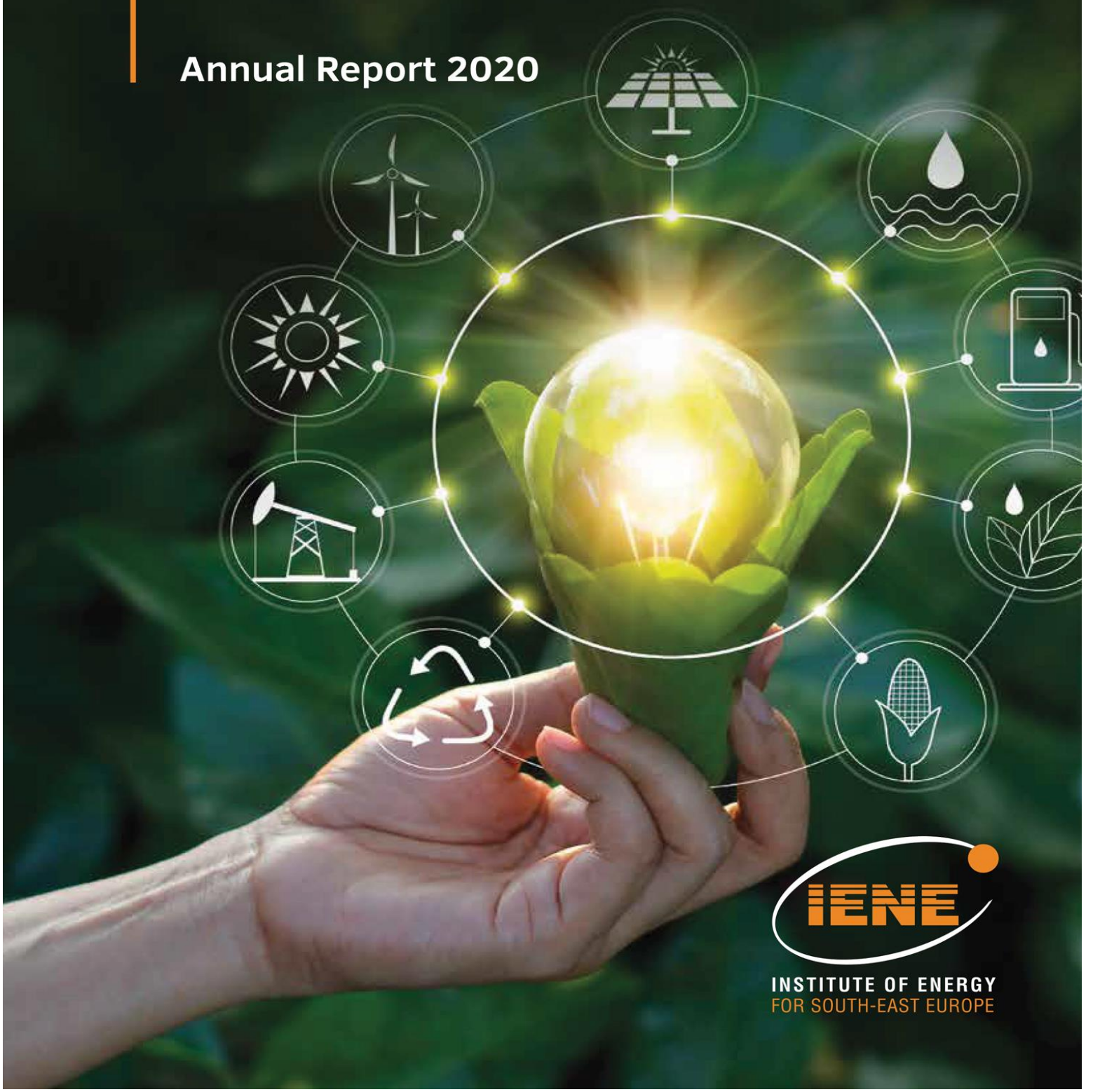
The Greek Energy Sector

Annual Report 2020



INSTITUTE OF ENERGY
FOR SOUTH-EAST EUROPE

"The Greek Energy Sector - Annual Report 2020"

Authors:
Dimitris Mezartasoglou, Head of Research, IENE
Costis Stambolis, Chairman and Executive Director, IENE
Alexandros Perellis, Senior Researcher, IENE
Alexandros Koutroumbousis, Senior Researcher, IENE

Institute of Energy for SE Europe (IENE)
3 Alexandrou Soutsou Street, Athens 106 71, Greece
Tel.: +0030 210 3628457, 3640278 fax: +0030 210 3646144
web: www.iene.gr, e-mail: secretariat@iene.gr

*The present study was financed by the Institute's own resources.

“The Greek Energy Sector - Annual Report 2020”

IENE Study (M56)

October 2020

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.

Table of Contents

Introduction

The publication of IENE's Annual Report, for a second consecutive year, on the Greek Energy Sector is a landmark for our Institute, especially considering the difficult working conditions that prevailed this year due to the coronavirus pandemic. Normally, it would have been issued in June, but restrictions due to the coronavirus crisis and the difficulties of organising such a complex project in these circumstances did not permit its completion before late September. In any case, this year's edition, much improved to that of 2019, aspires to contribute to a better understanding for the structure and operation of Greece's energy sector, a sector that undoubtedly constitutes the "backbone" of the economy and is a vital growth factor.

This year's Report covers all types of energy, including oil, natural gas, electricity, solid fuels, renewable energy sources as well as energy efficiency and cogeneration. It also refers to the current energy policy and how it fully reflects European targets and the key challenges in planning an overall energy strategy for the country. It also examines the energy position of Greece regarding latest developments and prospects in SE Europe. Lastly, the energy investment outlook over the period 2020-2030 is also presented.

The present Report, which was exclusively financed by the Institute's own resources, was prepared by IENE's scientific personnel and was based on data and analyses extracted from the Institute's database and official sources in Greece and globally. The significant research work undertaken by the Institute in recent years and its ongoing monitoring of the Greek and regional energy market formed the basis of such a Report.

I would like to believe that this Report, and the fact that access to it freely available, will be useful for the government, but also for businesses and companies active in the energy sector.

Costis Stambolis

Chairman and Executive Director IENE

Athens, October 2020

Executive Summary

The year 2019 saw significant progress in basic energy infrastructure projects and in the complex task of energy policy planning. The past year was marked by new developments in the Greek energy sector, including substantial institutional interventions mainly aimed at strengthening competition at all levels, which led to a further deregulation of the market for electricity and natural gas. These very interesting developments in 2019 - on the basis of both institutional changes and the implementation of specific projects - have created favourable prospects for 2021 and the long term.

Despite the coronavirus pandemic crisis and the serious consequences it still has for the energy sector, mainly due to a sharp drop in demand, the long-term prospects for growth and restructuring of the domestic energy market remain positive. A brief focus on the main developments in the Greek energy sector during 2019 follows as well as a detailed analysis of the prospects per energy source for 2020 and beyond.

Electricity

In the electricity sector, an important development in 2020 was the elimination of the day-ahead operational model based on a mandatory pool, along with the implementation of Target Model through the four new markets in the Hellenic Energy Exchange, which were launched on November 1, 2020, following the considerable preparatory work realised in 2018 and 2019 by the Ministry of Energy, the Regulatory Authority for Energy, the Electricity Market Operator, the Independent Power Transmission Operator and the Stock Exchange. In addition, the ongoing efforts to restructure PPC (Public Power Corporation) will be crucial in the further liberalisation of Greece's electricity market, with the main aim of the decarbonisation and the parallel increase in the use of Renewable Energy Sources (RES).

Of great significance are also the developments regarding the electricity interconnections of the islands with the power grid in mainland Greece, and improved cross-border interconnections that will enable the national electricity transmission system to cover the requirements of the new targets for RES penetration and the incorporation of energy storage systems by 2030. Indicatively, the Independent Power Transmission Operator (IPTO) has already announced the inclusion in its ten-year plan for the years 2021-2030 of the electricity interconnection of the North Aegean islands, to be realised at the same time as the interconnection of the Dodecanese. With regard to the country's international interconnections, IPTO's ten-year plan includes the construction of the second interconnector pipeline between the Greek and Bulgarian power systems, an upgrade of existing lines, and

the development of new interconnections with the neighbouring systems of North Macedonia and Turkey. Concerning the interconnection of Crete with the mainland grid, the "small" interconnector (Crete - Peloponnese) has been planned for 2020, while the "big" interconnector (Crete - Attica) is expected to be completed in 2023.

Natural Gas

The prospect of transforming Greece into a natural gas hub for the Balkan market begun in 2016 when construction work commenced on the TAP pipeline, and continued with projects that have been completed or are expected to be launched within the three-year period 2020-2022, such as the IGB pipeline which is currently under construction. The upgrade of DESFA's (Natural Gas Operator) LNG terminal at Revithoussa was completed in late November 2018, which, apart from the addition of third storage tank, also included an extension of the port facilities so that ships with a capacity of up to 260,000 cubic metres, the largest LNG tankers at the present time, can moor there. However, the most important project is the construction of a third tank at the facilities, with a capacity of 95,000 cubic metres, thus increasing guaranteed capacity at Revithoussa to 220,000 cubic metres.

Also expected to contribute to this grand plan is the operation of the floating LNG or FSRU terminal at Alexandroupolis, operated by Gastrade, a company of the Kopelouzos Group, of which the final investment decision is expected at the end of 2020. The FSRU will have storage facilities of 170,000 cubic metres and will be connected by pipeline with the national natural gas system, to become the fourth entry point for natural gas into Greece and SE Europe. This project is expected to supplement the operation of the Interconnector Greece – Bulgaria (IGB), the construction work of which commenced in 2019 and its completion is scheduled for 2021. The entry point of the pipeline will be at Komotini and the exit point at Stara Zagora in Bulgaria. The construction of TAP was recently completed, with the aim of making the first deliveries of natural gas within 2020. In parallel, the active support of the governments of Greece, Cyprus and Israel for implementing the East Med gas pipeline has created a new momentum, especially after the signing of the final intergovernmental agreement between Greece, Cyprus and Israel on January 2, 2020 in Athens.

Furthermore, several new projects are expected to be launched within 2020/2021, including the gas interconnector between Greece and North Macedonia and the reverse flow of the Greek-Turkish gas pipeline, which has been in operation since 2017. The promotion of this project - in conjunction with the construction by DESFA of a bypass pipeline along the length of the Greek-Turkish border in Evros - is considered a key factor so that Greece can benefit

from a direct interconnection with the Turkish Stream hub in Turkish territory. Another very important project for DESFA will be the transformation of the existing balancing platform into a gas trading hub, known as Hellenic Trading Point, which is expected in 2021, reinforcing the role of the Hellenic Energy Exchange.

Another important project concerning gas infrastructure is the transformation of the South Kavala depleted gas field into a permanent underground gas storage facility. The implementation and operation of this project is not expected before 2023.

In early 2018, the monopoly of the gas providers (EPA) in Attica and Thessaloniki-Thessaly ended, and now household consumers can switch suppliers. In practice, the full deregulation of the natural gas market also impacts the electricity market, since almost all electricity providers have already obtained from RAE a licence to procure natural gas; conversely, the two EPAs expanded into electricity market procurement. This means that the way is now open for the offer of "packages" to consumers that combine electricity and natural gas as a single energy product. Another important development at institutional level in the natural gas sector is the imminent privatisation of the Public Gas Corporation (DEPA) scheduled for 2021, to be accompanied by its separation into two separate companies so as to comply with EU unbundling requirements, i.e. separation of the commercial undertaking from the ownership and operation of the infrastructure.

Oil and Petroleum Products

In general, liquid fuels and petroleum products comprise an extremely dynamic sector of the economy, involved in all aspects of economic activity. According to the data of the Hellenic Petroleum Marketing Companies Association (SEEPE), internal market fuel sales rose slightly by 0.45%, from 6,655,720 tons in 2014 to 6,685,490 tons in 2018. It is worth noting that the drop in oil product consumption in 2018 as compared to 2017 (6,899,847 tons) was mainly due to a fall in consumption of heating oil and unleaded gasoline. The main feature of the domestic market for oil products is the lack of preventive control measures regarding the fuels in the market, so allowing scope for large-scale illegal activity (adulteration, smuggling) and problems in establishing rules of healthy competition; this impacts adversely the operation of healthy, law-abiding businesses, and ultimately public revenue.

Hydrocarbon Exploration Activities

Important developments are expected in 2020 and the succeeding years in hydrocarbon exploration activities in Greek territory; drilling is being planned in Katakolo and the Gulf of

Patras, the Ionian Sea and Western Greece, where actual concession areas are in place and exploratory drilling is planned for the period 2025-2028, as part of the strategic plan for reinforcing the country's energy security and increasing public revenue. Drilling operations are also planned in the concession areas south and southwest of Crete.

Hydrocarbon exploration will be of decisive importance in the next years, since Greece is set to eliminate lignite completely by 2028, as a major indigenous fuel. As the use of natural gas increases, while domestic lignite is being phased-out, locating hydrocarbon deposits becomes an imperative need. Therefore, Greece must make every possible effort in hydrocarbon production over the next years, so it can gradually cover part of the energy it consumes.

Significantly, during the period 2014-2019 Parliament ratified 11 lease agreements for concession of exploration and operation rights. The joint ventures that will undertake the exploration activities are international, consisting of French, American, Spanish and Greek companies. The concessions in the northern Ionian Sea and mainland Western Greece are more likely to yield crude oil deposits, with natural gas appearing further south, as indicated by the results of drilling in the past decades. The concessions in the southern Ionian Sea, especially to the west and south of Crete, feature great sea depths and no previous drilling, but the geological environment and geometric structures are very similar to those of Egypt and Cyprus, even Israel, where large natural gas deposits have been discovered in recent years.

Thus, drilling on land and sea in the following seven years will hopefully lead to specific finds and the start of domestic production. Discovery of deposits of at least 500 million barrels of oil equivalent or 3 trillion cubic feet of natural gas would occasion very considerable commercial developments for the country. In such a case, investment from large international firms would markedly increase, with a favourable impact on the growth of the domestic economy, accompanied by a robust legislative and institutional framework incorporating European directives and the required safety and environmental protection specifications.

Renewable Energy Sources (RES)

The transition of Greece’s energy system towards clean forms of energy is reflected in the National Energy and Climate Plan (NECP), which aims to high penetration of RES in the final energy consumption by 35% over the next decade (2020-2030), up from 17% now. The preparation, submission and ratification by the Greek Parliament of related draft legislation with provisions for simplifying licencing procedures for RES projects, aiming at reducing the

time required for obtaining a licence, was considered particularly important and is expected to greatly facilitate many "green" investment plans, assessed at €9 billion (RES in electricity production) by 2030, according to the NECP. Furthermore, issues of spatial planning are very important in the process of the maturity and licencing of RES projects, and in conjunction with the new Special Land-Use Plan for RES, now being drawn-up, are expected to play an important role in the growth of this sector over the next years.

The experience of recent years indicates that the rapidly evolving RES technologies can achieve low and competitive prices, with high penetration into the network. In this context, the power grid is being transformed by innovative technologies so as to incorporate the increasing penetration of RES that offer high-level performance, reliability and new services to consumers, while the market is reforming, seeking fresh tools for responding to the new challenges in its operation. In Greece, as in other countries, electricity is evolving as the main source of energy production and use, gradually replacing fossil fuels, as it enters into almost everywhere, such as transport, heating/cooling, etc., and hence enhancing growth. Electric vehicles and the production of hydrogen for fuel cells in buses and trucks, expected to enter the market shortly, will constitute the extension of the power grid. Greece has now the opportunity to develop RES on a large scale, giving high priority to grids, in an effort to radically change its production model in both electricity and transport sectors, but also in heating/cooling.

Energy Efficiency

In terms of energy efficiency, an important support program is the co-financed "Saving at Home", which offers incentives to citizens in order to improve the energy efficiency of their homes and thus, saving money and energy. The first two rounds of the program were successfully implemented, while a third one is expected to follow. "Saving at Home" (3rd Round) for private homes has a budget of €350-€400 million and will act as a bridge to the "mega-save" program for the energy upgrade of buildings, amounting to €5 billion in total, which will be launched in 2021 with annual financing of €500 million each year up to 2030. Another planned program is the "ELECTRA" program for public buildings, so that energy efficiency is achieved via Energy Service Companies (ESCOs) with increased participation by the private sector, as well as energy efficiency programs for industry, small- and medium-sized businesses and Energy Communities.

Energy efficiency obligation schemes are expected to emerge as crucial factors, as they are the most widespread market mechanism that leads to optimal implementation of energy

efficiency improvement measures in terms of costs and results. The energy efficiency obligation schemes require that energy efficiency measures are implemented not only by electricity and gas providers, as is the common practice in EU member-states, but also by oil product suppliers and oil marketing companies. The energy efficiency obligation schemes will account for a minimum of 20% of the total cumulative energy savings target, while both energy providers and distribution network operators will participate in the scheme.

Energy Policy

A very positive development in terms of energy policy in 2019 was the completion and updating of Greece's energy plan up to 2030 by the National Committee for Energy and the Climate at the Ministry of Energy and Environment, as well as long-term energy planning to 2050. Both have as a prime goal the country's energy transition to climate neutrality, as per EU requirements. Thus, the country now has two very useful tools for its energy strategy, since Greece's energy system, like that in many other countries, particularly in the EU, is now in a transition period; thus, gradually eliminating its lignite reliance for electricity generation and its contribution to the energy mix, aiming to a reduction of greenhouse gas emissions. The two plans, in their final edition, will comprise the Strategic Agenda on energy and climate issues, while the implementation plans must follow, adapting latest developments, in order to meet the targets for 2030 and 2050 respectively.

Climate Change

In 2019, Greece moved from the last places at the top in terms of climate policy, as it now aims at phasing out all lignite power producing units by 2028 at the latest. This commitment was also included in the new NECP, while PPC's new business plan is even more ambitious, as it includes the closing down of all lignite units by 2023. Hence, Greece is among the 15 most advanced countries in the EU in this respect, which have already decided to fully phase out coal/lignite, and is the first lignite-producing EU member state that has set a firm decarbonisation date prior to 2030. Moreover, Greece is the 33rd country globally that enters into the international Powering Past Coal Alliance.

Energy Investments

The need to move towards a "green" energy model requires the opening up of the domestic energy market, a change in the energy mix with increased participation of clean energy, higher investment in RES and energy efficiency, higher use in digitalisation and attractiveness of private capital in gas and electricity distribution networks, which will enable their expansion

and modernisation. The benefits of this transition will be not only environmental but also economic, since the turn towards a sustainable energy model will offer incentives for investment in clean energy and scope for innovative business activities, which will create new jobs.

At the epicentre of investment plans will be waste management, energy productivity, and recycling and cyclical economy activities. According to the NECP, total energy related investment, including cyclical economy projects, is expected to reach €44 billion up to 2030 in Greece, without taking into account investments in hydrocarbon exploration and exploitation activities. IENE's estimate for total energy investments, excluding cyclical economy but including hydrocarbon exploration and exploitation activities, exceeds €45 billion, as analysed in the present Report. These IENE estimates are based on a wide range of assumptions, including that the country will experience growth rather than recession (as projected for 2020) over the next decade, with an average annual growth rate of 1.5%.

However, there are risks and uncertainties, including, *inter alia*, the economy (recession, banking sector crisis, fall in demand, etc.), the regulatory framework (inadequate legal and legislative framework, bureaucracy, etc.), the absence of specialised studies, but also the security of infrastructure, all of which could impact the aforementioned energy investments. The prospects and targets for future energy investments, included in the present Report, must be assessed in the light of the above limitations. Even so, given that investments are a key factor for the short- and the long-term growth of the Greek economy, the targets for exploiting the high investment momentum offered by the energy sector must remain constant. Thus, the total energy investments, as estimated by IENE, must be considered as an investment potential and not as a given figure.

Impact of the coronavirus pandemic on the Greek energy market

This Report was at an advanced stage of preparation when the coronavirus crisis hit Europe, leading to a range of restrictive measures. The crisis also impacted the energy sector, as to all forms of energy. The most obvious consequence was a sudden, sharp drop in demand which affected all energy markets and led to a considerable fall in prices, especially in the oil sector, but also in the natural gas sector and, less so, the electricity sector.

The COVID-19 also impacted hydrocarbon exploration activities, the construction and maintenance of energy and industry units (electricity production, refining, transport), electricity providers and companies marketing oil products, the manufacturers of photovoltaic

modules and wind turbines, but also producers of batteries for electric vehicles and in turn the manufacturers of such vehicles, on the level of both demand and supply and prices. Also negative were the consequences on construction of new LNG and LPG tankers and offshore oil and gas production units. Further, the coronavirus impacted considerably the prices of EU emission trading system (ETS), due to the restrictions of economic activity overall.

In this context, IENE prepared a Special Interim Report, highlighting the above consequences of the coronavirus spread across the entire energy sector in Greece, citing a large amount of data. The methodology applied was based on: (a) thorough analysis of data derived from the main entities and companies of the domestic energy market; and (b) dispatching to selected domestic energy companies and then analysing targeted questionnaires, with the aim of obtaining a more comprehensive and detailed picture of the consequences that the virus brought about for companies in the various branches of the energy sector.

