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Greek Energy Market

Report 2019

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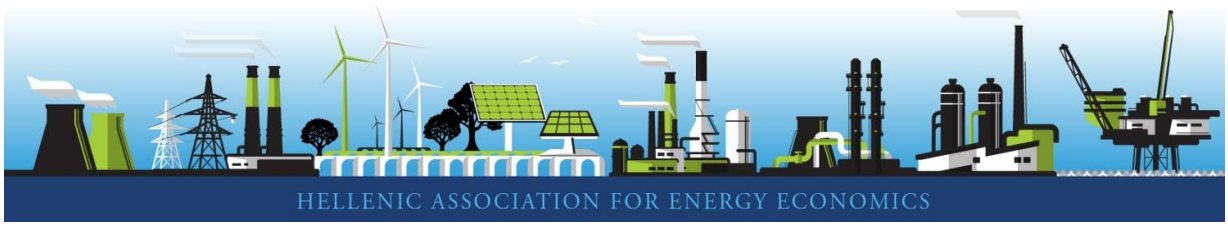
| Greek Energy Market Report |

HAEE 2019



Hellenic Association for Energy Economics

Hellenic Association for Energy Economics (HAEE) is the Greek association that brings together all those who study, debate and promote the knowledge of energy, environment and economy in our country. HAEE is the is a non-profit research and professional organization acting as an interdisciplinary forum for the exchange of ideas and experiences among energy experts.

HAEE was founded in 2015 in Greece, and has a global orientation welcoming the participation of researchers and practitioners from around the world interested in energy, environmental and economic related subjects. It acts as an independent consulting body for national and international organizations to whom it provides a broad contribution on issues related to energy, economics, policymaking and theory.

Through meetings and joint initiatives HAEE also provides a means of professional communication and exchange within its members and the authorities defining the Greek energy policy. HAEE organizes meetings amongst experts and specialists interested in networking - organizes conferences and seminars on both national and international levels - promotes training initiatives in the energy and economic sector - provides researches, studies and other services for its members.

HAEE promotes the understanding of energy, environment and economy related topics within universities and encourages the participation in the Association's activities of young students who are invited to seminars and conferences and can make use of the IAEE library for their academic works. HAEE is financially supported by member dues, contributions for research activities carried out for companies and bodies involved in the energy field, and by the sale of conference proceedings as well as conference fees and other initiatives.

While HAEE is the recognized Greek affiliate of the International Association for Energy Economics (IAEE), the IAEE did not participate in preparing this analysis, nor does it endorse any of the policy recommendations included in this report. IAEE is and remains strictly neutral on all matters of policy."

National Bank of Greece

National Bank of Greece operates for 178 years, leading one of the largest financial groups in the country, with a dynamic contribution to the support of the Greek economy. NBG Group has presence in 8 countries, where it runs 5 banks and 52 other financial services providers, with a workforce of 10,294 employees.

The Bank's wide customer base, high deposit market share, sufficient liquidity for the support of the Greek companies, high capital adequacy position, good reputation and long-term customer relationship within the Greek banking market, constitute its strategic competitive advantages.

NBG has long been the leading financing bank in the energy sector and has established a strong footprint across all segments of the industry, with total approved credit exposure of c.EUR3bn in corporate clients, c.EUR1bn in renewable energy projects (corresponding to a total capacity of approximately 1.1GW) and over EUR100m in private-public sector partnerships. Being committed to the backing of all major projects that aim to foster economic growth, NBG provides tangible support to the country's aspiration to evolve into a key energy hub for Europe, with obvious benefits for the domestic economy.

Foreword

As the world moves ever closer to a low carbon future with greater integration between different energy technologies, their co-dependency and synergies tend to increase. The role of renewables, energy storage, smart grids, alternative fuels and other modern technologies becomes all the more connected to traditional energy systems and fuels through interconnections, electrification, digitalization and other significant trends taking place right now. Therefore, the energy transition is currently in full swing and it is going to affect the entirety of the sector, posing great challenges for traditional players and creating opportunities for new and disruptive activities.

HAEE stands ready to analyze and review the course of the energy transition in the Greek market through its newly released "Greek Energy Market Report 2019" by providing all the most recent data and valuable insights. In this regard, HAEE's annual report manages to identify the relative strengths and weaknesses of the Greek energy market during a time of great change. The goal is to provide a full picture to international or domestic companies that might be willing to invest in the Greek energy sector, market participants, regulators and policy makers. Progress is assessed through a series of variables including the country's goals for 2020 and 2030, demographics, regulatory frameworks, energy security, sustainability, liberalization and through the use of detailed statistics.

On behalf of HAEE, I wish to express my sincere gratitude to our partner, National Bank of Greece, for its significant support and contribution towards the completion of this report. Namely, I would like to thank the CEO of NBG, Mr. Pavlos Mylonas, for endorsing the production of this report, Mr. Dimitris Kapotopoulos and Mr. Vassilis Karamouzis, with whom the idea was born, and of course Ms Argyro Banila and Mr. Harry Vovos for an excellent collaboration.

The report analyzes many significant developments in the Greek energy market, such as the optimization of the energy mix, the role of privatizations (ADMIE, DESFA, PPC, HELPE, DEPA), the liberalization of the electricity and natural gas markets, the potential of creating a regional natural gas hub through projects such as TAP, IGB, Alexandroupolis FSRU, Kavala Underground Storage and East Med, the assessment of progress in energy efficiency and the establishment of the Hellenic Energy Exchange. Given the fact that Greece traditionally depends on energy imports for a large percentage of its needs, the shift towards renewables production, building interconnections, different routes and sources for natural gas while gradually stepping away from lignite, will determine the country's energy security and sustainability in the decades to come.

At the same time, Greece has an opportunity to attract large investments from abroad, create added value and much needed employment to boost its economy after many years of recession. It is well understood that the energy sector can be a real driver for growth in the following years, given the country's many comparative advantages, such as a large renewable potential, close proximity to Central Europe, Africa, Eurasia and the Middle East, a specialized professional workforce and, a stable political and economic environment. Whether Greece will succeed or not, will depend on the consistent implementation of its policies and reforms, the change of culture within its market players, providing benefits for consumers, reducing carbon emissions and securing funding. The authors of this report present their projections and estimations, but ultimately it is up to the reader to form his/her own informed opinion about Greece's energy present and future.

Dr. Kostas Andriosopoulos
Chairman, HAEE

Foreword

It is a pleasure to introduce the distinct initiative of National Bank of Greece (NBG) to sponsor the "Greek Energy Market Report", a newly launched annual release of the Hellenic Association of Energy Economics. The inspiration for this report was originally drawn by the rapid changes that mark the Greek energy sector and the integral role NBG envisages to under take in the sector - financing investment activity for energy transition. Such a transition comprises a combination of diverse projects, including infrastructure upgrades, which improved the efficiency of the local energy landscape. NBG is committed to supporting in an attempt to promote the country's economic transformation towards sustainable growth.

The external environment is supportive in turning Greece into a regional energy hub. In particular, the European energy market is currently undergoing significant changes, as it has set an ambitious target of reducing its greenhouse gas emissions by 40 per cent by 2030. This will require a significant investment in renewable energy sources as well as the integration of the national energy systems into a "Single European Energy Market".

In this context, Greece - being at the crossroads between Europe, Asia and Africa - can play a key role in Europe's new energy networks (such as the Southern Gas Corridor). It can also play a critical role as a new entry port for liquefied natural gas (LNG),thus reinforcing energy diversification in the EU (which currently relies heavily on Russia for gas supply).

Moreover, under the broad guidelines of the EU decarbonization policy, the share of renewable energy sources in total electricity consumption in Greece has increased to 16per cent in 2017 from 3per cent in 2007. As green energy is gradually also becoming cheap energy (due to technological advancements), the role of renewable energy sources in Greece's energy mix is expected to strengthen further.

All the above reforms, combined with the projects envisioned for the interconnection between the mainland and islands, as well as the ongoing liberalization of the domestic electricity market, are expected to reduce wholesale electricity prices in Greece (that were higher by more than 20per cent versus the EU during the past five years on average). Taking into account that in several energy-intensive sectors (such as metals and cement) energy costs cover almost 20 per cent of their raw material cost, projects that increase energy efficiency boost the structural competitiveness of Greek industries.

With a total energy portfolio exceeding €2bn in utilized credit limits, NBG has led landmark event-financings involving strategic energy sponsors, and has continuously provided financing to large and medium corporate players of the sector. Moreover, NBG has channeled more than 1/3 of its funding towards renewable energy projects. Having a clear corporate vision to be the leading banking partner for energy investments in Greece, NBG is committed to diversify and broaden its energy portfolio. Against this background, the "Greek Energy Market Report" aims to constitute a useful toolkit for a varied audience interested in monitoring the latest developments of the Greek energy sector, and to support associated investments in the country. We rely on your warm reception of our initiative and we are convinced that it may set the basis of enhancing our institutional engagement and support for this vital sector for the Greek economy.

Mr. Paul Mylonas
CEO, National Bank of Greece

Coordinator

Professor **Dr. Kostas Andriosopoulos** is the Executive Director of the Research Centre for Energy Management at ESCP Europe Business School where he holds the position of full Professor in Finance and Energy Economics. He is also the Academic Director of the full-time (MEM) and the Executive (EMEM) Masters in Energy Management. Kostas holds a PhD in Finance (Cass Business School, City University London), where he has been the recipient of the prestigious Alexander S. Onassis Public Benefit Foundation's scholarship. He also holds an MBA and MSc in Finance (Northeastern University, Boston, USA), and a bachelor's degree in Production Engineering and Management (Technical University of Crete, Greece). Kostas is the founding Chairman of HAEE.

Lead Researcher

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Research Team

George Papadakis is a founding member of HAEE. He is currently a research associate of HAEE and works as a Business Developer in the renewables energy field. George holds an MSc in Energy Management from ESCP Europe in London and an MSc in Business and Administration, from the Technical University of Crete, Greece. He obtained his bachelor degree in Production Engineering and Management from Technical University of Crete, Greece.

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Konstantinos Ioannidis is an electrical engineer holding an MSc in Electrical and Computing Engineering from Democritus University of Thrace (DUTH). He was also awarded an MSc with distinction in Wind Energy Systems from the University of Strathclyde, Glasgow, UK and currently works as a research associate and energy advisor for the Hellenic Association for Energy Economics.

Leonidas Ourgantzidis is an economist holding a bachelor degree with honors from University of Macedonia, Thessaloniki, Greece. Leonidas' academic interests focus on the topics of Environmental and Energy Economics and he currently works as a research associate for Hellenic Association for Energy Economics.

Contributors

The authors are grateful to **Dr. Georgia Makridou** (Affiliate Professor, ESCP Europe Business School), **Konstantinos Dimitrainas** (Sector Head/ Large Corporate Banking Division - NBG), **Minas Polivios Tsagkarakis** (Senior Credit Analyst/ Large Corporate Banking Division - NBG) and **Eleftherios Soumpasis** (Senior Credit Analyst/ Large Corporate Banking Division - NBG) for their significant contribution towards the completion of the "Greek Energy Market Report - 2019".

Executive Summary

Energy consumption has become essential for our daily lives. Without the existence of all forms of energy, societies wouldn't be in a position to evolve in the way that globalization dictates. To benefit from the conveniences that modern life offers, we need to produce energy in a number of different ways.

Over the previous decades, we have been widely using what are known as fossil fuels, including coal, oil and natural gas. Currently, everything around us rely on these fuels including the majority of products and services. However, the two main drawbacks of their usage are first of all their scarcity, and second the fact that fossil fuels produce large amounts of greenhouse gases. Aiming to overcome those issues and secure environmental sustainability for the next generations, countries are currently heading towards the well known "Energy Transition".

The Energy Transition is a pathway towards the transformation of the global energy sector from fossil-based to zero-carbon by the second half of this century (2050). At the core of this transition is the need to reduce energy-related CO2 emissions and limit climate change. Decarbonization of the energy sector requires urgent action on a global scale, and while a global energy transition is underway, further action is needed to reduce carbon emissions and mitigate the effects of climate change.

Energy Transition is about to allow Renewables to become our main source of energy, while guaranteeing security of supply to all citizens, at an affordable price. This can be made possible by interconnecting our whole energy system, integrating novel storage technologies through the digitalization of the entire system. However, enormous challenges arise in terms of regulations, market design, affordability and reliability. In that context, according to the revised "Clean Energy Package", which sets the goals for climate & energy framework, by 2030, European Union countries should achieve the following 3 targets:

- At least 40% cuts in greenhouse gas emissions (compared to 1990 levels)
- At least 32% share for renewable energy
- At least 32.5% improvement in energy efficiency

Aiming to reach those targets, national authorities in Greece adopted a series of measures. The "Greek Energy Market Report 2019" reviews all the developments related to the Greek energy sector, by providing the most recent available data. Moreover, a concrete analysis is provided for 9 different sectors affecting the road towards Energy Transition. In order to achieve that, the report provides both global and European energy trends and then assesses the role of Greece in terms of following or not those patterns.

Moreover, the report identifies all energy aspects that Greece is lagging behind, hampering the accomplishment of the country's energy and climate targets. At the same time, it functions as a useful tool for those who want to have a solid view of the Greek energy market. Hence, this Report can be beneficial for international or domestic energy companies that might be willing to invest in the Greek energy sector, market participants, regulators and policy makers.

Aiming to capture all the topics mentioned above, the Report consists of 9 distinct chapters, covering the majority of the energy sector. Namely, Chapter 1 covers the country profile in Greece by analyzing and providing the key demographic, macroeconomic and energy statistics. A robust examination of the formation and role of the newly established Hellenic Energy Exchange is provided in Chapter 2. The next chapter, focuses on the electricity sector, highlighting various issues related to generation, capacities, prices and market shares.

Chapter 4 is dedicated to natural gas and explores all the developments that occurred in the market followed by the recent liberalization. Again, all the characteristics affecting supply and demand are carefully investigated in parallel with the projected plans for expansion of the market through new grid construction and use of LNG/CNG technologies.

Chapter 5 focuses on the significant penetration of Renewable Energy Sources in Greece, by providing unique data, geographical and market analysis, and an update in regards to the regulatory framework. Chapter 6 covers the oil market, which continues to play a crucial role for the country, and the recovery of the Greek economy.

The concept of energy efficiency is extensively analyzed in Chapter 7, highlighting the progress of Greece towards achieving all its energy related goals in various sectors, such as transportation, industry and households. Chapter 8, is a salient chapter since it provides HAEE's main outcomes and policy recommendations regarding the known Energy Trilemma. Concepts such as Greece's performance in terms of energy security, sustainability, energy equality and government policy are widely analyzed, in parallel with specific suggestions for improvement.

Finally, Chapter 9 outlines the existing framework in terms of all ongoing and future energy investments, covering all aspects of the sector, such as the development of electricity networks, natural gas pipelines, important RES investments and financing means.

The unique characteristic which can be considered as the comparative advantage of the "Greek Energy Market Report 2019", is that it managed to create and utilize a unique database from international robust data sources (such as the World Bank, OECD, Eurostat, IEA & Bloomberg) and at the same time gather substantial information from domestic data sources (such as EnEx, ADMIE, DESFA, RAE & Elstat).

In terms of the broader conclusions and findings of the Report, the Greek energy system is characterized by high consumption of conventional fuels based, in large part, on lignite which was strategically chosen for electricity production after the oil crisis of the 70s. In addition, the Greek energy system is widely dependent on imports which include crude oil, oil products and natural gas. In that context, the increasing penetration of natural gas into the final energy consumption, justifies its characterization as the "bridge fuel" towards the Energy Transition. Still, the vast penetration of RES in the system and the improvement in energy efficiency, reflect Greece's efforts to adopt European and national policies.

