The Greek Energy Sector

Annual Report 2023

INSTITUTE OF ENERGY
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The Greek Energy Sector –

Annual Report 2023

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IENE Study (M66)

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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
^{o}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
RAE	Regulatory Authority Energy
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-Turkey-Italy
PCI	Projects of Common Interest
TAP	Trans Adriatic Pipeline

Preface

The present third edition of the Annual Report for the Greek Energy Sector 2023 of the Institute of Energy for SE Europe (IENE) is a milestone for the Institute, taking into account the changing conditions that prevailed last year and also in 2023 in the global and European energy market, especially after Russia's invasion of Ukraine on February 24, 2022. The rising cost of energy and the disruption to supply chains triggered by the invasion make mapping and analysis of the energy sector more timely and vital than ever.

Normally, the Annual Report should have been released in 2021, but it was preceded by the publication of IENE's major reference study, the "SE Europe Energy Outlook 2021/2022", which deals with the current situation of the SE European energy sector and its outlook to 2040, which was released in March 2022 and moved the current version forward into 2023.

In any case, this updated version contributes to a better understanding of the structure and operation of the energy sector in Greece, a sector that undoubtedly constitutes the "backbone" of the economy and a key pillar of growth.

This year's Report covers all subsectors, such as Oil and Gas, Electricity, Solid Fuels, Renewable Energy Sources (RES), as well as Energy Efficiency and Cogeneration. It also refers to the energy policy followed today with an emphasis on sustainability and security of energy supply and how it fully meets the European goals, but also the important challenges that exist in formulating an overall energy strategy for the country. Furthermore, the energy position of Greece is examined in relation to the developments and perspectives in SE Europe, the latest developments in the legislative and regulatory framework are presented, the energy technologies of the next decade are highlighted, while estimates are formulated for the energy investment potential for the period 2022-2031.

It should be noted that the period since the publication of the last IENE's Report (see "The Greek Energy Sector - Annual Report 2020", available here) until today, and despite major problems due to the coronavirus pandemic, significant progress has been made in almost all sub sectors. Most notable is the impressive progress in the development of RES, where over the last two years (2021-2022) we have a marked increase in the total installed RES capacity by 2.5 GW, with the parallel addition of a new lignite unit (see Ptolemaida 5) and a natural gas unit (see natural gas combined cycle power plant of the Mytilineos Group in the "Aspra Spitia" of Boeotia), i.e. a combined thermal installed capacity of 1.5 GW, but also the electricity interconnection of the Cyclades, as well as the completion and operation of the "small" electricity interconnection of Crete-Peloponnese. However, there is an equally great development in the penetration of natural gas with the further expansion of the national gas network and regional grids and the emergence of the LNG terminal in Revithoussa as a dominant energy gateway for the supply not only of Greece but also of the Balkans. The successful relaunch of the "Save at Home" programme also gave the necessary boost to the wider effort being made to improve overall energy efficiency in the Greek energy system.

In this context, the European programme for the abolition of Russian energy fuels - oil, natural gas, coal – known as "REpowerEU", which was introduced in March 2022, and its implications for Greece, is being examined.

The preparation of this Annual Report, funded exclusively from the Institute's own resources, was carried out by the scientific staff of IENE and was based on data and analyses extracted both from IENE's database and from official sources from Greece and abroad. Finally, the important study activity developed by the Institute in recent years and the continuous and systematic monitoring of the Greek, regional and global energy market provided the necessary background on which the whole project was based.

I hope that this Annual Report and the free access to it will be useful to the State but also to all professionals and companies, in Greece and abroad, active in the energy sector.

Costis Stambolis

Chairman and Executive Director,
Institute of Energy for SE Europe (IENE)
Athens, July 2023

1. Introduction

The energy sector is of high importance for the development of the European and Greek economy. It is a key pillar of the economy as it creates added value, jobs and attracts investments, ensuring at the same time strong multiplier effects in economic activity. But the global energy system has been in turmoil for the last year due to the geopolitical realignments caused by Russia's invasion of Ukraine, which combined with the crisis caused by the Covid-19 pandemic that preceded it, are creating a new "fragile" environment in the energy sector, with significant implications for the economy. Energy security issues and continued high energy prices have created energy crisis conditions affecting households, commerce, industry, disrupting supply chains and hampering economic growth in general.

Undoubtedly, rising energy prices have hit most economies, but not at the same extent. Europe is experiencing the greatest impact mainly due to its energy dependence on Russia for natural gas and oil, with citizens' disposable income being "squeezed" as inflation rises.

With its main goal of carbon neutrality by 2050, the European Union has advanced a series of measures and strategies regarding sustainable development, secure energy supply and economic efficiency. But this commitment to this strategy undermines the security of energy supply, as the energy crisis has shown. The security of energy supply, which has been a priority for Europe in recent years, has evolved as a primary objective and a major issue after Russia's invasion of Ukraine. Attention must be paid to the risks associated with dependence on external sources, political insecurity in third party suppliers and transit countries, and the potential for disruption of energy supplies.

Price volatility, supply shortages, security issues and economic uncertainty have contributed to what the International Energy Agency (IEA) calls "the first truly global energy crisis, with effects that will be felt for years to come." The composition of a diversified energy mix is at the heart of energy security policies and the IEA estimates that the crisis is likely to accelerate the transition to more sustainable fuels. On the contrary, there is a belief that the negative economic outlook and short-term policy options with a shift towards fossil fuels could slow down the push towards renewables.

In response to the difficulties and disruptions in the global energy market caused by Russia's invasion of Ukraine, the European Commission presented the "REPowerEU" plan, which aims to make Europe independent of Russian fossil fuels by 2025 or earlier, without, however, reducing the energy dependence.

In Greece, major changes are observed in the way the market is organized and operated with the further liberalization of the natural gas market, the promotion of large- and medium-sized infrastructure projects, such as the start of construction of the Alexandroupolis FSRU and the commercial operation of the Interconnector Greece-Bulgaria (IGB), the government's promotion of hydrocarbon exploration activities, the 180-degree turn on delignitisation (which has now been postponed to after 2028), the legal and regulatory framework and the supply diversification of energy sources.

The geopolitical unrest in Eastern Europe as well as the coronavirus pandemic led to several changes in the regional energy landscape. In 2021, global energy consumption increased by almost 6% compared to 2020, with electricity generation from RES, mainly wind and solar, corresponding to approximately 13% of global electricity generation, which amounts to approximately 28%, with the addition of large hydropower plants. The installed RES capacity added in 2021 was a record, showing an increase of 6% compared to 2020, reaching 295 GW worldwide [1], despite continued supply chain disruptions caused by the Covid-19 pandemic, delays in the construction of RES projects and the record prices of raw materials. Globally, the installed RES capacity reached 3,068 TW in 2021, an increase of 9.3% compared to 2020 and 20.7% compared to 2019.

Amid rising demand for natural gas and electricity and expected price increase as economies rebounded after lockdowns due to the Covid-19 pandemic, the trend to reduce coal use has begun to shift and in the short term the European governments are "freezing" coal phase-out plans.

The purpose of this 3rd IENE Report on the Greek Energy Sector is to provide information on the main developments in all individual energy sectors for the past year. In addition, the Report aims to inform about the current important issues that concern the Greek energy sector, but also at the global and European level, as well as how the energy agenda is expected to be shaped in the next period of time. A topic of particular concern at this year's Report is that of energy security, given the developments on the front of Russia's invasion of Ukraine and the EU's decision to completely abandon Russian energy imports. This Report highlights the need for the diversification of Greece's energy supply sources and the best possible development of the domestic energy sources (RES and conventional fuels), with an emphasis on the construction of the appropriate energy infrastructure and the acceleration of hydrocarbon research activities.

In summary, it would be useful to refer, even briefly, to the individual Chapters of this Report. Chapter 2 describes the context in which the global and Greek economy operates, as well as the 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 targets, emphasizing the issue of energy security.

In Chapter 5, there is a reference to the energy market and infrastructure in Greece, while in Chapters 6-11 the Greek energy market is thoroughly analyzed by energy fuel (Chapter 6: Oil and Petroleum Products, Chapter 7: Natural Gas, Chapter 8: Electricity, Chapter 9: Solid Fuels, Chapter 10: RES, Chapter 11: Energy Efficiency and Cogeneration), which can be characterized as the backbone of the Annual Report, since they contain latest information.

In addition, Chapter 12 presents recent legislative and regulatory developments in the energy sector, with an emphasis on the restructuring of the domestic wholesale electricity market and the effort to modernize the RES licensing process. Chapter 13 describes the energy market in SE Europe and highlights the role of Greece in the regional energy market, while Chapter 14 presents the energy technologies expected to shape the future, emphasizing hydrogen and electricity storage.

Similarly, Chapter 15 summarizes the required energy investments in Greece over the next decade in the context of abandoning Russian gas and oil imports, in an attempt to find alternative sources of energy supply, enhancing energy efficiency and increasing the share of RES in energy mix. Finally, Chapter 16 refers to the prospects for the further development of the Greek energy market, while Chapter 17 summarizes the main conclusions of the Report.

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

2.1. The Global Economy: Trends and Prospects

The global economy continues to face significant challenges as growth rates shrink and inflation remains high, also as a result of Russia's invasion of Ukraine. The economies of the OECD countries grew at an annual rate of 2.5% in the third quarter of 2022, following GDP growth of 3.3% in the previous quarter and growth of 4.9% in the corresponding quarter of 2021. The annual rate of change of GDP in the most developed economies (G7) stood at 1.9%, compared to a rate of 2.4% in the previous quarter and growth of 4.3% in the corresponding quarter of 2021. The 20 largest economies of the OECD grew at a rate of 3.3% in Q3 2022, up from 2.8% in the previous quarter, and following growth of 4.8% in the corresponding quarter of 2021.

The war in Ukraine is still ongoing, with no sign of ending anytime soon, being the most important source of uncertainty for the global economy. The most important economic consequence of the war on a global scale is the increase in inflation, which in November in the 38 OECD countries reached 10.3%, falling marginally from 10.7%, which was recorded the previous month and is a high of the last 39 years. Structural inflation (i.e. excluding energy and food) reached 7.5%, while energy and food prices rose by 23.9% and 16.1% respectively.

In Europe in particular, the exceptionally mild winter so far and the strong supply of liquefied natural gas on the continent has resulted in inventories being maintained at seasonally high levels, while the price of natural gas has fallen to 18-month lows. Therefore, energy sufficiency for the winter is achieved. In addition, most governments are proceeding with fiscal interventions to support households and businesses, which limit the negative impact on economic activity. However, despite the positive developments recorded, Europe is still faced with strong uncertainty in the medium term.

Sustaining high inflation and a strong labor market in many countries have changed the stance of monetary policy to restrictive, leading to significant interest rate increases in a short period of time. The tightening of financial conditions has already begun to have an effect, while the rise in interest rates is expected to continue at a slower pace going forward. Although the possibility of a "soft landing" of economies and the avoidance of recession

[1] The majority of this Chapter came from the latest IOBE's Report entitled: "The Greek Economy - Quarterly Report - 4th Quarter 2022", http://iobe.gr/docs/economy/ECO_Q4_2022_REP_GR.pdf

remains a possible scenario, continued further interventions raise the possibility of a sharper than intended decreasing of economic activity.

The rate of change in global GDP last year (2022) is estimated at 3.1%, while for 2023 growth is forecast at 2.2% in the recent OECD report, up from 3% and 2.8% respectively predicted in the report of last June. Global trade volume growth is estimated at 5.4% in 2022, and is forecast to moderate to 2.9% in 2023 as demand eases and price pressures continue. Table 1 includes annual changes in GDP in 2021 and the most recent OECD forecasts (November 2022) for annual changes in 2022 and 2023, 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), 2021-2023

Economy	2021	2022		2023	
		Forecast	Difference from previous forecast *	Forecast	Difference from previous forecast *
Global	6,0	3,1	0,1	2,2	-0,6
US	5,7	1,8	0,7	0,5	-0,7
Japan	1,7	1,6	0,1	1,8	0,0
Canada	4,5	3,2	0,6	1,0	-1,6
United Kingdom	7,4	4,4	0,8	-0,4	0,4
Eurozone	5,2	3,3	0,7	0,5	-1,1
Germany	*2,6*	*1,8*	*0,1*	*-0,3*	*-2,0*
France	*6,8*	*2,6*	*0,2*	*0,6*	*-0,8*
Italy	*6,7*	*3,7*	*1,2*	*0,2*	*-1,0*
Turkey	11,4	5,3	1,6	3,0	0,0
China	8,1	3,3	-1,1	4,6	-0,3
India	8,7	6,6	-0,3	5,7	-0,5
Brazil	4,6	2,8	2,2	1,2	0,0
Global Trade	10,1	5,4	0,6	2,9	-1,0

* Difference in percentage points compared to previous OECD estimates (OECD Economic Outlook, June 2022).

Source: OECD Economic Outlook, Interim Report, ΟΟΣΑ, November 2022 [2]

Next, the recent and expected trends in the economies of the most important countries and associations of states for 2022 and 2023 are analyzed.

Among the most **developed countries**, the US in the third quarter of 2022 saw an annual growth rate of 1.9% from 1.8% in the previous quarter and 5% in the corresponding quarter of 2021. The marginal acceleration reflects the increase in exports, consumption, non-residential fixed capital investment and government spending, which was partially offset by a decrease in residential fixed investment. Inflation slowed for a sixth straight month to 6.5% last December, from a 40-year high last June 2022 (9.1%). In order to control inflationary pressures, the FED has proceeded with successive increases in its key interest rate, raising it by a total of 425 basis points from March 2022 to December 2022, to 4.25%-4.50%, while it is expected further increasing it to 4.75%-5.00% by the middle of this year (2023). In 2022 as a whole, the US economy is estimated to grow at a rate of 1.8%, while weak growth (0.5%) is predicted for the following year. This means that the macroeconomic effects of the energy and inflationary crisis have not fully emerged themselves, even in the largest economies.

The **eurozone** economy grew at a rate of 2.3% in the third quarter of 2022, up from 4.2% in the previous quarter and against a rate of 3.9% in the same quarter of 2021. Compared to the second quarter, there was growth of 0.3% on a seasonally adjusted basis, with fixed investment making the largest positive contribution (+0.8%), followed by household spending (+0.4%), which was partially offset by the negative impact of the trade balance (-1.1%). Inflation eased to 9.2% in December 2022 in the eurozone, from a record high of 10.6% found in October 2022. The ECB has made four consecutive increases in its key interest rate by 250 basis points since July of 2022 to last December, to 2%. Further increases are expected until the middle of this year, with an eye on high levels of inflation, which is set at 8.4% overall for 2022, before easing to 6.8% in 2023 and 3.4% in 2024. as expected. In 2022 as a whole, the eurozone is estimated to have grown at a rate of 3.3%, from 5.2% in 2021, while marginal growth of 0.5% is predicted for 2023.

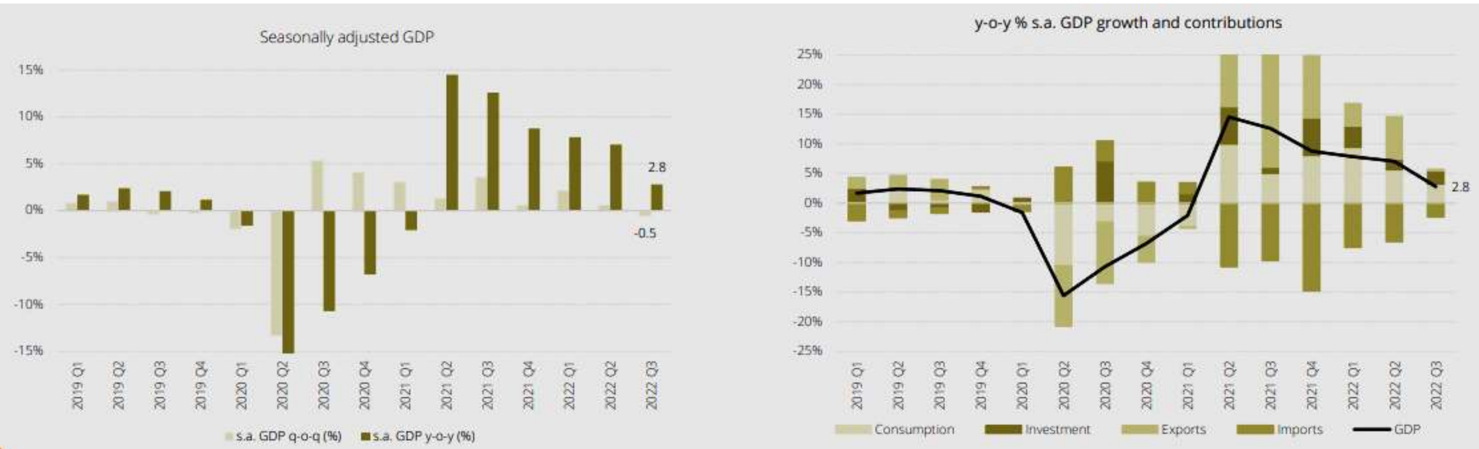
Also, **China**’s economy recorded an acceleration in its growth rate in the third quarter of 2022, to 3.9%, from a rate of 0.4% in the previous quarter and 4.9% a year earlier. The extended lockdowns due to the zero cases policy had a strong negative impact on both industrial activity and the domestic demand side. However, Chinese authorities recently decided to relax their policy on Covid-19 after waves of protests emerged due to citizens’ fatigue. Overall for 2022, growth is estimated at 3.3% and acceleration to 4.6% in 2023.

2.2. The Greek Economy: Trends and Prospects

The growth of the Greek economy slowed significantly in the third quarter of 2022 compared to the previous quarter, but remained slightly higher than the average in the eurozone. Specifically, GDP increased in the July-September period, a period in which estimates were optimistic due to the peak of tourism activity, at an annual rate of +2.8% (+2.3% in the eurozone), from +7.1% in the second quarter of 2022, while a year earlier it was growing by +12.6% with the restart of the Greek economy after the lifting of measures against Covid-19.

The slower pace of domestic GDP growth was mainly due to an unexpectedly large drop in the annual growth rate of exports, both exports of goods and services, a component that made the biggest contribution to GDP expansion in the previous quarter. On the contrary, the annual growth rate of imports showed a milder decline, which offset the contribution of investment growth to GDP and worsened the external balance deficit in national accounting terms. Household consumption made the biggest contribution to growth, which, albeit at a decreasing rate, continued its upward trend for another quarter (see the following Figure).

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



Sources: ELSTAT and IOBE

As for the exact developments of the GDP components during the third quarter of 2022, the annual growth rate of domestic consumption almost doubled to +3.6%, compared to a quarter earlier (+6.3%). The slowdown in domestic consumption is mainly due to the decrease in public consumption by -2.9% year-on-year, twice as much as in the previous quarter (-1.3%), due to the elimination of emergency support measures implemented during the pandemic and affected the corresponding figures a year earlier. In contrast, private consumption proved resilient to inflationary pressures, due to increased spending during the tourist season and fiscal support measures (+6.2% from +8.9% in Q2 2022).

Investments showed a higher annual growth rate of +12.3%, compared to +10.1% in the previous quarter. The resources of the Recovery Fund combined with the banks' credit expansion, as well as the very low base of fixed investments in recent years, can partly explain the aforementioned result. Inventories showed a large annual increase, by +30.2%, against +11.4% a quarter earlier, while fixed capital formation expanded annually by +7.7%, milder than in the second quarter of 2022 (+9.8%).

Regarding the developments in the external balance of the economy, the stagnation of exports at constant prices during the peak quarter of tourism activity is of particular interest. In detail, services exports registered an anemic annual growth of +3.0%, compared to +45.8% in the previous quarter, while goods exports fell marginally by -0.3% year-on-year (+1.5% in the previous quarter), for the first time since Q2 2020. The weak services export performance appears to be mainly a result of the higher base of comparison, with services exports showing +100.8% year-on-year growth in the corresponding quarter of 2021, the only quarter of 2021 in which the restrictions to deal with the pandemic did not apply.

The contraction in economic activity in the eurozone and the pressure of high energy product prices also acted as an obstacle on the annual growth rate of services exports, with the nominal value of services exports registering a strong annual increase of +25.8% in the third quarter of 2022 and during the same period the arrivals of visitors from abroad to Greece to increase by almost 60% on an annual basis.

The stagnation of exports combined with a milder slowdown in the corresponding growth rate of imports (+5.2% from +14.5% in the previous quarter), due to resilient domestic demand, worsened the external balance deficit in national account terms relative to with a year ago by approximately €902 million or -1.7% of quarterly GDP. Specifically, imports of goods increased (+8.6% vs. +16.7% in the previous quarter), while imports of services decreased (-4.6% vs. +7.9% in the previous quarter). Finally, it is worth noting that the domestic economy maintains a high degree of extroversion, with the annual average ratio of the sum of imports-exports to GDP remaining at a historic high of 82% in the third quarter of 2022.

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

Quarter	GDP		Final Consumption		Investments		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	180.393	-7,2%	163.441	-7,0%	20.240	-21,0%	48.968	2,0%	52.861	**-5,8%**
2013	175.948	-2,5%	156.885	-4,0%	19.587	-3,2%	49.843	1,8%	50.621	**-4,2%**
2014	176.974	0,6%	156.641	-0,2%	20.440	4,4%	53.954	8,2%	54.045	**6,8%**
2015	176.411	-0,3%	156.715	-0,0%	21.401	4,7%	56.661	5,0%	58.297	**7,9%**
2016	175.567	-0,5%	156.087	-0,4%	22.799	6,5%	56.426	-0,4%	59.964	**2,9%**
2017	177.427	1,1%	158.888	1,8%	21.659	-5,0%	61.229	8,5%	64.533	**7,6%**
a' 2018	44.873	1,8%	40.344	2,5%	5.145	-11,5%	16.095	8,5%	16.489	**4,7%**
b' 2018	45.029	1,7%	39.699	0,1%	6.203	16,5%	16.955	7,9%	17.203	**8,4%**

c’ 2018	44.980	0,5%	39.847	0,1%	5.492	-0,6%	16.855	6,7%	17.772	**8,8%**
d’ 2018	45.273	2,1%	39.840	-0,5%	6.491	29,8%	16.906	13,6%	17.692	**6,6%**
2018	180.155	1,5%	159.730	0,5%	23.331	7,7%	66.812	9,1%	69.156	**7,2%**
a’ 2019	45.642	1,7%	40.436	0,2%	6.045	17,5%	16.904	5,0%	17.735	**7,6%**
b’ 2019	46.115	2,4%	40.828	2,8%	5.520	-11,0%	17.907	5,6%	17.695	**2,9%**
c’ 2019	45.932	2,1%	40.124	0,7%	5.064	-7,8%	18.303	8,6%	18.144	**2,1%**
d’ 2019	45.807	1,2%	40.916	2,7%	5.735	-11,6%	16.962	0,3%	17.596	**-0,5%**
2019	183.497	1,9%	162.304	1,6%	22.364	-4,1%	70.076	4,9%	71.169	**2,9%**
a’ 2020	44.918	-1,6%	40.528	0,2%	6.328	4,7%	16.705	-1,2%	18.142	**2,3%**
b’ 2020	38.920	-15,6%	36.173	-11,4%	5.514	-0,1%	11.973	-33,1%	14.909	**-15,7%**
c’ 2020	40.997	-10,7%	38.781	-3,3%	7.149	41,2%	11.496	-37,2%	16.658	**-8,2%**
d’ 2020	42.682	-6,8%	38.362	-6,2%	5.859	-2,2%	14.822	-12,6%	16.101	**-8,5%**
2020	167.517	-8,7%	153.844	-5,2%	24.850	11,1%	54.996	-21,5%	65.812	**-7,5%**
a’ 2021	43.989	-2,1%	38.694	-4,5%	6.972	10,2%	16.590	-0,7%	17.292	**-4,7%**
b΄ 2021	44.571	14,5%	40.186	11.1%	7.556	37,0%	15.414	28,7%	18.728	**25,6%**
c’ 2021	46.169	12,6%	40.990	5,7%	7.587	6,1%	17.570	52,8%	20.327	**22,0%**
d’ 2021	46.436	8,8%	41.799	9,0%	8.015	36,8,2%	18.678	26,0%	21.303	**32,3%**
2021	181.164	8,1%	161.669	5,1%	30.130	21,2%	68.252	24,1%	77.650	**18,0%**
a’ 2022	47.447	7,9%	42.739	10,5%	8.390	20,3%	18.252	10,0%	20.307	**17,4%**
b’ 2022	47.726	7,1%	42.726	6,3%	8.321	10,1%	18.318	18,8%	21.438	**14,5%**
c΄ 2022	47.469	**2,8%**	**42.471**	**3,6%**	**8.523**	**12,3%**	**17.721**	**0,9%**	**21.380**	5,2%

Sources: Quarterly National Accounts, ELSTAT, December 2022

The structure of the recovery of the Greek economy changed during the third quarter of 2022 compared to the previous one, with private consumption again taking the leading role in it, after the significant slowdown in services exports. The increase in imports more than offset the positive contribution of investment to the recovery and worsened the external balance deficit in national accounting terms.

Medium- and long-term prospects

On consumption basis, the biggest constraint on consumer spending is the high, albeit declining, inflation, the cumulative effect of which has started to become more apparent since the last quarters of 2021. The full impact of high inflation and the resulting squeeze on real incomes is expected to intensify this year.

The gradual slowdown of the post-pandemic, initially explosive, willingness to consume is also affected by the depletion of savings accumulated during the pandemic, as well as the high cost of new and servicing existing borrowing. The expected maintenance of interest rates at high levels by the ECB throughout 2022, combined with the gradual de-escalation of inflation, may increase real interest rates.

The stimulation of employment, due to the strengthening of investment activity through the Recovery Fund and the planned appointments in the public sector, as well as the announced increase in the minimum wage, is expected to act as an obstacle on the slowdown in consumption. Household disposable incomes are also expected to be supported by the Greek government's expansionary policies, particularly the reduction of certain tax rates, subsidies and the increase in public spending at the end of the election cycle.

In terms of public expenditure, public consumption is expected to decrease in 2023, due to the gradual elimination of the energy support measures implemented in the previous year, as well as the target of achieving a budget surplus in the current year. However, the strengthening of employment in the public sector and the maintenance of some interventions due to inflation, may maintain the level of public consumption expenditure. Consumer spending in 2023 may be incrementally affected by the election cycle.

For 2022, the annual change in private and public consumption is estimated at 7.7% and -1.1% respectively, with total consumption at 5.5%. Consumption decelerates strongly, also due to the effect of the higher base of comparison, to 0.3% in 2023, with private consumption expanding by just 0.8%, while public consumption declines by -2.0%.

Investments are expected to maintain their upward trend in 2023 as well, with the resources of the Recovery Fund contributing to the broader strengthening of the extroversion and competitiveness of Greek businesses. Domestic fiscal support measures (electricity subsidies, reduction of tax rates) for businesses will complement the stimulation of investments.

On the other hand, for both consumption and investment, continued uncertainty and high inflation are the main factors dampening momentum this year. The expanded cost of production, due to high prices of energy and other intermediate goods, as well as the planned increase in nominal wages, combined with the higher cost of borrowing from the banking system, are projected to significantly squeeze corporate profits, reducing available investment funds. resources. The cost of borrowing for businesses is expected to be mitigated, however, with the granting of an investment grade to the Greek economy and the expansion of the investment base of corporate bonds.

For 2022, the annual change in investment is estimated at 12.1%. For 2023, investments are expected to be the main driver of growth, following the projected slowdown in private consumption and exports, with their annual change estimated at 8.5%.

As for services exports, their strong upward trend has been halted as early as the third quarter of 2022, due to the decline in economic activity in the Eurozone and the impact of the higher base of comparison. Also, goods exports, while a small contributor to overall export growth, fell marginally by -0.3% year-on-year in Q3 2022 (for the first time since Q2 2020), and may be further constrained by the weakening of the production of domestic enterprises, due to an increase in the cost of production. On the other hand, the depreciation of the euro against the dollar acted as a stimulus for exports outside the EU.

The growth rate of imports, as well as exports, is expected to slow significantly due to the more unfavorable macroeconomic climate. The dependence of domestic production on energy and intermediate imported goods, as well as their close relationship with durable domestic consumption, acts as a hindrance to the reduction of imports.

Taking into account the assumptions about the growth rate of the eurozone, the prices of energy and intermediate goods and taking into account the general climate of uncertainty, IOBE, in its Report entitled: "The Greek Economy - Quarterly Report - 4th Quarter 2022", estimates that the annual growth rate of exports will be 5.8% in 2022 and 2.1% in 2023, while that of imports will be 9.1% in 2022 and 2.7% in 2023, with the worsening of the current account to be one of the most important risks for the domestic economy.

Table 3: Comparison of Forecasts for Selected Economic Indicators for the Years 2022-2023 (at Constant Market Prices, Annual % Changes)

	Ministry of Finance		EC		IOBE		IMF		OECD	
	2022	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**	**2022**	**2023**
GDP	5,6%	1,8%	6,0%*	1,0%*	5,2%	1,4%	5,2%*	1,8%*	5,1%*	1,1%*
Consumption	:	:	:	:	5,5%	0,3%	:		:	:
Private Consumption	7,2%	1,0%	5,8%	1,0%	7,7%	0,8%	0,3%	1,1%	8,0%*	0,5%*
Public Consumption	0,2%	-1,5%	0.6%	-3.7%	-1,1%	-0,2%	1,8%	-3,1%	1,9%	1,6%
Gross Fixed Investment Capital	10,0%	15,5%	11,5%	6,3%	8,5%	7,4%	10,6%	10,5%	8,5%*	2,5%*
Exports	9,7%	1,0%	12,7%	3,9%	5,8%	2,1%	5,9%	5,7%	5,1%*	-0,5%*
Imports	10,1%	2,6%	9,9%	3,1%	9,1%	2,7%	1,5%	2,5%	9,3%	2,4%
Inflation (%)	9,7%	5%	10,0%	6,0%	9,6%	4,0%	9,2%*	3,2%*	9,5%*	3,7%*
Unemployment (% workforce)	12,7%	12,6%	12,6%	12,6%	12,3%	11,5%	12,6%*	12,2%*	12,6%	11,8%
Primary Balance of General Government (% GDP)	-1,6%	0,7%	-1,6%	1,1%	:	:	-4,5%	-1,9%	-1,6%*	0,5%*
Current Account Balance (% GDP)	:	:	-8,6%	-8,6%	:	:	-6,7%*	-6,3%*	-7,1%*	-8,9%*

Sources: Draft State Budget, Ministry of Finance, November 2022 - European Economic Forecast, Autumn 2022, European Commission, November 2022 - The Greek Economy 04/22. IOBE, January 2022 - IMF Country Report No. 22/173, IMF, June 2022, *World Economic Outlook, October 2022 – Economic Outlook 112, OECD, November 2022, *Revision, January 2023

Also, IOBE revises down the recovery to 5.2% for 2022, while it estimates a clearly slower growth of 1.4% in 2023 with a negative outlook, due to the above-mentioned risks, mainly the slowdown of the global economy and the maintaining inflation and uncertainty, factoring in the effect of the higher 2022 base.

3. The Global and European Energy Market

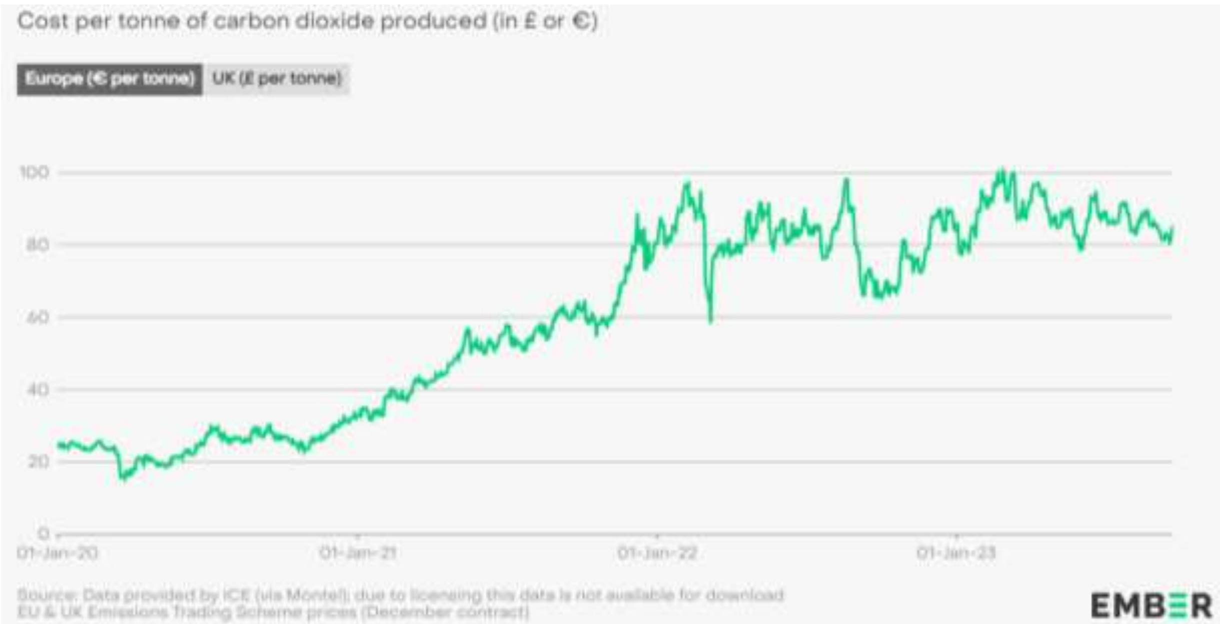
3.1 The Global Energy Market

In 2020, while global economies contracted significantly under the weight of lockdowns due to the Covid-19 pandemic, RES, such as wind, solar PV, geothermal and biomass, continued to grow rapidly and electric vehicles set sales records. In 2021 and 2022, the growing path of RES continued, setting a record for installed capacity. The new energy economy is going to be more electrified, efficient, interconnected and clean in the near future. In most markets, solar PV or wind now represent the cheapest source of electricity generation available. The cleantech sector is becoming an important area for investment and employment – and a dynamic area for international cooperation and competition.

The recovery from the Covid-19 pandemic is still ongoing, but it is uneven, and prone to constant reversals, e.g. happening in China today. Economic impacts appear to have intensified in most countries in late 2020 or early 2021. Countries with fiscal means and access to vaccines have seen strong recovery, however, many emerging markets and developing economies face ongoing risks due to low vaccination rates and increasing debt.

The rapid but uneven economic recovery from the Covid-induced recession has put major strains on parts of today's energy system, sparking sharp price increases in natural gas, coal and electricity markets. Despite the progress made by renewables and electrification, 2021 saw a big rebound in coal and oil use that continued into 2022. Largely because of this, the second largest annual increase in CO2 emissions on record.

Figure 2: Evolution of European CO2 Emissions Allowances, 2020-2023



Source: Ember

As shown in Figure 2, CO_2 emissions from fossil fuels have accounted for the largest proportion of total global emissions in recent years, accounting for around 91% of emissions in 2022 (compared to 9% from land use). This is a big change from the first half of the 20th century, when land use emissions were about the same as fossil fuel emissions [3].

Public spending through economic recovery packages for sustainable energy mobilized only a third of the investment needed to boost the energy sector, with the largest shortfall in developing economies that continue to face a public health crisis.

The studies of the International Energy Agency (IEA) entitled: "World Energy Outlook 2021 and World Energy Outlook 2022" [4] are particularly important as they are a key tool for global energy developments. The 2022 study points out that the energy crisis of 2022 is different from those that happened in the past, referring mainly to the oil crisis of 1970, as the current crisis has multiple dimensions: natural gas, but also oil, coal, electricity, food security and climate. What is required is not just a diversification of energy sources but a change in the nature of the energy system itself, keeping the provision of energy services affordable and secure. More specifically, the World Energy Outlook 2022 explores three scenarios that provide the framework for how the future of energy will shape up and explore the implications of various policy choices, investment and technology trends. Each scenario is based on a different vision of how policymakers can respond to today's crisis, each responding to current energy security and climate challenges in different ways and to a different degree:

1. **Net Zero Emissions by 2050 Scenario – NZE**: maps out how to achieve stabilization of the global average temperature at 1.5 degrees Celsius and meet the energy targets included in the UN Sustainable Development Goals. It essentially paves the way for the global energy sector to achieve net zero CO_2 emissions by 2050.
2. **Announced Pledges Scenario - APS**: which looks at where the energy sector can evolve if all announced energy and climate commitments, including energy access, are fully implemented on time.
3. **Stated Policies Scenario – STEPS:** which looks not at the commitments that governments have announced they want to achieve, but what they are actually doing to achieve their goals and assesses where this will lead the energy sector. It essentially maps the current political arrangements, based on a detailed assessment of the policies that exist or are being developed sector by sector by the various governments.

In the STEPS scenario, total energy supply increases by an average annual rate of change of 1.3% from 2021 to 2030, reaching 673 exajoules (EJ), while announced commitments (APS) limit the average annual rate of change to 0.7% (636 EJ in 2030). Both scenarios contrast with the NZE scenario where demand declines by an average of -0.5% per year to 524 EJ by 2030.

Table 3: Global Energy Supply by Fuel and Scenario (Mtoe), 2010-2050

	Stated Policies Scenario (EJ)						Shares (%)			CAAGR (%) 2021 to:	
	2010	2020	2021	2030	2040	2050	2021	2030	2050	2030	2050
Total energy supply	542	592	624	673	708	740	100	100	100	0.8	0.6
Renewables	45	69	74	116	169	215	12	17	29	5.2	3.8
Solar	1	5	5	18	36	52	1	3	7	14	8.1
Wind	1	6	7	17	29	38	1	2	5	11	6.2
Hydro	12	16	16	18	21	25	2	3	3	1.8	1.6
Modern solid bioenergy	24	33	36	46	54	62	6	7	8	3.0	1.9
Modern liquid bioenergy	2	4	4	7	9	11	1	1	1	5.2	3.2
Modern gaseous bioenergy	1	1	1	3	5	9	0	0	1	8.1	7.0
Other renewables	3	4	5	8	14	19	1	1	3	6.4	4.9
Traditional use of biomass	25	24	24	20	19	18	4	3	2	-2.3	-1.1
Nuclear	30	29	30	37	43	46	5	5	6	2.1	1.5
Unabated natural gas	115	139	146	150	147	147	23	22	20	0.3	0.0
Natural gas with CCUS	0	0	0	1	2	3	0	0	0	8.1	6.5
Oil	173	172	183	197	198	197	29	29	27	0.8	0.2
of which non-energy use	25	29	31	37	41	42	5	6	6	2.1	1.0
Unabated coal	153	157	165	151	128	111	26	22	15	-1.0	-1.4
Coal with CCUS	-	0	0	0	1	1	0	0	0	33	17

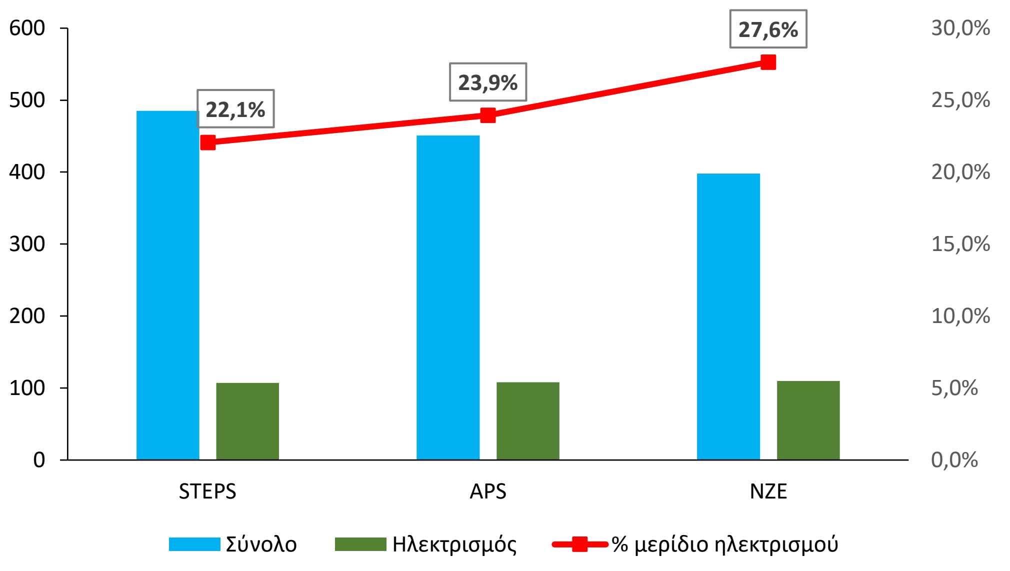
	Announced Pledges Scenario (EJ)						Shares (%)			CAAGR (%) 2021 to:	
	2010	2020	2021	2030	2040	2050	2021	2030	2050	2030	2050
Total energy supply	542	592	624	636	626	629	100	100	100	0.2	0.0
Renewables	45	69	74	141	239	319	12	22	51	7.5	5.2
Solar	1	5	5	23	56	89	1	4	14	17	10
Wind	1	6	7	21	44	63	1	3	10	13	8.0
Hydro	12	16	16	19	23	27	2	3	4	2.1	1.9
Modern solid bioenergy	24	33	36	53	70	81	6	8	13	4.6	2.9
Modern liquid bioenergy	2	4	4	11	18	19	1	2	3	11	5.3
Modern gaseous bioenergy	1	1	1	4	8	12	0	1	2	15	8.2
Other renewables	3	4	5	10	20	28	1	2	4	9.2	6.4
Traditional use of biomass	25	24	24	9	7	6	4	1	1	-10	-4.8
Nuclear	30	29	30	39	49	56	5	6	9	2.8	2.1
Unabated natural gas	115	139	146	130	99	77	23	20	12	-1.3	-2.2
Natural gas with CCUS	0	0	0	4	10	15	0	1	2	27	13
Oil	173	172	183	179	139	108	29	28	17	-0.3	-1.8
of which non-energy use	25	29	31	36	36	35	5	6	6	1.7	0.4
Unabated coal	153	157	165	132	73	33	26	21	5	-2.5	-5.4
Coal with CCUS	-	0	0	1	9	15	0	0	2	64	29

	Net Zero Emissions by 2050 Scenario (EJ)						Shares (%)			CAAGR (%) 2021 to:	
	2010	2020	2021	2030	2040	2050	2021	2030	2050	2030	2050
Total energy supply	542	592	624	561	524	532	100	100	100	-1.2	-0.5
Renewables	45	69	74	172	307	373	12	31	70	9.9	5.8
Solar	1	5	5	34	87	124	1	6	23	23	11
Wind	1	6	7	28	67	85	1	5	16	17	9.1
Hydro	12	16	16	21	27	30	2	4	6	3.2	2.3
Modern solid bioenergy	24	33	36	58	73	74	6	10	14	5.5	2.6
Modern liquid bioenergy	2	4	4	12	14	12	1	2	2	12	3.6
Modern gaseous bioenergy	1	1	1	7	12	15	0	1	3	21	8.8
Other renewables	3	4	5	13	26	34	1	2	6	12	7.1
Traditional use of biomass	25	24	24	-	-	-	4	-	-	n.a.	n.a.
Nuclear	30	29	30	43	59	63	5	8	12	3.8	2.6
Unabated natural gas	115	139	146	105	34	14	23	19	3	-3.6	-7.8
Natural gas with CCUS	0	0	0	8	21	27	0	1	5	38	15
Oil	173	172	183	143	76	40	29	26	7	-2.7	-5.1
of which non-energy use	25	29	31	34	32	29	5	6	5	1.1	-0.2
Unabated coal	153	157	165	86	15	2	26	15	0	-7.1	-14
Coal with CCUS	-	0	0	3	13	14	0	1	3	91	29

Source: IEA

The share of electricity in global final energy consumption has steadily increased in recent decades and will reach 19.8% in 2021. By 2030, the share of electricity increases to around 30% in the NZE scenario (Figure 3).

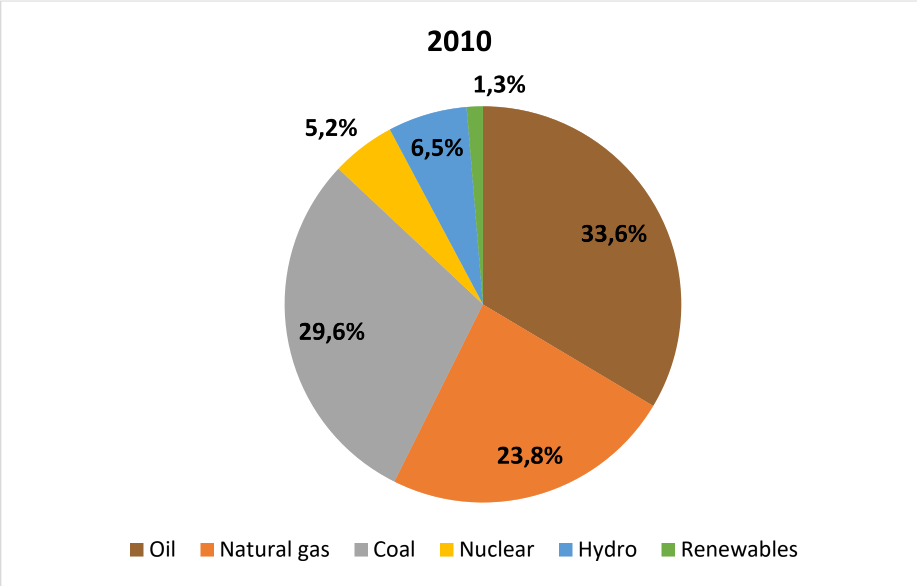
Figure 3: Share of Electricity in Global Final Energy Consumption in 2030 by Scenario (EJ)

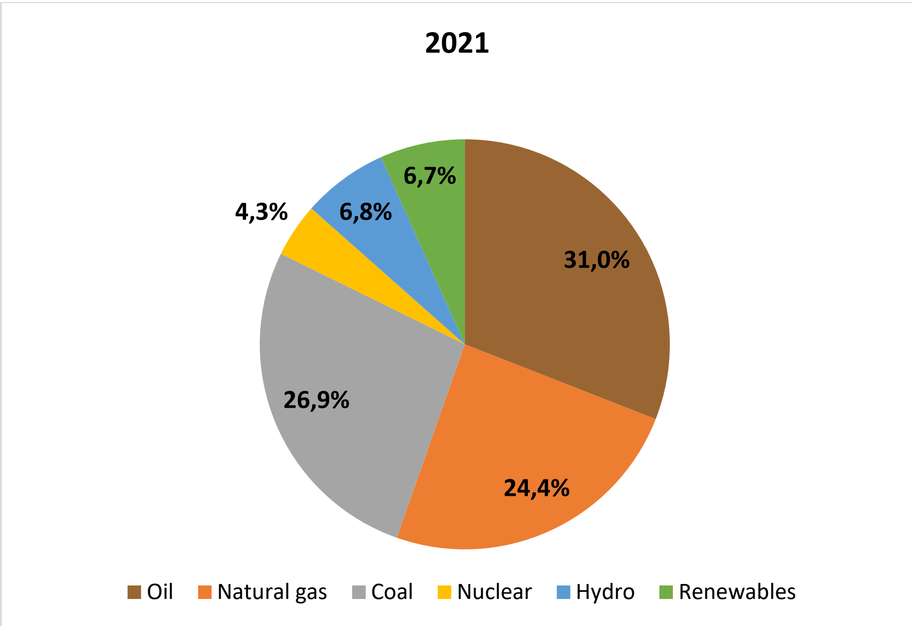


Source: IEA

Another important Report on the global energy situation is that of BP, the "BP Statistical Review of World Energy 2022/71st Edition" [5]. According to this Report, oil was the main energy source of the planet in 2021, followed by coal and natural gas which covered 82% of primary energy use (Figure 4). It should be noted that during the Covid-19 pandemic oil consumption showed the largest decrease, mainly attributed to the restriction of transport. The share of RES in the total primary energy consumption, although increasing from 2010 (1.3%) to 2021 (6.7%), remains at low levels.

Figure 4: Global Primary Energy Consumption, 2010 and 2021





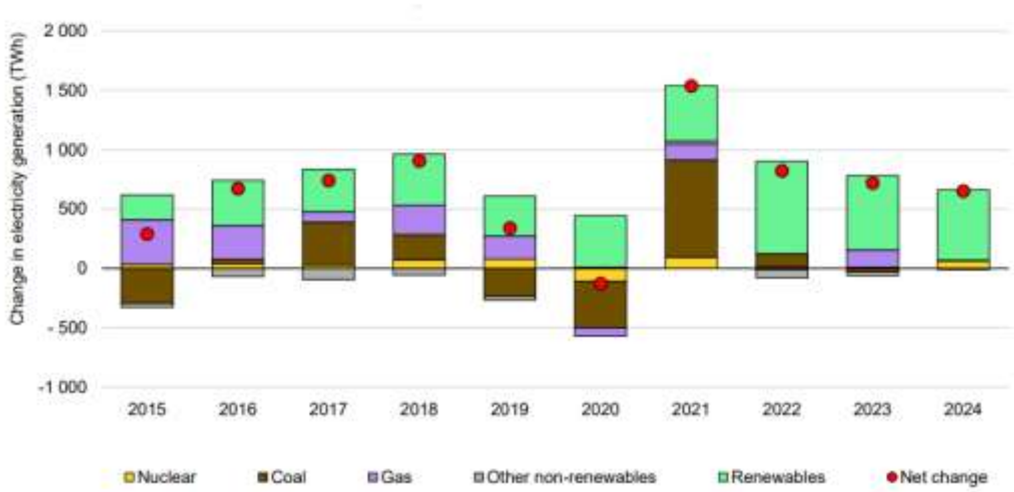
Source: BP

Furthermore, according to the IEA study "Electricity Market Report – January 2022" [6], after a slight decline in 2020, global electricity demand increased by 6% in 2021. It was the largest ever annual increase in absolute terms (over 1,500 TWh) and the largest percentage increase since 2010 after the financial crisis. About half of global growth was in China, where demand grew by about 10%. Globally, electricity demand was boosted by a rapid economic recovery, combined with more extreme weather conditions than in 2020, including a colder winter. The industrial sector contributed significantly to the increase in demand, followed by the commercial and service sectors, followed by the residential sector.

Coal-fired electricity generation reached an all-year high in 2021, rising 9%, the fastest growth rate since 2011, driven by high demand and the cost competitiveness of coal in some markets compared to natural gas. RES grew strongly, by 6%, despite the limited growth rate due to adverse weather conditions (especially for hydropower). Natural gas production rose by 2%, while nuclear by 3.5% to nearly 2019 levels. Overall, CO2 emissions from electricity production rose by almost 7%, reaching a record high.

Electricity generation from low-carbon technologies increased by 5.5% (555 TWh) in 2021, with 83% of this coming from renewables. Despite adverse weather conditions, the absolute increase in electricity generation from renewables in 2021 was the highest ever in absolute terms (up 6%). The use of nuclear energy for electricity generation showed an increase of about 3.5% to reach almost the level of 2019.

Figure 5: Change in Global Electricity Production by Technology, 2015-2024

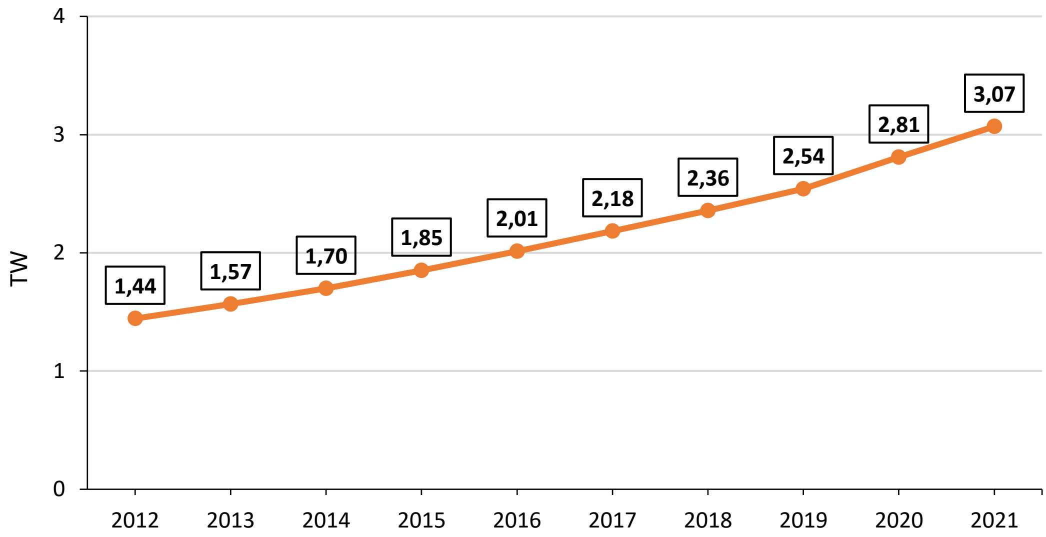


Source: IEA

The increase in the use of electricity requires a parallel increase in its share in energy-related investments. Since 2016, global investment in electricity has been consistently higher than in oil and gas. In the NZE scenario, investment in power generation and infrastructure is six times higher than in oil and gas by 2030.

In 2021, renewables have made impressive progress in the field of electricity generation. Over the past decade, installed RES capacity has increased by 130%, while non-renewable energy has increased by only 24% (Figure 5). In 2021, the total installed RES capacity for electricity generation reached 3,065 GW, producing approximately 8,000 TWh of electricity. To meet the International Renewable Energy Agency's (IRENA) 1.5°C Scenario, the installed capacity would need to more than triple by 2030 [7]. Figure 6 illustrates the development of RES projects worldwide in terms of their installed capacity, showing an average annual rate of change between 2013 and 2021 of 8.7% [8].

Figure 6: Evolution of Installed RES Capacity Worldwide



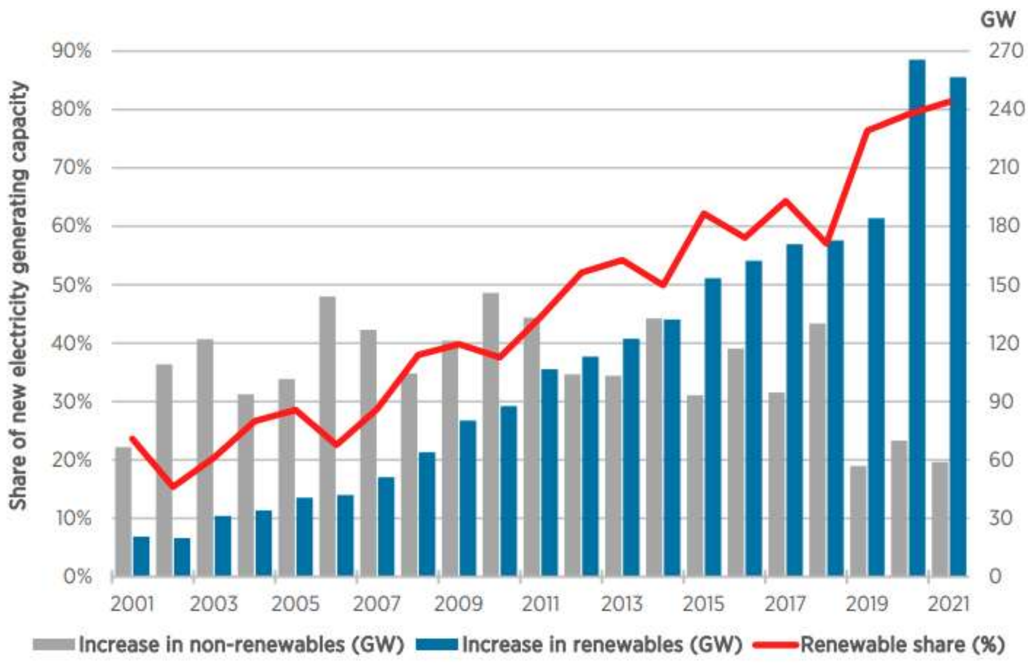
Source: IRENA

Among the RES technologies, solar PV has recorded the highest growth, more than 20 times in 2021 compared to 2010, as a result of large cost reductions due to technological advances, high rates of labor specialization, support and innovative financing models. By the end of 2021, the cumulative installed capacity of solar PV reached 843 GW worldwide, of which 133 GW were commissioned in 2021, with 57% of installations located in Asia [7].

Wind energy also experienced significant growth globally, as its installed capacity increased more than four times between 2010 and 2021. In 2021, the cumulative installed capacity of onshore wind reached approximately 769 GW worldwide. Regarding solar PV, Asia was the market leader in wind power in 2021, with 358 GW of cumulative installed capacity and with more than 48% of global installations located on its territories. The offshore wind market remains small compared to onshore wind, with 56 GW of cumulative installed capacity by the end of 2021. Asia and Europe equally contributed 50% (28 GW) of this total capacity.

Hydropower projects continued to hold the lead in terms of installed capacity. In 2021, the global installed capacity of hydropower projects (excluding pumped storage) reached 1,230 GW, 40% of the total installed capacity of RES projects. Other RES technologies, such as bioenergy, geothermal, solar thermal and wave energy, have also grown rapidly over the past decade, albeit at a small scale. The combined installed capacity of these technologies reached 166 GW in 2021, 86% of which was from bioenergy [7].

Figure 7: RES Share of Annual Power Capacity Expansion, 2001-2021



Source: IRENA

Furthermore, according to the IEA "Electricity Market Report – July 2022" [9], while global electricity demand grew by 6% in 2021, driven by a rapid economic recovery as pandemic restrictions eased, it is forecast to slow to 2.4% in 2022.

In the energy reality being shaped by the unstable conditions of war in Ukraine, the huge opportunity for clean technologies is becoming an important new area for investment and international competition. The IEA study estimates that if the world moves to zero emissions by 2050, then the annual market opportunity for manufacturers of wind turbines, solar PV panels, lithium-ion batteries, electrolyzers and fuel cells increases tenfold to $1.2 trillion by 2050, about 3.5 times higher than in the STEPS scenario.

At the same time, the global oil and natural gas markets have been in continuous fluctuation for the last two years. In the first four months of 2020, as the Covid-19 pandemic led transportation fuel demand to the lowest level, spot prices for Brent crude fell from $70 per barrel to less than $10/barrel. Over the next 18 months, however, Brent prices recovered steadily, surpassing $80/barrel by October 2021 and leading to higher fuel prices for consumers, moving to $85/barrel by late 2022 after peaking at $125/barrel in March 2022. In response to these higher prices, the United States and many other countries released stocks from their strategic oil reserves. The World Health Organization then labeled the Omicron strain of Covid-19 a "variant of concern", renewing fears of public health and economic disruption that drove oil prices into the low levels of $70s/barrel in late November and early December [10].

Since then, however, oil markets have reflected optimism about a global economic recovery and an increase in oil demand, despite the spread of the Omicron strain. By early 2022, prices had once again climbed above $80/barrel.

Another factor driving economic and geopolitical developments is the need for countries to adapt to the integration of climate risks, which is expressed by the need for greater interventions in the institutional framework and in investments with long periods of returns (a typical example is green financing). This structural need drives high prices and speculation in the medium term, before reaching a long-term new equilibrium.

However, in late February Russia launched a full-scale invasion of Ukraine, creating a humanitarian crisis and ushering in a potentially prolonged period of instability in Europe. Russia is the world's third largest oil producer, after the United States and Saudi Arabia, and is the second largest crude exporter (after Saudi Arabia). Russia exported about 5 million barrels of crude oil per day (mb/d) and nearly 3 mb/d of oil products at the end of 2021, according to the IEA.

This volatility, combined with government sanctions and the exit of many companies from Russia, has led to a rise in prices. Brent crude rose above $100/bbl in February 2022, neared $130/bbl in early March, and hovered around $110-115/bbl thereafter (Figure 8) [11]. Prices then fell to $90/bbl as demand steadily declined, so on October 5, 2022 OPEC cut production to avoid a rapid decrease in prices.

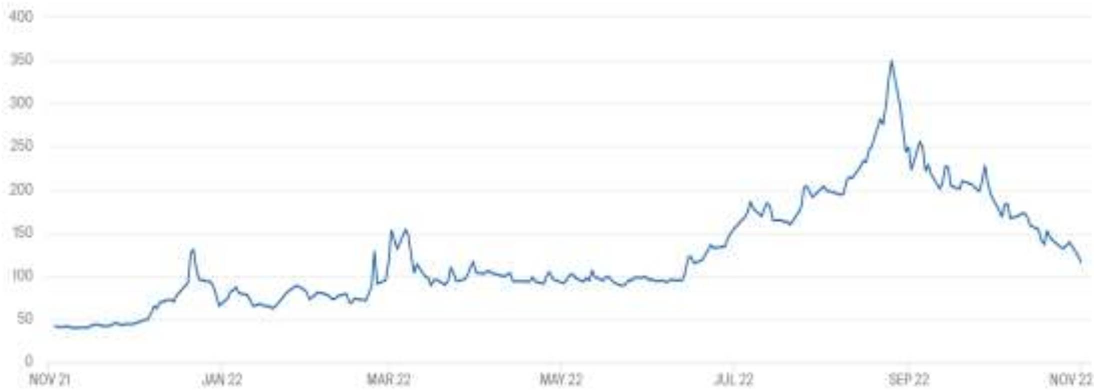
Figure 8: Global Oil Prices, Covid-19 and Russia's Invasion of Ukraine

Source: Resources for the Future

In the context of this major geopolitical upheaval, European gas markets experienced even greater price increases. Dutch TTF prices, which had already reached record levels in 2021, jumped to more than €165/MWh in early March and reached an astronomical price of

€340/MWh in August 2022, as a consequence of gas flow restrictions from the Nord Stream 1 pipeline as well as the worrying predictions for the coming winter. The EU then proposed measures to tackle high gas prices and ensure security of supply in the coming winter. This will be achieved through common gas markets, price capping mechanisms on the TTF gas exchange, new measures for the transparent use of infrastructure, solidarity between Member States and continuous efforts to reduce gas demand. The security climate created after the announcement of the above measures, combined with the increased flow of LNG cargoes and the maintenance of high temperatures in the autumn, led to a drop in natural gas prices, beginning in September 2022 (Figure 9).

Figure 9: Gas Prices in the Netherlands Title Transfer Facility (TTF), November 2021-November 2022



Source: ICE

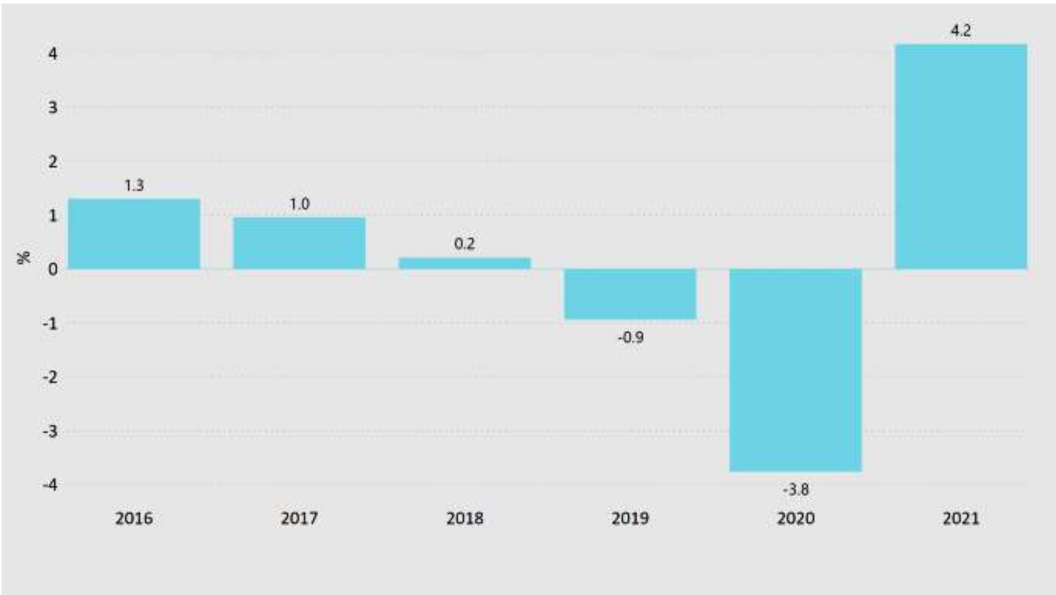
Russia's invasion of Ukraine and the ongoing war have brought the energy security issue of European countries back to the fore. The European Union's dependence on Russian gas supplies has increased over the past decade. Total gas consumption in the EU and the UK remained broadly stable over this period, but domestic production fell by a third and the gap was filled by increased imports. As a result, the share of Russian gas supplies increased from 25% of the region's total gas demand in 2009 to 32% in 2021 [12].

3.2 The European Energy Market

After Europe's electricity demand fell by 1.3% in 2019 and 4% in 2020, it increased by more than 4% in 2021 to reach the pre-pandemic level of 2019. Two main factors drove demand growth in 2021: firstly, Europe's economy grew strongly, driven by the industrial sector, while the recovery of the commercial sector was limited by health protection measures and secondly, 2021 was characterized by a cold year, so low temperatures increased the demand for heating. The most notable development on the energy supply side in 2021 was strong growth in coal-fired power generation, up more than 11%, following a 20% drop in 2020, which marked the first increase since 2012.

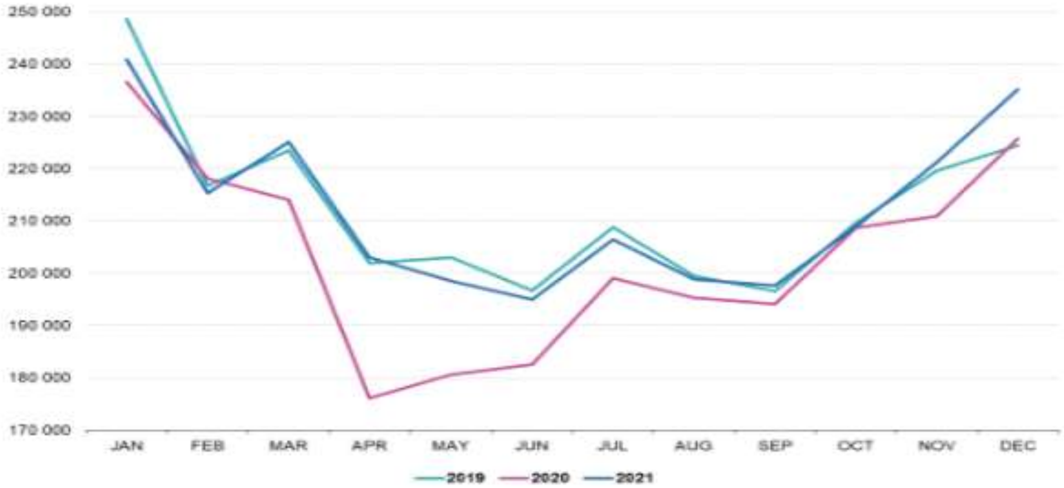
Despite the continuous decarbonisation efforts and the high rhetoric developed by the Commission in this direction, coal served 40% of the year's demand, followed by nuclear, with 30% (an increase of 6%). The main reasons for this resilience of coal as a main source of power in electricity generation have been strong growth in demand combined with relatively low growth in electricity generation from RES (only 1% growth, caused by extremely low wind speeds). In addition, high natural gas prices improved the competitive position of coal-fired plants against natural gas, despite the fact that allowances under the EU Emissions Trading Scheme (EU ETS) were more than twice as expensive as in 2020. High fuel prices resulted in high wholesale electricity prices [13].

Figure 10: Annual Percentage Change in Electricity Consumption in EU-27/EEA (Norway), Switzerland, 2016-2021



Source: ACER

Figure 11: Electricity Consumption by Final Consumers in the EU in 2019, 2020, 2021 in GWh



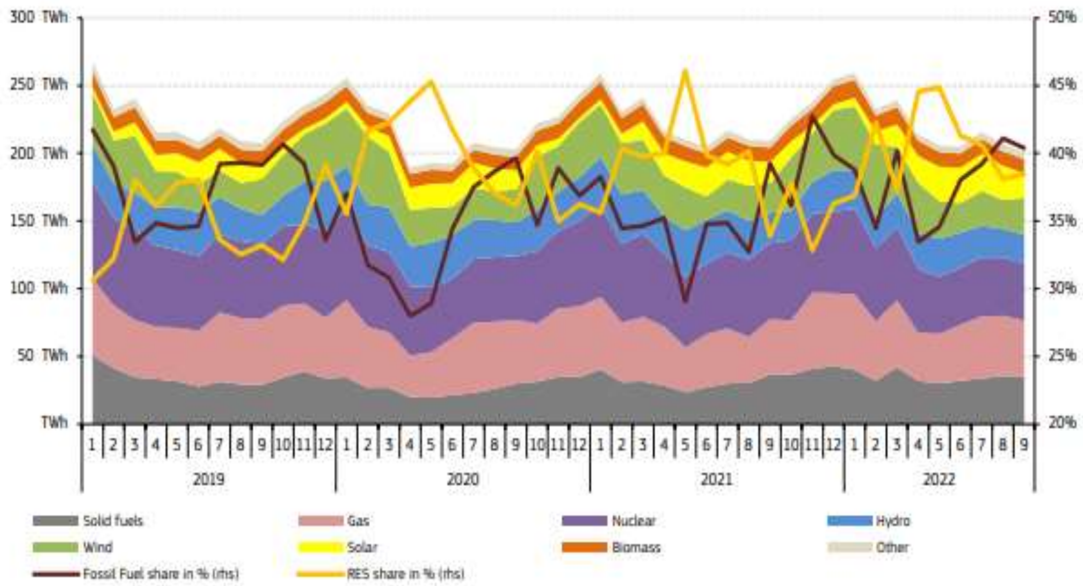
Source: Eurostat

Figure 12 shows the monthly evolution of the electricity generation mix in the EU. Despite reduced electricity demand in Q1 2022, fossil fuels increased their share of the mix. The share of electricity produced by burning coal, natural gas and oil (fossil fuel production) reached 37% in Q1 2022 and 36% in Q2 2022 (from 33% in Q2 2021). However, RES manage to increase their share to 43% (from 42% in the second quarter of 2021). Nuclear power remained under pressure due to unscheduled outages at France's nuclear power plants as well as capacity shutdowns in Germany, reducing its share of generation in the second quarter of 2022 to 21% (from 25% in the second quarter of 2021). Nuclear generation down 17% (-27 TWh) in Q2 2022 [14].

In the fossil fuel sector, coal gained ground in both absolute and relative terms in Q2 2022 compared to Q2 2021, in response to the rally in natural gas prices that reversed the shift from coal to natural gas recorded in 2020, despite high levels of carbon prices. Overall, fossil fuel production recorded an increase of 12 TWh per year (+6%). Coal's share of the mix increased to 15%, while natural gas's share fell slightly to 17% in the reporting quarter. In absolute terms, coal-fired generation increased by 15 TWh year-on-year (+19%), while gas-fired power plants recorded a decline in generation of 8 TWh (-7%). RES produced 5 TWh more electricity year-on-year, driven by increased wind and solar generation, despite sluggish hydro generation [14].

As a result of reduced nuclear and hydro generation in the third quarter of 2022, fossil fuels were able to increase their output level in the mix. The share of electricity produced by burning coal, natural gas and oil (fossil fuel production) increased to 40% in the third quarter of 2022 (from 36% in the third quarter of 2021). However, RES manage to increase their share to 39% (from 37% in the third quarter of 2021). Nuclear generation remained for another quarter under pressure due to unscheduled outages and delayed scheduled maintenance in France, reducing its share of generation in the third quarter of 2022 to 21% (from 27% in the third quarter of 2021). Nuclear generation fell by 24% (-41 TWh) in the third quarter of 2022.

Figure 12: EU Monthly Electricity Generation Mix, 2019-Q3 2022



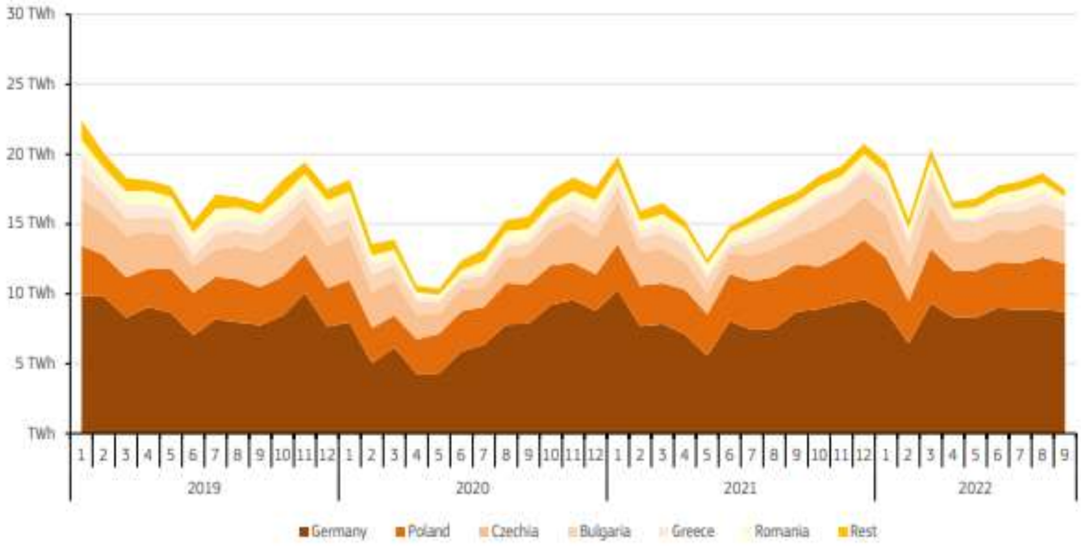
Source: European Commission

Figure 13 illustrates the return of lignite production after the decline seen in 2020 due to the pandemic, helped by the surge in natural gas and coal prices (which reduced the competitive advantage of natural gas and coal-fired power plants). Now the Member States with remaining lignite capacity increased their production in the second quarter of 2022 (with the exception of Greece). Monthly production peaked in June 2022 at around 18 TWh. In Germany, the country with the largest contribution of lignite to electricity generation, lignite production increased by 24% year-on-year in the second quarter of 2022, due to the effects of high natural gas prices combined with planned reduced nuclear generation.

In Poland, corresponding lignite production increased by 5% year-on-year in the second quarter of 2022, supported by lower natural gas production, while in the Czech Republic, an increase of 30% year-on-year was observed, with the above three Member States accounting for 82% of total lignite-based production in the EU in the second quarter of 2022. In contrast, in Greece, lignite production fell by 16% year-on-year, due to reduced lignite capacity, increased oil production, but also improved solar and wind production, combined with the slight decrease in electricity demand. In Bulgaria, reduced production from natural gas and hydropower contributed to the production of additional volumes of lignite (+55%)

compared to the second quarter of 2021. Lignite plants reached an 8% share of the EU electricity generation mix in the second quarter of 2022 and were responsible for about 34% of the total carbon dioxide emissions of the electricity sector in the reporting quarter.

Figure 13: Monthly Production of Lignite Plants in the EU, 2019 – September 2022

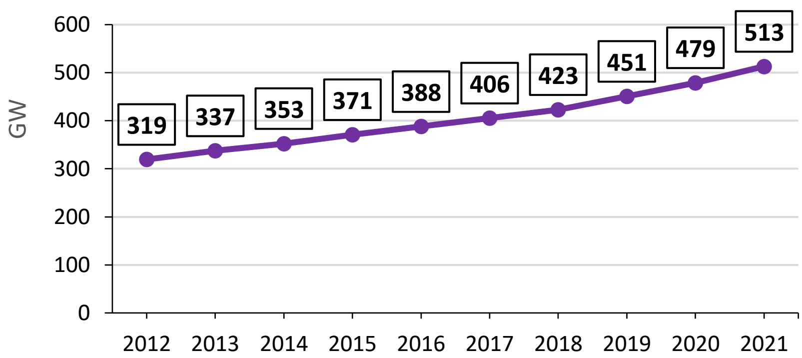


Source: European Commission

Despite the fact that the energy crisis has revived coal-fired generation, the increase in this fossil fuel for electricity production was only 1.5 units compared to the previous year, with a share of 15.99% of electricity in the EU and with trend down 6% in the last four months of 2022. Throughout the year, total EU coal-fired generation is up 7% in 2022 compared to 2021. There were large increases in coal-fired generation earlier in the year, namely 35% in March 2022 compared to March 2021, but this trend reversed in the last months of 2022 (Figure 13).

Regarding the installed capacity of RES in the European Union, it shows an increase from 2012 to 2021 with an average rate of change of 5.4% (Figure 14) [8].

Figure 14: Evolution of Installed RES Capacity in the EU, 2012-2021

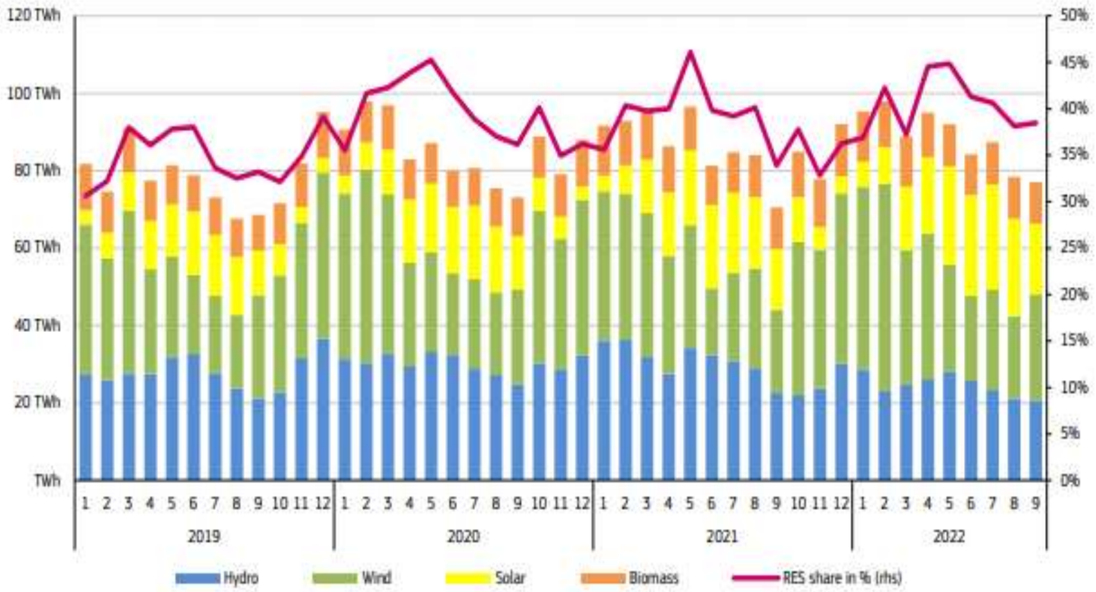


Source: IRENA

Figure 15 illustrates the evolution of the monthly RES production in the EU, alongside their share in electricity production. RES penetration reached 39% in Q3 2022, slightly higher than the 38% share in Q3 2021. A 3 TWh increase in RES generation contributed to the increase in RES penetration in Q3 of 2022.

The technologies that contributed to the increase in RES production in the third quarter of 2022 were solar (+16 TWh), onshore wind (+4 TWh), and biomass plants (+0.5 TWh) compared to the reference quarter in 2021 [14].

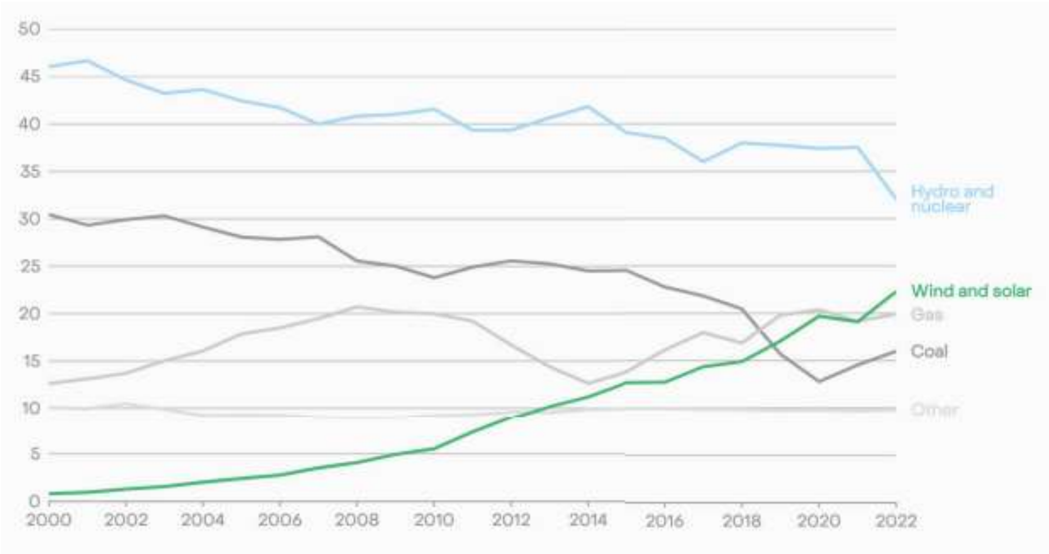
Figure 15: EU Monthly RES Generation and Share of Electricity Generation Mix, 2019 - Q3 2022



Source: European Commission

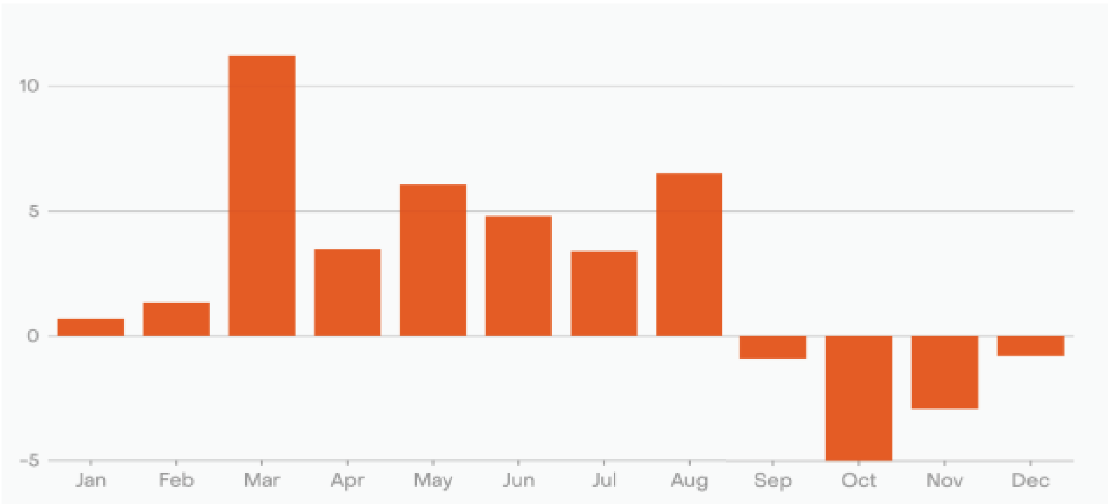
It is noteworthy to mention that 2022 was the year when wind and solar installations produced more electricity than natural gas plants for the first time. In particular, wind and solar contributed to a fifth (22.28%) of the EU electricity in 2022, overtaking natural gas (19.91%) for the first time in a sector dominated by nuclear and hydro (32.04%), according to data from think tank Ember Energy (Figure 16) [15].

Figure 16: EU Electricity Generation per Fuel (%), 2000-2022



Source: EMBER

Figure 17: Annual Changes in Electricity Generation From Coal in the EU, 2022 Compared to 2021 (TWh)



Source: EMBER

In fact, the 26 coal-fired power stations put on an idle status operated at an average of 18% of their capacity, and only a third of the extra 22 million tonnes of coal imported into the EU in 2021 was used. Despite this, carbon dioxide emissions from electricity production in the EU increased by 3.9% (26 million tonnes CO2), with the largest absolute increases recorded in Germany (13 MtCO2, +6.1%), Spain (7.6 MtCO2, +19%), Italy (6.9 MtCO2, +9.3%) and Bulgaria (4.7 MtCO2, +23%) but a decrease in Poland, the second largest source of emissions in the EU (-3.7 MtCO2, -2.9 %).

4. Energy Policy Targets

4.1. EU Targets

With its announcement on 11 December 2019, the European Commission presented the European Green Deal [16], which is a set of policy initiatives to put the EU on track towards a green transition, with the ultimate goal of achieving climate neutrality by 2050.

Undoubtedly, the goal set by the EU to make Europe the first carbon-neutral continent by 2050 is a challenge. A neutral energy footprint means that from 2050, no gaseous pollutants blamed for Climate Change should be emitted into the atmosphere by European countries, as it is estimated that in this way the increase in the temperature of the planet will be stabilized at 1.5°C.

The European Green Deal also supports the transformation of the EU into a fair and prosperous society with a modern and competitive economy. At the same time, it highlights the need for a holistic and cross-sectoral approach, in which all relevant policy areas contribute to the ultimate climate goal. The package includes interrelated initiatives covering climate, environment, energy, transport, industry, agriculture and sustainable finance.

Figure 18: The European Green Deal

Source: European Commission

The European Green Deal consists of the following eight key policy initiatives:

i. Raising the level of EU climate ambition for 2030 and 2050,

ii. Providing clean, affordable and secure energy,

iii. Mobilization of industry for a clean and circular economy,

iv. Building and renovating buildings in an energy and resource efficient manner,

v. Accelerating the transition to sustainable and smart mobility,

vi. Designing a fair, healthy and environmentally friendly food system,

vii. Conservation and restoration of ecosystems and biodiversity,

viii. Zero pollution ambition for an environment free of toxic substances.

The European Commission's work program for implementing the Green Deal is reflected in the Green Deal Roadmap [17], which includes an ambitious package of legal and other measures under each policy initiative, with a specific timetable for their adoption at EU level.

The "Fit for 55" package aims to adopt the ambitions of the European Green Deal. The name "Fit for 55"refers to the EU's target to reduce net greenhouse gas emissions by at least 55% by 2030. The proposed package aims to align EU legislation with the 2030 target.

The package is a set of proposals to revise climate, energy and transport legislation and take new legislative initiatives to align EU legislation with climate targets. It includes:

- review of the EU Emissions Trading System (ETS), including its extension to shipping, and a review of aviation emissions rules as well as the introduction of a separate ETS for road transport and buildings
- revision of the Effort Sharing Regulation regarding Member States' reduction targets in areas outside the EU ETS
- revision of the LULUCF Regulation on the inclusion of greenhouse gas emissions and removals from land use, land use change and forestry activities
- amendment of the regulation for setting $CO2$ emission standards for cars and semi-trucks
- revision of the RES Directive
- recasting the Energy Efficiency Directive
- reformulation of the Energy Taxation Directive
- carbon border adjustment mechanism (CBAM)
- revision of the Directive on the development of alternative fuel infrastructure
- the ReFuelEU Aviation initiative for sustainable aviation fuels

- the FuelEU Maritime initiative for a green European maritime space
- Social Fund for the Climate
- revision of the Directive on the Energy Performance of Buildings
- reduction of methane emissions in the energy sector
- revision of the Third Energy Package with regard to natural gas

The European Commission has already set specific energy and climate targets for 2030, which are summarized as follows:

- reduction of greenhouse gas emissions by at least 55%, compared to 1990 levels;
- a 37.5% reduction in greenhouse gas emissions for new passenger cars, 31% for semi-trucks and 30% for trucks, based on 2021 levels;
- increasing the share of RES by at least 32% in the final energy consumption, compared to the EU Reference Scenario 2007. However, on 30 March 2023 a political agreement was reached between the EU-27 countries to increase the target from 32% to 42.5%,
- improvement of energy efficiency by at least 32.5% on primary and final energy consumption, compared to the EU Reference Scenario 2007,
- promotion of electrical interconnections at a rate of 15% (i.e. 15% of the energy produced must be able to be transferred to other EU countries).

Figure 19: Climate and Energy Targets in the EU, 2020 and 2030

Source: European Commission

It is worth mentioning that the European Commission, within the framework of the "REPowerEU" project [18], which aims to completely eliminate Russian gas, oil and coal imports by 2027, building on the "Fit for 55" package, is now considering the following new targets for 2030:

- increasing the share of RES to 45% of the EU's final energy consumption, from 40% proposed in 2021, under the "Fit for 55" package of measures, i.e. compared to the EU Reference Scenario 2020.
- an increase in energy efficiency by at least 13% on final energy consumption, from 9% now, compared to the EU Reference Scenario 2020.
- more than doubling of the installed capacity of photovoltaics by 2025, compared to 2020, i.e. the total capacity to rise to 320 GW by the middle of the decade, and to 600 GW in 2030.
- production of 10 million tonnes of "green" hydrogen and 10 million tonnes of imports by 2030, to replace natural gas, coal and oil in industry and transport sectors.

4.2 National Targets

The adaptation of Greece's energy and climate policy to the revised targets of the European Commission for 2030 has been absolute, as they are included in the "Fit for 55" package, and achieved through the preparation of the revised National Energy and Climate Plan (NECP) and the adoption of the Climate Law. The last two, in conjunction with the Law on the Circular Economy [19], are expected to be the three main "tools" for the shift of the Greek economy towards carbon neutrality by 2050. Today, Greece's energy policy objectives, which are fully compatible with those of the EU, are summarized as follows in Table 4, according to the NECP of December 2019 [20] and its revised version presented in January 2023.

Table 4: Summary of National Targets in the Framework of the NECP (2019) and the Revised NECP (January 2023)

Target Year: 2030	Final NECP (2019)	Initial NECP (2019)	New targets in the revised NECP (January 2023)
Share of RES in Gross Final Energy Consumption	≥ 35%	31%	45%
Share of RES in Gross Final Electricity Consumption	≈61 – 64%	56%	80%
Final Energy Consumption	≈16,1 – 16,5 Mtoe (≥38%, compared to 2007 projections)	18,1 Mtoe	15,30 Mtoe
Share of Lignite in Power Generation	0%	16,5%	0%
Reduction of GHG Emissions	≥42%, compared to 1990 level, ≥55%, compared to 2005 level	32%, compared to 1990 level, 48%, compared to 2005 level	-55%

Sources: Ministry of the Environment and Energy, IENE

In this context, the main objectives of the current NECP are as follows:

- The adoption of an integrated model of sustainable growth in all economic sectors and the improvement of competitiveness,
- The achievement of combining the development of the energy sector with environmental protection with decisive measures to combat climate change,
- The option of energy policies with the best cost-benefit ratio for the energy transition,
- The management and utilization of waste with modern circular economy technologies,
- The emergence of Greece as an energy hub with a strong contribution to the energy security and security of supply within the EU,
- The strategy of diversifying energy imports, alongside the modernization and development of energy infrastructure and the lifting of the islands' energy isolation,
- The creation of an attractive investment environment to support the energy transition, with an emphasis on innovation and new technologies,
- The maximum utilization of European resources and mechanisms and
- The promotion of extroversion and innovation in order to achieve technological growth and create new high-quality jobs.

The main objective of the NECP is the design, planning and implementation of the most socially, environmentally and economically efficient policy measures, which will contribute to the achievement of the medium- and long-term national energy and climate goals, will contribute to the economic growth of the country, while at the same time they will respond to the challenge of reducing energy costs and in general protecting end consumers from high prices of energy products and services.

The national energy and climate targets for 2030 are formulated taking into account specific quantitative obligations undertaken by Greece as an EU member state (i.e. the targets for sectors outside the Emissions Trading System and reduction of national emissions of certain atmospheric pollutants, in compared to 2005), the characteristics and peculiarities of the national energy system, the domestic potential for the development of technologies and applications, the possibilities of adaptation, as well as the socio-economic characteristics of the country. Through this process, the adaptation of the national objectives based on the corresponding central European ones (i.e. the objectives for the sectors that are part of the

Emissions Trading System, for RES, for energy efficiency) and which are finally proposed in the context of the national plan.

Additionally, in the context of the NECP, the main quantitative policy targets set for the period up to 2030 are also "intermediate" targets for reducing greenhouse gas emissions by 2050, where Greece's goal is to participate in the commitment to a carbon-neutral economy at EU level.

According to the latest available information, since the revision of the 2030 targets, the new NECP will also foresee an intermediate target for 2040, as well as the changes in the energy mix and energy savings, which will have to be implemented in order to achieve carbon neutrality by 2050.

In January 2023, the Ministry of Environment and Energy, in the framework of the revision of the NECP, presented the proposal for its revision, which is subject to approval as the public consultation must be completed. The proposal for the new NECP is based on the development of preliminary scenarios of key energy quantities, with the main objectives summarized in Table 5.

Table 5: Targets of the New NECP

Έτος 2030	2021 (εκτίμηση)	ΕΣΕΚ 2019	Εξίσου σημαντική έμφαση στις ΑΠΕ και την ενεργειακή αποδοτικότητα	Μεγάλη έμφαση στις ΑΠΕ και λιγότερο στην ενεργειακή αποδοτικότητα	Μεγάλη έμφαση στην ενεργειακή αποδοτικότητα και λιγότερο στις ΑΠΕ
			ΕΣΕΚ Α/Β	ΕΣΕΚ Α	ΕΣΕΚ Β
Σύνολο αερίων του θερμοκηπίου συγκριτικά με το 1990	-26%	-40%	-55%	-55%	-55%
Δείκτης ΑΠΕ ως % ακαθάριστης τελικής κατανάλωσης ενέργειας	22%	35%	45%	46%	45%
Ενεργειακή αποδοτικότητα		0%	-6%	-3%	-7%
Τελική κατανάλωση ενέργειας (εκ. τιπ)	15.21	16.50	15.30	15.73	15.09
ΑΠΕ-Ηλεκτροπαραγωγή	36%	61%	80%	83%	79%
ΑΠΕ-Θέρμανση/Ψύξη	31%	43%	47%	43%	48%
ΑΠΕ-Μεταφορές	4%	19%	32%	36%	32%
RFNBO (% καύσιμα μεταφορών)	0%	0%	3.4%	3.7%	3.3%
Προηγμένα βιοκαύσιμα (% καύσιμα μεταφορών)	0%	1.5%	2.18%	2.78%	1.93%
Συμβατικά βιοκαύσιμα (% καύσιμα μεταφορών)	1.7%	1.7%	1.7%	1.7%	1.7%
ESR (% μεταβολή ΑτΘ στους τομείς εκτός ETS)	-32%	-40%	-47%	-46%	-48%

Source: Ministry of the Environment and Energy

Under the new NECP, the goal of a total reduction of gaseous pollutant emissions by 55% in 2030 is set, while great importance is given to the development of RES, hydrogen and energy storage systems. In particular, the goals set until 2030 are:

- Increasing the share of RES in final consumption to 45% from 35%.
- 6% improvement in energy efficiency.
- Increase the participation of RES in electricity generation to 80% from 61% in 2019.
- Increase the participation of RES in heating and cooling in 2030 to 47% when the target under NECP of December 2019 was 43%.