The main aim of the Interim Report was to investigate the ways in which the Greek energy system responded to the spread of the pandemic, and how it was affected by the restrictive measures applied while retaining its reliability and, in most respects, and continuing its regular operation. Concurrently, the Special Report constitutes a record of all energy-related developments at the time when the pandemic was peaking, and so contributes to shaping appropriate policies for handling similar crisis situations in future.

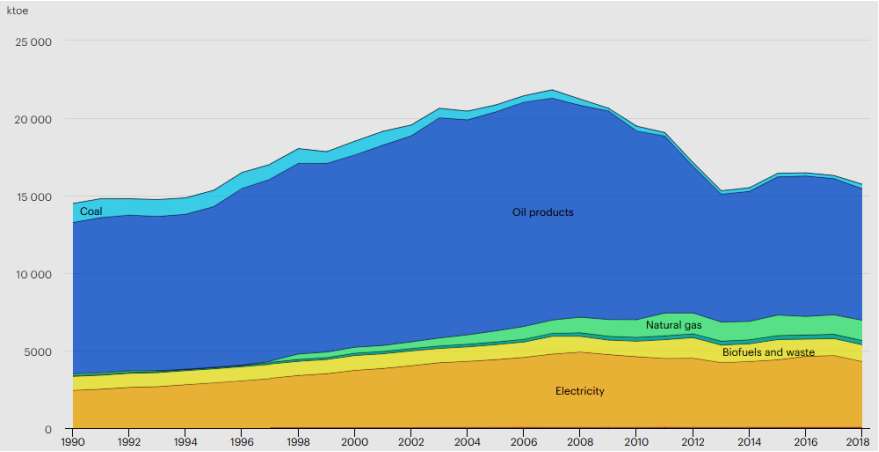
1. The Energy Market in Greece: A broad Overview

From the early 1990s until now, the Greek energy system has developed in line with the requirements of the national economy, the evolution of other economic activities and the growth of specific sectors, affecting consumer habits, but also European policies on energy, the environment and growth.

In the total energy system, domestic final energy consumption was at 15,735 kilotons of oil equivalent (ktoe) in 2018, down 3.5% from 2017. Figure 1 depicts the share of the various fuels in final energy consumption over the period 1990-2018. Oil products account for the largest share in final use consumption (54.2% in 2018), followed by electricity (27%), RES (8.7%), natural gas (8.3%) and lignite (1.8%).

The consumption of fossil fuels in final use, namely petroleum products, lignite and natural gas, decreased considerably in 2018 compared to consumption levels in 2007, falling by 36%. This reduction was to a large extent balanced by consumption of natural gas, the use of RES and electricity. Indicatively, consumption of natural gas rose by approx. 54% to 1,297 ktoe in 2018 as compared to 2007. Over the same period, the shares of oil products and lignite were reduced by 41% to 8,493 ktoe and by 47% to 282 ktoe respectively.

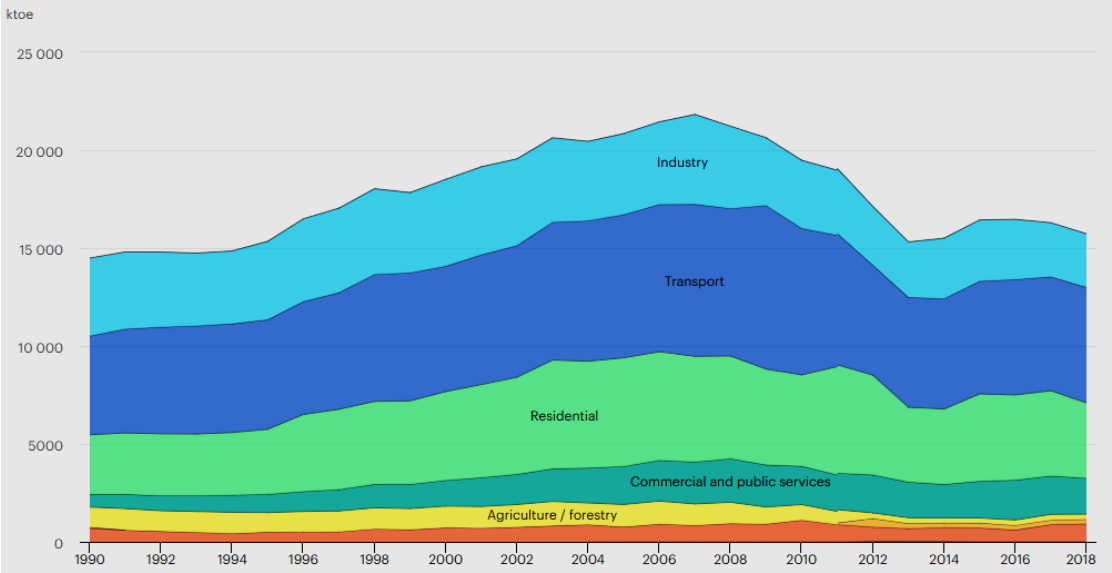
Figure 1: Final Energy Consumption by Type of Fuel in Greece, 1990-2018



Source: IEA

In 2018, the largest drop was in the industrial sector, a decline of approx. 40% to 2,739 ktoe, followed by the residential sector and transport, a decline of 29% to 3,845 ktoe and of 24% to 5,897 ktoe respectively in final energy consumption, as compared to 2007.

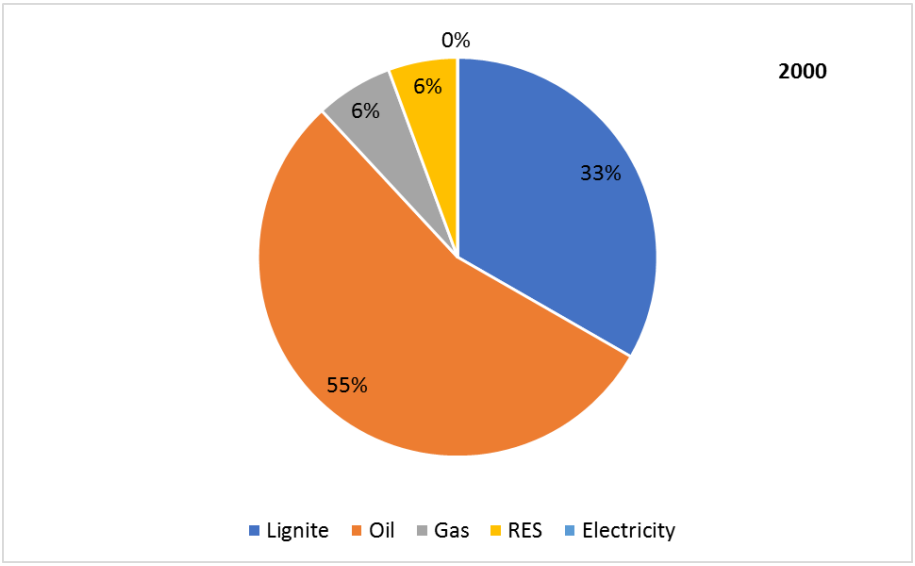
Figure 2: Final Energy Consumption by Sector in Greece, 1990-2018

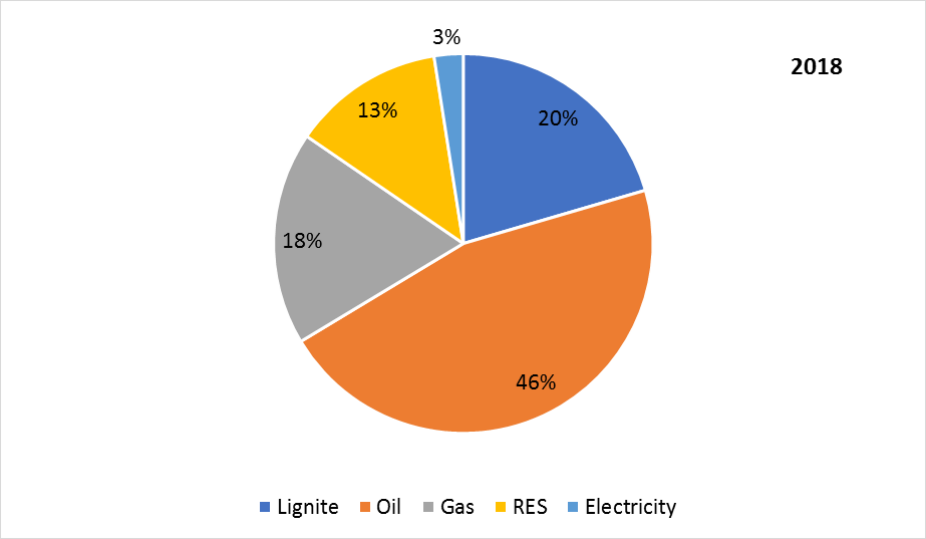


Source: IEA

Concerning Greece's total primary energy supply, IEA data for 2018 indicate that oil and oil products account for 46%, followed by lignite (20%), natural gas (18%) and RES (13%), as shown in Figure 3.

Figure 3: Total Primary Energy Supply in Greece, 2000 and 2018





Source: IEA

2. Oil and Oil Products

2.1. Oil Production, Imports and Exports

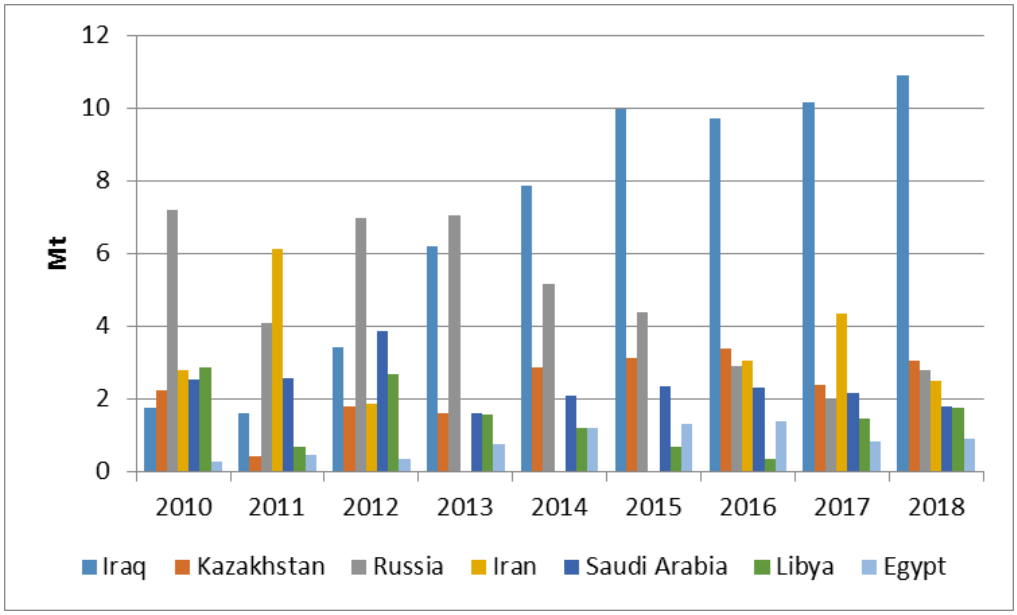
The production of crude oil in Greece in 2018 was insignificant (0.21 million tons, Mt) as compared to domestic final consumption of oil products at approx. 8.8 Mt in the same year. Indeed, it was derived from a single oil field (Prinos and Prinos North) of which the production, though increased by 450% over the last eight years, remained small at 3,300 barrels per day in 2019, when Greece consumes approx. 7.3 million tons or 142,000 barrels a day (average daily consumption of crude oil in the country). The company Energean is the sole oil producer in Greece. The two active oil fields, Prinos and Prinos North, are located offshore the island of Thasos in the Northern Aegean.

Therefore, Greece depends on imports of large quantities of crude oil in order to cover its needs. Iraq was the biggest crude oil supplier to Greece in 2018 with 10.9 Mt, followed by Kazakhstan and Russia with 3.1 Mt and 2.8 Mt respectively (see Figure 4). Imports from Iraq only accounted for 46% of total crude oil imports in Greece in 2018, which amounted to approx. 23.7 Mt (see Figure 5).

Imported crude oil is refined into oil products at four domestic refineries. Greece has increased considerably its refining capability in recent years, with exports of oil products at 20

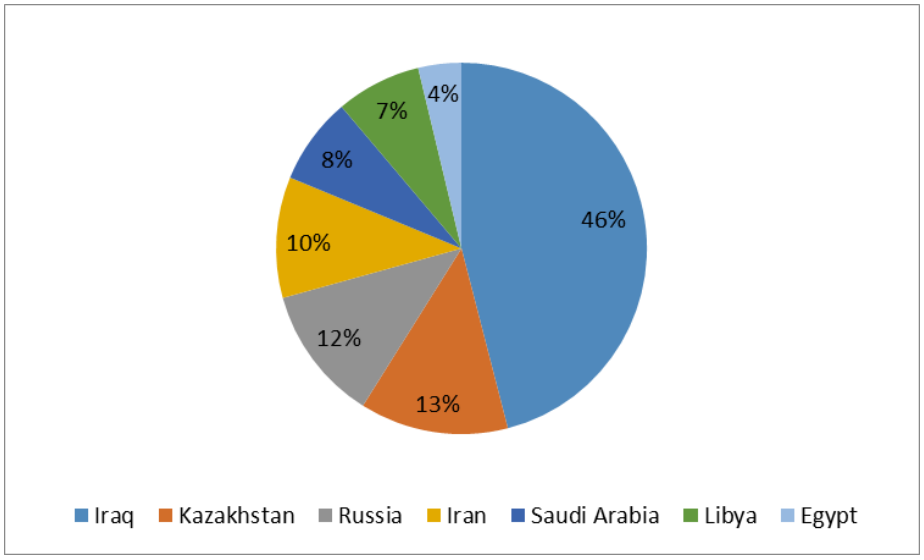
million tons in 2018, according to IEA data[1]. Greece also imports oil products, with imports at 3.8 million tons in 2018.

Figure 4: Greece's Crude Oil Imports by Country, 2010-2018



Source: Greece's Ministry of Energy

Figure 5: Greece's Crude Oil Imports by Country, 2018



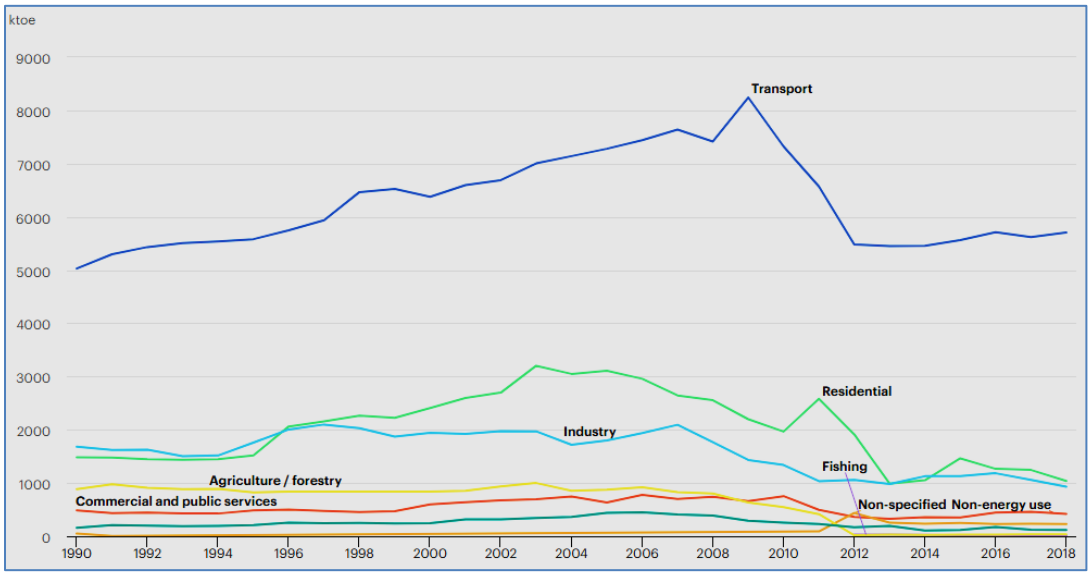
Source: Greece's Ministry of Energy

[1] https://www.iea.org/data-and-statistics?country=GREECE&fuel=Oil&indicator=Oil%20products%20imports%20vs.%20exports

2.2. Oil consumption

Over the period 2005-2015, oil consumption in Greece recorded a sudden drop by one third due to the economic crisis of 2008 (see Figure 6) and the Greek financial crisis that ensued, especially after 2009. In recent years, however, oil consumption recovered, rising by 9% between 2013 and 2015, mainly in transport and to an extent in the residential sector.

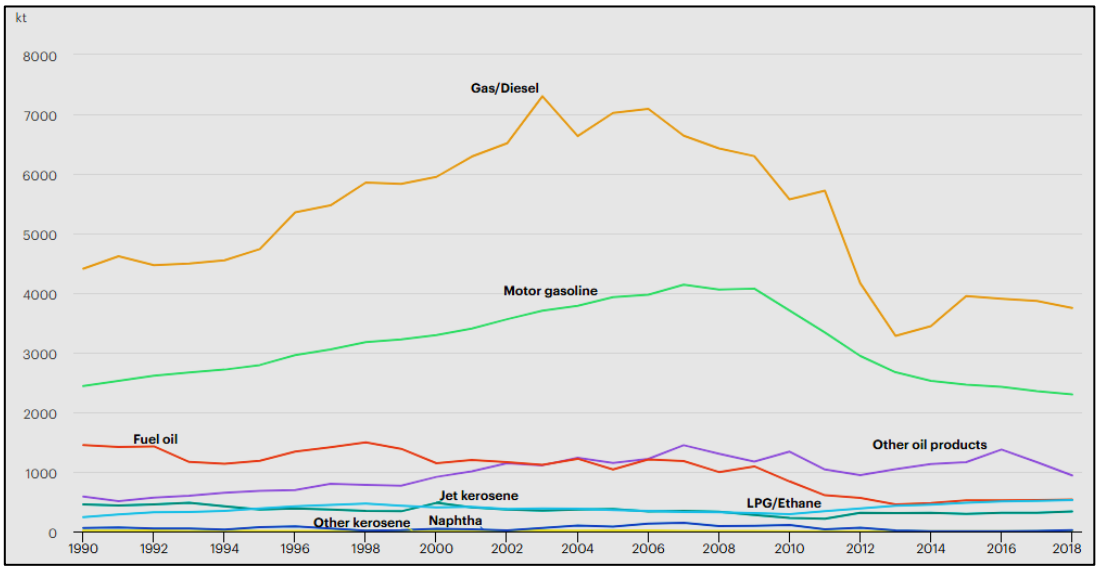
Figure 6: Oil Consumption by Sector, 1990-2018



Source: IEA (2020)

The transport sector consumed 5.6 Mtoe of oil in 2017 or 50% of total oil consumption. Road transport accounts for 87% of total oil consumption in transport, followed by domestic shipping at 10% and smaller shares for domestic air and railway transport. The transport sector mainly consumes diesel and gasoline, which together account for 62% of total oil consumption in Greece (see Figure 7).

Figure 7: Oil Consumption by Product, 1990-2018



Source: IEA (2020)

Approximately one third of the diesel is consumed in the residential sector for space heating. Heating oil represents one third of total residential energy consumption, the fourth highest share among IEA member-states. Residential oil consumption was considerably higher before the financial crisis (2009-2018). More specifically, it declined by 62% between 2011 and 2014, mainly due to a conjunction of high heating oil prices, reduced household income, and increased penetration of natural gas use because of a change in government policy (change of fuel in favour of biomass and natural gas). Consumption rose again in 2015.

Furthermore, Greece, in comparison to other countries, consumes a higher percentage of oil in power generation. Oil production units located on the islands accounted for 11% of total electricity generation in 2015, which was the highest among all IEA member-states. This is because many of the Greek islands are not yet connected to the mainland power grid but are supplied by autonomous production stations operating with oil-fired units (diesel and fuel oil).

2.3. The Refining Sector

Imported crude oil is refined into oil products at four domestic refineries (see Table 1). The three refineries that belong to HELPE (Hellenic Petroleum S.A.) are located in Aspropyrgos, Elefsina and Thessaloniki and represent approx. 65% of the country's total refining capacity, with crude oil and oil product storage tanks having a total capacity of 6.65 million cubic metres. The refinery of Motor Oil at Agioi Theodoroi near Corinth produces the rest.

In 2019, the utilisation rate of HELPE's refineries was negatively affected by the completion of the current cycle of operation at the refineries of Aspropyrgos and Elefsina and the temporary suspension of operation for maintenance works at the Elefsina refinery, which were completed in the fourth quarter. Consequently, the production of HELPE's refining sector recorded a slight drop and amounted to 14.2 million tons in 2019. HELPE's sales were impacted commensurately and amounted to 15.2 million tons; exports stood at 7.9 million tons or 52% of total sales, and sales of aviation and shipping fuel were up 5% at 2.8 million tons.