Overall, the energy sector in Greece has a higher contribution to gross value added and employment than in most EU countries, and is poised to grow significantly in the coming years, driven by a number of significant factors that are summarized below:

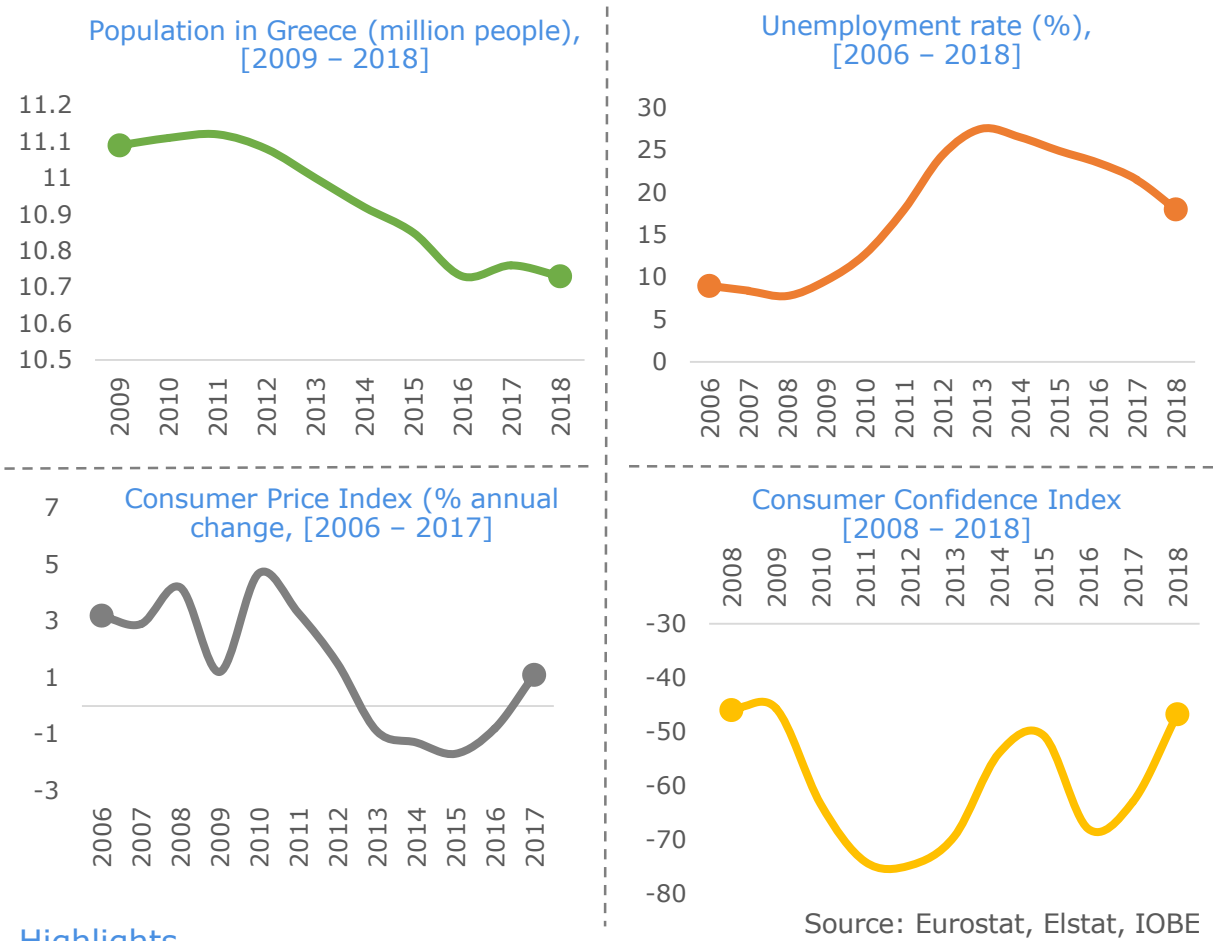
- Required optimization of the energy mix, consisting of the reduction of fossil-fuel generated electricity and increased RES contribution. This shift will be driven both by the revised EU policy of 32% renewable energy sources by 2030, and the preference for cheaper energy sources such as natural gas
- After the successful privatization of the Independent Power Transmission Operator in electricity (ADMIE), and the natural gas Transmission System Operator (DESFA) that took place in 2018, the state plans to privatize additional major energy assets such as the Public Power Corporation (PPC), the natural gas incumbent (DEPA) and the Hellenic Petroleum (HELPE) group
- The liberalization of the electricity and natural gas markets and the further separation of production and supply from transmission networks
- The potential for Greece to become a European gateway for natural gas, electricity and oil resources through major infrastructure projects such as the TAP-IGB-East Med gas pipelines, the Alexandroupolis FSRU or gas and oil exploration and production
- Efforts to improve energy efficiency and reduce cost driven by technologies such as smart metering, smart grid technologies and energy efficient buildings
- Major electricity infrastructure development initiatives such as the interconnection of the Greek islands with the main electricity grid
- The establishment of the Hellenic Energy Exchange in accordance with the electricity Target Model which is the basis for the development of the single energy market in Europe

Contents

"Everything that an investor needs to know about the Greek Energy Market"

1. Country Profile

Consumer confidence seems to recover after a long period of turbulences, yet unemployment rate in Greece remains the highest in the EU



Source: Eurostat, Elstat, IOBE

Highlights

Greece is a European Union member country since the 1st of January 1981, located in Southeast Europe with Athens being the nation's largest city and official country's capital. The country obtained the euro currency as a member of the Eurozone since the 1st of January 2001.

Greece's population numbered 10.738.868 million people in 2018. The population's decline can be linked to the severe economic crisis and the brain drain that followed.

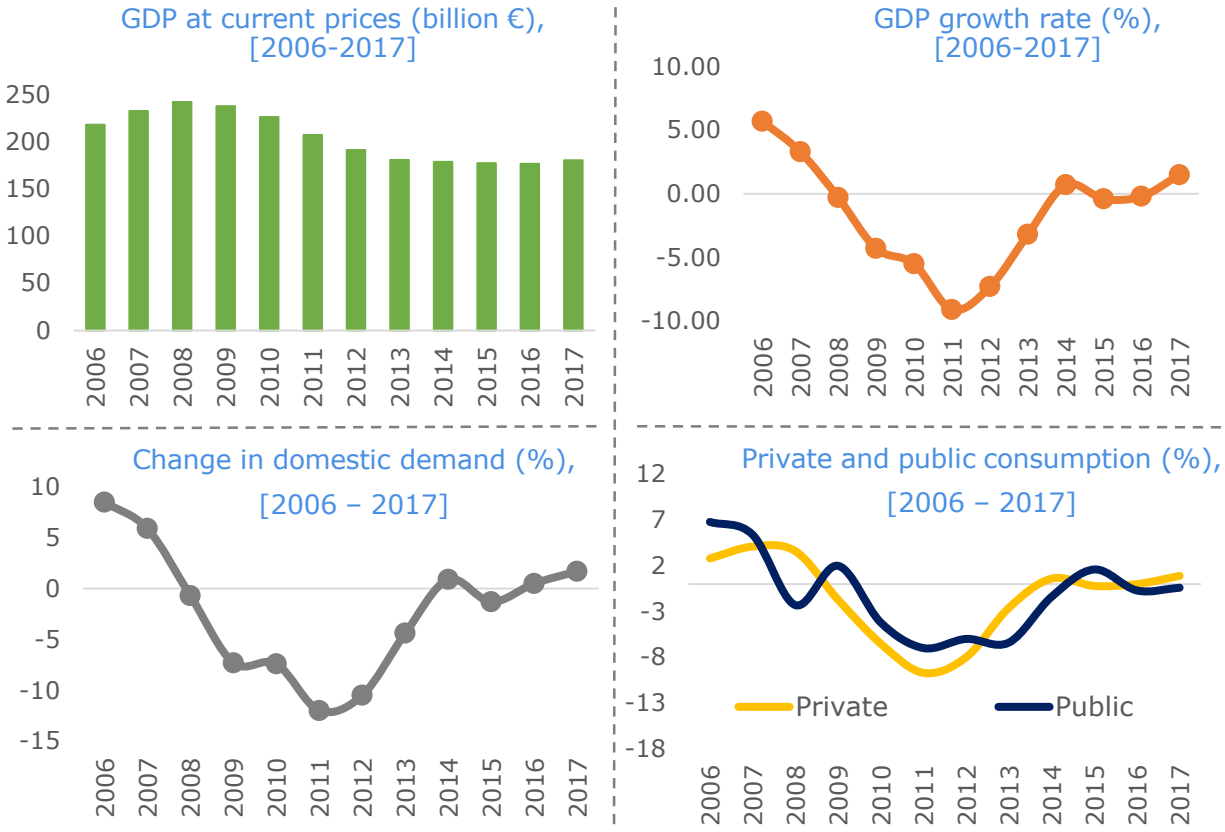
Even though unemployment in Greece dipped to 18% in December of 2018, from 20.8% the previous year, it remains the highest rate in the European Union. Youth unemployment rate continues to be the highest in the developed countries, since it was 39.5% in December 2018.

Consumer Price Index (CPI) provides an estimation of proportional change in the general level of prices of a fixed set of consumer goods and services of constant quantity and characteristics. CPI for Greece appears to follow a constant declining trend from 2010 to 2015, that seems to differentiate over the recent years.

Future developments of the households' consumption and saving are indicated by the Consumer Confidence Index. The index is composed based upon answers from households concerning the expected financial situation, their sentiment about the general economic situation and unemployment rate and the capability of savings.

Indicator values below 100, reveal a more pessimistic view of the households about the future of the economy, accompanied with a tendency to increase savings and reduce consumption. In Greece, households' views seem to be more pessimistic following the year 2008 and the emergence of the financial crisis, a trend which remained for more than five years but seems to recover during the recent period.

Greek economy faces a positive outlook and higher growth rate than the eurozone, since it is anticipated to grow at 2.4% on average during 2019-2022



Source: Elstat, HAEE's analysis

Highlights

Following 2008 financial crisis, the Greek economy went through a period of severe recession, since GDP at current prices (excluding inflation) faced a dramatic decline of 27.2%. Precisely, the highest amount of GDP is observed in 2008 at 242 billion euros and the lowest in 2016 at 176 billion euros.

The V-shape GDP growth rate reveals that following a period of economic stagnation, economy achieved positive figures of growth rate, which is directly affected by investment and expenditure. Current levels of domestic demand and exports' performance seem robust.

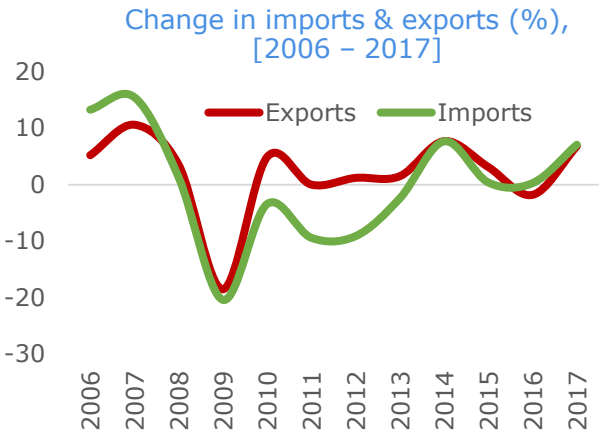
GDP growth is projected to edge up to 2.2% in 2019. Household consumption and investment will be enhanced with the rising confidence. In that context, continued implementation of the government's reform program will support the recovery.

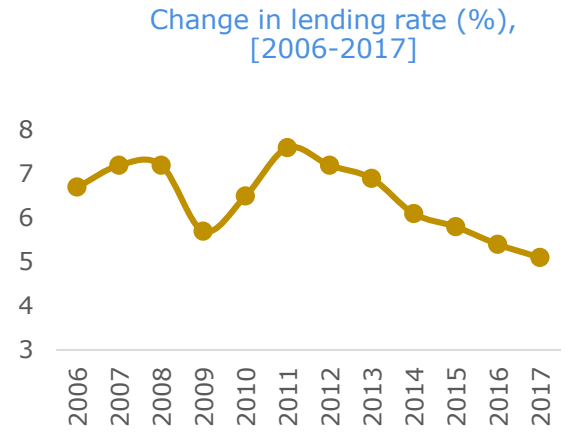
Total domestic demand follows the same pattern as GDP growth rate since it is consisted of three main macroeconomic variables. Final consumption, investment and the expenditure by the private and the general government sector, after the inclusion of the inflation contribution.

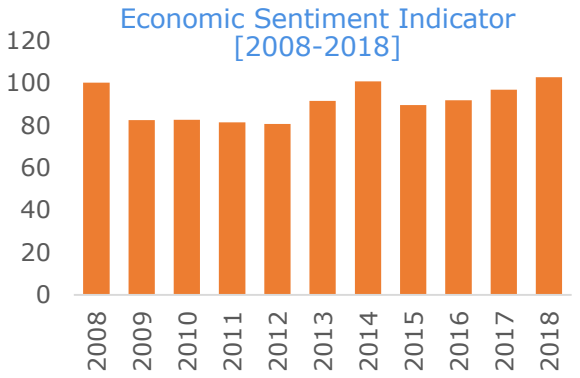
Private consumption indicates the amount of money that consumers spend for the purchase of goods and services. It is an indicator that incorporates purchases that refer to, among other sectors, energy, food, education, communication, transport and health.

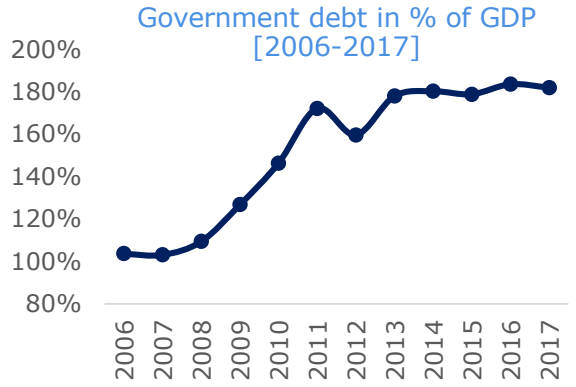
Public consumption provides a measurement of the value of goods and services that are received with the contribution of the public sector. From 2006 to 2013, Public Consumption in Greece appears to follow a declining turn, a trend which seems to be altering recently.

Huge government debt as percentage of total GPD remains the biggest issue for the Greek economy









Source: Eurostat, Elstat, IOBE

Highlights

Greece's exports seem to have a stable trend, except for the years between 2008 and 2010, which were significantly affected by the uncertainty of the imminent crisis. Regarding the period 2007 to 2009, imports indicate a constant declining trend, which changed over the recent years.

Lending Rate indicates the interest rate that is charged from financial institutions for loans to corporations up to 1 year. Lending Rate in Greece seems to follow a declining trend in order to stimulate economic growth by making easier for corporations to borrow money and finance investments.

The Economic Sentiment Indicator incorporates five different sectoral confidence indicators. Namely, the Industry Confidence, the Services Confidence, the Consumer Confidence, the Retail Trade Confidence and the Construction Confidence. For the case of Greece, the Economic Sentiment Indicator follows an upward trend, reflecting the relative optimistic views of managers and households.

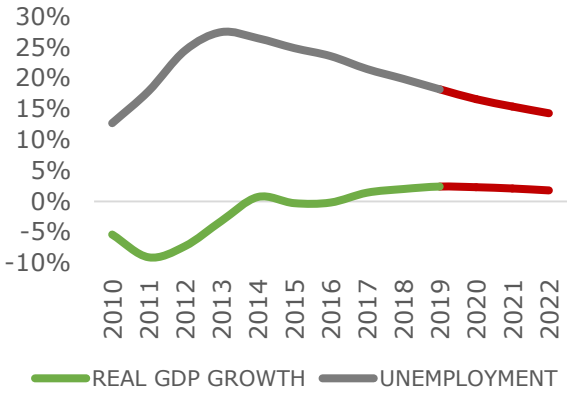
Evidence like the return of both the Economic Sentiment Indicator and the Consumer Confidence in their pre-crisis levels reflect the optimistic views and expectations of the market participants that reveal the positive economic environment for the country.

The issue that still worries national authorities is the increased level of government debt in GDP percentage. Greece continues to hold the Eurozone's highest ratio of public debt compared to its GDP, with 181.9%, followed by Italy at 133%. At the same time, the Eurozone's public debt represented 86.1 % of the EU's GDP.

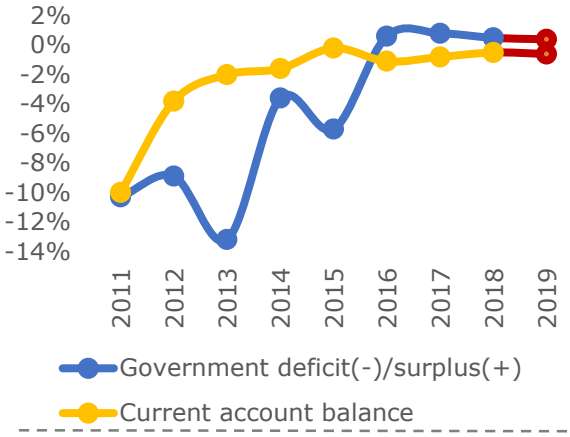
The analysis of the main macroeconomic indicators in Greece, reveals the country's increased possibility to rebound from the severe impact of the financial crisis. Authorities should focus on improving competitiveness and productivity through the creation of the conditions to overcome any structural difficulties.

Projections for economic growth and financial credibility illustrate the recovery of Greek economy in the next few years

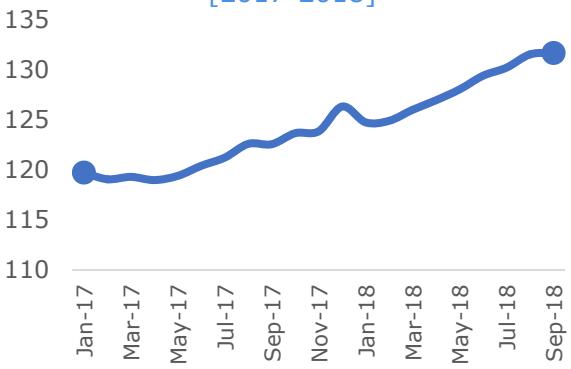
Real GDP growth and unemployment (%), [2010-2022]



Twin Deficits (%), [2011-2019]



Deposits of Individuals (in billion €), [2017-2018]



Credit ratings for Greece [2018]

Credit Rating Agency	Credit Rating	Outlook	Date of Last Review
Moody's	B1	Stable	Mar 2019
FITCH	BB-	Stable	Aug 2018
Standard & Poor's	B+	Positive	Jul 2018
Rating and Investment	B	Stable	Sep 2018
DBRS	B(HIGH)	Positive	Jun 2018

Source: Elstat, OECD, HAEE's analysis

Highlights

During the economic crisis, the Greek economy lost a quarter of its GDP. However, since the last year, economy returned to positive GDP growth. Regulatory reforms, tax reductions and increase in investments, is anticipated to boost public confidence of the markets and investors.

