correspond to improvements, modernization and maintenance of the NNGS, while €430 million correspond to new projects that create new capacity in the system.

More specifically, the most important new projects are:

- the "Doubling of the Karperi-Komotini high-pressure branch" (€290 million), a project that aims to provide uninterrupted capacity from the Virtual Trading Point (VTP) to all Exit Points of the specific branch and from all Northeastern Entry Points to all Exit Points of the branch
- the "Doubling of the Patima-Livadia high-pressure branch" (€140 million) which aims mainly to provide uninterrupted capacity to the users of the Floating Storage and Regasification Unit (FSRU) of the Dioriga Gas and, therefore, should be implemented subject to the Final Investment Decision of the Dioriga Gas

The Development Programme Draft also includes innovative projects related to the energy transition and decarbonization through appropriate investments of €15 million. These projects concern a pilot pyrolysis project and the connection of the DESFA network with the planned H2 Valley in Western Macedonia, for the injection of green hydrogen into the existing network and are largely related to the reduction of methane emissions in the NNGS. Finally, €18 million refer to two new connection projects.

Natural Gas Distribution Networks – Natural Gas Distribution Network Operators

Distribution Network Operators must construct the distribution network in accordance with the Development Plan approved by RAAEY, based on the development schedule included in the Distribution License. At the end of each calendar half-year, the Operators inform RAAEY of the progress of the network construction works in their license area. [49].

The country's distribution networks, depending on their operating pressure, are distinguished into:

- Medium pressure network (with a nominal pressure of 19.0 bar)

- Low pressure network (with nominal pressure 0.025 - 4.0 bar)

The expansion of natural gas consumers with the inclusion of 13 new cities in the distribution network within 2024 is planned by the former DEDA and current "ENAON Eda", as the single manager of the distribution networks under the umbrella of the Italian energy group Italgas is now called.

The 13 new cities that will be added to the gas distribution network are the following: Grevena, Livadia, Giannitsa, Veria, Florina, Kastoria, Argos Orestiko, Amfissa, Alexandria, Karpenisi, Orestiada, Patras and Ioannina.

In terms of network expansion, Itaglas' plans for 2024 foresee projects for over 650 kilometers of low-pressure network and approximately 50 kilometers of medium-pressure network, while specifically for Attica, 30 kilometers of new network will be added in 2024. In addition, the digitalization of the network with the integration of "smart meters" and advanced technological systems for cybersecurity occupy a central position in the company's immediate plans.

Table 20 shows the number of delivery points that each user represents and the monthly distributed quantity of natural gas (kWh) per distribution tariff category, based on data from the Hellenic Gas Distribution Company (ENAON Eda).

Table 20: Number of Delivery Points and Monthly Distributed Quantity of Natural Gas by Distribution Tariff Category, January 2024

GEOGRAPHIC REGION	THESSALONIKI			THESSALY			ATTICA			CENTRAL GREECE		
	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)
RESIDENTIAL	275.535	0	513.074.361	117.701	0	253.674.284	188.139	0	500.605.473	1.107	0	1.945.943
COMMERCIAL	5.494	0	71.233.271	2.898	0	32.816.125	7.577	0	163.396.743	32	0	3.545.621
CNG	6	0	5.182.844	4	0	1.556.403	0	0	0	0	0	0
INDUSTRIAL	36	0	46.665.717	44	2	59.295.026	88	0	87.634.887	82	0	122.900.059
AIR CONDITION / CHP	0	0	0	0	0	0	60	0	1.780.303	0	0	0
TOTAL	281.071	0	636.156.193	120.647	1	347.341.838	195.864	0	753.417.406	1.221	0	128.391.623

GEOGRAPHIC REGION	CENTRAL MACEDONIA			EASTERN MACEDONIA-THRACE			WESTERN MACEDONIA			WESTERN GREECE		
	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)
RESIDENTIAL	2.453	0	4.838.670	1.054	0	1.991.879	0	0	0	0	0	0
COMMERCIAL	45	0	2.195.134	18	0	6.300.753	0	0	0	0	0	0
CNG	22	0	49.629.475	0	0	0	0	0	0	0	0	0
INDUSTRIAL	22	0	40.717.660	28	0	59.607.249	0	0	0	0	0	0
AIR CONDITION / CHP	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2.542	0	97.380.939	1.1	0	67.899.881	0	0	0	0	0	0

GEOGRAPHIC REGION	EPIRUS			PELOPONNESE			TOTAL ENAON EDA		
	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)	NUMBER OF ACTIVATED DELIVERY POINTS WITH EXCLUSIVE REPRESENTATION	NUMBER OF ACTIVATED DELIVERY POINTS WITH PARALLEL REPRESENTATION	MONTHLY DISTRIBUTED GAS QUANTITIES (KWh)
RESIDENTIAL	0	0	0	0	0	0	583.443	0	1.270.920.368
COMMERCIAL	0	0	0	0	0	0	15.907	0	276.565.533
CNG	0	0	0	0	0	0	32	0	56.368.722
INDUSTRIAL	0	0	0	1	0	4.330.551	297	2	418.086.197
AIR CONDITION / CHP	0	0	0	0	0	0	60	0	1.780.303
TOTAL	0	0	0	1	0	4.330.551	599.679	2	2.021.940.820

Source: ENAON Eda

5.2.6 Natural Gas Infrastructure Projects

5.2.6.1 Revithoussa LNG Terminal

The Revithoussa Liquefied Natural Gas (LNG) Terminal is located on the island of Revithoussa, approximately 500 meters from the coast of Agia Triada, in the Gulf of Pachi, Megara, 45 km west of Athens. The station is strategically located close to areas with high natural gas consumption, such as Attica and Boeotia, so that it can supply natural gas to both the Greek market and the markets of neighboring countries, through the existing interconnection with Bulgaria and the future interconnection with North Macedonia. It is one of the twenty-eight corresponding liquefied natural gas stations, currently operating throughout the Mediterranean and Europe, and is unique in Greece for the reception of LNG tankers, receipt, storage, gasification of LNG and for the supply of natural gas to the National Natural Gas Transmission System (NNGTS).

It has a storage capacity of 225,000 m3 of LNG, consisting of two tanks of 65,000 m3 each and one larger one, with a capacity of 95,000 m3, and an hourly gasification capacity of 1250 m3 of LNG under normal operating conditions [50]

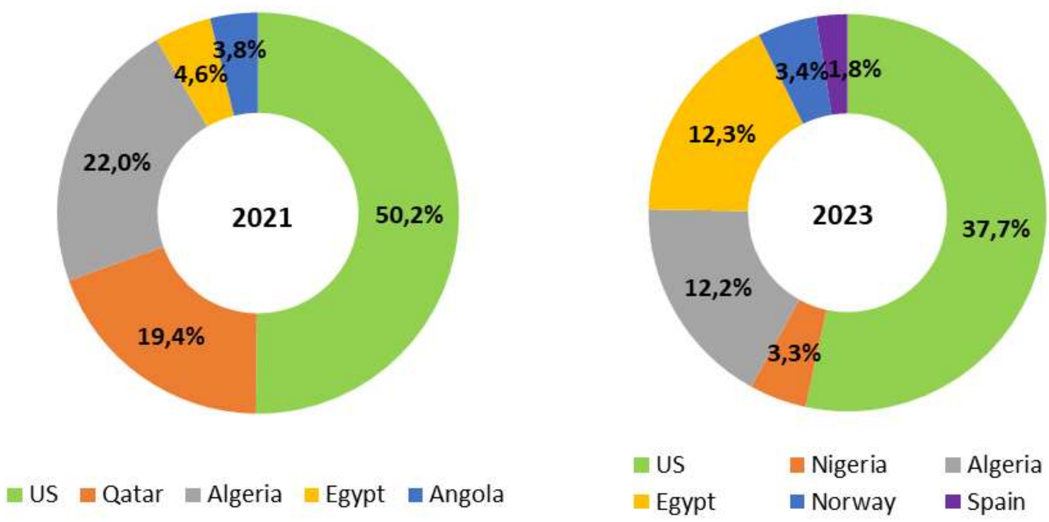
The Revithoussa terminal can accommodate ships from 25,000 to 266,000 m3 of LNG, a size that corresponds to the largest LNG carriers in the world, with a length of approximately 355 meters.

It is a critical infrastructure for Greece, as it guarantees security of supply and allows for the diversification of natural gas supply sources, providing operational flexibility to the transmission system, as well as increased capacity to meet peak natural gas demand. It is the only Entry Point of the network that injects natural gas into the Southern part of the country.

DESFA proceeded with the addition of a Floating Storage Unit (FSU) to the Revithoussa LNG terminal, increasing the total available storage capacity from 225,000 m3 to more than 380,000 m3. At the same time, DESFA is expected to proceed with the enhancement of the terminal's regasification capacity by 12%.

In 2021, the Revithoussa station covered almost 31.8% of total natural gas imports into Greece, while in the first quarter of 2022 Revithoussa became the main natural gas entry gateway into the country, covering 43.23% of imports. Figure 74 presents the origin of LNG cargoes unloaded at Revithoussa in 2021 (35 cargoes from 5 countries) as well as in 2023 with the receipt of 41 LNG cargoes from 7 countries.

Figure 74: Countries of Origin of LNG Imports in 2021 and 2023



In April 2022, the new Small Scale LNG pier at the Revithoussa terminal was included in the Operational Programme "Competitiveness, Entrepreneurship and Innovation 2014-2020". This specific project foresees the creation of a new pier, parallel to the northeastern coast of Revithoussa, which will have a total length of approximately 20m and a sea depth of approximately 12.00m at this length. The minimum width of the pier will be 30m. This pier will serve the docking of small-capacity LNG carriers, between 1,000 and 30,000 m^3 of LNG. The total cost of the project amounts to €18,070,120, with the private participation amounting to €9,185,060 and the total public expenditure proposed for registration in the Public Investment Programme amounting to €8,885,060.

5.2.6.2 Alexandroupolis FSRU

On October 1, 2024, the LNG terminal in Alexandroupolis came on stream. According to the initial schedule, the terminal was supposed to enter into operation in April 2024. After the start of work to connect the liquefied natural gas platform to the natural gas pipeline, a technical defect was detected – namely the presence of water in the pipeline. The malfunction was repaired using the so-called “non-intrusive method”, with a controlled supply of natural gas from the regasification platform to the natural gas transmission system of Greece [51].

The floating LNG reception, storage and gasification unit includes the following main parts [52]:

- Tanker mooring and LNG transfer systems.
- Four LNG storage tanks with a total capacity of up to 153,500 cubic meters.
- Three gasification units with a capacity of 315,000 cubic meters (275 mmscfd) of natural gas / hour (each).

- Power generation units to serve the needs of the floating unit in electricity
- Metering unit to measure the quantities of natural gas that are gasified.
- Accommodation, crew accommodation.

The liquefied natural gas is transferred from the transport tankers to the cryogenic tanks of the floating unit and then transported for gasification to the three gasification units. The gasification capacity of each unit is 315,000 cubic meters (275 mmscfd) of NG/hour.

The FSRU is worth €380 million and construction began in early 2022, adding an important link in the chain of projects that promote the attempt to stop importing Russian natural gas. Shareholders of the FSRU, owned by the company Gastrade, are Mrs. Elmina Copelouzou (20%), Gaslog (20%), DEPA Commercial (20%), DESFA (20%) and Bulgartransgaz (Bulgarian Natural Gas Transmission Operator) (20%).

Map 13: Location and Interconnections of FSRU Alexandroupolis

Source: Gastrade

Map 14: Alexandroupolis FSRU – New Energy Supply Gateway for Greece and the Wider Region

Source: Gastrade

5.2.6.3 Dioriga Gas FSRU

DIORYGA GAS S.A. has received an Independent Natural Gas System License from RAAEY (RAAEY Decision 1321/2018). The project concerns the construction and operation of an Independent Natural Gas System (IGS) which includes a Floating Storage Regasification Unit (FSRU) with a capacity of up to 210,000 m3 of LNG and its interconnection with the National Natural Gas Transmission System. The project includes:

A. Offshore Floating LNG Terminal which includes:

- Floating Storage and Regasification Unit (FSRU).
- Floating Mooring with multiple mooring points / buoys for mooring the FSRU at the stern and bow.

B. Submarine and Onshore Natural Gas Pipeline for the transmission of natural gas to the National Natural Gas Transmission System (NNGTS) through a new Metering Station.

The LNG will be imported via special LNG ships and stored in the specially designed cryogenic tanks of the Dioriga Gas FSRU and will either be regasified to supply the LNG terminal with natural gas or transferred to smaller capacity LNG ships or tanker trucks to supply ships or isolated customers [53].

The FSRU will be permanently anchored at a fixed point on a floating platform and will be located approximately 1.5 km southwest of the existing petroleum product receiving pier of the Refinery of "MOTOR OIL (HELLAS) CORINTH REFINERIES S.A." in the area of Agioi Theodoroi, Corinth. The minimum distance from the shore is estimated at 500 meters in isobaths of 50 meters. Maintaining the fixed distance of the FSRU from the shore will be ensured by mooring to a floating platform [49].

The maximum licensed capacity for natural gas supply to the Greek Gas Transmission System through the Dioriga Gas project is estimated at 4.3 bcm/year, allowing the regasification of up to 11.76 million Nm3 of natural gas per day. [53]. The project will enhance security of supply at national and European level, will constitute a new Entry Point of the NNGS and, with the required interconnections of the NNGS with the neighboring natural gas systems, will ensure access to the countries of SE Europe.

Map 15: Location of Dioriga Gas FSRU

Source: Motor Oil Hellas

In August 2023, the Dioriga Gas FSRU project secured environmental approval from the Ministry of Environment and Energy (MoEE) based on the study submitted in January 2023 [54].

By decision of the Ministry of Environment and Energy in March 2024, the possibility was given for the construction of the onshore natural gas pipeline that will connect the Dioriga Gas FSRU with the national natural gas system. Thus, the route and installation of the onshore high-pressure natural gas pipeline of the project "Independent Natural Gas System (INGS) at the Sousaki location of the Municipality of Loutraki - Perachora of Aghios Theodoroi, Regional Unit of Corinth, of the company Dioriga Gas S.A.", was defined, in the section from the Beach at the Sousaki location to the New Metering/Regulating Station for the connection of the new INGS with the National Natural Gas Transmission System in the Regional Unit of Corinth, Peloponnese Region.

5.2.6.4 FSRU Thessaloniki & Volos

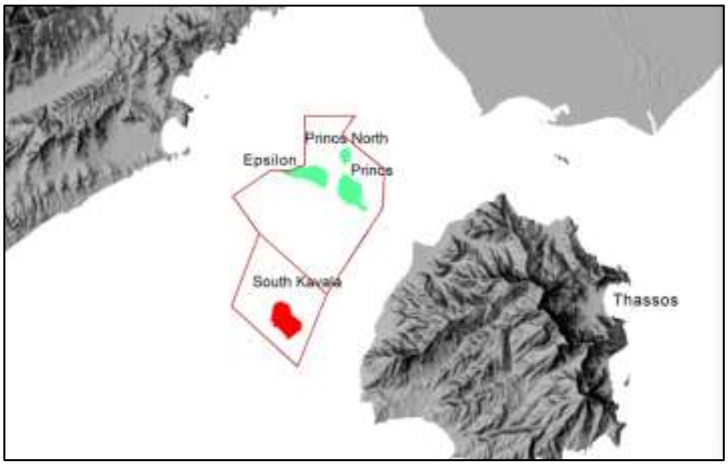
The RAAEY gave a positive opinion regarding the installation of the FSRU in the Pagasetic Gulf "ARGO FSRU", following a request by Mediterranean Gas for a change in the installation area, as well as the project implementation schedule. In particular, as provided for in the relevant decision of the Authority No. E-134/2023, the floating tank will be installed in a new location, while the schedule for the start of commercial operation is changed from January 2023 to the first quarter of 2025 [55].

It is noted, however, that the Minister of Environment, responding to questions from MPs regarding the opinion of the RAAEY on the installation of an FSRU in the Pagasitikos, stressed that Greece does not need new liquefied natural gas stations as it exceeds its needs from Revithoussa and the new Alexandroupolis terminal. Thus, the Minister stated that the project in question has no prospects of implementation, as it is becoming unsustainable [56].

5.2.6.5 Underground Natural Gas Storage Facility (UGS) of South Kavala

The €300-400 million project consists of the development of the nearly depleted South Kavala offshore natural gas field (operated by Energean – estimated gas reserves of 0.073 bcm) as an Underground Gas Storage (UGS). It is located in the Gulf of Kavala, 11 km south of the Prinos oil field, at a depth of 1,700 meters.

Map 16: The Depleted Natural Gas Deposit in South Kavala is Marked in Red



Source: Energean

On June 21, 2024, the 7th amendment to the November 23, 1999 Convention for the exploitation of hydrocarbons in the maritime area of the Thracian Sea, drawn up between the Greek State and Energean Oil & Gas, a subsidiary of the Energean plc group, was submitted for ratification by the Parliament. This amendment provides for the extension until 2039 of the exploitation licenses for the Prinos, North Prinos and Epsilon fields [57].

Energean is the beneficiary of this development, continuing to produce oil from the fields of the Gulf of Kavala, with expectations of boosting production through the further development of the Epsilon field, which, however, still requires significant investments (so far it has invested €600 million in the fields) as well as resolving the problems that have arisen with the contractor - manufacturer of the platform [57].

However, the national and local economies have also benefited, as they will continue to generate significant revenues from the maintenance of production activity: since 2008, when Energean acquired the Prinos licenses, and despite the fact that the field is in decline (maximum daily production of 4,000 barrels on average in 2018), around €430 million have flowed into the Greek State (taxes, social security funds), into public utility companies, and into domestic businesses. At the same time, around €270 million have flowed into the local economy of the prefecture of Kavala from employee salaries, contracting, supplies, and rentals.

Also, based on the new contract, the Greek State obtains additional income, as annual compensations of €200 per hectare for exploitation areas and €50 per hectare for research areas are established, to be paid by the contractor. Also, the contractor's exemption from paying royalties for the calendar year in which the selling price is below $50 per barrel is abolished [57].

Also, with the amendment of the contract, the exploitation license of the now depleted natural gas field in South Kavala is extended until November 23, 2024. It should be noted that for both the Prinos concession (Prinos, North Prinos, Epsilon) and South Kavala, the exploration licenses are valid until March 2025. Since 1981, when the fields of the Gulf of Kavala were first put into production, approximately 130 million barrels of oil equivalent have been produced. However, the proven reserves are in the order of 35 million barrels of oil and due to low pressures and hydrogen sulfide, their extraction cost is particularly expensive [57].

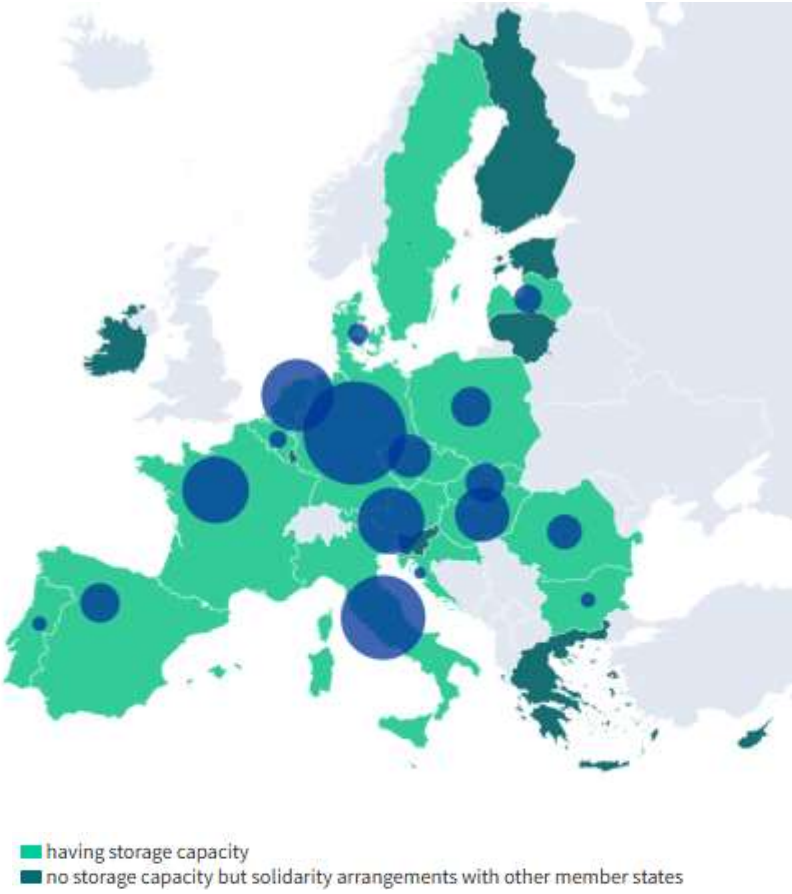
Greece is one of the few countries in the EU that does not have underground gas storage facilities, despite the fact that it now has an extensive system of mainly pipelines, branches and gas networks (estimated at more than 5000 km).

Ukraine has the largest underground gas storage facilities in Europe. The country's gas storage capacity — located in relative safety up to 2 km underground — totals more than 30 billion cubic meters. The operator Ukrtransgaz has one third of this space.

It is worth noting that in January 2023, Ukraine launched a new certification process that will allow gas storage operator UkrTransGaz to store strategic EU gas reserves in its vast underground storage facilities. “Successful certification will give UkrTransGaz the right to store not only gas of private foreign companies, but also strategic gas reserves of EU member states at Ukrainian gas storage facilities for the first time,” UkrTransGaz said in a statement [58].

Most EU Member States have gas storage facilities on their territory. The storage capacity of five countries (Germany, Italy, France, the Netherlands and Austria) represents two thirds of the total EU capacity. According to the Gas Storage Regulation, countries without storage facilities should store 15% of their annual domestic gas consumption in tanks located in other Member States and thus have access to gas stocks stored in other Member States. This mechanism strengthens the EU's security of gas supply and ensures a shared financial burden for filling the EU's storage capacity. Member States with smaller storage capacities cooperate with Member States with larger facilities to secure their stocks [59].

Map 17: Gas Storage Capacity and Filling Level in EU Member States (31 January 2024)



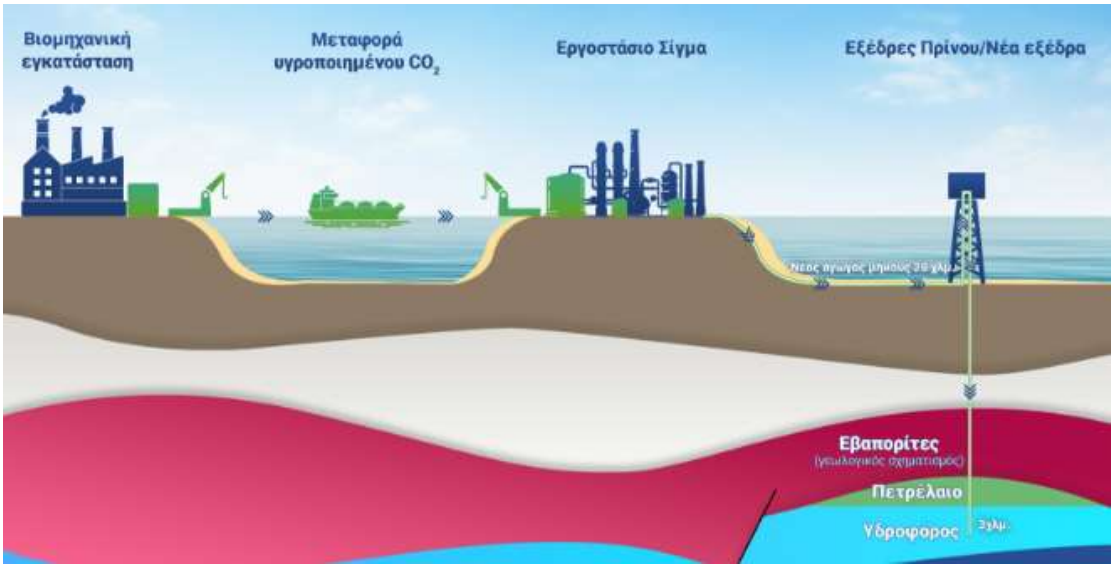
Source: European Commission

The existence of an underground natural gas storage facility is considered of strategic importance for Greece, as in times of energy crisis, such as the one that Europe is experiencing due to the Russia-Ukraine war, it offers further security of energy supply, while also playing a role in balancing prices.

It is noted that for both the Prinos concession (Prinos, North Prinos, Epsilon) and South Kavala, the exploration licenses are valid until March 2025. Since 1981, when production of the Kavala Gulf deposits began, approximately 130 million barrels of oil equivalent have been produced. The proven (2P) reserves are in the order of 35 million barrels of oil, however, their extraction is costly, both due to low pressures due to aging, and due to the high hydrogen sulfide content.

Meanwhile, Energean is rapidly advancing the planning for the Prinos CO2 storage project. The carbon dioxide storage project (PRINOS CO2) is the only one of its kind not only in Greece, but in the entire Southeastern Mediterranean. It has already been included in the European Union's Projects of Common Interest (PCI) and the goal is to have an operating license in 2026. The project is being developed by EnEarth, a subsidiary of Energean, in the Prinos concession area. EnEarth has already signed 10 non-binding Memoranda of Understanding with industries that emit CO2 [60].

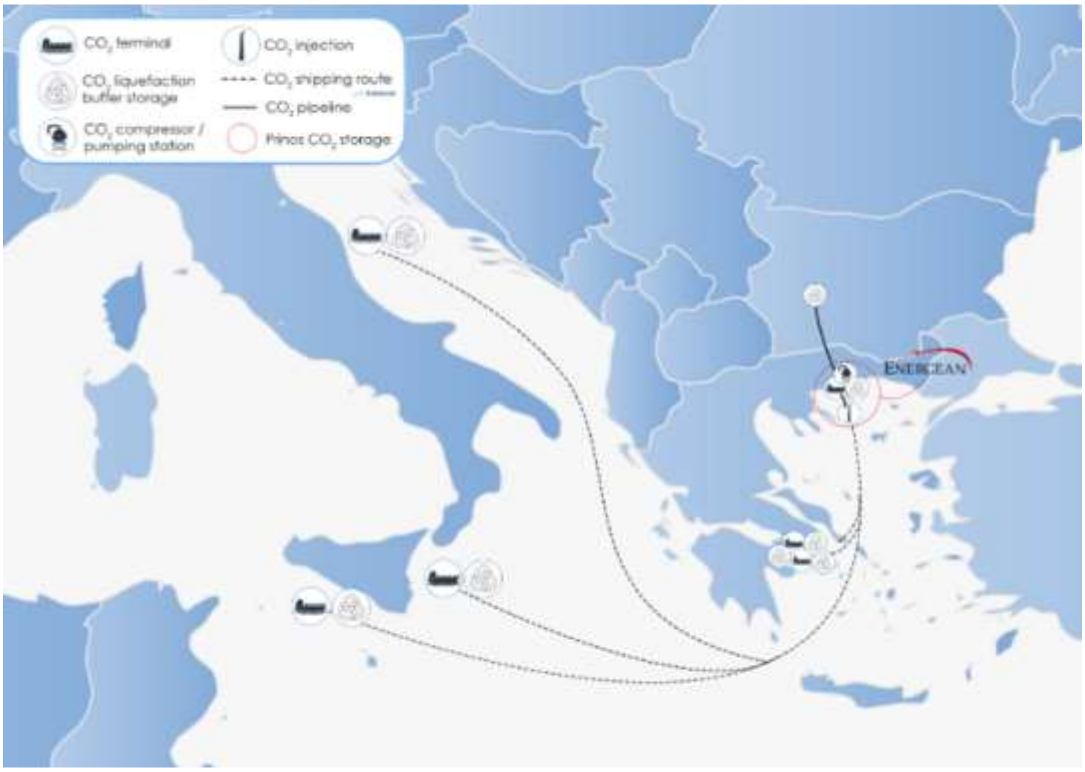
Figure 75: PRINOS CO2 Storage Project



Source: Energean

Studies conducted by Energean and other specialized companies have shown that the field can operate in a first phase with a storage capacity of 1 million tons of CO2, while there is the prospect of upgrading to store up to 3 million tons of CO2 per year for 25 years. Initially, a storage capacity of 1 million tons of CO2 per year in compressed form is planned. EnEarth submitted an application to the HEREMA in June 2024 for the acquisition of a storage permit, which is currently under evaluation. The acquisition of the operating permit is scheduled for 2026. In a next phase, from 2028, the facilities will receive CO2 in liquid form, which will be transported by ships. The CO2 will be supplied by industries that are unable to reduce CO2 emissions through fuel substitution (hard-to-abate industries) from Greece and neighboring countries, while there is also the prospect of directly capturing CO2 from the atmosphere (Direct Air Capture). In a second phase, the design foresees the expansion of capacity to 3 million tons per year and, in this regard, the necessary technical and geophysical studies are underway to confirm this possibility [60].

Map 18: Schematic Illustration of CO2 Transport from the Prinos Deposit



Source: Energean

The first phase of compressed CO2 storage is supported by a grant of €150 million from the Recovery and Resilience Fund (RRF). The total investment will exceed €1 billion. The development of the project is in full compliance with the provisions of Directive 2009/31/EC and will make a significant contribution to the effort to address the consequences of climate change and make Europe the first climate-neutral country, with the Net Zero Industry Act at its core.

5.2.6.6 Trans-Adriatic Pipeline (TAP) – Southern Gas Corridor

The Trans-Adriatic Pipeline (TAP) transports natural gas from the giant Shah Deniz II field in the Azerbaijani part of the Caspian Sea to Europe. The approximately 878 km long pipeline connects to the Trans Anatolian Pipeline (TANAP) at Kipi on the Greek-Turkish border, and crosses Greece, Albania and the Adriatic Sea, before coming ashore in southern Italy.

TAP facilitates the supply of natural gas to countries in Southeastern Europe through interconnections. Specifically, TAP connects to the Interconnector Greece-Bulgaria (IGB), which began commercial operation in October 2022, transporting gas from the Caspian to Bulgaria, thus enhancing energy security in yet another European country. TAP's exit points in Greece and Albania and the pipeline's landfall on the coast of Italy provide multiple opportunities for further transportation of Azerbaijani gas to wider European markets.

As a key part of the Southern Gas Corridor, TAP is a project of strategic and economic importance for Europe, offering reliable access to a new source of natural gas. It also plays an important role in strengthening Europe's energy security, diversifying its energy supply and transitioning to decarbonisation. TAP's share capital is held by: BP (20%), SOCAR (20%), Snam (20%), Fluxys (19%), Enagás (16%) and Axpo (5%) [61].

TAP starts at Kipi, where the Greek Compressor Station is located, near the Greek-Turkish border. Following a route of 550 km, with one compressor station and 22 valve stations, the pipeline crosses northern Greece to the Greek-Albanian border, southwest of Ieropigi Kastoria.

In Albania, the pipeline route starts at the municipality of Devoll, in the Korçë region, and travels approximately 215 km on Albanian territory, before entering the Adriatic Sea. In Albania, TAP operates a metering station in Bilisht, near the Greek-Albanian border, eight valve stations and a landing station. The pipeline reaches the Adriatic coast, 17 km northwest of the Albanian city of Fier, where the compressor station operates.

The subsea section of TAP runs along the bottom of the Adriatic Sea in the Strait of Otranto for approximately 105 km and at a depth of approximately 810 m. At depths exceeding 300 m, the pipelines are encased in concrete for additional mechanical protection and stability. TAP reaches land on the Italian coast north of San Foca through a 1.5 km long micro-tunnel more than 15 m below the surface of the coastal soil. The onshore Italian section extends for 8 km and ends at the Terminal Receiving Station in the municipality of Melendugno, where the pipeline's operation control centre is located.

Map 19: Route of the TAP Pipeline

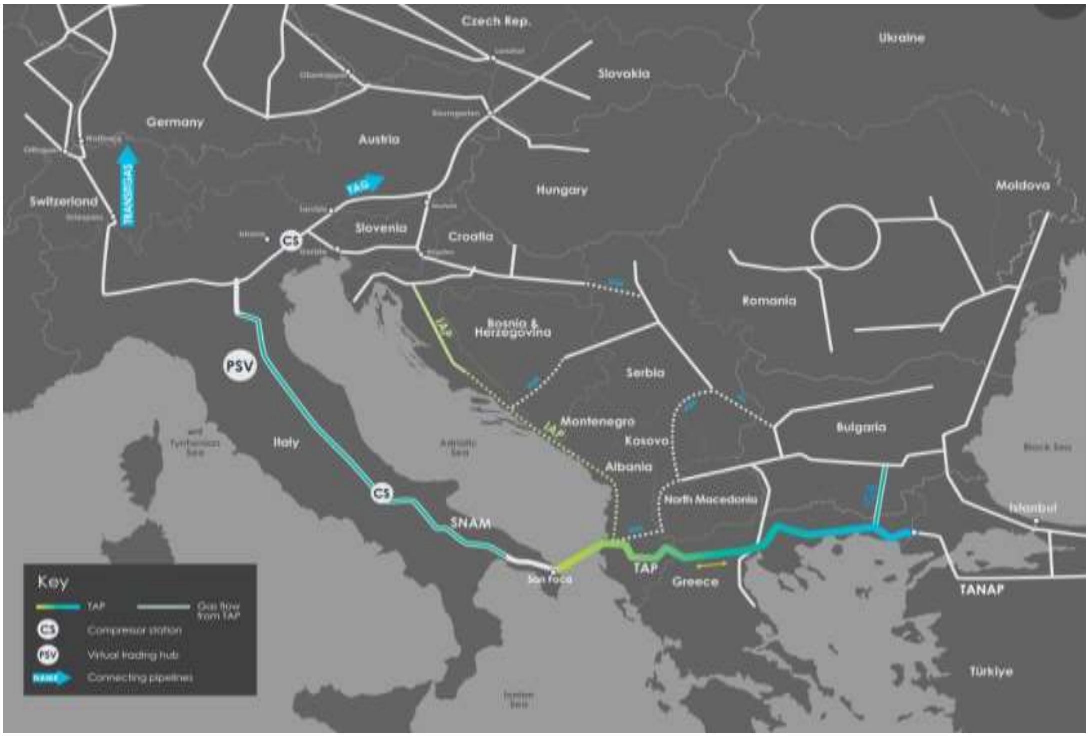
Source: TAP AG

Based on national and international safety and operational standards, TAP operates as a Transmission System Operator (TSO) and an Independent Transmission Operator (ITO), providing transport capacity to companies that want to transport natural gas through the TAP pipeline (shippers) in a safe, reliable and efficient manner.

The Southern Gas Corridor crosses seven countries and with a length of 3,500 km. constitutes one of the most complex natural gas value chains ever developed. With the participation of more than a dozen leading energy companies. The Southern Corridor consists of individual energy projects and specifically, includes:

- the second phase of development of the Shah Deniz field, involving drilling and offshore gas pumping facilities in the Caspian Sea
- the expansion of natural gas processing facilities at the Sangachal terminal on the Azerbaijani coast of the Caspian
- the expansion of the Italian natural gas transmission network
- possibilities for further connection to the natural gas networks of Southeastern, Central and Western Europe
- three pipeline construction projects:
    - South Caucasus Pipeline (SCP) – Azerbaijan, Georgia
    - Trans Anatolian Pipeline (TANAP) – Türkiye
    - Trans Adriatic Pipeline (TAP) – Greece, Albania, Italy

Map 20: Southern Natural Gas Corridor



Source: Trans Adriatic Pipeline

5.2.6.7 Ionian Adriatic Pipeline (IAP)

The IAP (Ionian Adriatic Pipeline) project is based on the idea of connecting the existing Croatian gas transmission system via Montenegro and the Republic of Albania with the TAP gas transmission system (see Map 19). The total length of the gas pipeline from Split to the Albanian Fier is 511 km, the nominal diameter of the gas pipeline is 800 mm and the operating pressure is 85/75 bar and the total capacity is 5 bcma. [62].

The implementation of the entire IAP project foresees the opening of a new energy corridor for the Western Balkans region within the Southern (fourth) Gas Corridor (SGC), with the aim of creating a new gas supply route from the Middle East and the Caspian region. From the Republic of Croatia, it will be possible to supply Central and Eastern Europe with gas from the Southern Corridor. The IAP will have the possibility of bidirectional gas flow, which makes the LNG project on the island of Krk in Croatia of exceptional importance, as it will be a source of natural gas for the IAP [62].

5.2.6.8 Greece - Bulgaria Interconnector Pipeline (IGB)

The construction works of the Greece-Bulgaria Interconnector (IGB) pipeline began in May 2019. On Greek territory, construction began in July 2019, after the issuance by RAAEY of the NGSA License, with Decision 671/27.06.2019, as defined in the Natural Gas Licensing Regulation.

The Greek-Bulgarian interconnector project consists of a pipeline approximately 182 km long, starting in Komotini. The pipeline ends in Stara Zagora, connecting the natural gas networks of Greece and Bulgaria, with the possibility of reverse flow.

The project has been included in the latest list of the 5th list of Projects of Common Interest (PCI) in the energy sector, which was approved on 19.11.2021. The Greek-Bulgarian interconnector is also included in the list of priority projects of the Central and South Eastern Europe Gas Connectivity (CESEC) initiative. Through the IGB, gas transit to the Bulgarian and South Eastern European markets is increasing.

Map 21: The Route of IGB

Source: Euractiv

The ICBG Pipeline Operator pointed out that with the IGB being part of the Southern Gas Corridor thanks to its direct connection to TAP, it will also be of strategic importance to explore the possibilities and further enhance the capacity of the existing infrastructure to enable increased supplies via TAP and TANAP in synergy with the Trans-Balkan Pipeline.

ICGB signed an interconnection agreement with the neighboring Gas Transmission System Operator, DESFA, for the interconnection point located in Komotini. The agreement complies with all applicable regulatory requirements and describes a comprehensive set of terms, conditions and procedures that will govern all operations at the interconnection point. Both Gas Transmission System Operators will ensure the safe, reliable and efficient operation of the interconnection point once it becomes commercially operational. In the monthly capacity auction for October, ICGB offered available capacity of 48,044,459 kWh/day at the interconnection point. The connection has already been successfully tested with quantities of natural gas to ensure safe operation after October 1, 2024. [63].

The Greece-Bulgaria IGB Interconnector is already connected to the Trans-Adriatic Pipeline (TAP) and the Bulgartransgaz gas transmission system. The new interconnection agreement will allow interested parties who have reserved capacity from the FSRU to transport gas via the IGB pipeline, creating a new route for gas deliveries to Southeastern and Central Europe. ICGB intends to put the Komotini DESFA/ICGB interconnection point into operation on 1 October 2024, subject to confirmation from upstream system operators.

The current capacity of the IGB is 3 billion cubic meters per year, with the potential to reach 5 billion cubic meters per year. The Independent Gas System Operator ICGB is already proceeding with the capacity expansion, as a strategic step to ensure access to gas supplies from diversified sources. It is also a vital project within the framework of the Vertical Gas Corridor, which unites the Gas System Operators of the region, including Moldova and Ukraine [63].

5.2.6.9 Vertical Gas Corridor

The first discussions on the creation of the Vertical Gas Corridor began in 2014, through a joint initiative of Greece-Bulgaria-Romania. It should be noted that the first study on the creation of the Vertical Corridor was prepared by IENE in 2015, entitled "The Vertical Corridor from the Aegean to the Baltic" [64]. The project has since been hit by several setbacks, with the 182km Greek-Bulgarian Interconnector (IGB) pipeline, due to open in 2022, seen as a comparatively small but crucial part of the project. The most vocal supporter of the Vertical Corridor is Bulgaria, through Bulgartransgaz. The state-owned company hopes the Corridor will replace the current route for Russian gas to Western Europe via Ukraine and transport gas from alternative supplies from the US, Qatar, Egypt and other countries through Bulgarian territory [65].

At the end of 2022, the signing of a Memorandum of Understanding between Greece, Bulgaria, Romania and Hungary for the construction of the Vertical Gas Corridor was announced.

Furthermore, the gas infrastructure managers participating in the Vertical Corridor initiative proceeded to sign a Memorandum of Understanding for the inclusion of Slovakia, Moldova and Ukraine on the sidelines of the Ministerial Conference of the countries participating in the Central and South-Eastern Europe Connectivity (CESEC) which took place on 18-19 January 2024 in Athens.

The Vertical Gas Corridor, which will cover over 1,000 kilometers, will allow the bidirectional flow of natural gas from the South to the North, aiming to strengthen the security of energy supply of Southeastern and Central Europe. The new infrastructure will interconnect the pipelines of Greece with those to the northern borders of the country and will transport natural gas that will reach Greece either via the pipelines or be delivered to the Hellenic Transmission System (HSTS) via the Revithoussa terminal or Gastrade's new floating storage and regasification unit (FSRU) in Alexandroupolis. From the HSTS, the gas will reach Bulgaria, Romania, North Macedonia, Serbia and further east to Moldova and Ukraine and west to Hungary and Slovakia. Thus, Greece will become a gas transit hub [65].

Map 22: Vertical Gas Corridor

Source: ΔΕΣΦΑ

From Greece, DESFA S.A. (National Gas System Operator) and Gastrade, which will transport liquefied natural gas (LNG) from the floating storage and regasification station FSRU of Alexandroupolis, are participating. From Bulgaria, the ICGB consortium, which manages the Greek-Bulgarian natural gas transmission pipeline IGB and in which the Bulgarian state gas company (BEH) and the DEPA partnership with the Italian Edison participate equally, also participates from Bulgaria, the state gas transmission operator Bulgartransgaz. In addition, the operators from Romania (Transgaz), Hungary (FGSZ), Slovakia (EUStream), Moldova (Vestmoldtransgaz) and Ukraine (GTSOU) are participating [66].

It is worth noting that in January 2015, IENE published the study "The Vertical Corridor: from the Aegean to the Baltic"[20] highlighting the key importance of the Vertical Corridor for the security of the country's energy supply.

[20] https://www.iene.gr/articlefiles/working%20paper%20no%2020.pdf

5.2.6.10 Interconnector Türkiye – Greece – Italy (ITGI) – Poseidon

The Interconnector Türkiye–Greece–Italy (ITGI) is a natural gas pipeline proposed as part of the Southern Gas Corridor. It is proposed to transport natural gas from the Shah Deniz field in Azerbaijan to European markets via Greece and Italy.

The Poseidon Greece–Italy interconnector consists of two sections: (a) the onshore section of approximately 760 km. which starts from the Greek-Turkish border at Kipi and crosses the Regions of Eastern Macedonia and Thrace, Central Macedonia, Western Macedonia, Thessaly and Epirus and ends at the coast of Thesprotia and (b) the underwater section of the project, with a length of approximately 210 km, which connects the Thesprotian coast with Otranto in Italy

The underwater section of the project (Greece - Italy) has been included in the latest list of PCI Projects of October 30, 2019. In the Development Study 2020-2029, prepared by DESFA, the final investment decision will be made after conducting a market test. According to the decision of March 26, 2020, the installation and route of the 8.2 km long onshore section is determined of the Greek section of the pipeline from the Metering and Compression facilities in Thesprotia to the landfall point of the sea route in Epirus.

Map 23: Onshore and Offshore Part of the IGI Pipeline

Source: DEPA

5.2.6.11 Greece – North Macedonia Interconnector (IGNM)

DESFA and the state-owned natural gas transmission company of North Macedonia Nomagas signed a contract, on Wednesday, September 27, 2023, for the supervision of the construction of the Greece-North Macedonia natural gas interconnector (IGNM) in the section of the neighboring country, following the government agreement for the construction of the project signed in March 2021 [67].

The contract concerns the supervision of the construction of the 68 km long natural gas pipeline within the territory of North Macedonia, which will form part of the 123 km long natural gas interconnector between North Macedonia and Greece and is expected to be ready by the end of 2024. DESFA was awarded the contract following an open tender process by Nomagas, in which 4 companies participated. The European Investment Bank, which is to finance the project with a grant of €2.475 million through the Western Balkans Investment Framework, supervised the relevant process [67].

The pipeline will extend from Nea Mesimvria to Negotino via the Evzonon/Gevgelis point, connecting the national natural gas transmission systems of Greece and North Macedonia, managed by DESFA and Nomagas respectively. Its initial capacity will be 1.5 billion cubic meters per year, with the possibility of expansion to 3 billion cubic meters per year, while studies have been carried out to ensure that the pipeline adopts the appropriate specifications for the transport of green hydrogen [67].

This investment, which has been designated as a Project of Mutual Interest by the Energy Community, will significantly enhance North Macedonia's security of supply. The pipeline will allow the neighboring country to further diversify its supply sources and create additional energy corridors, laying the foundations for further integration of the natural gas market in both the Western Balkans region and the EU. At the same time, the project further strengthens Greece's role as the energy gateway of Southeastern Europe, by transporting natural gas from the Greek National Gas Transmission System to North Macedonia and from there to the rest of Europe [67].

According to the DESFA Development Programme 2024 – 2033, the North Macedonia pipeline in the Greek section is expected to be ready in December 2025. It is recalled that in 2023, DESFA and Nomagas (the state-owned natural gas transmission company of North Macedonia) signed a contract to supervise the construction of the project in the section of the neighboring country. DESFA was selected as the contractor for the relevant contract following an open tender process by Nomagas, in which 4 companies participated. The European Investment Bank financed the project with a grant of €2.475 million through the Western Balkans Investment Framework (WBIF), and supervised the relevant process.

The project will further enhance Greece’s role as a gas hub, strengthening the country’s position as an energy crossroads, by transporting gas from the NNGS to North Macedonia and beyond. At the same time, this project promotes the regional development of the gas market and the activation of more users, contributing to the development of the Greek gas hub, which in turn will result in more favorable gas prices in the Greek market. It will also contribute to increasing the level of utilization of Greek infrastructures, such as Revithoussa, with the aim of reducing the System usage fees in the long term.

Map 24: The Route of the IGNM

Source: ENTSOG

5.2.6.12 Turkish Stream Pipeline

The Turkish Stream pipeline is a 930-kilometer-long natural gas pipeline connecting Russia and Türkiye across the Black Sea. Turk Stream, which consists of two parallel undersea pipelines, starts at the Russkaya compressor station located in the coastal Russian city of Anapa. The offshore section of the pipeline extends for 230 kilometers in Russian waters, while the remaining 700 kilometers pass through the Turkish exclusive economic zone of the Black Sea. The pipeline reaches Eastern Thrace and continues onshore for 180 kilometers from the Turkish Black Sea coast to the Turkish-Greece border [68].

Map 25: The Route of the Turkish Stream Pipeline

Gazprom is working on the prospect of upgrading the capacity of the Turkish Stream pipeline in Russia, with the aim of partially compensating for the loss of exports to Europe from 2022. As the Nord Stream and Yamal pipelines are not operating, and at the end of 2024 the transit of Russian gas through Ukraine will also be interrupted, as a result of which from the beginning of 2025 Turkish Stream will be the only available pipeline to transport Russian gas to Europe

5.2.6.13 East Med-Poseidon Pipeline

The EastMed-Poseidon Pipeline is a bidirectional energy interconnector designed to directly connect the energy resources of the Eastern Mediterranean with the European markets, via Cyprus, Greece and Italy, diversifying the sources and routes of supply and providing new price limits for natural gas. The total capacity of the EastMed-Poseidon pipeline is designed to supply quantities to Cyprus, Greece, Italy and other European markets of up to 12 billion cubic meters per year, with the possibility of expansion to a maximum flow of 20 billion cubic meters per year, based on the schedule of availability of the sources [69].

The Project is designed to be fully hydrogen compatible, providing a corridor to the EU for hydrogen produced in Israel, Cyprus and Southeastern Europe, as well as for hydrogen imported from the Middle East and North Africa.

Map 26: The Route of the East Med Pipeline

Source: IGI Poseidon

In 2020, Greece, Cyprus and Israel signed an agreement for the construction of a 2,000 km submarine pipeline to transport natural gas from the eastern Mediterranean to Europe, but the cost and geopolitical tensions have frozen the project.

According to the decision of the three Regulatory Authorities, the cost of the project amounts to €6.039 billion (with an acceptable range of variation of plus or minus 15%) and will be borne exclusively by the implementing body, without any expense for the three countries involved, Greece, Cyprus and Italy, nor transfer to the national natural gas tariffs. The recovery of the cost is planned to be done through regulated tariffs and its financing will be sought to be covered, in addition to equity, by community funds (Connecting Europe Facility) and bank loans.

The project has secured PCI (Project of Common Interest) status. It will include 1,300 km of submarine pipeline to be constructed, as is importantly underlined, within the European waters of Greece and Cyprus, as well as 500 km of underground pipeline from the Peloponnese to Florovouni in Thesprotia, to be connected from there to the Poseidon Pipeline submarine pipeline to Italy.

The implementing body has carried out an initial market test with over 10 companies in the global natural gas market, which demonstrated the potential market interest for the supply, in the period 2027-2047, of 7.2 bcm of gas per year to Italy, 2.7 bcm to Greece and 0.45 bcm to Cyprus.

However, a non-binding expression of interest will follow in 2024 and a binding phase immediately thereafter, for the allocation of transmission capacity products, with transmission agreements, in parallel with the conclusion of natural gas sale and purchase agreements between interested parties active in the European markets and the Eastern Mediterranean.

The pipeline is estimated to be operational in 2028. Specifically, according to the timetable provided, the necessary marine surveys are expected to be carried out in 2024 and the procedures for the commencement of construction of the underground pipeline are expected to begin. The completion of the construction of both the submarine and underground pipelines is scheduled for the first quarter of 2027, with test operation scheduled for the same year, followed by commercial operation in 2028 [70].

The Investment Request was accompanied by three critical studies: cost-benefit (CBA), cross-border cost allocation (CBCA) and basic advanced design (FEED). As it turns out, among other things, the benefit from fuel substitution is estimated at €1.665 billion, of which €514 million concern Greece and the rest in Cyprus.

5.2.6.14 Western Macedonia Pipeline

An emblematic project for the delignitization of Western Macedonia is the Western Macedonia pipeline. With a length of approximately 160 kilometers, the new pipeline will offer significant benefits to 9 Municipalities of Central and Western Macedonia, creating infrastructure for their development and economic viability. The project has a length of 157 km and a budget of €163 million and will ensure the smooth transition of the Regions of

Central and Western Macedonia, providing access to natural gas to a multitude of new areas and users.

In detail, it consists of 157 km of high-pressure natural gas pipeline of which the [71]:

- 93.4 km/30" HP pipeline starting from the area of the existing valve station in Trikala, Imathia and will end north of Ptolemaida (new Komnina valve station)
- 29.8 km/14" HP pipeline branch for the connection with the Kardias M/P
- 3.4 km/10'' HP pipeline branch for the connection with the Aspros Skydras M/P
- 9.1 km/10'' HP pipeline branch for the connection with the Perdikas Eordeas M/P
- 21.3 km/10" HP pipeline branch for the supply of the Veria/Naoussa areas including all the required accompanying facilities and valves for the proper operation of the project, as well as provisions for future expansions.

Regarding the route, the pipeline and its branches will cross the Regions of Central (Prefectures of Imathia, Pella) and Western Macedonia (Prefectures of Kozani, Florina), starting from Trikala, Imathia and ending in the Heart of Kozani, making it possible to supply natural gas to new areas and ensuring the potential access of new users (industrial, craft, agricultural & domestic consumption) to the wider region. The pipeline will be 100% compatible with the transport of hydrogen and will fully support the movement of renewable gases. In this context, it will constitute an important infrastructure that will support the investment projects that are being promoted so that Western Macedonia remains one of the most important energy centers in the country, even after the "extinguishment" of the lignite units, now with the production of RES and "green" hydrogen.

5.2.6.15 Remote Natural Gas Distribution Networks/Compressed Natural Gas (CNG)

The Government Gazette B' 3334/10.08.2018 approved the Framework for the Development of Remote Distribution Networks Using Compressed/Liquefied Natural Gas, which provides for the possibility of Distribution Network Operators to develop virtual CNG/LNG pipelines. In implementation of this Decision, Government Gazette B' 4298/27.09.2018 was issued with the terms and criteria for the tender for Virtual Pipeline services with CNG, a decision which was amended by Government Gazette B' 2945/16.07.2019.

With the Government Gazette B' 5661/17.12.2018, the technical specifications of competent bodies, terms and conditions for the establishment and operation of stations with the installation of compressed natural gas (CNG) supply devices in wheeled vehicles were determined.

Subsequently, with the Government Gazette B' 4271/16.09.2021, the Framework for the Development of Remote Distribution Networks Using Compressed/Liquefied Natural Gas was amended, in order, among other things, to expand the concept of the Virtual Pipeline with the adoption of the Virtual Interconnection, i.e. the supply of a Remote Distribution Network from other distribution or transmission networks [72].

CNG (Compressed Natural Gas) is the solution for supplying natural gas to consumers remote from natural gas networks (as is LNG - Liquefied Natural Gas). CNG functions as a precursor to natural gas networks or as a replacement for them, in case they cannot be developed.

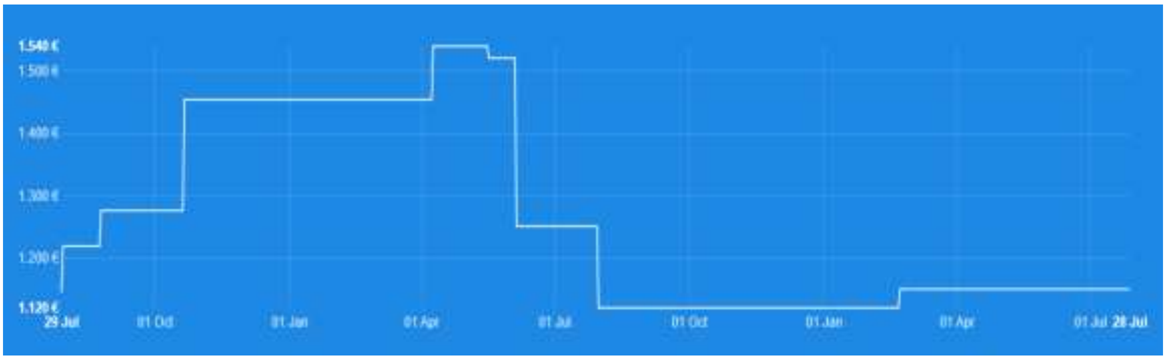
By 2023, 32 CNG vehicle refueling stations had been put into operation, as shown in the following map [73].

Map 27: CNG Station Network

Source: Eurogas

According to CNG Europe, natural gas is on average 40-60% cheaper than oil or gasoline, depending on the domestic markets. Figure 76 shows the evolution of compressed natural gas prices in Greece from July 2022 to July 2024, where prices are decreasing with a tendency to stabilize [74].

Figure 76: CNG Prices in Greece €/kg, 31/07/2023 – 28/07/2024



Source: Fuelo

IENE completed in November 2021 a special study "Cost-Benefit Study for the Expansion of the Natural Gas Transmission Network in Western Greece (Region of Epirus and Region of Western Greece)" [75], commissioned by RAAEY, which focused on investigating the feasibility of expanding the national natural gas transmission system to Western Greece, focusing on the Regions of Epirus and Western Greece, versus supplying the region via LNG or CNG trucks.

This specific study is of great importance, because natural gas, as a bridge fuel, will support Greece's energy transition to a zero-emission economy, while the existing transmission networks that are expected to be expanded will be able to distribute gaseous fuels from RES, such as biomethane and hydrogen. Therefore, these are infrastructures that will be the means for the further penetration of new, environmentally friendly sources into the Greek energy system.

This study reached certain key conclusions, such as that the transport of natural gas either by pipelines or by tankers and/or ships (LNG) presents advantages, but also disadvantages. Undoubtedly, the best option is to combine the methods, so as to outweigh the advantages of both and to address any obstacles and/or disadvantages of one or the other solution.

Regarding the technological criteria, various challenges are posed, such as how to build an LNG facility and a regasification station within or near the cities, etc. However, it is worth mentioning that such good practices exist and are already being implemented in Europe, while no significant and structural changes are expected in the LNG supply systems in the coming years. The continuous and effective training of the personnel who will operate the facilities in the cities of the two Regions is considered of paramount importance for their safe and efficient operation.

A key role in the progress of such an investment is played by the increasing or not prices of fuels and in particular LNG, but also of natural gas sold to the end consumer. At the same time, other important parameters that were taken into account are the economic situation of the country, the long-term prospects of the economy and trade, the annual growth rate, the level of energy prices in developed and developing markets, since these determine fuel consumption by the end consumer and help in the development of trade and the economy in general, etc.

5.2.6.16 Small Scale LNG Applications / Shipping

DESFA is promoting the penetration of natural gas into new areas of the country by developing small-scale LNG infrastructure. Specifically, the project of the LNG Storage and Regasification Station facilities developed by DESFA for the supply of the Central and Western Macedonia region has been completed. The new Station, which constitutes the first regional LNG storage and regasification station for the supply of a local natural gas network in Greece, was inaugurated by DESFA on Friday, July 12, in Aspro, Skydras.

With the start of operation of the new Station, a number of new areas and users in the wider region of Central and Western Macedonia will gain access to natural gas [76].

The Aspros LNG Station developed by DESFA provides another reliable and sustainable energy option to a number of new areas and users in the wider region of Central and Western Macedonia, contributing to the fight against energy isolation and strengthening the competitiveness of the local industry. Among the first users benefiting from the new facility are the canned fruit and vegetable company "Kronos", the canning industry DANAIS S.A., the General Hospital of Edessa, and the Distribution Stations for the low-pressure networks of the cities of Skydra and Edessa. The operator of the natural gas distribution network in these cities is the company Hengas.

The LNG Station will benefit the region until the Western Macedonia Pipeline, DESFA's flagship project that will ensure the smooth transition of the Central and Western Macedonia Regions to the post-lignite era, is put into operation, providing access initially to natural gas and then to hydrogen and other renewable gases. This type of installation is reusable and can be transferred to other areas that do not yet have access to the natural gas network.

The new infrastructure adds a new important link to the value chain of Small Scale LNG infrastructures that DESFA is developing. Recently, the LNG Truck Loading Station in Revithoussa, the first such facility in Southeastern Europe, completed 104 LNG Truck Loadings since the start of its commercial operation in November 2023, safely supplying remote users and industrial facilities in Greece and the wider region with over 4,675.00 m^3 of LNG or 30,139 MWh of equivalent energy. [76].

The Aspros LNG storage and regasification facility is the first in a series of similar facilities planned to be implemented in the near future by DESFA, according to the company's Ten-Year Development Plan 2023-2032.

5.2.6.17 Combined Cycle Units with Natural Gas Fuel

GEK TERNA Group together with Motor Oil Group is developing a new 877 MW gas-fired power plant in Komotini, an investment of €375 million. Komotini Thermal Power Plant, a company in which Motor Oil Renewable Energy (MORE) and GEK TERNA jointly participate with a 50% stake, has assigned the construction of the Plant to TERNA S.A. [77].

In August 2024, for the first time, natural gas was used in the new 877MW Komotini Thermal Power Plant, developed by GEK TERNA and the Motor Oil Hellas group. Specifically, a very small amount of 587 KWh was supplied to the new unit, according to DESFA data, which however marks the start of the trial operation of the new natural gas plant, which is coming to add to the country's electricity generation potential [78].

The new combined cycle unit with natural gas fuel is being built in the industrial area of Komotini on a privately owned plot of land of 181 acres with an installed capacity of 840 MW and an annual production of 5 TWh. Natural gas will be used as fuel, however the new production station will have the ability to burn hydrogen as well as mixed operation, which makes it compatible and fully supportive of the national and European plan for the gradual transition to green energy [79].

The heart of the new plant is the Siemens HL-class gas turbine, SGT5-9000HL. This technology is expected to reduce CO2 emissions by up to 3.7 million tons per year compared to a coal-fired power plant, with efficiency levels reaching even more than 64% [79].

In addition, the new unit includes, among others [78]:

- A Siemens Generator producing electricity with a capacity of 715MVA
- A Vertical Exhaust Gas Heat Recovery Exchanger, producing steam with 3 pressure stages (high, medium and low)
- A Siemens Steam Turbine with a capacity of approximately 289 MW, with 3 pressure stages (high, medium and low)
- A Siemens Generator producing electricity with a capacity of 350MVA
- Steam-electric cycle management system
- Siemens central plant control system
- Three-winding 400KV/18.5KV/20KV lifting M/S for the interconnection of the gas turbine and steam turbine generators with the 400KV CHP, with a capacity of approximately 1100MVA

- 6-gate 400KV CHP
- Tanks for drinking water and deionized water production
- Building facilities for the installation of equipment, operation and administration of the station as well as for the storage of materials and equipment

The new combined cycle gas turbine power plant fueled by natural gas is a vital project for the development of the region, as well as for the energy security of the country. The new unit will meet the increased needs for electricity in our country, which will be created due to the gradual withdrawal of lignite-fired power plants.

Taking into account the geographical location of the plant in the northern part of the country and therefore close to the interconnection points of the Greek Electricity Transmission System with neighboring interconnected countries, such as Türkiye, Bulgaria and North Macedonia to the west, the plant acquires additional strategic importance for the national high-voltage transmission system. It is also worth noting that the Komotini Thermal Power Plant is the second natural gas-fired power plant to be built in recent years, after the unit built by Mytilineos in Viotia.

5.3 Electricity

In Greece, the electricity market operates on the basis of the European Target Model, which is based on the Framework Guidelines issued by ACER and the Network Codes issued by the European Network of Transmission System Operators for Electricity (ENTSO-E) and approved by the European Commission, with the aim of having harmonised rules for cross-border exchanges of electricity and for the operation of wholesale electricity markets [80].

In Greece, the Target Model was completed with the launch of the Hellenic Energy Exchange on 1 November 2020. Greece was the last EU Member State to adopt the European Target Model in the wholesale electricity market, based on the 3rd Energy Package of measures (in force in July 2009). The integration of the 3rd Energy Package into the national legislative framework was carried out by Law 4001/2011, which concerns the Operation of Electricity and Natural Gas Energy Markets.