Table 1: Refineries in Greece

	Hellenic Petroleum (HELPE) S.A.			**MOTOR OIL**
Ownership	Paneuropean Oil and Industrial Holdings S.A: 42.6% Hellenic Republic Asset Development Fund: 35.5% Institutional investors: 15.3% Private investors: 6.6% Free float: 23.5%			Petroventure Holdings Limited: 40,0%; Doson Investments Company: 8,1%; Free float: 51,9%
Location	**Aspropyrgos**	**Thessaloniki**	**Elefsina**	**Agioi Theodoroi (Corinth)**
Type of Refining	Highly complex: catalytic, thermal, and hydro-cracking; MTBE* production; vacuum distillation	Hydroskimming; vacuum distillation; isomerisation; reforming	Topping: atmospheric distillation only; no vacuum distillation, reforming or desulphurisation	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 established	1958	1966	1972	1972

Sources: IENE, HELPE and Motor Oil

The production of the Motor Oil refinery also recorded a slight decline in 2019 compared to 2018 and amounted to 12.1 million tons, while sales stood at 14.4 million tons at approx. the same levels as in 2018. It is worth noting that Motor Oil's lower production and quantity of crude oil and raw materials processed in 2019 compared to 2018 was due to the scheduled periodic maintenance of the refinery's units. The Motor Oil refinery has also acquired the flexibility to process a broad range of crude oil types; thus, contributing to import diversification. Furthermore, the refinery can now easily switch between diesel and gasoline production and adapt to seasonal changes in Greece's demand. The upgrade and

modernisation works have placed the refineries among the most profitable in Europe, and their specifications are modern and environment-friendly.

Based on data by the Hellenic Petroleum Marketing Companies Association (SEEPE), domestic market's fuel sales were up 0.45%, from 6,655,720 tons in 2014 to 6,685,490 tons in 2018. More specifically, the domestic market's sales of gasoline declined by 8.98% (2014: 2,516,270 tons - 2018: 2,290,214 tons), sales of heating oil grew by 10.62% (2014: 2,363,892 tons - 2018: 2,614,881 tons), while fuel oil sales declined by 13.66% (2014: 208,029 tons - 2018: 179,616 tons). LPG sales rose by 17.28% (2014: 437,955 tons - 2018: 513,623 tons) due to increased use of autogas, kerosene sales dropped by 16.57% (2014: 3,145 tons - 2018: 2,624 tons), and asphalt sales dropped by 27.44% (2014: 158,683 tons - 2018: 115,141 tons). The reduction in the consumption of petroleum products in 2018 compared to 2017 was mainly due to the reduced consumption of heating oil and unleaded gasoline.

2.4. Latest Developments in Hydrocarbon Exploration and Exploitation in Greece

In Greece, the most significant development in the hydrocarbon sector over the past year was the signing in early July 2019 of agreements for four large concession areas with four joint ventures of Greek and foreign companies for the areas south and southwest of Crete and the Ionian Sea. The four concession areas in Greek territory in 2019 are depicted in Table 2; the relevant agreements were ratified by Parliament on October 10, 2019.

1. For the offshore area **"Ionian"** in western Greece, an agreement was signed on April 9, 2019 between the Greek State and the Repsol-HELPE joint venture. Also signed on the same day was the agreement for "Block 10 Ionian Sea" (in the Gulf of Kyparissia) between the Greek State and HELPE.

2. For concession and exploration and exploitation rights of the offshore areas **"Southwest and West of Crete"**, the agreements were signed on June 27, 2019. Earlier, in the first days of July 2018, it was announced that the Total-ExxonMobil-HELPE joint venture had been formally declared as the successful bidder in the international tender held by the Ministry of Energy.

Table 2: Hydrocarbon Concessions and Contracting Companies in Greece, 2019

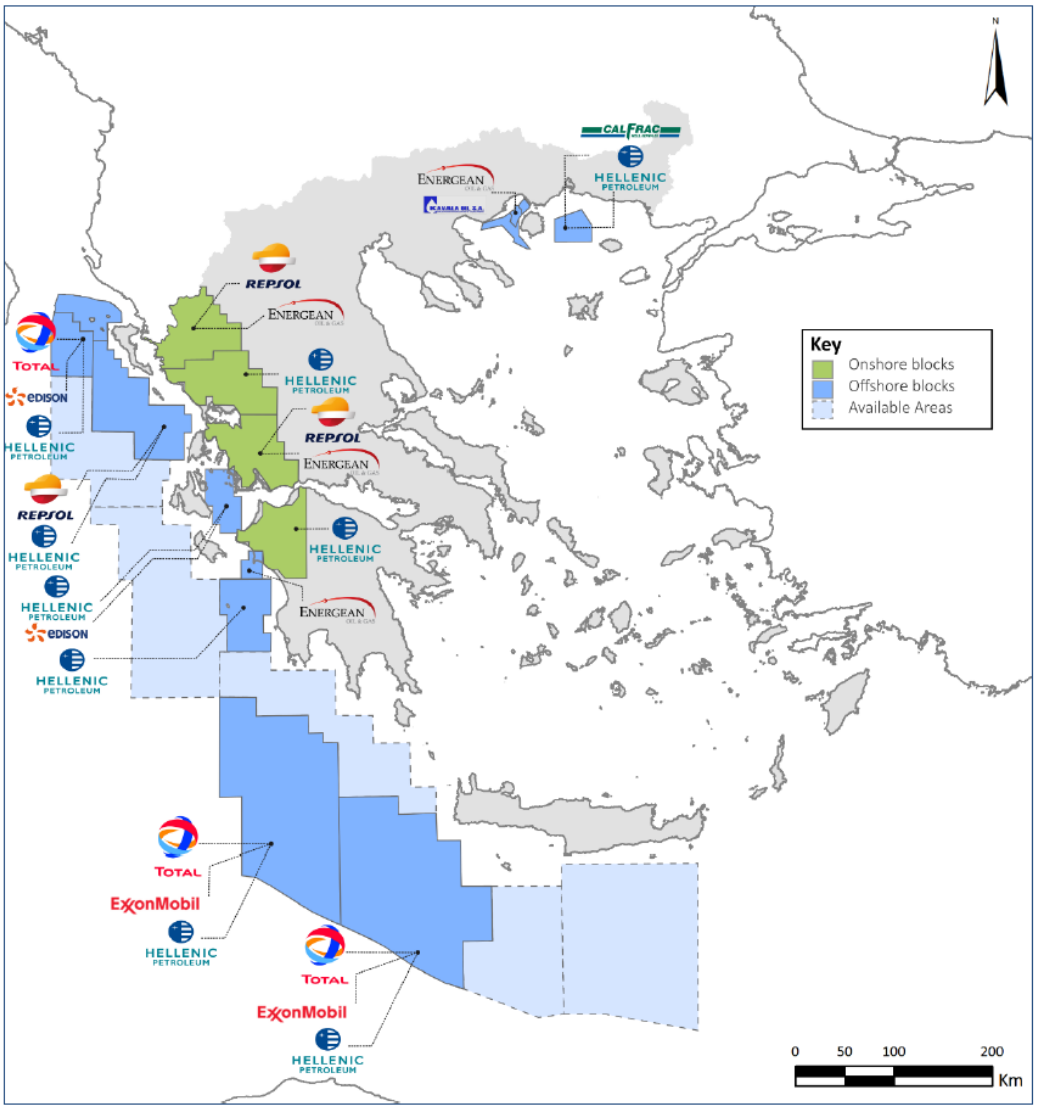
Date of publication in the Govt. Gazette (date when the agreement comes into effect)	Block	Location	Stage	Lessees, assignee, rates of participation
10/10/2019	Southwest of Crete	Offshore	Research	Total (40%, Assignee), ExxonMobil (40%), HELPE (20%)
10/10/2019	West of Crete	Offshore	Research	Total (40%, Assignee), ExxonMobil (40%), HELPE (20%)
10/10/2019	Ionian Sea	Offshore	Research	HELPE (50%, Assignee), Repsol (50%)
10/10/2019	Block 10	Offshore	Research	HELPE (100%)

Source: HHRM

However, the required seismic surveys in the above offshore blocks southwest and west of Crete are expected to be delayed due to the spread of the coronavirus pandemic, while the dramatic fall in oil prices has resulted in negative market sentiment delaying further any real progress. The exact date will be set depending, *inter alia*, on the availability of special seismic survey ships and weather conditions. It is worth noting that the initial seismic surveys for the Crete area appear encouraging, especially regarding the "Talos" field, which has a geological structure similar to that of the well-known Zohr field off the coast of Egypt.

Another important development was the announcement of the acquisition last February by Energean of the 50% share held by the French company Total in offshore Block 2 in the Ionian Sea. Since Energean is also in the process of acquiring Edison E&P, which holds 25% of exploration and exploitation rights over Block 2, upon completing this deal it will control 75% of the Block; the remaining 25% is held by HELPE. Energean has said that exploration up to now in that area indicates that "Block 2" includes part of a wider potential target, extending by 60% in Greek territory and by 40% in Italian, in a maritime area where Edison is active. Thus, that share, held by Edison, will also pass under the control of Energean.

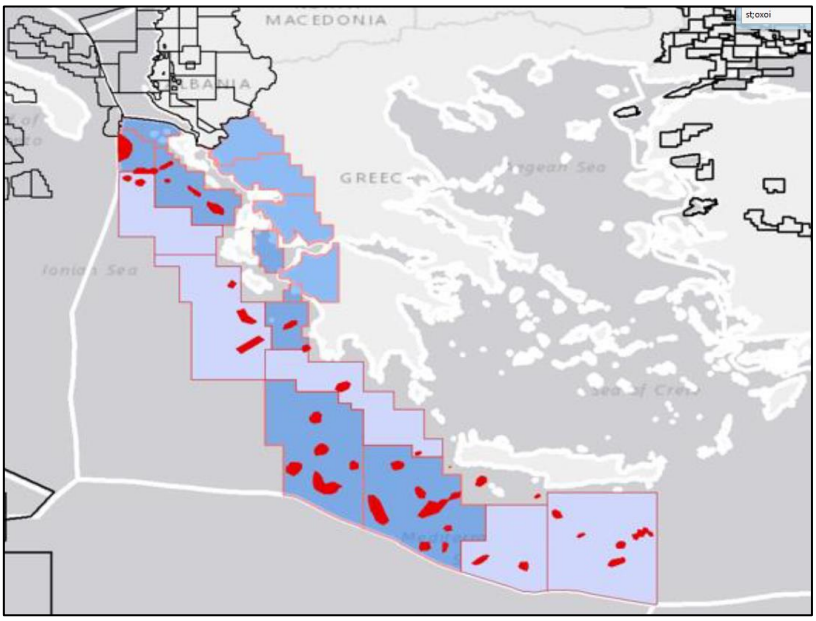
Map 1: Concession Areas in Greece, December 2019



Source: HHRM

According to HHRM, domestic hydrocarbon exploration activities are not only limited to the above areas that are already the concession areas, but also extend to offshore blocks that are available for concession. During the last months of 2019, the geological features of these blocks in the central Ionian Sea and south Crete were presented by HHRM to the international market and fora and have attracted the interest of international oil companies.

Map 2: Hydrocarbon Fields-Targets in the Ionian Sea and Crete, 2019



Source: HHRM

Regarding the area to the west and south-west of Crete, HHRM notes that the potential targets are located in rocks hidden under the seabed, while depths exceed by far 1,500 metres. Average water depth in these areas exceeds 2,500 metres and in many cases it is around 3,500 metres. Technology for drilling at such depths is expected to be available over the next three years, and the companies will decide then whether or not to proceed with exploratory drilling.

It is worth mentioning that areas that appear of interest do not necessarily "conceal" hydrocarbon quantities; this can only be confirmed with drilling operations. However, it is encouraging that in neighbouring countries, featuring similar geomorphology, hydrocarbons have been discovered and are already being exploited.

3. Natural Gas

3.1. The Natural Gas Market in Greece

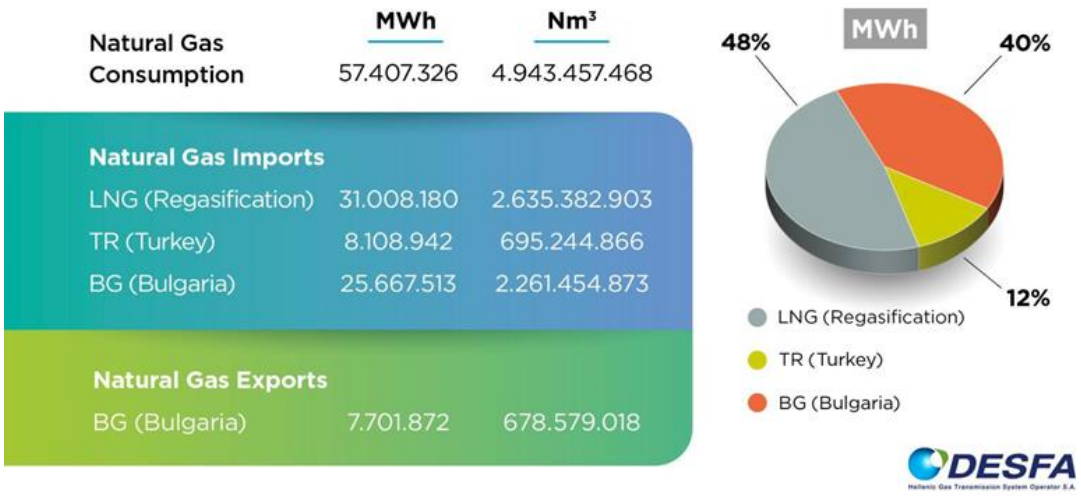
The Greek gas market appears to have recovered in 2019, after the extended period of financial crisis. In parallel, implementation of the actions outlined in the Gas Market Roadmap 2017-2022[2] continued; especially, those that aim at a transition to a fully deregulated market

[2] Govt. Gazette B' 59/18.01.2018

(e.g. reforms in the retail and wholesale markets, and corporate restructuring of supply companies).

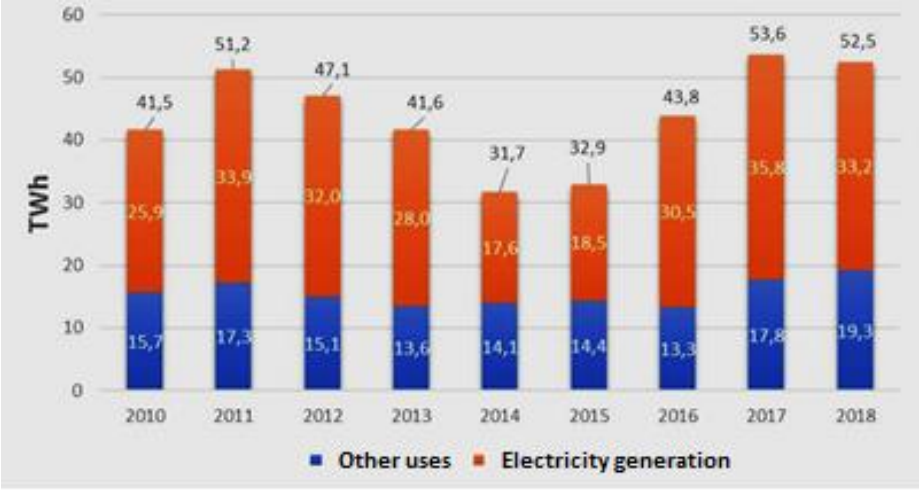
Based on data provided by DESFA[3], total consumption of natural gas in Greece in 2019 amounted to 57.4 TWh or 4.9 billion cubic metres, up 10% compared to the respective figure for 2018 and up 79% compared to 2014. Therefore, gas consumption in 2019 was the highest since it was first introduced in the country. It is worth mentioning that in 2019 Greece exported to Bulgaria gas quantities amounting to 7.7 TWh.

Figure 8: Natural Gas Consumption, Imports and Exports in Greece, 2019



Source: DESFA

Figure 9: Evolution of Gas Consumption in Greece, 2010-2018

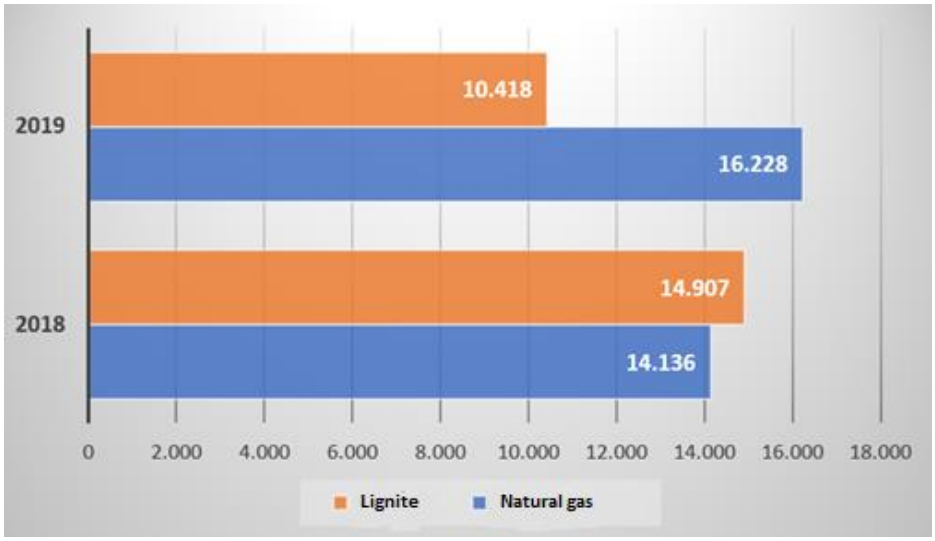


Source: RAE

[3] https://www.desfa.gr/userfiles/pdflist/DERY/TT/Leit_Stoix_ESFA_2019.pdf

The highest percentage of natural gas in 2019, as in all past years, was consumed in power generation by PPC's thermal units and private electricity producers. Indeed, the role of natural gas in power generation rose considerably in 2019 as compared to 2018. As shown in Figure 10, the production of units using natural gas as fuel increased by 15% in 2019 compared to 2018; on the contrary, the electricity generation from lignite was reduced by 30% compared to 2018.

Figure 10: Annual Production (GWh) of Thermal Stations in Greece, 2018-2019



Source: IPTO

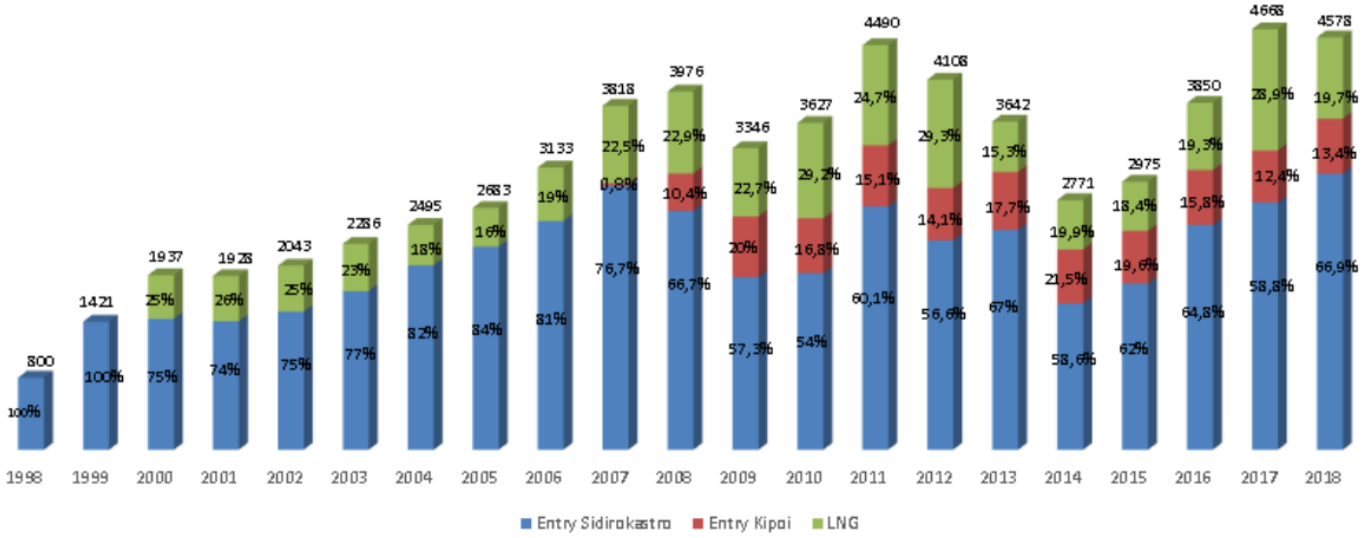
The penetration of natural gas in Greece remained at very low levels in 2018 (8%), compared to the average in other European countries, where it reaches 55%[4] and thus, electricity generation is still the main factor in Greece's gas demand.

3.2. Sources of Gas Supply in 2019

2019 was a reference year for the evolution of the market share between piped gas and imported LNG into Greece. Figure 11 depicts the contribution share of piped gas and LNG over the period 1998-2018.

[4] Sedigás informe "año gasista 2016 y Perspectivas 2017"; BP Statistical Review of world energy 2017.