- RES participation in transport to 32% from 19%.
- The participation of synthetic fuels increases to 3.4% from 0% today. Advanced biofuels (agricultural residues and cooking oils) will rise in 2030 to 2.18% from 1.7%. In addition, conventional biofuels will reach 1.7%.
- 100% electrification of passenger vehicles in 2030.

According to the new NECP, as presented by the Ministry of Environment and Energy, 7 interventions - technologies form its core:

- Rapid development of RES: PV and wind deployment (and the acceleration of offshore wind development) adding > 12GW by 2030 and exploiting the country's remaining hydro potential.
- Energy storage: The high RES penetration should be accompanied by the development of the required storage to balance and stabilize the system (batteries, pumped storage, etc.)
- Energy efficiency: Energy upgrading of buildings (insulations, devices, heat pumps), smart management of energy consumption and changing behaviors to reduce the required energy or the demand profile. These actions can have significant added value.
- Electrification of light transport: Electrification of light/medium vehicles with simultaneous development of charging infrastructure and interaction with the network. A large part of the required investments will be in vehicles and their batteries. A whole battery recycling economy should be created with a possible regional role in the Balkans.
- Creating a green hydrogen economy: Using it in transport (heavy vehicles, shipping, aviation), in industry and under conditions in power generation. There is already significant mobility in the area which, combined with competitive RES, can add value to the country.
- Development of synthetic, green fuels (RFNBO): With transport use (heavy vehicles, shipping, aviation) – a whole new industry that should immediately start to take shape.
- Innovation and systemic solutions in carbon capture and storage (CCUS) for the energy transition of the country's industry (mainly cement, refining, fertilizers). A national plan and coordination will be required given the lack of scale of local companies. Similar projects are coordinated by the states in Europe and America.

The preparation of the new NECP will be based on the Long-term Strategy for 2050 [21], which was submitted at the beginning of 2020 by the Greek government to the European

Commission. The Long-term Strategy sets 2030 as a reference point and assumes the achievement of the NECP's goals, presenting the available technological solutions to meet the carbon neutral economy by the middle of the current century.

At the same time, the first National Climate Law [22], which was passed at the end of May 2022 by the Greek parliament, defines the institutional framework and sets specific targets for the gradual reduction of greenhouse gas emissions, in order to achieve the national climate targets for 2030 and the transition to a carbon neutrality regime by 2050.

In order to achieve the long-term goal of carbon neutrality, the reduction of net anthropogenic greenhouse gas emissions by at least 55% and 80%, respectively, compared to 1990 levels, are defined as intermediate climate goals for the years 2030 and 2040, taking into account the projections of the NECP.

The main provisions of the National Climate Law are summarized as follows:

Delignitization

- It is envisaged that all lignite units will be shut down by 31 December 2028 at the latest with a review clause in 2023, subject to ensuring capacity adequacy and security of supply.

Electromobility

- From 2024, 1/4 of new company cars for private use registered should be pure electric or plug-in hybrid electric vehicles with emissions of up to 50g. CO_2/km
- From 2026, all new taxis in Athens and Thessaloniki must be electric.
- From 2026, 1/3 of new rental vehicles in Athens and Thessaloniki should be electric.
- Until December 31, 2023, there will be a re-examination of the measures in order to expand them to other areas, depending on the sufficient availability of charging stations.
- The process of installing chargers is simplified.
- From 2030, the registration of new vehicles with internal combustion engines is prohibited under European legislation. Greece will adopt the date set by the relevant European Regulation. The recommendation of the European Commission is for the measure to take effect in 2035.

Reduction of greenhouse gas emissions in buildings

- From 2025, the sale and installation of heating oil burners is prohibited.
- From 2030, the use of heating oil becomes mandatory, which will be mixed with biofuels at a rate of 30%.

- Special buildings (industries, warehouses, commercial buildings, etc.):
    - In buildings with a coverage of more than 500 m2, for which building permits for the construction of new buildings or additions to existing buildings are submitted from January 1, 2023, excluding tourist accommodations and temples, the installation of electricity production systems becomes mandatory from photovoltaic or thermal solar systems in a percentage corresponding to at least 30% of the coverage.
    - The possibility of exceptions is provided for individual buildings for morphological or aesthetic reasons or in areas with statutory protection status (traditional settlements and preserved buildings).

Businesses

- From January 1, 2024, Environmental Impact Studies for all projects and activities must include a mandatory quantitative recording of reductions/increases in CO_2 emissions that will result from the operation of the project/activity and a roadmap for achieving of decarbonisation targets.
- Facilities classified as:
    - in the environmental infrastructure systems (landfill, biological treatment, Recycling Sorting Center, etc.),
    - in tourist facilities and urban development projects in the sports and leisure building sector,
    - in poultry and aquaculture facilities,
    - in industrial activities and related facilities.

They must have reduced CO_2 emissions by at least 30% by 2030, compared to 2019. Excluded are business facilities that are part of the Greenhouse Gas Emissions Trading System (GHG). If the target is not achieved, a fine is imposed that does not exceed 0.5% of the company's annual revenue.

- It is possible to cumulatively assess similar facilities, offset emissions with plantings/forests, green certificates, etc.
- By 2026, they should have amended their Environmental Approval Decision and from 2026 and every year submit a report on the previous year's emissions, which will be verified by a certified body.
- In case of non-submission, a fine of €100 per day of delay is provided, which does not exceed 0.1% of the company's annual revenue.

- From 2023, businesses belonging to certain categories will have to submit an annual report on their carbon footprint for the previous year, which will be verified by a certified body. The submission of the report should be completed by 31/10 of each year.

Islands

- A Strategic Framework is established for the Gr-Eco Islands initiative of the Ministry of Environment and Energy for the integrated transition of the Greek islands towards carbon neutrality.
- The eligibility of the islands is determined taking into account certain criteria:
    - The permanent population
    - The prospect of electricity interconnection with the continental system
    - Their energy needs
    - Tourist traffic
    - Their accessibility in the field of transport and infrastructure
    - Usable natural resources
    - Their economic and social characteristics
- From 2030, the use of fuel oil for the production of electricity on the non-interconnected islands is prohibited.

Municipalities

- Until March 31, 2023, each Municipality calculates the carbon footprint, which is verified by a certified body and draws up a Municipal Emission Reduction Plan (MERP). The purpose is to reduce greenhouse gas emissions from its buildings, the municipal lighting, its vehicles, the utility facilities, the municipal water supply, drainage facilities, etc. MERP is updated annually.
- A 10% emission reduction target is set for 2025 and 30% for the year 2030, compared to 2019.
- The preparation of the MERP and its updates, from January 1, 2024, are a prerequisite for the evaluation of Municipalities' proposals for the implementation of programmes through financial tools in the field of energy saving and climate change.

Adaptation measures to the climate crisis

- From 2025, for new buildings located in high vulnerability zones, there should be mandatory risk insurance (a condition for the electrification of the building), following plans prepared by the Regions. As zones of high vulnerability are considered the areas located:

  - In zones of high flood probability, as shown on the flood risk maps.
  - In zones that are close to forest areas, characterized by a high risk of fire.

4.3 Energy Security

From 2021, Europe faces a sharp increase in energy prices, a phenomenon observed worldwide. EU Member States reacted immediately and agreed that concerted action and urgent measures are needed to mitigate the impact of rising energy prices on the most vulnerable households and businesses.

The Russian invasion of Ukraine in February 2022 further affected energy markets, prompting new energy price increases and concerns about the EU's ability to secure its energy supplies.

In March 2022, EU leaders agreed to phase out the EU's dependence on Russian fossil fuels. The European Council of March 24 and 25 discussed the impact of rising energy prices on citizens and businesses, as well as concrete measures to secure security of supply in the EU.

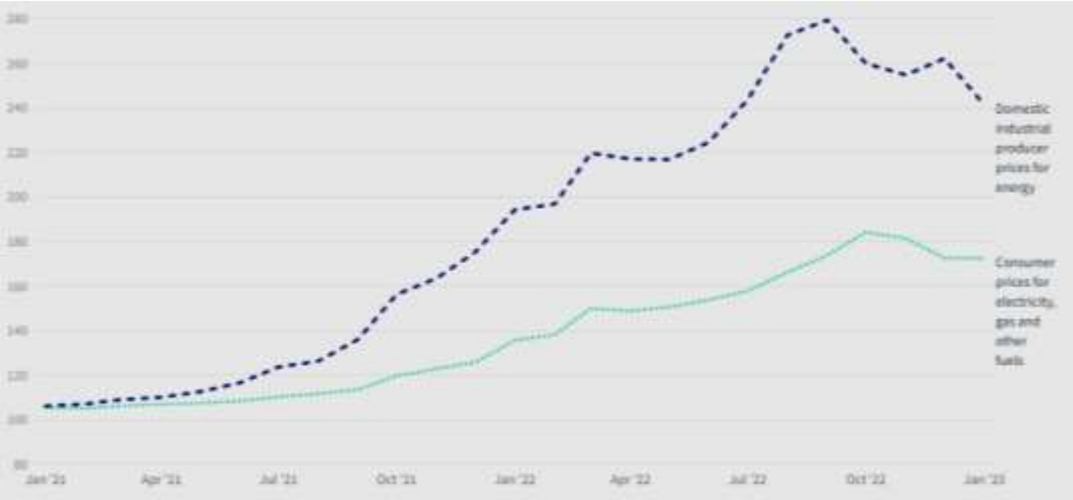
Factors that Led to the Rise of Energy Prices

The second half of 2021 saw a rapid increase in energy prices in the EU and worldwide. Although this development was to some extent expected in the context of the economic recovery after the Covid-19 pandemic and the easing of travel restrictions, energy prices rose more than expected. It was an unprecedented increase in natural gas prices on global markets (over 170% in 2021). The main factors that contributed to the rise in prices are the following:

- the unprecedented increase in natural gas prices on global markets (over 170% in 2021),
- the long and cold winter in early 2021, which led to increased use of heating systems, and then the long and hot summer and more intensive use of cooling systems, which intensified energy demand,
- the increased demand for LNG, with the consequent surge in its price,
- the largest consumption of natural gas in Asia due to the economic recovery,
- the increase in geopolitical tensions, including the war in Ukraine

In 2021, the increase in energy prices was unprecedented. Energy import prices, while quite volatile, have never previously changed by more than 30% annually, while energy imports cost more than double the previous year between December 2020 and December 2021, according to Eurostat’s data.

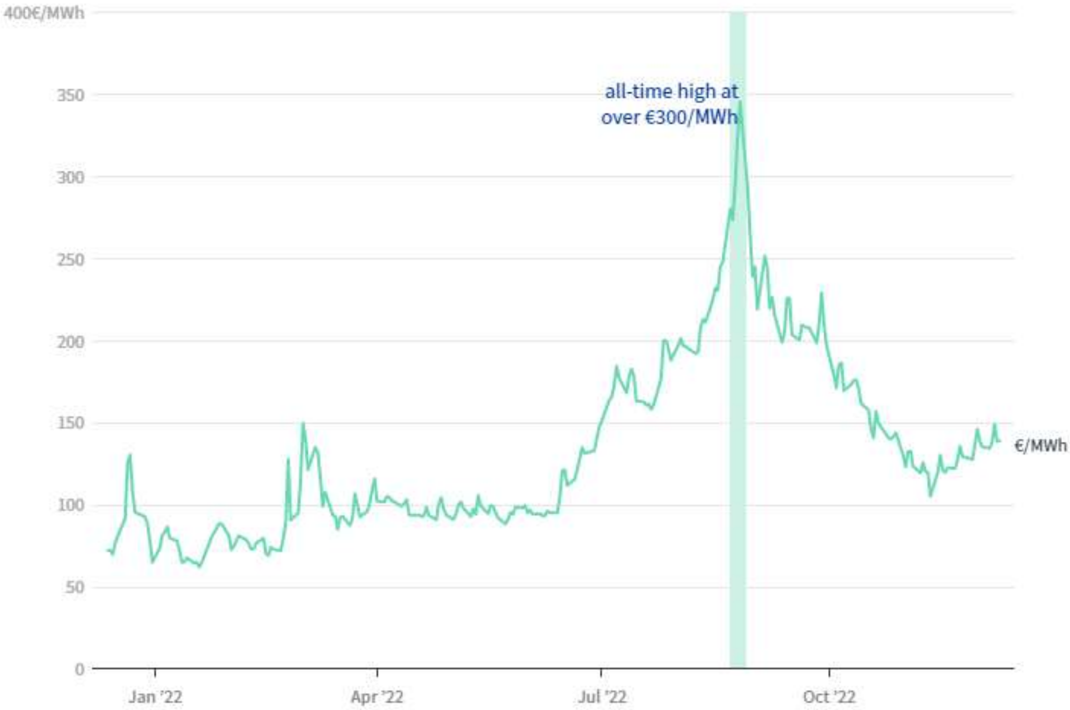
Figure 20: Increase in Energy Prices



Source: European Commission

Russia’s invasion of Ukraine (February 2022) further disrupted energy markets by increasing pressure on prices, particularly of natural gas and oil, raising concerns about the security of energy supplies in the EU. As a result of the hostilities and hardline of Russia in Europe’s natural gas supply, an unprecedented situation was created due to the reduction in the flow of Russian gas to the European market, leading prices to soar (August 2022 – €340/MWh).

Figure 21: Evolution of Natural Gas Prices in the EU in 2022

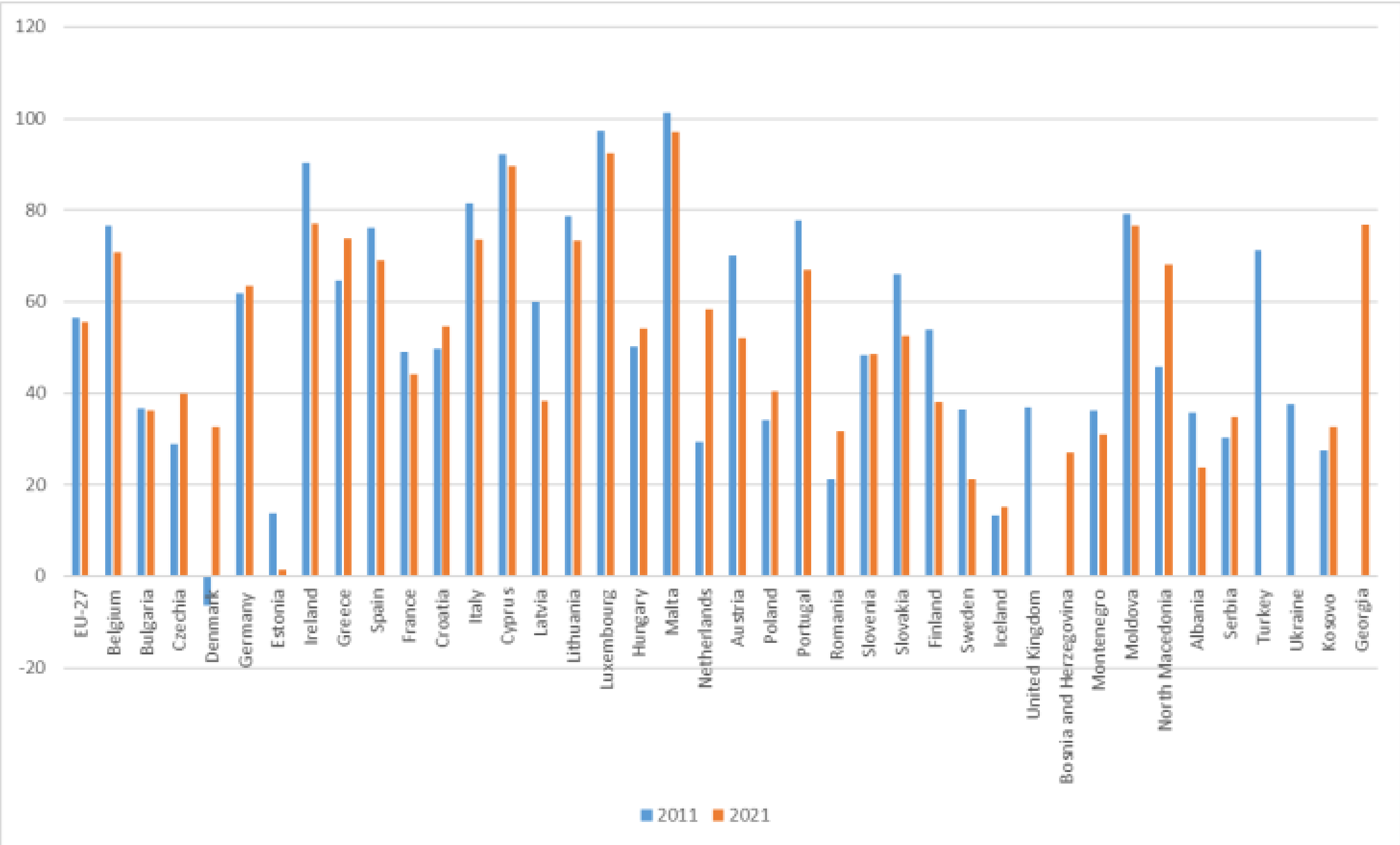


Source: European Commission

Russia is currently the main supplier of crude oil, natural gas and solid fossil fuels to the EU. In 2020, Russian energy imports reached 24.4% of the EU's energy needs. Natural gas was the fuel with the highest exposure to imports from Russia. In 2020, the EU received 46% of its natural gas imports from Russia, meeting 41% of gross available energy from natural gas.

Crude oil, a key commodity for the production of transport fuels and the petrochemical industry, was the fuel with the second largest import exposure from Russia. In 2020, the EU relied on Russia for 26% of its crude oil imports, which met 37% of the EU's energy needs. Finally, solid fossil fuels (such as coal) had the lowest import dependence of Russia, which provided 19% of the EU's solid fossil fuel use. In 2020, the EU imported 53% of hard coal from Russia, accounting for 30% of EU consumption.

Figure 22: Energy Dependence in Europe, 2011 and 2021



Source: Eurostat

EU Response and Measures

High energy prices have been a concern of the European Commission for some time before Russia's invasion of Ukraine. Already, in **September 2021**, the Ministers of Energy and Transport discussed this issue in an informal meeting of the Council. Ministers agreed that rising energy prices should be tackled urgently and in a coordinated manner in order to reduce the financial burden on households and businesses struggling to recover from the Covid-19 pandemic.

On **13 October 2021**, the European Commission issued a communication regarding a toolbox of possible measures, with which the EU and Member States will be able to deal with the immediate effects of price increases. The toolkit included:

- emergency income support for households
- state aid for businesses
- targeted tax reductions

In the European Council that took place on **October 21-22, 2021**[2], EU leaders called on the European Commission to analyze the functioning of the energy and carbon markets and asked to study as soon as possible medium- and long-term measures, which:

- contribute to energy at a price that is affordable for households and companies
- increase the resilience of the EU's energy system and the internal energy market
- provide security of supply and support the transition to climate neutrality, taking into account the diversity and specificity of the situations of the member states.

In **November 2021**, the EU Agency for the Cooperation of Energy Regulators (ACER)[3] and the European Securities and Markets Authority (ESMA)[4] published their Preliminary Assessments of Europe's high energy prices and the current wholesale electricity market design.

Also, the energy ministers met on **December 2, 2021**[5], stating that they still support the existing model of the wholesale electricity market, but have indicated that they are willing to consider other options which, without disrupting existing market fundamentals, could ensure adequate investment and better protect European consumers from price volatility.

On **December 15, 2021**[6], the Commission submitted new proposals for:

- decarbonisation of natural gas markets
- promotion of hydrogen
- reduction of methane emissions

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[2] https://www.consilium.europa.eu/en/meetings/european-council/2021/10/21-22/
[3] https://www.acer.europa.eu/events-and-engagement/news/acer-submits-european-commission-its-preliminary-assessment-europes-high
[4] https://www.esma.europa.eu/press-news/esma-news/esma-publishes-its-preliminary-report-eu-carbon-market
[5] https://www.consilium.europa.eu/en/meetings/tte/2021/12/02/
[6] https://ec.europa.eu/commission/presscorner/detail/en/ip_21_6682

These proposals include initiatives to improve the resilience of the natural gas system and strengthen existing security of supply provisions, as requested by Member States and as announced in the already published energy price communication and toolkit.

The European Council, meeting on **24 February 2022**[7], called for work to be taken forward at all levels, and invited the Commission, in particular, to put forward contingency measures, including on energy. Consequently, the Council presidency considered it essential to swiftly take forward discussions on preparedness and contingency measures at all levels in the energy sector in Europe, as well as on all the options for responding to Ukraine's requests for support, such as the synchronisation of Ukraine's electricity network with the Union network.

REPowerEU

On **8 March 2022**, the Commission proposed the "REPowerEU" plan[8], in order to tackle rising energy prices and enable the EU to abolish Russian fossil fuels. On 10-11 March 2022, EU leaders agreed to phase out the EU's dependence on Russian fossil fuels and called on the Commission to present a plan to ensure security of energy supply and affordability until the end of March 2022. On **March 23, 2022**[9], the European Commission presented:

- a legislative proposal on minimum gas storage obligations
- short-term options for temporary market intervention to limit price increases
- its readiness to create a special group for joint gas purchases

The European Council, which took place on **March 24 and 25, 2022[10],** adopted conclusions on the Russian military aggression against Ukraine, security and defence, energy, economic issues, Covid-19 and external relations. Leaders urged the Council and the Commission to discuss whether and how the specific short-term options presented by the European Commission would help reduce the price of natural gas and address the knock-on effects on electricity markets.

At the same time, leaders asked the Commission to come up with proposals to tackle excessive electricity prices, while protecting the single market and incentives for the green transition. They called the Commission and Member States to make the best use of the energy price toolbox and the recently adopted temporary framework for state aid to provide relief to citizens and businesses.

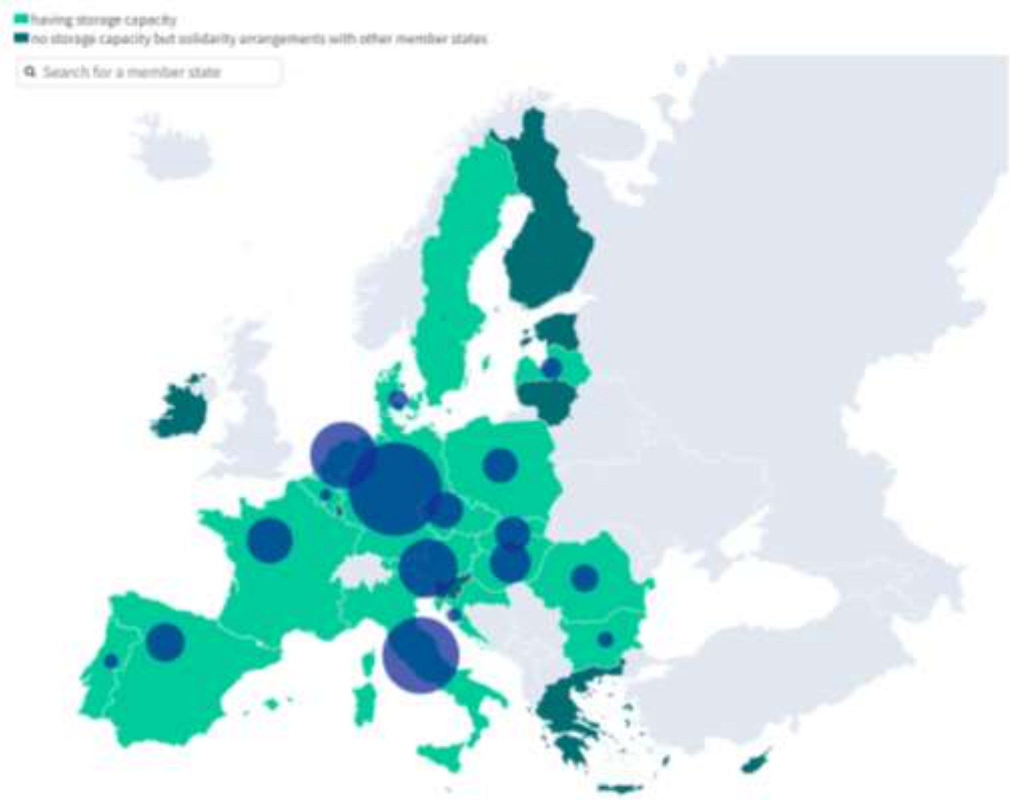
[7] https://www.consilium.europa.eu/en/meetings/tte/2022/02/28/
[8] https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1511
[9] https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1936
[10] https://www.consilium.europa.eu/en/meetings/european-council/2022/03/24-25/

On **May 2, 2022**[11], EU energy ministers presented their analyses of their situation with regard to the latest developments. They discussed the EU's level of preparedness in the event of a supply crisis and the solidarity measures and instruments at EU level that they would like to promote in this context.

On **May 11, 2022**[12], EU member states reached a mandate for negotiations with the European Parliament on the European Commission's proposal for natural gas storage. With the ultimate aim of enhancing the security of the EU's energy supply, the proposal seeks to ensure that the EU's gas storage capacity is covered before the onset of winter and that Member States share gas in a spirit of solidarity.

Most EU member states have natural gas storage facilities on their territory. The storage capacity of five countries (Germany, Italy, France, the Netherlands and Austria) represents two-thirds of the EU's total capacity. Under the new proposal, countries without storage facilities will cooperate with member states they have in order to secure their reserves. Cyprus, Estonia, Finland, Greece, Ireland, Lithuania, Luxembourg, Malta and Slovenia have no natural gas storage facilities.

Map 1: Natural Gas Storage Capacity of EU Member States



Source: European Commission

[11] https://www.consilium.europa.eu/en/meetings/tte/2022/05/02/
[12] https://www.consilium.europa.eu/en/press/press-releases/2022/05/11/member-states-agree-on-negotiating-mandate-for-gas-storage-proposal/

As part of the "REPowerEU" plan, the European Commission announced on **May 18, 2022**[13] a series of short-term measures as well as long-term improvements in European energy policy. More specifically, the Commission called on member states to continue using the tool of measures it has already presented, which contains measures to reduce energy bills. Moreover, the following short-term measures are added ahead of the next winter season:

In natural gas markets:

- Member States are given the possibility to temporarily extend final price arrangements to a range of consumers, such as households and industry.
- Provision is made for emergency liquidity measures to support the efficient functioning of commodity markets, taking into account state aid regulations.
- Using the EU Energy Platform for aggregate gas demand, securing competitive gas prices through common markets and reducing dependence on Russian gas.

Options for intervention in electricity markets for Member States:

- The possibility of redistributing excess profits to support consumers extends into the next winter season.
- Congestion revenues can be used to finance consumers.
- A temporary exemption is given for regulated retail prices to cover small and medium enterprises.
- For areas with limited interconnection, subsidies are allowed for the fuel cost for power generation in order to reduce the electricity price, as long as the subsidies are designed in a way compatible with European legislation. Especially in relation to the absence of restrictions on cross-border exports, sectoral legislation and state aid.

Measures in the case of a complete disruption of Russian natural gas supplies:

In the case of a complete disruption of Russian supplies, other emergency measures may be needed to manage the situation. The Commission called Member States to review the emergency plans they have prepared and take into account the recommendations made by the Commission. The Commission will facilitate the preparation of a plan for a coordinated reduction of European demand with preventive cutback measures so that it is ready if the need arises. In the spirit of solidarity, the less affected member states will reduce the demand for natural gas to the benefit of the more affected states.

In addition, an administrative price cap on natural gas at the European level may be needed in response to a total disruption. If implemented, this cap would be limited in duration and

[13] https://ec.europa.eu/commission/presscorner/detail/en/ip_22_3131

would not undermine the EU's ability to attract alternative sources of natural gas from pipelines or LNG or reduce demand.

On **May 19, 2022**[14], the Council and the European Parliament reached a political agreement on a Commission proposal on natural gas storage. With the ultimate aim of improving the security of the EU's energy supply, the proposal seeks to ensure that gas storage capacity in the EU is covered before the onset of winter and that Member States share gas in a spirit of solidarity. The interim agreement will have to be formally approved by both institutions.

During the meeting of the European Council on **May 30-31, 2022**[15], EU leaders agreed to a ban of almost 90% on all oil imports from Russia by the end of this year, with the temporary exception of crude oil delivered by pipeline. EU leaders also reviewed progress on phasing out imports of natural gas, oil and coal from Russia, which should be achieved as soon as possible, as agreed in the Versailles declaration, and called for further efforts to strengthen the EU's energy independence.

On **June 3, 2022**[16], the Council approved the sixth package of sanctions against Russia, which includes the ban on oil imports agreed by EU leaders at the European Council meeting in May 2022.

On **June 23 and 24, 2022**[17], EU leaders returned to the issue of rising energy prices during their meeting. Referring to the Versailles declaration and the recent European Council conclusions, EU leaders reiterated the call for the Commission to explore together with international partners ways to curb rising energy prices, including the feasibility of introducing temporary price caps.

Given that Russia is using natural gas as a "weapon", the European Council called the Commission to continue to make urgent efforts to ensure affordable energy supplies. The European Council also called the Council, together with the Commission, to take appropriate measures to ensure closer energy coordination between EU Member States.

On **June 27, 2022**[18], the Council finally adopted the Gas Storage Regulation, which aims to strengthen the security of the EU's energy supply in the context of the war in Ukraine.

On **July 26, 2022**[19], EU energy ministers reached a political agreement to voluntarily reduce natural gas demand by 15% this winter. Ministers exchanged views on the energy situation

[14] https://www.consilium.europa.eu/en/press/press-releases/2022/05/19/gas-storage-council-and-parliament-reach-a-provisional-agreement/
[15] https://www.consilium.europa.eu/en/meetings/european-council/2022/05/30-31/
[16] https://www.consilium.europa.eu/en/press/press-releases/2022/06/03/russia-s-aggression-against-ukraine-eu-adopts-sixth-package-of-sanctions/
[17] https://www.consilium.europa.eu/en/meetings/european-council/2022/06/23-24/
[18] https://www.consilium.europa.eu/en/press/press-releases/2022/06/27/council-adopts-regulation-gas-storage/

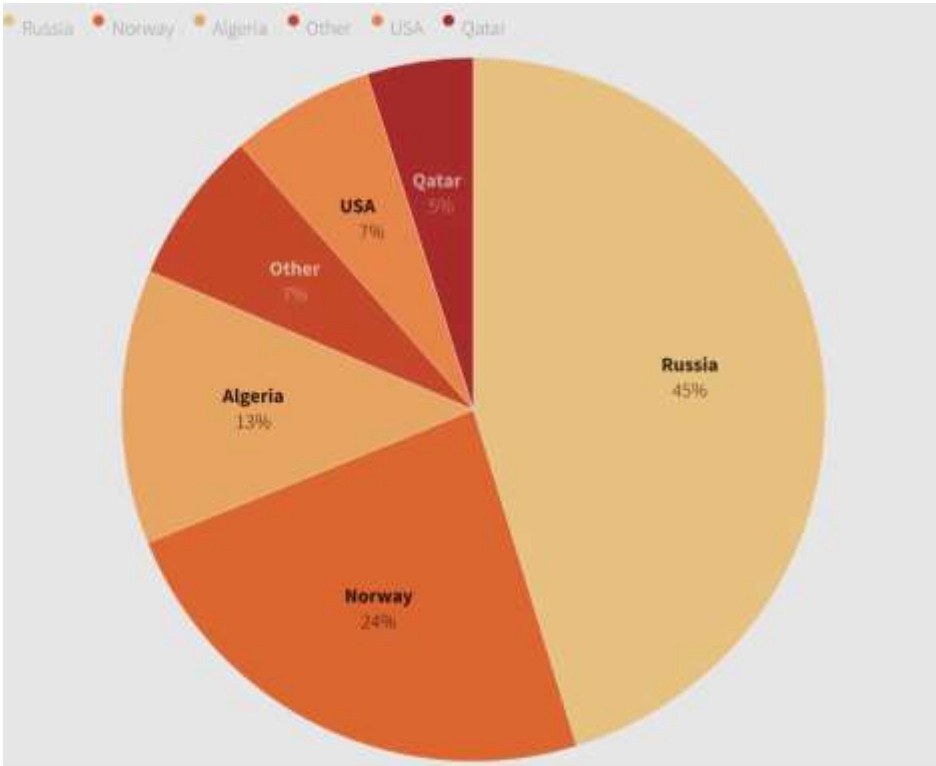
in Europe amid Russia's war against Ukraine. They also exchanged views on relevant national emergency measures and plans, as well as on further short-term actions to strengthen the EU's security of energy supply.

The Case of Europe

As mentioned earlier, the European Commission presented last March the ambitious "REPowerEU" plan to abolish Russian fossil fuels. The EU-27 member states aim to reduce Russian gas imports from 155 billion cubic meters per year (current) to around 55 billion cubic meters in 2023. EU-27 dependence on Russian gas is around 45%, with Norway supplies the EU with 24% and Algeria (with 13%) is the 3rd largest supplier, while the US and Qatar jointly share another 12% (see Figure 23).

The aforementioned plan, beyond the obvious strengthening of RES potential with a time horizon of 2030, has set overambitious goals for the immediate replacement of Russian natural gas. Among others, it envisages replacing 100 bcma of imported Russian natural gas with a combination of LNG, hydrogen and biomethane by the end of 2022. Essentially, it is about replacing one form of dependence with another, since additional imports of 60 billion cubic meters of LNG are foreseen, which will be added to the 100 billion cubic meters already imported by Europe and which correspond to 25% of the total consumption.

Figure 23: Share of EU Natural Gas Imports, 2021

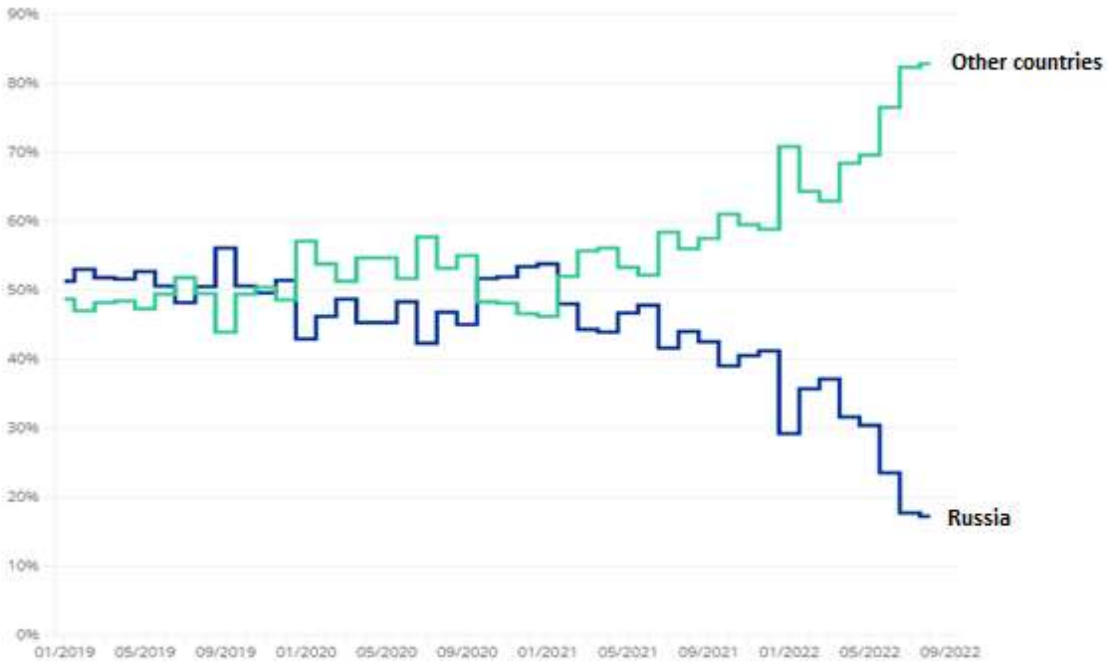


Source: European Commission

[19] https://www.consilium.europa.eu/en/meetings/tte/2022/07/26/

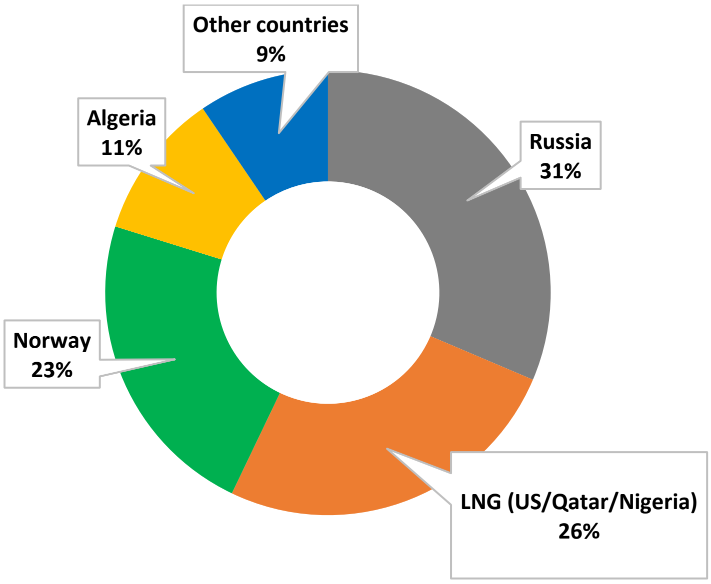
In 2021, the EU imported 83% of its natural gas. Since Russia's invasion of Ukraine, Russian gas imports to the EU have declined significantly. This loss was mainly offset by a strong increase in LNG imports, especially from the US [23].

Figure 24: EU Abolition of Russian Natural Gas



Source: European Commission

Figure 25: Share of EU Natural Gas Imports, H1 2022



Source: European Commission

Between January and August 2022, US LNG imports totaled about 40 bcm, nearly double the 2021 total (over 22 bcm) [23].

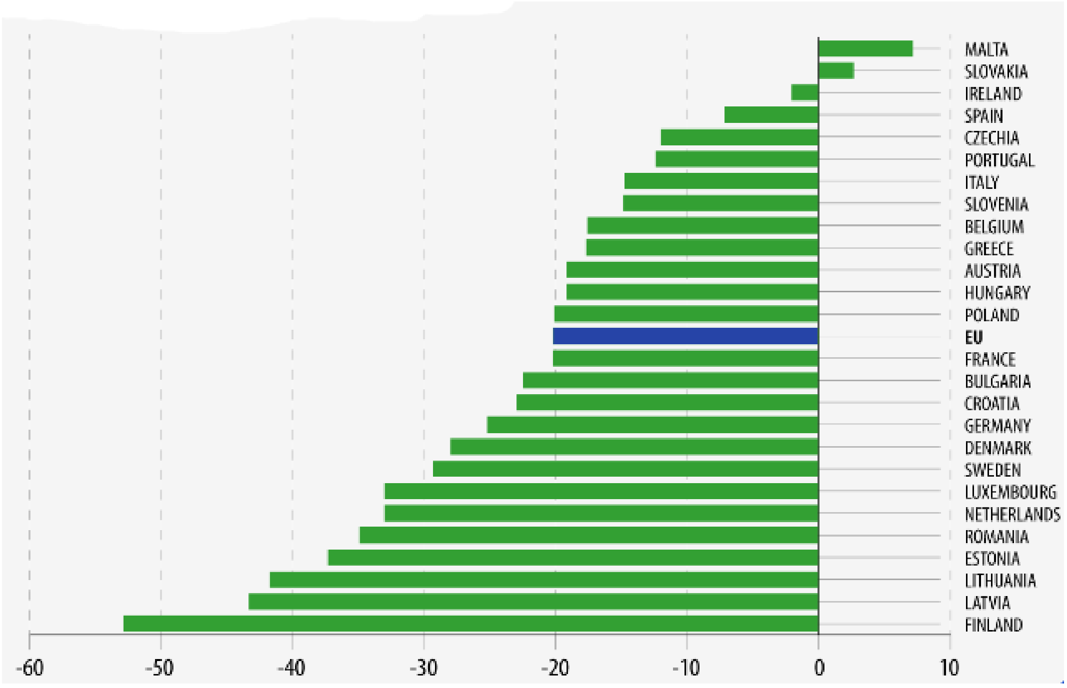
Figure 26: Monthly Volumes of LNG Imports from the US to the EU

Source: European Commission

Natural gas consumption in the EU decreased by 20.1% in the period August-November 2022, compared to the average consumption of natural gas for the same months (August-November) between 2017 and 2021. Regulation (EU) 2022/1369 of Council's coordinated gas demand reduction measures, part of the "REPowerEU" plan to end the EU's dependence on Russian fossil fuels, set a 15% reduction target for the period August 2022-March 2023 compared to the average for the same period of the previous five consecutive years.

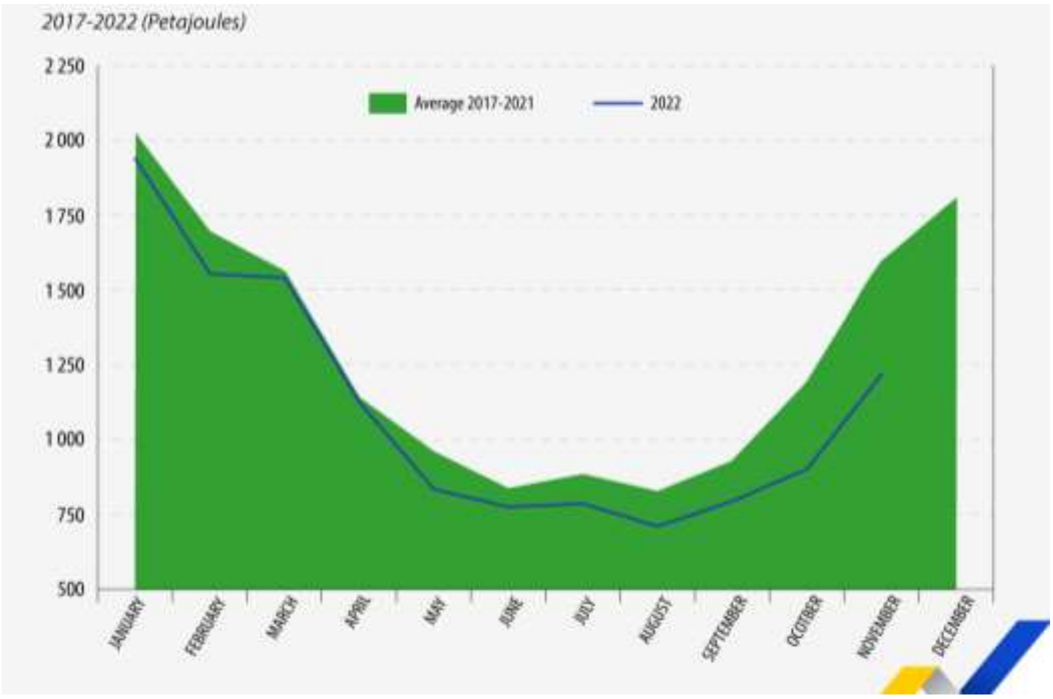
During August-November 2022, natural gas consumption decreased in most Member States (Figure 27). In 18 Member States, consumption fell beyond the 15% target, in some of them the reduction was very large (over 40%). Consumption decreased the most in Finland (-52.7%), Latvia (-43.2%) and Lithuania (-41.6%). Six Member States, while reducing their natural gas consumption, have yet to meet the 15% target. In contrast, natural gas consumption increased in Malta (+7.1%) and Slovakia (+2.6%) [24].

Figure 27: Reduction in Natural Gas Consumption in the EU by Country (August-November 2022 vs 2017-2021)



Source: Eurostat

Figure 28: Gas Consumption in the EU



Source: Eurostat

As part of increasing LNG imports, US President Joe Biden, during his visit to Brussels in March 2022, promised 15 billion cubic meters of US LNG. As market players argue, there is currently no additional LNG of this magnitude available in the global market to supply Europe, but neither exists the necessary infrastructure in LNG terminals, storage facilities and pipelines. Based on IENE calculations, it is estimated that around €60 billion of investments will be required over a 3-5 year time horizon in order to create the necessary infrastructure that will allow Europe to import natural gas from alternative suppliers, through pipelines and LNG to drastically reduce its dependence on Russian natural gas.

With the help of Washington, Europe imported a decent amount of LNG in the first months of 2022, but it will be quite costly to obtain such a large part of the limited global spot market indefinitely. In this LNG market, the European Union may face China, which also imports a large part of its LNG needs, and there is a danger that the two giants will enter a bidding "war". However, Europe can reduce the cost of imported LNG by signing long-term contracts.

An illustrative example of the current situation is that Germany, the largest natural gas importer and economy in Europe, does not have any LNG terminals, as it previously relied on Russian pipelines. It is now planning four LNG terminals, having to pay €3 billion over the next decade, according to the country's Ministry of Finance[20].

However, a possible immediate disruption of Europe from Russian energy supplies, in order to deprive Moscow of important foreign exchange earnings that help it finance its state budget and indirectly its military operations in Ukraine, would have disastrous economic consequences for Europe, which suddenly could be energy isolated, as it is known that it imports about 40% of its natural gas and 25% of its oil from Russia. While abolishing Russian oil is possible over time (6-9 months), due to the existence of several alternative suppliers, in the case of natural gas this is extremely difficult.

Having ruled out a voluntary abstention from Russian gas imports, the fear that now grips most European governments, including the Greek one, is that the flow from Moscow will be cut off by President Putin's decision to pay for imports in rubles. In fact, on April 27, 2022, Moscow cut off gas supplies to Bulgaria and Poland.

However, Russia will be the last to accelerate the disruption of natural gas flows to Europe, as it will face a serious problem of gas supply it exports to European countries and corresponds to almost 28% of its total production, which in 2020 reached 639 billion cubic meters and 75% of total natural gas exports[21]. With many thousands of kilometers of pipelines and an extensive network of compressors, metering stations and underground tanks, infrastructure that has been systematically developed over the last 50 years, it will be extremely difficult for Russia itself to reorient its exports to the East (China) and the South

[20] https://www.dw.com/en/germany-earmarks-3-billion-for-floating-lng-terminals/a-61480593
[21] https://www.kathimerini.gr/economy/international/561824971/dyskoli-i-apexartisi-tis-eyropis-apo-ti-rosiki-energeia/

(India, Pakistan), where it does not have a corresponding natural gas transmission network, while the termination of production in the large natural gas fields on the Yamal Peninsula is an extremely complex process with high costs.

It is now becoming apparent how energy vulnerable Europe is against Russia. A Europe which overlooked its necessity in the operation of the energy system in the transition period and downplayed the issue of energy security. Now, in the midst of an energy crisis and very high prices undermining any economic policy, Europe is beginning to realize the utility of coal, natural gas and oil (which together provide valuable electricity baseloads), postponing the much-desired abolishment of these fuels.

It makes an impression, however, that even at this last moment when Europe's energy security is at stake, the Commission's plan does not say a word about the obvious need to boost domestic oil and gas production. With European decision makers still believing that fossil fuels have no place in the future energy mix and achieving zero emissions by 2050, or even earlier, this is a non-negotiable condition at a time when Europe is responsible for only 7% of global greenhouse gas emissions.

The Case of Greece

In July 2022, RAE prepared a comprehensive plan to strengthen energy security in the case of a disruption of Greece's natural gas supply from Russia, which is summarized as follows [25]:

1. Increase the storage capacity of Revithoussa, the country's sole LNG terminal, to 375,000 cubic meters (from 225,000 today) through the addition of a fourth floating storage unit (FSU).
2. Use of diesel instead of natural gas in the five natural gas units that can operate with alternative fuel.
3. Increase the lignite mining by 50% over the next two years. In this context, the fuel is concentrated in the yards of the lignite units which are the main line of "defense" of the power grid in times of increased electricity demand and to deal with the load peaks, as seen in the summer of 2022. Various sources also note that at the beginning of 2023 the new high efficiency lignite unit of PPC "Ptolemaida V" is expected to be put into operation, while the increase in the operating hours of the lignite units of Agios Dimitrios is reportedly under discussion.
4. Monitor the availability of LNG cargoes in the international markets in order for DEPA Commercial to procure additional cargoes, if necessary.
5. Investigate the possibilities of strategic natural gas reserves in underground storages in Italy.

Also, the operation of the Southern Gas Corridor, which would essentially connect European markets with the Caspian Sea and the Middle East for the first time, marks the EU's first attempt to diversify the sources and routes of natural gas supply from Russia, with Greece to actively participate in it. The second phase of the Southern Gas Corridor, which concerns the operation of several gas pipelines in SE Europe, is being promoted significantly, while the EU is also looking for additional sources of supply, mainly LNG.

According to a Special Report recently prepared by Ms. Marika Karagiannis [26], the first source of supply of the Southern Gas Corridor, especially in its second phase, is Azerbaijan and, in particular, the Shah Deniz field. The total length of the Corridor is 3,500 kilometers and is divided into three parts: the South Caucasus Pipeline (SCP), from Baku to Erzurum, Turkey, the Trans-Anatolian Pipeline (TANAP), which will cross Turkey and reach the Greek borders at the Evros Gardens, and the Trans-Adriatic Pipeline (TAP), through Greece, Albania and the Adriatic Sea, to Italy.

The contracts, signed between the Azeri state company Socar and the natural gas companies of Greece (DEPA), Albania (Albgaz) and Italy (Snam Rete), provide an initial volume of 10 billion cubic meters per year, with provision for doubling after 2025. It is clear that these volumes of Azeri natural gas represent a small differentiation against Russian natural gas for Europe.

On March 17, 2022, the consortium announced[22] that the initial capacity of 10 billion cubic meters per year has been reached, with 8.5 bcm of them delivered to Italy. According to the official statemen, "TAP can double its capacity and expand in stages, up to 20 bcm within 45-65 months, as a result of requests to be received during the binding phase of a market test and the accumulated requests resulting in an economically viable outcome. The next binding phase is currently scheduled for July 2023. However, TAP can accelerate this timeline and launch the binding phase of the market test during 2022, provided that TAP receives interest for an earlier start in the ongoing public consultation. We invite all interested parties to take part in the ongoing market test".

Azerbaijan's geostrategic importance as a source of supply to Europe has increased given the geopolitical developments in Ukraine, and its new generation of fields is seen as a vital first source of diversification for Phase II of the Southern Gas Corridor and future interconnectors in SE Europe.

Phase II envisages the Interconnector Greece-Bulgaria (IGB) pipeline, which will run from Komotini to Stara Zagora, the construction of which started at the end of 2018 and entered

[22] https://www.tap-ag.com/news/news-stories/tap-transports-first-10-bcm-of-natural-gas-to-europe

into commercial operation in October 2022. Socar and Bulgargaz have already signed a contract for 3 billion cubic meters per year, with the possibility of expansion to 5 billion cubic meters in the coming years[23]. The IGB, 182 kilometers long, will be interconnected with TAP in Greece, in the area of Komotini, while the implementing body of the pipeline is the company ICGB AD, whose shareholders are Bulgargaz, with a percentage of 50% and YAFA POSEIDON, with a percentage 50% The IGB is the first project to be implemented within the framework of the Southern Gas Corridor, as well as the Vertical Corridor, as further extensions are planned in Romania, Serbia and Hungary, with Greece being the transit hub for Azeri natural gas in SE Europe.

More gas interconnectors are also being mapped in the wider region: the Bulgaria-Serbia (IBS) and Bulgaria-Romania (IBR) interconnectors and the Romania-Hungary (IRH) interconnector, which will also have the possibility of reverse flows. At the EU-Western Balkans Summit in Sofia in May 2018, Bulgaria and Serbia signed a Joint Declaration on the construction of the Interconnector Bulgaria-Serbia (IBS, Dimitrovgrad-Nis), to connect with TAP. The Serbian part of this pipeline has already been included by the EU in the list of Projects of Common Interest, with €49.6 million already approved. Its construction began in February 2022, and it is expected to be commissioned and transit Azeri natural gas to Serbia for the first time in 2023.

Similar joint declarations have also been signed for the Bulgaria-Romania and Romania-Hungary interconnectors, both of which have also been included in the EU's list of Projects of Common Interest. Therefore, all these projects will be implemented by the local gas companies through EU funding mechanisms, such as the EIB (the European Investment Bank) and the EBRD (the European Bank for Reconstruction and Development).

Another project being promoted in SE Europe is the Thessaloniki-Gevgelija gas interconnector, which will connect Greece to North Macedonia, a country almost entirely dependent on Russian natural gas. The pipeline, 120 kilometers long, will start from the compression station in Nea Mesimvria, on the outskirts of Thessaloniki, and will extend to Gevgelija and Stip, while an extension of the connecting pipeline to Kosovo is also planned.

In 2018, in Skopje, the gas TSOs of the two countries, DESFA and NER JSC SKOPJE, signed a Memorandum of Understanding to promote the construction of the gas interconnector in question. Currently, consultations are continuing regarding the market test and the issuance of a Final Investment Decision for the project, after the start of construction of the pipeline in 2022, based on the schedule. It should be noted that no contract has yet been signed

[23] Azernews (2017), "Details of IGB fulfillment plan to bring Azerbaijani gas to Bulgaria disclosed", https://www.azernews.az/oil_and_gas/120630.html

between North Macedonia and Azerbaijan, although the project is part of the Southern Gas Corridor.

An equally important project is East Med gas pipeline, which may allow Europe to receive natural gas directly from the fields of the Eastern Mediterranean. The construction of the pipeline will take about 4 years, but the key issue is not the technical part, but the commercial and geopolitical one, as it needs greater support from the countries potentially involved in the project, which is part of the PCI projects. It should be noted that the consortium (DEPA and Edison) that runs the project is continuing the design work. It is clear that the East Med pipeline is coming back into focus due to the wider developments and the conflict in Ukraine, as it is imperative for the EU to find viable and sufficient alternatives to replace Russian gas.

In the SE European region, there are currently three countries that play a key role in LNG supply: Greece, Croatia and Turkey. In Greece, the Revithoussa LNG terminal is one of the largest in the Mediterranean, receiving LNG from Algeria under the long-term contract between DEPA and Sonatrach, but it also receives spot cargoes from the US.

The ultimate goal of the US energy strategy for Europe is for the US to acquire a share of the European energy mix by exporting LNG to key European countries in the Vertical Corridor. In this context, US LNG will be able to regasify and enter the natural gas systems of Central and SE Europe, and supply countries such as North Macedonia and Hungary with natural gas in addition to the Russian one.

For this reason, apart from the LNG terminal of Revithoussa, the construction of a second LNG unit in the port of Alexandroupolis, in northern Greece, is being promoted[24]. Once completed, the Alexandroupolis FSRU will supply natural gas to the markets in Greece, Bulgaria, Romania and Serbia, as the LNG will be regasified at Alexandroupolis. The FSRU will be interconnected with the TAP and IGB, as well as the IBS and IBR interconnectors. In addition, it is worth noting that the Thessaloniki-Gevgelija interconnector may be interconnected with the FSRU, via TAP, in order to supply North Macedonia not only with Azeri but also with US regasified natural gas.

As a short-term solution to reduce dependence on imported Russian natural gas in order to make Greece’s energy system more resilient in terms of price increases and sufficiency, FSRUs are being promoted. If we take into account the total number of new FSRUs under

[24] The Alexandroupolis FSRU will be Greece’s fourth natural gas gateway, with a capacity of 6.1 billion cubic meters per year and a storage capacity of up to 170,000 cubic meters of LNG. The Final Investment Decision for its construction has been issued by the shareholders of Gastrade SA and its operation is expected to start by the end of 2023.

preparation and construction following the latest announcements, then their number is expected to increase significantly.

In particular, Gastrade, following progress on the Alexandroupolis FSRU, submitted to the Regulatory Authority of Energy (RAE) an application for the granting of a license for the “INGS Thrace”, which will include the FSRU with a capacity of 170,000 to 185,000 cubic meters of LNG, which will be 10 km from the nearest coast of Makri and 15 km from Alexandroupolis, the natural gas pipeline and the interconnection with TAP at the height of Anthia, with the construction of a Metering/Regulatory Station[25].

Motor Oil is also preparing its own FSRU, known as Dioryga Gas, at Agioi Theodoroi, near the company’s existing oil refinery. The FSRU’s storage capacity is up to 210,000 cubic meters of LNG, with a gasification capacity of 132,000 MWhs/day and an estimated annual demand of 2.5 bcm[26]. The first phase, non-binding, of the market test for the expression of intention to commit capacity to FSRU Dioryga Gas was completed on January 14, 2022, while 15 Greek and international companies expressed interest. The commissioning of the FSRU is set for late 2023 to early 2024.

Another proposed FSRU is the “Argo” FSRU in Volos. HRADF has reportedly obstructed the implementation of this project, licensed by RAE, informing investors that there is no such a project in the master plan that has been included in the upgrade of the port and in order to grant its use as an FSRU there should be a specific tender. It is worth mentioning that the Volos Port Authority is included in the list of ports that are going to be privatized by HRADF.

Moreover, energy company Elpedison recently submitted to RAE an application for the granting of an INGS license. The new project, known as “Thessaloniki FSRU”, will consist of a floating storage and regasification unit (FSRU), will be developed in Thermaikos Gulf, off Thessaloniki, and is expected to be commissioned within 2025.

The FSRU will have a storage capacity of 170,000 cubic meters of LNG and will be able to deliver up to 20 million cubic meters of natural gas per day. The project will also include a system of onshore and subsea pipelines that will connect the FSRU to Elpedison’s power plants in Thessaloniki (one existing and one under assessment), as well as to National Natural Gas System’s existing transmission pipelines in the area. The construction of the

[25] https://www.rae.gr/anakoinoseis/30043/

[26] https://www.desfa.gr/userfiles/5fd9503d-e7c5-4ed8-9993-a84700d05071/%CE%9A%CE%B5%CE%AF%CE%BC%CE%B5%CE%BD%CE%BF%20%CE%B3%CE%B9%CE%B1%20%CE%91%CE%BD%CE%AC%CF%81%CF%84%CE%B7%CF%83%CE%B7%20%CE%94%CE%99%CE%A9%CE%A1%CE%A5%CE%93%CE%91%20GAS-250719.pdf

“Thessaloniki FSRU” will enhance security of supply, allow expanded access to natural gas markets and contribute to decongesting the National Natural Gas Transmission System[27].

After the announcement for new FSRUs, market tests will determine how many and which of them will finally be implemented. However, the Greek FSRUs will have a high importance for LNG storage, which will be transported in the SE Mediterranean. They will constitute storage areas both for natural gas coming from Cyprus, Israel or Egypt and Algeria, as well as for quantities that will be transported via LNG tankers and will also transport US LNG.

Another important infrastructure in terms of energy security is the underground gas storage (UGS) facility in South Kavala, a project that has not been progressed for several years. According to the latest information, a new postponement of the tender for the concession of the South Kavala UGS is expected, as the Ministry of Environment and Energy and RAE consider that it is necessary to update the cost-benefit analysis for the project. It is worth noting that HRADF had set the goal of implementing the final phase of the tender at the end of May 2023; however, the war in Ukraine affected the data as included in the cost-benefit analysis, now under public consultation.

More specifically, with the current prices of natural gas, South Kavala UGS requires the investor and consumers to spend a total of approximately €1 billion, as the cost of filling the UGS is estimated at €500 million, while other €500 million is estimated to be required for the conversion works of the old field into natural gas storage facility.

In addition, the new data should also take into account the obligation to maintain safety reserves in natural gas undertaken by EU member states, based on the upcoming European legislation. The question is whether the obligation to maintain quantities equal to 15% of domestic consumption will remain valid until the end of the war. If this obligation is maintained, then it may be beneficial to utilize the South Kavala UGS. However, the Ministry of the Environment and Energy and the RAE seem to proceed with a new cost-benefit analysis for the project as well as with a possible amendment of the pricing regulation.

With regard to electricity infrastructure projects, the Greece-Egypt electricity interconnection is a milestone for energy security and the upgrading of Greece’s geopolitical role. In particular, the twin submarine electricity cable, following a route of 920 km from El Sallum to Nea Makri, will transport 3 GW of cheap green energy generated from wind and solar with a total capacity of 61 GW. 1/3 of the imports will be supplied to the domestic industry and the other 2/3 will be exported to the EU. To be precise, 1 GW will be

[27] https://www.imerisia.gr/oikonomia/40853_lng-ta-market-test-tha-krinoyn-posoi-termatikoi-stathmoi-tha-ylopoiithoyn

transferred from the Greece-Italy and Greece-Bulgaria grids and another 1 GW will be used for the production of green hydrogen.

It is worth noting that the electricity interconnection is expected to be completed 2.5 years after receiving the Final Investment Decision, while the total investment of the project, which is a candidate for the 6th list of PCI, is anticipated to exceed €3.5 billion. At the same time, the project will lead to the strengthening of transmission capacity between Greece and the EU by 700 MW, according to the cross-border impact study, while it has been included in the Ten-Year Network Development Plan 2022 of ENTSO-E. Some of the multiple benefits for Greece, Egypt and Europe from the implementation of the project are the reduction of emissions by 9-10 million tons per year, the reduction of natural gas needs by 4.5 billion cubic meters, the enhanced reliability and security of supply, while Greece is turning into an energy hub[28].

4.4 Critique on the Followed Energy Policy

The European Union is leading the global effort to tackle climate change and transition to a low greenhouse gas emission economy. For decades, it has set specific targets for the reduction of greenhouse gas emissions on behalf of the member states, so that the European economy can become carbon neutral by 2050.

In Greece, the National Energy and Climate Plan (NECP), which was published in December 2019, incorporates the main directions of EU policy and is the country's main energy policy tool for achieving the goals in the period 2021-2030.

However, the latest developments in energy and the climate are changing fast, creating an environment that is characterized by uncertainty due to the war in Ukraine. The International Energy Agency refers to the energy crisis saying that it is "the first truly global energy crisis, with effects that will be felt for several more years". This crisis motivated governments to formulate a new energy policy based on energy sufficiency, affordable prices and sustainability.

The first point of reference for the revision of the energy policy is the pan-European climate target, for at least a 55% reduction in net greenhouse gas emissions by 2030 compared to 1990 levels, which was incorporated into the Greek reality with Law 4936/2022 and which mandates the revision of the NECP of December 2019, which is only compatible with the previous and much lower ambitious EU-27 climate target of a 40% reduction in GHG emissions in 2030. Among others, increasing the goal of climate ambition requires a greater penetration of RES. In order for Greece to be compatible with the new European climate

[28] https://powergassupplyforum.gr/wp-content/uploads/2022/04/Karydas_s8.pdf

goal, RES penetration in the gross final electricity consumption between 83% and 88% by 2030 is required.

With regard to the “RePowerEU” plan, new dimensions are set in Europe’s energy planning:

- The urgent need to diversify Europe’s energy sources with immediate abolishment of Russian fossil fuels.
- The significant acceleration of RES penetration, increasing Europe’s energy self-sufficiency.
- The greater emphasis on energy efficiency, in order to deal with a possible disruption in the security of supply.

Natural gas will continue to play a role in Europe’s energy mix in the years to come. The new global treaty, however, requires its more rational use as far as it is absolutely necessary and, at the same time, the acceleration of its replacement in the mix with RES should be promoted.

The revised NECP will reflect the country’s key priorities in the field of energy and climate policy, as well as policy measures in a wide range of economic activities, such as transport, shipping, the agricultural sector, tourism, etc. At the same time, it will include new technologies and innovative applications that are gaining ground across Europe and are not included in the existing NECP, while it will be important to take advantage of the new financial resources and tools that are now available to finance the green transition.

The member states have until June 2023 to submit to the Commission the drafts of their new NECPs, while a year later is the deadline for submitting the final texts. At the same time, in March 2023 they should send a report to Brussels on the progress of the national plans.

With the submission to the European Commission at the end of 2019 of the NECP and the Long-term Energy Strategy, Greece updated its energy planning, now being particularly detailed, with ambitious goals and with special reference to RES and energy efficiency. However, NECP no longer meets the requirements of a comprehensive national energy policy, which needs to be modified following Russia’s invasion of Ukraine. The reason is that the design and writing of the NECP was completely based on specifications, which were decided and prepared in Brussels and apply to all countries independently, ignoring the specificities of each country and their percentage of dependence on Russian fossil fuels. After all, energy policy must now respond to sustainability, affordable prices and security of energy supply.

In the case of Greece and while it is an undeniable fact that hydrocarbons (oil and natural gas), of which 99% are imported, currently cover 61% of final energy consumption and will continue to cover most of the country's energy needs until 2030, they are hardly taken into account in the NECP from the point of view of their exploitation in the coming years, as attempts will be made to reduce their share (mainly oil) in the energy balance. And this is because NECP deals almost exclusively with reducing greenhouse emissions, increasing the share of RES in the gross final energy consumption and, at the same time, addressing energy poverty.

However, in the scenarios for future energy demand and supply mentioned in the NECP and prepared by CRES on its behalf, in 2030 the participation of hydrocarbons in final consumption is reduced to 54.7% and to 50.7% in 2040. So, despite the significant penetration of RES in the energy balance and energy efficiency, the country's energy economy will continue to be dominated by hydrocarbons. And this is because the share of natural gas in power generation and in consumption of households and in the commercial sector will have been increased, as delignitisation accelerates (however, lately there has been a shift to the use of lignite as a cheaper fuel than natural gas in power generation), while the large volume of cars will still be based on internal combustion engines, since electrification will move at very low levels, as predicted in the NECP.

However, the NECP does not foresee, or even set targets, for the oil and natural gas that Greece can produce in the next 20-30 years and their importance in reducing the country's energy dependence. There is certainly no reference to the significant refining advantage that Greece has today thanks to the enormous efforts, innovations and investments made by the country's two refining groups, which export almost 60% of their production, essentially supporting Greece's foreign trade balance. The NECP, following the Commission's specifications, avoids mentioning the "elephant in the room" which is hydrocarbons and their proposed exploitation during the next crucial years of the energy transition.

Emphasis on RES

Despite the fact that the NECP is a very useful plan for the development of RES and energy efficiency and an excellent tool for the country's energy transition to clean fuels, we cannot accept that it constitutes a national energy policy itself, as this requires a more holistic view of the energy sector. Perhaps, we will have to wait a little longer until the country's political system understands the need for the elaboration of a coherent energy policy, which will cover all forms of energy and will be able to properly assess Greece's comparative advantages, including and the advantages of the domestic energy sources, but will also realize that its utilization will be able to upgrade the country's geopolitical position, while reducing excessive energy dependence.

High Energy Dependence

A country, which is 61% dependent for its energy needs on hydrocarbons, i.e. oil and natural gas, which are imported almost 100%, should be seriously concerned with the issue of reduction of imported fuels. Unfortunately, this does not happen and in any energy policy document, no reference is made to this crucial issue of reducing the country's energy dependence.

With the issue of increased energy dependence having negative effects, not only on public finances, since it directly affects both the foreign trade balance, where until now hydrocarbon imports were responsible for 60% of the deficit, but also on the country's external relations, since for its energy supply Greece depends directly on various countries, with which it may not always maintain the best relations and, therefore, be exposed to threats. Compared to other EU member countries and as a result of relatively high imports of energy raw materials, Greece's energy dependence remains high, at 73.8% in 2021, while the EU-27 average is 55.5%, mainly in terms of fossil fuel imports, with IENE estimating that Greece's energy dependence in 2022 will increase.

Greece depends on imports of large quantities of crude oil to meet its needs. Today, the small domestic oil production is carried out by the company Energean, which is the only oil producer in the country with two active fields, Prinos and North Prinos, which are located offshore, in the North Aegean, northwest of the island of Thassos. Therefore, the issue of oil and natural gas is today of the utmost importance for Greece both from the point of view of high consumption, and even higher dependence on imports, but also due to the significant export activity in petroleum products that has been developed in recent years from the two refining groups, a fact that has very positive impact on economic growth and the country's external trade balance. In this context, continuing and strengthening in every way the field of research today, and future production tomorrow, should be a top priority in any alternative energy policy scenario.

Currently, Greece has the ability and the possibility to develop its upstream sector, as already occurred in the oil refining and trading sector, and therefore to claim a place in this rapidly developing sector in the Eastern Mediterranean. An industry with its own economic cycle that can easily create know-how and new and well-paid jobs in the mining, shipbuilding and repair industries, as well as the service sector.

In other words, Greece, in addition to a significant production of hydrocarbons that it can and should aim for, has all the potential to become a regional support base for oil exploration and production in the wider region, attracting investment and jobs. So, the development of the upstream sector in Greece should be a priority and a key component of an economic growth policy, a position that should be embraced by all political parties that believe in the potential of the Greek economy.

There is, however, one more reason why exploration activities should be supported at the government level, regardless of party origin, and this has to do with issues of national security and asserting sovereign rights in the Greek seas. As the IENE always supports, both the delineation of the EEZ and the extension of Greece's territorial waters up to 12 nautical miles are necessary conditions for the definition of blocks and therefore the establishment of a stable policy in favor of exploration activities comes to strengthen the efforts to define the continental shelf as well as the EEZ and above all to show in practice that Greece does not waive its legal rights, as they derive from the United Nations Convention on the Law of the Sea (UNCLOS).

Greece, which only recently returned to the field of hydrocarbon exploration activities after an unjustified and harmful for national interests 15-year absence, has any reason to intensify its efforts to discover commercially exploitable oil and natural gas fields. Particularly important is the fact that the costs of exploration activities, mining and production have been entirely borne by the concessionaire companies, based on contracts with the Greek government.

The Key Role of Natural Gas

Through the operation of existing and the construction of new gas-fired combined cycle units, the country will very soon have a total installed capacity of nearly 7.0 GW. At the same time, the expansion of the use of natural gas in industry, commercial enterprises and the domestic sector is progressing. In addition, it is worth mentioning that the natural gas distribution companies in Athens, Thessaloniki, Larissa and Volos are rapidly expanding their network in the big cities, while through DEDA they are now trying to create important networks in the region.

The consumption of natural gas seems logical to increase, which in 2021 stood at the historically high level of 7.0 billion cubic meters. After 2023, when only one lignite unit will operate by PPC, the modern 660 MW unit of Ptolemaida 5, natural gas consumption is expected to increase further, with electricity generation absorbing the lion's share, with a parallel rise in industrial, commercial and domestic sector. Although it is difficult to estimate the domestic gas consumption in the coming years, we should expect, based on the available data, a demand of 8-9 billion cubic meters per year after 2023, which may reach 10.0 billion cubic meters by 2030.

Given that so far 100% of gas supply is imported, with all flows, through pipelines, being completely controlled by Turkey (see Greece-Turkey interconnector, Turk Stream, TAP-TANAP), Greece has every reason to develop its own natural gas fields.

In conclusion, the goal of the new energy policy plan, which is expected to be expressed through the revision of the NECP of December 2019, is to focus on presenting the requirements of the national energy strategy and not on adopting a strictly defined scenario for the evolution of the energy system. It must examine the way and the extent to which specific directions (measures, policies, commitments, international trends) can affect the evolution of the energy system, with a view to consumer protection through the promotion of the most efficient energy options.

5. The Energy Market and Infrastructure in Greece

From the beginning of the 1990s until today, Greece's energy system is shaped based on the requirements of the national economy, the evolution of individual economic activities and the development of specific sectors, the consumption habits adopted, but also the European policies for energy, environment and growth. These until recently (e.g. 2010) largely affected the energy policy followed in Greece.

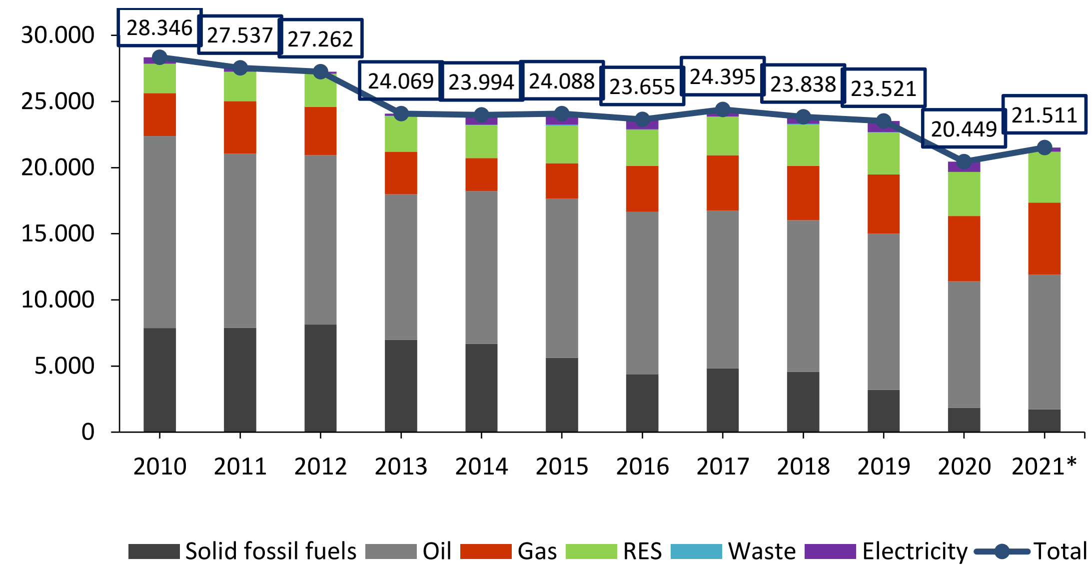
To understand the country's energy system, Eurostat's data on energy balance is used. An energy balance is the structured way of displaying energy quantities and shows what kind of and how much energy is produced, what and how much is consumed, where is consumed, i.e. it illustrates the balance between energy production and consumption. In addition, it helps to understand how energy products are transformed into each other, to highlight the various linkages 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 gross available energy, the gross inland consumption and the final energy consumption. The linkages between the various energy quantities of the energy balance, according to Eurostat, are presented in Annex I, while the energy balance of Greece for 2021 (provisional data) and 2010 as well as the energy balance 2020-2030, based on the NECP of December 2019, are listed in Annex II.

It should be pointed out that the energy balance includes two different and distinct balances: (a) the domestic energy consumption which concerns all the energy produced, imported and consumed in the country and (b) the electricity balance which concerns only the production and consumption of electricity. Essentially, the electricity generation balance is a subset of domestic energy consumption.

In the entire energy system, the gross inland consumption fluctuated at 21,511 thousand tons (Ktoe) in 2021, presenting a significant fall of 24.1%, compared to 2010 (Figure 29), while, compared to 2020, an increase of 5.2% was recorded. The trend to increase the penetration of RES in gross energy consumption continues and from 8% in 2010 it reached 17.8% in 2021. At the same time, the share of solid fuels decreased from 27.7% in 2010 to 8.0% in 2020 (Figure 29) [27].

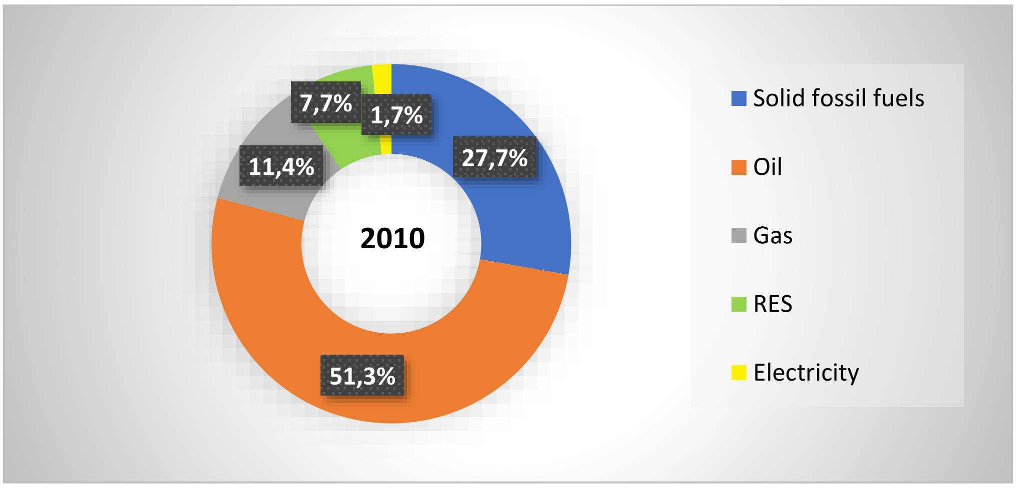
Figure 29: Gross Domestic Energy Consumption in Greece (ktoe), 2010-2021

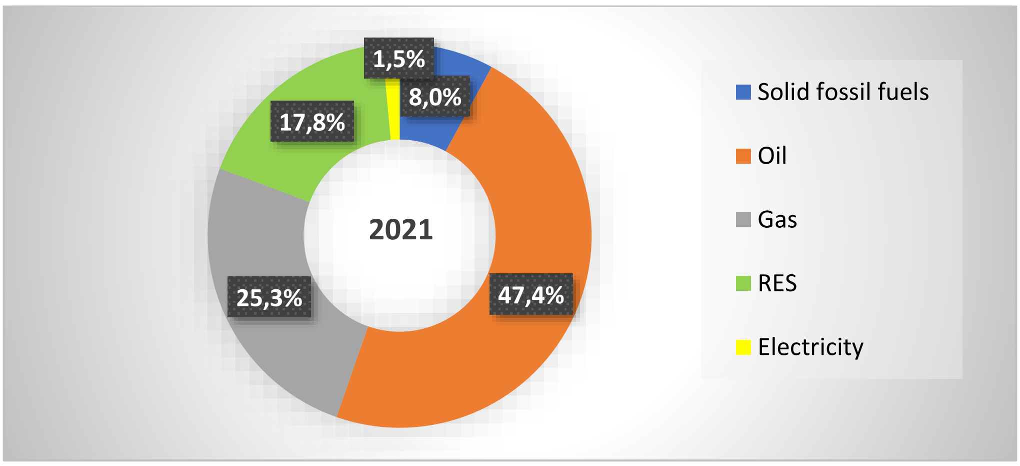


*Preliminary data

Source: Eurostat

Figure 30: Share of Sources in Gross Domestic Energy Consumption, 2010 and 2021



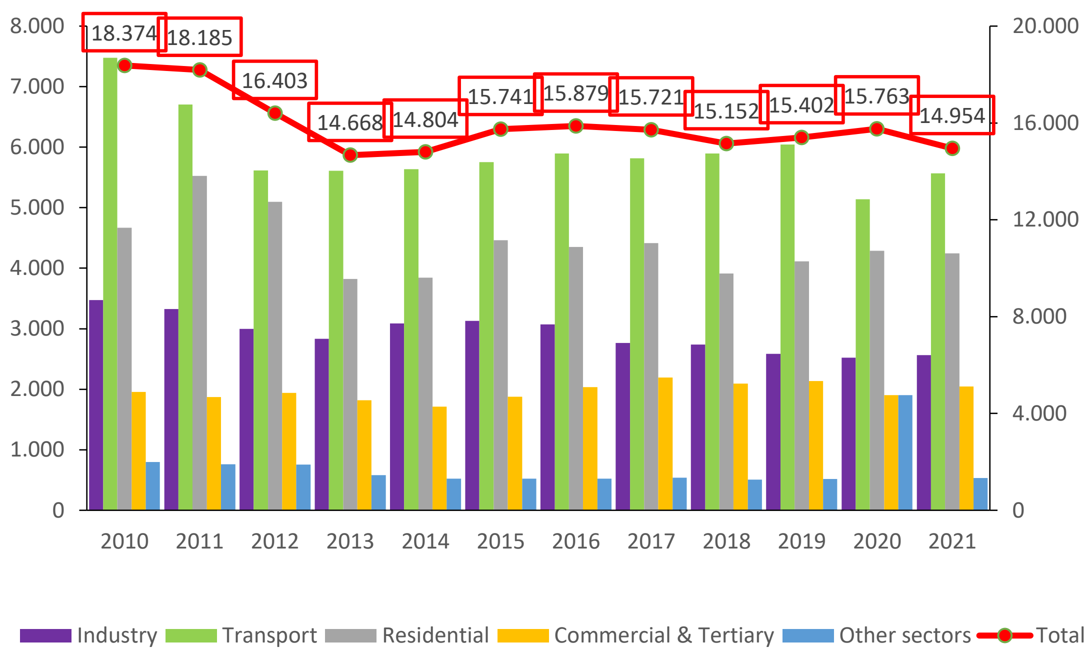


Source: Eurostat

After the sharp decrease in final energy consumption in 2013 (-20%, compared to 2010), a mild upward trend is observed in the period 2013-2021 (with the exception of 2018) with an average annual rate of change of -1.0%. In 2021, the total final energy consumption decreased by 5.13%, compared to 2020, and amounted to 14,954 Ktoe (Figure 31).

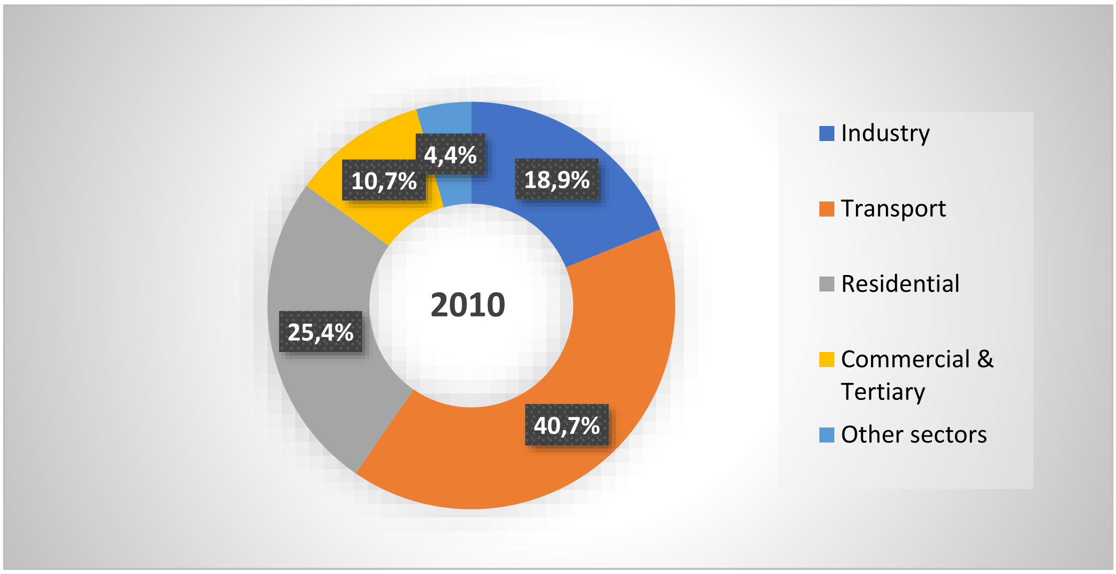
In 2021, there was a decrease in the participation of industry and transport in the final energy consumption by two and four percentage points, from 19% to 17% and from 41% to 37% respectively, compared to 2010, while an increase in their shares was recorded by domestic and the commercial-public sector. It should be noted that for 2021 the transport sector had the largest contribution as a share of final energy consumption (37.2% share), while also the participation of both the residential and industrial sectors was significant (28.4% and 17.2% respectively) (Figure 32) *[27]*.

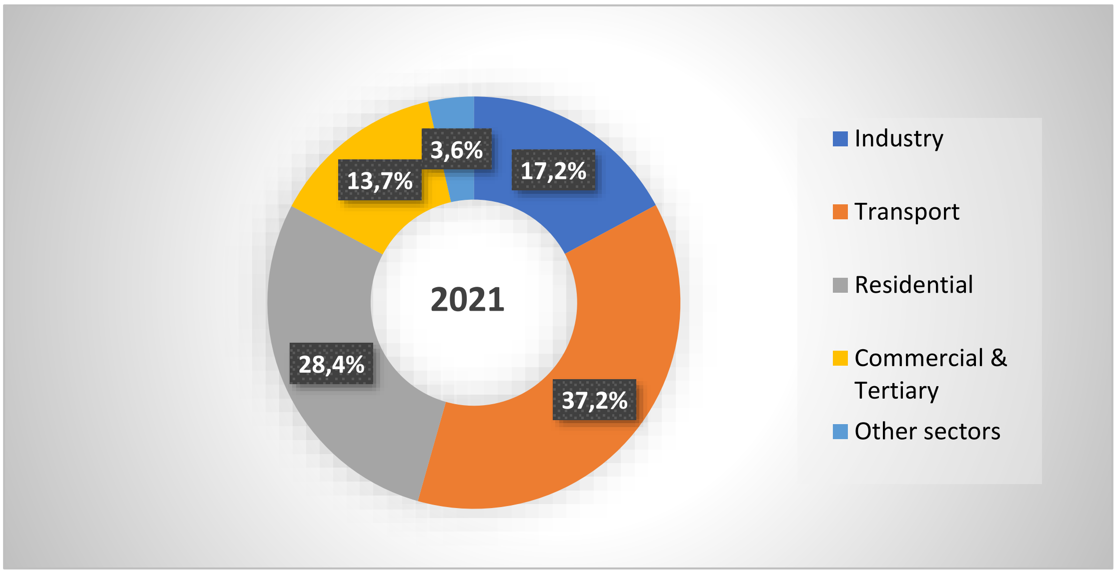
Figure 31: Final Energy Consumption by Sector in Greece (thousands of tons), 2010-2021



Source: Eurostat

Figure 32: Participation of Individual Sectors in Final Energy Consumption in Greece, 2010 and 2021

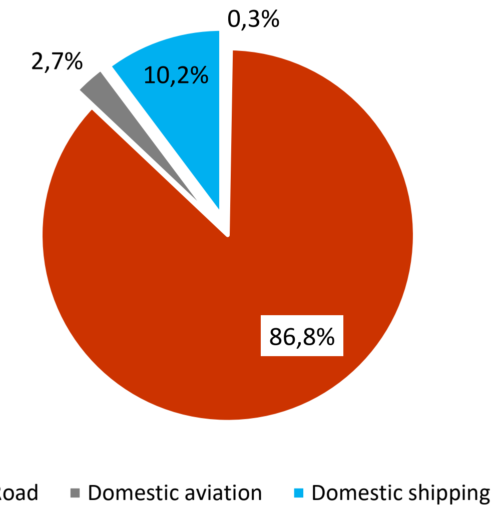




Source: Eurostat

In the transport sector, road transport dominates energy consumption, corresponding 86.8% of the sector in 2021 (Figure 33).

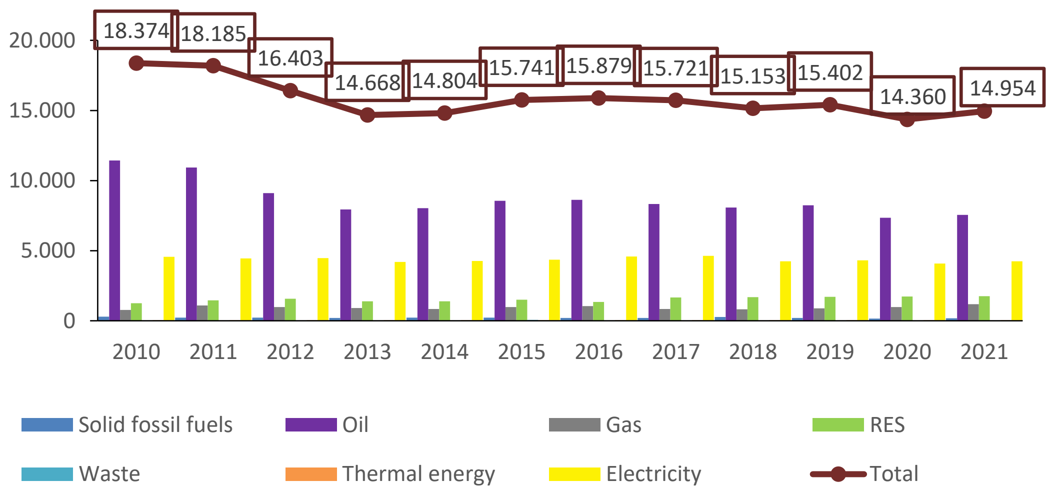
Figure 33: Share of Transport Mode in the Final Energy Consumption of the Transport Sector, 2021



Source: Eurostat

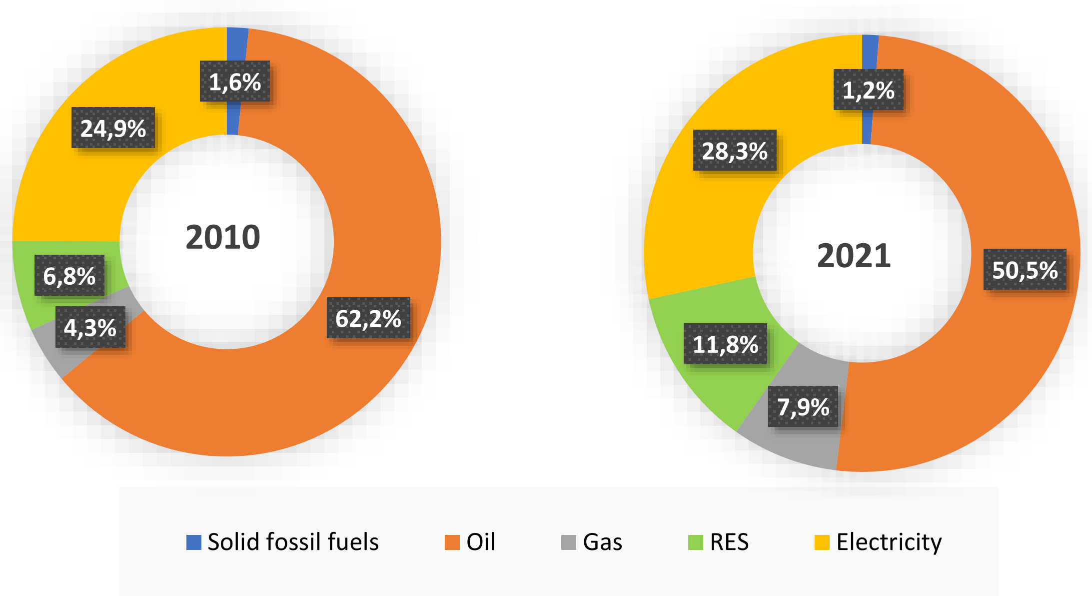
Figure 34 shows the contribution of the various types of fuel to the final energy consumption during the period 2010-2021. The largest share in the end-use sectors corresponds to the consumption of petroleum products (50.5% for 2021), followed by electricity, the use of RES and natural gas with percentages of 28.3%, 11.8% and 7.9% respectively. The consumption of solid fuels and petroleum products in the end-use sectors decreased significantly in 2021, compared to the consumption levels of 2010 (decrease of -39.0% and -33.9% respectively). This decline is largely offset by the increase in the use of RES and the consumption of natural gas, whose consumption increased by 41.2% and 50.6% respectively in 2021, compared to 2010. Electricity consumption showed a decrease by -7.3% in the same period [27].

Figure 34: Final Energy Consumption per Fuel in Greece (thousands of tons), 2010-2021



Source: Eurostat

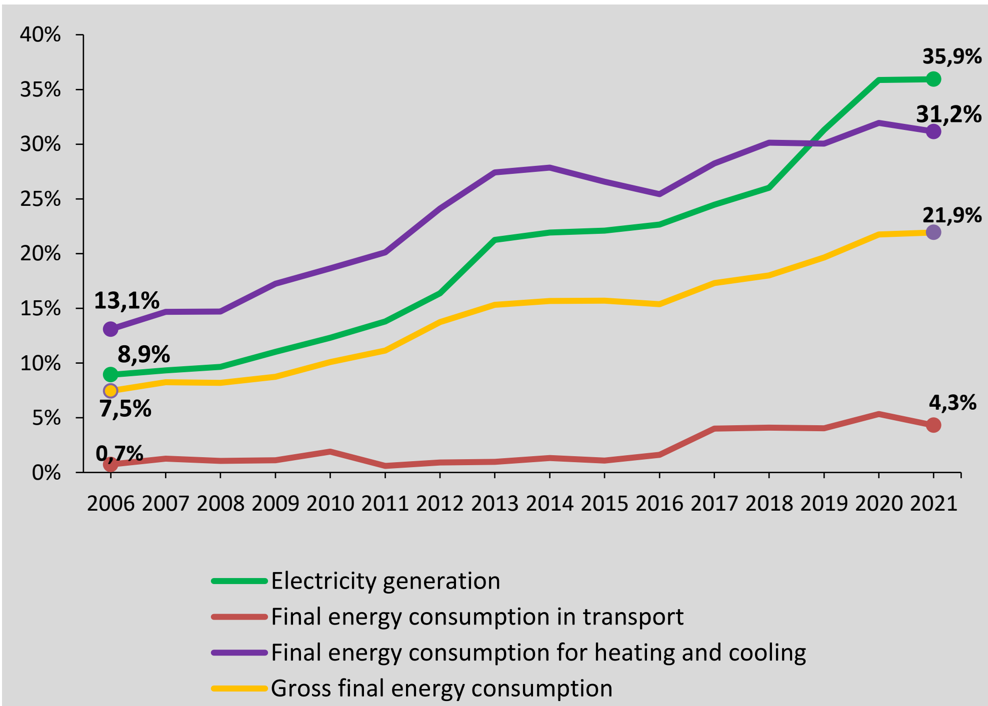
Figure 35: Participation of Fuels in the Final Energy Consumption in Greece, 2010 and 2021



Source: Eurostat

The contribution of RES to energy consumption in Greece showed a significant increase during the period 2006-2021, as its total contribution in 2021 as a share of gross energy consumption amounted to 21.9% (Figure 36) [28].

Figure 36: Total and Specific Participation Shares of RES in the Domestic Energy System in the Methodology Base of the European Union, 2006-2021



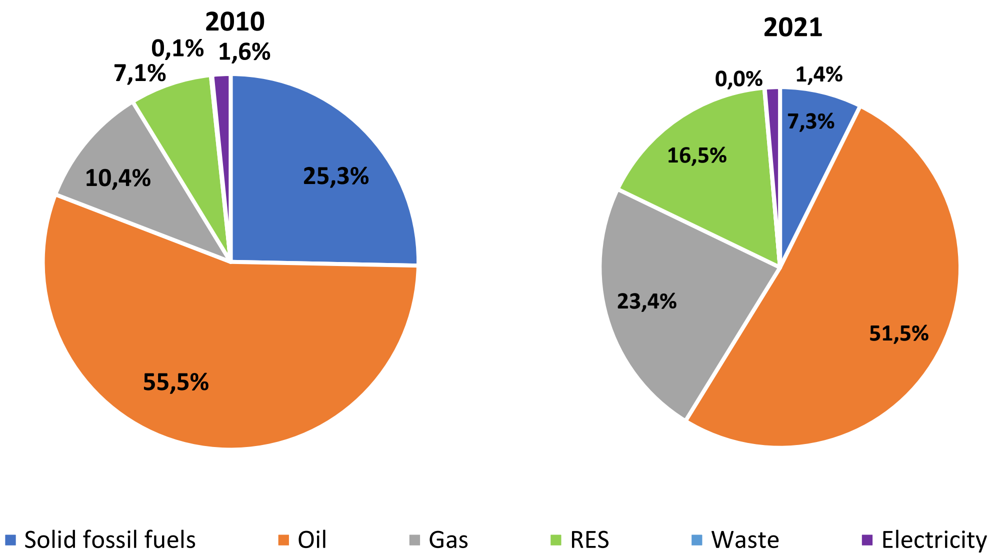
Source: Eurostat

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, the contribution of RES to both gross electricity consumption and final energy consumption for heating and cooling in the period 2007-2021 showed a significant increase with an average annual growth rate of 8% and 7% respectively.