The basic infrastructure for the implementation of the European model is the interconnected European electricity network, a truly great European achievement, which allows electricity transactions in neighboring countries. The Greek System operates with 400 kV interconnection lines with the systems of Albania, Bulgaria, North Macedonia, Türkiye and Italy and IPTO, the operator of the national grid, has initiated significant expansions.

The formation of the single European electricity market aims to increase competition and market liquidity, resulting in a reduction in prices at European level, thus limiting the total cost of energy for end consumers. Infrastructure projects and interconnections also play an important role in this direction, aiming at the unrestricted flow of electricity from areas with low prices to areas with higher prices, thus contributing to the reduction of energy costs through price convergence [81].

However, with the introduction of the target model in the electricity market, its implementation did not bring the expected price reduction. However, at the 28th Annual National Conference "Energy & Development 2024" organized by IENE on November 6 and 7, 2024 in Athens, the CEO of HENEX argued that Greece has always been a more expensive wholesale market and that the Target Model is not responsible for energy accuracy. He also said that before 2021, when the Target Model was adopted, the gap with wholesale prices in Germany was 70%, while now it has decreased below 30%. He argued, finally, that Greece is wrongly considered a stock exchange market in electricity, since only 5% of electricity quantities are traded in the day-ahead market [82].

Other analysts argue that the implementation of the European model is characterized by three basic and asymmetrical choices:

- the great freedoms of movement of producers,
- the strong central control from Brussels and the difficulty in the adoption of corrective changes,
- the trust in the competitive functioning and self-regulation of the market and the absence of control mechanisms.

Despite the strictly legal transformation of the market, aligned with the European model, the structural characteristics of the Greek market were not taken into account, such as limited interconnections with other countries, areas with saturated transmission networks and insufficient competition.

Another rule of the European Model that leads to distortions in the energy market is the regulation of the day-ahead price at the marginal cost, i.e. at the level of the last accepted bid, for all those who offered, who are thus paid at a level above their bid. And the same applies to the Balancing Market.

In order to correct the above distortions, RAAEY issued a Ministerial Decision for the establishment of a Temporary Mechanism for the Return of Part of the Revenues of the Day-Ahead Market, which was implemented from July 2022 to June 1, 2023.

This mechanism provided for a methodology and a mathematical formula for the calculation on a monthly basis of the administratively determined unit price for each category of production units and for the RES portfolios and the return of part of the revenues of the Day-Ahead Market and the Intraday Market of electricity.

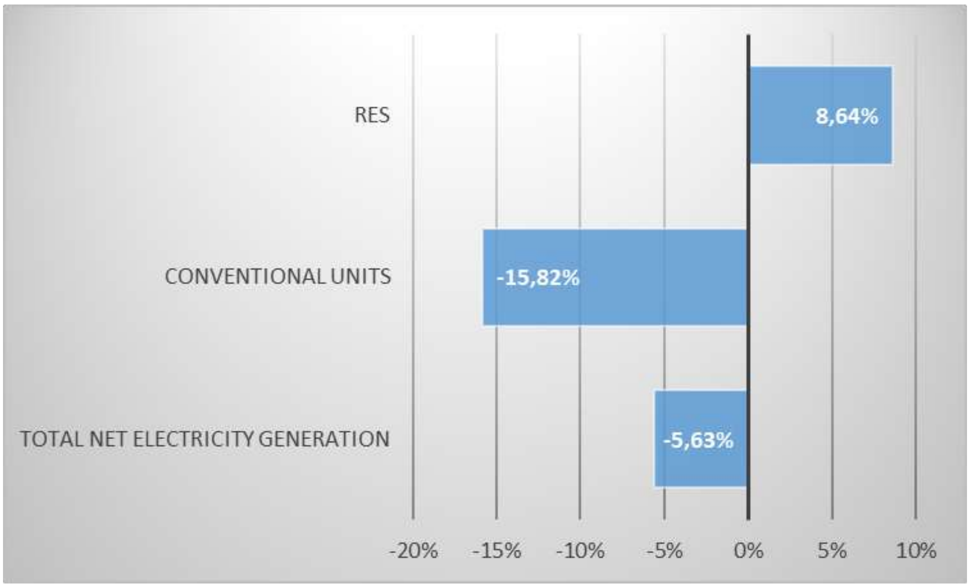
5.3.1 Supply and Demand

Domestic lignite has historically played a significant role in Greek electricity production and covered 20% of total electricity demand in the interconnected sector in 2019, while in 2023 their share fell to 10%. Their dominance has decreased in the last decade due to the decrease in electricity consumption and the increasing penetration of RES in electricity generation, mainly wind and solar energy.

Electricity generation

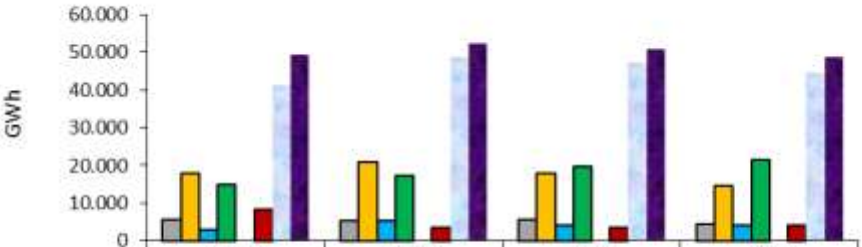
According to the monthly Energy Bulletin of IPTO [83], in 2023, Greece produced 44.6 TWh of electricity, a decrease of -5.63% compared to 2022. RES were the largest energy source in terms of domestic electricity generation with 21.4 TWh in 2023 and a share in the domestic mix of 43.8%, surpassing natural gas, which followed with 14.6 TWh and a share of 30.0%. Notable is the contraction of the contribution of lignite to electricity generation in the last three years, from 5.7 TWh in 2020 to 4.5 TWh in 2023 (Figures 77-79). For the period January 2023 - December 2023, the electricity balance reached 48,798 GWh, a decrease of -3.9% compared to 2022 [83].

Figure 77: Change in Net Electricity Production (GWh) 2023/2022



Source: IPTO

Figure 78: Electricity Generation by Source, 2020-2023

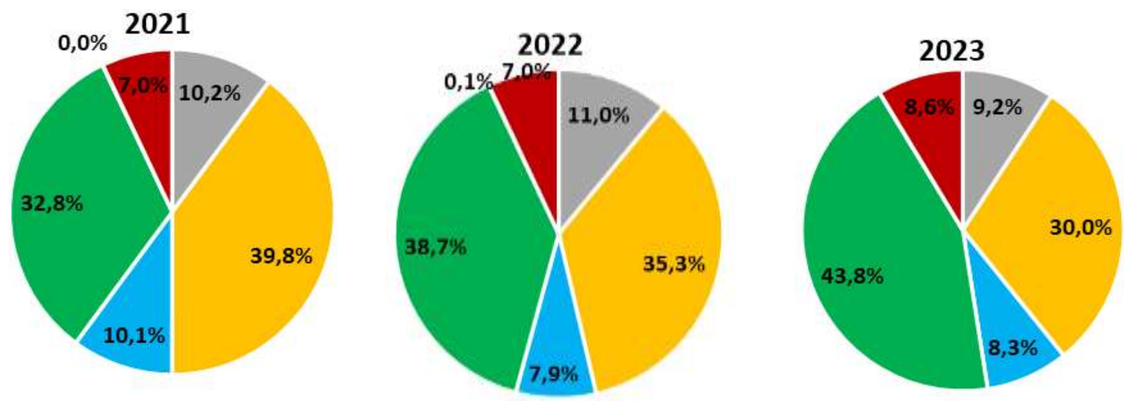


	2020	2021	2022	2023
Lignite	5.722	5.341	5.586	4.513
Gas	17.815	20.873	17.949	14.631
Hydro	2.901	5.294	4.005	4.047
RES	14.800	17.193	19.674	21.373
Other	5,9	20,3	26,9	15,5
Net Imports	8.207	3.683	3.553	4.218
Net Generation	41.243	48.721	47.240	44.580
Total Electricity (Production + Net Imports)	49.450	52.404	50.793	48.798

Source: IPTO

The contribution of the various sources to electricity production has varied over the last three years, as shown in the Charts below. In 2023, RES dominated the mix with a percentage of 43.8%, displacing natural gas in second place with a percentage of 30.0%. There is also a decrease in electricity production from hydroelectric plants compared to 2021 as well as a decrease in production from lignite and net imports decreased by 1.8 percentage points compared to 2021.

Figure 79: Fuel Share in Electricity Production, 2021, 2022 and 2023

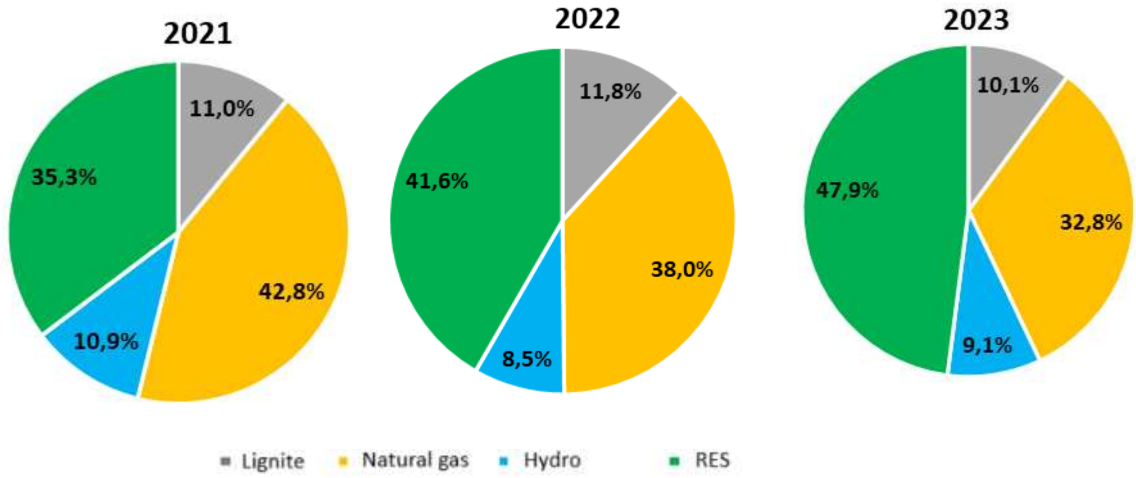


Source: IPTO

Regarding the share of various forms of energy in clean electricity generation in 2023, a decrease in the percentage of natural gas is observed by 10% compared to 2021, falling to 32.8%, while the penetration of RES accelerated from 35.3% in 2021 to 47.9% in 2023.

Furthermore, lignite reduced its percentage in the electricity generation mix by 1.7%, reaching 10.1% in 2023.

Figure 80: Fuel Share in Net Electricity Production, 2021, 2022 and 2023

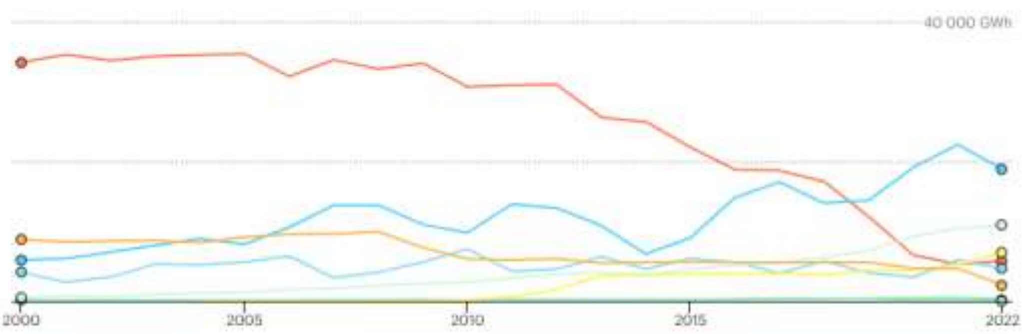


Source: IPTO

According to IPTO data, 2022 was a milestone as it reversed the picture of previous years, where the largest share in net electricity generation was contributed by natural gas and previously by lignite. This trend continued in 2023 with RES leading the electricity mix, with a share of 47.9% and production of 21.4 TWh.

Cumulatively, in 2023, the share of RES and hydroelectric power plants reached 57.0% in total, exceeding the sum of the participation of all fossil fuels, which amounted to 42.1%, which makes most kilowatt-hours produced in 2023 "green". Electricity production from RES remained at high levels during the first half of 2024. Specifically, according to IPTO data for electricity production between January and June, RES (wind, photovoltaic and hydroelectric) covered 58.1% of electricity production, while the rest was covered by natural gas units with a percentage of 35.6% and lignite with a percentage of 6.2%. This performance is close to the levels of 2023, when RES accounted for 57.0% of production, despite the fact that dozens of megawatts of new RES, mainly photovoltaics, have been added to the country's production capacity in the meantime. Sources from the renewable energy sector attribute the development to the fact that the increase in production capacity is not accompanied by a corresponding increase in electricity demand, especially during the hours when RES production is maximized. Thus, network operators proceeded to cut RES production for reasons of system stability.

Figure 81: Evolution of Electricity Production by Source in Greece GWh, 2000-2022

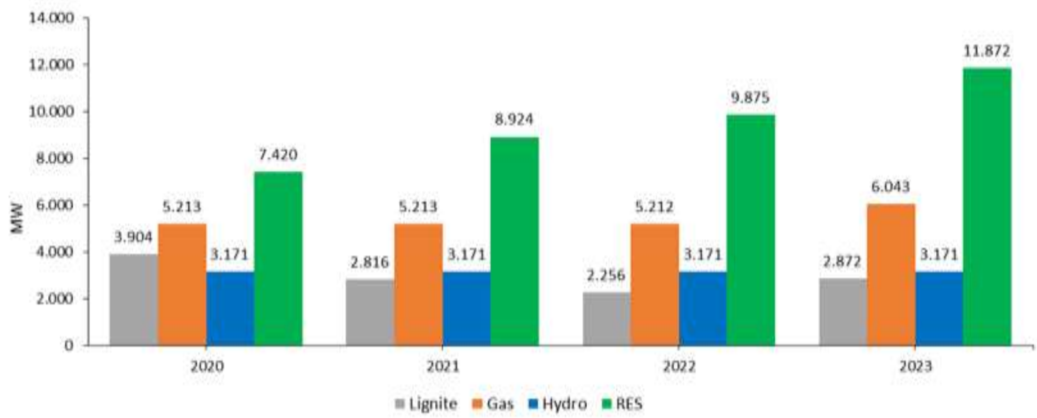


Source: IEA

Installed Capacity

In 2023, the total installed capacity of the units in the interconnected system of Greece reached 23,958 MW, marking an increase of 16.7% from 2022 levels (20,514 MW). According to a December 2023 DAPEEP Bulletin [84], RES recorded the largest increase in domestic installed capacity in the interconnected system in 2023 compared to 2022, highlighting a new installed capacity of 1,997 MW and a total installed capacity of 11.9 GW. Similarly, natural gas and lignite plants showed an increase in installed capacity by 15.9% and 17.3% respectively.

Figure 82: Total Installed Capacity of Units per Fuel, 2020-2023



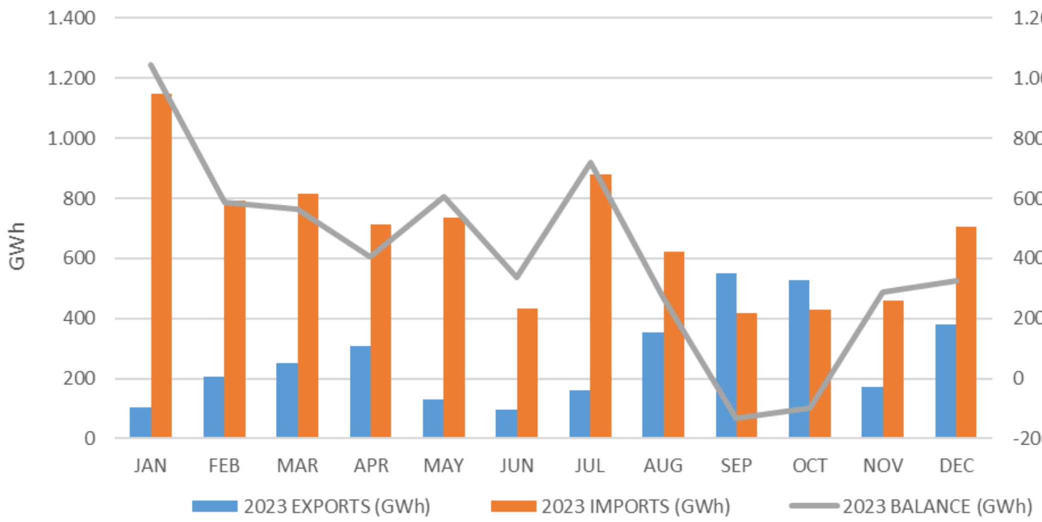
Sources: IPTO, DAPEEP

Electricity Imports and Exports

Greece is interconnected with neighboring countries and, in addition to domestic electricity production, is increasingly active in electricity trade. According to the Ten-Year Development Plan of IPTO 2024-2033 [85], the Greek interconnected electricity system, with the completion of the 2nd Greece-Bulgaria interconnection line that was put into operation in June 2023 and the completion of interconnection projects in neighboring countries by the end of 2023, meets the 15% target and before 2025, i.e. earlier than the target year of 2030 with the full utilization of these interconnections. For the year 2030, the interconnection rate is 16.8%.

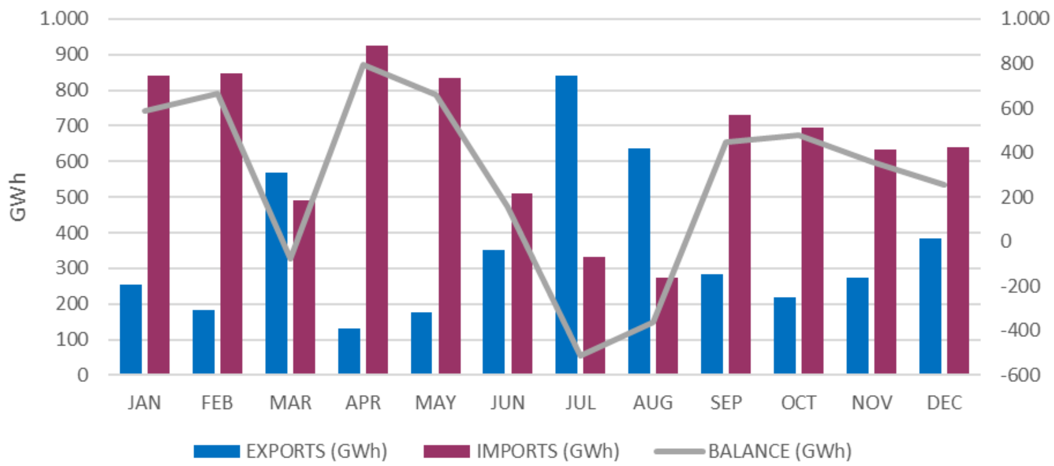
Natural flow electricity imports in Greece (Figures 83 and 84) amounted to 9.2 TWh in 2023, increased by 5.2% compared to 2022, mainly from Bulgaria, Albania and North Macedonia. Correspondingly, electricity exports from Greece in 2023 amounted to 3.24 TWh, down 32.8% compared to 2022, mainly to Italy, Albania and North Macedonia. Greece was a net importer of electricity for all months of 2023, except for September and October. [83]

Figure 83: Evolution of Electricity Flows, 2023



Source: IPTO

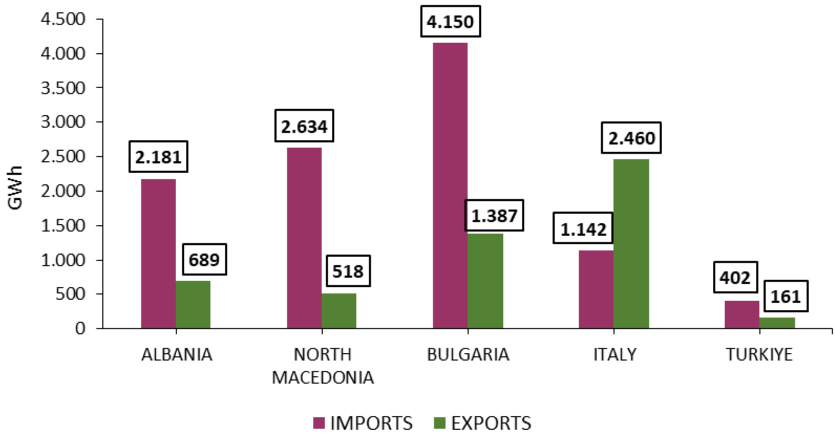
Figure 84: Evolution of Electricity Flows, 2022



Source: IPTO

Regarding commercial import-export programmes, Bulgaria was the country from which Greece received the largest amount of electricity in 2023 (4,150 GWh), while the largest amount was exported to Italy (2,460 GWh).

Figure 85: Commercial Electricity Import-Export Programmes per Interconnection of Greece in 2023 (GWh)



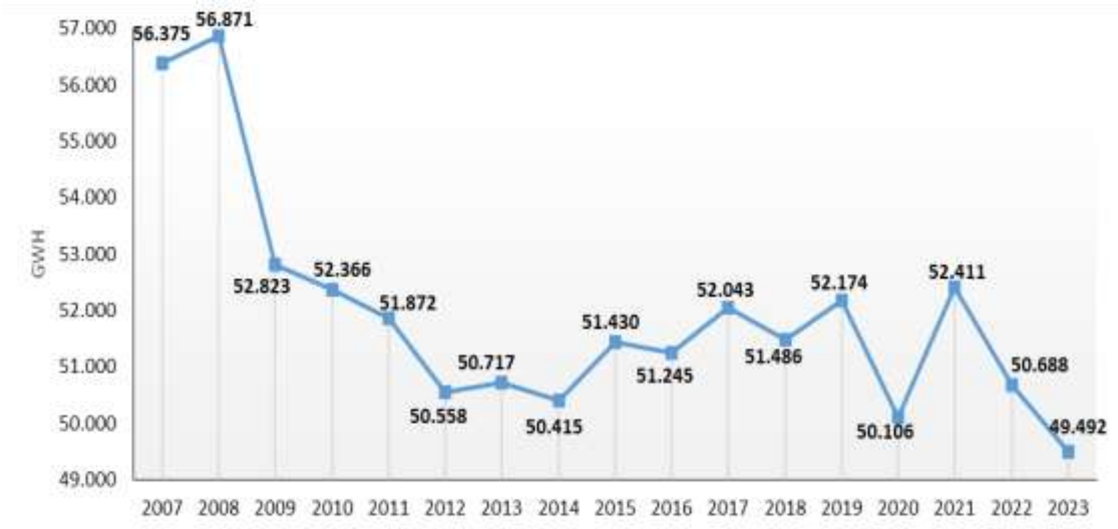
Source: IPTO

The Greek market remained import-oriented in 2023, but the conditions that developed in the first quarter of 2024 led to a significant reduction in the deficit in the balance while there were periods during which Greece was an energy exporter. The increase in the RES production base combined with favorable weather conditions and stagnant demand were the main reasons that led to the increase in exports. In the long term, the expansion of cross-border interconnections and the addition of storage units may make Greece an energy exporter for the wider region and for Central Europe.

Electricity Demand

According to data from IPTO, electricity demand in Greece increased steadily until its peak of 56.9 TWh in 2008, followed by a six-year period of decline from 2009 to 2014, as a consequence of the economic crisis. In 2020, electricity demand showed a significant decrease of 4.0% compared to 2019 mainly due to the COVID-19 pandemic and the restrictive measures implemented. In 2021, demand recovered and Greece consumed 52.4 TWh of electricity, while in 2022 and 2023 a downward trend is observed mainly due to mild weather conditions that limited heating needs in winter and cooling needs in summer (Figure 86) [83].

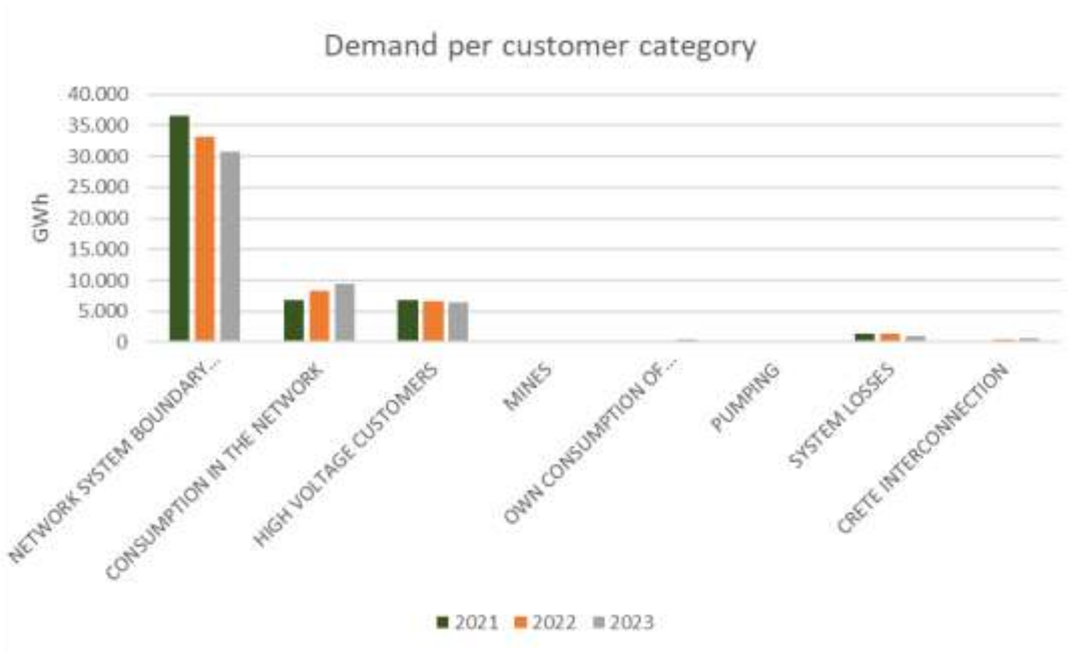
Figure 86: Evolution of Electricity Demand in Greece, 2007-2023 (GWh)



Source: IPTO

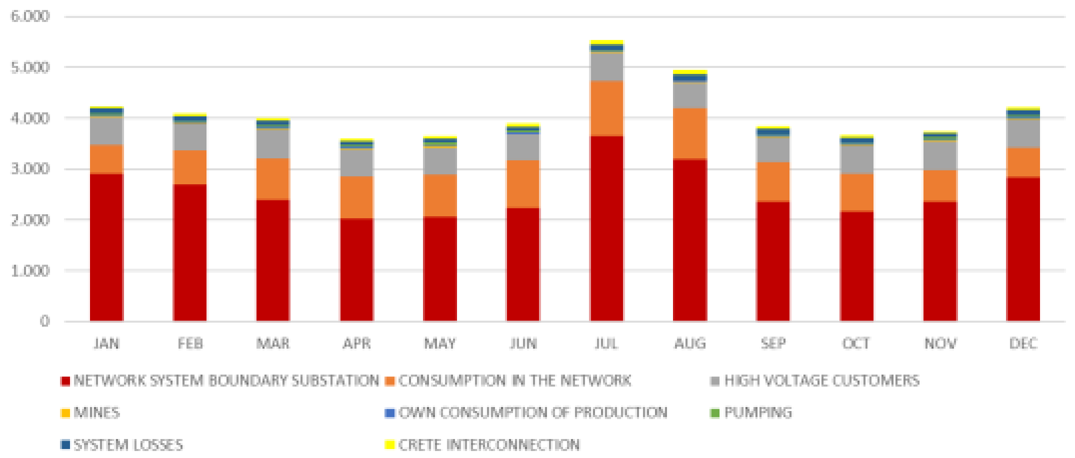
As can be seen from Figures 87 and 88, electricity consumption in the system was decreasing from 2021 to 2023, while the opposite trend was observed for consumption in the network. As for December 2023, in absolute numbers, the largest decrease was recorded in the distribution network, which means that consumption by households and small and medium-sized enterprises decreased. An important factor is the reduction in energy costs, which in the case of household consumers was assisted by the relatively high temperatures that prevailed in November and December 2023.

Figure 87: Electricity Demand by Customer Category (GWh), 2021- 2023



Source: IPTO

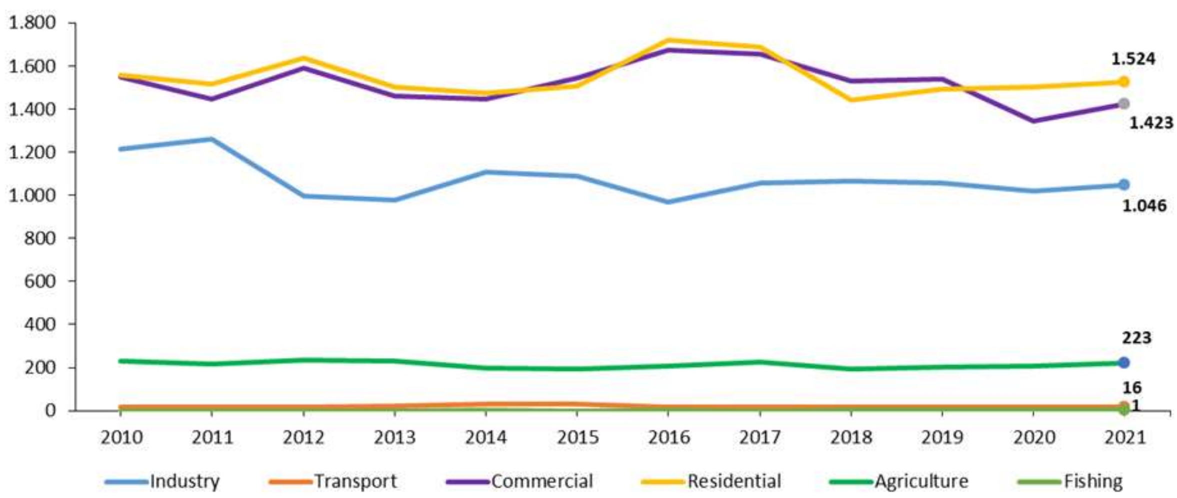
Figure 88: Electricity Demand by Customer Category (GWh) and per Month, 2023



Source: IPTO

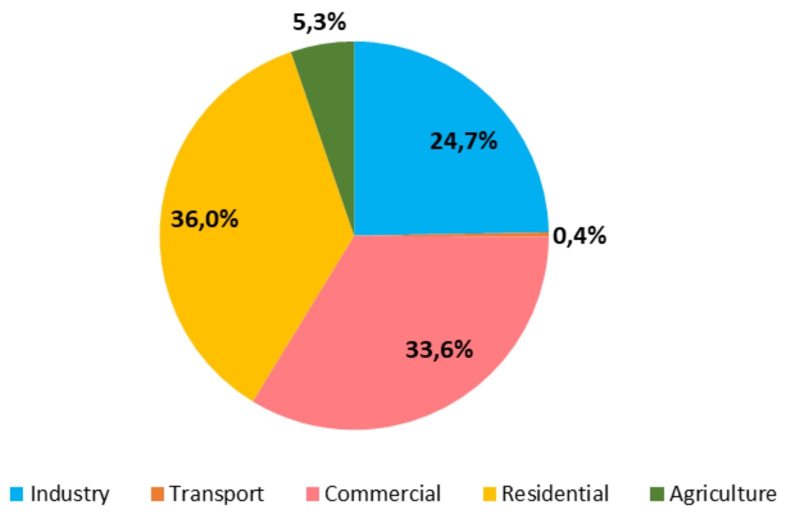
According to Eurostat data, the commercial and public sector was the sector that consumed the most electricity, accounting for 35.8% of total final electricity consumption in 2022 (Figure 89). This was followed by the residential sector with 34.5% and the industrial sector with 24.7%. Other sectors, such as transport and agriculture, accounted for only a small share of total final electricity consumption.

Figure 89: Final Electricity Consumption in Greece by Sector, 2010-2022 (thousand tons)



Source: Eurostat

Figure 90: Percentage Distribution of Sectors in the Final Electricity Consumption, 2022



Source: Eurostat

5.3.2 The Structure of the Electricity Market

The current model of the Greek electricity market fully complies with the European **Target Model**. The liberalization of the domestic electricity market aims to improve the conditions of competition and to create a stable and predictable market model, with incentives for the entry of new participants into the market as well as attracting new investments and primarily for the benefit of the Greek consumer and the national economy. The reform of the country's wholesale electricity market, with the introduction from 1 November 2020 of the markets provided for by the European Target Model, was a pivotal point for the development and future of the Greek energy market in general. Participants in the domestic wholesale electricity market now have all the possibilities to operate in accordance with the basic principles of the European Target Model. Among these possibilities are the possibility of concluding bilateral contracts between producers and suppliers, the possibility of correcting their positions even on an intraday horizon, the introduction of risk management tools and the creation of reliable economic signals for necessary investments.

Law 4512/2018 and specifically Part C “Energy Exchange” defined the following markets:

- **Forward Market:** This market allows participants to enter into electricity purchase and sale contracts, with an obligation of physical delivery, as defined in the relevant market code, and to trade energy financial instruments.
- **Day Ahead Market:** This market allows participants to submit orders for electricity transactions with an obligation to physically deliver the next day. The day-ahead market also reports the quantities of energy that have been committed through transactions on forward products, which have been carried out either through the wholesale forward

market or outside it. At the same time, an implicit allocation of transmission capacity will be carried out on the interconnections, through the coupling of the day-ahead markets of European countries.

- **Intra Day Market**: This market allows participants to submit trading orders for physical delivery on the physical delivery settlement day, after the deadline for submitting trading orders in the day-ahead market, taking into account the quantities of energy that have been committed through transactions on electricity futures products that they have carried out, the results of the day-ahead market, as well as any restrictions that have arisen from the balancing market. Participants may trade in order to minimize the deviation of their net position resulting from transactions in all markets from the quantities sold/purchased in real time.
- **Balancing Market**: The balancing market includes the balancing capacity market, the balancing energy market, as well as the imbalance settlement process. Participants are obliged to submit bids with a physical delivery obligation for all of their available capacity, both in the balancing energy market and the balancing capacity market.

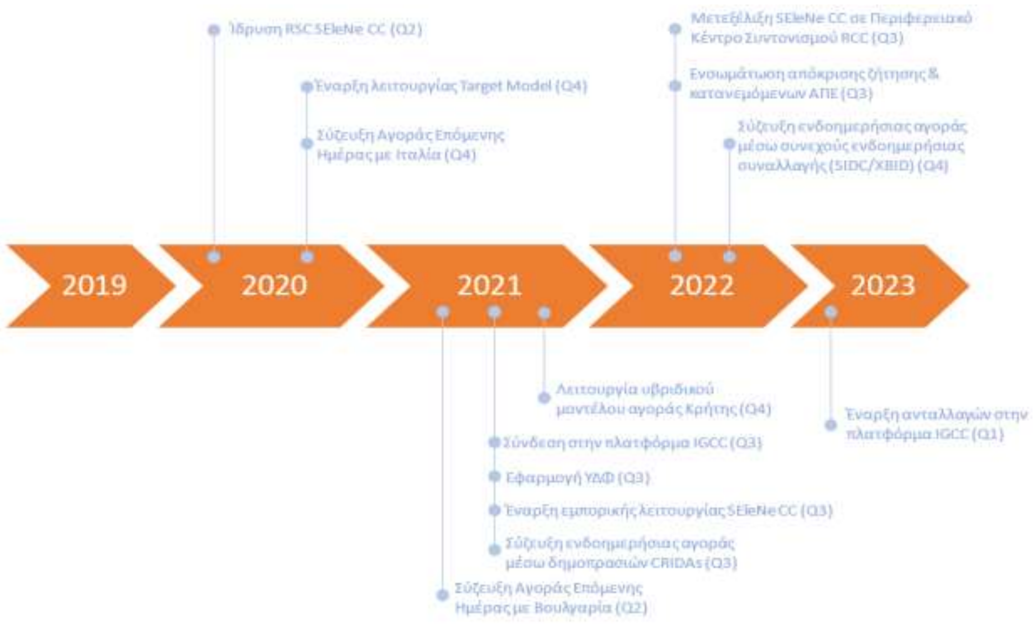
The operation of the first three markets has been assigned to the Hellenic Energy Exchange, while the Balancing Market is the exclusive responsibility of IPTO [86].

Figure 91: Energy Markets Based on Target Model

Figure 92: Greek Electricity Market

By adopting the “Target Model”, Greece has achieved a significant shift in the energy sector in certain periods. The country has become a net exporter of electricity in periods such as the summer months with significant RES penetration. This development means that more energy is produced than is consumed, with positive effects on the country’s energy independence and trade balance. [48]

Figure 93: Evolution of Greece’s Target Model



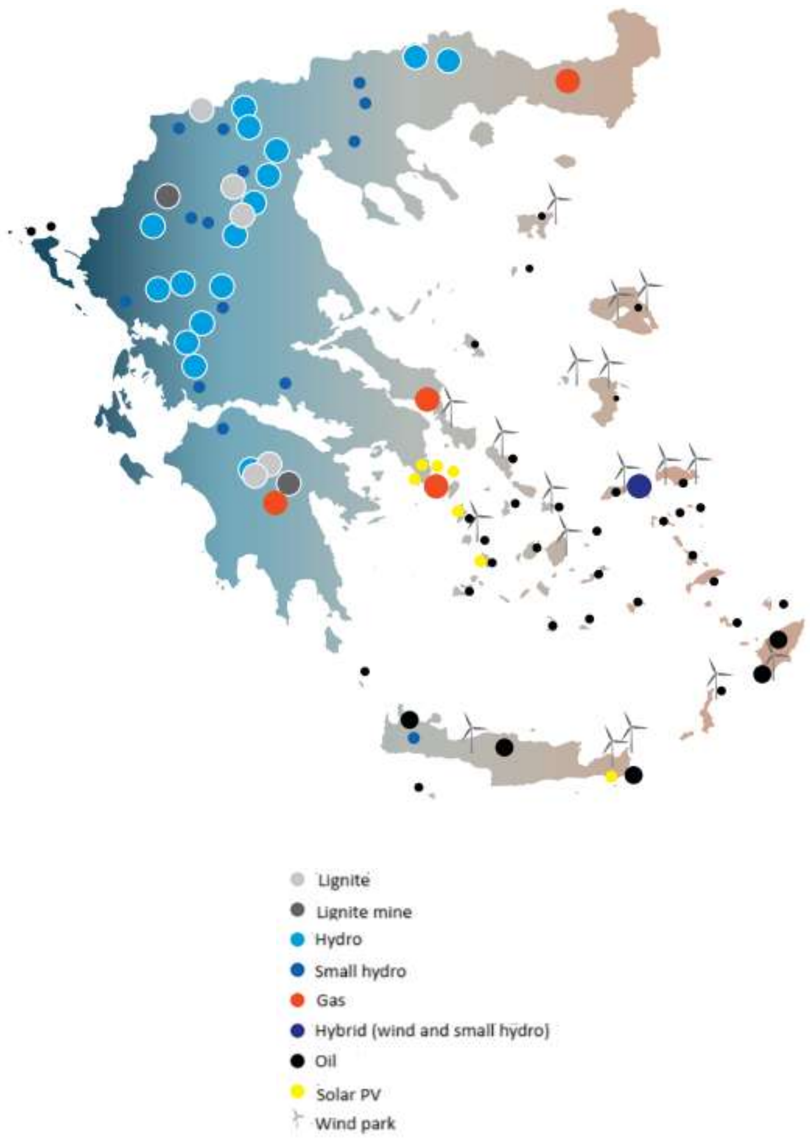
Source: MoEE

Wholesale Market

PPC dominated the Greek electricity market in 2023, with a 56% share of electricity supply, serving approximately 5.6 million customers. The installed capacity of power plants amounted to 10.1 GW in 2023, of which 4 GW were from RES plants. In 2023, PPC generated 19.3 TWh, with the electricity generated coming from natural gas (33%), RES (25%), lignite (23%) and oil (19%) and with a 39% share of electricity production in Greece [87].

PPC's energy mix includes lignite, hydroelectric and oil stations, as well as natural gas stations, as well as RES installations. It also owns the Electricity Distribution Network (Medium & Low Voltage, approximately 246,000 kilometers long and High Voltage, approximately 1,000 kilometers long), whose Operator is its 100% subsidiary, DEDDIE S.A.

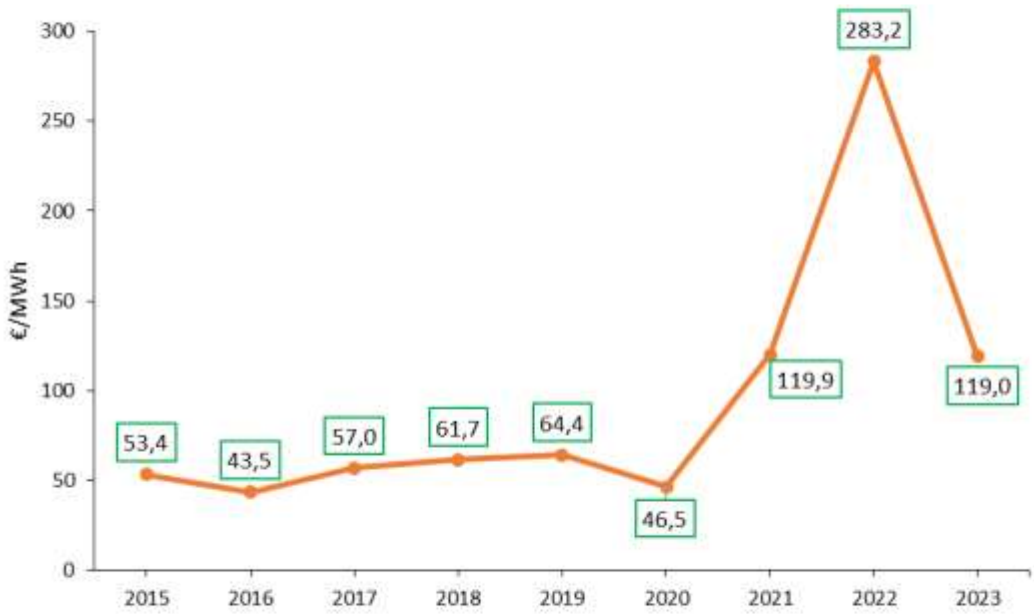
Map 28: PPC's Portfolio of Units in Greece



Source: PPC

Regarding electricity prices in the wholesale market, according to IPTO, prices in the day-ahead and intraday markets fell from 283.3 €/MWh in 2022 to 119.01 €/MWh [88]. Figure 94 shows the evolution of prices: after rising prices in 2021 and skyrocketing in 2022, prices fell in 2023, but remained at high levels compared to prices in the period 2015-2020.

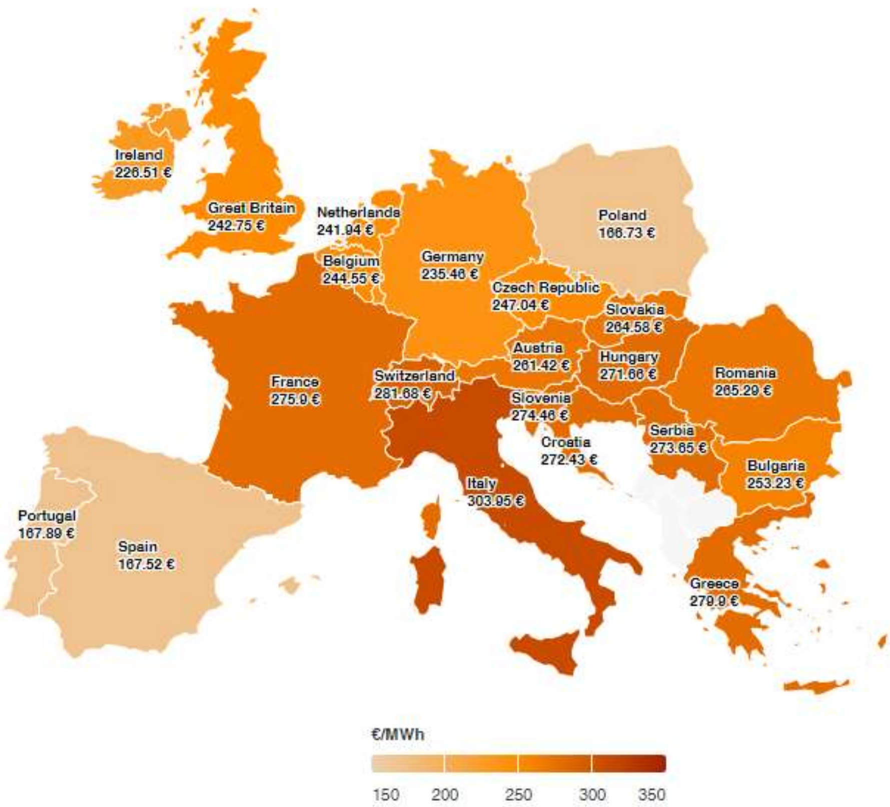
Figure 94: Evolution of the Weighted Average Electricity Purchase Price (Day-Ahead Market and Intraday Market) in the Interconnected System, 2015-2023



Source: IPTO

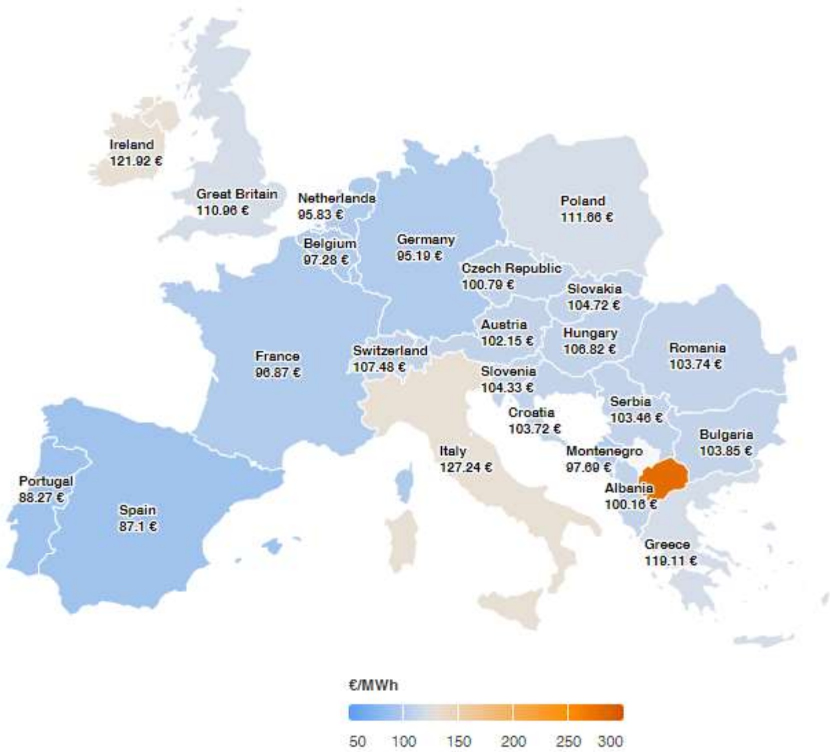
However, the Greek electricity price for 2021 was among the highest in Europe, at €116.44/MWh, while for 2020, the corresponding price was €45.09/MWh (Maps 17 and 18). Russia's invasion of Ukraine on February 24, 2022, marked the beginning of a period of intense volatility in wholesale electricity prices, which have skyrocketed since the start of the war. For 2022, wholesale electricity prices were particularly high as a result of increases in natural gas prices due to the war in Ukraine (Map 29).

Map 29: Wholesale Electricity Prices for 2022



Wholesale electricity prices decelerated further in 2023, due to subdued natural gas demand and mild weather conditions (Map 30).

Map 30: Wholesale Electricity Prices for 2023

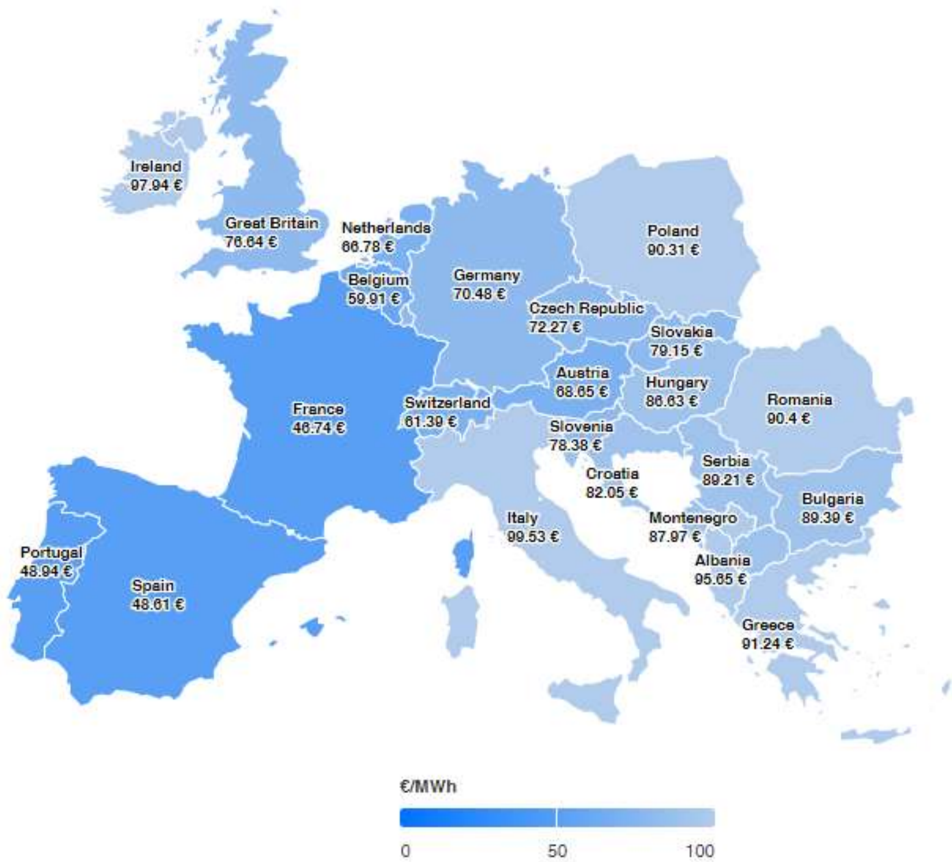


Source: IENE

In 2024, wholesale electricity prices across Europe fell below pre-war levels. A mild winter and lower overall demand for natural gas contributed to this downward trend in energy prices (Map 31).

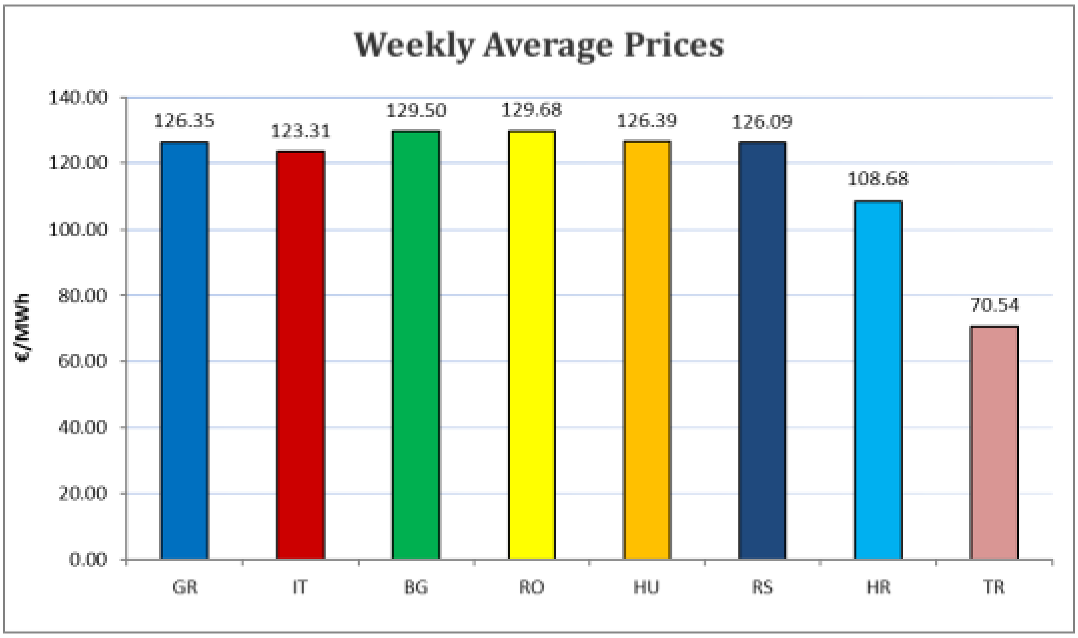
However, during July 2024, the electricity grid in SE Europe was effectively cut off from the rest of the continent for several days, preventing it from sourcing cheaper electricity from the West. This triggered a search for supplies from neighbouring markets, amid a heatwave and increased demand. The high wholesale prices then passed on from one market to another, eventually affecting Greece. It is indicative that the maximum hourly market clearing prices even reached €850/MWh, with the average price peaking at €210/MWh on the Energy Exchange.

Map 31: Wholesale Electricity Prices for the Period 01/01/2024 to 26/08/2024



Source: IENE

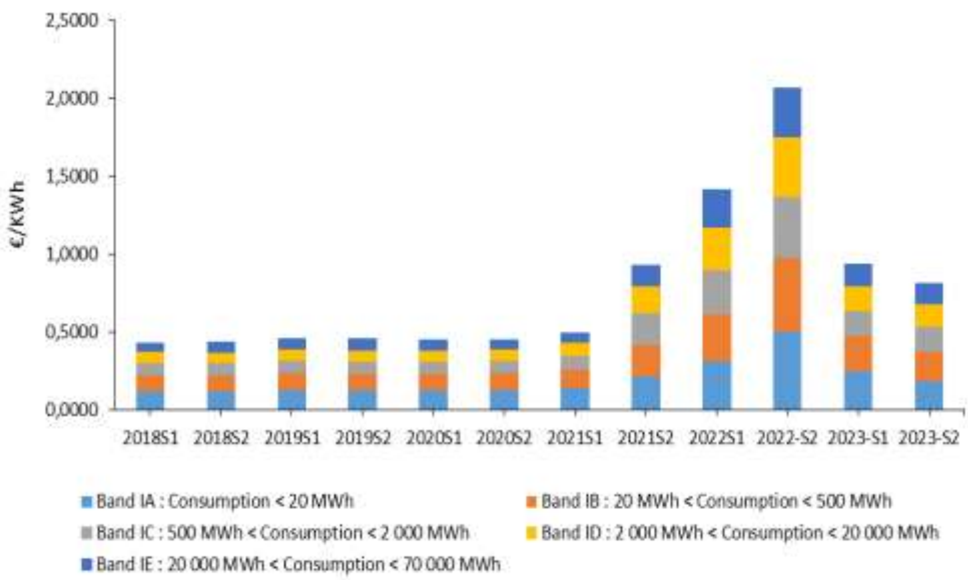
Figure 95: Wholesale Electricity Prices in SEE countries, 19-25 August 2024



Sources: EXE, IPEX (GME), IBEX, OPCOM, HUPX, SEEPEX, CROPEX, EXIST (EPIAS)

In Greece, the price of electricity for non-household consumers[21] amounted to €0.1546/kWh (before taxes and contributions) in the second half of 2023, reduced by 45.4% compared to the second half of 2022 (Figure 96).

Figure 96: Electricity Prices for Non-Household Consumers in Greece, First Half of 2018 – Second Half of 2023

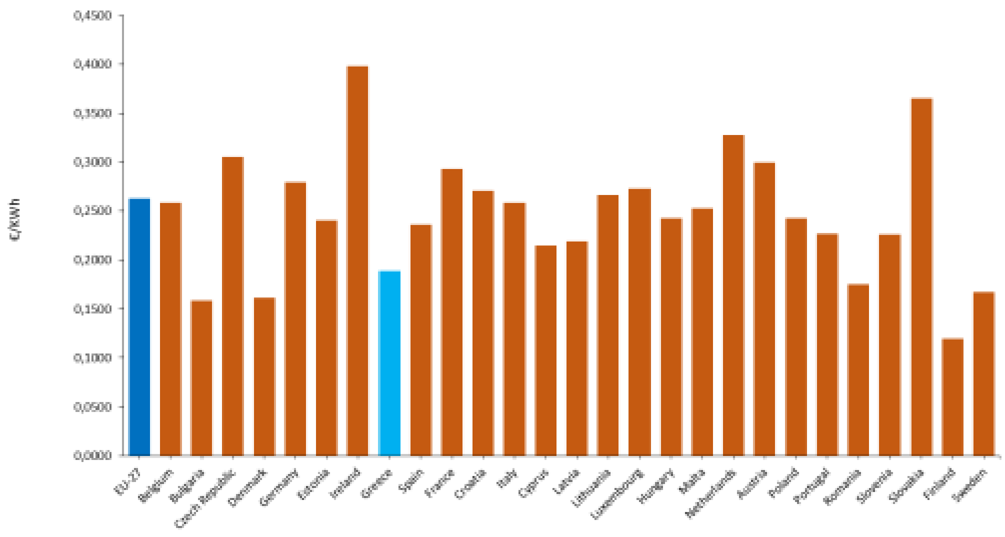


Source: Eurostat

Note: The above electricity prices are before taxes and levies.

[21] It concerns consumption between 500 MWh and 2,000 MWh.

Figure 97: Electricity Prices for Non-Household Consumers in Europe, second half of 2023



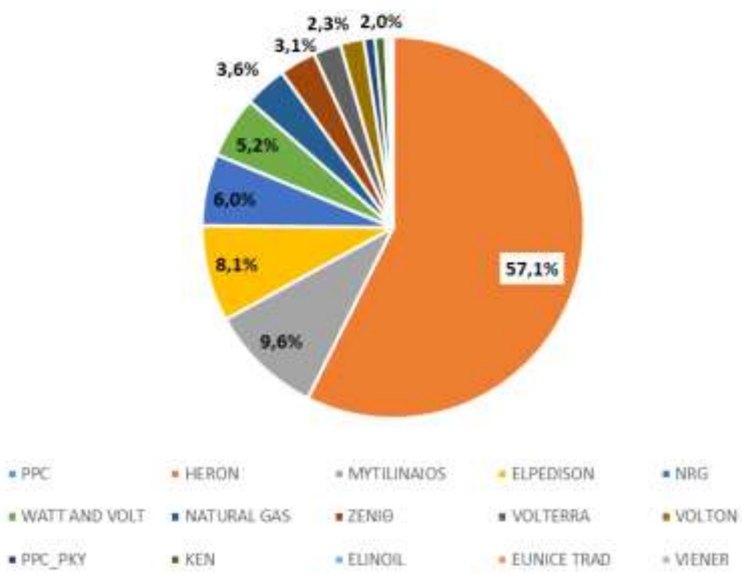
Source: Eurostat

Note: The above electricity prices are before taxes and levies

Retail Market

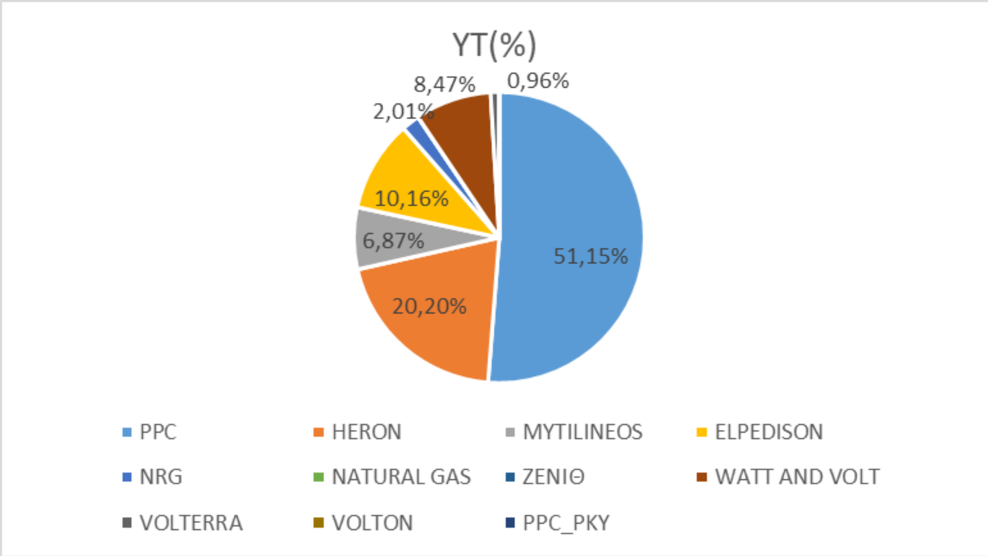
PPC remained the main supplier in the retail electricity market in 2023, representing 87.02% of the total number of supplies at high voltage (HV), 41.18% of medium voltage (MV), 65.98% of low voltage (LV) of the Interconnected System and 63.5% of the total (Figures 98 & 99) [89].