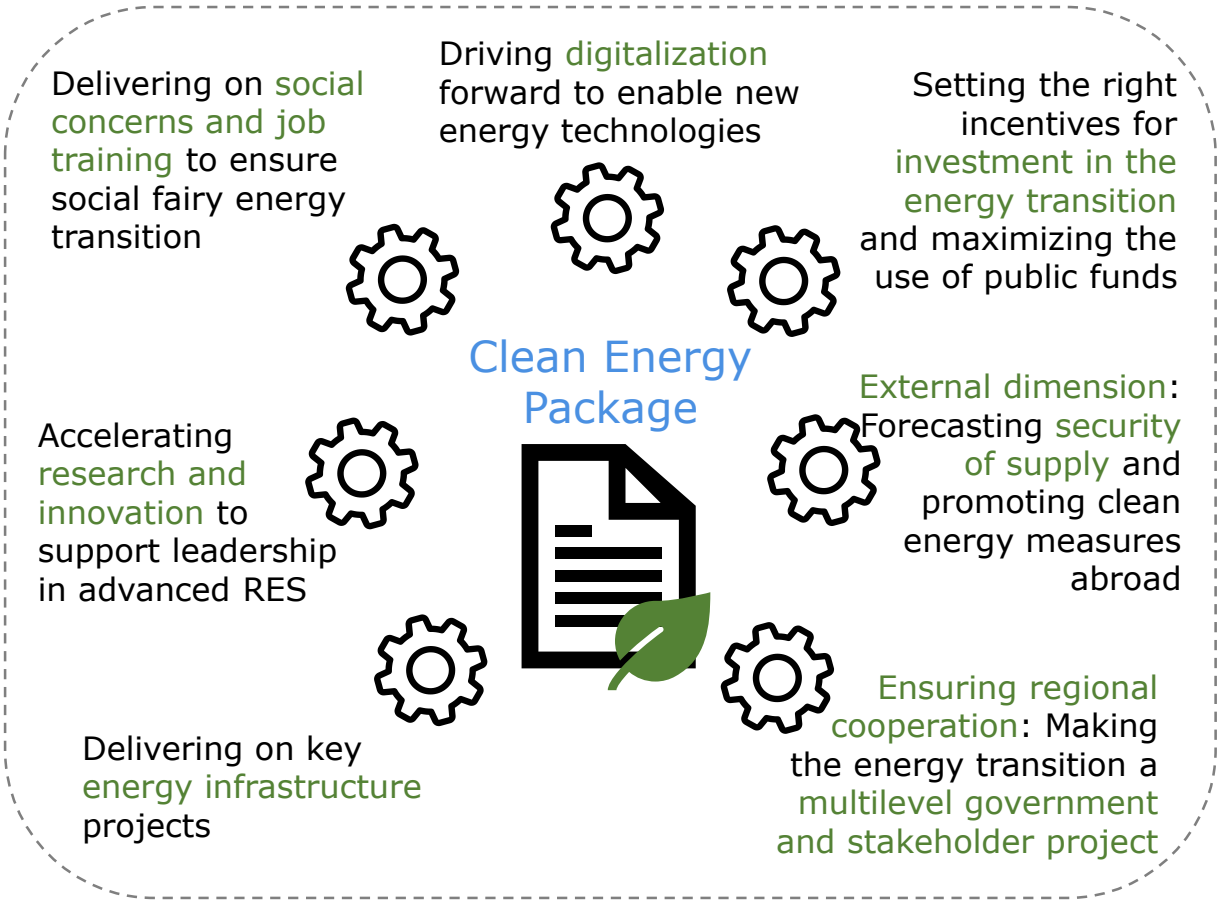
Projections regarding the unemployment rate, forecast a steady reduction to 14.3% in 2022 and more decline is been expected, as the economy will recover and the country will continue to gain the confidence of both domestic and foreign investors. Before economic crisis the Greek economy was characterized by large current account and government deficit . From 2010 onward both deficits were reduced drastically.

The citizens recover their trust to the credit system, as since the last year, deposits are gradually returning to Greek banks. Particularly, in January 2017 the level of personal deposits was at 119.75 billion euros and experienced an incremental increase until the end of that year, where it reached the value of 126.35 billion euros. After that point, deposits in Greek banks are constantly rising.

As far as the credibility of Greece in financial market is concerned, the last few months, Bond rating agents, raised up their credit ratings for Greece. In particular, Moody's rated Greece with B1 with stable outlook in their latest assessment in March of 2019 while Standard & Poor's rated Greece B+ with also a positive outlook. Additionally, the rating of DBRS was B (HIGH) with a positive outlook (June 2018). On the other hand, the rating of FITCH and DBRS was BB- and B respectively with stable outlook for both of them. The rating of DBRS is concerned June 2018 while the FITCH rating referred to August 2018 (two months later)

Overall, there are already signs of recovery in the Greek economy which are expected to be more persistent in the following years, reversing the trends that existed due to economic crisis. Those positive signs are depicted both to economic trends and credibility outlook of the country.

The Clean Energy Package is a set of measures that provides an energy policy framework to accelerate the clean energy transition in the EU



Source: European Commission, HAEE's analysis

Highlights

The Clean Energy for all Europeans Package was presented in November 2016 by the European Commission and aims to keep the European Union competitive during the energy transition, by placing the consumers at the center of the energy policy.

The Package consists of 8 different legislative acts as shown: Energy Performance in Buildings Directive, Renewable Energy Directive, Energy Efficiency Directive, Governance Regulation, Electricity Directive, Electricity Regulation, Risk-Preparedness Regulation and Regulation for the Agency for the Cooperation of Energy Regulators (ACER).

These new rules are being formally adopted from the EU countries, and as a result in Greece, since the first months of 2019. The key aspect of the package is that it sets up a governance system for the EU, and each member state is obliged to create a national energy and climate plan, explaining how they will achieve their respective targets.

The Clean Energy Package also outlines some measures for the building sector and suggests a modern design for the EU electricity market, that corresponds to the new market reality.

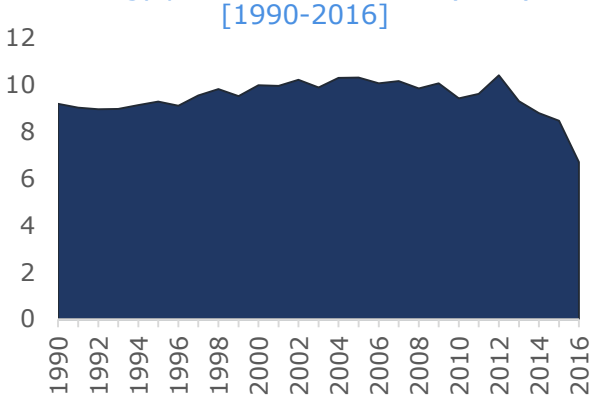
Moreover, it strengthens the rights of the consumers and enables them to participate in the transition by producing their own renewable energy and feeding it into the grid.

With the implementation of these policies, two new targets for the EU are set for 2030: a binding renewable energy target of at least 32% and an efficiency target of at least 32.5% with a possible upward revision in 2023.

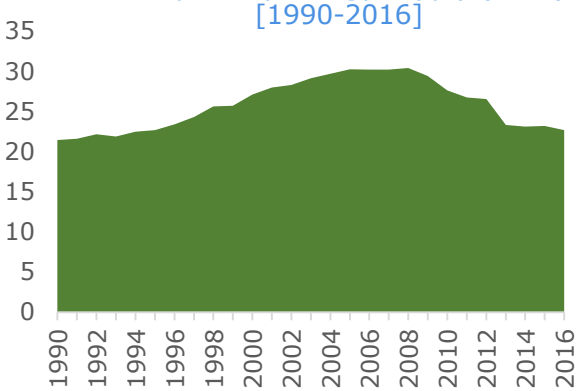
Besides that, they will lead to steeper emission reductions than anticipated (around 45% relative to 1990 compared to the existing target of 40%).

Greece is far away from energy independency, since there is a significant gap between total production and total consumption

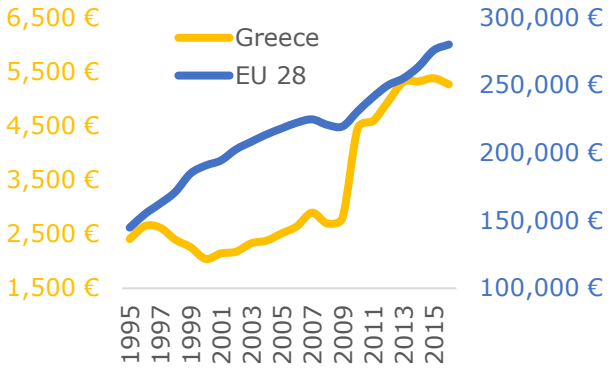
Energy production in Greece (Mtoe), [1990-2016]



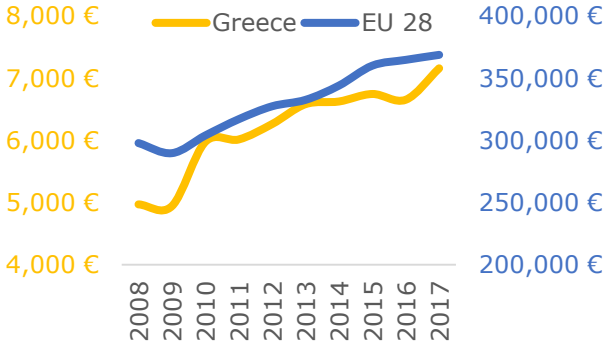
Total primary energy supply (Mtoe), [1990-2016]



Total amount of energy tax revenue in Greece and EU 28 (millions €), [1996-2016]



Total environmental taxes in Greece and EU 28 (millions €), [2008-2017]



Source: IEA & Eurostat, HAEE's analysis

Highlights

The energy production remained stable during 1990-1995 in Greece, whereas in the following 16 years there was a slight increase with minor fluctuations. The energy production peaked at 10,4 toe in 2012 and during the last 4 years, a huge decline was observed (27% in respect to 1990 and 35.5% in respect to 2012).

It is obvious that Greece is far away from energy independency, and therefore the study of primary energy supply in respect to energy consumption becomes crucial. Primary energy supply can be defined as the energy production augmented by net energy imports, minus international bunkers and plus the difference in stock changes.

Primary energy supply was at 21,44 toe in 1990 and reached the highest value of 30,42 toe in 2008. The effects of financial crisis are visible, reducing the energy supply from 2009 to 2016 by 23%.

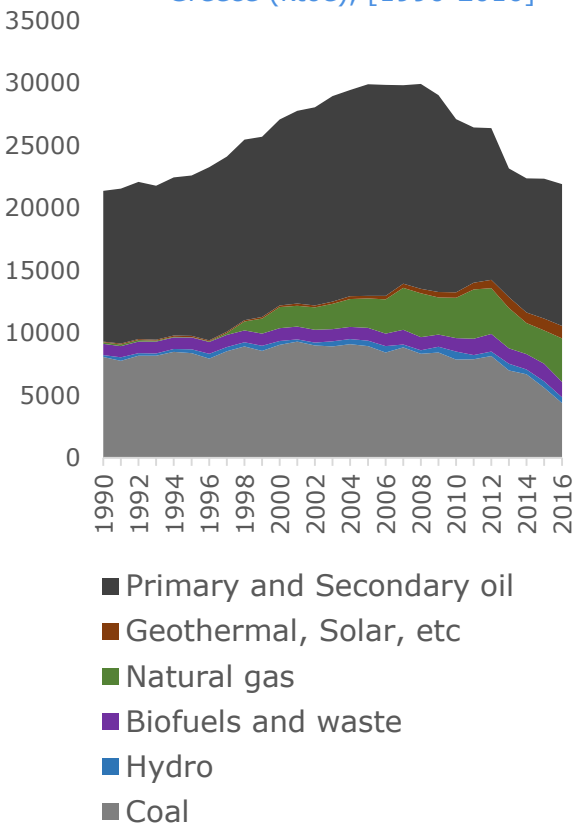
Although the energy taxation revenues steadily increased from 1995 to 2015 in Europe, this pattern differs in the case of Greece. From 1995 to 1999 there was a downward trend in energy taxation which in following years and until 2008 completely reversed. A slight decrease is noticed in a two-year period (2007-2008) while from 2009 and onwards the revenues from energy taxation skyrocket.

The sharp increase in energy taxation revenues in the last 10 years, could be interpreted either by the environmental-friendly policy adopted by European Union in Greece, which constitutes a decisive factor for increasing revenues from taxation, or as a mechanism of money collection from the government in order to meet its financial needs due to economic crisis.

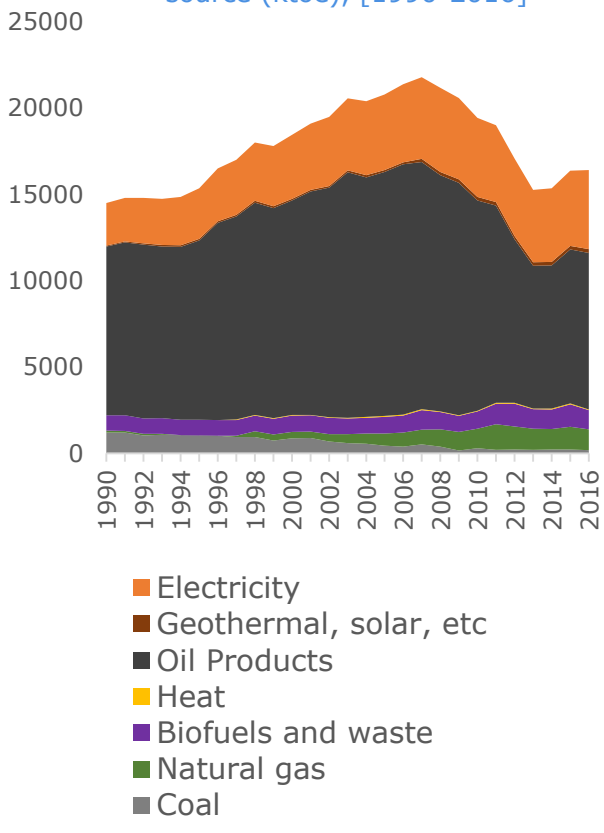
Considerable increases in environmental taxation are visible as well. The total government revenues from this source altered from 4.972 in 2008 to 7.162 million euros in 2017.

The intertemporal interplay between energy supply and energy consumption by source in Greece

Total primary energy supply in Greece (ktoe), [1990-2016]



Total final energy consumption by source (ktoe), [1990-2016]



Source: IEA

Highlights

Fuels contribute disproportionately in the aggregated primary energy supply. Particularly, the contribution percentage of primary and secondary oil, in primary energy supply, is between 50% and 60% in Greece. The percentage of coal lies between 20% and 30% while the contribution of all other fuels reaches the value of 29% (2016) of the total primary energy supply.

Primary and secondary oil supply peaks at 16.393 ktoe in 2008, and after this point follows a downward trend concluding at 11.357 ktoe in 2016. Furthermore, primary energy supply of coal increases until 2007 (8.836 ktoe) and from 2007 to 2016 is declined by 50% (4.369 ktoe).

Biofuels and waste, natural gas, geothermal, solar and other fuels increase the primary energy supply throughout this 16 year period. Particularly, natural gas experiences a remarkable increase of 2429% in those 16 years, while the corresponding percentages for biofuels & waste, hydro and other fuels are 38%, 214% and 1580% respectively.

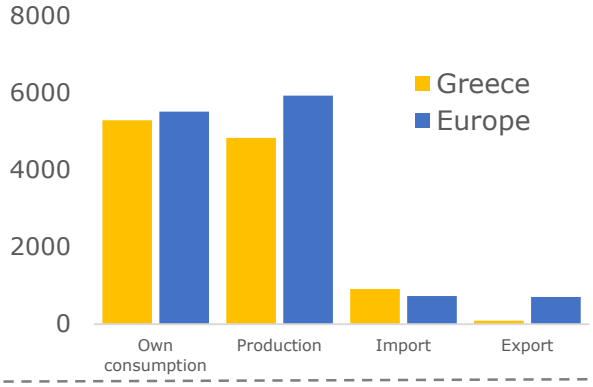
Total energy consumption varies among different sources of energy. Oil products dominate the energy consumption, while the second most consuming source of energy is electricity, with coal consumption following. The intensity of oil products and coal is declining over time, whereas the intensity of electricity continuously rises.

Natural gas consumption experienced a similar increase to natural gas supply and the consumption of biofuels & waste, heat and other sources of energy increasing significantly in percentage, indicating intention of changing the patters of energy consumption.

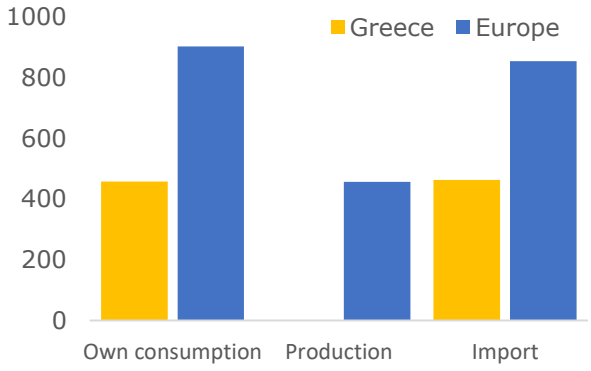
Future efficiency requires huge transformations in energy consumption as a whole and in its components, both in percentage and in absolute values.

Greece imports the majority of its oil and gas needs, which is translated as a huge cost and low rating in terms of security of supply

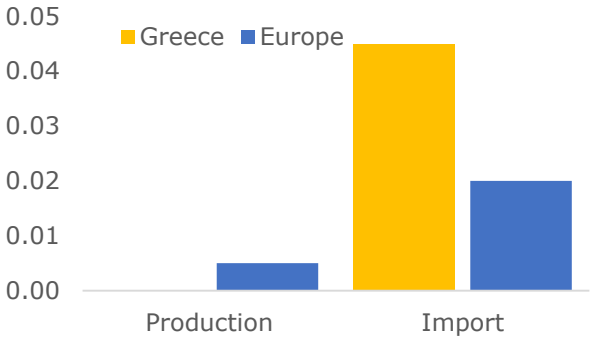
Electricity key figures per capita in Greece and Europe (KWh), [2017]



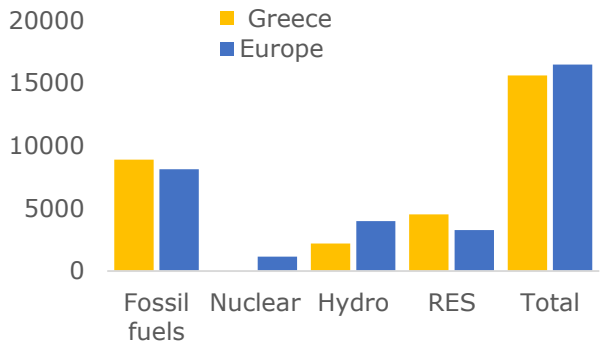
Natural gas key figures per capita in Greece and Europe (cubic meters), [2017]



Crude oil key figures per capita in Greece and Europe (bbl.), [2017]



Production capacities by source per capita in Greece and Europe (KWh), [2017]



Source: Eurostat, HAEE's analysis

Highlights

Although electricity consumption in Europe is completely covered by the generation and the net exports of electricity are positive, in Greece there is a deficit of electricity which is covered through electricity imports.