The share of electricity from RES in 2021 was 35.9%, showing an impressive increase, compared to 2006, when the corresponding share was 9%. In particular, with regard to the electricity production from RES, with features of uncontrolled production, i.e. the electricity production from photovoltaic and wind plants (in the Transmission System), the percentage of wind farms amounted to 48.6% and of photovoltaic parks to 25.0%. In addition, the share of hydropower plants stood at 23.9% of electricity generation from RES in 2021.

Regarding the gross available energy in Greece, Eurostat's data for 2021 show that oil and petroleum products corresponded to 51.5%, followed by natural gas (23.4%), RES (16.5%) and fossil fuels (7.3%). The reduction observed in the gross available energy from solid fossil fuels in 2021, compared to 2010, is noteworthy, which is of about -78.2%, as well as the increase in the share of RES over the same years, which reached 75.2% [28].

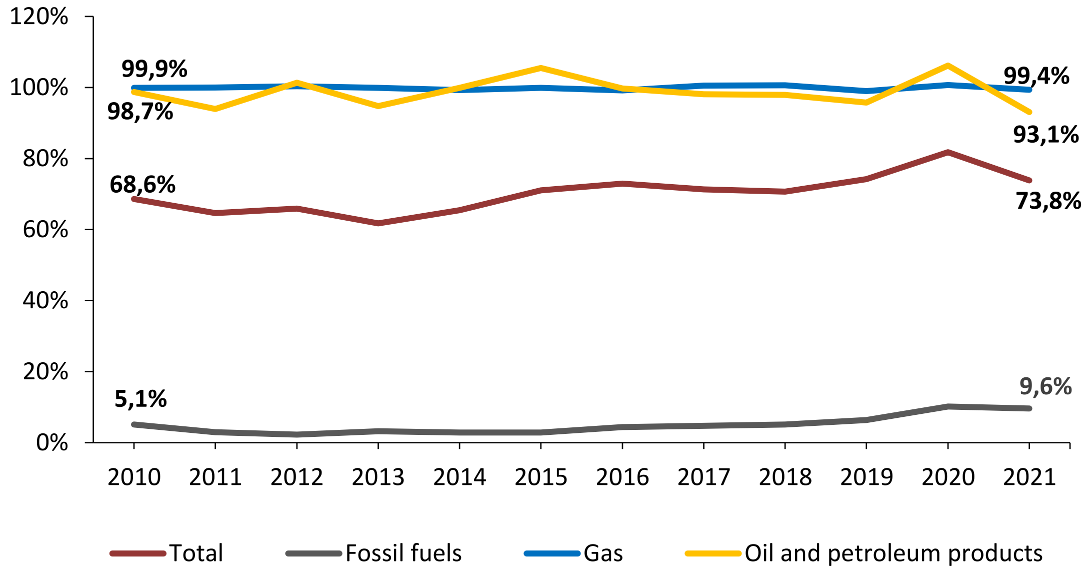
Figure 37: Total Gross Available Energy in Greece, 2010 and 2021



Source: Eurostat

Despite the steadily increasing penetration of RES in the national energy mix over the last decade, the energy dependence index is moving in the opposite direction, recording a significant deterioration. In 2010, 68.6% of the gross available energy in Greece came from imports. In 2021, this share increased to 73.8%, mainly due to an increase in the share of imported oil and fossil fuels. More specifically, the share of imports of oil and petroleum products in 2021 amounted to 93.1%, of natural gas to 99.4%, remaining relatively stable since 2010, and of solid fuels to 9.6% (Figure 38).

Figure 38: Degree of Energy Dependence of Greece, 2010-2021



Source: Eurostat

5.1 Oil and Petroleum Products

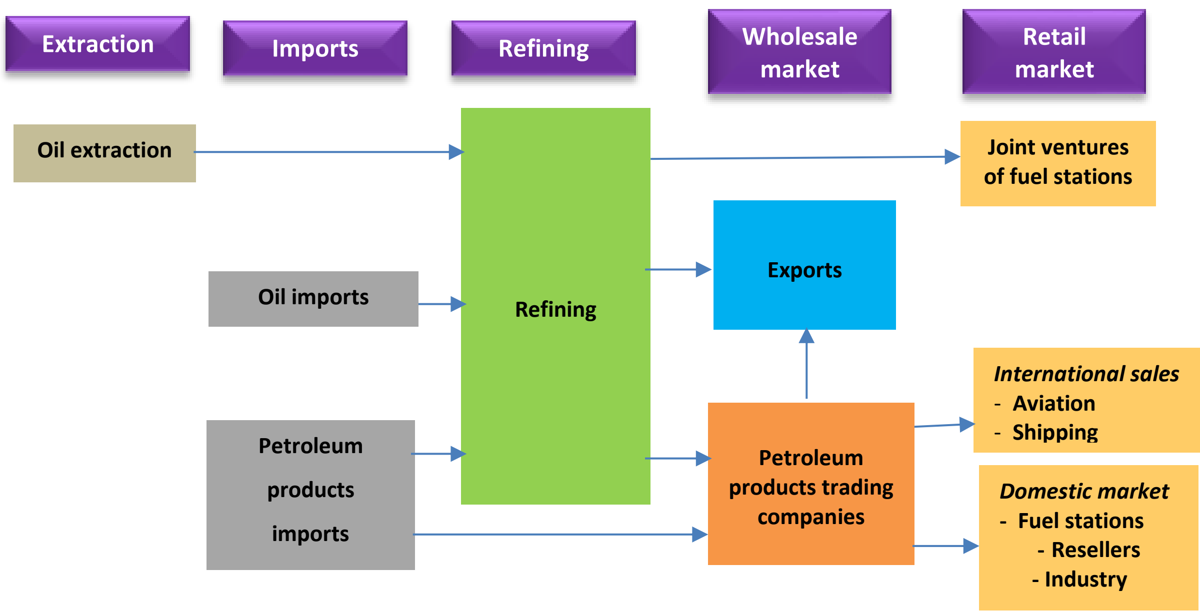
5.1.1 Structure of the Domestic Market of Petroleum Products

The domestic market of petroleum products consists of the following segments (Figure 39):

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

Market operation is supported by appropriate transport, production and storage infrastructure such as refineries, pipelines, tankers, port facilities.

Figure 39: Market of Petroleum Products in Greece



Sources: IENE, IOBE

The Greek oil market is regulated by Law 3054/2002 "Organization of the oil market and other provisions" (as amended) and the relevant Licensing Regulation. There are active in the market [29]:

- 2 refinement companies with 4 refineries.
- 25 Petroleum Marketing companies holding a type A license, with storage and trading facilities throughout Greece.
- 21 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.
- 19 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.
- 10 companies holding a type D license – namely a license to trade Asphalt. 7 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.

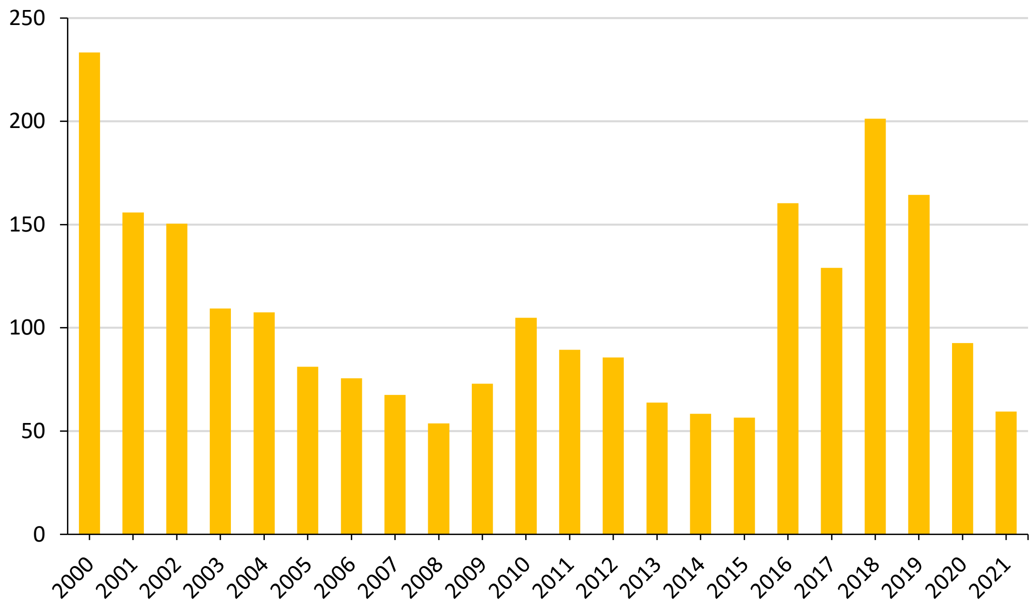
The following are used for the transportation and distribution of fuels: [29]:

- a pipeline network
- approximately 1.200 Public fuel trucks
- approximately 200 Private fuel trucks of the Trading Companies
- approximately 8.000 Private small trucks for the distribution of heating oil

5.1.2 Oil Production, Imports and Exports

The production of crude oil[29] in Greece in 2021 was insignificant (59.4 thousand tons, Mt), compared to the gross domestic consumption of petroleum products of about 10.2 million tons in 2021 [30].

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

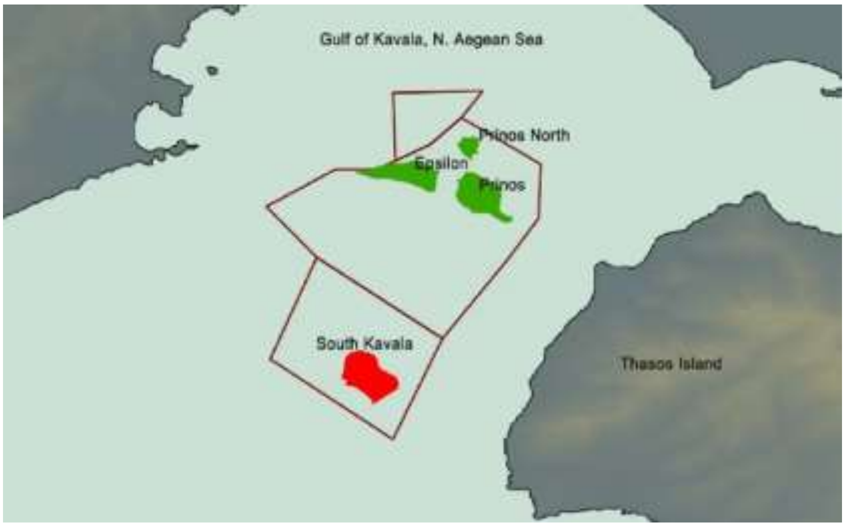


Source: Eurostat

It came from a specific field (Prinos and Northern Prinos), whose production, although increased by 450% in the last 8 years, remained small at 3,300 barrels per day in 2019 and decreased by 45% in 2020 to 1,800 barrels per day, at a time when Greece consumes approximately 160,000 barrels per day (average daily crude consumption in the country). The Energean company is the country's sole oil producer. The two active oil fields, Prinos and North Prinos, are located offshore in the North Aegean.

[29] 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 coal oils and natural gas liquefaction).

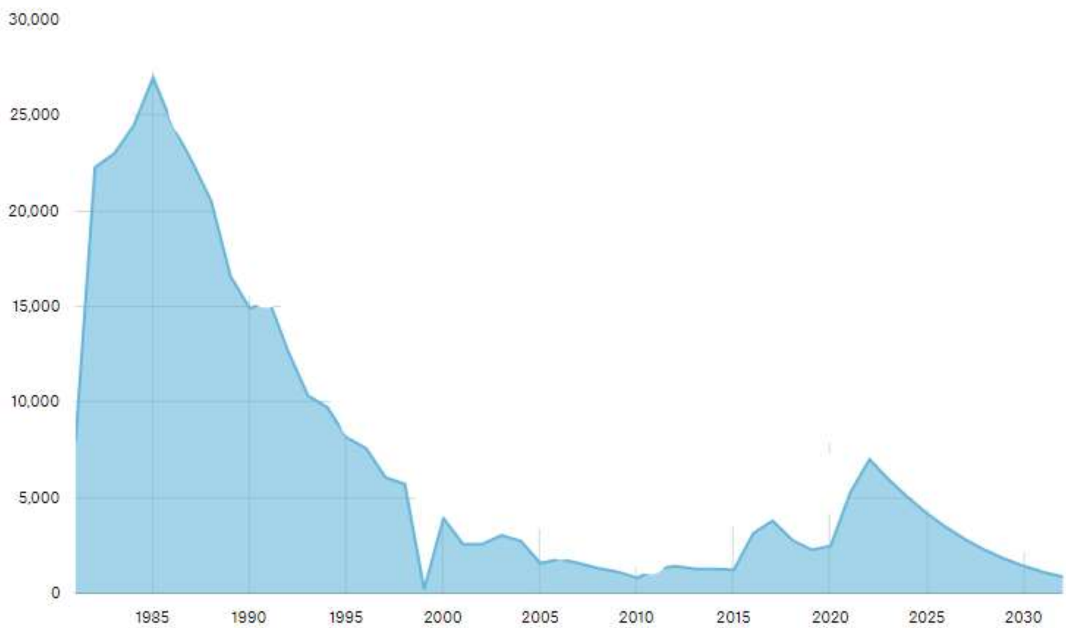
Map 2: Prinos, Northern Prinos and Epsilon Deposits in the Gulf of Kavala



Source: Oil and Gas Journal

The Prinos basin was explored in the 1970s and the Prinos field was discovered in 1974, through 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 quantities of 8,000 to 10,000 bpd. Production peaked in 1985 at 27,000 bpd, but has declined steadily since then (Figure 41) [31]. Based on economic assumptions, oil production will continue until the field reaches its economic limit in 2032. The field currently accounts for about 61% of the country's daily production [32].

Figure 41: Evolution of Prinos Gas Field Production, barrels per day (bpd)



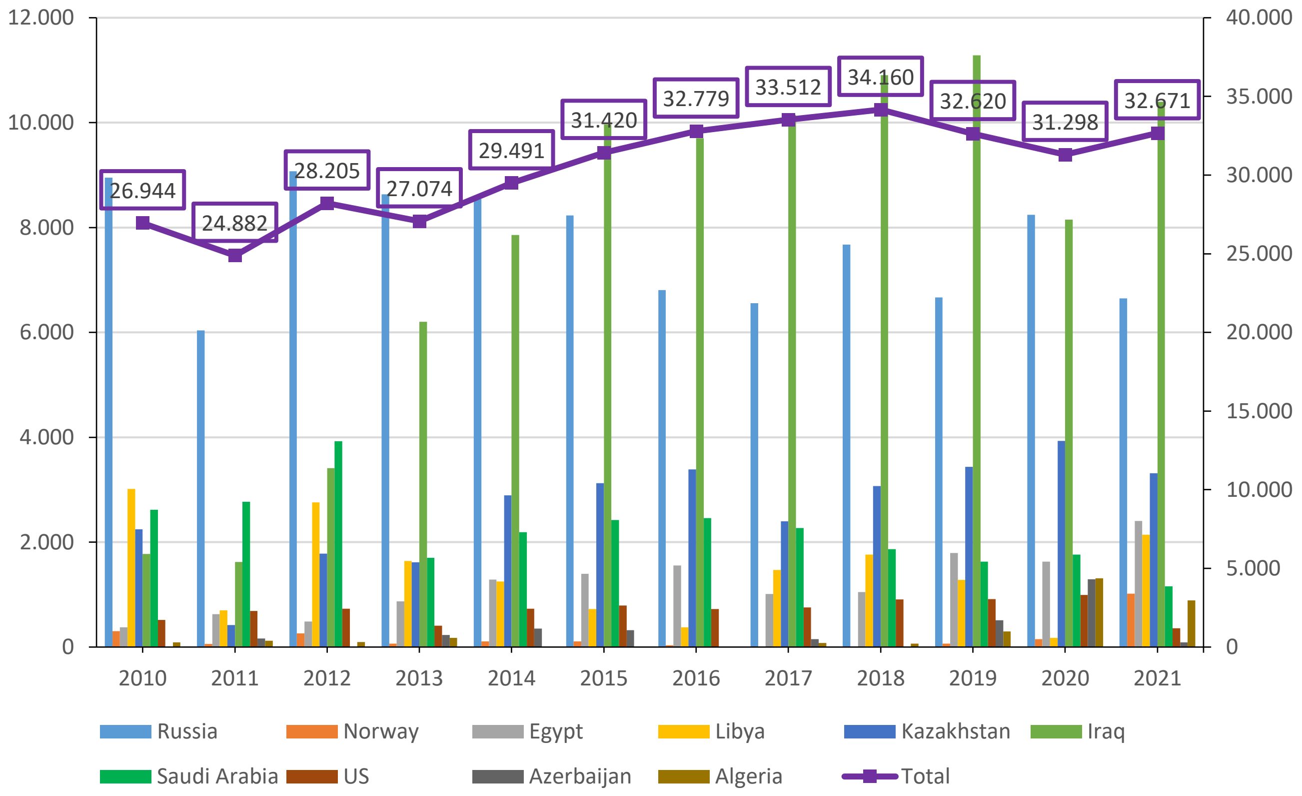
Source: Global Data [32]

Given the market conditions, the company has implemented a restructuring and modernization programme for Prinos, with the aim of its gradually abolishment of oil price fluctuations and further reducing its environmental footprint through carbon capture and storage as well as pure hydrogen production (Eco H2). At the same time, it has restarted investment in the development of the Epsilon field in the Prinos Basin, which is scheduled to come into production through vertical drilling from the new Lamda offshore platform in the first half of 2023 [33].

It must be emphasized that the Prinos field has been proved to be incredibly productive, albeit difficult in terms of geological structure, since a total of approximately 130 million barrels have been extracted to date, i.e. three times the amount of the initial projections.

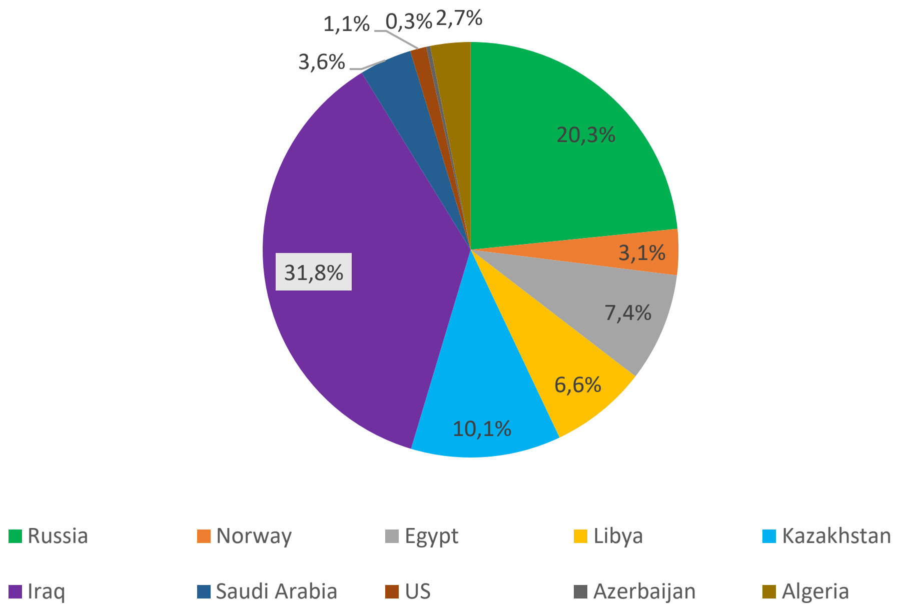
Therefore, Greece depends on imports of large quantities of crude oil and petroleum products to meet its needs. Iraq was the largest supplier of crude oil to Greece in 2021, with 10.4 million tonnes, followed by Russia with 6.65 million tonnes and Kazakhstan with 3.3 million tonnes (Figure 42). Imports from Iraq alone accounted for 31.8% of Greece's total imports of crude oil and petroleum products in 2021, which amounted to 32.67 million tons (Figure 43) [34].

Figure 42: Imports of Oil and Petroleum Products in Greece by Country (thousands of tons), 2010-2021



Source: Eurostat

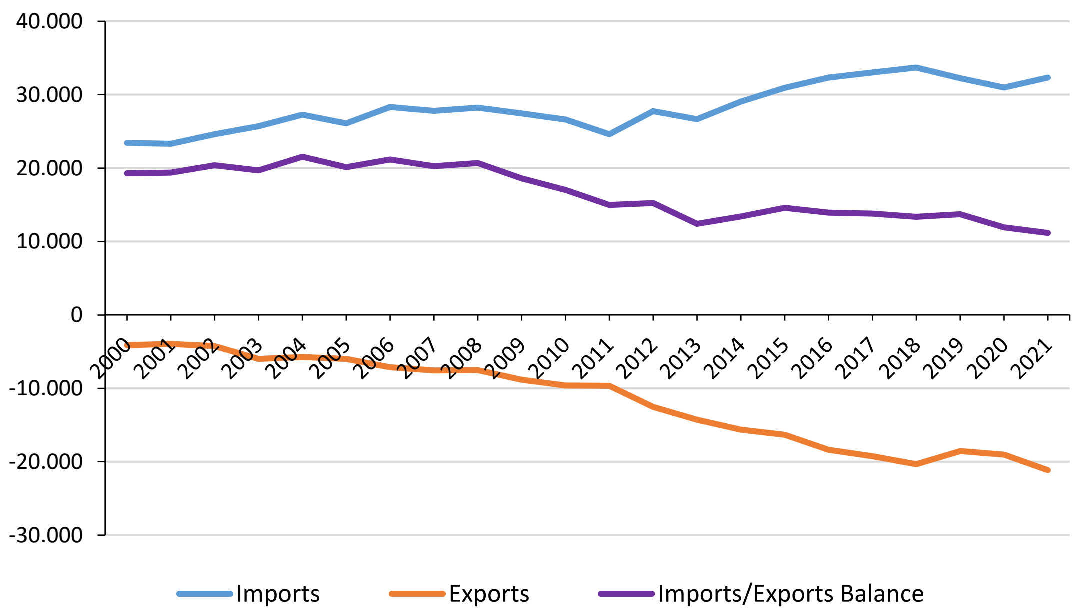
Figure 43: Share of Imports of Petroleum Products in Greece by Country, 2021



Source: Eurostat

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

Figure 44: Imports and Exports of Petroleum Products in Greece, 2000-2021

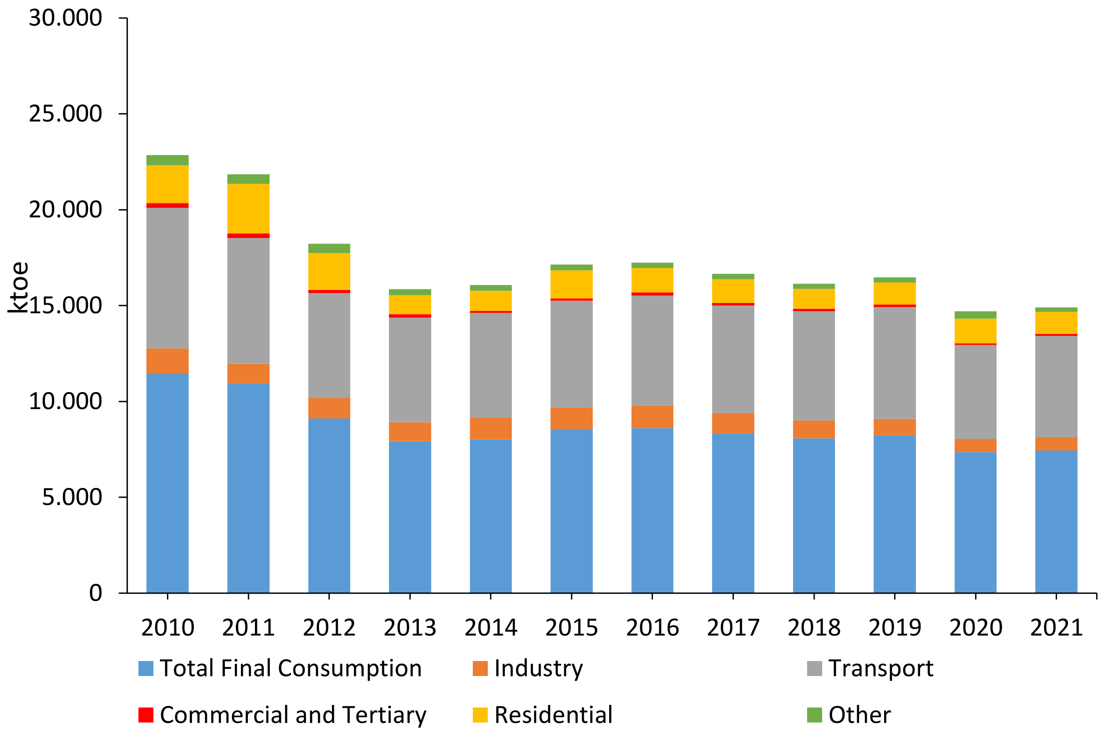


Source: Eurostat

5.1.3 Oil Consumption

The consumption of petroleum products in Greece, after the reduction suffered during the period of 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 caused by the Covid-19 pandemic, while in 2021 it increased by only 1.3% [35].

Figure 45: Consumption of Oil and Petroleum Products by Sector (thousands of tons), 2010-2021

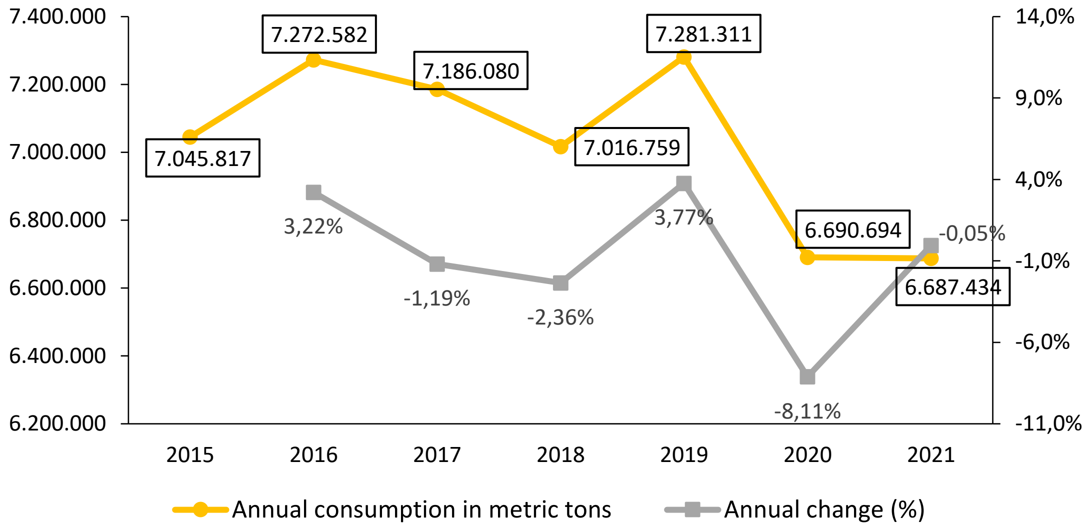


Source: Eurostat

The transportation sector consumed 5.3 million tons of oil in 2021, accounting for 70.8% of total oil consumption. The household sector followed with 15.3% and industry with 9.4%. Road transport accounted for 86.1% of transport oil consumption, followed by domestic shipping with 10.9% and small shares of domestic air and rail transport (2.87% and 0.13% respectively). The transport sector for 2021 was mainly based on diesel and petrol, which together accounted for 87.9% of the total oil consumption in Greece.

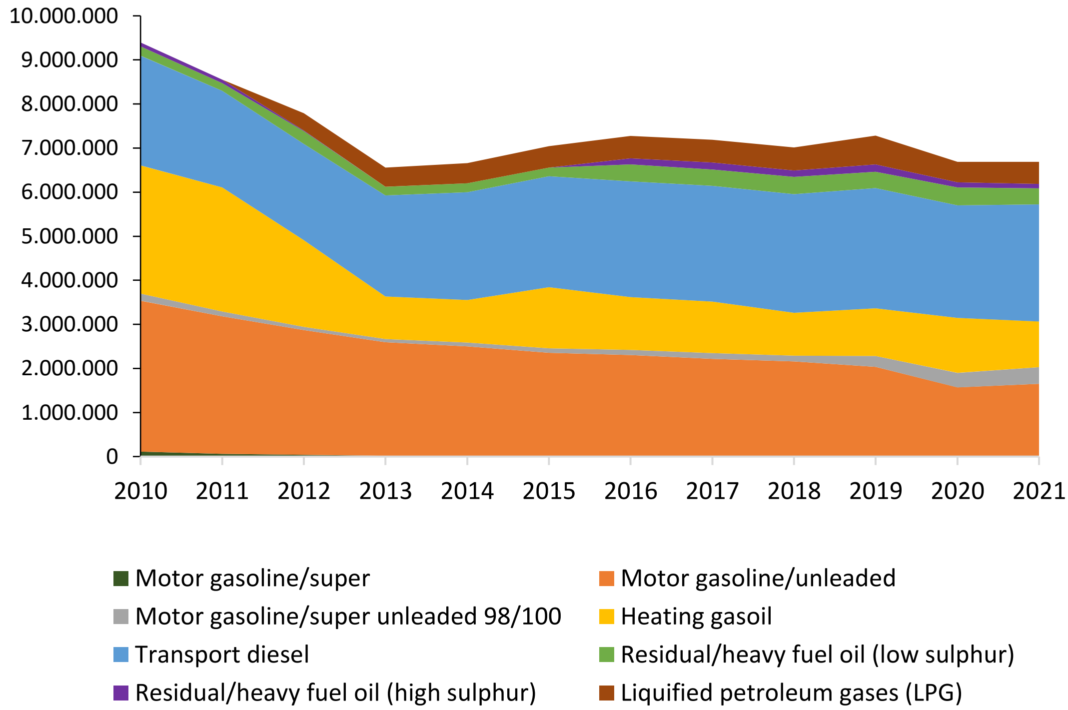
According to the data released by the Hellenic Statistical Authority [36], the reduction in the consumption of petroleum products in 2020, compared to 2019, was 8.1%, while in 2021 the consumption was maintained at the levels of 2020, as a minimum drop of 0.05% was recorded (Figure 47). The decrease in consumption in 2020 came from the fall in the consumption of high sulfur fuel oil by -28.7%, LPG by -28.1%, unleaded gasoline by -23% and diesel by -6.5%. In contrast, heating oil consumption increased by 15.2%, low sulfur fuel oil by 8.2% and super unleaded 98 and 100 octane by 34.8%. For 2021, there was an increase in the annual consumption of unleaded gasoline by 5.1%, super unleaded gasoline 98/100 by 13.6%, diesel by 4.1%, and LPG by 6.6%. On the contrary, a decline in annual consumption was observed in heating oil by 16.7% and in the categories of low and high sulfur fuel oil with percentages of 9.8% and 13.6% respectively.

Figure 46: Annual Total Consumption of Petroleum Products, 2015-2021



Source: ELSTAT

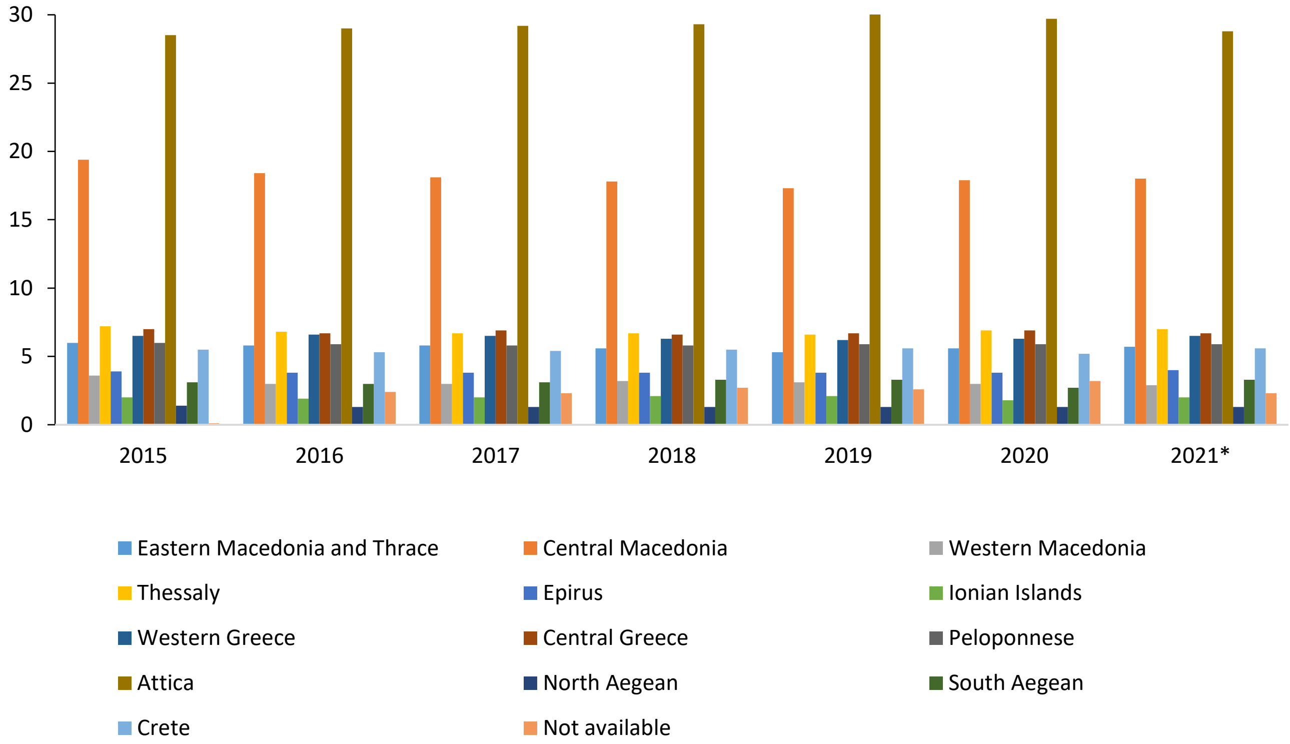
Figure 47: Consumption of Petroleum Products by Category in Greece (metric tons), 2010-2021



Source: ELSTAT

During 2015-2021, the Regions with 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 [36].

Figure 48: Percentage (%) of Oil Consumption per Region, 2015-2021

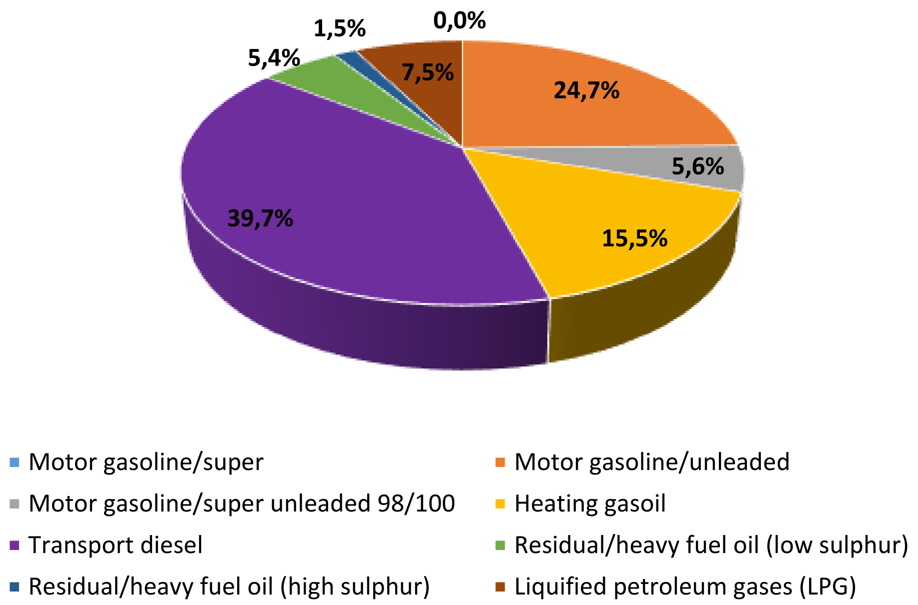


**Preliminary data*

Source: ELSTAT

For 2021, diesel accounted for the largest category of petroleum consumption (39.7%), followed by unleaded gasoline (24.7%) and heating oil (15.5%) (Figure 49).

Figure 49: Consumption Shares of Petroleum Products in Greece by Category, 2021



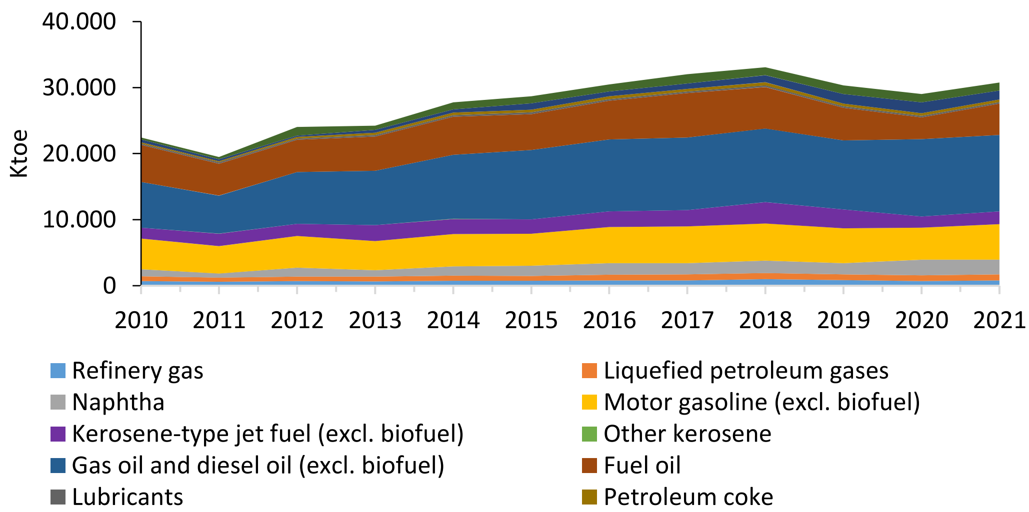
Source: ELSTAT

For gross electricity generation, oil accounted for around 10% in 2021, which remained relatively stable over the period 2010-2021.

5.1.4 The Refining Sector

Refining capacity in Greece decreased by 12% in 2020, compared to 2018, contrary to the upward trend observed in the period 2013-2018 (Figure 50), but recovered in 2021, showing an increase of 6.1%. Total refining capacity in 2021 was 30.8 million tonnes.

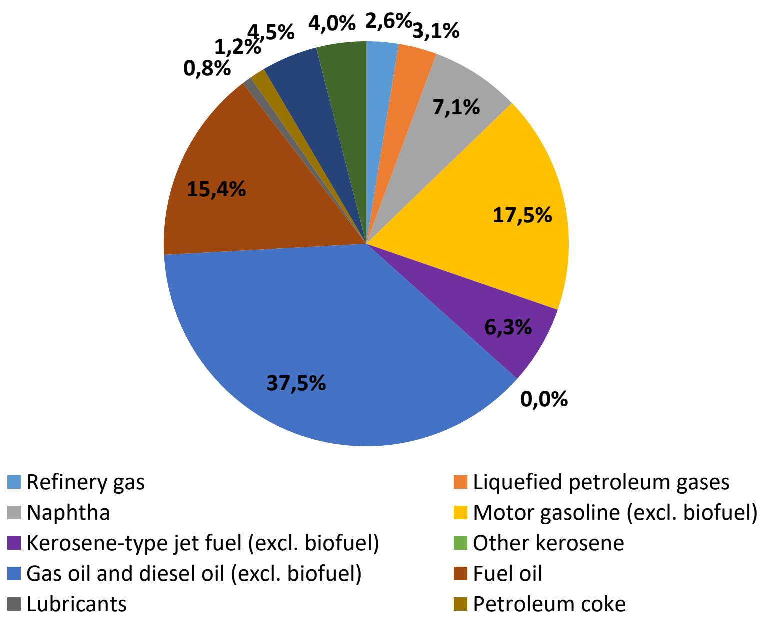
Figure 50: Petroleum Products in Greece (thousands of tons), 2010-2021



Source: Eurostat

Diesel production reached 11.6 million tonnes in 2021, accounting for the highest share at 37.5% of the country's refining capacity. Gasoline and fuel oil accounted for 17.5% and 15.4% respectively of refined products in Greece in 2021 (Figure 51).

Figure 51: Share of Petroleum Products in Greece, 2021



Source: Eurostat

Imported crude oil is refined into petroleum products at four domestic refineries (Table 5). The three refineries, which belong to HELLENIC PETROLEUM DEPPP SA, a subsidiary of the HELLENiQ ENERGY Group, are located in Aspropyrgos, Elefsina and Thessaloniki and represent approximately 65% of the country's total refining capacity, while they have total storage tanks for crude oil and petroleum products with a capacity of 6.65 million cubic meters. Motor Oil's Agios Theodoros refinery, near Corinth, produces the rest.

Table 6: Active Refineries in Greece

	HELLENiQ ENERGY			Motor Oil
Ownership (30.6.2021)	Paneuropean Oil and Industrial Holdings S.A: 47,1% Hellenic Republic Asset Development Fund: 35,5% Institutional investors: 8,6% Private investors: 8,7%			Petroventure Holdings Limited: 40,0%; Doson Investments Company: 5,6%; Free float: 54,4%
Location	**Aspropirgos**	**Thessaloniki**	**Elefsina**	**Agioi Theodoroi (Corinth)**

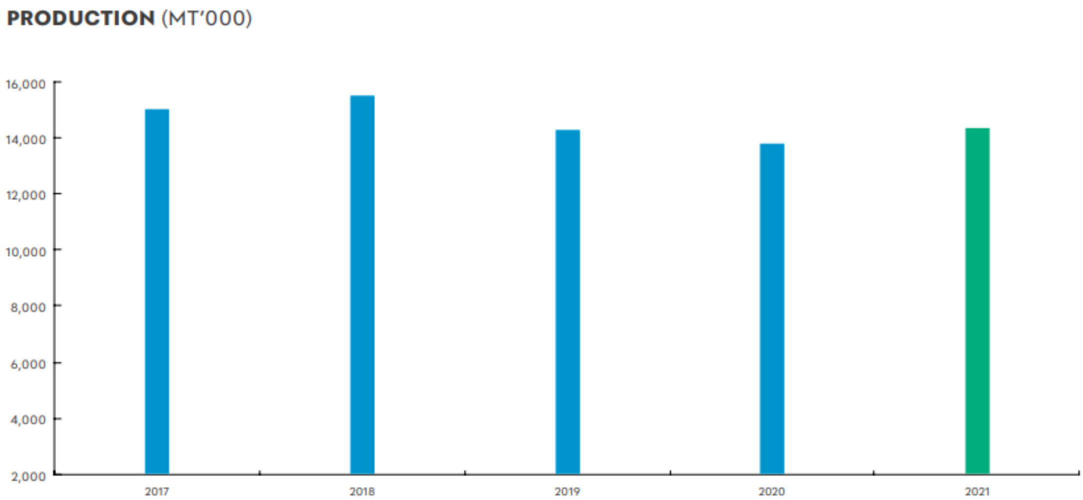
Refining Type	Highly complex: fluid catalytic and thermal cracking; vacuum distillation, naphtha & diesel hydrotreating; isomerisation; reforming; mild hydrocracking; bio-ethers (ETBE/TAEE) & propylene production.	Hydroskimming: vacuum distillation, naphtha & diesel hydrotreating; isomerisation; reforming.	Highly complex: high pressure hydrocracking and thermal cracking; vacuum distillation; diesel hydrotreating; steam reformer.	Complex: catalytic and thermal cracking; isomerisation; MTBE production; vacuum distillation; mild hydrocracking; hydrotreating; reforming; lube production; alkylation; dimerisation
Nelson Complexity Index	9,7	5,8	12	11,54
Capacity (Mt/year)	7,5	4,5	5,3	10
Capacity (kb/d)	148	90	106	185
Year of establishment	1958	1966	1972	1972

Sources: IENE, HELLENiQ ENERGY and Motor Oil

HELLENiQ ENERGY's Refineries

In 2021, despite adverse conditions, the Group's refineries maintained high levels of operation with production increasing to 14.4 million tons from 13.8 million tons in 2020 [37].

Figure 52: Production of HELLENiQ ENERGY's Refineries



Source: HELLENiQ ENERGY

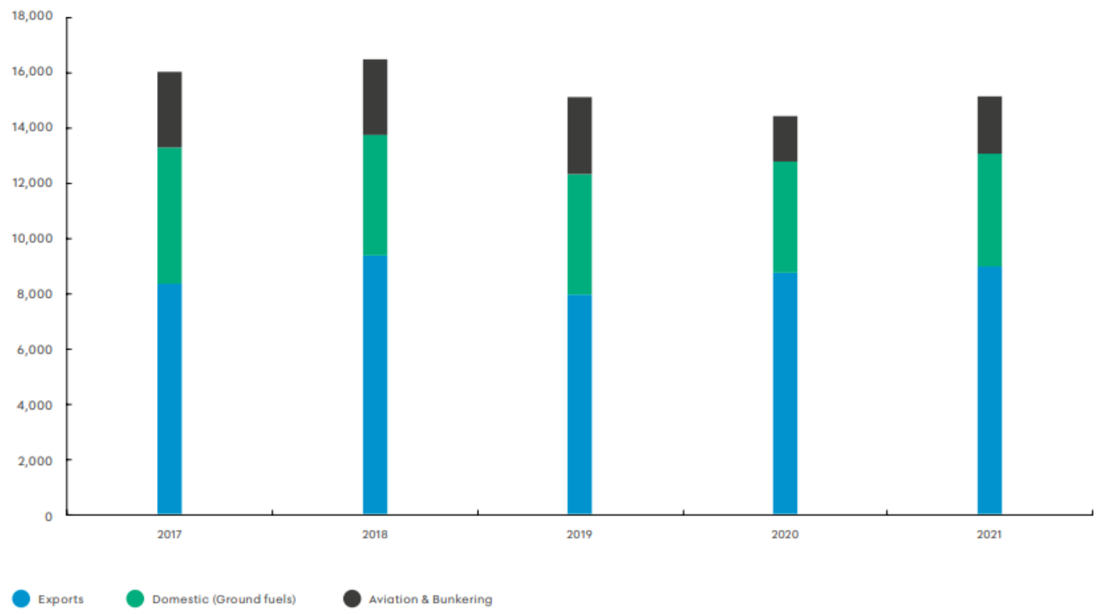
The operation of the refineries led to the production of medium fractions (jet, gasoil and diesel) at 48.1% (50.2% in 2020) of the total, while the production of gasolines amounted to

21.3% (20.3% in 2020). Overall, the production rate of high added value products reached 80%, one of the highest rates in the European refining industry, while fuel oil stood at 8.9%, reflecting the operational optimization of the Aspropyrgos refinery.

The Aspropyrgos refinery started production of IMO marine fuel in November 2019, adjusted to market trends to ensure its supply of clean fuels and within 2021 took advantage of the flexibility in its production mix, depending on market conditions. In addition, the Aspropyrgos refinery, after the conversions to the gasoline additive production units, covers the obligation to supply E5 gasoline to the internal market, without the addition of pure bioethanol, improving the quality and the environmental footprint of the final product and substituting imports [37].

Fuel sales are carried out to oil trading companies in Greece, including EKO ABEE, a subsidiary of the HELLENiQ ENERGY Group, as well as to specific special customers, while more than 50% of production is exported. All the Group's refined products meet the applicable European standards (Euro VI). During 2021, domestic market sales, due to the gradual recovery of fuel demand in the second Semester and the increase in tourist traffic, showed an increase of 2%, compared to 2020, and reached 4.1 million tons, with traffic fuels to return to the corresponding levels of 2019 (pre-Covid-19 period) [37].

Figure 53: HELLENiQ ENERGY's Refinery Product Sales per Trade Channel (MT'000)



Source: HELLENiQ ENERGY

On July 29, 2021, the Hellenic Petroleum company started the hive-down process by way of a spin-off of its refining, supply and trading and petrochemicals business and its transfer to a new entity that will be established in accordance with par. 3 of Article 57, Articles 59-74 of L. 4601/2019 and Article 52 of Law 4172/2013, as in force [38].

The Extraordinary General Meeting of the Shareholders of the Hellenic Petroleum company on September 20, 2022 approved the amendment of the company's corporate name to "HELLENiQ ENERGY Holdings Société Anonyme" and its distinctive title to "HELLENiQ ENERGY Holdings S.A.".

The Ministry of Development and Investments with its decision no. 2709611ΑΠ/23.09.2022 approved the amendment of the relevant article of the company's Articles of Association. The Athens Stock Exchange's Corporate Actions Committee was notified on September 29, 2022 of the aforementioned decision and respective amendment. Following the above and the Committee's decision, the Company's corporate name on the Athens Exchange will change, with effect from October 4, 2022, to "HELLENiQ ENERGY Holdings Société Anonyme" and its distinctive title to "HELLENiQ ENERGY Holdings S.A.".

Motor Oil Refinery

The total amount of crude and other raw materials processed by the company in fiscal year 2021, compared to fiscal year 2020, is analyzed below [39].

Table 7: Motor Oil's Aggregate Volume of Crude Oil and Other Raw Materials

	Metric Tons 2021	Metric Tons 2020
Crude	9,454,053	8,646,406
Fuel Oil raw material	1,052,457	963,678
Gas Oil	2,355,477	2,109,302
Other	284,275	197,700
Total	**13,146,262**	**11,917,086**

Source: Motor Oil

The figures for the evolution of the refinery's production per product and the company's sales per product over 2020-2021 can be seen in the tables below.

Table 8: Motor Oil's Refinery Production per Product, 2021 and 2020

Refinery Production per Product	Thousand MT 2021	Thousand MT 2020
Lubricants	231	236
LPG	212	211
Gasoline	1,876	1,665
Jet Fuel	1,063	844
Diesel (Automotive - Heating)	4,682	4,766
Naphtha	729	691
Semi-finished products	43	43
Special Products	1,117	1,535
Fuel Oil	2,617	1,431
Total	**12,569**	**11,421**

Source: Motor Oil

Table 9: Motor Oil's Sales per Product and Refinery Production per Product, 2021 and 2020

Sales per Product	Thousand MT 2021	Thousand MT 2020
Asphalt	976	1,446
Fuel Oil	2,713	1,580
Diesel (Automotive - Heating)	4,705	4,997
Jet Fuel	1,685	1,082
Gasoline	2,379	2,084
LPG	219	208
Lubricants	262	278
Other	1,327	974
Total (Products)	**14,266**	**12,649**
Crude Sales / Other Sales	6	1
Total	**14,272**	**12,650**

Source: Motor Oil

The lower amount of crude oil and petroleum products in fiscal year 2020, compared to fiscal year 2021, is due to a significant extent to the periodic maintenance works of the refinery units with emphasis on the mild hydrocracking complex that were carried out between January and February 2020 [39].

Pump Prices

The trajectory of the retail price of a petroleum product (i.e. the price at the pump of a gas station) is determined mostly by the trajectory of the international price of the corresponding product, but also by the refining margins, which refiners set for the various product categories. This international price is determined on the stock market every day by the purchase and sale of products and contracts, as is the case for other products that are a type of stock exchange transaction and constitutes the reference price for off-market fuel purchases and sales as well [40].

That is, the buyer enters into an agreement to receive a quantity of fuel at a price of X dollars per ton above the international price of the future delivery date. This way of determining the price, based on a reference to a price that is not known in advance, is the usual way of dealing in international fuel buying and selling.

International prices are almost always the benchmark for fuel purchase contracts between refiners and their customers. That is, the current selling price of the products produced by the refineries is determined based on international prices, exchange rates and the refining margin. In addition to international prices (i.e. essentially prices from the refinery), the specific price at the pump of a gas station is also determined by the following factors [40]:

- the taxes and duties imposed on fuel by the Greek State
- the depreciation of the gas station's fixed investments
- the cost of transportation and distribution

- administrative costs
- the profit of the trading company and
- the owner's profit of the gas station.

Retail fuel prices vary considerably across the EU-27, as shown in Table 10, mainly due to differences in national tax rates. The price of Eurosuper 95 in Greece was set at €1,905 per liter on 20 February 2023 – significantly higher than the EU-27 average of €1,698.01/lt. The Eurosuper 95 price in Romania was set at €1,350/lt on 20 February 2023, significantly lower than the EU-27 average. Similarly, the Eurosuper 95 price in Bulgaria stood at €1.303/lt on 5 December – also significantly below the EU-27 average [41].

Table 10: Fuel Prices (Including Taxes) in Selected Countries on February 20, 2023

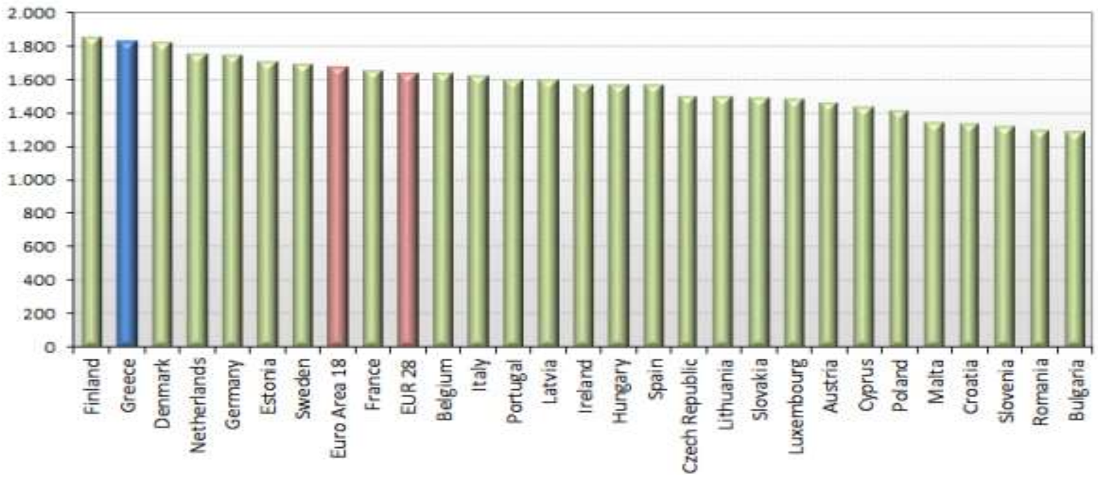
Country	95 RON Unleaded (€/lt)	Gas Oil Automobile (€/lt)	Heating Oil (€/lt)
Bulgaria	1,303	1,443	1,179
Croatia	1,438	1,544	0,965
Cyprus	1,381	1,569	1,108
Greece	1,902	1,718	1,200
Hungary	1,617	1,652	1,652
Italy	1,860	1,837	1,577
Romania	1,350	1,477	1,381
Slovakia	1,569	1,552	-
Slovenia	1,367	1,535	1,134
Spain	1,637	1,611	1,097

Source: ec.europa.eu

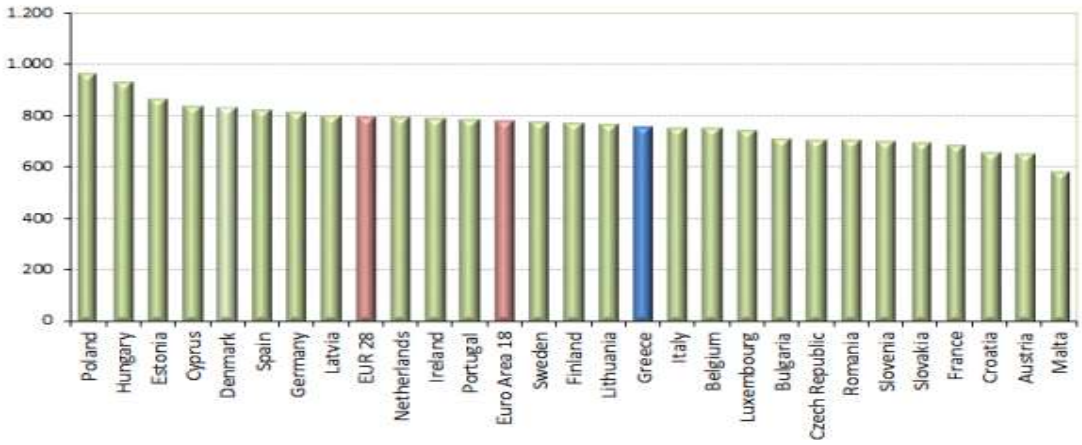
According to the weekly overview of fuel prices of the Ministry of Development and Investments concerning prices on December 26, 2022, the retail prices of unleaded gasoline, diesel and heating oil with and before taxes in the EU-27 are presented in the diagrams below [42]:

Figure 54: Retail price (€) for petrol, diesel and heating oil with and without taxes, 26/12/2022

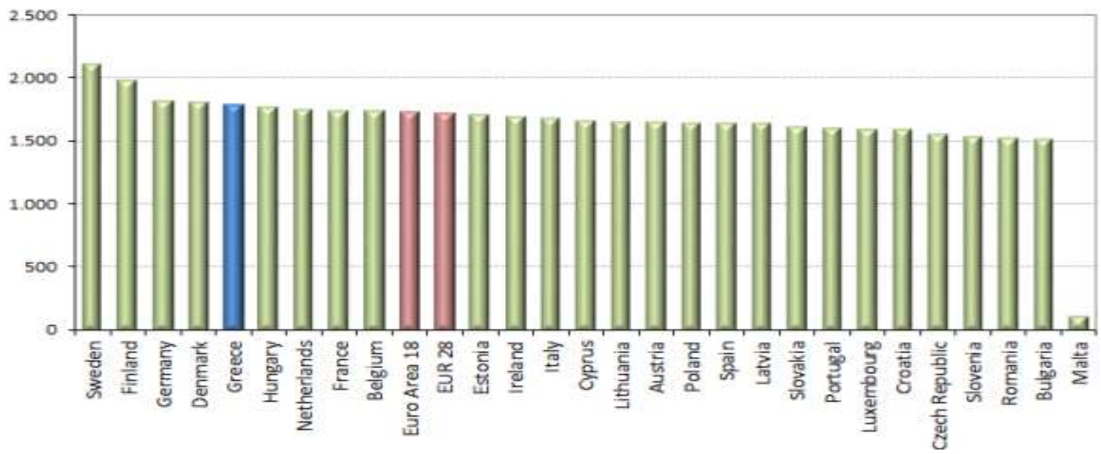
Euro super 95 with taxes – 26/12/2022



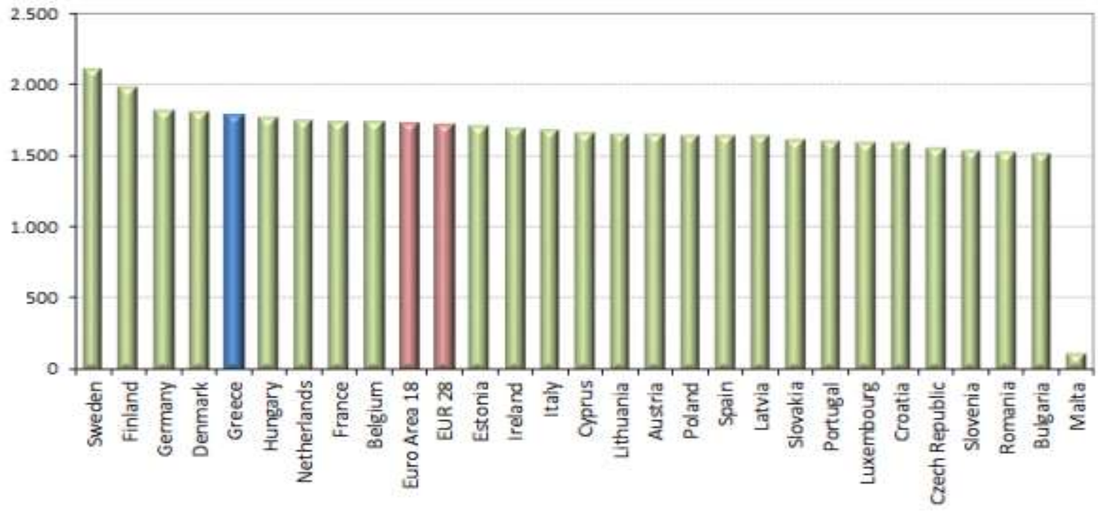
Euro super 95 without taxes – 26/12/2022



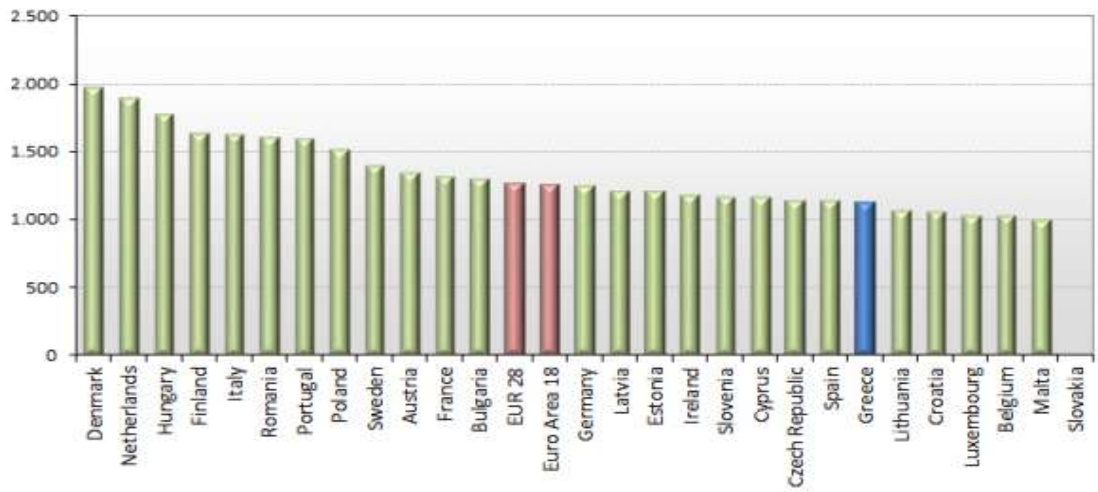
Fuel oil with taxes – 26/12/2022



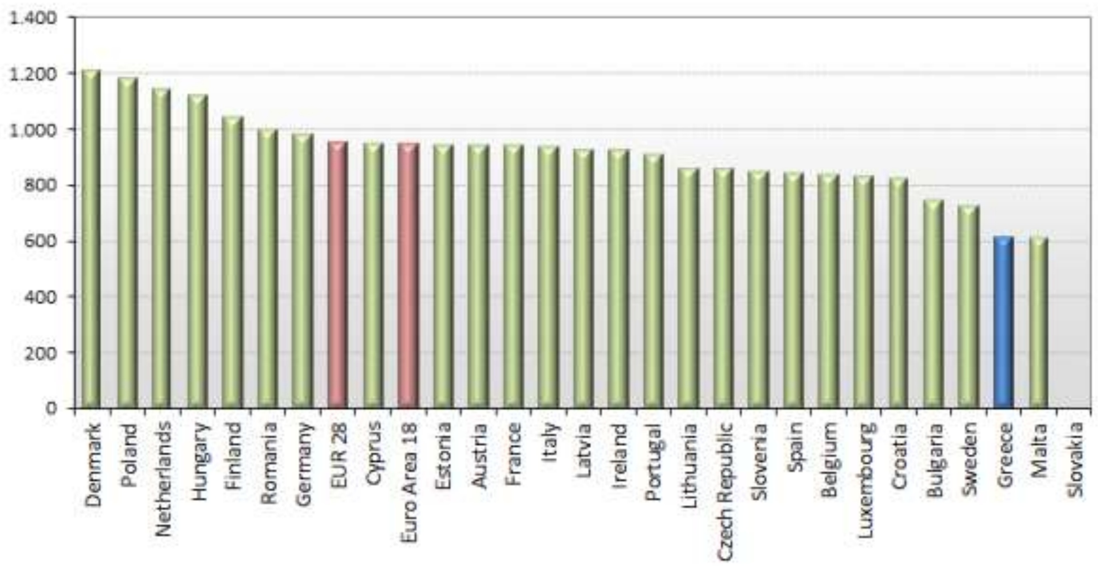
Fuel oil without taxes – 26/12/2022



Heating oil with taxes – 26/12/2022



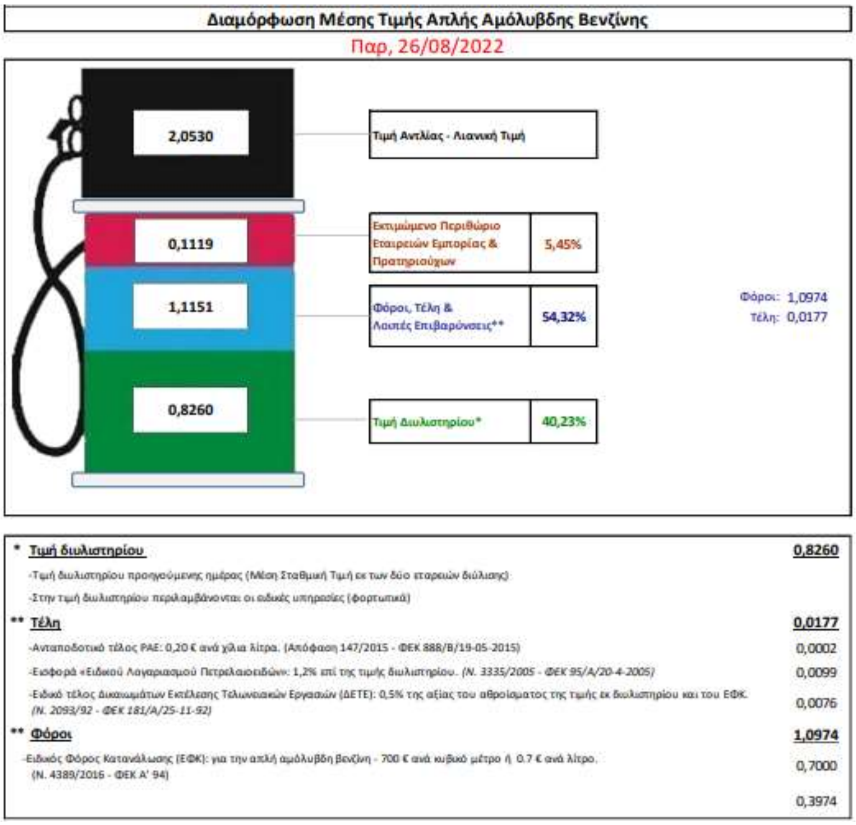
Heating oil without taxes – 26/12/2022

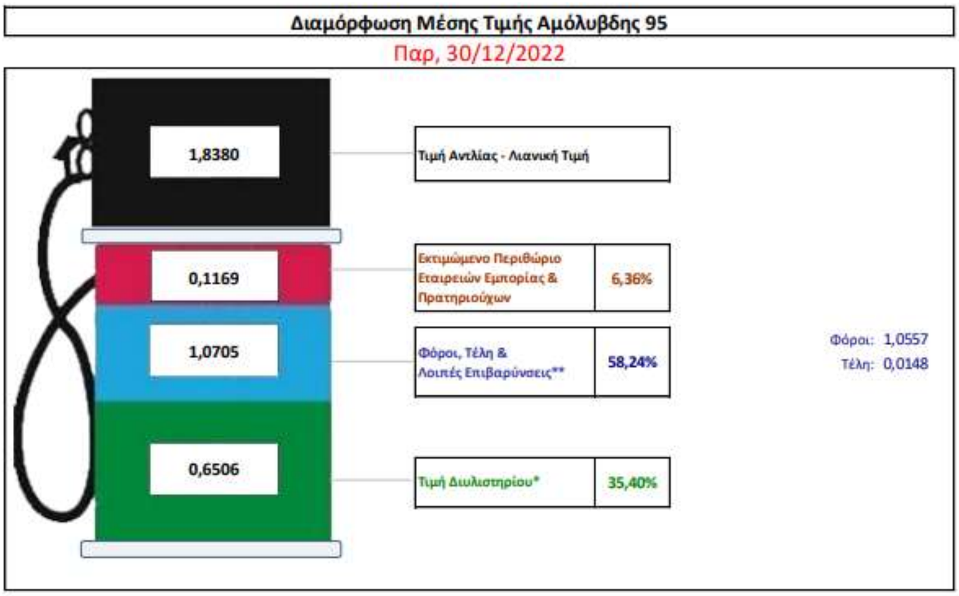


Source: Ministry of Development and Investments

As an example regarding the retail price, the final retail price of gasoline on August 26, 2022 and December 30, 2022 will be mentioned, the latter being formed by the refinery price by 35.40%, by taxes (fixed and variable) by 58.24%, and from the estimated margins of trading companies, liquid fuel carriers and gas stations by 6.36% [43].

Figure 55: Formulation of Average Price of Unleaded Gasoline, 26/08/2022 and 30/12/2022



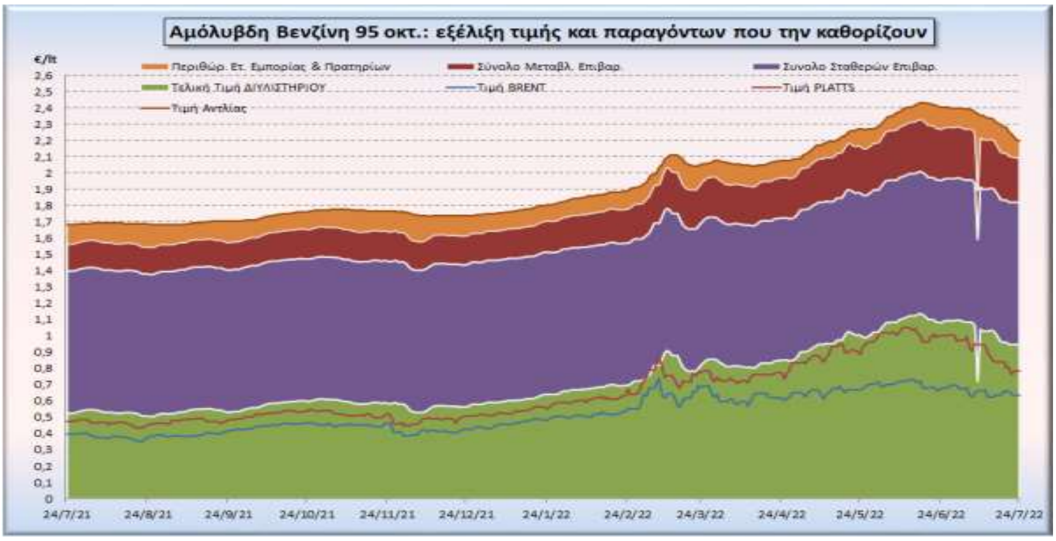


* **Τιμή διυλιστηρίου**	**0,6506**
-Τιμή διυλιστηρίου προηγούμενης ημέρας (Μέση Σταθμική Τιμή εκ των δύο εταιρειών διύλισης)	
-Στην τιμή διυλιστηρίου περιλαμβάνονται οι ειδικές υπηρεσίες (φορτωτικά)	
** **Τέλη**	**0,0148**
-Ανταποδοτικό τέλος ΡΑΕ: 0,20 € ανά χίλια λίτρα. (Απόφαση 147/2015 - ΦΕΚ 888/Β/19-05-2015)	0,0002
-Εισφορά «Ειδικού Λογαριασμού Πετρελαιοειδών»: 1,2% επί της τιμής διυλιστηρίου. (Ν. 3335/2005 - ΦΕΚ 95/Α/20-4-2005)	0,0078
-Ειδικό τέλος Δικαιωμάτων Εκτέλεσης Τελωνειακών Εργασιών (ΔΕΤΕ): 0,5% της αξίας του αθροίσματος της τιμής εκ διυλιστηρίου και του ΕΦΚ. (Ν. 2093/92 - ΦΕΚ 181/Α/25-11-92)	0,0068
** **Φόροι**	**1,0557**
-Ειδικός Φόρος Κατανάλωσης (ΕΦΚ): για την απλή αμόλυβδη βενζίνη - 700 € ανά κυβικό μέτρο ή 0.7 € ανά λίτρο. (Ν. 4389/2016 - ΦΕΚ Α' 94)	0,7000
-Φόρος Προστιθέμενης Αξίας (ΦΠΑ): 24% επί του συνόλου της τιμής διυλιστηρίου των μικτών ονομαστικών περιθωρίων κέρδους και των παραπάνω φορολογικών επιβαρύνσεων. (Ν. 2859/2000 όπως τροποποιήθηκε και ισχύει με το Ν. 4389/2016 (ΦΕΚ Α' 94)	0,3557

Source: Ministry of Development and Investments

The trend of Brent, Platts (HCIF/MED), refinery prices and retail prices of 95 octane unleaded gasoline, as well as the corresponding indicative trading margins up to 24 July 2022 are presented in Figure 56 [43]:

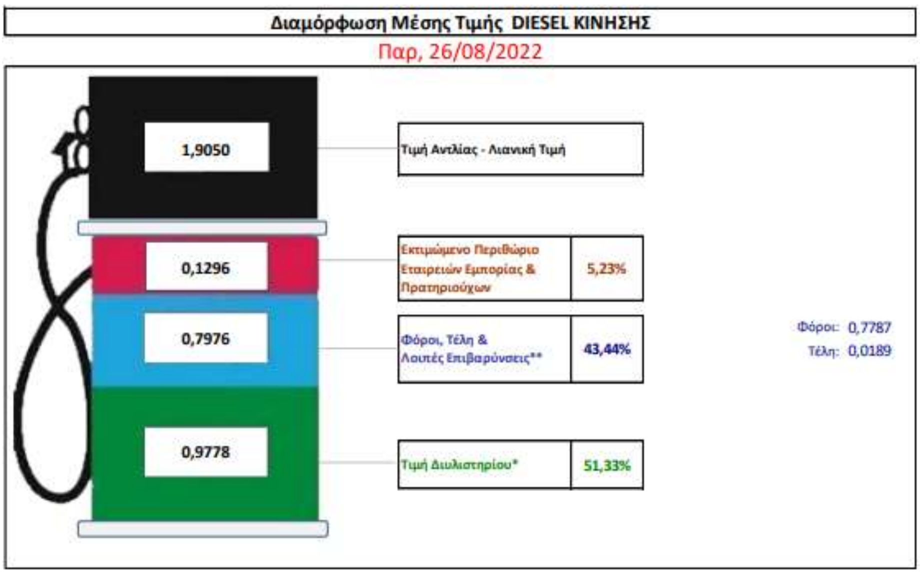
Figure 56: 95 RON Unleaded: Price Evolution and Factors that Determine it



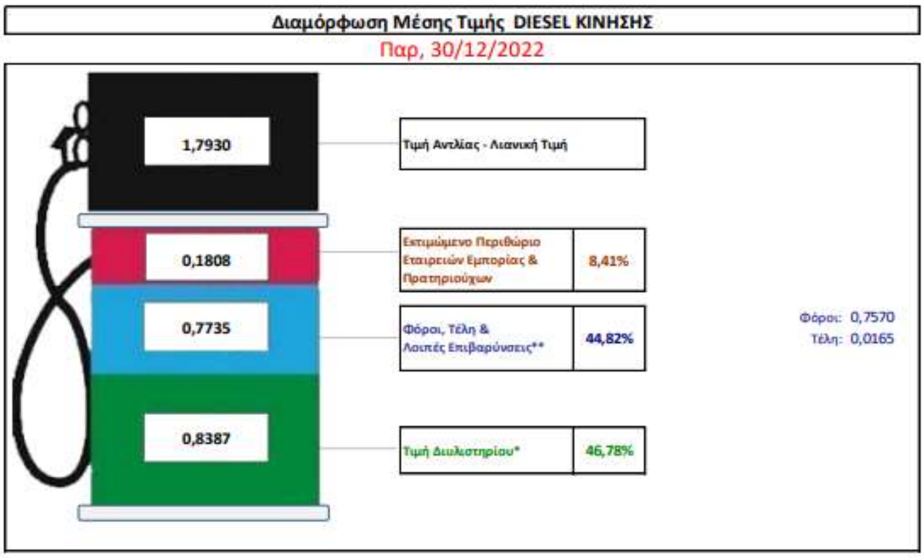
Source: Ministry of Development and Investments

For August 26, 2022 and December 30, 2022, the final retail price for diesel traffic is formed by the refinery price by 51.33% in August 2022 and 46.78% in December 2022, by taxes (fixed and variable) by 43.44% in December and 44.82% in December, and from the estimated margins of trading companies, liquid fuel carriers and gas stations by 5.23% and 8.41% respectively [43].

Figure 57: Formulation of Average Price of Diesel Oil, 26/8/2022 and 30/12/2022



* **Τιμή διυλιστηρίου**	**0,9778**
-Τιμή διυλιστηρίου προηγούμενης ημέρας (Μέση Σταθμική Τιμή εκ των δύο εταιρειών διύλισης)	
-Στην τιμή διυλιστηρίου περιλαμβάνονται οι ειδικές υπηρεσίες (φορτωτικά)	
** **Τέλη**	**0,0189**
-Ανταποδοτικό τέλος ΡΑΕ: 0,20 € ανά χίλια λίτρα. (Απόφαση 147/2015 - ΦΕΚ 888/Β/19-05-2015)	0,0002
-Εισφορά «Ειδικού Λογαριασμού Πετρελαιοειδών»: 1,2% επί της τιμής διυλιστηρίου. *(Ν. 3335/2005 - ΦΕΚ 95/Α/20-4-2005)*	0,0117
-Ειδικό τέλος Δικαιωμάτων Εκτέλεσης Τελωνειακών Εργασιών (ΔΕΤΕ): 0,5% της αξίας του αθροίσματος της τιμής εκ διυλιστηρίου και του ΕΦΚ. *(Ν. 2093/92 - ΦΕΚ 181/Α/25-11-92)*	0,0069
** **Φόροι**	**0,7787**
-Ειδικός Φόρος Κατανάλωσης (ΕΦΚ): για το πετρέλαιο κίνησης - 410 € ανά κυβικό μέτρο ή 0,41 € ανά λίτρο. (Ν. 4389/2016 - ΦΕΚ Α' 94)	0,4100
-Φόρος Προστιθέμενης Αξίας (ΦΠΑ): 24% επί του συνόλου της τιμής διυλιστηρίου των μικτών ονομαστικών περιθωρίων κέρδους και των παραπάνω φορολογικών επιβαρύνσεων. (Ν. 2859/2000 όπως τροποποιήθηκε και ισχύει με το Ν. 4389/2016 (ΦΕΚ Α' 94)	0,3687

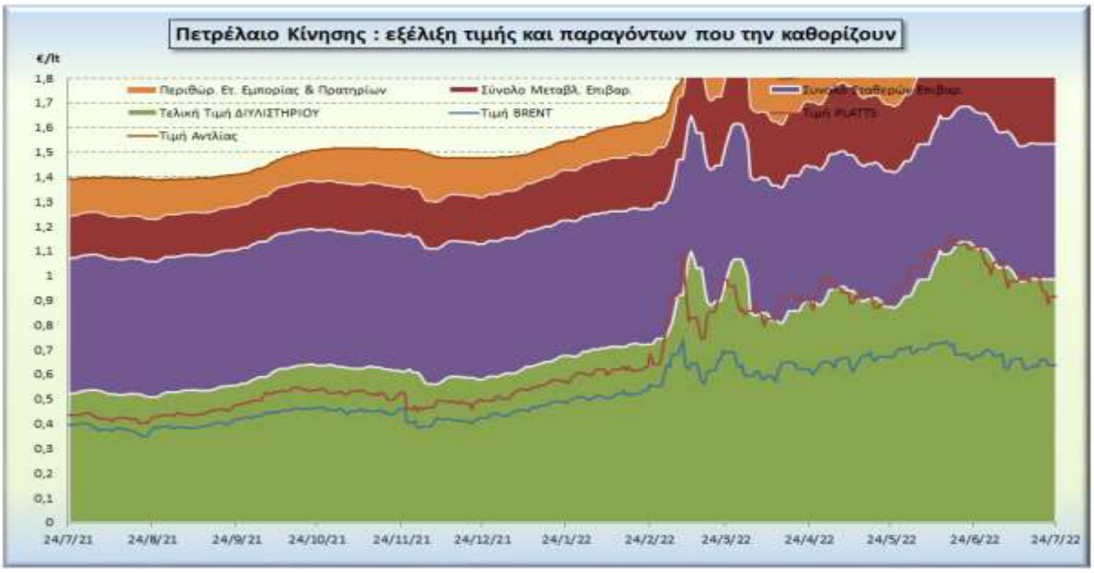


* **Τιμή διυλιστηρίου**	**0,8387**
-Τιμή διυλιστηρίου προηγούμενης ημέρας (Μέση Σταθμική Τιμή εκ των δύο εταιρειών διύλισης)	
-Στην τιμή διυλιστηρίου περιλαμβάνονται οι ειδικές υπηρεσίες (φορτωτικά)	
** **Τέλη**	**0,0165**
-Ανταποδοτικό τέλος ΡΑΕ: 0,20 € ανά χίλια λίτρα. (Απόφαση 147/2015 - ΦΕΚ 888/Β/19-05-2015)	0,0002
-Εισφορά «Ειδικού Λογαριασμού Πετρελαιοειδών»: 1,2% επί της τιμής διυλιστηρίου. *(Ν. 3335/2005 - ΦΕΚ 95/Α/20-4-2005)*	0,0101
-Ειδικό τέλος Δικαιωμάτων Εκτέλεσης Τελωνειακών Εργασιών (ΔΕΤΕ): 0,5% της αξίας του αθροίσματος της τιμής εκ διυλιστηρίου και του ΕΦΚ. *(Ν. 2093/92 - ΦΕΚ 181/Α/25-11-92)*	0,0062
** **Φόροι**	**0,7570**
-Ειδικός Φόρος Κατανάλωσης (ΕΦΚ): για το πετρέλαιο κίνησης - 410 € ανά κυβικό μέτρο ή 0,41 € ανά λίτρο. (Ν. 4389/2016 - ΦΕΚ Α' 94)	0,4100
-Φόρος Προστιθέμενης Αξίας (ΦΠΑ): 24% επί του συνόλου της τιμής διυλιστηρίου των μικτών ονομαστικών περιθωρίων κέρδους και των παραπάνω φορολογικών επιβαρύνσεων. (Ν. 2859/2000 όπως τροποποιήθηκε και ισχύει με το Ν. 4389/2016 (ΦΕΚ Α' 94)	0,3470

Source: Ministry of Development and Investments

The trend of Brent, Platts (HCIF/MED), refinery prices and retail prices for diesel, as well as the corresponding indicative trading margins until July 24, 2022 are presented in Figure 58.

Figure 58: B7 Fuel Oil: Price Evolution and Factors that Determine it

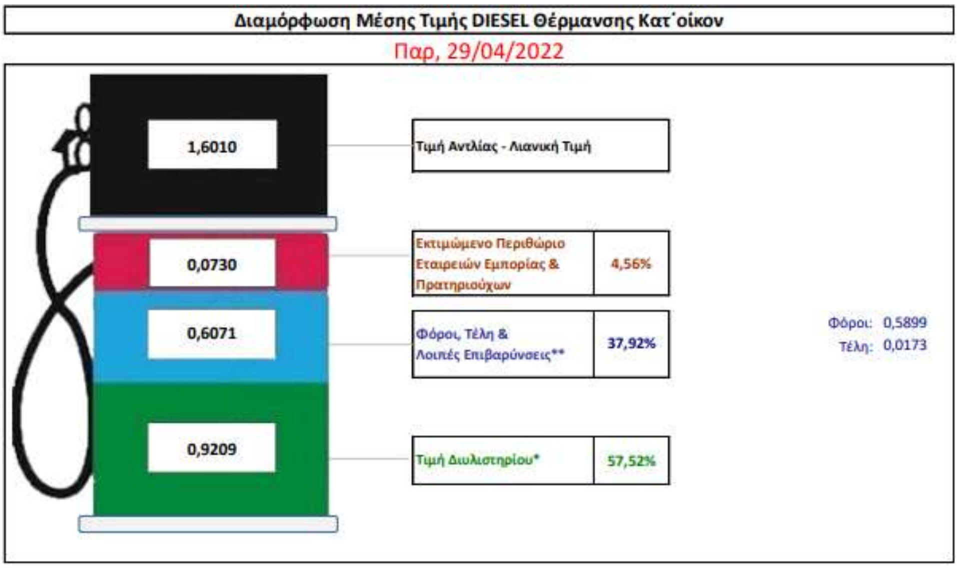


Source: Ministry of Development and Investments

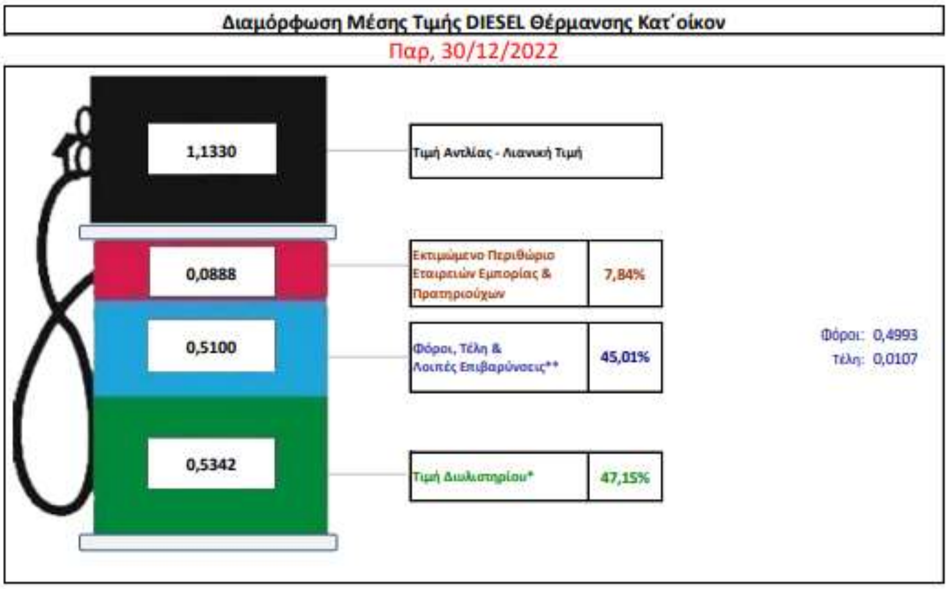
For April 29, 2022 and December 30, 2022, the final retail price of heating oil is formed by the refinery price by 57.52% and 47.15% respectively, by taxes (fixed and variable) by

37.92% and 45.01% respectively, and from the estimated margins of trading companies, liquid fuel transporters and gas stations by 4.56% and 7.84% respectively [43].

Figure 59: Formulation of Average Price of Heating Diesel at Home, 29/4/2022 and 30/12/2022



* **Τιμή διυλιστηρίου**	**0,9209**
-Τιμή διυλιστηρίου προηγούμενης ημέρας (Μέση Σταθμική Τιμή εκ των δύο εταιρειών διύλισης)	
-Στην τιμή διυλιστηρίου περιλαμβάνονται οι ειδικές υπηρεσίες (φορτωτικά)	
** **Τέλη**	**0,0173**
-Ανταποδοτικό τέλος ΡΑΕ: 0,20 € ανά χίλια λίτρα. (Απόφαση 147/2015 - ΦΕΚ 888/Β/19-05-2015)	0,0002
-Εισφορά «Ειδικού Λογαριασμού Πετρελαιοειδών»: 1,2% επί της τιμής διυλιστηρίου. *(Ν. 3335/2005 - ΦΕΚ 95/Α/20-4-2005)*	0,0111
-Ειδικό τέλος Δικαιωμάτων Εκτέλεσης Τελωνειακών Εργασιών (ΔΕΤΕ): 0,5% της αξίας του αθροίσματος της τιμής εκ διυλιστηρίου και του ΕΦΚ. *(Ν. 2093/92 - ΦΕΚ 181/Α/25-11-92)*	0,0060
** **Φόροι**	**0,5899**
-Ειδικός Φόρος Κατανάλωσης (ΕΦΚ): για το πετρέλαιο θέρμανσης - 280 € ανά κυβικό μέτρο ή 0,280 € ανά λίτρο. (Ν. 4389/2016 (ΦΕΚ Α' 94)	0,2800
-Φόρος Προστιθέμενης Αξίας (ΦΠΑ): 24% επί του συνόλου της τιμής διυλιστηρίου των μικτών ονομαστικών περιθωρίων κέρδους και των παραπάνω φορολογικών επιβαρύνσεων. (Ν. 2859/2000 όπως τροποποιήθηκε και ισχύει με το Ν. 4389/2016 (ΦΕΚ Α' 94)	0,3099

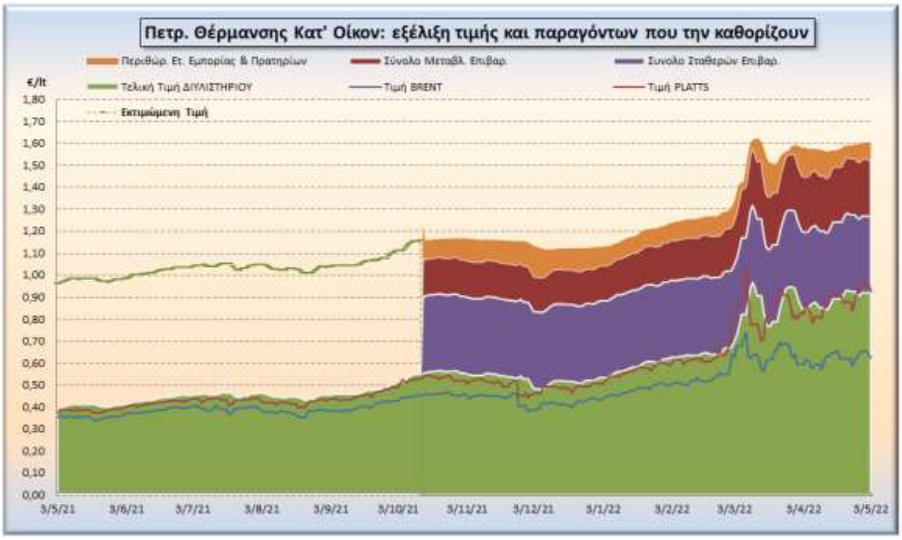


* **Τιμή διυλιστηρίου**	**0,5342**
-Τιμή διυλιστηρίου προηγούμενης ημέρας (Μέση Σταθμική Τιμή εκ των δύο εταιρειών διύλισης)	
-Στην τιμή διυλιστηρίου περιλαμβάνονται οι ειδικές υπηρεσίες (φορτωτικά)	
** **Τέλη**	**0,0107**
-Ανταποδοτικό τέλος ΡΑΕ: 0,20 € ανά χίλια λίτρα. (Απόφαση 147/2015 - ΦΕΚ 888/Β/19-05-2015)	0,0002
-Εισφορά «Ειδικού Λογαριασμού Πετρελαιοειδών»: 1,2% επί της τιμής διυλιστηρίου. *(Ν. 3335/2005 - ΦΕΚ 95/Α/20-4-2005)*	0,0064
-Ειδικό τέλος Δικαιωμάτων Εκτέλεσης Τελωνειακών Εργασιών (ΔΕΤΕ): 0,5% της αξίας του αθροίσματος της τιμής εκ διυλιστηρίου και του ΕΦΚ. *(Ν. 2093/92 - ΦΕΚ 181/Α/25-11-92)*	0,0041
** **Φόροι**	**0,4993**
-Ειδικός Φόρος Κατανάλωσης (ΕΦΚ): για το πετρέλαιο θέρμανσης - 280 € ανά κυβικό μέτρο ή 0,280 € ανά λίτρο. (Ν. 4389/2016 (ΦΕΚ Α' 94)	0,2800
-Φόρος Προστιθέμενης Αξίας (ΦΠΑ): 24% επί του συνόλου της τιμής διυλιστηρίου των μικτών ονομαστικών περιθωρίων κέρδους και των παραπάνω φορολογικών επιβαρύνσεων. (Ν. 2859/2000 όπως τροποποιήθηκε και ισχύει με το Ν. 4389/2016 (ΦΕΚ Α' 94)	0,2193

Source: Ministry of Development and Investments

The trend of Brent, Platts (HCIF/MED), refinery prices, retail prices for home heating oil, as well as the corresponding indicative trading margins until May 3, 2022 are presented in Figure 60.

Figure 60: Heating Diesel at Home: Price Evolution and Factors that Determine it



Source: Ministry of Development and Investments

Refining is a successful branch 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. Any new obligations imposed on the refining sector under the new energy efficiency obligation scheme must take these limitations into account.

5.1.5 Exploration and Exploitation of Hydrocarbons in Greece

According to the Special Report of the IENE Hydrocarbons Committee (Upstream) “Economic and Geopolitical Benefits from Hydrocarbons’ Exploitation in Greece” [44], which completed in April 2022, and according to numerous published analyzes and studies by international institutes, companies and countries, hydrocarbons were, are and will continue to be for several more decades a key component of the energy mix of the global, European and the Greek economy, with natural gas in particular being the transitional fuel.

The current global 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 center of social and economic thinking. It is now becoming clear that in the complex and unstable geopolitical environment, the pursuit of energy self-sufficiency will once again be set as a key objective of any energy strategy. As it has already become clear, the crisis has pushed the EU to rearrange its energy policy, with the aim of aboilishing Russian natural gas as quickly as possible. In this context, several member states are revising their energy strategy, assessing with a different perspective the exploration of hydrocarbons in their territory, as they are now preparing plans to abolish Russian imports of energy products.