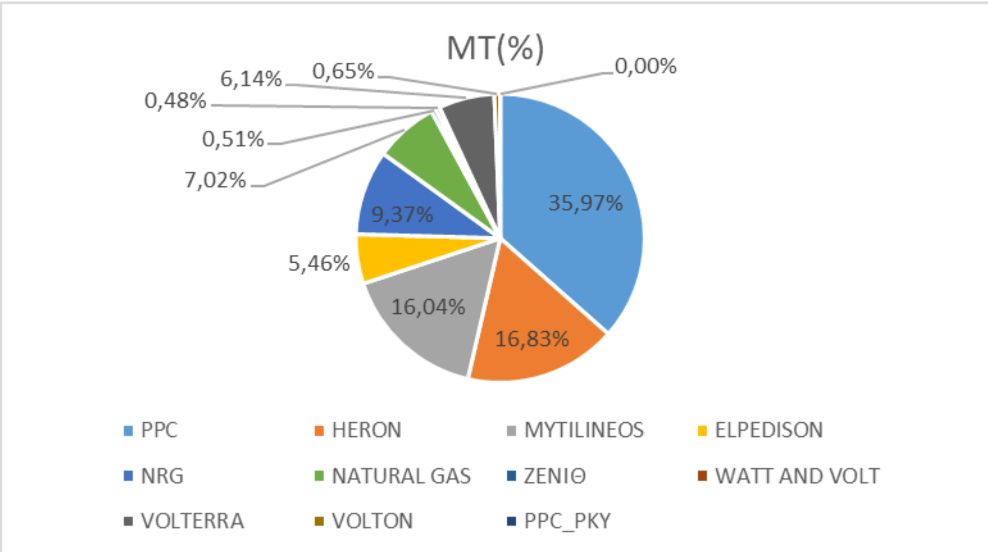
Figure 98: Shares of Suppliers' Load Representatives, 2023

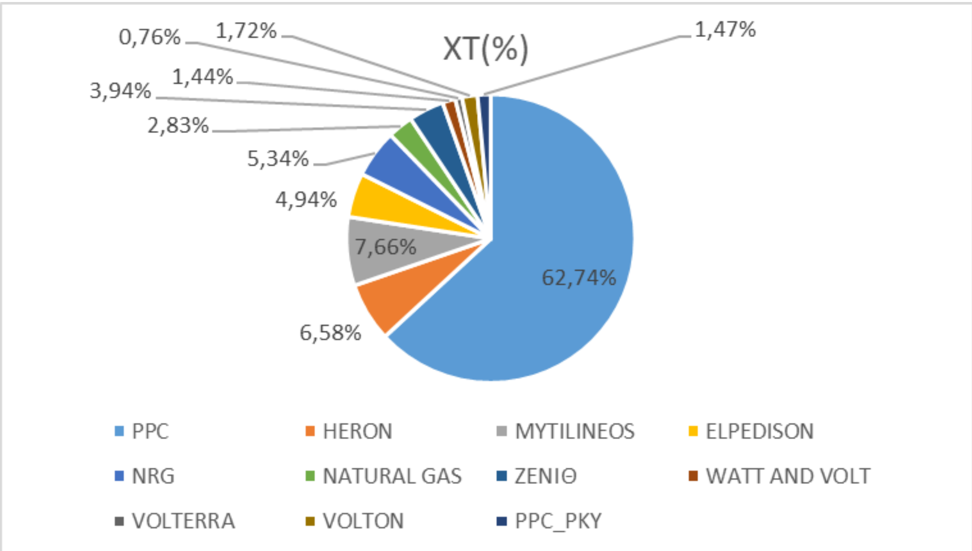


Source: IPTO

Figure 99: Shares of Load Representatives Per Voltage Level (HV: high voltage, MV: medium voltage, LT: low voltage), 2023



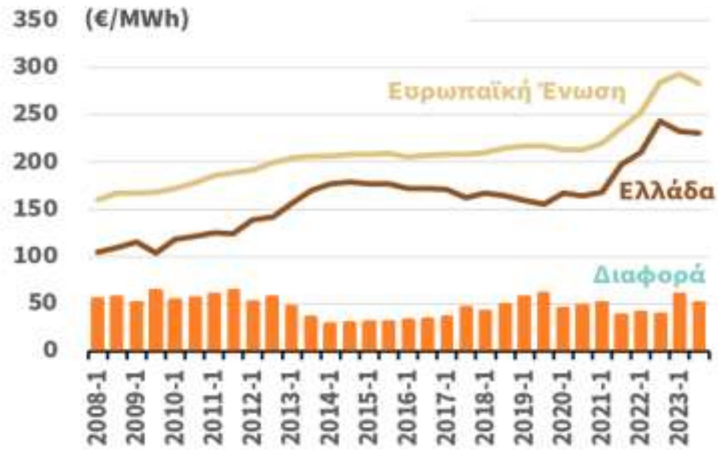




Source: IPTO

As shown in Figure 100, Greece has historically had the lowest retail electricity price for households compared to the European average [90].

Figure 100: Retail Electricity Prices in Greece and the EU, 1st half 2008 – 1st half 2023

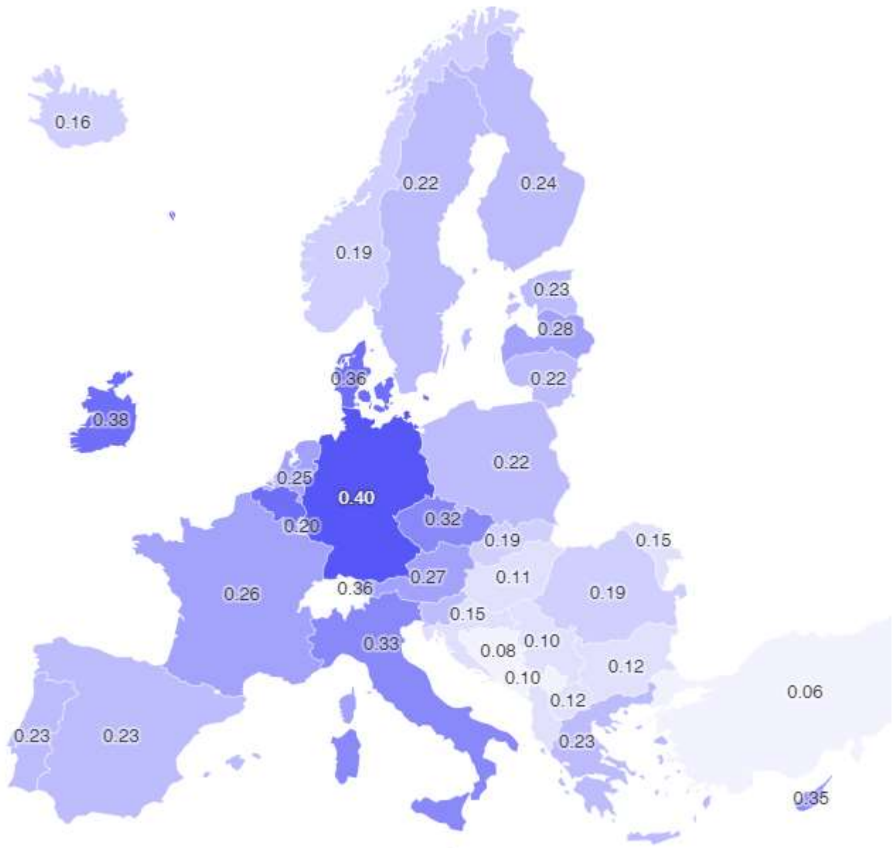


Sources: Eurostat, MoEE

<u>Note</u>: with taxes and charges, consumption 2,500 – 4,999 KWh

According to Eurostat data, electricity prices for household consumers, including taxes, for Greece reached €0.2305/KWh, when in the EU the average was €0.2525/KWh [91].

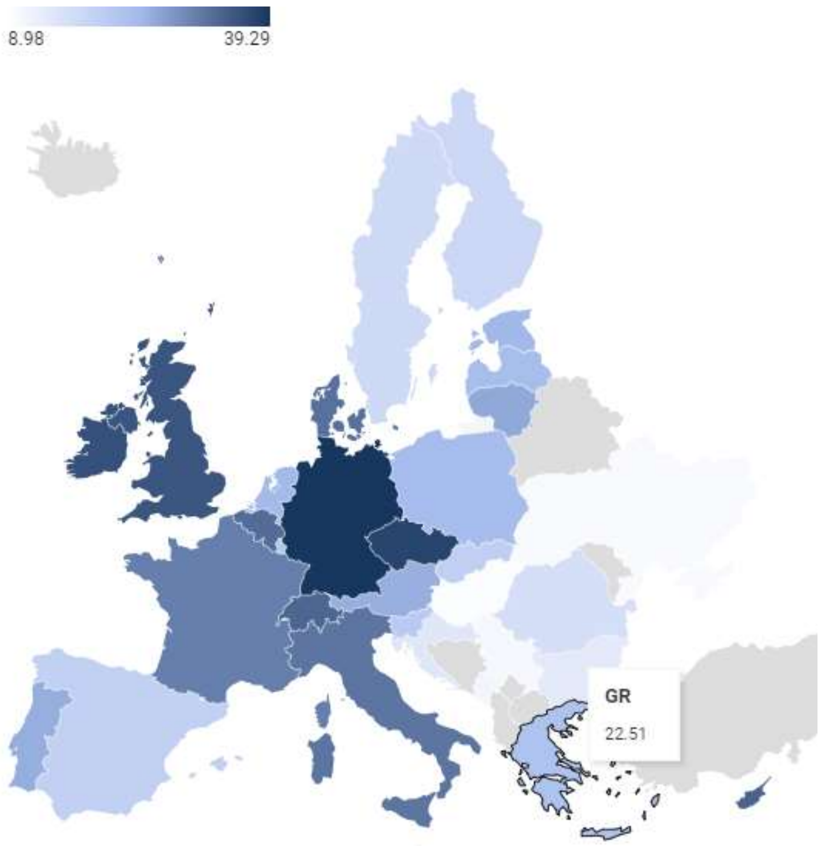
Map 32: Electricity Prices for Residential Consumers (Including Taxes and Charges), Second Half of 2023 (€/KWh)



Source: Eurostat

According to the monthly price table announced by HEPI (Household Energy Price Index), Greece ranks below the EU average in household electricity prices (including taxes and other charges), with the country ranking 18th among 33 European countries in July 2024 [92]

Map 33: End-user Electricity Prices (c€/kWh) in July 2024



Source: Household Energy Price Index

In order to support households due to increased energy prices, the Special Tariff (green color marking) was introduced from January 2024, which during the first 7 months of 2024 had an average price for all supply companies of 13 cents/kWh, while the average price of the green tariff for the dominant supplier for the same period amounted to 12 cents/kWh, i.e. almost at the pre-energy crisis level.

The government announced a set of measures to address the distortion that occurred in the electricity market in July 2024 with an increase in prices. Among the measures announced were the extraordinary taxation for the month of August of electricity producers that used natural gas as fuel, as well as the subsidy of household consumers with 1.6 cents/kWh for the first 500 kWh, so that the final price for the majority of this category of consumers would remain below the level of 15 cents/kWh. At the same time, for the beneficiaries of the Social Household Tariff, the subsidy for August was enhanced and amounted to 5 cents/kWh, maintaining the price for the 700,000 consumers of this category at the pre-energy crisis level, approximately 11.3 cents/kWh [93].

5.3.3 Non-Interconnected Islands

Non-Interconnected Islands (NIIs) are the islands of the Greek Territory whose Electricity Distribution Network is not connected to the Transmission System or the Distribution Network of the mainland. The management of the Electricity Systems of the Non-Interconnected Islands, which includes the management of production, the operation of the market and the systems of these islands, is the responsibility of HEDNO S.A. and is carried out in accordance with the "Management Code for Electricity Systems of Non-Interconnected Islands", provided for in article 130 of Law 4001/2011 [94].

With the completion of Phase 1 of the Cyclades interconnection (Syros, Mykonos, Paros and Naxos) with the Continental System in March 2018, with the completion of Phases 2 and 3 of the Cyclades interconnection and the Crete-Peloponnese interconnection in 2021, the reliability and stability of the islands' electricity supply is further strengthened. However, a significant number of NDIs continue to be supplied by the local production stations of PPC S.A., which operate with fuel oil, heavy (fuel oil) or light (diesel). The contribution of RES, and in particular the wind and photovoltaic plants, which operate on these islands, is also significant.

In the Greek territory there are currently 28 autonomous island power systems, each of which is powered by one or more thermal power plants and consists of one or more islands, interconnected by submarine cables. These systems are served by oil units (mainly in small and medium systems), while in the power plants of Rhodes, Kos-Kalymnos, Thira and Lesvos, gas turbine units (fueled with light oil - diesel) have also been installed [48].

According to data from the Hellenic Electricity Distribution Network (HEDNO)'s Island Management Directorate, the total installed capacity of production units in the NIIs amounted to approximately 1.1 GW in 2023, of which 78.62% concerned thermal plants (Table 21) [95].

Table 21: Installed Capacity (MW) of Generation Units in the NIIs, April 2024

Category	Installed Capacity (MW)
Thermal Units*	1.005,224
Wind	108,05
Solar PV**	51,45
PV Special Programme***	4,76
PV Net Metering***	23,04
Hybrid	2,95
Total	**1.195,47**

Notes: *Latest available data 2023, **The installed capacity of PV Special Programme and net metering is not taken into account, *** Capacity that binds electric space.

Source: HEDNO

Similarly, total energy production in the NIIs amounted to approximately 2.4 TWh in 2023, of which approximately 86% concerned thermal plants (Table 22) [95].

Table 22: Electricity Production (MWh) in the NIIs, 2021 & 2023

Category	2021	2023
Thermal	3.676.971	2.066.333
Wind	708.242	226.368
Solar PV	206.565	82.995
PV Special Programme	-	7.725
PV net metering	-	2.313
Hybrid	4.334	5.593
Biogas	3.936	-
Total	**4.600.000**	**2.391.327**

Source: HEDNO

According to data from the Ministry of Environment and Energy [96], the additional cost of electricity that needs to be produced on the non-interconnected islands is estimated at €763 million for 2024. This cost is socialized, that is, covered through the Social Welfare Services by all Greek consumers.

Table 23: Electricity Costs in the Non-Interconnected Islands

Ομάδες νησιών	ΕΚΤΙΜΗΣΗ ΑΝΤΑΛΛΑΓΜΑΤΟΣ ΥΚΩ 2024 (€)
Δωδεκάνησα[1]	223.505.950,4
Ιόνιο[2]	1.415.768,6
Κρήτη[3]	356.427.846,8
Κυκλάδες[4]	89.688.888,5
Νησιά Β.Α. Αιγαίου[5]	85.299.299,3
Σποράδες[6]	6.189.276,7
Σύνολο	**762.527.030,3**

Περιλαμβάνουν:
[1] Αγαθονήσι, Άγιο Ευστράτιο, Αρκιούς, Αστυπάλαια, Κάρπαθο, Κω-Καλύμνου, Μεγίστη, Πάτμο, Ρόδο και Σύμη
[2] Αντικύθηρα, Ερεικούσα και Οθωνούς
[3] Κρήτη και Γαύδο
[4] Αμοργό, Ανάφη, Δονούσα, Θήρα, Κύθνο, Μήλο, Σέριφο και Σίφνο
[5] Ικαρία, Λέσβο, Λήμνο, Σάμο και Χίο
[6] Σκύρο

Source: MoEE

5.3.4 Latest Developments in the Domestic Electricity Market

(a) Electricity interconnection of the islands with the country's mainland system

Completed projects

Cyclades Interconnection - Phase II and III (2020)

The Cyclades interconnection project concerns the interconnection of Syros, Mykonos, Paros and Naxos with the mainland system and the strengthening of the interconnection of the

Andros - Tinos complex. Connection of Paros-Naxos (7.6 km), Naxos-Mykonos (40 km), Lavrio-Syros (Laying of a 2nd cable 108 km).

It has been characterized by a Ministerial Decision (November 2006) as a project of "general importance for the country's economy" and is being implemented in four phases. To date, Phases A, B and C of the project have been completed, while Phase D is in the implementation stage. More specifically:

- Phase A was completed in 2018. Specifically, the interconnection of Syros and Paros with the Interconnected System and their integration into it took place in March 2028 and the interconnection of Mykonos with the Interconnected System and its integration into it took place in May 2018. The diversion of all departures from the old outdoor Lavrio Substation to the new GIS Lavrio Substation was gradually completed by 2020.
- Phase B was completed in September 2020. At the same time, in December 2019 and February 2020, the replacement of the Evia - Andros and Andros - Tinos cable lines was completed respectively.
- In order to expedite the completion of Phase 3 and given that this required, among other things, the expansion of the Syros GIS substation, which would in fact be delayed due to the unavailability of the required equipment, it was decided that the connection of the second Lavrio - Syros cable line would be temporarily made to an existing 150 kV capacitor gate. The implementation of this temporary solution was completed in October 2020. The completion of all individual sub-projects and the transition to the final topology took place one year later.

The implementation cost amounts to €169.6 million, with co-financing from the European Regional Development Fund and the NSRF 2014-2020 with €67.4 million.

Crete - Peloponnese interconnection (2021)

- The longest and deepest AC cable connection in the world.
- Cost: €374.5 million, co-financed by the European Regional Development Fund and the National Strategic Reference Framework 2014-2020 with €106.1 million.

Skiathos Interconnection (2022)

- Mantoudi-Skiathos connection (28.4 km)
- Cost: €56.3 million

Projects in progress

Phase 4 of the Cyclades Interconnection

Submarine interconnections Naxos-Thira, Thira-Folegandros, Folegandros-Milos, Milos-Serifos, Serifos-Lavrio with submarine three-core cables.

- Estimated completion year: 2025
- Cost: €490 million, co-financed by the Recovery and Resilience Fund with €164.5 million.

Crete-Attica Interconnection (Ariadne interconnection)

- Estimated completion year: 2025
- Cost: €1,138 million, with co-financing from the European Regional Development Fund and the NSRF 2014-2020 for the 1st stage of the project with €294.5 million. With the inclusion of the 2nd stage in the NSRF 2021-2027 estimated additional grant of €255.5 million.

Future interconnection projects

Dodecanese Interconnection

- estimated completion year: 2029
- Cost: €2,048 million
- Funding: The project has been proposed for a grant from the Islands Decarbonization Fund

Interconnection of NE Aegean islands

- estimated completion year: 2030
- Cost: €1,208 million
- Funding: To be included in a Programme for a grant

(b) International Interconnections

Since October 2004, the Greek Transmission System has been operating synchronously and in parallel with the interconnected European Transmission System under the general coordination of ENTSO-E (European Network of Transmission System Operators for Electricity). The parallel operation of the Greek Transmission System with the European one is achieved through interconnection transmission lines, mainly 400 kV, with the Systems of Albania, Bulgaria, North Macedonia and Türkiye. In addition, the Greek Transmission System is connected asynchronously through a 400 kV submarine direct current link with Italy.

The new interconnection between Greece and Bulgaria was put into operation in June 2023. The project concerned the implementation of a second interconnection line between the Systems of Greece and Bulgaria, which was carried out with an overhead 400 kV HV interconnector between the N. Santas substation and the Maritsa East 1 substation. The line has a nominal transmission 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 Bulgarian territory. The new 400 kV Greece - Bulgaria interconnection line is an important project of European interest and bears the title "PCI" with code 3.7.1 since 2013, having been included in the 4th list of Projects of Common Interest (PCI) by the EU of the NSI East Electricity Priority Corridor (North-South Electricity Interconnections in Central Eastern and South Eastern Europe) [48].

Map 34 shows both the existing interconnections (black color), those under construction and under study, and the new interconnections based on planned interconnection projects (green color).

Map 34: Electricity Interconnections of the Greek Electricity System

Source: IPTO

(c) Electricity Storage

In Directive 2019/944 of the European Parliament and of the Council, energy storage in the context of electricity systems is defined as: “the postponement of the final use of electricity to a time later than its production or the conversion of electricity into a form of energy that can be stored, the storage of that energy, and the subsequent re-conversion of that energy into electricity or the use in a different energy carrier."

Storage technologies available today, suitable for power system and user applications, include the following (non-exhaustive list):

- Mechanical methods
  - Pumped storage
  - Compressed air storage
  - Flywheels
- Theraml methods
  - Storage using molten salts, liquefied air, etc.
- Electrochemical method
  - Lead-acid batteries
  - Ni-Cd batteries - NaS batteries
  - Sodium-nickel-chloride batteries
  - Li-ion batteries
  - Flow batteries
  - Lead Carbon batteries, etc.
- Electrical and magnetic methods
  - Supercapacitors
  - Superconducting magnetic energy storage

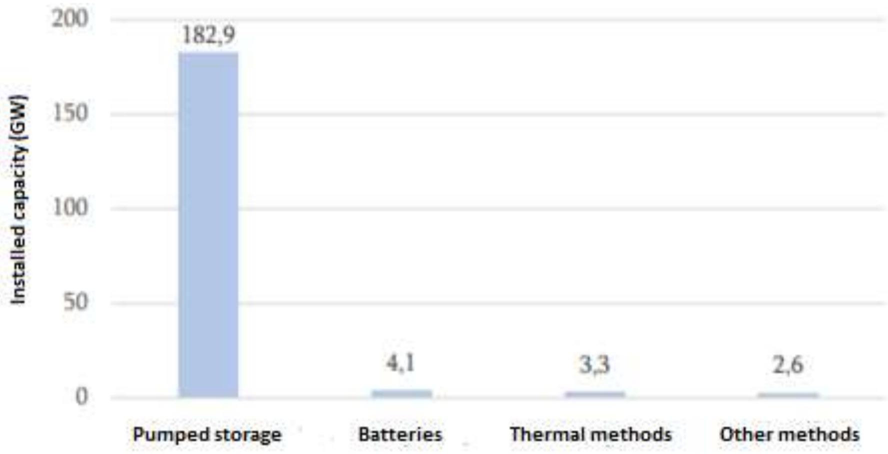
In addition, the chemical methods include hydrogen storage technologies H2 and Power-to-X (synthetic fuels), which are rapidly developing and are expected to play an important role in the future. In the last year, the country has experienced an explosion of interest in licensing new electricity storage facilities.

Moreover, one of the main changes in the revised NECP of August 2024 is the 30% increase in the target for batteries compared to the draft of October 2023. Specifically, the target for batteries increases from 3.1 GW to 4 GW. Combined with the approximately 2 GW it sets as a target for pumped storage, the total storage capacity reaches 6 GW. This storage capacity is necessary to support the increased penetration of RES and limit grid stability problems.

Pumped Storage

The dominant electricity storage technology, with data from November 2020, is pumped storage, with an installed capacity worldwide of around 183 GW (Figure 101) [97].

Figure 101: Installed Capacity by Energy Storage Technology



Source: ODE

The Greek electricity system currently has the open-cycle pumped-storage hydroelectric power stations of Thisavros and Sfikia, with a total production capacity of 699 MW, which have been operating since the late 1990s.

According to the proposal for the revision of the National Energy and Climate Plan of August 2024 [48], pumped storage projects are proposed to reach 1,745 MW in 2030, 2,949 MW in 2035, 4,464 MW in 2040, 5,251 MW in 2045 and 5,453 MW in 2050, with the installed energy storage capacity reaching 66,781 MWh by mid-century.

The approximately 700 MW of pumped storage systems operating in Greece belong to PPC, while the large system in Amfilochia is being built by TERNA, which has a total installed capacity of 680 MW for generation and 730 MW for pumping. It is an investment of a total of €650 million with an annual energy production of approximately 816 GWh [98]. It should be noted that it is a key project that has been characterized, since 2013, as a Project of Common European Interest and in 2014 as an Investment of Strategic Importance.

Map 35: Location of the Project: Amfilochia Pumping Station

Source: TERNA ENERGY[22]

The project includes two independent upper reservoirs, Agios Georgios and Pyrgos, with volumes of approximately 5 million cubic meters and 2 million cubic meters respectively, while the lower reservoir uses the existing Kastraki Lake of PPC (Map 36).

Map 36: Reservoirs of the Amfilochia Pumping Station

Source: TERNA ENERGY

The investment interest is high and already exceeds the targets as a series of projects with a capacity of more than 8 GW are in various stages of the licensing process. According to the

[22] https://www.iene.eu/articlefiles/inline/tsiknakou%2028%2009%202022.pdf

latest data from the RAAEY, 33 licenses for pumped storage have been granted to date, with a capacity of more than 5.26 GW and a capacity of 50.9 GWh.

Applications for licenses from the Energy Regulatory Authority continue with the investment interest in pumped storage projects, both large and small, increasing. Already another 5 projects have applied for a storage license in the last July 2024 cycle of the Hellenic Energy Regulatory Authority, with a total capacity of 1.2 GW, while two projects had applied for a storage license in the June cycle with a total capacity of 875 MW (megawatts), of which 500 MW is for HelleniQ Renewables.

(d) Electromobility in Greece

A key priority of Greece's new energy policy is now the promotion of electromobility, as it will rely to a large extent on the production of electricity from RES, while at the same time offering significant energy savings through improved energy efficiency.

To this end, the National Electromobility Plan was put out for consultation on 19 May 2023 until Friday 16 June 2023, which includes measures for the development of electromobility in all transport sectors with the aim of reducing emissions of greenhouse gases and supporting the "green" economy.

As reported by the Ministry of Environment and Energy [99], the development of a National Electromobility Plan, in collaboration with the co-responsible bodies, the Ministry of Infrastructure and Transport and the Ministry of Development and Investments, ensures continuity in the policies promoting electromobility that have been implemented over the last 4 years. The purpose of this holistic plan is to provide guidance on the electrification of all transport sectors and therefore operates in 3 basic dimensions:

- The 1st dimension concerns the development of the necessary charging infrastructure.
- The 2nd dimension concerns the electrification of existing vehicle fleets and means of transport.
- The 3rd dimension concerns the development of the ecosystem around this market, with the aim of providing smart solutions to the new needs that electromobility brings with it.

In order to provide incentives to citizens, Decision 132625/2024 (Government Gazette 3076B) was published on June 3, 2024, which decided to announce the Action entitled “I MOVE ELECTRICALLY - 3RD CYCLE”, with a total budget of €33 million, which provides for increased subsidy amounts for private consumers, which can reach €11,000. “I MOVE ELECTRICALLY 3” in addition to vehicles also subsidizes electric motorcycles, electric bicycles, and microcars.

The purpose of the Action “I MOVE ELECTRICALLY - 3rd Cycle” is to promote electromobility and the further penetration of electric vehicles in the fleet of vehicles circulating within the Greek territory, as a factor that will contribute to the reduction of pollutant emissions, within the framework of the National Plan for Energy and Climate.

The purpose of this action is to grant an “ecological bonus”. This will be granted in the form of a subsidy for the purchase or lease of purely electric vehicles with simultaneous optional but subsidized withdrawal of old vehicles.

The individual objectives of the programme are:

- The renewal of the fleet of private vehicles,
- The renewal of the fleet of light commercial vehicles, and
- The development of "smart" private EV recharging infrastructures.

At the same time, the proposal for a revised NECP (August 2024) [48] includes two scenarios, with the second adopting more increased targets until 2030. Regarding the estimated distribution between the types of electric vehicles (pure electric vehicles -BEV and plug-in hybrid vehicles- PHEV11), this is estimated for cars at a ratio of 50%-50% in the immediate following years, with a gradual shift to 67%-33% in 2030 in favor of pure electric vehicles. Correspondingly, for light trucks, the percentage of pure electric-BEVs is predicted to exceed 90-95% compared to plug-in hybrid-PHEVs throughout the period until 2030.

In any case, the emphasis until 2030 falls on the development of charging points and not on the increase in the fleet of electric vehicles (at least in the baseline scenario). Additionally, the NECP states that the necessary total number of publicly accessible charging points is estimated at approximately 40,000 to 100,000 points for the year 2030, when by September 2023, according to the data included in the NECP, 4,014 publicly accessible charging points have been installed throughout the territory.

According to ACEA data (l’Association des Constructeurs Européens d’Automobiles) [100], as shown in Table 24, sales of rechargeable electric cars in Greece, battery and plug-in hybrids (BEV and PHEV), in 2023 increased by 83% compared to 2022 and reached 15,205 units in total. Thus, BEV and PHEV electric vehicles in Greece accounted for 11.3% of total registrations in 2023 compared to 7.9% in 2022. Specifically, total sales of battery electric cars (BEV) in Greece in 2023 reached a record number of 6,379 units, compared to only 2,827 registrations that had been made in 2022. This means that the increase that occurred reached 126% [100].

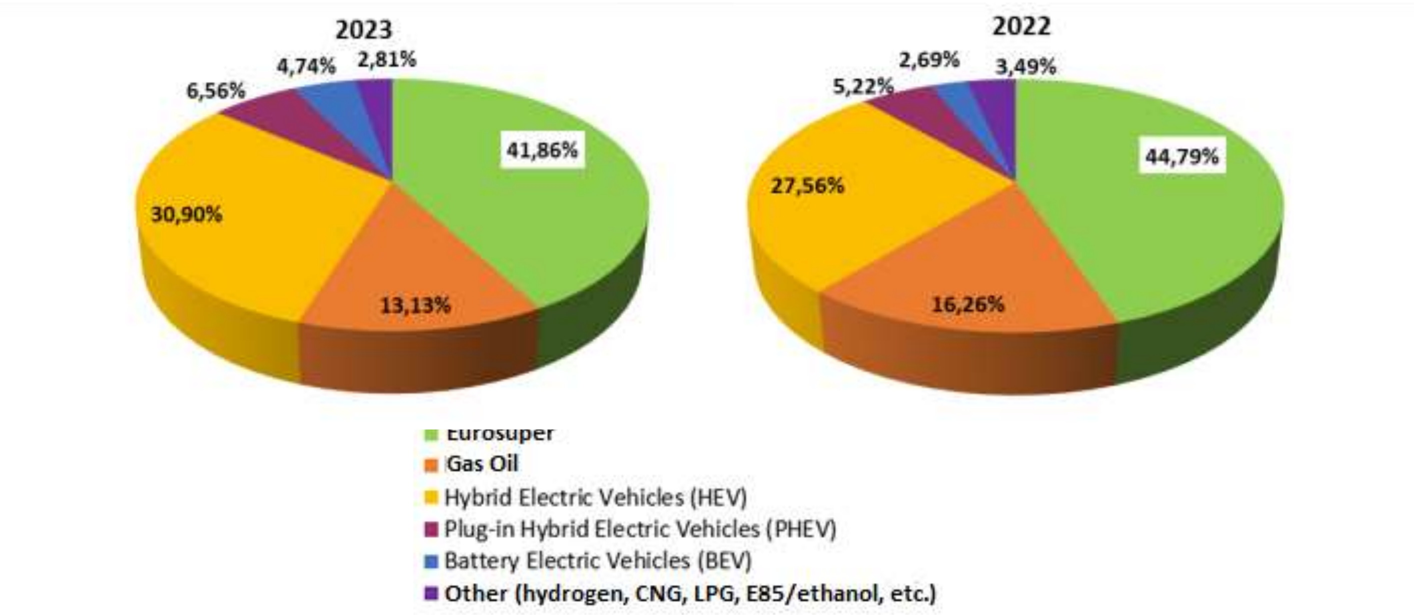
Table 24: Vehicle Sales by Fuel Type in Greece, 2023 & 2022

	Number of vehicles 2023	Number of vehicles 2022	% Δ 23/22
Eurosuper	56.293	47.151	+19,4%
Gas Oil	17.653	17.114	+3,1%
Hybrid Electric Vehicles (HEV)	41.560	29.019	+43,2%
Plug-in Hybrid Electric Vehicles (PHEV)	8.826	5.493	+60,7%
Battery Electric Vehicles (BEV)	6.379	2.827	+125,6%
Other (hydrogen, CNG, LPG, E85/ethanol, etc.)	3.773	3.679	+2,6%
TOTAL	**134.484**	**105.283**	**27,7%**

Source: ACEA

In addition to the sheer number of sales, the percentage of electric cars in the total has also increased significantly. So, while in 2022 battery-powered models had just 2.69% market share, in 2023 their share rose to 4.74%.

Figure 102: Share of Vehicle Sales by Fuel Type, 2023 & 2022

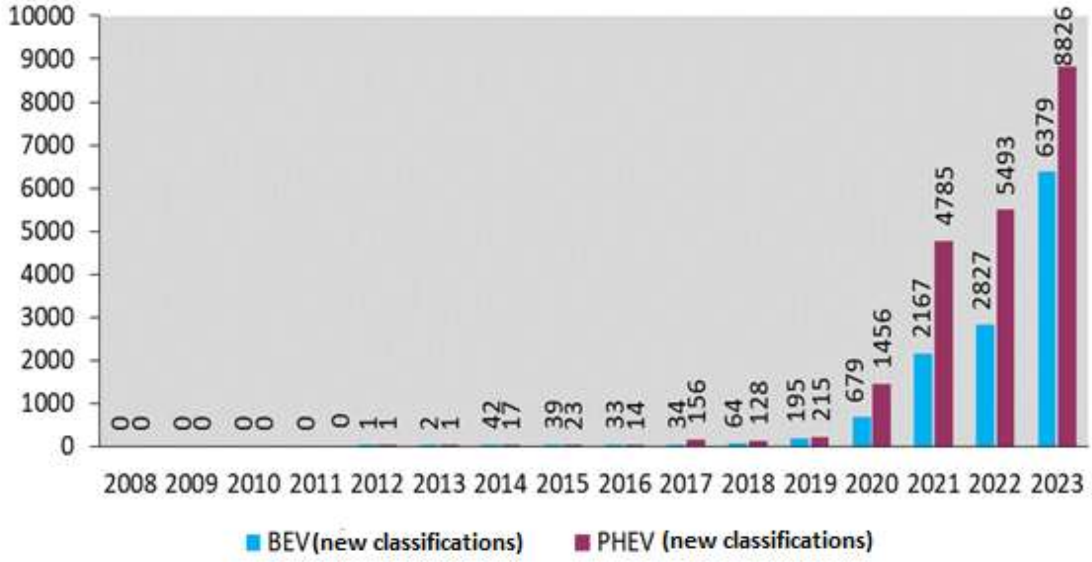


Source: ACEA

Regarding the companies in the pure electric car category, Tesla was first with 1,843 registrations and a share of 25.2%. Peugeot followed with 987 registrations (13.5%), while the top three is closed by Opel (9.4%). Fourth in electric car sales was Volkswagen with 516 sales (7.0%) and the top five is completed by Mercedes with 480 sales (6.6%).

The historical evolution of BEV and PHEV vehicle registrations in Greece is shown in Figure 103.

Figure 103: New BEV and PHEV Vehicle Classifications in Greece, 2008-2023

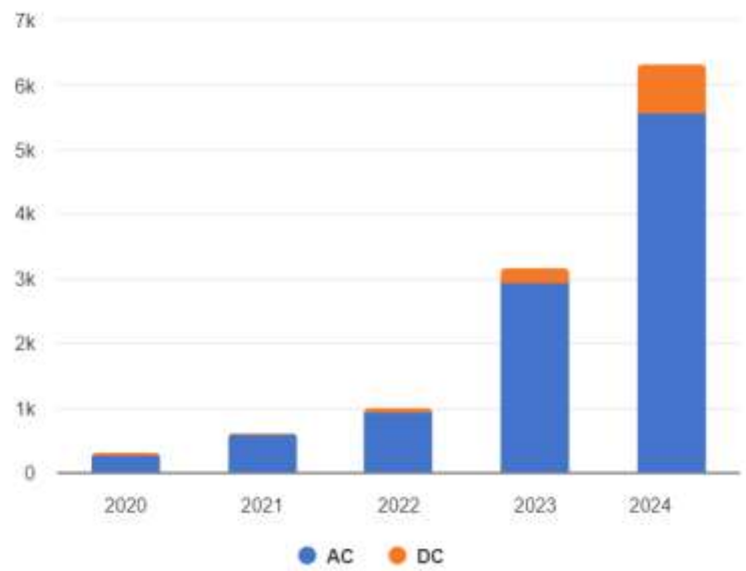


Notes: BEV: purely electric vehicles, PHEV: plug-in hybrid vehicles

Source: ACEA

Regarding the charging infrastructure in Greece, the total number of recharging points in the third quarter of 2024 amounted to 5,575 points for alternating current (AC) charging and 741 points for direct current (DC) charging. The evolution of recharging points over time is illustrated in Figure 104 [101].

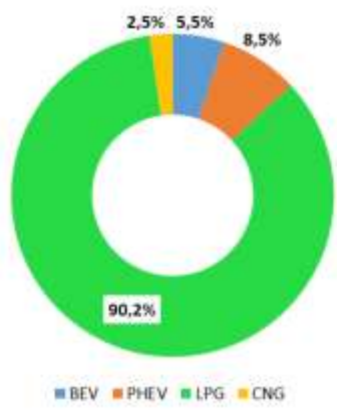
Figure 104: Evolution of Total Recharging Points in Greece



Source: EAFO

According to the European Alternative Fuels Observatory (EAFO) [102] for 2023, the total number of passenger cars and vans with alternative fuels (BEV, PHEV, H2, LPG, CNG, LNG) amounted to 243,338 out of a total of 6,320,468 passenger cars, representing a percentage of 3.85%. The distribution of types of passenger vehicles with alternative fuels is shown in Figure 105.

Figure 105: Share of Alternative Fuel Passenger Vehicles by Type in Greece, 2023



Source: EAFO

(d) Smart Grids in Greece

Smart Grid is the electrical network that serves with high reliability, quality of electricity supply and in an economical way all users, who are connected to it, producers and consumers, with the aim of efficient use of energy.

Smart grids coordinate the needs and capabilities of producers, network operators, consumers and other market participants so that they operate in the best way, minimizing costs and environmental impact, maximizing stability and reliability. Consumers, through their direct information, contribute to the balancing of production and demand and therefore to the reliability of the system [103].

In addition, the smart grid uses all available energy resources, promotes new products and services, consumers are able to choose from a multitude of products and services, and also improves the quality of electricity through automation and mechanisms that limit damage and allow for their immediate restoration. The transition to an energy market that will combine the achievement of high environmental standards, with high-quality services at low cost, can only be implemented through smart grids, which places them at the center of the strategic planning of Electricity Distribution Companies [103].

In the case of HEDNO, the new energy landscape means that the distribution network becomes "smart", with the widespread use of digital technologies and the processing of a huge amount of data being almost a one-way street for managing such a complex system.

HEDNO has already installed 360,000 smart meters in the first half of 2024, which were placed in public buildings, businesses and large offices, with low voltage electricity. This is equipment following a tender, which was won by the Sagemcom – Protasis consortium.

According to HEDNO, smart meters will be installed in all homes by 2030. In this context, the project includes the supply and installation of a total of 7.3 million smart electricity meters to low-voltage customers throughout Greece (5,200,000 single-phase and 2,100,000 three-phase), as well as their integration into a telemetry system with a capacity of 8 million metering points. At the same time, an equal number of existing meters to low-voltage customers will be dismantled, while the project costs €1.2 billion.

5.4 Solid Fuels

Lignite represents a large part of Greece's mining activity, being a key fossil fuel and an important component of the country's energy security. Weaning the economy off the polluting fuel of lignite is a key priority of the Greek government. The reasons that make delignification an imperative are both environmental due to the phenomenon of climate change and economic due to the increasing trend of pollutant emission prices. This transition away from lignite is feasible and can be supported due to the strong potential of Renewable Energy Sources that Greece has and which will constitute its main national energy resource in the energy mix of the future [48].

Table 25 presents the retirement schedule of operating lignite units that has been taken into account in the NECP revision proposal of August 2024 [48].

Table 25: Retirement Schedule of Operating Lignite Units

Power plant	Fuel	Net installed Capacity	Decommissioning
Agios Dimitrios I	lignite	274	END of 2023
Agios Dimitrios II	lignite	274	END of 2023
Agios Dimitrios III	lignite	283	END of 2023
Agios Dimitrios IV	lignite	283	END of 2023
Agios Dimitrios V	lignite	342	END of 2025
Meliti	lignite	289	END of 2025
Megalopoli IV	lignite	256	END of 2025
Ptolemaida	lignite	615	END of 2028

*until 31/03/2024

Source: MoEE

In parallel with the withdrawal of the lignite production plants, the operation of the mines that supply them will be terminated. In the above production units (mines - production plants), the equipment will be dismantled and removed, as well as the restoration of the affected areas.

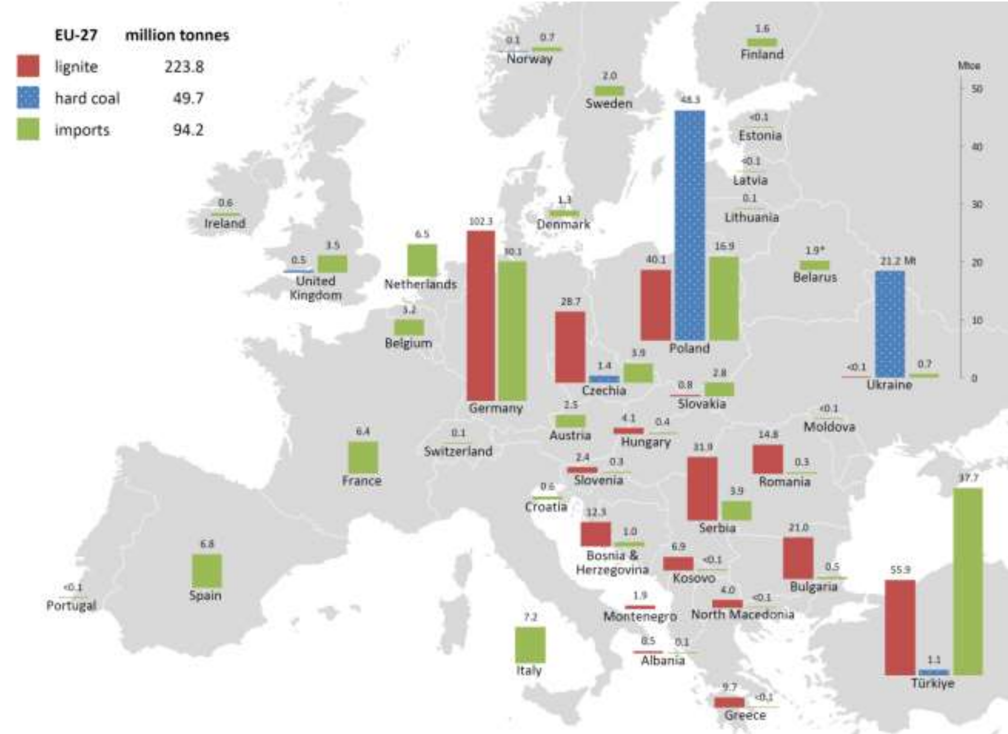
In implementation of a Programme Agreement, which is provided for in paragraph 3 of Article 155 of Law 4759/2020) and signed between PPC, YPEN and YPANEP, PPC undertook the conduct of competitions for the preparation of the Special Urban Planning Studies (SUP) for the cores of the Delignitization Zones (DZ) of Ptolemaida, Amyntaio-Kleidiou-Achlada and Megalopolis.

Of Greece's two lignite centers – Megalopolis and Western Macedonia – production activities are now concentrated in the Ptolemaida mines in Western Macedonia, where the new 660 MW Ptolemaida V power plant is located. In 2023, Greek lignite production decreased by 28.9% to 9.7 million tons, of which PPC produced 9.5 million tons. The Greek lignite sector is now focused on post-mining projects, such as solar photovoltaic parks, pumped storage, battery energy storage and the return of land to the public sector for redevelopment, including industrial areas and recreational areas with the creation of new lakes. [104]

The closure of the last nuclear power plants in Germany in April 2023 and uncertainty about the speed and cost of the transition to renewable energy sources were offset by a decline in industrial energy demand. The figures for 2023 show a decline in demand for coal and lignite: total coal supply (including lignite) shrank by 107.1 million tonnes, or 22.7%, compared to 2022, to just 367.7 million tonnes. The reasons for this are many and varied, but the high cost of greenhouse gas emission allowances is a major factor.

Hard coal production in the EU fell by 9.0% in 2023 compared to 2022, reaching 49.7 million tonnes, with most of this production in Poland. In addition, lignite production fell dramatically, by 24.0% to 223.8 million tonnes in 2023, as demand for lignite for electricity generation fell across the EU except Slovenia. Bulgaria experienced the largest relative decline of 40.9%, followed by Greece, Poland, Germany and Romania. In absolute terms, the largest decline was recorded in Germany where lignite mines produced 28.6 million tonnes less than in 2022, translating into a 21.8% decline [105].

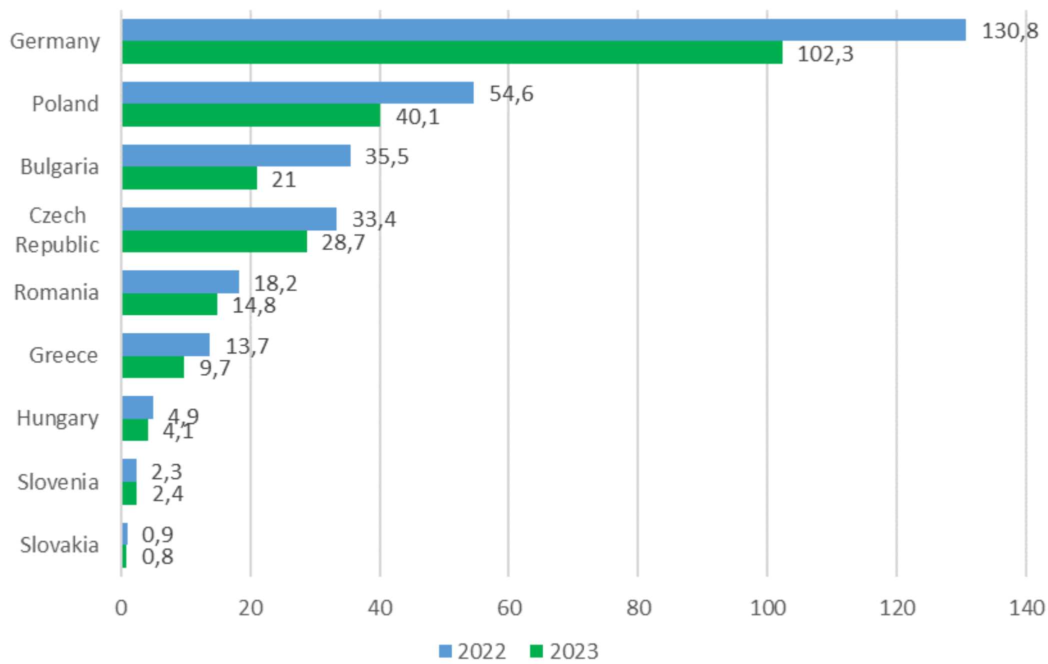
Map 37: Lignite, Hard Coal Production and Hard Coal Imports in the EU, 2023



Source: Euracoal

As shown in Figure 106, primary energy production from lignite in Greece decreased in 2023 by 29.2% compared to 2022, while it also decreased by -71% compared to 2015.

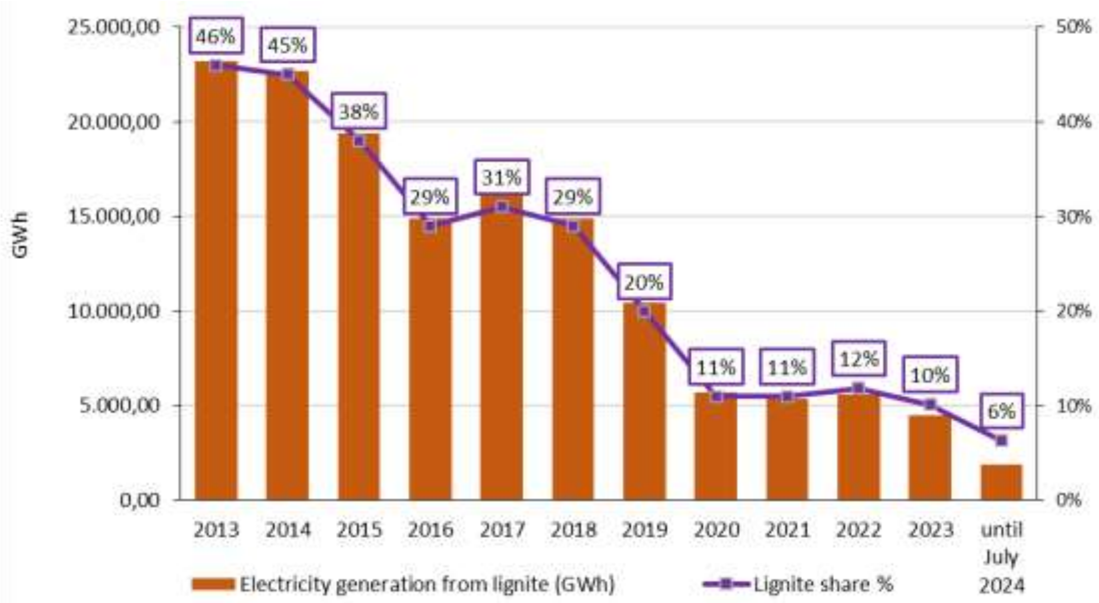
Figure 106: Lignite Production, 2022 & 2023 (Mt)



Source: Euracoal

According to IPTO data [106], the electricity generated from lignite decreased significantly from 23.23 TWh in 2015 to 5.59 TWh in 2022 and to 4.51 TWh in 2023, due to the development of RES, the lower overall demand for electricity and the high cost of emission allowances that makes electricity generation from lignite uneconomic. Electricity generation from lignite decreased by -77% from 2015 to 2023. However, for 2022, there is a return to the use of lignite in electricity generation as a replacement for natural gas due to its high prices resulting from the restriction of natural gas flows from Russia (Figure 107).

Figure 107: Evolution of the Use and Share of Lignite in Electricity Generation, 2013-July 2024

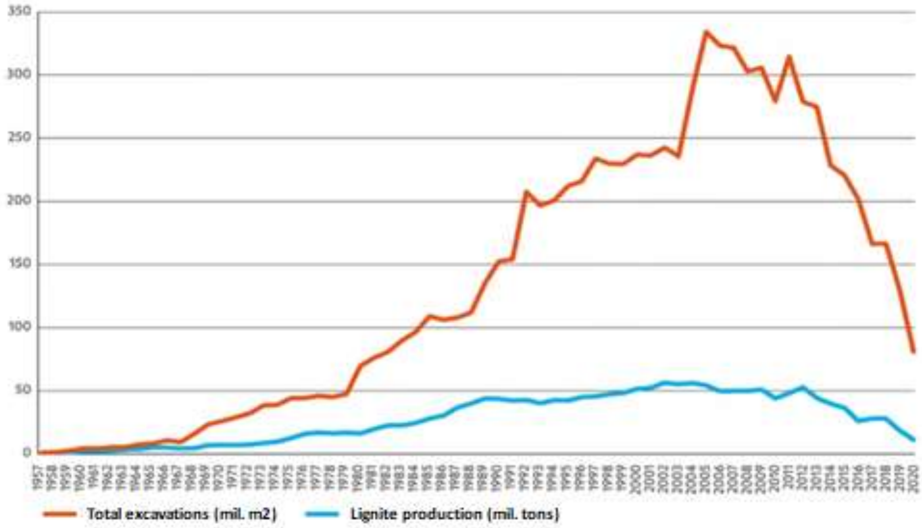


Source: IPTO

The lignite mines, mainly of the Public Company of Greece in the areas of Aliveri, Kozani - Ptolemaida - Florina and Megalopolis, ensured, since 1955 and for a period of approximately 65 years, the necessary quantities of lignite, a particularly important energy fuel for the Greek economy, on which the country's electrification was based [107].

Since the start of the operation of the mines in the Kozani – Ptolemaida – Florina region in 1957, lignite production has shown a significant increase. Specifically, from 1.4 million tons in 1960, it rose to 11.7 million tons in 1975, to 27.3 million tons in 1985, and to 55.8 million tons in 2002, when the maximum production was recorded. Production was maintained at 50 million tons per year until 2012, when its gradual decline began (Figure 108). In 2020, lignite production from the Mines in the Lignite Center of Western Macedonia was 10.3 million tons *[107].*

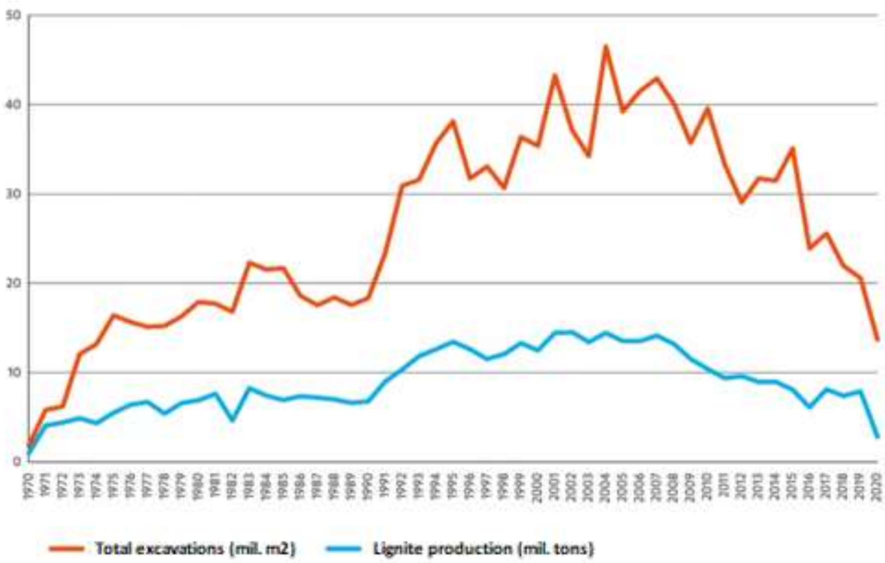
Figure 108: Historical Evolution of Lignite Production and Total Excavations at the PPC Mines of Ptolemaida - Amyntaion - Florina (1958 – 2020)



Source: PPC

The exploitation of the deposit in the Megalopolis area in Arcadia in the Peloponnese began in 1970 and was a special case at a global level, because for the first time, lignite of such a low quality level was mined and used for the production of electricity. The annual production of lignite from 4.1 million tons in 1971 gradually rose to 14.5 million tons in 2002, which was the maximum production. Production was maintained at 13-14 million tons per year until 2008, when a small gradual decline began. In the five-year period 2015-2019, production fluctuated at the level of 6-8 million tons per year, while in 2020, lignite production from the Megalopolis mines was 2.8 million tons (Figure 109).

Figure 109: Historical Evolution of Lignite Production and Total Excavations in the Megalopolis Mines (1970–2020)

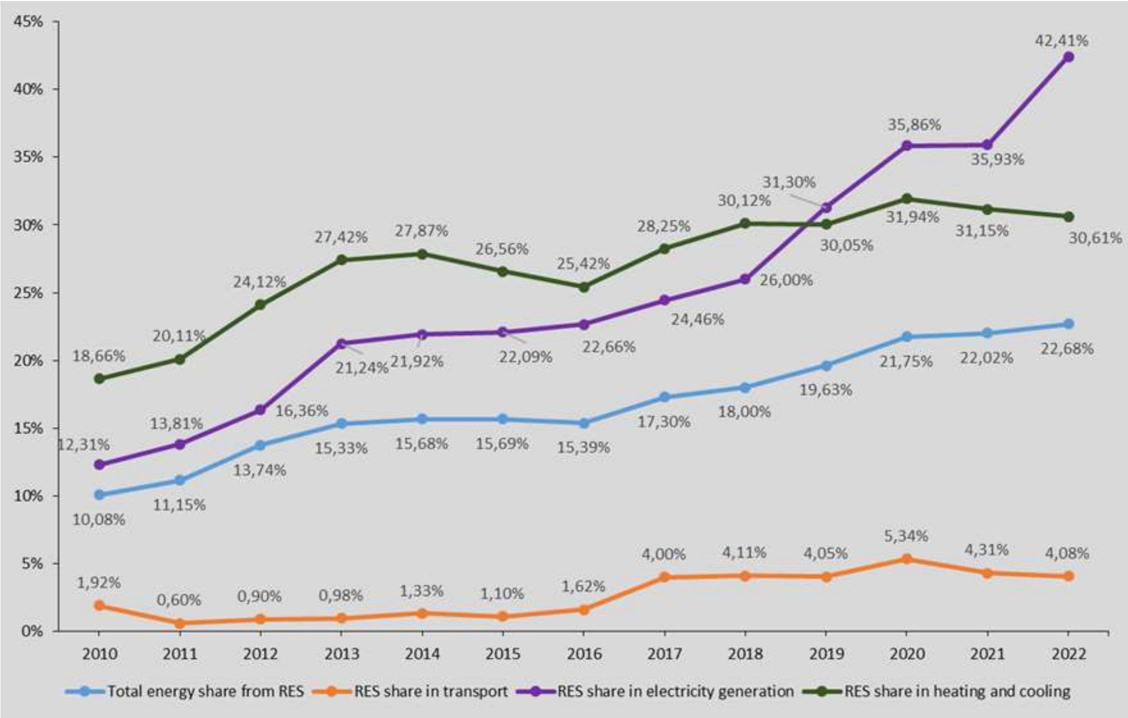


Source: PPC

5.5 Renewable Energy Sources (RES)

The contribution of RES to electricity generation in Greece shows a significant increase during the period 2010-2022, as their total contribution in 2022 amounted to 42.41%, a significant increase since 2010, where their share was 12.31% (Figure 110), according to Eurostat's data.

Figure 110: Total and Specific RES Shares in the Greek Energy System Based on the European Union Methodology, 2010-2022



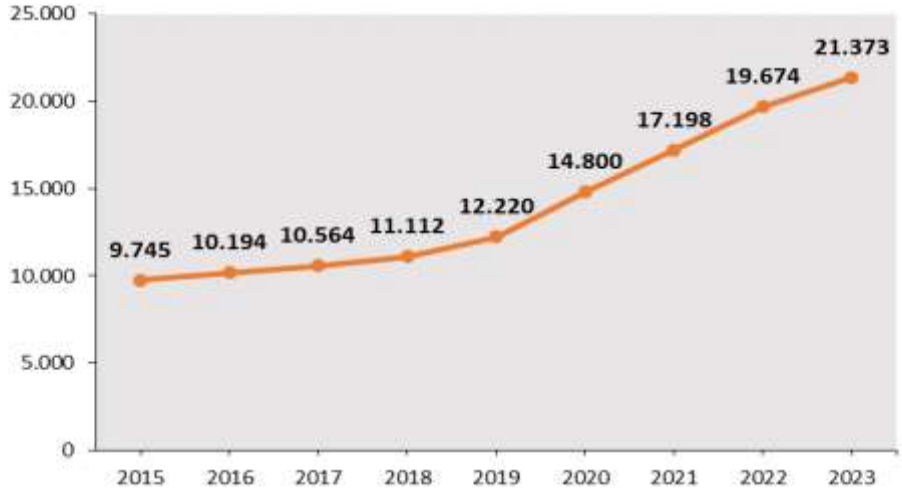
Source: Eurostat

A significant percentage increase is shown in the share of RES in transport from 2016 to 2017, with this percentage being maintained in the following years, reaching 4.08% in 2022. The total share of energy from RES shows a steady increasing trend from 2010 to 2022, while RES for heating and cooling follow a course with fluctuations, ending in 2022 at a share of 30.61%.

5.5.1 Electricity Production from RES

In Greece, electricity generation from RES in the interconnected system reached 21.4 TWh in 2023, up from 14.8 TWh in 2020, according to data from IPTO (Figure 111), a consequence of the rapid growth of installed wind and solar power capacity.

Figure 111: Electricity Generation from RES in Greece, 2015-2023 (GWh)



Source: IPTO

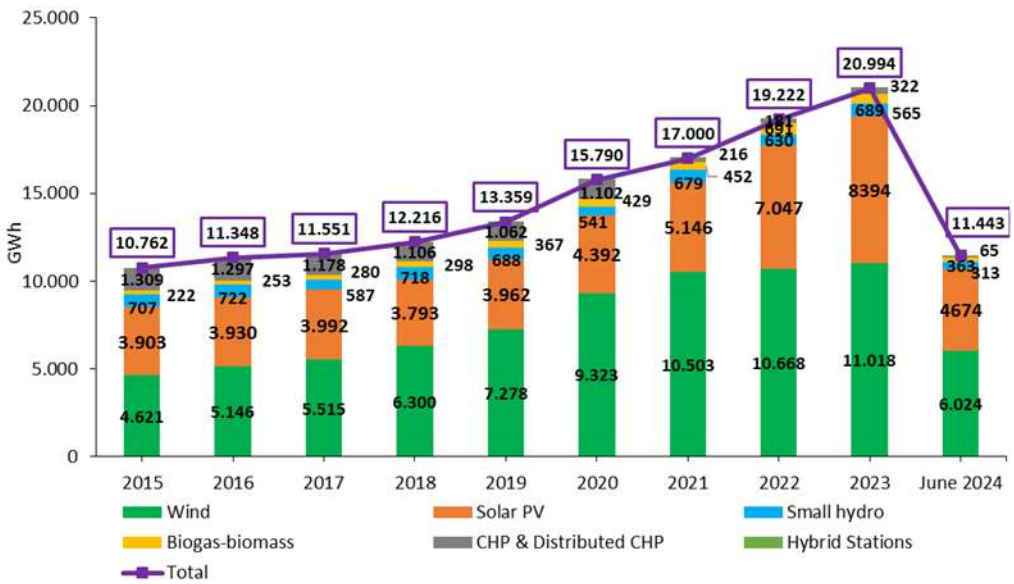
According to DAPEEP data [108], the total energy production in Greece from wind in the Interconnected System amounted to 10,791 GWh in 2023, while small hydroelectric plants and biogas-biomass reached 689 GWh and 561 GWh respectively in the same year. In addition, the total energy production of CHP units in the interconnected system reached 322 GWh. Finally, the production from photovoltaics in the interconnected system approached 7.9 TWh in 2023, while the production from photovoltaics of the Special Programme on Rooftops reached 451 GWh (Figure 112). For 2023, total energy production reached 20,668 GWh, an increase of 9.6% compared to 2022 when total energy production reached 18,860 GWh, with wind power accounting for a 52.2% share and photovoltaics following with 40.2%.