In 2017, Greeks consumed 5.287 KWh per person in average, while the corresponding generation was only 4.837 KWh. The difference between consumption and production corresponds to 450 KWh which is approximately 8.5% of the aggregated consumption and is covered through net imports.

There is also a gap between consumption and production of natural gas, which was expected, seeing that Greece does not produce natural gas and therefore the demand is completely covered by imports. Furthermore, EU cannot produce the consumed amounts of natural gas but has made improvement as far as the natural gas production is concerned.

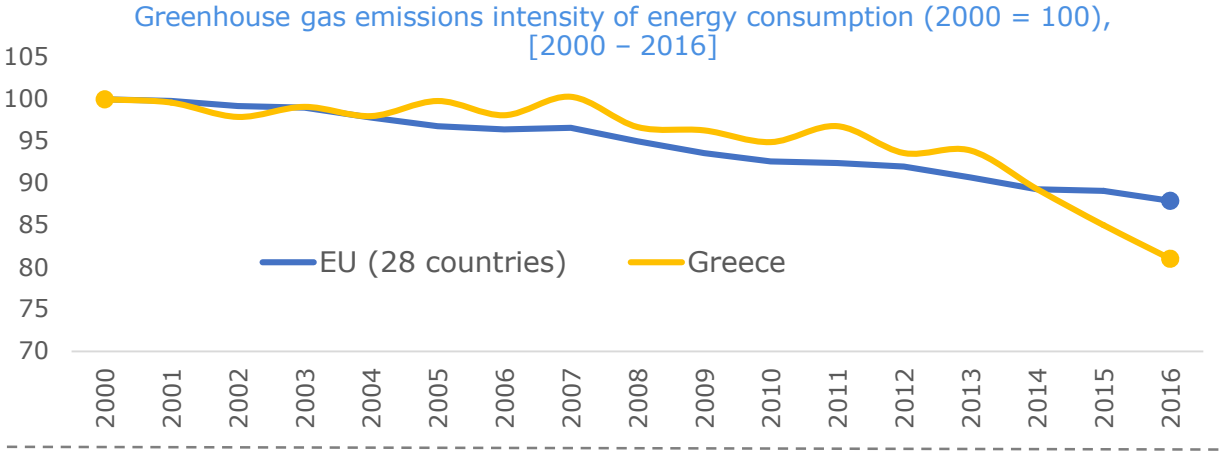
Crude oil production is also zero in Greece and in conjunction with zero natural gas production poses a threat related to energy security. It is evident that the total national consumption of crude oil is covered exclusively by imports.

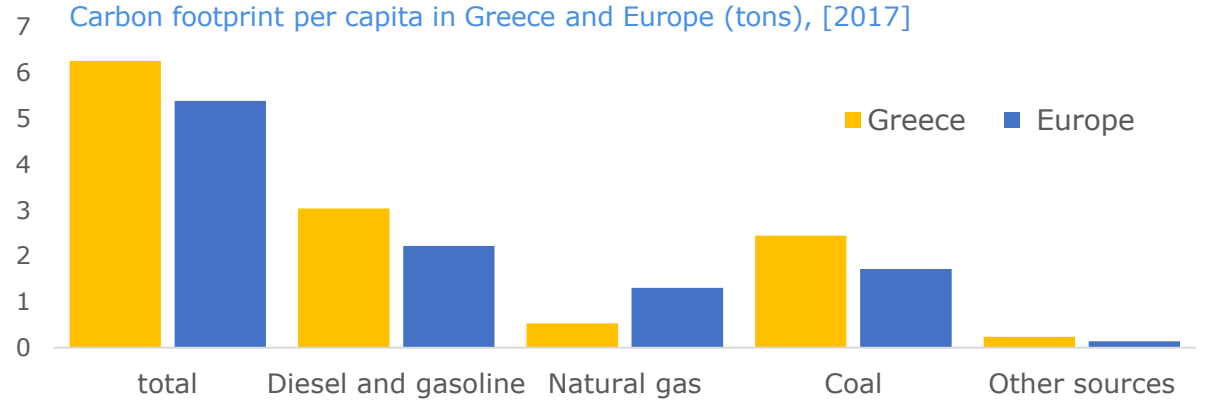
Production capacity differs according to different sources of energy per capita both in Greece and EU. The total energy production per capita is 15.606,19 KWh in Greece which is divided into 4.525,80 KWh of RES per capita, 2.184,87 KWh of hydro production per capita and 8.895 KWh of fossil fuels production per capita.

That is, 57% of total production comes from fossil fuels, 14% form hydro and 29% from renewable sources of energy. Production of nuclear is zero both in percentage and absolute value.

Overall, European percentages are almost identical with the Greek ones, with minor differences concerning mainly the production of nuclear energy.

Greece has completed the national target of 20% reduction in greenhouse emissions in respect to 1990 levels, mainly because of the financial crisis





Source: Eurostat, HAEE's analysis

Highlights

EU has set specific targets for greenhouse gas emissions to be met until 2020, 2030 and 2050 by EU countries. In Greece, the reduction of greenhouse emissions is mainly the result of less energy use due to the financial crisis.

As a result, the decrease in percentage values is greater than EU 28 but more policies should be applied for the restriction of greenhouse gas emissions on the grounds that the recovery of Greek economy will increase the emissions if a proper energy policies framework is missing.

Carbon footprint can be defined as the aggregated carbon emissions released into the atmosphere, as a result of economic or other activity. Lower carbon footprint constitutes a challenge for the future EU's and world's sustainability.

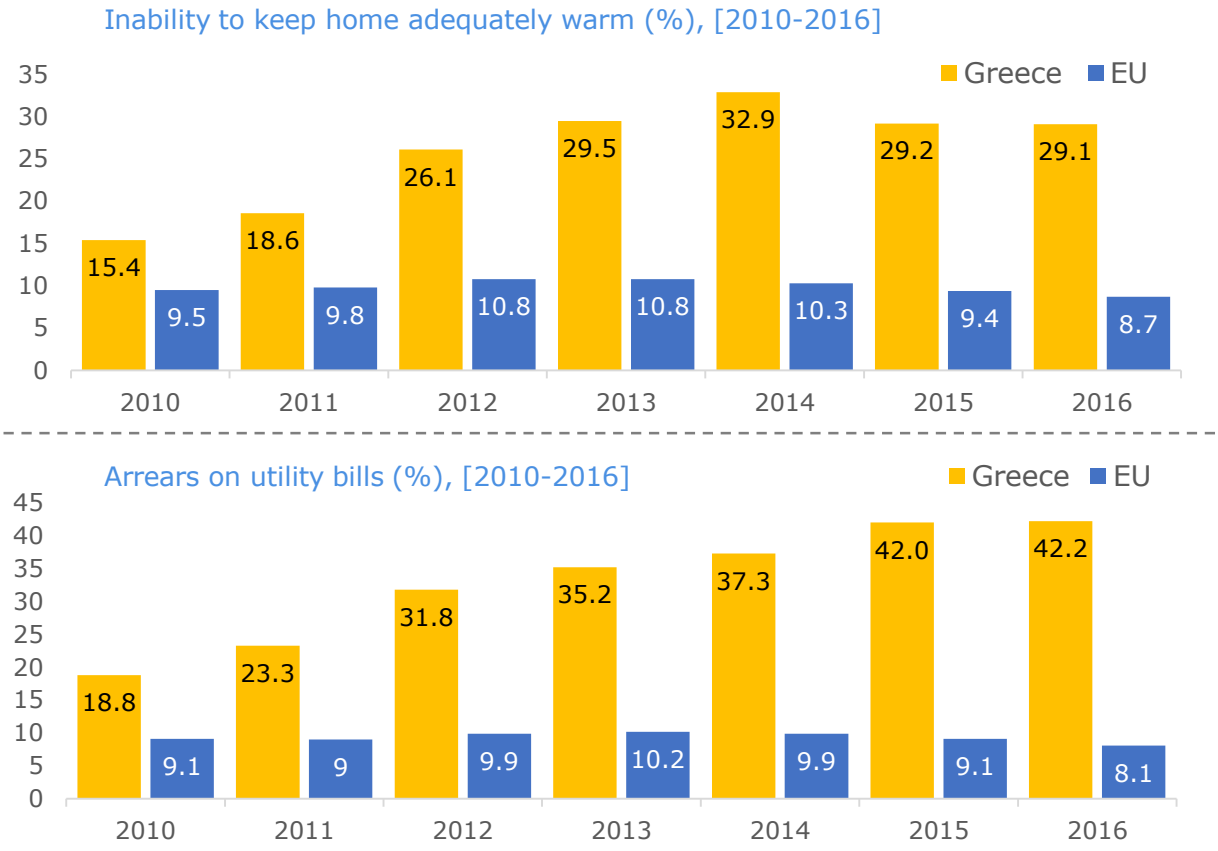
In Greece, the total carbon footprint is measured at 6,26 tons per capita while EU is more efficient with a total of 5,39 tons per capita. This total consumption in Greece is divided into 49% of Diesel and gasoline emissions, 8% of natural gas emissions, 39% of coal consumption emissions and 4% of emissions from other sources

Diesel and gasoline are the major sources of carbon emissions and the reason for almost half of the aggregated carbon emissions in Greece. Natural gas is the only source of energy in which Greece outperforms EU in per capita levels.

In particular, Greece emits 35% less carbon dioxide coming from natural gas, in relation to EU 28, which is approximately 1 ton difference in absolute values.

Carbon footprint of coal comes second in size with 2,45 tons emitted (39%). The corresponding number for EU is 1,72 tons of carbon emissions and the carbon footprint of other sources is minimal.

Compared to the rest EU countries, Greece has experienced the biggest increase as far as the inability to keep homes adequately warm



Source: European Commission, HAEE's analysis

Highlights

In Greece, the gradual increase in utility bills in conjunction with the financial crisis have led households to cope with energy poverty; that is the inability to keep their homes adequately warm or to pay off their energy utility bills. However, this appears as a national problem, seeing that European Union faces stability on those variables.

Among the EU 28 countries, Greece has experienced the biggest increase concerning the inability to keep homes adequately warm. Particularly, in 2010 only 15.4% of households declared this inability while in 2016 the percentage almost doubled reaching 29.1%.

In EU 28, the trend remains stable as an outcome of increased percentages observed mainly in Greece, Italy, Spain and Croatia and of decreased percentages met in Bulgaria, Latvia, Malta, Portugal and Romania.

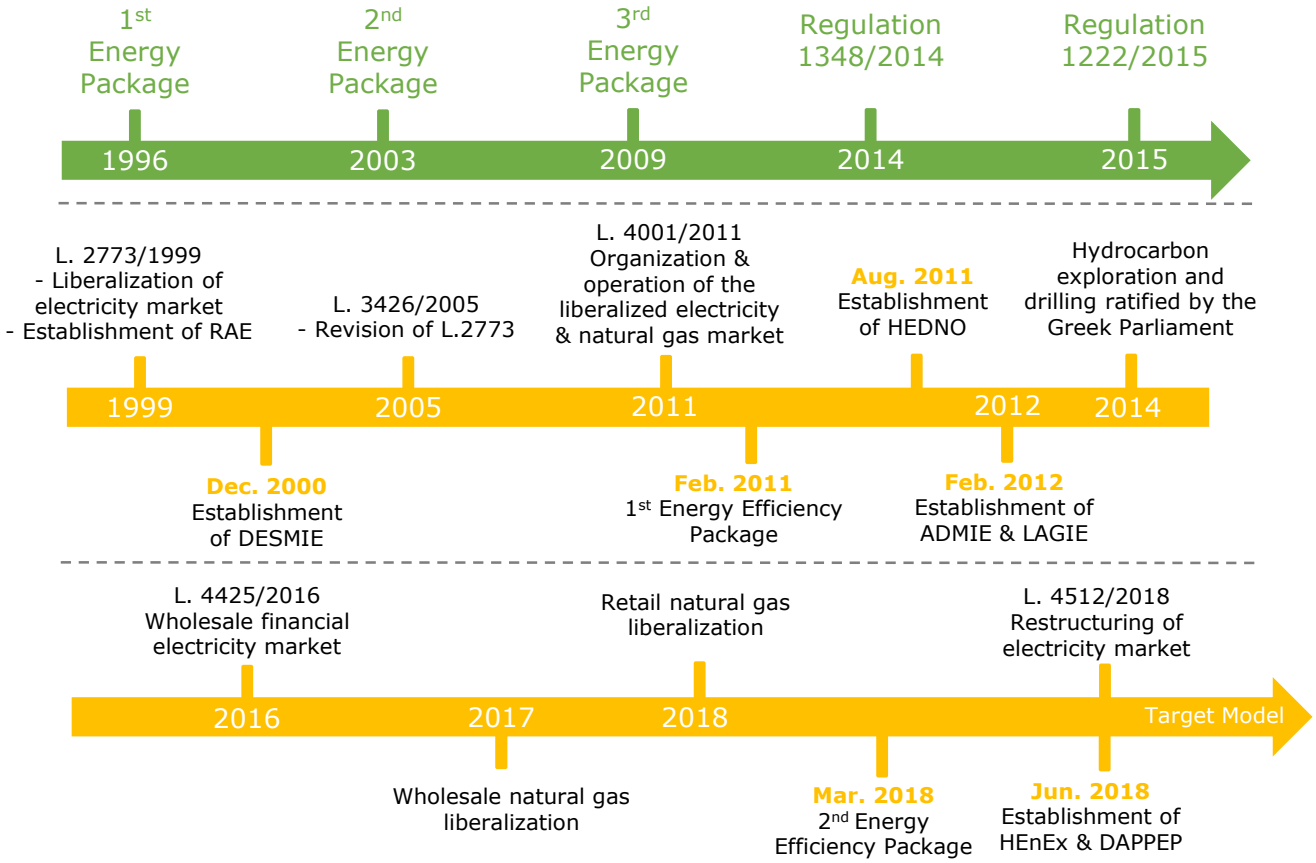
Arrears on utility bills (heating, gas, water, electricity, etc.) is another measurement of energy poverty and European Union 28 has also managed to perform well in this indicator, with a stable trend which seems to decline in the most recent years.

On the other hand, the intense and persistent impact of financial crisis in Greece increased the inability of households to meet the energy utilities obligations. In particular, the percentage of households which encountered difficulties in utility bills, was 18.8% in 2010, while it more than doubled in 2016 reaching approximately 40% of households.

EU adopts a series of measures in order to tackle energy poverty with the most dominant to be the integration of energy markets through Energy Exchanges. Furthermore, the implementation of other measures is discussed while the majority of EU 28 countries began to introduce national measures in order to curb the sources of energy poverty.

The liberalization process of energy market has been relatively delayed, however significant developments are observed recently

Timeline of the liberalization process in the Greek energy market



Highlights

Source: HAEE's analysis

In order to harmonize and liberalize the EU's internal energy market, measures have been adopted since 1996 to address market access, transparency and regulation, consumer protection, supporting interconnection, and adequate levels of supply.

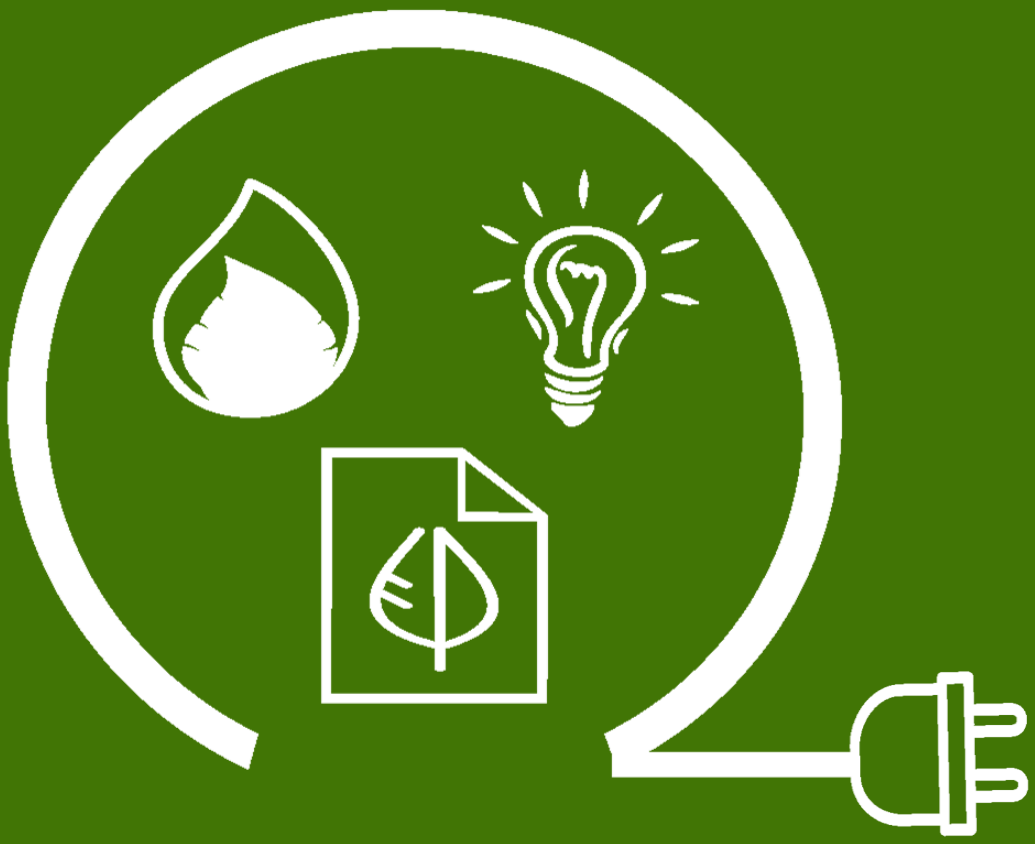
These measures aim to build a more competitive, customer-centered, flexible and non-discriminatory EU electricity market with market-based supply prices. In doing so, they strengthen and expand the rights of individual customers and energy communities, address energy poverty, clarify the roles and responsibilities of market participants and regulators and address the security of the supply of electricity, gas and oil, as well as the development of trans-European networks for transporting electricity and gas.