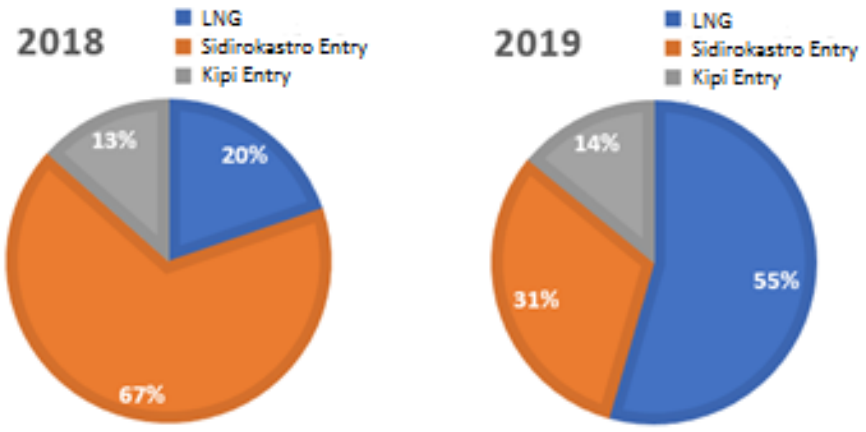
Figure 11: Evolution of Gas Imports into Greece, 1998-2018



Source: DESFA

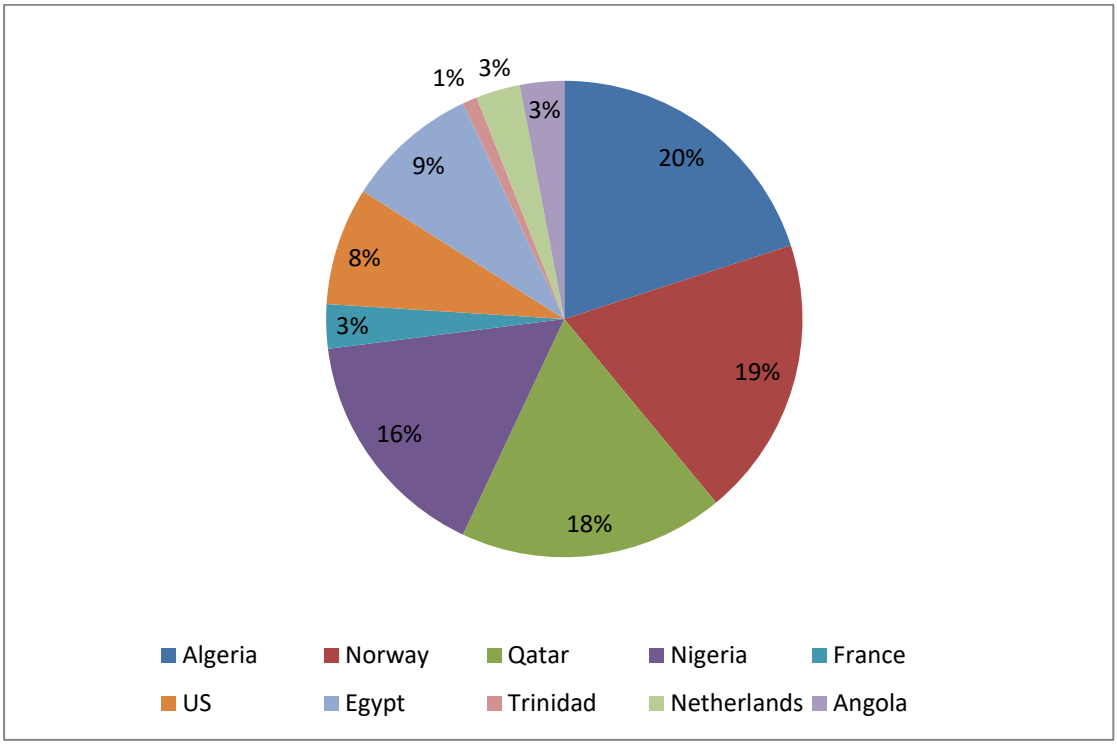
These shares changed significantly in 2019 compared to 2018. More specifically, LNG accounted for 55% in 2019 against 45% for piped gas, when the maximum share of LNG had been 29% in 2010 and 2012. In 2018, LNG accounted for 20%. It is the first time that LNG exceeded in quantity the gas supplied via pipelines.

Figure 12: Change in the Share of Gas Supply Sources in Greece, 2018-2019



Source: DESFA

Figure 13: LNG Imports into Greece by Country of Origin, 2019



Source: DESFA

3.3. Natural Gas Infrastructure Projects

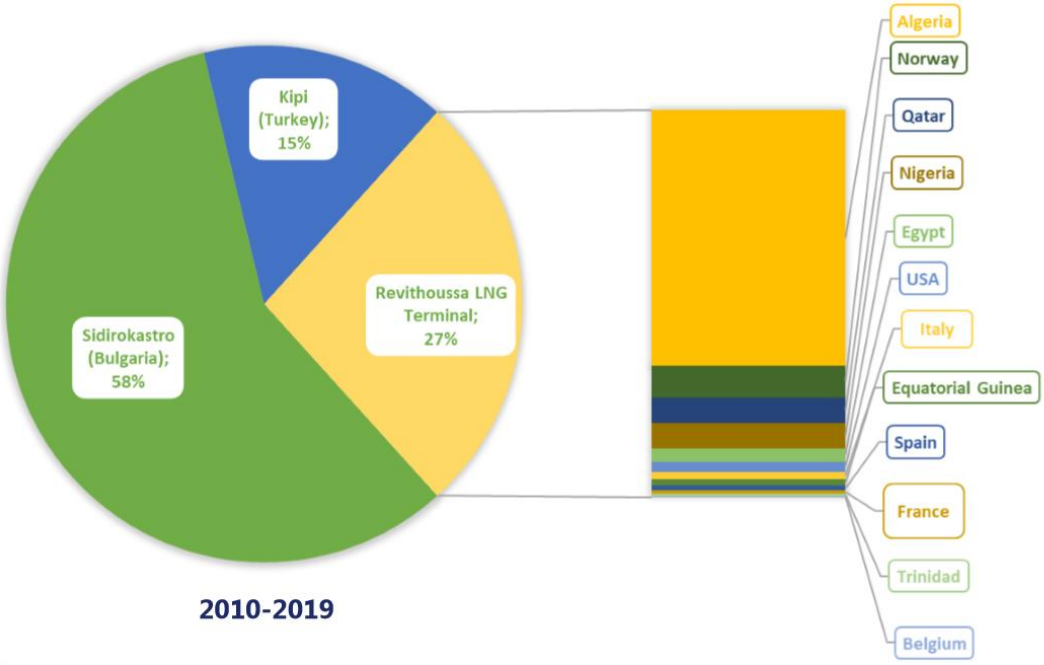
3.3.1. Revithoussa LNG Terminal

In January 2019, the commercial operation of the third storage tank of the terminal commenced. In parallel, in the context of the second upgrade of the terminal, the capacity for LNG gasification increased, and there is now the possibility of mooring larger LNG tankers, up to Q-MAX size (in practice, the largest LNG tankers in the global market can now be accommodated).

Based on the operational data of the LNG terminal for 2019, it is clear that the target of handling greater LNG quantities has been achieved; thus, improving the liquidity of the market

and strengthening the country's security of gas supply. According to DESFA's data[5], there was an increase both in sources of gas supply (see Figure 14) and in the number of unloadings after the upgrade of the terminal (see Figure 15).

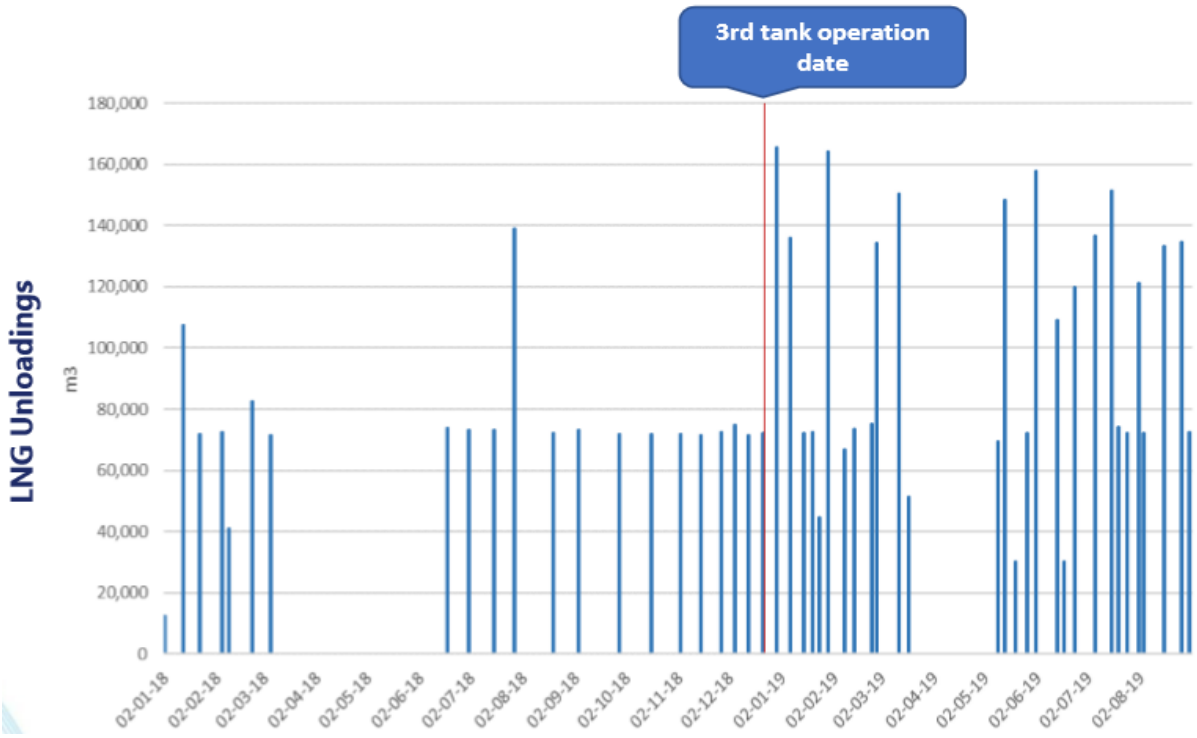
Figure 14: Countries of Origin of LNG Imports at the Revithoussa Terminal, 2010-2019



Source: DESFA

Figure 15: Number of LNG Unloadings Before and After the Upgrade of the Third Tank

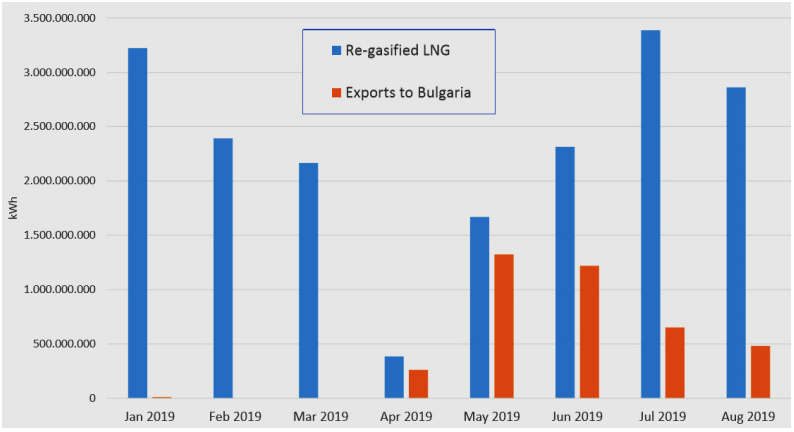
[5] Avlonitis, G. (2019), "Wholesale market and infrastructure", RAE Day Conference *(84th TIF),* http://www.rae.gr/site/file/categories_new/about_rae/factsheets/2019/gen/16092019?p=file&i=1



Source: DESFA

Lastly, the upgrade of the LNG terminal also contributed (increase from 1 mcm/d to 5.5 mcm/d after the upgrade[6]) to realising gas exports to Bulgaria via the Sidirokastro Reverse Flow Exit Point, as shown in Figure 16.

Figure 16: The Role of the Upgraded LNG Terminal in Cross-Border Trade



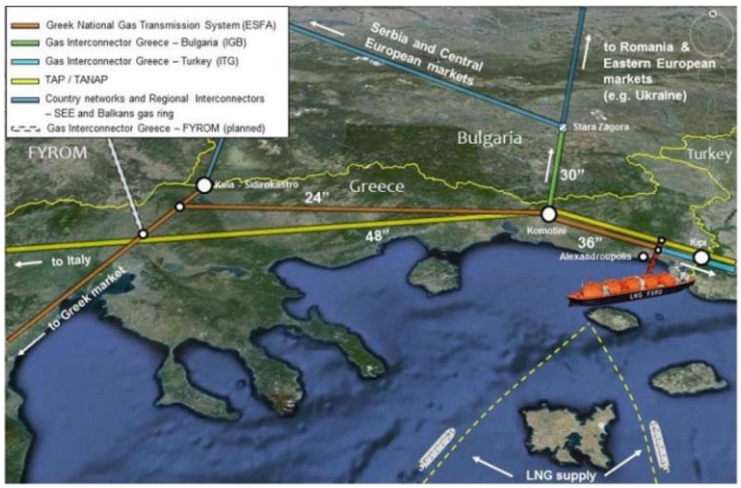
Source: DESFA

[6] DESFA (2017), "10-year Forecast for Technical Capacity of Natural Gas Transmission System Entry Points", https://www.desfa.gr/userfiles/pdflist/anathewrimenes_texn_dynamikotites_07-2017-gr-v2.pdf

3.3.2. Alexandroupolis FSRU

The project will consist of one Floating Storage Regasification Unit (FSRU), which will be permanently moored at a fixed point at a distance of 17.6 km south-west of Alexandroupolis harbour and 10 km from the coast at Makri.

Map 3: Alexandroupolis FSRU



Source: Gastrade

Gastrade, a company of the Copelouzos Group, is developing the project in Alexandroupolis; the budget is €380 million and the annual capacity is 5.5 bcm. The project constitutes a departure in terms of national energy policy, but is also of high significance for Europe. It is part of the EU's policy for Central and South-eastern Europe Energy Connectivity (CESEC) with the European Natural Gas System via the development of a Vertical Corridor and has been included in the updated list of Projects of Common Interest of 30 October 2019[7].

The first non-binding phase of the Market Test was successfully completed on December 31, 2018, in which 20 companies expressed their interest for 12.2 bcm per year. On December 23, 2019, DEPA's Board of Directors approved the participation of the company in Gastrade's share capital with a share of 20%. On January 8, 2020, the participation of Bulgartransgaz EAD in Gastrade's share capital was also approved with a share of 20%, and the related agreement was signed in late August. Thus, the shareholder composition now stands as follows: Copelouzos Group 40%, GasLog 20%, DEPA 20% and Bulgartransgaz 20%.

[7] ANNEX to COMMISSION DELEGATED REGULATION (EU) amending Regulation (EU) No 347/2013 of the European Parliament and of the Council as regards the Union list of projects of common interest SWD(2019) 395 final.

On January 10, 2020, the second phase of the Market Test went ahead, whereby interested parties were invited to submit binding offers by March 24, 2020, after a third extension was given. By that deadline, binding offers for total quantities of 2.6 bcm per year had been submitted, with a timetable of 5 to 15 years. Binding offers were submitted by DEPA and PPC on the Greek side, the Bulgarian company Bulgartransgaz, and two private trading companies from Romania and Serbia.

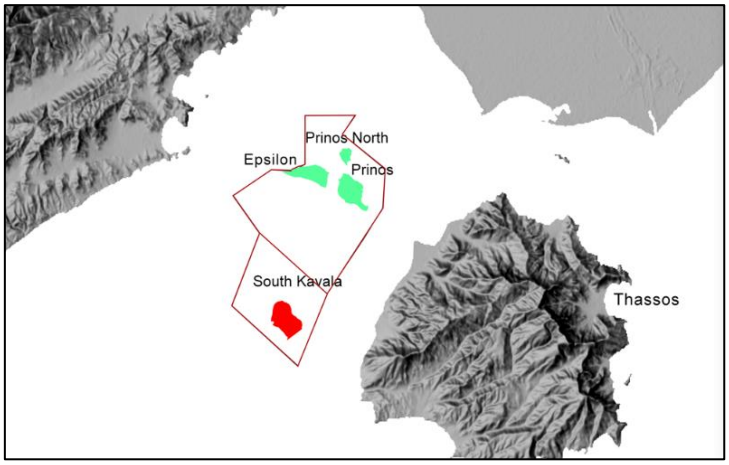
In early March 2020, three groups submitted offers for the construction of the pipeline and other works that will connect the Alexandroupolis FSRU with the National Natural Gas Transmission System. More specifically, binding offers were submitted by the joint venture of the Italian firm Saipem with the Greek construction company TERNA and the Dutch companies BOSKALIS and VAN OORD.

According to the expected project's timetable, the Final Investment Decision (FID) is expected in the fourth quarter of 2020. The construction of the FSRU will last two years and the commencement of commercial operation is scheduled for early 2023.

3.3.3. South Kavala Underground Gas Storage (UGS)

This project, having a budget of €300 million - €400 million, aims at exploiting the depleted offshore gas field of South Kavala (used by the company Energean – remaining gas reserves assessed at 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 metres.

Map 4: The Red-coloured Area is the Depleted Natural Gas Field in South Kavala



Source: Energean

The South Kavala UGS is an energy infrastructure project that will enhance the security of gas supply at national and European level for the benefit of the end consumer. It offers long-term capability for the storage of natural gas, in contrast to the Revithoussa LNG terminal, which is suitable only for short-term storage. It should be noted that Greece is the only EU country that has no permanent underground gas storage facility even though 40% of the country's electricity generation is now based on natural gas. European countries store at minimum 20% of their annual gas consumption in underground gas storage facilities.

According to the preliminary plans of the project, the capacity of the UGS is assessed at approx. 1 bcm. Annual volume throughput is assessed at 360 million Nm3 or 720 million Nm3, for one or two cycles per year, respectively.

It is worth mentioning that the project has been included in the list of Projects of Common Interest (PCI) that was adopted on October 30, 2019 (Cluster increase storage capacity in South-Eastern Europe) by the European Commission and the member states at the meeting of Regional Teams for the PCIs.

On March 10, 2020, a Joint Ministerial Decision[8] was issued for commencing the procedure of exploiting the field. More specifically, the Hellenic Republic Asset Development Fund (TAIPED) will conduct an international tender for the concession of rights for the construction, maintenance, operation and exploitation of the field as a UGS for a period of up to 50 years.

On June 29, 2020, TAIPED announced[9] the commencement of an international tender procedure for the concession of rights for the use, development and exploitation of the underground natural field at the location of the almost depleted gas field "South Kavala", with the aim of converting it into a gas storage facility.

On August 11, 2020, TAIPED announced[10] an extension to September 30, 2020 of the deadline for expressing interest for the concession agreement for the use, development and exploitation of the underground natural field at the location of the natural gas field "South Kavala".

[8] https://diavgeia.gov.gr/doc/%CE%A9%CE%99%CE%93%CE%A74653%CE%A08-6%CE%95%CE%A5?inline=true
[9] https://www.hradf.com/storage/files/uploads/yafa-e-narkshdiagwnismoy-29062020.pdf
[10] https://www.hradf.com/storage/files/uploads/yafa-e-narkshdiagwnismoy-29062020.pdf

3.3.4. Trans Adriatic Pipeline (TAP)

The Trans Adriatic Pipeline (TAP) project involves the construction of a gas pipeline that will transport gas from the area of the Caspian Sea to Europe. TAP is now connected to the Trans Anatolian Pipeline (TANAP) at the Greek-Turkish border and then continues through northern Greece, Albania and the Adriatic Sea before terminating at the coast of southern Italy, where it is connected to the Italian natural gas system.

Map 5: TAP Route

Source: TAP AG

The TAP pipeline will be connected with the Greek Natural Gas System and the IGB pipeline. It will also provide new Exit Points for supplying gas distribution networks in Western Macedonia, and will have reverse flow capability for transmitting gas at competitive prices via the Italian system.

On July 1, 2019, the project operator conducted a Market Test, in accordance with the guidelines approved by the Regulatory Authorities of Greece, Italy and Albania. The Non-Binding stage was completed on October 21, 2019 with the publication of the Demand Assessment Phase Report.

On March 30, 2019, the installation of the first pipelines of the project's offshore section was completed successfully, with a length of 105 km, connecting the coasts of Albania and Italy. Construction work on that section started in October 2018.

On November 25, 2019, the introduction of natural gas in a 2-km section of the pipeline (between Evros and the Kipoi Compression Terminal)[11] commenced. This is the initial stage of the commissioning process, and aims at ensuring that the project is fully safe and ready for

[11] TAP (2019), "TAP Introduces First Natural Gas into the Greek Section of the Pipeline as part of its Testing Phase", https://www.tap-ag.com/news-and-events/2019/11/26/tap-introduces-first-natural-gas-into-the-greek-section-of-the-pipeline-as-part-of-its-testing-phase

operation. According to data[12] provided by the project operator, the project was 95% completed by late April 2020.

On January 20, 2020, the three operators involved in natural gas transmission systems (TAP, SRG and DESFA) invited those interested in participating in a public consultation concerning a proposal for increased capacity for the TAP pipeline up to February 21, 2020. In early June 2020, the three operators announced that the binding phase of the market test for increased capacity is expected to be realised in July 2021, rather than in January of that year as initially scheduled, so that more time is given for the energy markets to recover, following the coronavirus pandemic.

3.3.5. Interconnector Greece - Bulgaria (IGB)

The project of the Greek - Bulgarian Interconnector (IGB) consists of a pipeline with a length of 182 km that begins in Komotini and ends in Stara Zagora, effectively connecting the gas networks of Greece and Bulgaria, while it will have reverse flow capability.