Figure 112: Evolution of Energy Production from RES by Technology in the Interconnected System (GWh), 2018 – June 2024

Source: DAPEEP

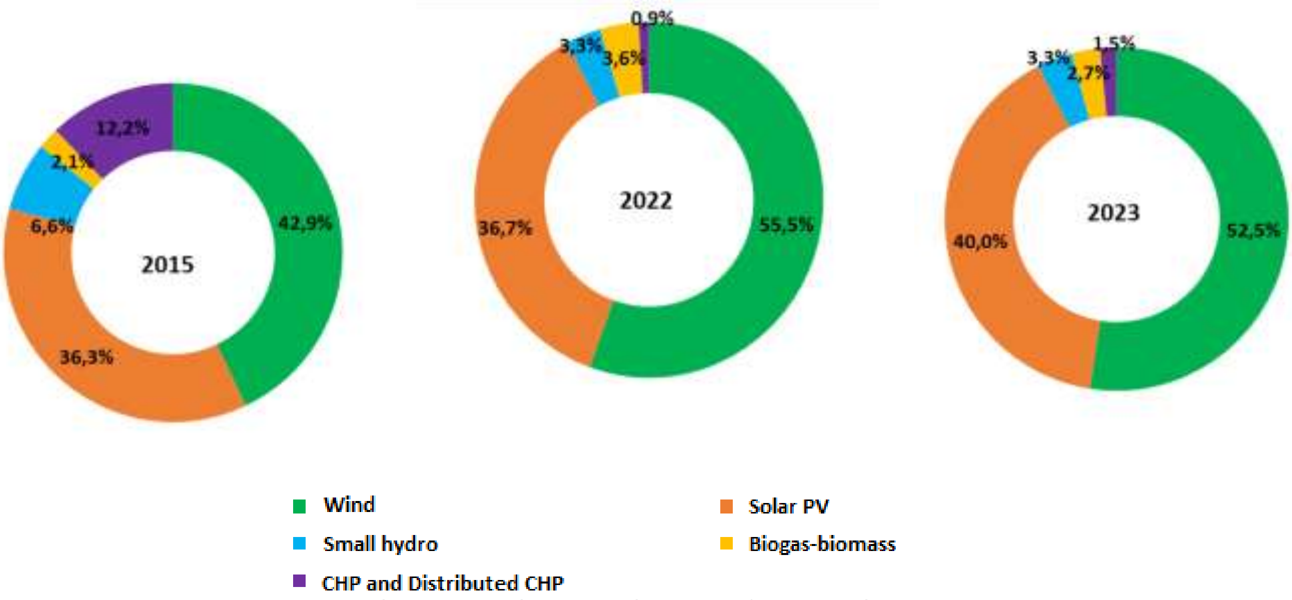
Regarding the entire country, energy production from RES amounted to 21 TWh in 2023, from 10.8 TWh in 2015 and 19.2 TWh in 2022, showing an increase of 95.1% and 9.2% respectively. Wind power accounted for the largest share of energy production in 2023 with a share of 52.5%, from 42.9% in 2015, with a decrease in their share in 2023 compared to 2022 by 3 percentage points, with a simultaneous increase in the share of photovoltaics in the energy mix from 36.7% in 2022 to 40.0% in 2023 (Figures 113 and 114).

Figures 113: Evolution of Energy Production by RES Technology (GWh) in Greece, 2015-June 2024



Source: DAPEEP

Figure 114: Share of Technologies in Energy Production from RES, 2015, 2022 & 2023

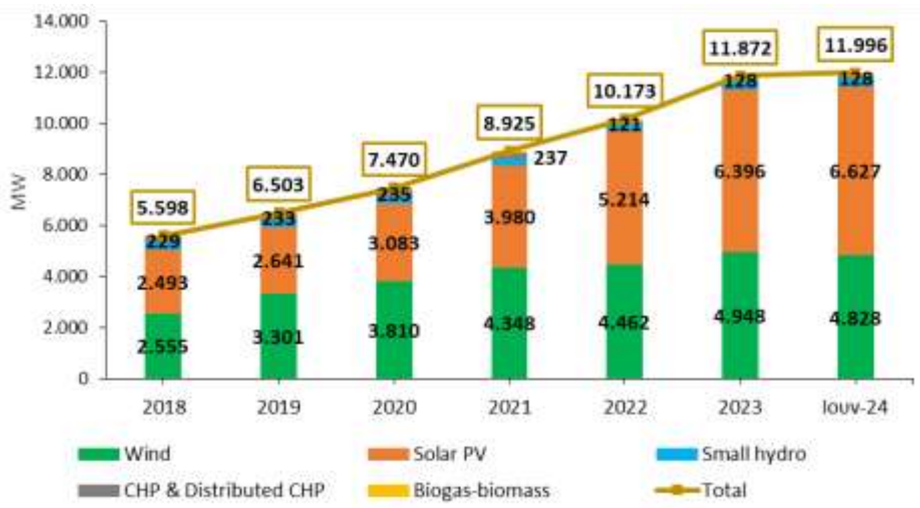


Source: DAPEEP

5.5.2 Installed Capacity from RES

Based on DAPEEP data [109], the total installed capacity of RES units in the Interconnected System of Greece amounted to 11,872 MW in 2023 (Figure 115), with the vast majority of this being based on photovoltaics (54%) and wind (42%).

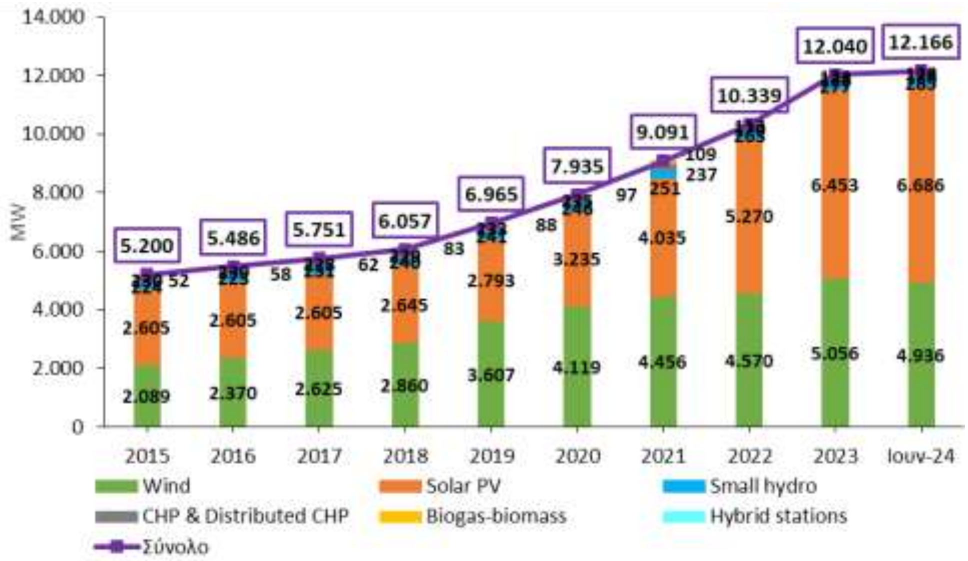
Figure 115: Evolution of Installed Capacity in the Interconnected System (MW), 2018-2022



Source: DAPEEP

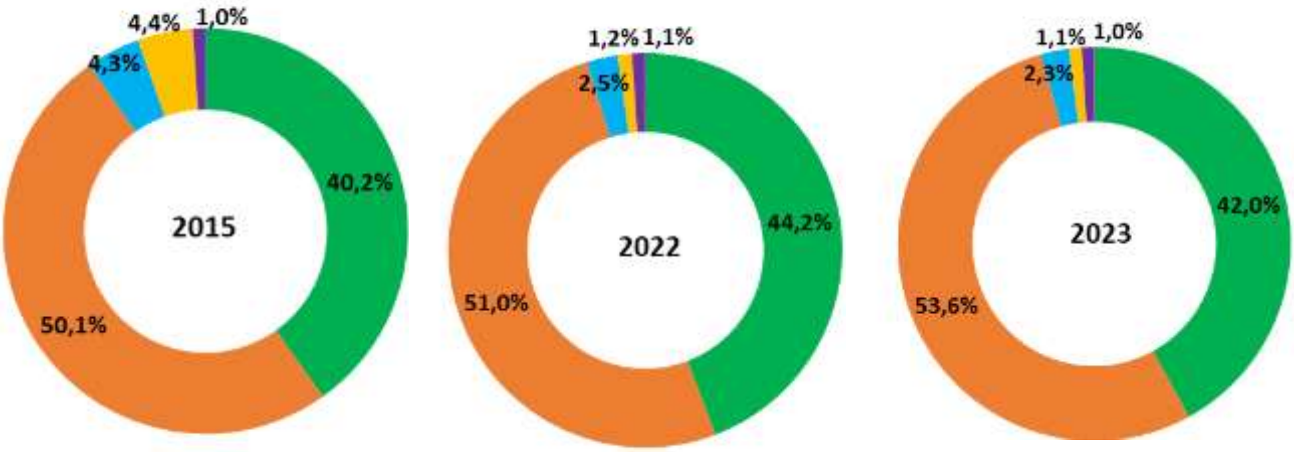
Across the country, the installed capacity of RES projects reached 12,040 MW in 2023, with photovoltaics accounting for 53.6% of the total installed capacity, followed by photovoltaics which accounted for 42.0% (Figures 116 and 117).

Figure 116: Evolution of Installed Capacity in Greece by RES Technology (MW), 2015-June 2024



Source: DAPEEP

Figure 117: Percentage of Installed RES Capacity by Technology in Greece, 2015, 2022 and 2023



Source: DAPEEP

5.5.3 Onshore Wind

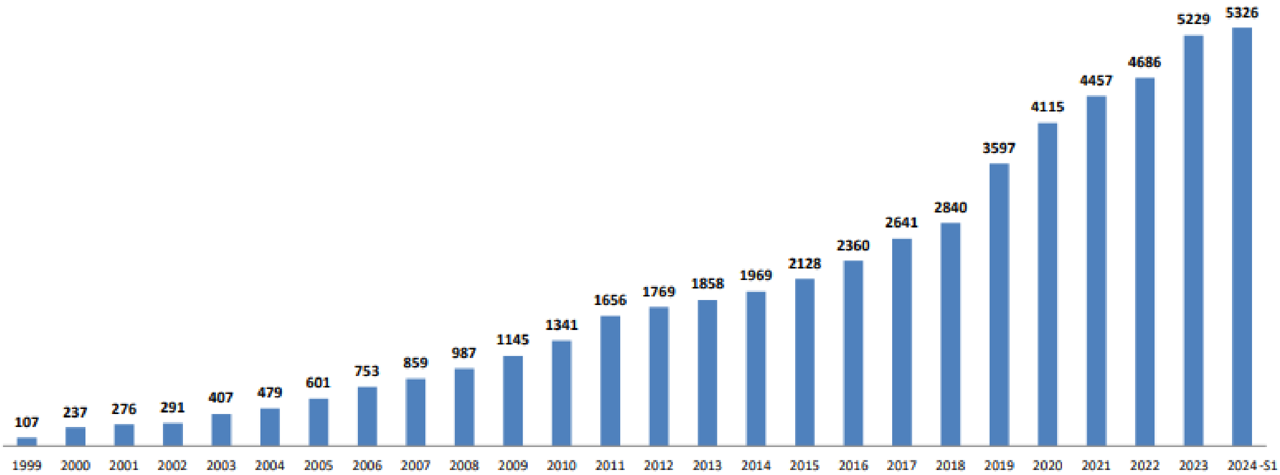
According to the annual Wind Energy Statistics in Greece announced by the Hellenic Wind Energy Association (ELETAEN), the total wind power in Greece at the end of 2023 was 5,229 MW, exceeding the 5,000 MW milestone for the first time, while by June 2024 it reached 5,326 MW (Figure 118) *[110]*.

According to Statistics, in 2023, 153 new wind turbines with a total installed capacity of 542.8 MW were connected to the grid, corresponding to investments of over €600 million. This is an increase of 11.6% compared to the end of 2022.

2023 is the second -after 2019- best year with the most wind installations. The acceleration of growth is due to the gradual completion of large wind investments thanks to the efforts of businesses, the scientific community and wind energy professionals operating in Greece. 2023 is a milestone year because for the first time, the installed wind power in Greece exceeded 5,000 MW. The marginal wind turbine that led the total power to exceed 5,000 MW is a wind turbine in the Kafireas wind farm in Evia that was connected to the grid in the 2nd half of 2023 *[111].*

At the end of 2023, over 850 MW of new wind farms were under construction or had been contracted, of which over 300 MW are expected to be connected to the grid within the next 12 months. To these must be added another 400 MW that have been selected in tenders, have submitted performance bonds but do not belong to any of the above categories. As a result, the total wind power will approach 6.5 GW within the next three years [111].

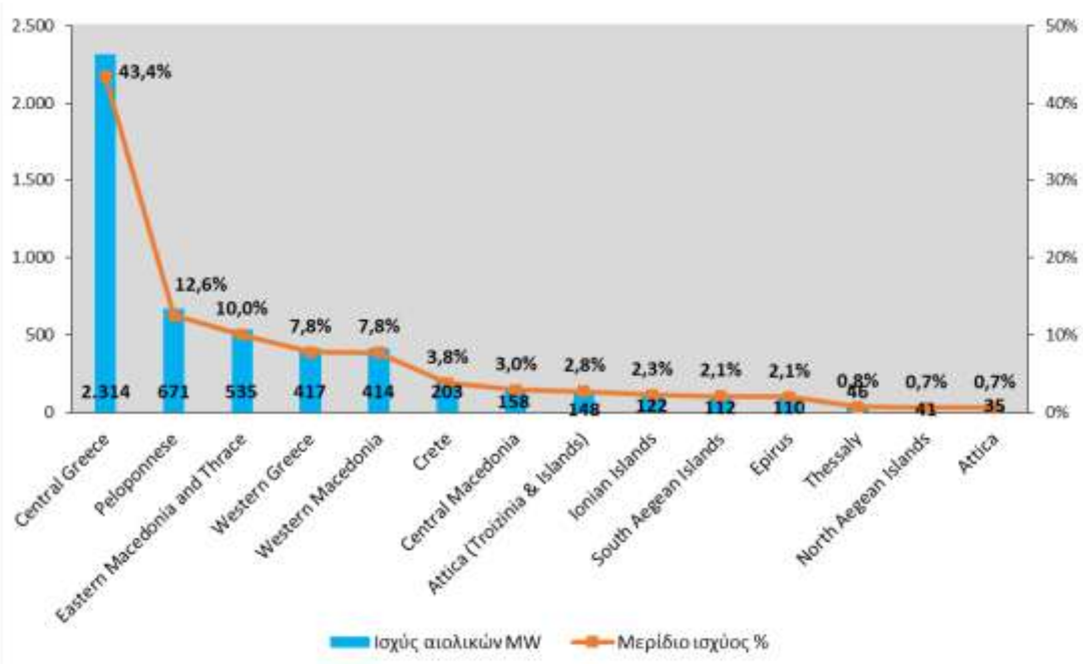
Figure 118: Evolution of Installed Capacity (MW) of Onshore Wind in Greece, 1999-first half of 2024



Source: ELETAEN

At the regional level, Central Greece remained at the top of wind installations in the first half of 2024, hosting 2,314 MW (43.4%), followed by Peloponnese with 671 MW (12.6%) and Eastern Macedonia - Thrace with 535 MW (10.0%).

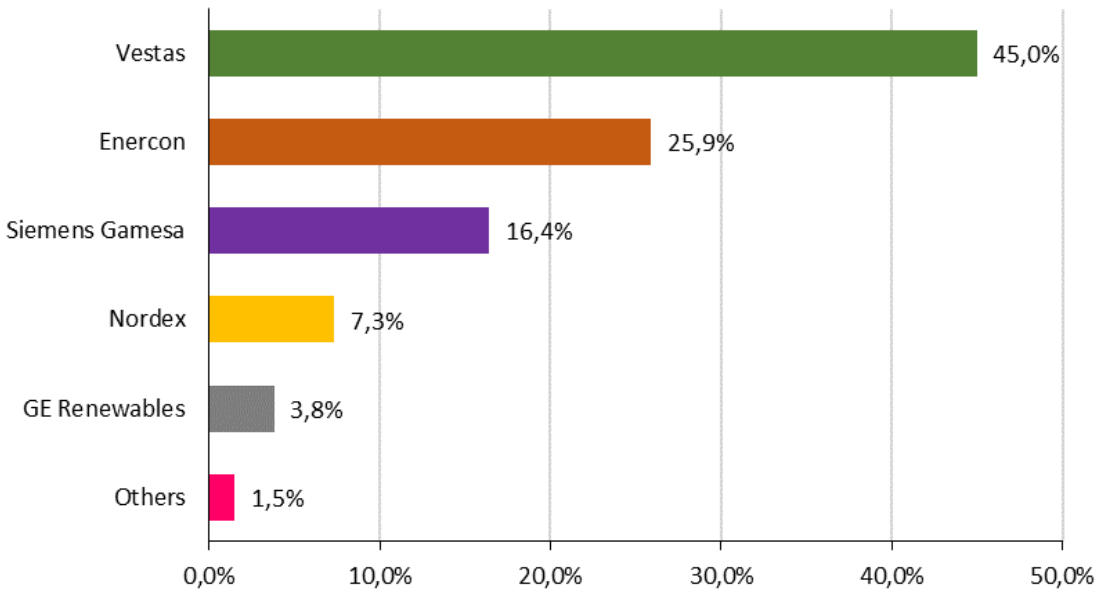
Figure 119: Geographical Distribution of Wind Power by Region (MW), First Half of 2024



Source: ELETAEN

Regarding wind turbine manufacturers, Vestas has supplied 45.0% of the total installed wind power in Greece, Enercon 25.9%, Siemens Gamesa 16.4%, Nordex 7.3% and GE Renewable Energy 3.8% (Figure 120) [111].

Figure 120: Share of Wind Turbine Manufacturers in Total Installed Wind Power in Greece, 2023



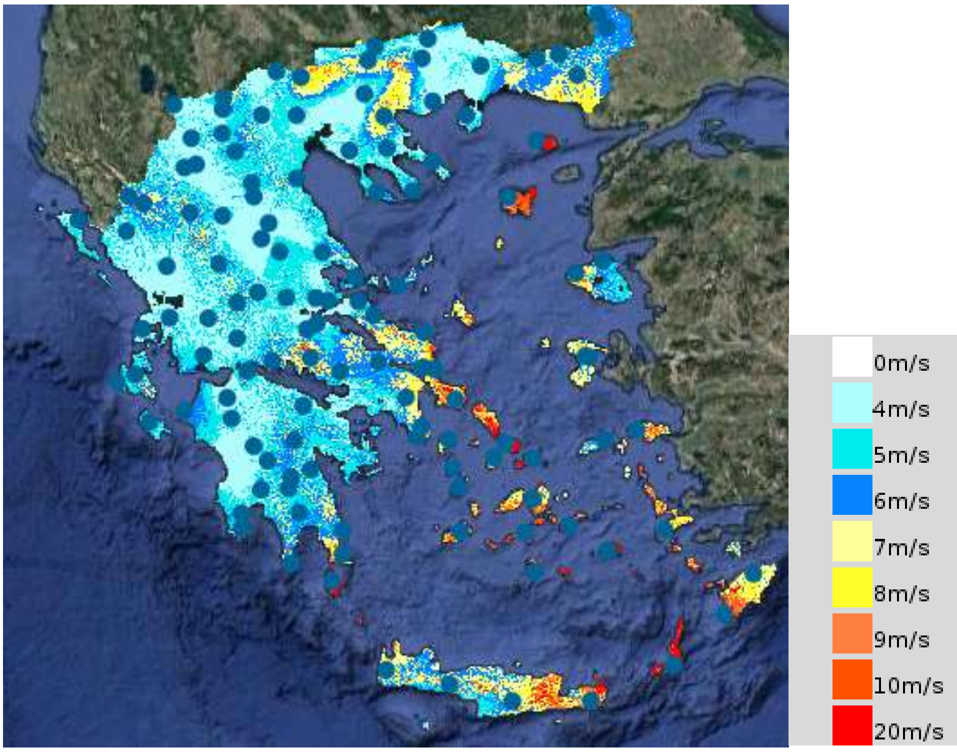
Source: ELETAEN

During 2023, in the Greek Interconnected System [111]:

- the highest hourly penetration of wind power was 86% and was observed on Sunday 10.09.2023 (04:00 – 05:00),
- for a total of 2,117 hours of the year, the penetration of wind power was above 30% of energy demand,
- for a total of 4,737 hours, the penetration of variable RES was above 30% and for 1,717 hours it was above 60%,
- the total hourly penetration of RES exceeded 100% of demand for 120 hours during 2023.

Greece's high wind potential is found mainly in its island regions (e.g. Crete, Aegean, Evia, etc.), where most wind farms are currently located. The exploitation of wind potential, combined with the improvement of the technologies incorporated in modern wind turbines, is expected to contribute significantly towards sustainable development.

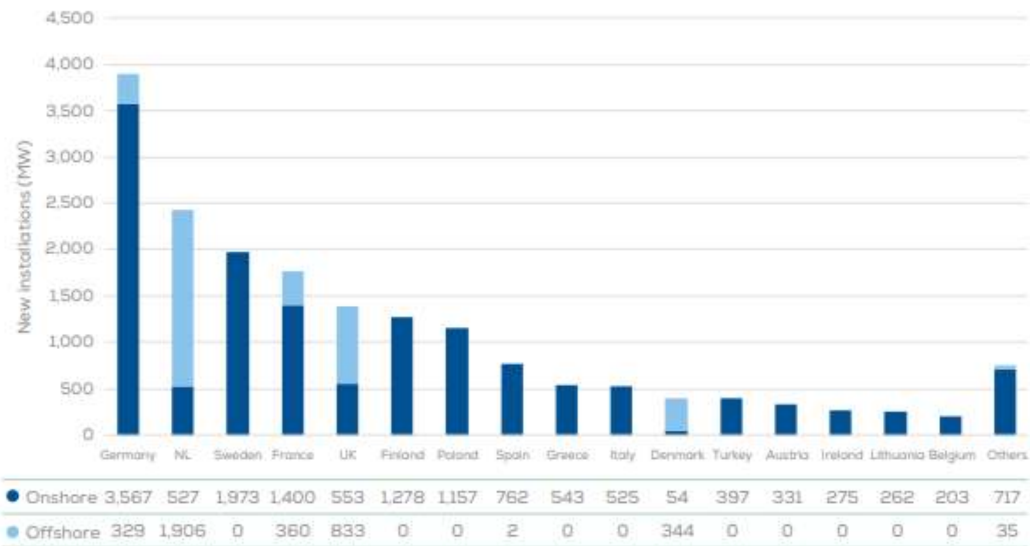
Map 38: Wind Potential in Greece, 2024



Source: RAAEY [112]

Greece ranked ninth in Europe in terms of new wind installations in 2023, surpassing countries such as Italy and Denmark with 543 MW. As a result, installed capacity now reached 5,226 MW, while it is noteworthy that additions in 2023 were more than double compared to 2022.

Figure 121: New Installed Capacity (MW) of Onshore and Offshore Wind by Country In Europe, 2023

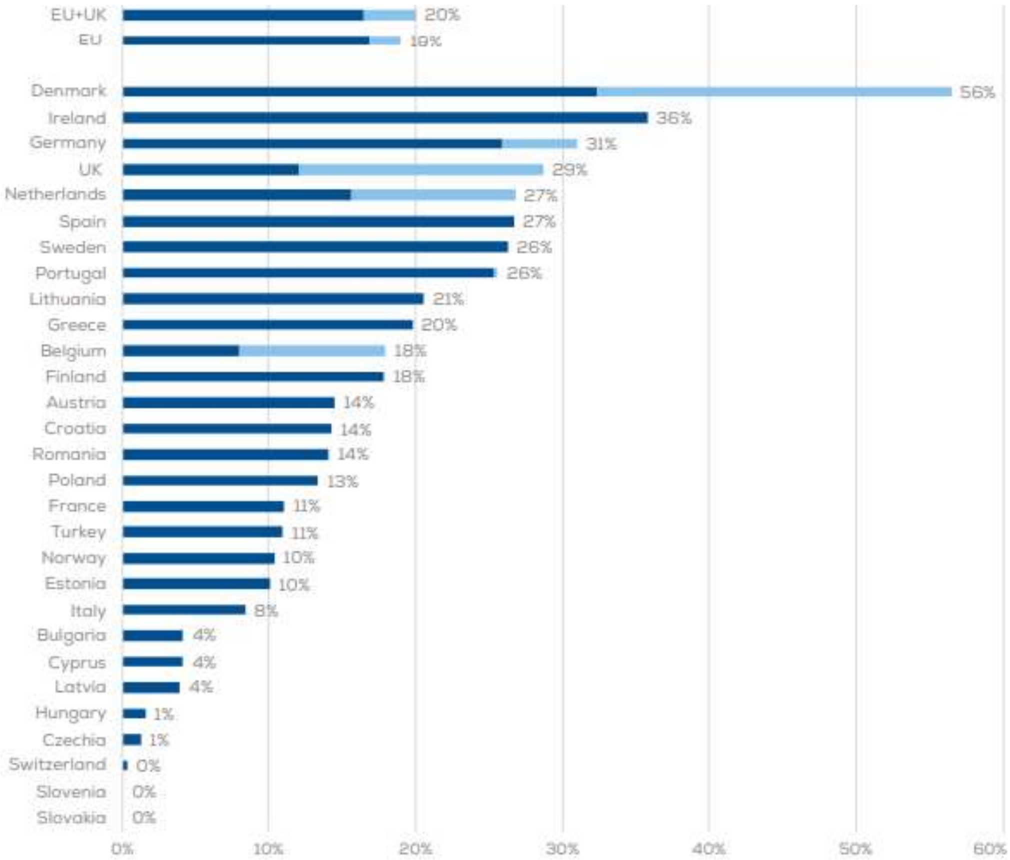


Source: WindEurope

According to the annual report of the WindEurope association "Wind energy in Europe - 2023 Statistics and the outlook for 2024-2030" [113], Greece is slightly above the European average

(19%) in terms of the degree of penetration of wind power in electricity demand with a percentage of 20% and ranks 10th on the list.

Figure 122: Percentage of Electricity Demand Covered by Wind Energy in Various EU Countries, 2023



Source: WindEurope

5.5.4 Offshore Wind

The legislative framework governing offshore wind development in our country is defined by Law 4964/20223. Based on the definition of Law 4964, Article 65, paragraph 11, Offshore Wind Farm (OWF) is defined as "The array of wind turbines producing electricity located in the sea area, whether they are permanently based on the seabed, or floating and connected to the seabed by mobile means".

According to the above law, the responsible body on behalf of the Greek state is the HEREMA with regard to the management of rights relating to the research, exploration and determination of the Organized Development Areas of the WFP (POAYAP), as well as the assignment of research rights to third parties in the said development areas.

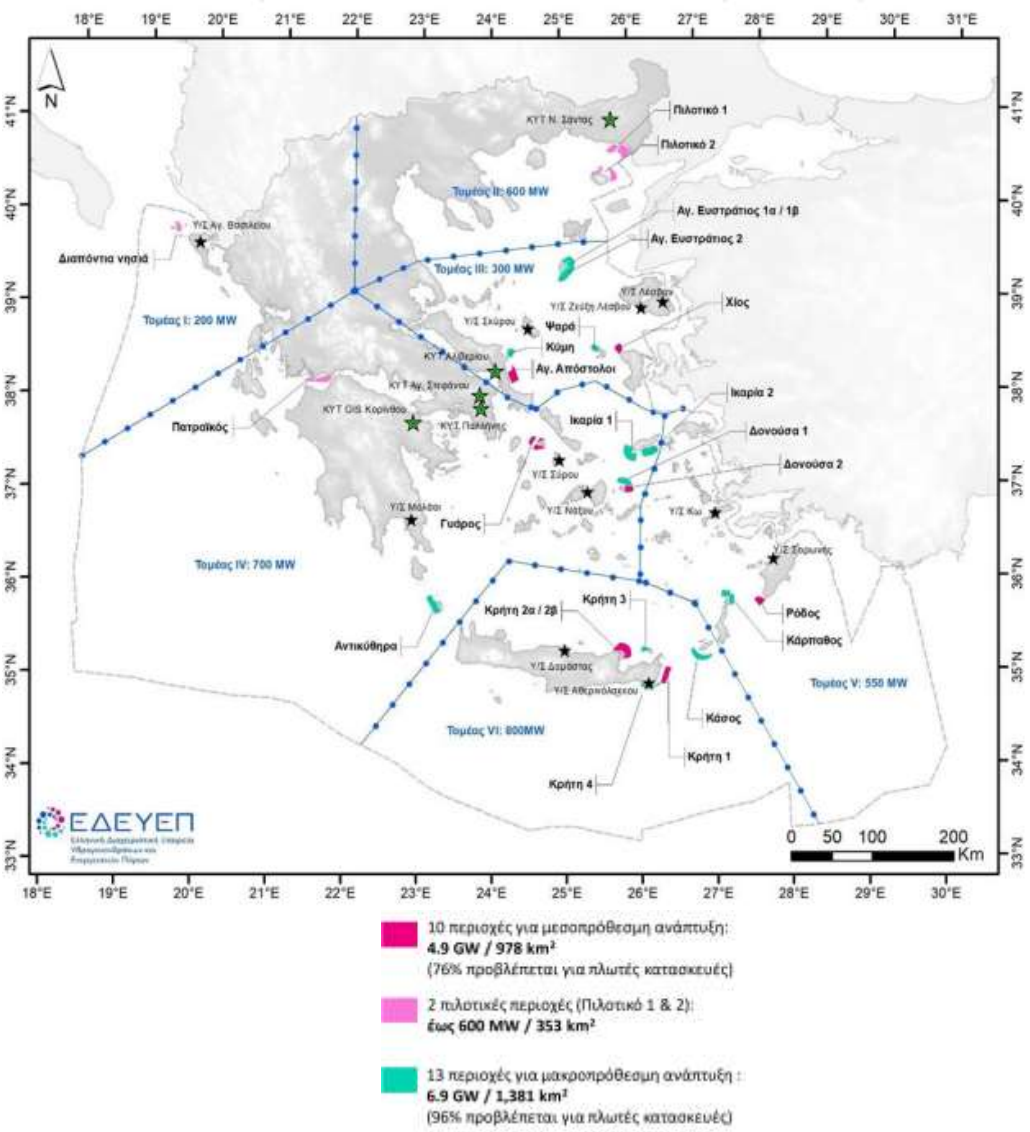
In September 2023, the National Offshore Wind Farm Development Programme was presented by HEREMA [114], which identifies the eligible POAYAP proposed for their development in the medium and long term and are as follows:

Medium-term development areas (until 2030-2032): 10 potential POAYAP covering an area of 978 km2 with a total estimated capacity of 4.9 GW, with the largest number of these being suitable for floating base HAP (7 out of 10 potential POAYAP).

Long-term development areas (after 2030-2032): 13 potential POAYAP covering an area of 1,381 km2 with a total estimated capacity of 6.9 GW, with the largest number of these being suitable for floating base HAP (12 out of 13 potential POAYAP).

The draft National Hydropower Development Programme includes 2 additional pilot areas, totaling 25 areas, with a total area of 2,712 km2 and an estimated minimum capacity of 12.4 GW. The majority of the proposed sea areas are suitable for floating hydropower technology, as described in Map 39 [115].

Map 39: Potential POAYAP – Prioritization for Development



Source: HEREMA

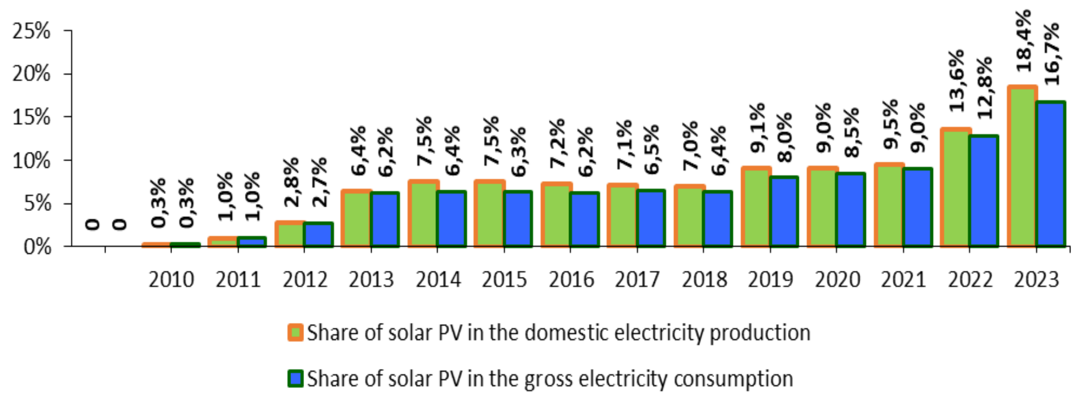
According to the country's preliminary energy planning, the target for Offshore Wind Farms (OWFs) is 1,900 MW in 2030 and 6,200 MW in 2035. The target for 2050 is 17,300 MW. Achieving these targets requires significant investments: over €6 billion by 2030 and over €28 billion by 2050. These investments can and are expected to have a high Greek added value (almost 67%).

Regarding the European reality, the cumulative installed offshore wind capacity in Europe by the end of 2023 was approximately 34.24 GW with 3.8 GW added in 2023, according to data from Wind Europe [113]. The largest proportion of this came from the United Kingdom (14.76 GW), followed by Germany (8.54 GW), the Netherlands (4.74 GW), Denmark (2.65 GW) and Belgium (2.26 GW).

5.5.5 Solar PV

In 2023, Greece was first in Europe in terms of the percentage of domestic electricity generation produced by photovoltaics, with a percentage more than double the European average of 8.6% and more than triple the global average of 5.4% [116].

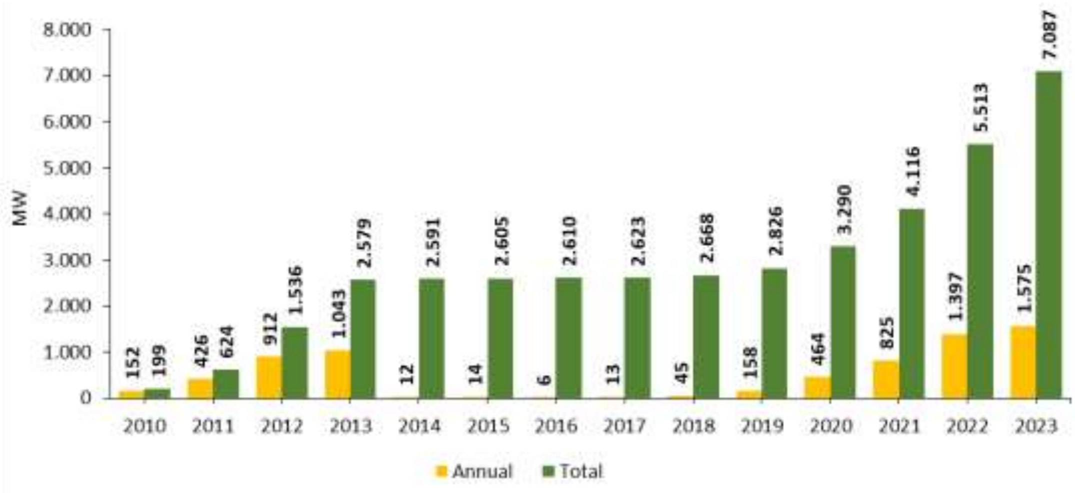
Figure 123: Share of Solar PV in Domestic Electricity Production and Gross Electricity Consumption, 2010-2023



Source: HELAPCO

According to HELAPCO's data [117], the Greek solar PV market installed more MWp than any other technology in 2023, a result of the huge investment interest that continues unabated. Specifically, photovoltaics accounted for 74% of all new installed capacity from RES in 2023.

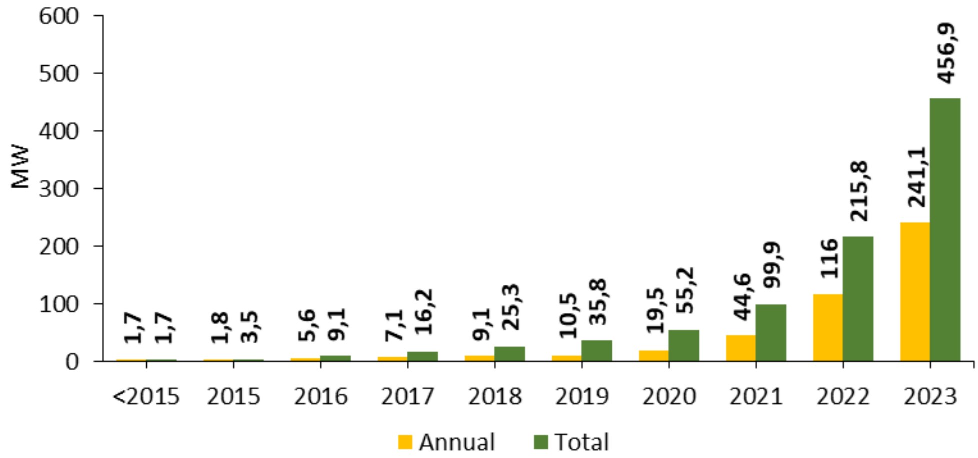
Figure 124: Annual and Total Installed Capacity of Interconnected Solar PV Systems, 2010-2023



Source: HELAPCO

In 2023, the market for self-generation systems was growing, but at a slower pace than in the previous year. Specifically, 241 MWp of new systems with energy offset or virtual net metering were installed, bringing the total capacity of this category to 457 MWp (Figure 125).

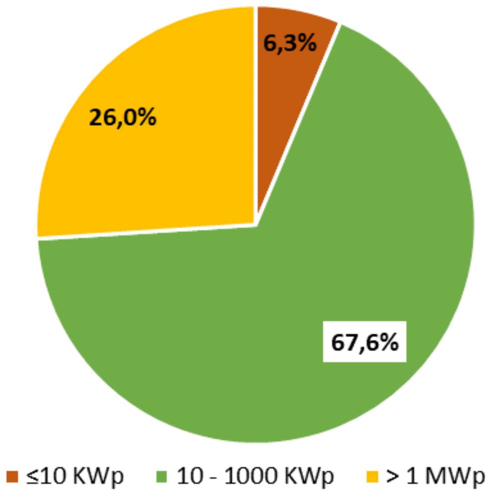
Figure 125: Annual and Total Installed Capacity of Self-generation Solar PV Systems, 2015-2023



Source: HELAPCO

In addition, within 2023, 1,795 small battery systems were interconnected with a production of 12.66 MWh, within the framework of the "Photovoltaics on the Roof" programme [117].

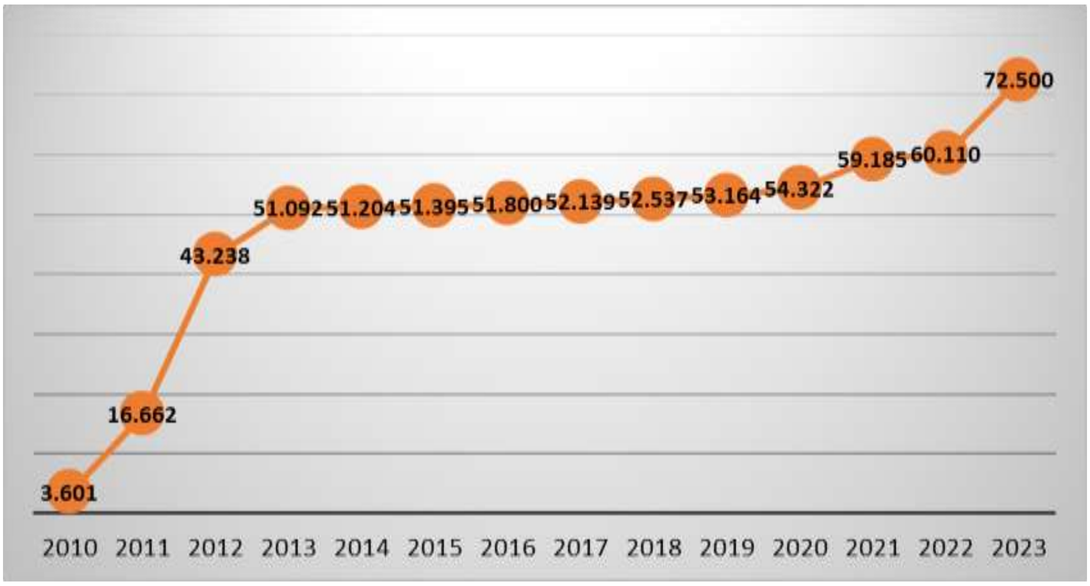
Figure 126: Market Share by Size in Total Installed Capacity, 2023



Source: HELAPCO

Figure 127 shows the growth of installed solar PV systems from 2010 to 2023, showing an annual growth rate of 26% in the period 2011-2023 [117].

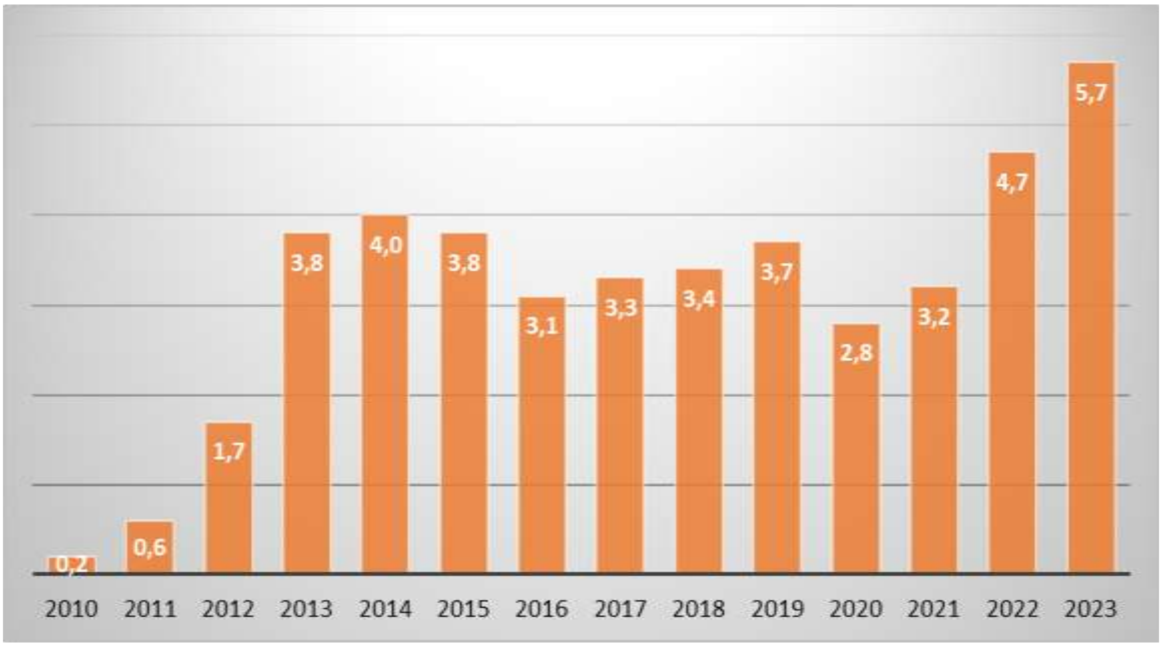
Figure 127: Number of Connected Solar PV Systems, 2010-2022



Source: HELAPCO

According to the HELAPCO, thanks to photovoltaics, the emission of 5.7 million tons of CO2 was prevented in 2023. This is the amount of CO2 emitted by 4.6 million new cars with internal combustion engines, each of which travels an average of 10,000 kilometers per year. The environmental benefit is equivalent to planting 147.6 million conifers or 90.1 million deciduous trees within the urban fabric during their development for a decade.

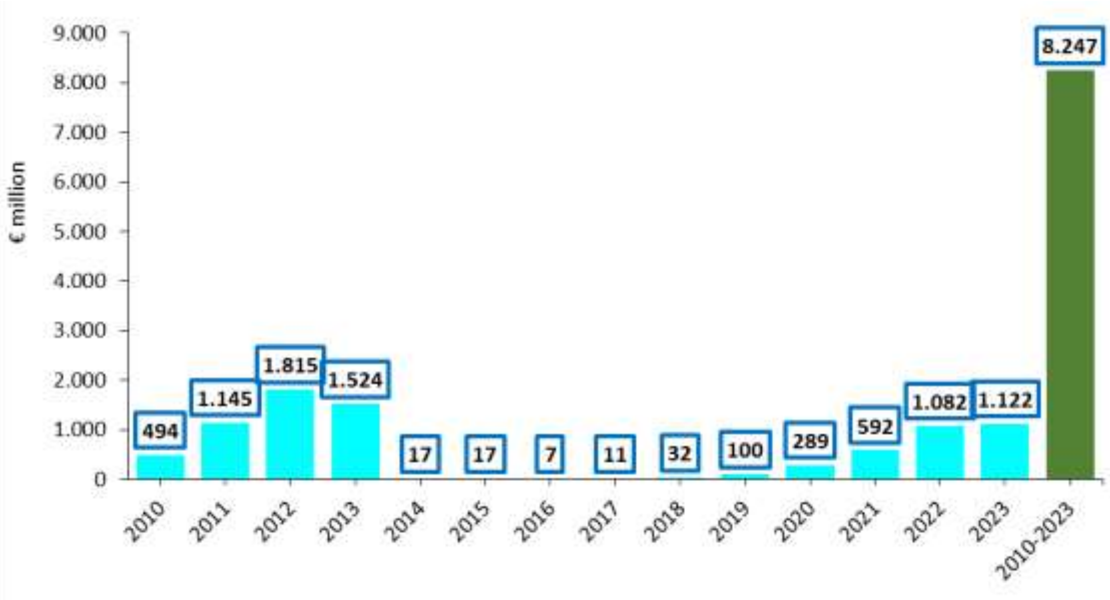
Figure 128: Less CO2 Emissions Due to Solar PV (million tons), 2010-2023



Source: HELAPCO

In 2023, €1.12 billion were invested in new photovoltaic projects in Greece, with the total amount in the period 2010-2023 amounting to €8.3 billion (Figure 129).

Figure 129: Solar PV Investments (€ Millions) in Greece, 2010-2023



Source: HELAPCO

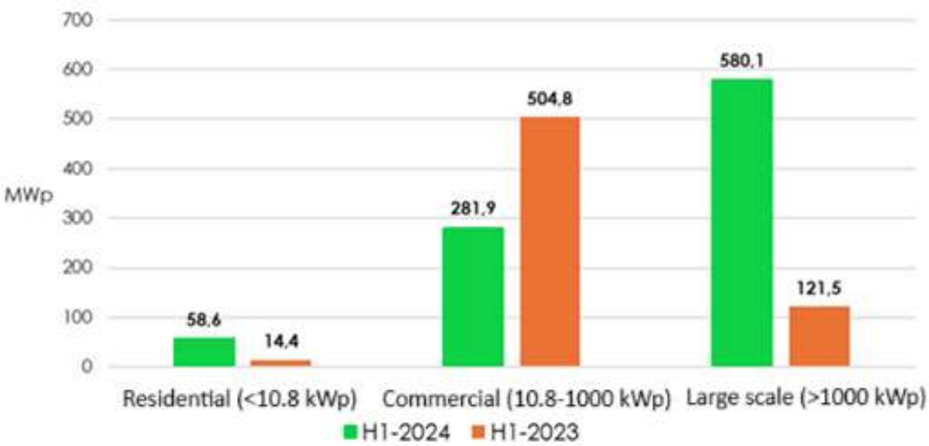
Regarding the first half of 2024, [118] 920.6 MWp of photovoltaics were interconnected, while the installed capacity of new systems increased by 43.7% compared to the corresponding period last year, with the total installed capacity of photovoltaics by the first half of 2024 reaching 8,024 MWp. In residential systems (due to the "Photovoltaics on the Roof" programme), new installations were four times higher than in the corresponding period of 2023. New photovoltaic interconnections in the first half of 2024 were almost ten times higher than those of wind (97 MW) for the corresponding period (Table 26).

Table 26: New Installed Capacity (MW) of Solar PV Systems in the First Half of 2024

MWp				
Category	**Net Metering**	**Virtual Net Metering**	**Energy sale**	**Total**
Residential (≤10,8 kWp)	58,254	0,3	-	**58,55**
Commercial (10,8-1000 kWp)	89,618	15,936	176,374	**281,93**
Large scale (>1000 kWp)	22,323	1,395	556,345	**580,06**
Total	**170,195**	**17,631**	**732,719**	**920,55**

Source: HELAPCO

Figure 130: Market Comparison in the First Half of 2024 Compared to the Corresponding Period in 2023

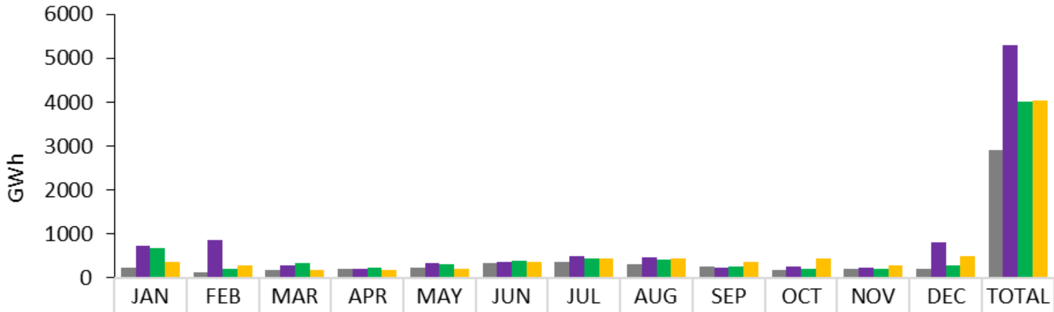


Source: HELAPCO

5.5.6 Hydro

Electricity production from hydroelectric projects decreased in 2023 compared to 2022 and especially to 2021. Specifically, according to data from IPTO [83], in 2023, 4,047 GWh were produced, which was an increase of only 1.0% compared to 2022, but was 23.6% lower than 2021, mainly due to the drought in the summer of 2023.

Figure 131: Electricity Generation from Hydro (GWh), 2020 - 2023



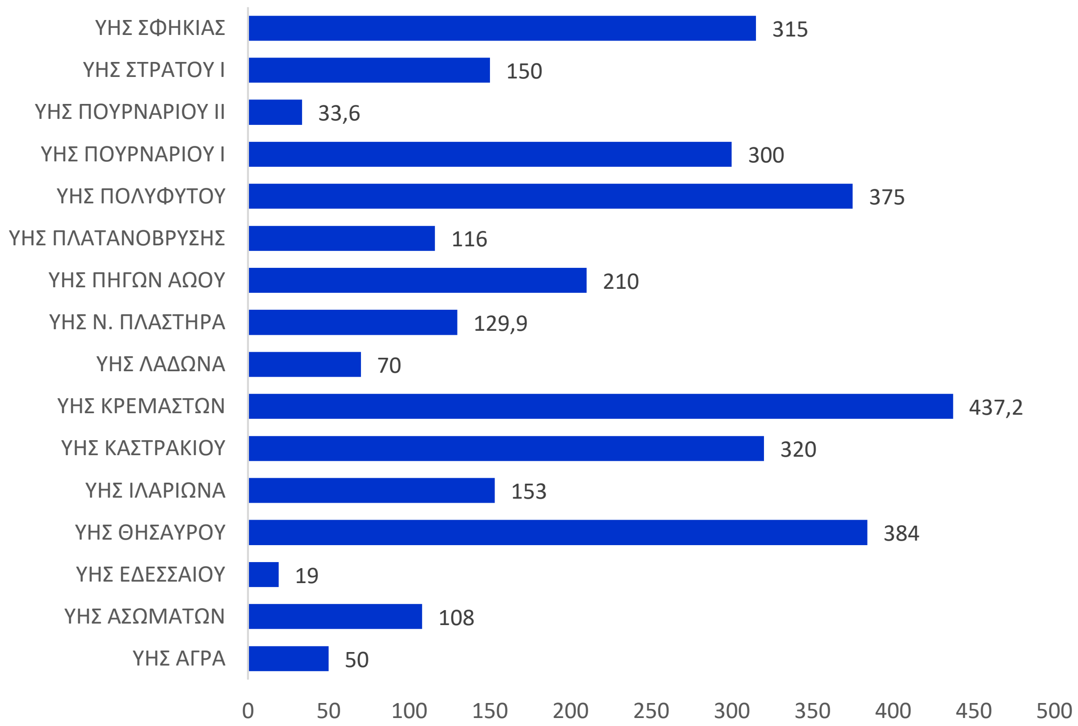
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
2020	231	129	179	211	245	348	377	324	271	182	206	197	2.900
2021	742	864	275	218	328	367	500	459	240	253	233	814	5.294
2022	683	206	338	228	312	379	448	429	270	207	212	294	4.006
2023	353	287	187	176	217	371	432	436	360	441	289	499	4.047

2020 2021 2022 2023

Source: IPTO

The total capacity of hydroelectric plants in Greece by the end of 2023 was 3,171 MW, with a net production of 4,047 GWh, as shown in Figure 132.

Figure 132: Net Capacity of Hydroelectric Plants in Greece (MW), December 2023



Source: IPTO

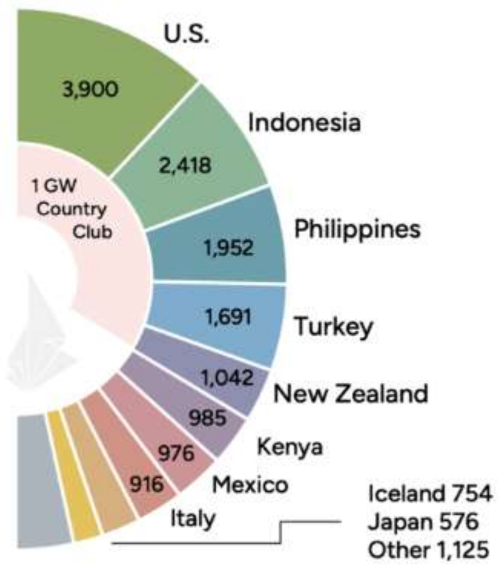
Regarding small hydro power plants, according to the data of DAPEEP of December 2023 [84], their total capacity reached 277 MW and energy production reached 689 GWh throughout Greece.

5.5.7 Geothermal

Geothermal energy is a mild and renewable form of energy, produced by exploiting underground geothermal potential. It has a minimal to zero environmental footprint and can, with current technological capabilities, produce thermal or/and electrical energy. In order for an underground hot fluid to be considered to have geothermal potential, its temperature must exceed 30°C. It has the smallest CO_2 footprint among other RES and is used in electricity generation, heating of facilities and buildings, water desalination, greenhouses, drying of products, other mild industrial uses and spa tourism. For example, it can provide heat to a city, through central heating or in greenhouses without the need to use another fuel to maintain a constant temperature within the facilities. Specifically, geothermal energy provides heat to greenhouses in Maggana, Xanthi and in Chrysoupoli, Kavala. Basic uses of geothermal energy worldwide concern the heating of greenhouses and aquaculture, drying of agricultural products, desalination of water to cover water supply, other mild industrial uses, but also for district heating of buildings, settlements, villages and even cities.

The global installed capacity of geothermal applications in electricity generation worldwide by the end of 2023 reached 16,355 MW, showing an increase of 481 MW compared to 2022, with the US leading with 3,900 MW *[119].*

Figure 133: The 10 Countries with the Largest Installed Geothermal Capacity in 2023

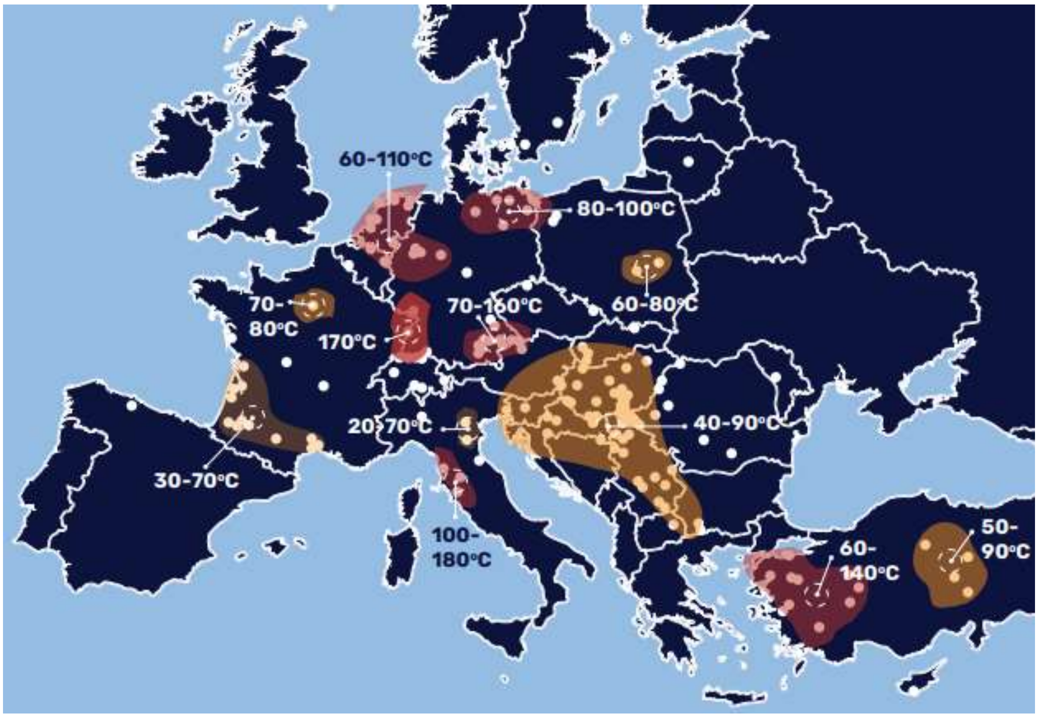


Source: ThinkGeoEnergy

According to a report by the European Geothermal Energy Council (EGEC) [120] at the end of 2023, there were over 3.5 GWe of geothermal electricity generation capacity in Europe distributed across 143 operational plants, producing 20 TWh/year, with the EU contributing around 7 TWh/year.

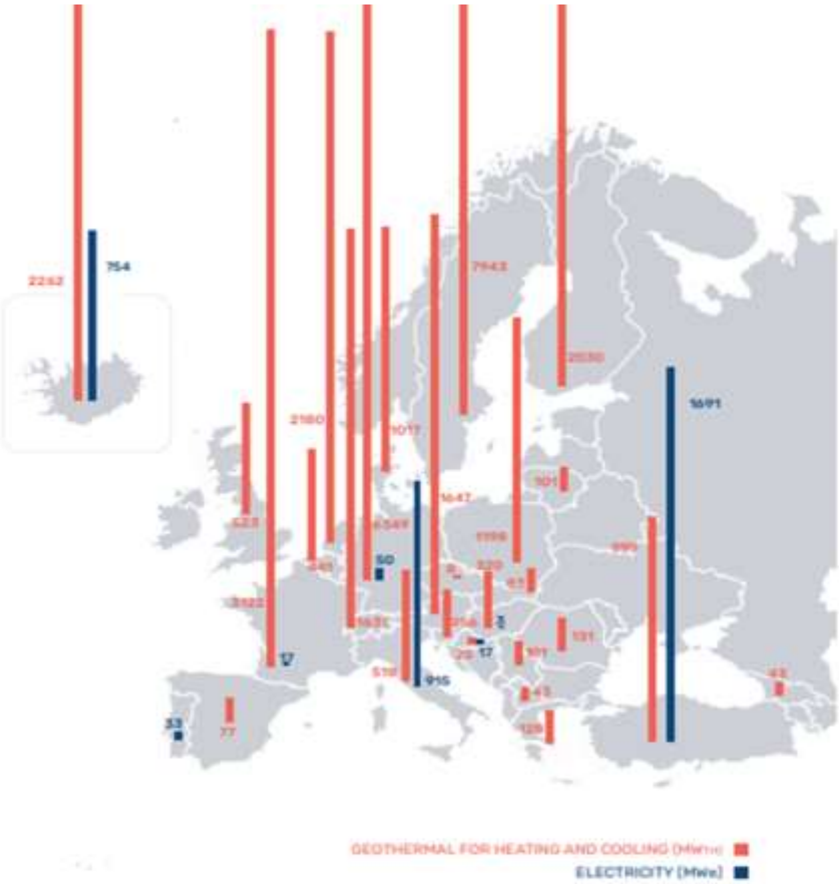
According to the same report at the end of 2023, there were 401 geothermal sources in Europe, with 298 of them in EU Member States. The total installed geothermal capacity in Europe for heating and cooling reached 6 GWth in 29 countries. Eight new systems came on stream in the EU in 2023, adding 33.9 MWth to European geothermal heating and cooling. In addition, 64 new projects were announced, with significant developments in Germany, the Netherlands and Croatia. France remains the leader in geothermal heating capacity in the EU, second only to Iceland in Europe.