For the case of Greece, officially since 2007 all electricity customers in the interconnected system had the choice of alternative supplier. Enhanced competition though is still weak, since PPC's dominates the market share (79.76% in Jan.2019).

Considering the natural gas market, Greece's geopolitical position serves as the crossroad between the abundant-at-natural-gas East and the demanding West. The infrastructure projects of pipelines interconnecting Bulgaria, Italy and Turkey offer source diversification and security of supply, eliminating the danger of an energy crisis similar to the ones that Europe has witnessed in the past.

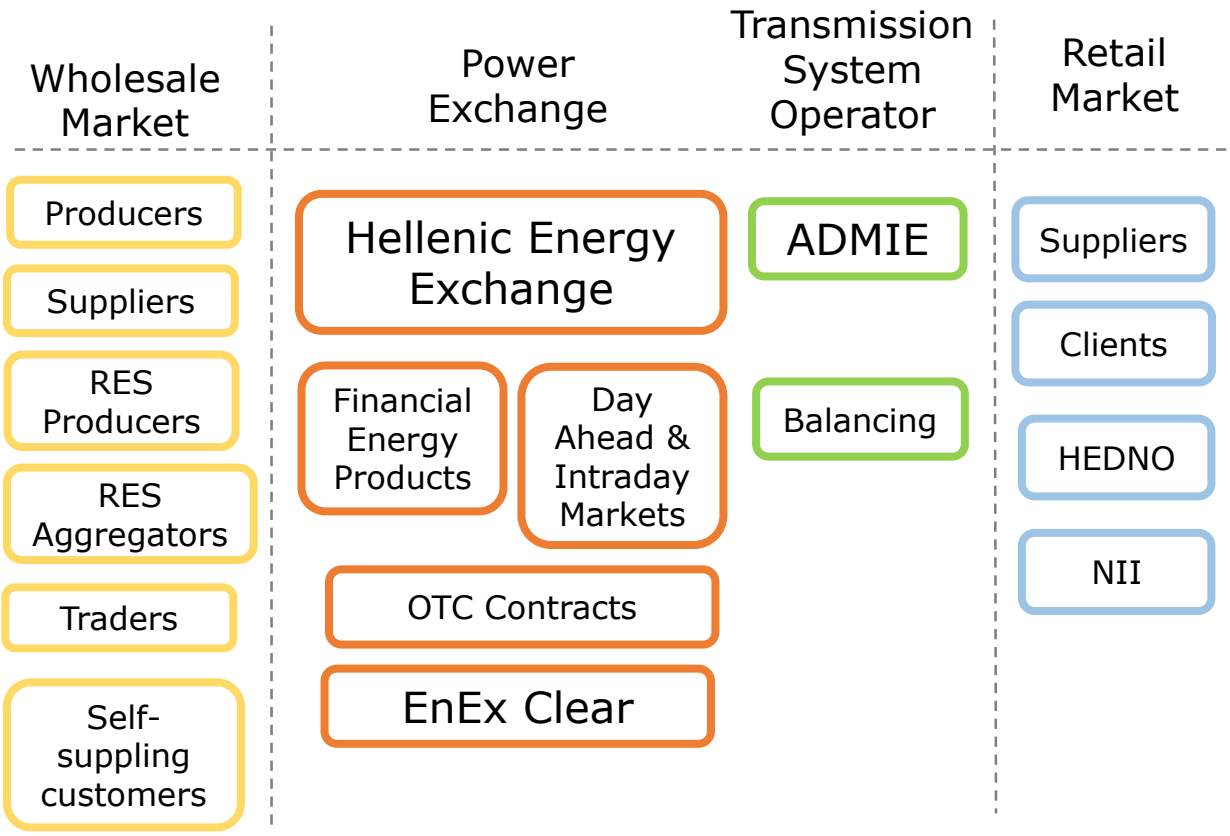
However, the development of the market around the liberalization process in Greece was established only in 2017 regarding the wholesale market, while the retail gas market was officially liberalized at the begging of 2018. Currently, the regulatory framework encompasses all necessary provisions to facilitate the imports and the network use from third parties. Further privatization plans of the incumbent company DEPA reveal the will to create a liberalized regional market. The implementation of electricity and gas market reforms are the necessary steps towards the implementation of the Target Model in 2020.

2. Hellenic Energy Exchange



Hellenic Energy Exchange will organize and operate Greece's new electricity, natural gas and environmental markets

The imminent framework of Greek energy market



Source: HAEE's analysis

Highlights

Aiming to enhance competition, Greece has introduced numerous stages towards the liberalization and deregulation of wholesale electricity market. The formation of Hellenic Energy Exchange (HEnEx) is one basic reform that is in line with European regulation.

Until the start of 2018, the electricity market in Greece operated through the public company LAGIE, which was responsible for undertaking the operation and monitoring the Day-Ahead market and Intraday coupling.

LAGIE's further responsibilities comprised clearing, settlement and reporting of transactions to both the Regulatory Authority for Energy (RAE) and the Agency for the Cooperation of Energy Regulators (ACER).

Aiming to modify this structure, Greek authorities in co-operation with the European Commission, have jointly formed a framework towards the implementation of Target Model guidelines.

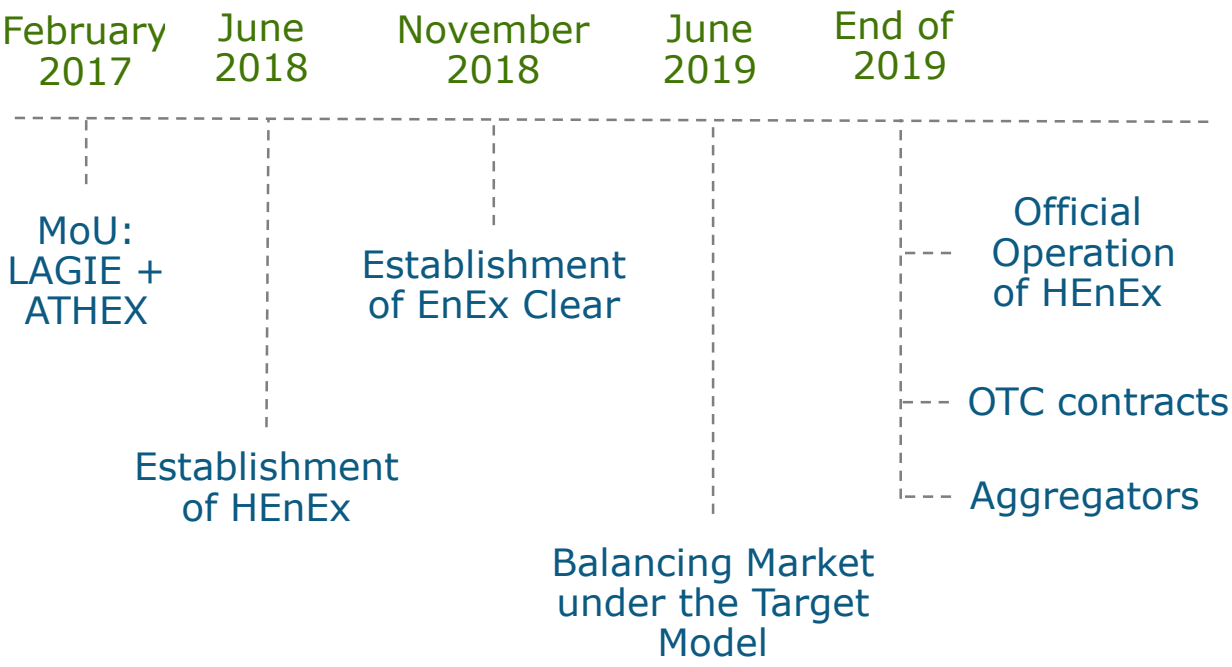
The Greek energy market framework was shaped radically in February 2017, when the Market Operator (LAGIE) and Athens Stock Exchange (ATHEX) signed a memorandum of cooperation, aiming to establish the Hellenic Energy Exchange that is designed to replace the current system of mandatory pool by the end of 2019.

The operation of the energy market is complemented by new provisions that will allow natural gas and environmental products to enter the platform. At the same time, the objective is to include RES, which can facilitate to the forthcoming Power Exchanges, as suppliers.

Following the formation of HEnEx, a new entity was established as the market Clearing House, in order to undertake the responsibilities of Clearing, Risk Management and Settlement of the transactions.

The Hellenic Energy Exchange is expected to launch operations by the end 2019, as part of a plan to restructure the domestic electricity energy market, lower energy cost and strengthen security of supply

Timeline



Source: HAEE's analysis

Highlights

In line with the Third Energy Package, the transition to the new Target Model of the European wholesale energy market, includes the formation of voluntary basis Power Exchanges, in parallel with the existence of Over the Counter (OTC) bilateral contracts.

HEnEx operates in this exact way, by permitting participants to submit different orders for the supply of electricity for different production levels and time intervals, and at the same time keeps a record of all OTC contracts.

On January 2018, HEnEx was established as the successor of LAGIE , which transferred to the newly established entity, all the responsibilities assigned to it considering the operation of the energy market.

Consistent with the proposed market codes, spot markets concern at least physically-deployed energy-based financial instruments, with the ability of either limit or broaden the scope of the license to non-physical energy financial instruments.

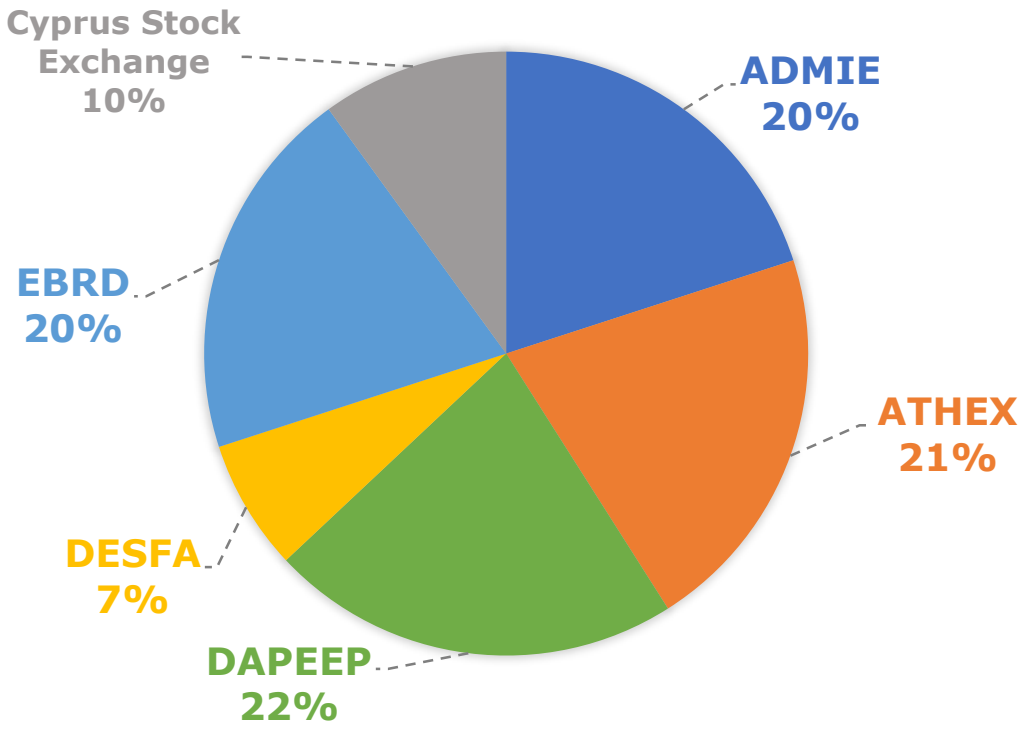
According to current planning, the software system implementation, the internal training and the completion of ADMIE's interconnection systems will occur in May 2019.

The procedure of user acceptance internal testing and fixing possible errors will follow in July 2019. In October 2019 the processes of (i) Commissioning, (ii) Participants Training and (iii) Dry Run will take place.

According to ENTSO-E (2018) market coupling with Italy is expected to take place during the 1st quarter of 2019, while coupling with Bulgaria and North Macedonia is anticipated to occur by the end of 2020.

HEnEx is anticipated to encourage competition, guarantee transparency, enhance liquidity and facilitate integration with the rest European electricity markets

Hellenic Energy Exchange ownership structure



Source: HAEE's analysis

Highlights

The establishment of the new energy exchange is critical to the reform of the Greek energy sector. It is also an essential element in the EU target model for energy markets, which Greece is committed to adopt.

An initial step towards the Target Model was the restructure of the previous Market Operator (LAGIE) to "RES Administrator & Guarantee of Origins", with the distinctive title DAPEEP.

According to HEnEx ownership structure, DAPEEP will participate with a share of 22% to the new entity, thus ensuring the participation of the Greek state. Besides, the role of ATHEX is of crucial importance (21%) since it is expected to contribute with the necessary expertise in the formation of HEnEx.

Beyond the two major shareholders (DAPEEP and ATHEX), the required capital was covered by the contribution of other entities, such as the electricity and gas Transmission System Operators (TSOs), (ADMIE 20% & DESFA 7%, respectively), the European Bank for Reconstruction and Development (20%) and Cyprus Stock Exchange (10%).

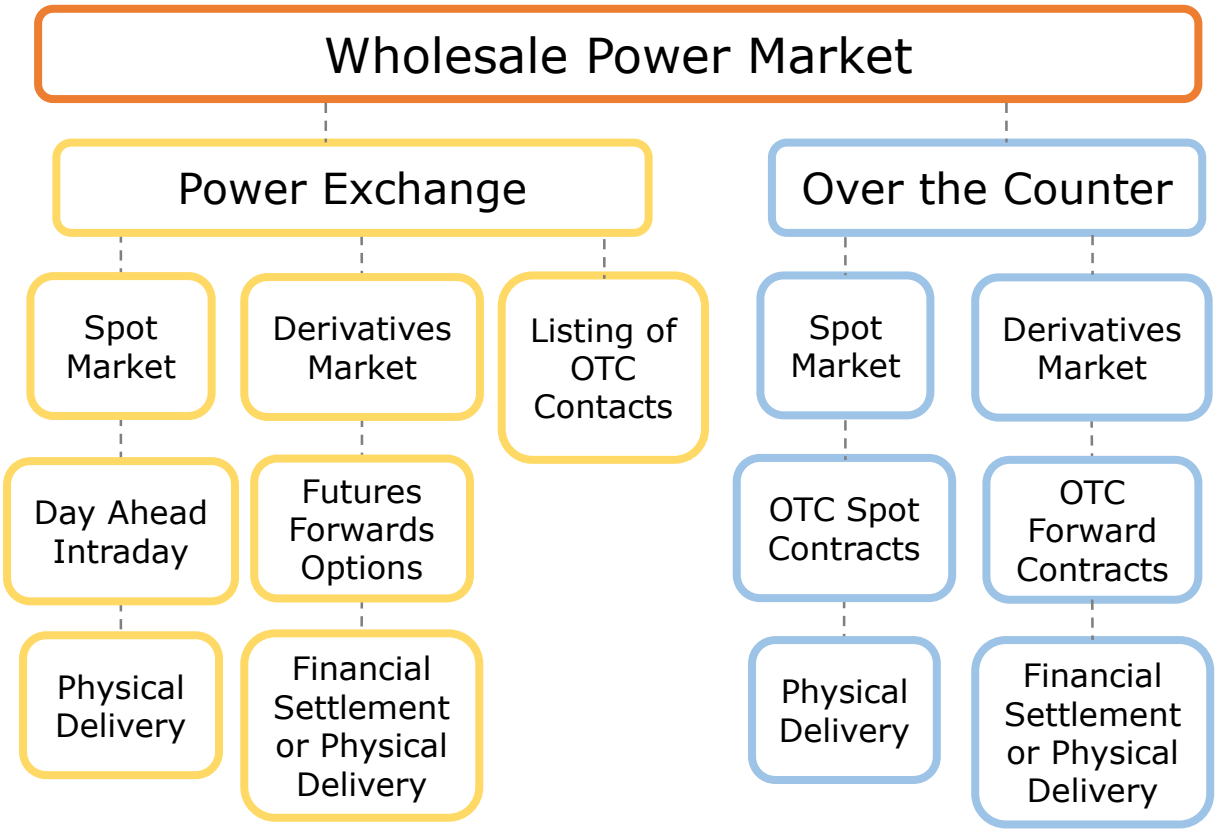
In terms of ownership structure, each acquisition or transfer of shares, for which the shareholding percentage reaches or exceeds 1/5, 1/3, 1/2 or 2/3 of share capital, is subject to prior approval from RAE.

Regarding the basic characteristics of the introduced Power Exchange, standardization, transparency, low transaction cost and elimination of counterparty risk are some of the features accompanied with its function.

In contrast to the existing mandatory pool, the new PX is anticipated to provide a fair, secure and regular transaction process.

The two pillars of the imminent wholesale power market are the power exchange and Over the Counter transactions (OTC)

Wholesale market structure



Source: HAEE's analysis

Highlights

Both pillars of the wholesale market comprise of spot and derivative markets that lead to either physical or financial settlements. Hellenic Energy Exchange operation and OTC contracts function in a complementary way. Still numerous differences exist between them.

The dynamic two-sided OTC contracts are available only to a limited number of participants, and since their supervision and regulation is problematic (given that transactions are opaque), both participants encounter high levels of counterparty risk

Cross-border transactions will be conducted in a transparent and reliable manner, ensuring greater liquidity in the energy market, and at the same time providing a competitive environment for the benefit of the final consumers.