The project has been included in the latest list of PCIs of October 30, 2019. In addition, the Greek - Bulgarian interconnector is included in the list of priority projects of the Central and South-Eastern Europe Gas Connectivity (CESEC) initiative. It is anticipated that gas transmission to the markets of Bulgaria and South-Eastern Europe will be increased via the IGB.

Map 6: IGB Route

Source: ENTSOG

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

On April 3, 2019, the EU approved financing of €39 million for the construction of the project. On July 18, 2019, RAE granted to the company ICGB AD (50% Bulgarian state company BEH – 50% YAFA Poseidon S.A.) pursuant to its decision No. 671/2019, a licence for an Independent Natural Gas System (ASFA). The ASFA concerns the Greek section of the Greek - Bulgarian interconnector (IGB). According to the above decision, the IGB will be connected with the National Natural Gas System (ESFA), the TAP natural gas transmission system and Bulgaria's natural gas transmission system, and will strengthen the position of Greece as regional energy hub, contributing to the increase of competition in Greece's natural gas market and creating benefits for both domestic and Bulgarian consumers.

In early October 2019, the Regulatory Authorities of Greece and Bulgaria jointly approved the project's Operation Code and Pricing Regulations.

On October 10, 2019, Bulgaria's Energy Minister Mrs. Temenuzhka Petkova and the Minister of the Environment and Energy of the Hellenic Republic Mr. Kostis Hatzidakis signed an Intergovernmental Agreement setting the terms of construction and operation of the pipeline by the company ICGB AD.

Construction work on the pipeline started on October 28, 2019 and will last 18 months. The pipeline has been designed in order to operate in two phases. In the first phase, expected to start commercial operation on July 1, 2021, the capacity of the pipeline will be 3.0 bcm per year, of which 2.7 bcm will be offered for long-term products and 0.3 bcm for short-term products. In the second phase, subject to additional commercial interest, the capacity of the pipeline can be increased up to a total of 5 bcm per year with the addition of a compressor, of which 4.5 bcm will be offered for long-term products and 0.5 bcm for short-term products.

3.3.6. Poseidon Turkey - Greece - Italy Pipeline (ITGI)

The Poseidon Greece - Italy Interconnector consists of two sections: (a) the onshore section, with a length of approx. 760 km, which begins at the Greek - Turkish border at Kipoi and passes through the Regions of eastern Macedonia and Thrace, central Macedonia, Western Macedonia, Thessaly and Epirus before terminating at the coast of Thesprotia; and (b) the offshore section of the project, with a length of approx. 210 km, which connects the coast of Thesprotia with Otranto in Italy.

The offshore section of the project (Greece - Italy) has been included in the latest list of PCIs, of October 30, 2019. In the Development Study 2020-2029 prepared by DESFA, the final investment decision of this project will be reached after conducting a market test. According

to the decision of March 26, 2020[13], the installation and route of the onshore section of the Greek part of the pipeline, with a length of 8.2 km, from the Metering and Compression facilities in Thesprotia to the landing point of the sea route to Epirus were set. The main concern about this project is whether and to what extent is directly competitive with TAP or whether it constitutes an additional route for potential Russian gas exports to Europe.

Map 7: IGI Route

Source: DEPA

3.3.7. Interconnector Greece - North Macedonia (IGNM)

The construction of this pipeline, with a budget of €47.8 million and an annual capacity of 3 bcm, aims at interconnecting the natural gas systems of Greece and North Macedonia and achieving a diversification in North Macedonia's gas supply sources, which until recently were entirely dependent on the Trans Balkan Pipeline and since January 2020 on Turkish Stream, via Bulgaria. The access to ESFA and especially to the Revithoussa terminal and to gas via TAP will enhance competition; thus, potentially leading to lower gas supply prices in the neighbouring country.

At the same time, this project promotes the development of a regional gas market and the entry of more users, contributing to the growth of the Greek gas hub, which in turn will result in better gas prices in the Greek market too. It will also contribute to an increase in the use of Greece's infrastructure, such as the Revithoussa LNG terminal, with the aim of lowering system user charges in the long term. The project within Greek territory consists of the construction of a 54.3 km pipeline beginning at Nea Mesimvria and extending to the border with North Macedonia.

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

Map 8: IGNM Route

Source: ENTSOG

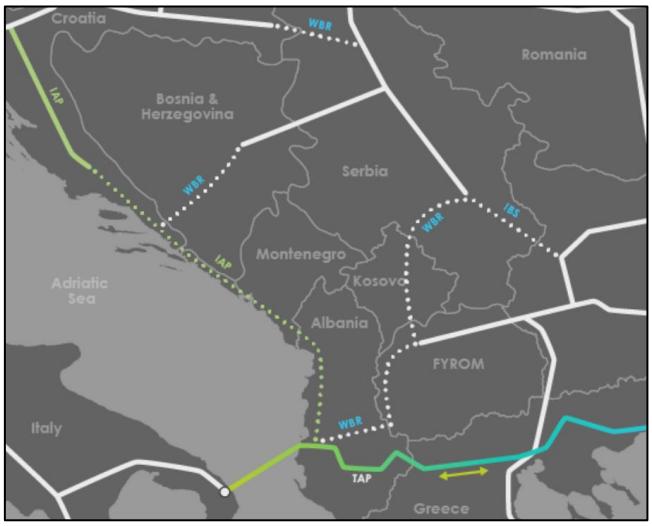
The final investment decision is expected in December 2020. The project will be implemented after the signing of a cooperation agreement with MER (state-owned company for the exploitation of North Macedonia's energy resources), which will include the stages that must be followed by both sides for the implementation of the interconnection as well as the details of each side's obligations and responsibilities. The project is at the stage of completion of basic planning, while the environmental terms have already been approved.

On February 6, 2020, Greece's Energy Ministry approved the environmental terms for the construction and operation of the project "High Pressure Gas Pipeline Nea Mesimvria - Eidomeni". In this decision, DESFA was named as the entity undertaking the proposed project. According to the approved ESFA Development Plan 2017-2026, the above decision covers one out of three terms linked to approving inclusion of the project in the Development Plan. The other two concern the commitment of gas transport by users (requires the conduct of a market test by DESFA) and the decision about financing the project.

3.3.8. Ionian - Adriatic Pipeline (IAP)

The Ionian Adriatic Pipeline (IAP) is a proposed pipeline to supply gas in SE Europe. It begins in Albania and passes through Montenegro, Bosnia and Herzegovina and Croatia. In Albania, it will be connected to the TAP pipeline.

Map 9: IAP Route



Source: TAP AG

The project is currently at the stage of preliminary planning[14] (Croatia - Montenegro - Albania), while the construction licence procedure is in progress in Croatia and Albania.

3.3.9. Turkish Stream Pipeline

The Turkish Stream pipeline is a gas pipeline connecting Russia with Turkey across the Black Sea. On January 18, 2020, the opening ceremony was held, marking the first deliveries of natural gas to Turkey via the new Turkish Stream pipeline. On January 27, 2020[15], 1 bcm of natural gas was delivered via the pipeline.

[14] Energy Community (2020), "Ionian Adriatic Pipeline", https://energy-community.org/regionalinitiatives/infrastructure/PLIMA/Gas16.html
[15] Gazprom (2020), "First billion cubic meters of gas supplied via TurkStream", https://www.gazprom.com/press/news/2020/january/article498525/

Map 10: Turkish Stream Route

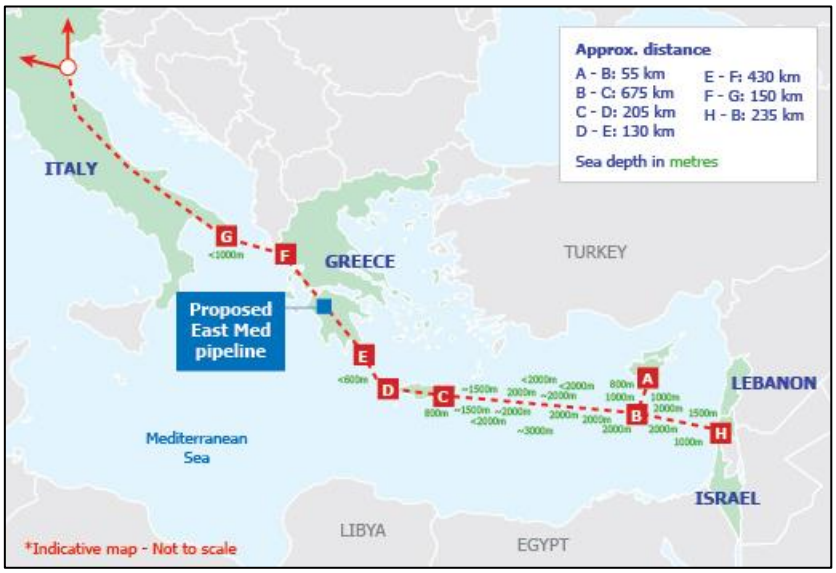
Source: Gazprom

In addition, according to an announcement by Bulgartransgaz, Russian gas for Bulgaria, Greece and North Macedonia is now delivered via the new entry point (on the Bulgaria - Turkey border). In practice, this means that as of early January 2020 Gazprom, by delivering gas via the Turkish Stream pipeline, replaced the route that passed through Ukraine and Romania via the Trans Balkan Pipeline. At the same time, new conditions are now in place for access to the LNG terminal at Revithoussa and to the Alexandroupolis FSRU.

3.3.10. The East Med Pipeline

This project was conceived by DEPA-Edison in 2011 and has been promoted by the above companies. The East Med pipeline is now included in the latest PCI list of October 30, 2019. On January 2, 2020, an Intergovernmental Agreement between Greece - Cyprus - Israel was signed in Athens for the implementation of the aforementioned project. Italy, which was absent in the ceremony, through the Italian Minister for Economic Development, Mr. Patuanelli, sent a letter to the Greek Minister for Environment and Energy, according to which Italy supports the project in the context of the European PCIs.

Map 11: East Med Pipeline Route



Source: IGI Poseidon

On January 2, 2020, Energean and DEPA signed a Letter of Intent for the sale and purchase of 2 bcm of natural gas per year (corresponding to 20% of the pipeline's initial capacity) from Energean's fields (Karish and Tanin, via the FPSO "Energean Power") in Israel's Exclusive Economic Zone. Further details, including terms, points of sale, the composition of the natural gas, the charterer, etc., will be agreed and included in the Gas Sales Purchase Agreement[16] (GSPA).

On March 3, 2020, a Joint Ministerial Decision was issued approving the commencement of the licencing procedure for the East Med pipeline and especially for the Greek onshore section of the pipeline. The licencing procedure is expected to be completed by the fourth quarter of 2021, so that the implementation of the East Med pipeline can begin then, while it is expected to be completed in 2024.

On April 29, 2020, YAFA Poseidon issued a call for the preliminary contruction activities for the East Med pipeline, with a total cost of €2.4 billion before tax and €2.97 billion after tax. More specifically, the activities concern the detailed engineering design, procurement, construction, transport, installation and pre-commissioning (EPCI) of the pipeline's offshore sections. This call for tenders concerns the first stage of the East Med pipeline, which is

[16] Energean (2020), "Energean and DEPA agreement paves the way for commercial operation of East Med pipeline", *Joint Press Release*, https://www.energean.com/media/3629/20100202-energean-depa-loi.pdf

planned to transport 10 bcm/year plus 1 bcm for Cyprus, will end on June 20, and will be completed with the selection of two contractors. The design and development of the first stage takes into account all research and development activities, including the related pre-investment, on the basis of a possible increase of the pipeline's capacity to 20 bcm/year at a later stage.

The draft law for the Intergovernmental Agreement on the East Med pipeline was submitted to Parliament on May 4, 2020, after the licencing process for the project had commenced in Greece and a call for tenders had been issued for the main parts of the final feasibility study prepared by the entity undertaking the project, YAFA Poseidon. The Intergovernmental Agreement for the construction of the pipeline was ratified by the Greek Parliament on May 14, 2020.

The next steps of the project involve the completion of the feasibility study, amounting to approx. €70 million, and the taking of the final investment decision (FID). Taking also into account the data in the studies mentioned above, the greatest obstacles for the implementation of the project remain the following:

- ensuring sufficient quantities of natural gas for exports
- achieving competitive prices
- concluding a series of sale agreements with European customers

In addition, the technical challenges of the project will have to be met, especially the great depths at which certain subsea sections of the pipeline are planned. Given the current and future demand for natural gas in Europe, the potential contribution of the East Med pipeline in covering gas supply requirements will not exceed 3%, at best.

3.3.11. Dioryga Gas FSRU

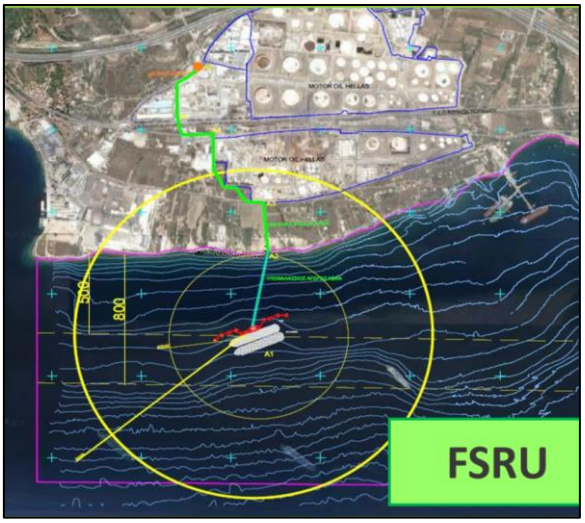
This project (proposed and promoted by the Motor Oil Hellas group[17]) consists of a Floating Storage Regasification Unit to be anchored at a distance of 1.5 km south-west of Motor Oil's refinery in Agioi Theodoroi near Corinth. The project, which obtained an ASFA licence from RAE in early March 2019, will be connected to ESFA via an offshore and onshore pipeline.

The planned storage capacity of the unit is 135,000 to 170,000 m^3, with maximum regasification capacity of 470,000 ncm/h or an annual capacity of 2.6 bcm. The project will

[17] Satras, N. (2019), "DIORYGA GAS FSRU Project - part of European Natural Gas Grid", *RAE Day Conference (84th TIF)*, http://www.rae.gr/site/file/categories_new/about_rae/factsheets/2019/gen/16092019?p=file&i=4

strengthen security of gas supply at national and European level, will constitute a new ESFA entry point, and, upon the required interconnections of ESFA with neighbouring gas systems, will obtain access to the countries of SE Europe.

Map 12: Dioryga Gas FSRU



Source: Motor Oil Hellas

It will also create benefits for the end consumer, since it will provide additional liquidity to the LNG market (lower procurement prices) and contribute to the decongestion of the LNG terminal at Revithoussa, of which the first indications emerged in the last quarter of 2019 and upon drafting the Final Annual LNG Unloading Plan for 2020 by DESFA[18]. Lastly, the project may operate auxiliarily:

- with the LNG terminal at Revithoussa (proximity - double unloadings);
- with the 2020-2024 5-year Development Plan for the natural gas distribution network of DEDA (Public Gas Distribution Network), which provides LNG supply to the cities of Patras, Agrinio and Pyrgos;
- with activities in the emerging Marine LNG & Small-Scale LNG market.

[18] Liaggou, Ch. (2019), "Οξύνεται ο ανταγωνισμός εγχώριων ομίλων στην αγορά φυσικού αερίου", https://www.kathimerini.gr/1052415/article/oikonomia/epixeirhseis/o3ynetai-o-antagwnismos-egxwriwn-omilwn-sthn-agora-fysikoy-aerioy

4. Electricity

In Greece, the electricity market operated until recently on the basis of a pool structure, meaning that the total available power formed a "pool" from which participants in the distribution network drew the electricity they supply to their customers - consumers.

In recent years, there has been an ongoing effort to exploit RES potential, with the aim of meeting the country's commitment for higher RES penetration into the Greek energy system, but also for exploiting domestic resources towards safeguarding energy supply. Emphasis is given to high commercial maturity technologies that exploit domestic potential (e.g. wind farms, solar PV parks, biomass, small hydro), which have attracted high investor interest.

It is worth noting that gas and RES units have started replacing a large segment of lignite production, leading to a considerable increase in total installed capacity for power generation in the last decade thanks to the RES.

4.1. Supply and Demand

Historically, lignite has played a significant role in Greece's power generation and covered almost 20% of total electricity demand in the interconnected – except of the islands - system in 2019 and much higher share (more than 60%) in previous years. However, its dominance has been reduced in the last decade due to the fall in electricity consumption and the increased penetration of RES for power generation - mainly wind and solar - and natural gas. RES covered almost one third of the total domestic electricity demand over the three-year period 2017-2019.

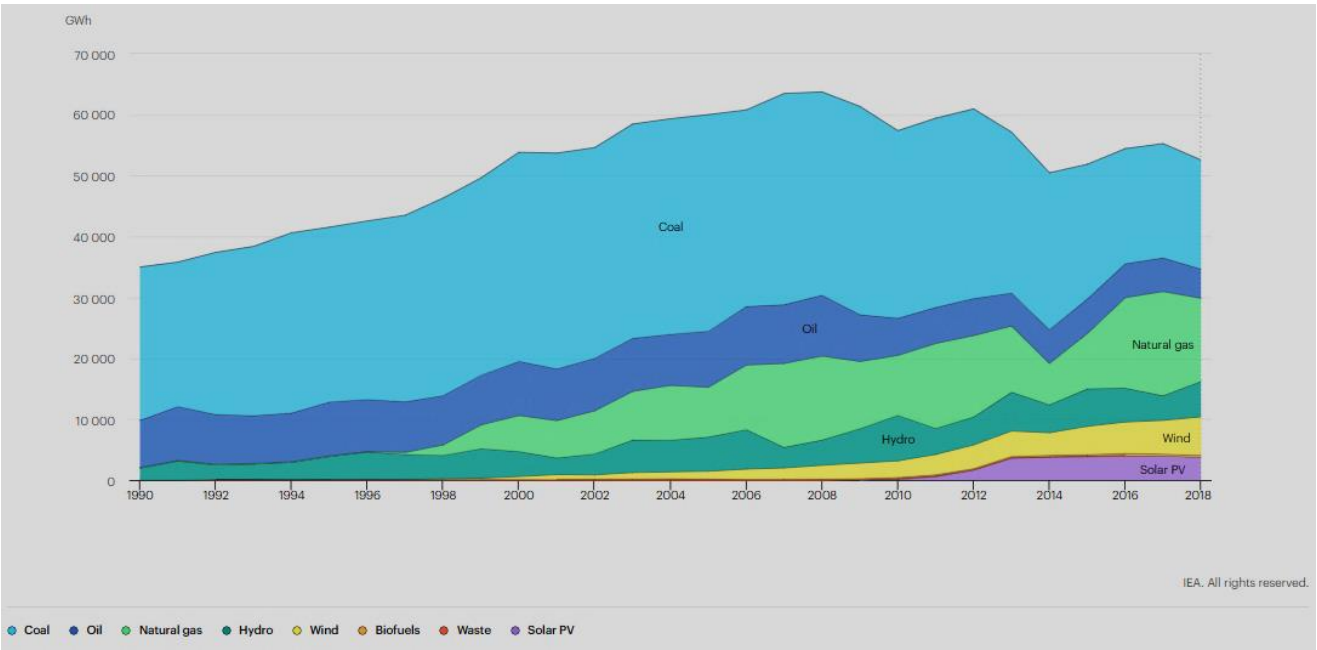
Power Generation

In 2019, Greece produced 42.2 TWh of electricity in the interconnected system, down 6.6% from levels in 2018. Natural gas was the largest source of energy in domestic power generation, accounting for 16.2 TWh in 2019, followed by RES, which increased their share from 11.1 TWh in 2018 to 12.2 TWh in 2019. The contribution of lignite in power generation has declined considerably over the last two years, from 14.9 TWh in 2018 to 10.4 TWh in 2019.