Map 40: Mapping the Main Geothermal District Heating and Cooling Reservoirs in Europe in 2023



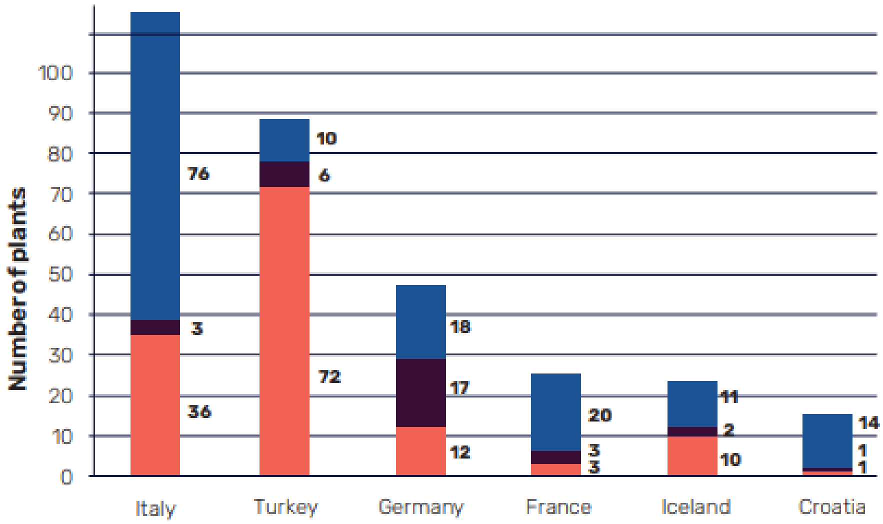
Source: EGEC

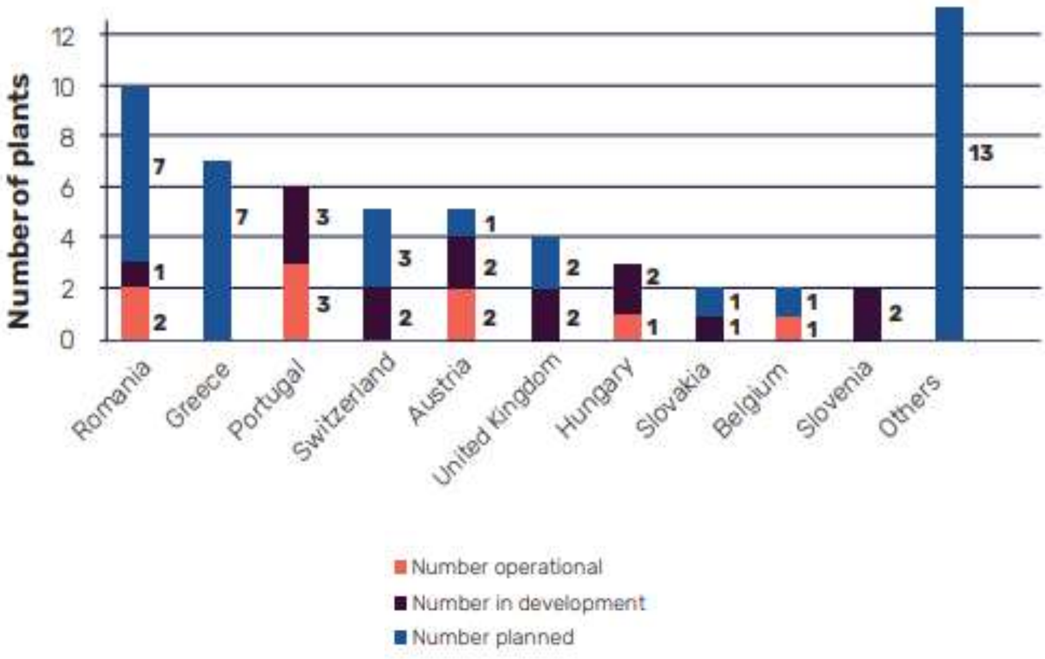
Figure 134: Installed Geothermal Capacity for Electricity and Heating/Cooling in 2023



Source: EGEC

Figure 135: Number of Geothermal Power Plants in Europe in 2023





Source: EGEC

Geothermal energy is a stable source of clean energy and can also contribute to reducing energy costs for households and businesses and be applied to a wide range of activities, from electricity production and the agricultural sector to spa tourism. After all, geothermal energy is one of the pillars of the National Energy and Climate Plan.

In our country, there is strong investment interest in the market, with emphasis mainly on the geothermal fields of the Aegean but also in other regions such as central and eastern Macedonia, Thrace and Eastern Central Greece. PPC Renewables, by selecting a strategic partner, has already set as its priority the issue of exploiting the four high-enthalpy geothermal fields in Lesvos, Milos-Kimolos-Polyaigos, Nisyros and Methana [121].

Despite the significant geothermal potential of the Greek area, the utilization of geothermal energy is very limited with current zero electricity production and with many geothermal applications for direct use either abandoned or not completed.

Map 41: Existing Proven and Potential Geothermal Fields in Greece

Source: MoEE

The direct (thermal) uses of geothermal energy, according to a conference of the North Aegean Region [122] described in Table 27:

Table 27: Geothermal Uses in Greece, 2023

Χρήση	Εγκατεστημένη Ισχύς (MW)
Λουτροθεραπεία	43,0
Θέρμανση Θερμοκηπίων	36,35
Αφυδάτωση αγροτικών προϊόντων	0,30
Θέρμανση χώρων	0,55
Θέρμανση εδαφών	1,00
Υδατοκαλλιέργειες	3,86
Υποσύνολο (άμεσες χρήσεις)	**85,06**
Γεωθερμικές Αντλίες Θερμότητας (κατ' εκτίμηση)	190,0
Σύνολο	**275,06**

Source: Hellenic Survey of Geology & Mineral Exploration (HSGME)

Greece has a rich geothermal potential and an important step towards the development of geothermal energy and the exploitation of Greece's rich geothermal potential was taken in May 2021 with the publication of the Geothermal Works Regulation of the Ministry of Environment and Energy (Government Gazette 1960/B/14-5-2021) issued under the authority of Article 11 of Law 4602/2019 (A' 45). The Regulation contains innovative regulations concerning the terms and methods of carrying out research, exploitation or management of geothermal potential, as well as any other matter related to rational activity, health and safety and environmental protection, while it applies to any area for which research, exploitation and management rights exist in accordance with applicable legislation, within which the work is carried out.

Following the publication of the new Geothermal Works Regulation, the Ministerial Decision was issued on the terms and procedure for leasing research, exploitation and management rights in geothermal fields of national interest (T>90oC) and undesignated areas (Government Gazette B’ 1460/2022).

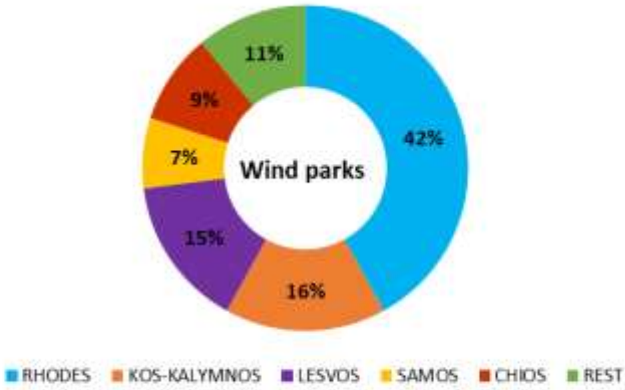
On January 18, 2024, a European Parliament resolution on geothermal energy (2023/2111(INI)) was issued, which is intended to serve as a guide for developments within the EU in the field of geothermal energy either as a source of electrical and thermal energy production, or as an energy saving technology (geothermal pumps). The resolution calls on the Commission to present an EU geothermal strategy that will provide concrete guidance to Member States and local administrations to accelerate the development of geothermal energy, and to base its strategy on a comprehensive assessment of the geothermal energy potential in "shallow, medium, deep and ultra-deep subsoil in all 27 Member States".

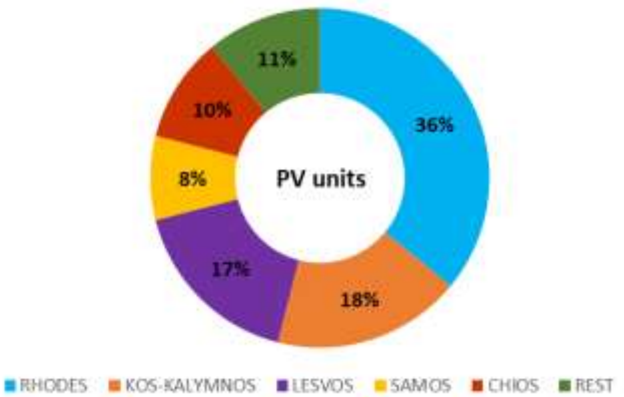
The resolution focuses on the issues of district heating and the use of geothermal heat pumps. It stresses that in areas with insufficient subsoil data, governments can play a role in financing the mapping of geothermal resources and exploratory drilling.

5.5.8 RES on the Islands

According to the HEDNO Information Bulletin for April 2024 [95], in the Non-Interconnected System of Greece, there were 162.46 MW of RES installed, broken down into 108.05 MW of wind farms and 51.45 MW of photovoltaic plants (excluding the power of the Special Programme PV and Net Metering). The power distribution of the 52 wind farms and 641 photovoltaic plants is presented in Figure 136.

Figure 136: Geographical Distribution of Installed RES Capacity in the Non-Interconnected Islands, April 2024





Source: HEDNO

Table 28: RES in the Non-Interconnected Islands

Ομάδες νησιών	Εγκατεστημένα Φ/Β (kW)	Διαθέσιμο περιθώριο για νέα φ/β (kW)	Εγκατεστημένα Αιολικά (kW)	Διαθέσιμο περιθώριο για νέα αιολικά (kW)	Διαθέσιμο περιθώριο για υβριδικά (kW)
Δωδεκάνησα[1]	38.760,2	4.125,4	66.350	11.400,0	31,2 (0,4 MW σε λειτουργία)
Ιόνιο[2]	0,0	86,3	0,0	0,0	0,0
Κυκλάδες[3]	2.988,0	2.747,2	4.515,0	9.100,0	13,4
Νησιά του Β.Α. Αιγαίου[4]	24.818,5	6.443,6	37.150,0	5,0	18,7 (2,6 MW σε λειτουργία)
Σποράδες[5]	342,1	64,4	0,0	650,0	1,7
Σύνολο	**66.908,8**	**13.466,7**	**108.015,0**	**21.155,0**	**65,8** (3 MW σε λειτουργία)

Source: MoEE [96]

They include:

1 Agathonisi, Agios Efstratios, Arkios, Astypalaia, Karpathos, Kos, Megisti, Patmos, Rhodes and Symi

2 Antikythera, Ericousa and Othonous

3 Amorgos, Anafi, Donousa, Thira, Kythnos, Milos, Serifos and Sifnos

4 Ikaria, Lesvos, Limnos, Samos and Chios

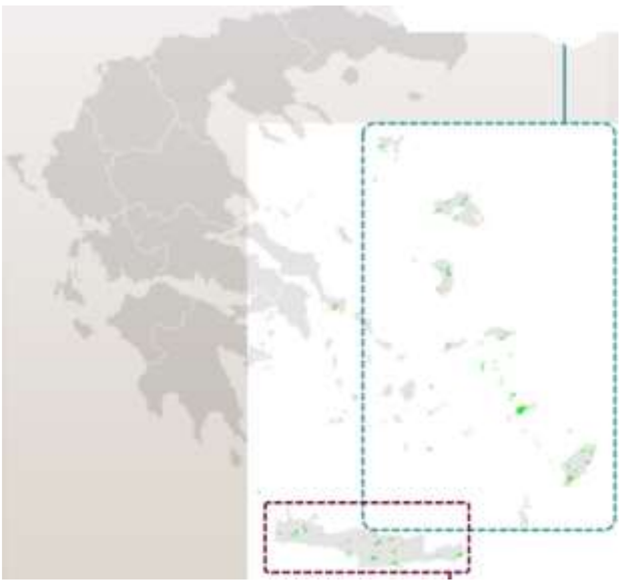
5 Skyros

All the NIIs currently have almost saturated electricity networks and therefore cannot support the installation of new RES stations beyond the margins announced by RAAEY. Particularly for the islands that are expected to remain uninterconnected, at least for a considerable period of time, the goal is to greatly reduce the use of oil for electricity generation with the installation of modern RES units in combination with storage technologies. In this direction, the installation of hybrid RES stations is being promoted. Through hybrid energy production systems, it is possible to achieve a RES penetration rate of >80%. Pilot projects are already being implemented in Agios Efstratios and Astypalaia.

According to the Draft revised version of the National Energy Strategy (October 2023) and with regard to the installation of hybrid systems, it is initially planned to integrate hybrid plants with a guaranteed capacity of 240 MW by 2026. Hybrid plants with a total guaranteed capacity of 120 MW will be installed on non-interconnected islands, such as Rhodes, Lesvos, Kos, Megisti, Antikythera, Gavdos, Ericoussa, etc. The remaining hybrid plants with a total guaranteed capacity of 120 MW will be installed in Crete and will include pumped storage systems with wind plants with a guaranteed capacity of up to 50 MW, hybrid plants consisting of accumulators with wind plants with a guaranteed capacity of up to 50 MW and plants with photovoltaic plants with a guaranteed capacity of up to 50 MW.

In this direction, a special framework for the Operational Support Scheme was established for the conclusion of an Operational Support Contract for Hybrid Plants in the Mediterranean Sea until 31 December 2026 with article 113 of Law 5037/2023, which amended article 21 of Law 4414/2016, which concerns hybrid stations with wind turbines and photovoltaic systems, as RES production units.

Map 42: Development of Hybrid RES Systems



Source: MoEE

The Island Decarbonization Fund is a new tool that enables the financing of RES projects and energy transition on islands, ensuring the necessary resources, which, depending on the price of pollutants in the coming years, can reach up to €3 billion.

Table 29: RES on the Interconnected Islands

Ομάδες νησιών	Εγκατεστημένα Φ/Β (kW)	Εγκατεστημένα Αιολικά (kW)
Κυκλάδες[1]	10.314,6	18.600
Κρήτη	147.619	202.690
Εύβοια	103.039,7	236.930,00
Σποράδες[2]	730,8	-
Νησιά Περ. Αττικής[3]	8.643	6.535
Περιφέρειες Μακεδονίας & Θράκης[4]	4.668	230
Σύνολο	**275.015,1**	**464.985**

Source: MoEE [96]

They include:

1 Ios, Sikinos, Mykonos, Naxos and the Small Cyclades, Paros, Antiparos and Syros

2 Alonissos, Skiathos and Skopelos

3 Tinos, Aegina, Salamis, Kea, Andros and Agistri

4 Thassos, Samothrace and Ammouliani

5.5.9 RAAEY's Competitions for RES and Storage

The Regulatory Authority for Energy, after the first pilot competitive procedure in 2016, proceeded with the implementation of permanent competitive procedures in the period 2018-2020, during which, on the one hand, the target of 2.6 GW that had been initially set was exceeded, and on the other hand, there was a drastic reduction in prices to the benefit of consumers and the national economy *[123]*.

The European Commission, in its "2022 Guidelines on State aid for climate, environmental protection and energy" (section 4.9), has set out the conditions under which State aid to support the development and operation of energy storage infrastructure may be compatible with EU law. In line with the provisions of the Guidelines, Greece notified a State aid scheme for electricity storage facilities (SA 64736), which was approved by the European Commission Decision under reference C(2022) 6461/05.09.2022 "RRF – Greece – Financial support in favour of electricity storage facilities" *[124]*.

Subsequently, with article 143F "Financial support for electricity storage stations in the Greek Electricity Transmission System" of law 4001/2011 (hereinafter the "Law"), as added by article 225 of law 4920/2022 (Government Gazette A' 74/15.04.2022), the institutional framework was established for the inclusion in a support regime of electricity storage stations connected and operating in the connected grid, as well as storage stations installed in countries within the European Economic Area (EEA).

In this context, following the joint ministerial decision no. MoEE/NHE/55948/1087/20.05.2023, the Regulatory Authority for Energy proceeded to conduct the first Competitive Bidding Procedure for the granting of investment and operational aid to electricity storage stations in accordance with the provisions of article 143Φ of Law 4001/2011 (A' 179), during which, on the one hand, the initial target of 400 MW was exceeded, and on the other hand, there was a drastic reduction in prices compared to the starting price of the competitive procedure for the benefit of consumers and the national economy.

Specifically, according to Ministerial Decision no. MoEE/NE/55948/1087/2023 (ΦΕΚ 3416/B/20-05-2023) "Competitive bidding procedures for the granting of investment and operational aid to electricity storage stations, in accordance with subparagraph 2A of paragraph 2 of article 143Φ of law 4001/2011 (A' 179)" the total auctioned capacity through the Competitive Bidding Procedures amounts to one thousand (1000) MW of maximum injection capacity of Supported electricity storage stations. The following Table specifies the number of Competitive Procedures and the auctioned capacity in each Competitive Procedure. The ultimately awarded capacity of each Competitive Procedure may be increased or decreased in relation to the auctioned capacity of Table 30.

Table 30: RAAEY's Tenders for Storage, 2023

Year – Quarter of Announcement	Competitive bidding procedures	Total auctioned capacity (MW)
2023 - B'	A' Competitive Procedure	400
2023 - C'	B' Competitive Procedure	300
2023 - D'	C' Competitive Procedure	300
	Total	**1000**

Source: MoEE

The scheme foresees that electricity storage systems may receive investment and operating aid after participating in a competitive bidding process. The projects that will be selected will be obliged to participate in 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 1000 MW of storage stations. The projects that will be selected will have to be put into operation by the end of 2025.

5.5.10 The PPAs Market

In the Greek market, almost all energy is traded on the Energy Exchange markets (Day-Ahead Market, Intraday Market, Continuous Intraday Market), as well as on the Bilateral Electricity Contracts (Power Purchase Agreements - PPAs) market, which although has developed in recent years, the contracted quantities through PPAs remain at low levels compared to the total daily demand.

PPAs are usually long-term contracts lasting between 10-20 years and are divided into two types:

- In commercial PPAs, where both the power producer and the counterparty are non-state entities, such as utilities, electricity traders, large consumers, industries, etc.
- In government PPAs, where the counterparty to the power producer is a government entity offering either a competitively determined Contract for Difference (CfD) or an administratively determined Feed-in Tariff (FIT).

Electricity producers agree either directly with large electricity consumers or indirectly through a PPA manager, developer, fund manager or IPP (independent power producer), volumes and prices of green energy for a period of over 10 years. In this way, both sellers and buyers of electricity win as one side ensures the sale of electricity quantities and the other sufficient volumes to cover its energy needs at competitive prices and for a long period of time.

PPAs emerge as a useful tool for the development of RES without subsidies, as they ensure financial security for investors, banks and energy buyers.

The great investment interest has highlighted the need to establish a platform for concluding bilateral contracts for energy production from RES (RES PPAs Platform). Greece's strategy in promoting green bilateral energy contracts through the development of the central platform has two main objectives [48]:

- Promote the financing and development of renewable energy sources, aligning with broader European goals for a faster energy transition.
- By providing a simpler and standardized framework for bilateral PPAs, Greece aims to attract both domestic and international investors in the renewable energy sector.

According to the NECP, the conclusion of bilateral energy contracts in energy-intensive sectors of the economy is promoted. The reduction of energy costs for energy-intensive industrial consumers and agricultural utilities is sought through the conclusion of bilateral electricity purchase and sale contracts with financial settlement or physical delivery between electricity suppliers and electricity producers from RES with the aim of transferring the economic benefit of "cheap" green energy to final industrial consumers and farmers.

IENE's Working Paper No. 34 entitled "The Market for Long-Term Bilateral Power Purchase Agreements (PPAs) in Greece – Part A" [125] provides information on the importance of these bilateral contracts but also highlights the distortions that occur in the effort to expand their application to sectors beyond industry. As IENE's Working Paper (No 34) explains, although the implementation of PPAs is an easy solution for the decoupling of high energy prices from natural gas prices as they are based on the very low production costs of RES, however, their universal application to all consumers and their effects on the competitive field require more analysis. This is because the participation of many consumers in long-term bilateral contracts directly with producers can create an exclusive non-competitive buying and selling relationship, which is best avoided in a free market.

Greece is now in 5th place in the European ranking with the most PPAs, as it is behind only Spain, Germany, Italy and the United Kingdom and ahead of France, Sweden, Finland and Portugal.

A milestone for the PPA market in Greece was the signing in early May 2023 of a 10-year agreement between PPC (as an energy producer) and the Viohalco Group for the total electricity needs of the energy-intensive industry, estimated at 1.2 TWh per year. In early 2024, a PPA was signed between EYATH and Terna Energy. Based on the agreement, EYATH will be supplied with electricity up to 100 GWh per year, for a period of 8 years with an option for an additional 4 years. This energy will come from both wind and photovoltaic plants. In the first half of 2023, the 10-year PPA signed by the joint venture of PPC Renewables with RWE Renewables (METON Energy) with the Italian paper industry Sofidel was announced, through which the Italian paper industry's unit in Katerini will be supplied for ten years with "green" electricity from the METON photovoltaic park being developed in Amyntaio, Western Macedonia.

METON also plays a leading role in the PPAs it signed with Iron (with the latter acting as offtaker) for the supply of 192 "green" gigawatt hours per year through 3 bilateral electricity purchase contracts from respective photovoltaic installations.

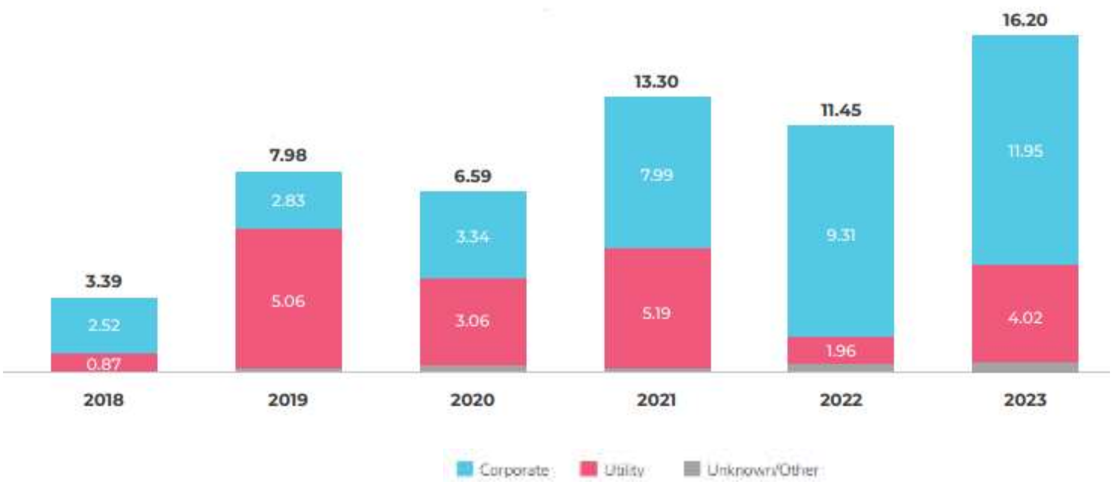
There is also the PPA between the Mytilineos group and the Portuguese EDPR for the latter's 78 MW wind farms, while the Karatzis group will sell the electricity to the Mytilineos group, which will be produced by three photovoltaic parks, with a total capacity of 270.8 MW, as the two sides signed a long-term PPA contract. These are parks in Larissa and Magnesia, which are expected to operate within the third quarter of 2024. The agreement that is considered to have "raised the curtain" on the Greek PPA market is the one signed in the summer of 2022 by Cero Generation (Macquarie group) with the Swiss energy group Axpo Trading for the sale of the energy that will be produced by the 100 MW photovoltaic park in the Prosotsani area, which began operation in September 2024 [125].

Figure 137: Overview of the Main PPAs in Greece – Contracted Capacity of 1.1 GW Until March 2024

Source: Aurora Energy Research

According to the annual report of the Swiss energy consulting company Pexapark [126], in Europe, bilateral contracts signed between RES electricity producers (mainly photovoltaics) and large consumers amounted to 16.2 GW in 2023, which is 40% higher than in 2022. The number of PPAs jumped to 272, recording an impressive increase of 62% in 2023 compared to 2022.

Figure 138: Power of PPAs in Europe, 2018- 2023



Source: Pexapark

In 2023, Greece is among the top five countries in PPAs based on the size of electrical capacity, where bilateral contracts corresponded to 0.95 GW and 9 deals were made for PPAs (Map 43).

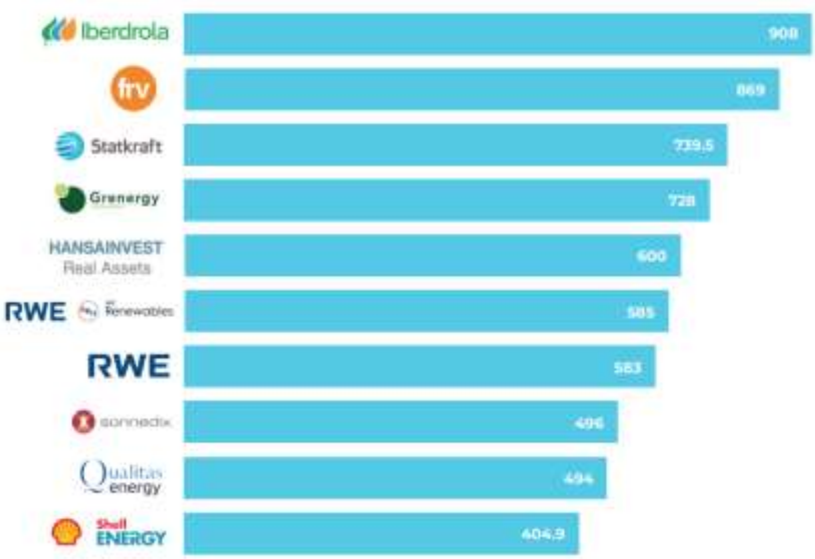
Map 43: The European PPAs Market in 2023

Source: Pexapark

In terms of the total number of European PPAs and the RES technology that provided clean energy, photovoltaics are in first place with 10.5 GW and 160 agreements, onshore wind is in second place with 2.3 GW and 58 PPAs, and offshore wind is in third place with 2 GW and 20 agreements.

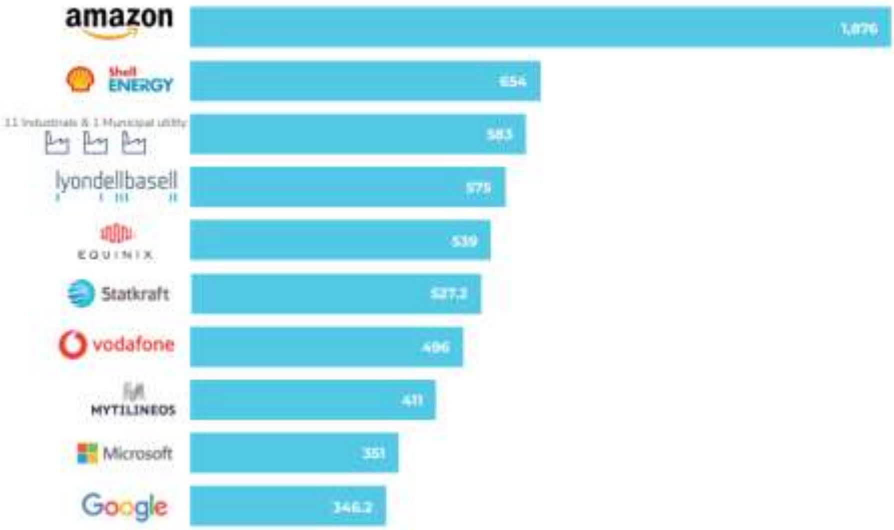
In the top 10 of PPAs sellers is the energy giant in RES, Iberdrola, with 908 MW and 9 agreements, while Amazon is among the largest buyers of green electricity on the European continent.

Figure 139: The Largest PPAs Sellers in Europe in 2023, MW



Source: Pexapark

Figure 140: The Largest PPAs Buyers in Europe in 2023, MW



Source: Pexapark

5.5.11 RENEWABLE ENERGY COUNTRY ATTRACTIVENESS INDEX

Energy security has become a top priority for governments amid geopolitical instability and soaring natural gas prices. As a result, governments around the world are looking to accelerate and expand national renewable energy (RES) programmes to reduce their dependence on energy imports, according to the 63rd edition of EY's semi-annual global Renewable Energy Country Attractiveness Index (RECAI).

Greece's attractiveness for renewable energy investments has increased significantly, with the country moving up two places in the ranking in June 2024 compared to six months earlier, to 16th place out of 40 countries – a record high (Table 31). The report notes that the installed capacity of renewable energy projects in Greece has doubled in the last four years, with green energy now accounting for 50% of electricity generation. It also adds that high energy prices and government support have led to the creation of local energy production communities. It also highlights Greece's improved ranking in Bilateral Power Purchase Agreements (PPAs), with the country climbing from 26th to 21st place in the relevant index. It notes that although the number of such agreements in Greece remains relatively small, the emerging PPAs market is showing signs of growth. This market is dominated by solar energy projects that fully exploit the sunshine, with a smaller share from onshore wind [127].

Table 31: RES Attractiveness Index – RECAI INDEX

					Technology-specific scores							
Ranking	Market	Previous ranking	Movement vs. previous	Score	Onshore wind	Offshore wind	Solar PV	Solar CSP	Biomass	Geothermal	Hydro	BESS*
1	US	1	●	73.6	59.7	61.2	56.5	51.2	30.1	49.2	39.1	57.6
2	China Mainland	3	▲	72.0	53.6	57.8	61.5	55.8	52.6	30.6	52.9	57.1
3	Germany	2	▼	70.5	54.2	52.1	55.2	31.7	51.5	39.5	28.9	41.4
4	France	4	●	68.7	56.2	50.4	53.0	32.6	48.1	39.3	40.8	31.3
5	Australia	5	●	68.5	53.0	34.0	56.9	50.1	42.1	15.7	24.7	47.7
6	UK	7	▲	68.4	59.5	60.1	45.8	15.1	56.2	37.6	37.9	49.5
7	India	6	▼	66.5	51.5	25.7	61.8	48.7	44.3	24.7	48.2	31.8
8	Denmark	9	▲	64.3	52.7	52.3	47.1	17.3	44.1	16.4	21.5	18.2
9	Canada	11	▲	64.1	60.3	34.2	46.3	19.8	36.1	34.8	45.8	27.0
10	Japan	13	▲	64.0	49.0	53.5	49.6	19.1	57.6	44.6	30.5	31.1
11	Netherlands	10	▼	63.6	51.0	49.4	47.4	16.1	52.7	24.7	26.5	21.8
12	Spain	8	▼	63.6	51.5	35.8	50.2	48.2	40.4	15.4	23.0	25.9
13	Italy	14	▲	62.8	48.4	42.7	50.3	35.7	42.4	39.3	49.2	32.8
14	Ireland	12	▼	62.8	48.9	46.5	46.7	19.9	37.1	18.1	22.0	29.8
15	Chile	16	▲	61.3	51.6	25.2	47.8	54.2	37.3	49.5	41.8	30.1
16	Greece	18	▲	60.6	50.0	31.5	47.7	35.3	44.8	29.1	36.3	29.5
17	Belgium	21	▲	60.4	54.4	39.6	42.2	18.4	44.9	20.3	27.1	29.6
18	Poland	15	▼	60.3	48.1	41.5	47.9	13.9	47.1	19.9	35.1	26.0
19	Sweden	17	▼	59.7	50.1	41.1	40.7	16.1	44.9	18.6	35.4	26.1
20	Brazil	19	▼	59.6	50.1	33.1	53.0	25.9	49.2	12.9	46.6	19.1

*Battery energy storage systems

Source: EY

5.5.12 Recycling of RES Project Materials

The development of the photovoltaic panel and wind turbine market implies an increase in waste from these two technologies in the future. In order for these technologies to constitute a truly economic and environmentally friendly electricity generation technology, a sustainable waste management policy from RES should be implemented.

The continuous increase year by year in wind farms and installed wind turbines leads to an ever greater use of resources and for this reason proper waste management is considered necessary.

A wind turbine consists of the foundation, the tower, the generator and the blades. After the end of its life cycle, the wind turbine is dismantled, its individual materials are managed and the site is restored. According to ELETAEN [128], the recycling rate is significant at 85-90%. The blades are a challenge due to the composite materials they contain. These materials are similar to those used in the construction of boats and pleasure boats, and are non-toxic after their manufacture. Despite the large growth of wind energy in the coming years, the share of composite waste from wind turbines will be less than 10% worldwide in 2025.

The wind industry aims to achieve 100% wind turbine recycling and significant progress has been made in recent years. Wind turbine manufacturers have already designed and implemented solutions for composite materials on two fronts: a) the development of new techniques for the efficient recycling of existing blades by separating their materials. The separated materials are then used to manufacture new blades. An important example is the new chemical process developed by Vestas with its partners in the CETEC initiative. This process separates the blade materials by chemically breaking down the resin of the composite materials into separated "clean" materials that are reused. This eliminates the need for any other type of management of old blades when they are decommissioned. As this chemical process is based on widely available chemicals, it is compatible for industrialization and rapid development in large climates. The method has been awarded by the international scientific community.

b) the development of new materials so that the new blades are fully recyclable in a more easy and efficient way. Such blades have already been installed and are now available on the international market. For example, Siemens Gamesa has developed fully recyclable blades, the first of which was installed in July 2022 in Germany. Already available on the international market are, for example, 132 recyclable blades from Siemens Gamesa in an RWE offshore wind farm in the United Kingdom. And LM Wind Power (GE group) has manufactured its own fully recyclable blade.

The "Urban Blades" initiative of ELETAEN in collaboration with the urban equipment products manufacturing and marketing company Urban Innovations is important. The initiative seeks the alternative management of old blades, through their conversion into urban equipment products (benches, planters, bus stops, info kiosks, etc.) and carefully designed furniture [128].

According to estimates by the European Union of the Composites Industry (EuCIA) [129], wind turbine blade waste will account for 10% of the total volume of thermoset composite waste by 2025 (approximately 5% of the estimated composite waste combining thermosets and thermoplastics), corresponding to 66,000 tons of thermoset composites. This makes recycling of the composite materials from which the blades are made a priority for the wind turbine industry. This requires logistical and technological solutions for dismantling, collection, transportation and waste management.

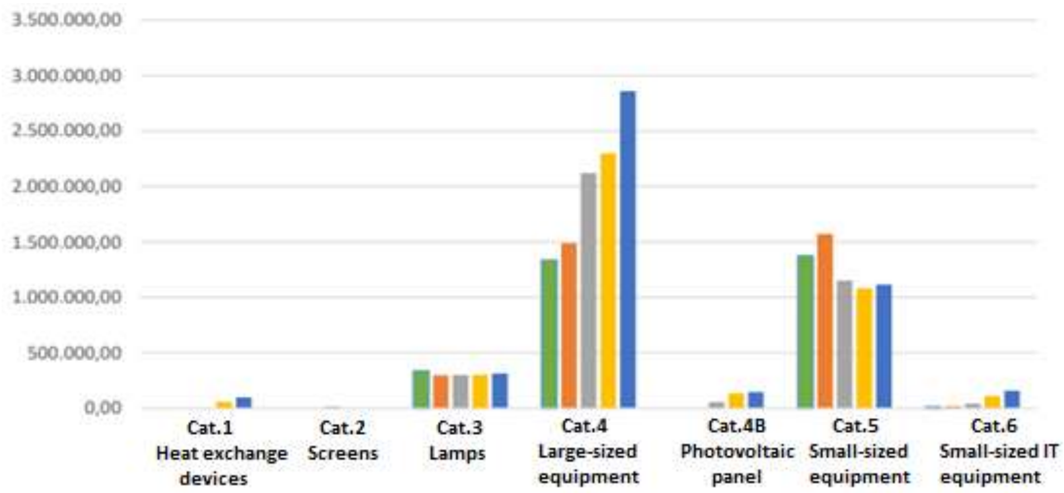
In addition, with the ever-increasing use of photovoltaics, new challenges arise. The collection of PV panel waste is carried out by SSED FOTOKYKLOSI SA, which began in 2020 and received approval as the first and only competent body for the management of photovoltaic panels.

Photovoltaic panels fall under the category of Electrical and Electronic Equipment (EEE) according to Directive 2012/19/EC of the European Parliament and of the Council of 4/7/12 which regulates the rules and conditions for the alternative management of WEEE.

Photovoltaic panels are mostly composed of 80% glass, 10% aluminum and copper. However, there are other valuable and economically critical materials such as metallic silicon and antimony. Recycling at this point focuses on glass, aluminum and silicon which are reused in the production process, either of photovoltaics or in another industrial sector.

Based on the 2023 PHOTOCYCLE report [130], the collected quantities of photovoltaic panel waste are significantly lower than the remaining quantities of electronic equipment, as shown in Figure 141.

Figure 141: Electronic Equipment Waste Collection (Kg), 2019-2023



Source: PHOTOCYCLE

Due to the lack of domestic PV module recovery units, SED PHOTOCYKLOSI has contracted with an Italian company for the recycling of PV module waste. If the management of photovoltaic panels after their end of life is not provided for, their waste can have significant impacts on the environment.

Regarding recycling at biomass stations, according to the Hellenic Biomass Association (HELLABIOM) [131], recycling takes place from the first day of operation of power plants and biomass thermal units, through the sustainable utilization of organic resources which, otherwise, would uncontrollably burden the environment.

The concept of recycling in biomass plants is therefore based on 4 basic and distinct pillars:

- Utilization of organic matter (residual biomass) as raw material - fuel for the operation of the units on a daily basis,
- Management of consumables and waste (e.g. lubricants, oils, filters, etc.) within the framework of normal operation and maintenance and through collaborations with licensed recipients,

➢ Utilization of energy production by-products (e.g. ash, biochar) as useful soil conditioners for agriculture, materials for industry, solid biofuels for domestic and professional use, etc.,

➢ Complete recycling of the technical equipment of the unit at the end of its active or conventional life cycle, in accordance with the environmental provisions provided for.

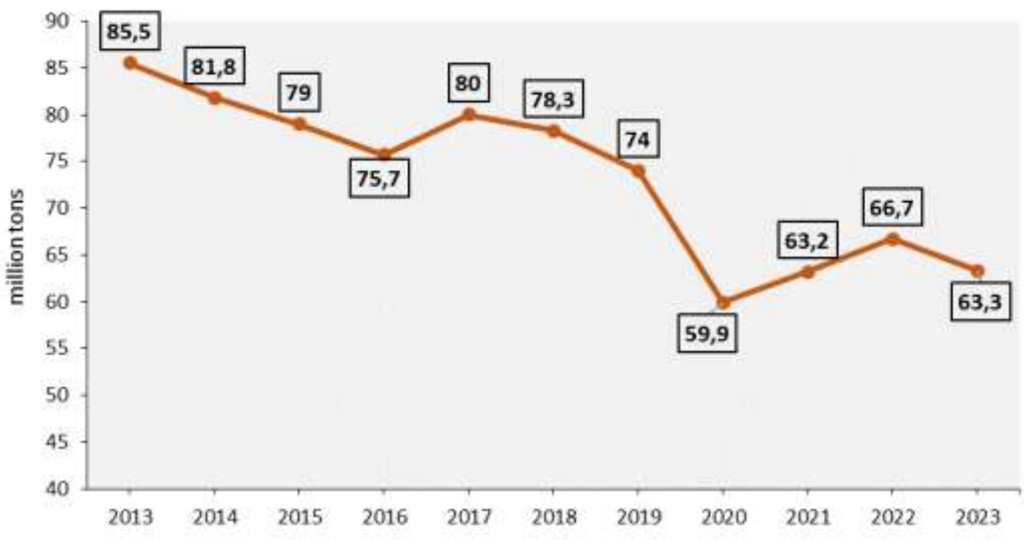
5.6 Greenhouse Gas Emissions

5.6.1 The Situation in Greece

According to data from the Energy Institute's Statistical Review of World Energy 2024/73rd Edition, greenhouse gas emissions in Greece decreased in 2023, reaching 63.3 million tons, from 85.5 million tons in 2013 (Figure 142). The largest drop in emissions occurred in 2020, due to the reduction in activities due to the coronavirus pandemic.

It is noted that the above emissions are the sum of carbon dioxide emissions from energy, carbon dioxide emissions from the combustion of waste gases, methane emissions (in carbon dioxide equivalent) related to the production, transport and distribution of fossil fuels, as well as carbon dioxide emissions from industrial processes.

Figure 142: Evolution of Greenhouse Gas Emissions in Greece



Source: Energy Institute

Greece's main tool for achieving its climate objectives for reducing greenhouse gas emissions in the electricity and heat production, energy-intensive industry and aviation sectors is the EU-27 Emissions Trading System (ETS) which has been operating since 2005. Based on the latest revision of the relevant directive "DIRECTORY (EU) 2023/959 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 10 May 2023 amending Directive 2003/87/EC establishing a scheme for greenhouse gas emission allowance trading within the Union and Decision (EU) 2015/1814 on the establishment and operation of a market stability reserve in respect of the Union greenhouse gas emission allowance trading scheme" from January In 2024, the ETS was extended to cover 100% of emissions from large ships (5,000 tonnes and above) moving between EU ports and 50% of emissions from ships departing from or arriving at EU ports via third countries. In addition, from 2027 or at the latest from 2028, a second Emissions Trading System (ETS-2) will be introduced, covering greenhouse gas emissions from the buildings and road transport sectors.

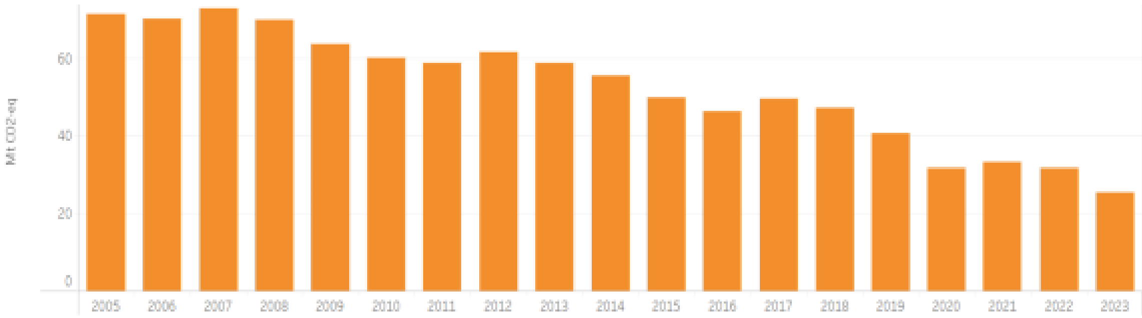
The European Commission published the Climate Action Progress Report in October 2024 [132], which shows that net greenhouse gas emissions in the EU fell by 8.3% in 2023 compared to the previous year. This is the biggest annual fall in decades, with the exception of 2020, when COVID-19 led to a 9.8% reduction in emissions. Net greenhouse gas emissions are now 37% below 1990 levels, while GDP grew by 68% over the same period, showing the continued decoupling of emissions from economic growth. The EU remains on track to meet its commitment to reduce emissions by at least 55% by 2030.

Among the report's findings are the following:

- an unprecedented 16.5% reduction in 2023 emissions from power and industrial installations included in the EU Emissions Trading System.
- a 24% reduction in emissions from electricity and heating under the EU Emissions Trading System, thanks to the development of renewable energy sources, in particular wind and solar power.
- The EU Emissions Trading System generated revenues of €43.6 billion in 2023 for investments in climate action.
- an approximately 2% reduction in total emissions from buildings, agriculture, domestic transport, small industries and waste in 2023.
- an increase of 8.5% in natural carbon removals in the EU in 2023, reversing the recent downward trend in land use and forestry.
- On the other hand, emissions from aviation increased by 9.5%, continuing their trend in the post-COVID era.

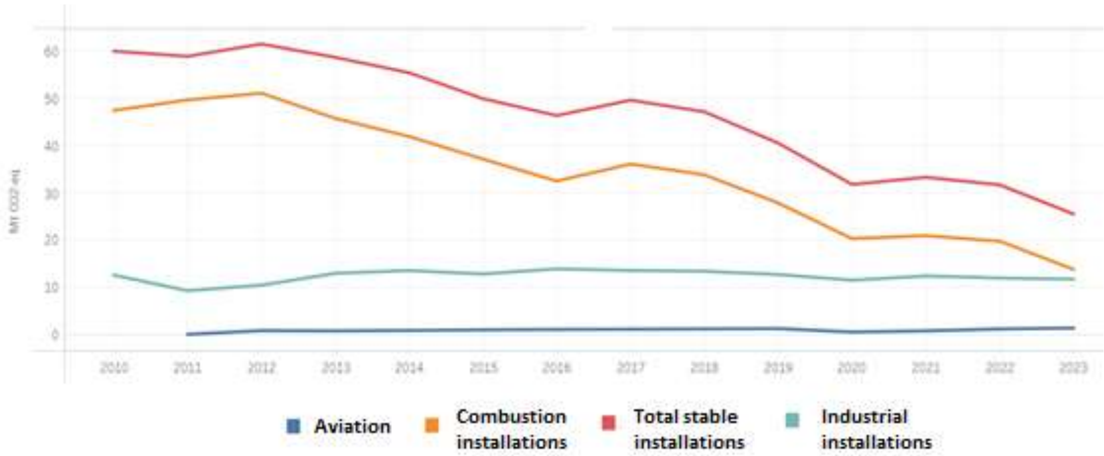
In 2023, the lowest emissions from stationary installations in the sectors included in the ETS were recorded since 2005, the year the ETS started, both in the EU-27 (1,071 million tonnes) and in Greece (25 million tonnes) [133].

Figure 143: Evolution of Greenhouse Gas Emissions in Greece within the Framework of the Emissions Trading System (Stationary Installations)



Source: European Environment Agency

Figure 144: Evolution of Greenhouse Gas Emissions in Greece by Sector



Source: European Environment Agency

Between 2005 and 2023, Greece ranks 4th among Member States in terms of reducing emissions from the electricity and heat production and energy-intensive industry sectors, with a percentage of -65.4%. The progress in Greece is mainly attributed to the reduction in the use of lignite in electricity generation with -85.8% fewer emissions in 2023 compared to 2005. The reduction from natural gas plants was much smaller in the corresponding period with a percentage of -3.7% between 2005-2023. Emissions from natural gas-fired power plants were 6.17 million tons in 2023, down 17.7% compared to 2022 and at the same levels as the corresponding emissions in 2020.

According to the CCPI (Climate Change Performance Index) for the assessment of countries in addressing climate change for the year 2025, Greece ranks 33rd with "moderate" performance in Greenhouse Gas Emissions and 37th with "low" performance in Climate Policy [134].

Table 32: Country Ranking Table for Greenhouse Gas Emissions, 2025 Results

Rank	Country	Score*	Overall Rating	GHG per Capita – current level (including LULUCF)**	GHG per Capita – current trend (excluding LULUCF)**	GHG per Capita – compared to a well-below-2°C benchmark	GHG 2030 Target – compared to a well-below-2°C benchmark
1.	–	–	Very High	–	–	–	–
2.	–	–	Very High	–	–	–	–
3.	–	–	Very High	–	–	–	–
4.	Luxembourg	34.13	High	Very Low	Very High	Very high	Very high
5.	Sweden	31.79	High	Very high	High	High	High
6.	Chile	30.87	High	High	Medium	Very high	Very high
7.	Philippines	30.73	High	Very high	Low	Very high	Very high
8.	Nigeria	30.50	High	High	Medium	Very high	Very high
9.	Estonia	29.90	High	Low	Very high	High	Medium
10.	United Kingdom	29.67	High	Medium	High	High	High
11.	Pakistan	29.58	High	Very high	Medium	Very high	High
12.	Denmark	29.09	High	Medium	High	High	High
13.	India	28.78	High	Very high	Very Low	Very high	Very high
14.	Morocco	28.76	High	High	Very Low	Very high	Very high
15.	Portugal	28.11	High	High	Very High	Medium	Medium
16.	Thailand	28.08	High	High	Medium	High	High
17.	Netherlands	27.29	High	Low	Very High	Medium	Medium
18.	Romania	27.26	High	High	Medium	High	Medium
19.	Egypt	27.14	High	High	Low	Very high	High
20.	Slovakia	26.89	High	Medium	High	High	Medium
21.	Germany	26.81	Medium	Low	High	Medium	High
22.	Algeria	26.75	Medium	Medium	Medium	High	High
23.	Switzerland	26.74	Medium	High	High	Medium	Medium
24.	Norway	26.49	Medium	Medium	High	Medium	High
25.	France	26.34	Medium	Medium	High	Medium	Medium
26.	Belgium	26.03	Medium	Low	High	Medium	Medium
27.	Spain	26.02	Medium	High	High	Medium	Medium
28.	Finland	25.90	Medium	Low	Very High	Low	Medium
29.	Lithuania	25.83	Medium	High	Medium	High	Low
30.	Malta	25.80	Medium	High	Medium	Medium	High
31.	European Union (27)	25.63	Medium	Medium	High	Medium	Medium
32.	Slovenia	25.58	Medium	Medium	High	Low	Medium
33.	Greece	25.15	Medium	Medium	High	Low	Medium
34.	Hungary	24.84	Medium	Medium	High	Medium	Low
35.	Austria	24.25	Medium	Medium	High	Low	Medium
36.	Mexico	24.19	Medium	High	Very Low	High	Medium
37.	Cyprus	23.35	Medium	Medium	Medium	Low	High
38.	Italy	23.34	Medium	Medium	Medium	Medium	Medium
39.	Malaysia	23.32	Medium	Medium	Very Low	High	Medium
40.	Belarus	23.10	Medium	High	Medium	High	Low
41.	Australia	22.91	Medium	Very Low	High	High	High
42.	Czech Republic	22.32	Low	Very Low	High	Medium	Low
43.	South Africa	22.28	Low	Medium	High	Low	Low
44.	Ireland	21.92	Low	Very Low	High	Low	High
45.	Poland	21.58	Low	Low	Medium	Low	Medium

Source: Germanwatch, NewClimate Institute & Climate Action Network

5.6.2 CO2 Capture and Storage Projects

There are three Carbon Capture and Storage (CCS) investment projects in Greece, confirming that the technology will play a decisive role in the decarbonization of industries and the achievement of the ambitious goal of reducing greenhouse gas emissions by 55% by 2030.

Prinos CO_2 Storage

The "Prinos CO2 Storage" project is the only one being developed in the Eastern Mediterranean, while in total in the European South only three such projects, in Prinos, Ravenna, Pyrenees, are in progress. The Greek project was officially included in the new list of 'Projects of Common/Mutual Interest (PCI/PMI) of the EU "UNDER COMMISSION DELEGATED REGULATION (EU) 2024/1041 of 28 November 2023 amending Regulation (EU) 2022/869 of the European Parliament and of the Council as regards the Union list of projects of common interest and projects of mutual interest" [135].

The “Prinos CO2” project is planned to be a CO2 storage hub on an industrial/commercial scale in the Mediterranean. The project aims to manage CO2 produced from both local and remote sources.

Within the country, the CO2 will be transported to Prinos by pipeline, while from other countries the transport will be by ship. For the “ApolloCO2” project of DESFA, which includes a new network of CO2 transport pipelines, €75 million have been secured from REPowerEU. The network will start from the borders of Attica with Boeotia, cross the basin towards the South and initially collect pollutants, in gaseous form, from cement factories and refineries.

At a facility in the Revithoussa area, the CO2 will be liquefied and temporarily stored in a special facility, until it is loaded onto CO2 ships, which will transport it by sea to the Prinos storage facilities. Polluters emitting around 11 million tons of CO2 per year are located within the scope of the project. To date, feasibility studies have been completed.

According to sources at the Ministry of Environment and Energy (MoEE), the application for a CO2 storage permit – accompanied by the relevant technical studies – is expected to be submitted to HEREMA by the end of June, which will then be sent to the European Commission for assessment. Based on the research permit, Energean has until August 2025 to complete the investigation of the CO_2 storage potential.

The project budget is over €1.5 billion, of which approximately €600 million concern the DESFA part and the rest of Energean. Energean's design includes the construction of a storage facility in an exhausted Prinos deposit, with an absorption capacity of 2.5 to 3 million tons of CO2 per year in full operation. The first phase, for a capacity of approximately 1 million tons per year, is expected to begin in 2026, with a gradual injection of CO_2, while Phase B (up to 3 million tons) will follow in 2028. According to Energean's schedule, the binding market test will take place in 2024, so that by the first quarter of 2025 binding contracts will have been signed with the industrial companies (emitters) that will be selected and the Final Investment Decisions will be made by both sides. As of April 2024, Energean has signed 9 non-binding Memoranda of Understanding (MoUs) with interested emitters from Greece and neighboring countries. Energean plans to carry out the required drilling at Prinos around the end of 2025, with the aim of subsequently obtaining the operating permit and having the CO2 storage unit operational by the first quarter of 2026 [136].

IFESTOS

TITAN Group has signed a Grant Agreement with the EU Innovation Fund for the pioneering carbon capture project “IFESTOS” to be implemented in Greece. The project was selected under the third call for proposals for large-scale projects by the EU Innovation Fund in July

2023. The EU Innovation Fund, one of the world's largest programmes for funding innovative technologies aimed at reducing CO_2 emissions, will support the Group's project with a grant of €234 million. TITAN Group's carbon capture project "IFESTOS" foresees the construction of a large-scale carbon capture unit at Titan's Kamari plant in Viotia.

As the group reports [137], this facility will enable the reduction of CO2 emissions during cement production and the provision of innovative, "green" building materials to our markets. The demand for these materials is constantly increasing, as they contribute to the creation of a sustainable and climate-friendly residential environment. TITAN will produce approximately 3 million tons of zero-carbon cement per year to serve the growing needs for "green" construction in the Athens metropolitan area and beyond. Depending on the relevant regulatory and licensing framework, the operation of these technologies could lead to annual greenhouse gas emission avoidance of more than 1.9 million tons of CO2, making Kamari one of the largest carbon capture facilities in Europe. The project will be part of an ecosystem of projects that will combine carbon capture facilities with transport and storage infrastructure. TITAN has already signed memorandums of understanding with potential partners and will continue to mature the project.

IRIS

On Thursday, July 13, 2023, the European Union's Innovation Fund selected Motor Oil's IRIS project for funding of €127 million, subject to the successful completion of the Grant Agreement Preparation process. The grant agreement was signed with the European Commission in December and the project's financing has been approved. The project is currently in the process of preparing the technical design agreements for the project's financing from banks. The technical details will then lead the company to make a final investment decision by the end of 2025. Construction of the project, which has a completion horizon of three years, will begin in mid-2025. It is expected to be operational by mid-2028.

Specifically, the IRIS project concerns the capture of carbon dioxide from the hydrogen production unit of the Motor Oil refinery. IRIS will drastically reduce the refinery's carbon footprint, while at the same time demonstrating an industrial hydrogen production ecosystem with extremely low carbon emissions and its use as a clean energy carrier. This project gives Motor Oil the opportunity to substantially reduce its carbon footprint, produce 56,000 tons per year of blue hydrogen that meets all sustainability limits and finally lay the foundation for the production of e-fuels through the construction and operation of a new low carbon synthetic methanol production unit [138].

Finally, it is worth noting that small-scale Carbon Capture technologies, incorporating the captured CO2 into solid or liquid chemical compounds, are also expected to be used in the shipping sector. The recent decisions of the International Maritime Organization (IMO/MEPC 80, July 2023) for binding absolute reduction targets for greenhouse gas (GHG) emissions, such as, among others, the goal of decarbonizing shipping (net zero) in the year 2050 and the indicative intermediate but ambitious absolute reduction targets for greenhouse gas emissions in the year 2030 and the year 2040, make Carbon Capture and Storage (CCS) technology an important solution for shipping, at least until synthetic fuels mature. CCS technology has already been included in the IMO's sustainable pathways and is expected to be one of the shipowners' compliance options to achieve the goals of decarbonizing shipping [48].

5.6.3 Prospects for the implementation of CCUS technologies in Greece

The IENE pioneering study entitled "Prospects for the Implementation of CCUS Technologies in Greece" (M64) [139] proposes five possible locations in Greece as CCUS hubs as well as a detailed timetable, from 2024 to 2032, for their establishment.

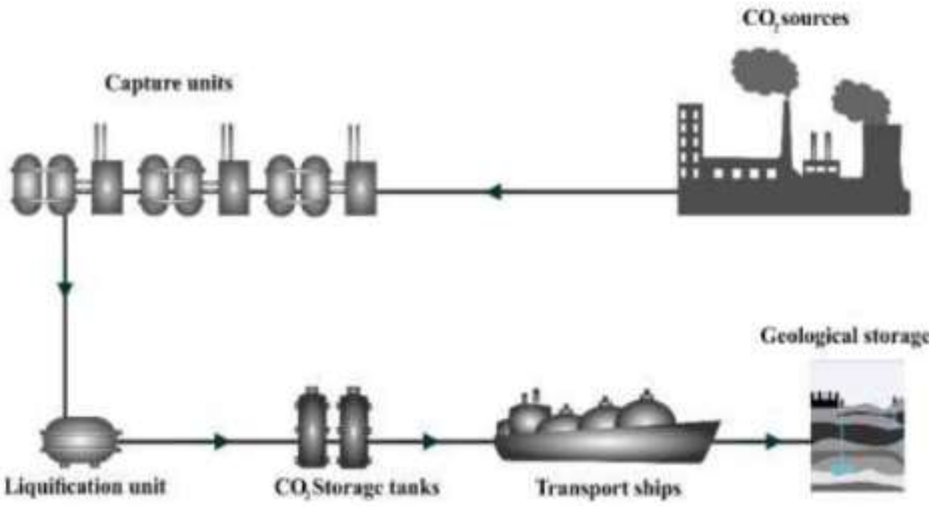
In the IENE study, the hubs that qualify, in addition to Prinos, are the Corinth-Aspropyrgos hub, the Thessaloniki hub, the Alexandroupoli hub, the Volos hub and the Western Macedonia hub concerning the production of electricity in Ptolemaida.

Map 44: Proposed Areas for CCUS Hubs in Greece

Source: IENE

The hubs are essentially complete chains of CO2 capture, liquefaction, transport and storage, in close proximity to industrial complexes, with a final destination in port facilities, from where the CO2 will be transported by special-specification ships to its final storage, either in Greece, in Prinos, or in other areas in the Mediterranean.

Figure 145: Schematic Illustration of a CO2 Capture, Storage and Transport Hub



Source: IENE

The roadmap developed in the IENE study provides a clear and systematic approach to the development of a CCUS cluster in Greece, with the time milestones described as follows:

2024: Setting the scene

In 2024, the Greek CCUS initiative begins with the completion of a comprehensive feasibility study. This study will provide critical insights into the technical, economic, and environmental aspects of implementing CCUS in Greece. Based on the findings of the feasibility study, the next step is to submit a funding proposal to the EU to financially support this ambitious project. The successful completion of these two initial stages is essential to lay the foundations for the development of the Greek CCUS cluster.

2025: Securing EU funding and technical design

Building on the foundations laid last year, efforts in 2025 will focus on securing EU funding for the Greek CCUS cluster. This financial support is crucial for the project to be implemented at the right scale and have the necessary impact. At the same time, detailed engineering design for the first CCUS hub in Greece is underway. This stage is crucial to ensure the effective and safe capture, utilization and storage of carbon emissions.

2026: Initial operations and CO2 transport ships

The year 2026 marks a significant milestone as the CCUS facility in Prinos begins operation, demonstrating the feasibility and effectiveness of CCUS technology in Greece. In addition, to facilitate the transport and storage of captured CO2, orders are placed for the construction of CO2 transport vessels, which are essential for the long-term success of the Greek CCUS cluster.

2027: Expanding horizons

With the successful operation of the Prinos facilities, the focus in 2027 turns to the expansion of CCUS infrastructure. Construction of the first CCUS hubs in Elefsina and Agioi Theodoroi begins. At the same time, feasibility studies for potential CCUS hubs in Thessaloniki and Alexandroupoli are underway, broadening the scope of the Greek CCUS cluster.

2028: Infrastructure development

In 2028, the construction of the CCUS hubs in Elefsina and Agioi Theodoroi is completed, marking a significant step forward in Greece's "journey" to CCUS. CO2 transport ships are also delivered, enhancing the cluster's ability to transport and store carbon emissions. In addition, the operation of these hubs begins, which will now be able to proceed with the capture, utilization and safe storage of CO2.

2029: Expanding functions and design

Construction of the CCUS hubs in Thessaloniki and Alexandroupoli begins in 2029, further expanding the reach of the Greek CCUS cluster. Meanwhile, the design phase of the CCUS hub in Volos begins, ensuring a comprehensive and systematic approach to the expansion of the infrastructure.

2030: Full scale operation

By 2030, CCUS hubs in Thessaloniki and Alexandroupoli are operational, effectively covering many key areas of Greece. This marks a significant achievement in Greece’s commitment to reducing carbon emissions and combating climate change.

2032: Completion of the vision

The construction of the Volos CCUS hub is completed in 2032, finalizing the infrastructure of the Greek CCUS cluster. This integrated network of hubs extends across the country, effectively capturing, utilizing and storing carbon emissions from various industries and sectors.

5.7 Energy Efficiency and Cogeneration

5.7.1 Promoting Energy Efficiency and High-Efficiency Cogeneration of Electricity & Heat in Greece in 2023

Energy Efficiency, EE, is an important element of the National Strategy for addressing the Climate Crisis, but also for reducing its dependence on imported fuels. Greece continued to invest in measures and processes that improve Energy Efficiency in all sectors, in line with the

European Union's objectives for its Climate Neutrality by 2050. The main strategic objectives and policies for Energy Efficiency in Greece are analyzed as follows:

1. **Reducing Energy Consumption:** Greece aims to reduce final energy consumption by at least 32.5% by 2030, in accordance with the European Energy Efficiency Directive, 2018/2002/EU. This entails implementing measures in sectors such as Industry, Transport and the Buildings sector.
2. **Energy Upgrading of Buildings:** One of the main points of the energy strategy is the improvement of the energy efficiency of the building stock, especially those in the public sector, such as hospitals, educational buildings, municipal stores, etc. By 2035, it is planned to renovate a large part of the buildings with the aim of their energy upgrading through programmes such as "Save".
3. **Development of Renewable Energy Sources (RES):** Increasing energy production from RES is critical for energy efficiency. Greece is investing in wind, solar, and hydroelectric projects, while also seriously considering new technologies, such as smart grids and energy storage.
4. **Energy Efficiency in Industry:** Improving Energy Efficiency in Industry, through investments in energy-saving technologies and lower energy consumption production processes, is essential to achieving national goals.
5. **Information and Dissemination Measures related to Energy Efficiency:** Greece continues to support programmes that provide incentives for Energy Saving to businesses and individuals, as well as information campaigns to raise public awareness about energy efficiency.

Serious issues concerning the penetration of Energy Efficiency are the challenges and prospects of Energy Efficiency, such as:

- **Financing** of Energy Efficiency programmes based on both European funds, mainly from the Recovery and Resilience Fund, but also on state resources, on private investments for the implementation of EE projects.
- **Technological Development:** The integration of new technologies is essential to improve energy efficiency. Innovation in the areas of smart grids, energy storage and renewable energy plays an important role.
- **Environmental Sustainability:** Energy Efficiency policies are combined with Environmental protection and social well-being and cohesion, ensuring that the transition to Green Energy is fair and inclusive.