The existence of a Clearing House in the framework of Hellenic Energy Exchange, eliminates any chances of counterparty risk. Yet, the interaction of prices on the two markets is highly correlated, since the prices formed in any Power Exchange, function as a benchmark or reference price for the prices shaped at the corresponding OTC market.

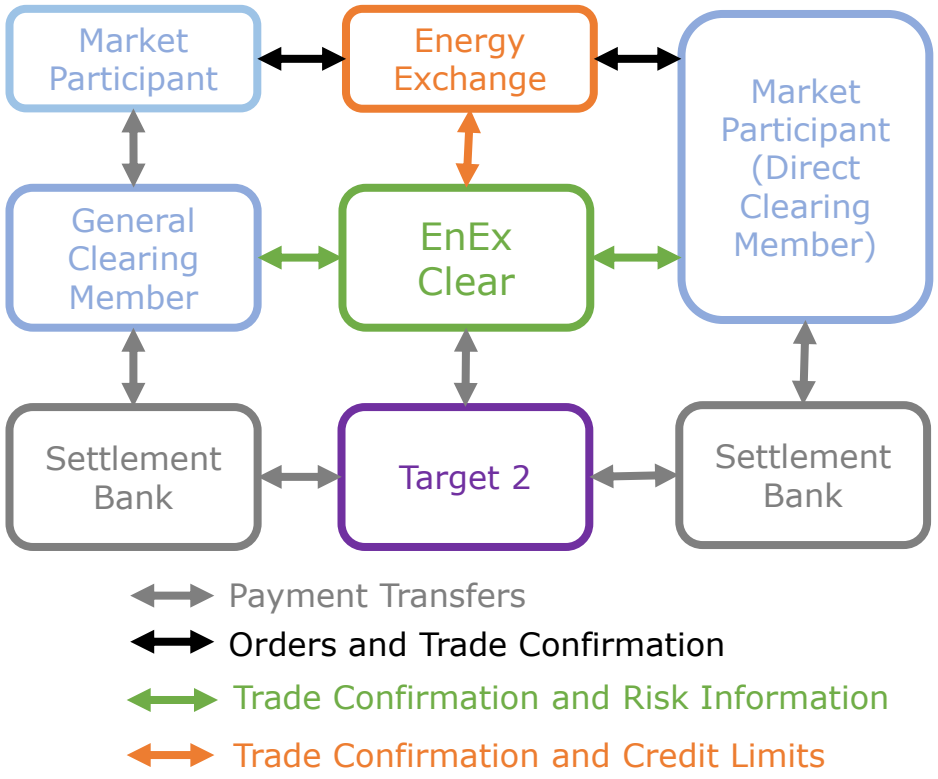
In case of bilateral trading, all Forward contract specifications included in a bilateral OTC contract are at the sole discretion of the two participants involved, apart from those affected by power mitigation rules, as decided by RAE.

According to European experience, OTC transactions are anticipated to prevail in the market, at least during the following years, since participants are reluctant to enter the Power Exchange since most companies are not familiar with this new concept.

For instance, in 1996, 96.1% of all transaction recorded were completed through OTC transactions, while only the remaining 3.9% was attributed on Power Exchanges.

EnEx Clear is a clearing house that was established following the formation of HEnEx, and undertakes the responsibilities of clearing, settlement and transaction coverage

Interplay among market participants in the wholesale market



Source: HEnEx, HAEE's analysis

Highlights

Given that participants are required to maintain margin accounts, a clearing house is interposed among counterparties to guarantee financial reliability. EnEx Clear intervenes between counterparties' transactions and undertakes the role of buyer vs each seller and vice versa for the clearing of transactions.

EnEx Clear is 100% subsidiary of the Hellenic Energy Exchange. Its main role is to aggregate the obligations of the counterparties considering their positions and manages counterparties risk.

The clearing house is responsible for the completion of the financial obligations before the delivery process starts by the TSO. Energy Clear performs the financial settlement of the transactions, the collaterals management and the clearing fund contribution management, in Central Bank with the use of Target 2 system.

The use of the Ancillary System of Target 2 offers an easy access to money transfer for all participants, even to the foreign ones.

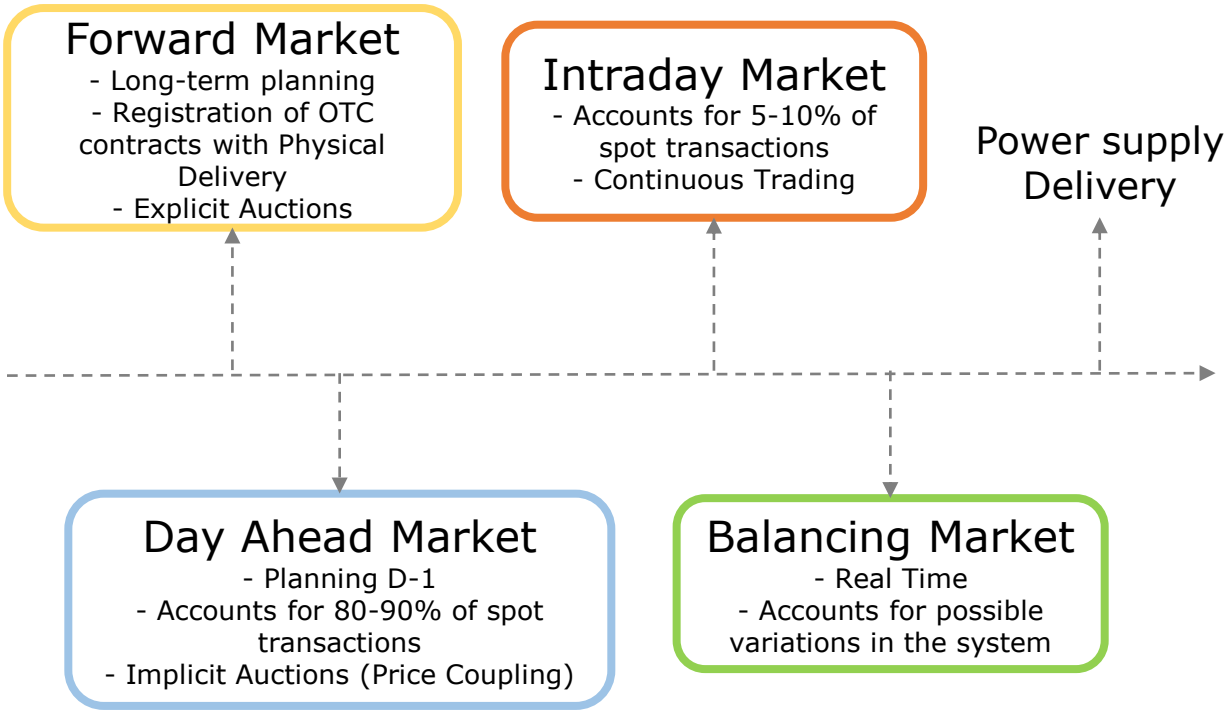
Members could be either Direct Clearing Members (DCM) which are common energy market participants or General Clearing Members (GCM) such as credit institutions and investment firms.

DCM which are legal entities and have their registered seat or branch in Greece or abroad, are eligible to clear their own transactions while GCM are eligible to clear their transactions as well as other participants' transactions.

Default takes place when there is no sufficient amount, in the settlement account of the Clearing Member in Target 2, to match its obligations for: financial settlement, required margin deposits, possible adjustments in Clearing Fund contributions, fees and taxes.

Participants can take advantage of the flexibility provided by the introduced forward and intraday markets

Sequence of the introduced markets in HEnEx



Source: HAEE's analysis

Highlights

The Forward market refers to agreements between two participants for buying or selling a specific quantity of electricity at a specific price, on a specified future date.

The elements included in such a contract are standardized and comprise of the underlying title, the delivery date and the contract size.

The settlement price of the Forward contracts is not recorded in the transaction system. In the Forward Market, participants arrange their long-term planning through explicit auctions. Besides, the Forward Market is the place where OTC contracts with physical delivery are registered.

Day-Ahead market refers to wholesale transactions in each D-1 calendar day, where electricity supply contracts are auctioned for each market time unit (1 hour) of physical delivery in day D.

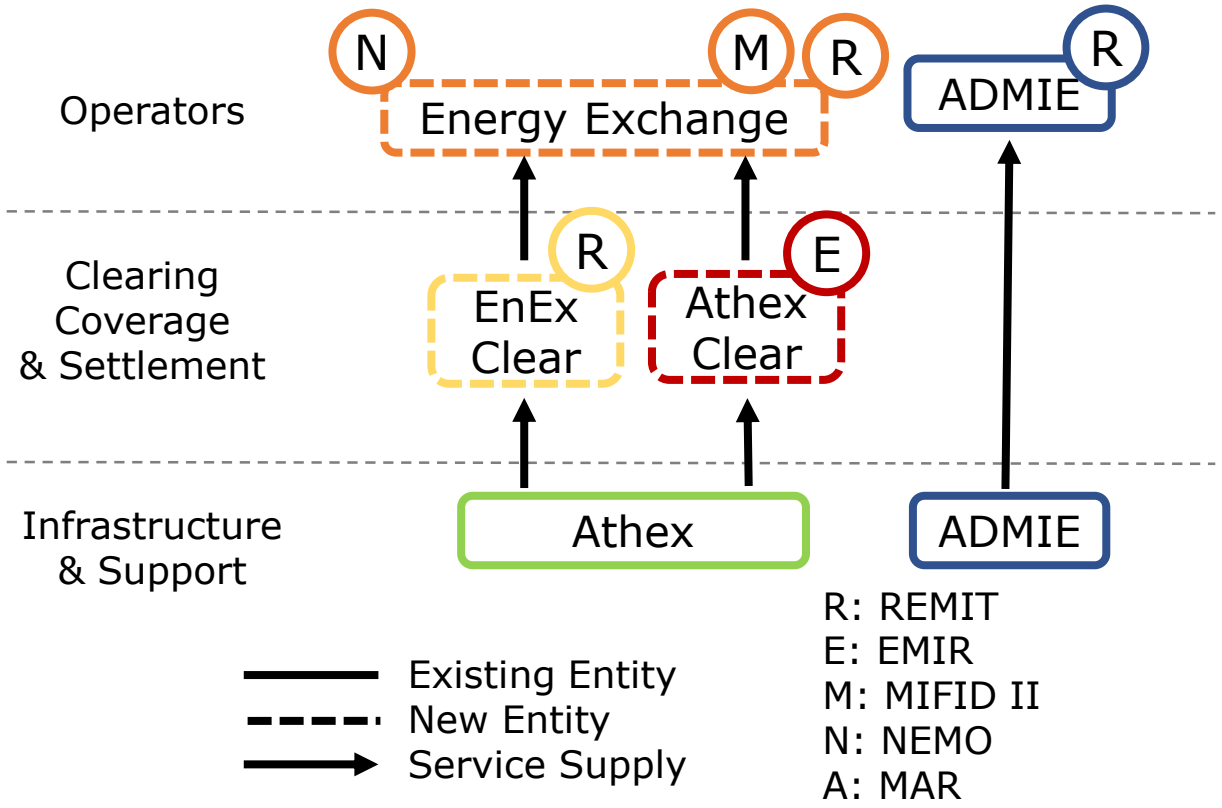
All transactions of energy financial products with physical delivery are also declared. The delivery day (D) consists of twenty-four purchased time units, starting at 01:00 Easter Europe Time (EET) on calendar day D and ending at 01:00 EET on the next calendar day D+1

Intraday is the market in which transactions to buy and sell electricity with physical delivery obligation are auctioned after the gate closure of the day ahead market (D-1 and D) and for physical delivery at day D Participation is optional for all Participants.

The objective of balancing market is the optimal use of available resources to balance generation-load. It introduces significant technical complexity but is essential for safe operation (especially with the expected increase in RES penetration).

Hellenic Energy Exchange will provide access to new energy markets and introduce new products on the domestic market

Flow of services and licenses under the new market structure



Source: HEnEx, HAEE's analysis

Highlights

The direction of the arrows denotes the flow of services, starting from the bottom level of infrastructure and support towards the middle level of clearing, and finally towards the upper level of market operation.

All the entities depicted in the specific figure need to comply with various European licenses. Those licenses are specifically directed by the EU through numerous regulations and directions that form the entire regulatory framework that rules the operation of the wholesale electricity market.

The clearing house (EnEx Clear) undertakes the responsibilities of clearing, settlement and transaction coverage. Given that participants are required to maintain margin accounts, clearing house is interposed between counterparties to guarantee financial reliability. The foremost responsibility of a clearing house is to keep a record and archive all transactions.

Registered participants of HEnEx are obliged to pay fees for the trading services provided by the HEE. The overall fees comprise the following components: Annual fee, separately for each market. This component represents the cost of trading services for the participation in the markets, and it is a fixed amount per year.

Membership fee which is separate for all markets. Transactions fee, for each MWh traded, both bought and sold, by each registered participant.

Finally, ADMIE as the Transmission System Operator, is committed to ensure the security of supply, hence ensuring the country's continuous and uninterrupted electricity supply, fulfilling all quality, safety and efficiency criteria.

ADMIE is also responsible for the well function of the Balancing Market, which is a very important market function standing at the junction of the financial and physical activities.

Trade permits market participants to adjust positions within and across borders, and at the same time allows efficient allocation of risks among them

Functional breakdown by entity in spot and derivative markets

Functions	Forward	Day Ahead	Intraday	Balancing
Trading	Hellenic Energy Exchange	Hellenic Energy Exchange	Hellenic Energy Exchange	ADMIE
Clearing, Settlement & Risk Management	Athex Clear	EnEx Clear	EnEx Clear	ADMIE
Operators	Athex	Athex	Athex	ADMIE

Source: HEnEx, HAEE's analysis

Highlights

The table describes the various functions of the new market structure and the corresponding allocation of each entity that is responsible for the well-functioning of spot and derivative markets.

Participants can take advantage of the Forward market in order to hedge against price volatility. This is the market where they forecast the medium-term supply/demand balance, schedule of power plant maintenance and sale/purchase operations (1 year until 1 month prior to day D).

One month prior to day D, participants revise the supply/demand balance to more accurate weather forecasts and availability of power plants, sale/purchase operations on the forward markets.

In the Day Ahead market producers should determine the production schedule, create operating schedule for the power plants, balancing supply and demand on the Day-Ahead market (DAM) and send nominations to Transmission System Operator.

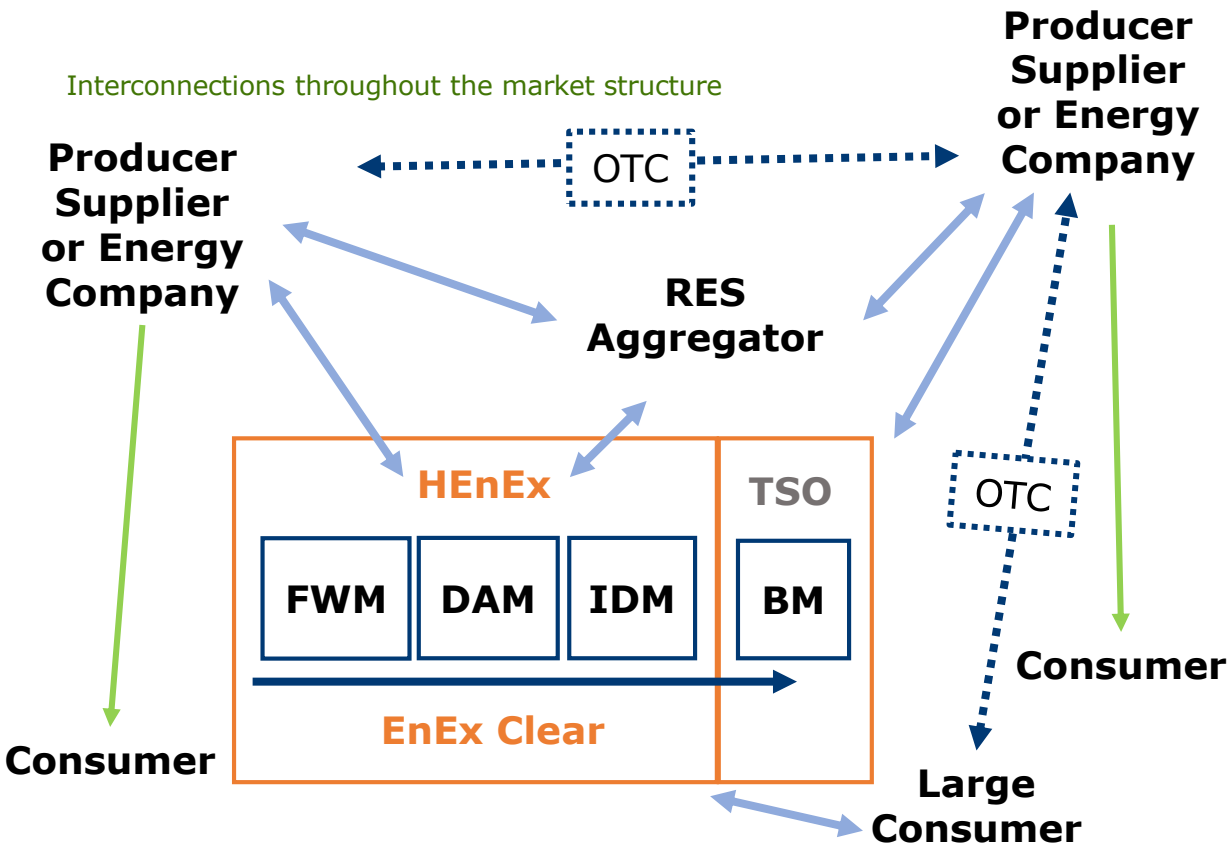
The Intraday market is the place where participants respond to latest unanticipated changes in the portfolio, send re-nominations to Transmission System Operator, and sale/purchase operations 60/30 minutes before delivery. In general, this is the market where participants optimize their correct positions before closing them.

Maintaining a real-time balance between electrical power generated and consumed is essential for safeguarding a power system's security. Due to the non-storability of electricity in large scale at the present time, disturbances of the equilibrium between generation and load cause the system frequency to deviate from its set value.