Table 3: Change in Power Generation (GWh) in the Greek Interconnected System, 2018-2019

Source: IPTO[19]

Figure 17: Power Generation by Type of Fuel, 1990-2018



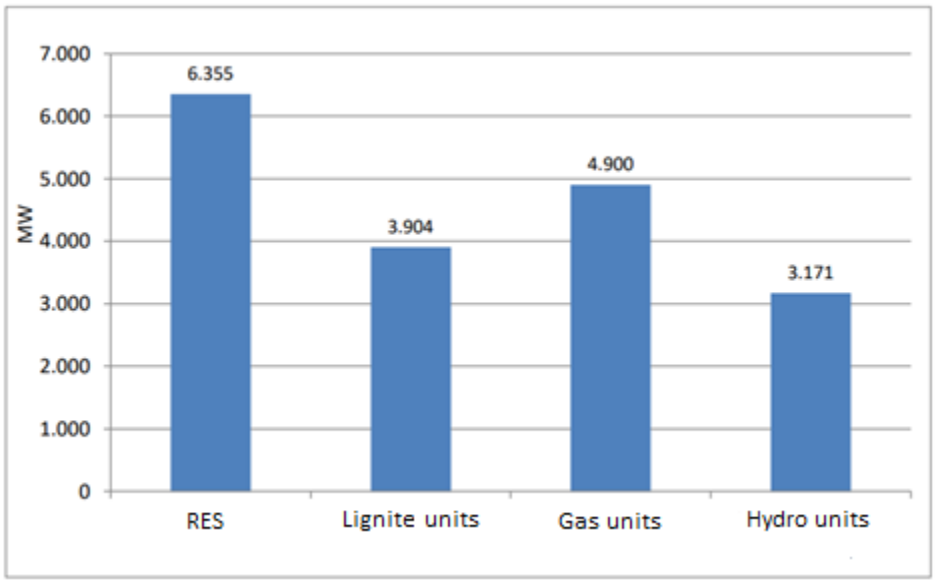
Source: IEA (2020)

[19] http://www.admie.gr/fileadmin/groups/EDRETH/Monthly_Energy_Reports/Energy_Report_201912_v1.pdf

Installed Capacity

In 2019, the total installed capacity of power generation units in the Greek interconnected system amounted to 18.3 GW, up 5.2% from levels in 2018 (17.4 GW). RES were the only power generation source that increased its share in domestic installed capacity in the interconnected system in 2019 as compared to 2018, with new installed capacity of 886 MW and total installed capacity at 6.3 GW. In 2019, the total installed capacity of lignite, hydro and gas units remained at the same levels as in 2018, as shown in Figure 18.

Figure 18: Total Installed Capacity of Units by Type of Fuel in the Greek Interconnected System, 2019



Source: Hellenic Energy Exchange

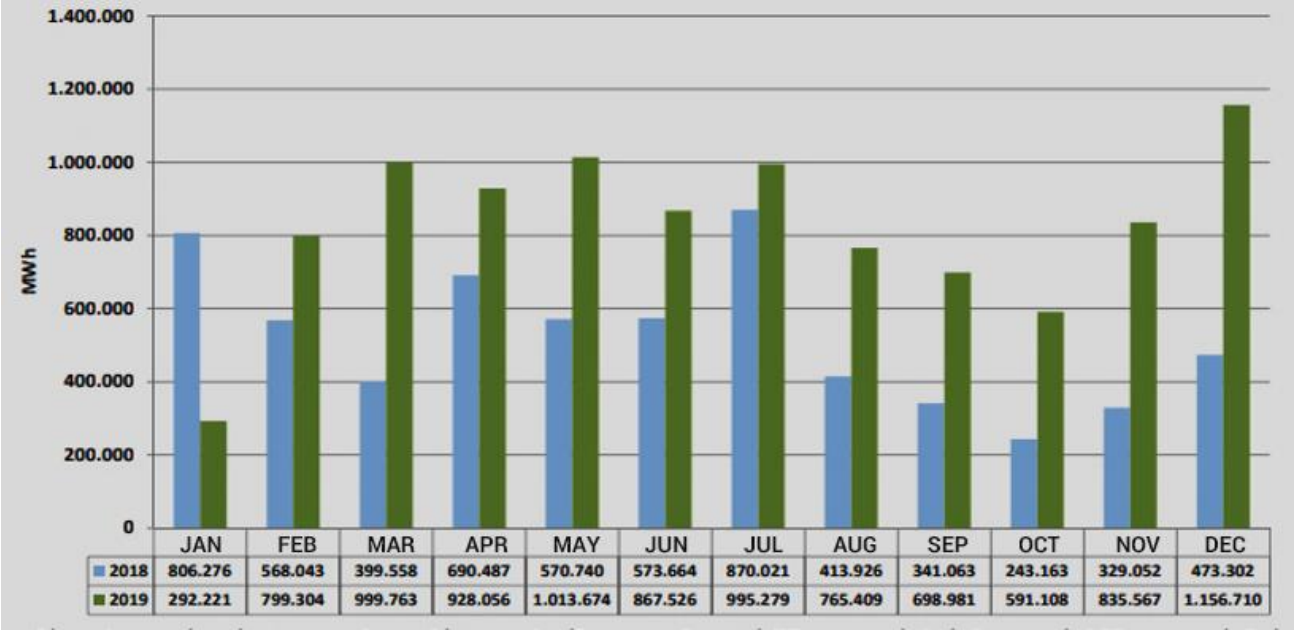
Electricity Imports and Exports

Greece is well connected to neighbouring countries and apart from the domestic electricity production is increasingly becoming active in power tading activities. However, the interconnection index[20] of the country's power grid is at 9%, i.e. at levels lower than in other power systems in SE Europe as the interconnection indices in Bulgaria and Rumania are at 12% and 11% respectively. Electricity imports increased due to new interconnections, though they vary considerably from year to year.

[20] Defined as the ratio of the import capacity of existing interconnections to the installed power generation capacity of the system each time.

More specifically, electricity imports into Greece amounted to 9.6 TWh in 2019, mainly from Bulgaria, Italy and North Macedonia. Electricity exports amounted to 2.9 TWh in the same year, mainly routed to Italy, Albania and North Macedonia. Greece has been a net importer of electricity for many years, with total net imports in 2019 at approx. 6.7 TWh, covering approx. 13% of the country's needs, based on IPTO's data. It is worth noting that a second electricity interconnection between Bulgaria and Greece is under development and is expected to become operational by 2023. This project is of great importance for the market coupling of both countries, and is expected to increase considerably the interconnectivity of Greece and bring the country closer to the minimum European target of 15% by 2030.

Figure 19: Electricity Balance (MWh) at the Interconnections of Greece, 2018-2019



	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2018	806.276	568.043	399.558	690.487	570.740	573.664	870.021	413.926	341.063	243.163	329.052	473.302
2019	292.221	799.304	999.763	928.056	1.013.674	867.526	995.279	765.409	698.981	591.108	835.567	1.156.710

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

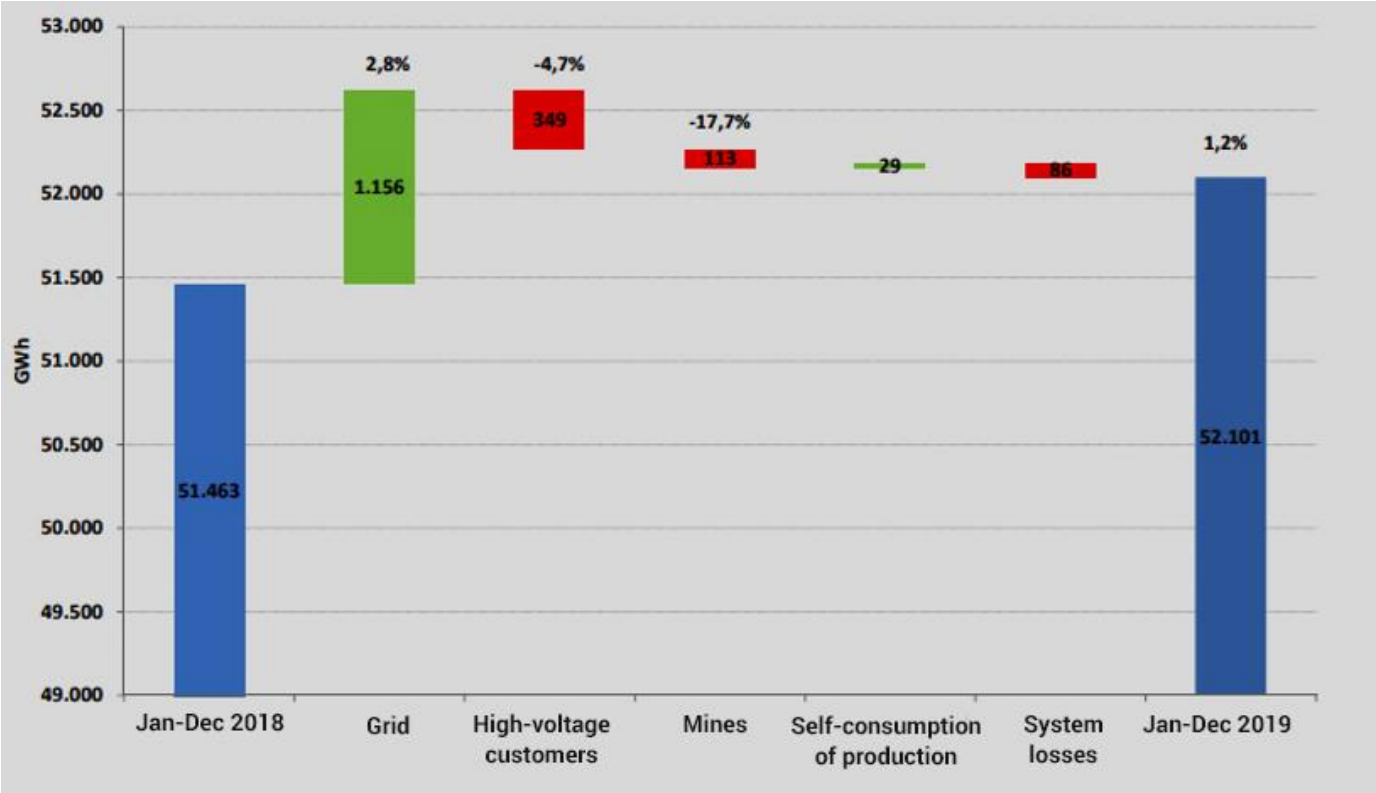
Source: IPTO

Electricity Consumption

Electricity consumption in Greece increased steadily up to the peak of 58.8 TWh in 2008; followed by a 5-year period of decline, from 2009 to 2013, as a result of the prolonged financial crisis. The electricity consumption has recovered slightly in recent years, and in 2019 Greece consumed 52.1 TWh (see Figure 20) in the interconnected system (except of the islands, with 5.6 TWh).

Based on IEA data, the residential sector consumed the majority of electricity, accounting for 36% of total final electricity consumption in 2017, followed by the commercial (35.6%) and the industrial (22.7%) sectors. Other sectors (i.e. agriculture and transport) accounted for a smaller share of total final electricity consumption.

Figure 20: Change in the Electricity Demand (GWh) in the Interconnected System of Greece, 2018-2019



Source: IPTO

4.2. Non-Interconnected Islands

In Greece (mainly in the Aegean Sea), most islands currently obtain electricity from autonomous power generation plants, operating with diesel and fuel oil, and RES units (wind and photovoltaic). These islands have not yet been interconnected with the mainland grid, mainly due to technical and financial difficulties, since interconnections are capital-intensive projects.

The electricity market of the Non-Interconnected Islands (NII) now consists of 29 autonomous systems, since Paros and Syros were interconnected in May 2018 and Mykonos in May 2019. Some of these systems comprise several islands (island clusters), and the operation and management of the NII market is undertaken by the Hellenic Electricity Distribution Network

Operator (HEDNO) and more specifically by its Island Management Division. According to RAE data[21], peak demand varies among the 29 autonomous island clusters:

- peak demand in 19 "small" autonomous systems is up to 10 MW;
- peak demand in 8 "medium-sized" autonomous systems fluctuates from 10 MW to 100 MW; and
- peak demand in 2 "large" autonomous systems, namely Crete and Rhodes, is over 100 MW.

Electricity consumption in the NII varies correspondingly, from a few hundred MWh in the smaller islands (e.g. Antikythira, Agathonisi, etc.) to some TWh in the largest NII (Crete).

As mentioned above, the NII are usually equipped with units that use diesel as fuel and are expensive, environment-unfriendly, and cannot benefit from the advantage of economies of scale. However, the NII feature excellent conditions for wind and solar energy utilisation. The operation of these types of energy in the islands is complicated by their variability and the need for back-up systems.

Based on data provided by the HEDNO's Island Management Division, the total installed capacity of power generation units in the NII was approx. 2.2 GW in 2019, of which 79% concerned thermal stations (see Table 4), increased by 7.4% compared to 2018 levels (2,070.10 MW).

Table 4: Installed Capacity (MW) of Power Generation Units on NII, 2019

Categories	Installed Capacity (MW)	Percentage (%)
Thermal Stations*	1,756.97	79.0%
Wind Parks	306.15	13.8%
Photovoltaic**	129.75	5.8%
Special Program PV and net metering	27.15	1.2%
Biogas	0.99	0.0%
Hybrid	2.95	0.1%
Hydro	0.3	0.0%
Total	**2,224.26**	**100.0%**

Notes: *Last available data is for 2018; **Installed capacity of Special Program P/V and net metering is not taken into account.

Source: HEDNO

[21] http://www.rae.gr/site/categories_new/electricity/market/mdn.csp

Similarly, power generation in the NII was at approx. 5.6 TWh in 2019, of which 83% concerned thermal stations (see Table 5), recording a very slight drop in the range of 0.3% as compared to levels in 2018 (5,572 GWh).

Table 5: Power Generation (MWh) in NII, 2019

Categories	Power Generation (MWh)	Percentage (%)
Thermal Stations	4,594,664.4	82.7%
Wind Parks	700,386.2	12.6%
Photovoltaic*	218,647.9	3.9%
Special Program PV and net metering	34,786.4	0.6%
Biogas	4,382.1	0.1%
Hybrid	1,696.6	0.0%
Hydro	859.3	0.0%
Total	5,555,423.0	100.0%

Note: *Power generation by Special Program P/V and net metering is not taken into account.

Source: HEDNO

5. Solid Fuels

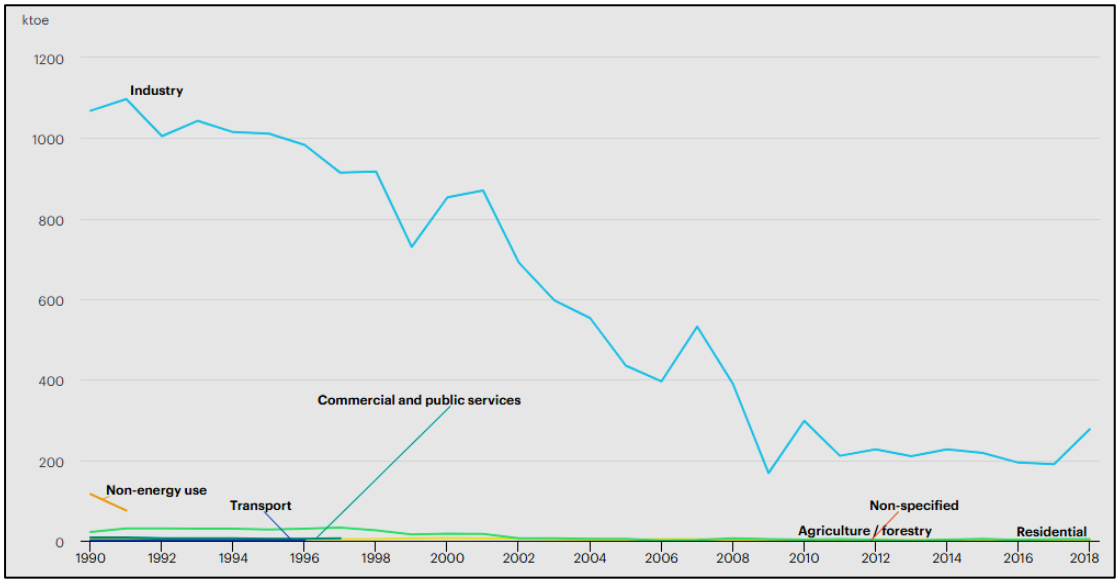
Lignite accounts for a large part of Greek mining activity, a basic fossil fuel and an important element for the country's energy security. Greece is the fourth largest lignite producer in Europe, after Germany, Poland and the Czech Republic. It is the second fuel, after oil, with the largest contribution to the total primary energy supply, but accounts for a small part only of total final consumption by industry. Based on data from the European Association for Coal and Lignite (EURACOAL)[22], lignite production in Greece amounted to 36.5 million tons in 2018, and power generation from lignite was at 14.9 TWh in the same year.

Based on IPTO's data, electricity produced from lignite declined considerably from 14.9 TWh in 2018 to 10.4 TWh in 2019, due to the increase in RES, lower total demand for electricity, and the high cost of emission rights, which makes power generation from lignite uneconomic. Lignite production fell by 50% between 2012 and 2018, in conjunction with reduced demand for power generation from lignite. PPC is the sole owner and operator of the five lignite-fired power stations in Greece, deploying 14 units in total and employing 6,223 workers (4,363 in production plants and mines and 1,860 as subcontractors).

[22] EURACOAL (2020), "Coal Industry across Europe", *7th edition*, https://euracoal.eu/library/publications/

Imported hard coal (approx. 0.4 million tons), almost all from Russia, is used in the cement industry.

Figure 21: Final Lignite Consumption by Sector in Greece, 1990-2018



Source: IEA (2020)

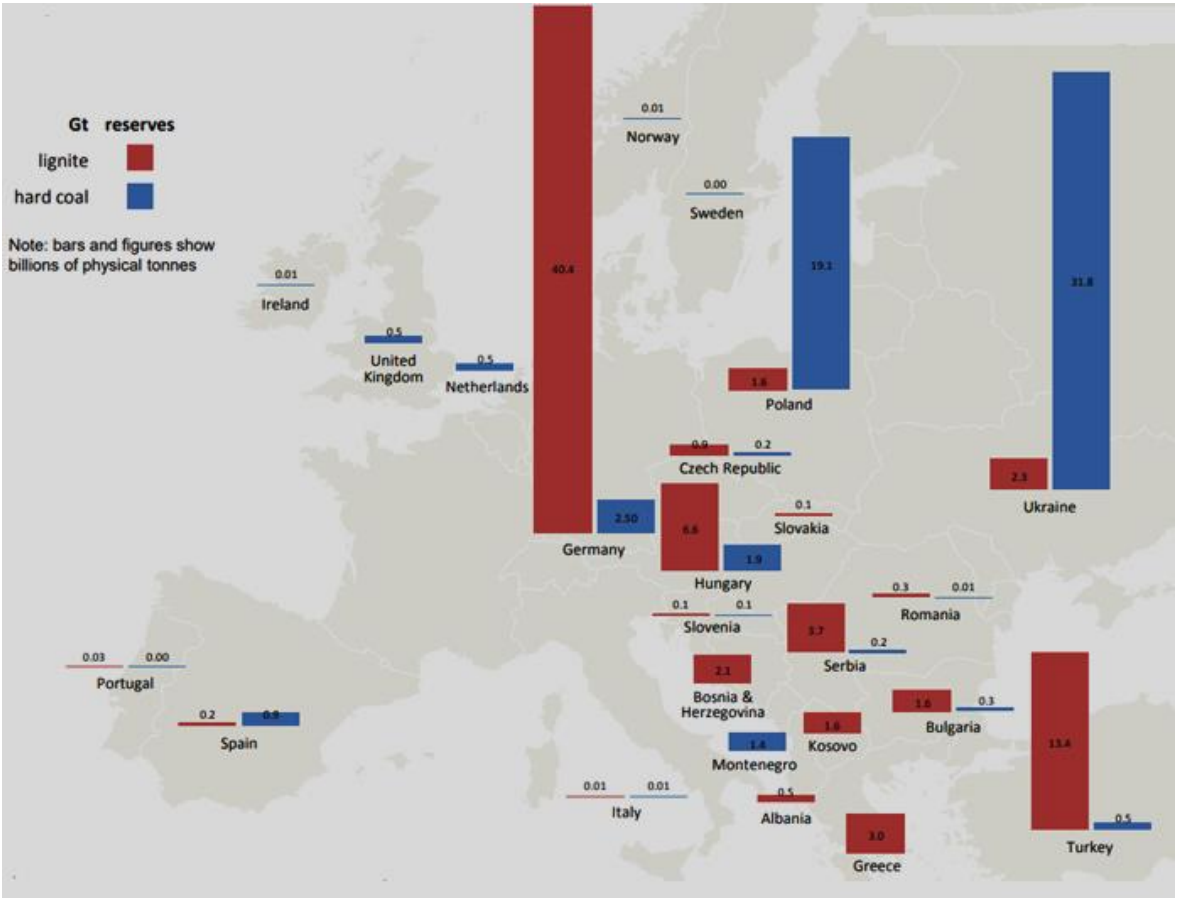
Total confirmed geological reserves of lignite in Greece amount to approx. 5 billion tons. These deposits are geographically dispersed across Greek territory[23]. Based on current technical-economic conditions, the deposits that are suitable for energy exploitation amount to approx. 3.2 billion tons and are equivalent to 450 million tons of oil. The main exploitable deposits are in the regions of Ptolemais, Amyntaio and Florina, with reserves estimated at 1.8 billion tons, in the area of Drama, with reserves of 900 million tons, and in the area of Elassona with 169 million tons. There is also a lignite field with reserves of approx. 223 million tons in the area of Megalopolis, in the Peloponnese.

Based on total exploitable lignite reserves in the country and the expected rate of consumption in future, it is estimated that these reserves are sufficient for more than 45 years. Up to now, mined quantities of lignite amount to 29% of total reserves. In addition to lignite, Greece has a large deposit of peat in the area of Philippi (eastern Macedonia). Exploitable reserves at this deposit are estimated at 4 billion cubic metres and are equivalent to approx. 125 million tons of oil.

[23] https://www.dei.gr/el/oruxeia/apothemata-kai-poiotita

In general, the quality of the Greek lignite is low. Thermogenic power is in the range of 975-1,380 kcal/kg in the areas of Megalopolis, Amyntaio and Drama, 1,261-1,615 kcal/kg in the Ptolemais area, and 1,927-2,257 kcal/kg in the areas of Philippi and Elassona. An important comparative advantage of lignite in Greece is the low sulphur content.