The “hydrocarbons” chapter starts again to be considered a priority for many European countries. Norway, one of Europe’s main suppliers of natural gas, has announced a new round of concessions on nine more Arctic offshore blocks, Denmark has announced that it will exploit its own oil fields by 2050, while the UK government intends to exploit its own deposits in the North Sea. Also, the Netherlands continues to exploit the large Groningen natural gas field until depletion, while Italy secures its backs through the energy giant ENI [45], with Spain following with Repsol and France with Total Energies expanding into the wider geographical area of the SE Mediterranean, Middle East and North Africa. At the same time, we have been witnessing an increase in the exploration and production activities of small gas fields in Southern, Central and Eastern Europe as well as in larger offshore fields in the Black Sea (Hungary, Poland, Romania, Bulgaria and Turkey).

Europe’s strategic decision to rapidly abolish Russian natural gas and the need to find alternative sources of supply, together with the oil price skyrocketing to levels above $70 a barrel, is making hydrocarbon exploration commercially viable again in deep seas and complex geological environments and stimulated the interest in potential deposits in Greece. An important development, because Greece is a country that depends almost 100% on oil and natural gas imports, with a huge participation of these in the energy balance. Thus, the discovery of commercially exploitable hydrocarbon deposits is expected to be of enormous importance to both the economy and its national security.

A careful reading of the recent NECP and the Pissarides Report reveals that hydrocarbons, and in particular natural gas, will continue to account for more than 50% of Greece’s energy mix for several decades to come. As it is clear, based on numerous studies, that fossil fuels are NOT going to be completely replaced, at least until 2050, by other energy sources such as RES and green hydrogen, and RES will act complementary to fossil fuels, with natural gas playing the role of transitional fuel, Greece must urgently proceed to strengthen and accelerate its domestic hydrocarbon exploration and exploitation activities [44].

Studies prepared by the Hellenic Hydrocarbons and Energy Resources Management Company (HEREMA) and the Academy of Athens, as well as publications by reputable academics and companies, concluded that there is a high propability for the existence of very significant 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.) [44]. In fact, the IENE study mentioned earlier estimates that the potential reserves of natural gas in the country may reach levels of 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 surveys, which need further geological and geophysical studies and of course drilling for the veryfication of natural gas deposits.

Despite the long-term efforts since 1975 of the Greek government and the joint venture schemes of public and private Greek and foreign companies, the Greek Hydrocarbon Research and Production Industry, apart from the activity in the Prinos area in the North Aegean, has not been developed significantly. This occurred not because of negative technical results from the research works, but mainly because of the long-term delays and interruptions of the research works caused by the delays and the lack of continuity and consistency of the Greek government, 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 still are optimistic, based on the results of geochemical, geological and geophysical studies and drillings, in comparison with discoveries in the wider area, particularly during 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 major oil companies, in conjuction with the published positive results of the research works, strengthen the prospects for the existence of very important hydrocarbon reserves, especially in the sea blocks of Ionion, Crete and Thermaikos and in the land area of Western Greece.

Therefore, it is necessary to give guarantees to the investors of the Greek concession areas, in order to speed up the hydrocarbon exploration activities. The gradual weakening of the coronavirus pandemic internationally will lead to a gradual increase in the demand and production of hydrocarbons. As long as the supply remains reduced, the energy cost of hydrocarbons will remain high. Greece must and can change from being an exporter of petroleum products and an importer of crude and natural gas into a producer of hydrocarbons and an exporter of natural gas. This development is estimated to create business opportunities in related industrial sectors (shipyards, chemical industry, pipeworks, etc.), with an increase in private investment, new jobs, while reducing overall energy costs, increasing energy security and diversification of supply, revitalization of the indebted economy, while giving increased geopolitical and geostrategic value to the country.

The goal of the political leadership is to start seismic surveys as soon as possible, in order to evaluate the potential of the deposits and to decide whether their exploitation is beneficial. This practically translates into immediate implementation of the outstanding contractual obligations of the contractor companies with a first programme costing several 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 the surveys until discovery and production, requires about 7-10 years.

In this context, the government decided to speed up and intensify the processes of finding hydrocarbons. Thus, at the beginning of April 2022, a meeting was held between the political leadership of the Ministry of Foreign Affairs and the administration of HEREMA, the aim of which was to reassess whether and in what way hydrocarbon activities could be incorporated more effectively in the new global environment that have been shaped due to the war in Ukraine. The result was the Prime Minister’s statements on the measures to deal with the energy crisis, which he stated that “for the energy self-sufficiency of the country, in addition to the investments in RES, we should convert Greece into a gateway for energy products and energy savings, while the exploitation of national deposits is certainly included natural gas with financial interest".

Historical background

After a deafening silence and indifference to hydrocarbon exploration activities for an extremely long period of time that actually reached 15 years (1996-2011), the Greek government woke up in the midst of the financial crisis and revised the legislative framework (2011), conducted geophysical surveys with new technology to attract investors (2012) and gradually proceeded to call for international tenders (2012-2015) with the ratification of 11 Lease Agreements in the Hellenic Parliament (2014-2019).

In addition, the necessary Strategic Environmental Impact Assessemnts were completed and approved and the EU Environmental Directives (2016) were incorporated into Greek Law. The presence of HELLENiQ ENERGY (shareholder is the Greek State with 35%) was decisive with the comparative advantage of the in-depth knowledge of the Greek area by its high-level geoscientists, combined with its strong commercial and financial position, while the competitive presence of the constantly strengthening Energean was absolutely positive. In the 2010s, there was a cross-party will to boost hydrocarbon exploration activities, which was unfortunately burdened by the familiar backslidings of public administration that showed that interest was steadily waning.

Regarding hydrocarbon exploration activities in Greece, the climate has turned negative in the last two years (2020-2021). In view of Climate Change priorities and the policy to deal with it, despite their positive moves in the period 2012-2019, almost all political parties began to oppose exploration activities with obvious negative impact on the state apparatus (environmental permits, transit permits, etc.). Also, due to the spread of the coronavirus pandemic since the beginning of 2020 and the changing strategy of the oil companies, which had a presence in the Greek upstream market, some of them decided to change their strategy and invest more on green energy projects.

At the same time, the objections by environmental organizations against hydrocarbon exploration activities in the country intensified, such as obstruction in the execution of seismic surveys by Repsol in the area of Ioannina, public consultations in Western Greece, legal appeals to the Council of State (e.g. against the seismic environmental permit in the Ioannina region, against the Strategic Environmental Impact Assessment in the Crete region). While the final decisions of the Council of State rejected the objections of the ecological organizations, the significant long-term delay in the adjudication and issuance of the decision, combined with the corresponding approvals of environmental permits (see Katakolo area where the approval of an environmental permit to carry out production drilling is still pending since 2019), created a negative business climate for the continuation of exploration activities.

The skepticism of the political parties also affected individual local players who reacted, rather mildly, while the majority of local government representatives (Regional Mayors and Regional Councils of Peloponnese, Western Greece, Epirus, Crete) during the mandatory public consultations positioned themselves positively for conducting exploration activities. Of particular interest is that the wider public opinion and local communities, in the vast 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, seems at first embarrassed and then does not react positively to the investors (oil companies) who ask for guarantees to protect their investments, especially in the case of drilling and discovery of deposits where investments amount to tens of million dollars. At the same time, the advent of Covid-19 and the reduced energy demand in 2020-2021 temporarily "hit" the oil industry. In this context, oil companies are forced to readjust their strategy and some of them prepare either to withdraw, returning the concessions to the Greek State, or to freeze exploration investments, while the rest of them are on standby given the positive prospects of the areas under investigation. Consequently, the state-owned HEREMA, which is mandated to oversee business activities and coordinate exploration activities, is now in an obvious predicament and is forced to grant, within the limits of legality, extensions to the execution of contractually mandated exploration activities.

The business situation worsened with the statements of the Greek Minister of Foreign Affairs, who stated in April 2021[30], as in February 2022[31], that Greece is not going to become an oil and gas producing country. A typical example of the negative climate that had formed in 2021 in the Greek hydrocarbon market was the sending of an open letter to the Greek Prime Minister by a group of 47 young executives, specialized in the sector and employed in positions of responsibility in large companies, organizations and educational institutions, mainly abroad, in an effort to stimulate interest in hydrocarbon exploration activities in Greece.

It is recalled that the Spanish Repsol, which participated, as 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 to the

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

Aitoloakarnania area before they even started 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 held 50% and management, although fulfilling its contractual obligations arising from the Lease Agreements with the Greek State.

The two Greek companies, however, continue the exploration activities; Energean in the Ioannina region and HELLENiQ ENERGY UPSTREAM in the Ionian Sea. Repsol's withdrawal is officially related to the new global strategy announced by the company in October 2020, which, among others, concerns the company's commitment to withdraw from 14 countries in which it was active in hydrocarbon exploration, and where Greece was one of them, but its negative business opportunities during exploration activities, mainly in terms of licensing and support from the state, combined with the intensities and delays of the work due to the actions of ecological organizations, contributed decisively to the final business decision.

Also, Total Energies in 2021 initially withdrew from the offshore block 2 west of Corfu (joint venture Total Energies 50% operator with Edison 25% and HELLENiQ ENERGY UPSTREAM 25%), transferring its rights to Energean and then in April 2022 from the West and Southwest regions of Crete (joint venture Total Energies 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. The business experience of Total Energies was similar to that of Repsol and negatively increased its continued presence in the country, while it was the company that actively participated in international tenders, showing interest in Greece.

It is worth mentioning that, in parallel with the aforementioned business movements of international oil companies to withdraw from exploration activities in Greece, HELLENiQ ENERGY UPSTREAM proceeded with a partial divestment from the area of hydrocarbon exploration activities in August 2021, returning to the Greek State the relevant rights to the land "NW Peloponnese" and "Arta – Preveza" areas, before even carrying out the minimum geophysical exploration work as predicted in the Lease Agreement, given that the Group's strategy is now to focus hydrocarbon exploration activities only on offshore blocks.

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

Thus, at the end of 2021, hydrocarbon exploration was at a critical point, even for the fulfillment of the minimum contractual obligations arising from the Lease Agreements between the contractor companies and the Greek State [46] and which in fact had all been ratified by the Hellenic Parliament now having the force of law. And all this background is developing in the shadow of the energy crisis that is beginning to burden Europe as a result of the strategic options of the European Union to immediately change the energy mix, without having secured the necessary technologies and infrastructure.

However, the government changed its negative stance in 2022. In light of the negative developments of the war in Ukraine, the energy crisis and high energy prices, the EU is revising its energy policy and the Greek government follows. It is worth noting the characteristic speech, in February 2022, of the Secretary General of the Ministry of the Environment and Energy, Ms. Alexandra Sdoukou, at the annual hydrocarbon conference EGYPS 2022 in Cairo, Egypt, who emphasized the following: “We need more exploration activities and production of natural gas, 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”[32].

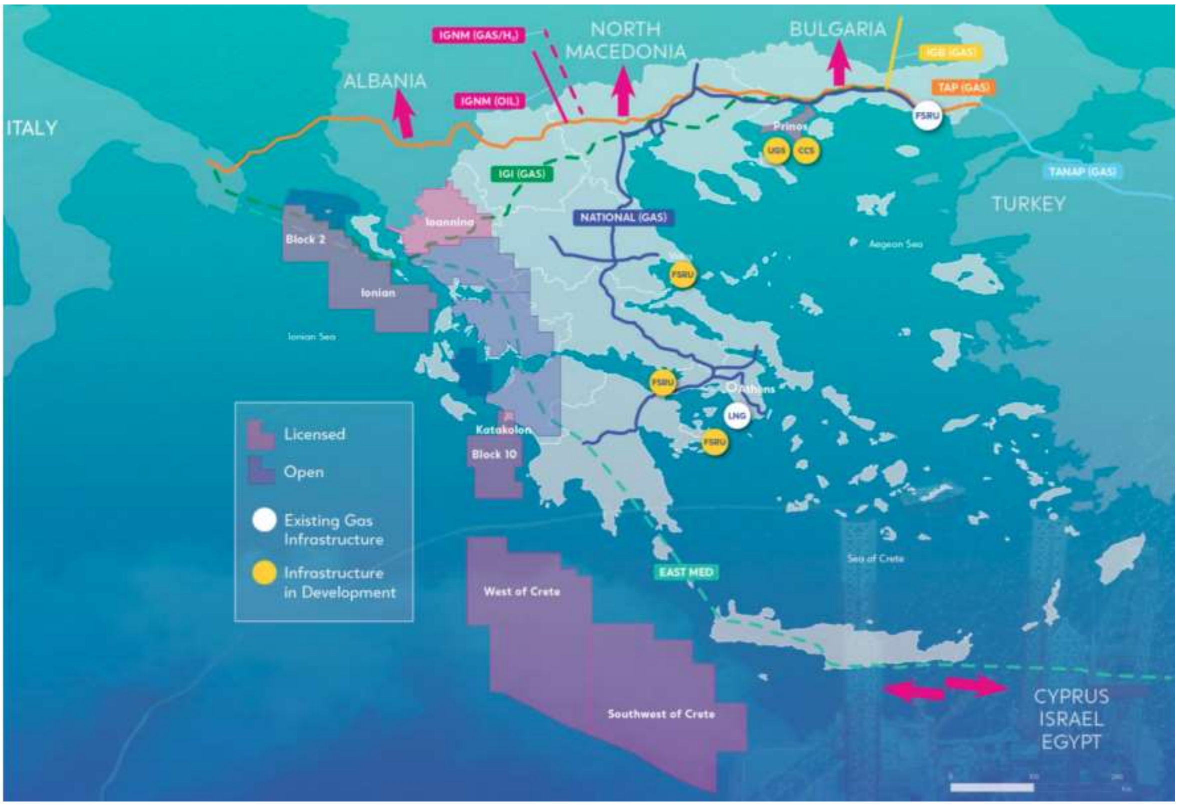
In this environment, full of backbiting and controversial positions, the companies decide and proceed with the implementation of their contractual obligations and in 2022 seven seismic campaigns are carried out in all the offshore areas that have been granted. HEREMA fully supports the work, especially the recording of seismic surveys throughout the Ionian Sea area and West of Crete. The next two years (2023-2024) will be decisive for the future of the exploration activities, since the seismic data will be processed and interpreted, the existing studies will be combined with the new findings and important technical and business decisions will be made by the companies on whether or not to continue the activities. For the time being, the official statements of the parties involved from the Greek State (HEREMA, Ministry of the Environment and Energy) are more than positive and create further optimism for the discovery of significant hydrocarbon deposits. [47]

After seven years (2012-2019) of successfully conducted by the Greek State 4 international tenders for the granting of Hydrocarbon Exploration and Production rights, during which 11 new areas were gradually granted, the result is that today exploration activities are being

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

carried out in 8 areas in Epirus, the Ionian Sea and the offshore area of Crete, including also the exploration and production areas of the Prinos concession (see Map 3). [48]

Map 3: Portfolio of Active Concession Areas



Source: HEREMA

<u>Current status of exploration activities</u>

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

<u>Ionian Region and Region 10</u>

Area 10 Lease Agreement: Law 4630/2019 (Government Gazette A΄155/10.10.2019)

Ionian Region Lease Agreement: Law 4629/2019 (Government Gazette A΄154/10.10.2019)

Stage: 1st three-year Research Phase (nine-month extension, end of phase July 2023)

Contractor: HELLENiQ ENERGY UPSTREAM (100%)

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

After the processing and interpretation of the 2D seismic data, the Contractor immediately proceeded in the 4th quarter of 2022, in addition to its contractual obligations in the first research phase and effectively fulfilling the obligations of the next phase, to record 2,430 sq. km of 3D seismic data in the region 10 and 1,150 sq. km in the Ionian region.

The new seismic data is now being processed, to be interpreted and combined with all existing geological, geophysical and drilling data to more precisely identify areas and geological targets, before final investment decisions are made to undertake exploration drilling. It is estimated that the Contractor will inform the Greek State and enter both areas within July 2023 in the 2nd Exploration Phase, according to the Lease Agreement, which however does not include mandatory drilling included in the 3rd Phase [49]. The business strategy that the Contractor will pursue in these highly promising areas for the discovery of hydrocarbon deposits will be interesting.

Region 2

Start Date: 15/03/2018

Lease Agreement: Law 4525/2019 (Government Gazette A΄47/15.03.2018)

Stage: 1st Research Phase (3-year extension, end of phase March 2024)

Contractor: Energean (75% operator) and HELLENiQ ENERGY UPSTREAM (25%)

There is mapped geological structure in the area from existing 2D seismic from previous years, so the consortium decided to replace the recording of new 2D seismic and proceed directly to the acquisition of 3D seismic. The recording of the new 3D seismic data took place in the last quarter of 2022 and the processing of the data is in progress. It is estimated that by the end of the phase (March 2024) the consortium will have examined all the research data and will have made the business decisions on whether or not to enter the next research phase and to perform exploratory drilling. [49].

<u>Ioannina Region</u>

Start Date: 03/10/2014

Lease Agreement: Law 4300/2014 (Government Gazette A΄222/03,10,2014)

Stage: 2nd Research Phase

Contractor: Energean (100%)

This is the most mature concession in terms of exploration activities, but with significant time delays since the start of work. The minimum technical programme has been completed with geological, geochemical and environmental studies as well as recording, processing and interpretation of 400 Km of 2D seismic data and at least one research target has been identified. The company intends to carry out the “Epiros 1” drilling in the area of Giorganista (Municipality of Zitsa) and the procedures for obtaining the approvals of the environmental studies have already begun with the completion of the required public consultation, while the company’s updates with the local communities continue. At the same time, the cooperation of the Contractor with HEREMA and Ministry of the Environment and Energy continues for the completion of the permits with the aim of performing the exploratory drilling in the first half of 2024, the first in the promising onshore area after many years of inactivity.

<u>West and Southwest Crete Region</u>

Start Date: 10/10/2019

Western Crete Region Lease Agreement: Law 4631/2019 (Government Gazette A΄156/10,10,2019)

Southwest Crete Region Lease Agreement: Law 4628/2019 (Government Gazette A΄153/10,10,2019)

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

Contractor: ExxonMobil (70%, operator) and HELLENiQ ENERGY UPSTREAM (30%)

These are the most promising blocks of the Greek area for the existence of large natural gas deposits, as seen from 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 records) in combination with preparation of geological and geochemical studies.

The consortium, after the withdrawal of Total Energies, which was the operator, continues the exploration activities with ExxonMobil as an operator, 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 collaboration 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, it was decided by the operator to increase the network by recording more seismic data from the contractual obligation of 3,250 km per area.

According to published data of HEREMA, almost twice the kilometers of the contractual obligation (12,278 km) were recorded, which is interpreted as 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 frames of the contractual obligations. The next three-year research phase has as a contractual obligation, per region, the acquisition of three-dimensional seismic data, with an obligation to conduct research drilling during the Third Phase of the exploration activities. However, it is not excluded that the consortium, depending on the interpretation of the seismic and the size of the geological targets, will 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 3D seismic during the trenching operations of possible discoveries.

Katakolo Region

Start Date: October 2014

Lease Agreement: Law 4298/2014 (Government Gazette A΄220/03,10,2014)

Stage: Development and Production (25 years as of 2016)

Contractor: Energean (100%)

The Katakolo field, which is located on the west coast of the Peloponnese, was discovered in the early 1980s by the Public Oil Company (DEP) and is still today the only area in Western Greece with a proven discovery of oil and natural gas. Recoverable reserves are estimated at 18 million boe. More specifically, the offshore area has confirmed oil and natural gas reserves, while the onshore area is promising for shallow biogenic gas discoveries. In August 2016, the Contractor proceeded to disclose the exploitability of the "West Katakolo" deposit and entered into a 25-year exploitation license. Production is expected to begin following the approval of the relevant Environmental Impact Assessment. However, while the public consultation has been completed since 2020, the final approval is still pending, with the obvious result of raising questions about the effective operation of state licensing services.

Prinos Concession

Stage: Research and Exploitation (25 years)

Contractor: 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 takes place in the Prinos, North Prinos and soon Epsilon fields in the Gulf of Kavala (8 km west of Thassos and 18 km south of the beaches of Kavala). Production began in early 1981, with initial volumes of 9,000 barrels per day and peaked at approximately 28,000 barrels per day in 1982-1986. Since then, production has fallen significantly, falling below 1,500 bpd with signs of recovery since 2016. In particular, total domestic production stood at 206k tonnes in 2018 (about 4,300 bpd), a level that is the highest since 2000, while more than 2.3 million tons of crude have been produced since 2000.

The field has produced more than 125 million barrels since 1981. 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 Recovery and Resilience Fund for the development of the first CCS facility in Greece.

The "North Prinos" field was developed as a satellite field of "Prinos" in 1996, with production starting the following year and producing quantities of 3,000 barrels per day. In

2009, a new extended horizontal offset inclined well was drilled, reaching a total depth of 4,370 m. The oil is relatively heavy (17-24°API), acidic, with a dissolved gas quantity of 253 cu. feet/barrel (45 cu m/cu m), 20-30% hydrogen sulphide (H2S) 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 sulphide, and a dissolved gas quantity of 349 cu ft/bbl (62.1 cu m/cu m).

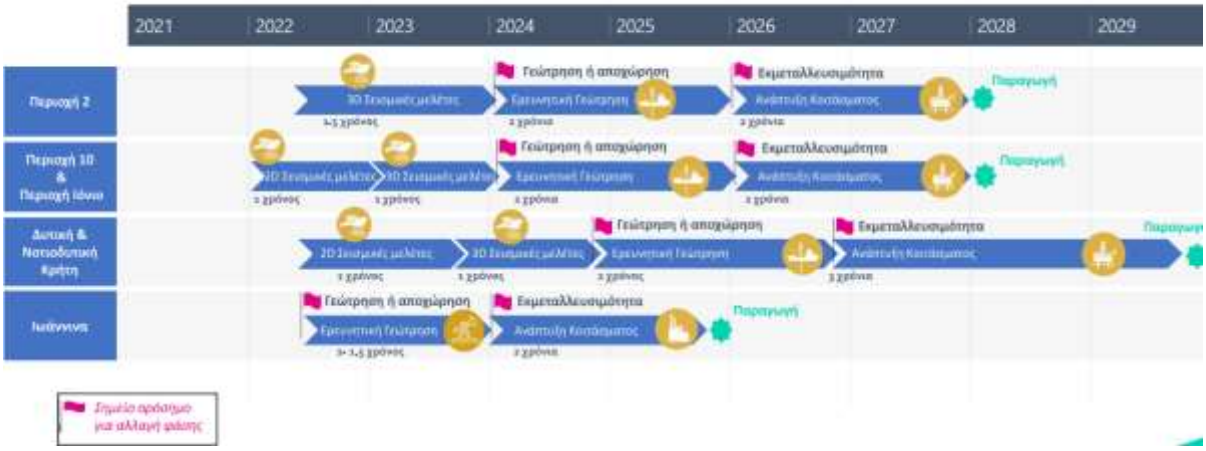
The company exploiting the deposits in the Prinos area is Energean, the only company that produces oil in Greece, which estimates that the remaining reserves of the specific deposits are in the order of 100 million barrels (2P+2C).

It is worth noting that as a consequence of the Covid-19 pandemic and the collapse of oil prices, in April and May 2020, the contractor company Energean announced the suspension of its activities in the Prinos complex and applied to the Greek state for state aid based on the temporary EU state aid framework. The proposed business plan concerns how Energean will use government 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 the CO_2 pipeline to enhance oil recovery and provide multiple synergy opportunities for the future conversion of depleted Prinos reservoirs into permanent storage facilities for captured CO_2.

At the beginning of January 2022[33], the Black Sea Trade and Development Bank (BSTDB) provided a loan of up to €90.5 million to Energean. The proceeds will fund Energean's investment plans - in particular the development of the Epsilon and Prinos fields - and will also support its working capital needs and the finalization of structural expenditures in the Prinos infrastructure complex. Energean expects first oil from the Epsilon development in 1H 2023.

[33] https://www.bstdb.org/news-and-media/press-releases/press-releases_5888

Figure 61: Hydrocarbon Exploitation Timetable in All Active Concession Areas



Source: HEREMA

At this point, special focus must be given on the strict environmental specifications and protection measures contained in the Greek legislation and the Lease Agreements for the execution of exploration and production activities. It is clear that the contracting companies in all the granted areas meet all these measures, which HEREMA constantly controls.

The objective of the exploration activities is to assess the size and prospects of the country's potential natural gas reserves. The recent geophysical surveys have been implemented at a time when natural gas is at the top of Europe's energy agenda due to supply shortages that have led to large increases in energy costs for industry and households. The next step in the process is to analyze and evaluate the data. From previous studies by HEREMA and estimates by the Greek and international analysts, it has emerged 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-pollution energy system.

It is worth noting that the reassessment of the hydrocarbon exploration and exploitation programme in Greece does not in any case constitute a shift from the basic energy priorities that have been set. However, in the shadow of the Ukrainian crisis, it is worth noting to what extent (and with what "formula") this programme would be possible to join the European energy transition plan, in which Greece aims to play a leading role.

In this context, RES remain the dominant fuel of the Greek energy policy, with the ultimate goal the transition towards a carbon neutral economy. Nevertheless, during the transition, natural gas will be a bridge fuel, supporting the further penetration of RES. Hence, it is worth examining whether in the decarbonization phase there is any "space" for the upstream sector, especially if it is combined with newly emerging green applications.

According to HEREMA [50], hydrocarbons are a necessary component of a balanced energy transition, which will last for several decades (and after 2050) and in this interval natural gas will have to cover the energy gap and also provide solutions to society's needs for affordable energy. In this context, important 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.

The development of a domestic hydrocarbon production industry, mainly based on natural gas, can make a significant contribution to Greece's economy and to the wider climate and energy goals. Bearing in mind that the cost of fossil fuel imports in Greece over the last decade amounted to approximately €150 billion, the development of such a sector could have a tremendous impact. It is expected to reduce import dependency and enhance security of supply as the development of the Greek gas market is projected, generating a potentially significant revenue surplus for the national economy and budget, strengthening Greece's strategic position as a regional and European energy hub [46].

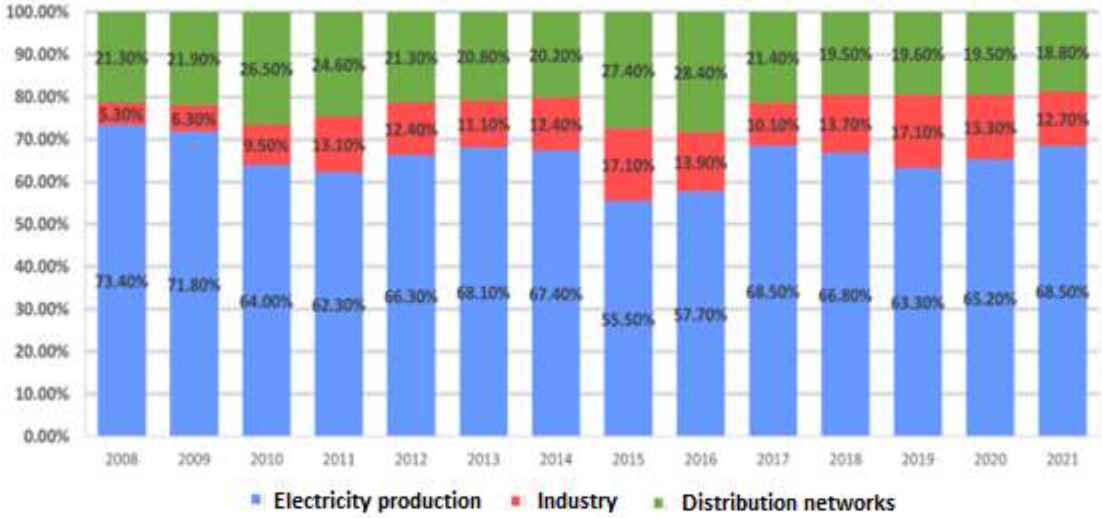
5.2 Natural Gas

5.2.1 The Natural Gas Market in Greece

2021 was a record year for natural gas consumption in Greece, according to DESFA's annual data. Domestic consumption during January-December 2021 increased by 10.81% and reached 69.96 TWh from 63.1 TWh in 2020 [51]. On the contrary, for 2022 the total consumption decreased by 19.04%, reaching 56.64 TWh. In addition, total gas demand (domestic consumption and exports) increased by 3.84%, reaching 38.91 TWh, compared to 37.47 TWh in the corresponding period last year. A decrease of 10.33% was noted in domestic consumption from 33.80 TWh to 30.31 TWh, while a notable increase in gas exports was 134.33%, from 3.67 TWh to 8.60 TWh [52].

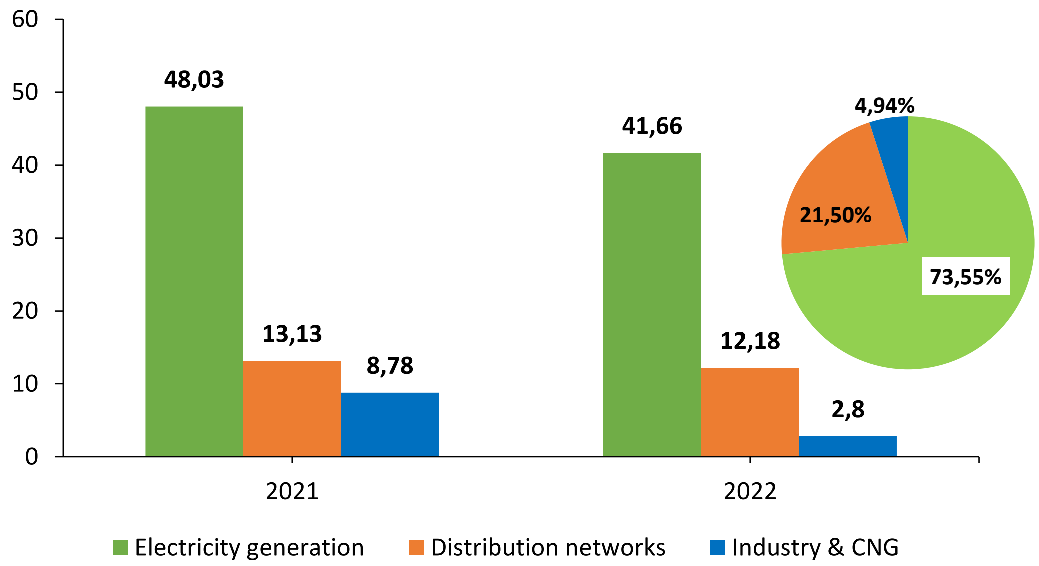
For 2022, the largest part of domestic demand covering 73.6% corresponds to the consumption of electricity generating units, followed by residential consumers with a percentage of 21.5% and companies connected to the distribution networks, with a percentage of 18.8%, as well as the domestic industries, which are directly connected to the high pressure system of DESFA, with a percentage of 12.7% (Figure 63) [53] .

Figure 62: Historical Evolution of Percentage Demand For Natural Gas by Customer Category, 2008-2021



Πηγή: PAE

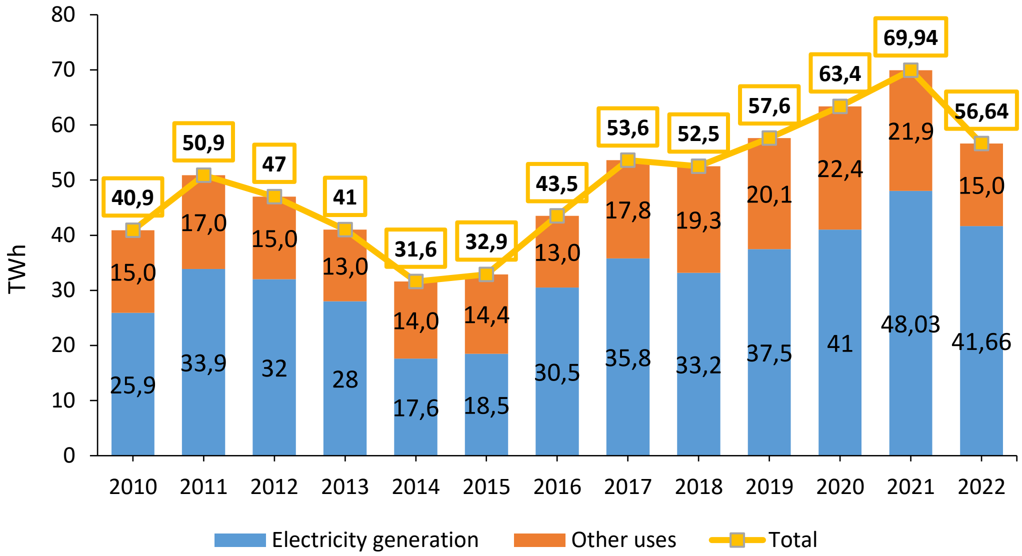
Figure 63: Domestic Gas Consumption (TWh) by Customer Category, 2021 and 2022



Source: DESFA

As shown in Figure 64, the consumption of natural gas in Greece decreased by 19.0% in 2022, compared to 2021, in compliance with the objectives set by the EU to reduce consumption by 15% in the period from August 2022 by March 2023, compared to the average for the same period of the previous five years. The target was set as part of the effort to reduce the EU's dependence on Russian fossil fuels and strengthen the security of the EU's energy supply.

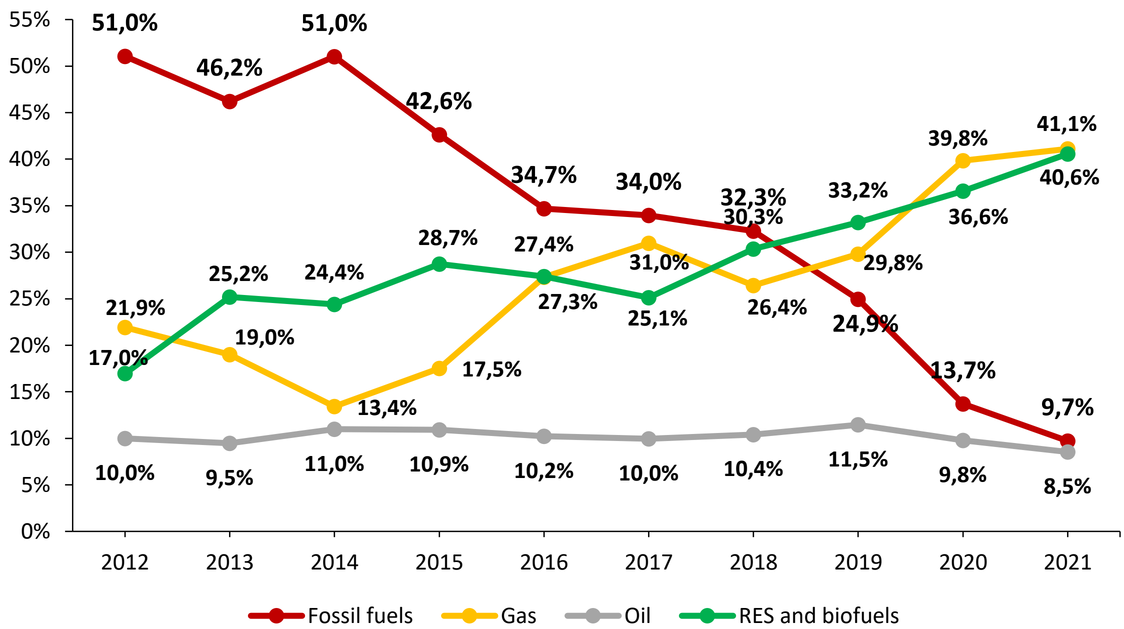
Figure 64: Evolution of Natural Gas Consumption in Greece (TWh), 2010-2022



Sources: RAE, DESFA

The largest percentage of natural gas in 2021, as in all previous years, was consumed in the production of electricity from PPC's thermal units and private power producers. In fact, the role of natural gas in electricity generation was significantly strengthened in 2021, reaching 41.1% of gross electricity production, from 39.8% in 2020 and 21.9% in 2012 (Figure 66).

Figure 65: Shares of Sources in Gross Electricity Production, 2012-2021

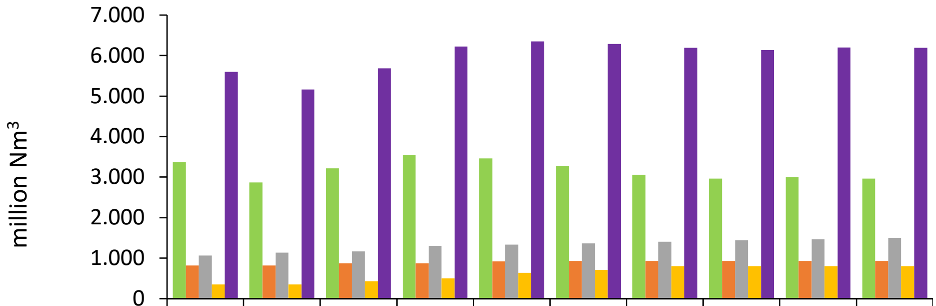


Source: Eurostat

According to the 2021-2030 Development Study prepared by DESFA [54], the demand for natural gas, based on the base scenario, is expected to vary from 5,602 bcm of natural gas in

2021 to 6,195 bcm of natural gas in 2030. It is worth noting that the IENE, based on data that has been processed and given delignitisation, as well as the expansion of natural gas networks in urban centers and in the periphery, estimates that by 2030 domestic natural gas demand will have exceeded 8.0 bcm and possibly reach as high as 10.0 bcm.

Figure 66: Estimation of Natural Gas Demand in Greece, Base Scenario – Revised NECP, 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 consumption connected to the high pressure grid	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 National Natural Gas Transmission System	5.602	5.167	5.686	6.225	6.352	6.288	6.190	6.135	6.197	6.195

Source: DESFA

5.2.2 Natural Gas Supply Sources

Until December 2020, Greece had three natural gas entry points: one at the Greek-Turkish border at Kipi, one at the Greek-Bulgarian border near Sidirokastro, and one at the Revithoussa LNG terminal (Agios Triada entry point). The import of natural gas at the specific points in 2020 was divided as follows: 53.82% of the natural gas was imported through the two main entry points of the National Natural Gas Transmission System from Bulgaria (31.9 million MWh) and from Turkey (6.1 million MWh), while 46.18% was imported through the Revithoussa LNG terminal (32.6 million MWh).

From the end of December 2020, the Nea Mesimvria entry point, which connects the National Natural Gas Transmission System to the Trans-Adriatic Pipeline (TAP), was put into commercial operation, and through this entry point 650 MWh were imported until 31.12.2020. In this context, Greece now has four natural gas entry points.

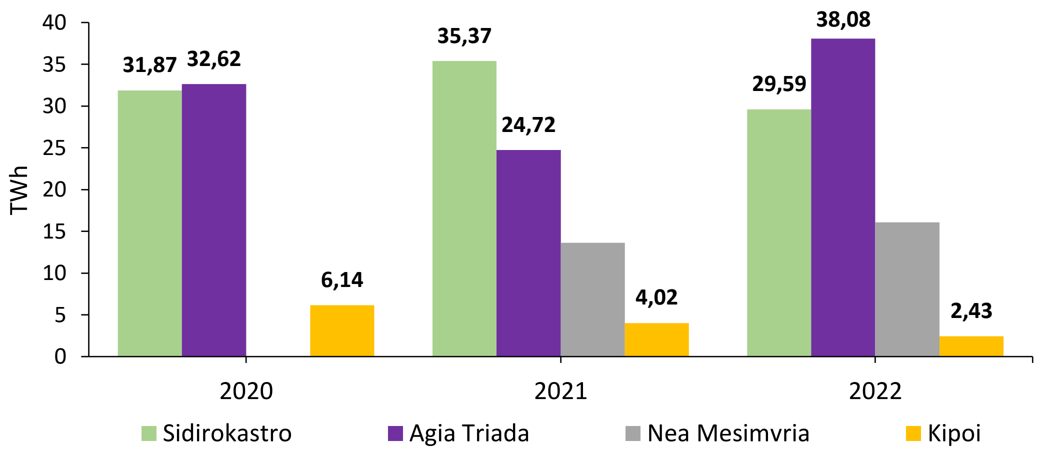
For 2021, natural gas imports recorded an increase compared to the previous year, reaching 77.73 TWh, compared to 70.64 TWh for 2020. The entry point at Sidirokastro remained the main natural gas inflow gateway to the National Natural Gas Transmission System, while the contribution of the new entry point in Nea Mesimvria was also notable [51].

The quantities imported from the Sidirokastro entry point amounted to 35.37 TWh, which covered 45.5% of the total imports, marking an increase of 10.98% compared to the corresponding period last year.

With the opening of the fourth entry point to the National Natural Gas Transmission System, the country's security of supply was further strengthened and the diversification of supply sources and infrastructure was expanded. During its first year of operation, a quantity equal to 13.61 TWh was imported through Nea Mesimvria, which corresponded to 17.5% of the total imports, while approximately 4.02 TWh (5.17%) was imported into the National Natural Gas Transmission System from the entry point to Evros Gardens (Figure 51) [51].

According to DESFA's data for 2022, the consumption of natural gas in Greece decreased by 19.0%, reaching 56.64 TWh, from 69.96 TWh in 2021. The decrease in domestic consumption was covered by the remarkable increase of 288.68% recorded in natural gas exports from 7.6 TWh in 2021 to 29.54 TWh in 2022. In particular, 34.27% of the total demand for 2022 was related to natural gas exports, mainly to Bulgaria from the interconnection point in Sidirokastro, while smaller quantities of natural gas were also exported to Italy through the TAP pipeline from Nea Mesimvria. Accordingly, natural gas imports amounted to 86.16 TWh, recording an increase of 10.84%, compared to 77.73 TWh in 2021. The largest quantities entered the country from the Revithoussa LNG Terminal, which covered 44.2% of imports, recording a significant increase compared to last year. In second place was the entry point of Sidirokastro, which covered 34.34% of imports (29.59 TWh), followed by the entry point in Nea Mesimvria, which, through the TAP pipeline, covered 18.64% of imports (16.06 TWh). Finally, Evros Gardens covered 2.82% of imports (2.43 TWh) (Figure 68) [55].

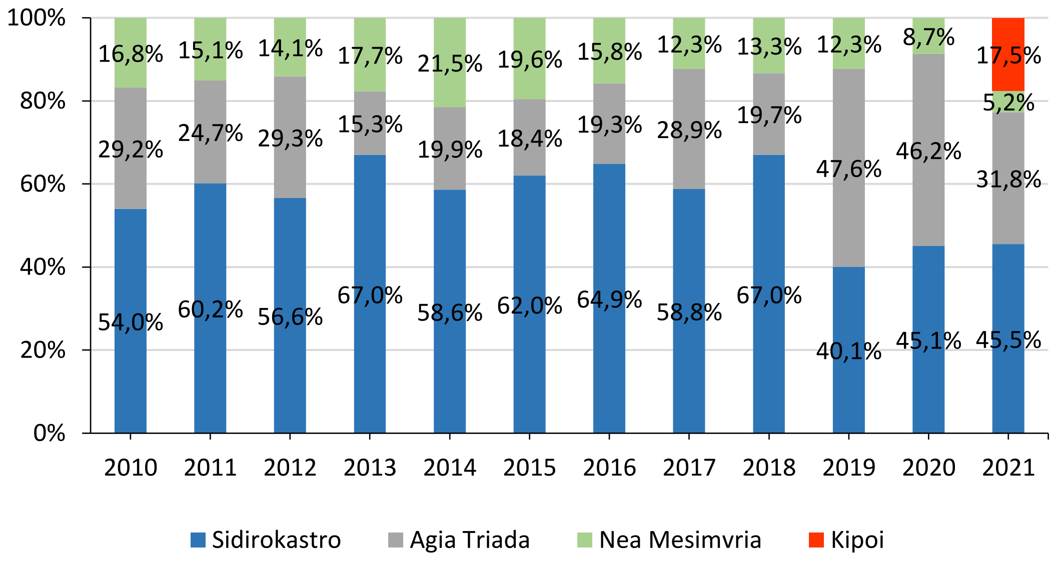
Figure 67: Distribution of Natural Gas Imports by Entry Point, 2020, 2021 and 2022



Source: DESFA

As shown in Figure 68, the participation rates of entry points in natural gas imports changed in 2022, compared to 2021 and 2020. In 2021, the percentage of LNG (entry point Agia Triada) decreased as it was evident for the first time the participation of the entry point Nea Mesimvria with a percentage of 17.5% in natural gas imports, while in 2022 it dominated natural gas imports, due to the surge in the prices of natural gas transported by pipelines as Russia significantly reduced the supply of natural gas to Europe.

Figure 68: Evolution of the Percentage Participation of Natural Gas Entry Points in Imports into Greece, 2010-2022



Sources: DESFA, IENE

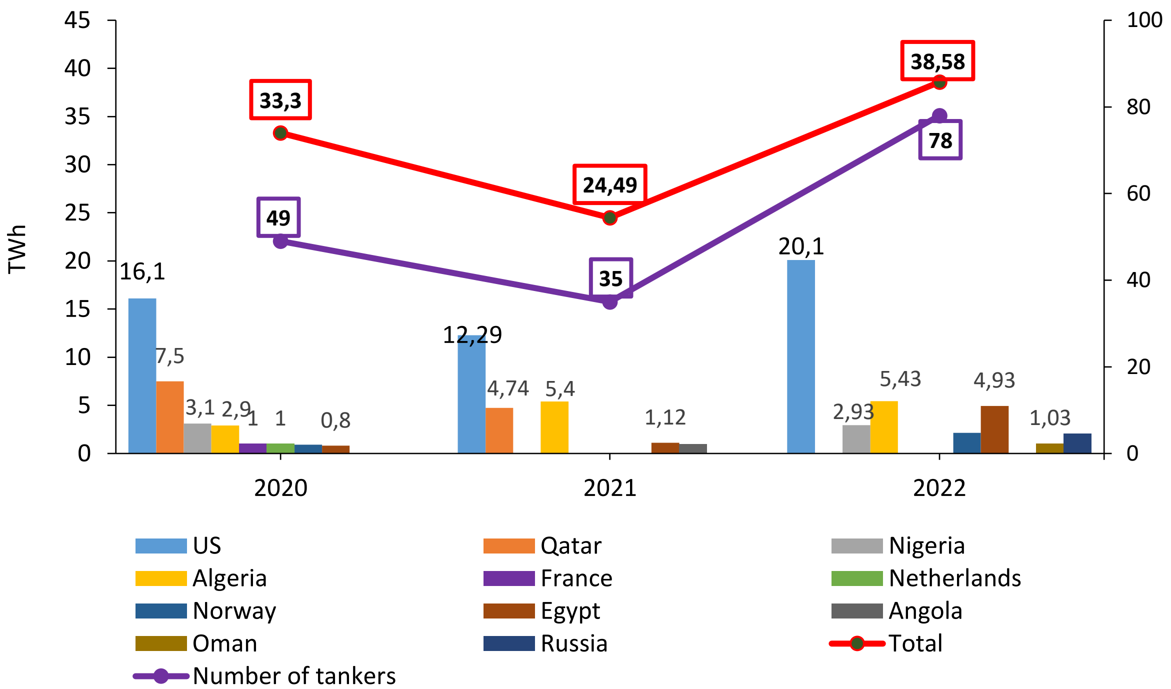
According to DESFA's data for 2020, the tankers that unloaded in Revithoussa transported cargo from 8 different countries. Although in 2019, Algeria maintained a dominant position in the quantities of LNG imported to the country with a percentage of 20%, in 2020 US took the first place with a percentage of 48%. Qatar also recorded double digits (22%), followed by Nigeria and Algeria with 9% and Norway, Egypt, France and the Netherlands with 3%. (Figure 69).

Regarding the LNG imports at the Revithoussa Terminal during 2021, they reached nearly 24.51 TWh from 35 vessels compared to about 33.40 TWh from 49 vessels in 2020. Despite the decrease compared to the previous year, essentially almost a third (31.8%) of imported natural gas came from LNG cargo imports. The reductions mainly concern LNG imports from the US and Qatar (-26.96% and -44.59% decrease respectively), while LNG imports from Algeria increased quite notably by 60.24% compared to 2020. LNG imports from Egypt also increased by 29.74%, according to DESFA's data. The US remain the largest importer of LNG in Greece with 12.29 TWh (50.14%), with significant imports particularly in the fourth quarter of 2021, with Algeria coming second with 5.40 TWh (22.04%). Qatar and Egypt follow with 4.74 (19.37%) and 1.12 TWh (4.59%) respectively, while Angola is in the last place for 2021 with 0.94 TWh (3.84%) (Figure 70) [51].

For 2022, the largest quantities entered from the Revithoussa LNG Terminal, which covered 44.2% of imports, achieving a record increase compared to last year. Sidirokastro entry point was in second place covering 34.34% of imports (29.59 TWh), followed by the entry point in Nea Mesimvria, which, through the TAP pipeline, covered 18.64% of imports (16.06 TWh). Finally, Kipoi entry point in Evros covered 2.82% of imports (2.43 TWh).

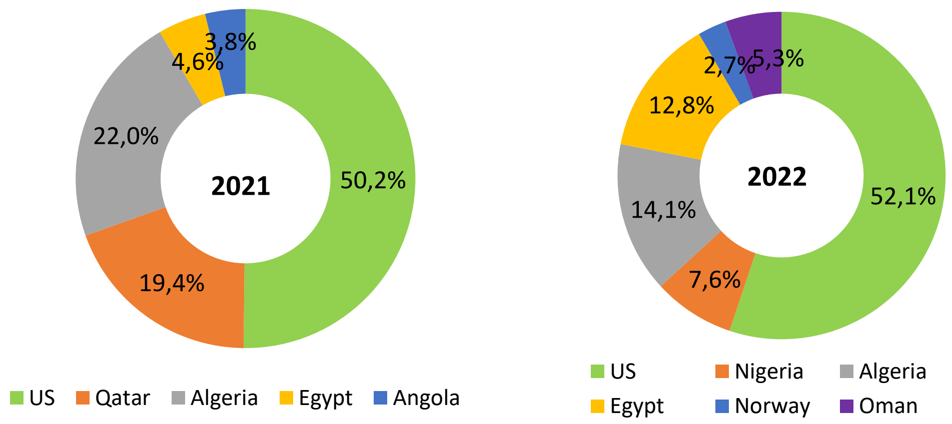
Revithoussa played a vital role in the diversification of the energy supply sources of the country and the wider region, receiving, for the first time since its launch, 78 tankers from 10 countries, which unloaded a total amount of 39.19 TWh of LNG, compared to about 24.51 TWh from 35 tankers from 5 countries in 2021. The increase was mainly driven by LNG cargoes from the US, which increased by 63.55% compared to 2021, reaching 20.10 TWh, compared to 12.29 TWh the previous year, with the US remaining the largest importer of LNG in Greece with a percentage of 51.29%. In second place were imports from Algeria (5.43 TWh), followed by Egypt (4.93 TWh), Nigeria (2.93 TWh), Norway (2.13 TWh), Russia (2.03 TWh) and Oman (1.03 TWh). Cargoes below 1 TWh were also imported from Spain (0.43 TWh), Indonesia (0.11 TWh) and Cameroon (0.07 TWh) (Figure 70) [55].

Figure 69: LNG Imports by Country, 2020, 2021 and 2022



Source: DESFA

Figure 70: LNG Import Shares by Country, 2021 and 2022



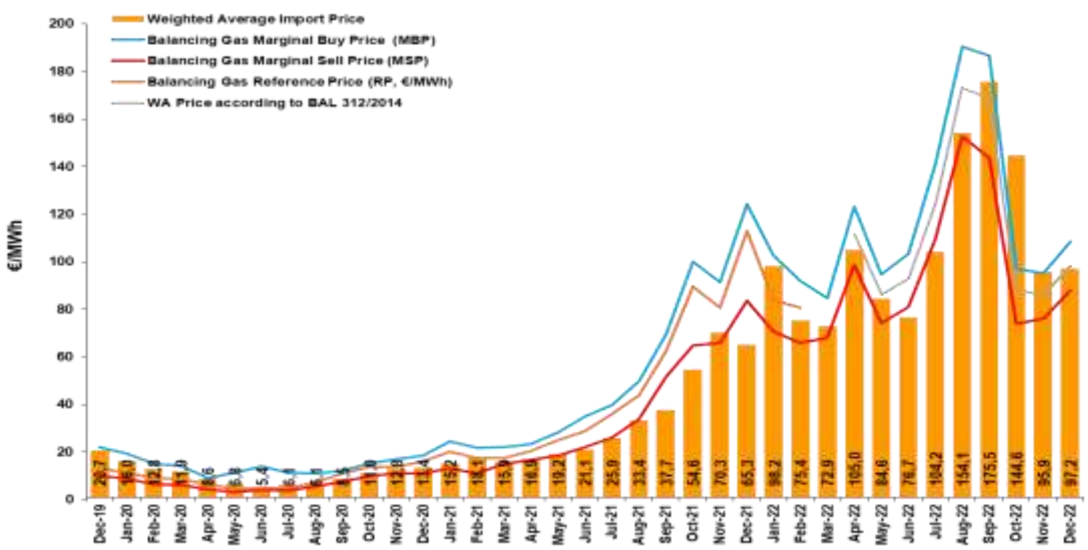
Source: DESFA

5.2.3 Natural Gas Prices

According to the RAE announcement of March 14, 2023 [56], Figure 71 shows:

- the Weighted Average Import Price, per month, for the period December 2019-December 2022,
- the evolution of the Balancing Gas Reference Price in relation to the Balancing Gas Marginal Buy Price, the Balancing Gas Marginal Sell Price, as reported on DESFA's website, which were used to calculate the relevant prices on a monthly basis.

Figure 71: Evolution of Weighted Average Import Price in Greece, December 2019 – December 2022

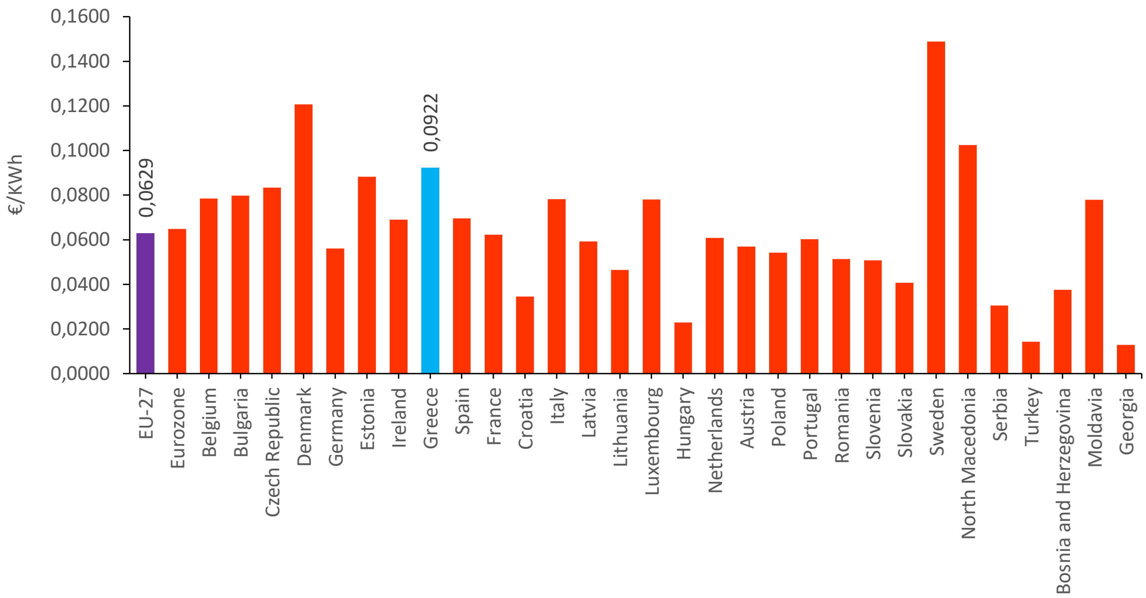


Source: RAE

The main observation for the evolution of import prices in 2022 is the significant increase that reaches 521% for the period April 2021-April 2022. More specifically, the Weighted Average Import Price was set at 105.0 €/MWh in April 2022 and at 16.9 €/MWh in April 2021. This increase is attributed to the surge in demand for energy after the opening of the economy from the pandemic and the geopolitical "games" played by Russia, which was one of the largest energy suppliers of Europe.

According to Eurostat's data [57], the final price of natural gas for domestic consumption (before taxes and levies) in Greece was €0.0922/kWh in the first half of 2022, compared to €0.0629/kWh in the EU-27 average.

Figure 72: Final Natural Gas Prices for Household Consumption in Europe, H1 2022



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

Source: Eurostat

5.2.4 The Retail Market

For EDA THESS, the new consumer connection contracts in the area of Thessaloniki amounted in 2021 to 17,194, marking an increase of 9.5% compared to the previous year and progressively amounting to 288,017. The new consumer connection contracts in the area of Thessaly reached 8,823, marking an impressive increase of 24% compared to 2020 and progressively exceeding 123,934. An active role was played by the programme for replacing oil heating systems with natural gas ones in Thessaly, which is implemented within the framework of the NSRP 2014-2020 of the Region of Thessaly and the NSRP staff structure of the Ministry of Environment and Energy [58].

In 2021, a total of 24 companies held a natural gas supply license, while 22 natural gas suppliers were active in the market [59]. According to RAE data, the active users (suppliers) of natural gas in February 2021 are presented in Table 11 [60].

Table 11: Active Natural Gas Suppliers, February 2021

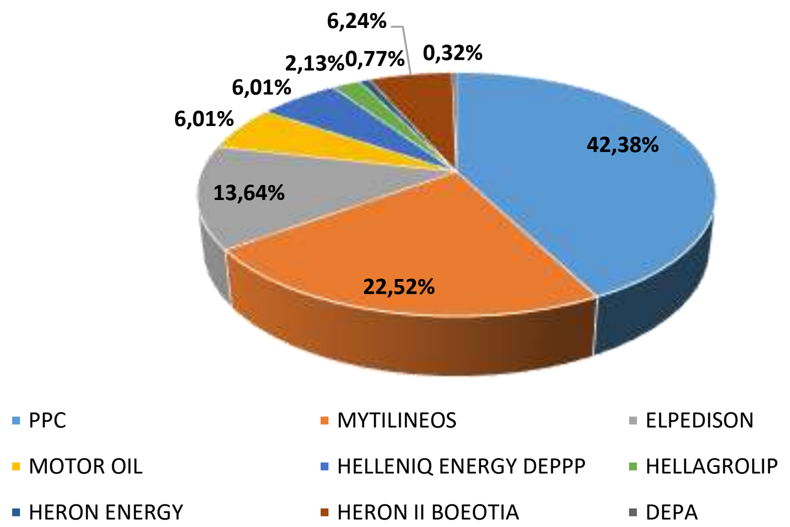
A/A	SUPPLIER COMPANY	Decision of Ministry of Development and Investments/RAE (Grant or Modification)
1	DEPA	Opinion.356/2010 Modification of Decision.129/2015
2	THESSALONIKI THESSALIA GAS SUPPLY COMPANY S.A. (ZENITH)	Decision.332/2015 Decision.333/2015
3	NATURAL GAS - HELLENIC ENERGY COMPANY	Opinion.151/2017 Decision.331/2015
4	PROMITHEAS GAS S.A.	Opinion.357/2010
5	ELPEDISON S.A.	Decision.1095/2017
6	MYTILINEOS GROUP S.A.	Decision.32/2016
7	ANOXAL S.A. METALS PROCESSING AND RECYCLING INDUSTRY LIMITED COMPANY (ANOXAL S.A.)	Decision.682/2014
8	FULGOR HELLENIC CABLES S.A.	Decision.276/2013
9	ELVALHALCOR S.A. (ELVAL S.A.)	Decision.113/2013 Decision.683/2014
10	MNG Trading	Opinion.375/2010
11	HERON THERMOELECTRIC S.A.	Decision.870/2012
12	SIDENOR INDUSTRIAL STEEL S.A.	Decision.162/2013
13	GREENSTEEL - CEDALION	Decision.655/2014
14	SOVEL S.A. GREEK COMPANY	Decision.148/2013
15	MOTOROIL GREECE CORINTH REFINERY S.A.	Decision.1096/2017
16	BA GLASS GREECE S.A.	Decision.355/2017 (Modification of Decision.561/2014)
17	WATT AND VOLT S.A.	Decision.281/2015 (Modification of Decision.96/2015)
18	EFA ENERGY COMPANY OF NATURAL GAS S.A.	Decision.465/2018 (Modification of Decision.559/2014)
19	VOLTERRA S.A.	Decision.240/2016

20	NRG SUPPLY AND TRADING S.A.	Decision.1125/2020 (Modification of Decision.356/2015)
21	NRG SUPPLY AND TRADING S.A. (SUPPLIER OF LAST RESORT)	Decision.1125/2020 (Modification of Decision.356/2015)
22	KEN PRODUCTION AND TRADE OF ENERGY PRODUCTS	Decision.883/2017
23	ELINOIL S.A.	Decision.473/2015
24	PETROGAZ S.A.	Decision.452/2017
25	PPC S.A.	Decision.0239/2018

Source: RAE

According to DESFA's data [61], PPC held the largest percentage of energy consumed in the natural gas market for 2021 with a share of 42.4%, followed by the Mytilineos company with a percentage of 22.5% and Elpedison with a percentage of 13.6%, while other companies with smaller percentages follow (Figure 74).

Figure 73: Natural Gas Market Shares by Transmission User 2021, % of Energy Consumed (Quarterly Average)



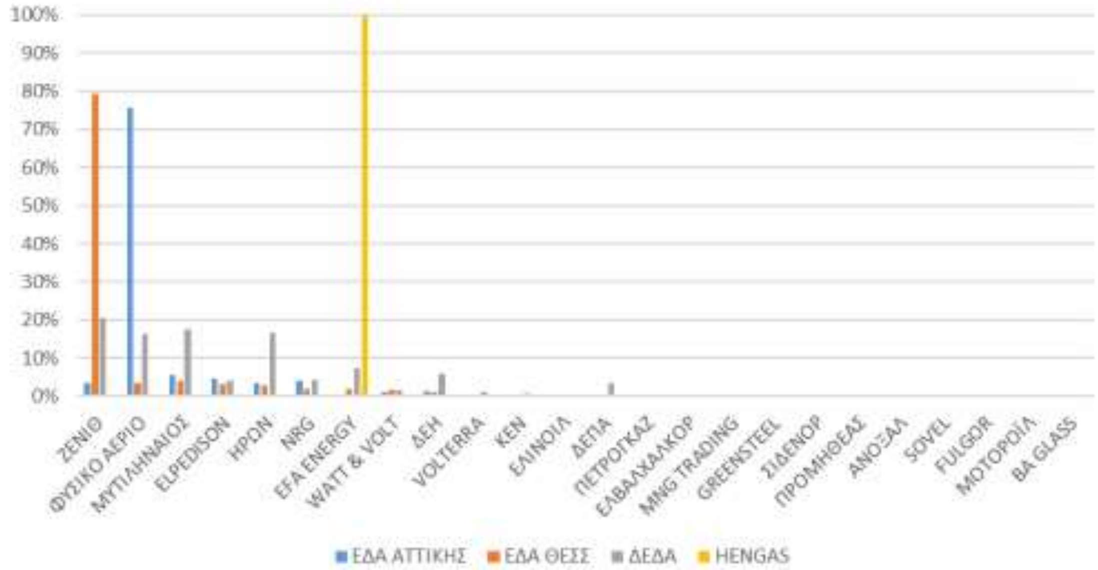
Note: Market shares only concern consumers directly connected to the National Natural Gas Transmission System

Source: DESFA

In 2021, the companies ZENITH and FYSIKO AERIO were the two main suppliers in the entire retail natural gas market (including residential, commercial and industrial customers), representing 55.50% and 25.75% of the market respectively, based on the number of delivery points, as well as 33.80% and 26.35% respectively, based on consumption volume.

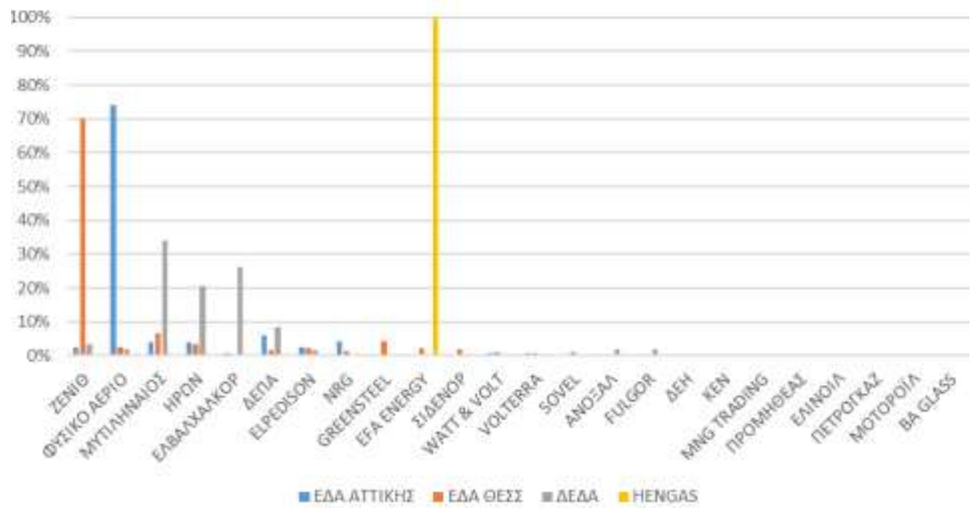
The market shares of suppliers based on the number of delivery points and consumption volume per Distribution Network for the year 2021 are shown in Figures 74 and 75 respectively [59].

Figure 74: Market Shares of Natural Gas Suppliers by Number of Meters, 2021



Source: RAE

Figure 75: Market Shares of Natural Gas Suppliers by Consumption Volume, 2021



Source: RAE

According to the RAE 2021 Annual Report, the companies ZENITH and FYSIKO AERIO maintain a very significant market share in the regions from which they originated. More specifically, in the Attica Distribution Network, FYSIKO AERIO continues to hold 75.58% and 74.15% of the market based on the number of delivery points and consumption volume respectively. In the Thessaloniki and Thessaly Networks, ZENITH continues to hold 80.76% and 75.33% respectively based on the number of delivery points and 79.14% and 61.11% of the market respectively based on consumption volume. On the contrary, in DEDA's networks, which are newer and in which there was no previous dominant supplier, the market is "shared" among several suppliers. ZENITH holds the largest market share based on the number of delivery points (20.46%), while MYTILINEOS holds the largest market share based on consumption volume (34.05%). The networks of HENGAS started commercial operation only in the autumn of 2022 from the network of Deskatis. It is noteworthy, however, that currently all customers in this network are represented by the EFA ENERGY company [59].

5.2.5 National Natural Gas Transmission System

The total length of the main natural gas transmission pipelines amounted to 1,466 km in 2021. In particular, 512 km referred to the central high-pressure gas transmission pipeline and 954 km to the supply pipelines of the various regions of the country. The length of the network did not change in 2021, compared to 2020 (Table 11) [62].

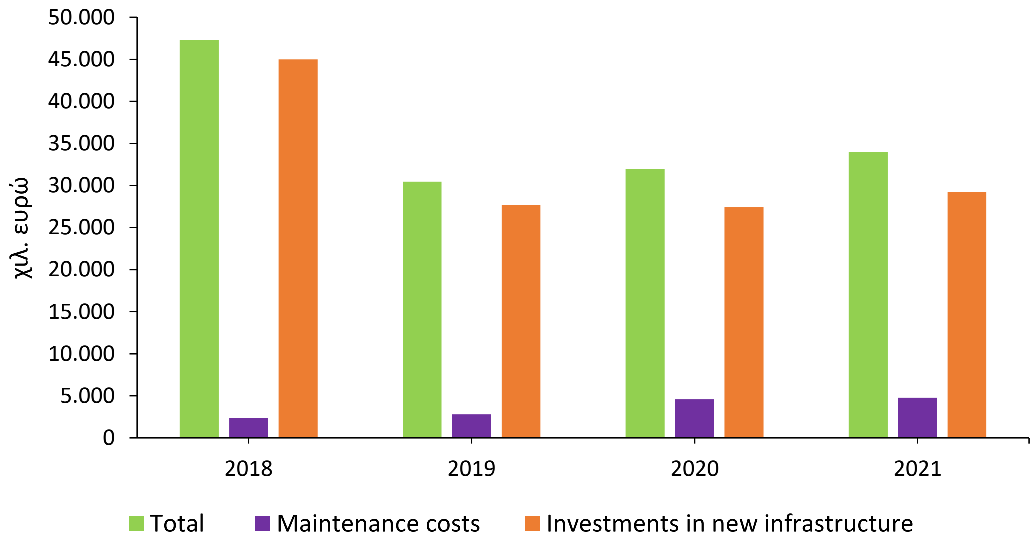
Table 12: Length of Natural Gas Pipelines (km)

	2018	2019	2020	2021
Central high pressure gas pipeline	512	512	512	512
Supply pipelines of the regions of the country	**952**	**954**	**954**	**954**
Total	**1.464**	**1.466**	**1.466**	**1.466**

Source: ELSTAT

The maintenance costs of natural gas transmission infrastructure amounted in 2021 to €4.8 million, showing an increase of 4.7% compared to 2020, where the corresponding costs amounted to €4.6 million, and the investments in new infrastructure amounted to €29.21 million in 2021, showing an increase of 6.6% compared to the corresponding investments in 2020, which amounted to €27.41 million [62].

Figure 76: Expenditures for Natural Gas Transmission Infrastructure, 2018-2021



Source: ELSTAT

<u>DESFA's Development Programme</u>

In August 2020, DESFA submitted to RAE for approval a draft of the Development Programme for the period 2021-2030. Based on the comments submitted to the public consultation and observations of the Authority, DESFA submitted a final draft of the Development Programme on December 22, 2020. The RAE approved the DESFA Development Programme 2021-2030 with decision number 116/2021 of January 28, 2021. The main points of the Development Programme foresee the following for the projects within a 3-year Development Period [63]:

- New Projects
  - High pressure pipeline to Western Macedonia
  - High pressure pipeline to Patras
  - Measuring/Regulation Station of Corinth
  - Metering/Regulation Station for the cities of Argos/Nafplio
  - Measuring/Regulation Station of Tripoli
- Planned Projects
  - Measuring/Regulation Station in South Mesimvria for the connection of National Natural Gas Transmission System with TAP (Deleted by RAE as completed)
  - Nea Mesimvria Pipeline – Evzonon/Gevgelija and Metering Station
  - Interconnection of the IGB pipeline with the National Natural Gas Transmission System in the area of Komotini

- Interconnection with Alexandroupolis FSRU
- User connection projects (e.g. Installation of a Metering Station at Ano Liosion Natural Gas Bus Filling Station, Connection of ELVAL with National Natural Gas Transmission System, Connection with the CNG Station of DEPA Commercial in Komotini, etc.)
- National Natural Gas Transmission System's Expansion Projects in new areas (Pilot tanker loading station, new small scale LNG jetty at Revithoussa Terminal, etc.)
- Projects to increase the capacity and security of supply of the National Natural Gas System (Compression station in Kipi and Regulation Station in Komotini, upgrade of compression station in Nea Mesimvria, etc.)
- National Natural Gas System improvement, modernization and maintenance projects

Overall, the 2021-2030 Development Programme aims at: (a) promoting the penetration of natural gas in new areas, for the benefit of regional development, (b) strengthening the System and increasing capacity and security of supply, (c) implementing projects which is necessary for the smooth, economical and uninterrupted operation of the National Natural Gas System and (d) achieving an increased level of environmental protection, especially in the areas that are at the phase of delignitisation [64].

On August 4, 2022 with RAE decision no. 666/2022 approved the Development Programme of DESFA for the period 2022-2031 [65]. This new Programme includes projects with a projected budget of €855.7 million, of which €183 million correspond to new projects, while the rest correspond to those already approved in the Ten-Year Development Programme 2021-2030. Of these, €161 million correspond to expansions in new areas, the main one being the network expansion project in Ioannina, and €14.5 million relate to improvements, modernization and maintenance of the National Natural Gas System.

The main points of the National Natural Gas System Development Programme 2022-2031 are the following [66]:

- Extension of the National Natural Gas Transmission System towards Ioannina
- Measuring/Regulation Station of Veroia
- Measuring/Regulation Station of Naoussa
- Expansion and upgrade of Metering/Regulation Stations of Distribution Exit Point "Athens"
- Relocation of the Keratsini branch

o Construction of a new Metering/Regulation Station in Markopoulo to replace the existing one

o Electronic Information System - upgrade of operations

o Development of an information system for undertaking by DESFA the role of Forecasting Officer for the National Natural Gas Transmission System balancing zone

o New natural gas electronic information system

Natural Gas Distribution Networks – Natural Gas Distribution Network Operators

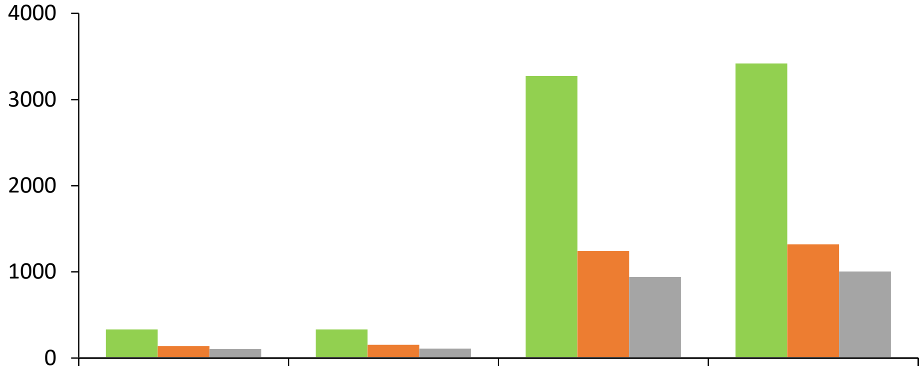
The Operators of the Distribution Networks must construct the Distribution Network in accordance with the Development Plan approved by RAE based on the development schedule included in the Distribution License. At the end of each calendar semester, the Operators inform RAE of the progress of Network Construction Work in their License Area [64].

The country's Distribution Networks, depending on their operating pressure, are divided into:

- Medium pressure network (with a nominal pressure of 19.0 bar)
- Low pressure network (with a nominal pressure of 0.025 - 4.0 bar)

Figure 77 presents the total developed medium- and low-pressure Distribution Network in Greece for the years 2019 and 2020. In Attica, during the year 2020, the medium-pressure network was developed by 1.8 km, while the low-pressure network was developed by 147 km. In Thessaloniki respectively, the medium-pressure network developed by 15.3 km and the low-pressure network by 78.1 km, while in Thessaly the medium-pressure network developed by 2.9 km and the low-pressure network by 64 km.

Figure 77: Evolution of Pipeline Length per Distribution Network and per Nominal Operating Pressure

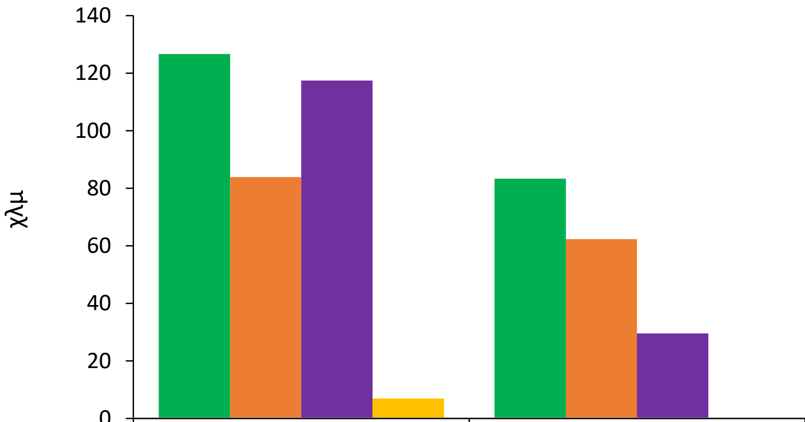


	Medium pressure		Low pressure	
	2019	2020	2019	2020
Attica	332,2	333,7	3.272	3.419,00
Thessaloniki	137,2	152,5	1.241,50	1.319,60
Thessaly	106	108,9	941,1	1005,1

Source: RAE

The existing Distribution Network of the rest of Greece, per Regional Unit, is presented in Figure 78 [64].

Figure 78: DEDA Network Analysis by Region for 2020



	Medium pressure	Low pressure
Central Greece	126,67	83,33
Central Macedonia	83,88	62,29
Eastern Macedonia & Thrace	117,43	29,61
Peloponnese	6,87	0

Source: RAE

Operators are responsible for developing the Distribution Network in their license's geographic area. According to Article 58 of the Distribution Network Management Code, the Operator prepares and submits to RAE a rolling five-year Development Plan every year. In this context, the EDA Attica, the EDA THESS and the DEDA submitted in October 2020 to the

RAE for approval Development Programs for the period 2021-2025, which were put to public consultation and subsequently approved with the number 1581 /2020 (Government Gazette B' 5754/28.12.2020), 1582/2020 (Government Gazette B' 5999/31.12.2020) and 1615/2020 (Government Gazette B'844/4.03.2021) decisions respectively [67].

According to the approved Development Programs, in the next five years 2021-2025 investments totaling €560 million will be made, 2,724 km of pipelines will be developed and 254,791 new consumers will be connected. The estimated added consumption for the next five years will be more than 6 million MWh.

Table 13: Development of Distribution Networks 2021-2025

	Επενδύσεις (€)	Χιλιόμετρα δικτύου	Εκτιμώμενες συνδέσεις	Εκτιμώμενη κατανάλωση (MWh)
ΘΕΣΣΑΛΟΝΙΚΗ	96.820.000	238	60.100	814.701
ΘΕΣΣΑΛΙΑ	61.450.000	199	30.250	648.558
ΑΤΤΙΚΗ	129.220.000	560	96.076	2.857.465
ΣΤΕΡΕΑ ΕΛΛΑΔΑ	47.417.680	320	17.255	357.892
ΚΕΝΤΡΙΚΗ ΜΑΚΕΔΟΝΙΑ	43.658.699	327	12.463	404.748
ΑΝΑΤΟΛΙΚΗ ΜΑΚΕΔΟΝΙΑ & ΘΡΑΚΗ	62.077.073	485	18.211	550.452
ΔΥΤΙΚΗ ΕΛΛΑΔΑ	39.005.942	208	10.909	274.990
ΔΥΤΙΚΗ ΜΑΚΕΔΟΝΙΑ	57.129.554	238	5.312	216.610
ΗΠΕΙΡΟΣ	23.252.152	149	4.215	200.735
ΣΥΝΟΛΟ	**560.031.101**	**2.724**	**254.791**	**6.326.150**

Source: RAE

5.2.6 Natural Gas Infrastructure Projects

5.2.6.1 Revithoussa LNG Terminal

The LNG Terminal of Revithoussa is located on the island of Revithoussa, approximately 500 meters from the coast of Agia Triada, in the Gulf of Pachis Megaron, 45 km west of Athens. The station is strategically located near gas consuming regions such as Attica and Boeotia, so that it can supply natural gas both to the Greek market and to 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 LNG terminals operating today throughout the Mediterranean and Europe and is unique in Greece for receiving LNG tankers, receiving, storing, gasifying LNG and supplying natural gas to the National Natural Gas Transmission System.

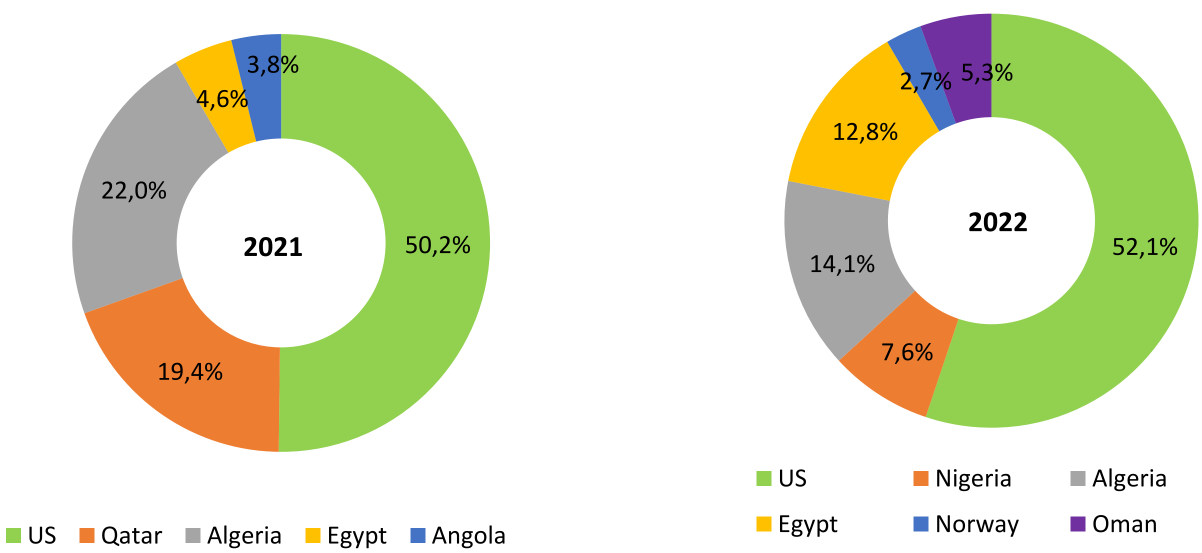
It has a storage capacity of 225,000 m3 of LNG, consisting of two tanks of 65,000 m3 each and a larger one, with a capacity of 95,000 m3 and an hourly gasification capacity of 1250 m3 of LNG under normal operating conditions. [68]

The Revithoussa terminal can accommodate vessels from 25,000 to 266,000 m3 of LNG, a size corresponding 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 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 in the Southern part of the country.

DESFA added a Floating Storage Unit (FSU) at 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 strengthening the possibility of regasification of the terminal by 12%.

In 2021, the Revithoussa terminal covered almost 31.8% of the total natural gas imports in Greece, while in the first quarter of 2022 Revithoussa became the main natural gas gateway in the country, covering 43.23% of imports. Figure 79 shows the origin of LNG cargoes unloaded at Revithoussa in 2021 (35 cargoes from 5 countries) as well as in 2022 with the receipt of 78 LNG cargoes from 6 countries.

Figure 79: Countries of Origin of LNG Imports in 2021 and 2022



In April 2022, the new small scale LNG jetty at the Revithoussa terminal was included in the Operational Programme "Competitiveness, Entrepreneurship and Innovation 2014-2020". The specific project envisages the creation of a new pier, parallel to the north-eastern coast of Revithoussa, which will have a total length of approximately 20 meters and a sea depth of approximately 12 meters along this length. The minimum width of the pier will be 30 meters. This jetty will serve the docking of small-capacity LNG transport vessels, between 1,000 and 30,000 m^3 of LNG. The total cost of the transaction amounts to €18,070,120, with the private participation amounting to €9,185,060 and the total public expenditure proposed for enrollment in the Public Investment Program amounting to €8,885,060.

5.2.6.2 Alexandroupolis FSRU

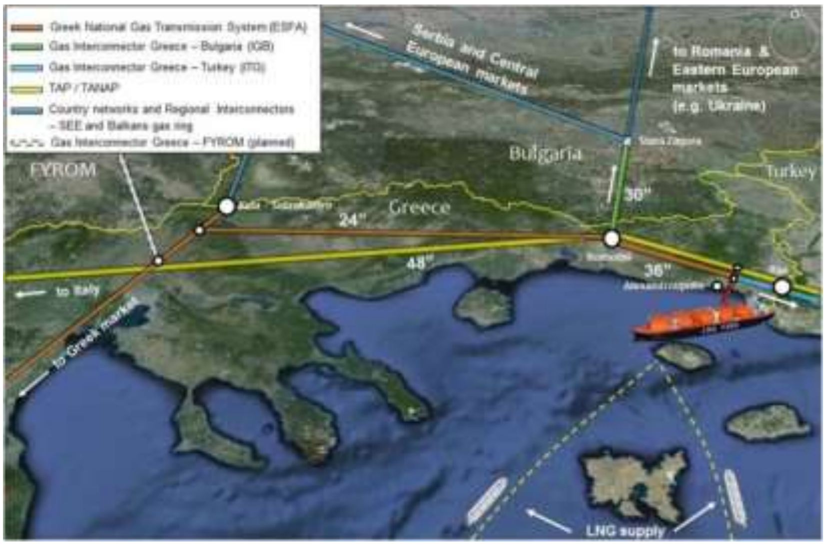
The FSRU, with a capacity of 153,500 m2 LNG, will be connected to the National Natural Gas Transmission System of Greece with a 28 km long pipeline, through which the gasified LNG will be promoted to the markets of Greece, Bulgaria, the wider region (Romania, Serbia, North Macedonia, etc.) but also with the prospect of supplying Ukraine as well.

The “start signal” for the construction works of the Alexandroupolis FSRU by Gastrade was officially given in a special ceremony held on Tuesday, May 3, 2022. The Prime Minister of Greece, Kyriakos Mitsotakis, and the Prime Minister of Bulgaria, Kiril Petkov, co-signed the special symbolic plaque to start the implementation of the project, which is to be a new energy gateway, playing a decisive role in the energy security and independence of Greece, but also of SE Europe and also contributing to the smooth energy transition and energy pluralism of the region.

The Alexandroupolis FSRU is expected to be operational at the end of 2023, with the contracted gasification capacity already reaching up to 60% of the technical capacity of 5.5 bcm per year. It is noted that the Independent Natural Gas System of Alexandroupolis has been included and financed by the NSRF Operational Programme “Competitiveness, Entrepreneurship and Innovation 2014-2020” with the amount of public expenditure amounting to €166.7 million.

In addition, during the ceremony for the start of the implementation of the first FSRU in Alexandroupolis, it was announced that the license was secured by RAE for the implementation of a second FSRU in Thrace by Gastrade. The project will also consist of one FSRU and will be deployed near the first FSRU in the Thracian Sea, off Alexandroupolis. The FSRU will have a storage capacity of 170,000 m3 of LNG and will be able to deliver up to 22.7 million m3 of natural gas per day or 5.5 billion cubic meters annually. The project will also include an onshore and subsea pipeline system that will connect the FSRU to existing natural gas pipelines in the area [69].

Map 4: Location and Interconnections of the Alexandroupolis FSRU



Source: Gastrade

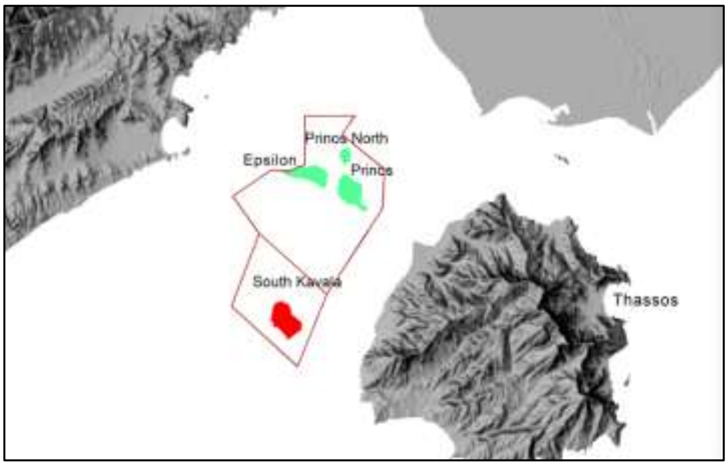
Map 5: Alexandroupolis FSRU – New Energy Supply Gateway for Greece and the Wider Region

Source: Gastrade

5.2.6.3 Underground Gas Storage Facility in South Kavala

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

Map 6: The Depleting Natural Gas Field in South Kavala is Marked in Red



Source: Energean

The South Kavala UGS is an energy infrastructure that will strengthen the supply security of the natural gas market at national and European level, for the benefit of the end consumer. It offers the possibility of long-term storage of natural gas in contrast to the Revithoussa LNG terminal. It should be noted that Greece is the only country in the EU, which does not have an underground gas storage, even though a significant part of the country's electricity production is based on natural gas. Additionally, European countries store at least 20% of their annual natural gas consumption in UGS.

According to the preliminary design of the project, the UGS capacity is estimated at about 1 bcm. Annual volume throughput is estimated at 360 million Nm3 or 720 million Nm3, for one or two cycles per year respectively. It is noted that the project has been included in the 5th List of PCI adopted on November 19, 2021 by the European Commission and the Member States at the meeting of the Regional Groups for PCI.

On March 10, 2020, a Joint Ministerial Decision was issued [70], with which the exploitation process of the field began. More specifically, HRADF will conduct an international tender for the granting of the right to construct, maintain, operate and exploit the field as a UGS facility for a period of up to 50 years. On June 29, 2020, HRADF announced the launch of an international tender for the concession of the use, development and exploitation of the UGS facility [71].

On August 11, 2020, HRADF announced the extension of the date for submission of expressions of interest for the award of a concession contract for the use, development and exploitation of the UGS facility until September 30, 2020. In October 2020, three schemes showed interest, namely Energean, the GEK TERNA-DESFA consortium and the Chinese company China Machinery Engineering Co (CMEC)-Maison Group, which on March 30, 2021 was rejected from the next phase.

RAE is expected to determine the basic principles and guidelines for the methodology for setting the tariffs for the use of UGS facility, an element that is a basic prerequisite for the tender to be carried out by HRADF. UGS facility will operate as Independent Natural Gas System and under Regulated Third Party Access (rTPA) regime.

Greece is one of the few countries in the EU that does not have underground gas storage facility despite the fact that it now has an extensive system of mainly pipelines, branches and gas networks (estimated at more than 5,000 km) and has an increased consumption that in 2021 reached 7.0 billion cubic meters. While the need for the creation of UGS facilities had already been identified since 2008/2010, successive governments did absolutely nothing to ensure the proper operation of the National Natural Gas System, with the result that the country is at risk in several cases of running out of gas (and electricity) due to increased demand or extreme weather conditions, while the inability to store gas seasonally contributes to upward trends in prices[34].

While in the period 2011/2012 there was on the table a comprehensive and fully financed by private funds proposal of the concessionaire company (i.e. Energean) of the field in Prinos and South Kavala, the government in deviation and breach of the exploitation agreement, but under the unbearable pressure of the "troika"[35], was forced to transfer the ownership of the depleted gas field of South Kavala to HRADF. With HRADF in question, not having the necessary know-how and often acting against the national interest and energy security (since it is essentially controlled by foreign power centers), not having the slightest interest in proceeding with the utilization of this strategic project.

Finally and after many attempts, in 2018 a clear order was given to HRADF, after seven years of indifference, to proceed with a tender for the exploitation of the underground geological structure in South Kavala and its transformation into a permanent UGS facility, with the investment estimated at €400 million. After several bureaucratic entanglements, the tender was finally announced in 2020 with RAE simultaneously finalizing the operating and pricing

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[34] Stambolis, C. (2022), "When Will Greece Finally Get an Underground Gas Storage Facility?", https://www.energia.gr/article/195891/pote-epiteloys-tha-apokthsei-h-ellada-ypogeia-apothhkh-fysikoy-aerioy

[35] The "troika" is a term used to refer to the single decision group created by three entities, the European Commission, the European Central Bank and the International Monetary Fund. It was formed in the aftermath of the European debt crisis as an ad hoc authority with a mandate to manage the bailouts of Cyprus, Greece, Ireland and Portugal, in the aftermath of their prospective insolvency caused by the world financial crisis of 2007-2008.

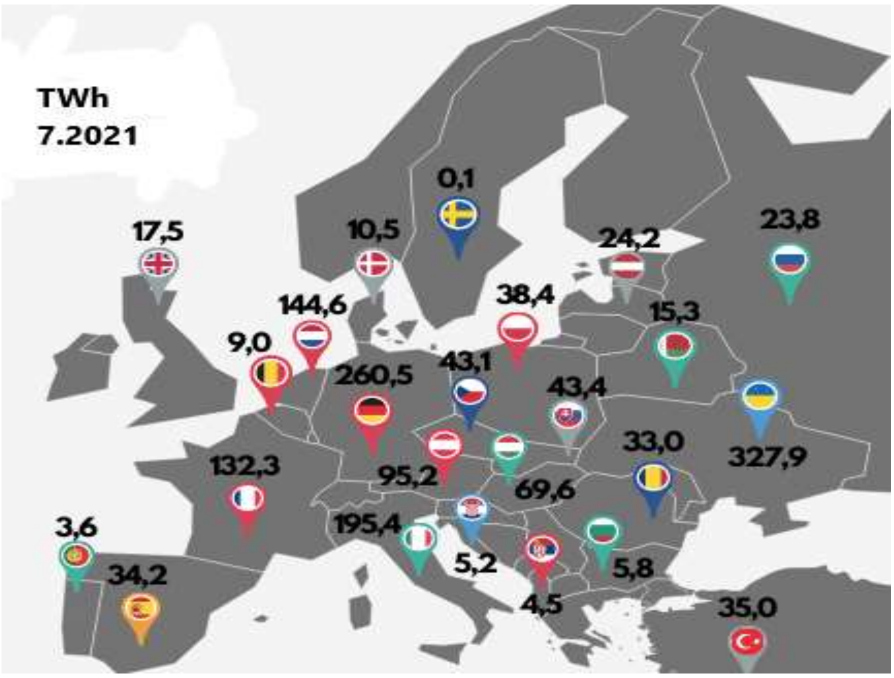
regulations for the UGS facility. Today, the project is literally languishing, despite the fact that two serious investment schemes have emerged (Energean and the DESFA-TERNA consortium) with continuous extensions being given for the date of submission of binding offers.

Meanwhile, the cost of the investment is estimated by the companies to have exceeded €1.0 billion, since a large part of it corresponds to the cost of the permanent volume of gas (known as cushion gas) that is required to be stored at all times. With the prevailing high gas prices, the investment costs have been significantly increased and therefore the financial data and the repayment terms of the investment have changed drastically. For this reason, the proposed by RAE cost recovery of only 50%, from the storage and management services of the UGS facility, is directly opposed by the investors who now declare their inability to undertake such a project. With RAE prioritizing the social interest in order to avoid overcharging consumers, the only remaining solution is government's intervention to secure European funds so that a part of the investment (of about €400 to €500 million) is covered by government's subsidy. This is necessary since it essentially concerns a basic energy infrastructure of national (and European) importance.

At the time of writing this text (March 2023), the outcome of the HRADF tender for the selection of the joint venture contractor that will undertake the organization and operation of the South Kavala UGS remains unknown. In any case, this is a particularly important infrastructure project with a strategic significance since its development will be able to greatly enhance the security of the National Natural Gas System.

In contrast, Europe has a total of 170 underground natural gas storage facilities. Specifically, 60 are in Germany, 16 in France, 13 active and 7 under construction in Italy. The closest to Greece are in Bulgaria, which has 1 UGS, and in Romania, with 8. The total gas capacity of 170 LNG in Europe exceeds 4.2 trillion cubic meters, with Germany holding 42% of the total capacity [72].