The task of restoring the power balance and guaranteeing system security is entrusted to the Transmission System Operators (ADMIE).

Hellenic Energy Exchange aspires to play a crucial role in the development of the national and regional economy

Interconnections throughout the market structure



Source: HAEE's analysis

Highlights

An important characteristic of the imminent wholesale market is the combination of market with physical existence and market without a physical existence.

Bilateral trade or Over the Counter (OTC) can either be financial or physical, with the latter including actual physical delivery. Pure bilateral trade refers to direct transactions between a buyer and a seller without using any intermediaries.

In the upcoming energy market , generators, distributors, traders and consumers can trade electricity either via OTC contracts or on a power exchange. Due to the confidentiality of the OTC market many players may use the power exchange price index as a reference for their bilateral contract.

The four markets included in HEnEx, its linkages with OTC bilateral agreements and the rest of market participants set the broad framework of interconnections throughout the market structure.

Given the new services that are expected to be available over the next period, HEnEx is expected to act as a central risk-taking and risk-management platform for all market participants, enabling them to diversify their variable costs and pricing policy.

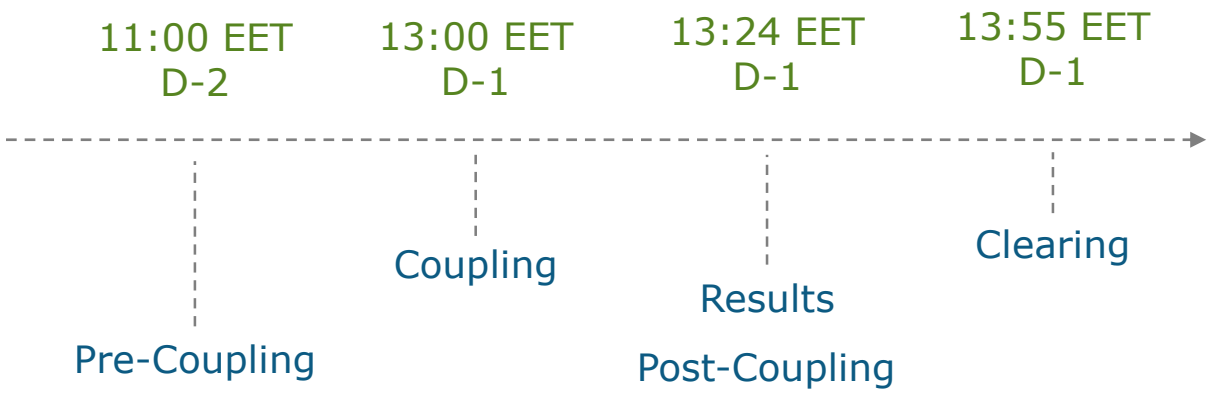
Those radical reforms in the forthcoming market structure, will allow participants to enhance their expertise in energy trading and develop risk-taking and risk-management strategies.

The development of a competitive regional hub in Greece requires the establishment of an Energy Exchange able to attract increased volume.

The issue of volume traded is fundamental for exchanges since it indicates the representativeness of the power exchanges with respect to the rest of the market.

Day-Ahead market refers to wholesale transactions in each D-1 calendar day, where electricity supply contracts are auctioned for each market time unit of physical delivery in day D

Day Ahead market processes / Overview



Source: HAEE's analysis

Highlights

The delivery day (D) consists of twenty-four purchased time units. Gate opening is at 10:30 (D-1) and last for 150 minutes, since Gate closure time is at 13:00 (D-1). The trading system is a daily Double-side (generation and demand) auction for every hour to match transactions at a single price.

The product traded is an hourly contract that specifies the size (MWh) and value (€/MWh). Hourly bids are the most common type of bids in Power Exchanges, and the essential information required on each bid includes: participant's details, type of bid (sale or buy), hour of the day, quantity and price.

Market agents permitted to participate in the HEnEx, such as generators, distributors, traders, suppliers and large consumers, submit their bids throughout the transaction system, determining the quantity and the price they are willing to sell or buy.

After receiving the bids, a verification and validation process is performed. Each sale bid specifies the quantity and its minimum price, at which the seller is willing to supply electricity. On the other hand, each buy bid specifies the desired quantity and the maximum price, at which buyers are willing to pay.

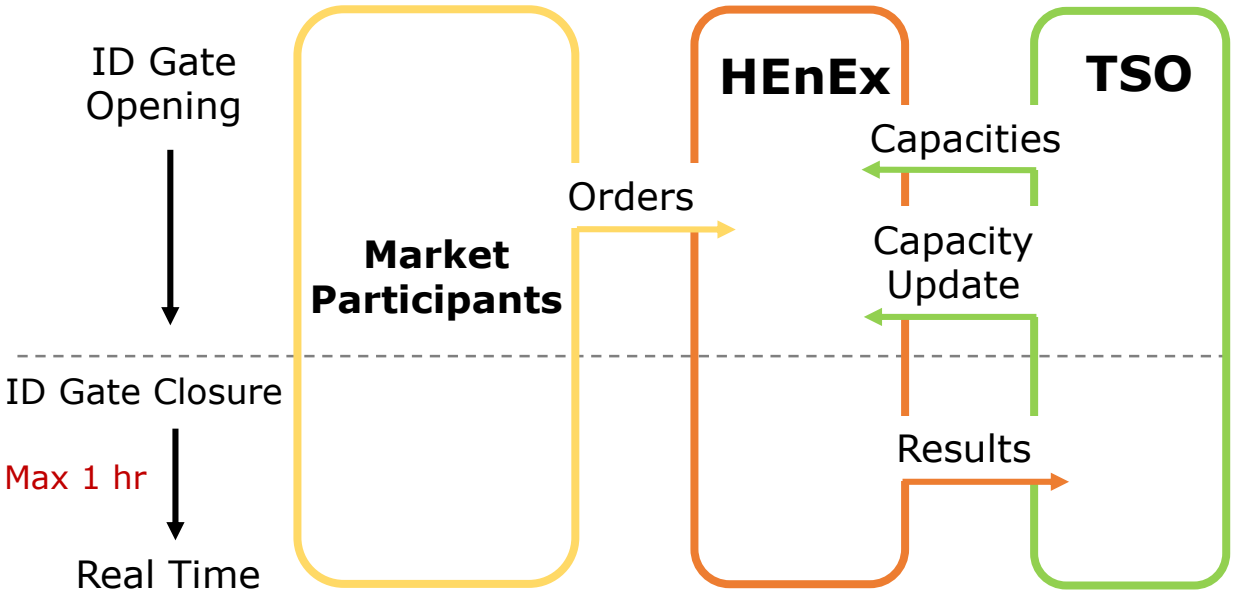
The anonymous submitted bids are collected in the transaction system until the predetermined closure time and followed by a specific procedure of auction algorithm computation, a clearing price is determined for every hour.

The clearing or matching price for every hour is settled when demand and supply curves aggregated and intersected. In that way, demand is covered for 24 hours, 7 days per week.

The types of orders that can be submitted by participants in the Day-Ahead market are the following: Step-wise Orders, Linear piecewise Orders, Block Orders.

Intraday market offers short-term trading products along with block products in order to facilitate the optimum participation of RES units

Intraday market processes / Overview



Source: HAEE's analysis

Highlights

Intraday market concerns wholesale trading on each calendar day D. The implementation of the Intraday market in HEE will take place in two phases.

During the 1st phase, auction sessions shall be implemented in Greece while during the 2nd phase, trading will occur both internally and at the borders.

The design of the Greek Intraday market will be adapted to implement pan-European Continuous Intraday Trading through the already agreed Intraday solution.

This procedure allows transactions in which orders may be executed as soon as they are placed in the frame of the Intraday market.

Apart from Step-wise, Linear piecewise and Block Orders that are available in Local & Complementary Intraday Auctions, Continuous Intraday Trading includes the following general types of orders: Hourly Orders, Half-hourly Orders.

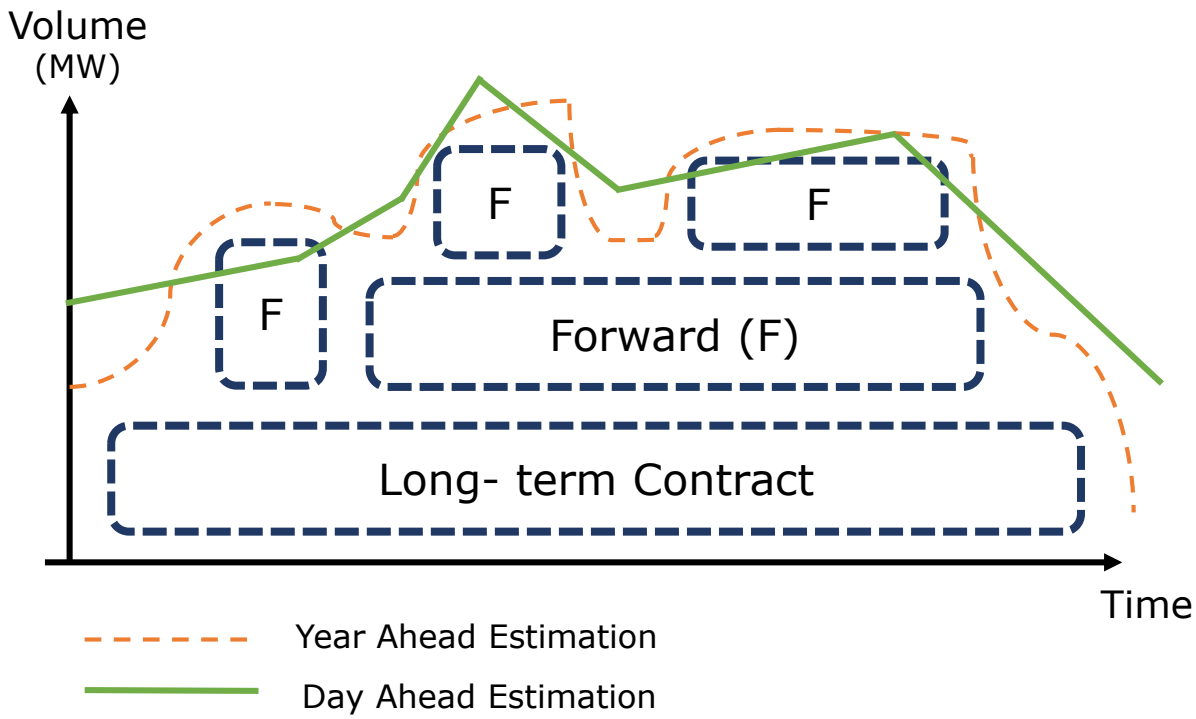
Aiming to ensure the reduction of imbalances and financial exposure, players can utilize the following order types: Limit Orders, Linked Orders, Iceberg Orders, Predefined Block Orders, User Defined Block Orders.

The Continuous trading matching algorithm supports the following order execution restrictions: None, Fill or Kill, Immediate or Cancel, All or Nothing. Finally, the Continuous trading matching algorithm supports the following order validity restrictions: Good for session, Good till date.

The Intraday market functions as an extension of Day-Ahead fine tuning, since participants can update their trading position based on their risk profile as approaching to real-time and submit more accurate short-term forecasts for Renewable Energy Resources, such as solar and wind.

The Forward market refers to agreements between two participants for buying or selling a specific quantity of electricity at a specific price, on a specified future date

Forward market processes / Overview



Source: HAEE's analysis

Highlights

The elements included in Forward contracts are standardized and comprise of the underlying title, the delivery date and the contract size. The settlement price of the Forward contracts is not recorded in the transaction system.

The buyer of the contract has the obligation to buy a certain quantity of electricity, while the seller of such a contract has an obligation to sell a certain quantity of electricity at a certain price, on an agreed future date.

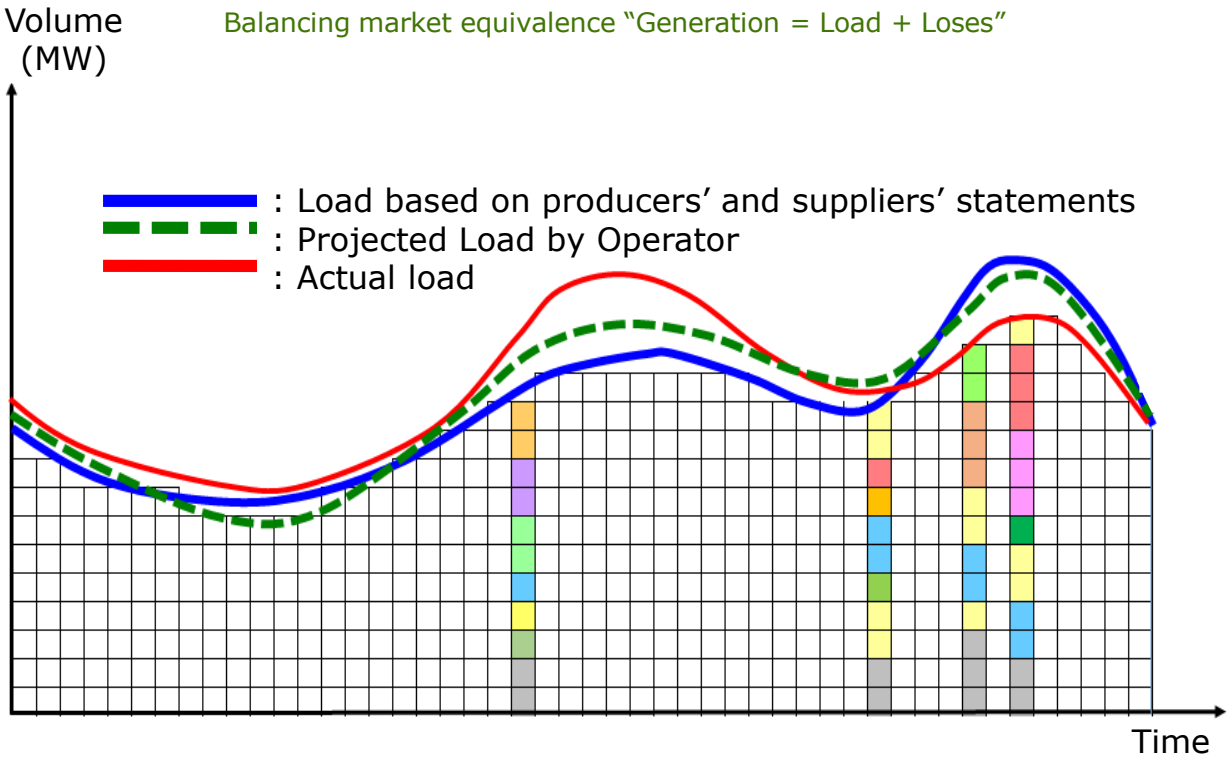
A supplier participating in the Forward market may pre-determine "today" the price and the agreed quantity that it is required to deliver according to the agreed contract, which in terms of the HEnEx function, are designed to be Monthly, Quarterly or Yearly Standardized Contracts.

At the same time, the participant is completely flexible to differentiate its position within that horizon. In this way, the fundamentals are shaped for entirely exploitation of price fluctuations, leading to a significant diversification of costs.

The types of orders that could be submitted in the Forward market are the following: Market Order, Limit Order, Linked Order and Iceberg Order. Furthermore, an order may be submitted with the following execution and time requirements: Good for Day, Good till Canceled, Good till date, Immediate or Cancel, Fill or Kill, All or None and Stop Order.

In addition, the Forward market structure involves the registration of bilateral OTC contracts with physical delivery obligation, at HEnEx's platform. In case of bilateral trading, all Forward contract specifications included in a bilateral OTC contract are at the sole discretion of the two participants involved, apart from those affected by power mitigation rules, as decided by RAE.

The balancing market introduces significant technical complexity but is essential for safe operation of the system



Source: ADMIE

Highlights

Given that the Balancing market affects and is affected by the physical operation of the electrical system, its objective is the optimal use of available resources to balance generation-load.

Balancing market is critical for the safety of the system as it has not only economic but also physical effects. Today it has a small market share (up to ~ 5%) but will increase as the penetration of RES increases.

Following a Public Consultation RAE adopted the option of "Central dispatch and Unit Based", instead of "Self-dispatch on Portfolio Basis". The selected approach will promote the smooth transition to the new market and as the system reaches a certain level of maturity, Balancing Responsible Parties will begin to participate in the system.

Currently, ADMIE is working on the implementation of Market Management System and Settlement System for the Operation of the Balancing Market. After this stage, a Dry Run will follow.

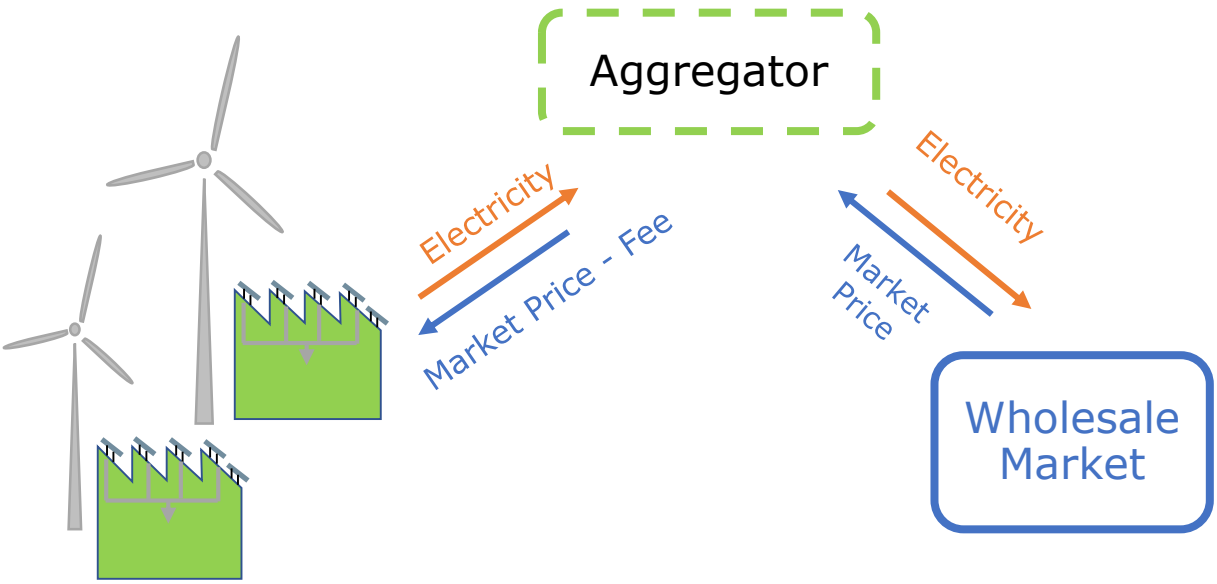
The well functioning of the balancing market is an initial but necessary step for market coupling. Approximately in 2020 it is expected to be implemented at European level.