Map 13: Exploitable Lignite Reserves in Europe



Source: EURACOAL

According to the updated NECP of December 2019, all PPC's lignite-fired power plants are expected to be phased out by late 2023 (apart from the new one, Ptolemais 5, currently under construction, which is expected to be phased out in 2028), with a total capacity of approx. 4 GW, and all lignite mines in the regions of western Macedonia and Megalopolis are set to be closed.

Greece to Phase Out Lignite

The fuel that drove the country's electrification is gradually being phased out, in line with EU policy and the country's committments. It is expected that the first PPC's lignite units to close by 2020 are the ones of Amyntaio and Kardia; the procedures for the retirement of their

personnel are under way, and a Master Plan for the way ahead will be ready by the end of the year. The Master Plan will include strong tax and development incentives and emphasis on manufacturing, tourism and green energy, to ensure a smooth transition to the post-lignite era for the regions of western Macedonia and Megalopolis.

In February 2020, the Inter-Ministerial Committee responsible for the lignite phase-out appointed Mr. Kostis Mousouroulis, a senior official of the European Commission, as Coordinator of the Just Transition Development Plan (SDAM) for the regions of western Macedonia and Megalopolis. More specifically, the Ministerial Council Act states that Mr. Mousouroulis will be the Chairman of the Coordination Committee, i.e. the Working Group, which, under the supervision of Inter-Ministerial Committee, will draw up and implement the Just Transition Plan and will coordinate the activities related thereto, starting in 2020. It is worth noting that IENE recently completed a special Report[24] on behalf of the SDAM Coordination Committee about the current situation and the prospects of regions in energy transition in Greece.

The proper transition of lignite regions into an era of clean energy, development and business growth requires financing in several sectors. What is sought is financial assistance for infrastructure projects and support for fast-track investments in RES, energy efficiency and electromobility, projects to support and strengthen the primary sector, and other projects that promote innovation and competitiveness.

Attaining these aims will require full and productive utilisation of all available financing means and sources for the transition into the post-lignite era. In particular, the investments under consideration will enable full utilisation of the resources of the three pillars of the Just Transition Mechanism (Just Transition Fund, Special InvestEU status, Public Sector Credit Facilities), while also advancing the financing of investments via the other sources, by mobilising considerable private capital (leverage).

[24] IENE (2020), "Υφιστάμενη Κατάσταση και Προοπτικές για τις Περιοχές σε Ενεργειακή Μετάβαση στην Ελλάδα", *IENE Study (M58)*, https://www.iene.gr/articlefiles/final%20report.pdf

Table 6: Timeframe for Shutting Down Lignite-fired Plants in Greece

Lignite-fired plant	Rated capacity	Year of shutdown
Kardia 1	275	2019
Kardia 2	275	2019
Kardia 3	280	2021
Kardia 4	280	2021
Agios Dimitrios 1	274	2022
Agios Dimitrios 2	274	2022
Agios Dimitrios 3	283	2022
Agios Dimitrios 4	283	2022
Agios Dimitrios 5	342	2023
Amyntaio 1	273	2020
Amyntaio 2	273	2020
Florina/Meliti	289	2023
Megalopolis 3	255	2022
Megalopolis 4	256	2023

Source: NECP

In this context, initiatives are being planned and developed to utilise all financing means and tools. At this point, it is worth noting that the aim is fast-track implementation of the investments, with a considerable part thereof being realised in 2022 and 2023. The total time allocation of the investment cost will depend on several parameters, such as approval of the incentives by the European Commission, land restoration, public investments and other supportive programs and projects, simplification of licencing procedures, etc. Prompt finalisation of the incentives will be significant for the unimpeded and timely implementation of the investment plans. At the same time, land restoration works impact directly the timing of the investments, due to both the financing costs they involve and the fact that they constitute a precondition for implementing some of the investments.

In addition, the realisation of public investments, especially on the level of infrastructure, will increase considerably the attractiveness of the areas and the capability to accommodate new investment plans, while the maturity of the project's studies in conjunction with the completion of Special Urban Planning and the acceleration of the licencing procedures will contribute decisively to fast-track implementation of the financing plan.

It is worth noting that taking into consideration the investment plan as envisaged at this stage, which will obviously be enriched with new investments over time, the total capital cost of foreseen investments (which are initially estimated at more than €5 billion), the parameters

of each financing source and the need to adopt the best possible financing scheme, the initial plan for the financing has as follows:

- 10% subsidies, by turning to account the first pillar of the Mechanism (Just Transition Fund)
- 30% loans on favourable terms, by using the other two pillars (Special InvestEU status, Public Sector Credit Facilities) and other financing tools
- 40% commercial loans, by drawing financing from domestic and international credit institutions
- 20% equity capital, by mobilising and attracting the private capital of candidate investors.

This financing scheme indicates that a considerable part of the investments will be realised through leverage of commercial (bank) loans and equity capital, since important investments that are already mature do not require further support.

In parallel, utilising the Just Transition Mechanism, not with the aim of exhausting immediately the subsidies (Just Transition Fund) but rather by making the fullest possible use of all three pillars, will alow the incorporation and implementation of an increasing number of investments.

Indicatively, in July 2020, the state's Green Fund approved the first two calls for submitting proposals for financing "green" actions, with beneficiaries being the lignite-dependent municipalities of Amyntaio, Florina, Eordaia, Kozani and Megalopolis. The first call concerns the submission of Action Plans for Energy and the Climate and the second call concerns the financing of interventions for promoting the cyclical economy, with positive social and environmental impact, in the context of the National Strategy for the Cyclical Economy.

In August 2020, the Green Fund approved the third successive call for submitting proposals for financing "green" actions, in the context of its first-ever program for phasing out lignite. The call aims at the preparation of the related studies and planning and licencing procedures for the comprehensive management system for the pilot program of cyclical liquid waste management in these areas. The beneficiaries of the Program include the Region of western Macedonia and all First-Degree Local Authorities in the Kozani and Florina Regional Units. The total budget made available with this Call amounts to €1 million, with a minimum budget of €100,000 for each proposal.

The ultimate goal is to promote a comprehensive model for the cyclical management of urban waste from towns and villages in the Kozani and Florina Regional Units of the western Macedonia Region. More specifically, there will be support for developing comprehensive systems for urban waste management, so that the waste sludge produced is processed towards converting it into an environment-friendly renewable fuel and/or a secondary material that is useful and safe for humans and the environment.

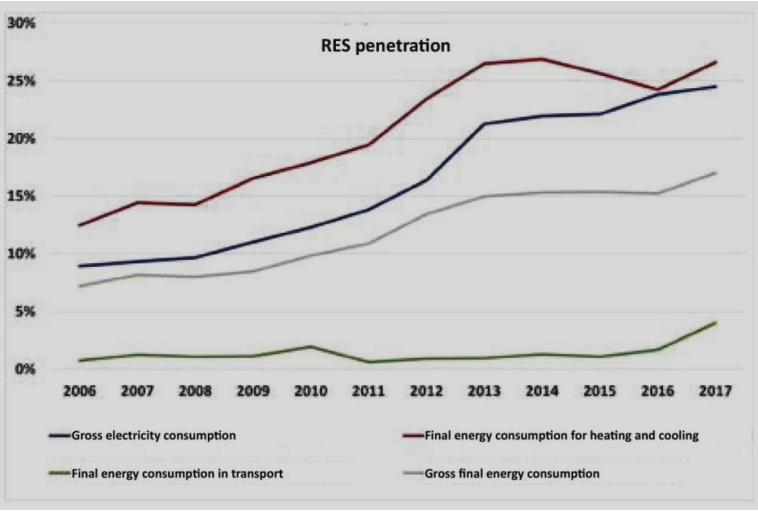
6. Renewable Energy Sources (RES)

The contribution of RES in energy consumption in Greece has shown a significant increase over the period 2006-2017, as their overall contribution in 2017 as a share of gross final energy consumption amounted to 17%, more than doubling the corresponding share in 2006 (see Figure 22), based on NECP's data.

Apart from the transport sector, in which the share of RES recorded marginal variations and a stable increase only in 2016 and 2017, the contribution of RES in both gross electricity consumption and final energy consumption for heating in the period 2006-2016 increased considerably, at an average annual rate near 10%.

It is worth noting that the variations observed in different periods in the share of RES in final energy consumption for heating are exclusively due to the use of solid biomass, which has fluctuated over recent years, following its sharp increase in the early 2010s and its peak in 2012.

Figure 22: Total and Specific Shares of RES in the Greek Energy System on the Basis of EU Methodology, 2006-2017



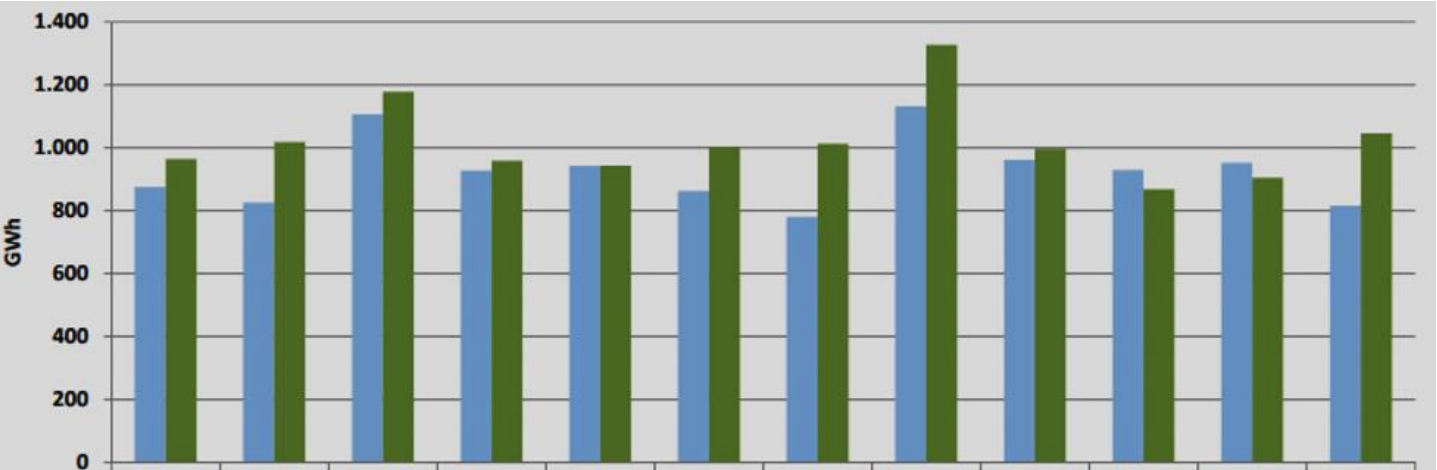
Source: NECP

Based on NECP's data, the share of RES in domestic gross electricity consumption in 2017 was 24.5%, a marked increase as compared to 2006, when the respective share was in the range of 9%. More specifically, regarding power generation from RES with non-controllable production features, i.e. power generation from photovoltaic and wind units, the percentage already amounts to over 15% in gross final electricity consumption.

6.1. Power Generation from RES

In Greece, power generation from RES in the interconnected system amounted to 12.2 TWh in 2019, up from 11.1 TWh in 2018, as a result of the fast growth of the installed capacity of wind and solar and the reduction in total electricity supply over the last decade.

Figure 23: Power Generation from RES in Greece, 2018-2019

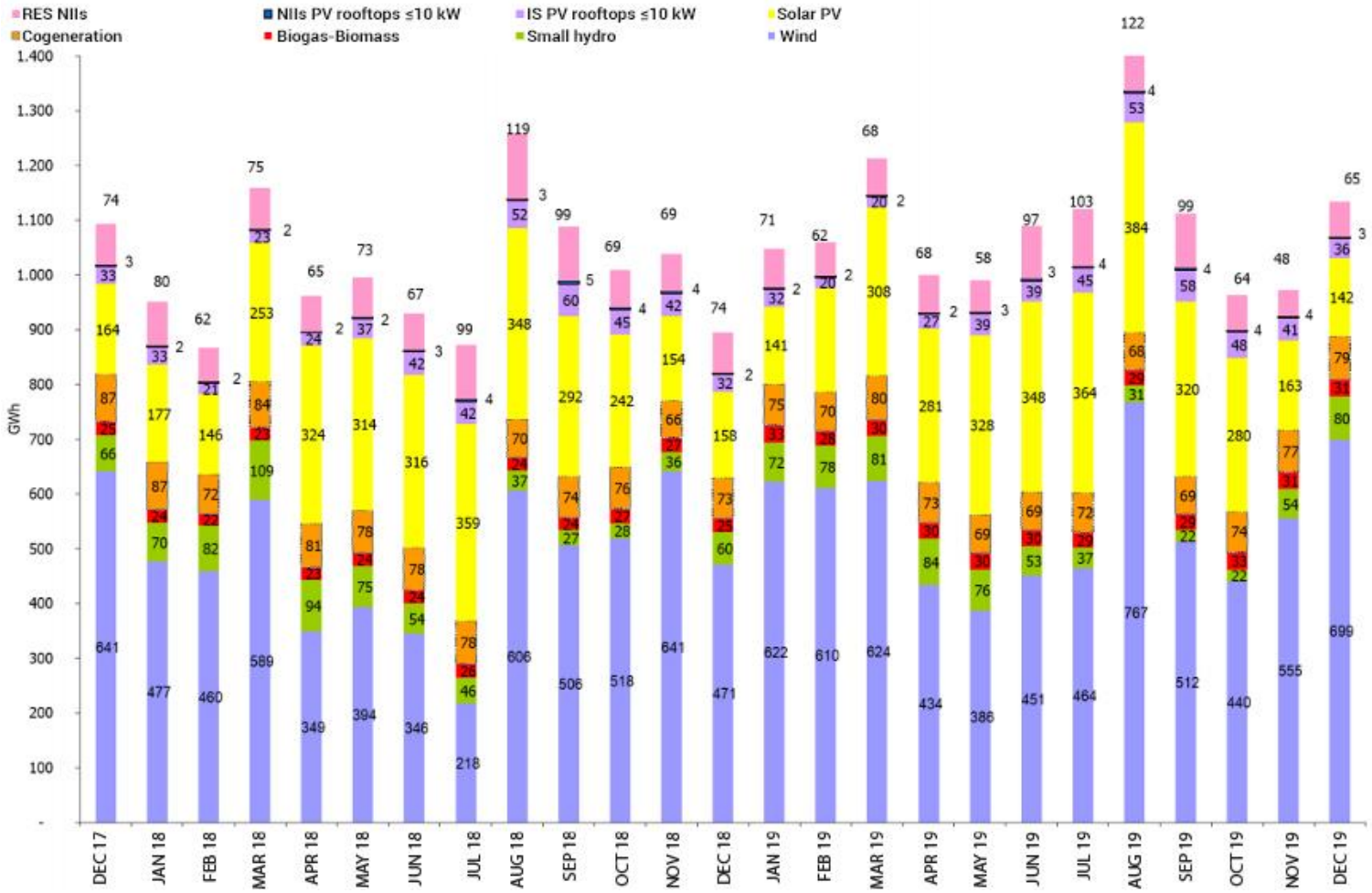


	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2018	875	826	1.106	927	942	863	781	1.132	961	929	952	816
2019	964	1.019	1.178	958	943	1.003	1.013	1.327	996	868	905	1.046

Source: IPTO

Total power generation in Greece from wind forms interconnected to the system amounted to approx. 6.6 TWh in 2019, and from small hydro units and biogas-biomass stood at 690 GWh and 362 GWh respectively. In addition, the total power generation from cogeneration units and assigned cogeneration interconnected system units stood at 186 GWh and 876 GWh respectively. The electricity generation from solar PV units in the interconnected system was almost 3.2 GWh in 2019 (see Figure 24).

Figure 24: Power Generation of RES and Cogeneration (GWh) Units and Rooftop Photovoltaic Power Stations ≤10 kW, 2017-2019



Source: LAGIE (Hellenic Electricity Market Operator)

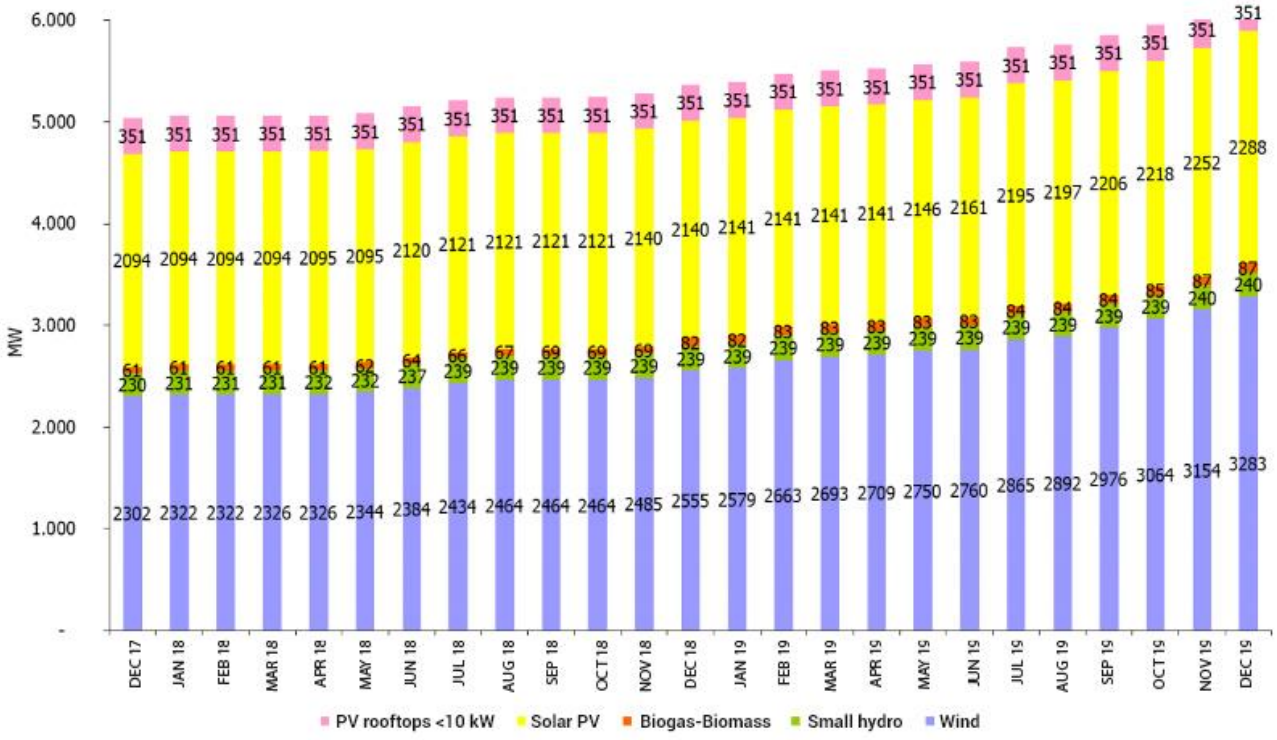
Greece has significant RES potential, which can contribute substantially to an environment-compatible restructuring of its energy system. This potential mainly comprises solar, wind, hydro and geothermal energy as well as biomass.

The ample wind potential is mainly found in the country's island regions (e.g. Crete, Aegean Sea, Evia, etc.), where most wind farms are currently located. The exploitation of Greece's wind potential, in conjunction with improvements in the technologies used in state-of-the-art wind turbines, is expected to contribute significantly towards sustainability.

6.2. Installed Capacity from RES

Based on data from the bulletin of the Renewable Energy Sources Operator & Guarantees of Origin (DAPEEP) of December 2019[25], the total installed capacity of RES units operating in the Greek interconnected system and of rooftop photovoltaic units smaller than 10 kW amounted to 6,249 MW in 2019 (see Figure 25), of which the majority is based on wind (52.5%) and photovoltaic (36.6%) units.

Figure 25: Installed Capacity (MW) of RES Units Operating in the Greek Interconnected System and Rooftop Photovoltaic Units ≤10 kW, 2017-2019



Source: LAGIE

During 2005-2019, the installed capacity of onshore wind farms increased almost six-fold, and more than 2.9 GW of new power capacity were added to existing plants in Greece (see Figure 26).