To implement all of the above, in 2023, Greece approved and implemented a series of national policies, laws and ministerial decisions, related to energy saving, in line with European guidelines and targets for Energy Efficiency. The main regulations and decisions include the following: The National Energy and Climate Plan (NECP) is Greece's central plan for energy policy until 2030 and incorporates EU requirements for energy efficiency. Although it was approved in 2019, it was revised in 2023 to incorporate more ambitious targets. The legislative and regulatory initiatives reflect the country's continuous effort to improve Energy Efficiency and reduce greenhouse gas emissions, in line with European and international targets.

The key regulations and decisions include the following:

1. **Law 4964/2022** ("Climate Law"):
   - Although passed in 2022, the Climate Law forms the basis for measures implemented in 2023. It includes binding targets for the reduction of greenhouse gas emissions and promotes energy efficiency in various sectors, such as industry and buildings.
   - It provides for the energy upgrade of public and private buildings, with the aim of reducing energy consumption and using renewable energy sources.
2. **Law 4951/2022** ("Licensing Procedures for RES and Energy Storage Projects"):
   - Facilitates and accelerates licensing procedures for Renewable Energy Sources and energy storage projects, indirectly contributing to energy savings through the promotion of RES.
3. **Ministerial Decision MoEE/DEPEA/7423/2023** ("Save 2023"):
   - It sets out the terms and conditions for participation in the "Save 2023" programme, which offers subsidies for the energy upgrade of residential buildings.
   - It provides for the installation of thermal insulation materials, the upgrade of window frames, the replacement of heating systems with more energy-efficient ones, and the installation of photovoltaic systems.
4. **Ministerial Decision MoEE/DEPEA/8650/2023** ("Energy Efficiency of Public Buildings"):
   - Incorporates measures to upgrade the energy efficiency of public buildings. This decision sets out the specifications for energy audits and improvements to be carried out in public buildings to reduce energy consumption.
   - Requires all new public buildings to be "nearly zero energy" (nZEB).
5. **Ministerial Decision MoEE/DEPEA/9281/2023** ("Incentives for the Use of Energy Efficient Home Appliances"):
   - Provides subsidies for the replacement of old, energy-intensive household appliances with new, energy-efficient ones. The programme includes appliances such as refrigerators, air conditioning systems and washing machines.
6. **Ministerial Decision MoEE/DEPEA/10234/2023** ("Save for Business" programme):
   - It concerns the enhancement of energy efficiency in small and medium-sized enterprises through the upgrading of equipment and the improvement of building

infrastructure. It provides subsidies for the installation of energy-efficient lighting, heating, and cooling/freezing systems.

Energy Efficiency is considered an investment with high capital costs and therefore its penetration into the application sectors requires financial incentives from the State. In 2023, the Greek State offered various subsidies and financial incentives for energy saving projects, both to individuals and businesses. These programmes were financed through national resources, European funds and special financial mechanisms. Below are some of the most important programmes:

1. "Save 2023" Programme

- **Description:** "Save 2023" is a popular programme that offers subsidies for the energy upgrade of homes. Its goal is to reduce energy consumption and improve the energy efficiency of buildings.
- **Covered Expenses:** Thermal insulation, window replacement, heating and cooling system upgrades, photovoltaic installation, and "smart" energy management systems.
- **Subsidies:** The subsidy rate ranges from 40% to 85%, depending on the income of the beneficiaries and their geographical location.
- **Financing:** The programme is funded through the EU Recovery and Resilience Fund, as well as from national resources.

2. "Save for Business" programme

- **Description:** This programme concerns the energy upgrading of small and medium-sized enterprises (SMEs) with the aim of reducing energy consumption and operating costs.
- **Covered Expenses:** Energy upgrading of buildings, replacement of lighting, heating and cooling systems, installation of RES, and energy management.
- **Subsidies:** The subsidy rate for businesses ranges from 30% to 70%, depending on the size of the business and the type of investment.
- **Financing:** The programme is funded by the Recovery and Resilience Fund, as well as by the new Development Law.

3. "Recycle – Change Device" Programme

- **Description:** This programme provides subsidies for the replacement of energy-intensive household appliances with new, energy-efficient ones.
- **Covered Expenses:** Refrigerators, air conditioners, washing machines, and other high-consumption appliances.
- **Subsidies:** Subsidies cover 30% to 50% of the cost of new devices.

- **Financing:** The programme is funded through the NSRF and national resources.

4. "Photovoltaics in the Roof" Programme

- **Description:** This programme provides subsidies for the installation of photovoltaic systems on residential roofs, with the aim of producing green energy and reducing dependence on the electricity grid.
- **Covered Expenses:** The subsidy rate ranges from 35% to 60% of the installation cost, depending on the region and the income of the beneficiary.
- **Financing:** The programme is financed by the Recovery Fund and the European Regional Development Fund.

5. "Save at Home II"

- **Description:** Although it is an continuation of the "Save" programme, "Save at Home II" concerns additional subsidies for homes that were not covered in the first cycle of the programme.
- **Subsidies:** Provides subsidies for energy upgrades with a rate of up to 85% for special categories of beneficiaries.
- **Financing:** It is financed by the NSRF and the Recovery Fund.

6. "I Move Electric 2" Programme

- **Description:** It promotes the purchase of electric vehicles and the creation of charging infrastructure, contributing to energy savings and the reduction of gas emissions.
- **Subsidies:** Subsidies of up to 40% are provided for the purchase of electric cars and 50% for the installation of charging stations.
- **Financing:** Funded by the NSRF and national resources.

The **"Electra" Programme** aims to promote energy efficiency and renewable energy sources in public buildings, including buildings owned by municipalities and other public bodies. The purpose of the programme is to reduce energy consumption – e.g. in public buildings by at least 30%. - to limit greenhouse gas emissions and promote Sustainable Development, - to promote the use of renewable energy sources to meet the energy needs of buildings and, finally, - to improve the comfort conditions of building users through the upgrade of energy systems.

Budget and Financing:

- The total amount of the programme is approximately €640 million.
- The funding comes mainly from the Recovery and Resilience Fund (RRF) and national resources.
- The programme covers 100% of the eligible expenditure for energy upgrades in public buildings.

Eligible Expenditures:

- Thermal insulation of buildings (walls, roof, floor).
- Replacement of frames with energy-efficient frames.
- Upgrading of heating and cooling systems (e.g., heat pumps, high-efficiency boilers).
- Installation of photovoltaic systems to cover part of the energy needs.
- Lighting systems with LED technology.
- "Smart" energy management systems to control and monitor energy consumption.
- Upgrading of elevators to reduce energy consumption.

Beneficiaries:

- Municipalities and Regions of Greece.
- Public bodies and organizations that manage buildings for public use (schools, hospitals, public offices, sports centers, etc.).

Submission Process:

- Beneficiaries must submit proposals for the energy upgrade of their buildings.
- Proposals are evaluated based on expected energy savings, CO_2 emission reduction and technical maturity of the project.
- Approved proposals receive funding and can start implementing the projects.

Prospects and Benefits:

The "Electra" programme is an important step towards Greece's energy transition, combining the need for Energy Efficiency with the promotion of Sustainability, in public buildings and is expected to contribute significantly to reducing their energy consumption, saving resources and reducing energy costs for municipalities and the public sector. The energy upgrade of public buildings will also improve the quality of life of citizens who use them daily. The reduction of greenhouse gas emissions will strengthen the country's efforts to address Climate Change.

These programmes represent the main actions of the Greek state, in 2023, to enhance energy efficiency in the **building sector** and promote the use of renewable energy sources, within the framework of the broader strategy for Climate Change and Sustainable Development.

Regarding the promotion of Energy Efficiency in the **industrial sector**, energy audits continued, based on the corresponding articles of Laws 4342/15 & 4843/21, which consider industries/companies with >250 employees and a turnover >€50 million as obligated. However, there is no legal obligation for industries/companies to implement the energy saving measures (ESM) recommended by the energy auditor, which creates problems in achieving the country's Energy Efficiency targets. In 2023, Energy Efficiency has a distinct role in the country's energy policy and planning. However, achieving the targets urgently requires decisions to make faster progress; decisions that will overcome bureaucratic problems and public sector bottlenecks.

5.7.2 The Status of High Efficiency Combined Heat and Power (CHP) in Greece in 2023

High Efficiency Cogeneration of Electricity and Heat is a technology that allows the simultaneous production of electricity and useful heat from the same energy source, maximizing energy efficiency and reducing greenhouse gas emissions. In Greece, the state of CHP in 2023 presents the following main trends and characteristics:

1. Existing Capacity and Technologies

In 2023, the total installed capacity of CHP units in Greece amounts to approximately 200-300 MW. Most of these units are located in industrial facilities, agricultural applications (greenhouses) and district heating facilities, as shown in Table 33.

Table 33: Total Installed Capacity of CHP Units in Greece, 2023

		MW	% of total
1	Distributed CHP units		
	Total 1	**132,00**	**100**
2	Non-Distributed CHP units		
	Industry	52,10	52,23
	Agriculture	30,71	30,83
	District heating	16,00	16,06
	Tertiary	0,80	0,88
	Total 2	**99,61**	**100,00**
	Total 1+2	**231,61**	

- Technologies used for cogeneration mainly include:
    - **Gas and steam turbines:** Common in large industrial plants and district heating installations.

- **Internal combustion engines:** They are mainly used in smaller industrial facilities and hospitals.
- **Very small-scale systems (Micro-CHP)**: These systems are mainly developed for home use or small businesses, but their penetration remains limited.

2. Regulatory and Legislative Framework

- In 2023, Greece has adapted its regulatory framework to support the development of cogeneration, in line with European directives. The **Climate Law 4964/2022** and other ministerial decisions promote the integration of CHP units into the country's energy system.
- Incentives are provided, such as priority connection to the grid and guaranteed prices for electricity produced by CHP units, especially when this energy comes from RES or waste.

3. Development Actions and Programmes

- The **National Energy and Climate Plan (NECP)** includes specific targets for increasing cogeneration as part of the strategy to reduce emissions and increase energy efficiency. These targets include the strengthening of existing units and the construction of new ones, mainly in industrial areas and in sectors where there is a demand for thermal energy.
- The **"Save 2023" programme** includes subsidies for improving energy efficiency in industrial facilities through the installation or upgrade of CHP units.

4. Applications and Uses

- The main sectors where co-production has found application in Greece are:
  - **Industry:** Chemical industry, refineries and other energy-intensive industries.
  - **District heating:** Cities such as Kozani and Ptolemaida have district heating systems that operate with cogeneration.
  - **Hospitals and large buildings:** They use small-scale CHP units to produce electricity and cover heating needs.

5. Challenges and Prospects

- **Challenges:** Challenges include the need for further investments, the technical and financial viability of small CHP units and the upgrading of the grid to better integrate the units into the system.
- **Outlook:** The prospects for the development of cogeneration are positive, as Greece is moving towards a green transition, and cogeneration offers an effective solution to reduce energy consumption and CO_2 emissions.

Overall, the situation of CHP in Greece in 2023 presents a steady but slow growth, with increasing prospects, as the country progresses towards the implementation of the NECP objectives and European guidelines.

6. Recent Developments in the Legislative and Regulatory Framework of the Energy Market in Greece

The main legislative regulations enacted during 2024, both in national and European legislation, are summarized in sections 6.1 and 6.2 respectively.

6.1 Greek Legislation

1. Law No. 5092/2024 (Government Gazette A'33/04-03-2024)

Entitled "terms of use of public property in coastal areas and other provisions", which, with articles 46-50, brought amendments to Laws 4001/2011, 4602/2019 and 4618/2019, establishing provisions for the Adequacy of Energy Supply of the Non-Interconnected Islands during the transitional period until the completion of their interconnection with the Mainland System, the license for electricity production and the addition of production capacity on the island of Crete until full interconnection with the Mainland System, the operation of electricity production units on the island of Crete and the transfer, installation and operation of electricity production units on the island of Crete, etc.

2. Law No. 5106/2024 (Government Gazette A' 63/01.05.2024)

Entitled "regulations to address the multi-level impacts of climate change in the areas of: a) water management, b) forest management and protection, c) urban resilience and policy, d) combating illegal construction, e) energy security and other urgent provisions", with the aim of addressing the impacts of climate change at three (3) levels: 1) the protection of water, forests and the natural environment, 2) the creation of sustainable and resilient urban areas, the suppression of illegal construction and the resolution of related spatial and urban planning issues, and 3) the reduction of energy costs for vulnerable households, first and second degree Local Government Organizations, Local and General Land Improvement Organizations and Municipal Water Utilities and Sewage, and the further promotion and modernization of Renewable Energy Sources. It provided for: a) the establishment of a private law legal entity under the name "Thessaly Water Management Organization, Public Company" and the operation of an advisory committee and local committees, for the protection and management of the waters of the Water Department of Thessaly, b) the regulation of issues of the Water Supply and Sewerage Company of the Capital and the Water Supply and Sewerage Company of Thessaloniki and the updating of the maintenance and operation contract of the External Water Supply System of the greater Capital area, c) the creation of Hybrid Cooperative Schemes and the regulation of the management, protection and exploitation of public forests, d) the updating of the operating framework of the Natural Environment and Climate Change Organization, e) the institutionalization of urban policy and urban resilience plans, f) the establishment of a unified framework for the control and combating unauthorized construction, g) the establishment of the "Apollo" Programme to reduce the energy costs of vulnerable households, first and second degree Local Government Organizations, Local and General Land Improvement Organizations and Municipal Water Supply and Sewerage Enterprises throughout the Territory, h) the modernization of the licensing process for Renewable Energy Sources and Offshore Wind Farm projects and the installation of remote monitoring and remote management systems, and i) the institutionalization of a subsidy for billable electricity consumption.

3. Law No. 5151/2024 (Government Gazette A' 173/04.11.2024)

Entitled "Regulations for the modernization of waste management, the improvement of the energy saving framework, the development of energy projects and the addressing of urban planning issues" it amends the existing framework with the aim of increasing the recycling rate through an integrated plan with the active participation of the Ministry of Environment and Energy, the creation of strong waste management bodies, the simplification of waste management procedures and the resolution of problems in the management of municipal waste. Furthermore, it seeks to address problems of licensing and installation of Renewable Energy Sources (RES) projects, the promotion of the installation of RES technologies to enhance the "diversity" of RES energy from different technologies in the energy mix, the promotion of the installation of electricity storage stations in order to limit the discharges of "green" energy and reduce the cost of electricity during the evening hours when the production of RES from photovoltaic stations is limited. In addition, it includes the integration of articles of Directive (EU) 2023/2413 of the European Parliament and of the Council of 18 October 2023 "amending Directive (EU) 2018/2001, Regulation (EU) 2018/1999 and Directive 98/70/EC with regard to the promotion of energy from renewable sources, and repealing Council Directive (EU) 2015/652" (RED III, series L), the promotion of the implementation of energy saving programmes and the better functioning of energy market actors. In addition, the aim is to assist those affected by natural disasters, rationalize the use of real estate, especially tourist properties, ensure the smooth operation of the Central Council for Urban Planning Issues and Disputes, as well as suspend building permits in specific areas.

4. Ministerial Decision MoEE/DAPEEK/93976/2772 (Government Gazette B' 5074/05.09.2024)

Amendment and replacement of the ministerial decision under reference MoEE/DAPEEK/15084/382/19.02.2019 "Installation of production plants by self-producers with the application of energy offsetting or virtual energy offsetting in accordance with article 14A of Law 3468/2006, as in force, and by Energy Communities with the application of virtual energy offsetting in accordance with article 11 of Law 4513/2018" (B' 759).

5. Ministerial Decision MoEE/DAPEEK/86389/2479 (Government Gazette B' 4844/22.08.2024)

Allocation of a special fee to areas where Renewable Energy Sources (RES) and Hybrid plants operate, in accordance with article 87 of Law 4964/2022.

6. Ministerial Decision MoEE/DAPEEK/74967/2171 (Government Gazette B΄ 4283/22.07.2024)

2nd Amendment to the decision under reference YPEN/DAPEEK/100333/4251/3.10.2022 "Establishment of the Monitoring Committee for the Support Scheme for electricity generation plants from RES and CHP plants and hybrid plants of article 12 of law 4414/2016, as amended by article 47 of law 4951/2022" (B' 5273)

7. Decision E-240/2024 (Government Gazette B' 6295/15.11.2024)

Conducting a third (3rd) Competitive Bidding Procedure for the granting of investment and operational aid to electricity storage stations in accordance with the provisions of article 143F of Law 4001/2011 (Government Gazette A’ 179).

8. Decision E-215/2024 (Government Gazette B 5543/04.10.2024)

Amendment of the methodology for calculating an unfeasible Market Programme, in accordance with the provisions of par. 6 of article 2 and par. 4 of article 102 of the Balancing Market Regulation and par. 4 of article 18 of law 4425/2016.

9. Decision E-216/2024 (Government Gazette B' 5544/04.10.2024)

Approval of amendment to the Reference Load Calculation Methodology, in accordance with the provisions of par. 5 of article 84 of the Balancing Market Regulation and par. 4 of article 18 of law 4425/2016, as in force.

10. Decision E-199/2024 (Government Gazette B' 5433/27.09.2024)

Assignment of the services of Supplier of Last Resort for Electricity to the companies "PPC S.A." and "Metlen Energy & Metals S.A." for the period from 29.09.2024 to 28.09.2026, in accordance with the provisions of the third paragraph of paragraph (b) of paragraph 2 of article 57 of Law 4001/2011 and approval of the relevant consideration.

11. Decision. E-150/2024 (Government Gazette B' 3969/08.07.2024)

Guidelines regarding the introduction of sub-hourly products for trading in the Day-Ahead Market and the Intraday Market.

12. Decision E- 85/2024 (Government Gazette B΄ 3394/13.06.2024)

Declaration of nullity of the competition "Procedure, terms and criteria for selection with a call for expressions of interest from candidate Suppliers of Universal Electricity Service for a period of two years from 23.6.2024" announced with decision no. E-46/2024 (B' 1554) of the RAAEY.

13. Decision E-120/2024 (Government Gazette B΄ 3327/12.06.2024)

Amendment of the Risk-Preparedness Plan in accordance with Regulation (EU) 2019/941 of the European Parliament and of the Council of 5 June 2019 on risk-preparedness in the electricity sector and repealing Directive 2005/89/EC.

14. Decision E-135/2024 (Government Gazette B΄ 3315/12.06.2024)

Amendment of the Balancing Market Regulation in accordance with articles 17 and 18 of Law 4425/2016 and of the Management Code of the Greek Electricity Transmission System in accordance with article 96 of Law 4001/2011, regarding the operation of Intraday Auctions in the context of the Single Intraday Coupling.

15. Decision E-126/2024 (Government Gazette B' 3314/12.06.2024)

Amendment of the Regulation for the Clearing of Transactions in the Day-Ahead and Intraday Markets in accordance with paragraph 2 of article 13 of law 4425/2016 and the executive decision regarding the "Risk management procedures in the Clearing System and other related issues" in accordance with paragraph 2 of article 13 of law 4425/2016 and the provisions of chapter 2 of the same Regulation.

16. Decision E-145/2024 (Government Gazette B' 3267/10.06.2024)

Day of commencement of operation of the Intraday Auctions in accordance with the provisions of subsection 7.1.2 of Chapter 7 of the Day-Ahead and Intraday Market Operating Regulations.

17. Decision 249/2024 (Government Gazette B΄ 3165/04.06.2024)

Approval of the Operating Regulations of the Postgraduate Studies Programme entitled "Modern Applications of Electrical Power Systems" of the Department of Electrical and Computer Engineering of the University of Peloponnese.

18. Decision E-125/2024 (Government Gazette B' 3099/04.06.2024)

Amendment to the Operating Regulation of the Day-Ahead Market and the Intraday Market in accordance with article 10 of Law 4425/2016 regarding the operation of Intraday Auctions within the framework of the Single Intraday Coupling.

19. Decision 808/2024 (Government Gazette B΄ 3067/29.05.2024)

Decision on notification no. 11684/23.12.2022, in accordance with articles 5 to 10 of law 3959/2011, concerning the acquisition of exclusive control by the company with the name "MOTOR OIL (HELLAS) CORINTH REFINERIES S.A." (hereinafter referred to as "MOH") over the company with the name "THALIS ENVIRONMENTAL SERVICES S.A." (hereinafter referred to as "THALIS"), within the meaning of article 5, par. 2 (b) of law 3959/2011.

20. Decision E-61/2024 (Government Gazette B' 1850/26.03.2024)

Amendment of the methodology for implementing rules for accepting Buy/Sell Orders with an interconnected price in the Day-Ahead Market and the Intraday Market in accordance with the provisions of subsections 4.1.3.2, 4.3.3 and 5.10.3 of the Day-Ahead Market and Intraday Market Operating Regulations, and par. 4 of article 18 of Law 4425/2016.

21. Decision E-49/2024 (Government Gazette B' 1610/11.03.2024)

Approval of the first amendment to the Product Specifications on the Natural Gas Trading Platform in accordance with the provisions of section 4.2 and subsection 4.4.3.4 of the Natural Gas Trading Platform Regulation.

22. Decision E-46/2024 (Government Gazette B' 1554/08.03.2024)

Procedure, terms and criteria for selection with a call for expressions of interest for candidate Universal Electricity Service Suppliers for a period of two years from 23.06.2024.

23. Decision E-36/2024 (Government Gazette B΄1384/01-03-2024)

Amendment of the Operating Regulation of the Day-Ahead Market and the Intraday Market, in accordance with article 10 of Law 4425/2016 and of the Balancing Market Regulation, in accordance with articles 17 and 18 of Law 4425/2016, in order to allow the participation of demand response in the Day-Ahead Market and the Intraday Market.

6.2 European Legislation

1. Directive 2024/1275/EC of the European Parliament and of the Council of 24 April 2024 on the Energy Performance of Buildings, which entered into force on 14-05-2024, will enable the rapid decarbonisation of the building stock, which still accounts for around 40% of the EU's total energy consumption, and ultimately increase our energy security and reduce our dependence on imported fossil fuels. The European Mission for Climate-Neutral and Smart Cities continued to make a significant contribution to the energy savings targets of the REPowerEU project. Thirty-three cities have received a Mission Label, which recognises their climate measures and investment plan to achieve climate neutrality by 2030.

2. Regulation (EU) 2024/1735 of the European Parliament and of the Council of 13 June 2024 establishing a framework of measures to strengthen Europe's net-zero emission technology ecosystem and amending Regulation (EU) 2018/1724.

Timelines for net zero technology clean energy generation projects (including (i) hydrogen technologies: electrolyzers and fuel cells; (ii) solar photovoltaic, solar thermal electric and solar thermal technologies; and (iii) onshore wind and offshore renewable energy technologies), where the permitting process should not exceed:

- 12 months for the construction or expansion of net zero strategic projects with an annual production capacity of less than 1 GW.
- 18 months for the construction or expansion of net zero strategic projects, with (i) an annual production capacity of 1 GW or more or (ii) where the capacity is not measured in GW.

The timeframes for the construction or expansion of net zero strategic projects are shorter: 9 months and 12 months respectively. These timeframes exclude the time required for the environmental assessment process. Environmental impact assessment: a reasoned opinion must be issued within 3 months of receiving all the necessary information. The timeframes for public consultation must not exceed 90 days.

3. Regulation (EU) 2024/1787 of the European Parliament and of the Council of 13 June 2024 on the reduction of methane emissions from the energy sector and amending Regulation (EU) 2019/942. The new methane regulation introduces new requirements for the measurement, reporting and verification of methane emissions from the energy sector for oil, natural gas, LNG and coal, and for the reduction of those emissions. The regulation entered into force on 04-08-2024 and provides for potentially severe penalties for non-compliance. It introduces amendments to Regulation (EU) 2019/942 and lays down rules on tools ensuring transparency regarding methane emissions.

4. Directive (EU) 2024/1788 of the European Parliament and of the Council of 13 June 2024 concerning common rules for the internal markets in renewable gas, natural gas and hydrogen, amending Directive (EU) 2023/1791 and repealing Directive 2009/73/EC. This Directive revises the existing legislative framework for the gas sector, and in particular Directive 2009/73/EC - also known as the EU Gas Directive. It establishes a common framework for the decarbonisation of the gas and hydrogen markets, in order to contribute to the achievement of the EU's climate and energy objectives. It includes provisions for customer engagement and protection in the retail green gas market, hydrogen infrastructure and markets, renewables and low-carbon gas in existing gas infrastructure and markets, network design, security of supply and storage.

5. The **new Ecodesign Regulation for Sustainable Products (Regulation (EU) 2024/1781)** extends the potential scope beyond energy-related products and allows for the introduction of new requirements focusing on resource efficiency, circularity and the promotion of sustainable product design in the EU. This regulation aims to replace the existing Ecodesign Directive (2009/125/EC) and extends ecodesign criteria to cover a wider range of products, including textiles, by setting comprehensive ecodesign requirements. The regulation aims to reduce environmental impact, promote a circular economy and ensure that sustainable products become the norm on the EU market.

7. The Regional Market in SE Europe and the Role of Greece

7.1 The SE European Market

The energy sector is an important economic activity for most countries in SE Europe with a particularly high contribution to infrastructure investments and market development. The countries of SE Europe consist of Albania, Kosovo, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, North Macedonia, Greece, Hungary, Montenegro, Romania, Serbia, Slovenia, Türkiye and Israel. The geopolitical position of SE Europe is unique as it can be considered as an energy bridge between eastern suppliers and western consumers. In addition, the region, especially the Black Sea and the Eastern Mediterranean, can develop into energy producers with significant exporting potential.

Map 45: The SE European Region

Source: IENE

IENE focuses on the study of the energy sector of SE Europe and therefore proceeds with the preparation of the updated edition of the "SEE Energy Outlook", the basic reference study for the energy sector of SE Europe. By activating the wide network of partners it has in all the states of the region, the Institute of Energy of SE Europe utilizes, once again, the strengths of the most important experts in the regional energy sector to write under its guidance the various chapters of the “SEE Energy Outlook 2025/2026”.

More than 25 experts from academic institutions, government agencies and large energy companies, as well as established independent energy consultants, as well as the scientific and research staff of the Institute, collaborate in this leading and innovative edition of IENE. This is the fourth time that IENE has prepared a study of such scope and dimensions, while it is recalled that the first edition of the “SEE Energy Outlook” was published in 2011.

“SEE Energy Outlook 2025” is a comprehensive study that examines the current energy situation in the SEE region, but also covers the trends and prospects of the energy market from today to 2050. The study covers all 15 countries in the region: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Greece, Hungary, Israel, Kosovo, Montenegro, North Macedonia, Romania, Serbia, Slovenia and Türkiye.

It is worth noting that this new edition of the Outlook will also provide energy information for some countries around SEE, such as Egypt, Syria, Lebanon, Moldova, Ukraine, Slovakia, Austria, Azerbaijan and Italy, which are closely related in both geographical and economic terms to the core countries of the region.

The study contains evidence-based comparative data, detailed sectoral analyses and estimates and forecasts regarding energy demand and production. After a series of introductory chapters, where the economic and political background is presented along with the key energy policy issues of SEE, the study examines the impact of the regional integration process, the energy transition and competition issues on SEE’s energy prospects. The study also discusses in detail the EU’s policies on decarbonisation, as well as the Green Deal, in relation to the necessary infrastructure investments and energy security requirements. The main parts of the leading IENE study, in its new edition, include the following: the economies of the region, energy policy, energy security, examination of the countries of SEE including their legal framework, energy transition and decarbonisation, energy infrastructure, forecasts on energy demand and supply with a horizon of 2050 (oil and gas, electricity, RES, energy efficiency), energy technologies and energy investment prospects.

The energy sector analysis focuses on the main sectors of the region, such as oil (upstream, midstream, downstream), natural gas, power generation, renewable energy sources, energy efficiency, cogeneration, hydrogen and environmental protection.

Another important aspect of the “SEE Energy Outlook 2025/2026” study concerns energy interconnections in SE Europe, the Black Sea and the Caspian region in the oil, gas and power sectors. At the same time, the major energy projects in the region (oil and gas pipelines, gas storage facilities, nuclear power plants, hydrocarbon exploration projects, refineries, renewable energy units and energy efficiency projects) are described and analyzed in depth.

The study also covers recent developments in the energy market liberalization process for both electricity and gas, as well as the competitive conditions prevailing in the region's market, while also examining broader aspects of environmental protection and the state of energy security in SEE.

In addition, the updated IENE "Outlook" includes an examination of energy technologies that are suitable and feasible to be implemented in the SEE region as well as the potential for local production.

In parallel, the "SEEE Outlook 2025/2026" highlights, among other things, the overarching issue of energy security and how it can be enhanced at national and regional level. The study concludes with an in-depth analysis and a series of forecasts on investment opportunities for a range of different fuels and by country, while also assessing the business opportunities of the region's dynamic energy sector. The "SEE Energy Outlook 2025/2026" is expected, based on the current IENE programming, to be published in May 2025.

Looking at the SE European region at the forefront of the energy revolution, the region's large renewable energy potential, particularly solar and wind, positions it as a key player in Europe's energy transition. However, unlocking this potential will require overcoming regulatory barriers, upgrading grid infrastructure and promoting regional cooperation. If these challenges are addressed, SE Europe can lead Europe's push towards a cleaner, more sustainable energy future.

The Southeastern European region enjoys some of the best natural conditions for developing renewable energy projects in Europe. Countries such as Greece, Bulgaria and Romania receive between 1,900 and 2,400 hours of sunlight per year, making the region ideal for large-scale solar projects. Coastal areas along the Black Sea, the coastal areas of Greece, the Aegean islands and the mountainous areas of Greece, North Macedonia and Serbia are prime locations for wind energy development. Despite these advantages, the development of renewable energy sources in Southeastern Europe has been slower than in other parts of Europe. The region is still heavily dependent on coal and other fossil fuels, particularly lignite, which is one of the dirtiest forms of energy production. Replacing fossil fuels with renewable energy sources offers potential for reducing greenhouse gas emissions.

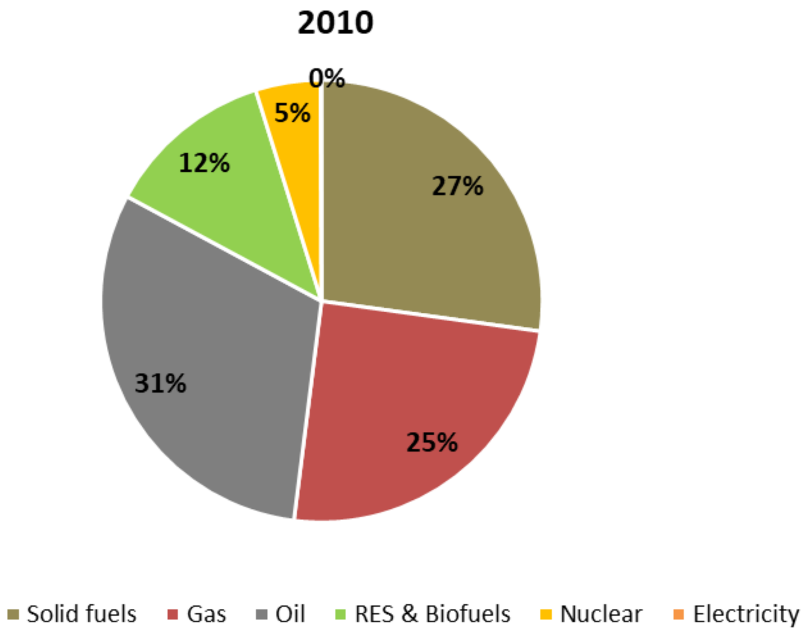
Bulgaria is a perfect example of this potential for reducing emissions. Bulgarian electricity generation is still heavily dependent on fossil fuels – particularly lignite. This is a significant problem because, while lignite is the cheapest source of fossil fuel electricity, it causes the highest CO_2 emissions per tonne when burned, a third more than hard coal and three times more than natural gas. In Romania, fossil fuels still accounted for almost 30% of the electricity mix in 2023. Greece, by contrast, is a shining example of developing renewables and reducing the share of lignite in its energy mix in recent years.

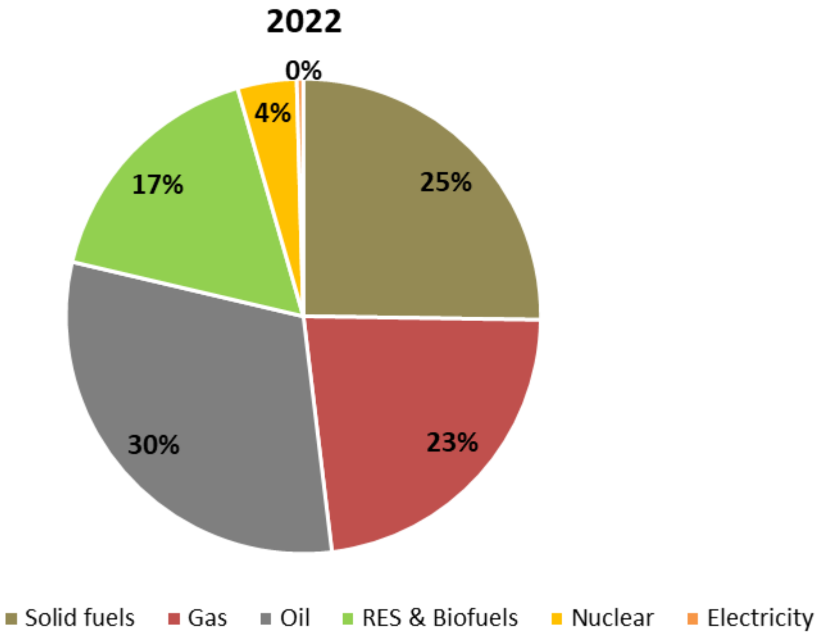
SE Europe is home to many energy-intensive industries, particularly in sectors such as manufacturing and chemicals, which are a link in global supply chains. To remain competitive and retain contracts with multinational companies committed to net zero targets, industries in the region need to switch to cleaner energy sources. The new European Green Industrial Plan provides further incentives to accelerate this shift, encouraging the development of clean energy technologies and local supply chains to ensure energy independence.

The countries of SE Europe have revised their National Energy and Climate Plans (NECPs) to reflect more ambitious renewable energy targets. The REPowerEU initiative contributes to accelerating investments in renewable energy infrastructure, grid modernization and cross-border interconnections, which are crucial to unlocking the region’s full potential.

Looking at the broader energy map of SEE, the regional energy mix in Total Energy Supply between 2010 and 2022 is changing, which despite the increase in renewables and the large contribution of natural gas remains locked in high solid fuel consumption and significant oil imports. In addition, there is less use of solid fuels, but the decline is not as large as expected to advance the EU’s decarbonization agenda. Therefore, there is a major political and environmental challenge, which the governments of the countries concerned, sooner or later, will have to face.

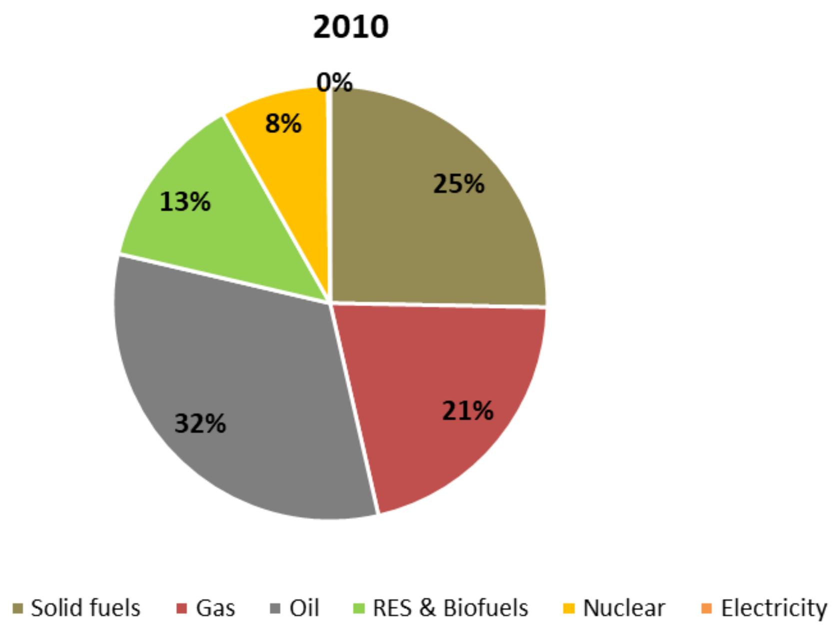
Figure 146: Total Energy Supply (%) in SE Europe, including Türkiye, 2010 and 2022

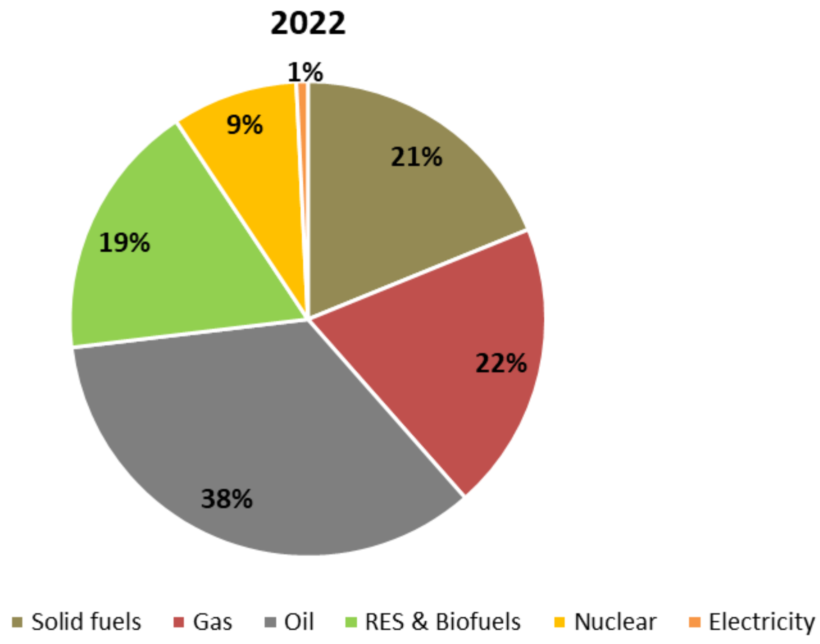




Source: Eurostat, IENE

Figure 147: Total Energy Supply (%) in SE Europe, Excluding Türkiye, 2010 and 2022





Source: Eurostat, IENE

The region of SE Europe is characterized by high dependence on oil and natural gas imports, with the region being 87% dependent on oil imports, while in the case of natural gas the dependence reaches 88%. This high dependence on hydrocarbon imports leads many countries to search for domestic sources of hydrocarbons and this has already led to increased exploration and new discoveries, especially in Romania, Albania, Croatia, Cyprus, Israel and Türkiye (Black Sea).

Furthermore, nuclear energy, although contributing only 4.0% to the total gross inland consumption in SEE (including Türkiye) and 8% if we remove Türkiye from the picture, remains a viable option, as it covers significant base load needs in some countries (Romania, Bulgaria, Croatia, Slovenia, Hungary) and is fully compatible and supportive of the (revised) EU policies for reducing carbon emissions. In view of the current plans in Romania, Bulgaria, Hungary and Türkiye to expand the installed nuclear capacity, nuclear energy is expected to play a crucial role in boosting electricity generation and covering much larger electricity loads in SEE over the next decade.

In terms of security of energy supply, the SEE region as a whole appears to be more vulnerable than the rest of Europe (mainly Western European countries). This is due to the limited supply options so far, mainly for natural gas, the difficult morphology of the various countries and the region's dependence on a small number of oil and gas suppliers. Energy security in SEE can be strengthened by implementing a broader plan (which is already underway) to improve interconnections for both electricity and natural gas across the region and also by further diversifying the energy mix of the various countries.

In particular, the issue of taking measures to address the rise in prices in the wholesale markets of SEE was raised in September 2024 by the Energy Ministers of Greece, Romania and Bulgaria to the Commission. In a letter, the three Ministers point out that price volatility in SE Europe has put significant pressure on the economies of the countries, threatening both energy security and market stability across the region.

The main issues raised include:

- Insufficient interconnection capacity: The lack of cross-border interconnections hinders efficient electricity flows in the SE European region at critical times, exacerbating price increases, especially during evening peak hours when renewable energy production is reduced. The development of these missing interconnection links is crucial to alleviate congestion and converge cross-border prices.
- Fragmentation of energy markets: The limited integration of regional electricity markets with the wider EU system has led to significant price divergences, with disparities often exceeding €50-100/MWh. To restore market cohesion and improve price stability, it is essential to accelerate infrastructure investments and integrate our markets more closely with the EU market.
- Reduced flexible generation capacity: The availability of flexible generation sources, particularly hydropower, has been limited by prolonged droughts, leading to greater reliance on coal- and gas-fired plants. This situation highlights the urgent need for investment in flexible and clean generation capabilities.

- Geopolitical factors and security of supply: The reversal of traditional electricity flows due to Ukraine becoming a net importer from the SE European region is further pressing the system, pushing up prices.

7.2 Greece in SE Europe

In the last two years (2023-2024), there has been an impressive restoration of Greece's energy prestige (which had declined significantly during the economic crisis) in the wider region of SE Europe, thanks to the completion of a series of infrastructure projects, mainly in natural gas, but also to the further impressive penetration of Greek companies, mainly in the field of RES and electricity markets in the region. These projects include the completion and operation of the Hellenic-Bulgarian gas interconnector (IGB) in 2023, the completion and commercial operation of the floating LNG unit in Alexandroupolis (2024) and the new 400 KV Greece-Bulgaria electricity interconnection (2024). All of the above projects, on the one hand, ensure greater energy access for Greece to the countries of the north, and on the other hand, contribute to the energy security of the countries of the region. In other words, it is a two-way energy relationship through which our country is given the opportunity to develop extroversion, at a diplomatic and energy level, and at the same time to benefit economically through increased exports of natural gas and electricity.

The commercial operation of the FSRU in Alexandroupolis, which was inaugurated on October 1, 2024, is a turning point in the country's energy developments and at the same time signals multiple benefits, transforming Alexandroupolis into an energy hub and contributing to the achievement of national goals. Importantly, the Greek system will be supplied annually with approximately 45,000 MWh of natural gas, which corresponds to 1.5 bcm per year or 27% of the total annual gasification capacity of the station. The project is connected to the National Natural Gas Transmission System through a 28 km pipeline, through which the gasified LNG will be promoted to the markets of Greece, Bulgaria and the wider region, from Romania, Serbia and North Macedonia, to Moldova and Ukraine. Therefore, the project significantly contributes to the attempt to stop relying the Central and SE Europe on Russian natural gas.

The importance of the Alexandroupolis FSRU is great, as with this unit, Greece acquires a second “gateway” for liquefied gas, after the DESFA terminal in Revithoussa. Thus, the diversification of supply sources and natural gas suppliers increases. At the same time, security of supply and competition in the wider region are strengthened. In this way, Greece is developing into a natural gas transit hub in Southeastern Europe, leveraging the geostrategic advantages of its location. Another reason why the Alexandroupolis FSRU is of great importance for Greece’s regional energy policy is due to the fact that, in combination with the IGB, they form the basis of the Vertical Corridor, which will transport gas from Greece northwards “to the Baltic Sea”. This corridor was first proposed jointly by Greece, Bulgaria and Romania in November 2014 following a meeting of energy ministers and the signing of a memorandum. IENE prepared the first feasibility study, which was completed in March 2015. The Vertical Corridor essentially consists of sections of existing pipelines, with the addition of some additional pipelines that will be needed in some places, through which a supplier will be able to transport gas from Greece northwards to any country (e.g. Bulgaria, Romania, Serbia, Moldova, Hungary, Ukraine), whose Operator will have contracted, based on an agreement, and will follow the specific protocols for the transport of gas provided for by the group of countries that make up the Vertical Corridor.

The Vertical Corridor concerns the creation of a gas supply route for quantities of up to 10 billion cubic meters per year (bcma), which will start from Greece and end in Slovakia in the west and Ukraine in the east, while Serbia may be included very soon, which is far from the planning stage at this stage. So far, the Gas System Operators participating in the Vertical Corridor process include the following: Bulgartransgaz and ICGB from Bulgaria, Transgaz from Romania, FGSZ from Hungary, EUSTREAM from Slovakia, VMTG from Moldova, GTSOU from Ukraine and DESFA from Greece.

A binding “market test” carried out by the region’s natural gas system operators in July 2024 found complete reluctance on the part of users (mainly commercial gas companies) to commit capacity in the long term, in contrast to the results of the non-binding phase held in May, where 27 companies from Greece and abroad had expressed interest. The Vertical Corridor, which is an alternative route for transporting natural gas from Greece to the northernmost countries in the region, is supported by both the EU and the US government as part of the effort to wean itself off Russian gas and strengthen the region’s energy security.

The basic infrastructure of the Vertical Corridor is the Greece-Bulgaria gas interconnector (IGB), the construction of which was completed in October 2022, while it was put into full commercial operation 12 months later. The pipelines and bypasses of other countries come and "clip" onto the IGB, through which gas is transported from one country to another, through the activation of special transport protocols that the various Operators in the region have concluded between themselves. In order to complete the gas transport chain offered by the Vertical Corridor, the construction of additional pipelines and interconnectors will be required, with a total cost estimated at €400-€500 million.

The Operators' "eyes" are turned towards Brussels and Washington, as both had previously declared their support for the project. The Operators, however, despite the current challenges facing the project, due to the lack of binding interest, declare their readiness to proceed with further examination and study of the project, assessing that the "wreck" of the recent market test is temporary and will not affect the long-term viability of the project. It should be emphasized that the Vertical Corridor project constitutes a strategic objective of the broader European plan for the de-dependence on Russian gas with a target date of 2027, as well as the further development of the regional gas market through the strengthening of cross-border gas transportation and trading.

As market players with knowledge of the matter observe, “the Vertical Corridor project seems to be temporarily ‘stuck’ due to the companies’ reservations about making long-term commitments in an environment of intense market liquidity, which has recently been literally flooded with Russian gas arriving in the region via TurkStream at a price €8-€10 cheaper than European prices, as set in the Dutch TTF.” A typical example is the Greek market, where Russian gas imported through the Sidirokastro gateway in the second half of 2024 covered an average of 60% of domestic consumption.

Cross-border electricity trade between Greece and neighboring countries has also been strengthening recently, thanks to the international electricity interconnections that have been created and are operating successfully with Italy, Albania, North Macedonia, Bulgaria, Türkiye, as well as new ones that are under development.

According to the relevant data, cross-border electricity trade in 2023 between Romania - Bulgaria was 1.5 TWh, Bulgaria - Greece 2.8 TWh and Greece - Italy 1.3 TWh. The driving force for energy flows in the interconnections is the significant price differences between the individual markets: the average electricity price in Romania and Bulgaria in 2023 was 104 €/MWh, in Greece 119 €/MWh and in Italy 127 €/MWh. The development of electricity imports and exports also has a direct benefit for the consumer as more expensive domestic sources are replaced by cheaper imports.

Greece's position in international electricity interconnections is set to be further strengthened in the coming period through the operation of the Great Sea Interconnector, with 1.0 GW in the first phase of electricity connection with Cyprus and Israel (2025/2026), 3 GW with Egypt (2026) and perhaps 3.0 GW with Croatia (2027/2028). Although Greece will be a net importer in cross-border electricity trade in 2022, the necessary infrastructure is now in place, while new ones are being created, which will allow much larger electricity exports to surrounding countries once we can fully utilize our domestic energy sources, from natural gas and RES.

At the same time, Greek companies are establishing their presence in the Balkans. According to the new business plan of PPC, "in addition to the critical role in Greece and the strong presence in Romania, the strategic plan also includes development in Bulgaria and/or the wider region, where the Group aims to have 1.1 GW of installed capacity by 2030". With its presence in the Balkans, the PPC Group will succeed with the expanded and complementary

RES portfolio of photovoltaic and wind parks, spreading the risk by taking advantage of the different meteorological conditions in each region", the company reports. It is noted that PPC holds the first position in the market in the production, distribution and supply of electricity in Greece, while in Romania it is the largest supplier with 3 million customers, holds the second place in distribution networks and is the largest producer of electricity from RES with power units of 597 MW. According to the business plan presentation, the benefit from synergies in the Balkans is estimated at €50 million per year.

The picture of the energy market and the dominant role of Greece in the region would not be complete if we did not mention the pivotal role played by the two major refining groups, HELLENiQ ENERGY and Motor Oil. The HELLENiQ ENERGY Group operates in the markets of Southeastern Europe through a network of over 300 service stations, where it holds a significant position in fuel marketing in Cyprus, Bulgaria, Serbia, Montenegro and the Republic of North Macedonia. In terms of the production of refined products per capita, Greece holds the scepter throughout SE Europe. This means that SE Europe and to a large extent the Eastern Mediterranean and North Africa rely on Greece for their oil supply. This enormous success of our oil industry is due to timely and targeted investments in the upgrading and modernization of the two groups during the period (2006-2012), which allowed for a rapid increase in production and exports at competitive prices. Greece, although in the southernmost part of the Aegean Peninsula, is today an energy pillar of the entire Balkan region and beyond, supplying significant quantities of refined products to Cyprus, Bulgaria, Serbia, Montenegro, North Macedonia and Türkiye, which reach almost 60% of the total production of the two major refining groups. With an already strong oil footprint in SE Europe, Greek oil companies are planning to further upgrade their presence, with HELLENiQ ENERGY in discussions for the reactivation of the Thessaloniki-Skopje oil pipeline, while processes are also underway for the construction of a new oil pipeline from Alexandroupolis to Burgas in Bulgaria.

In parallel with the development of conventional energy sources, Greece has made impressive strides in the promotion of RES over the last 10 years, where it holds one of the largest total installed capacity sizes at almost 16.0 GW, including large hydroelectric plants and a participation in 59.0% of the country's total installed capacity. Essentially, it holds second place in the region after Türkiye, which due to its size, state aid and the activation of the domestic industry has developed the RES sector in various ways with a total RES capacity reaching 59.0 GW. It is worth noting that photovoltaics produce 20.0% of electricity in Greece, based on data for 2023, which ranks our country second in the world, behind only Chile, according to the annual report of the climate think tank Ember. At the same time, Greece maintains a leading position in the production and export of solar thermal systems (solar water heaters), as well as in RES construction assignments outside Greece with large companies acting as EPC contractors. In conclusion, cooperation between the countries of Southeastern Europe must be further strengthened, with Greece at the center, due to its geopolitical position, in order to create a network of energy hubs that will ensure the energy security and sustainability of the EU. This region is rich in natural resources (sun, sea and wind) offering huge opportunities for the production of cheap energy, while investments in clean technologies are increasing the GDP of the participating countries.

8. Energy Technologies

Energy technology is an engineering science, which has as its main purpose the efficient, safe, environmentally friendly and economically viable extraction, conversion, transport, storage and use of energy, while preventing any side effects on humans, nature and the environment. After World War II, enormous progress has been achieved in the development of a wide range of energy technologies used worldwide, while continuous technological progress has led to many improvements and higher efficiencies, with the significant introduction of new low-emission technologies.

The purpose of this Chapter is to identify, describe and evaluate energy technologies that are sustainable, tested and can be implemented immediately or in the coming years in Greece, but also in the wider region of SE Europe, at competitive prices.

Overview of Clean Energy Technologies in Greece

Renewable Energy Sources (RES) can be used in electricity generation, but also in heat production and transport. Most RES technologies are suitable for use in Greece, but also in SE Europe and several of them are already used in most countries in the region. However, there is a huge RES potential in SE Europe, in order to further exploit solar thermal systems and photovoltaics, wind, hydroelectricity and biomass, as well as other technologies, used to a small extent or new, such as biofuels, biomethane, geothermal energy, ocean energy and offshore wind, as analyzed in detail in the IENE reference study “SE Europe Energy Outlook 2021/2022”[23].

1. Offshore Wind

The development of offshore wind farms is a national strategic priority, as it is expected to strengthen our country's energy transition plan and contribute to energy security, offering clean and affordable energy in the energy mix. The Greek maritime area is characterized by

[23] IENE (2022), “SE Europe Energy Outlook 2021/2022”, https://www.iene.eu/en/congress/47/iene-study-see-energy-outlook-2021-2022

very good wind potential with little variability throughout the year, which makes it particularly attractive to investors for electricity production, compared to other maritime areas of the Mediterranean, as it favors higher energy yields of offshore wind farms.

According to the draft of the revised version of the National Energy and Climate Plan (NECP)[24], the installed capacity of offshore wind farms is expected to reach 1.9 GW by 2030. It is noted that this target is not final and is expected to be finalized before the final submission of the revised version of the NECP. The offshore wind farm projects to be developed in Greek seas will consist of both fixed bottom and floating projects.

Offshore wind farm projects exhibit high energy efficiency (high utilization factor) and the distribution of their production throughout the day allows for the limitation of their participation in grid saturation, the reduction of conventional production during the evening hours and the reduction of electricity costs.

Regarding the framework for offshore wind farms, in July 2022, Law 4964/2022 (A' 150) was passed, which specifies in detail for the first time the framework for the development of offshore wind farms in the Greek maritime area. The objective of the framework is to ensure strict procedures for the selection of offshore wind farm development areas with a view to the protection and preservation of the marine environment. The careful design of the regulatory and legal framework is expected to benefit our country by ensuring a balance between consumers, local communities and the state, while creating the framework for ensuring the implementation of safe investments in our country.

The regulatory model that was chosen attributes to the state, through the Hellenic Hydrocarbon and Energy Resources Management Company (EDEYEP), which is designated as the responsible Body for offshore wind farms, the primary role in the planning and selection of the Organized Development Areas for Offshore Wind Farms (POAYAP), while at the same time, detailed procedures for the siting of the areas are prescribed, which greatly mitigates risks and provides the necessary investment security, already at the initial stage of planning.

The granting of exploration rights to investors and subsequent development of offshore wind farm projects within these areas will be carried out following a specific evaluation process based on quality criteria, while the competition for the price of energy that will follow at a later stage will guarantee consumer protection. The design of the electricity transmission network and the cost of interconnection are constantly being optimized and reformed thanks

[24] https://commission.europa.eu/system/files/2023-11/GREECE%20-%20DRAFT%20UPDATED%20NECP%202021-2030%20EL.pdf

to the regulatory framework, with the necessary provision for offshore wind farm projects in the IPTO plans for the interconnection of the islands.

To this end, the Coordination Committee for the Connection and Development of Offshore Wind Farm Projects has already been established and is operating, aiming at expediting the procedures and effective cooperation and communication of all competent bodies involved in shaping the framework for offshore wind farm development projects. It is noted that the development of offshore wind farms in the country requires a challenge that presupposes the resolution of various relevant issues, such as the need to create the necessary infrastructure (e.g. shipyards, ports), the availability of specialized human resources for such projects, problems in supply chains and the high level of competition with other areas where large-scale development of offshore wind farms is taking place internationally.

According to the preliminary Ten-Year Development Plan 2025-2034 of IPTO, there are 5 areas (Thrace, Crete, Cyclades, Attica and Dodecanese), in which the first offshore wind farms in the country are expected to be developed. In particular, pilot projects of 600 MW have been planned in Evros and Samothrace, another 600 MW in Crete, in the Cyclades and specifically on the islands of Syros, Paros and Naxos, 250 MW projects are underway, while on the islands of the Cyclades near Attica as well as in the South Euboean Gulf, 200 MW projects will be carried out and in the Dodecanese, 350 MW projects.

2. Biomethane

Biomethane is a renewable gas, which is mainly obtained through the upgrading of biogas. Biogas comes from organic materials, such as human or animal waste/sewage, food waste, distillery waste or agricultural materials. Because the carbon in this material has just been taken from the atmosphere and belongs to the short carbon cycle, biogas and biomethane are considered renewable fuels. Biomethane has similar properties to natural gas and for this reason can be transported through the available infrastructure.

It can also be used as a fuel for vehicles and generally for all purposes for which natural gas is used. Biomethane can be injected and distributed through the natural gas network, after it has been compressed to pipeline pressure and an odorization agent, usually tetrahydrothiophene, has been added, so that leaks along the network can be detected.

Currently, 99 biogas power plants are operating in Greece with a total installed capacity of 116 MWe, while there is no biomethane production. The biomass categories used are livestock waste (cattle, pig farms, sheep and goats, poultry), agricultural residues (from winter cereals, e.g. durum and soft wheat, oats, rye, vetch, triticale), agro-industrial waste (whey), food residues (e.g. from restaurants) and organic municipal waste. The above raw materials can be used as raw materials for the production of biogas/biomethane.

3. Hydrogen

One of the clean forms of energy with zero carbon emissions is hydrogen. Pure hydrogen must be produced from other compounds containing hydrogen, such as fossil fuels, biomass or water. Each production method requires an energy source, namely thermal (heat), electrolytic (electricity) or photovoltaic (light) energy. Hydrogen, produced from renewable electricity (green hydrogen), has no carbon emissions associated with its production or use, unlike hydrogen currently produced from fossil fuels (blue or grey hydrogen).

Hydrogen can be stored as a liquid, gas or chemical compound and converted into usable energy through fuel cells or by combustion in turbines and engines. Hydrogen uses cover a wide range of energy applications, such as as a fuel for transportation, as a substitute for natural gas for heating or electricity generation, or as a feedstock in a range of industrial applications (such as ammonia production or steelmaking).

The potential of renewable hydrogen as a clean and flexible energy carrier has been recognized for many years, but the economic and technological challenges associated with creating a hydrogen economy have only recently begun to be overcome. With the ever-decreasing costs of renewables and hydrogen technology, and emerging export markets, the factors required to develop a global renewable hydrogen sector are beginning to be understood.

In Greece, and according to the estimates of the European body “Fuel Cells and Hydrogen Joint Undertakings”, the potential for the production of renewable electricity in 2030 is significant and this creates great opportunities for the country to utilize renewable electricity in the production of hydrogen by water electrolysis.

These opportunities also include the possibility of utilizing the existing natural gas infrastructure for the transport and distribution of hydrogen, by blending hydrogen into the public natural gas network in the immediate (2025-2030) and medium term (2030-2040) period and possibly converting part of the natural gas network for the exclusive use of hydrogen in the long term (after 2040).

However, converting the network to exclusive hydrogen pipelines will be a longer-term perspective, as hydrogen production volumes are expected to remain relatively low until 2030.

In the short and medium term, hydrogen could therefore be blended with methane in the existing natural gas network, without the need for special adaptations to the transmission, distribution and end-use infrastructure.

As for the use of hydrogen in Greece, apart from the road transport sector and shipping (especially domestic shipping which represents almost 10% of total transport demand and is the highest in Europe), there are possibilities for hydrogen exploitation in industry, replacing the existing use of hydrogen derived from fossil fuels.

The final targets for hydrogen production are currently under investigation. However, for the time being, for 2030 the total production of green hydrogen is estimated to reach at least 0.92 TWh, which corresponds to a capacity of installed electrolysis systems of approximately 300 MW, while the aim is to gather the appropriate resources in combination with the creation of a hydrogen absorption chain in uses that cannot be electrified, in order to further accelerate hydrogen production by 2030. The total consumption of green hydrogen is estimated at 63.6 TWh/year by 2050, however the largest percentage (approximately 70%) is estimated to be consumed for the production of synthetic hydrocarbons for use in transport.

4. Biofuels

a. Conventional Liquid Biofuels

Conventional liquid biofuels are already used in Greece in the form of biodiesel with a mandatory blending quota of 7% by volume in road transport diesel, and bioethanol/bioethers with a mandatory blending quota of 3.3% in energy content in gasoline, equivalent to approximately 5% by volume. Biodiesel is produced almost entirely in Greece in 18 plants with raw materials oilseed energy crops (rapeseed, sunflower, soybean, cottonseed) and oil waste (used frying oils) (FAME). Bioethanol is produced from the fermentation of sugar/starch crops (sugar beet, sugar cane, grain, corn) and is imported. Before blending, however, it is mostly converted into ethers in refineries in order to lower the evaporation point.

The production/consumption of conventional liquid biofuels is not developed further in order not to create a problem in the supply of food and feed, in accordance with EU policy. The upper limit of conventional biofuels as a percentage of transport fuels is maintained at 1.7% throughout the energy transition, indicating a gradual reduction in their production in absolute terms.

b. Advanced Liquid Biofuels

Advanced biofuels are produced by hydrogenating vegetable oils or other biological fats, such as animal fat, used cooking oils and tall oil (a waste from paper industries). For this purpose, “blue” or “green” hydrogen is used and biological oily/fatty waste is used as the carbon feedstock. This chemical process first removes the oxygen content of the feedstock and then breaks down and isomerizes the organic molecules, resulting in diesel (advanced biodiesel) or kerosene (SAF-Sustainable Aviation Fuel).

Technologies for gasification of woody residues and synthesis of liquid fuels using green hydrogen through the Fischer-Tropsch chemical process are also under research, which achieves the catalytic conversion of a mixture of CO (produced from gasification) and H2 into liquid fuels (diesel, gasoline, kerosene). One of the liquid fuels that is also being examined as a substitute for gasoline and can be produced with similar technologies is methanol (biomethanol).

Currently, there is no production of advanced biofuels in Greece. However, the participation of advanced biofuels is expected to reach 2.4% of transport fuels by 2030 and 17% by 2040. The main limitation is the availability of raw materials and the cost of production, which, however, has a downward trend. Advanced liquid biofuels will be used primarily in the transport sector, simultaneously replacing conventional biofuels.