Map 7: Underground Gas Storage Facilities in Europe in 2021



Source: Prospero

The existence of a UGS facility is considered of strategic importance for Greece, as in times of energy crisis, such as the one Europe is now experiencing due to the Russia-Ukraine war, it offers further security of energy supply, while it also plays a role in balancing prices.

5.2.6.4 Trans-Adriatic Pipeline (TAP)

As part of the Southern Gas Corridor, TAP provides a cost-effective, direct natural gas transport route. The Southern Gas Corridor is a system of natural gas pipelines, with a total length of 3,500 km, extending from the Caspian Sea to Europe.

TAP starts from the Evros Gardens, where the Greek Compression Station is located, near the Greek-Turkish border. Following a route of 550 km, with a compression 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 from the municipality of Devoll, in the region of Korça, and runs approximately 215 kilometers through 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 kilometers northwest of the Albanian city of Fier, where the compressor station operates

The subsea section of the TAP runs across the bottom of the Adriatic Sea in the Strait of Otranto for approximately 105 km and at a depth of approximately 810 meters. At a depth exceeding 300 meters, the pipelines are coated with concrete, for additional mechanical protection and stability. TAP goes onshore on the Italian coast north of San Foca through a micro-tunnel of 1.5 kilometers long and more than 15 meters below the land surface of the coast. The onshore Italian section extends for 8 kilometers and ends at the Receiving Terminal in the municipality of Melendugno, where the pipeline's operational control center is located.

Map 8: TAP Pipeline Route

Source: TAP AG

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

On March 30, 2019, the installation of the first pipelines of the subsea section of the 105 km long project that will connect the coasts of Albania and Italy was successfully completed. Work on this section had started in October 2018.

On November 25, 2019, the filling of a 2 km pipeline section (between Evros and the Kipoi Compressor Station) with natural gas began [73]. This is the initial stage of the commissioning process which aims to ensure that the project is completely safe and ready for operation. According to data[36] of the project manager, at the end of April 2020, the project was 95% complete.

On January 20, 2020, the three gas transmission system operators involved (TAP, SRG and DESFA) invited interested parties to participate in a public consultation on the TAP capacity expansion project proposal until February 21, 2020. In early June 2020, the three operators announced that the binding phase of the market test for the increased capacity is expected

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[36] TAP (2020), "Project progress", https://www.tap-ag.com/pipeline-construction/project-progress

to take place in July 2021, instead of January of the same year as initially planned, in order to give more time for the energy markets to recover.

On November 15, 2020, TAP AG officially announced the completion of the construction and trial operation of the TAP and its operational readiness, almost four and a half years after its construction began. This date is defined as the official Commercial Operation Date (COD) of the pipeline, as defined in the Exemption Decision granted by the Regulatory Authorities of Greece, Albania and Italy. The COD milestone marks the beginning of the 25-year period of exemption from ownership unbundling, third party access and tariff setting. From this date onwards, users who have secured capacity on the pipeline are obliged to pay tariffs, as defined in the Pricing Regulation. Finally, from 15.11.2020, TAP started offering daily natural flow products on the capacity booking platform through PRISMA auctions at the Kipi entry point and the Melendugno exit point in Italy. In Nea Mesimvria, daily auctions started at the end of December 2020, when the measuring station of Nea Mesimvria was put into operation [64].

On December 31, 2020, the first quantities of natural gas from Azerbaijan arrived in Greece and Bulgaria, through the interconnection point with DESFA in Nea Mesimvria, as well as in Italy, through the interconnection point with SNAM Rete Gas in Melendugno. In March 2021, TAP transports the first 1 bcm of natural gas to Europe [74].

The pipeline has been laid at a depth of at least one meter below the ground surface, with the aim of protecting the environment and minimizing the impact on neighboring communities. The only above ground facilities are the Receiving Terminal, compression and valve stations.

5.2.6.5 Interconnector Greece - Bulgaria (IGB)

Currently, Bulgaria and Greece have an interconnection point, located on the Greek-Bulgarian border, in the Kulata/Sidirokastro area, connecting Bulgartransgaz's gas transmission system with the gas transmission system operated by DESFA. The Kulata/Sidirokastro connection point operates primarily as an entry point to Greece, while reverse flow is also possible.

The investment decision for the project was adopted in 2015. The project is implemented by the IGB consortium, in which the Bulgarian state, through the holding company Bulgarian Energy Holding, and the Greek-Italian company IGI Poseidon participate with equal shares. There is the potential to increase capacity from 3 to 5 billion cubic meters per year, given the imminent operation of the Alexandroupolis FSRU, where the Bulgarian state already holds a 20% stake.

The construction work of the IGB started in May 2019. On Greek territory, the construction started in July 2019, after RAE issued the Permit of Independent Natural Gas System, with Decision 671/27.06. 2019, as defined in the Natural Gas Permits Regulation. The project of the Greek-Bulgarian interconnector consists of a pipeline of approximately 182 km with a starting point in Komotini. The pipeline will end in Stara Zagora, connecting the natural gas networks of Greece and Bulgaria, while there will be the possibility of reverse flow.

The project has been included in the 5th list of PCI as approved on 19.11.2021. Also, the Greek-Bulgarian interconnector is included in the list of priority projects of the initiative for the Energy Interconnection of the countries of Central and South Eastern Europe (Central and South Eastern Europe Gas Connectivity – CESEC). Through the IGB, the transit of gas to the markets of Bulgaria and SE Europe is increasing.

Map 9: IGB Pipeline Route

Source: Euractiv

In June 2019, the company ICGB AD requested the amendment of the Exemption Decision to postpone the maximum date of the start of commercial operation of the IGB. According to the company, the delay in the start of the commercial operation of the pipeline is due to the delay in the start of the construction works, due to objections and legal disputes during the awarding procedures of the project's contractors. Following communication with the European Commission's Directorate-General for Energy and the consent of the users who have reserved long-term capacity in the pipeline through the Market Test with Advanced Reservation Capacity Agreements that they have entered into with the company, so that the modification does not affect the their business plans, the Regulatory Authorities of Greece and Bulgaria jointly approved the requested amendment (RAE Decision 568/10.03.2020), according to which the earliest date for commercial operation of the pipeline would be July

1, 2021. However, the Covid-19 pandemic further delayed the start of commercial operation of the pipeline [64].

Within June 2022, it began to be filled with gas in order to start the operational tests. The opening ceremony of the IGB was held on July 8, 2022 by the Prime Minister of Greece. The pipeline allows the transit of gas from the Greek to the Bulgarian gas network through a second interconnection between the two countries under an "exception" regime (granted according to Article 36 of Directive EC/2009/73 by Joint Decisions of the Energy Regulatory Authority of Greece No768/2018 and of the EWRC of Bulgaria No:P-BO-2 on 08.08.2018) [75].

On October 1, 2022, the commercial operation of the Greece-Bulgaria Interconnector officially began. As Prime Minister Kyriakos Mitsotakis pointed out at the ceremony for the pipeline's operation in Sofia: "The start of commercial operation of the IGB is a great moment, not only for SE Europe, but for Europe more broadly, as this pipeline significantly enhances the energy and logistics security for all interconnected countries in the Balkans, but also in the European continent as a whole".

In addition, the CEO of ICGB stated "IGB is contributing to the fulfillment of Bulgargaz's agreement with SOCAR to supply gas to Bulgaria from Sah Deniz. In combination, with the Revithoussa LNG terminal and the Alexandroupolis FSRU, it increases the flow capacity by 3 bcm, while with the appropriate compressor, it can even reach 5 bcm" [76]. The IGB is expected to change the energy map in the region at a time when Europe is facing its worst energy crisis in decades, triggered by the Russian invasion of Ukraine.

5.2.6.6 Interconnector Turkey – Greece – Italy (ITGI) – Poseidon

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

The pipeline between Greece and Italy Poseidon consists of two sections: (a) the land section of approximately 760 km length starting from the Greek-Turkish border in Kipoi and crossing the Regions of Eastern Macedonia and Thrace, Central Macedonia, Western Macedonia, Thessaly and Epirus and ending in off the coast of Thesprotia and (b) the subsea part of the project, approximately 210 km long, connecting the Thesprotia coast to Otranto, Italy.

The subsea part 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 taken after conducting a market test. According to the

March 26, 2020 decision[37], the installation and route of the 8.2 km long land section of the Greek section of the pipeline from the Metering and Compression facilities in Thesprotia to the point of sealing of the sea route in Epirus is determined.

Map 10: Onshore and Offshore Section of IGI

Source: DEPA

5.2.6.7 Interconnector Greece - North Macedonia (IGNM)

The pipeline is planned to have a total length of 123 kilometers and will extend from Nea Mesimvria to Negotino via Evzoni/Geugelija connecting the national gas transmission systems of Greece and North Macedonia, managed by DESFA and NER respectively. Its initial transport 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 in order for the pipeline to have the appropriate specifications for the transport of green hydrogen.

The project, the cost of which is estimated to reach €110 million, will further upgrade Greece's role as a natural gas hub by transporting natural gas from National Natural Gas System to North Macedonia and wider. At the same time, this project promotes the regional development of the gas market and the activation of more users by contributing to the development of the Greek gas hub, which in turn will result in more favorable gas prices in the Greek market as well. It will also contribute to increasing the degree of use of the Greek infrastructure, such as Revithoussa LNG terminal, with the aim of reducing the System's usage fees in the long term. The required project within the Greek territory consists of the construction of a 54.3 km long pipeline, which starts from Nea Mesimvria to the border with North Macedonia.

[37] https://diavgeia.gov.gr/doc/%CE%A8%CE%9B%CE%A5%CE%A84653%CE%A08-%CE%983%CE%A7?inline=true

Map 11: IGNM Pipeline Route

Source: ENTSOG

A Cooperation Agreement for the development and construction of the Greece-North Macedonia natural gas interconnector was signed on September 10, 2021 by DESFA and NER JSC SKOPJE. The Greek section of the project consists of an approximately 55-kilometer, 30-inch-diameter pipeline that runs from Nea Mesimvria, in the Thessaloniki area, to Evzoni, on the border between the two countries, and a Border Metering Station. The Greek section of the project was expected to begin in Q3 2022 and be completed in Q3 2024.

The RAE, with its decision 775/2020, approved the inclusion of the Greek section of the project in the 2020-2029 Ten-Year Development Programme of DESFA, subject to a successful Market Test that proves that there is sufficient interest from the market for this project. On July 26, 2022, DESFA announced the start of the Market Test process for the commitment of capacity on the Greek side of the Evzones-Geugelija Interconnection Point, in a single phase regarding the Gas Interconnection between Greece and North Macedonia [77].

5.2.6.8 Ionian – Adriatic Pipeline (IAP)

The Ionian Adriatic Pipeline (IAP) project is based on the idea of connecting Croatia's existing natural gas transmission system through Montenegro and Albania to the TAP system. The total length of the natural gas pipeline from the city of Split in Croatia to the city of Fieri in Albania is 511 km. Its capacity of 5 bcm/year provides the natural gas supply of Albania (1 bcm), Montenegro (0.5 bcm), southern Bosnia and Herzegovina (1 bcm) and Croatia (2.5 bcm) [78].

The implementation of the entire project of the Ionian Adriatic Pipeline allows the opening of the new energy corridor for the region of SE Europe with the aim of creating a bidirectional natural gas supply from the Middle East and the Caspian region. The Ionian-Adriatic pipeline will be capable of two-way natural gas flow, i.e. it will be able to supply the SE European natural gas to other sources, one of them being the future LNG terminal on the island of Krk. The comprehensive Feasibility Study funded by WBIF was completed in April 2014 [78].

Map 12: IAP Pipeline Route

Sourec: TAP AG

The project is currently in the initial design phase (Croatia – Montenegro – Albania) while the construction licensing process is ongoing in Croatia and Albania.

5.2.6.9 Turkish Stream Pipeline

The Turkish Stream pipeline is a 930 km long natural gas pipeline connecting Russia to Turkey across the Black Sea. Turk Stream originates from the Russkaya compressor station located in the coastal Russian city of Anapa. The offshore section of the pipeline stretches 230 kilometers in Russian waters, while the remaining 700 kilometers pass through Turkey's Exclusive Economic Zone in the Black Sea. The pipeline reaches eastern Thrace and continues on land for 180 km from the Turkish Black Sea coast to the Turkey-Greece border [79].

Map 13: Turkish Stream Pipeline Route

On January 18, 2020, an opening ceremony was held, which also marked the first deliveries of natural gas through the new Turkish Stream pipeline to Turkey. On January 27, 2020[38], 1 bcm of natural gas was delivered through the pipeline.

In addition, according to an announcement by Bulgartransgaz, Russian natural gas deliveries for Bulgaria, Greece and North Macedonia are now transported through the new entry point (Bulgaria-Turkey border). In practice, this means that Gazprom, from the beginning of January 2020, by transporting gas through the Turkish Stream, replaced the route that passed through Ukraine and Romania via the Trans Balkan Pipeline. In parallel with this project, conditions are being created for access to the LNG terminal in Revithoussa and the Alexandroupolis FSRU.

5.2.6.10 East Med Pipeline

Despite the intense political background and the efforts of some countries to derail the project, the prospects for the construction of East Med gas pipeline remain positive. Geopolitical developments and Europe's energy sufficiency have brought the construction of the pipeline back to the fore.

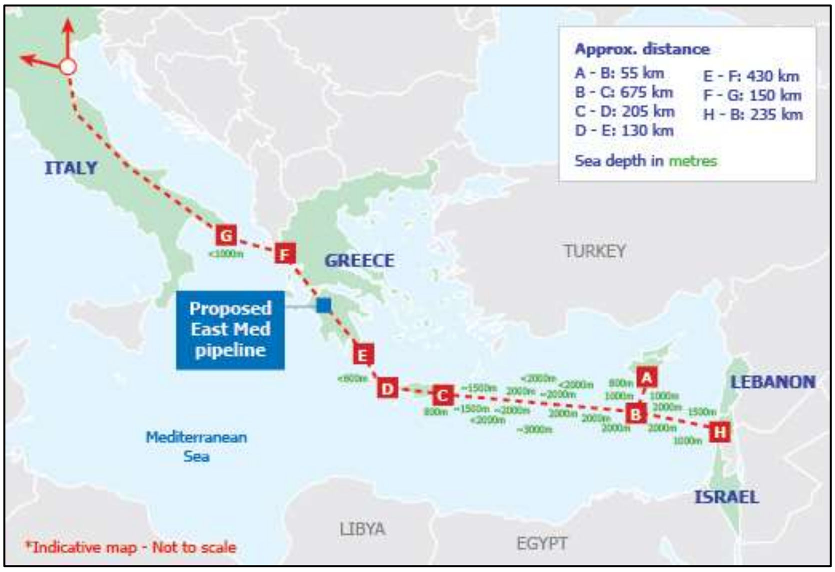
East Med pipeline is promoted by IGI Poseidon, in which DEPA and Italy's Edison participate. The pipeline will be approximately 2,000 km long, of which more than 1,400 km are subsea. It is going to connect Israel, Cyprus and Greece, ending in Italy. In the Greek territory, it is going to pass through Crete and Southeast Peloponnese, where it will then cross the Greek mainland for about 600 km, to reach Italy through the subsea section of the POSEIDON pipeline, which is about 210 km long.

[38] Gazprom (2020), "First billion cubic meters of gas supplied via TurkStream", https://www.gazprom.com/press/news/2020/january/article498525/

The subsea section of the project includes two pipelines with an average distance of 100 meters between them. The Cyprus - Crete section will have a total length of approximately 690 km, of which approximately 400 km are within Greek territory, and a transport capacity of 11 billion km/year. The southern line, again in the section Cyprus - Crete, will have a total length of approximately 740 km, and a transport capacity of 10 billion km/year.

In recognition of their great importance and contribution to the achievement of the EU's energy security objectives, in accordance with the criteria of Regulation 347/2013, the East Med pipeline and the POSEIDON pipeline have been designated since 2013 as EU Projects of Common Interest, in particular because they enhance security and diversification of energy supply and support market integration and competition in Europe. As a PCI project, the East Med pipeline benefits from fast-track procedures provided by the EU Regulation 347/2013. The development activities of the project are also supported through the co-financing of the EU programme "Connecting Europe Facility" [80].

Map 14: East Med Pipeline Route



Source: IGI Poseidon

On January 2, 2020, the Greece - Cyprus - Israel Intergovernmental Agreement was signed for the implementation of the East Med gas pipeline. On March 3, 2020, a Ministerial Decision was issued according to which the start of the licensing cycle for the East Med pipeline and more specifically the Greek onshore part of the pipeline was approved.

On April 29, 2020, YAFA Poseidon issued an invitation for the preparatory activities of the East Med pipeline, with a total cost of €2.4 billion before taxes and €2.97 billion after taxes. In particular, the activities concerned the detailed design, procurement, construction, transportation, installation and pre-commissioning of the offshore sections of the pipeline.

The specific tender was for phase A of the East Med which is designed to transport 10 bcm/year plus 1 bcm for Cyprus and lasted until 20 June 2020. The design and development of Phase A takes into account all activities study and development, including the relevant pre-investments, with a view to a possible increase in the capacity of the pipeline to 20 bcm/year, in a later phase.

In January 2020, after evaluating the results of the extensive planning and surveys carried out by IGI Poseidon during the period 2015-2019, DNV issued a first Feasibility Report for the project, which contained recommendations to be considered during the next phase. As the project completes activities that included, among others, a recent optimization of the route and geophysical studies, DNV assessed the current status of the project from a technical point of view and highlighted the points that need to be addressed in the next phase of execution [81].

The submission to the Parliament of the draft law of the Intergovernmental Agreement for the East Med pipeline on May 4, 2020 follows the start of the project's licensing process in Greece and the announcement of key parts of the final feasibility study carried out by the project's implementing body, the YAFA Poseidon. The Intergovernmental Agreement for the construction of the pipeline was ratified by the Greek Parliament on May 14, 2020.

In June 2022, IGI Roseidon issued a call for expression of interest for the assignment of part of the equipment for the project and more specifically for the supply and installation of the four decompression stations, which are to be installed in Cyprus, Crete, Megalopolis and mainland Greece. The estimated budget for the equipment amounts to €250 million, while the goal of IGI Poseidon is to arise up to 5 prospective contractors [82].

At the same time, the rest of the project's preparatory services are in progress, one of the most important of which is the implementation studies (FEED). Also, detailed subsea survey and mapping has been carried out in the offshore areas of Crete and Cyprus in order to map the pipeline route. However, in parallel with the technique, the environmental "maturity" of the infrastructure is also progressing, as at the end of May the Ministry of the Environment and Energy gave a positive opinion on the Preliminary Determination of Environmental Requirements Studies, which paves the way for the preparation and submission of the Environmental Impact Assessment [82].

In addition, DEPA Commercial is in advanced discussions with suppliers from Israel and Egypt, for importing natural gas into Europe through the pipeline. IGI Poseidon S.A. completes the development activities of the project and aims to fulfill the conditions for a positive Final Investment Decision within 2023. Updating the feasibility and maturity of the East Med gas pipeline is an important step, as it highlights East Med as a key project for EU diversification from Russian gas.

The European Union, in the context of the "RePowerEU" project, has put the Union's independence from Russian energy as its main focus. In this context, the pipeline is an infrastructure of utmost importance to achieve that objective. The Commission's "RePowerEU" plan comes at the most appropriate time for the pipeline and moves along three axes. The first axis concerns energy savings, the second one the greater penetration of RES and the third axis the diversification of natural gas and oil suppliers. In the context of the third axis, the Commission is promoting new agreements with LNG supplier countries, such as Israel, Egypt and Algeria, while planning the joint natural gas market for the entire Union. A very important issue is the willingness to provide €10 billion through financing schemes for new natural gas infrastructure, such as pipelines and storage facilities. In this context, the conditions about the East Med gas pipeline are particularly positive.

5.2.6.11 Dioriga Gas FSRU

The company Dioriga Gas S.A. has received an Independent Natural Gas System License from RAE (RAE Decision 1321/2018) for a project concerning:

A. FSRU which includes:

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

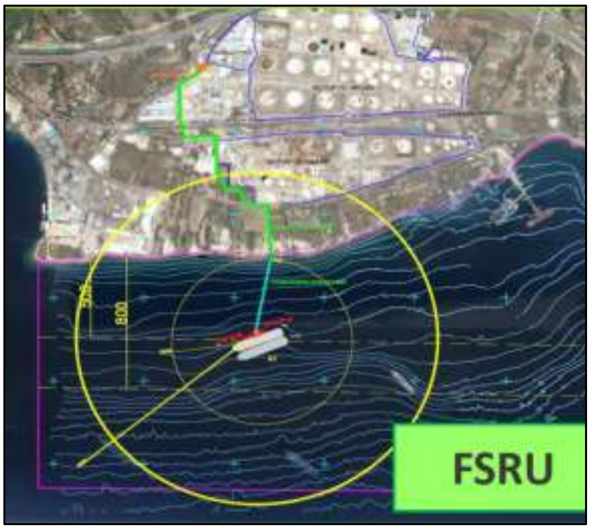
B. Subsea and onshore natural gas pipeline for transporting natural gas into the National Natural Gas Transmission System through a new Metering Station.

The LNG will be imported via special LNG vessels and stored in the specially designed cryogenic tanks of the FSRU and either will be regasified to supply the National Natural Gas Transmission System with natural gas or it will be transferred to smaller capacity LNG vessels or tankers to refuel ships or isolated customers [83].

The FSRU will be permanently moored at a fixed point on a floating platform and will be approximately 1.5 km southwest of the existing jetty for receiving petroleum products of the Refinery of "MOTOR OIL (HELLAS) CORINTH REFINERY S.A." in the area of Agioi Theodoroi in Corinth. The minimum distance from the coast is calculated at 500 meters in equal depths of 50 meters. Maintaining a constant distance of the FSRU from the shore will be ensured by mooring to a floating platform [64].

The maximum licensed capacity to supply natural gas to the National Natural Gas Transmission System through the Dioriga Gas FSRU is estimated at 4.3 bcm/year, allowing regasification of up to 11.76 million Nm3 of natural gas per day [83]. The project will strengthen the security of supply at national and European level, will be a new Entry Point of the National Natural Gas System and with the required interconnections of the National Natural Gas System 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

The first phase – non-binding – of the Market Test for the expression of intention to commit capacity at the Dioriga Gas FSRU was completed on January 14, 2022. Expression of interest was submitted by 15 Greek and international companies. The LNG quantities, committed by these prospective users of the infrastructure for all the products allocated and for the first five years of operation of the FSRU, were more than double the initial estimates of the Group. In June, the binding Market Test for the Dioriga Gas FSRU was carried out, while the investment decision for the implementation of the project was expected to be taken by the end of 2022, after the results of the binding market test.

5.2.6.12 Thessaloniki and Volos FSRUs

Elpedison, the subsidiary of HELLENiQ ENERGY and the Italian Edison, with activity in the supply of electricity and natural gas and in power generation with two natural gas plants, is also expanding its activities into LNG terminals.

The company submitted to RAE an application for the granting of an Independent Natural Gas System license. The new project, “Thessaloniki FSRU”, will consist of an FSRU, will be developed in Thermaikos Gulf, off Thessaloniki, and is expected to be commissioned within 2025.

The FSRU will have a storage capacity of 170,000 m3 of LNG and will be able to deliver up to 20 million cubic meters of natural gas per day. The project will also include a system of onshore and subsea pipelines that will connect the FSRU to Elpedison’s power generation units in Thessaloniki (one existing and one under planning), as well as to National Natural Gas System’s existing transmission pipelines in the area. The construction of the “Thessaloniki FSRU” will enhance security of supply, allow expanded access to natural gas markets and contribute to decongesting the National Natural Gas Transmission System.

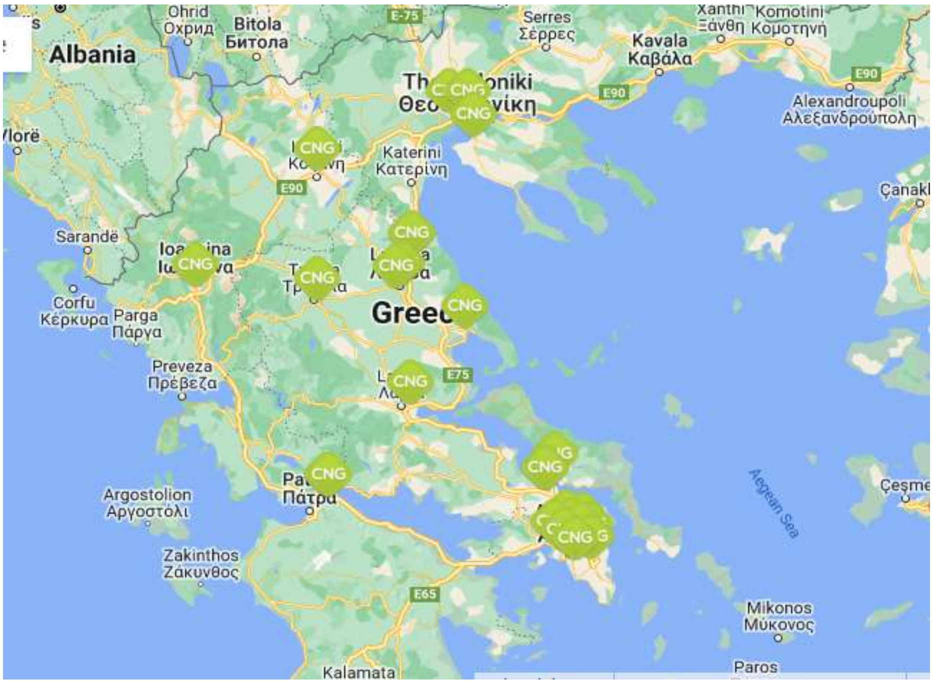
Regarding the Mediterranean Gas FSRU in Volos, it has been already licensed by RAE, while there is a delay as HRADF informed the investors that there is no such design in the master plan that has been prepared for the upgrade of the port, as well as that in order to grant the use for FSRU a tender should be held [84].

5.2.6.13 Isolated Natural Gas Distribution Networks/Compressed Natural Gas (CNG)

According to the 2021-2025 Development Programme of EDA THESS, isolated areas have been included to be supplied with a Virtual CNG Pipeline, in accordance with RAE Decision 643/02.07.2018 “Framework for the Development of Isolated Distribution Networks using Compressed/Liquefied Natural Gas” (Government Gazette B 3334/10.08.2018), as amended by RAE Decision 633 “Amendment of RAE Decision 643/2018 Framework for the Development of Isolated Distribution Networks using Compressed/Liquefied Natural Gas” (Official Gazette 4271/B/16.9.2021).

The 2022-2031 Development Programme of DESFA proposes a CNG station in conjunction with the project “Measuring and Regulating Station in the area of Poria” in order to supply the Grevena area with CNG. The gas will be transported to the CNG station through the TAP pipeline. The start of operation of the project was planned for November 2022, while the integration into the system is scheduled in January 2023 [85]. By 2022, 26 CNG refueling stations had been commissioned, as shown in the following map [86].

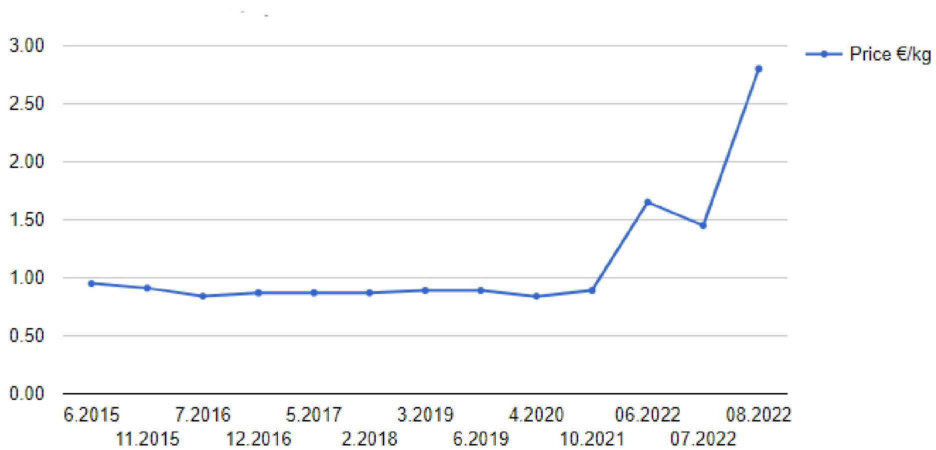
Map 16: Network of CNG Stations



Source: NGVA

According to CNG Europe, natural gas is on average 40%-60% cheaper than oil or petrol, depending on the domestic markets. Figure 80 presents the evolution of CNG prices in Greece from June 2015 to August 2022, where a significant price increase of 175% is observed over the same period [87].

Figure 80: CNG Prices in Greece



Source: CNG Europe

In November 2021, the IENE completed a special study on "Cost-Benefit Analysis for the Expansion of the National Natural Gas Transmission System to Western Greece (Epirus

Region and Western Greece Region)" [88], on behalf of RAE, against the supply of the Regions through 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 carbon neutral economy, while the existing transmission networks that are expected to be expanded will be able to distribute fuels from RES, such as biomethane and hydrogen. Therefore, these are infrastructures that will be the means for the further penetration of new sources, friendly to the environment, into the Greek energy system.

The aforementioned study concluded that, among others, the transport of natural gas either through pipelines or through tankers and/or ships (LNG) presents advantages and disadvantages. Undoubtedly, the best option is to combine the methods 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 unit within or near cities, etc. However, it is worth mentioning that such good practices exist and are already being implemented in Europe, while not significant and structural changes in LNG supply systems are expected in the coming years. The continuous and effective training of the staff who will operate the facilities in the cities of the two Regions is considered of capital importance in order to ensure their safe and efficient operation.

A key role in the progress of such an investment is the increasing or non-increasing prices of fuel and especially of LNG, but also of natural gas sold to the final 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 final consumer and help develop trade and the economy in general, etc.

5.2.6.14 Small Scale LNG/Shipping Applications

The Poseidon Med II programme played a vital role in the growing adoption of LNG as a marine fuel in the Eastern Mediterranean shipping. Poseidon Med II was a European programme with a total duration of 6 years, from June 2015 to December 2021 and a total budget of €53,279,405, which was co-financed by 50% from the EU's "Connecting Europe Facility" mechanism.

The programme involved three countries (i.e. Greece, Cyprus and Italy) and six European ports (i.e. Piraeus, Patras, Heraklion, Igoumenitsa, Limassol and Venice), and the LNG terminal in Revithoussa. DEPA Commercial was responsible for coordinating the programme, while DESFA has the role of Technical Coordinator.

In particular, Poseidon Med II contributed to the establishment of a regulatory and legislative framework for the implementation of safe LNG refueling activities in the Greek ports that led to the relevant Presidential Decree of 2019. As early as 2020, the Greek Ministry of Shipping gave the “green light” to Port of Piraeus to start LNG refueling operations, either ship-to-ship or truck-to-ship, provided that the necessary investments are in place. It also supported the preparation of a Practical Safety Guide for Port Authorities during LNG bunkering operations.

The contribution of Poseidon Med II was significant at the Revithoussa LNG terminal, where due to its importance in completing the supply chain of the wider region, it financed the studies for the implementation of the construction of an LNG truck loading station, as well as a new small-scale LNG pier for the servicing of small feeder/supply vessels of between 1,000 m3 and 30,000 m3 capacity, which were expected to be commissioned in the first half of 2022 and 2023 respectively.

For the ports of Piraeus, Patras, Heraklion and Igoumenitsa, Poseidon Med II funded the studies for the development of small-scale LNG infrastructure, including the master plans for LNG bunkering facilities within the ports. Furthermore, the programme financed the conversion plans of ten conventional ships and for five of which the detailed design was implemented, as well as the design of two new RO-PAX ferries, one conventional and one innovative that will use LNG as fuel.

The adoption of LNG as a marine fuel helps to comply with increasingly stringent environmental standards, including the IMO 2020 regulations and the objectives of the European Green Deal [89].

5.2.6.15 Combined Cycle Units With Natural Gas Fuel

Helleniq Energy and Edison have reached an investment decision for the construction of the new combined cycle unit of their joint company Elpedison in Thessaloniki. The CCGT, with a capacity of 826 MW, is one of the first new generation power plants to be licensed by the RAE in 2019, but up to today the company’s shareholders have not made an investment decision. The unit is fully licensed in terms of environmental, planning and other requirements and as all indications show it will be the last to start construction against the rest of the same class.

It is worth reminding that the CCGT of 826 MW of Mytilineos in Agios Nikolaos of Viotia is already in trial operation, the 877 MW “Thermoelectric Komotini” of GEK TERNA - MOTOR

OIL is also being built, while recently PPC, DEPA Commercial and Damco Energy proceeded with the investment decision for the construction of the 840 MW natural gas plant in Alexandroupolis. The shareholders of Elpedison were expected until May 2023 to make the investment decision for the Thessaloniki CCGT.

Table 14: New Gas-fired Power Plants in Greece

Units	Companies	Installed capacity (MW)	Implementation phase
CCGT Thessaloniki	Elpedison	826	Awaiting Final Investment Decision
CCGT Agios Nikolaos Boeotia	Mytilineos Group	826	In trial operation
Thermoelektriki Komotini	GEK TERNA-MOTOR OIL	877	Under construction
CCGT Alexandroupolis	PPC, DEPA Commercial and Damco Energy	840	Under construction

Sources: Companies' websites, IENE

The war in Ukraine and the abolishment of Russian natural gas created a need across Europe to secure alternative sources of supply of this fossil fuel until the green transition. Therefore, natural gas power plants are also gaining ground to fill Europe's energy gap.

However, apart from the upheavals in Europe's energy planning, which favor natural gas power plants, in Greece there is another reason for the "blocking" of the investment decision of Elpedison's shareholders. The existing natural gas units of the independent producers are reaching 20 years of life cycle. The same applies to the PPC unit in Komotini. According to market executives, these power plants, when the new ones are built, will be phased out. Over a period of three/four years, they will initially operate as auxiliary units until they are finally characterized as decommissioned ones. So, there is room available to develop new power plants with higher efficiency and lower operating costs. This was another reason why Elpedison seems to have been led to make the investment decision for the construction of the new plant in Thessaloniki.

5.3 Electricity

In Greece, the electricity market operates based on the European Target Model under 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 harmonized rules for cross-border exchanges of electricity and for the operation of wholesale electricity markets [90].

In Greece, the Target Model was completed with the launch of the Hellenic Energy Exchange on November 1, 2020. In recent years, there has been a continuous effort to exploit the RES potential, with the aim of meeting the country's commitments for the highest penetration of these in the Greek energy system, but also the utilization of domestic potential to ensure energy supply. The emphasis is on technologies of high commercial maturity and domestic potential (e.g. wind farms, photovoltaics, biomass, small hydro), which have attracted high investment interest.

It is worth noting that natural gas and RES plants have begun to replace a large part of lignite production, resulting in a significant increase in the total installed capacity for electricity generation over the last decade due to RES.

The preliminary Reform Plan for the Greek electricity market, with the distinct title "Market Reform Plan", was submitted by the Greek government to the European Commission in July 2021. In November 2021, the Greek authorities received the Commission's Opinions (with no. C (2021) 8532 final/29.11.2021 document) on the initial plan, which were then brought to the attention of the competent bodies and Operators. Within 2022, the final text of the Reform Plan was submitted by the Greek government to the European Commission; however, important outstanding issues remain to be settled by the so-called Reform Plan of the Greek electricity market, as reflected in the RAE Activity Report for 2021 [59].

Table 15: Summary of Market Reform Plan

Market Reform Plan	
Part A. Actions for the Wholesale Markets	
1. Distinction of Balancing Energy and Energy due to Re-dispatching → early 2022	9. Resumption of the possibility of BSPs to submit Balancing Energy bids with negative prices → end 2021 linked to A1
2. Distinct portfolio-based reserves market establishment → to explore	10. Participation of RES units in the Electricity Markets having full balancing responsibilities → early 2022
3. Participation of Demand Response in the wholesale markets → early 2022	11. Activation of scarcity pricing mechanism → to explore
4. Participation of storage in the wholesale markets → end 2022	12. Exploration (pros/cons) portfolio-based bidding in DAM and IDM and nomination platforms → to explore
5. Participation of dispatchable RES units and RES portfolios as BSPs in the Balancing Market → early 2022	13. Exploration of self-scheduling and central dispatch → to explore
6. Launch of Complementary Regional Intraday Auctions (CRIDAs) → 2021	14. Participation in the EU balancing platforms (MARI/PICASSO) → 2024
7. Participation of Traders in the Intraday market - Launch of Intraday PTR Auctions for non-EU bidding zone borders → 2022, conditional	15. 70% target (margin available for cross-zonal trade) → mid or end 2022
8. Launch of Continuous Intraday Coupling → 2022	16. TSO-DSO Coordination Platform →2024
Part B. Interconnections and grid reinforcement	
1. Cross-border interconnection projects 1. New interconnection Greece-Bulgaria → 2022 2. Italy (pre-feasibility studies) 3. North Macedonia (feasibility study) 4. Turkey (pre-feasibility study) 5. Albania (very preliminary)	4. Reinforcement of transmission system 1. Completion of the 400 kV backbone Peloponnese → high priority 2. Compensation and stability enhancement → Q1 2022 3. Rouf EHV S/S 4. Argyroupoli EHV S/S 5. Filippi-Santa 6. Nevrokopi etc. 7. Kerkyra 8. Halkidiki 9. Katerini and others 10. South Ionian loop 11. Various others
2. Southeast Electricity Network Coordination Centre (SEleNe CC)	
3. Islands interconnection projects 1. Crete Phase 1 → operational 2. Crete Phase 2 → mid 2023 3. Skiathos → end 2022 4. Cyclades Phase D → 2024 5. Dodecanese → 2028 6. North East Aegean islands → before 2030	

Source: RAE

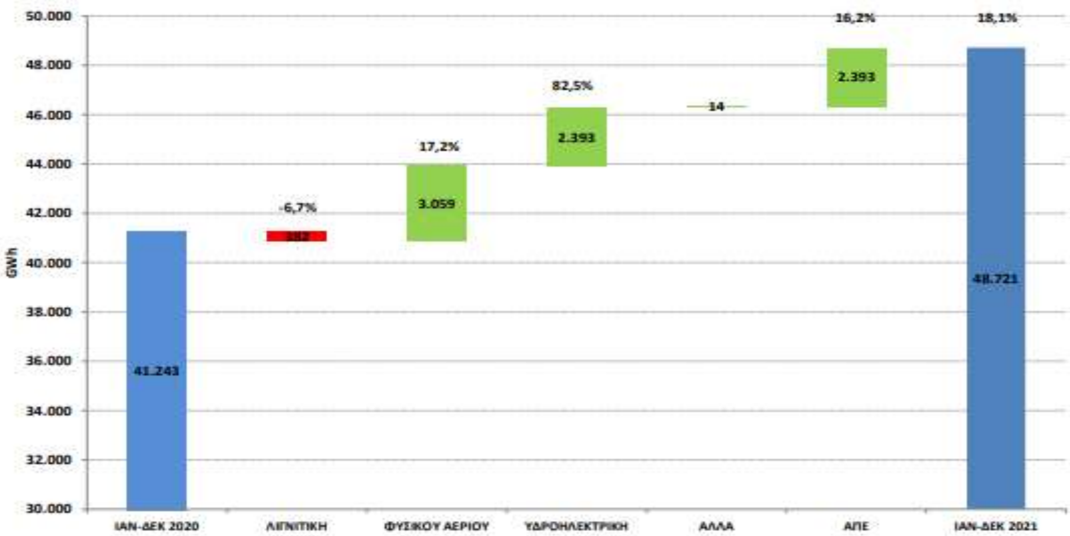
5.3.1 Supply and Demand

Domestic lignite historically played an important role in the Greek electricity production and covered 20% of the total interconnected electricity demand in 2019, while in 2021 its percentage dropped to 10%. Lignite's dominance has declined over the past decade due to the decreasing electricity consumption and the increasing RES penetration in power generation, mainly wind and solar, as well as natural gas.

Power generation

In 2021, Greece produced 48.7 TWh of electricity in the interconnected system, an increase of 18.13% from 2020 levels. Natural gas was the largest source of energy in terms of domestic electricity generation, with 20.9 TWh in 2021, followed by RES, which increased its share from 14.8 TWh in 2020 to 17.2 TWh in 2021. It is noteworthy that the contribution of lignite to electricity generation has decreased in the last two years, from 5.7 TWh in 2020 to 5.3 TWh in 2021 (Figures 81 and 82) [91]. For the period January 2022-December 2022, 47.2 TWh were produced in the interconnected system and grid, showing a decrease of 3.12%, while the electricity balance reached 50.675 GWh [92].

Figure 81: Change in Electricity Generation (GWh) in the Interconnected System of Greece, 2020-2021

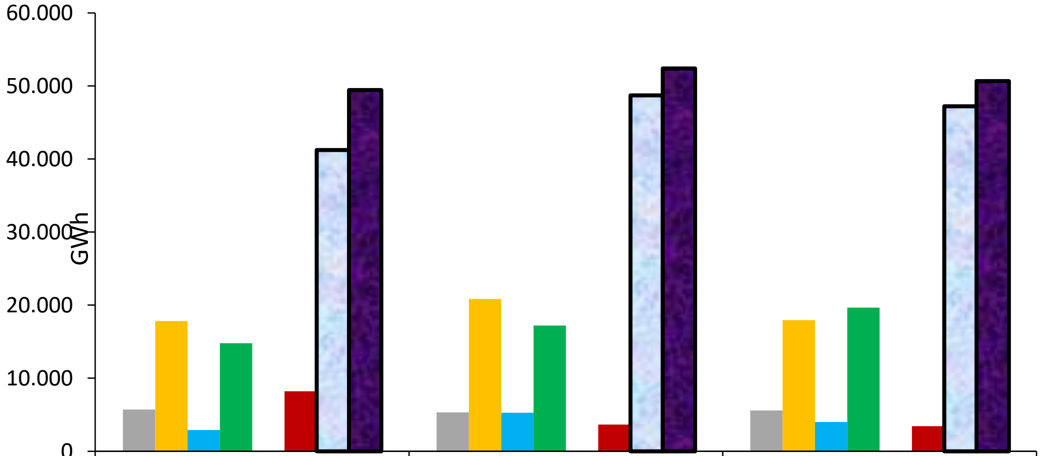


Source: IPTO

Figure 82: Change in Net Output (GWh), 2021- 2022

Source: IPTO

Figure 83: Electricity Production by Source, 2020, 2021 and 2022

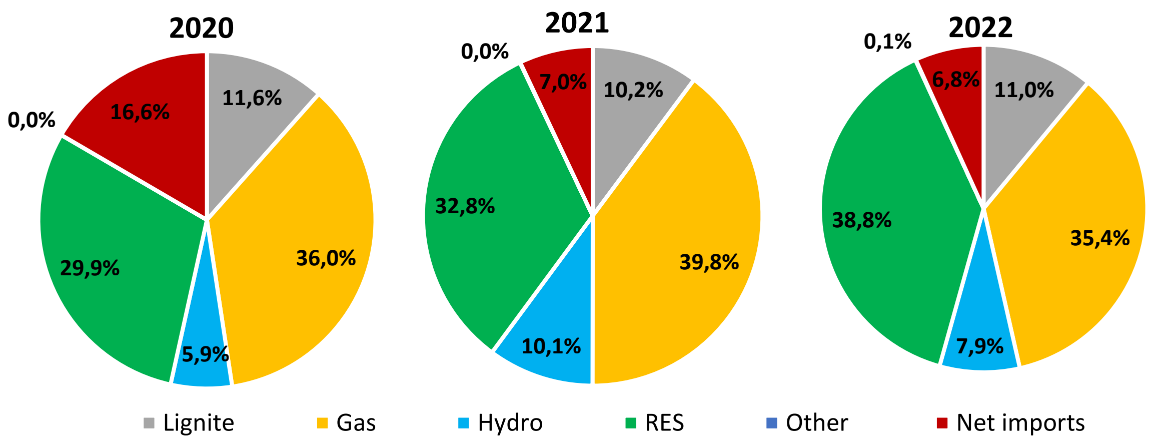


	2020	2021	2022
Lignite	5.722	5.341	5.586
Gas	17.815	20.873	17.949
Hydro	2.901	5.294	4.004
RES	14.800	17.193	19.662
Other	5,9	20,3	26,9
Net imports	8.207	3.683	3.448
Net generation	41.243	48.721	47.228
Total electricity	49.450	52.404	50.675

Source: IPTO

The contribution of the various sources to the availability of electricity has varied over the last three years, as can be seen from the Figures below. In 2022, RES dominated the mix with a percentage of 38.8% displacing natural gas in second place with a percentage of 35.4%, while there was a decrease in electricity production from hydropower plants compared to 2021 and a small increase in production from lignite, while net imports remained flat.

Figure 84: Fuel Share in Electricity Production, 2020, 2021 and 2022



Source: IPTO

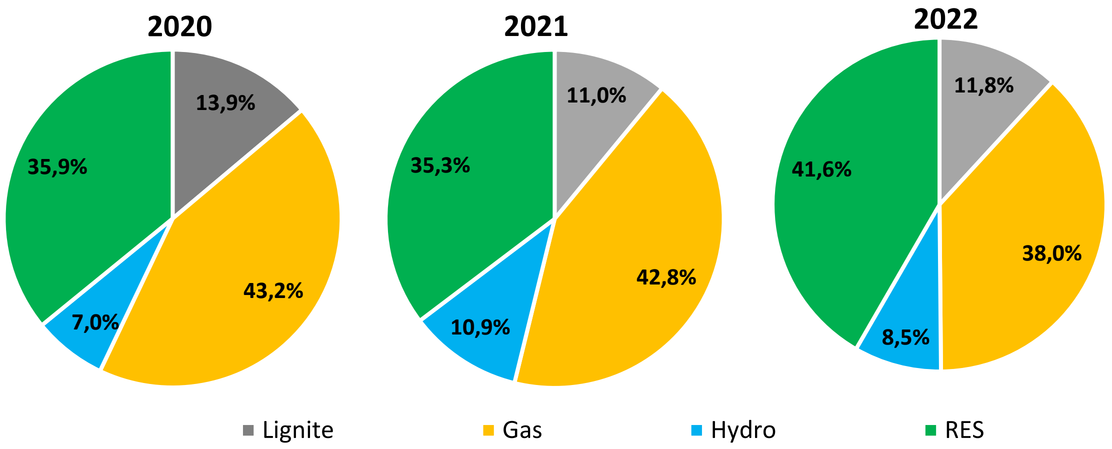
Regarding the share of the various forms of energy in the clean electricity generation in 2022, there was a decrease in the percentage of natural gas by 5 points, falling to 38%, while the penetration of RES accelerated from 35.3% in 2021 to 41.6% in 2022. Furthermore, lignite increased its share in the power generation mix by almost one unit, reaching 11.8% in 2022.

According to the ADMIE data, the past year was a milestone as the image of previous years was reversed, where the largest share in clean electricity generation was occupied by natural gas and previously by lignite. Thus, in 2022, RES was the dominant fuel, with a share of 41.6% and a production of 19.7 TWh. The second place was occupied by natural gas with 38% and 17.9 TWh and the third place by lignite with 11.8% and 5.6 TWh. Hydropower followed with 8.5% and 4 TWh.

Cumulatively, the share of RES and hydropower reached 50.1% in total, even slightly exceeding the sum of the participation of all fossil fuels, which was 49.9%, which makes "clean" most of the kilowatt-hours produced in 2022.

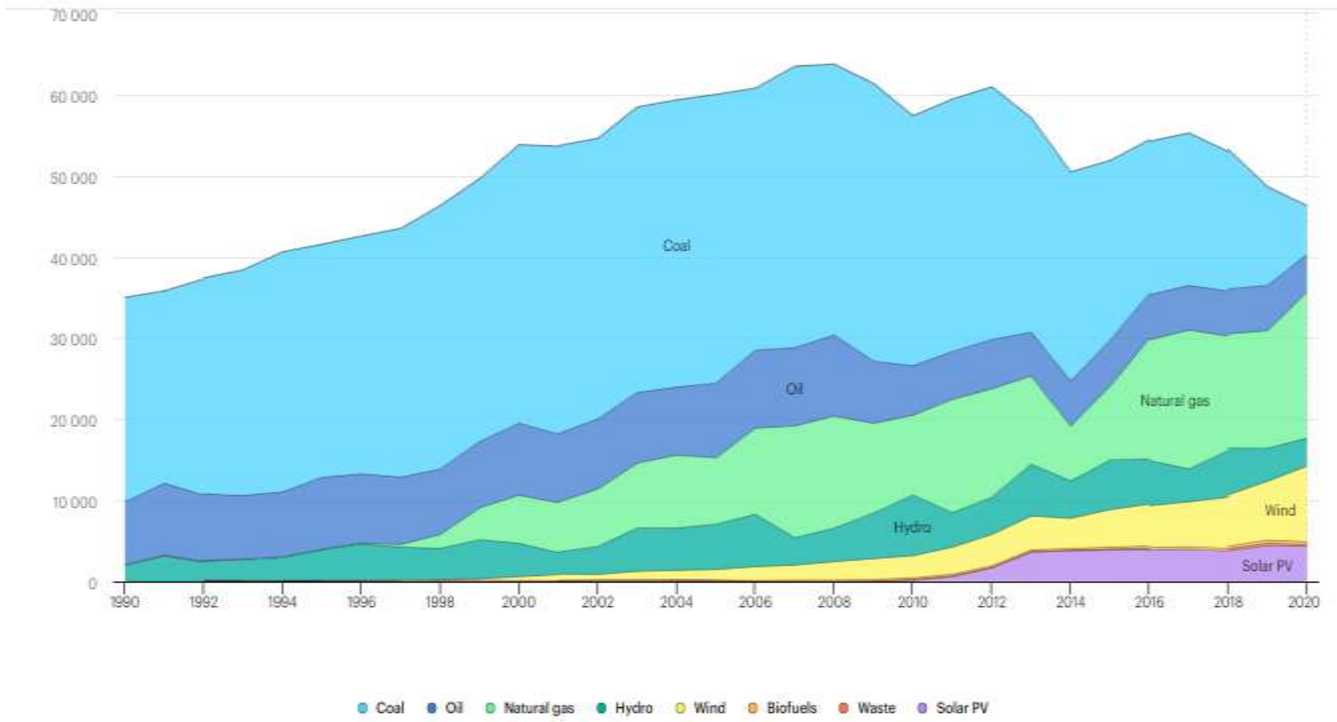
Compared to 2021, the share of gas decreased by a little more than 4%, as in 2021 it was the dominant fuel with 42.8%. The reduction in the use of gas in power generation is a positive sign, in the perspective of achieving the goal of a 15% reduction in gas consumption, which all EU member states have undertaken on a voluntary basis for this winter season.

Figure 85: Fuel Share in Net Electricity Generation, 2020, 2021 and 2022



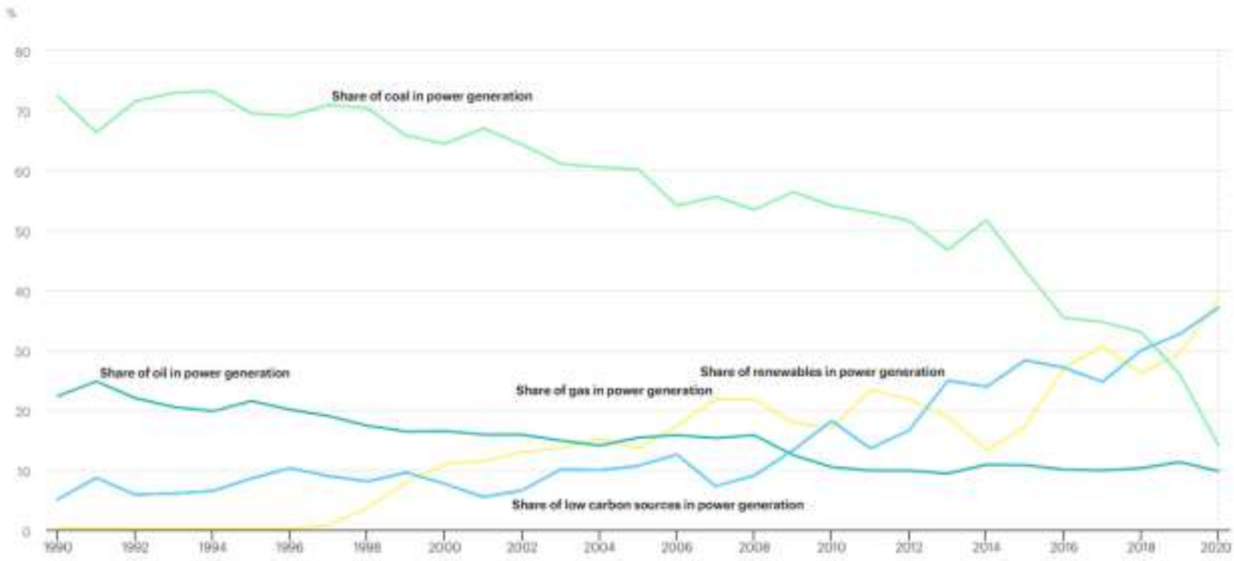
Source: IPTO

Figure 86: Evolution of Electricity Production (GWh) by Source in Greece, 1990-2020



Source: IEA

Figure 87: Fuel Shares in Electricity Generation in Greece, 1990-2020

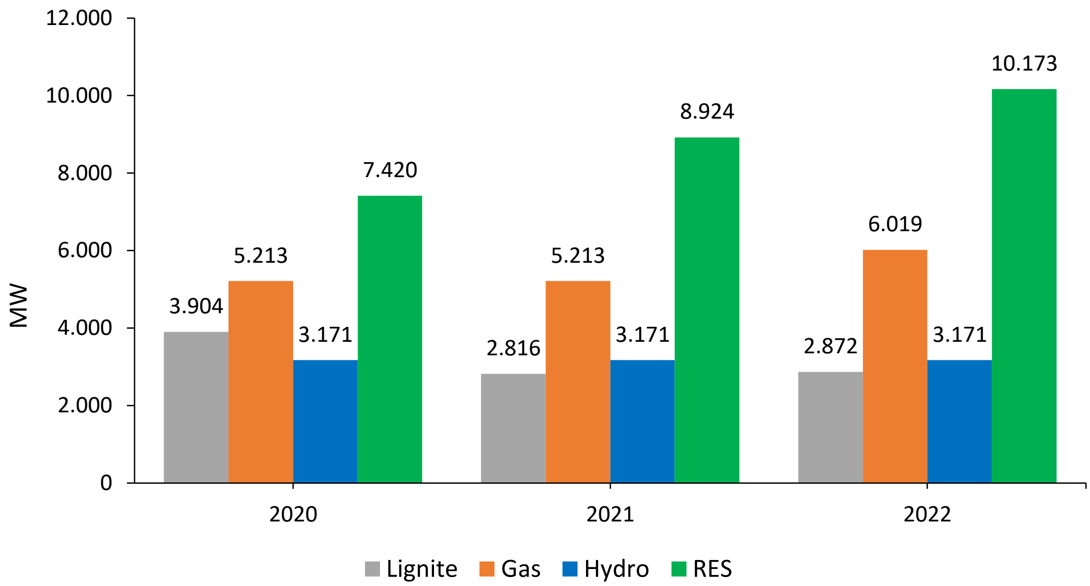


Source: IEA

Installed capacity

In 2021, the total installed capacity of units in Greece's interconnected system reached 20.1 GW, marking an increase of 2.1% from 2020 levels (19.7 GW). RES was the only power generation source to see an increase in domestic installed capacity in the interconnected system in 2021, compared to 2020, recording a new installed capacity of 1500 MW and a total installed capacity of 8.9 GW. The domestic installed capacity of natural gas and hydropower units remained at the same levels, while lignite capacity decreased by 27.9% in 2021, compared to 2020, as illustrated in Figure 88. Regarding the installed RES capacity for the 2022, according to the latest DAPEEP Bulletin available [93], this reached 10,173 MW in the interconnected system, while in the last two years (2021-2022) the capacity of the lignite units, as well as the hydropower ones, has been unchanged, with the capacity of the natural gas units increasing in 2022 [92].

Figure 88: Total Installed Capacity per Fuel, 2020, 2021 and 2022



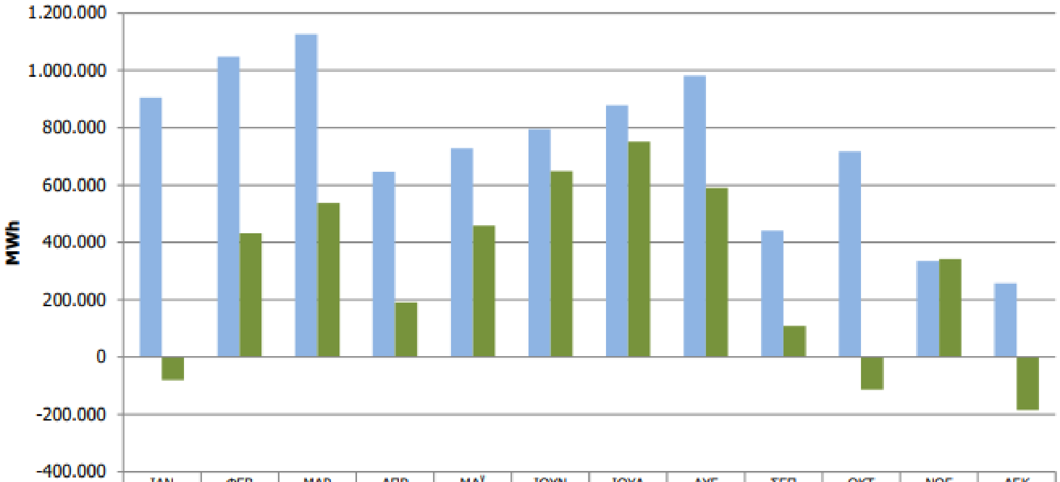
Sources: IPTO, DAPEEP

Electricity Imports and Exports

Greece is interconnected with the neighboring countries and apart from the domestic production of electricity, it is increasingly active in electricity trade. According to the Ten-Year Development Programme of IPTO 2022-2031 [94], the Greek interconnected electricity system met the 10% interconnectivity goal set for 2020, while based on the projected interconnection projects that are in the implementation phase (completion of the second Greece-Bulgaria electricity interconnector line), it will also meet the goal of 15% before 2025. For the year 2030, the interconnectivity goal is 19.2% in the scenario of implementing only the first stage and 15.4% in the scenario where no stage of the Greece-Cyprus interconnection is implemented.

Electricity imports in Greece amounted to 8.4 TWh in 2021, down 21.6% compared to 2020, mainly from Bulgaria, Albania and North Macedonia. Similarly, electricity exports to Greece in 2021 amounted to 4.8 TWh, increased by 156% compared to 2020, mainly to Italy, Albania and North Macedonia. Greece has been a net importer of electricity for many years with total net imports amounting to around 3.65 TWh in 2021, according to ADMIE data. It is worth mentioning that a second electricity interconnection between Greece and Bulgaria is under development, which is expected to be operational by 2023. This particular project is of great importance for meeting the market coupling of the two countries and is expected to significantly increase the connectivity of Greece towards the minimum common European target of 15% by 2030 [91].

Figure 89: Electricity Balance (MWh) in the Interconnections of Greece, 2020-2021

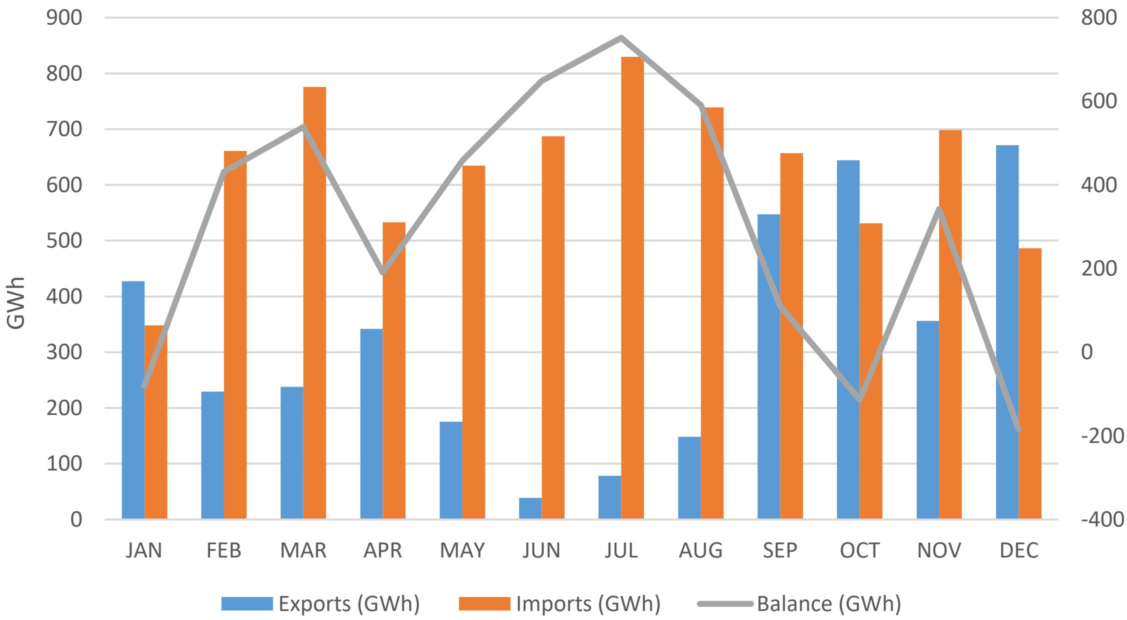


	ΙΑΝ	ΦΕΒ	ΜΑΡ	ΑΠΡ	ΜΑΪ	ΙΟΥΝ	ΙΟΥΛ	ΑΥΓ	ΣΕΠ	ΟΚΤ	ΝΟΕ	ΔΕΚ
2020	905.810	1.048.207	1.126.459	646.246	728.842	795.036	878.797	981.615	441.244	717.608	334.845	258.051
2021	-79.516	431.432	538.251	190.670	458.618	648.491	751.716	590.735	109.456	-113.597	342.041	-184.932

Note: The electricity balance on the interconnections is calculated as the difference ("Actual Import Flows" – "Actual Export Flows") for all interconnections.

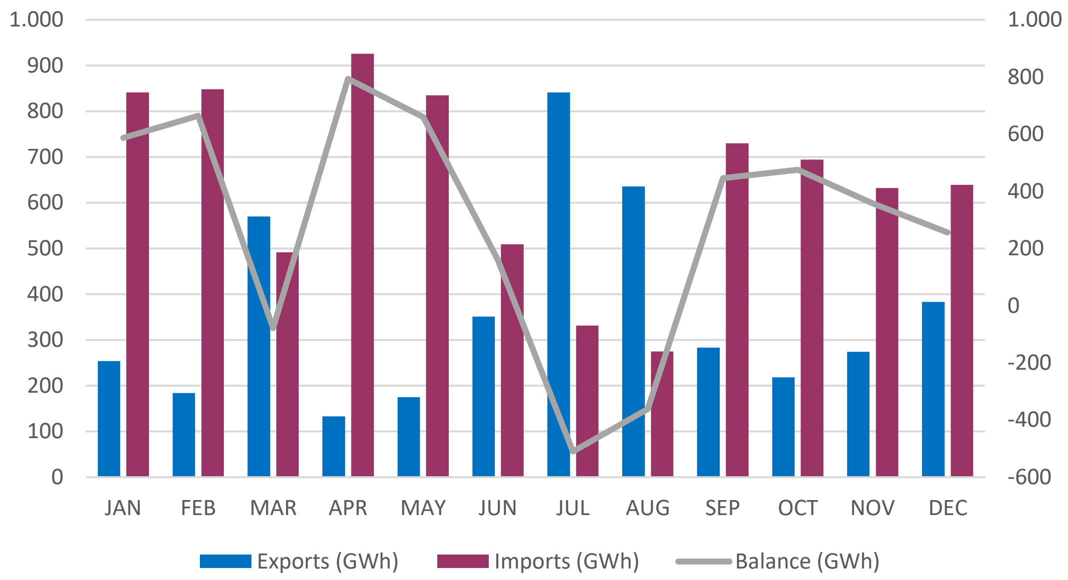
Source: IPTO

Figure 90: Evolution of Natural Energy Flows, 2021



Source: IPTO

Figure 91: Evolution of Natural Energy Flows, 2022



Source: IPTO

Figure 92: Evolution of Electricity Imports and Exports in Greece, 1990-2020

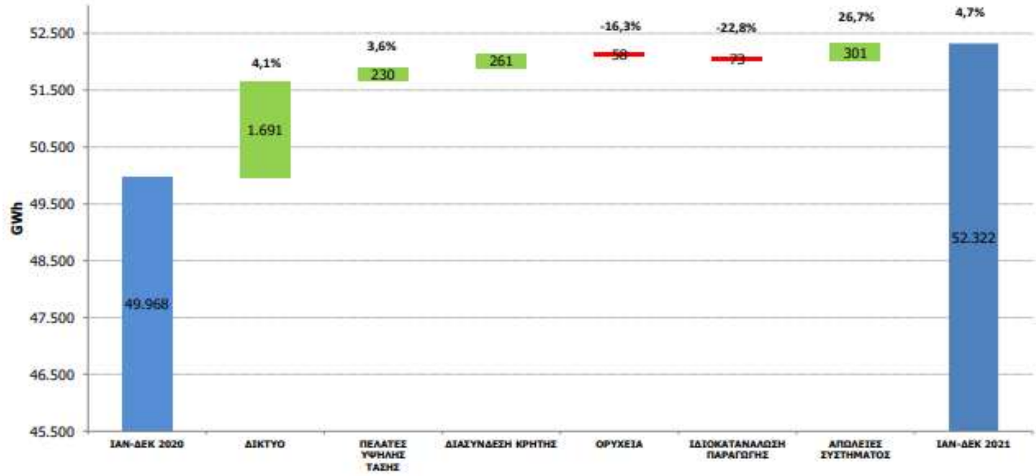
Source: IEA

Electricity Consumption

Electricity consumption in Greece increased steadily to a peak of 58.8 TWh in 2008, followed by a five-year period of decline from 2009 to 2013, as a result of the economic crisis. In 2020, electricity consumption in the country's interconnected system (44,906 GWh) showed a noticeable decrease compared to 2019 (46,969 GWh) by 4.4%, mainly due to the Covid-19 pandemic and the restrictive measures implemented.

Electricity consumption has recovered and in 2021 Greece consumed 52.4 TWh of electricity in the interconnected system (Figure 93) [91]. For 2022, a further decrease in electricity demand is recorded.

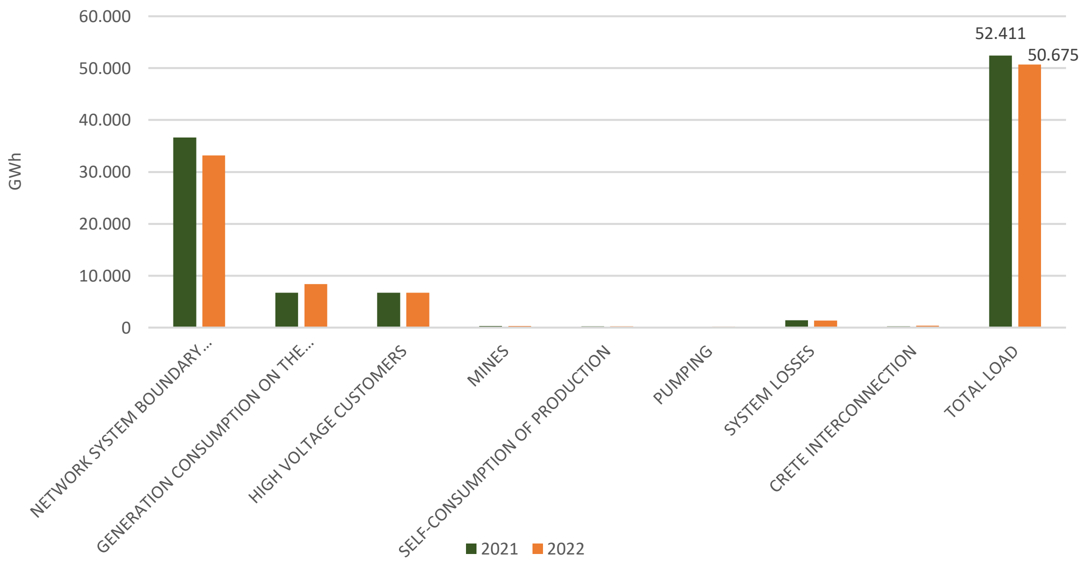
Figure 93: Change in Electricity Demand (GWh) in the Interconnected System of Greece, 2020-2021



Source: IPTO

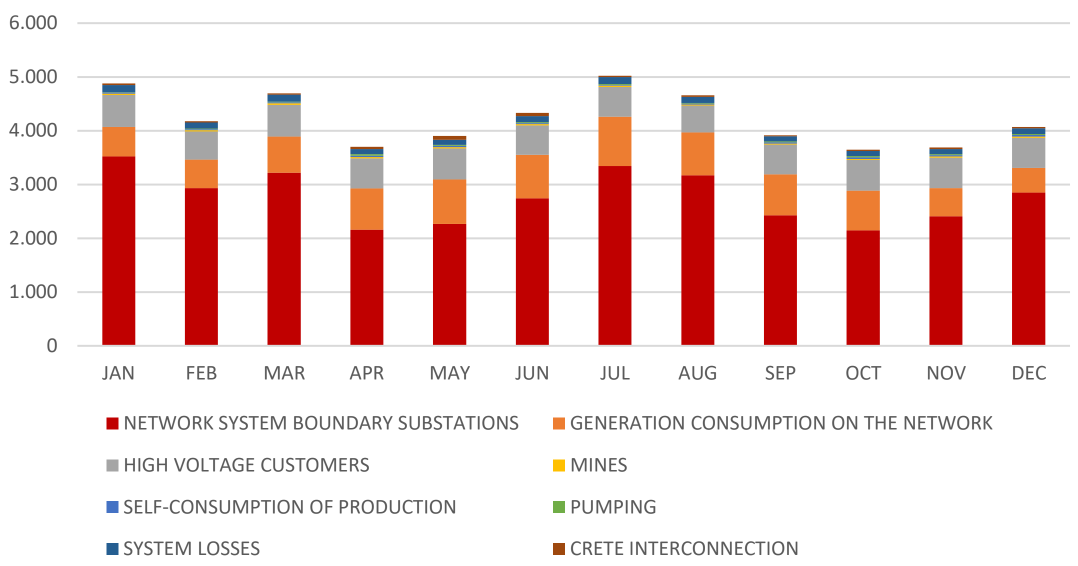
As can be seen from Figures 94 and 95, the annual change in electricity consumption is decreasing, especially from July 2022, so the entire second half of 2022 saw a drop in demand for electricity. With regard to December, in absolute numbers the biggest decrease recorded in the distribution network, which means that the consumption of households and small- and medium-sized enterprises decreased. An important factor is the reduction in energy costs, which in the case of domestic consumers was supported by the relatively high temperatures that prevailed in November and December 2022.

Figure 94: Electricity Demand by Customer Category (GWh), 2021 and 2022



Source: IPTO

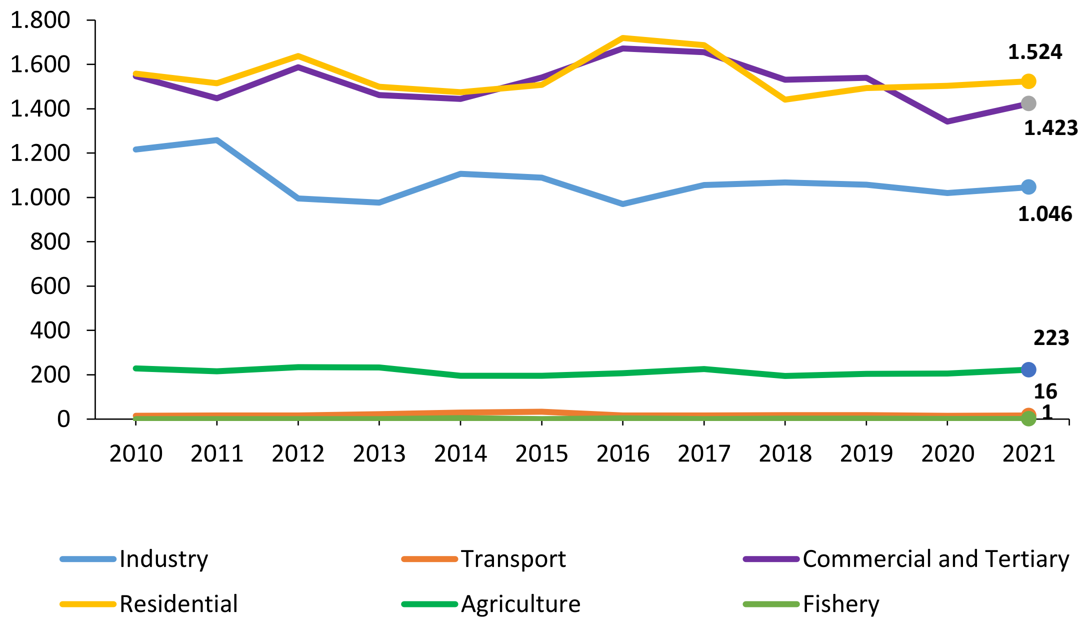
Figure 95: Electricity Demand by Customer Category (GWh), per Month in 2022



Source: IPTO

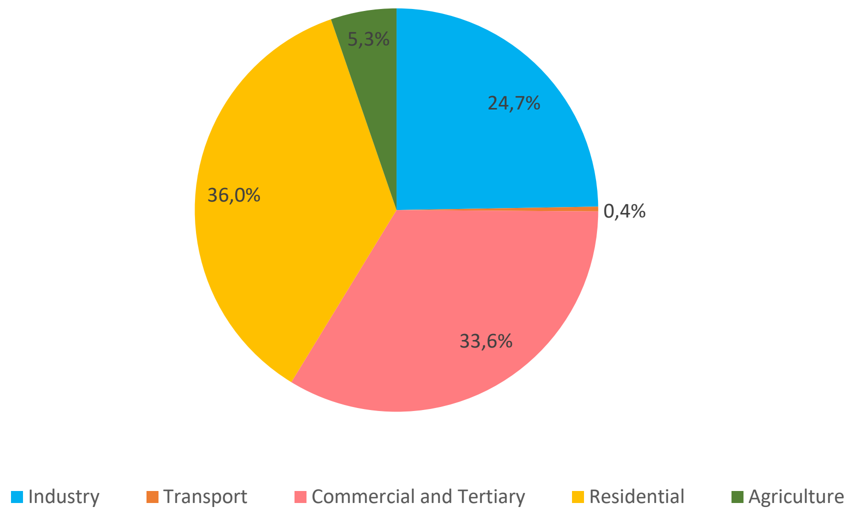
According to Eurostat's data, the household sector was the sector that consumed the most electricity, accounting for 36.8% of total final electricity consumption in 2021 (Figure 96). It was followed by the commercial sector with 32.8% and the industry sector with 24.9%. Other sectors (i.e. other energy sectors, but also transport) represented only a small share of the total final electricity consumption.

Figure 96: Final Electricity Consumption in Greece by Sector, 2010-2021 (thousand tons)



Source: Eurostat

Figure 97: Percentage Distribution of Sectors in Final Electricity Consumption in 2021



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 market participants as well as the attraction of 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 November 1, 2020 of the four markets foreseen by the European Target Model, was a pivotal point for the evolution of the Greek energy market in general.

Participants in the domestic wholesale electricity market now have all the possibilities to operate according to the basic principles of the European Target Model. Among these possibilities is the possibility of concluding bilateral contracts between producers and suppliers, the possibility of correcting their positions also on an intraday horizon, the introduction of risk management tools and the creation of reliable financial signals for necessary investments.

Law 4512/2018, specifically Part C "Energy Exchange", defined the following markets:

- **Forward Market:** This market allows participants to enter into electricity purchase and sale contracts, with a physical delivery obligation, as they will be defined in the relevant market code and to trade energy financial instruments.
- **Day Ahead Market:** This market allows participants to submit electronic trading orders with the obligation of physical delivery the next day. In the day-ahead market, the quantities of energy that have been committed through transactions on

futures products, which have been carried out either through the wholesale market of futures products, or outside of it, are also declared. At the same time, there will be an implicit allocation of the transport capacity in the interconnections, through the coupling of the day-ahead markets of the European countries.

- **Intra Day Market:** This market allows participants to submit trading orders for physical delivery on the physical delivery fulfillment day, after the deadline for submitting trading orders in the day-ahead market, taking into account the quantities of energy committed through electricity futures transactions they have made, 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 trading in all markets, from the quantities sold/bought in real time.
- **Balancing Market:** The balancing market includes the balancing power market, the balancing energy market, as well as the clearing process. Participants have an obligation to submit bids with a physical delivery obligation for all of their available power, both in the balancing energy market and in the balancing power 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 [95].

Figure 98: Energy Markets based on the Target Model

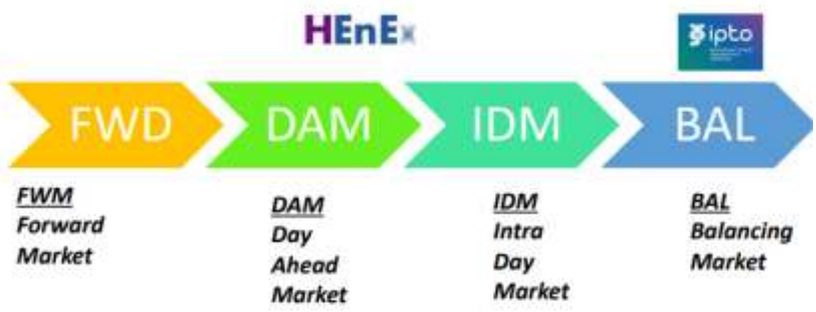


Figure 99: The Greek Electricity Market

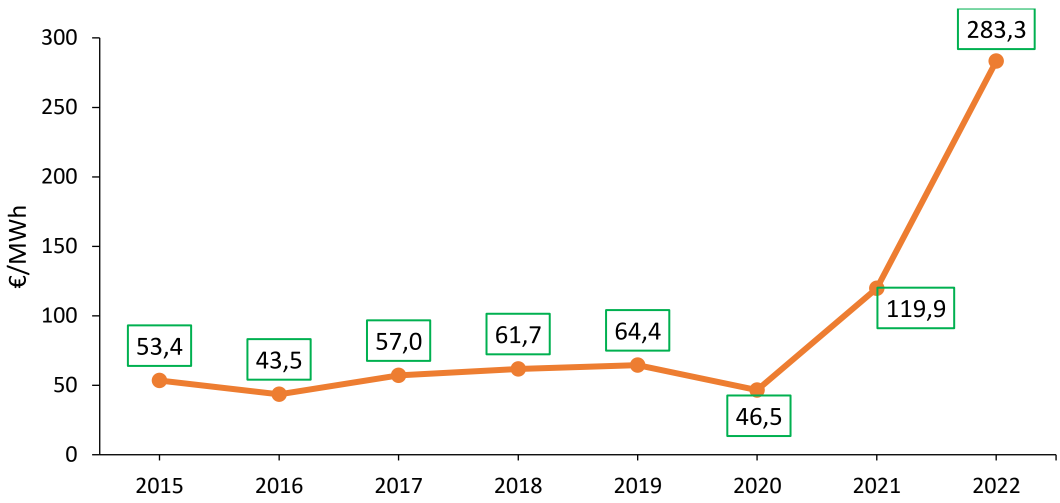
Wholesale Market

The vertically integrated state electricity company PPC dominates the Greek electricity market. The installed power generation capacity of PPC amounted to 10.4 GW in 2021 and represented approximately 49% of the installed power generation capacity in Greece [96]. PPC's energy mix includes lignite, hydropower, oil, natural gas and RES plants. It is also the owner of the Electricity Distribution Network (Medium & Low Voltage, approximately 244,000 km long and High Voltage approximately 1,000 km long), whose Operator is its 100% subsidiary company DEDDIE SA.

In 2021, PPC produced 26 TWh, which together with the 1.0 TWh it imported, covered 43.7% of the total demand. The electricity produced came from lignite (20.5%), oil (15.3%), natural gas (42.4%), hydropower (20.4%) and RES (1.4%) [96].

According to IPTO's Bulletins, electricity purchase prices in the wholesale market increased significantly in 2021, mainly in the second half of 2021 and skyrocketed in 2022 as a result of Russia's invasion of Ukraine. More specifically, from 46.5 €/MWh the average price of electricity in the interconnected system in 2020, prices reached 119.9 €/MWh in 2021 and jumped to 283.3 €/MWh in 2022 [97].

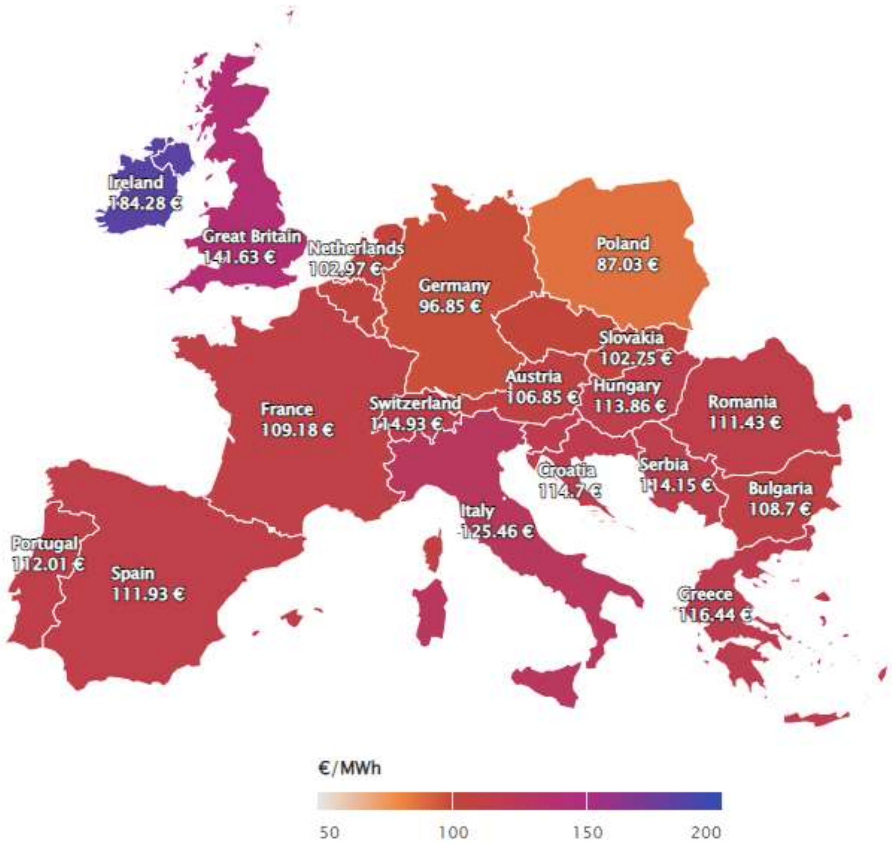
Figure 100: Weighted Average Electricity Market Price (Day-Ahead Market and Intraday Market) in the Interconnected System, 2015 to 2022



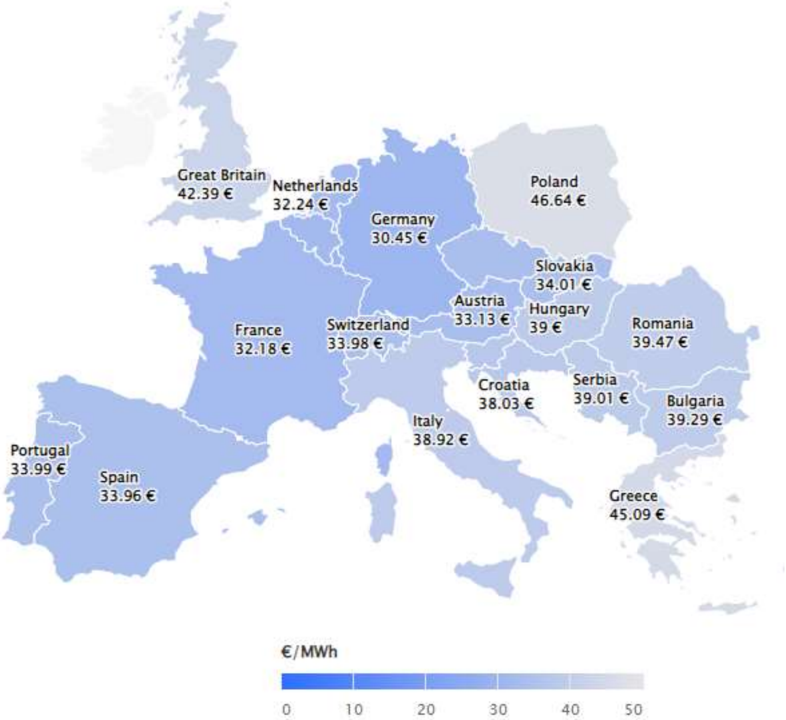
Source: IPTO

However, the Greek electricity price for 2021 was ranked among the highest in Europe, at €116.44/MWh, while for 2020, the corresponding price was at €45.09/MWh (Maps 17 and 18).

Map 17: Wholesale Electricity Day-Ahead Prices in Europe for 2021



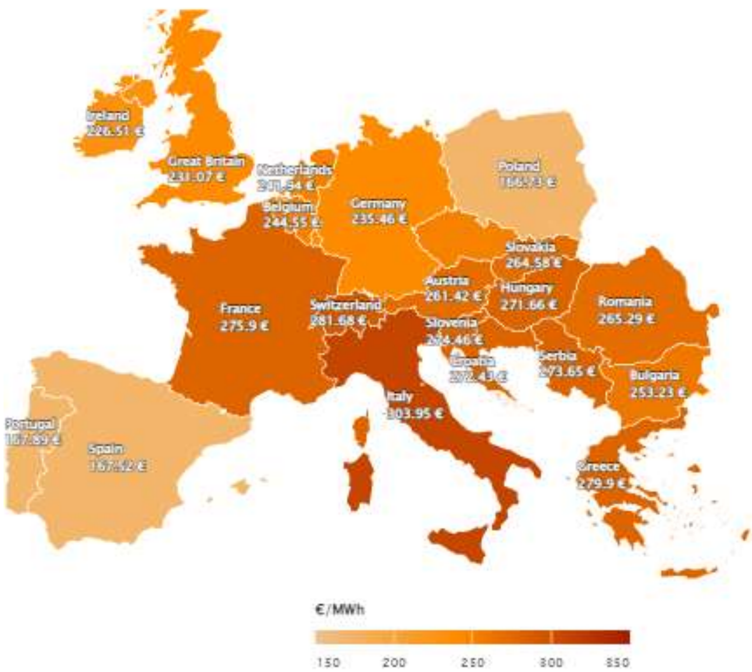
Map 18: Wholesale Electricity Day-Ahead Prices in Europe for 2020



Source: IENE

Russia's invasion of Ukraine on February 24, 2022 marked the beginning of a period of intense volatility in wholesale electricity prices, which have soared since the start of the war. For 2022, wholesale electricity prices were particularly high as a result of gas price increases due to the war in Ukraine, as shown in Map 19.

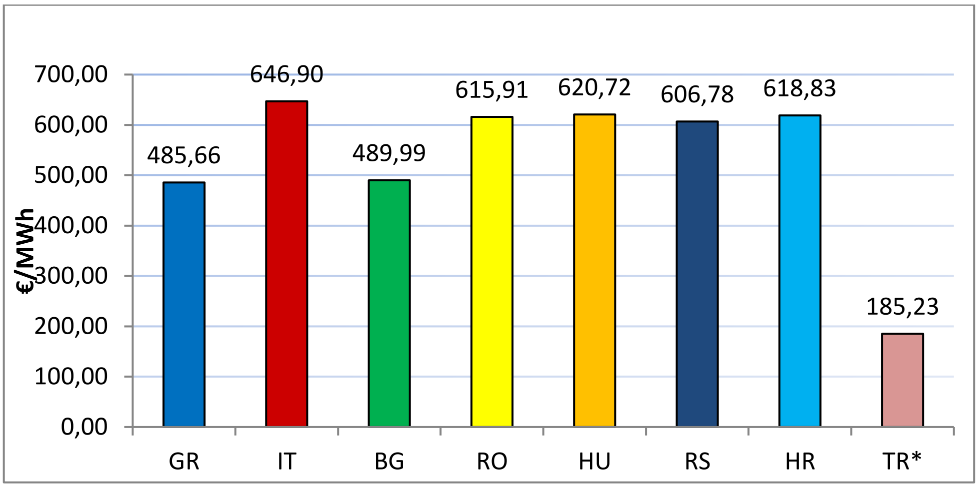
Map 19: Wholesale Electricity Day-Ahead Prices in Europe for 2022



Source: IENE

More specifically, over August 22-28, 2022, Greece recorded an electricity price of €485.66/MWh, with the highest price in SE Europe appearing in Italy at €649.90/MWh (Figure 101).

Figure 101: Wholesale Electricity Prices in SE European Countries, 22-28 August 2022

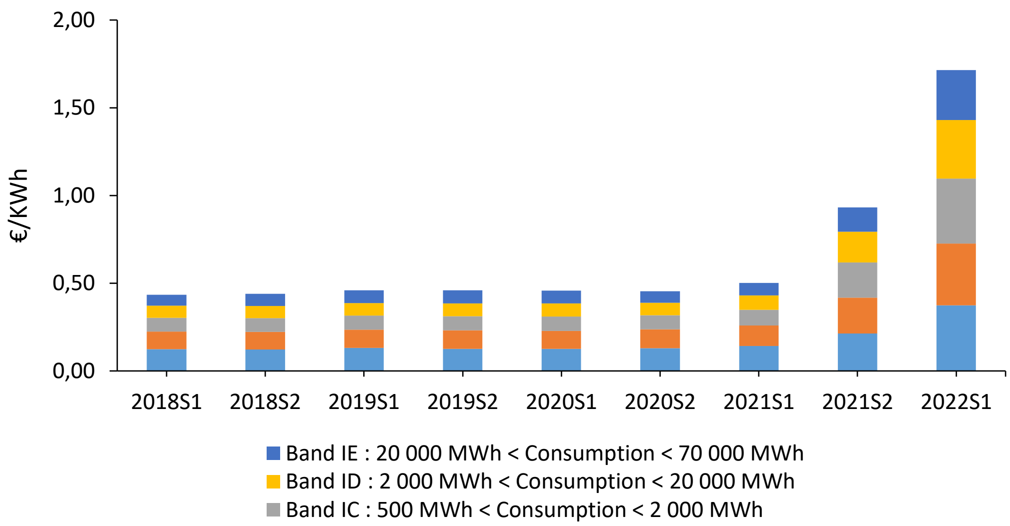


*Wholesale electricity prices in Turkey are based on daily €-TRY exchange rates from the ECB.

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

In Greece, the price of electricity for non-household consumers[39] amounted to €0.3696/kWh (before taxes and contributions) in the first half of 2022, increased by 84% compared to the second half of 2021 (Figure 103).

Figure 102: Electricity Prices for Non-Domestic Consumers in Greece, 1st Semester 2018 – 1st Semester 2022

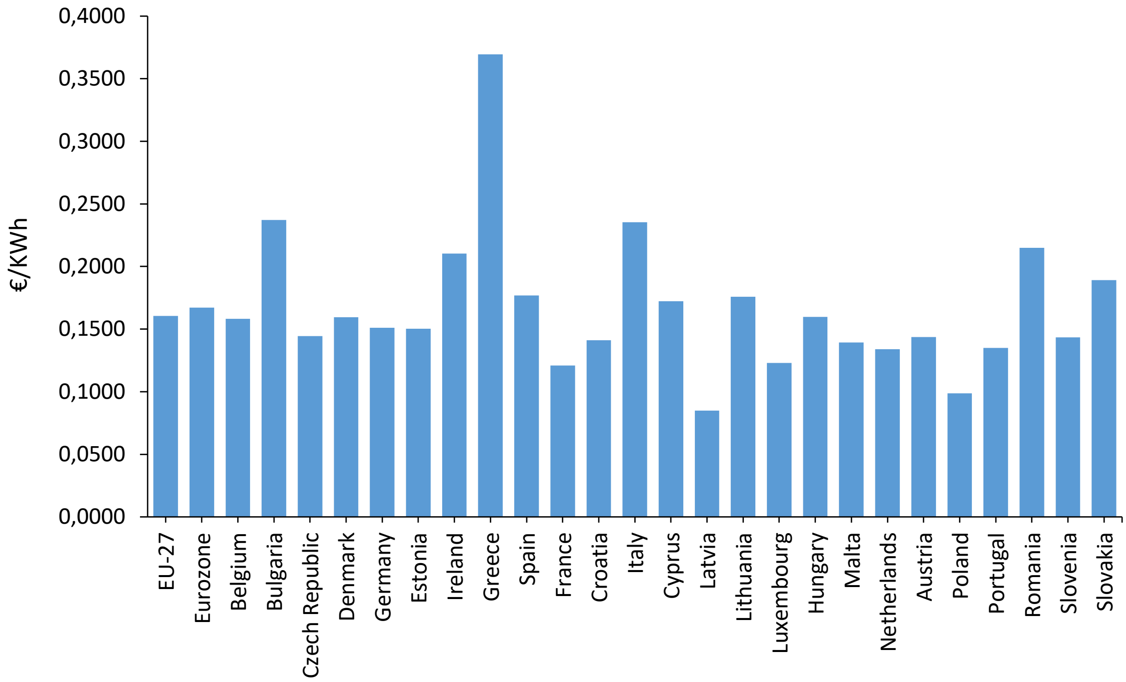


Note: The above electricity prices are before taxes and levies

Source: Eurostat

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

Figure 103: Electricity Prices for Non-Household Consumers in Europe, First Half 2022



Note: The above electricity prices are before taxes and levies

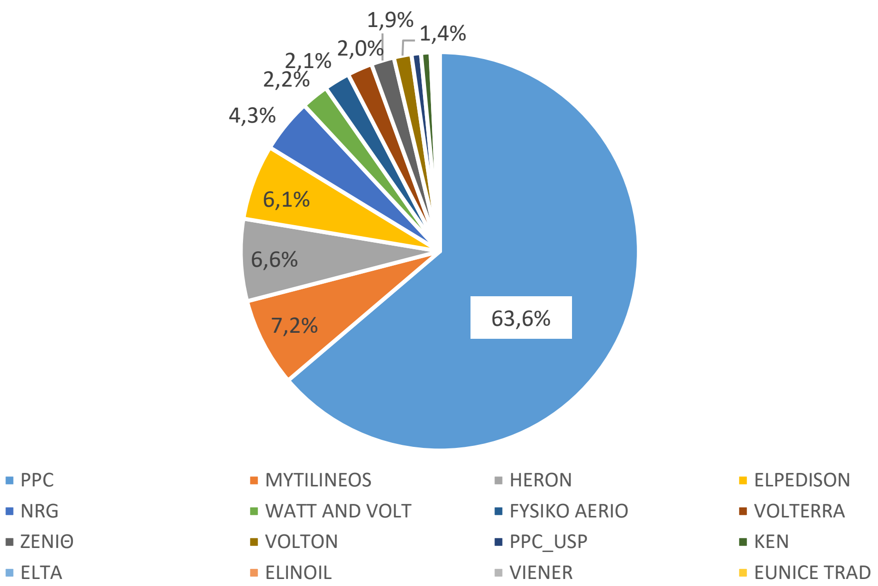
Source: Eurostat

Retail Market

Approximately 5.8 million of PPC customers consumed 6.3% of the total electricity in Greece in 2021, according to PPC Annual Report 2021 [96]. The percentage of PPC in the supply market for the first seven months of 2022 was consistently high, reaching 63.6% and with a much lower percentage followed by Mytilineos, Heron and Elpedison. The stabilization of PPC's share reflects the climate of insecurity that governs consumers due to the energy crisis and the steep increase in prices.