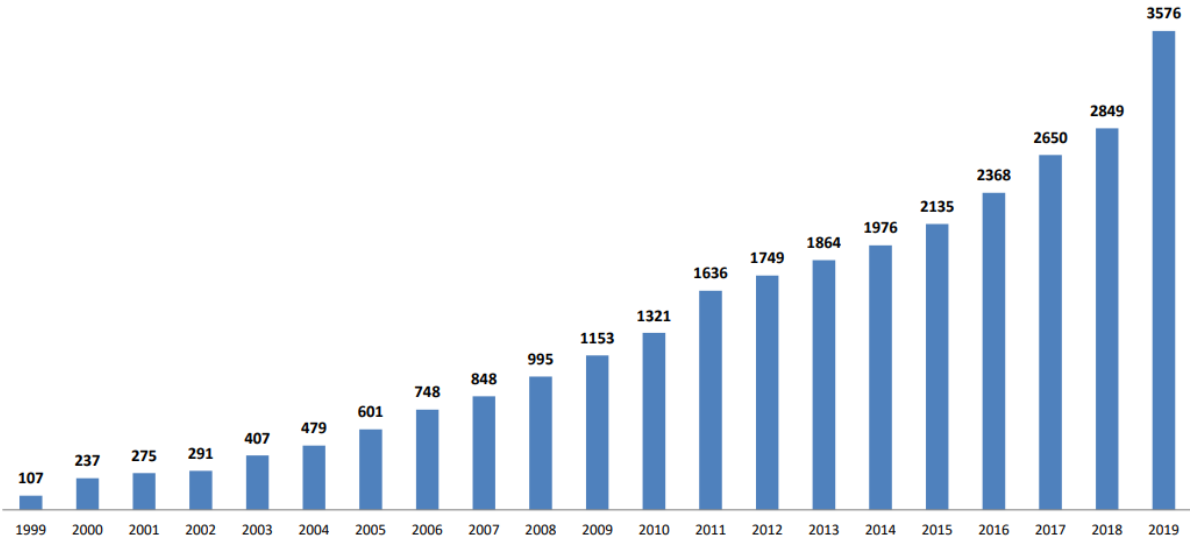
2019 - A Record Year for Wind Energy in Greece

2019 was a record year for wind energy in Greece, since 727 MW of new wind farms were connected to the network, almost four times the annual average during the previous decade

[25] http://www.lagie.gr/fileadmin/groups/EDRETH/RES/20200326_DELTIO_APE_DECEMBER.pdf

(185 MW). In addition, the largest wind farm complex, with a capacity of 154.1 MW, was connected in South Evia (Kafireas) by Enel Green Power.

Figure 26: Installed Capacity (MW) of Onshore Wind in Greece, 1999-2019

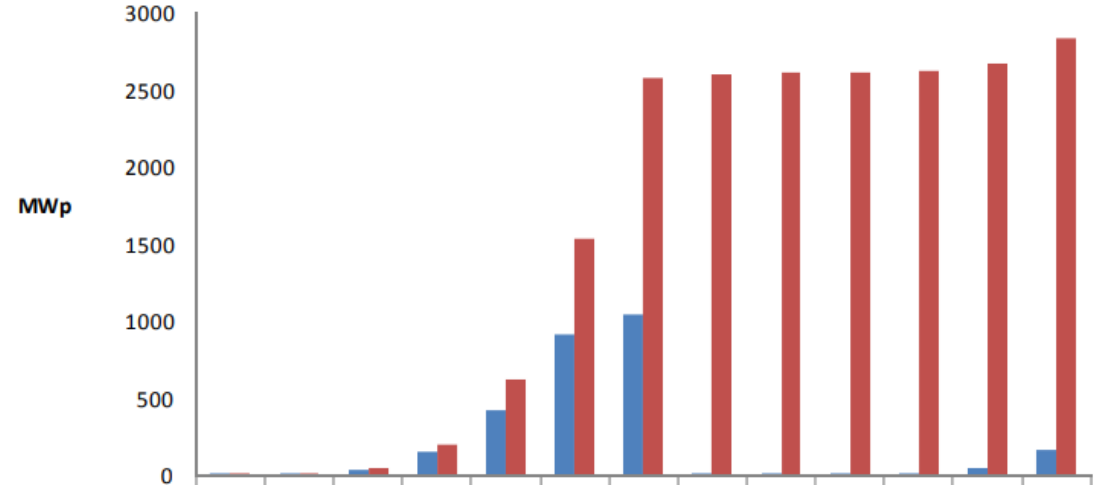


Source: Hellenic Wind Energy Association

It is worth noting that the sharp increase of solar PV projects in Greece during the period 2011-2013 was due to the greater financial incentives for these type of investments. However, this short-lived increase resulted in a long-term and substantial rise in consumers' electricity bills, due to higher special taxes for RES levied on consumers. The entities shaping energy policy in Greece were concerned about this development and reacted by blocking new solar PV projects, even if they required only a small percentage of compensation compared to past projects.

In 2019, the domestic solar PV market showed the first substantial indications of recovery, and the trend is towards an imminent return to figures in the range of hundreds of MW annually. In the past year, autoproduction systems increased by 3.1% compared to 2018, still at levels considerably lower than the country's potential. For another year, the solar PV market covered approx. 7% of Greece’s electricity needs, placing the country in the fourth position globally (after Honduras, Italy and Germany) regarding the contribution of solar PV in total electricity demand.

Figure 27: Installed Capacity (MW) of Photovoltaics in Greece, 2007-2019



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Annual installed capacity	2	10	35	152	426	912	1.043	17	10	5,4	12,9	43,1	160
Cumulative installed capacity	2	12	47	199	625	1.537	2.579	2.596	2.607	2.612	2.625	2.668	2.828

Source: HELAPCO

Table 7: New Installed Capacity (MW) of Photovoltaics in Greece, 2019

New installations that interconnected within 2019	Number of systems	Power (MWp)
Solar PV parks	246	150,29
Net Metering	362	9,57
Special Solar PV programme (expired 31.12.2019)	17	0,16
Total	**625**	**160,02**

Source: HELAPCO

Net-metering is one of the tools for promoting autogeneration and autoconsumption using RES. Net-metering allows the consumer to cover a substantial part of his autoconsumption, while also providing him with the capability to use the network for indirect storage of the green energy. However, the number of autoproduction projects remains small compared to the country's potential: the number of net-metering units was 362 in 2019, with a total installed capacity of 9.57 MW, while only approx. 10% of autoproduction systems has been installed in the residential sector, by the criterion of installed MW.

6.3. RES in Non-Interconnected Islands (NII)

As discussed earlier, there are currently in operation 29 autonomous island systems in Greece. In these NII, there must be a special focus on using RES for power generation, since there is

high potential for their use and they are economically advantageous, since in most NNI both the final average power generation costs and the corresponding variable costs of oil use are very high. In addition, the European Directive 2015/2193/EU has come into force for limiting emissions of pollutants from medium-sized combustion plants for power generation, which will ultimately lead to their elimination from the NII.

However, the penetration of RES generation is subject to specific limitations, which are mainly determined by the technical minima of installed thermal units and the maximum permissible hourly penetration of non-controllable RES on the basis of load.

Total RES penetration in the NII is currently close to 21% of power generation, though without capability for further substantial penetration if the above limitations are not addressed, mainly through the application of innovative management technologies, utilising the technology of modern-day RES units with power electronics and/or with the installation and operation of storage systems. However, as a first step, HEDNO is in the process of readjusting its planning for developing state-of-the-art NII electricity systems, with higher RES penetration, modernisation and digitalisation of its infrastructure in the 29 non-interconnected island systems[26].

A special case are the many uninhabited islands and islets in Greek territory, which have very high wind potential and where wind and solar PV parks could be installed.

The promotion of the use of hybrid stations with RES, i.e. RES and storage, is another solution in cases where the electricity interconnection of the islands is not economically viable, but such stations will have to be assessed as to technical-economic factors and compared to the existing situation, and their installation and operation can be promoted only if it is ensured that power generation costs are reduced in total in the autonomous system involved each time and as compared to other mature solutions. Research concerning the operation of such stations at pilot application is necessary, and already several such projects are at an advanced stage of development. However, the framework for their support must be planned so that no stranded assets are created, demanding further support and subsidies from outside the electricity market, while the possibility of future interconnection of each island with the mainland grid and the impact on the operation and operational reinforcement of hybrid stations must also be taken into consideration.

[26] http://dda.gr/pfiles/a58762e2c76300cedc96984520d1bb7512b13507.pdf

One parameter that will have to be taken into account in the country's energy planning is the ad-hoc studies for the final solution in each island system and the update of spatial planning for the RES in NII, so that any further penetration of RES can be promoted without obstacles and additional regulatory and licencing-related delays.

7. Energy Efficiency and Cogeneration

7.1. Energy Efficiency

Greece has applied a wide range of energy efficiency policies in recent years, most of which are based on adapting the requirements of the European Commission Directive on Energy Efficiency to the Greek legislation. The policy measures applied in the past did not result in substantial energy savings as envisaged initially, due to the economic and financial crisis, low public awareness, inadequate data and lack of financing.

In recent years, Greece has made substantial progress in promoting energy efficiency in buildings, which can be summarised as follows:

- The Greek Regulation for the Energy Efficiency of Buildings (KENAK), which determines the minimum energy efficiency requirements for buildings
- Designating buildings as being of almost zero energy consumption
- Introducing a system of Energy Inspections and the issue of Energy Certificates
- Planning a long-term strategy for renewing building stock
- The "Saving at Home" publicly financed program
- The energy upgrade of public buildings through specific actions, such as the first Energy Saving program for Local Authorities, etc.

Improving energy efficiency in all fields of consumption is the biggest challenge for the public policies to be implemented in the following decade. Therefore, it is an absolute and horizontal priority that should cover the entire scope and mix of policies and measures to be adopted. Energy savings achieved through improved energy efficiency have a direct impact on how energy is consumed, on the technologies used and on meeting consumer energy needs, also making a substantial contribution towards improving the competitiveness of all industrial activities.

According to the NECP, the objective is to improve energy efficiency in final energy consumption by at least 38% in relation to the foreseen evolution of final energy consumption by 2030, as estimated in 2007 in the context of the EU energy policies; thus, resulting in final

energy consumption levels of not more than 16.5 Mtoe in 2030. There is also satisfactory performance in terms of the relevant evaluation indicators concerning the rate of reduction both with regard to final energy consumption for 2017 (16.8 Mtoe) and the energy savings target for 2020 (18.4 Mtoe), taking into account the increase in final energy consumption in order to reverse the impact of the economic recession of the previous years.

This rate of reduction is even higher if adjusted to primary energy consumption, in which case it stands at more than 43%. This demonstrates that the overall objective is to achieve an improvement in energy efficiency across the entire energy system, attaining a particularly high level of improvement in terms of how energy is made available for consumption, always in the most cost-effective way. An additional objective is set in respect of the cumulative amount of energy savings to be attained over the period 2021-2030 in accordance with Article 7 of Directive 2012/27/EU on energy savings obligations. According to the available final energy consumption figures, cumulative energy savings of at least 7.3 Mtoe should be achieved over the period 2021-2030. However, the objective will be re-calculated on the basis of the final energy consumption figures for the years 2016-2018. In addition, an objective is set for the annual energy renovation of a total floor area of the thermal zone of central public administration buildings equal to 5,400 square meters, representing just 3% of the total floor area.

The need to renovate the existing building stock is indisputable, as this will result in significant energy savings and in cost savings for citizens, and will also improve the comfort, safety and health conditions in the use of these buildings. To that end, it is necessary to establish a central quantitative objective for the renovation and replacement of residential buildings with new nearly zero-energy buildings, which could in aggregate amount to 12%-15% of all residential buildings by 2030. The objective is to have an average of 60,000 buildings or building units upgraded each year in terms of energy and/or replaced with new more energy-efficient ones. This particular objective will contribute significantly to the major upgrading of the ageing building stock, while at the same time providing a substantial boost to the construction industry through high added value technologies and essentially ensuring increased financial and operating benefits for households in Greece, also enabling them to cover their energy needs.

Moreover, in respect of this dimension as well as other dimensions of the NECP, the aim is also to increase the use of natural gas in final consumption. More specifically, natural gas is expected to be the intermediate fuel for switching to a low GHG emissions model in all final

consumption sectors, and may also lead to both improved energy efficiency and lower energy costs compared to other conventional technologies. A key aim is to achieve a higher gas share in all final consumption sectors and, essentially, to ensure that its increased use replaces part of the current consumption of petroleum products in these sectors. The development of the necessary transmission and distribution infrastructure to allow access to natural gas for higher percentages of end users in the building sector and the further increase in its use in industry and transport are priorities for the forthcoming period. The quantitative objective for this priority is to increase the direct use of natural gas in the final consumption sectors by at least 50% compared to 2017.

Finally, the implementation of all the necessary investments in final energy consumption sectors with a view to improving energy efficiency requires that more effective financing mechanisms are planned in order to increase and maximise the current levels of private capital leverage. The active involvement of the financial sector and the promotion of innovative financing mechanisms and market mechanisms, including energy performance contracts, are critical parameters for attaining this objective.

7.1.1. Energy Efficiency in Buildings

Since buildings are currently responsible for approximately 40% of energy consumption, there is a need to promote the improvement of the energy efficiency of buildings through renovation and modernisation, as well as to adopt corresponding measures for renewing the stock of end-of-lifecycle buildings, while at the same time using construction and demolition waste in conformity to the principles of circular economy. Reducing the energy consumption of buildings requires the increased use of energy-efficient and low-emission heating systems and the renovation or construction of smarter buildings, with improved insulation materials, inter alia, in full conformity to the principles of circular economy. The Energy Performance of Buildings Directive contributes to improved quality of life and makes a significant contribution towards the reduction in GHG emissions by 2050.

Another highly important policy is the optimal use of RES technologies to cover heating and cooling needs and of RES autoproduction systems to cover the needs of buildings for electricity, also by strengthening the role of consumers. These actions will also ensure a lower cost of living. However, the necessary methods and means must be provided, to help people make this transition.

7.1.2. Energy Efficiency in Transport

In the transport sector, the use of vehicles powered by alternative fuels and electricity, the sharp drop in unit energy consumption per type of vehicle, the use of second-generation biofuels, the complete electrification of railway infrastructure and the increase in the share of track-based modes of transport in the overall transport work will, by the end of the next decade, totally transform the technological structure and fuel mix used in the transport sector, thus impacting the national economy as a whole. Finally, given that Greece is a leader in shipping, it is important to promote emission reduction technologies in shipping in compliance with the decision of the International Maritime Organisation (IMO) of April 2018 for a 50% reduction in emissions by 2050, compared to 2008, and totally eliminating emissions by 2100.

7.2. Cogeneration

Cogeneration is defined as the simultaneous production of power and heat (and/or cooling) from the same initial energy source. In general, cogeneration systems can cover all final energy uses (electricity, heating, steam production, cooling) and thus, they are used across a broad range of applications (e.g. greenhouses, residential complexes, manufacturing facilities, etc.). In addition, these systems allow for the dispersal of power generation units so that they reflect the needs of local consumption, offering high performance, avoiding losses in transport and increasing the flexibility of an area's power system.

The fuel most commonly used in cogeneration systems is natural gas, which, compared to other fossil fuels, has lower greenhouse gas emissions. In specific applications, as in agriculture companies, biomass may also be used.

Greece has one of the lowest rates of cogeneration among the EU-28 member states, even though it has a 40-year related tradition, initially in the industrial sector.

In 2019, the total installed cogeneration capacity and distributed cogeneration units throughout the country was 233.4 MW, based on DAPEEP's data, which covers mostly the industrial sector, the primary and tertiary sectors as well as the district heating of towns. An appropriate legal framework can promote cogeneration, in conjunction with support of mechanisms for autoproduction, but Greece is lagging in long-term stability. Also, the related legislation is characterised by complexity (e.g. frequent changes in energy laws, amendments, etc.), while the bureaucracy in licencing procedures is an obstacle for any investor wishing to become active in the sector.

Table 8: Annual Electricity Generation from Cogeneration and RES in Greece, 2010-2019

Year	Annual Electricity Generation from Cogeneration Units	Annual Electricity Generation from Distributed Cogeneration Units	Total Electricity Generation from RES and Cogeneration	CHP % of the Total
	GWh	GWh	GWh	%
2010	115	0	3,256.5	3.53
2011	142	0	3,959.5	3.59
2012	149	0	5,406.5	2.76
2013	119	943	9,156.0	1.30
2014	159	1,116	9,091.0	1.75
2015	188	1,121	10,051.0	1.87
2016	185	1,112	10,469.0	1.77
2017	195	984	11,552.0	1.69
2018	183.5	918	12,211.5	1.50
2019	186.5	876	13,357.5	1.40

Source: Hellenic Association for the Cogeneration of Heat and Power (HACHP)

According to studies undertaken before the financial crisis, there are significant prospects for cogeneration in several sectors of the Greek economy, e.g. in industry, in district heating from cogeneration units, in the primary and tertiary sector (hospitals, hotels, etc.) that can be financed by EU funds (e.g. via the Structural Funds and Cohesion Fund), but also for very small cogeneration for buildings.

According to the Cogeneration Observatory and Dissemination Europe, the potential of Greece is estimated at 11.1 TWh/year of primary energy saving, as per the methodology of the Directive on Energy Saving (27/2012/EC). Considering the implementation of the aforementioned actions possible, the Observatory estimates the potential at 24 TWh/year of primary energy saving and the reduction of CO_2 emissions at 14 million tons.

Table 9: Electricity Cost from Cogeneration and RES in Greece, 2010-2019

Year	Cost for Cogenerated Electricity from Cogeneration Units and Distributed Cogeneration Unit, million €	Total Cost of Electricity from RES and Cogeneration, million €	CHP % of Total Cost
2013	67.1	1,747.5	3.84
2014	56.6	1,638.4	3.45
2015	56.2	1,476.4	3.81
2016	41.1	1,329.0	3.09
2017	38.5	1,691.4	2.28
2018	37.3	1,719.5	2.17
2019	42.6	1,848.8	2.30

Source: Hellenic Association for the Cogeneration of Heat and Power (HACHP)

8. Anticipated Energy Investments in Greece (2020-2030)

Taking into account the large and medium-sized energy projects already under development, but also assessing the dynamics of implementing planned projects, Greece appears to have amassed a substantial energy related investment potential. This is currently estimated at above €45 billion over the next decade or about €4.5 billion on an annual basis.

Table 10 summarises the anticipated energy investments in Greece over the next decade (2020-2030). These estimates are based on several assumptions, most important of which is that from 2021 onwards the country will return to growth, with an anticipated average annual growth rate of 1.5% over the next decade (2021 – 2030).

Table 10: Anticipated Energy Investments in Greece, 2020-2030

	Sector	Description	Expected Investments in million €
OIL	Hydrocarbons' exploration and production (Upstream)	▪ Field exploration, new drilling for oil and natural gas, construction of infrastructure onshore and offshore*	4,500
	Refining and trade (Downstream)	▪ Upgrade and modernisation of refining plants	3,200
NATURAL GAS	Pipelines, natural gas networks and other facilities	▪ Development of urban and regional networks (city grids)	1,200
		▪ Cross-border pipelines**	300
		▪ Underground gas storage facility in South Kavala	400
		▪ LNG Terminals (including the FSRU in Alexandroupolis and Agioi Theodoroi and supplementary projects at Revithoussa)	900
ELECTRICITY	Power generation (new units)	▪ PPC's lignite unit (including cogeneration)	500
		▪ Natural gas units (CCGT)	1,100
		▪ Energy storage (including electricity storage devices and pump-storage projects)	2,500
	Power grid	▪ Oil units on the islands (including Crete and Rhodes)	150
		▪ Upgrade and extension of existing network and island interconnection (including new high voltage transmission lines)	7,500
	RES	▪ Small hydroelectric units	100
		▪ Wind	4,500
		▪ Photovoltaics***	3,200
		▪ Concentrating Solar Power Systems	500
		▪ Biomass (including liquid biofuels)	650
		▪ Geothermal (high and low enthalpy)	500
ENERGY EFFICIENCY	Energy efficiency	▪ Buildings' energy upgrade (private and public commercial buildings)	11,000
RESIDENTIAL AND COMMERCIAL SOLAR POWER APPLICATIONS	Residential and commercial solar power applications	▪ Solar power systems in hotels, industry, residences, maintenance, replacement, etc.	1,500
RESEARCH & INNOVATION	Research & Innovation	▪ Research and innovative energy applications	1,000
	Total Estimated Investments to 2030*		***45,200***

Note: *Total investment cost is an IENE estimate and is based on 8-10 exploration and production drillings. **Including the TAP and IGB pipelines and the Greece - North Macedonia interconnector pipeline. The East Med pipeline is not included. ***Including central autoproduction units, P/V facilities and power storage systems. ****Investments related to countering climate change, flood control, forests, the cyclical economy and recycling are not included.

Source: IENE

Data on the energy investments, as shown in Table 10, has been collected and analysed from a number of sources, including the following:

- The targets set in the revised NECP. It is worth noting that the NECP envisages a radical transformation of the domestic energy sector that will lead to a carbon-neutral economy (by 2020) for the benefit of society and environment and specifies the following seven policy priorities:
    1. Climate Change, emissions and removal of greenhouse gases
    2. High Penetration of Renewable Energy Sources is the electricity mix
    3. Substantial Improvement in energy efficiency
    4. Security of energy supply
    5. Energy market competion
    6. Research, innovation and competitiveness
    7. Agriculture, shipping and tourism
- Published energy-related business and investment proposals and analyses conducted by IENE on a regular basis.
- The Development Plan for the National Natural Gas System (ESFA) 2017-2026, with a total budget of €1,502,687,000, as published by DESFA. Also, the Development Plan 2020-2029 by DESFA, from which very limited differences arise.
- The Transmission System Development Plan 2020-2029, as published by IPTO. Also, the Capacity Sufficiency Study 2020-2030 by IPTO.
- The Long-Term Energy Strategy for 2050, as prepared by the Ministry of the Environment and Energy, which constitutes a roadmap for climate and energy issues.

Table 10 does not include legislative, regulatory, administrative and financing work, nor plans for creating investment incentives, which are necessary for promoting and completing many of the investments presented.