5. Renewable Fuels of Non-Biological Origin (RFNBO)

These fuels are produced using, as a carbon source, CO2 captured from waste gases/flue gases of specific industrial processes (until 2040 according to EU policy), from biomass or from the atmosphere (DAC - Direct Air Capture), and, as a hydrogen source, "green" hydrogen. They are also called e-fuels due to the use of large amounts of electricity for the production of green hydrogen and the capture of carbon dioxide from the air. The synthesis is carried out using catalytic chemical processes of the Fischer-Tropsch type or methanol synthesis, from synthesis gas (a mixture of CO, CO2, H2). They are technologies under development, mainly in terms of energy consumption and the cost of their production.

One of these fuels is ammonia. It is produced in a renewable form from nitrogen in the air and green hydrogen with the Haber-Bosch catalytic reaction. The use of ammonia for ship propulsion is under investigation. Another alternative being considered for ship propulsion is the use of methanol (of biological origin or not). In Greece there is currently no production or use of renewable fuels of non-biological origin. However, it is expected to reach 1% of transport fuels by 2030 and 23% by 2040. The main uncertainty is the technical, and mainly economic, optimization of the relevant technologies.

6. Carbon Capture, Utilisation and Storage (CCUS)

Carbon dioxide capture from industrial exhaust/waste gases is the fastest way to reduce the carbon footprint of this sector, at least until alternative technologies based on RES and hydrogen are developed. The captured CO2 can be used to synthesize synthetic fuels until 2040, in accordance with EU policy (in order to reduce the use of new fossil fuels in transport).

It can also be stored in sealed geological formations. In this context, the facilitation of investments for the capture of CO2 emitted by industrial installations, mainly refineries and cement factories, is being considered. Two projects have already been approved for co-financing by the Innovation Fund: the IRIS project for the capture of CO2 in the hydrogen production unit of a refinery in Corinth, and the IFESTOS project for the capture of CO2 in a cement production plant in Boeotia.

At the same time, the first CO2 storage unit in Prinos, Kavala, has already been submitted to the Recovery and Resilience Fund for co-financing and is maturing in terms of licensing. The unit will have an absorption capacity of 2.5 million tons of CO2 per year in full operation. It is estimated that the first phase (for a capacity of approximately 1 million tons per year) will be completed by the end of 2025 and the second phase (full capacity) by the end of 2027.

The completion of the relevant licensing and regulatory framework for the capture, transport, use and storage of CO2 is also progressing. The responsibility for supervising the construction and operation of these projects has also been assigned to HEREMA. It is worth noting that CCUS technologies are also expected to be used in the shipping sector. The recent decisions of the International Maritime Organization (IMO/MEPC 80, July 2023) on binding targets for absolute reduction of greenhouse gas (GHG) emissions, such as, among others, the goal of decarbonizing shipping (net zero) in 2050 and the indicative intermediate but ambitious targets for absolute reduction of GHG emissions in 2030 and 2040, make this technology an important solution for shipping.

CCUS technology has already been included in the IMO sustainable pathways and is estimated to be one of the compliance options for shipowners to achieve the goals of decarbonizing shipping. In addition, it is appropriate to take into account that the captured CO2 from the capture of gaseous emissions using “CCS onboard” technology may be used as a raw material, e.g. for the production of alternative fuels with recycled carbon, e.g. blue methanol.

It is worth mentioning that IENE completed a special study on the prospects for carbon capture, utilization and storage (CCUS) in Greece in October 2023. The creation of CCUS hubs in Greece is the main innovative element of IENE's pioneering study, as it has the advantage of not requiring the construction of expensive infrastructure, such as extensive pipelines or storage wells, while it can serve more than one industrial and other units located in the same area. This study proposes five potential locations (Corinth - Aspropyrgos, Thessaloniki, Alexandroupoli, Volos and Western Macedonia, with a focus on power generation in Ptolemaida) in Greece as CCUS hubs as well as a detailed timetable, from 2024 to 2032, for their creation.

7. Electromobility

Electric mobility is expected to experience significant growth in the coming years in Greece, with the National Energy and Power Sector (NECP) stating that our country's goal is for 1 in 3 cars to be electric by 2030. The penetration of electric vehicles in the Greek vehicle market is very low, but significant developments have been recorded in recent years.

First of all, technology continues to evolve. One only has to consider that in 2011 the average range of an electric vehicle was only 117 km. and has now reached almost 400 km. Corresponding are the improvements in charging time, software and of course the charging networks that have expanded significantly internationally in the previous years.

Also, in 2023 the first cheap electric models made their appearance in Europe, mainly from Chinese manufacturers. By 2024, European manufacturers are expected to follow suit, with small-to-medium-sized models priced at €20,000-€25,000, without subsidies, to compete directly with conventional vehicles.

These are cars with ranges of close to 400 km that will allow drivers to drive electrically inside and outside the city, taking advantage of the ever-growing public charging network. The low cost of acquisition is an important incentive if one considers the large difference between the price of fuel and the corresponding electricity needed to charge an electric vehicle.

Specifically, in Greece, in 2024, the implementation of municipal charging plans (SFEO) is expected to gradually begin so that each driver has the solutions they need, not only in large urban centers but also in the periphery. Also, an important development for our country is the requirement that from January 1, 2024, at least 1/4 of new private company cars registered by company cumulatively be pure electric vehicles or plug-in hybrid electric vehicles. At the same time, the “I Drive Electric 2” programme continues, the payments of which reached €5.4 million last December alone. In total, in 2023, the programme allocated €14 million for 5,823 applications involving 6,021 vehicles. It is noteworthy that the penetration of electric (BEV) and rechargeable (PHEV) vehicles reached 13.7% of all new registrations in Greece last November, having made a jump of 4.5% in one year.

8. Energy Storage

Today, the two main storage technologies are pumped storage and batteries. Pumped storage is the dominant storage technology worldwide. Its main advantages are technological maturity, rapid response and fairly high efficiency. However, finding and building the two reservoirs required in pumped storage systems is difficult and time-consuming, while it is accompanied by significant environmental impacts, such as interference with species habitats - especially aquatic ecosystems, deforestation and the removal of large amounts of vegetation before filling the reservoirs. Battery storage systems have very fast responses, shorter installation times and higher efficiency than pumped storage, while they are able to offer a multitude of energy services. The progress of these technologies and the increased demand have led to an impressive reduction in their costs. However, disadvantages of batteries are their comparatively short lifespan, sensitivity, safety issues, limited availability of raw materials for their manufacture and the environmental impacts of their disposal, which require the development of relevant recycling systems.

In Greece, storage technologies have acquired a central position in the National Energy Strategy, as they are expected to lead to a significant increase in the penetration rate of RES production in the country's energy mix, as they are expected to replace the operation of conventional electricity generation units during peak load hours.

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

Therefore, storage units effectively replace expensive electricity generated by high-cost units with low-cost clean electricity available in conditions of high RES production, thus facilitating the overall integration of RES and reducing RES electricity cuts during peak hours.

In addition to the installation of short-term storage systems, e.g. batteries, the storage of electricity in pumped storage stations is particularly important. The installation of large-capacity storage stations, such as pumped storage stations, will also enhance the country's power and energy sufficiency. Large-capacity storage stations also contribute to the storage of excess RES production for long periods, i.e. an expected situation under conditions of very high penetration of RES production in the country's energy mix, as well as the provision of backup and ancillary services to the system.

9. Smart Grids

A significant challenge and policy priority is the promotion of smart grids in Greece. Digitalization and upgrading are expected to contribute to creating highly flexible conditions for the operation of the domestic energy system. Also, the finalization of the investment model in smart meters and smart electricity distribution networks, as well as the sources of financing, is expected to play an important role.

The electricity distribution network is a critical infrastructure for the transformation of the energy system and the implementation of the vision for its delignification. The technological upgrade and transition of the distribution network to the digital era is a basic prerequisite for both the improvement of its operational parameters and reliability, and for the further development of domestic energy markets. It will also facilitate the achievement of the goals of energy planning, which foresees an ever-increasing role for RES and decentralized production and improvement of energy efficiency at all levels.

It will also allow the adoption of a two-way operating model of the electricity market, with the active participation of consumers, who will be able to provide balancing or flexibility services to the system, adjusting their demand according to the conditions and at the same time operating as producers (prosumers), with the possible contribution of aggregators, as well as the coupling of all final energy consumption sectors.

The increased needs for data sharing between the distribution network operator, suppliers, public authorities and other stakeholders require the further development of data exchange systems, as well as the creation of standards in systems, protocols and data formats. With the development of smart grids and business models that focus on data and the total digitalization of the grid, the upgrade of IT infrastructures and cybersecurity is a critical factor. This requires, among other things, close cooperation between transmission and distribution network operators, interoperability between systems, and the definition of a single cybersecurity framework in the EU, including preventive, corrective and defensive plans for the energy system.

In Greece, IPTO is currently in a transformation phase that will transform it into a digital Electricity Transmission Operator (Digital TSO) with an emphasis on:

- **Asset Performance Management System:** system that allows the management of the Administrator's assets through the control and evaluation of their condition, preventing errors and enhancing the security and efficiency of the system.
- **Digital Infrastructure & Digital Grid:** network optimization through real-time load balancing, network controls and connected end-to-end markets.

- **Data Analytics Strategy:** Big & Open data management software for the supervision and control processes of the electricity market.

Correspondingly, HEDNO is following the digital transition and is upgrading itself so that it can optimally support the end consumer, industrial and residential:

- **With new “software” digital services** that modernize the Operator, such as the upgrade of the website, a new mobile app with the aim of better serving the consumer.
- **With new “hardware” digital services**, such as smart meters that provide knowledge of consumption in real time and the application of telematics in the management of the vehicle fleet for more direct interventions in the Network.

With the above actions, the Operators will contribute to the national effort for greater penetration of RES in production and the energy mix, in reducing production costs but also in adapting network operations to the new data of strengthening decentralized energy production.

According to the draft of the revised version of the National Energy Strategy, the installation of smart meters is required. HEDNO plans for all consumers to have a smart meter by 2030. As of 2021, 13,000 smart meters had been deployed at the medium voltage level and 70,000 at the low voltage level, mainly for consumers with high electricity demand. In 2022, 100,000 smart meters were installed. It is estimated that they will increase to 500,000 in 2023 and between 800,000 and 1 million each year from 2024 to 2030.

10. Nuclear Technologies

Greece is a country that lacks nuclear expertise and does not own a nuclear power plant. However, it imports around 2-4 TWh of electricity annually from Bulgaria, part of which is produced by the existing nuclear power plant in Kozloduy.

Greece is interested in participating in a pan-European programme for the next generation of small modular reactors (SMRs) and is closely monitoring the development of the technology, which is still expensive at the moment. As for the argument that countries without nuclear power are safer in the event of an accident, people with knowledge of the process say that it no longer has any basis in a region like SE Europe, which is full of nuclear power plants. Both the existing ones and those that will be built in the coming years.

In this environment, and although no official discussion has yet been opened in Greece, processes are taking place behind the scenes, as SE Europe acquires more and more reactors, the need to balance the stability of the Greek system is deemed essential and none of the “clean” technologies seem capable of ensuring it.

The issue that comes back to the table is whether a “nuclear cooperation” between Greece and Bulgaria can contribute to balancing the system. The costs today are not cheap and the price of nuclear energy, even of small reactors (SMRs), is at €80-€120/MWh, considerably higher compared to the prices of RES. With the difference that the production of photovoltaic and wind power is not stable on a 24-hour basis.

The idea of cooperation with Bulgaria is not new. It was first proposed at the heart of the energy crisis, shortly after Russia’s invasion of Ukraine in February 2022, and concerned the new nuclear reactor in Kozloduy. A year later, in July 2023, following a meeting between the Greek Prime Minister and the then Bulgarian Prime Minister Nikolay Denkov, the latter revealed that the Greek government was interested in investing in the new reactors. That is, for a Greek company to acquire a stake in one of the new units in Kozloduy. An alternative option would be a 20-year power purchase agreement. That is, for Greece to conclude a long-term agreement with the nuclear power plant, a bilateral contract (PPA), at competitive prices, in order for Greece to purchase part of the additional energy production.

However, at this stage, there are no thoughts about such an investment in Greece, especially when Greek society is not ready for such a conversation, as is the case everywhere where there are no nuclear power plants. Besides, it is no coincidence that the countries that invest in this technology are those that already have such units and are upgrading them. However, in the future, things may change. If SMR technology advances, prices drop significantly and the relevant market begins to develop, the discussion about such investments in Greece will be on a different footing.

9. Investing in the Energy Sector

9.1. Introduction

The energy sector is one of the most strategic sectors of the Greek economy, influencing many other sectors and a large part of economic activity. Both the uninterrupted supply of abundant electricity and natural gas, basic conditions for the smooth operation of housing and production infrastructure, and the provision of liquid fuels, necessary for transport, domestic heating and electricity generation, mainly in the island area, constitute the driving force of the economy.

The energy sector is capital and investment intensive. Based on Greece's geographical location, its comparative advantages and the planned structural changes, the energy sector can and should (under certain conditions) be one of the main drivers of development of the Greek economy. There are currently significant investment opportunities in Greece, both in the primary energy sector (e.g. hydrocarbon exploration and production, RES and energy efficiency), as well as the necessary investments in the transmission, distribution and infrastructure of natural gas and electricity.

Investments in the energy sector aim at both the maintenance and upgrading of existing systems and units and their expansion and therefore constitute a key element of the investment horizon. With the energy sector as a whole constituting, in a way, the "backbone" of economic development in our country due to the special position it holds in relation to the broader "productive fabric" of the economy.

Today, a multitude of small and large energy projects are underway in Greece, which between them cover all individual sectors. In summary, these projects include RES projects and mainly the installation of new wind and photovoltaic parks, solar thermal plants, small hydroelectric projects, biogas plants and the development of geothermal fields. As investments in RES projects progress, the need for electricity storage is considered imperative, which means that there will be significant investments in storage systems (pumped storage and electric batteries). A significant part of energy investments, from now on, will include the thousands of small or larger interventions to improve the energy efficiency of residential and tertiary sector buildings, transport and industry.

Also, activity in natural gas is intense, as many projects are planned to expand natural gas networks in cities and in the region, the construction of new branches and cross-border pipelines, the creation of new floating LNG terminals and the development of small-scale LNG.

Of key importance is the completion of the island electricity interconnections of the Cyclades and the "large" electricity interconnection of mainland Greece with Crete, while investments by private companies for the further development of the retail electricity market and in general in the digitalization of the electricity market are of interest.

Furthermore, the planned energy investments include the continuous modernization of the refineries of HELPE and Motor Oil through maintenance and upgrade projects, as well as hydrocarbon exploration, following the change in the Greek government's stance and the resurgence of exploration.

With total estimated investments exceeding €67 billion for the period 2024-2030, the Greek energy sector has serious room for qualitative improvement and further development and can indeed provide the necessary impetus to the development process in the coming years. The necessary modernization of the electricity and natural gas systems, interventions in final energy consumption and strategic decisions for the exploitation of natural resources and the promotion of Greece's geographical position could contribute to this.

At the same time, we should take seriously its significant export character, with exports of refined petroleum products, worth over €14.0 billion in 2023, contributing 27.5% to total Greek exports. Oil and gas pipelines, electrical cables, solar thermal systems and insulating materials have recorded a remarkable export performance in the last five years, with their exports reaching a total of €2.5 billion.

More specifically, Greece maintains export activities in the following energy sectors:

- **Petroleum products:** The Helleniq Energy and Motor Oil groups export significant quantities of petroleum products to the Mediterranean and Balkan regions
- **Electricity exports** to Italy, North Macedonia, Albania, Türkiye and Bulgaria
- **Building materials for insulation** (e.g. aluminum, window frames)
- **Solar thermal systems** (e.g. solar water heaters, flat solar collectors)
- **Electricity storage** (e.g. batteries for RES systems, with a particularly significant presence of Systems Sunlight, which specializes in the development, production and distribution of batteries and energy storage systems for industrial, consumer and advanced technology applications)
- **Cables:** Use in electricity transmission and distribution networks, RES, island interconnections with mainland systems, as well as offshore wind farms (e.g. Cablel Hellenic Cables Group exports high and extra-high voltage submarine and overhead cables)
- **Electronic electricity meters for industrial and commercial applications** (e.g. Landis+Gyr S.A., based in Corinth, exports meters to France and other French-speaking markets around the world)
- **Oil and natural gas pipelines** (e.g. Corinth Pipeworks has one of the largest varieties of steel pipes in the world used in onshore natural gas and oil pipelines, CO2 reinjection pipelines and petrochemical and fuel pipelines)

The above export activities constitute a very good basis for their further expansion both geographically and quantitatively. The further development of energy product exports will inevitably lead to greater investments, strengthening the productive potential of companies and increasing employment. For this reason, the state should support in every possible way the companies that are active in the production and export of energy products.

The energy sector can emerge as one of the most important sectors for the economic prospects of Greece, despite the adversities of the recent coronavirus pandemic and the Russia-Ukraine and Israel-Hamas wars, both of which are still ongoing. In addition to its direct contribution to production and employment, this is the case for at least two additional reasons. Firstly, it is related to the role of energy costs and energy supply security for the competitiveness of the economy and determining the level of prosperity of citizens and, secondly, to attracting investments for the exploitation of domestic energy resources, the modernization of energy infrastructure and the catalytic role that these factors can have for the development of new activities.

9.2. Total Estimated Energy Investments in Greece

Table 34 summarizes the estimated energy investments in Greece for the period 2024-2030, based on the forecasts of the National Energy and Climate Plan (October 2024) and various energy and industrial stakeholders. These estimates take into account a number of assumptions (see Annex IV), including the assumption that the country, from 2024 onwards, will follow a growth path rather than a recession over the next six years with an average annual growth rate of 1.5%.

Table 34: Estimated Energy Investments in Greece, 2024-2030

	Sector	Description	Estimated Investments in million. €
OIL	Upstream	▪ Field surveys, new oil and gas drilling, construction of infrastructure on land and at sea*[1]	1,500
	Downstream	▪ Upgrading and modernizing refining facilities	3,500
NATURAL GAS	Pipelines, natural gas networks and other facilities	▪ Development of urban and regional networks (city grids)	1,500
		▪ Cross-border pipelines*[2]	150
		▪ Underground gas storage facility in South Kavala	800
		▪ LNG terminals and FSRUs*[3]	1,500
ELECTRICITY	Electricity generation (new units)	▪ Prinos CCUS	1,500
		▪ CCGT units*[4]	1,500
		▪ Energy storage (including batteries and pumped storage projects)	3,000
	Electricity grid	▪ Hybrid RES systems in the island area	250
		▪ Upgrading and expansion of the existing network and island interconnection (including new H/T transmission lines)	4,000
	RES	▪ Small hydro	150
		▪ Wind (onshore and offshore)	11,000
		▪ Solar PV*[5]	9,000

		▪ Concentrating Solar Power	300
		▪ Biomass (including liquid biofuels)	750
		▪ Geothermal energy (high and low enthalpy)	500
		▪ Green hydrogen/CCUS units	2,600
ENERGY EFFICIENCY	Energy Efficiency	▪ Energy upgrading of buildings (private and public commercial buildings)	8,000
		▪ Electromobility	12,500
DOMESTIC AND COMMERCIAL SOLAR THERMAL APPLICATIONS	Domestic and Commercial Solar Thermal Applications	▪ Solar thermal systems in hotels, industry, residences, maintenance, replacement, etc.	1,500
RESEARCH AND INNOVATION	Research and Innovation	▪ Research and innovative energy applications	2,000
	Total Estimated Investments until 2030		***67,500***

__Notes:__ ***[1]**The total investment cost is an estimate by IENE and is based on 3-4 planned exploration and production wells, ***[2]**Includes the Greece-North Macedonia interconnector and upgrades of existing facilities. It does not include the East Med pipeline, ***[3]**Includes the FSRUs in Alexandroupolis (INGS Alexandroupolis and INGS Thrace) of Gastrade, Thessaloniki of Elpedison, Agioi Theodoroi of Motor Oil and Volos (INGS Argo) of Mediterranean Gas, as well as additional projects at the Revithoussa terminal, ***[4]** Includes the new CCGTs of (a) GEK TERNA-Motor Oil, (b) PPC-DEPA Commercial-Damco Energy, (c) Elpedison and (d) Mytilineos Group, ***[5]** Includes central self-generation units, rooftop PV installations and electricity storage systems.

Source: IENE

The energy investments presented in Table 34 result from:

- The goals set by the revised National Energy and Climate Plan (NECP) of October, with a total budget of €96 billion. It is noted that the NECP foresees the radical transformation of the domestic energy sector, which will lead to a climate-neutral economy for the benefit of society and the environment.
- The recording of energy business and investment proposals and the analyses carried out by IENE on an ongoing basis.

- The National Natural Gas System Development Programme 2023-2032[25], with a total budget of €1.27 billion, published by DESFA. Also, the 2021-2030 Development Study[26] and the 2023-2032 Demand Assessment Study[27] published by DESFA.
- The Transmission System Development Programme 2024-2033[28], published by the IPTO. Also, the 2022-2031 IPTO's Capacity Adequacy Study.
- The Electricity Market Reform Plan, as uploaded on the RAAEY website.
- The Long-Term Energy Strategy for 2050[29], drafted by the Ministry of Environment and Energy, which constitutes a roadmap for climate and energy issues.
- The investment programmes of energy companies.

Table 34 does not include the design, legislative, regulatory, administrative and financial work, as well as the work of creating investment incentives, which is necessary for the promotion and completion of many of the investments presented.

9.3. Sources of Financing for Energy Investments

Today, there is a large number of financial sources and tools, so that the interested investor, private company or state entity, can carefully explore and choose the most appropriate form of financing. The following is a brief description of the offered community, national and international sources of financing, where funds, as well as know-how, can be raised, in order to be useful and support small and large energy investments in Greece.

9.3.1. European Financing Sources

The following five European Structural Funds have played a decisive role in financing energy projects during the period 2014-2020, while they are expected to contribute significantly during the programming period 2021-2027:

- The **European Regional Development Fund (ERDF)**, which promotes the balanced development of the different regions of the EU.
- The **European Social Fund (ESF)**, which supports employment-related projects across Europe and invests in Europe's people - workers, young people and all those looking for work.

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25 https://www.desfa.gr/userfiles/consultations/%CE%A3%CF%87%CE%AD%CE%B4%CE%B9%CE%BF%20%CE%A0%CE%91%20%CE%94%CE%95%CE%A3%CE%A6%CE%91%202023%202032_final.pdf

26 https://www.desfa.gr/userfiles/pdf/f_%CE%9C%CE%B5%CE%BB%CE%AD%CF%84%CE%B7%20%CE%91%CE%BD%CE%AC%CF%80%CF%84%CF%85%CE%BE%CE%B7%CF%82%202021-2030_GR.pdf

27 https://www.desfa.gr/userfiles/5fd9503d-e7c5-4ed8-9993-a84700d05071/f_Demand%20Forecast%20Study%202023-2032.pdf

28 https://www.admie.gr/sites/default/files/2023-10/%CE%94%CE%A0%CE%91%202024-2033%20%CE%9A%CF%8D%CF%81%CE%B9%CE%BF%20%CE%A4%CE%B5%CF%8D%CF%87%CE%BF%CF%82.pdf

29 https://ypen.gov.gr/wp-content/uploads/2020/11/lts_gr_el.pdf

- The **Cohesion Fund (CF)**, which finances projects in the transport and environment sectors in countries where the gross national income (GNI) per capita is below 90% of the EU average.
- The **European Agricultural Fund for Rural Development (EAFRD)**, which focuses on solving the specific challenges faced by EU rural areas.
- The **European Maritime and Fisheries Fund (EMFF)**, which helps fishermen adopt sustainable fishing practices and coastal communities diversify their economies to improve the quality of life along Europe's coasts.

It is noted that during the 2021-2027 programming period:

- The use of financial instruments is increasing.
- The importance of repayable aid (provided through financial instruments) is increasing.
- Grants are generally decreasing.
- The possibility of combining Fund resources with resources from other sources is given.
- The pursuit of increased leverage and recycling of resources is strengthened.

The broader European programmes:

- The **Horizon programme** during the 2021-2027 programming period (Horizon Europe), but also during the 2014-2020 period (Horizon 2020). The programme is the largest European Research and Innovation programme.
- The **Connecting Europe Facility (CEF)** programme, which finances growth, employment and competitiveness through investments in European infrastructure (Projects of Common Interest and cross-border cooperation projects) in the Energy, Transport and Telecommunications sectors.
- The **InvestEU programme** during the 2021-2027 programming period, which will focus on sustainable infrastructure, research, innovation and digitalisation, small and medium-sized enterprises and social investment and skills.
- The **Just Development Transition (JDT) programme** during the 2021-2027 programming period, which constitutes the main pillar for the design of a development strategy in the JDT areas and is expected to provide the necessary means to achieve significant economic, social and environmental results. The JDT Programme has a total budget of €1.63 billion. and is structured into priorities such as: (a) the strengthening and promotion of entrepreneurship, with actions to strengthen businesses – with an emphasis on small and medium-sized ones – and the

interconnection of entrepreneurship with research and innovation, (b) the energy transition, with energy-related actions such as district heating, electromobility, energy storage systems, etc., (c) the circular economy, with actions aimed at the reuse of lignite soils and the development of new economic activities and (d) the fair labor transition, with actions to strengthen the skills of the human resources of the transition areas and the promotion of employment.

- The **Islands Decarbonization Fund programme**, drawing resources from the auction of 25 million tons of unallocated CO2 emission rights (Ministerial Act EYDEP/YMEPERAA 12299/25-10-22). The actions to be financed include the change of the energy model in the islands not interconnected with the mainland electricity transmission system, as well as faster electricity interconnection and energy saving projects. Part of the Decarbonization Fund funds will be used to finance electricity interconnection projects on the islands in order to accelerate the implementation of the IPTO plan, as well as energy saving projects. This new financing mechanism is a key tool for achieving the objectives of article 21 “Transformation of the Development Model of the Islands and their Transition to Climate Neutrality” of the recently passed National Climate Law (Law 4936/2022, A’ 105). The amount of funding for the years 2024-2030 that will be allocated for the decarbonization of the Ionian and Aegean islands in Greece from the Decarbonization Fund is estimated at approximately €2.27 billion in current prices, while the total expenditure is estimated at €5.4 billion, depending on the price of emission rights in monetary valuation.

The specific European funds for Climate Change and Energy:

- The **European Just Transition Fund (JTF)**, which was funded in June 2021 with new EU funds of €17.5 billion.
- The **European Emissions Trading Scheme (EU ETS)**, which is the central European mechanism for reducing greenhouse gas emissions. Part of the resources from the EU ETS are used to promote energy efficiency measures and policies.

European programmes specific to Climate Change and energy:

- The **LIFE programme**, which is the EU's financial instrument for the environment and Climate Change.

European investment banks:

- The **European Investment Bank (EIB)**, which aspires to become a “Climate Bank”.

- The **European Bank for Reconstruction and Development (EBRD)**, which in recent years has focused on financing projects in the transport, energy and water and sanitation sectors.
- Other European and international investment banks.
- Transnational agreements and memoranda of understanding/cooperation.

In addition to the above, funds from the European Recovery Fund will play an important role due to the unprecedented economic recession, the consequences of the pandemic and Russia's war in Ukraine. Of the total capital of the European Recovery Fund, amounting to €672.5 billion, the amount allocated to Greece amounted to €31 billion, of which €18 billion were in the form of grants and the remaining €13 billion in the form of zero-interest loans. However, Greece, through the national Recovery Fund, is expected to draw from the supplementary package of the "REPowerEU" plan, announced by the European Commission in May 2022, an additional €3 billion, reaching €34 billion.

9.3.2. National Financing Sources

The main sources of financing for state investments in general:

- The **Regular Budget.**
- The **annual Public Investment Programme (PIP)** (both the national PIP, which includes projects financed purely from national resources, and the co-financed PIP, which includes projects in the financing scheme of which European funds, European programmes and/or other International Financing Organizations, etc. participate with resources. It is noted that the programming is three-year, e.g. PIP 2021-2023.
- The **National Development Programme** of Law 4635/2019, the object of which is the medium-term development planning for the utilization of national resources of the PIP.
- The **Infrastructure Fund**, which aims to finance the private and public sector for the implementation of small and medium-sized projects, with an emphasis on the sectors of energy, environment and urban development, as well as its participation in relevant Public and Private Partnerships Private Sector (PPP).

National funds specifically for Climate Change and Energy:

- National revenues from the **European Emissions Trading System** (revenues from auctions of greenhouse gas emission rights), through the Green Fund.

- The **Green Fund**, which aims to support programmes, measures, interventions and actions aimed at promoting and restoring the environment, supporting the country's environmental policy and serving the public and social interest.

- The **National Energy Efficiency Fund**, which is expected to be a basis for the development of new financial tools that will combine subsidies, guarantees and loans, for the financing of programmes and other measures to improve energy efficiency as well as the development of the energy services market.

National (co-financed) programmes specific to Climate Change and energy:

- The national part of the **LIFE programme**, namely the **LIFE-IP AdaptInGR programme**, for the 1st (2016-2025) and 2nd (from 2026) adaptation cycle.
- The **Save at Home** and **Electra programmes** for private and public buildings, respectively.

The Greek financial sector:

- Greek investment and other banks, including the Investment Bank of Greece.
- Investment firms
- Insurance institutions

Simple and complex financial tools:

- Green bonds and green financing in general.
- Energy Performance Contracts (EPCs).
- Investment loans, which will be repaid (and) by a programme.
- Self-generation and energy offset schemes, mainly for financing the energy upgrade of residential buildings of energy-vulnerable households.
- Energy communities, with the participation of natural persons and/or Local Government Organizations and/or Public and Private Law Legal Entities.

Utilization of market mechanisms:

- Creation of an organized Greek energy market for financial products, in order to achieve a smooth transition to the new market framework.
- Operation of the Hellenic Energy Exchange (HEEX) and a stock exchange trading platform within the framework of the natural gas market, expanding the country's development potential as an energy hub.
- Operational support, especially for RES (through a Special RES Account), for the period of time that these are legitimate.

- Competitive procedures for Energy Saving, with the offer of financial support for technical energy saving interventions in sectors with high potential, such as the industrial and tertiary sectors.

Incentives:

- Financial incentives.
- Investment incentives.
- Tax incentives. Indicatively, the increase in fixed asset depreciation rates for energy saving investments for legal entities and the tax exemption of expenses for the energy upgrade of buildings and the installation of RES systems for individuals and legal entities.
- Urban planning incentives. Indicatively, incentives for the relocation of industrial units to Industrial and Business Areas (IBAs).
- Investment laws.
- Energy efficiency obligation schemes, which ensure that energy distributors and/or energy retail companies designated as obligated parties, achieve a cumulative end-use energy saving target.

It is noted that incentives may relate to making investments or achieving goals in general. For example, they may relate to the production and distribution of new technology/low carbon fuels.

Other facilities:

- Ensuring the possibility of financing part of the project from banking institutions.
- Providing guarantees.
- Taking on part of the business risk that financial institutions do not assume.
- Facilitating access to financing for Energy Service Companies (ESCOs).
- Adopting a low discount rate to determine the minimum energy efficiency requirements for buildings.

Investment budgets of energy companies (ESFA, IPTO, etc.) for the part of the investment cost that is not financed by third-party sources, such as those mentioned here.

Mobilization of private capital:

- Innovative blended/hybrid finance programmes, in collaboration with the domestic financial sector
- Blended concessional loans
- Lease-financing

- Risk-sharing instruments, such as blended insurance and guarantee instruments
- Mechanisms focused on aggregating investments.

Other prompts:

- Motivating large public interest entities, within the framework of Law 4403/2016, on Corporate Social Responsibility and more broadly, to publish and, by extension, carry out actions and investments with environmental and social feasibility.
- The United Nations Environment Programme Finance Initiative (UNEP FI), which guides the financial sector to serve people and the planet, today and for future generations. It includes the Principles for Responsible Banking, the Principles for Sustainable Insurance and the Principles for Responsible Investment.

9.3.3. Critical Success Factors

The successful implementation of the above energy investments to serve the aforementioned objectives is considered to be achieved primarily through the following:

- Timely completion of the relevant study, legislative, regulatory, administrative and financial work, as well as the work of creating investment and other incentives.
- Timely environmental licensing, which may also require optimization of procedures.
- Targeted incentives for the research sector to expand beyond EU-funded programmes to a more outward-looking policy that will invite and welcome international collaborations with institutions and other states.
- Further integration of the EU-NA Europe energy market, with regulatory and political stability.
- Investment and economic stability and investment incentives in general, necessary for leveraging significant private capital.

It is noted that to the extent that many of the above energy investments require systems and components produced in China or other countries whose economies have been affected for a prolonged period of time, the completion of the investments may be delayed. This makes it necessary to make relevant provisions in the financing scheme of the investments.

10. Prospects for Further Development of the Greek Energy Market

Both globally and at a national level, the energy sector is emerging as one of the most resilient and dynamically developing. This is evidenced by the course of investments over the last five years, where despite the continuous crises (see pandemic, war in Ukraine and the Middle East, rising interest rates), they follow a steady upward course.

According to data from the International Energy Agency (IEA)[30], in 2024, total investments in the energy sector worldwide are expected to exceed $3 trillion, covering the entire spectrum of energy sources and related infrastructure. More specifically, investments in the fossil fuel sector are expected to reach $1.12 trillion in 2024. As for projects related to clean energy, the investment breakdown is as follows:

- **Low Carbon: $31 billion**
- **Nuclear: $80 billion**
- **Grids and Energy Storage: $452 billion**
- **Energy Efficiency and Related Projects: $669 billion**
- **Renewable Energy Sources (RES): $771 billion**

The upward trend observed in energy investments internationally was also followed in Greece, if we take into account the data presented in Chapter 9.2, which shows projected investments in the Greek energy sector for the period 2024-2030, which are estimated at €67.5 billion, including funds for research. It should be noted that the vast majority of additional investments concern RES and Energy Efficiency.

However, in parallel with investments in energy production units (conventional and RES), in electricity and natural gas networks, in energy efficiency improvement systems, in research, etc., there are also investments in services and in the design-consulting sector that are really difficult to record, let alone predict. However, as energy markets change and become more flexible, new players appear that contribute investments and dynamism to the market. With the most well-known example that of the creation of the electricity retail market in Greece that has developed over the last 10 years, creating around 1,500-2,000 new jobs. Recently, we have the market for electric batteries, the charging and servicing of electric cars and electromobility in general, which has also contributed and will contribute to many new jobs.

[30] IEA (2024), "World Energy Investment 2024", https://iea.blob.core.windows.net/assets/60fcd1dd-d112-469b-87de-20d39227df3d/WorldEnergyInvestment2024.pdf

IENE estimates that the number of net new jobs in this new sector will have exceeded 2,000 by 2030.

A similar mobility is observed in the consulting services sector with many new companies and offices having been created in recent years, employing many new scientists and engineers. To the above new activities in the energy sector, we should add the investments that are now underway in hydrogen and those planned in CCUS systems, with the first results in terms of infrastructure not being visible before 2028. However, there is a commitment from the government and the industries involved, which means that in this sector of the energy transition we will soon see the creation of new turnover and therefore employment. Taking into account both the investments in fixed and new production units and the development at the service level, the general feeling is that we are facing a strongly developing course of the Greek energy sector that will inevitably positively affect several other sectors (e.g. building, construction, metallurgy, electrical products, etc.). The further digitalization of the energy sector (e.g. smart electricity and gas meters, energy consumption control systems, etc.) is going to bring about significant changes, contributing to its modernization.

Furthermore, we should note that the tectonic changes in the energy sector over the last five years have allowed us to see traditional companies from the fossil fuel sector, such as HELLENiQ ENERGY and Motor Oil, expanding into RES. At the same time, it is clear that all these large companies and investors see a path of success and high profitability from the continuous transformation of the sector. This trend is reinforced by the fact that "green" investments and generally the movements of companies in clean forms of energy, the circular economy and sustainability, find financing much more easily, as the international investment industry knows that this is where the future lies. Indicative of the increase in interest is the issuance of green bonds to finance RES and energy efficiency projects, which have shown a steady increase in recent years.

Furthermore, the Recovery Fund funds act as an accelerator of developments in a context where events themselves accelerate the changes that need to be made, causing a creative upsurge throughout the energy sector, as well as infrastructure.

The assessment is that all these changes will also have specific benefits for the economy and for citizens in general. In addition to the many new jobs that are already being created, the energy transition to more environmentally friendly and lower-cost forms of energy, to which all these investments and acquisitions contribute, will offer abundant and cheaper energy to all consumers. This is a small "revolution", which is taking place in the midst of energy insecurity, due to geopolitical tensions in Ukraine and the Middle East. With the recent energy crisis having acted as a catalyst, offering incentives to consumers, households and businesses, to proceed with investments aimed at improving the energy efficiency of residential and commercial buildings, offices, hotels, etc. The overall assessment regarding the further development prospects of the Greek energy sector is absolutely positive. Because beyond the emphasis placed so far on so-called green development, very soon the government, through the programmes and mechanisms it controls, and mainly companies, will be called upon to invest on a large scale in electrical networks, in natural gas and hydrogen, in new fuels (e-fuels), but also in further research and production of hydrocarbons, in a serious effort to reduce the country's enormous energy dependence on imported fuels. Something it will be forced to do within the framework of the new European strategy to strengthen the EU's energy autonomy.

11. Conclusion

The energy crisis that began in 2021, intensified in 2022 due to Russia's invasion of Ukraine, was constrained in 2023 with the start of hostilities in the Middle East and continued in the first half of 2024, had a significant impact on the domestic energy sector, leading to a decrease in gross domestic energy consumption.

A characteristic of the Greek energy sector is the country's historically high dependence on oil and natural gas, imported by 99% on average, but with a decrease in the use of lignite in domestic electricity generation, with a notable increase in the contribution of RES only in recent years. A particularity of the national energy system is the limited extent of district heating networks in an electrical system consisting of the interconnected system and the autonomous electrical systems of the islands (Non-Interconnected Islands - NII).

Greece has been moving towards an energy transition to clean energy sources in recent years, following the trend towards a decarbonized European economy, through Directives and regulations of a comprehensive energy package, which has as its main objective the production of clean energy, the establishment of active participation of consumers as energy producers (prosumers) and the reduction of energy costs by at least 2030.

The production of clean electricity in Greece reached a historic high in 2023, as 57% of the energy mix was covered by wind, photovoltaic and hydroelectric plants, exceeding 25 TWh. In 2022, the corresponding percentage was 50.12%. Specifically, with regard to RES, their growth has been rapid in recent years in our country, with the annual production of green energy reaching a decade-long record in 2023, reaching 21.35 TWh, an increase of 147% compared to the annual electricity production from RES in 2014, which was 8.64 TWh. It is noted that in August 2023, the largest monthly production from RES in the history of the electrical system was achieved, which was 2.25 TWh. It is also worth noting that - for the first time - RES production moved above 1.5 TWh per month throughout the year.

However, the rapid penetration of RES and the high investment interest in green development over the last two years has led to the rejection, more and more frequently, of thousands of megawatt hours of generated electricity, due to the inability of the system to absorb the energy produced by photovoltaic and wind farms during the day.

The above problem is linked to the particularly low levels of electricity demand due to mild weather conditions and already low consumption (as a result of the energy crisis), combined with the increased production of RES, especially during midday hours. This combination, which characterizes the country's electrical system mainly in spring and autumn, has created several problems in the network due to the ongoing installation of new RES projects, and constitutes a potentially major threat to the electrical system that creates risks of blackouts, especially on days when loads are very low.

Regarding demand, over the last decade, the coverage of total demand from RES production increased by 151%, reaching over 43% in 2023, the highest recorded so far.

At the same time, in 2023, the participation of lignite in the domestic energy mix shrank further, reaching a historic low of 10.1%. This decrease reflects the significant progress of the country's delignitization programme - given that in 2014, energy production from lignite exceeded 54% - and the continuous upward trend of environmentally friendly forms of energy.

In order to have a more complete picture of the current state of the Greek energy sector, it is necessary to summarize key energy figures.

Total energy system

- Gross available energy in Greece stood at 23,774 thousand tons in 2022, showing a significant decrease of 23.4% compared to 2010, while, compared to 2021, an increase of 1.9% was recorded.
- Total energy supply reached 20,663 thousand tons in 2022, decreased by 25.3% compared to 2010.
- For 2022, the transport sector had the largest contribution as a share in final energy consumption (share of 38.1%), while the participation of both the residential and industrial sectors was also significant (share of 28.0% and 16.7% respectively). In the transport sector, road transport dominates energy consumption, accounting for 85.1% of the sector in 2022.

- The contribution of RES to the energy supply in Greece shows a significant increase during the period 2010-2022, as their total contribution in 2022, as a share of the total energy supply, amounted to 17.7%.
- The share of electricity from RES in 2023 was 35.9%, showing an impressive increase compared to 2006, when the corresponding share was 9%.
- Greece's degree of energy dependence is high. In 2010, 68.6% of the gross available energy in Greece came from imports. In 2021, this share jumped to 81.8%, mainly due to an increase in the share of imported oil and fossil fuels.
- Two main problems are identified that hinder investments. One is the electricity sector, where the two operators, IPTO and HEDNO, have budgeted significant investments for the coming years, and the second is the cuts in electricity injection, which are already expected to reach close to 5% of green production in 2024, with further upward trends in the future. In this case, the main solution is energy storage through batteries and pumped storage.

Oil

- Crude oil production in Greece, which began about 40 years ago in 1981, was halted in 2021 due to a series of technical problems, resulting in zero production in 2022 and 2023.
- Iraq was Greece's largest supplier of crude oil in 2022, with 10.4 million tons, followed by Russia with 5.95 million tons and Kazakhstan with 3.13 million tons.
- The consumption of petroleum products in Greece, after the decrease it suffered during the economic crisis (-30.6% in 2013 compared to 2010) and the recovery in the period that followed, decreased sharply in 2020 compared to 2019 by -10.8%, mainly due to the crisis from the Covid-19 pandemic, while in 2021 it increased by only 1.3%.
- The transport sector consumed 5.8 million tons of oil in 2022, representing 70.0% of total oil consumption. The residential sector follows with 15.4% and industry with 9.5%.

Gas:

- Total natural gas demand in Greece decreased by 21.56% compared to 2022, according to DESFA data for 2023 [37]. Specifically, total demand (domestic consumption & exports) of natural gas decreased by 21.56%, reaching 67.60 TWh from 86.18 TWh in 2022.
- Domestic natural gas consumption in Greece decreased by -10.1% in 2023 compared to 2022, in line with the EU target of reducing consumption by 15% in the period from

August 2022 to March 2023, compared to the average of the same period of the previous five years.

- The largest percentage of natural gas in 2023, as in all previous years, was consumed in the production of electricity by the thermal units of the Public Power Corporation and private power producers. However, the use of natural gas for electricity generation declined in 2023, reaching 68% of total natural gas consumption from 74% in 2022.

Electricity:

- Electricity demand stood at 49,492 GWh in 2023, down 2.4% compared to 2022, which stood at 50,688 GWh.
- Cumulatively, in 2023, the share of RES and hydroelectric power reached 57.0% overall, exceeding the sum of the participation of all fossil fuels, which stood at 42.1%, which makes most kilowatt-hours produced in 2023 "green".
- 2022 was a milestone as the picture of previous years was reversed, where the largest share in clean electricity production was occupied by natural gas and previously by lignite. This trend continued in 2023 with RES leading the electricity mix, with a share of 47.9% and production of 21.4 TWh.
- In 2023, renewable sources produced more energy than the country's electricity demand and the system and distribution network operators (IPTO and HEDNO) were forced to cut excess green overproduction in order to maintain the stability of the electricity system and avoid a possible blackout.
- In 2023, the total installed capacity of the units in the Interconnected System of Greece reached 23,958 MW, marking an increase of 16.7% from 2022 levels (20,514 MW). According to the December 2023 DAPEEP Bulletin [84], RES recorded the largest increase in domestic installed capacity in the interconnected system in 2023 compared to 2022, recording a new installed capacity of 1,997 MW and a total installed capacity of 11.9 GW. Similarly, natural gas and lignite plants showed an increase in installed capacity by 15.9% and 17.3% respectively.

Table 35: Total Installed Electricity Capacity in Greece, 2023

Fuel Mix	Installed Capacity (GW)
Interconnected System	
Lignite units	2,87
Gas units	6,03
Hydro plants	3,17
Total RES systems	11,87
Total installed capacity in the interconnected system (A)	**23.95**
Non Interconnected Islands (NIIs)	
Total thermal units	1,005
Total RES systems	0.19
Total installed capacity in the NIIs (B)	**1,195**
Grand Total (A+B)	**25,15**

Sources: IENE, IPTO, DAPEEP, HEDNO

- In 2023, the total electricity generation in the interconnected system of Greece amounted to 43.86 TWh, while the corresponding one in the NIIs amounted to 2.23 TWh. The grand total reached 46.09 TWh, with the distribution of this being analyzed in Table 36.

Table 36: Total Electricity Generation in Greece, 2023

Fuel Mix	Net Production (TWh)
Interconnected System	
Total RES and CHP systems	20,668
Hydro plants	4,05
Gas units	14,63
Lignite units	4,513
Total electricity generation in the interconnected system (A)	**43.861**
Non Interconnected Islands (NIIs)	
Total thermal units	1,9
Total RES systems	0,33
Total electricity generation in the NIIs (B)	**2,23**
Grand Total (A+B)	**46,09**

Sources: IENE, IPTO, DAPEEP, HEDNO

- The Greek market remained import-oriented in 2023, but the conditions that developed in the first quarter of 2024 led to a significant reduction in the deficit in the balance while there were periods during which Greece was an energy exporter. The increase in the RES production base combined with favorable weather conditions and stagnant demand were the main reasons that led to the increase in exports. In the long term, the expansion of cross-border interconnections and the addition of storage units may make Greece an energy exporter for the wider region.

Lignite

- The electricity produced from lignite decreased significantly from 23.23 TWh in 2015 to 5.59 TWh in 2022 and to 4.51 TWh in 2023, due to the development of RES, lower overall demand for electricity and the high cost of emission allowances that makes electricity production from lignite uneconomic.
- In 2023, Greek lignite production decreased by 28.9% to 9.7 million tons, of which PPC produced 9.5 million tons.

Energy efficiency

- Greece aims to reduce final energy consumption by at least 32.5% by 2030, in accordance with the European Energy Efficiency Directive, 2018/2002/EU. This entails the implementation of measures in sectors such as industry, transport and the building sector.
- One of the main points of the energy strategy is to improve the energy efficiency of the building stock, especially those in the public sector, such as hospitals, educational buildings, municipal stores, etc. By 2035, it is planned to renovate a large part of the buildings with the aim of their energy upgrade through programmes such as "Save".
- In 2023, the total installed capacity of CHP units in Greece amounts to approximately 200-300 MW. Most of these units are located in industrial facilities, agricultural applications (greenhouses) and district heating facilities.
- Overall, the CHP situation in Greece in 2023 presents a steady but slow growth, with increasing prospects, as the country progresses towards the implementation of the NECP objectives and European guidelines.

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ANNEXES

ANNEX I: RELATIONSHIP BETWEEN ENERGY VARIABLES IN THE ENERGY BALANCE

Gross available energy	GAE	=	+	PPRD	Primary production
			+	RCV_RCY	Recovered & recycled products
			+	IMP	Imports
			-	EXP	Exports
			+	STK_CHG	Change in stock
Total energy supply	NRGSUP	=	+	GAE	Gross available energy
			-	INTMARB	International maritime bunkers
			-	INTAVI	International aviation
Gross inland consumption	GIC	=	+	GAE	Gross available energy
			-	INTMARB	International maritime bunkers
Transformation input	TI_E	=	+	TI_EHG_E	Electricity & heat generation
			+	TI_CO_E	Coke ovens
			+	TI_BF_E	Blast furnaces
			+	TI_GW_E	Gas works
			+	TI_RPI_E	Refineries & petrochemical industry
			+	TI_PF_E	Patent fuel plants
			+	TI_BKBPB_E	BKB & PB plants
			+	TI_CL_E	Coal liquefaction plants
			+	TI_BNG_E	For blended natural gas
			+	TI_LBB_E	Liquid biofuels blended
			+	TI_CPP_E	Charcoal production plants
			+	TI_GTL_E	Gas-to-liquids plants
			+	TI_NSP_E	Not elsewhere specified
Electricity & heat generation (transformation input)		=	+	TI_EHG_MAPE_E	Main activity producer electricity only
			+	TI_EHG_MAPCHP_E	Main activity producer CHP
			+	TI_EHG_MAPH_E	Main activity producer heat only
			+	TI_EHG_APE_E	Autoproducer electricity only
			+	TI_EHG_APCHP_E	Autoproducer CHP
			+	TI_EHG_APH_E	Autoproducer heat only
			+	TI_EHG_EDHP	Electrically driven heat pumps
			+	TI_EHG_EB	Electric boilers
			+	TI_EHG_EPS	Electricity for pumped storage
			+	TI_EHG_DHEP	Derived heat for electricity production
Refineries & petrochemical industry (transformation input)	TI_RPI_E	=	+	TI_RPI_RI_E	Refinery intake
			+	TI_RPI_BPI_E	Backflows from petrochemical industry
			+	TI_RPI_PT_E	Products transferred
			+	TI_RPI_IT_E	Interproduct transfers
			+	TI_RPI_DU_E	Direct use
			+	TI_RPI_PII_E	Petrochemical industry intake
Transformation output	TO	=	+	TO_EHG	Electricity & heat generation
			+	TO_CO	Coke ovens
			+	TO_BF	Blast furnaces
			+	TO_GW	Gas works
			+	TO_RPI	Refineries & petrochemical industry

			+	TO_PF	Patent fuel plants
			+	TO_BKBPB	BKB & PB plants
			+	TO_CL	Coal liquefaction plants
			+	TO_BNG	Blended in natural gas
			+	TO_LBB	Liquid biofuels blended
			+	TO_CPP	Charcoal production plants
			+	TO_GTL	Gas-to-liquids plants
			+	TO_NSP	Not elsewhere specified
Electricity & heat generation (transformation output)	TO_EHG	=	+	TO_EHG_MAPE	Main activity producer electricity only
			+	TO_EHG_MAPCHP	Main activity producer CHP
			+	TO_EHG_MAPH	Main activity producer heat only
			+	TO_EHG_APE	Autoproducer electricity only
			+	TO_EHG_APCHP	Autoproducer CHP
			+	TO_EHG_APH	Autoproducer heat only
			+	TO_EHG_EDHP	Electrically driven heat pumps
			+	TO_EHG_EB	Electric boilers
			+	TO_EHG_PH	Pumped hydro
			+	TO_EHG_OTH	Other sources
Refineries & petrochemical industry (transformation output)	TO_RPI	=	+	TO_RPI_RO	Refinery output
			+	TO_RPI_BKFLOW	Backflows
			+	TO_RPI_PT	Products transferred
			+	TO_RPI_IT	Interproduct transfers
			+	TO_RPI_PPR	Primary product receipts
			+	TO_RPI_PIR	Petrochemical industry returns
Energy sector	NRG_E	=	+	NRG_EHG_E	Own use in electricity & heat generation
			+	NRG_CM_E	Coal mines
			+	NRG_OIL_NG_E	Oil & natural gas extraction plants
			+	NRG_PF_E	Patent fuel plants
			+	NRG_CO_E	Coke ovens
			+	NRG_BKBPB_E	BKB & PB plants
			+	NRG_GW_E	Gas works
			+	NRG_BF_E	Blast furnaces
			+	NRG_PR_E	Petroleum refineries (oil refineries)
			+	NRG_NI_E	Nuclear industry
			+	NRG_CL_E	Coal liquefaction plants
			+	NRG_LNG_E	Liquefaction & regasification plants (LNG)
			+	NRG_BIOG_E	Gasification plants for biogas
			+	NRG_GTL_E	Gas-to-liquids (GTL) plants
			+	NRG_CPP_E	Charcoal production plants
			+	NRG_NSP_E	Not elsewhere specified (energy)
Available for final consumption	AFC	=	+	NRGSUP	Total energy supply
			-	TI_E	Transformation input
			+	TO	Transformation output
			-	NRG_E	Energy sector
			-	DL	Distribution losses
Final non-energy consumption	FC_NE	=	+	TI_NRG_FC_IND_NE	Non-energy use industry/transformation/energy
			+	FC_TRA_NE	Non-energy use in transport sector
			+	FC_OTH_NE	Non-energy use in other sectors

Non-energy use industry/transformation/energy	TI_NRG_FC_IND_NE	=	+	TI_NE	Non-energy use in transformation sector
			+	NRG_NE	Non-energy use in energy sector
			+	FC_IND_NE	Non-energy use in industry sector
Final energy consumption	FC_E	=	+	FC_IND_E	Industry
			+	FC_TRA_E	Transport
			+	FC_OTH_E	Other
Industry*	FC_IND_E*	=	+	FC_IND_IS_E	Iron & steel
			+	FC_IND_CPC_E	Chemical & petrochemical
			+	FC_IND_NFM_E	Non-ferrous metals
			+	FC_IND_NMM_E	Non-metallic minerals
			+	FC_IND_TE_E	Transport equipment
			+	FC_IND_MAC_E	Machinery
			+	FC_IND_MQ_E	Mining & quarrying
			+	FC_IND_FBT_E	Food, beverages & tobacco
			+	FC_IND_PPP_E	Paper, pulp & printing
			+	FC_IND_WP_E	Wood & wood products
			+	FC_IND_CON_E	Construction
			+	FC_IND_TL_E	Textile & leather
			+	FC_IND_NSP_E	Not elsewhere specified (industry)
Transport	FC_TRA_E	=	+	FC_TRA_RAIL_E	Rail
			+	FC_TRA_ROAD_E	Road
			+	FC_TRA_DAVI_E	Domestic aviation
			+	FC_TRA_DNAVI_E	Domestic navigation
			+	FC_TRA_PIPE_E	Pipeline transport
			+	FC_TRA_NSP_E	Not elsewhere specified (transport)
Other	FC_OTH_E	=	+	FC_OTH_CP_E	Commercial & public services
			+	FC_OTH_HH_E	Households
			+	FC_OTH_AF_E	Agriculture & forestry
			+	FC_OTH_FISH_E	Fishing
			+	FC_OTH_NSP_E	Not elsewhere specified (other)
Statistical differences	STATDIFF	=	+	AFC	Available for final consumption
			-	FC_NE	Final non-energy consumption
			-	FC_E	Final energy consumption
Gross electricity production	GEP	=	+	GEP_MAPE	Main activity producer electricity only
			+	GEP_MAPCHP	Main activity producer CHP
			+	GEP_APE	Autoproducer electricity only
			+	GEP_APCHP	Autoproducer CHP
Gross heat production	GHP	=	+	GHP_MAPCHP	Main activity producer CHP
			+	GHP_MAPH	Main activity producer heat only
			+	GHP_APCHP	Autoproducer CHP
			+	GHP_APH	Autoproducer heat only

Source: Eurostat

ANNEX II: ENERGY BALANCES

1. Energy Blaance of Greece for 2022, ktoe

ktoe 2022		Total	Solid fossil fuels	Manufactured gases	Peat and peat products	Oil and petroleum products	Natural gas	Renewables and biofuels	Non-renewable waste	Nuclear heat	Heat	Electricity	Fossil energy	Bioenergy
+ Primary production	PPRD	5,254.1	1,658.7	Z	0.0	0.0	0.0	3,595.4	0.0	0.0	0.0	Z	1,658.7	942.0
+ Recovered & recycled products	RCV_RCY	18.9	0.0	Z	0.0	18.9	Z	0.0	Z	Z	Z	Z	18.9	0.0
+ Imports	IMP	37,602.9	53.5	0.0	0.0	31,928.1	4,885.1	69.8	0.0	Z	0.0	666.5	37,247.0	77.0
- Exports	EXP	18,678.6	64.9	0.0	0.0	17,825.7	412.7	5.3	0.0	Z	0.0	370.1	18,514.4	9.3
+ Change in stock	STK_CHG	-423.3	-84.7	0.0	0.0	-267.8	-68.7	-2.1	0.0	Z	Z	Z	-421.2	-2.1
= Gross available energy	**GAE**	**23,773.9**	**1,562.5**	**0.0**	**0.0**	**13,853.6**	**4,403.7**	**3,657.8**	**0.0**	**0.0**	**0.0**	**296.4**	**19,988.8**	**1,007.6**
- International maritime bunkers	INTMARB	1,953.8	0.0	0.0	0.0	1,953.8	0.0	0.0	Z	Z	Z	Z	1,953.8	0.0
= Gross inland consumption	**GIC**	**21,820.1**	**1,562.5**	**0.0**	**0.0**	**11,899.8**	**4,403.7**	**3,657.8**	**0.0**	**0.0**	**0.0**	**296.4**	**18,035.1**	**1,007.6**
- International aviation	INTAVI	1,156.7	Z	Z	Z	1,156.7	Z	0.0	Z	Z	Z	Z	1,156.7	0.0
= Total energy supply	**NRGSUP**	**20,663.4**	**1,562.5**	**0.0**	**0.0**	**10,743.1**	**4,403.7**	**3,657.8**	**0.0**	**0.0**	**0.0**	**296.4**	**16,878.3**	**1,007.6**
Gross inland consumption (Europe 2020-2030)	GIC2020-2030	21,375.4	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Primary energy consumption (Europe 2020-2030)	PEC2020-2030	20,925.8	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Final energy consumption (Europe 2020-2030)	FEC2020-2030	16,111.9	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Transformation input	**TI_E**	**41,724.0**	**1,514.3**	**0.0**	**0.0**	**35,025.2**	**3,154.1**	**2,012.6**	**0.0**	**0.0**	**0.0**	**17.8**	**39,703.8**	**131.6**
+ Electricity & heat generation	TI_EHG_E	8,016.3	1,514.3	0.0	0.0	1,318.1	3,154.1	2,012.0	0.0	0.0	0.0	17.8	5,996.7	131.0
+ Main activity producer electricity only	TI_EHG_MAPE_E	6,388.4	593.5	0.0	0.0	992.8	2,904.1	1,897.9	0.0	0.0	0.0	Z	4,490.5	16.7
+ Main activity producer CHP	TI_EHG_MAPCHP_E	956.0	920.7	0.0	0.0	0.0	0.0	35.2	0.0	0.0	0.0	Z	920.7	35.2
+ Main activity producer heat only	TI_EHG_MAPH_E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0
+ Autoproducer electricity only	TI_EHG_APE_E	5.7	0.0	0.0	0.0	0.0	0.0	5.7	0.0	0.0	0.0	Z	0.0	5.7
+ Autoproducer CHP	TI_EHG_APCHP_E	648.4	0.0	0.0	0.0	325.3	250.0	73.2	0.0	0.0	0.0	Z	575.3	73.2
+ Autoproducer heat only	TI_EHG_APH_E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0
+ Electrically driven heat pumps	TI_EHG_EDHP	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Electric boilers	TI_EHG_EB	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Electricity for pumped storage	TI_EHG_EPS	17.8	Z	Z	Z	Z	Z	Z	Z	Z	Z	17.8	10.2	0.2
+ Derived heat for electricity production	TI_EHG_DHEP	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	0.0
+ Coke ovens	TI_CO_E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0
+ Blast furnaces	TI_BF_E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0
+ Gas works	TI_GW_E	1.0	0.0	0.0	0.0	1.0	0.0	0.0	Z	Z	Z	Z	1.0	0.0
+ Refineries & petrochemical industry	TI_RPI_E	33,705.5	Z	Z	Z	33,705.5	Z	0.0	Z	Z	Z	Z	33,705.5	0.0
+ Refinery intake	TI_RPI_RI_E	30,271.1	Z	Z	Z	30,271.1	Z	Z	Z	Z	Z	Z	30,271.1	0.0
+ Backflows from petrochemical industry	TI_RPI_BPI_E	0.0	Z	Z	Z	0.0	Z	0.0	Z	Z	Z	Z	0.0	0.0
+ Products transferred	TI_RPI_PT_E	2,638.3	Z	Z	Z	2,638.3	Z	0.0	Z	Z	Z	Z	2,638.3	0.0
+ Interproduct transfers	TI_RPI_IT_E	796.0	Z	Z	Z	796.0	Z	0.0	Z	Z	Z	Z	796.0	0.0
+ Direct use	TI_RPI_DU_E	0.0	Z	Z	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Petrochemical industry intake	TI_RPI_PII_E	0.0	Z	Z	Z	0.0	Z	0.0	Z	Z	Z	Z	0.0	0.0
+ Patent fuel plants	TI_PF_E	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	Z	Z	Z	0.0	0.0
+ BKB & PB plants	TI_BKBPB_E	0.0	0.0	0.0	0.0	Z	Z	0.0	0.0	Z	Z	Z	0.0	0.0
+ Coal liquefaction plants	TI_CL_E	0.0	0.0	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ For blended natural gas	TI_BNG_E	0.0	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	0.0	0.0
+ Liquid biofuels blended	TI_LBB_E	0.0	Z	Z	Z	Z	Z	0.0	Z	Z	Z	Z	0.0	0.0
+ Charcoal production plants	TI_CPP_E	0.6	Z	Z	Z	Z	Z	0.6	Z	Z	Z	Z	0.0	0.6
+ Gas-to-liquids plants	TI_GTL_E	0.0	Z	Z	Z	Z	0.0	Z	Z	Z	Z	Z	0.0	0.0
+ Not elsewhere specified	TI_NSP_E	0.6	0.0	0.0	0.0	0.6	0.0	0.0	0.0	Z	Z	Z	0.6	0.0