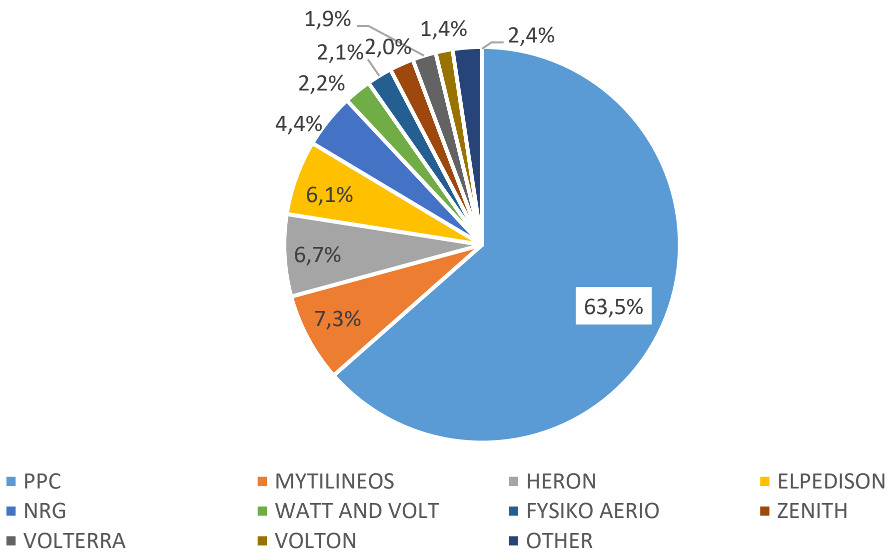
PPC remained in 2022 (January – July) the main supplier in the retail electricity market, representing 87.02% of the total number of high voltage services, 41.18% of MV, 65.98% of HT Interconnected System and 63.5% of the total (Figures 105 and 106) [92].

Figure 104: Shares of Electricity Suppliers, January - July 2022



Source: IPTO

Figure 105: Shares of Load Representatives By Voltage Level, January-July 2022

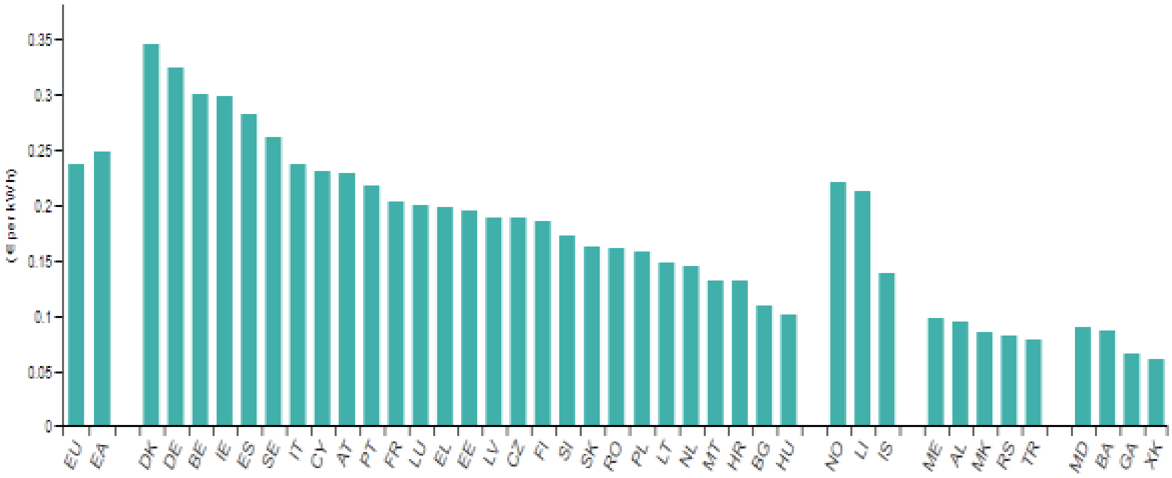


Source: IPTO

According to RAE's 2020 Annual Report, the Herfindahl-Hirschman Index (HHI), which is the market "concentration" index, is estimated at 4.171 in the interconnected system, in terms of consumption volume. The index is constantly decreasing but continues to significantly exceed the limit of 2,000 which is considered as the limit of a competitive market.

According to Eurostat's data, electricity prices for residential consumers, including taxes, for Greece reached €0.2305/KWh, when in the EU the average was €0.2525/KWh [98].

Figure 106: Electricity Prices For Residential Consumers (Including Taxes), H2 2021



Source: Eurostat

5.3.3 Non Interconnected Islands (NIIs)

In Greece (mainly in the Aegean), most of the islands are currently electrified by autonomous power stations, mainly operating with oil, diesel and fuel oil, and RES stations (wind and photovoltaic). These islands have not yet been interconnected with the continental electricity system, mainly due to technical and economic difficulties as subsea interconnections are capital-intensive projects.

The electricity market of the Non-Interconnected Islands (NIIs) now consists of 23 autonomous systems. Electricity consumption in the NIIs also varies in size, from several hundreds of MWh in the smaller islands (e.g. Antikythira, Agathonisi, etc.), to several TWh in the largest NIIs (Crete). According to data from the Island Management Directorate of DEDDIE, the total installed capacity of production units in the NIIs amounted to approximately 1.1 GW in 2022, of which 84.6% related to thermal plants (Table 15) [99].

Table 16: Installed Capacity (MW) of Units in the NIIs, November 2022

Categories	Installed Capacity (MW)
Thermal Plants*	940,72
Wind	108,06
Solar PV**	51,45
PV of Special Programme and Net Metering	7,09
Hybrid	2,95
Total	**1111,57**

Notes: *Latest available data of 2021, **The installed capacity of Special Programme of PV and net metering is not taken into account.

Source: DEDDIE

Similarly, the total energy production in the NIIs amounted to about 4.6 TWh in 2021 of which about 7.9% was for thermal plants and 2.25 TWh by November 2022 (Table 17) [99].

Table 17: Electricity Production (MWh) in the NIIs, 2021 and 2022

Categories	2021	January-November 2022
Thermal	3.676.971	1.915293
Wind	708.242	249.269
Solar PV*	206.565	82.896
Hybrid	4.334	4.514
Biogas	3.936	-
Total	**4.600.000**	**2.251.972**

Note: *The installed capacity of Special Programme of PV and net metering is not taken into account.

Source: DEDDIE

5.3.4 Latest Developments in the Domestic Electricity Market

(a) Electricity interconnections of the islands with the mainland grid

Cyclades

The project of interconnecting the Cyclades has been characterized as a project of "general importance for the economy of the country". The project aims on the one hand to increase the reliability of the supply of the interconnected Islands and on the other hand to reduce production costs (substitution of oil with other energy sources, in line with the evolution of the energy mix on the mainland grid) *[100]*.

The project was designed with the aim of minimizing the environmental footprint on the Islands. In this direction, the new substations have been located close to the coast in order to avoid the construction of overhead transmission lines on the Islands, while their interconnection with each other and with the mainland grid is done through subsea high-voltage cables.

According to the aforementioned information, IPTO implements the project in several phases *[100]*:

Phase A'

The implementation of Phase A' was completed in the first months of 2018. Phase A' includes the interconnection of Syros with Lavrio, as well as with the Islands of Paros, Mykonos and Tinos. After its completion, the units of the autonomous stations were placed in emergency reserve and the loads of the Islands are now supplied through the National Electricity Transmission System (loads of Andros - Tinos are already supplied from the National Electricity Transmission System through the transmission line which connects South

Euboea with Andros). The project, with a budget of €264.3 million (including preliminary costs), was co-financed by the European Union and the NSRF 2007-2013 and 2014-2020 and received a loan from the European Investment Bank.

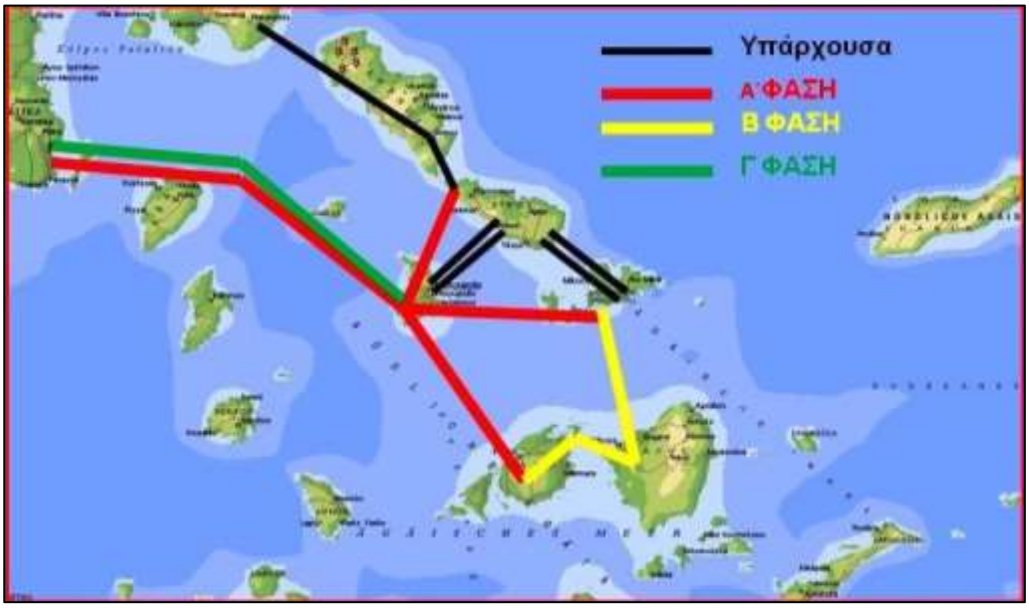
Phase B’

Phase B’ of the Cyclades interconnection was completed in September 2020. It includes the interconnection of Naxos with Paros and Mykonos. In parallel with Phase B’, the upgrade of the existing cable Andros - Livadi (South Euboea) 14.5 km long and Andros - Tinos 4 km long was planned with the installation of new XLPE 150 kV AC cables with a nominal capacity of 200 MVA. The upgrade project was completed at the beginning of 2020. The Phase B’ project with a budget of €47.3 million as well as the project to upgrade the existing cable Andros – Livadi with a budget of €22.2 million are co-financed by the European Union and the NSRF 2014-2020.

Phase C’

Phase C’ of the Cyclades interconnection was put into operation with a temporary interconnection in Syros in October 2020 and the final interconnection in June 2021. It includes the laying of the second cable Lavrio - Syros, as well as the required interconnection works (inductors and gates) in Lavrio and Syros.

Map 20: Electricity Interconnection of the Cyclades



Source: IPTO

Phase D’

In 2021, the implementation of the fourth and final phase of the interconnection of the Cyclades, amounting to €410 million, began, which includes the interconnection of the islands of Thira, Milos, Folegandros and Serifos with the mainland grid. The tender procedures for the Thira interconnection have been completed and the supply and installation contracts for the Naxos-Thira cable and the Thira substation & SVC have already been signed. Also, tenders were announced for the interconnection with the mainland grid of the islands of Milos, Folegandros and Serifos. The subsea line of Thira is expected to be electrified in the first half of 2023 and the rest of the islands are estimated to be interconnected with the mainland grid in the first half of 2024. The completion of the interconnection of the Cyclades will allow the development of RES units with a total capacity of 332 MW in islands, according to the estimates presented in the Ten-Year Development Plan 2022-2031 of IPTO, achieving a more stable, green and economical energy mix for the island complex. The project has been approved for co-financing by the Recovery and Resilience Fund [101].

Crete

The interconnection of Crete with the mainland grid becomes necessary, due to the following that characterize the system of Crete [100]:

- Very high variable cost of production due to the use of oil in the local production stations, which is reflected as a significant burden on consumers to cover the public utility services.
- Large annual growth rate of the Island's load. It is noted that the load during the summer months is marginally covered by the local stations.
- The great difficulty or impossibility of finding sites and securing permits for strengthening local stations or developing new ones.
- The ever-increasing interest in exploiting the rich RES potential, the penetration of which in the Island's power generation mix is limited due to technical limitations (mainly significant stability issues that high RES penetration can create in an autonomous electricity system like that of Crete).
- Low level of supply reliability, especially in case of failures in the production system.

The Crete-Peloponnese interconnection is the first phase of the interconnection of Crete with the mainland grid. The project consists of the construction of the 150 kV AC 2x200 MVA interconnection between Crete and Peloponnese. The project includes two subsea cables of 135 km each, upgrades of existing and construction of new overhead transmission lines, underground cables and substations in Peloponnese and Crete, controlled synchronous reactive power compensation system in Heraklion. The landing points of the subsea cables are in Kissamos Bay (Crete) and Malea Peninsula (Peloponnese) [102].

Within 2020, the substations in Peloponnese and Chania, the underground transmission cables in Crete and Peloponnese, one subsea cable and most of the overhead lines in Peloponnese were completed, which allowed the successful trial electrification of the interconnection in December 2020. The second subsea cable, the final arrangements of the overhead lines in the Peloponnese and the controlled synchronous reactive power compensation system were gradually completed by May 2021, and since then the interconnection became operational in July 2021.

The project, with a budget of €356.4 million, was co-financed by the European Union and the NSRF 2014-2020 and through a loan by the European Investment Bank.

The Crete - Attica interconnection project (second phase) is the natural continuation of the Crete - Peloponnese interconnection project and is carried out by ADMIE's 100% subsidiary "ARIADNI INTERCONNECTION MONOPROSSOPI AEES", established on the basis of RAE decisions 816/2018 and 838/ 2018 as the implementing body, and whose sole purpose is the construction and financing of the project. In addition, it has been assigned with the selection of companies that will enter into contracts with ADMIE and deal with the maintenance of the system for 10 years, for which ADMIE will be responsible.

This project consists of two sub-projects: The first concerns the "Study, Procurement and Installation of cables and electrode stations for the direct current (HVDC) electrical interconnection between Crete and Attica (2 x 500 MW)" and the second concerns the "Study, Procurement and Installation of two Conversion Stations and a Substation for the DC Electric Interconnection between Crete and Attica (2 x 500 MW)".

The selection of contractor companies has been completed and the relevant contracts have been signed. The study - construction works of the electricity interconnection of Crete-Attica have already started. The project with a total budget of €1.1 billion has been included in the specialization of the Operational Programme "Competitiveness, Entrepreneurship and Innovation 2014-2020" with No. 4101/1467/A1/25-6-2019 Decision of the Monitoring Committee for funding from the NSRF Programme Period 2014-2020.

Map 21: Electricity Interconnections of Crete with the Continental System of Greece

Source: Ariadne Interconnection

(b) Electricity Storage

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

Storage technologies available today, suitable for electricity systems and user applications, include (non-exhaustively):

- Mechanical methods
  - Pump storage
  - Storage with compressed air
  - Flywheels
- Thermal methods
  - Storage using molten salts, liquefied air, etc.
- Electrochemical methods
  - Lead-acid batteries
  - Nickel-Cadmium (Ni-Cd) batteries - Sodium-Sulfur (NaS) batteries
  - Sodium-nickel-chloride batteries
  - Lithium ion batteries (Li-ion)
  - Flow batteries
  - Lead-carbon accumulators (Lead Carbon) etc.
- Electrical and magnetic methods
  - Supercapacitors

- Superconducting magnetic energy storage

In addition, in the category of chemical methods belong H2 hydrogen storage and Power-to-X (synthetic fuels) technologies, which are in rapid development and are expected to play an important role in the future.

In the last year, the country has seen an explosion of interest in licensing new electricity storage facilities. The application strength in mid-2021 exceeds 9000 MW, with the majority of these already converted to generation permits, far exceeding the needs of our national system in the medium term.

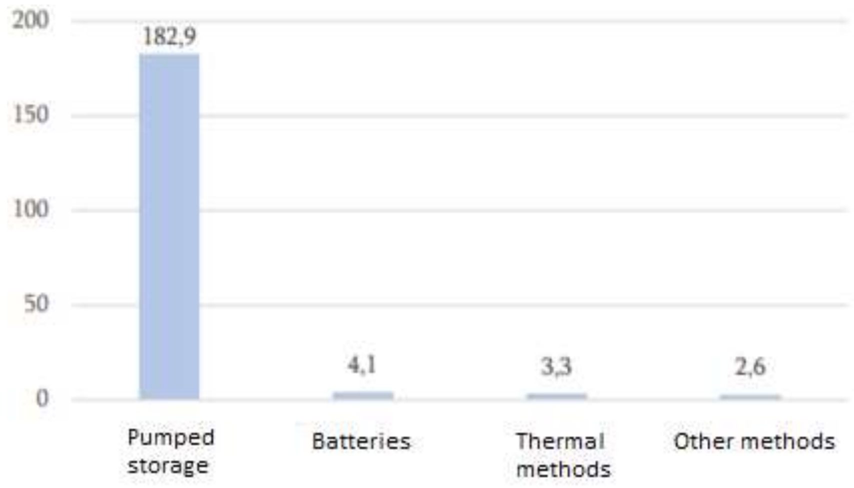
In Greece, significant penetration of electricity storage systems is predicted over the next decade. According to the NECP, after 2025 new storage systems will be added (in addition to the existing Sfikia and Thisavros hydropower stations) with an installed capacity of 0.7 GW. The working group of the Ministry of the Environment and Energy presented various scientific models in the context of preparing the NECP. According to the TIMES model, the cost of new storage systems included in the system after 2025 is estimated at around €0.5 billion. As for the PRIMES energy model, which also includes the possibility of exploiting small decentralized storage systems (batteries) either autonomously or cumulatively, in 2030 the storage and energy capacity harnessed by storage units may reach 2.7 GW and 2.3 TWh respectively.

In addition, the storage needs of the Greek interconnected system with reference to 2030 were valued in 2019 by a study by the NTUA on behalf of RAE at 2,000-3,000 MW (total capacity of a mixture of short- and long-term storage, including existing pumped storage stations), depending on the considered RES development scenarios.

Pump Storage

Dominant electricity storage technology, with November 2020 data, is pumped storage, with a worldwide installed capacity of around 183 GW (Figure 107) [103].

Figure 107: Installed Capacity (GW) by Energy Storage Technology



Source: ODE

The Greek electricity system today has the Thisavros and Sfikia hydropower plants, with a total production capacity of 699 MW, which have been in operation since the late 1990s. As for the NIIs, reducing energy dependence on oil is inextricably linked to increasing penetration of RES and storage.

On the NIIs, the introduction of storage is possible through the framework of hybrid stations, i.e. combinations of RES and storage units operating as single distributed entities. Despite the significant investment interest and approximately 160 production licenses of guaranteed power of more than 500 MW and RES power of more than 1100 MW, only 2 small projects have been implemented to date [103]:

- Eunice's hybrid station in Tilos (Kos-Kalymnos system), which includes an 800 kW wind turbine, 160 kW PV and 800 kW/2.8 MWh NaNiCl2 technology batteries. The station has been in commercial operation since 2019.
- The hybrid energy project of PPC Renewables in Ikaria. The project consists of the Stravokoundura Wind Park, the Proesperas and the Kato Proesperas small hydropower plants. The hybrid project of Ikaria, "Naeras", with a total capacity of 6.85 MW, was inaugurated on June 5, 2019. The entire project has been connected to the electricity grid of DEDDIE and has been operating since the beginning of 2019 [104].

At the same time, high penetration pilot projects in autonomous systems are being developed. These include the hybrid energy project of Agios Efstratios, which is being developed by CRES and includes A/C 900 kW, PV 220 kW, batteries 1.5 MVA/2.6 MWh and a district heating system with electric boilers and hot water storage. In Astypalaia, a pilot project for the electrification of transport with energy supply from RES units and a battery storage system is being launched, while there are discussions for applications in various small NIIs' systems. These projects include the development of large wind and solar PV units relative to the size of the islands, combined with battery technology storage arrangements and demand management measures, in order to achieve RES penetration of 50%-90% on an annual basis. Small battery systems have also been installed at power plants of Karpathos, Gavdos and Kythnos, as pilot applications [103].

In summary, storage projects in Greece have been and are being promoted by PPC, but also by private groups, such as subsidiaries of foreign groups like EDF, TERNA Energy, and many medium and smaller companies, such as Eunice Laboratories, Creta Solar System, Zefyros EPE, Phoenix Solar, Western S.A., etc.

For example, it is reported that investment in a hybrid storage project is being promoted by TERNA Energy in Amari, Crete, while it has received a production license for a pumped storage project with two independent upper reservoirs "Agios Georgios and Pyrgos" in the Municipality of Amfilochia with a total capacity of 680 MW.

DEDDIE, which has a list of hybrid plants (combination of RES and pumped storage), which have requested or received a production permit, records in its published data a total of 28 projects until 1.1.2022, where 44 applications with a total capacity of 71.9 MW have been submitted [105].

(c) Electromobility in Greece

A key priority of Greece's new energy policy is now the promotion of electromobility, as it will be largely based on the production of electricity from RES, while also offering significant energy savings through the improvement of energy efficiency.

However, there are significant obstacles to the domestic development of electromobility. The high initial cost of electric vehicles is the most important problem for its development, which has also affected the viability of the required charging infrastructure. The completion of the institutional framework and the development of the required infrastructure are important parameters and challenges for the further development of electromobility, in combination with the reduction of the cost of acquiring electric vehicles which is expected to be accelerated, according to estimates of the international automotive industry in the period up to 2025.

It is worth noting that 328 of the country's 332 municipalities, which are obliged by Community Directive to develop charging points per thousand inhabitants, with funding from the Green Fund, are now preparing studies to identify the most suitable charging points.

A third issue facing the market is the high installation cost, which accounts for only 20%-25% of the machine, with the largest part representing the cost of connecting to the grid when a power increase or a new transformer is required.

With a series of incentives, like all European countries, Greece supports the electric vehicle market and already in 2021 the first cycle of the “Move Electric” programme was successfully completed, exceeding the national target by 183.6% as 6,697 electric vehicles were registered against target for 3,750. The first cycle of the “Move Electric” programme, with a total budget of €100 million, closed with 19,000 applications and a turnover of €70 million in the market, of which 69% were electric bicycles.

In July 2022, the second cycle of the “Move Electric” programme began with total funds of €75 million for 2022 and 2023. According to the new “Move Electric” programme, the subsidy rate for the purchase of an electric vehicle is increased from 20% to 30% and the maximum amount to €8,000 from €6,000 that applied in the previous cycle. The withdrawal of an old vehicle is rewarded with €1,000, while the purchase of a smart home charger is rewarded with €500. For the purchase of electric two-wheelers and three-wheelers of category L5e to L7e, it increases from 20% to 40% and the maximum subsidy amount from €800 to €3,000. Especially for young people up to 29 years old, the increase of the aid by €1,000 for the purchase of electric minicars is foreseen. For companies, the subsidy rate for the purchase of an electric vehicle is increased from 20% to 30% and the maximum amount to €8,000 per vehicle.

Overall in 2021, hybrid electric vehicles accounted for 19.6% of all new passenger cars registered across the EU, compared to 11.9% in 2020. Plug-in electric vehicles also saw strong sales growth, accounting for 18% of total car registrations, up from a 10.5% share in 2020, according to the European Automobile Manufacturers’ Association (ACEA). However, conventional fuel types still dominate EU car sales in terms of market share in 2021, accounting for 59.6% of all new registrations.

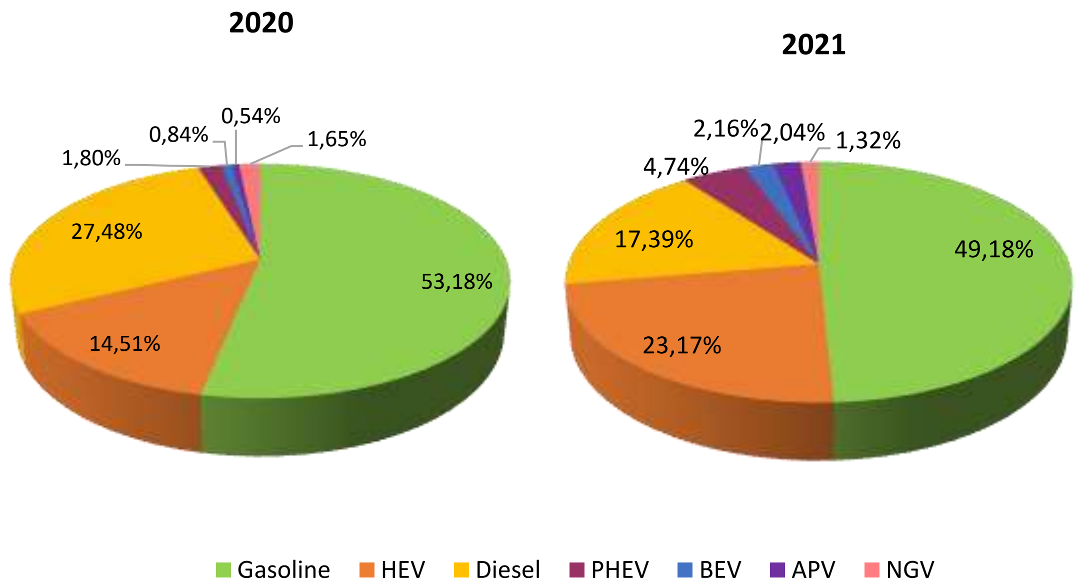
According to data from ACEA [106], as shown in Table 18, as well as the European Alternative Fuels Observatory (EAFO) [107] in Figure 109, the sales of rechargeable electric vehicles in Greece, battery and plug-in hybrids (BEV and PHEV), in 2021 increased by 226% compared to 2020 and reached 6,961 units in total, of which 746 were sales in the month of December and the 2,162 of the last quarter. Thus, BEV and PHEV electric vehicles in Greece stood at 6.9% of total registrations in 2021, compared to 2.6% in 2020.

Table 18: Vehicle Sales by Fuel Type in Greece

	Number of vehicles 2021	Number of vehicles 2020	% Change 21/20
Gasoline	49.625	43.060	+15,2%
Diesel	17.549	22.251	-21,1%
Hybrid Electric Vehicles (HEV)	23.382	11.751	+99,0%
Plug-in Hybrid Electric Vehicles (PHEV)	4.785	1.456	+228,6%
Battery Electric Vehicles (BEV)	2.176	679	+220,5%
Natural Gas Vehicles (NGV)	1333	1339	-0,4%
Alternatively Powered Vehicles (APV)	2061	441	+367,3%
Total	**100.911**	**80.977**	**24,62%**

Source: ACEA

Figure 108: Share of Vehicle Sales by Fuel Type, 2020 and 2021



Source: AMVIR

The 2,176 BEV cars sold in Greece in 2021 corresponded to 24 brands and 42 models. Dominant in this market is Tesla, while in second place is Volkswagen.

Figure 109: Percentage of BEV and PHEV Vehicle Sales by Manufacturer in Greece, 2021

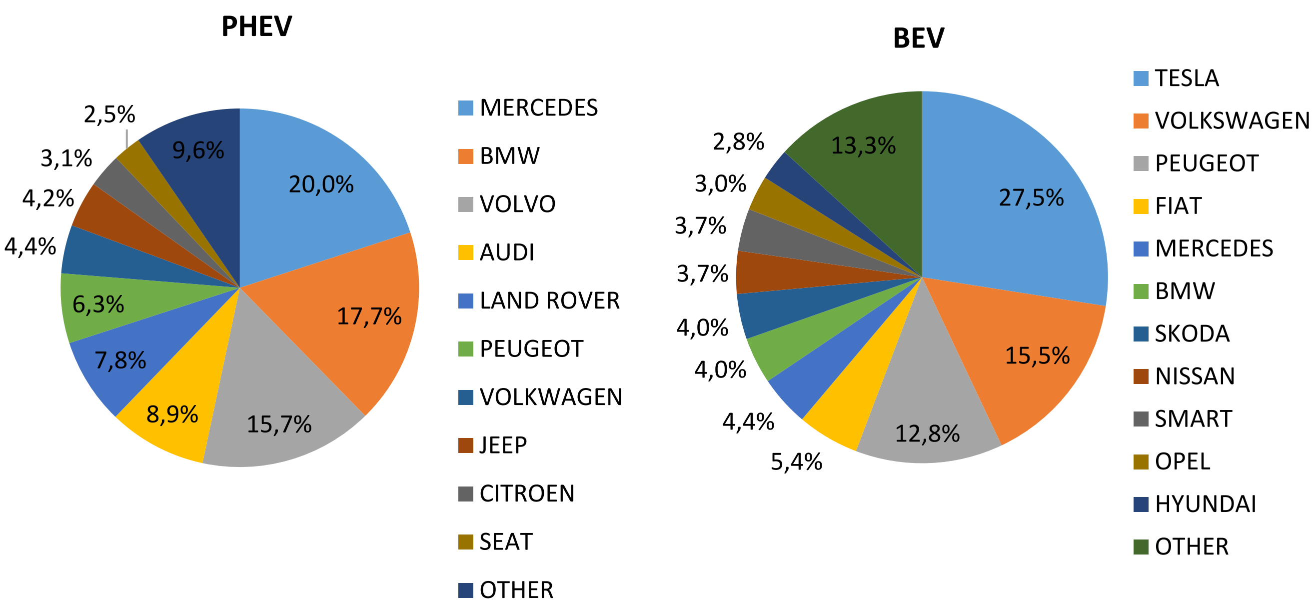
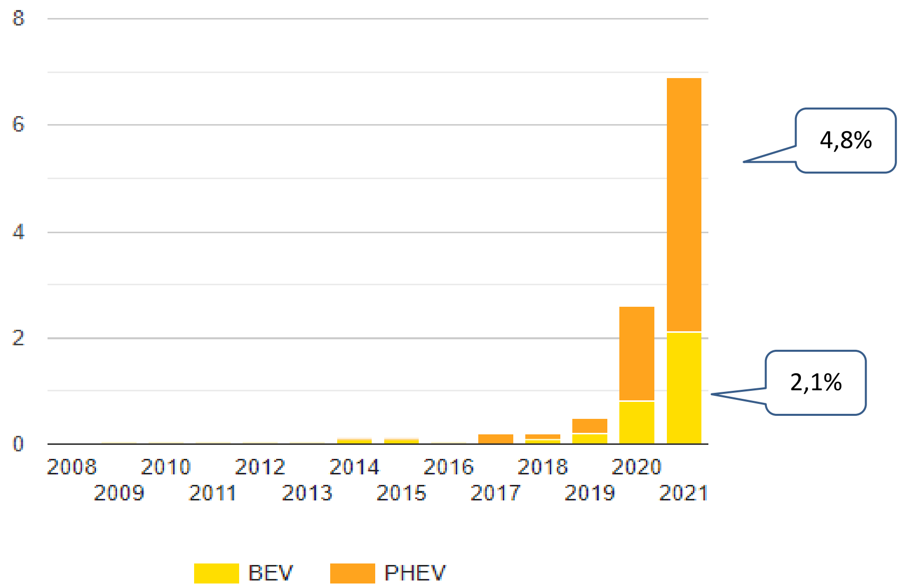


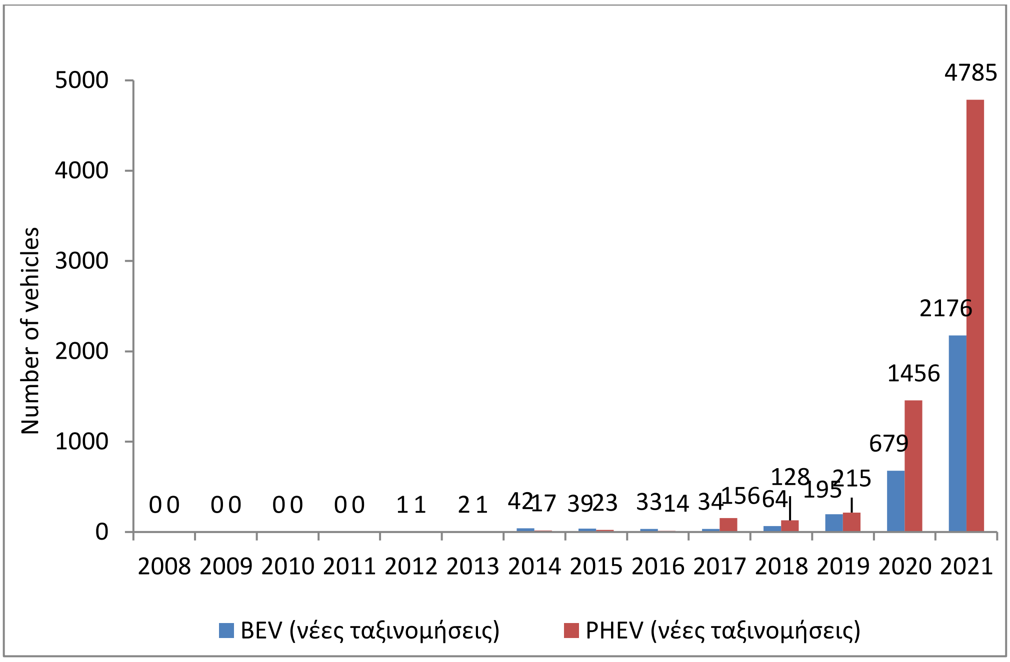
Figure 110: New Registered Electric-Hybrid Cars in Greece in Relation to Total New Registered Cars (in %)



Source: EAFO

The evolution of BEV and PHEV vehicle registrations in Greece from 2008 to 2021 is shown in Figure 111.

Figure 111: New BEV and PHEV Vehicle Classifications in Greece, 2008-2021

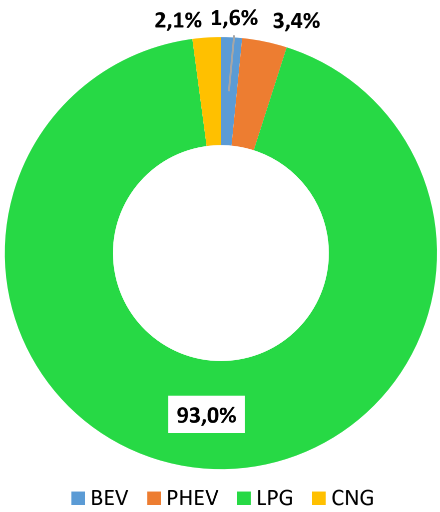


Note: BEV: battery electric vehicles, PHEV: plug-in hybrid electric vehicles

Sources: ACEA, IENE

For the period up to July 28, 2022, the total of passenger cars with alternative fuels amounted to 243,338 out of a total of 6,137,610 passenger cars, representing a percentage of 3.96%. The distribution of types of passenger vehicles with alternative fuels is shown in Figure 112 [108].

Figure 112: Share of Alternative Fuel Passenger Vehicles by Type in Greece, July 2022



Source: European Commission

(d) Smart Grids in Greece

Smart grids are electricity network that use digital technologies, sensors and software to better match the supply and demand of electricity in real time while minimizing costs and maintaining the stability and reliability of the grid.

Smart grids coordinate the needs and capabilities of producers, grid operators, consumers and other market participants to operate optimally, minimizing cost and environmental footprint, maximizing stability and reliability. Consumers, through their immediate information, contribute to the balancing of production and demand and therefore to the reliability of the system [109].

In addition, the smart grid uses all available energy resources, promotes new products and services, consumers are able to choose from a variety of products and services as well as improves the quality of electricity through automation and mechanisms that limit breakdowns and allow their immediate restoration.

The transition to an energy market that will combine the achievement of high environmental standards, with high-level services at low costs, can only be realized through smart networks, which places them at the center of the strategic planning of Electricity Distribution Companies [109].

In the case of DEDDIE, the new energy landscape means that the distribution network is becoming "smart", with the widespread use of digital technologies and the processing of a huge amount of data being about the only way to manage such a complex system.

In accordance with the provisions of Directive 2009/72/EC of the European Parliament, article 59 of Law 4001/2011, the decision of the Deputy Minister of Energy and Mineral Resources in Official Gazette B 297/13.2.2013 "DEVELOPMENT OF SMART METERING SYSTEMS IN NATIONAL ELECTRICITY DISTRIBUTION NETWORK", by which it was approved the large-scale gradual replacement of the existing measurement systems of the final consumption of electricity in the Hellenic Electricity Distribution Network with corresponding smart measurement systems, the positive Opinion 10/2012 of the RAE, the implementation of a pilot installation of smart meters was approved to low voltage consumers. DEDDIE is launching the nationwide expansion of telemetry, which has been proposed to be financed through the Recovery Fund. More specifically, the project includes the supply and installation of 7.5 million smart meters to low-voltage customers throughout the Greek territory (5,400,000 single-phase and 2,100,000 three-phase) and their inclusion in a telemetering center with a capacity of 8 million measuring points. In parallel, the same number of existing meters will be disconnected for Low Voltage Customers of DEDDIE. The estimated implementation time of the project is 6 years [110].

Smart meters will pave the way for a number of innovative applications and services, such as energy savings thanks to real-time consumption monitoring, and the implementation of DEDDIE's multi-zone tender tariffs for smart meters, as the Operator proceeded with a review of the schedule, specifying the deadline for submission of tenders for June 8, 2022 from May 30, 2022 which was before.

This is the fourth extension in a row that the tender in question has received, as the initial date for submitting bids was February 14 and three postponements have followed since then. It is recalled that the tender concerns the supply of smart meters that will replace the current analog "clocks" recording electricity consumption.

In the first phase of the tender, technical proposals will be submitted by the interested parties and a short list of up to six candidates will be selected. Among the candidates, those who pass the second stage of the tender will be invited to submit technical and financial offers. In the third and final stage, there will be direct negotiations, which will concern the technical, commercial and financial requirements of the Declaration Issue.

The models of "smart and sustainable cities", based on the increased integration of clean energy technologies together with the use of advanced information and communication technologies, are one of the main axes of the restructuring of the energy sector. A "smart" city invests in human and social capital, in traditional and modern communication infrastructure, fostering a sustainable economic development and a high standard of living, with prudent management of natural resources as well as through participatory governance. Using "smart" means at city level improves people's living conditions, attracts businesses and investments at local level and increases the purchase value of real estate.

Smart meters and smart grids will be a critical part of these plans, allowing the monitoring and management of the large volumes of information that will be required for their harmonised operation, significantly helping the rational use of energy by end consumers at city level. Combined with the new regulatory framework of the demand response mechanism and energy communities, the role of cities and citizens in the transition and ultimately in the restructuring of the energy sector is expected to be significantly promoted. In addition, the use of smart applications is also related with urban regeneration, with the main objective of improving the living standards of residents and the operating conditions of businesses.

Particularly important is the issue of energy management in smart homes and energy networks in the coming years. In this context, Greece participates in the research project InterConnect (Interoperable Solutions Connecting Smart Homes, Buildings and Grids), through five institutions: Gridnet, Cosmote, Wings, Heron and the Athens University of Economics and Business. The four-year project falls under the European Horizon 2020 programme and lays the foundations for the digitization of smart energy management solutions. InterConnect focuses on eight main technologies: digital platforms, Internet of Things, cloud, energy networks, big data, cybersecurity, ontology and standardization.

In total, more than 50 institutions from the energy, telecommunications, industry and research sectors from 11 European countries will collaborate to develop innovative solutions for the digitization and interconnection of smart homes, buildings and energy networks, leveraging cutting-edge technologies such as Artificial Intelligence, Blockchain and the most advanced SAREF protocol for direct networking of household devices and sensors with energy networks.

Greece is one of the 7 countries where these solutions will be piloted. The flexible business models that will emerge will be implemented by the entities involved in the operation of energy networks, for the benefit of consumers and the environment. At the same time, the activation of start-ups will be supported through 3 open calls for the selection and financing of 42 innovative ideas.

5.4 Solid fuels

Lignite represents a large part of Greece’s mining activity, being a basic fossil fuel and an important component of the country’s energy security. As part of the government’s decarbonisation plan as implemented in the NECP, PPC’s lignite production was almost halved in 2020, falling by 49% to 13.1 Mt and further reduced to 12.1 Mt in 2021. Electricity production from lignite was 5.7 TWh in 2020, representing just 11.4% of total generation in the interconnected system (excluding several islands), compared to 27.4 TWh or 51.1% in 2010, having been gradually replaced by natural gas production with a share of 36% and RES with 28% in 2020.

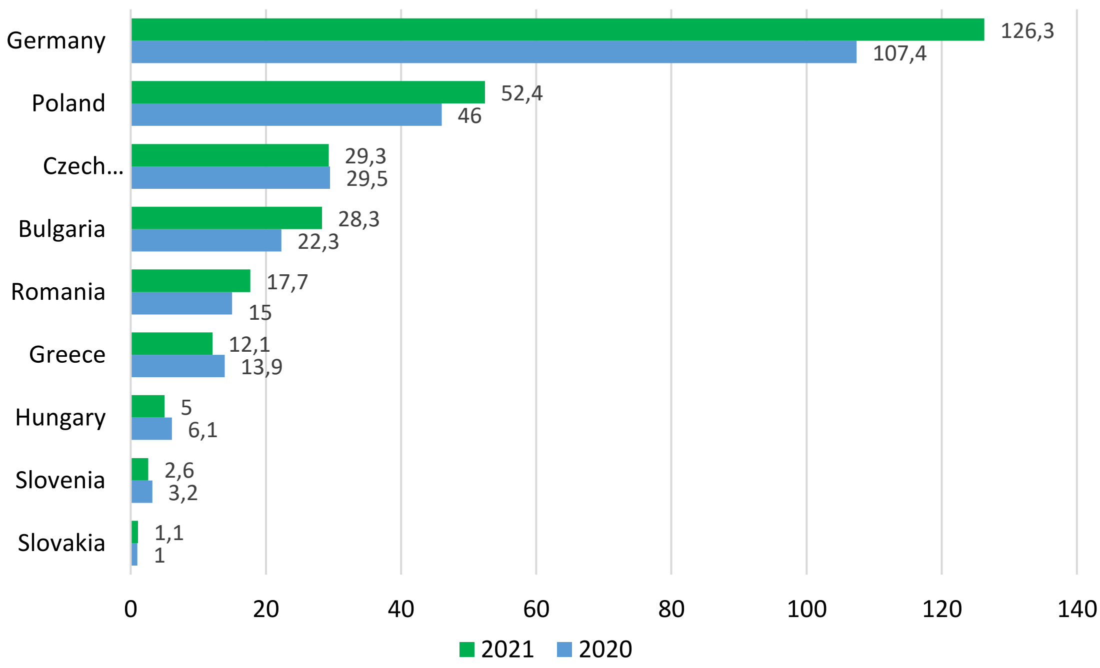
Higher prices for CO2 emission allowances and environmental restrictions on older lignite plants, as well as other factors, including electricity imports, have led to a drastic reduction in lignite use. As a result, employment at PPC’s lignite mines and power plants fell by 19% in 2020 to 4,357 people as the company has introduced a voluntary retirement scheme. In 2020, Greece became dependent on imported energy for the majority of its electricity production as electricity generation from domestic energy sources fell below 50% for the first time [111].

Greece's lignite production, mostly from PPC, increased by 17.6% to 6.7 Mt in the first half of 2022, surpassing the 5.7 Mt in the first half of 2021. PPC operates seven thermoelectric stations with a total power of 2,225 MW, which are supplied with lignite from the lignite centers of Western Macedonia and Megalopolis. After the closure of two mines in 2021, three mines remain in operation: two in Western Macedonia and one in Megalopolis.

Due to the EU energy crisis, lignite production is expected to reach 14.0 Mt in 2022, compared to the planned 11.4 Mt, delaying the closure of the Megalopolis mine by two years and recovering additional lignite from the closed mines of Western Macedonia. According to pre-crisis estimates, lignite would contribute to the electricity generation mix in 2022 by 9% or 4.5 TWh, but given the new energy situation caused by the war in Ukraine, electricity generation from lignite is estimated at 6.8 TWh. The new 660 MW "Ptolemaida V" plant is in trial operation and was expected to enter commercial operation after March 2023 [112].

In recent years (2020-2021), Greece was the sixth largest producer of lignite among European member states, according to data from EURACOAL (Figure 113).

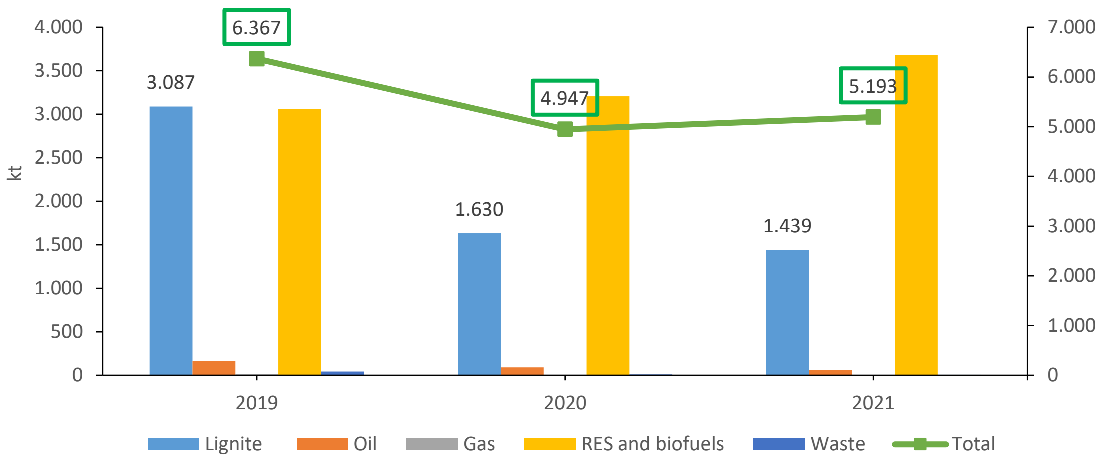
Figure 113: Lignite Production, 2020 and 2021 (Mt)



Source: Euracoal

As illustrated in Figure 114, the primary energy production from lignite in Greece decreased in 2021 by -53% compared to 2019 and by -12% compared to 2020.

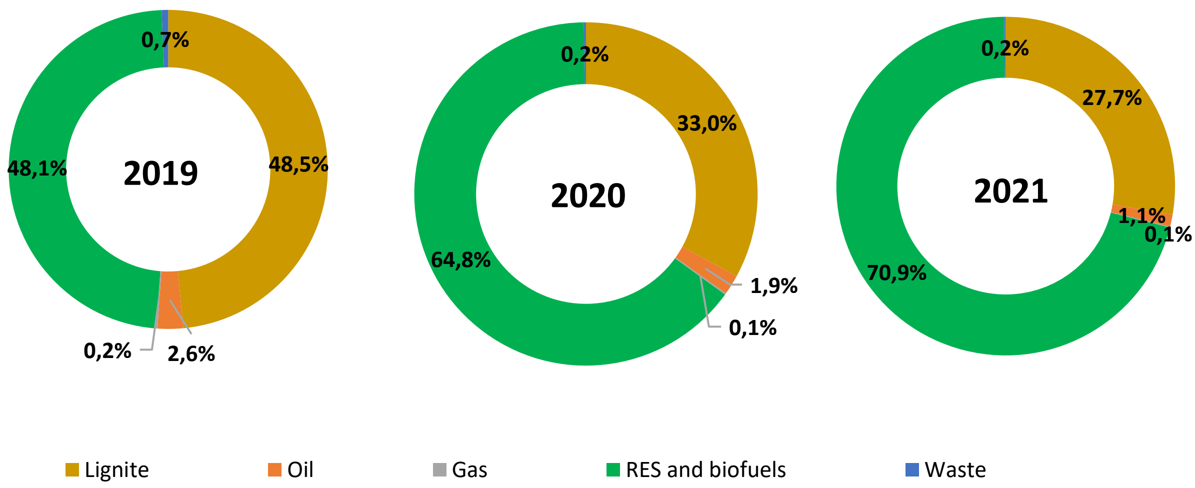
Figure 114: Primary Energy Production per Fuel (thousands tons)



Source: Eurostat

Regarding the contribution of lignite to primary energy production, Figure 115 shows a large decrease in its percentage from 48.5% in 2019 to 33% in 2020 and to 27.7% in 2021, possessing the second place after RES which provided 70.9% of primary energy production in Greece in 2021.

Figure 115: Fuel Shares in Primary Energy Production, 2019, 2020 and 2021

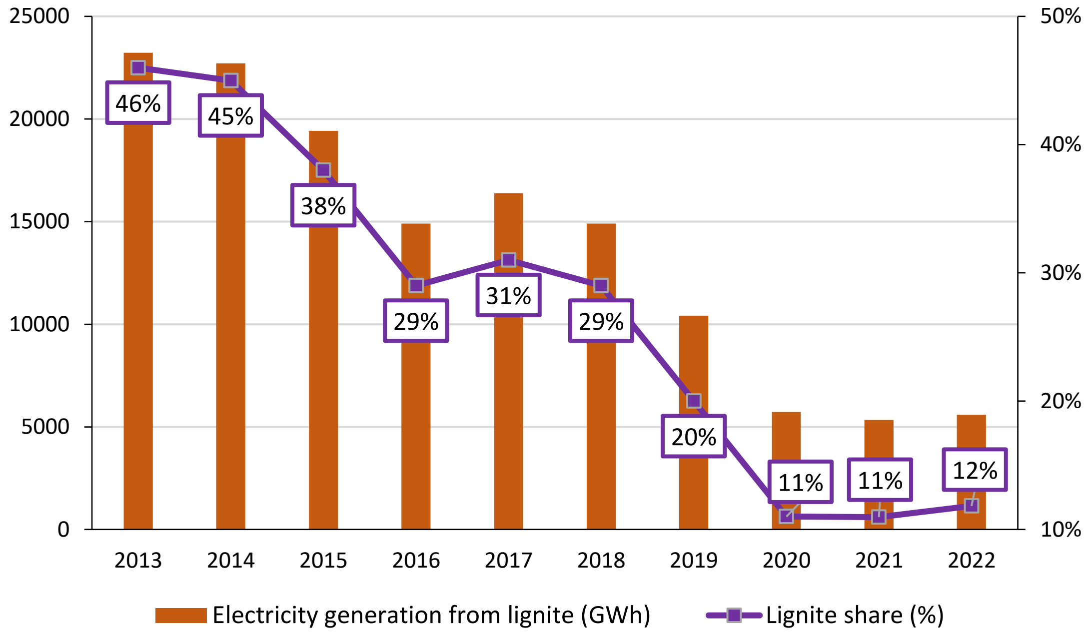


Source: Eurostat

According to IPTO's data [113], electricity generated from lignite decreased significantly from 10.4 TWh in 2019 to 5.34 TWh in 2021 and 5.59 TWh in 2022 due to the RES deployment, lower overall demand for electricity and high cost of CO2 emission allowances that make power generation from lignite uneconomical. Electricity production from lignite has decreased by 179% between 2018 and 2021, from 14.9 TWh to 5.3 TWh respectively.

For 2022, however, there is an increase to the use of lignite in power generation as a replacement for natural gas due to its high prices resulting from the limited natural gas flows from Russia (Figure 116).

Figure 116: Evolution of Use and Share of Lignite in Power Generation, 2013-2022

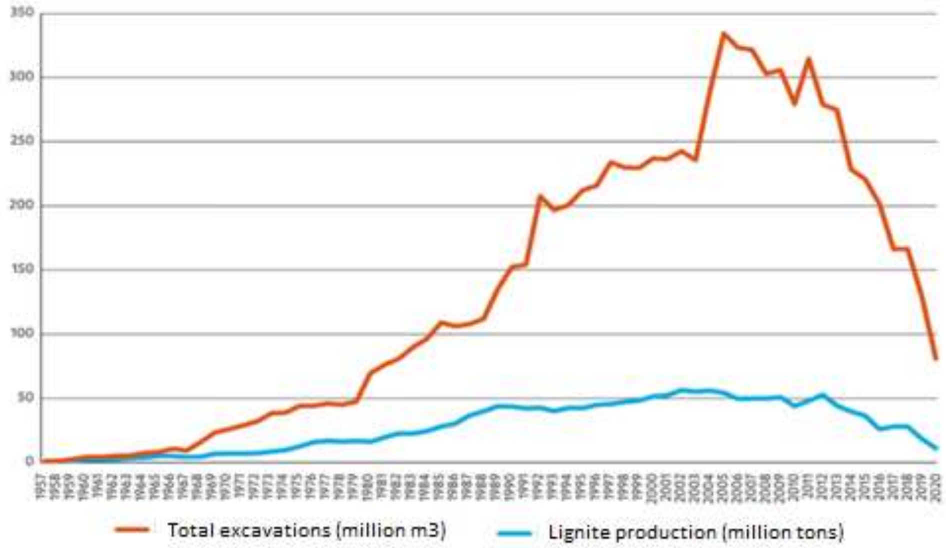


Source: IPTO

The lignite mines, mainly of PPC in the areas of Aliveri, Kozani - Ptolemaida - Florina and Megalopolis, ensured, from the year 1955 and for a period of approximately 65 years, the necessary quantities of lignite, a particularly important energy fuel for the Greek economy [114].

Since the beginning of the operation of the mines in the area of Kozani - Ptolemaida - Florina in the year 1957, the production of lignite has shown a significant increase. More 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, which marked the maximum production. Production was maintained at the level of 50 million tons per year until the year 2012, when its gradual decline began (Figure 117). In the year 2020, the production of lignite from the mines of the Lignite Center of Western Macedonia was 10.3 million tons *[114]*.

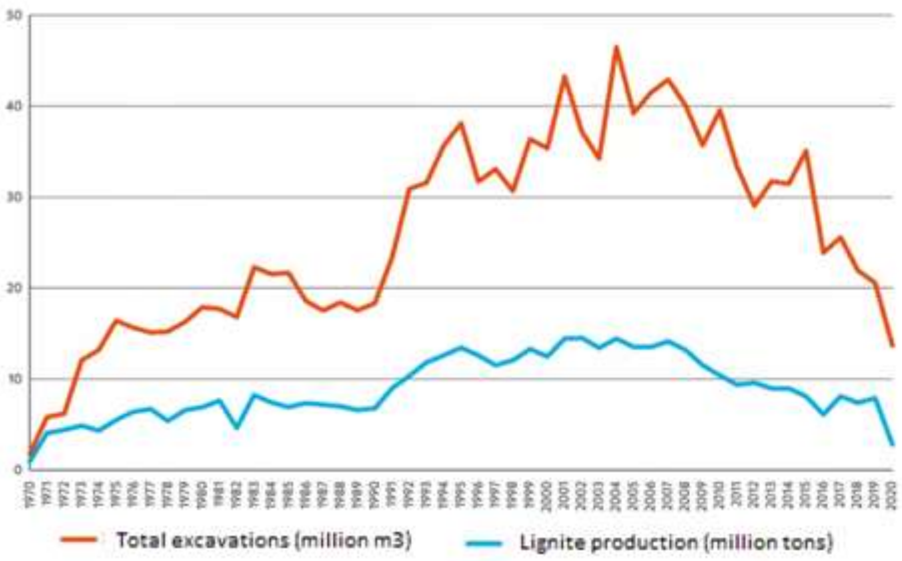
Figure 117: Evolution of Lignite Production and Total Excavations at the Ptolemaida – Amyntaio – Florina Mines of PPC (1958 – 2020)



Source: PPC

The exploitation of the deposit in the area of Megalopolis began in 1970 and was a special case at the 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 the year 2002 which was the maximum production. Production was maintained at 13-14 million tons per year until the year 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 118).

Figure 118: Evolution of Lignite Production and Total Excavations at the Mines of Megalopolis (1970 – 2020)



Source: PPC

According to the NECP of December 2019, all PPC lignite units are expected to be decommissioned by the end of 2028 (except for the new Ptolemaida V unit, which is estimated to be decommissioned after 2030), a total capacity of approximately 4 GW, and to close all lignite mines in the regions of Western Macedonia and Megalopolis.

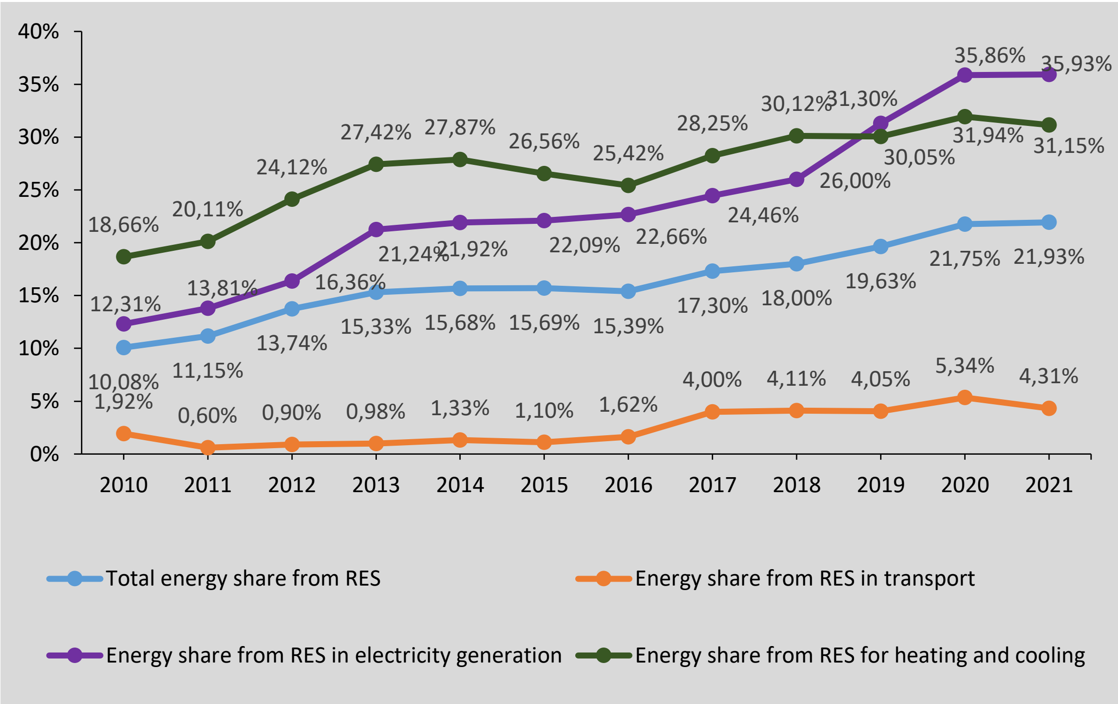
By August 2021, the following means of production had been permanently decommissioned and retired:

- Unit I, II, III and IV of Ptolemaida steam power plant (lignite)
- Unit I and II LIPTOL steam power plant (lignite)
- Unit I, II, III and IV Aliveri steam power plant (lignite)
- Unit I, II and III of Lavrio steam power plant (natural gas)
- Unit 8 and 9 of Agios Georgios steam power plant (natural gas)
- Unit I, II, III and IV Kardia steam power plant (lignite)
- Unit I and II of Amyntaio – Filota steam power plant (lignite)
- Mine of Amyntaio
- Mine of Kardia

5.5 Renewable Energy Sources (RES)

The contribution of RES to electricity generation in Greece shows a significant increase during the period 2010-2021, as their total contribution in 2021 amounted to 35.93%, showing a substantial increase from 2010, where their share was at 12.31% (Figure 119), according to Eurostat's data.

Figure 119: Total and Specific Participation Shares of RES in the Energy System of Greece in the Methodology Base of the European Union, 2010-2021



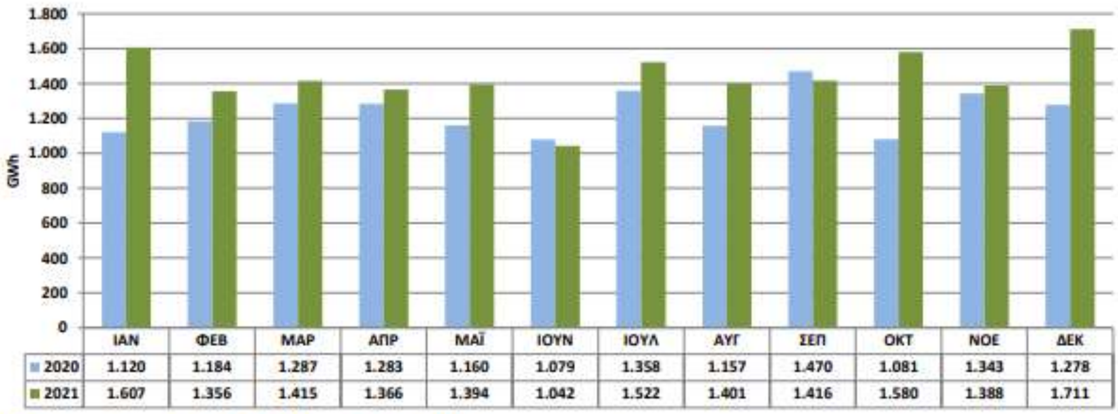
Source: Eurostat

A significant percentage increase is shown in the share of RES in transport from 2016 to 2017, while this share reached 4.31% in 2021. The total share of energy from RES shows a steady increasing trend from 2010 to 2021, while RES for heating and cooling follow a path with fluctuations, ending in 2021 at a share of 31.15%.

5.5.1 Electricity Production from RES

In Greece, electricity generation from RES in the interconnected system reached 17.2 TWh in 2021, from 14.8 TWh in 2020, according to IPTO's data (Figure 120), as a result of the rapid development of the installed capacity of wind and solar.

Figure 120: Electricity Generation from RES in Greece, 2020-2021

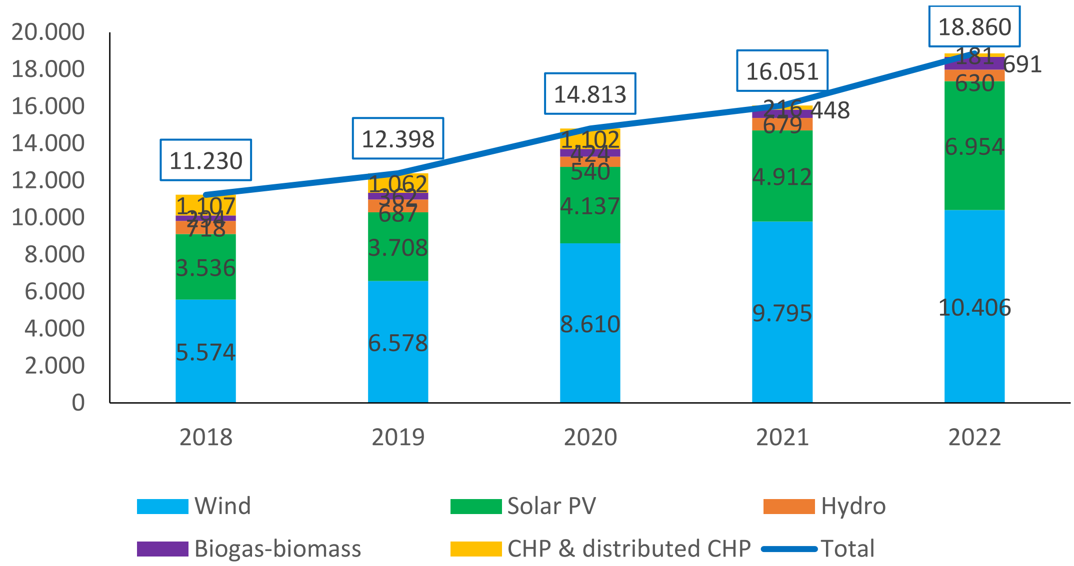


Στην παραγωγή ηλεκτρικής ενέργειας από μονάδες ΑΠΕ περιλαμβάνονται:
- παραγωγή στο σημείο έγχυσης στο Σύστημα από μονάδες ΑΠΕ που συνδέονται απευθείας σε Υ/Σ Συστήματος.
- παραγωγή από Κατανεμόμενες Μονάδες ΣΗΘΥΑ που έχει χαρακτηριστεί ΣΗΘΥΑ.
- εκτίμηση της παραγωγής στο Δίκτυο (η παραγωγή στο Δίκτυο προκύπτει από πιστοποιημένες μετρήσεις για την Μέση Τάση και εκτιμήσεις για την Χαμηλή Τάση).

Source: ΑΔΜΗΕ

According to DAPEEP's data [115], the total energy production in Greece from interconnected wind farms reached approximately 9.8 TWh in 2021, while from small hydro and biogas-biomass plants reached 679 GWh and 448 GWh respectively in the same year. Also, the total electricity production of cogeneration units of the interconnected system reached 215 GWh. Finally, the electricity production from photovoltaics in the interconnected system approached 4.4 TWh in 2021, while the production from photovoltaics of the Special Rooftop Programme reached 441 GWh (Figure 121). For 2022, total energy production reached 18,860 GWh, an increase of 17.5%, compared to 2021, when total energy production reached 16,051 GWh, with wind having a 55.2% share, followed by photovoltaics with 36.9% (2022).

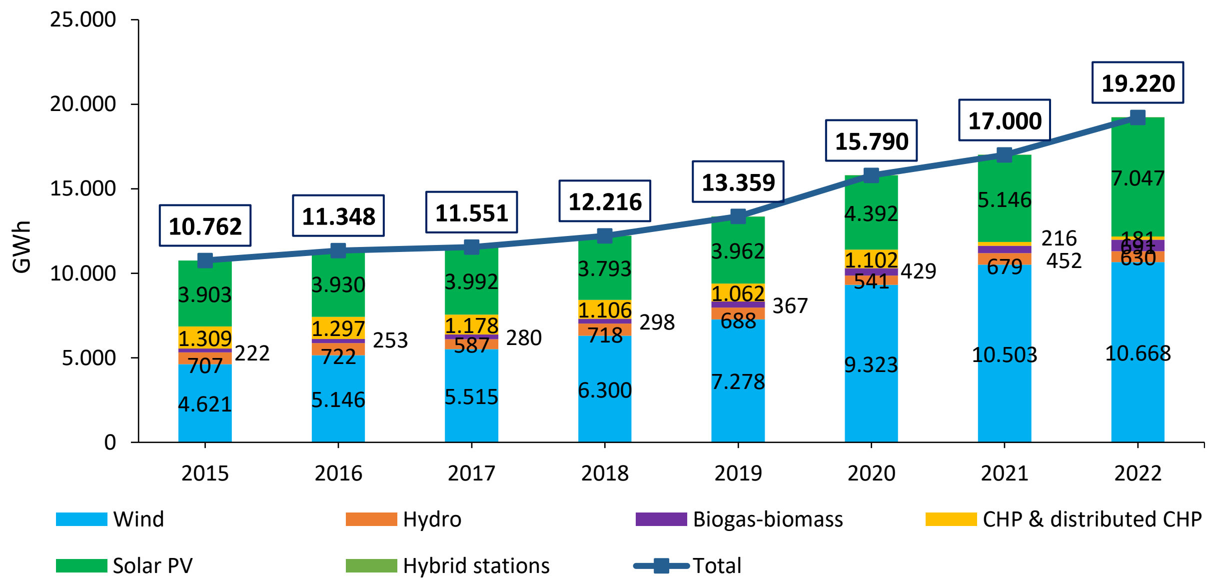
Figure 121: Evolution of Electricity Generation in the Interconnected System (GWh), 2018-2022



Source: DAPEEP

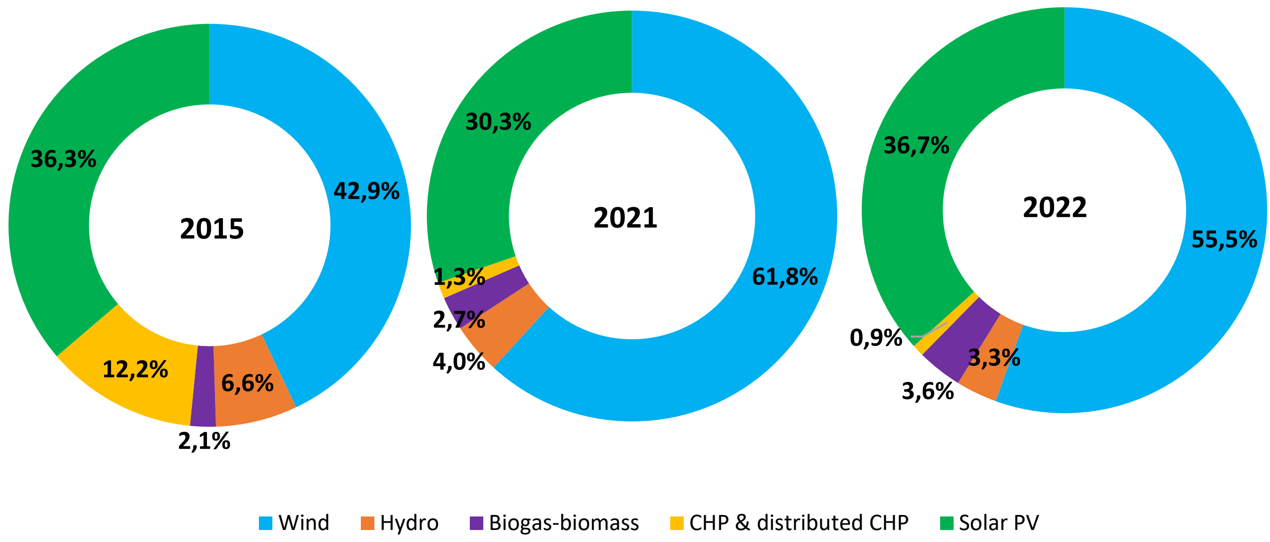
The production of energy from RES reached 17 TWh in 2021 from 10.8 TWh in 2015 and 15.79 TWh in 2020, showing an increase of 58% and 7.7% respectively. Wind accounted for the largest percentage of energy production in 2021 with a percentage of 61.8%, from 42.9% in 2015, while in 2022 their share decreased to 55% with an increase in the share of photovoltaics to 36.7% (Figures 122 and 123). As for 2022, based on the latest DAPEEP's data [116], the total energy production reached 19.22 TWh, showing an increase of 13% compared to 2021.

Figure 122: Evolution of Electricity Production by RES Technology (GWh) in Greece, 2015-2022



Source: DAPEEP

Figure 123: Share of RES Technologies in Electricity Production, 2015, 2021 and 2022

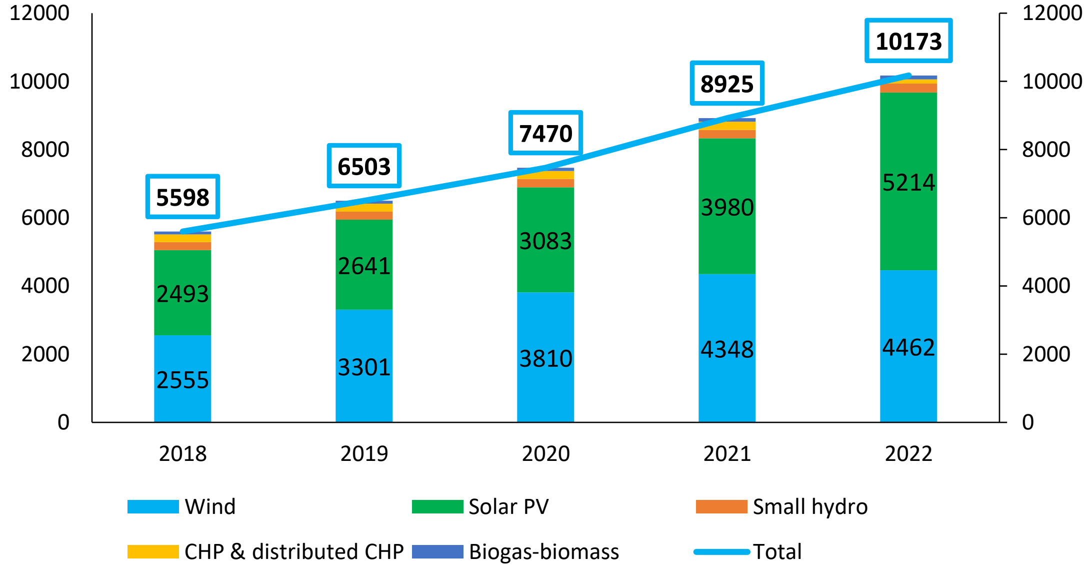


Source: DAPEEP

5.5.2 Installed Capacity from RES

Based on DAPEEP's data [116], the total installed RES capacity in the interconnected system and rooftop PVs of less than 10 kW amounted to 8,925 MW in 2021 (Figure 124), with the vast majority based on wind (48.7%) and PV (44.6%). In 2022, in the interconnected system the total installed RES capacity reached 10,173 MW, with photovoltaics increasing their percentage compared to 2021 to 51.3% and wind following with a percentage of 43.9%.

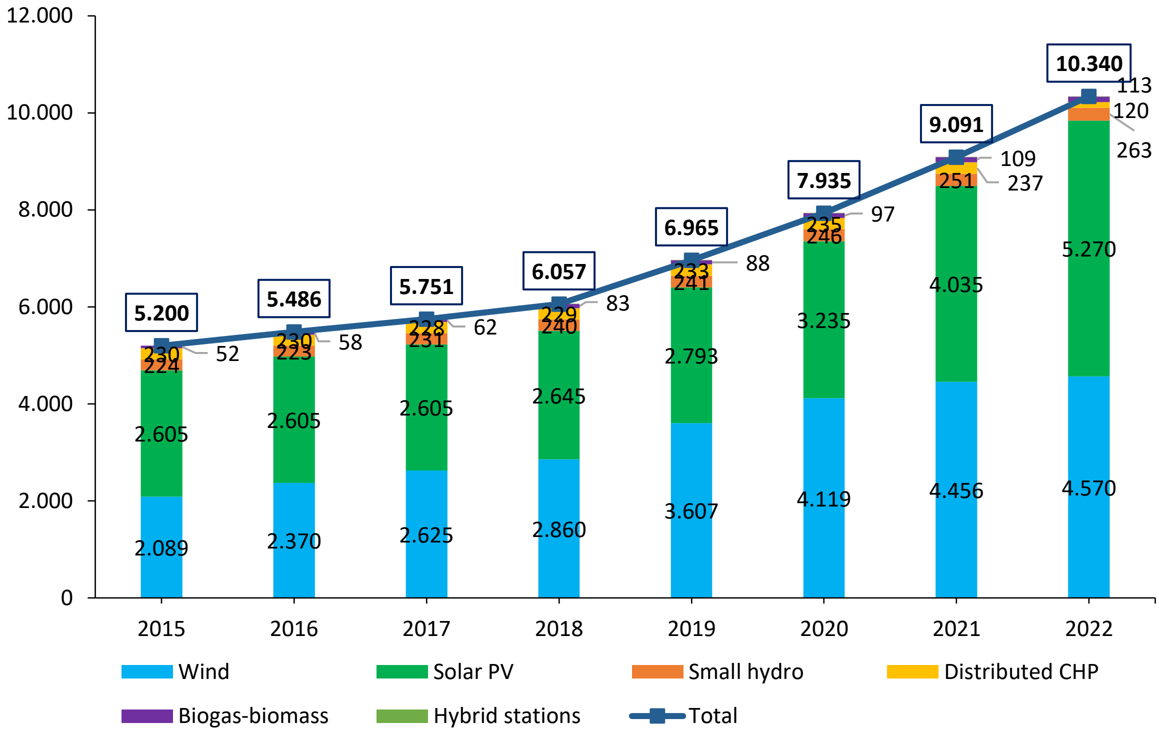
Figure 124: Evolution of Installed Capacity in the Interconnected System (MW), 2018-2022



Source: DAPEEP

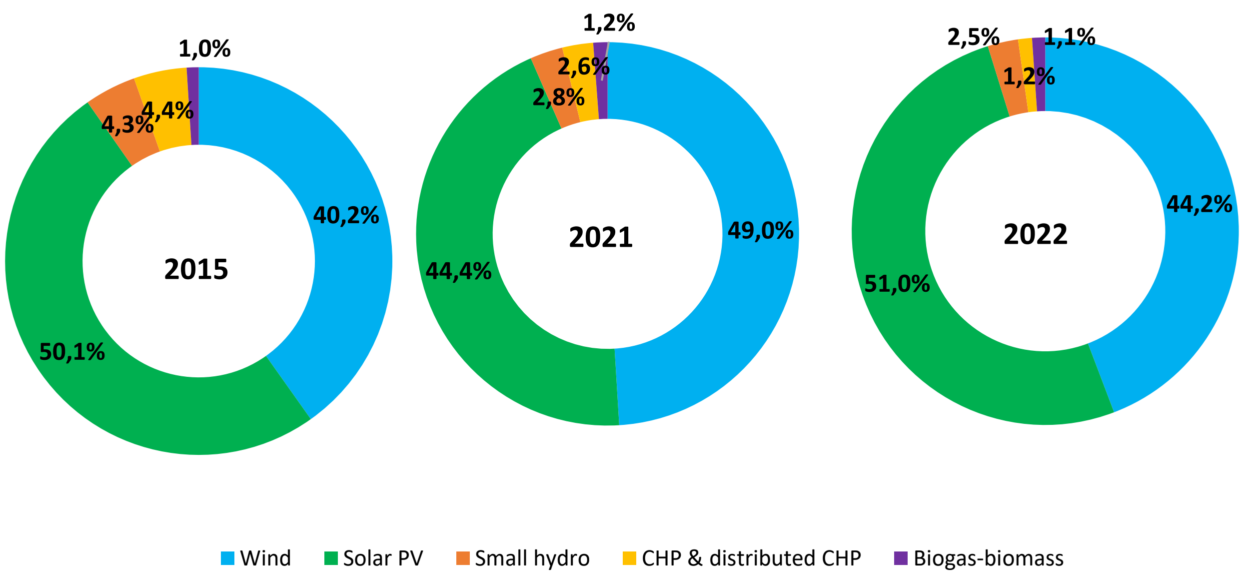
The installed capacity of RES projects reached 9,091 MW in 2021, with wind contributing to 49.0% in the total installed capacity, followed by photovoltaics with 44.4% (Figures 125 and 126). In 2022, the installed RES capacity in Greece showed an increase of 14%, reaching 10,340 MW.

Figure 125: Evolution of Installed Capacity by RES Technology (MW) in Greece, 2015-2022



Source: DAPEEP

Figure 126: Percentage of Installed RES Capacity per Technology in Greece, 2015, 2021 and 2022



Source: DAPEEP

5.5.3 Wind Energy

According to the Hellenic Wind Energy Association (HWEA or ELETAEN), the total installed wind capacity in Greece at the end of 2021 was 4,451 MW, showing an increase of 8.2% compared to 2020, an annual growth that is reduced compared to the period of 2019/2020, mainly due to administrative obstacles but also delays due to the Covid-19 pandemic *[117].* For the year 2022, the total installed wind capacity reached 4,570 MW (Figure 125), showing an increase of 5.2% compared to 2020 *[118].*

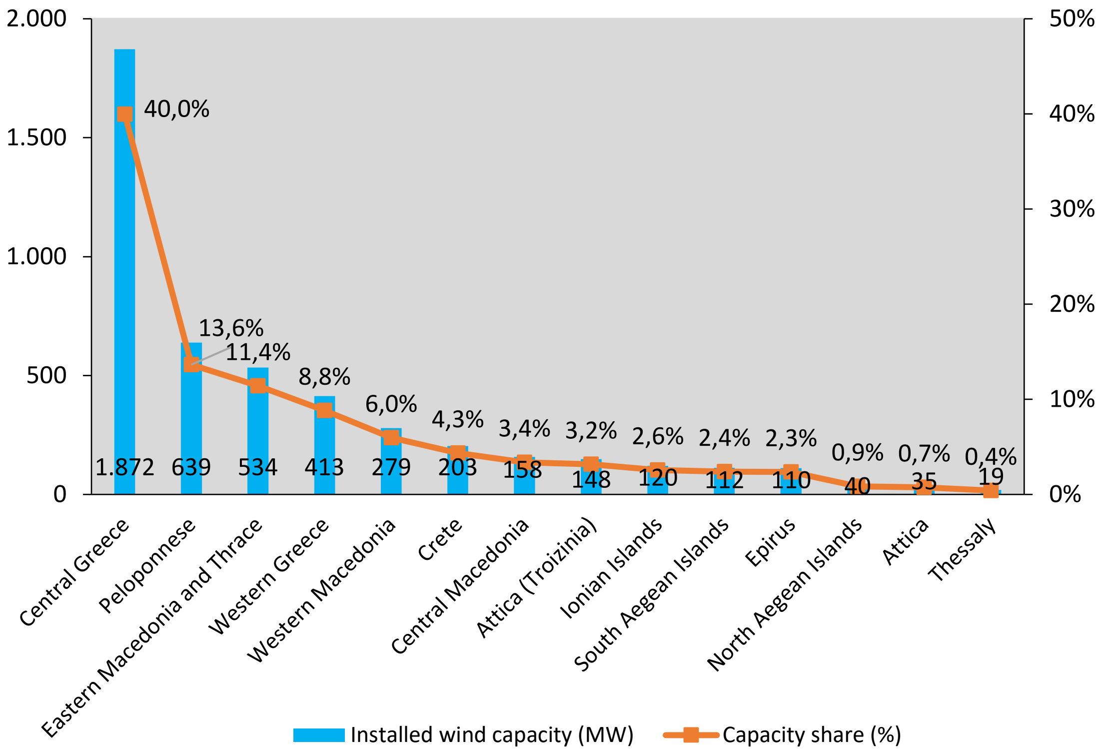
During 2021, 128 new wind turbines with a total capacity of 338.3 MW were connected to the grid, corresponding to investments totaling more than €340 million. Also, at the end of 2021, more than 650 MW of new wind farms were under construction, the vast majority of which is expected to be connected to the grid within 18 months *[117]*. At the end of 2022, over 840 MW of new wind farms were under construction, the vast majority of which are expected to be connected to the grid within the next 18 months. Another 450 MW are in the contracting phase or about to start their construction. As a result, the total installed wind capacity will reach around 6 GW within the next three years *[118]*.

Figure 127: Evolution of Installed Capacity (MW) of Onshore Wind in Greece, 1999-2022

Source: HWEA

At the level of Regions, Central Greece remains at the top of the wind installations since it has 1,872 MW (40%), followed by the Peloponnese Region, with 639 MW (13.6%) and Eastern Macedonia - Thrace Region, where there are 534 MW (11.4%).

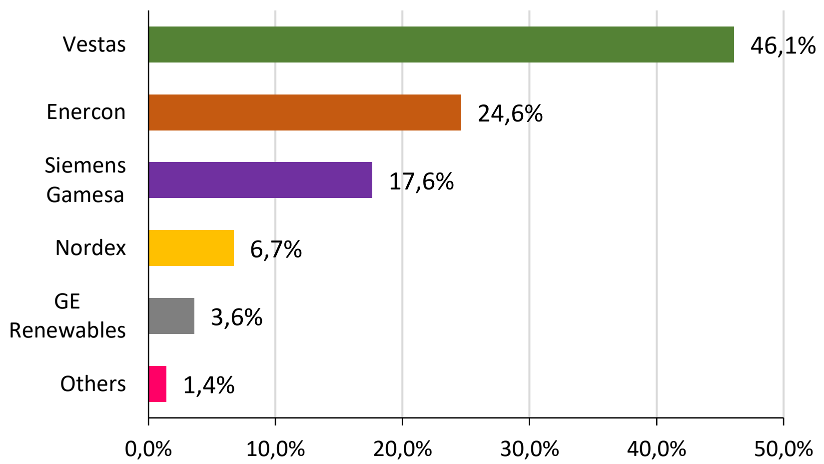
Figure 128: Geographical Wind Distribution by Region (MW), 2022



Source: HWEA

Regarding wind turbine manufacturers, Vestas has supplied 44.6% of the total wind capacity in Greece, Enercon 25.1%, Siemens Gamesa 18.5%, Nordex 7.1% and GE Renewable Energy 3.5% (Figure 129) [118].

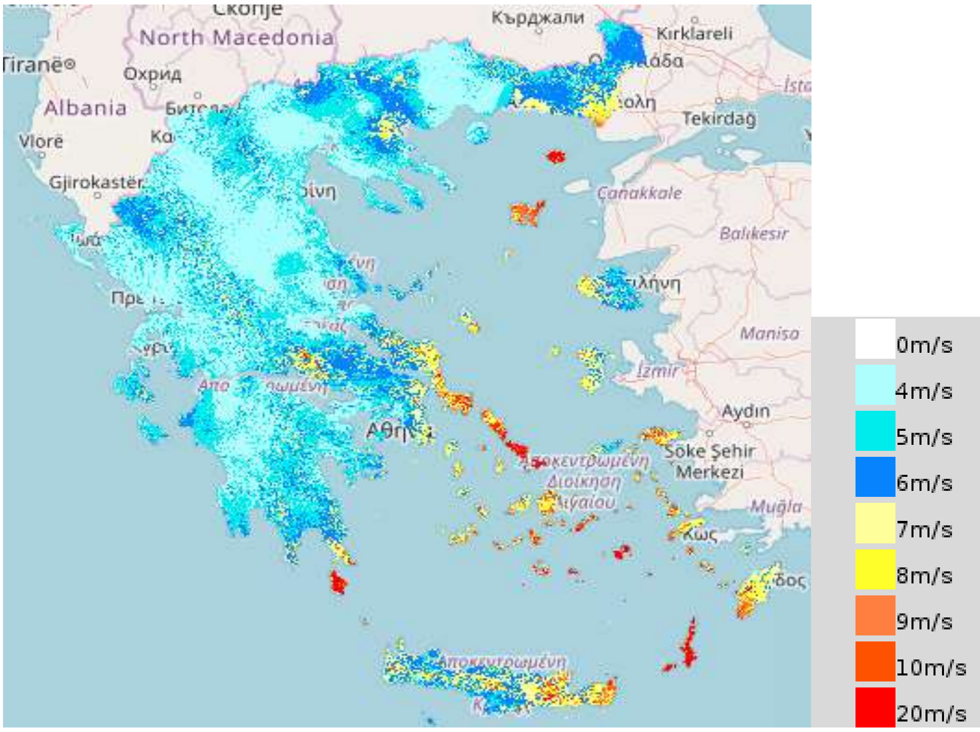
Figure 129: Share of Wind Turbine Manufacturers in the Total Attributed Wind Power in Greece, 2022



Source: HWEA

Greece's rich wind potential is found mainly in its island regions (e.g. Crete, Aegean, Euboea, etc.), where most wind farms are currently located. The exploitation of the wind potential, combined with the improvement of the technologies incorporated in modern wind turbines, is expected to contribute significantly towards sustainable development.

Map 22: Wind Potential in Greece, 2020



Source: RAE [119]

5.5.4 Photovoltaic Energy

2020 was a special year for photovoltaics as the pandemic affected the market with possible delays in the supply chain, but also because there was a change in the way the tariff is set with a “declaration of readiness” and not with the electricity that used to be the case. In 2021, the Greek PV market installed more megawatts than any other technology, a result of the huge investment interest that continues unabated *[120]*.

Based on data provided by the Hellenic Association of Photovoltaic Companies (HELAPCO) *[121]*, 780 systems with a total capacity of 453.8 MWp were installed but not interconnected within 2020, and submitted a “declaration of readiness” with the aim of being interconnected within 2021. A distinction is made between the new annual and total installed capacity and the new annual and total capacity of systems interconnected with the grid. This distinction makes sense because installed capacity reflects equipment sales, number of systems and jobs, while interconnected systems affect the capacity available in the system but also the financial figures of the Special RES Account and payments to RES producers.

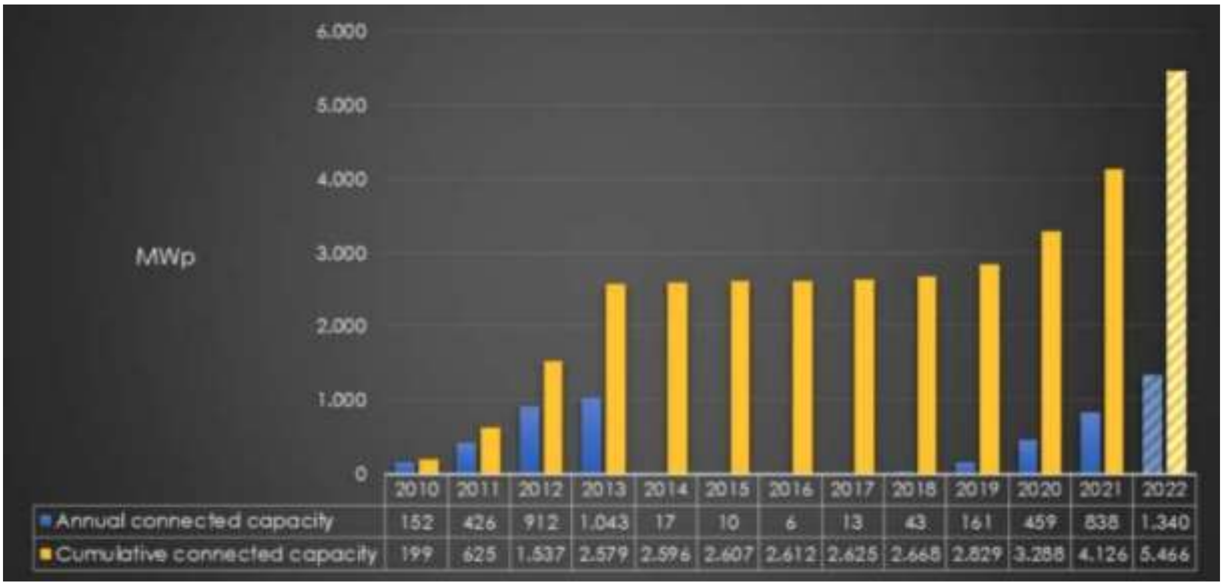
Table 19: Installed Capacity (MW) of Solar PV in Greece, 2020 and 2021

2020	MWp	2021	MWp
New installed solar PV capacity in 2020	913	New capacity of interconnected solar PV in 2021	838
New installed capacity of interconnected solar PV in 2020	459	Total capacity of interconnected solar PV up to 2021	4.126
Total installed capacity of solar PV until 2020	3.742		
Total installed capacity of interconnected solar PV up to 2020	3.288		

Source: HELAPCO

For 2022, according to HELAPCO data, it is estimated that 1,340 MW of new photovoltaic installations will be installed, increasing the total capacity in the grid to 5,466 MW [122]. In the first four months of the year, the large 204.3 MW solar PV park in Kozani was completed and commissioned by HELLENiQ Renewables (formerly HELPE Renewables), a landmark project as it is the largest single RES project in Greece up to today and the largest solar PV park with double-sided frames in the entire Europe.

Figure 130: Annual and Total Solar PV Connections to the Grid, 2010-2022



Note: Figures for 2022 are estimates

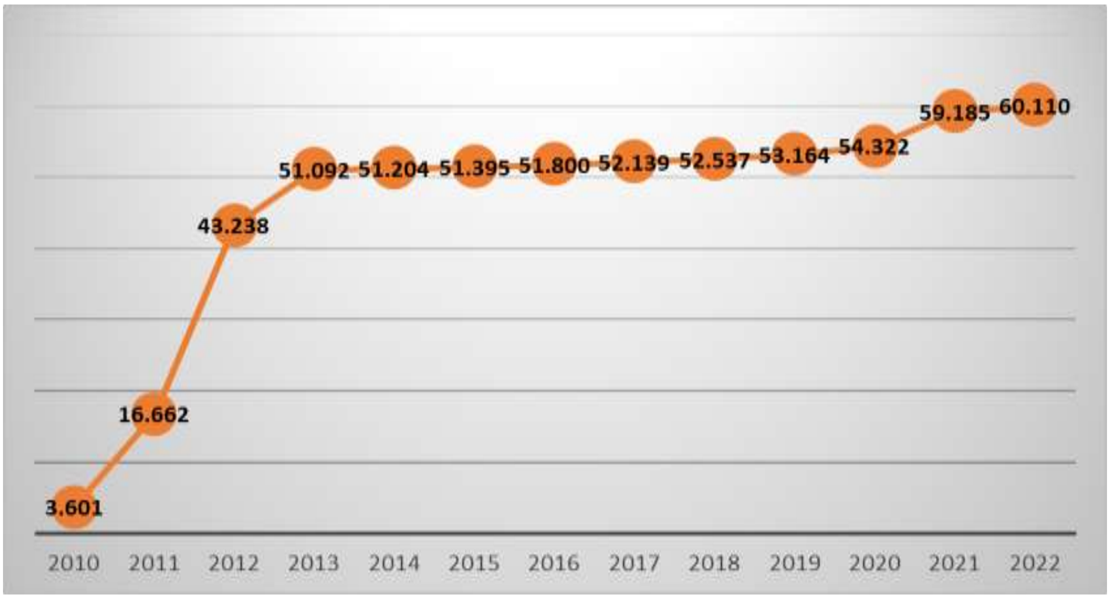
Source: HELAPCO

Of the 838 MWp of solar PV that were interconnected in 2021, 454 MWp had submitted a “declaration of readiness” as early as 2020 but were electrified in 2021. Similarly, additional 370 MWp had submitted a “declaration of readiness” in 2021 but electrified in 2022 [120].

In 2020, the market for self-generation systems almost doubled compared to the previous year, still remaining at levels significantly below the country's potential. More specifically, 17 MWp of new systems with net metering or virtual net metering were installed, bringing the total capacity of this category to 51 MWp, with commercial systems covering more than 90% of this capacity and residential systems falling significantly behind [121]. In 2021, the market of self-generation systems more than doubled compared to the previous year. More specifically, 38 MWp of new systems with net metering or virtual net metering were installed, bringing the total capacity of this category to 89 MWp [120].