Transformation output	TO	38,763.7	0.0	0.0	0.0	34,203.4	0.0	0.1	Z	Z	36.0	4,524.1	36,821.0	49.0
+ Electricity & heat generation	TO_EHG	4,560.1	Z	Z	Z	Z	Z	Z	Z	Z	36.0	4,524.1	2,617.6	48.9
+ Main activity producer electricity only	TO_EHG_MAPE	3,967.5	Z	Z	Z	Z	Z	Z	Z	Z	Z	3,967.5	2,264.0	42.9
+ Main activity producer CHP	TO_EHG_MAPCHP	325.8	Z	Z	Z	Z	Z	Z	Z	Z	28.3	297.5	198.0	3.2
+ Main activity producer heat only	TO_EHG_MAPH	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	0.0
+ Autoproducer electricity only	TO_EHG_APE	1.8	Z	Z	Z	Z	Z	Z	Z	Z	Z	1.8	1.0	0.0
+ Autoproducer CHP	TO_EHG_APCHP	252.5	Z	Z	Z	Z	Z	Z	Z	Z	7.7	244.7	147.4	2.6
+ Autoproducer heat only	TO_EHG_APH	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	0.0
+ Electrically driven heat pumps	TO_EHG_EDHP	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	0.0
+ Electric boilers	TO_EHG_EB	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	0.0
+ Pumped hydro	TO_EHG_PH	12.4	Z	Z	Z	Z	Z	Z	Z	Z	Z	12.4	7.1	0.1
+ Other sources	TO_EHG_OTH	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0	0.0
+ Coke ovens	TO_CO	0.0	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Blast furnaces	TO_BF	0.0	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Gas works	TO_GW	0.0	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Refineries & petrochemical industry	TO_RPI	34,203.4	Z	Z	Z	34,203.4	Z	0.0	Z	Z	Z	Z	34,203.4	0.0
+ Refinery output	TO_RPI_RO	30,769.3	Z	Z	Z	30,769.3	Z	Z	Z	Z	Z	Z	30,769.3	0.0
+ Backflows	TO_RPI_BKFLOW	0.0	Z	Z	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Products transferred	TO_RPI_PT	2,648.1	Z	Z	Z	2,648.1	Z	Z	Z	Z	Z	Z	2,648.1	0.0
+ Interproduct transfers	TO_RPI_IT	786.0	Z	Z	Z	786.0	Z	0.0	Z	Z	Z	Z	786.0	0.0
+ Primary product receipts	TO_RPI_PPR	0.0	Z	Z	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Petrochemical industry returns	TO_RPI_PIR	0.0	Z	Z	Z	0.0	Z	0.0	Z	Z	Z	Z	0.0	0.0
+ Patent fuel plants	TO_PF	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ BKB & PB plants	TO_BKBPB	0.0	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Coal liquefaction plants	TO_CL	0.0	Z	Z	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Blended in natural gas	TO_BNG	0.0	Z	Z	Z	Z	0.0	Z	Z	Z	Z	Z	0.0	0.0
+ Liquid biofuels blended	TO_LBB	0.0	Z	Z	Z	Z	Z	0.0	Z	Z	Z	Z	0.0	0.0
+ Charcoal production plants	TO_CPP	0.1	Z	Z	Z	Z	Z	0.1	Z	Z	Z	Z	0.0	0.1
+ Gas-to-liquids plants	TO_GTL	0.0	Z	Z	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Not elsewhere specified	TO_NSP	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0

Energy sector	NRG_E	1,590.9	0.0	0.0	0.0	1,342.6	38.4	1.7	0.0	Z	0.0	208.1	1,499.8	4.0
+ Own use in electricity & heat generation	NRG_EHG_E	110.3	0.0	0.0	0.0	16.3	0.0	1.7	0.0	Z	0.0	92.3	69.0	2.7
+ Coal mines	NRG_CM_E	23.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	23.3	13.3	0.3
+ Oil & natural gas extraction plants	NRG_OIL_NG_E	3.1	Z	Z	Z	0.9	1.7	0.0	Z	Z	0.0	0.4	2.9	0.0
+ Patent fuel plants	NRG_PF_E	0.0	0.0	0.0	0.0	Z	Z	0.0	0.0	Z	0.0	0.0	0.0	0.0
+ Coke ovens	NRG_CO_E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0
+ BKB & PB plants	NRG_BKBPB_E	0.0	0.0	0.0	0.0	Z	Z	0.0	0.0	Z	0.0	0.0	0.0	0.0
+ Gas works	NRG_GW_E	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0
+ Blast furnaces	NRG_BF_E	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	Z	0.0	0.0	0.1	0.0
+ Petroleum refineries (oil refineries)	NRG_PR_E	1,422.2	0.0	0.0	0.0	1,325.3	30.3	0.0	0.0	Z	0.0	66.6	1,393.6	0.7
+ Nuclear industry	NRG_NI_E	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0	0.0
+ Coal liquefaction plants	NRG_CL_E	0.0	0.0	0.0	0.0	Z	Z	Z	Z	Z	0.0	0.0	0.0	0.0
+ Liquefaction & regasification plants (LNG)	NRG_LNG_E	6.4	Z	Z	Z	Z	6.4	Z	Z	Z	0.0	0.0	6.4	0.0
+ Gasification plants for biogas	NRG_BIOG_E	0.0	Z	Z	Z	Z	Z	0.0	0.0	Z	0.0	0.0	0.0	0.0
+ Gas-to-liquids (GTL) plants	NRG_GTL_E	0.0	Z	Z	Z	Z	0.0	Z	Z	Z	0.0	0.0	0.0	0.0
+ Charcoal production plants	NRG_CPP_E	0.0	Z	Z	Z	Z	Z	0.0	0.0	Z	0.0	0.0	0.0	0.0
+ Not elsewhere specified (energy)	NRG_NSP_E	25.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	25.5	14.6	0.3

Distribution losses	DL	510.7	0.0	0.0	0.0	0.0	9.3	0.0	0.0	Z	8.6	492.7	299.1	5.3
Available for final consumption	AFC	15,601.5	48.2	0.0	0.0	8,578.6	1,201.8	1,643.7	0.0	0.0	27.4	4,101.9	12,196.6	915.8
Final non-energy consumption	FC_NE	449.6	0.0	0.0	0.0	428.4	21.3	0.0	Z	Z	Z	Z	449.6	0.0
+ Non-energy use industry/transformation/energy	TI_NRG_FC_IND_NE	433.0	0.0	0.0	0.0	411.7	21.3	0.0	Z	Z	Z	Z	433.0	0.0
+ Non-energy use in transformation sector	TI_NE	3.9	Z	Z	Z	3.9	Z	0.0	Z	Z	Z	Z	3.9	0.0
+ Non-energy use in energy sector	NRG_NE	46.9	Z	Z	Z	46.9	Z	0.0	Z	Z	Z	Z	46.9	0.0
+ Non-energy use in industry sector	FC_IND_NE	382.2	Z	Z	Z	361.0	21.3	0.0	Z	Z	Z	Z	382.2	0.0
+ Non-energy use in transport sector	FC_TRA_NE	9.0	0.0	0.0	0.0	9.0	0.0	0.0	Z	Z	Z	Z	9.0	0.0
+ Non-energy use in other sectors	FC_OTH_NE	7.6	0.0	0.0	0.0	7.6	0.0	0.0	Z	Z	Z	Z	7.6	0.0
Final energy consumption	FC_E	15,399.7	71.1	0.0	0.0	8,332.7	1,182.2	1,648.0	0.0	Z	27.4	4,138.3	11,974.8	920.5
+ Industry sector	FC_IND_E	2,565.5	65.2	0.0	0.0	788.1	568.7	121.0	0.0	Z	0.0	1,022.6	2,005.5	130.1
+ Iron & steel	FC_IND_IS_E	148.0	0.0	0.0	0.0	20.2	29.3	0.0	0.0	Z	0.0	98.5	105.8	1.1
+ Chemical & petrochemical	FC_IND_CPC_E	222.2	0.0	0.0	0.0	29.4	152.4	0.0	0.0	Z	0.0	40.4	204.8	0.4
+ Non-ferrous metals	FC_IND_NFM_E	570.8	0.0	0.0	0.0	30.6	231.9	0.0	0.0	Z	0.0	308.3	438.4	3.3
+ Non-metallic minerals	FC_IND_NMM_E	573.6	45.4	0.0	0.0	386.0	34.8	6.8	0.0	Z	0.0	100.7	523.6	7.9
+ Transport equipment	FC_IND_TE_E	6.0	0.0	0.0	0.0	1.4	0.1	0.0	0.0	Z	0.0	4.5	4.1	0.0
+ Machinery	FC_IND_MAC_E	80.8	0.0	0.0	0.0	19.8	9.5	0.0	0.0	Z	0.0	51.5	58.7	0.6
+ Mining & quarrying	FC_IND_MQ_E	76.8	19.8	0.0	0.0	37.1	0.7	0.0	0.0	Z	0.0	19.2	68.6	0.2
+ Food, beverages & tobacco	FC_IND_FBT_E	473.0	0.0	0.0	0.0	156.6	68.9	86.8	0.0	Z	0.0	160.7	317.2	88.6
+ Paper, pulp & printing	FC_IND_PPP_E	71.6	0.0	0.0	0.0	11.3	21.1	3.0	0.0	Z	0.0	36.2	53.0	3.4
+ Wood & wood products	FC_IND_WP_E	34.0	0.0	0.0	0.0	2.4	0.3	22.4	0.0	Z	0.0	8.9	7.8	22.5
+ Construction	FC_IND_CON_E	118.6	0.0	0.0	0.0	64.0	3.5	0.0	0.0	Z	0.0	51.1	96.7	0.6
+ Textile & leather	FC_IND_TL_E	44.6	0.0	0.0	0.0	13.9	10.8	0.0	0.0	Z	0.0	19.9	36.1	0.2
+ Not elsewhere specified (industry)	FC_IND_NSP_E	145.4	0.0	0.0	0.0	15.3	5.4	1.9	0.0	Z	0.0	122.7	90.8	1.3
+ Transport sector	FC_TRA_E	5,866.0	0.0	0.0	0.0	5,819.8	27.2	0.0	0.0	Z	Z	19.0	5,857.9	0.2
+ Rail	FC_TRA_RAIL_E	24.3	0.0	0.0	0.0	7.0	Z	0.0	0.0	Z	Z	17.3	16.8	0.2
+ Road	FC_TRA_ROAD_E	4,992.8	Z	Z	Z	4,966.0	25.1	0.0	0.0	Z	Z	1.7	4,992.1	0.0
+ Domestic aviation	FC_TRA_DAVI_E	228.8	Z	Z	Z	228.8	Z	0.0	Z	Z	Z	Z	228.8	0.0
+ Domestic navigation	FC_TRA_DNAVI_E	617.9	0.0	0.0	0.0	617.9	Z	0.0	0.0	Z	Z	Z	617.9	0.0
+ Pipeline transport	FC_TRA_PIPE_E	2.1	Z	Z	Z	0.0	2.1	0.0	Z	Z	Z	0.0	2.1	0.0
+ Not elsewhere specified (transport)	FC_TRA_NSP_E	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	Z	Z	0.0	0.1	0.0
+ Other sectors	FC_OTH_E	6,968.1	5.9	0.0	0.0	1,724.8	586.3	1,527.1	0.0	Z	27.4	3,096.7	4,111.4	790.2
+ Commercial & public services	FC_OTH_CP_E	2,098.2	3.1	0.0	0.0	120.6	108.7	385.5	0.0	Z	0.0	1,480.2	1,077.1	35.2
+ Households	FC_OTH_HH_E	4,316.6	1.7	0.0	0.0	1,284.5	465.7	1,111.6	0.0	Z	27.4	1,425.8	2,592.8	724.6
+ Agriculture & forestry	FC_OTH_AF_E	272.9	0.4	0.0	0.0	42.8	10.2	29.9	0.0	Z	0.0	189.5	161.6	30.4
+ Fishing	FC_OTH_FISH_E	12.8	0.0	0.0	0.0	11.6	0.0	0.0	0.0	Z	0.0	1.2	12.3	0.0
+ Not elsewhere specified (other)	FC_OTH_NSP_E	267.6	0.6	0.0	0.0	265.2	1.7	0.0	0.0	Z	0.0	0.0	267.6	0.0
Statistical differences	STATDIFF	-247.8	-22.9	0.0	0.0	-182.4	-1.7	-4.4	0.0	0.0	0.0	-36.4	Z	Z

ktoe 2022		Total	Solid fossil fuels	Manufactured gases	Peat and peat products	Oil and petroleum products	Natural gas	Renewables and biofuels	Non-renewable waste	Nuclear heat	Heat	Electricity	Fossil energy	Bioenergy
+ Gross electricity production	GEP	4,524.1	495.0	0.0	0.0	440.6	1,645.9	1,930.1	0.0	0.0	0.0	Z	2,581.6	48.9
+ Main activity producer electricity only	GEP_MAPE	3,980.0	210.0	0.0	0.0	357.8	1,513.7	1,886.0	0.0	0.0	0.0	Z	2,081.5	4.9
+ Main activity producer CHP	GEP_MAPCHP	297.5	285.0	0.0	0.0	0.0	0.0	12.5	0.0	0.0	0.0	Z	285.0	12.5
+ Autoproducer electricity only	GEP_APE	1.8	0.0	0.0	0.0	0.0	0.0	1.8	0.0	0.0	0.0	Z	0.0	1.8
+ Autoproducer CHP	GEP_APCHP	244.7	0.0	0.0	0.0	82.9	132.2	29.7	0.0	0.0	0.0	Z	215.0	29.7
+ Gross heat production	GHP	36.0	28.3	0.0	0.0	0.0	7.7	0.0	0.0	0.0	Z	0.0	36.0	0.0
+ Main activity producer CHP	GHP_MAPCHP	28.3	28.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	28.3	0.0
+ Main activity producer heat only	GHP_MAPH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0
+ Autoproducer CHP	GHP_APCHP	7.7	0.0	0.0	0.0	0.0	7.7	0.0	0.0	0.0	Z	0.0	7.7	0.0
+ Autoproducer heat only	GHP_APH	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0

Sourec: Eurostat

2. Energy Balance of Greece for 2010, ktoe

ktoe 2010	Total	Solid fossil fuels	Oil and petroleum products	Natural gas	Renewables and biofuels	Hydro	Tide, wave, ocean	Wind	Solar photovoltaic	Solar thermal	Geothermal	Primary solid biofuels	Charcoal	Biogases	Renewable municipal waste	Pure biogasoline	Blended biogasoline	Pure biodiesels	Blended biodiesels	Pure bio jet kerosene	Blended bio jet kerosene	Other liquid biofuels	Ambient heat (heat pumps)	Non-renewable waste	Industrial waste (non-renewable)	Non-renewable municipal waste	Electricity	Fossil energy	Bioenergy
+ Primary production	9,493.7	7,315.4	104.8	7.6	2,033.8	642.7	0.0	233.4	13.6	241.4	16.0	724.9	Z	49.3	0.0	0.0	Z	112.5	Z	0.0	Z	0.0	0.0	32.0	32.0	0.0	Z	7,459.9	886.7
+ Recovered & recycled products	0.0	0.0	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Imports	31,133.6	400.7	26,612.9	3,230.7	156.9	Z	Z	Z	Z	0.0	0.0	100.0	41.5	0.0	0.0	0.0	0.0	15.4	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	732.3	30,841.9	159.3
- Exports	9,833.7	0.0	9,591.9	0.0	0.1	Z	Z	Z	Z	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	241.7	9,789.2	0.9
+ Change in stock	263.0	146.9	119.9	-3.8	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	263.0	0.0
= **Gross available energy**	31,056.5	7,863.0	17,245.7	3,234.5	2,190.6	642.7	0.0	233.4	13.6	241.4	16.0	824.9	41.5	49.3	0.0	0.0	0.0	127.9	0.0	0.0	0.0	0.0	0.0	32.0	32.0	0.0	490.6	28,775.6	1,045.2
- International maritime bunkers	2,710.1	0.0	2,710.1	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	2,710.1	0.0
= **Gross inland consumption**	28,346.5	7,863.0	14,535.7	3,234.5	2,190.6	642.7	0.0	233.4	13.6	241.4	16.0	824.9	41.5	49.3	0.0	0.0	0.0	127.9	0.0	0.0	0.0	0.0	0.0	32.0	32.0	0.0	490.6	26,065.6	1,045.2
- International aviation	682.0	Z	682.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	682.0	0.0
= **Total energy supply**	27,664.5	7,863.0	13,853.7	3,234.5	2,190.6	642.7	0.0	233.4	13.6	241.4	16.0	824.9	41.5	49.3	0.0	0.0	0.0	127.9	0.0	0.0	0.0	0.0	0.0	32.0	32.0	0.0	490.6	25,383.6	1,045.2
Gross inland consumption (Europe 2020-2030)	28,346.5	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Primary energy consumption (Europe 2020-2030)	27,238.3	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Final energy consumption (Europe 2020-2030)	19,055.8	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
Transformation input	35,283.6	7,566.5	24,554.7	2,060.5	1,066.7	642.7	0.0	233.4	13.6	0.0	0.0	1.9	0.0	47.3	0.0	0.0	0.0	127.9	0.0	0.0	0.0	0.0	0.0	32.0	32.0	0.0	3.1	34,216.3	177.1
+ Electricity & heat generation	12,083.4	7,566.5	1,484.3	2,060.5	936.9	642.7	0.0	233.4	13.6	0.0	0.0	0.0	0.0	47.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	32.0	32.0	0.0	3.1	11,145.9	47.3
+ Main activity producer electricity only	9,544.3	5,488.2	1,228.6	1,897.3	930.1	642.7	0.0	233.4	13.6	0.0	0.0	0.0	Z	40.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	8,614.2	40.5
+ Main activity producer CHP	2,094.6	2,078.3	16.3	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	2,094.6	0.0
+ Main activity producer heat only	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0
+ Autoproducer electricity only	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	0.0	0.0
+ Autoproducer CHP	441.4	0.0	239.3	163.2	6.8	Z	Z	Z	Z	0.0	0.0	0.0	Z	6.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	32.0	32.0	0.0	Z	434.6	6.8
+ Autoproducer heat only	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0
+ Electrically driven heat pumps	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Electric boilers	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Electricity for pumped storage	3.1	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	3.1	2.5	0.0
+ Derived heat for electricity production	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Coke ovens	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Blast furnaces	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	Z	0.0	0.0
+ Gas works	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	Z	0.0	0.0
+ Refineries & petrochemical industry	23,070.4	Z	23,070.4	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	23,070.4	0.0
+ Refinery intake	21,889.0	Z	21,889.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	21,889.0	0.0
+ Backflows from petrochemical industry	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Products transferred	750.5	Z	750.5	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	750.5	0.0
+ Interproduct transfers	430.9	Z	430.9	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	430.9	0.0
+ Direct use	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Petrochemical industry intake	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Patent fuel plants	0.0	0.0	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	Z	Z	0.0	0.0
+ BKB & PB plants	0.0	0.0	Z	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0	Z	0.0	0.0	Z	0.0	Z	0.0	Z	0.0	Z	0.0	0.0	0.0	Z	0.0	0.0
+ Coal liquefaction plants	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ For blended natural gas	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	Z	0.0	0.0
+ Liquid biofuels blended	127.9	Z	Z	Z	127.9	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	127.9	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	0.0	127.9
+ Charcoal production plants	1.9	Z	Z	Z	1.9	Z	Z	Z	Z	Z	Z	1.9	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	0.0	1.9
+ Gas-to-liquids plants	0.0	Z	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Not elsewhere specified	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0

Transformation output	28,759.4	0.0	23,651.8	0.0	125.3	Z	Z	Z	Z	Z	Z	Z	0.7	0.0	Z	Z	0.0	Z	124.6	Z	0.0	Z	Z	Z	Z	Z	4,935.9	27,726.1	141.7
+ Electricity & heat generation	4,982.3	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	4,935.9	4,074.3	16.3
+ Main activity producer electricity only	3,999.3	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	3,999.3	3,263.6	13.2
+ Main activity producer CHP	766.7	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	720.4	634.2	2.4
+ Main activity producer heat only	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Autoproducer electricity only	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Autoproducer CHP	214.3	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	214.3	174.9	0.7
+ Autoproducer heat only	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Electrically driven heat pumps	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Electric boilers	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Pumped hydro	2.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	2.0	1.6	0.0
+ Other sources	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Coke ovens	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Blast furnaces	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Gas works	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Refineries & petrochemical industry	23,651.8	Z	23,651.8	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	23,651.8	0.0
+ Refinery output	22,454.1	Z	22,454.1	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	22,454.1	0.0
+ Backflows	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Products transferred	766.8	Z	766.8	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	766.8	0.0
+ Interproduct transfers	430.9	Z	430.9	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	430.9	0.0
+ Primary product receipts	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Petrochemical industry returns	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Patent fuel plants	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ BKB & PB plants	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Coal liquefaction plants	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Blended in natural gas	0.0	Z	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Liquid biofuels blended	124.6	Z	Z	Z	124.6	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	124.6	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	124.6
+ Charcoal production plants	0.7	Z	Z	Z	0.7	Z	Z	Z	Z	Z	Z	Z	0.7	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.7
+ Gas-to-liquids plants	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Not elsewhere specified	0.0	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0

Energy sector	1,633.4	0.0	1,084.2	18.5	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	530.7	1,535.8	1.8
+ Own use in electricity & heat generation	368.7	0.0	23.4	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	345.3	305.2	1.1
+ Coal mines	82.4	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	82.4	67.2	0.3
+ Oil & natural gas extraction plants	22.0	Z	0.0	18.5	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	3.4	21.3	0.0
+ Patent fuel plants	0.0	0.0	Z	Z	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	Z	0.0	Z	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0
+ Coke ovens	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0
+ BKB & PB plants	0.0	0.0	Z	Z	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	Z	0.0	Z	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0
+ Gas works	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0
+ Blast furnaces	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0
+ Petroleum refineries (oil refineries)	1,160.3	0.0	1,060.8	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	99.6	1,142.0	0.3
+ Nuclear industry	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Coal liquefaction plants	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Liquefaction & regasification plants (LNG)	0.0	Z	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Gasification plants for biogas	0.0	Z	Z	Z	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	Z	0.0	Z	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0
+ Gas-to-liquids (GTL) plants	0.0	Z	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0
+ Charcoal production plants	0.0	Z	Z	Z	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	Z	0.0	Z	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0
+ Not elsewhere specified (energy)	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0
Distribution losses	342.7	0.0	0.0	17.5	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	325.3	282.9	1.1
Available for final consumption	19,164.2	296.5	11,866.6	1,137.9	1,249.3	0.0	0.0	0.0	0.0	241.4	16.0	823.0	42.2	2.0	0.0	0.0	0.0	0.0	124.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,567.5	17,074.7	1,006.9
Final non-energy consumption	1,108.2	0.0	754.3	353.9	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	1,108.2	0.0
+ Non-energy use industry/transformation/energy	1,073.1	0.0	719.2	353.9	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	1,073.1	0.0
+ Non-energy use in transformation sector	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Non-energy use in energy sector	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	0.0
+ Non-energy use in industry sector	1,073.1	Z	719.2	353.9	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	1,073.1	0.0
+ Non-energy use in transport sector	33.1	0.0	33.1	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	33.1	0.0
+ Non-energy use in other sectors	2.0	0.0	2.0	0.0	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	2.0	0.0

Final energy consumption	18,373.8	301.5	11,427.6	781.6	1,249.3	Z	Z	Z	Z	241.4	16.0	823.0	42.2	2.0	0.0	0.0	0.0	0.0	124.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,567.5	16,284.3	1,006.9
+ Industry sector	3,472.8	298.2	1,338.4	373.5	246.8	Z	Z	Z	Z	1.3	0.0	244.8	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,216.0	3,002.4	249.4
+ Iron & steel	177.1	0.0	3.9	61.3	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	112.0	156.5	0.4
+ Chemical & petrochemical	194.3	0.0	104.2	44.8	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	45.3	185.9	0.2
+ Non-ferrous metals	764.5	122.1	114.5	63.9	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	464.0	679.2	1.5
+ Non-metallic minerals	968.9	170.9	589.1	60.2	1.5	Z	Z	Z	Z	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	147.2	940.3	2.0
+ Transport equipment	25.6	0.0	18.3	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	7.3	24.2	0.0
+ Machinery	18.9	0.0	3.8	3.1	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	12.0	16.7	0.0
+ Mining & quarrying	59.4	0.0	45.9	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	13.5	57.0	0.0
+ Food, beverages & tobacco	580.5	0.0	95.8	81.8	217.6	Z	Z	Z	Z	0.0	0.0	216.9	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	185.3	328.8	218.2
+ Paper, pulp & printing	121.5	0.0	35.2	31.1	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	55.1	111.3	0.2
+ Wood & wood products	48.2	0.0	1.9	0.9	26.3	Z	Z	Z	Z	0.0	0.0	26.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	19.1	18.4	26.4
+ Construction	128.3	0.0	128.2	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.1	128.2	0.0
+ Textile & leather	88.9	0.0	21.2	15.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	52.7	79.2	0.2
+ Not elsewhere specified (industry)	296.7	5.1	176.3	11.5	1.3	Z	Z	Z	Z	1.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	102.4	276.5	0.3
+ Transport sector	7,476.9	0.0	7,322.1	14.5	124.6	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.6	0.0	0.0	0.0	Z	0.0	0.0	0.0	15.7	7,349.4	124.7
+ Rail	24.3	0.0	20.4	Z	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	4.0	23.6	0.0
+ Road	6,486.1	Z	6,347.4	14.1	124.6	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	124.6	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	6,361.5	124.6
+ Domestic aviation	237.2	Z	237.2	Z	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	Z	237.2	0.0
+ Domestic navigation	717.1	0.0	717.1	Z	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	717.1	0.0
+ Pipeline transport	0.3	Z	0.0	0.3	0.0	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	0.0	0.3	0.0
+ Not elsewhere specified (transport)	11.8	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	11.8	9.6	0.0
+ Other sectors	7,424.1	3.4	2,767.1	393.6	877.9	Z	Z	Z	Z	240.1	16.0	578.2	42.2	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,335.8	5,932.6	632.9
+ Commercial & public services	1,957.4	0.0	254.6	138.9	16.2	Z	Z	Z	Z	8.9	5.9	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,547.7	1,656.5	6.5
+ Households	4,686.5	3.4	1,966.4	254.6	836.9	Z	Z	Z	Z	231.2	0.2	563.3	42.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,558.9	3,542.8	610.7
+ Agriculture & forestry	798.4	0.0	546.2	0.0	23.1	Z	Z	Z	Z	0.0	8.2	14.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	229.1	733.2	15.7
+ Fishing	1.8	0.0	0.0	0.0	1.8	Z	Z	Z	Z	0.0	1.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.0	0.0	0.0
+ Not elsewhere specified (other)	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Statistical differences	-317.8	-5.0	-315.3	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	Z

ktoe	Total	Solid fossil	Oil and	Natural gas	Renewable	Hydro	Tide, wave,	Wind	Solar	Solar	Geothermal	Primary solid	Charcoal	Biogases	Renewable	Pure	Blended	Pure	Blended	Pure bio jet	Blended bio	Other liquid	Ambient	Non-	Industrial	Non-	Electricity	Fossil energy	Bioenergy
+ Gross electricity production	4,935.9	2,648.1	523.6	845.2	908.0	644.7	0.0	233.4	13.6	0.0	0.0	0.0	Z	16.3	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	11.1	11.1	0.0	Z	4,027.9	16.3
+ Main activity producer electricity only	4,001.3	1,932.8	450.0	712.9	905.5	644.7	0.0	233.4	13.6	0.0	0.0	0.0	Z	13.8	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	0.0	0.0	0.0	Z	3,095.8	13.8
+ Main activity producer CHP	720.4	715.2	5.2	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	0.0	0.0	0.0	Z	720.4	0.0
+ Autoproducer electricity only	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	0.0	0.0	0.0	Z	0.0	0.0
+ Autoproducer CHP	214.3	0.0	68.4	132.3	2.5	Z	Z	Z	Z	0.0	0.0	0.0	Z	2.5	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	11.1	11.1	0.0	Z	211.8	2.5
+ Gross heat production	46.4	45.5	0.9	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	46.4	0.0
+ Main activity producer CHP	46.4	45.5	0.9	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	46.4	0.0
+ Main activity producer heat only	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+ Autoproducer CHP	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
+ Autoproducer heat only	0.0	0.0	0.0	0.0	0.0	Z	Z	Z	Z	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Source: Eurostat

3. Energy Balance of Greece for 2022 (historical)-2050

Συνοπτικό Ενεργειακό Ισοζύγιο [ktoe]	2022	2025	2030	2035	2040	2045	2050
Καθαρές Εισαγωγές	**18416**	**16600**	**13966**	**10510**	**7407**	**5309**	**4358**
Στερεά Καύσιμα	212	156	80	15	0	0	0
Πετρελαϊκά	12963	11716	9203	7115	4626	2673	1209
Φ. Αέριο	4626	3986	3973	2905	2191	2104	1955
Ανανεώσιμο Υδρογόνο	0	0	0	0	0	0	0
Ηλεκτρισμός	302	272	156	-319	-574	-956	-570
Βιομάζα-Βιοκαύσιμα	313	469	523	690	878	934	1022
Ανανεώσιμη Αμμωνία	0	0	0	0	2	134	148
Ανανεώσιμη Μεθανόλη	0	0	26	88	200	218	225
e-Κηροζίνη	0	0	4	16	84	186	288
Ανανεώσιμα Υγρά Καύσιμα	0	0	0	0	0	16	80
Ποντοπόρος Ναυτιλία	**1894**	**1840**	**1830**	**1830**	**1730**	**1725**	**1721**
Διάθεση Πρωτογενούς Ενέργειας	**21798**	**20993**	**19154**	**18158**	**17366**	**17054**	**17923**
Στερεά Καύσιμα	1548	1102	81	16	0	0	0
Πετρελαϊκά	11866	10056	7828	6026	3932	2248	813
Φ. Αέριο	4385	4007	3790	2585	1758	1608	1396
Ηλεκτρισμός	302	272	147	-347	-610	1000	-621
ΑΠΕ	3697	5556	7362	10003	12432	14334	16281
Ανανεώσιμη Αμμωνία	0	0	0	0	2	-125	-110
Ανανεώσιμη Μεθανόλη	0	0	-59	-140	-232	-213	-205
e-Κηροζίνη	0	0	4	16	84	186	289
Ανανεώσιμα Υγρά Καύσιμα	0	0	0	0	0	16	80
Ακαθάριστη Εγχώρια Κατανάλωση	**22141**	**20993**	**19150**	**18142**	**17282**	**16852**	**17554**
Στερεά Καύσιμα	1683	1102	81	16	0	0	0
Πετρελαϊκά	11248	10056	7828	6025	3932	2248	813
Φ. Αέριο	4647	4007	3790	2585	1758	1608	1396
Υδρογόνο	0	0	0	0	0	0	0
Ηλεκτρισμός	302	272	147	-347	-610	-1000	-621
ΑΠΕ	4260	5556	7362	10003	12432	14334	16281
Ανανεώσιμη Αμμωνία	0	0	0	0	2	-125	-110
Μεθανόλη	0	0	-59	-140	-232	-213	-205
Τελική Κατανάλωση Ενέργειας	**16774**	**16801**	**16006**	**15064**	**14325**	**13595**	**13364**
Τελική Κατανάλωση Ενέργειας, χωρίς Θερμότητα Περιβάλλοντος	**16350**	**16236**	**15175**	**14069**	**13184**	**12423**	**12186**
Τελική Κατανάλωση Ενέργειας							
ανά τομέα							
Βιομηχανία	2826	2494	2270	2136	2075	2002	1995
Οικιακός	4524	4379	4174	4025	4007	3877	3788
Τριτογενής	2233	2241	2330	2437	2514	2609	2703
Μεταφορές	6920	7343	6882	6121	5388	4762	4537
Αγροτικός	271	344	350	345	341	345	342
ανά καύσιμο							
Στερεά Καύσιμα	213	157	81	16	0	0	0
Πετρελαϊκά	9033	8611	7084	5383	3470	1846	497
Φ. Αέριο	1128	1229	1101	863	383	223	168
Ηλεκτρισμός	4288	4406	4603	5182	6245	6869	7177
Θερμότητα	48	43	42	41	44	37	31

Συνοπτικό Ενεργειακό Ι-σοζύγιο [ktoe]	2022	2025	2030	2035	2040	2045	2050
ΑΠΕ	1639	1790	2066	2224	2471	2467	2512
Θερμότητα περιβάλλοντος	424	564	831	996	1141	1173	1178
Υδρογόνο	0	0	0	1	50	96	126
Ανανεώσιμη Αμμωνία	0	0	0	0	4	39	72
Συνθετικά καύσιμα	0	0	16	69	200	476	1132
Βιομεθάνιο	0	0	181	280	307	344	396

Source: NECP (August 2024)

ANNEX III: Electricity in Greece

1. Demand (MWh), 2023 – JULY 2024

2023

ΜΗΝΑΣ	Υ/Σ ΟΡΙΩΝ ΣΥΣΤΗΜΑΤΟΣ ΔΙΚΤΥΟΥ	ΚΑΤΑΝΑΛΩΣΗ ΠΑΡΑΓΩΓΗΣ ΣΤΟ ΔΙΚΤΥΟ	ΠΕΛΑΤΕΣ ΥΨΗΛΗΣ ΤΑΣΗΣ	ΟΡΥΧΕΙΑ	ΙΔΙΟΚΑΤΑΝΑΛΩΣΗ ΠΑΡΑΓΩΓΗΣ	ΑΝΤΛΗΣΗ	ΑΠΩΛΕΙΕΣ ΣΥΣΤΗΜΑΤΟΣ	ΔΙΑΣΥΝΔΕΣΗ ΚΡΗΤΗΣ	ΣΥΝΟΛΙΚΟ ΦΟΡΤΙΟ	ΣΥΝΟΛΙΚΟ ΦΟΡΤΙΟ ΣΥΣΤΗΜΑΤΟΣ
ΙΑΝ	2.902,05	566,23	550,50	24,29	27,31	32,02	100,46	42,47	4.244,32	3.679,09
ΦΕΒ	2.896,45	579,62	506,42	22,26	28,08	18,03	92,67	53,96	4.097,50	3.417,88
ΜΑΡ	2.397,34	820,25	563,47	21,76	36,47	35,45	82,89	51,36	4.008,98	3.188,73
ΑΠΡ	2.015,27	843,94	524,52	20,05	35,11	33,45	77,94	56,79	3.609,07	2.763,13
ΜΑΙ	2.056,85	838,21	535,61	19,05	34,00	37,71	77,79	62,53	3.661,52	2.823,52
ΙΟΥΝ	2.227,82	946,20	507,60	15,49	34,72	22,53	74,84	69,04	3.898,55	2.952,15
ΙΟΥΛ	3.658,37	1.074,21	546,43	17,81	27,11	11,23	110,06	83,65	5.529,96	4.455,75
ΑΥΓ	3.185,59	1.022,96	487,59	17,71	34,39	13,26	103,26	86,12	4.951,00	3.928,04
ΣΕΠ	2.353,75	776,11	492,46	15,28	33,12	23,59	93,69	59,21	3.847,30	3.071,20
ΟΚΤ	2.158,25	752,58	551,26	19,07	25,64	16,07	87,99	68,35	3.679,32	2.926,74
ΝΟΕ	2.363,38	614,59	560,62	18,63	29,92	42,85	79,65	38,58	3.750,21	3.135,62
ΔΕΚ	2.827,95	590,67	553,77	20,67	28,50	41,15	97,45	55,87	4.214,04	3.623,36
	30.846,05	**9.526,56**	**6.380,25**	**232,06**	**374,36**	**327,35**	**1.078,67**	**725,72**	**49.491,55**	**39.964,99**

2024

ΜΗΝΑΣ	Υ/Σ ΟΡΙΩΝ ΣΥΣΤΗΜΑΤΟΣ ΔΙΚΤΥΟΥ	ΚΑΤΑΝΑΛΩΣΗ ΠΑΡΑΓΩΓΗΣ ΣΤΟ ΔΙΚΤΥΟ	ΠΕΛΑΤΕΣ ΥΨΗΛΗΣ ΤΑΣΗΣ	ΟΡΥΧΕΙΑ	ΙΔΙΟΚΑΤΑΝΑΛΩΣΗ ΠΑΡΑΓΩΓΗΣ	ΑΝΤΛΗΣΗ	ΑΠΩΛΕΙΕΣ ΣΥΣΤΗΜΑΤΟΣ	ΔΙΑΣΥΝΔΕΣΗ ΚΡΗΤΗΣ	ΣΥΝΟΛΙΚΟ ΦΟΡΤΙΟ	ΣΥΝΟΛΙΚΟ ΦΟΡΤΙΟ ΣΥΣΤΗΜΑΤΟΣ
ΙΑΝ	3.036,20	672,11	570,91	21,01	31,77	52,13	97,36	54,88	4.536,45	3.864,35
ΦΕΒ	2.519,22	714,08	557,88	18,42	26,88	41,62	87,49	45,83	4.011,40	3.297,33
ΜΑΡ	2.215,68	891,68	582,41	16,89	32,36	62,73	78,91	29,99	3.910,65	3.018,96
ΑΠΡ	1.795,56	986,71	556,36	17,16	33,08	89,87	74,47	22,12	3.555,11	2.568,40
ΜΑΙ	1.917,69	981,91	527,51	14,15	30,79	59,77	77,87	50,45	3.660,13	2.678,23
ΙΟΥΝ	3.015,18	1.073,10	557,01	12,04	27,58	54,39	87,81	73,60	4.900,50	3.827,40
ΙΟΥΛ	3.791,89	1.140,82	564,54	14,08	28,65	43,97	113,23	100,55	5.802,74	4.656,91
ΑΥΓ										
ΣΕΠ										
ΟΚΤ										
ΝΟΕ										
ΔΕΚ										
	18.291,40	**6.465,40**	**3.916,62**	**113,75**	**211,10**	**384,27**	**616,93**	**377,51**	**30.376,98**	**23.911,58**

Source: IPTO

2. Evolution of Electricity Mix (MWh)

2023

ΜΗΝΑΣ	ΛΙΓΝΙΤΙΚΗ ΠΑΡΑΓΩΓΗ	ΠΑΡΑΓΩΓΗ ΑΠΟ Φ. ΑΕΡΙΟ	ΥΔΡΟΗΛΕΚΤΡΙΚΗ ΠΑΡΑΓΩΓΗ	ΠΑΡΑΓΩΓΗ ΑΠΟ ΑΛΛΑ ΚΑΥΣΙΜΑ	ΑΠΕ ΣΥΣΤΗΜΑΤΟΣ	ΠΑΡΑΓΩΓΗ ΣΤΟ ΔΙΚΤΥΟ (ΑΠΕ)	ΔΙΑΣΥΝΔΕΣΗ ΚΡΗΤΗΣ (ΑΠΕ)	ΠΑΡΑΓΩΓΗ ΑΠΟ ΣΥΜΒΑΤΙΚΕΣ ΜΟΝΑΔΕΣ	ΣΥΝΟΛΟ ΠΑΡΑΓΩΓΗΣ ΣΤΟ ΣΥΣΤΗΜΑ	ΣΥΝΟΛΟ ΠΑΡΑΓΩΓΗΣ
ΙΑΝ	405,532	885,725	353,362	2,231	984,504	365,229	1,361	1.646,870	2.632,939	3.198,168
ΦΕΒ	611,167	917,775	286,531	1,893	1.012,430	679,618	1,404	1.817,366	2.831,200	3.510,818
ΜΑΡ	428,766	949,211	187,044	0,300	1.058,839	820,246	2,430	1.565,321	2.626,610	3.446,858
ΑΠΡ	275,156	1.099,621	175,728	0,777	806,813	845,941	0,815	1.551,282	2.359,010	3.204,951
ΜΑΙ	199,692	873,382	215,867	1,421	924,831	838,206	0,334	1.291,362	2.216,527	3.054,733
ΙΟΥΝ	218,540	1.595,388	171,042	1,804	628,615	946,202	0,104	1.986,555	2.615,274	3.561,476
ΙΟΥΛ	591,388	1.910,425	431,952	1,564	800,793	1.074,208	0,003	2.935,329	3.736,127	4.810,335
ΑΥΓ	371,479	1.618,973	436,067	1,631	1.230,797	1.022,907	0,000	2.429,140	3.659,937	4.682,884
ΣΕΠ	187,093	1.507,491	360,307	0,890	1.148,446	776,106	0,216	2.055,781	3.204,441	3.980,547
ΟΚΤ	358,380	1.326,658	440,540	1,003	899,172	752,583	0,463	2.126,581	3.026,210	3.778,799
ΝΟΕ	377,494	863,713	288,504	0,964	1.215,558	614,587	1,304	1.630,675	2.847,547	3.461,934
ΔΕΚ	488,517	1.181,499	499,202	1,244	1.125,134	590,674	1,822	2.170,462	3.297,418	3.888,092
	4.513,204	**14.630,842**	**4.047,146**	**15,532**	**11.835,762**	**9.526,557**	**10,560**	**23.206,724**	**35.053,046**	**44.579,603**

2024

ΜΗΝΑΣ	ΛΙΓΝΙΤΙΚΗ ΠΑΡΑΓΩΓΗ	ΠΑΡΑΓΩΓΗ ΑΠΟ Φ. ΑΕΡΙΟ	ΥΔΡΟΗΛΕΚΤΡΙΚΗ ΠΑΡΑΓΩΓΗ	ΠΑΡΑΓΩΓΗ ΑΠΟ ΑΛΛΑ ΚΑΥΣΙΜΑ	ΑΠΕ ΣΥΣΤΗΜΑΤΟΣ	ΠΑΡΑΓΩΓΗ ΣΤΟ ΔΙΚΤΥΟ (ΑΠΕ)	ΔΙΑΣΥΝΔΕΣΗ ΚΡΗΤΗΣ (ΑΠΕ)	ΠΑΡΑΓΩΓΗ ΑΠΟ ΣΥΜΒΑΤΙΚΕΣ ΜΟΝΑΔΕΣ	ΣΥΝΟΛΟ ΠΑΡΑΓΩΓΗΣ ΣΤΟ ΣΥΣΤΗΜΑ	ΣΥΝΟΛΟ ΠΑΡΑΓΩΓΗΣ
ΙΑΝ	391,105	1.357,632	366,438	1,394	1.543,827	672,106	2,136	2.116,630	3.702,613	4.374,719
ΦΕΒ	373,425	1.139,170	270,587	1,412	1.146,238	714,076	2,714	1.784,394	2.933,346	3.647,422
ΜΑΡ	285,704	1.387,808	264,916	1,303	976,950	891,682	3,941	1.939,831	2.920,822	3.812,504
ΑΠΡ	207,009	1.154,027	233,434	1,483	1.193,728	986,709	2,358	1.815,991	2.813,088	3.798,797
ΜΑΙ	50,237	1.592,910	298,639	1,524	941,387	981,906	0,857	1.913,330	2.855,374	3.837,480
ΙΟΥΝ	190,835	1.941,318	386,495	1,352	1.163,527	1.073,096	0,098	2.524,041	3.687,684	4.760,762
ΙΟΥΛ	386,203	2.313,098	445,197	1,231	1.450,240	1.143,824	0,000	3.147,887	4.597,927	5.743,752
ΑΥΓ										
ΣΕΠ										
ΟΚΤ										
ΝΟΕ										
ΔΕΚ										
	1.884,576	**10.932,024**	**2.255,547**	**9,877**	**8.415,897**	**6.465,399**	**12,115**	**15.082,024**	**23.510,036**	**29.975,435**

Source: IPTO

3. Production of Distributed Units in the Greek System, 2023

ΜΟΝΑΔΑ	ΠΑΡΑΓΩΓΟΣ	ΚΑΥΣΙΜΟ/ΤΕΧΝΟΛΟΓΙΑ	ΚΑΘΑΡΗ ΙΣΧΥΣ (MW)	ΚΑΘΑΡΗ ΠΑΡΑΓΩΓΗ (GWh)	ΣΥΝΤΕΛΕΣΤΗΣ ΧΡΗΣΙΜΟΠΟΙΗΣΗΣ (%)
ΑΗΣ ΑΓ. ΔΗΜΗΤΡΙΟΥ II	ΔΕΗ	ΛΙΓΝΙΤΗΣ	274,00	9,11	4,47%
ΑΗΣ ΑΓ. ΔΗΜΗΤΡΙΟΥ III	ΔΕΗ	ΛΙΓΝΙΤΗΣ	279,00	46,75	22,52%
ΑΗΣ ΑΓ. ΔΗΜΗΤΡΙΟΥ IV	ΔΕΗ	ΛΙΓΝΙΤΗΣ	279,00	28,26	13,62%
ΑΗΣ ΑΓ. ΔΗΜΗΤΡΙΟΥ V	ΔΕΗ	ΛΙΓΝΙΤΗΣ	335,00	45,15	18,11%
ΑΗΣ ΑΓ. ΔΗΜΗΤΡΙΟΥ I	ΔΕΗ	ΛΙΓΝΙΤΗΣ	274,00	8,38	4,11%
ΑΗΣ ΜΕΓΑΛΟΠΟΛΗΣ IV	ΔΕΗ	ΛΙΓΝΙΤΗΣ	256,00	0,00	0,00%
ΑΗΣ ΜΕΛΙΤΗΣ I	ΔΕΗ	ΛΙΓΝΙΤΗΣ	289,00	32,13	14,94%
ΑΗΣ ΠΤΟΛΕΜΑΪΔΑΣ 5	ΔΕΗ	ΛΙΓΝΙΤΗΣ	616,00	216,42	47,22%
ΥΗΣ ΑΓΡΑ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	50,00	1,17	3,16%
ΥΗΣ ΑΣΩΜΑΤΩΝ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	108,00	22,11	27,51%
ΥΗΣ ΕΔΕΣΣΑΙΟΥ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	19,00	0,76	5,40%
ΥΗΣ ΘΗΣΑΥΡΟΥ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	384,00	43,94	15,38%
ΥΗΣ ΙΛΑΡΙΩΝΑ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	153,00	1,91	1,68%
ΥΗΣ ΚΑΣΤΡΑΚΙΟΥ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	320,00	52,37	22,00%
ΥΗΣ ΚΡΕΜΑΣΤΩΝ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	437,20	71,89	22,10%
ΥΗΣ ΛΑΔΩΝΑ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	70,00	10,66	20,46%
ΥΗΣ Ν. ΠΛΑΣΤΗΡΑ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	129,90	65,86	68,14%
ΥΗΣ ΠΗΓΩΝ ΑΩΟΥ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	210,00	11,86	7,59%
ΥΗΣ ΠΛΑΤΑΝΟΒΡΥΣΗΣ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	116,00	14,53	16,83%
ΥΗΣ ΠΟΛΥΦΥΤΟΥ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	375,00	71,42	25,60%
ΥΗΣ ΠΟΥΡΝΑΡΙΟΥ I	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	300,00	12,31	5,51%
ΥΗΣ ΠΟΥΡΝΑΡΙΟΥ II	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	33,60	1,26	5,05%
ΥΗΣ ΣΤΡΑΤΟΥ I	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	150,00	17,18	15,39%
ΥΗΣ ΣΦΗΚΙΑΣ	ΔΕΗ	ΥΔΡΟΗΛΕΚΤΡΙΚΟ	315,00	45,97	19,62%
ΗΡΩΝ ΘΕΡΜΟΗΛΕΚΤΡΙΚΗ I	ΗΡΩΝ	Φ.Α. ΑΕΡΙΟΣΤΡΟΒΙΛΟΣ	49,25	0,00	0,00%
ΗΡΩΝ ΘΕΡΜΟΗΛΕΚΤΡΙΚΗ II	ΗΡΩΝ	Φ.Α. ΑΕΡΙΟΣΤΡΟΒΙΛΟΣ	49,25	0,00	0,00%
ΗΡΩΝ ΘΕΡΜΟΗΛΕΚΤΡΙΚΗ III	ΗΡΩΝ	Φ.Α. ΑΕΡΙΟΣΤΡΟΒΙΛΟΣ	49,25	0,00	0,00%
ELPEDISON ΘΙΣΒΗ	ELPEDISON	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	410,00	164,69	53,99%
KORINTHOS POWER	ΚΟΡΙΝΘΟΣ POWER	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	433,46	197,48	61,24%
PROTERGIA_CC	ΜΥΤΙΛΗΝΑΙΟΣ	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	432,70	218,13	67,76%
ΑΗΣ ΑΛΙΒΕΡΙΟΥ 5	ΔΕΗ	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	417,00	200,75	64,71%
ΑΗΣ ΚΟΜΟΤΗΝΗΣ I	ΔΕΗ	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	472,00	127,52	36,31%
ΑΗΣ ΛΑΥΡΙΟΥ IV	ΔΕΗ	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	536,00	147,76	37,05%
ΑΗΣ ΛΑΥΡΙΟΥ V	ΔΕΗ	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	379,15	188,62	66,87%
ΑΛΟΥΜΙΝΙΟΝ	ΜΥΤΙΛΗΝΑΙΟΣ	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	334,00	99,28	39,95%
ΕΝΕΡΓΕΙΑΚΗ ΘΕΣΣΑΛΟΝΙΚΗΣ	ELPEDISON	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	418,00	179,91	57,85%
ΗΡΩΝ II ΒΟΙΩΤΙΑΣ	ΗΡΩΝ	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	433,70	197,08	61,08%
ΘΗΣ ΑΓ. ΝΙΚΟΛΑΟΣ II	ΜΥΤΙΛΗΝΑΙΟΣ	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	806,00	471,68	78,66%
ΜΕΓΑΛΟΠΟΛΗ V	ΔΕΗ	Φ.Α. ΣΥΝΔ. ΚΥΚΛΟΣ	811,00	191,66	31,76%
ΣΥΝΟΛΟ			**11.803,47**	**3.215,95**	**36,62%**

Source: IPTO

4. Supply Analysis of Load Representatives, 2024

ΕΚΠΡΟΣΩΠΟΣ ΦΟΡΤΙΟΥ	2024-01	2024-02	2024-03	2024-04	2024-05	2024-06	2024-07	ΣΥΝΟΛΟ
ΔΕΗ	2.313,9	1.986,7	1.920,6	1.688,7	1.749,6	2.489,5	3.012,7	**15.161,7**
ΜΥΤΙΛΗΝΑΙΟΣ	647,1	587,5	596,5	574,7	600,0	710,8	815,4	**4.532,1**
ΗΡΩΝ	469,0	451,3	459,2	432,7	411,1	516,1	574,7	**3.314,1**
ELPEDISON	256,5	229,9	219,1	212,5	206,5	273,7	309,4	**1.707,6**
NRG	235,9	210,8	206,3	191,5	202,1	263,3	302,7	**1.612,7**
ΦΥΣΙΚΟ ΑΕΡΙΟ	142,7	130,2	128,7	118,0	116,5	149,3	171,3	**956,7**
ΖΕΝΙΘ	119,0	100,9	96,0	80,8	84,2	122,4	148,6	**751,9**
VOLTERRA	72,8	71,3	69,8	68,3	66,9	79,9	90,2	**519,1**
VOLTON	54,5	47,5	45,6	40,1	42,3	60,0	72,5	**362,6**
ΔΕΗ_ΠΚΥ	42,8	35,1	33,3	26,7	27,2	37,2	41,2	**243,4**
EUNICE TRAD	6,7	6,0	6,1	6,5	7,2	9,9	11,3	**53,6**
ΕΛΙΝΟΙΛ	6,8	6,5	6,7	6,3	6,7	7,8	9,7	**50,5**
ΟΤΕ	2,1	1,9	1,9	1,7	1,8	5,8	11,4	**26,4**
ΜΥΤΙΛΗΝΑΙΟΣ_ΠΚΥ	2,4	1,9	2,1	1,7	1,8	2,6	4,3	**16,8**
ΒΙΕΝΕΡ	2,2	2,1	2,0	2,1	2,1	2,6	3,6	**16,7**
ELPEDISON_ΠΚΥ	2,1	1,8	1,7	1,4	1,4	1,9	2,2	**12,5**
ΗΡΩΝ_ΠΚΥ	2,0	1,5	1,4	1,2	1,2	1,6	1,8	**10,8**
ΕΛΤΑ	1,6	1,3	1,2	1,0	1,1	1,8	2,4	**10,3**
SOLAR ENERGY	1,3	1,2	1,1	1,1	1,1	1,6	2,0	**9,5**
NRG_ΠΚΥ	1,6	1,4	1,3	1,1	1,1	1,5	1,6	**9,5**
ΚΟΡΙΝΘΟΣ POWER	0,6	0,6	0,6	0,5	0,3	0,3	0,3	**3,1**
ΜΑΡΚΟΥ	0,6	0,7	0,8	0,4	0,1	0,1	0,1	**2,8**
ΒΙΟΛΑΡ	0,3	0,2	0,2	0,1	0,1	0,1	0,5	**1,5**
ΣΥΝΟΛΟ	**4.384,5**	**3.878,3**	**3.802,1**	**3.459,0**	**3.532,3**	**4.739,8**	**5.589,9**	**29.385,9**

Source: IPTO

5. Share of Load Representatives per Voltage Level

ΕΚΠΡΟΣΩΠΟΣ ΦΟΡΤΙΟΥ	ΥΤ(GWh)	ΥΤ(%)	ΜΤ(GWh)	ΜΤ(%)	ΧΤ(GWh)	ΧΤ(%)	ΣΥΝΟΛΟ(GWh)	ΣΥΝΟΛΟ(%)
ΔΕΗ	159,98	24,57%	440,27	37,19%	2.412,41	64,25%	3.012,67	53,90%
ΜΥΤΙΛΗΝΑΙΟΣ	242,98	37,31%	217,05	18,33%	355,33	9,46%	815,35	14,59%
ΗΡΩΝ	157,71	24,22%	187,86	15,87%	229,14	6,10%	574,71	10,28%
ELPEDISON	76,44	11,74%	69,40	5,86%	163,56	4,36%	309,40	5,54%
NRG	7,57	1,16%	98,66	8,33%	196,45	5,23%	302,68	5,41%
ΦΥΣΙΚΟ ΑΕΡΙΟ	0,00	0,00%	70,99	6,00%	100,34	2,67%	171,33	3,07%
ΖΕΝΙΘ	0,15	0,02%	7,64	0,65%	140,86	3,75%	148,65	2,66%
VOLTERRA	6,16	0,95%	56,96	4,81%	27,06	0,72%	90,18	1,61%
VOLTON	0,00	0,00%	8,38	0,71%	64,16	1,71%	72,55	1,30%
ΔΕΗ_ΠΚΥ	0,00	0,00%	0,00	0,00%	41,17	1,10%	41,17	0,74%
ΟΤΕ	0,00	0,00%	10,11	0,85%	1,29	0,03%	11,40	0,20%
EUNICE TRAD	0,01	0,00%	4,82	0,41%	6,49	0,17%	11,31	0,20%
ΕΛΙΝΟΙΛ	0,00	0,00%	5,27	0,45%	4,38	0,12%	9,65	0,17%
ΜΥΤΙΛΗΝΑΙΟΣ_ΠΚΥ	0,00	0,00%	0,00	0,00%	4,34	0,12%	4,34	0,08%
ΒΙΕΝΕΡ	0,00	0,00%	3,57	0,30%	0,00	0,00%	3,57	0,06%
ΕΛΤΑ	0,00	0,00%	1,28	0,11%	1,10	0,03%	2,37	0,04%
ELPEDISON_ΠΚΥ	0,00	0,00%	0,00	0,00%	2,23	0,06%	2,23	0,04%
SOLAR ENERGY	0,00	0,00%	1,11	0,09%	0,93	0,02%	2,04	0,04%
ΗΡΩΝ_ΠΚΥ	0,00	0,00%	0,00	0,00%	1,81	0,05%	1,81	0,03%
NRG_ΠΚΥ	0,00	0,00%	0,00	0,00%	1,64	0,04%	1,64	0,03%
ΒΙΟΛΑΡ	0,00	0,00%	0,46	0,04%	0,01	0,00%	0,47	0,01%
ΚΟΡΙΝΘΟΣ POWER	0,26	0,04%	0,00	0,00%	0,00	0,00%	0,26	0,00%
ΜΑΡΚΟΥ	0,00	0,00%	0,08	0,01%	0,00	0,00%	0,08	0,00%
ΣΥΝΟΛΟ	**651,25**	**100,00%**	**1.183,92**	**100,00%**	**3.754,70**	**100,00%**	**5.589,86**	**100,00%**

Source: IPTO

ANNEX IV: Assumptions for Energy Investments in Greece, 2024-2030

A. Electricity generation

Thermal

(i) ***Lignite*** with installed capacity higher than 400 MW
€2.9-6.0 million/MW

(ii) ***Gas*** (CCPs)

€470,000/MW

(iii) ***Oil***

€340-€540/kW

Large Hydro

For large hydro with installed capacity higher than 50 MW

€2.2 million/MW

Notes:

(a) Includes all mechanical and electrical work, as well as ports

(b) Includes all civil engineering works (i.e. roads, dams, bridges)

CHP

(i) ***CCGT CHP:*** €700,000 - €1,300,000/MWe, with average standard cost of €1,000,000/MWe. The annual operation and maintenance (O&M) costs are approximately €35,000/MWe.
(ii) ***CHP with natural gas engine:*** €600,000 - €1,200,000/MWe, with average standard cost of €735,000/MWe. The annual operation and maintenance (O&M) costs are approximately €175,000/MWe.
(iii) ***Fluidised Bed Combustion CHP with lignite use:*** €1,900,000 - €3,900,000/MWe, with average standard cost of €2,280,000/MWe. The annual operation and maintenance (O&M) costs are approximately €70,000/MWe.
(iv) ***CHP biomass:*** €3,000,000 - €3,500,000/MWe. The annual operation and maintenance (O&M) costs are approximately €70,000/MWe.

B. Energy Storage

(i) ***Pumped storage for a hydroelectric power station with a lifespan of 40 years***
€580,000/MW

(ii) ***Batteries with a battery/station lifespan of 12/25 years***
€250,000/MW

C. Electricity Transmission System[31]

(i) ***Overhead lines***

Total cost per circuit route length (km), based on total asset cost, excluding financing costs:

a. 380-400 kV, circuit 2: €500,000

b. 380-400 kV, circuit 1: €360,000

c. 150 kV, circuit 2: €175,000

d. 150 kV, circuit 1: €125,000

[31] It is based on estimates from the implementation of recent similar projects in the Greek Electricity Transmission System. It is noted that per project the unit costs vary depending on the specific characteristics of the projects (routing, terrain morphology, total distance, depth for submarine interconnections, etc.). Also, the unit costs may vary depending on the current prices of metals on the international market (copper, aluminum) and especially for submarine interconnections with the current conditions prevailing in the market for the construction and laying of submarine cables.

(ii) ***Underground cables***

Total cost per route length (km)

a. 380-400 kV, circuit 2: €3,750,000

b. 150 kV, circuit 2: €1,200,000

c. 150 kV, circuit 1: €600,000

All cables are for alternating current (AC) lines. Data is insufficient to evaluate direct current (DC) cables.

(iii) ***Subsea cables***

Total cost per route length (km):

a. AC cables (150-220 kV): €1,000,000

b. DC cables (250-500 kV): €750,000

D. RES[32]

(i) ***Wind***

Onshore: €1.2-1.3 million/installed MW

Offshore: €3.0 million/installed MW

(ii) ***Solar thermal***

Solar tower (with storage): €6.0-9.0 million/installed MW

CSP: €4.3 million/MW

(iii) ***Photovoltaics***

- **park:** €0.8-0.95 million/installed MW
- **rooftops:** €0.6-0.92 million/installed MW

(iv) ***Biomass***

€2.2 – 3.0 million/installed MW

(v) ***Hydro***

€1.8 million/installed MW

(vi) ***Geothermal*** (high enthalpy)

€4.0 – 4.5 million/installed MW

[32] Οι παραδοχές βασίζονται στην υπόθεση ότι οι επενδύσεις των ΑΠΕ υλοποιούνται γραμμικά μέσα στο χρόνο, ικανοποιώντας τους επιμέρους μεσοπρόθεσμους στόχους του ΕΣΕΚ.

(vii) *Green hydrogen*

(a) Alkaline electrolytes

€949,000/MW of 5 MW

€663,000/MW of 100 MW

(b) Electrolysis of Polymer Electrolyte Membrane or Proton Exchange Membrane

€980,000/MW of 5 MW

€720,000/MW of 100 MW

E. Natural Gas

Cost of installing natural gas pipelines:

(i) *Main pipelines*

€1.0 – 1.2 million/km for pipelines with a diameter of 36’’-48’’

€1.4 – 1.6 million/km for pipelines with a diameter of 58’’

(ii) *Branches*

€0.70-0.75 million/km for pipelines with a diameter of 26’’

(iii) *Urban networks*

According to the Distribution Network Development Plans for the period 2020-2024 by the competent Natural Gas Distribution Network Operators (EDA Attica, EDA THESSA and DEDA), below are included the weighted average unit costs of installing Low Pressure pipelines (maximum operating pressure up to 4 barg) and the weighted average unit costs of installing Medium Pressure pipelines (maximum operating pressure up to 19 barg).

Δίκτυο Διανομής	ΕΔΑ Αττικής (*)	ΕΔΑ ΘΕΣΣ (+)	ΔΕΔΑ
Χαμηλή Πίεση	82,00 €/m	117,00 €/m	65,00 €/m
Μέση Πίεση	Μη διαθέσιμο	331,00 €/m	240,00 €/m

Notes:
(*) The prices include:
- Construction – Contractor cost – (72%)
- Supervision cost (8%)
- Materials cost (15%)
- External inspection cost (1%)
- Capitalized operating cost (4%)

(+) Prices include:
- Construction – Contractor cost
- Materials cost
- Personnel cost

F. Estimated CAPEX for Hydrocarbon Exploration

(i) *Onshore deep drilling*

$40 - $60 million per drilling for depths between 3,000 m. and 6,000 m.

(ii) *Offshore drilling* (shallow waters)

$15 - $20 million per drilling

(iii) *Offshore drilling* (deep waters)

$50 - $100 million per drilling for depths up to 2,000 m.

$120 - $200 million per drilling for extremely deep waters (over 2,000 m)

(iv) *Horizontal drilling*

From land to sea $15,000 - $18,000 per dreilling for a 60-70 day operation.