Figure 131 shows the development of the installed solar PV systems from 2010 to 2022, showing an annual rate of growth of 14% in the period 2011-2022 [122].

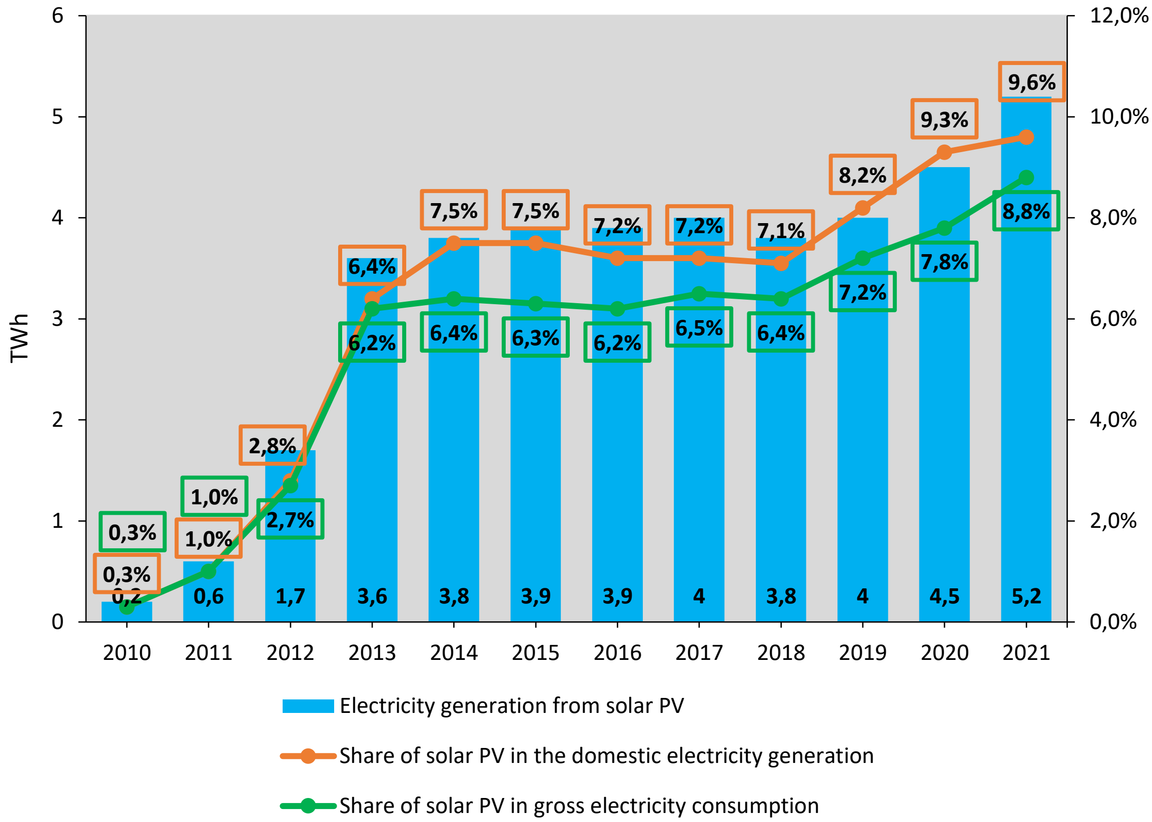
Figure 131: Number of Connected Solar PV Systems, 2010-2022



Source: HELAPCO

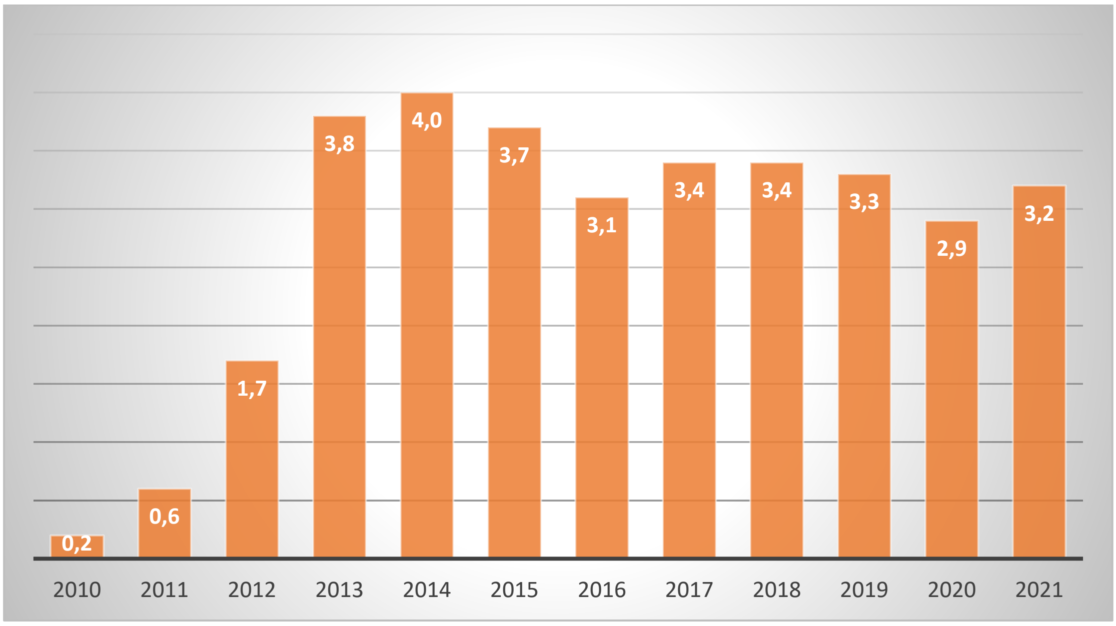
In 2021, photovoltaics in Greece produced 5.26 TWh or 8.8% of gross electricity consumption, preventing the release of 3.2 million tons of CO_2 from the substitution of fossil fuels (Figures 132 and 133) [122].

Figure 132: Evolution of Electricity Generation from Solar PV and Shares in Gross Electricity Generation, 2010-2021



Source: HELAPCO

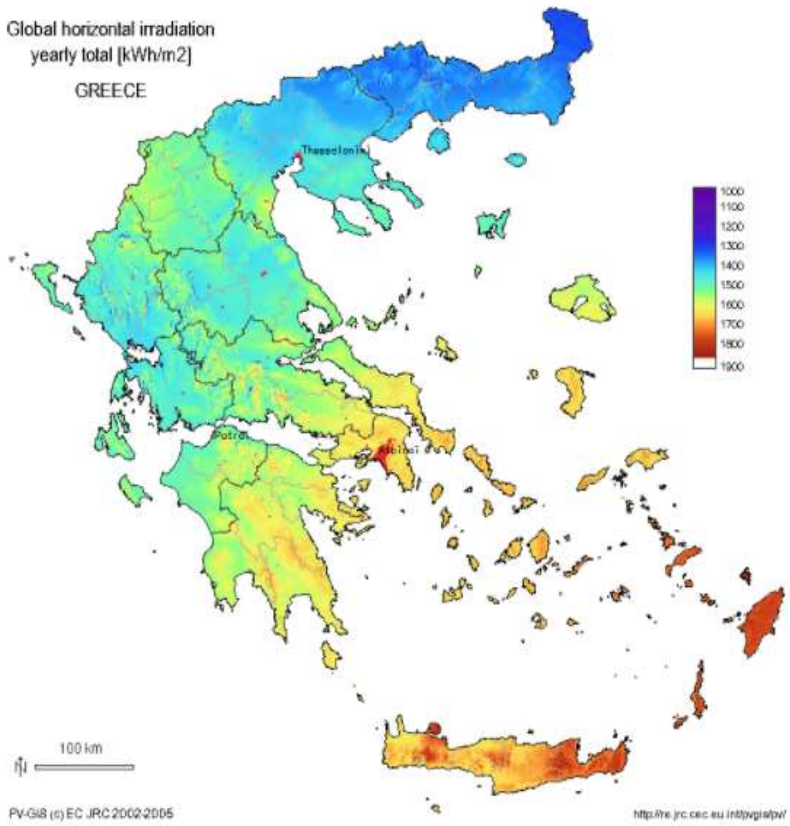
Figure 133: Less CO2 Emissions Due to Solar PV Installations (million tons), 2010-2021



Source: HELAPCO

The exploitation of domestic solar energy can be a viable electricity generation option, especially in areas with very high solar potential (e.g. Crete, Peloponnese, Aegean islands). Consequently, solar systems can be integrated into a wide range of applications.

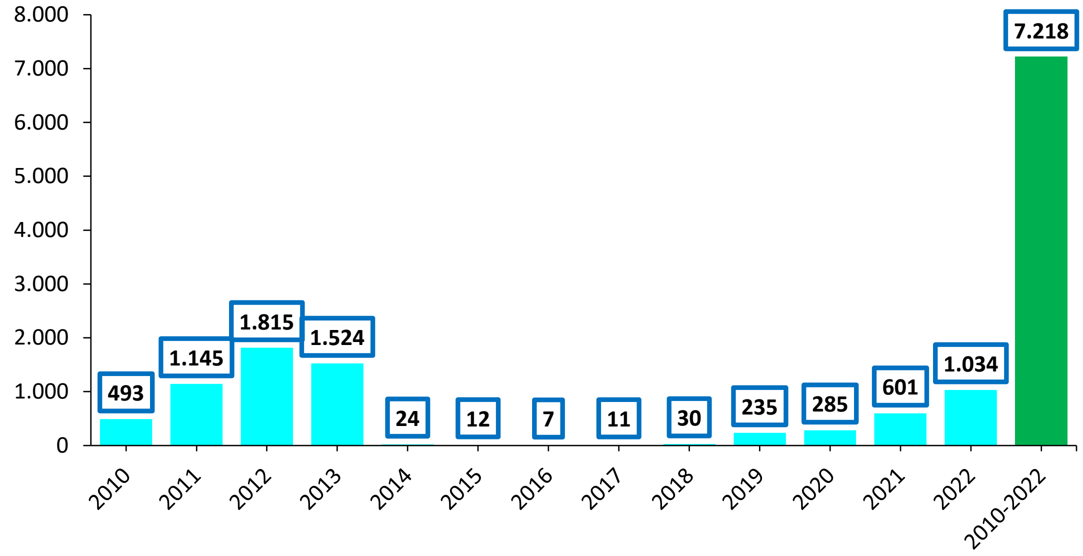
Map 23: Solar PV Potential in Greece



Source: European Commission

The annual and total investments in photovoltaic systems for the period 2010-2022 are shown in Figure 134. In the period 2014-2018, significantly reduced investments in the photovoltaic sector are observed due to the economic crisis, while from 2019 there is a recovery with 2022 recording a 72% increase in investments in photovoltaics compared to 2021.

Figure 134: Solar PV Investments in Greece (€ million), 2010-2022

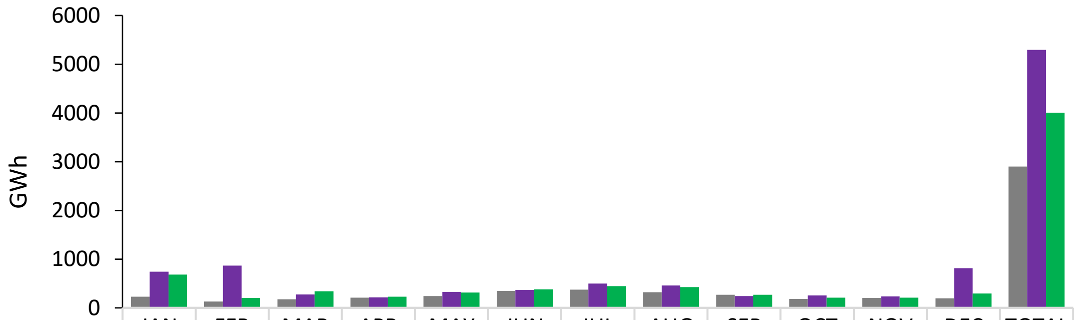


Source: HELAPCO

5.5.5 Hydro

The electricity production from hydropower projects increased significantly in 2021 compared to 2020, while in 2022 there was a decrease in the production of electricity from hydropower projects by 24%. More specifically, according to IPTO data [91], in 2021, 5,294 GWh were produced, which was an increase of 82.5% compared to 2020 (2,900 GWh), while in 2022 the production reached 4,006 GWh, significantly reduced compared to 2021, due to the drought in the summer of 2022.

Figure 135: Electricity Generation from Hydropower (GWh), 2020, 2021 and 2022



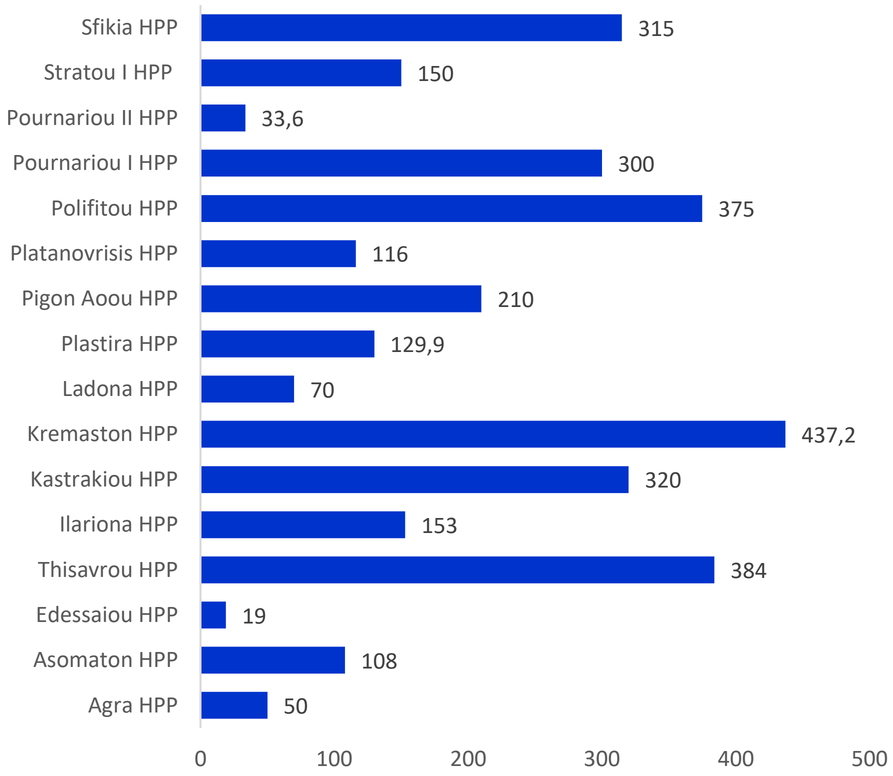
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
2020	231	129	179	211	245	348	377	324	271	182	206	197	2900
2021	742	864	275	218	328	367	500	459	240	253	233	814	5294
2022	683	206	338	228	312	379	448	429	270	207	212	294	4006

2020 2021 2022

Source: IPTO

The total capacity of hydropower plants in Greece by the end of 2022 was 3,171 MW, as shown in Figure 136.

Figure 136: Net Capacity of Hydropower Plants in Greece (MW), December 2022



Source: IPTO

Regarding the small hydropower plants, according to DAPEEP data of December 2022, their total capacity reached 263 MW in the interconnected system.

5.5.6 Geothermal

Geothermal is a renewable energy source that lies inside the earth, it does not depend on the randomness of weather conditions and under conditions of sustainable exploitation it can contribute as a base load, directly strengthening the energy security of each country. It has the smallest CO_2 footprint among other RES types and is used in power generation, plant and building heating, water desalination, greenhouses, product drying, other mild industrial uses and spa tourism. For example, it can provide heat to a city, through central heating or even to greenhouses without the need to use another fuel to maintain a constant temperature inside the premises. More specifically, geothermal provides heat to greenhouses in Mangana, Xanthi and Chrysoupoli, Kavala. Basic uses of geothermal 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 or even cities.

The installed capacity of geothermal applications in electricity generation worldwide by the end of 2021 reached 15.8 TW, showing an increase of 240 MW compared to 2020, with the US leading with 3.7 TW *[123]*.

Figure 137: The 10 Countries With the Largest Installed Geothermal Capacity in 2021

Source: ThinkGeoEnergy

Geothermal potential refers to native natural hot fluids, surface or underground, and the heat of geological formations, whose temperature exceeds 30°C. Geothermal potential is considered a mining mineral and the right to research/exploit it is leased by the state exclusively after a tender.

Map 24: Existing Proven and Probable Geothermal Fields in Greece

Source: Ministry of the Environment and Energy

Also important is shallow geothermal energy (with a temperature lower than 25°C), which can contribute to the heating and cooling of buildings in Greece. The exploitation of shallow geothermal energy is done with the use of heat pumps. Water-to-water heat pumps are usually used, which produce hot or cold water and can be combined with either fan-coil units or central air conditioning units. Water-to-air heat pumps are also used, which produce hot or cold air and are connected directly to a network of air ducts.

Shallow geothermal systems are divided into two categories:

- in open loop systems and
- in closed loop systems

Open-loop systems use water from the installation area's aquifers to feed the heat pump's primary circuit, which is then pumped back into the area's aquifer. The hydrological formation can be either surface (lake, river) or underground.

Closed-loop systems consist of a closed network of pipes, which is buried in the ground in a vertical or horizontal arrangement or is submerged in a pond. The piping network in this case is called a geoexchanger, in which water or a water/antifreeze solution circulates depending on the operating conditions.

According to the Hellenic Society for the Environment and Culture Heritage, confirmed fields of national interest are located in Milos and Nisyros, while there are scattered fields of local interest (also confirmed) in central and eastern Greece and in the Aegean. The benefits of utilizing geothermal energy are multiple with the most important being the generation of electricity on islands instead of expensive diesel, the reduction of CO2 emissions, the development of isolated areas, innovative applications in agricultural production and industry and the development of thermal tourism [124].

In Greece, a substantial growth has been recorded with the investment development of ILEKTOR's partnership with PPC Renewables, for the utilization of the four high-temperature geothermal fields of Lesvos, Milos-Kimolos-Polyaigos, Nisyros and Methanone for electricity generation.

The total investment programme reaches €120 million. The cost of research is estimated at €70 million, while another €50 million is estimated to be invested in the construction of the electricity production units. In each of the four areas, 5 MW of geothermal plants are to be built in the event that surveys show that there is a geothermal potential.

ILEKTOR will participate, through its 100% subsidiary "Geoenergy of the Aegean", with 51% in the joint company that will develop the geothermal fields. PPC Renewables will retain a

49% stake in the company “Geothermal Objective II” which was established for the purpose of financing, study, installation, construction and operation of geothermal power plants from the exploitation of the geothermal potential of the areas leased by PPC Renewables and specifically:

(a) In the geothermal field of Milos - Kimolos - Polyaigos Islands,

(b) In the geothermal field of Nissiros Island,

(c) In the geothermal field of Lesvos Island and

(d) In the geothermal field of the Methana peninsula.

The first unit, that of Milos, is expected to operate until 2025, provided that the necessary permits and local consent are secured. Geothermal is one of the forms of RES that allows stable production throughout the 24 hours since it is not affected by weather conditions.

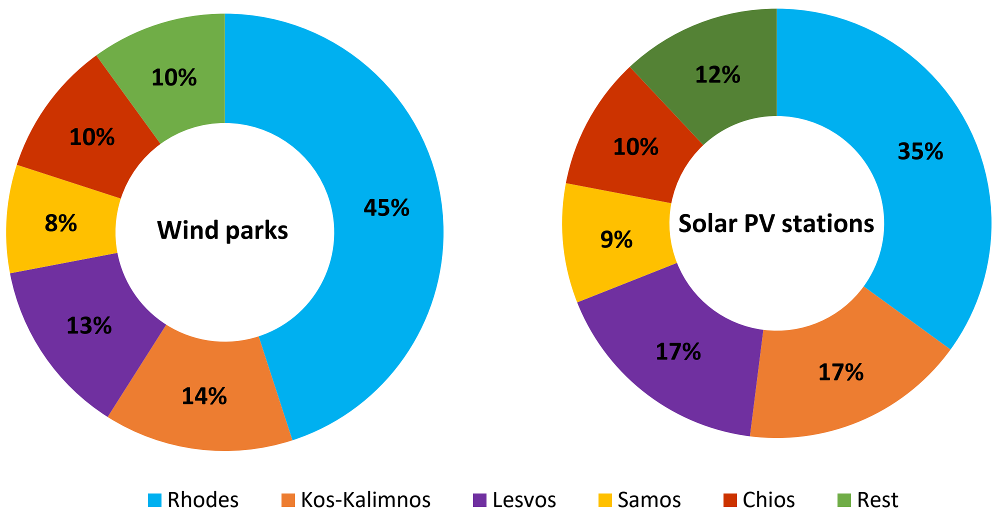
Greece has a rich geothermal potential and an important step for the development of geothermal and the utilization of Greece’s rich geothermal potential was made in May 2021 with the publication of the Geothermal Works Regulation of the Ministry of the Environment and Energy (Government Gazette 1960/B/14-5-2021) issued under the authorization of Article 11 of Law 4602/2019 (A΄ 45). The Regulation contains innovative regulations concerning the conditions and methods of carrying out research, exploitation or management of geothermal potential, as well as any other issue related to rational activity, health and safety and environmental protection, while it applies to every space for which the rights of research, exploitation and management exist in accordance with the applicable legislation, within which the work is carried out.

Following the publication of the new Geothermal Works Regulation, the Ministerial Decision was issued regarding the conditions and procedure for leasing research, exploitation and management rights in geothermal fields of national interest (T>90°C) and non-designated areas (Government Gazette B’ 1460/2022). Corresponding Ministerial Decision for geothermal fields of local interest (90°C > T > 30°C) and areas of geothermal interest is in the final stage of processing.

5.5.7 RES in the NIIs

According to the Information Bulletin of DEDDIE for November 2022 [99], in the Non-Interconnected System of Greece there are 162.46 MW of RES installed, which can be analysed as 108.06 MW of wind farms and 51.45 MW of photovoltaic plants (not including the power of PV Special Programme and Net Metering). The capacity distribution of the 53 wind farms and the 641 photovoltaic plants is presented in Figures below.

Figure 138: Geographical Distribution of Installed RES Capacity in the Non-Interconnected Islands, May 2022



Source: DEDDIE

5.5.8 RAE auctions

RAE considers the auctioning of as much RES capacity as possible in the coming years to be decisive for the achievement of Greece's goals.

According to Decision No. YPEN/DAPEEK/123726/5096 (Government Gazette 6250/B/27.12.2021):

- From 27.12.2021 until 31.12.2022, competitive tendering procedures specific to the following categories will be conducted:

  (a) Photovoltaic plants with an installed capacity greater than or equal to 500 kW and less than or equal to 1 MW that do not belong to Energy Communities of Law 4513/2018 (A΄ 9).

  (b) Photovoltaic plants with an installed capacity of less than 500 kW that do not belong to Energy Communities of Law 4513/2018 (A΄ 9) and do not meet the conditions for exemption from competitive procedures of paragraphs 3a to 3h of Article 7 of Law 4414/ 2016 (A' 149), as well as photovoltaic plants with an installed capacity of less than or equal to 1 MW that belong to Energy Communities of Law 4513/2018 (A' 9) and do not meet the conditions for exemption from competitive procedures of par. 3a to 3h of article 7 of Law 4414/2016 (A' 149).

- From 01.01.2023 to 31.12.2025, competitive bidding procedures specific to the following categories will be conducted:

(a) Wind farms with a maximum output capacity greater than 60 kW and less than or equal to 6 MW.

(b) Photovoltaic plants with an installed capacity of less than or equal to 1 MW.

With the Ministerial Decision YPEN/GD E/66576/5877/2022 (Government Gazette 3522/B/7-7-2022), the installed capacity was determined, by technology or category of electricity generation stations from RES and Cogeneration, which is auctioned through a competitive bidding process, the number of competitive bidding processes per year, the timetable for carrying out the competitive processes and other issues related to the competitive bidding processes.

From the year 2023 onwards, the joint competitive procedures involve stations installed in countries of the European Economic Area with which there is active Cross-Border Energy Trade, in accordance with par. 2 of article 7 of Law 4414/2016. In accordance with RAE Decision No. 691/2022, the final results of the Joint Competitive Tendering Process for RES plants were issued in accordance with Proclamation No. 2/2022.

In addition, RAE Decision No. 606/2022 stipulates that during the third quarter of 2022, a joint competitive bidding process for wind and photovoltaic plants will be carried out, as follows:

Year – Proclamation Quarter)	Type of Competitive Bidding Procedures	Station technologies	Station categories	Total auctioned capacity (MW)
2022-C'	Common	Wind and Solar PV	Wind farms with a maximum capacity of more than 6 MW	1000

5.5.9 Renewable Energy Country Attractiveness Index (RECAI)

Energy security has emerged as a top priority for governments amid geopolitical instability and skyrocketing natural gas prices. As a result, governments around the world are looking for ways to accelerate and expand national RES programmes in order to reduce dependence on energy imports, according to the 59th edition of EY's six-monthly global report, Renewable Energy Country Attractiveness Index (RECAI).

The attractiveness of Greece in terms of investments in RES increased significantly with the country "gaining" three more places in the relative ranking, possessing the 21st place, among 40 other countries - a historically high performance, for the third consecutive edition of the

RECAI index (Table 20). This progress, according to the EY report, is driven by Greece's target to double its installed RES generation capacity, to around 19 GW by 2030, and the recent commissioning of a 204 MW double-sided solar park, one of the largest of its kind in Europe [125].

Table 20: RES Attractiveness Index – RECAI INDEX

Rank	Previous rank	Movement on previous index	Market	Score
1	1	●	US	74.2
2	2	●	China Mainland	71.4
3	5	▲	UK	70.2
4	6	▲	Germany	69.6
5	4	▼	France	69.5
6	7	▲	Australia	69.1
7	3	▼	India	68.6
8	8	●	Japan	66.3
9	10	▲	Spain	64.4
10	11	▲	Netherlands	64.3
11	15	▲	Denmark	62.4
12	14	▲	Ireland	62.3
13	9	▼	Brazil	62.2
14	12	▼	Chile	62.0
15	13	▼	Italy	61.9
16	18	▲	Canada	61.2
17	20	▲	Sweden	59.4
18	17	▼	Israel	59.3
19	22	▲	Poland	59.3
20	16	▼	Morocco	59.2
21	24	▲	Greece	58.9

Source: EY

5.6 Energy Efficiency and Cogeneration

At this time, when Europe is experiencing war again after 77 years since the end of WWII, global energy prices are unusually high and create an unstable and uncertain, political and mainly economic, environment, harming households, industries and entire economies, Energy efficiency and energy demand management play a particularly important role, since they offer immediate opportunities to reduce energy costs and decrease dependence on imported fossil fuels.

In June 2022, the IEA held the 7th Annual World Conference on Energy Efficiency, in Denmark, where delegates, with the participation of an IENE representative, adopted a joint statement stating, among others, "…Energy efficiency policies have proven successful in reducing energy bills, and strengthening consumer protection and energy security. It is also important to achieving global goals of net zero emissions from energy... As part of the clean energy transition, the emphasis on energy efficiency also provides the opportunity to create more jobs, support economic development and industrial production. However, the current scale of energy efficiency action is not sufficient and there is a need to accelerate implementation globally…".

In the Greek energy policy, energy efficiency plays an important role in the new era of the energy transition, as can be seen from the NECP data, which is an ambitious plan but, under certain conditions, the goals it sets can be achieved.

In short, the NECP proposes:

- final energy consumption not to exceed 16.5 Mtoe in 2030,
- primary energy consumption not to exceed 21.0 Mtoe in 2030,
- to achieve cumulative energy savings (buildings and transport) of 7.3 Mtoe in the period 2021-2030,
- building renovations to cover, on an annual basis, 3% of the total heated surface area of central government buildings, by 2030.

Special measures are scheduled for buildings in order to implement an ambitious plan to renovate and improve the energy efficiency of the public building stock, through the participation of Energy Service Companies (ESCOs) and the renewal of buildings at the end of their life cycle.

The "ELEKTRA" programme is designed for public buildings, which was expected to start in late July/August 2022. The announced budget is in the order of €640 million, where €470 million is a loan from the European Investment Bank (EIB) and €140 million is a contribution from the Recovery and Resilience Fund. The government subsidy ranges from 50% to a maximum of 70%, the remaining amount will be covered by own resources or borrowing, where the Deposit and Loans Fund plays an important role.

The difficulties for the successful completion of the programme concern the:

- Energy prices (volatile due to current adverse conditions)
- Continued price increases in materials/machinery required for energy efficiency measures due to high inflation
- Time-consuming procedures for the approval and implementation of the projects,
- Difficulties for government entities to cover the remaining 30% of the budget, which is required.

The "SAVE" Programme

The Ministry of the Environment and Energy is also preparing targeted incentives to promote energy efficiency measures in private buildings as well, by adopting an ambitious strategy for the renovation of the building stock in order to renovate 12%-15% of buildings by 2030, in accordance with the current NECP, also based on its experience from previous programmes over a decade ago, where the "SAVE" programme played an important role. Initially, the programme subsidized single-family houses or apartments in multi-family buildings, while now it also includes the energy upgrade of multi-family houses (2021).

<table>
<tr><th>SAVE
Nº
(Data of the Ministry of the Environment and Energy)</th><th>YEAR</th><th>BENEFICIARIES</th><th>BUDGET (€ million)</th><th>POSITIVE / NEGATIVE (2021)</th></tr>
<tr><td>1</td><td>2011</td><td>8,102</td><td></td><td rowspan="5">Advantages:
- best designed from all the previous ones.
- 20.8% of beneficiaries from low income (€5-10k/year) with a budget of €120 million.
- Creation of an electronic platform for its onsite examination completeness of the application.
Disadvantages:
- Bureaucracy for permits, time contractor selection, etc.
- Problems with electronic platform for electronic building ID (required)
- Significant price increases of materials for EU measures
- Participation is still low in the apartment buildings</td></tr>
<tr><td>2</td><td>2012</td><td>36,971</td><td></td></tr>
<tr><td>3</td><td>2018</td><td>37,305</td><td>502.99</td></tr>
<tr><td>4</td><td>2019</td><td>20,975</td><td>778.01</td></tr>
<tr><td>5</td><td>2020-21</td><td>36,364 (with apartment buildings estimated to reach 50,000)</td><td>632.00</td></tr>
</table>

Summary of the "SAVE" programmes, 2011-2021

Undoubtedly, the “SAVE” programme, upon its completion, will have a significant impact on the reduction of energy consumption in the household sector of the country, which is characterized by high energy intensity, but this is not enough.

The “Recycle-Change Device” Programme

In addition, the “Recycle-Change Device” programme, which is implemented by the Ministry of the Environment and Energy, subsidizes Greek households for the replacement of old electrical appliances with new, environmentally friendly and more energy efficient ones. The programme was announced on June 17, 2022, funding applications opened on June 21, 2022, the application deadline was on July 8, 2022, and the purchase deadline was on September 16, 2022. The total budget of the programme amounts to €148 million, distributed by Region.

Only the following categories of devices participate in the programme:

- Air conditioners – split unit air conditioning units
- Refrigerators
- Freezers

The grant is provided through programme’s vouchers, which can be used when purchasing a new appliance at an electrical retailer and cover a part of the total cost. For each purchase of a new subsidized device, the obligation to provide an old one for recycling that belongs to the same category is simultaneously created.

According to the Application Guide of the “Recycle-Change Device” programme, the final value of each voucher depends on the category of the beneficiary, the characteristics of the corresponding device, as well as its purchase price, and is determined according to the following table:

		Ποσοστό (%) ενίσχυσης επί της λιανικής τιμής πώλησης της συσκευής (όπως προκύπτει κατά τη στιγμή της αγοράς)			
		1η εισοδηματική κατηγορία ωφελούμενου *	2η εισοδηματική κατηγορία ωφελούμενου *	3η εισοδηματική κατηγορία ωφελούμενου *	4η εισοδηματική κατηγορία ωφελούμενου *
		50%	**45%**	**35%**	**30%**
Μέγιστη ονομαστική αξία προ ΦΠΑ κάθε επιταγής (ανώτατο ποσό επιχορήγησης προ ΦΠΑ ανά περίπτωση)	Κλιματισμός | 9.000 Btu/h	274,19 €	246,77 €	191,94 €	164,52 €
	Κλιματισμός | 12.000 Btu/h	322,58 €	290,32 €	225,81 €	193,55 €
	Κλιματισμός | 18.000 Btu/h	459,68 €	413,71 €	321,77 €	275,81 €
	Κλιματισμός | 24.000 Btu/h	572,58 €	515,32 €	400,81 €	343,55 €
	Ψυγεία	342,74 €	308,87 €	240,32 €	205,65 €
	Καταψύκτες	181,45 €	163,71 €	127,42 €	108,87 €

Summary of the financial support of the "Recycle-Change Device" programme

For the calculation of income categories, the average annual income per family member is taken into account. It is noted that the average annual income per family member in some cases is similar with the individual income.

- If the average annual income per family member ≤ €5,000, the beneficiary belongs to the 1st income category.
- If €5,000 < the average annual income per family member ≤ €10,000, the beneficiary belongs to the 2nd income category.
- If €10,000 < the average annual income per family member ≤ €20,000, the beneficiary belongs to the 3rd income category.
- If €20,000 ≤ the average annual income per family member, the beneficiary belongs to the 4th income category.

The programme is expected to have significant benefits, such as:

- saving electricity in the domestic sector and therefore reducing energy costs for the average household.
- improving the balance of energy imports by reducing the degree of dependence on third sources.
- reduction of greenhouse gas emissions.

Industry – Transport

An important role for the promotion of Energy Efficiency is played by both Industry and Transport, where energy consumption is characterized as high and, therefore, there is considerable energy saving potential.

In industry, in 2018, an important programme to improve energy efficiency was launched, by carrying out energy audits, as required by the Energy Efficiency Directive (EED) 2012/27/EU and its amendment of 2018/2002.

The first phase of the energy audits of the obliged companies and/or industries, which started in 2018 and completed in 2021, was carried out in accordance with the provisions of the EED and the Law 4342/2015 and concerns companies with employees greater than 250 people and/or an annual turnover of €50 million or more. The energy audit was carried out by energy auditors certified by the Ministry of the Environment and Energy and is characterized by relative success, since a percentage greater than 60% of the obliged companies/industries received the required certificate of participation in the energy audit and submitting the required data from the energy audit electronically in the related platform of the Ministry of the Environment and Energy. It is noted that companies/industries that implement ISO 50001, which concerns Energy Management, are not required to undergo an energy audit.

The companies/industries that did not take part in the first phase, mainly due to ignorance of the Law or considering that they do not belong to the obliged companies, received a notification letter from the Ministry of the Environment and Energy to complete the energy audit within a period of one month, otherwise the Ministry would impose a fine of several thousand of euros.

In 2022, the second phase of energy audits of all obliged companies/industries began, which will also show the progress achieved in energy efficiency, with the implementation of energy saving measures, which were proposed by the energy audit of the first phase.

A serious disadvantage of the programme is the non-compulsory implementation of all or part of the proposed energy saving measures by the obliged companies and/or industries. It should be emphasized that the mandatory implementation of energy saving measures by the obliged companies and/or industries is not proposed in the EED and, therefore, also in the Greek Law, which integrates the Directive into the Greek legal energy framework.

This disadvantage is likely to have a serious impact on the energy consumption of companies/industries that did not implement the energy saving measures proposed by the energy audit. The energy crisis we are experiencing today is likely to change this behavior of companies, which is expected to be seen in the second phase of the audits.

With regard to transport, in direct connection with the objectives of the NECP, the National Recovery and Resilience Plan, recently announced by the Greek government, and in particular Axis 1.3, promotes a "green" and sustainable transport system for Greece, with the transition in electrification to be a strategic choice for the country.

Thus, the National Recovery and Resilience Plan promotes:

- The strengthening of the penetration of electric vehicles in order to reduce CO2 emissions and improve the footprint of the transport sector,
- The development of the necessary charging infrastructure to strengthen electric mobility throughout the country. Overall, the installation of charging points in urban and suburban areas is foreseen, which is a prerequisite for achieving the goals of the NECP for electrification.

More specifically:

- Under this programme, the creation of charging stations for electric vehicles throughout Greece is subsidized, initially at airports, national roads, vehicle service stations, gas stations, etc.
- The replacement of part of the urban transport fleet in Athens and Thessaloniki with electric buses is promoted and the replacement of old polluting taxis with electric ones is also subsidised.
- The strengthening of investments to reduce the CO2 footprint in passenger shipping is promoted.

Finally, an important point of the above programme is the creation of new or upgrading of existing industrial units using state-of-the-art green technology, with mandatory operation of a research and development department for the promotion of innovative products and services as well as the strengthening of the new CO2 collection technology and its storage.

IENE recognizes the value of early action to promote energy efficiency in all sectors of the economy in order to achieve the net zero energy goals by 2050, which requires the implementation of coordinated actions and policy.

6. Recent Developments in the Legislative and Regulatory Framework of the Energy Market in Greece

6.1 The Electricity Market Model

Since November 2020, the wholesale electricity market in Greece has changed, from its previous model (i.e. the Mandatory Pool) to its organization based on the European Target Model, as formulated by the Agency for the Cooperation of Energy Regulators (ACER). The aim of the new model - which consists of the following markets for wholesale electricity products: the Day Ahead Market, the Intra-Day Market and the Balancing Market - is the unified configuration and operation of electricity markets at pan-European level, a goal that is estimated to facilitate cross-border trade in electricity at regional level.

In particular, the Target Model, according to which the domestic wholesale electricity market is organized, includes all the rules and provisions for the creation of an internal European electricity market that promotes cross-border trade, produces economic results and serves the best use of interconnections to ensure the uninterrupted energy transit. Through this system of rules, electricity flows freely between EU Member States, meeting its needs at the lowest possible cost.

Among others, the key features of the European Target Model are:

- The development of a common capacity calculation methodology, giving the competent authorities the possibility to review the volume of annual capacity rights. The two alternative methodologies allowed in this context are (a) the method of available transfer capacity and (b) the method based on the flows of the networks.
- The development of a framework for the granting of long-term transmission rights on electricity interconnections between Member States.
- The coupling of individual national day-ahead markets through implicit auctions. In these, energy flows are calculated taking into account interconnection capacity and price, so that prices outside the border converge when there is sufficient cross-border capacity. In this context, the designed price coupling mechanism leads with its application to the maximization of the overall performance of the markets, shaping electricity flows, from lower to higher price.
- The implementation of continuous intraday trading through a single European platform for intraday markets in order to share the capacity of interconnections

and to better manage the cost of discrepancies between production and demand.

- The electricity balancing, which includes three main elements: (a) the assurance of reserves, (b) the activation of balancing energy and (c) the settlement of the imbalance of energy balances.
- The European Target Model promotes to a greater extent the sharing of balancing resources, among the Transmission System Operators, who should have harmonized the balancing products and those of the reserves, taking into account local specificities and any technical weaknesses.

Important benefits for the market stemming from the adoption of the model are, among others, the better management of energy produced by RES, due to their stochasticity, the development of conditions to strengthen competition within the market, the contribution to security of supply, as well as the promotion of interconnection upgrade projects.

6.2 The Electricity Market Framework

The Markets of the Target Model

The restructuring of the domestic wholesale market, according to the European Target Model, is based on **Law 4512/2018** on the arrangements for the implementation of the Structural Reforms of the Economic Adjustment Programme and other provisions. Through its provisions, and in particular from Section A, Part C, Chapters A and B thereof, the Hellenic Energy Exchange (No. 96) is initially established which manages the Derivatives Market - Forward Market, where any energy financial instruments are under negotiation. The market in question allows participants to conclude electricity purchase and sale contracts, with a physical delivery obligation, as will be defined in the relevant market code, and to trade energy financial instruments.

At the same time, with Article 74 of the aforementioned law, the set of individual energy markets, within the new form of the wholesale market, is defined as follows:

Day ahead Market

The electricity market, in which electricity purchase and sale transactions are carried out with the obligation of physical delivery on the following day (Physical Delivery Fulfillment Day) and in which the transactions carried out on energy financial instruments with physical delivery are declared.

Intraday Market

The electricity market, in which electricity purchase and sale transactions are carried out with a physical delivery obligation, after the expiry of the deadline for submitting trading orders in the Next Day Market and concern the Day of Fulfillment of Physical Delivery.

Balancing Market

The electricity market, which includes the Balancing Power and Balancing Energy Markets and the imbalance clearing process.

- *Balancing Power Market:*
  The market in which power is offered to cover the reserve requirements of the dystem which (power) is maintained by the participants for a predetermined period of time.

- *Balancing Energy Market:*
  The market in which the participants offer electricity used by the Operator of the National Electricity Transmission System in order to maintain the frequency of the system in a predetermined range, as well as the balance of electricity production and demand, in compliance with the electricity exchange programmes with neighboring countries

At the same time, the same provision defines who has the right to participate in the markets of the new model, where natural or legal persons who have the right to trade in one or more energy markets are counted as participants. In fact, these persons include both self-supplied customers and cumulative representation agencies.

Finally, it is noted that the management of the operation of the Day Ahead, Intraday and Forward (Financial) Markets is assigned to the Hellenic Energy Exchange, as a successor to LAGIE, which was designated as the Nominated Electricity Market Operator (NEMO) for the coupling of the day-ahead and intraday electricity market, according to the Ministerial Decision APEIL/G/Φ1/ok.184866 Gazette B 2678 2015): Definition of LAGIE S.A. as "Electricity Market Operator", art.4 Regulation (EU) 2015/1222. At the same time, the Balancing Market is the responsibility of IPTO.

At the European level

Overall, at the European level, the European Target Model is based on Framework Guidelines issued by ACER and Network Codes issued by the European Network of Electricity Transmission System Operators (ENTSO-E) and then approved by the European Commission, with the aim of having harmonized rules for both cross-border exchanges of electricity and for the operation of wholesale electricity markets. These network codes are divided into "Market", "Operation" and "Connection", and are part of the effort to integrate the internal energy market and, by extension, to achieve the energy goals of the European Union.

The aforementioned purchase codes include:

- Regulation (EU) 2015/1222 - Establishes detailed guidelines on cross-zonal capacity allocation and congestion management in the day-ahead and intraday market
- Regulation (EU) 2016/1719 - Establishes detailed rules for cross-zonal capacity allocation in futures markets
- Regulation (EU) 2017/2195 - Establishes harmonized rules applicable to electricity balancing

These functioning codes include:

- Regulation (EU) 2017/1485 - Defines the guidelines for the operation of the electricity transmission system
- Regulation (EU) 2017/2196 - Defines the emergency and restoration procedures related to the electricity system

Finally, the aforementioned link codes include:

- Regulation (EU) 2016/631 - Defines the requirements for the connection of power generators to the grid
- Regulation (EU) 2016/1388 - Defines the rules for the prudence of demand installations and distribution systems with the network
- Regulation (EU) 2016/1447 - Defines the requirements for the grid connection of high voltage direct current systems and direct current connected power park units.

Individual Balancing Market Arrangements

Apart from the above, the Balancing Market, which is governed by EU Regulation 2017/2195 and the corresponding national legislation - in particular Laws 4001/2011 and 4425/2016, as amended and are now in force - includes the Power Market Balancing, the Balancing Energy Market and the Clearing of Discrepancies. Therefore, since this market is in the responsibility of IPTO, its operation is mainly governed by the Balancing Market Regulation, as it is constantly updated and defines the rules and procedures for its effective operation.

Through this Regulation, the last update of which took place in March 2022, they are defined, among others, those who have the right to participate in this market, the rules and conditions for their participation, the rules for validating Energy and Balancing Power Offers by the Operator, the sanctions for participants, in case of non-compliance with the provisions of the Regulation, the Balancing Market Clearing process, the process of exchanging information with the other involved bodies, as well as procedures for protecting commercially sensitive information (The latest Amendment to the Balancing Market Regulation (B΄ 4516/2020): Resolution RAE 185/2022, Official Gazette B' 985, 4.3.2022).

Redesigning the European Electricity Market

The IENE Special Report "European Electricity Market Reform and Decoupling of Electricity and Natural Gas Prices" [126], which was completed in March 2023, highlights the Commission's revisions to electricity market planning and the trend towards decoupling of wholesale electricity and natural gas prices following interventions by several European governments to impose price caps.

The Special Report refers to the dramatic increase in electricity prices across the EU over the past 18 months, which has highlighted the weaknesses of the existing system, which is heavily influenced by the prices of a strategic fuel, natural gas, which, after the invasion of Russia in Ukraine, moved to particularly high levels.

The existing model of operation of the European and domestic wholesale electricity markets, known as the "Target Model", has as its ultimate goal the creation of a single European electricity market, without restrictions on transactions, by strengthening competition and shaping better prices for consumers.

In addition, the policies followed contributed to the large penetration of natural gas into electricity, "decommissioning" coal units and especially lignite-fired ones. It should be noted that almost three decades ago when the electricity market was designed, the penetration of RES and natural gas was insignificant. Therefore, it is necessary to adapt to the new conditions, where there is now a significant and increasing penetration of RES in the electricity generation mix of the countries.

Also, the energy crisis has highlighted the need to decouple electricity prices from rising natural gas prices and to adopt a new market model that distinguishes between energy resources that are used when they are available and not on-demand, but also on-demand energy resources, based on their respective contribution to the electricity mix. This could ensure, according to estimates, about 50% of lower electricity prices, given that on-demand energy resources (such as natural gas, nuclear and coal) have a 60% share of the electricity mix, a share that will continue to decline as the energy transition accelerates.

As electricity prices in Europe continue to move at high levels, the European Commission considers that the current design of the electricity market does not fully serve the needs of the market and does not ensure competitive prices for consumers.

In this context, the EU is proceeding with the design of a "deep and comprehensive" reform of the existing electricity market in order to deal with the energy crisis, which has worsened further after Russia's war in Ukraine. The measures include a cap on electricity producers' profits that would save €140 billion and bring lower prices to consumers [126].

On March 14, 2023, the European Commission submitted Regulation Proposals "to amend regulations (EU) 2019/943 and (EU) 2019/942, as well as Directives (EU) 2018/2001 and (EU) 2019/944, with the aim of improving the design of the EU electricity market"[40] as well as "for the amendment of regulations (EU) no. 1227/2011 and (EU) 2019/942 in order to improve the protection of the EU against the manipulation of the wholesale energy market"[41].

The reform proposed by the Commission provides revisions of various pieces of EU legislation — notably the Electricity Regulation, the Electricity Directive and the Regulation on Wholesale Energy Market Integrity and Transparency (REMIT). It introduces measures that incentivize long-term contracts for electricity generation from non-fossil fuels and introduce more clean flexible solutions to the system to compete with gas, such as demand response and storage.

6.3 Recent Legislative Regulations/Interventions in the Greek Energy Market

(I) Maximum Energy Prices

Moreover, in the shadow of the ongoing energy crisis that the Member States of the European Union have to face - as it started after the outbreak of the Covid-19 pandemic and intensified with the start of the war in Ukraine and the growing need for the Union's independence from energy products of Russia - particularly high prices have been recorded on the energy market for months. This leads to the need to take measures by the individual state mechanisms in order to deal with the situation in the best possible way. Therefore, in Greece, a regulation was recently filed to impose a cap on wholesale electricity prices that aims to suspend the adjustment clause in electricity tariffs and return prices to last autumn's level.

In particular, this recent regulation was included in the draft law for the "Modernization of the licensing process for Renewable Energy Sources - Phase B, Licensing of electricity production and storage, framework for the development of Pilot Marine Floating Photovoltaic Plants and more specific provisions for energy and environmental protection" and provides that electricity producers will be compensated with administratively determined prices which will be set by the following ministerial decision. This will determine

[40] https://eur-lex.europa.eu/legal-content/EL/TXT/PDF/?uri=CELEX:52023PC0148&from=EN
[41] https://eur-lex.europa.eu/legal-content/EL/TXT/PDF/?uri=CELEX:52023PC0147&from=EN

the formula for determining the maximum price for each category of power generation units, taking into account where necessary the price variation due to carbon dioxide emissions.

In addition, the new regulation foresees the start of the emergency mechanism on August 1, 2022 with a one-year duration, while it stipulates that the difference between the maximum prices and those set on the Stock Exchange will be transferred to the Energy Transition Fund to finance the reduction of tariffs. Finally, it includes the changes that energy suppliers will have to apply to end consumers in relation to the formulation of supply tariffs.

(II) Domestic Electricity Market

The IENE Special Report "European Electricity Market Reform and Decoupling of Electricity and Natural Gas Prices" presents the new model for Greece's electricity market, with the aim of containing the rising prices caused by the energy crisis, which came into force on 1 July 2022 with the introduction, as a first step, of price caps in the wholesale market; for electricity producers of all categories.

In particular, the price for hydropower installations was set at €112/MWh, for RES at €85/MWh, for natural gas power plants at €253.98/MWh and for lignite plants at €206.71/MWh. These caps remained in effect for the first month, starting on July 1, 2022. The revenue generated from the difference between these caps and the average day-ahead market price was transferred to the Energy Transition Fund for the coverage of the subsidy.

The calculations for the final price of electricity per KWh, after subtracting the subsidies, is based on the new PPC price list. The government, guided by PPC's new price list, sets a single price for all suppliers, while PPC's dominance sets a standard for the entire market.

Greece's model, active since last July, is thought to be more efficient than the model implemented by the Iberian Peninsula countries and therefore more suitable for use across the EU. The Greek intermediate mechanism sets compensation caps per electricity generation technology, while the electricity exchange market remains intact to operate normally based on the Marginal System Price.

The main features of the Greek model are summarized in Table 21. The revenues recovered are used to subsidize the electricity bills of households and businesses, through the Energy Transition Fund, which is managed by DAPEEP.

Table 21: Basic Characteristics of the Greek Electricity Model

Reintroduction of cost-plus price regulation for all electricity generators. Regulated prices differ per technology and revenues used to provide financial support to energy consumers	
Policy objective	To re-regulate all electricity generators and pay them on a cost-plus basis instead of on the basis of the market price for electricity
Impact on consumer prices	The measure would not reduce the day-ahead wholesale market price. The regulation would intervene ex-post. Generated revenues can be used to provide direct relief to energy consumers most suffering from the high prices (e.g., through vouchers to households, and financial support to businesses).
Impact on gas consumption	No increase is expected in gas consumption.
Impact on integrity of the Single Market and impact on security of electricity security	The measure would have a strong impact on the functioning of the internal market as it would remove any price-based competition between generators. As all generators would be regulated based on their costs, also inefficient cost structures would be paid for.
Suitability for swift implementation	Very challenging. To revert to the cost-plus regulation national regulators needs very detailed information about the different plants. This information is in many cases not available and cannot be obtained in short delay.
Budgetary cost	No direct budgetary costs.
Risk of subsidised electricity exports outside the EU	The measure is unlikely to trigger increased exports to third countries.
Impact on decarbonisation	The measure is likely to significantly impact investor certainty, which may mean support may be needed for all future electricity generation. This regulatory risk will be reflected in higher costs of capital and lower renewables deployment in future. The risk is particularly high when all revenues above the costs are clawed-back as it is the case here. The measure is likely to disincentivize the conclusion of long-term PPAs and national hedging strategies.
Conclusion	**This option should not be recommended given that it would entirely remove price-based competition between different generation technologies, remunerate generators for inefficient operations and disincentivize investments in new more cost-effective technologies.**

Source: Euractiv

The IENE Special Report “European Electricity Market Reform and Decoupling of Electricity and Natural Gas Prices” [126] points out that since last July major interventions in the domestic electricity market have been recorded in Greece, which are summarized as follows:

- In the wholesale market, a price cap per electricity generation technology has been introduced from July 2022.
- In the retail market, electricity suppliers are obliged from August 2022 to offer fixed monthly tariffs for customers and publish them on the 20th of the previous month. Throughout the duration of this measure, customers can switch suppliers without any early exit penalty.
- From November 1, 2022, an additional levy of €10/MWh has been imposed on the quantities of natural gas used for the production of electricity.
- The combination of the above measures and interventions by the state has led to a normalization of the operating conditions of the market, as can also be seen from the lower prices that have been established at the consumer level.

(III) RES

On July 30, 2022, Law 4964/2022 (Government Gazette 15A/30.07.2022) was published on the subject "Provisions for the simplification of environmental licensing, establishing a framework for the development of Offshore Wind Farms, dealing with the energy crisis, environmental protection and others provisions". This law is a key milestone for the start of the development and operation of offshore wind farms, which are part of the general framework for the greater energy autonomy of the country and, at the same time, independence from fossil fuels. The new provisions cover, among others, the following:

- With a Joint Ministerial Decision, the National Offshore Wind Farm Development Programme will be approved, which will outline in which sea areas of the country the development of Offshore Wind Farms is possible.
- With the issuance of a relevant Presidential Decree, one or more Organized Development Areas of Offshore Wind Farms will be demarcated, which are parts of the sea areas included in the ational Offshore Wind Farm Development Programme, and the conditions for the development of Offshore Wind Farms will also be defined.
- With a decision of the Entity responsible for Offshore Wind Farms, which will be issued within two months of the publication of the Presidential Decree delimiting the Organized Development Areas of Offshore Wind Farms, the process of granting related research permits within the demarcated Organized Development Areas of Offshore Wind Farms will begin. Research Licenses will be granted to interested parties who will meet specific technical and financial criteria and will also submit a relevant letter of guarantee.
- The holders of the Research Permits will have the possibility to prepare all the necessary measurements and studies within the Organized Development Areas of Offshore Wind Farms for which they received the relevant Research Permit and at the same time participate in the competitive bidding process for the possibility of installing a wind farm and receiving operational support.
- After approximately 2.5 years from the granting of the Research Permits, separate installation areas will be defined by Ministerial Decision, within the Organized Development Areas of Offshore Wind Farms, as well as an assessment of the maximum capacity of Offshore Wind Farms that can be installed in each of them.
- The RAE will then announce a competitive tendering process for the granting of operational support to the Offshore Wind Farms projects that will be developed within these Installation Areas.

- Each participant in the tender will submit separate bids for each Installation Area, located within the Organized Development Areas of Offshore Wind Farms that has received a Research Permit and for which it wishes to install an Offshore Wind Farm project.
- For the selection of the investor of the Offshore Wind Farm and the granting of operational aid, the criterion will be the lowest bid price in euros per megawatt hour, for the compensation of the energy produced by the Offshore Wind Farms project developed within the specific Installation Area.
- The participant, who will be selected through the competitive bidding process for a specific Installation Area, will have the exclusive right to license, develop and operate the Offshore Wind Farm project within the Installation Area [127].

(IV) Hydrocarbon Exploration Activities, New Responsibility of HHRM

The Hellenic Hydrocarbon Resources Management (HHRM) was founded in 2011 (Law 4001/2011 Chapter B) and is based in Athens. It is a state-owned company with the Greek State as the sole shareholder (100%), which operates independently as a private sector economic entity with a mandate to represent national interests in the upstream field [128].

Law 4409/2016 has transposed Directive 2013/30/EU into Greek law. This law imposes on operators the obligation to ensure that all necessary measures are taken for the prevention of serious accidents in offshore hydrocarbon operations. Operators are also liable for their contractors' actions or omissions which led or contributed to major accidents.

Licenses granted or transferred under Law 2289/1995 are issued on the basis of the applicant's ability to meet the requirements for operations within the framework of Law 4409/2016. When assessing the technical and financial ability of the applicant for a license, account shall be taken of the following: (i) the risk, the hazards and any other relevant information relating to the licensed area concerned; (ii) the particular stage of offshore oil and gas operations; (iii) the applicant's financial capabilities; and (iv) the available information relating to the safety and environmental performance of the applicant.

HHRM shall grant the license only upon evidence from the applicant that the latter has made or will make adequate provisions to cover liabilities potentially deriving from the applicant's offshore oil and gas operations. When assessing the technical and financial capabilities of an applicant for a license, special attention shall be paid to any environmentally sensitive marine and coastal environments [129].

7. The Energy Market in SE Europe and the Role of Greece

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 SE European region consists of Albania, Kosovo, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, North Macedonia, Greece, Hungary, Montenegro, Romania, Serbia, Slovenia, Turkey and Israel. The geopolitical position of SE Europe is unique as it can be seen 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 export potential.

Map 25: The SE European Region

Source: IENE

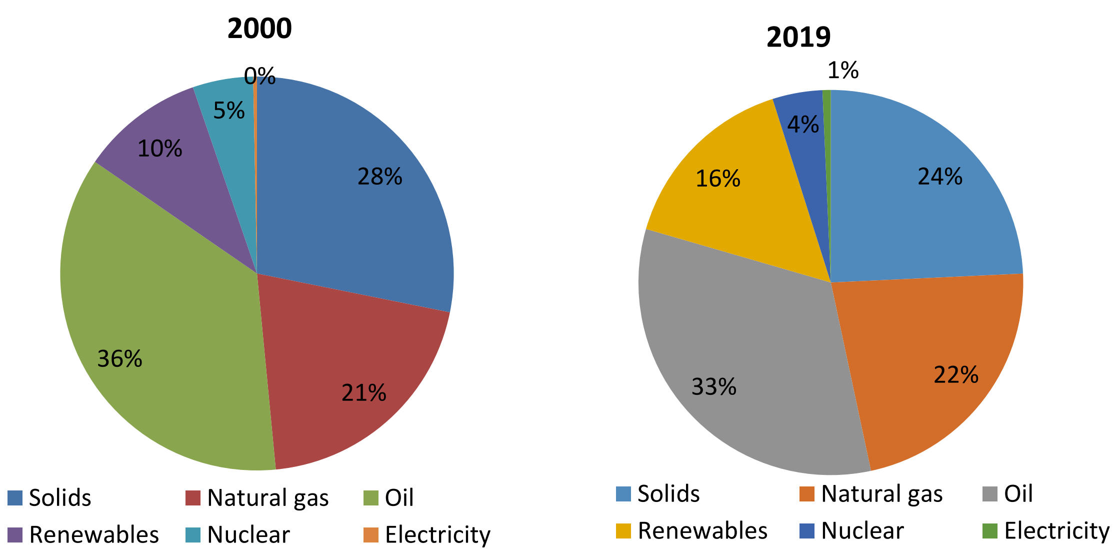
IENE focuses on the study of the energy sector of SE Europe and therefore completed in April 2022 its major reference study, “SEE Energy Outlook 2021/2022” [130], which covers the current status of the energy sector and the outlook from now to 2040, analyzing trends in the current environment of economic and geopolitical realignments and uncertainty regarding the security of critical energy resources and focusing on recent developments in SE Europe.

According to this study, although the economies of the SE European region appear widely differentiated in terms of structure and level of development, they share certain challenges, which seem to be common to all. Among them, the global economic and financial crisis (2008/2009), the impact of the coronavirus pandemic as well as the Russia-Ukraine war that have profoundly affected the region collectively and each country individually.

Today, energy policy formulation and decision-making in SE Europe faces enormous challenges for various reasons, but mainly for issues related to geography and energy security, the existence of abundant but largely unexplored domestic energy resources, diverse demographics elements, with the large disparities that exist in the economies of the various countries and due to the EU requirements, both to the Member States and to the Contracting Parties of the Energy Community, for decarbonisation commitments.

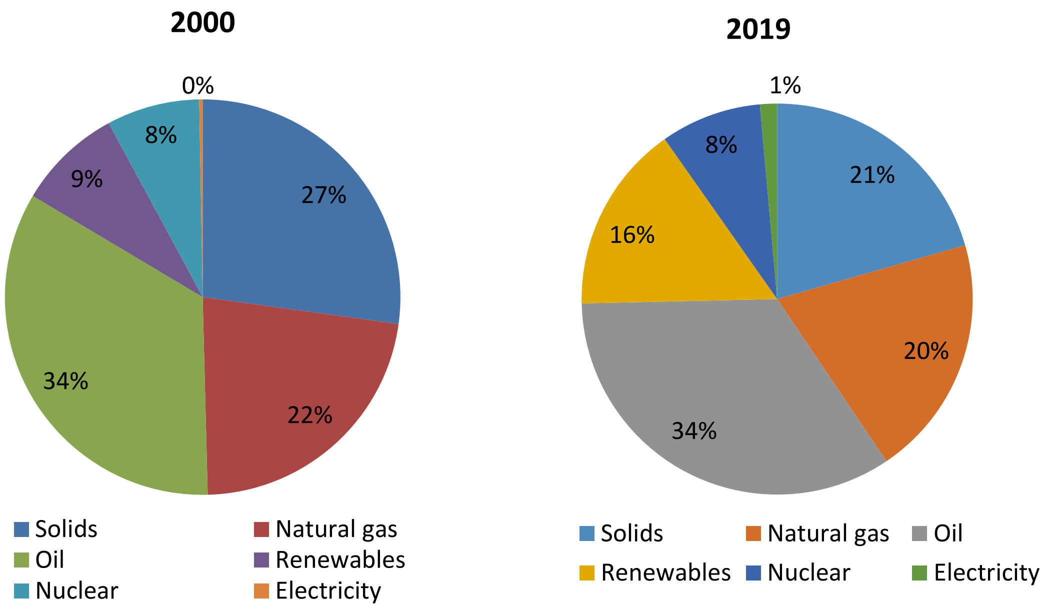
Looking at the broader energy map of SE Europe, the change in the regional energy mix between 2000 and 2019 is obvious, which despite the huge increase in RES and the large contribution of natural gas remains dependent to high solid fuel consumption and significant oil imports. In addition, there is less use of solid fuels, but the decline is not as great as expected to promote the EU's decarbonisation 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 139: Gross Inland Consumption (%) in SE Europe, including Turkey, 2000 and 2019



Sources: Eurostat, IENE

Figure 140: Gross Inland Consumption (%) in SE Europe, without Turkey, 2000 and 2019



Sources: Eurostat, IENE

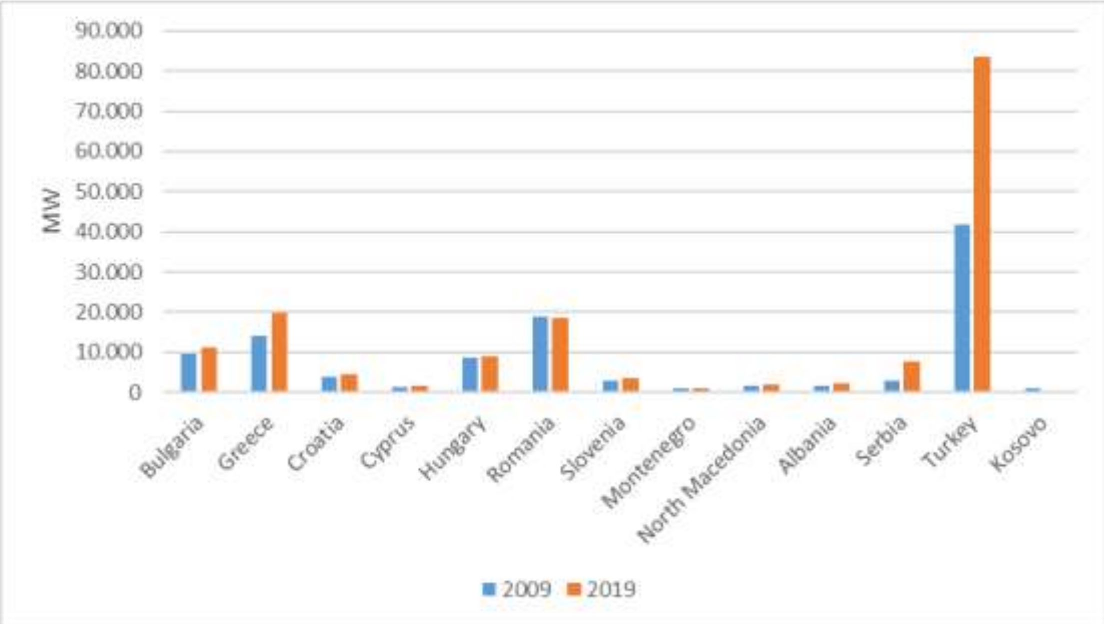
SE Europe is characterized by high dependence on oil and natural gas imports with the region being 87% dependent on oil imports, while in the case of natural gas the dependence reaches 88%. This high dependence on hydrocarbon imports is leading many countries to look for domestic sources of hydrocarbons and this has already led to increased exploration activities and new discoveries particularly in Romania, Albania, Croatia, Cyprus, Israel and Turkey (Black Sea). It seems likely that oil and gas production at the SE European level will increase by 2025, thereby reducing import dependence to some extent.

In addition, the “SEE Energy Outlook 2021/2022” study defines the concept of the Expanded South Corridor for natural gas to include all major natural gas pipelines, LNG regasification terminals and underground gas storage facilities. This Expanded South Corridor will provide the necessary background for the operation of regional gas trading hubs that are currently developing rapidly and are directly linked to similar gas hubs that operate today in various European countries.

Furthermore, nuclear power, although contributing only 4.0% of total gross inland consumption in SE Europe (including Turkey) and 8% without Turkey, 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 to reduce carbon emissions. In view of current plans in Romania, Bulgaria, Hungary and Turkey to expand the installed nuclear capacity, nuclear power is expected to play a critical role in boosting electricity generation and meeting much larger electricity loads in SE Europe over the next decade.

The electricity sector and its further expansion form the backbone of the region's economic and energy development. With approximately 165 GW of total installed capacity for power generation in 2019, the region's electricity system appears to be adequately supplied. However, this is not entirely true as there are significant differences between the installed capacity of different countries, as shown in Figure 141.

Figure 141: Total Installed Capacity for Electricity Generation in SE Europe, 2009 and 2019



Sources: Eurostat, IENE

Regarding the security of energy supply, the SE European region as a whole appears to be more vulnerable than the rest of Europe (mainly the countries of Western Europe). This is due to the limited supply options, 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 SE Europe can be enhanced by implementing a wider plan (already underway) to improve interconnections for both electricity and natural gas across the region and also by further diversifying energy mix of the various countries. In recent times, and based on recent experience, the number of energy security risks in SE Europe has expanded to include risks from natural disasters (i.e. earthquakes, floods, storms) as well as terrorist threats.

Many large cross-border energy projects are under development in the region, including natural gas pipelines, electricity interconnections, RES installations (e.g. wind farms, photovoltaic plants, geothermal plants, biomass plants) and interventions in the residential sector through energy efficiency improvement programmes.

A key conclusion of the "SEE Energy Outlook 2021/2022" study in the field of investment is that the prospects in the energy sector in all the countries of the region are absolutely positive for the next decade, especially in the four major countries (Turkey, Bulgaria, Romania and Greece) with the Eastern Balkans to be ahead of the Western ones. There appears to be a significant improvement in expected and planned projects and related investments between now and 2030. Compared to the IENE projections made in 2017 for the period 2016-2025, the total estimated energy investments for the period 2021-2031 in the region appear much higher at €483.7 billion which is 25% higher compared to 2017 estimates when the corresponding investments for the original group of 13 countries (as shown in the 2017 Outlook) estimated at €387 billion. This is a huge improvement compared to 5 years ago and clearly highlights the much increased interest and will for energy investment in SE Europe. For more analysis of the energy sectors of the SE European region, see the "SEE Energy Outlook 2021/2022" study [130].

Greece in SE Europe

The energy crisis[42], which mainly affected Europe and intensified after the Russian invasion of Ukraine (February 2022), and was characterized by supply disruptions and very high prices of natural gas and electricity, once again brought Greece to the fore, which thanks to the organization and structure of its energy system and the synergies it has developed with all neighboring countries, played a key role in ensuring the energy supply of the wider region. A typical example is Bulgaria which, thanks to Greece's support in supplying it with natural gas, last April cut off the supply of gas from Russia's Gazprom, after first securing gas from Greece through reverse flow in the Sidirokastro interconnection. Today, Greece has also zero Russian gas imports, having reliable alternative suppliers.

Greece's natural gas export activity was further boosted following the inauguration of the Greek-Bulgarian interconnector pipeline, known as the IGB, on October 1, 2022. This pipeline that follows a vertical route as part of the "Expanded South Corridor" (on the axis Komotini - Stara Zagora), connects the national gas system of Greece with that of Bulgaria, with the latter being able to supply additional quantities of gas through the TAP, which crosses all of Northern Greece and through Albania ends up in Southern Italy.

[42] Stambolis, C. (2022), «Greece's position in the energy landscape is being strengthened», https://www.kathimerini.gr/economy/561904603/enischyetai-i-thesi-tis-elladas-sto-energeiako-topio/

The concept of the "Expanded South Corridor" includes all construction projects of large natural gas pipelines, LNG regasification terminals, as well as underground gas storage facilities, which will supply the system with quantities of natural gas to the countries of SE Europe and which will then be directed to the main European markets.

Map 26: The Expanded South Corridor

Source: IENE

It should be noted that Greece started natural gas exports to Bulgaria three years ago in response to an emergency situation (February 2020), while the exports continued in the following period with Bulgarian companies taking advantage of the LNG supply possibilities offered by Greece. With the LNG terminal in Revithoussa having played a vital role in the emergence of Greece as a key supplier of gas to the region, especially after the expansion and upgrade of the terminal in 2018, now having a capacity of 225,000 cubic meters and a gasification capacity of 1,400 m3/h. In fact, the terminal has been recently further upgraded in terms of capacity with the addition of a large floating tank with a capacity of 140,000 m3 and thus can accommodate around 80-90 LNG unloadings per year.

Thanks to the significant storage and gasification capabilities offered by the Revithoussa LNG terminal and the two interconnections with Bulgaria (Sidirokastro and IGB), Greece exported last year sufficient quantities of gas to the neighboring countries. These reached almost 3.0 bcma corresponding to 35.0% of Greece's total gas deliveries in 2022 exceeding 8.5 bcma. With the full operation of the IGB, the upgrade of Sidirokastro thanks to the reverse flow, the new pipeline between Greece and North Macedonia (2025) and the addition of two new

FSRUs (i.e. Alexandroupolis and Agioi Theodoroi) in 2023/2024, Greece is further strengthening its position and aspires to become a key supplier of gas to the Balkans. In this direction, the operation of the Vertical Corridor, which is a continuation of the IGB, is expected to contribute, and with the partnership of Bulgaria, Romania, Serbia and Hungary, it will be operational after 2024.

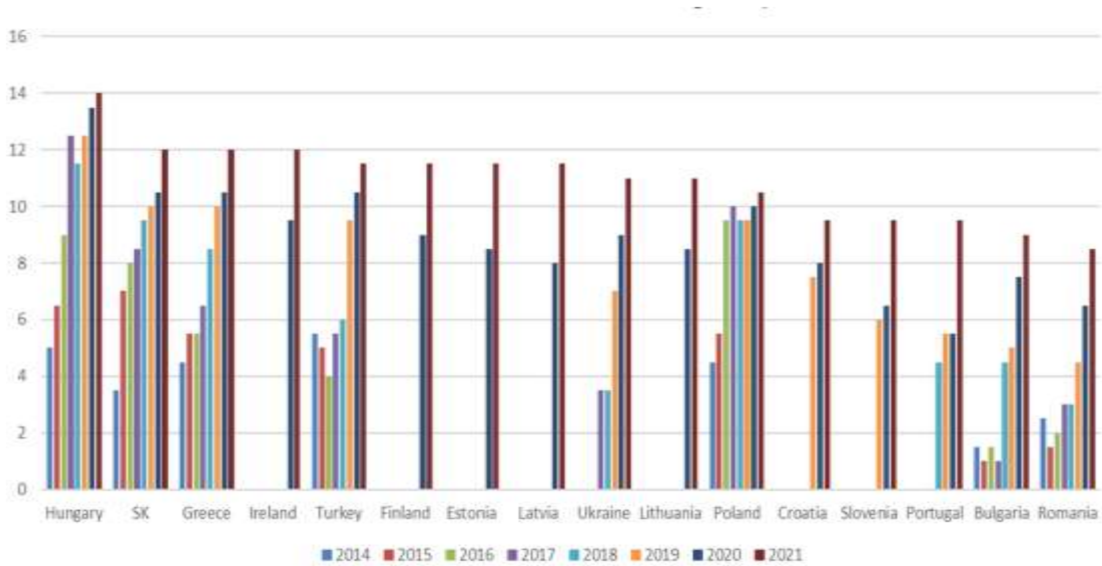
The picture of the energy market and the dominant role of Greece in the region would not be complete if we did not refer to the vital role played by the two large refining groups, HELLENiQ ENERGY and Motor Oil. They both had a refining production of 27 million tons in 2021, while they exported 23 million tons of petroleum products in the same year. In terms of the production of refined petroleum products per inhabitant, Greece holds the first place in 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 upgrading and modernization of the two groups in the period (2006-2012), which allowed the enormous increase in production and exports at competitive prices.

Greece, although in the southernmost part of the Aimos peninsula, is today an energy pillar of the entire Balkan region and beyond, supplying significant quantities of refined petroleum products to Cyprus, Bulgaria, Serbia, Montenegro, North Macedonia and Turkey which reach almost 60% of the total production of the two large refining groups. With an already strong oil footprint in SE Europe, the Greek oil companies are planning to further upgrade their presence with HELLENiQ ENERGY being in negotiations for the reactivation of the Thessaloniki-Skopje oil pipeline, while there are also negotiations for the construction of a new oil pipeline from Alexandroupolis to Burgas (Bulgaria).

The cross-border electricity trade between Greece and the neighboring countries has recently been strengthened thanks to the international electricity interconnections that have been created and operate successfully with Italy, Albania, North Macedonia, Bulgaria, Turkey, as well as new ones that are under development. Greece’s position in international electricity interconnections is to be further strengthened in the coming period through the operation of the EuraAsia Interconnector, with 1.0 GW in the first phase of electricity interconnection with Cyprus and Israel (2025/2026), 3 GW with Egypt (2026) and perhaps 3.0 GW with Croatia (2027/2028). Although Greece was a net importer in the cross-border electricity trade in 2022, the necessary infrastructure is now in place, and new one is being created, which will allow much greater electricity exports to the surrounding countries once we can fully utilize our domestic energy sources, from natural gas and RES.

In our broader view of the strengthening of Greece's strategic role in the energy sector of SE Europe, the fact of the emergence of the Hellenic Energy Exchange within a very short period of time (launched on November 1, 2020) is of no small importance acting as a key energy hub of the wider region due to the increasing volume of contracts, mainly electricity, which are being processed on a daily basis. In addition, on March 21, 2022, the natural gas trading platform started operating, which in practice is the most recent gas trading hub in Europe. Due to the completeness of its specifications (since it follows the European design), the increased gas liquidity that the domestic market has meanwhile acquired and its transparency, the European Federation of Energy Traders (EFET) ranks it far ahead of the corresponding gas hubs operating today in the region, excluding Istanbul.

Figure 142: Gas Hub Benchmarking Study



Source: European Federation of Energy Traders (EFET)

In parallel, with the development of conventional energy sources, in the last 10 years or more, Greece has made significant steps in the promotion of RES, where it has one of the largest total installed capacity at almost 13.0 GW, including large hydropower plants and participation in 58% of the country's total installed capacity. Essentially, it ranks second in the region after Turkey, which due to its size, state aid and domestic industry activity has diversified its RES sector with a total RES capacity reaching 47.0 GW. However, Greece maintains a primary position in the production and exports of solar thermal systems (solar water heaters), as well as in assignments for the construction of RES projects outside Greece with large companies acting as EPC contractors.

It is estimated that after the new legislative regulations (Climate Law, etc.) the growth rate of both RES applications and energy efficiency, especially in buildings, will accelerate, thus contributing to the growth of investments. Finally, Greece's energy investments are moving at not inconsiderable levels until the end of the current decade, where based on the recent major IENE study, “SEE Energy Outlook 2021/2022”, these are estimated at €44.4 billion, while for the entire region of SE Europe, these reach €372.3 billion, i.e. increased by 58.6% compared to similar IENE estimates for 2017. A fact that proves the ever-increasing interest in the development of infrastructure and the energy market in general in the area.

In conclusion, the big stake for our country in terms of its energy position in SE Europe is not so much to become what many call an “energy hub” and imply the concentration of energy infrastructure and energy corridors - since the dominant energy hub in the region is unquestionably Turkey -, but the strengthening of its geopolitical and economic position in every way and means. Infrastructure certainly helps in this direction, but it cannot be the only goal. Dominance at the level of economy and markets and consequent strategic autonomy must be the main target.

8. Energy Technologies

Energy technology is an engineering science, whose main purpose is the efficient, safe, environmentally friendly and economically viable extraction, conversion, transport, storage and use of energy, while preventing any side effects to humans, nature and the environment. Since World War II, enormous progress has been made in the development of a wide range of energy technologies used worldwide, while continued technological progress has led to many improvements and higher efficiencies, notably the introduction of new low-emission technologies.

The purpose of this Chapter is to identify, describe and evaluate the 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 can be used in power generation, but also in the production and heat transfer. Most RES technologies are suitable for use in Greece, but also in SE Europe and several of them are already used in most countries of the region. However, there is a huge RES potential in SE Europe, in order to further exploit solar thermal systems and photovoltaics, wind, hydro and biomass, but also other technologies, little used or new, such as biofuels, biomethane, geothermal, ocean energy and offshore wind, as thoroughly analyzed in the “SE Europe Energy Outlook 2021/2022” study prepared by IENE [131].

8.1 Offshore Wind

With regard to offshore wind farms in Greece, Law 4964/2022 was passed at the end of July 2022 “Provisions for the simplification of environmental licensing, establishing a framework for the development of Offshore Wind Farms, dealing with the energy crisis, environmental protection and others provisions”, while at the same time the Ministry of the Environment and Energy has completed the mapping of the appropriate “blocks”. It is the sea areas within the territorial waters of 6 nautical miles that have the specifications to host floating or fixed wind turbines, with the aim of exploiting the country’s high wind potential, estimated at 30 GW. According to an estimate of the Ministry of the Environment and Energy, large investments of €6 billion can be implemented in the field of offshore wind farms to install 2 GW of parks by 2030.

It is worth noting that in December 2022 a closed working meeting was held at the Norwegian Embassy of Greece between representatives of the Norwegian Offshore Wind Cluster (NOWC) and the Greek companies TERNA, Motor Oil, HELLENiQ ENERGY, Kopelouzos

Group, PPC Renewables, Intrakat, Ellaktor, ENTEKA , Eunice, Jasper Wind, ITA, RF Energy and Resinvest. The Norwegian business cooperative has more than 300 member companies, including the giant Equinor, covering the entire supply chain and aiming to become a player in the global offshore wind farm development market. The subject of the meeting was the investigation of cooperation room in the development of offshore wind farms in the Greek seas. However, HELLENiQ ENERGY (formerly HELPE) has already established a joint venture with RWE Renewables, a world leader in offshore wind energy, with the aim of developing, implementing and operating offshore wind farms in Greece.

8.2 Biomethane

The only pending issue for the commercial exploitation of biomethane in Greece is the acceleration of the procedures by the State and the competent regulatory authority for the finalization of the relevant legislative and regulatory framework. More specifically, the RAE approval of the biomethane distribution license applications, which DEDA has already submitted since last December, is expected, as well as the final consent of sellers and buyers for DEDA to proceed with the first two biomethane pilot projects in Serres and Imathia.

The application concerns the temporary licensing of DEDA, until the overall institutional/regulatory framework for the development of the biomethane market as distributed renewable gas fuel in our country is established. Biomethane will be produced from agricultural and livestock residues, as well as the organic fraction of municipal solid waste. Therefore, its production will have a parallel significant contribution to the development and consolidation of the circular economy in our country.

Also, there is a lot of interest from producers. Biogas producers who sold to PPC and investors in the sector are asking for the formal obstacles to expire so that they can operate normally in the biomethane market.

8.3 Hydrogen

One of the clean forms of energy with zero carbon emissions is hydrogen. Pure hydrogen must be produced from other hydrogen-containing compounds such as fossil fuels, biomass or water. Each production method requires an energy source, i.e. thermal (heat), electrolytic (electricity) or photolytic (light) energy. Hydrogen, produced from renewable electricity (green hydrogen), has no carbon emissions associated with its production or use, unlike hydrogen produced today from fossil fuels (blue or grey hydrogen).

Hydrogen can be stored as a liquid, gas or chemical compound and is converted into usable energy through fuel cells or by burning in turbines and engines. The uses of hydrogen cover a wide range of energy applications, such as as a fuel for transport, as a substitute for natural gas for heating or electricity generation, or as a raw material 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, yet the economic and technological challenges associated with creating a hydrogen economy have only recently begun to be overcome. With the ever-decreasing cost of renewables and hydrogen technology, and emerging export markets, the factors required to develop a global renewable hydrogen sector are beginning to be realized.

In Greece and according to the estimates of the European entity “Fuel Cells and Hydrogen Joint Undertakings”, the possibilities for the production of renewable electricity in 2030 are significant and this creates great opportunities for the country to utilize renewable electricity in the production of hydrogen with water electrolysis.

These opportunities also include the possibility of utilizing the existing natural gas infrastructure for hydrogen transport and distribution, with hydrogen blending into the public natural gas network in the immediate (2025-2030) and medium-term (2030-2040) periods, and potentially converting it into a long-term (after in 2040) part of the natural gas network for exclusive use of hydrogen.

However, converting the grid to dedicated hydrogen pipelines will be a longer-term prospect, 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.

Regarding the use of hydrogen in Greece, apart from the road transport sector and shipping (especially domestic shipping which represents almost 10% of the total transport demand and is the highest in Europe), there are possibilities for hydrogen utilization in industry, replacing the existing use of hydrogen derived from fossil fuels.

The national and European strategy for hydrogen is already underway, with investment interest particularly important and increased in recent years. 20 projects are being prepared by Greece, of which 5 are already on the EU list of Important Projects of Common European Interest (IPCEI) for Hydrogen. The remaining 15 are maturing and coming from different companies across the hydrogen value chain and are aligned with the national hydrogen policy. The 5 Greek projects in the first wave of IPCEI Hydrogen list are summarized as follows[43]:

[43] https://www.mononews.gr/business/konstantinos-papaloukas-pia-ine-ta-erga-pou-vazoun-ti-ellada-sto-charti-tou-idrogonou

- **Blue Med**: A project by Motor Oil for the production of low carbon footprint blue hydrogen and green hydrogen, with a timeframe stretching out to 2025. The hydrogen is to be used in infrastructure and means of transport. It is expected that both the Hellenic Gas Transmission System Operator (DESFA) and the Public Power Corporation (PPC), along with research institutions, will be joining the project.
- **Green HIPo**: A project by Advanced Energy Technologies (Advent Technologies) for the construction of electrolyte and fuel cells production units. The combined heat and power fuel cells are expected to be produced by Advent Technologies for the White Dragon project in their main production line in West Macedonia.
- **White Dragon:** A cluster of projects for the production of green hydrogen in West Macedonia through solar energy electrolysis and distribution through DESFA and TAP pipelines. The participants of the cluster are the Public Gas Corporation, Advent Technologies, Copelouzos Group (DAMCO ENERGY SA), Corinth Pipelines SA, TAP AG, DESFA, Terna Energy, Motor Oil and PPC.
- **H2CAT TANKS:** A project by B&T Composites for the production of high-pressure tanks from composite materials and carbon fibres for the storage of hydrogen used in transport.
- **H2CEM – TITAN:** A project by TITAN for the production of cement by the use of green hydrogen. The project mainly concerns the production, storage and use of green hydrogen for combustion to be used for the production of energy with the view of decarbonising cement units.

According to the moderators' categorization, the Green HIPo, White Dragon and H2CAT Tanks projects are included in the IPCEI "Hydrogen Technologies" sub-category, while Blue Med and H2CEM are included in the "Hydrogen decarbonisation" sub-category. Also, it is worth mentioning that a Special Committee has been established to prepare the National Strategy for Hydrogen.

At the same time, the Greek government should ensure the easy spatial arrangement and licensing of small hydrogen production units that will be connected to photovoltaic and/or wind systems of small or medium capacity, the transport and storage of small amounts of hydrogen in larger national storage infrastructure, the modernization of the regulatory framework for the production, transport, storage, disposal and use of hydrogen according to the standards of other European countries.

Also, all energy market players should proceed immediately to assess the situation and include in their services new manufacturing transformation methodologies, in the first phase of the existing storage areas, networks and metering stations and host in suitable infrastructure mixtures of natural gas with hydrogen, up to 30% in the first phase, but even more if required in the future.

Furthermore, DESFA [132] participates in the project of 12 European Operators to create a hydrogen transport network, which will cover 21 European countries, with the proposal to build by 2040 a new pipeline that will connect Athens and Thessaloniki, ending in Kavala and the depleted field of gas located there. DESFA's proposal is complemented by the natural gas pipeline to Western Macedonia, which will be "hydrogen ready" from the start, thus including Greece on the map of the European Hydrogen Backbone (EHB), i.e. the initiative for the development of a "backbone" of projects for the distribution of renewable gas in Europe.

The project will follow the same route as the section of the National Natural Gas System, which runs through the above areas. For its design, the driving force was to cover the expected demand in 2040, i.e. the future needs for renewable gas from industries and refineries in the wider area of Attica and Thessaloniki. The extension of the pipeline to Kavala is part of the conversion of the local depleted deposit into an underground hydrogen storage facility.

Finally, it is worth mentioning that the first refueling station with liquefied hydrogen for passenger and generally relatively small-sized electric vehicles in Greece was inaugurated last May at the premises of the National Center for Scientific Research "Demokritos" and will initially operate as a pilot. The facilities include a unit for the production of "green" hydrogen through water electrolysis using electricity from photovoltaics, an innovative hydrogen compressor at 200 bar, high-pressure hydrogen storage tanks and a system for refueling vehicles with hydrogen fuel. The filling station has a metal hydride technology compressor and operates quietly with very low energy requirements. It has been built within the premises of the National Center for Scientific Research "Demokritos", is charged through photovoltaic panels and uses a tap water supply.

8.4 Biofuels

According to the NECP [20], the contribution of biofuels will remain dominant, with a particularly increasing share of advanced biofuels especially during the last period of the 2020-2030 period.

The main objective for biofuels should be the promotion of the use of the Greek raw materials and the support of domestic biodiesel producers. In Greece, biodiesel is produced and made available by the Greek companies, which use energy crops, cottonseed oil and used vegetable oils and animal fats that are converted into said fuel in the processing units operating in the country. In fact, more Greek companies are getting constantly biodiesel distribution and production licenses in order to further strengthen domestic production.

The most effective policy measure to promote the use of biofuels in transport is the continuation of the existing regulatory framework of the obligation to blend biofuels and use biofuels as such. More specifically, the obligation to mix motor diesel with biodiesel at a rate of 7% was foreseen and at a rate of 1% for 2019 and 3.3% for 2020 on the energy content of gasoline with bioethanol, while both new enhanced blending obligations and the possible extension of the measure to other transport sectors will be gradually examined.

8.5 New “Green” Fuels

HELLENiQ ENERGY, in the context of the energy transition and the policy of reducing carbon emissions, promotes the production of renewable and carbon-neutral fuels. The goal is to produce fuels that will not come from fossil hydrocarbons, but from biomass, sequestered carbon dioxide, waste, etc., that can be used by existing vehicles with internal combustion engines and will have a low or zero carbon footprint.

Request of the European Association of Fuel Producers (FuelsEurope), of which HELLENiQ ENERGY is a member, to the European institutions and the governments of the member countries is to give tax incentives for the production of the new fuels, which by 2050 can contribute 160 million tons of oil equivalent, out of the 350 million tons of oil equivalent currently consumed in Europe, contributing to the abolition of fossil fuels.

The new raw materials for the production of liquid fuels instead of crude oil can be biomass, RES, waste and the captured carbon dioxide that will be used to produce sustainable biofuels, hydrogenated vegetable oils, synthetic fuels, pure hydrogen and/or fuel from recycled plastic. The “Refinery of the Future” will be the hub where all these different fuels will be processed to meet industrial specifications, e.g. automotive or petrochemical industry.

8.6 Carbon Capture and Storage (CCS)

Carbon dioxide (CO2) is one of the atmospheric gases to which a share of the responsibility for climate change is attributed. Its capture and geological storage is one of the available options for reducing greenhouse gases in the atmosphere and stabilizing the climate. Demonstration and small-scale projects have shown that the capture and geological storage of CO2 is technically feasible. However, the technology requires upgrading, especially with regard to the geological storage of large amounts of CO2.

The CCS technology includes:

1. Capture and collection of CO_2 at its emission points, such as oil and gas production platforms, industry (cement factories, power plants, refineries, steel mills, etc.), or even directly from the atmosphere.
2. Its transportation to permanent storage locations via pipelines and/or ships.
3. Its geological storage under land or under the sea, in underground saline aquifers or in depleted natural gas fields.

Pilot (small-scale) CO_2 geological storage units have been operating without problems for decades. Two of them are located in Europe, specifically in the North Sea and the Barents Sea, where CO_2 produced by the respective oil and gas extraction platforms is stored in geological formations.

For Greece, a relevant scientific study, published in 2020 by HEREMA, is a “guide” on the subject [133]. As stated in its conclusions, “the storage of carbon dioxide emissions in underground geological formations is a well-understood, permanent and safe technology, which is crucial to reducing emissions and meeting the Paris targets”.

It is further emphasized that “common myths and possible misconceptions related to CCS technology include the risk of CO_2 leakage or environmental damage, permanent storage and impact on earthquakes. However, decades of expertise from the oil and gas industry, as well as data from monitoring, measurement and verification of storage sites and a number of academic studies are combined to reinforce the essential role of CCS technology in reducing global CO_2 emissions”.

Recently, Energean Oil & Gas, a subsidiary of the Energean group, commissioned Halliburton with the evaluation study of the carbon dioxide storage potential in the Prinos Basin, in Kavala. The carbon dioxide storage project in Prinos is an investment of €390 million, which has already received the green light from the European Union’s Recovery and Resilience Fund and which will make Prinos a model industrial complex not only in Greece but also in the Mediterranean in general. In addition, it will significantly enhance the competitiveness of domestic industry and will have significant benefits for the environment, drastically reducing the environmental footprint of industrial activity in Greece.

Prinos is considered as the ideal site to host a carbon dioxide storage unit with an estimated capacity to store up to 50% of the pollutants emitted by the domestic industry over a period of 20 years, starting from 2025. It is worth mentioning that IENE is currently preparing a special study on the perspectives of carbon dioxide capture, utilization and storage (CCUS) in

Greece[44]. This specific study does not aim simply at the theoretical investigation of CCUS technologies or their application possibilities in Greece. On the contrary, it is going to be a detailed roadmap for the introduction of CCUS in our country, with the selection of geographical areas for the creation of industrial CCUS hubs, but also with specific timetables for all its aspects, from the legislative framework to spatial planning issues.

8.7 Electromobility

Electromobility is expected to experience particular growth in the coming years in Greece, with the NECP reporting 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 small, but in the last two years (2020 and 2021) we have seen significant developments. In particular, the Law on electromobility was published in the Government Gazette in July 2020[45], putting into effect the "Move Electric" programme of the Ministry of the Environment and Energy.

In fact, the first phase of the programme was successfully completed in 2021, exceeding the national target by 183.6%, as 6,697 electric vehicles were registered against a target of 3,750. The first phase of the "Move Electric" programme, with a total budget of €100 million, closed with 19,000 applications and a turnover of €70 million in the market, of which 69% were electric bicycles. By May 2022, the second phase of the programme was opened with a budget of €50 million for 2022, including increased subsidies for the purchase of electric cars and two-wheelers, while establishing social criteria for the disabled, three children and – for the first time – for young people up to 29 years old. Special care is also taken for companies operating on islands. The second phase of the "Move Electric" programme will have retroactive effect from 1.12.2021 and citizens will be able to submit their applications until 31.12.2023.

However, representatives of the Greek companies, which play a leading role in the development of the new electromobility market, confirm that there are still several problems that need to be solved. They also assure that if the licensing issues of the charging stations are resolved, the Greek driver will be able to completely eliminate the "stress of the battery" and enjoy the experience of electromobility in less than two years, a very realistic goal, according to market players.

"In some cases, licensing approvals can be delayed up to 6-8 months", the Director of Strategy and Business Development of NRG Mr. Ilias Petris recently stated in the newspaper "Kathimerini"[46], through which Motor Oil also entered the electromobility market. This

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[44] https://www.iene.gr/page.asp?pid=5708&lng=1
[45] https://www.e-nomothesia.gr/kat-aytokinita/nomos-4710-2020-phek-142a-23-7-2020.html
[46] https://www.kathimerini.gr/economy/561704998/met-empodion-i-ilektrokinisi-stin-ellada/

statement was also confirmed by Mr. Spyros Kiartzis, CEO of ElpeFuture, a subsidiary of HELLENiQ ENERGY, which develops an extensive network of charging stations for electric vehicles as well as the corresponding electromobility services.

The two oil groups are leading the development of the charging network by leveraging their extensive network of service stations throughout the territory and are the ones who have installed almost 80% of the available in public use fast chargers. HELLENiQ ENERGY has installed 35 fast chargers, geographically covering the whole country and aims for a number of 100 fast chargers by the end of 2022. To date, according to Mr. Kiartzis, the company has installed 60 fast charging electric chargers, mainly in EKO stations and BP, while aiming for 7,000 charging points in strategic points of interest nationwide, within the next five years.

NRG started with the installation of a fast charger at each Ionian Road interstate before the framework for the electromobility market was even established, seeing in time that the country would have to adapt to the Commission's Directive on the mandatory installation of a charging station every 60 km on the highways and on the central roads.

To date, as Mr. Petris emphasizes, NRG has installed 33 fast chargers and 71 simple ones and will soon put into operation an additional 15 simple and 7 fast chargers, covering 91 cities throughout Greece. A wide network of mainly simple chargers in more than 65 cities, in collaboration with retail chains and supermarkets, has been developed by PPC through "PPC Blue", while it has also installed 15 fast chargers in key points, such as "Eleftherios Venizelos" airport, Thessaloniki International Fair and IKEA.

In their "journey" to electromobility so far, the Greek companies have also recorded the first problems that appear in each new market. The problems are mainly found in the development of a network of fast chargers (capacity of more than 50 kW), technology that allows the battery of a medium displacement electric car to be filled in half an hour compared to about two hours of a simple one (capacity of 20-22 kW). The installation of a simple fast charger basically requires the company's request to DEDDIE for electricity along with an update of the responsible statement of the electrical equipment installer. Things are more difficult in the case of fast chargers, for which the installation requires a capacity increase and becomes extremely complicated when it requires a new substation. In these cases, the delay is several months.

Mr. Kiartzis from ElpeFuture mentions the case of the installation of a fast charger in Glyfada where he had to wait 8 months for the upgrading of the electricity distribution network to be completed, and Mr. Petris from NRG said about a fast charger in Tatoi who was waiting 7 months for the upgrading. "All the entities involved, urban planning, municipalities, regions, DEDDIE, archeology services, must help to simplify the licensing process", the General

Director of electromobility of PPC Blue, Mr. Kyriakos Kofinas, emphasizes, pointing out the need to increase the number of publicly accessible charging points.

An important role will be played by the municipalities, which are obliged under a Community Directive to develop one charging point per thousand inhabitants. With funding from the Green Fund, 328 of the country's 332 municipalities are preparing studies to identify the most suitable charging points. The model for the development of charging points in the municipalities has not yet been decided, although the most prevalent seems to be that of the auction to assign them to private individuals for a fee.

The charging price issue is also a concern for companies, especially in the current era of high prices. The charging price for fast chargers ranges around 50-62 cents/kWh. Charging is billed as a service at a VAT rate of 24% and could be reduced to the low 6% that applies to electricity, according to market representatives and reduce charging costs by around 15%.

A third issue facing the market is the high installation cost, which accounts for only 20%-25% of the machine, with the largest part representing the cost of connecting to the grid when a capacity increase or a new transformer is required. Some companies propose subsidizing part of this cost from the Recovery Fund.

In summary, some of the problems that limit the promotion of electromobility in Greece are the high cost of acquiring electric models (despite subsidies), the lack of appropriate infrastructure and the geographical distribution of the country's population, given that Attica has a population of about 5 million of which a large part lives in apartment buildings with limited parking spaces available for the development of charging infrastructure, the low autonomy, the possibility of energy transmission-distribution and the pricing.

It is worth mentioning that the National Strategy for Electromobility is expected to be completed by October 2023, with the Ministry of Transport having secured the appropriate funding, while the Strategy will include, in addition to electric vehicles, maritime transport, rail and micromobility.

8.8 Energy Storage

Today, the two main energy storage technologies are pumped storage and batteries. Pumped storage is the dominant storage technology worldwide. Its main advantages are technological maturity, rapid response and high performance levels. However, it is difficult and time-consuming to find suitable sites for the construction of the two reservoirs required in pumped-storage systems, while at the same time it is accompanied by significant environmental impacts, such as interference with species' habitats - especially aquatic ecosystems, deforestation and the removal of a large amount of vegetation before filling the reservoirs.

Storage systems with batteries (mainly lithium-ion) have very fast responses, shorter installation times and greater degrees of efficiency than pumped storage, while being able to offer a variety of energy services. Advances in these technologies and increased demand have led to a dramatic reduction in their costs. However, disadvantages of batteries are the comparatively short life time, sensitivity, safety issues, limited availability of raw materials for their manufacture and the environmental impact of their disposal, which require the development of relevant recycling systems.

In Greece, energy storage technologies are one of the main topics in the NECP, while the financing of a total capacity of 1,380 MW has been secured from the Recovery Fund with the amount of €450 million. In a study prepared on behalf of RAE [134], the needs of the Greek system in storage units, taking into account a 60% participation of RES in the electricity generation mix in 2030, as foreseen in the NECP, are estimated at 1,500-1,750 MW.

According to RAE data[47], 181 projects for storage units with a total capacity of 14.3 GW have been licensed for production to date. Of these, 9.64 GW concern 120 projects for storage units and the remaining 47 projects concern storage units combined with RES.

Among the projects that are awaiting the issuance of an institutional framework are the iconic pumped storage projects of Terna Energy in Amfilochia and Amari in Crete. The implementation of new flagship projects, such as Eunice's €280 million investment in Western Macedonia for the creation of a central electricity storage unit through lithium-ion batteries with a total capacity of 250 MW, depends on the institutional framework and the support mechanism it will incorporate. Storage permits for a total capacity of 1 GW have been secured by PPC Renewables in the areas of Western Macedonia and Megalopolis, Terna Energy for four storage units with a total capacity of 375 MW, Intrakat for projects with a total capacity of 496.6 MW, Egnatia Group for projects with a capacity of 1,344 MW across the country, France's ACUO Energy for projects with a total capacity of 586.75 MW, Mytilineos, which has 25 energy storage projects under development, involving a combination of photovoltaic and battery power generation, Italy's Enel Green Power, France's EDF and also French Total Eren, but also German Accusol.

Law 4951/2022 "Modernization of the licensing process for Renewable Energy Sources Phase B, Licensing of production and storage of electricity, framework for the development

[47] https://energypress.gr/news/adeies-paragogis-se-181-project-apothikeysis-gia-143-gigavat-ehei-idi-dosei-i-rae-sta-95

of Pilot Marine Floating Photovoltaic Stations and more specific provisions for energy and environmental protection" was passed by the Greek Parliament in July 2022. The aim is to achieve the installation and operation of 1,500 MW of storage projects by 2030, around 700 MW of pumped storage and 800 MW of batteries.

The Law foresees, among others, the establishment of three categories of permits for electricity storage projects, starting with the individual storage stations. In the case of RES projects with storage units, a categorization is made into RES stations combined with electricity storage units, which do not absorb energy from the grid (the storage is behind the RES station), as well as into RES stations with storage units that they can both inject and absorb power from the grid.

The first projects will be eligible for aid through a competitive process based on the notified aid scheme for RES projects, while the second category of projects will not be able to receive aid. In the case of consumers with integrated storage, the projects will again be categorized in terms of whether or not energy can be injected into the grid. For the first case of projects, it will be necessary to license the storage unit, while for the second it is not.

In addition, investment support through the Recovery Fund is foreseen, amounting to €200 million to finance 700 MW of batteries[48]. The selection of the beneficiaries of the aid will be made after tenders, with the first being scheduled for the summer of 2023. It is noted that there is strong investment interest, as RAE has granted 140 licenses for the production of 10,300 MW, while 78 applications have still been submitted for 4,800 MW energy storage projects.

It is worth mentioning that last year IENE organized a special workshop on energy storage and power grid management [135]. The aim of the specific workshop was to highlight the great expectations and challenges created by energy storage, but also the need for advanced energy management systems, which implies the application of large-scale RES, and on the one hand to explore the related possibilities and challenges in a period during which the development of energy storage systems has caused a real revolution in the field of RES.

Also, in 2019, IENE prepared a special study on the "Energy Transition of the Island of Kastellorizo" [136], which describes the installation of photovoltaic and wind units, combined with a battery system that aims to almost completely cover the island's electricity needs.

[48] https://energypress.gr/news/oi-paremvaseis-toy-epikeimenoy-nomoshedioy-gia-plaisio-adeiodotisis-ton-stathmon-apothikeysis

8.9 Smart Grids

An important challenge and policy priority is the promotion of smart grids in Greece. Digitization and upgrading is expected to contribute to the creation of 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 is expected to play an important role, as well as the sources of financing.

The electricity distribution network is a critical infrastructure for the transformation of the energy system and the realization of the vision for its delignitisation. The technological upgrade and transition of the distribution network to the digital age is a basic condition both for the improvement of its operational parameters and reliability, as well as for the further development of the domestic energy markets. It will also facilitate the achievement of energy planning objectives, which envisage an ever-increasing role for RES and decentralized generation and improving energy efficiency at all levels.

It will also allow the adoption of a two-way operation 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 acting as producers (prosumers), with the potential contribution of aggregators, as well as the coupling of all final energy consumption sectors.

The increased needs of data sharing between the distribution network operator, suppliers, public authorities and other interested parties require the further development of data exchange systems, but also the creation of standards in systems, protocols and data formats. With the development of smart grids and data-centric business models and the total digitization of the network, upgrading IT infrastructure and cyber security is a critical factor. In this context, inter alia, close cooperation between transmission and distribution network operators, interoperability between systems, definition of a single cyber security framework in the EU, including preventive, corrective and defensive plans for the energy system, are required.

In Greece, IPTO is currently undergoing a transformation phase that will turn it into a digital Electricity Transmission System Operator, emphasizing:

- **Asset Performance Management System:** system that allows the management of the Operator'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 audits and connected end-to-end markets.

- **Data Analytics Strategy:** Big and Open data management software for the supervision and control processes of the electricity market.

Correspondingly, DEDDIE follows the digital transition and is upgraded so that it can optimally support the end consumer, industrial and domestic:

- **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 immediate interventions in the network.

With the above actions, the Operators will contribute to the national effort for a greater penetration of RES in production and the energy mix, to reduce production costs and also to adapt network operations to the new data of strengthening decentralized energy production.

Regarding smart meters, the initial call for expressions of interest for the large project of replacing analog clocks and installing smart meters in Greece was published on December 14, 2021. Essentially, this concerns only the first phase of a long process and in particular the “pre-selection of candidates in the context of Phase I of the negotiation process with the publication of a tender procedure for the drawing up of framework agreement contracts for the supply of equipment”. After 8 years since the announcement of the first tender for the installation of smart meters in Greece and after several postponements, the DEDDIE tender for smart meters has attracted the interest of seven major companies, providing integrated solutions for the energy market worldwide. These are: ITRON, Landis+Gyr, Elster, PROTASIS, Iskraemeco, Gridspertise and Intrasoft International.

The offers of the companies were opened on June 14, 2022, and since then the first phase of the competition has begun, namely the evaluation of the control process of the conditions for participation and the quality selection criteria by the Conducting Committee. After the completion of the control process, the second phase of the tender will begin, with the notification of the detailed document of the negotiated procedure to the economic entities pre-selected in the first phase.

Regarding the timetable, DEDDIE aims to complete the replacement of analogue clocks with smart meters in Low Voltage within a five-year horizon, while the whole project will evolve until 2030. In particular, the timetable for the installation of 7,354,000 “smart meters” will depend certainly on the development of the competition and the given goal of the Operator to be completed in a shorter period of time.

It is noted that at the same time two other small tenders are underway for the supply of Medium Voltage electronic meters and modems (€5.1 million) and three-phase Low Voltage electronic meters and modems (€3.27 million).

8.10 Nuclear Technologies

Greece is a country that does not have nuclear energy expertise and does not own a nuclear power plant. However, it imports about 2-4 TWh of electricity per year from Bulgaria, part of which is produced by the existing nuclear power plant in Kozloduy.

Recently, the nuclear cooperation between Greece and Bulgaria is among the scenarios that the Greek government is working on in order to ensure the long-term purchase of cheap electricity. In particular, the idea concerns the desire of Bulgaria to proceed with the expansion of the existing nuclear power plant in Kozloduy and the possibility of entering into a long-term agreement (bilateral contracts) at competitive prices in order to channel the additional electricity production and among the candidate countries is Greece.

In fact, Bulgarian Prime Minister Kirill Petkov recently reported that prospective suppliers are currently being studied, while Bulgaria is proceeding with a feasibility study, committed to return in 12 months with a specific proposal to the Greek government regarding the viability of the project in question[49].

[49] https://www.kathimerini.gr/opinion/interviews/561769867/o-prothypoyrgos-tis-voylgarias-kiril-petkof-stin-k-exetazoyme-tin-pyriniki-synergasia/

9. Investing in the Energy Sector

9.1. Introduction

The energy sector as a whole represents 6.0% of the country's Gross Domestic Product (GDP) and is one of the most strategic sectors of the Greek economy, affecting many other sectors and a large part of economic activity. The uninterrupted supply of abundant electricity and natural gas as well as the provision of liquid fuels, necessary for transport, domestic heating and power generation, mainly in islands, are the driving forces of the economy.

The energy sector is capital and investment intensive. Based on the geographical position of Greece, its comparative advantages and the planned structural changes, the energy sector can and must (under certain conditions) be one of the main growth drivers of the Greek economy. There are significant investment opportunities in Greece today, both in the primary energy sector (e.g. exploration and production of hydrocarbons, 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 both at the maintenance and upgrading of existing systems and units as well as at their expansion and are therefore 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 wider production axis of the economy.

Today, numerous small and large energy projects are underway in Greece, covering all individual sectors. In summary, these projects include RES projects and mainly the installation of new wind and photovoltaic farms, solar thermal plants, small hydropower projects, biogas units and the development of geothermal fields. As investment in RES projects progresses, the need for electricity storage is imperative, which means that there will be significant investment in storage systems (pumped storage and batteries). An important part of energy investments, from now on, will include the thousands of small or larger interventions to improve the energy efficiency of buildings, but also businesses 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 FSRUs and the development of small-scale LNG.

Of key importance is the completion of the electricity interconnections of the Cyclades and the electricity interconnection of mainland Greece with Crete, while the completion of the construction of the new state-of-the-art lignite power plant of PPC in Ptolemaida and the investments by private companies for the further development of the retail electricity market and in general the digitization of the electricity market.

Furthermore, the planned energy investments include the ongoing modernization of the HELLENiQ ENERGY and Motor Oil refineries through maintenance and upgrading projects, as well as hydrocarbon exploration activities, following the change of stance of the Greek government.

With total estimated investments amounting to €66 billion over a decade (2022-2031), the Greek energy sector has huge potential for quality improvement and further development and can indeed provide the required boost to the development process in the coming years. The necessary modernization of the electricity and natural gas systems, interventions in the final energy consumption and strategic decisions for the utilization of natural resources and the promotion of Greece's geographical position could contribute to this.

At the same time, we should take seriously its important export activity, with exports of refined petroleum products, worth approximately €10.0 billion in 2021, contributing 26% to the total of the Greek exports. Oil and natural gas pipelines, electricity interconnections, solar thermal systems and insulating materials have recorded a remarkable export performance over the last five years, with their exports reaching a total of €2.0 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 the Balkans
- **Electricity exports** to Italy, North Macedonia, Albania, Turkey and Bulgaria
- **Building materials for insulation** (e.g. aluminium, frames)
- **Solar thermal systems** (e.g. solar water heaters, flat solar panels)
- **Electricity storage** (e.g. batteries for RES systems, with the presence of Sunlight Systems particularly important, which specializes in the development, production and distribution of batteries and energy storage systems for industrial, consumer and advanced technology applications)
- **Cables:** Use of the cables in electricity transmission and distribution networks, RES, interconnections of islands with continental systems, but also offshore wind farms (e.g. Cablel Hellenic Cables Group exports high and ultra-high voltage underwater and above-ground cables)

- **Smart meters for industrial and commercial applications** (e.g. Landis+Gyr SA, 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 worldwide used in onshore natural gas and oil pipelines, CO2 re-injection pipelines and petrochemical and fuel pipelines)

The aforemntioned export activities are a very good basis for their further expansion both geographically and quantitatively. The further development of exports of energy products will inevitably lead to greater investments, strengthening of the production potential of companies and an increase in employment. For this, the government should support in every possible way the companies active in the production and export of energy products.

The energy sector can emerge as one of the most important sectors for Greece's economic prospects, despite the adversities of the coronavirus pandemic in the last two years and now Russia's war in Ukraine. Apart from its direct contribution to output and employment, this is for at least two additional reasons. First, it is related to the role of energy costs and security of energy supply for the competitiveness of the economy and determining the level of welfare of citizens, and secondly, to attracting investments to exploit domestic energy resources, modernize energy infrastructure and the catalytic role that these factors can have for the development of new activities.

9.2. Energy Investment per Fuel

Electricity

In the power generation sector, the major investments launched, implemented or even completed by the major players in the sector are creating new data on the electricity market map. In particular, in the next few years, it is expected that 4 new units, 3 natural gas and one lignite, will be added to the electricity system of Greece.

The most mature investment, which has already been completed and is expected to join the system in the near future, is Mytilineos' new gas-fired combined cycle plant, currently in trial operation. The new unit, with a total capacity of 826 MW, was built in Agios Nikolaos Boeotia and includes the most modern and efficient gas turbine in Europe, while it is planned to operate as a base unit and to replace a large part of the lignite power that will be decommisioned as part of delignitisation phase. At the same time, the environmental benefit will also be important as the new unit will produce 250 kg of CO2 per megawatt hour when currently lignite units produce from 1.2 to 1.5 tons of CO_2 per megawatt hour, i.e. 6 times more. The investment cost amounted to €350 million.

The second combined cycle unit fueled by natural gas is being built by the joint venture of GEK TERNA with Motor Oil Hellas with a capacity of 877 MW at the Komotini Industrial Zone, with an investment cost of €375 million. The two groups participate with an equal percentage of 50% in the Komotini Thermoelectric Company, which has undertaken the construction and operation of the new unit. The aim is to put the unit into commercial operation at the beginning of 2024. With this new unit, the thermal portfolio of GEK TERNA is expected to increase to 1.5 GW, while both groups, which also have a presence in the supply market, will strengthen their vertical activities. Finally, the increased natural gas requirements of the new plant will help achieve economies of scale for LNG supply.

Elpedison's 826 MW natural gas-fired combined cycle unit in Thessaloniki is also in the development stage. The final investment decision for the construction of the unit, with a total cost of €450-€500 million, is expected to be taken in May 2023, however preliminary work has begun in the area where the unit is to be built. This particular unit marks the company's decision to play a central role in the energy transition with its executives estimating that natural gas and coal, after the war in Ukraine, will continue to be the dominant fuels for the operation of the base units.

Also, PPC, DEPA Commercial and Damco Energy recently received the final investment decision for the construction of a new natural gas plant, with a capacity of 840 MW, in Alexandroupolis, with the works already started. The new combined cycle unit is expected to be commissioned at the end of 2025.

In addition to private groups, PPC also has ambitious investment plans for the natural gas power generation sector. Among others, the company proceeded to complete the Ptolemaida V unit which was built with lignite fuel and which is expected to start its commercial operation by next May, having been put into trial operation since the end of 2022.

As regards the electricity networks, after the completion of the construction by IPTO of the Peloponnese-Crete interconnection, which was put into operation in July 2021, the construction works of the Attica-Crete interconnection continue, with its estimated completion within this year. At the same time, the complete interconnection of the Cyclades is progressing, while towards the end of the decade the electricity interconnections of the Dodecanese and the islands of the North Aegean are expected to be completed.

Natural Gas

As demand for natural gas in Greece increases, stregthening and further expansion of the distribution network, as well as the construction of new branches and cross-border pipelines, are foreseen. Already, the Greece-Bulgaria interconnector or IGB pipeline has been put into commercial operation since October 2022, while the Greece-North Macedonia interconnector pipeline is at an advanced stage of design. The completion of the TAP pipeline, which passes along Thrace and Eastern and Western Macedonia, created prospects for the construction of new branches, with the aim of supplying natural gas to urban and suburban centers (e.g. Amyntaio, Kozani, Florina, Grevena, Kastoria, Ioannina).

At the same time, five FSRU projects are at an advanced stage of development, two offshore Alexandroupolis, one in Agioi Theodoroi, near Corinth, known as Dioryga Gas, one in Thessaloniki and one offshore in Volos, known as Argo FSRU. Their completion in the period 2023/2024 is going to contribute to the strengthening of Greece's geopolitical position, since it will stimulate its transit role in energy.

In particular, the most mature is the Alexandroupolis FSRU project, where the terminal is expected to be installed in the port in November 2023. In this project, which is being developed by the Gastrade company in the Alexandroupolis area, the Kopelouzos Group, Gaslog, DEPA, DESFA and Bulgartransgaz participate. The project is considered to be of high importance as it enhances security of supply, diversifies sources and routes of energy supply, enhances the development of competition and supports the creation of a hub in the wider SE European region.

At the same time, Gastrade has announced its intention to develop a second FSRU in Alexandroupolis, with the possibility of importing 5.5 billion cubic meters of natural gas per year. The creation of a second FSRU will double capacity, to 11 billion cubic meters, with the aim of expanding gas exports even further north, reaching as far as Ukraine.

In addition to the power plant, the Motor Oil Hellas group is also planning the construction of an FSRU, known as Dioriga Gas. It is considered a strategic project that will serve the immediate needs of natural gas supply, and at the same time will incorporate the possibility of receiving renewable fuels of the future, such as hydrogen.

Elpedison is also planning a new FSRU in Thessaloniki, known as the "Thessaloniki FSRU", which is expected to be deployed in the Thermaic Gulf and operational within 2025. The FSRU will have a storage capacity of 170,000 cubic meters of LNG and will be able to deliver up to 20 million cubic meters of natural gas per day. The project will also include a system of onshore and subsea pipelines that will connect the FSRU to Elpedison's power generation units in Thessaloniki (one existing and one under planning), as well as to National Natural Gas System's existing transmission pipelines in the area.

Regarding the Argo FSRU, Mediterranean Gas is the company developing the specific project in the port of Volos, with a regasification capacity of 5.2 billion cubic meters of natural gas per year. It is worth noting that on December 19, 2022, the first phase of the Market Test was successfully completed for the expression of interest and commitment of capacity in the specific project, while its commercial operation is planned for the first quarter of 2025.

After the completion of the major expansion project of the LNG terminal in Revithoussa in November 2018, with the addition of the third tank, a specially equipped tanker, known as FSU, has now been added since last July, which has a total capacity of 150,000 to 174,000 cubic meters in conditions of 100% filling. It is worth mentioning that in the implementation of the integrated plan of the Ministry of the Environment and Energy for the energy supply of the country, in case of disruption of the supply of natural gas from Russia and based on the decision issued by RAE, it was agreed that DESFA should proceed with awarding the tender for the lease of a floating LNG storage tank (FSU) for a period of twelve (12) months, for the purpose of security of supply.

In addition, the construction of the new small-scale LNG jetty at the Revithoussa terminal is underway for the loading of small-scale LNG carriers with a capacity of 1,000 to 30,000 cubic meters. The smallest of these will refuel ships, indicatively in Piraeus, while the largest will supply LNG storage and distribution satellite stations in other ports in Greece or abroad. In April 2022, the specific project was included in the Operational Programme "Competitiveness, Entrepreneurship and Innovation 2014-2020", with the total cost amounting to €18 million, while the end date of the project is December 31, 2023.

Oil

The projected investments in the oil sector in the current decade (2022-2031) are going to focus on two main axes. The first axis concerns the investments carried out on a continuous basis by the country's two oil groups, i.e. HELLENiQ ENERGY and Motor Oil, which aim to maintain and further modernize and upgrade the four refineries, which are already operating in Greece, with ultimate goal:

- The increase in refining capacity in order to rise exports to the Balkans and elsewhere.
- The expansion of the petroleum products produced with an emphasis on added value and low carbon products.
- Taking advantage of the opportunities arising from the new form of gas stations, which will sell an increased range of products, such as gasoline, CNG, diesel, electricity and, where applicable, hydrogen, LNG, etc.
- The reduction of the carbon footprint of the refineries themselves.

The second axis of oil investments concerns hydrocarbon exploration. It may be that the Greek Prime Minister’s announcements at the beginning of April 2022 regarding the restart of hydrocarbon exploration and exploitation activities were accompanied by the official announcement of the French TotalEnergies about its withdrawal from the two offshore blocks of Crete, but the climate has changed and the government is speeding up exploration and exploitation activities.

The plan of the Greek government for the exploitation of the domestic deposits seems to be limited in the first phase to the simple survey to record the size of the hydrocarbon deposits in its territory. The Greek companies (HELLENiQ ENERGY and Energean), as well as the US ExxonMobil, which are already located in the offshore and onshore concessions, will bear the burden of conducting the seismic surveys.

Indicatively, in February 2023, it was announced the completion of two-dimensional seismic surveys in the two offshore blocks West and South-West of Crete, carried out by ExxonMobil, operator of the two blocks that owns 70% of the consortium of concessionaires (with HELLENiQ ENERGY holding the rest 30%). The Investment Decision for exploratory drilling will be taken towards the end of 2023 and if it is positive, the drilling in the offshore blocks of Crete will start at the end of 2024 or at the beginning of 2025.

It is worth mentioning that in February and March 2022, the first two-dimensional seismic surveys of HELLENiQ ENERGY were carried out in the “Ionio” and “Kyparissiakos Gulf” offshore concessions. This was followed in the winter of 2022 by 3D seismic surveys in the same blocks, as well as in that of Energean’s northwestern Ionian Sea. Their results will potentially unlock the arrival of new investors, capable of carrying out the drilling.

RES

Law 4951/2022 on RES aims to modernize the licensing process for RES projects, increase the capacity of the electricity grid, reduce the average licensing time for new RES projects to 14 months from 5 years, and develop storage projects of at least 3.5 GW by 2030. Also, to reserve space for self-production and net metering. The strategic goal by 2030 is for the total installed power from RES to rise to 25 GW, from 8.62 GW today. For the implementation of new RES investments with a total capacity of more than 12 GW, it is estimated that investments of €10 billion will be needed.

(a) Electricity Generation from RES

According to the new NECP, an increase in the share of RES participation in gross final energy consumption is expected to at least 35% by 2030 (80% in gross final electricity consumption in the same period), from almost 17% in 2017, mainly at the expense of the use of fossil fuels.

In order to achieve the above objectives, the following are required:

- Construction of small and large (utility-scale) power plants from RES, with the majority of them mainly involving photovoltaic and wind (including offshore wind farms), as well as construction of concentrating solar power systems.
- Installation of photovoltaic systems on roofs, with interconnection to the electricity supply network. Within the decade, the availability of building elements with integrated photovoltaic and related energy elements is predicted.
- Construction of new small and large hydropower plants.
- Construction of geothermal units. These units can only be built where there are geothermal fields (high enthalpy in Milos and Nisyros, medium enthalpy in Lesvos, etc.)
- Construction of electricity generation units from biomass. It is noted that the use of biomass in Greece is limited in relation to the availability of residual biomass.
- RES self-production units for industrial facilities, space heating-cooling, hotel and other equipment (washing machines, dryers, ironers, etc.), as well as desalination projects, irrigation, etc. in non or insufficiently electrified areas.

(b) Production of other forms of energy with RES

<u>Utilization of Solar and Geothermal Energy for Heat Production/Use</u>

- Solar thermal water heating systems
- Space heating
- Heat for industrial and agricultural processes

Production of Liquid-Gaseous Biofuels

- Construction of biofuel production units. For example, production of biomethane (from plants) for injection into the natural gas network and bioethanol (from plants)/biodiesel (from fats) for blending into transport fuels (cars and trucks).
- Strengthening biofuel markets.

Production of Solid Biomass

- Construction of biomass/biogas units, indicatively, with the participation of local livestock cooperatives

It is noted that during the utilization of biomass, less greenhouse gases and especially sulfur dioxide are produced compared to the use of solid fossil fuels. Also, the energy utilization of vegetation, which grows on its own, produces less methane and carbon dioxide than would be produced during its natural decomposition.

New District Heating Networks

- Construction of district heating and district cooling units and networks in the domestic, tertiary and agricultural sectors, utilizing specific geothermal fields of low enthalpy, residual solid biomass.

Opportunities are presented, among others, regarding:

  - Utilization of local RES potential (mainly biomass) for district heating in areas of Northern Greece and semi-mountainous/mountainous areas, as well as in specific islands of the Northern Aegean.

  - Utilization of existing district heating infrastructure, in areas under delignitisation phase where biomass or other fuel is available.

The NECP aims to develop district heating networks using solid biomass and geothermal energy of the order of 3 GWh.

Primary Sector

- Projects to strengthen the primary sector, through the promotion of woody biomass energy crops or tree plantations
- Sustainable forest management projects

Improving Energy Efficiency

Improving energy efficiency of homes and equipment is considered one of the most cost-effective ways to achieve energy, climate and greenhouse gas emission reduction goals, as well as energy poverty and security.

(a) Energy upgrading of buildings (private and public commercial buildings)

Buildings are currently responsible for approximately 40% of final energy consumption. In order to reduce the thermal quantities and the energy and carbon footprint of buildings and cities, manage energy consumption, limit climate impacts and reverse urban climate change as much as possible, as well as improve the energy efficiency of the building stock, it is foreseen within the framework of Directives 2010/31/EU and 2018/844/EU the implementation of energy efficiency upgrading works in 15% of the country's public and private buildings in the period 2020-2030, i.e. in approximately 60,000 buildings per year, i.e. 600,000 buildings.

More specifically, they are required:

- Programmes for energy upgrading of public buildings, moving to new buildings and construction of new buildings as follows:
    - From 01.01.2021, any new lease or purchase of a building or building unit by central government agencies must be near-zero energy consumption (energy class A and above).
    - From 01.01.2024, all buildings housing public authorities should be classified in energy class B' and above.

The ELEKTRA programme, with a total budget of €500 million with the prospect of an increase, aims to create attractive and sustainable energy upgrade investments in the building stock of the general government entities.

- From 01.01.2021, for every building or building unit available for sale or for rent, the energy efficiency index will be declared in all commercial advertisements.

The concept of energy upgrading also includes self-production systems from RES to meet building needs for electricity.

- Residential energy upgrade programmes. After the two successful implementation phases of the “Save at Home” programme, it is expected that there will be a third phase, while special emphasis will be placed on addressing energy poverty.
- Energy upgrade programmes for other private buildings, industrial buildings, tertiary sector buildings, etc.

(b) Increasing energy efficiency except for buildings

In order to upgrade the energy efficiency of energy infrastructure and to improve energy efficiency in transmission, distribution, load management and the interoperability of networks, it is required:

- Replacement of transformers, transmission lines and related power supply equipment with more energy efficient ones.
- Replacement of compressors and related equipment of natural gas networks with more energy efficient ones.

It will also be promoted with information programmes if not funding/incentives:

- Energy efficiency upgrade/replacement of industrial equipment with more efficient ones.
- Energy efficiency upgrade of heating-cooling systems of industrial premises.
- Upgrading energy efficiency in the agricultural sector (pumping stations, agricultural machinery, etc.).
- Installation of automation, architectural interventions, etc. to reduce energy consumption in greenhouses and livestock units.
- Replacement of lamps/lights in municipal and public spaces in general with new technology.
- Replacement of automatic traffic signaling systems with new technology, low consumption and voltage (48V LED).

Energy Storage

Greece’s goal is to have at least 3.5 GW of electricity storage facilities in operation by the end of 2030, in addition to the existing two hydropower plants. The storage projects will contribute to increasing the penetration of RES and thereby reducing the country’s energy dependence on imported fossil fuels and enhancing its capacity sufficiency and energy competitiveness. They will also contribute to reducing greenhouse gas emissions by at least 55% by 2030, in line with the objectives of the European Green Deal, reducing electricity costs for end consumers.

By the end of 2025, based on the forecasts of the Recovery and Resilience Fund (RRF), storage facilities with a total capacity of around 1,500 MW will have been added, of which 800-900 MW will mainly come from limited capacity storage systems (e.g. batteries) and about 700 MW from large capacity storage systems (e.g. pumped storage). Greece was the first country among the EU to notify the General Directorate of Competition of an aid scheme for electricity storage facilities.

Electricity storage systems are divided into two categories: (a) pure storage projects, i.e. individual storage facilities for which the electricity storage permit will be granted in proportion to the requirements existing for specific RES projects and (b) storage projects which are combined with RES projects.

In the context of strengthening the storage capacity of the network, a series of investments is foreseen, such as:

- Construction of pumped storage facilities (e.g. in the area of Amfilochia and Amari in Crete).
- Construction of battery storage facilities, at a grid or consumer scale.
- Construction of RES projects for charging EV batteries, as far as possible autonomously from the grid.
- Construction of RES projects for the production of hydrogen (power-to-gas) for injection into the natural gas network, its use as a fuel for heating buildings or in transport to power fuel cells.
- Electricity generation projects from RES for heating-cooling (power-to-heat), such as through heat pumps or batteries.

Hydrogen

In 2021, substantial steps had been made in the development of the hydrogen market in Greece. In the first wave of Important Projects of Common European Interest (IPCEI) for hydrogen, the participation of five Greek projects was approved (see Chapter 8). This development means that the shortlisted projects are one step closer to being supported by European Union financial instruments and participating in the emerging European hydrogen value chain.

After the approval and pre-notification of the projects by the member states, each scheme will be asked to demonstrate to the European Commission the maturity of the projects from a technical and financial point of view, in accordance with the criteria for the IPCEI. Among others, the innovative character, the proposed industrial exploitation, the possibility of undertaking and successfully implementing the project by the interested party, the feasibility of the proposed projects, the spill-over effects and the completeness of business plans will be examined. The process will lead to the precise determination of the financial gap that should be covered by national and European aid.

The aim of the Greek participation in the first wave of IPCEI for hydrogen is to signal the start of a domestic hydrogen economy, through the implementation of the qualified projects and its interconnection with the emerging pan-European hydrogen value chain. This will be noted with the parallel creation of industrial-scale hydrogen production, processing, storage and transport units, but also the creation of internal demand by initially supplying energy-intensive industrial consumers and continuing with the transport and shipping sectors.

According to the National Hydrogen Strategy for 2030, a domestic production of 3,500 GWh of hydrogen from electrolysis, with a total capacity of 750 MW, is foreseen, which will be supplied by electricity generation from RES projects, with a capacity of 3 GW (80% photovoltaic and 20% wind). The green hydrogen produced will mainly replace natural gas and partly petroleum products in the fields of refineries, industry and transport.

9.3. Estimated Energy Investments in Greece (2022-2031)

Table 22 summarizes the estimated energy investments in Greece over a decade, for the period 2022-2031. These estimates take into account a number of assumptions (see Annex IV), including the assumption that the country, from 2022 onwards, will follow a path of growth rather than recession over the next decade with an average annual growth rate of 1.5%.

Table 22: Estimated Energy Investments in Greece, 2022-2031

	Sector	Description	Estimated investments in million €
OIL	Upstream	▪ Field exploration, new oil and gas drillings, construction of onshore and offshore infrastructure*[1]	5,500
	Downstream	▪ Upgrading and modernization of refining facilities	3,500
NATURAL GAS	Pipelines, natural gas networks and other infrastructure	▪ Development of urban and regional networks	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	▪ Completion of PPC's lignite-fired power plant	300

	(new plants)	(including CHP) and resumption of mines	
		▪ Natural gas units (CCGT)*4	1,500
		▪ Energy storage (including batteries and pumped storage projects)	3,000
	Electricity network	▪ Oil-fired power plants on the islands (including Crete and Rhodes)	150
		▪ Upgrade and expansion of the existing network and interconnection of islands (including new high-voltage transmission lines)	4,000
	RES	▪ Small hydropower plants	150
		▪ Wind (onshore and offshore)	9,000
		▪ Solar PV*5	12,000
		▪ Concentrating Solar Power	600
		▪ Biomass (including liquid biofuels)	750
		▪ Geothermal (high and low enthalpy)	500
		▪ Green hydrogen/CCUS	4,000
ENERGY EFFICIENCY	Energy efficiency	▪ Energy upgrade of buildings (private and public commercial buildings), energy savings in businesses and industry	12,000
		▪ Electromobility	2,500
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	1,100
	Total Estimated Investments up to 2031		***66,000***

<u>Σημείωση:</u> ***1**The total investment cost is an IENE estimate and is based on planned 8-10 exploration and production drillings, ***2**The Greece-North Macedonia interconnection pipeline is included. The East Med gas pipeline is not included, ***3**The FSRUs in Alexandroupolis (INGS Alexandroupolis and INGS Thrace) of Gastrade, Thessaloniki of Elpedison, Dioriga Gas of Motor Oil and Volos (INGS Argo) of Mediterranean Gas, as well as complementary projects at the Revithoussa LNG terminal are included, ***4**The new CCGTs of (a) GEK TERNA-Motor Oil, (b) PPC-DEPA Commercial-Damco Energy, (c) Elpedison and (d) Mytilineos Group are included, ***5** Central self-generating units, rooftop PV installations and electricity storage systems are included.

Source: IENE

The energy investments presented in Table 22 result from:

- The goals set by the revised National Energy and Climate Plan (NECP[50]), with a total budget of €43.8 billion. It should be noted that the NECP envisages the radical transformation of the domestic energy sector, which will lead to a carbon-neutral economy for the benefit of society and the environment.
- The recording of energy business and investment proposals and the analyzes carried out by IENE on a continuous basis.

[50] https://energy.ec.europa.eu/system/files/2020-01/el_final_necp_main_el_0.pdf

- The Development Programme of the National Natural Gas System 2023-2032, with a total budget of €1.27 billion, published by DESFA. Also, the Development Study 2021-2030 and the Demand Assessment Study 2022-2031 of DESFA have been taken into account.
- The Transmission System Development Programme 2023-2032, which has been published by IPTO. Moreover, the 2022-2031 Capacity Adequacy Study, also prepared by IPTO.
- The Electricity Market Reform Plan, as uploaded on the RAE website.
- The Long-term Energy Strategy for 2050, prepared by the Ministry of the Environment and Energy, which is a roadmap for climate and energy issues.
- The investment programmes of energy companies.

The above Table does not include the 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.

9.4. Sources of Financing for Energy Investments

Today, there is a large number of financing sources and tools, so that the interested investor, private company or government entity, can examine and carefully choose the most suitable form of funding. The following is a brief description of the offered community, national and international sources of financing, where funds and know-how can be drawn, in order to be useful and support small and large energy investments in Greece.

European Funding Sources

The following five European structural funds have played a decisive role in the financing of 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 various regions of the EU.
- The **European Social Fund (ESF)**, which supports employment-related projects across Europe and invests in Europe's human resources - workers, young people and all those looking for work.
- The **Cohesion Fund (CF)**, which finances projects in the transport and the 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 dealing with the particular challenges facing the EU's rural areas.
- The **European Maritime and Fisheries Fund (EMFF)**, which helps fishermen to adopt sustainable fishing practices and coastal communities to diversify their economies to improve the quality of life along Europe's coasts.

It is noted that during the programming period 2021-2027:

- The use of financial tools is increasing.
- The importance of repayable aid (given through financial instruments) is increasing.
- Grants are generally reduced.
- It is possible to combine Fund resources with resources from other sources.
- The pursuit of increased leverage and recycling of resources is strengthened.

The broadest European programmes:

- The **Horizon programme** during the programming period 2021-2027 (Horizon Europe), but also during the period 2014-2020 (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** in the programming period 2021-2027, which will focus on sustainable infrastructure, research, innovation and digitalisation, small and medium-sized enterprises and social investment and skills.
- The **Just Transition programme** during the programming period 2021-2027, which is the main pillar for planning a development strategy in the lignite areas and is expected to provide the necessary means to achieve significant economic, social and environmental results. The Just Transition programme has a total budget of €1.63 billion and is structured in 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 actions of an energy nature such as district heating, electrification, 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 specific European funds for Climate Change and energy include:

- The **European Just Transition Fund (JTF)**, which was financed in June 2021 with new EU funds amounting to €17.5 billion.
- The **European Emissions Trading Scheme (EU Emissions Trading Scheme, EU ETS)**, which is the central European Mechanism for reducing greenhouse gas emissions. Part of the resources from the EU ETS is used to promote energy efficiency measures and policies.

The European programmes specific to Climate Change and energy:

- The **LIFE programme**, which is the EU 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, water and sanitation sectors.
- Other **European** and **international investment banks**.
- **Interstate agreements** and **memoranda of cooperation/understanding**.

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 attributable 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 receive from the supplementary package of the "REPowerEU" project, as announced by the European Commission in May 2022, an additional amount of €3 billion, reaching €34 billion in total.

National Funding Sources

The main sources of funding for government investments in general include:

- The **Regular Budget**.

- The annual **Public Investment Programme (PIP)** (both the national PIP, which includes projects that are financed purely from national resources and the co-financed PIP, which includes projects in the financial structure of which European funds, European programmes and/or other International Financial Organizations, etc. It is noted that the planning is for three years, e.g. 2021-2023.

- The **National Development Programme (NDP)** of Law 4635/2019, the subject of which is the medium-term development plan for the utilization of the 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 energy, environment and urban development sectors, as well as its participation in relevant Public and Private Partnerships (PPP).

The specific national funds for Climate Change and energy include:

- National revenues from the **European Emissions Trading System** (revenues from auctions of greenhouse gas emissions rights), through the Green Fund.

- The **Green Fund**, which aims to support programmes, measures, interventions and actions aimed at highlighting and restoring the environment, supporting the country's environmental policy and serving the public and social interest. Programmes of €73 million were recently announced to the country's Municipalities for Environmental Upgrade Projects.

- The **National Energy Efficiency Fund (ETEAP)**, which is expected to be the basis for the development of new financial tools that will combine subsidies, guarantees and loans, to finance programmes and other measures to improve energy efficiency as well as the development of energy services market.

The Climate Change and energy specific national (co-financed) programmes include:

- The national part of the **LIFE programme**, namely the **LIFE-IP AdaptInGR programme**, for the 1st (2016-2025) and 2nd (from 2026) adaptation phase.
- The **"Save at Home"** and **"Electra"** programmes for private and public buildings, respectively.

The Greek financial sector:

- The Greek investment and other banks, including the Investment Bank of Greece.
- Investment companies.
- Insurance institutions.

Simple and complex financial tools:

- Green bonds and green financing in general.
- Energy Performance Contracts (EPCs).
- Investment loans, to be repaid (also) by a programme.
- Self-production and net metering schemes, mainly for the financing of energy upgrading of residential buildings of energy-vulnerable households.
- Energy communities, with the participation of persons and/or Local Government Organizations and/or Legal Entities of Public or Private Law.

Utilization of market mechanisms:

- Creation of an organized Greek energy market of financial products, in order to achieve a smooth transition to the new market framework.
- Operation in the Hellenic Energy Exchange of a trading platform within the natural gas market, expanding the country's potential as an energy hub.
- Operating aids, especially for RES (through the Special RES Account), for the period of time that these are legitimate.
- Competitive procedures for energy savings, 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. For example, the increase in fixed depreciation rates for energy saving investments for legal entities and the tax exemption for costs for the energy upgrade of buildings and the installation of RES systems for natural and legal entities.
- Urban planning incentives. Indicatively, incentives for the relocation of industrial units to Industrial and Business Areas.
- Investment laws.
- Energy efficiency obligation schemes, which ensure that energy distributors and/or energy retailers designated as obliged parties achieve a cumulative end-use energy savings target.

It is worth noting that the incentives may concern the realization of investments or the achievement of goals in general. Indicatively, they can relate to the production and distribution of new technologies/low carbon fuels.

Other incentives:

- Ensuring the possibility of financing part of the project from banking institutions.
- Provision of guarantees.
- Undertaking part of the business risk that financial institutions do not undertake.
- Facilitating access to financing for Energy Service Companies (ENSCOs).
- Adoption of a low discount rate to determine the minimum energy efficiency requirements of buildings.

Investment budgets of energy companies (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 entities of public interest in the context of Law 4403/2016, Corporate Social Responsibility and more widely, to publish and by extension implement 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 generations to come. It includes the Principles for Responsible Banking, the Principles for Sustainable Insurance and the Principles for Responsible Investment.

Critical Success Factors

The success of the implementation of the above energy investments to serve the aforementioned goals is expected to mainly depend on the following:

- Timely completion of the relevant legislative, regulatory, administrative and financial work, as well as the work of creating investment and other incentives.

- Timely environmental permitting, which may also require optimization of processes.
- Targeted incentives to the research industry 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 and Southeast Europe’s energy market, with regulatory and political stability.
- Investment and financial stability and investment incentives in general, necessary for leveraging significant private capital.

To the extent that many of the aforemntioned energy investments require systems and components produced in China or other countries whose economy has been affected for an extended period of time, the completion of the investments may be delayed. This makes relevant projections necessary in the financing scheme of the investments.

10. Prospects for the Further Development of the Greek Energy Market

Globally and at the Greek level, the energy sector emerges as one of the most resilient and dynamically developing sectors. This is evidenced by the trajectory of investments over the last three years, where despite the successive crises (see pandemic, war in Ukraine, rising interest rates), they follow a steadily upward trend.

According to data from the International Energy Agency (IEA), in 2022 the total investments in the energy sector globally reached $2.4 trillion and cover the entire range of energy sources and related infrastructure. It should be noted that the global energy investments increased by 8% compared to 2021.

More specifically, the power generation sector absorbed $977 billion, the fossil fuel sector $852 billion and projects related to improving energy efficiency $563 billion. As for projects related to clean forms of energy, the allocation to investments is as follows:

- **Electric vehicles:** $93 billion.
- **Low carbon footprint and CCUS projects:** $19 billion.
- **Electricity grids and energy storage:** $377 billion.
- **Energy efficiency and similar projects:** $470 billion.
- **RES:** $472 billion.

So we see that in 2022 60% of the total global energy investments were directed to projects related to clean forms of energy, with an exaggeration in terms of electricity grids, since these serve at the same time electricity produced from fossil fuels. Therefore, the actual percentage of clean energy investment is closer to 50%.

The upward trend observed in energy investments globally was also followed in Greece, if we take into account the data contained in Chapter 9.3, where data are listed for the projected investments in the Greek energy sector in the period 2022-2031. These are estimated at €66.0 billion, including funds for research, significantly higher than the €45.2 billion estimated for the period 2020-2030, as stated in the corresponding IENE Report for 2020[51].

We should also note that the majority of additional investments concern RES and energy efficiency, since 60% of the total investments in the energy sector during the current decade, based on Table 1 in subsection 9.3 of this Report, correspond to RES projects, energy upgrading of buildings and energy saving projects in businesses and industry.

However, with the investments in energy production units (conventional and RES), in electricity and gas grids, in energy efficiency improvement systems, in research, etc., there are also investments in services and in the consulting sector which are really hard to record. But as energy markets change and become more flexible, new players are emerging to bring investment and dynamism to the market.

Taking into account both the investments in fixed and new production units as well as the development at the level of services, the general feeling is that we are in front of a strong development trend of the Greek energy sector which will positively affect several other sectors (e.g. building, construction, metallurgy, electrical products, etc.). And the further digitization of the energy sector (e.g. smart electricity and gas meters, energy consumption control systems, etc.) is going to bring about significant changes, helping to modernize it.

Also, we should note that the tectonic changes in the energy sector during the last five years have allowed us to see traditional companies from the fossil fuel field, such as HELLENiQ ENERGY (formerly HELPE) and Motor Oil, expanding their activities into RES. With the latter suddenly acquiring a huge size in the area of RES with the acquisition of Anemos from ELLAKTOR. At the same time, they allowed us to see powerful investors vote for the Greek energy, such as Fairfax in Mytileneos or the almost complete deal of the Australian First Sentier in Terna Energy.

Still, it is clear that all these major companies and investors see a path to success and great profitability from the ongoing transformation of the sector. This trend is reinforced by the fact that green investments and in general the movements of companies in clean forms of energy, the circular economy and sustainability, secure financing much more easily.

[51] IENE (2020), «The Greek Energy Sector – Annual Report 2020», *IENE Study (M56),* https://www.iene.gr/articlefiles/iene_meleti_2020_final1.pdf

The assessment is that all these changes will have specific benefits for the economy and for citizens in general. In addition to the many new jobs already being created, the energy transition to more environmentally friendly and lower-cost forms of energy, to which all these investments and acquisitions are contributing, will provide abundant and cheaper energy for all consumers. This is a small "revolution", which is taking place in the middle of an energy crisis, which has not yet stopped. With the crisis having acted as a catalyst offering incentives to consumers, households and businesses should proceed with investments aimed at improving the energy efficiency of homes and commercial buildings, offices, hotels, etc.

11. Conclusions

In recent years, the health crisis, due to the spread of the coronavirus pandemic, and the energy crisis, particularly due to Russia's invasion of Ukraine, have had a significant impact on the domestic energy sector, leading to a decline in gross domestic energy consumption.

A characteristic of the Greek energy sector is the historically high dependence of the country on oil and natural gas, 99% of which are imported on average, but also the large use of lignite in domestic electricity generation, with a notable increase in the contribution of RES only in recent years. A peculiarity of the national energy system is the limited extent of the district heating networks in an electrical system consisting of the interconnected system and the autonomous electrical systems of the islands (Non-Interconnected Islands - NIIs).

Greece has been moving towards the energy transition to clean energy sources, following the trend for a decarbonized European economy, through Directives and regulations of an integrated 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 until 2030 at least.

The efficient and secure operation of the single interconnected European energy market and free and highly competitive energy flows, through energy exchanges and transmission and distribution networks throughout Europe, are undoubtedly the main goals of the energy policy of Europe and Greece.

The integration and rapid promotion of RES at the top of Greece's energy mix through regulations and market conditions and not with costly subsidies, as well as the absorption and integration of the emerging dispersed and horizontally developed energy production, are included in the updated NECP.

Energy storage and energy saving technologies, the development of modern infrastructure (e.g. electricity and natural gas interconnections, expansion of smart networks and charging points throughout Greece for electric cars) and the greater penetration of electric vehicles are also expected to play a decisive role in transport, dealing with cross-border problems, the security of interconnected national networks, the use of new technologies (e.g. hydrogen, biomethane) as well as energy poverty.

At the same time, the development of smart grids and electricity distribution meters, energy communities, self-regulation of consumption by the consumer/producer, the development of small private production and the net metering, with the respective consumptions from the national grid, among others, will reduce energy needs and it is expected to develop the necessary energy efficiency which, together with RES and energy storage, are the pillars for meeting the carbon neutral target by 2050.

Also, the prospects of restarting the hydrocarbon exploration and exploitation activities in Greece are now characterized as promising, as such prospects can drastically change, depending on the quantitative and qualitative characteristics of the blocks, the energy landscape of Greece and help achieve its development goals. But even in the case of a small production of both oil and natural gas, with the aim of covering part of the domestic energy needs, this effort will have economic and geopolitical benefits and therefore must be supported by all governments and political parties, regardless political beliefs, as it has a direct impact on the creation of domestic know-how and jobs, with an absolutely positive contribution to economic development, but also to the security of energy supply. It should also be mentioned the pivotal role of an increased domestic production of hydrocarbons for the reduction of the country's energy dependence.

In order to have a more complete picture of the current state of the energy sector in Greece, it is deemed necessary to enumerate key energy quantities.

Total energy system

- The gross inland energy consumption reached 21,511 thousand tons in 2021, showing a significant decrease of 24.1%, compared to 2010, while, in relation to 2020, an increase of 5.2% was recorded.
- For 2021, the transport sector had the largest contribution as a share of final energy consumption (37.2%), while also the participation of both the residential and industrial sectors was significant (28.4% and 17.2% respectively). In the transport sector, road transport dominates energy consumption, accounting for 86.8% of the sector in 2021.
- The contribution of RES to energy consumption in Greece shows a significant increase during the period 2006-2021, as its total contribution in 2021, as a share of gross energy consumption, amounted to 21.9%.
- The share of electricity from RES in 2021 was 35.9%, showing an impressive increase, compared to 2006, when the corresponding share was 9%.
- The degree of energy dependence of Greece is high. In 2010, 68.6% of the gross available energy in Greece came from imports. In 2021, this share increased to 81.8%, mainly due to an increase in the share of imported oil and fossil fuels.

For oil

- The production of crude oil in Greece in 2021 was insignificant (59.4 thousand tons), compared to the gross domestic consumption of petroleum products of the order of 10.2 million tons in 2021.
- Iraq was the largest supplier of crude oil to Greece in 2021, with 10.4 million tons, followed by Russia with 6.65 million tons and Kazakhstan with 3.3 million tons.
- The consumption of petroleum products in Greece, after the reduction 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 caused by the Covid-19 pandemic, while in 2021 it increased by only 1.3%.
- The transport sector consumed 5.3 million tons of oil in 2021, accounting for 70.8% of total oil consumption, followed by the household sector with 15.3% and industry with 9.4%.
- Total production of petroleum products reached 30.8 million tons in 2021.

For natural gas:

- 2021 was a record year for natural gas consumption in Greece, as domestic consumption between January and December 2021 increased by 10.81% and reached 69.96 million MWh from 63.1 million MWh in 2020. In contrast, for 2022, total consumption was reduced by 19.04%, reaching 56.64 TWh, as dictated by the EU's targets to reduce 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 role of natural gas in electricity generation significantly increased in 2021 reaching 41.1% of gross electricity generation, up from 39.8% in 2020 and 21.9% in 2012.
- In 2022, there was a huge 288.68% increase in natural gas exports from 7.6 TWh in 2021 to 29.54 TWh in 2022. Correspondingly, natural gas imports reached 86.16 TWh, registering an increase of 10.84% compared to 77.73 TWh in 2021. The largest quantities entered the country from the Revithoussa LNG terminal, which covered 44.2% of imports, recording a significant increase compared to 2021.

For electricity:

- Regarding electricity demand, it reached 50,675 GWh in 2022, reduced by 3.3%, compared to 2021, which amounted to 52,411 GWh. It is characteristic that after the first quarter of 2022, a decline in energy demand was observed due to the high prices of natural gas and electricity, which began to increase from February 2022, due to Russia's invasion of Ukraine. In 2022, electricity demand was about the same as in 2018.

- In 2022, RES dominated the electricity generation mix, with a percentage of 38.8%, leading natural gas to the second place, with a percentage of 35.4%. There was also a decrease in the share of hydropower plants to 7.9% from 10.1% in 2021 and a small increase in production from lignite with a share of 11% (10.2% in 2021), while imports remained at the same levels.
- 2022 was a milestone as RES were the dominant fuel in terms of electricity generation, with a share of 41.6% and a production of 19.2 TWh. Natural gas held the second place with 38% and 17.9 TWh and lignite the third place with 11.8% and 5.6 TWh, followed by hydro with 8.5% and 4 TWh.
- In 2022, the total installed capacity of units in Greece's interconnected system reached 20.82 GW. The installed RES capacity in Greece reached 10,172 MW over the same year, a reduced capacity of lignite units was recorded, while the capacity of natural gas and hydropower plants remained unchanged. The grand total per power generation source is analyzed in Table 21.

Table 21: Total Installed Electricity Capacity in Greece, 2022

Fuel Mix	Installed Capacity (GW)
Interconnected system	
Lignite units	2,25
Natural gas units	5,2
Hydropower units	3,2
Total RES units	10,17
Total installed capacity in the interconnected system (A)	**20,82**
Non-Interconnected Islands (NIIs)	
Total thermal units	0,94
Total RES units	0.17
Total installed capacity in the NIIs (B)	**1,11**
Grand Total (A+B)	**21,93**

Sources: IENE, IPTO, DAPEEP, DEDDIE

- In 2022, the total electricity generation in the interconnected system of Greece amounted to 46.43 TWh, while the corresponding one in the NIIs amounted to 2.26 TWh. The grand total reached 48.69 TWh, the breakdown of which is analysed in Table 22.

Table 22: Total Electricity Production in Greece, 2022

Fuel Mix	Net Generation (TWh)
Interconnected system	
Total RES and CHP units	18.9
Hydropower units	4
Natural gas units	17,95
Lignite units	5,58
Total electricity generation in the interconnected system (A)	**46.43**
Non-Interconnected Islands (NIIs)	
Total thermal units	1,9
Total RES units	0,36
Total electricity generation in the NIIs (B)	**2,26**
Grand Total (A+B)	**48,69**

Sources: IENE, IPTO, DAPEEP, DEDDIE

- The vertically integrated state electricity company PPC dominates the Greek electricity market. The installed power generation capacity of PPC reached 10.4 GW in 2021 and represented approximately 49% of the installed power generation capacity in Greece. In 2021, PPC produced 26 TWh, which together with the 1.0 TWh it imported, covered 43.7% of the total demand. The electricity produced came from lignite (20.5%), oil (15.3%), natural gas (42.4%), hydro (20.4%) and RES (1.4%).

For lignite:

- Electricity generation from lignite decreased significantly from 10.4 TWh in 2019 to 5.34 TWh in 2021 and 5.59 TWh in 2022 due to the development of RES, lower overall demand for electricity and high cost of CO2 allowances that makes power generation from lignite uneconomical.
- Greece's lignite production, mostly from PPC, increased by 17.6% to 6.7 Mt in the first half of 2022, surpassing the 5.7 Mt in the first half of 2021. PPC operates seven thermal power plants with a total capacity of 2,225 MW, which are supplied with lignite from the lignite areas of Western Macedonia and Megalopolis. After the closure of two mines in 2021, three mines remain in operation: two in Western Macedonia and one in Megalopolis.

For energy efficiency:

- Most of the buildings in Greece are energy-intensive, thermally unprotected, no energy-efficient materials have been used for their construction and in overall they do not meet high comfort standards. This is because over 50% of residential buildings in Greece were built before 1980, when relevant legislation and stricter energy efficiency regulations had not been implemented, there were no Community Directives to reduce emissions and no energy efficiency systems were implemented.
- On the contrary, the buildings, which were constructed after 2010, when the Regulation on the Energy Performance of Buildings (KENAK) began to be implemented and its minimum requirements were incorporated in all newly constructed buildings, constitute only 1.5% of the total housing stock.
- A key tool for promoting energy efficiency in Greece is the “Save at Home” programme.
- In addition, the “Recycle-Change Device” Programme, implemented by the Ministry of the Environment and Energy, subsidizes the Greek households for the replacement of old electrical appliances with new, environmentally friendly and more energy efficient ones. The total budget of the programme amounts to €148 million.
- Also, an important role for the promotion of energy efficiency is played by both industry and transport, where energy consumption is characterized as high and, therefore, there is considerable energy saving potential.
- In industry, in 2018, an important programme to improve energy efficiency was launched, by carrying out energy audits, as required by the Community Directive on Energy Efficiency (Energy Efficiency Directive-EED) 2012/27/EU and its amendment of 2018/2002. The first phase of the energy audits of the obliged companies and/or industries started in 2018 and ended in 2021. In 2022, the second phase of the energy audits of all the obliged companies/industries started, which will also show the progress achieved in the energy efficiency, with the implementation of energy saving measures, which were proposed by the energy audit of the first phase.

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Appendices

Appendix I: Relations Between Energy Quantities 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

Appendix II: Energy Balance of Greece for 2021 and 2010

1. Energy Balance of Greece for 2021, ktoe (preliminary data)

Ktoe 2021 preliminary	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	Pure biogasoline	Blended biogasoline	Pure biodiesels	Blended biodiesels	Pure bio jet kerosen	Blended bio jet kerosene	Other liquid biofuels	Ambient heat (heat	Non-renewable waste	Industrial waste	Non-renewable	Electricity	Fossil energy	Bioenergy
+ Primary production	5,193.0	1,439.1	59.4	4.1	3,682.5	507.6	0.0	901.4	451.5	303.9	4.3	786.9	Z	127.2	0.0	13.9	Z	146.1	Z	0.0	Z	0.0	439.6	7.9	7.9	0.0	Z	1,510.5	1,074.1
+ Recovered & recycled products	13.7	0.0	13.7	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	13.7	0.0
+ Imports	38,757.8	164.2	32,315.7	5,429.8	196.2	Z	Z	Z	Z	0.0	0.0	33.4	39.2	0.0	0.0	83.2	0.8	39.6	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	651.8	38,297.2	202.1
- Exports	21,542.1	0.0	21,146.2	13.4	47.5	Z	Z	Z	Z	0.0	0.0	4.6	0.0	0.0	0.0	0.0	9.0	20.0	14.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	335.1	21,358.7	50.6
+ Change in stock	899.0	107.6	756.4	28.2	6.9	Z	Z	Z	Z	Z	Z	0.0	0.0	0.0	0.0	5.1	-0.5	2.3	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	892.2	6.9
= **Gross available energy**	**23,321.4**	**1,710.9**	**11,999.1**	**5,448.7**	**3,838.0**	**507.6**	**0.0**	**901.4**	**451.5**	**303.9**	**4.3**	**815.6**	**39.2**	**127.2**	**0.0**	**102.2**	**-8.6**	**168.0**	**-14.0**	**0.0**	**0.0**	**0.0**	**439.6**	**7.9**	**7.9**	**0.0**	**316.8**	**19,354.8**	**1,232.6**
- International maritime bunkers	1,810.8	0.0	1,810.8	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	1,810.8	0.0
= **Gross inland consumption**	**21,510.6**	**1,710.9**	**10,188.3**	**5,448.7**	**3,838.0**	**507.6**	**0.0**	**901.4**	**451.5**	**303.9**	**4.3**	**815.6**	**39.2**	**127.2**	**0.0**	**102.2**	**-8.6**	**168.0**	**-14.0**	**0.0**	**0.0**	**0.0**	**439.6**	**7.9**	**7.9**	**0.0**	**316.8**	**17,544.0**	**1,232.6**
- International aviation	696.5	Z	696.5	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	696.5	0.0
= **Total energy supply**	**20,814.1**	**1,710.9**	**9,491.9**	**5,448.7**	**3,838.0**	**507.6**	**0.0**	**901.4**	**451.5**	**303.9**	**4.3**	**815.6**	**39.2**	**127.2**	**0.0**	**102.2**	**-8.6**	**168.0**	**-14.0**	**0.0**	**0.0**	**0.0**	**439.6**	**7.9**	**7.9**	**0.0**	**316.8**	**16,847.6**	**1,232.6**
Gross inland consumption (Europe 2020-2030)	21,070.9	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	20,334.2	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)	15,210.9	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	**42,804.8**	**1,528.1**	**35,283.0**	**3,728.8**	**2,249.8**	**507.6**	**0.0**	**901.4**	**451.5**	**0.0**	**0.0**	**27.0**	**0.0**	**92.1**	**0.0**	**102.2**	**0.0**	**168.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**7.9**	**7.9**	**0.0**	**7.1**	**40,552.1**	**389.4**
+ Electricity & heat generation	8,372.1	1,528.1	1,122.3	3,728.8	1,977.8	507.6	0.0	901.4	451.5	0.0	0.0	25.2	0.0	92.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	7.9	7.9	0.0	7.1	6,391.4	117.4
+ Main activity producer electricity only	6,886.9	655.8	945.5	3,406.1	1,879.5	507.6	0.0	901.4	451.5	0.0	0.0	9.8	Z	9.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	5,007.4	19.0
+ Main activity producer CHP	910.2	872.4	0.0	0.0	37.8	Z	Z	Z	Z	0.0	0.0	0.0	Z	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	872.4	37.8
+ 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	7.7	0.0	0.5	0.0	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	7.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	0.5	7.2
+ Autoproducer CHP	560.2	0.0	176.3	322.7	53.3	Z	Z	Z	Z	0.0	0.0	15.4	Z	37.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	7.9	7.9	0.0	Z	506.9	53.3
+ 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	7.1	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	7.1	4.2	0.1
+ 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	0.1	0.0	0.1	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	0.1	0.0
+ Gas works	0.4	0.0	0.4	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	0.4	0.0
+ Refineries & petrochemical industry	34,159.9	Z	34,159.9	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	34,159.9	0.0
+ Refinery intake	30,729.7	Z	30,729.7	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	30,729.7	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	2,117.4	Z	2,117.4	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	2,117.4	0.0
+ Interproduct transfers	1,312.7	Z	1,312.7	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	1,312.7	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	270.2	Z	Z	Z	270.2	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	102.2	Z	168.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	0.0	270.2
+ Charcoal production plants	1.8	Z	Z	Z	1.8	Z	Z	Z	Z	Z	Z	1.8	Z	Z	Z	0.0	Z	0.0	Z	0.0	Z	0.0	Z	Z	Z	Z	Z	0.0	1.8
+ 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	0.3	0.0	0.3	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	0.0	0.0	0.0	0.0	Z	0.3	0.0

Transformation output	**39,258.1**	**0.0**	**34,261.3**	**0.0**	**245.1**	**Z**	**Z**	**Z**	**Z**	**Z**	**Z**	**Z**	**0.4**	**0.0**	**Z**	**Z**	**76.7**	**Z**	**168.0**	**Z**	**0.0**	**Z**	**Z**	**Z**	**Z**	**Z**	**4,704.7**	**37,104.6**	**288.0**
Electricity & heat generation	4,751.7	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	4,704.7	2,843.3	42.9
+ Main activity producer electricity only	4,200.8	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	4,200.8	2,496.8	38.3
+ Main activity producer CHP	298.5	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	258.5	193.7	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	3.0	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	3.0	1.8	0.0
+ Autoproducer CHP	244.5	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	237.4	148.2	2.2
+ 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	5.0	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	5.0	3.0	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	34,261.3	Z	34,261.3	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	34,261.3	0.0
+ Refinery output	30,796.1	Z	30,796.1	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	30,796.1	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	2,154.1	Z	2,154.1	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	2,154.1	0.0
+ Interproduct transfers	1,311.0	Z	1,311.0	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	1,311.0	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	244.7	Z	Z	Z	244.7	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	76.7	Z	168.0	Z	0.0	Z	Z	Z	Z	Z	Z	0.0	244.7
Charcoal production plants	0.4	Z	Z	Z	0.4	Z	Z	Z	Z	Z	Z	Z	0.4	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	0.0	0.4
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	**1,794.4**	**0.0**	**1,298.5**	**208.8**	**2.3**	**Z**	**Z**	**Z**	**Z**	**0.0**	**0.0**	**0.0**	**0.0**	**2.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**Z**	**0.0**	**0.0**	**0.0**	**284.9**	**1,676.6**	**4.9**
Own use in electricity & heat generation	160.1	0.0	15.1	0.0	2.3	Z	Z	Z	Z	0.0	0.0	0.0	0.0	2.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	0.0	0.0	0.0	142.7	99.9	3.6
Coal mines	25.5	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	25.5	15.1	0.2
Oil & natural gas extraction plants	9.0	Z	0.0	9.0	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	0.0	9.0	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)	1,559.3	0.0	1,282.5	199.8	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	77.0	1,528.0	0.7
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)	40.5	0.0	0.8	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	39.7	24.4	0.4
Distribution losses	**512.6**	**0.0**	**0.0**	**18.7**	**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**	**482.5**	**316.8**	**4.4**
Available for final consumption	**14,960.4**	**182.8**	**7,171.7**	**1,492.3**	**1,831.0**	**0.0**	**0.0**	**0.0**	**0.0**	**303.9**	**4.3**	**788.7**	**39.6**	**32.9**	**0.0**	**0.0**	**68.1**	**0.0**	**153.9**	**0.0**	**0.0**	**0.0**	**439.6**	**0.0**	**0.0**	**0.0**	**4,246.9**	**11,406.7**	**1,121.9**
Final non-energy consumption	**736.8**	**0.0**	**432.3**	**304.5**	**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**	**Z**	**736.8**	**0.0**
Non-energy use industry/transformation/energy	718.0	0.0	413.6	304.5	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	Z	718.0	0.0
+ Non-energy use in transformation sect	3.6	Z	3.6	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	3.6	0.0
+ Non-energy use in energy sector	31.8	Z	31.8	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	31.8	0.0
+ Non-energy use in industry sector	682.7	Z	378.2	304.5	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	Z	682.7	0.0
Non-energy use in transport sector	13.3	0.0	13.3	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	13.3	0.0
Non-energy use in other sectors	5.4	0.0	5.4	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	5.4	0.0

Final energy consumption	14,953.9	184.0	7,559.0	1,177.3	1,764.6	Z	Z	Z	Z	303.9	4.3	788.7	39.6	34.5	0.0	0.0	0.0	0.0	153.9	0.0	0.0	0.0	439.6	0.0	0.0	0.0	4,233.3	11,472.1	1,055.3
+ Industry sector	2,565.7	179.3	700.4	507.4	132.0	Z	Z	Z	Z	1.7	0.1	104.4	0.0	21.9	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1,046.5	2,009.2	139.8
+ Iron & steel	145.6	0.0	11.8	37.0	0.1	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	Z	0.0	0.0	0.0	96.7	106.2	1.0
+ Chemical & petrochemical	98.5	0.0	25.9	30.4	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	42.1	81.4	0.4
+ Non-ferrous metals	613.1	0.0	7.2	281.0	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	325.0	481.3	3.0
+ Non-metallic minerals	639.5	132.6	348.1	36.8	17.9	Z	Z	Z	Z	0.0	0.0	17.5	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	Z	0.0	0.0	0.0	104.2	579.4	18.8
+ Transport equipment	5.6	0.0	1.2	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	4.3	3.8	0.1
+ Machinery	89.5	0.0	27.0	9.2	0.5	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	Z	0.0	0.0	0.0	52.8	67.6	1.0
+ Mining & quarrying	104.3	46.7	36.8	0.3	0.6	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.0	0.0	Z	0.0	0.0	0.0	19.9	95.6	0.8
+ Food, beverages & tobacco	462.5	0.0	153.6	66.2	84.0	Z	Z	Z	Z	0.0	0.0	61.7	0.0	21.9	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	Z	0.0	0.0	0.0	158.6	314.2	85.4
+ Paper, pulp & printing	71.3	0.0	15.7	15.6	3.1	Z	Z	Z	Z	0.0	0.0	3.0	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	37.0	53.2	3.4
+ Wood & wood products	34.0	0.0	1.9	0.3	22.3	Z	Z	Z	Z	0.0	0.0	22.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	Z	0.0	0.0	0.0	9.5	7.9	22.4
+ Construction	115.8	0.0	55.1	8.1	1.7	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	Z	0.0	0.0	0.0	50.9	93.5	2.1
+ Textile & leather	46.3	0.0	6.1	19.3	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	20.9	37.8	0.2
+ Not elsewhere specified (industry)	139.7	0.0	10.1	3.3	1.9	Z	Z	Z	Z	1.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	Z	0.0	0.0	0.0	124.4	87.3	1.3
+ Transport sector	5,566.2	0.0	5,380.6	21.0	148.7	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	148.7	0.0	0.0	0.0	Z	0.0	0.0	0.0	16.0	5,411.1	148.8
+ Rail	15.1	0.0	0.0	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	15.1	9.0	0.1
+ Road	4,830.4	Z	4,660.3	21.0	148.3	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	148.3	0.0	0.0	0.0	Z	0.0	0.0	0.0	0.9	4,681.8	148.3
+ Domestic aviation	151.4	Z	151.4	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	151.4	0.0
+ Domestic navigation	568.5	0.0	568.1	Z	0.4	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	Z	0.0	0.0	0.0	Z	568.1	0.4
+ Pipeline transport	0.0	Z	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	0.0	0.0	0.0
+ Not elsewhere specified (transport)	0.8	0.0	0.8	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	0.0	0.8	0.0
+ Other sectors	6,821.9	4.6	1,478.0	648.8	1,483.8	Z	Z	Z	Z	302.2	4.2	684.3	39.6	12.6	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	439.6	0.0	0.0	0.0	3,170.9	4,051.9	766.7
+ Commercial & public services	2,045.5	0.0	99.3	142.7	380.5	Z	Z	Z	Z	11.1	2.4	13.4	0.0	12.6	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	340.8	0.0	0.0	0.0	1,423.0	1,087.8	39.2
+ Households	4,244.1	3.2	1,106.8	499.3	1,075.4	Z	Z	Z	Z	291.2	0.0	645.7	39.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	98.9	0.0	0.0	0.0	1,523.6	2,550.7	699.2
+ Agriculture & forestry	298.0	0.6	43.0	4.4	27.1	Z	Z	Z	Z	0.0	1.8	25.2	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	223.0	180.5	27.3
+ Fishing	12.0	0.0	10.7	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	1.3	11.5	0.0
+ Not elsewhere specified (other)	222.4	0.8	218.2	2.4	1.0	Z	Z	Z	Z	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	221.4	1.0
Statistical differences	-730.2	-1.2	-819.6	10.5	66.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-1.6	0.0	0.0	68.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.5	Z	Z

ktoe	Total	Solid fossil	Oil and	Natural	Renewables	Hydro	Tide,	Wind	Solar	Solar	Geother	Primary	Charcoal	Biogase	Renewabl	Pure	Blended	Pure	Blended	Pure bio	Blended	Other	Ambien	Non-	Industri	Non-	Electricity	Fossil	Bioenergy
+ **Gross electricity production**	4,704.7	457.2	401.8	1,933.6	1,908.4	512.6	0.0	901.4	451.5	0.0	0.0	3.6	Z	39.3	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	3.6	3.6	0.0	Z	2,796.3	42.9
+ Main activity producer electricity only	4,205.8	209.2	359.3	1,766.5	1,870.8	512.6	0.0	901.4	451.5	0.0	0.0	1.4	Z	4.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	0.0	0.0	0.0	Z	2,335.0	5.4
+ Main activity producer CHP	258.5	248.1	0.0	0.0	10.4	Z	Z	Z	Z	0.0	0.0	0.0	Z	10.4	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	0.0	0.0	0.0	Z	248.1	10.4
+ Autoproducer electricity only	3.0	0.0	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	Z	3.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	0.0	0.0	0.0	Z	0.0	3.0
+ Autoproducer CHP	237.4	0.0	42.5	167.1	24.2	Z	Z	Z	Z	0.0	0.0	2.2	Z	22.0	0.0	0.0	Z	0.0	Z	Z	Z	0.0	Z	3.6	3.6	0.0	Z	213.2	24.2
+ **Gross heat production**	47.1	40.0	0.0	7.1	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	47.1	0.0
+ Main activity producer CHP	40.0	40.0	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	40.0	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	7.1	0.0	0.0	7.1	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	7.1	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

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	4,666.5	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. Summary of Energy Balance of Greece for the Period 2020-2030

ktoe	2020	2022	2025	2027	2030
Primary Energy Production	**5799**	**5468**	**6031**	**6696**	**7021**
Solid fuels	2180	1140	960	940	1
Petroleum products	281	332	408	459	536
Natural Gas	21	28	48	48	64
RES	3317	3969	4615	5249	6420
Net imports	**19985**	**19272**	**18440**	**17740**	**17406**
Solid fuels	158	161	137	140	152
Petroleum products	13774	13292	12742	12403	11612
Natural Gas	5230	5074	4784	4426	4800
Electricity	533	444	425	409	394
Bioenergy	290	301	351	362	448
Seagoing Shipping	**1931**	**2003**	**2111**	**2162**	**2237**
Gross domestic consumption	**23853**	**22737**	**22360**	**22274**	**22190**
Solid fuels	2339	1301	1097	1080	153
Petroleum products	12124	11620	11039	10701	9912
Natural Gas	5250	5101	4832	4474	4864
Electricity	533	444	425	409	394
RES	3608	4270	4966	5611	6868
Fuel consumption in electricity generation	**6605**	**5066**	**4331**	**4055**	**3671**
Lignite	2178	1139	959	938	0
Petroleum products (incl. refineries)	746	534	431	360	140
Natural Gas	3608	3309	2816	2375	2666
Bioenergy	72	85	125	164	322
Geothermal heat	0	0	0	217	542
Net consumption by refineries	**236**	**235**	**232**	**229**	**226**
Consumption by refineries	31696	31540	31072	30760	30291
Refinery output	31460	31305	30840	30530	30065
Energy industry consumption	**1602**	**1593**	**1583**	**1578**	**1574**
Petroleum products	1443	1435	1414	1400	1379
Electricity	100	94	100	101	103
Bioenergy	59	63	69	78	92
Net electricity generation by thermal plants	**3018**	**2610**	**2295**	**2054**	**1835**
Lignite	698	447	390	390	0
Petroleum products (incl. refineries)	309	234	190	163	71
Natural Gas	1974	1883	1648	1395	1574
Biomass-Biogas	37	46	66	84	135
Geothermal	0	0	0	22	54
Grid/Storage losses and selfconsumption of electricity	**498**	**458**	**433**	**420**	**419**
Non-energy uses	**765**	**765**	**765**	**765**	**765**
Final energy consumption	**17336**	**17357**	**17406**	**17357**	**17384**
Final energy consumption without ambient heat	**16926**	**16789**	**16714**	**16590**	**16508**
Final energy consumption without international transport	**16291**	**16286**	**16297**	**16230**	**16232**
by sector					
Industry	3011	2984	2943	2928	2879
Residential	4691	4556	4480	4430	4465
Tertiary	2177	2239	2331	2376	2451
Transport	6997	7108	7163	7121	7066
Agriculture	459	471	487	502	523
by sector (without ambient heat)					
Industry	3011	2984	2943	2928	2879
Residential	4572	4321	4211	4133	4130
Tertiary	1887	1907	1909	1907	1910
Transport	6997	7108	7163	7121	7066

Agriculture	459	471	487	502	523
by fuel					
Solid fuels	160	162	139	141	153
Petroleum products	9287	9004	8551	8299	7750
Natural Gas	1244	1386	1597	1672	1759
Electricity	4612	4571	4680	4712	4852
District heating	43	43	41	40	39
RES (direct use)	1580	1622	1705	1725	1955
Ambient heat	410	568	692	766	876

Source: NECP (2019)

Appendix III: Electricity in Greece

1. Demand (MWh), 2021 - 2022

2021

MONTH	SYSTEM TO NETWORK BOUNDARY SUBSTATIONS	DEMAND SUPPLIED BY GENERATION UNITS ON THE NETWORK	HIGH VOLTAGE CONSUMERS	MINES	SELF-PRODUCTION	PUMPING	SYSTEM LOSSES	CRETE INTERCONNECTION	TOTAL DEMAND	SYSTEM DEMAND
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
JUL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	36.659.965	**6.741.486**	**6.740.754**	**295,507**	**246,492**	**82,807**	**1.382,437**	**261,072**	**52.410,519**	**45.669,033**

2022

MONTH	SYSTEM TO NETWORK BOUNDARY SUBSTATIONS	DEMAND SUPPLIED BY GENERATION UNITS ON THE NETWORK	HIGH VOLTAGE CONSUMERS	MINES	SELF-PRODUCTION	PUMPING	SYSTEM LOSSES	CRETE INTERCONNECTION	TOTAL DEMAND	SYSTEM DEMAND
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	33.182,232	**8.362,771**	**6.706,183**	**270,503**	**251,987**	**206,587**	**1.326,921**	**380,734**	**50.687,917**	**42.325,146**

Source: IPTO

2. Evolution of Electricity Generation Mix (MWh), 2021 - 2022

2021

MONTH	LIGNITE	NATURAL GAS	HYDRO	OTHER FUEL	SYSTEM RES	NETWORK RES	CRETE INTERCONNECTION (RES)	CONVENTIONAL GENERATION	SYSTEM GENERATION	TOTAL GENERATION
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5.340,794	**20.873,296**	**5.294,017**	**20,279**	**10.451,129**	**6.741,488**	**6,151**	**31.528,386**	**41.985,666**	**48.727,154**

2022

MONTH	LIGNITE	NATURAL GAS	HYDRO	OTHER FUEL	SYSTEM RES	NERWORK RES	CRETE INTERCONNECTION (RES)	CONVENTIONAL GENERATION	SYSTEM GENERATION	TOTAL GENERATION
JAN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
FEB	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
APR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MAY	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
JUL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
AUG	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SEP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
OCT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
NOV	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DEC	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	5.585,624	**17.948,609**	**4.005,248**	**26,868**	**11.291,276**	**8.362,770**	**19,892**	**27.566,349**	**38.877,517**	**47.240,287**

Source: IPTO

3. Production of Distributed Units in the Greek System, 2022

PRODUCTION UNIT	PRODUCER	FUEL/TECHNOLOGY	NET CAPACITY (MW)	NET GENERATION (GWh)	UTILISATION COEFFICIENT (%)
AGIOS DIMITRIOS1	PPC	LIGNITE	274,00	0,00	0,00%
AGIOS DIMITRIOS2	PPC	LIGNITE	274,00	26,56	13,03%
AGIOS DIMITRIOS3	PPC	LIGNITE	283,00	105,62	50,16%
AGIOS DIMITRIOS4	PPC	LIGNITE	283,00	49,78	23,64%
AGIOS DIMITRIOS5	PPC	LIGNITE	342,00	178,05	69,97%
MEGALOPOLI3	PPC	LIGNITE	255,00	0,00	0,00%
MEGALOPOLI4	PPC	LIGNITE	256,00	63,53	33,36%
MELITI	PPC	LIGNITE	289,00	57,66	26,82%
PROLEMAIDA5	PPC	LIGNITE	616,00	125,40	27,36%
AGRAS	PPC	HYDRO	50,00	2,76	7,42%
AOOS	PPC	HYDRO	210,00	11,72	7,50%
ASOMATA	PPC	HYDRO	108,00	7,15	8,89%
EDESSAIOS	PPC	HYDRO	19,00	2,37	16,73%
ILARIONAS	PPC	HYDRO	153,00	22,36	19,64%
KASTRAKI	PPC	HYDRO	320,00	35,77	15,02%
KREMASTA	PPC	HYDRO	437,20	51,12	15,72%
LADONAS	PPC	HYDRO	70,00	12,80	24,58%
PLASTIRAS	PPC	HYDRO	129,90	2,53	2,62%
PLATANOVRYSI	PPC	HYDRO	116,00	10,71	12,42%
POLYFYTO	PPC	HYDRO	375,00	21,51	7,71%
POURNARI1	PPC	HYDRO	300,00	49,60	22,22%
POURNARI2	PPC	HYDRO	33,60	6,13	24,51%
SFIKIA	PPC	HYDRO	315,00	19,46	8,30%
STRATOS1	PPC	HYDRO	150,00	17,40	15,59%
THESAVROS	PPC	HYDRO	384,00	20,45	7,16%
AGIOS NIKOLAOS2	MYTILINEOS	NATURAL GAS	806,00	22,21	3,70%
ALIVERI5	PPC	NATURAL GAS	417,00	180,68	58,24%
ALOUMINIO	MYTILINEOS	NATURAL GAS	334,00	139,84	56,27%
ELPEDISON THESS	ELPEDISON	NATURAL GAS	400,18	153,31	51,49%
ELPEDISON THISVI	ELPEDISON	NATURAL GAS	410,00	142,16	46,60%
HERON CC	HERON2_V	NATURAL GAS	422,14	185,79	59,15%
KOMOTINI	PPC	NATURAL GAS	476,30	130,21	36,74%
KORINTHOS POWER	KOR_POWER	NATURAL GAS	433,46	223,93	69,44%
LAVRIO4	PPC	NATURAL GAS	550,20	128,37	31,36%
LAVRIO5	PPC	NATURAL GAS	377,66	66,66	23,73%
MEGALOPOLI5	PPC	NATURAL GAS	811,00	279,62	46,34%
PROTERGIA CC	MYTILINEOS	NATURAL GAS	432,70	0,00	0,00%
HERON1	HERON	NATURAL GAS	49,25	0,03	0,07%
HERON2	HERON	NATURAL GAS	49,25	0,02	0,04%
HERON3	HERON	NATURAL GAS	49,25	0,02	0,06%
TOTAL			**12.061,11**	**2.553,25**	**28,45%**

Source: IPTO

4. Load Representatives' Supply Analysis, 2022

LOAD REPRESENTATIVE	2022-01	2022-02	2022-03	2022-04	2022-05	2022-06	2022-07	2022-08	2022-09	2022-10	2022-11	2022-12	TOTAL
PPC	3.022,3	2.084,2	2.308,7	2.258,8	2.306,8	2.607,1	3.061,5	2.842,3	2.310,4	1.994,8	2.173,9	2.495,9	**30.627,0**
MYTILINEOS	322,8	282,0	316,4	255,3	275,6	311,0	359,2	331,5	333,5	433,0	312,6	296,4	**3.057,1**
HERON	298,8	287,4	293,2	237,1	254,0	289,5	336,2	309,0	277,4	263,4	261,8	272,1	**3.359,6**
ELPEDISON	276,7	233,8	266,6	254,9	236,4	257,2	303,6	296,7	245,4	229,8	225,3	237,3	**3.033,7**
NRG	200,8	171,5	194,1	150,2	163,3	188,7	220,1	202,9	176,4	166,3	166,4	182,1	**2.183,0**
ATTIKI GSC	98,5	83,1	91,5	71,2	79,2	91,1	103,8	96,8	89,0	82,4	86,5	96,7	**1.071,5**
WATT AND VOLT	117,0	93,8	101,9	72,7	75,8	86,8	106,2	98,3	76,0	67,6	70,8	83,1	**1.048,0**
VOLTERRA	87,1	83,5	90,8	74,9	81,6	91,0	99,8	92,7	88,6	83,3	76,4	72,3	**1.021,6**
ZENITH	92,8	75,7	85,8	62,1	63,2	74,7	93,4	86,9	68,6	54,8	69,7	84,4	**922,1**
VOLTON	73,8	59,3	68,1	49,6	49,2	55,4	66,3	59,2	42,6	36,3	35,6	40,2	**634,6**
PPC_USP	41,2	33,1	37,5	26,1	25,7	29,4	33,5	32,8	27,0	26,3	28,8	35,5	**377,2**
KEN	33,8	29,2	36,1	29,7	29,3	31,2	37,0	33,6	24,8	20,5	20,4	21,9	**347,6**
ELTA	12,7	10,8	11,2	8,0	8,1	10,1	12,0	10,8	7,5	6,0	5,6	6,2	**109,2**
ELINOIL	9,5	8,8	9,3	8,0	8,4	8,7	9,0	10,9	9,7	7,8	8,0	8,6	**107,5**
VIENER	8,5	8,5	8,6	6,8	7,7	8,8	7,6	6,2	7,4	6,5	6,5	5,3	**88,1**
EUNICE TRAD	3,7	3,7	3,9	3,2	3,8	4,6	5,1	4,9	4,7	5,1	4,9	5,1	**52,3**
OTE	2,6	2,2	2,4	2,0	2,0	1,2	2,2	2,2	1,8	1,7	1,7	1,9	**24,0**
MYTILINEOS_USP	1,5	1,1	1,2	0,9	0,8	1,0	1,9	1,8	1,5	1,4	1,5	1,9	**16,4**
ELPEDISON_USP	1,1	0,9	1,0	0,7	0,7	0,8	1,8	1,7	1,4	1,3	1,5	1,8	**14,7**
SOLAR ENERGY	1,1	1,0	1,3	1,0	1,1	1,2	1,6	1,3	1,3	1,4	1,1	1,1	**14,5**
LIG. MEGALOP	2,9	2,2	2,3	2,7	3,3	0,4							**13,8**
HERON_USP	1,2	1,0	1,1	0,8	0,8	0,9	1,5	1,4	1,2	1,1	1,2	1,5	**13,8**
LIG. MELITIS	1,9	2,1	2,6	3,0	3,0	0,3							**12,9**
MARKOU	0,6	0,7	0,8	0,4	0,1	0,1	0,1	0,1	1,6	3,6	1,3	0,7	**9,9**
NRG_USP	0,5	0,4	0,4	0,3	0,3	0,3	1,0	1,0	0,8	0,8	0,9	1,1	**7,8**
VIOLAR	0,4	0,2	0,2	0,1	0,1	0,1	0,1	0,1	0,7	2,2	0,6	0,3	**5,0**
KOR_POWER	0,4	0,3	0,3	0,5	0,3	0,2	0,1	0,1	0,2	0,6	0,4	0,2	**3,6**
HERON2_V	0,5	0,3	0,0	0,6	0,3	0,2	0,1	0,0	0,1	0,2	0,4	0,3	**3,0**
GREEN	0,3	0,2	0,2										**0,7**
LRS	0,0	0,0	0,0	0,1	0,0	0,1	0,0	0,0	0,0	0,0	0,0	0,0	**0,2**
TOTAL	**4.714,8**	**4.040,6**	**4.537,2**	**3.563,8**	**3.739,0**	**4.158,0**	**4.864,4**	**4.515,1**	**3.799,4**	**3.530,3**	**3.563,7**	**3.954,0**	**48.980,3**

Source: IPTO

5. Market Share of Load Representatives per Voltage Level, 2022

LOAD REPRESENTATIVE	HV(GWh)	HV(%)	MV(GWh)	MV(%)	LV(GWh)	LV(%)	TOTAL(GWh)	TOTAL(%)
PPC	554,51	87,55%	309,83	39,30%	1.631,59	64,43%	2.495,93	63,12%
MYTILINEOS	11,02	1,74%	126,95	16,10%	158,43	6,26%	296,39	7,50%
HERON	4,15	0,66%	108,12	13,72%	159,87	6,31%	272,15	6,88%
ELPEDISON	62,82	9,92%	49,36	6,26%	125,14	4,94%	237,31	6,00%
NRG	0,10	0,02%	69,66	8,84%	112,32	4,44%	182,08	4,61%
ATTIKI GSC	0,00	0,00%	38,82	4,92%	57,84	2,28%	96,66	2,44%
ZENITH	0,00	0,00%	3,14	0,40%	81,27	3,21%	84,41	2,13%
WATT AND VOLT	0,00	0,00%	6,50	0,82%	76,64	3,03%	83,14	2,10%
VOLTERRA	0,30	0,05%	50,89	6,45%	21,10	0,83%	72,28	1,83%
VOLTON	0,00	0,00%	4,15	0,53%	36,02	1,42%	40,17	1,02%
PPC_USP	0,00	0,00%	0,00	0,00%	35,51	1,40%	35,51	0,90%
KEN	0,00	0,00%	2,43	0,31%	19,51	0,77%	21,94	0,55%
ELINOIL	0,00	0,00%	6,27	0,80%	2,31	0,09%	8,57	0,22%
ELTA	0,00	0,00%	1,96	0,25%	4,27	0,17%	6,23	0,16%
VIENER	0,00	0,00%	5,34	0,68%	0,00	0,00%	5,34	0,14%
EUNICE TRAD	0,01	0,00%	2,53	0,32%	2,52	0,10%	5,06	0,13%
OTE	0,00	0,00%	1,03	0,13%	0,90	0,04%	1,93	0,05%
MYTILINEOS_USP	0,00	0,00%	0,00	0,00%	1,91	0,08%	1,91	0,05%
ELPEDISON_USP	0,00	0,00%	0,00	0,00%	1,77	0,07%	1,77	0,04%
HERON_USP	0,00	0,00%	0,00	0,00%	1,50	0,06%	1,50	0,04%
SOLAR ENERGY	0,00	0,00%	0,44	0,06%	0,68	0,03%	1,12	0,03%
NRG_USP	0,00	0,00%	0,00	0,00%	1,10	0,04%	1,10	0,03%
MARKOU	0,00	0,00%	0,67	0,08%	0,00	0,00%	0,67	0,02%
HERON2_V	0,33	0,05%	0,00	0,00%	0,00	0,00%	0,33	0,01%
VIOLAR	0,00	0,00%	0,28	0,04%	0,01	0,00%	0,30	0,01%
KOR_POWER	0,16	0,02%	0,00	0,00%	0,00	0,00%	0,16	0,00%
TOTAL	**633,39**	**100,00%**	**788,37**	**100,00%**	**2.532,22**	**100,00%**	**3.953,97**	**100,00%**

Source: IPTO

Appendix IV: Assumptions for Estimated Energy Investments in Greece, 2022-2031

A. Electricity Generation

Natural gas (CCPs)
€400 million (for units with a capacity of 800 MW)

CHP

(i) ***Combined cycle (CCGT) CHP:*** €700.000 - €1.300.000/MWe, with an average typical cost of €1.000.000/MWe. 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 an average typical cost of €735.000/MWe. 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 an average typical cost of €2.280.000/MWe. Annual operation and maintenance (O&M) costs are approximately €70.000/MWe.

(iv) ***CHP biomass:*** €3.000.000 - €3.500.000/MWe. Annual operation and maintenance (O&M) costs are approximately €70.000/MWe.

B. Energy Storage

(i) ***Pump storage for a hydropower plant with a lifespan of 40 years***
€800.000/MW

(ii) ***Batteries (4-hr lithium-ion system)***
€1.269.600/MW

C. Electricity Transmission System[52]

(i) ***Overhead lines***

Total cost per circuit path length (km), based on total cost of assets, excluding financing costs:

a. 380-400 kV, circuit 2: €700.000

b. 380-400 kV, circuit 1: €500.000

[52] It is based on estimates from the implementation of recent related projects in the Greek Electricity Transmission System. It should be noted that the unit costs per project vary depending on the specific characteristics of the projects (route, soil morphology, total distance, depth for subsea interconnections, etc.). Also, the unit costs may vary depending on the current prices of metals on the international market (copper, aluminum) and especially for subsea interconnections with the current conditions prevailing in the subsea cable construction and laying market.

c. 150 kV, circuit 2: €250.000

d. 150 kV, circuit 1: €180.000

(ii) ***Underground cables***

Total cost per route length (km):

a. 380-400 kV, circuit 2: €5.600.000

b. 150 kV, circuit 2: €1.800.000

c. 150 kV, circuit 1: €900.000

All cables are alternating current (AC) lines. There are insufficient data to evaluate direct current (DC) cables.

(iii) ***Subsea cables***

Total cost per route length (km):

a. AC cables (150-220 kV): €1.700.000

b. DC cables (250-500 kV): €900.000

D. RES[53]

(i) ***Wind***

Onshore: €1,0-1,1 million/installed MW

Offshore: €2,0 million/installed MW (for the first 1.5 GW) and €3,7-€4,0 million/installed MW (for the remaining 1.2 GW)

(ii) ***Solar thermal energy***

Solar tower (with storage): €6,0-9,0 million/installed MW

CSP: €4,3 million/installed MW

(iii) ***Solar PV***

Park: €650.000/installed MW

Rooftops: €700.000/installed MW (for 400-500 kW)

(iv) ***Biomass***

€2,2-3,0 million/installed MW

(v) ***Hydro***

Large hydro: €2,0 million/installed MW (without expropriations)

Small hydro (up to 15 MW): €2,5 million/installed MW

(vi) ***Geothermal*** (high enthalpy)

€4,0-4,5 million/installed MW

[53] The assumptions are based on the assumption that RES investments are implemented linearly over time, satisfying the individual mid-term goals of the NECP.

(vii) *Green hydrogen*

Alkaline electrolytes: €460.000-€920.000/MW

Polymer Electrolyte Membrane or Proton Exchange Membrane: €644.000-€1.564.000/MW

(viii) *Biogas*

€0,665/kWh (for 110.000 tons of incoming biomass)

€0,570/kWh (για 320.000 tons of incoming biomass)

€0,530/kWh (για 500.000 tons of incoming biomass)

E. Natural Gas

Unit price range of investments:

Fixed equipment category	€/m	Unit	Description
medium pressure steel networks	230-370		it depends on the diameter of the pipe and the number of components
Low pressure networks PE	73-100		it depends on the diameter of the pipe and the number of components
Distribution pipes	1.049-1.610		it depends on the content that each operator attributes to the term distribution
Urban meters		178-360	it depends on the category and the size of meters
Intersection stations 19/4		50.000-73.329	it depends on the mechanical and electronic equipment which includes
CNG installation		344.000-795.000	it depends on the content that each operator includes in the station
LNG installation		serious discrepancies	it depends on the content that each operator includes in the station

F. Estimated CAPEX for Hydrocarbon Exploration Activities

(i) *Onshore deep drilling*

€35 - €40 million per drilling for depths up to 3.000 meters

€60 million per drilling for depths between 3.000 meters and 6.000 meters

(ii) *Offshore drilling* (shallow waters)

€30 million per drilling

(iii) *Offshore drilling* (deep waters)

€50 - €100 million per drilling for depths up to 2.000 meters

€150 - €200 million per drilling for extremely deep waters (more than 2.000 meters)

(iv) *Horizontal drilling*

€25 million per drilling