The corresponding Network Code Electricity Balancing is expected to be finalized by the end of 2019. It is estimated to be completed in 2020 and will include both cross-border regulation, management arrangements and other ancillary services.

Its design includes the careful consideration of Aggregators through incorporating demand management programs for their clients.

RES aggregation can accelerate the integration of intermittent electricity sources, enhance demand flexibility and decrease the reliance on renewable energy support schemes

Aggregation model



Source: HAEE's analysis

Highlights

In a changing electricity market landscape, where the share of intermittent renewable energy in the energy mix is increasing, system flexibility becomes crucial.RES producers will gain increased incentives to be competitive, yet at the same time they will undertake the responsibility of forecasting their production accurately.

Namely they will be financially responsible for the additional balancing cost of the power system when this is caused by imbalances between their forecasts and their actual production.

As part of the solution, the aggregation of renewable energy can significantly accelerate the integration of intermittent electricity sources, complement demand flexibility and decrease the reliance on renewable energy support schemes.

Target Model, implies a direct decentralization of procedures which, until now, were under the central control of the Independent Power Transmission Operator (IPTO). Sooner or later the balancing responsibility will be transferred from the IPTO to individual RES producers.

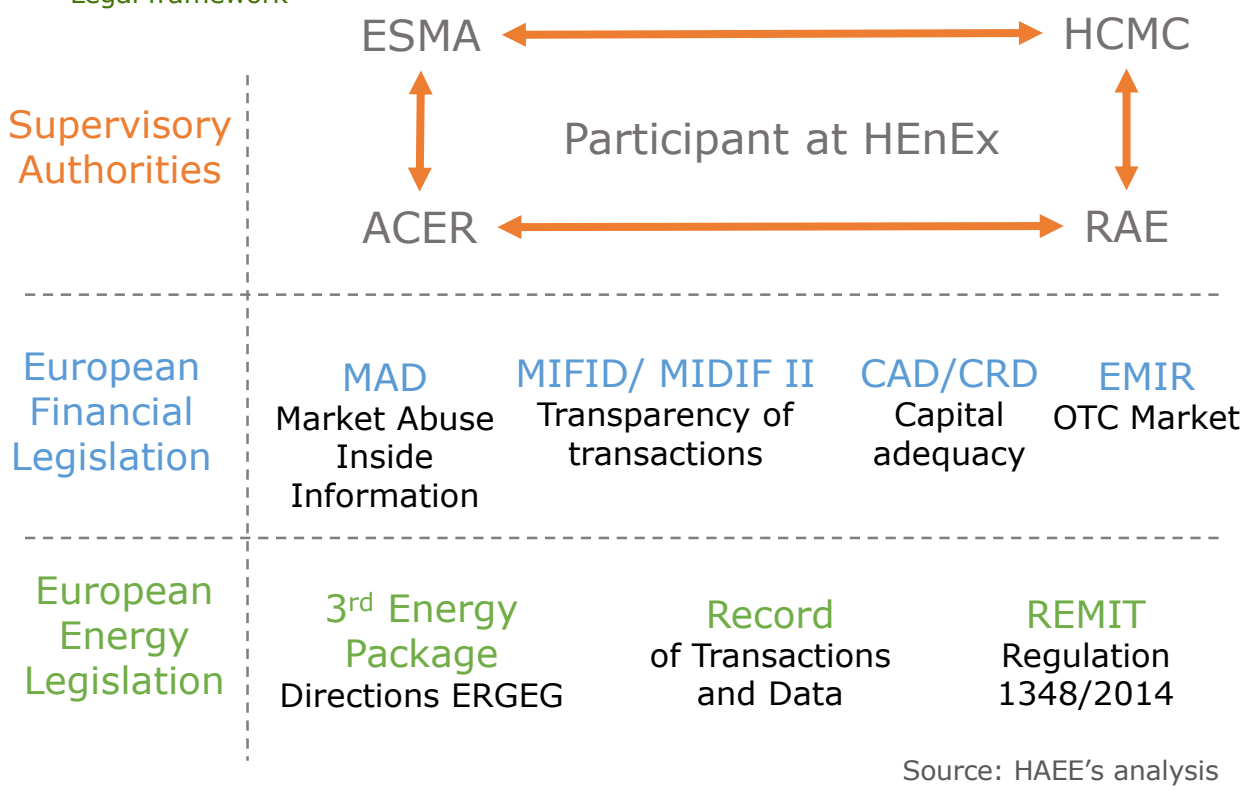
RES Aggregators, through which many RES producers participate in the market and in the balancing mechanism within larger portfolios, will play an important role in this context.

Aggregators of demand and/or generation are therefore expected to have an increasingly important role in the future. A market participant could function as customer of an Aggregator or transform into a service provider on its own.

The design of Hellenic Energy Exchange accounts for the participation of Aggregators since they could minimize the balancing cost: the cost of imbalance settlement and the cost of Non-compliance charges.

RAE and the HCMC cooperate for the effective implementation of the legal framework which relates to the operation, the integrity and the transparency of the energy market

Legal framework



Source: HAEE's analysis

Highlights

As authorities sought to comply with the Target Model, the legislative and regulatory framework of the Greek sector has been significantly modified over the recent years.

A set of Directions and Regulations imposed by the European Union, ensures confidence in the integrity of Hellenic Energy Exchange. The prices shaped on wholesale energy markets reflect a fair and competitive interplay between supply and demand and do not generate any undue profits from market abuse.

Effective oversight of wholesale energy markets requires the regular monitoring of details of contracts including orders to trade as well as data on capacity and use of facilities for production, storage, consumption or transmission of electricity and natural gas.

Hellenic Energy Exchange complies with various European licenses, such as the Regulation on Wholesale Energy Market Integrity and Transparency (REMIT), the European Market Infrastructure Regulation (EMIR), the Markets in Financial Instruments Directive (MIFID II), the Market Abuse Regulation (MAR), and the Nominated Electricity Market Operator (NEMO).

This framework is closely supervised by both national (RAE & Hellenic Capital Market Commission) and European regulators (ACER & ESMA). Hellenic Capital Market Commission is the authority responsible for granting a license to HEnEx, and in parallel has the obligation to supervise the Forward market.

Based on the introduced legal framework, financial products trading in HEnEx, such as derivatives, options and futures, are subject to specific financial legislation. According to EMIR , the clearing house manages the settlement fund, which covers the likelihood of default of any market participant.

The next goal is the establishment of Hellenic Trading Point (HTP) referring to natural gas market

Natural Gas Hellenic Trading Point - Timeline

Until 1.7.2018	From 1.7.2018 until today	End of 2019	End of 2020
OTC trades for Shippers only	OTC trades for both Shippers and Traders Trades with TSO for Balancing Gas	OTC trades for both Shippers and Traders Trades with TSO for Balancing Gas Anonymous exchange spot trades	OTC trades for both Shippers and Traders Trades with TSO for Balancing Gas Anonymous exchange spot trades Futures, Derivatives
Virtual Point Nomination **DESFA** Since 2013	**Virtual Trading Point with Balancing Platform** **DESFA** Live 1/7/2019	**Trading Platform (Gas Hub)** **DESFA + HEnEx** In Progress	**Trading Platform (Gas Hub)** **DESFA + HEnEx** To be Developed

Source: HEnEx, HAEE's analysis

Highlights

Through the Balancing Platform, developed in cooperation with the Athens Exchange Group, DESFA will be able to buy and sell through auctions the quantities of gas needed, in order to balance the National Natural Gas Transmission System.

In parallel, with the activation of the Virtual Trading Point, natural gas traders not involved in physical trading are offered for the first time the possibility to operate in the Greek market, since it is now possible to get involved in natural gas transactions, irrespective of whether they have contracted capacity at entry/exit points or not.

The 4th revision of the Greek Network Code and, in particular, the establishment of a Balancing Platform is the most decisive step in the development of a functioning wholesale gas market, according to the Gas Target Model, as well as for the achievement of the strategic objective of creating a regional gas hub.

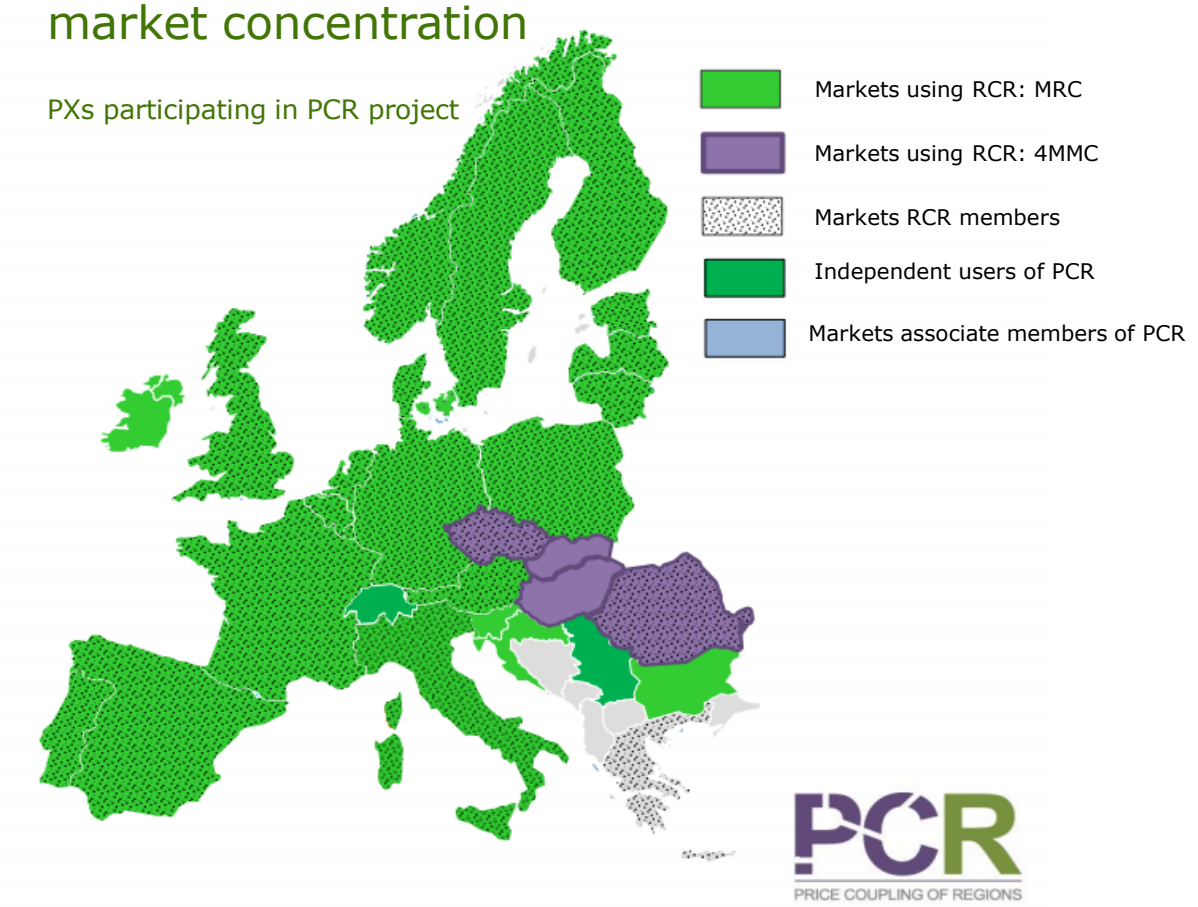
The next step involves the operation of a Trading Platform, where anonymous transactions between gas market participants will take place. These transactions will be used to calculate the marginal prices for the purchase and sale of gas.

Hellenic Energy Exchange will act as a Trading Platform Operator for the function of natural gas market. EnEx Clear is designed to be the gas clearing house.

The basic characteristics of Hellenic Trading point would be to provide easy access to users, possibility of cross-border transactions, liquidity and absolute transparency in transactions.

The Hellenic Trading Point should be benefited from being a Virtual hub with entry-exit mechanism. It will act as a supply source assisting diversity and connectivity, while transparency on data and regulatory processes would directly reduce risk for market participants.

The two major benefits of a common market design, through the implementation of the Target Model are increased competition and reduced market concentration



Source: HEnEx

Highlights

The European electricity market is the largest in the world, since 42 Transmission System Operators (TSOs) in 35 countries serve over 500 million customers. The length of the transmission lines was 312693 km in 2017 while the total electricity consumption represents 15% of global consumption at the level of 3.278TWh (2017).

Given the ongoing coupling between various regions in Europe, in the coming years we are likely to witness a significant integration among energy markets. Pooling of resources saves the European customers 13 billion euros per year. Cross border trading of electricity denotes 13% of total sales in Europe (2017).

Numerous benefits can be derived from cross-boarder trading. Namely, the optimal use of interconnections, the enhanced security of supply, the increased social welfare, the promotion of realistic and competitive prices, the encouragement for new investments through the allocation of efficient economic signals and finally the promotion of competition.

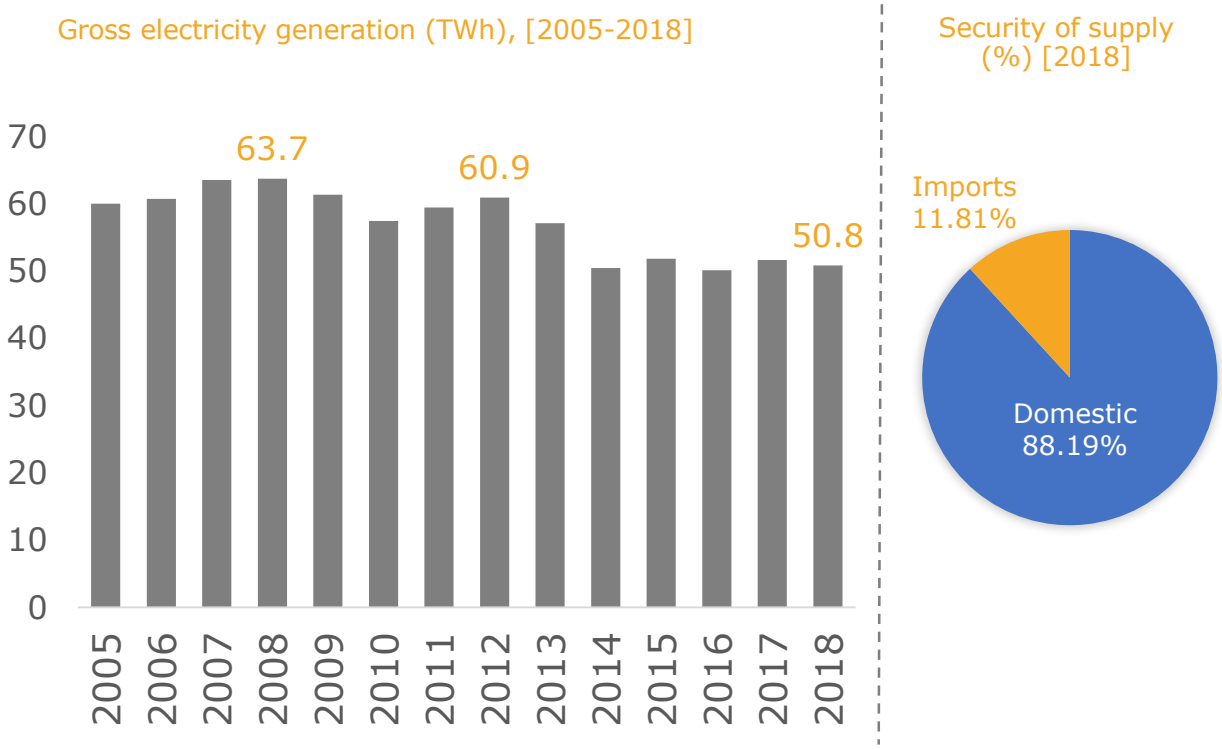
Multi-Regional Coupling (MRC) is known as the coupling of regions and efficient management of available transmission capacities between areas and countries. Following the establishment of the HEnEx, market coupling with Italy is expected to take place within 2020, with other neighboring bidding zones to follow.

Furthermore, in 2018, HEnEx joined the Price Coupling of Regions (PCR) project, which is an initiative of eight Power Exchanges covering the majority of European electricity markets. One of the key achievements of PCR is the development of a single price coupling algorithm, known as EUPHEMIA.

The goal is to create a pan-European electricity market by removing barriers for cross-border trading subject to network constraints. In overall, Internal Energy Market (IEM) is expected to increase liquidity, efficiency, social welfare and transparency of prices and flows.

3. Electricity

Fossil fuels are still essential for the security of supply and the containment of electricity prices for industrial and household consumers



Source: Eurostat, HEnEx, HAEE's analysis

Highlights

Gross electricity generation in Greece remained relatively steady from 2005 to 2018 due to the economic crisis. Greece generated 50.8 terawatt hours (TWh) of electricity in 2018, a decrease of 20% since 2008.

Fossil fuels have historically played an important role in Greek power generation, and accounted for more than 70% of the total electricity generated in the previous decades. However, their dominance has decreased over the recent years, due to a fall in electricity consumption and the growth of renewable generation by wind and solar.

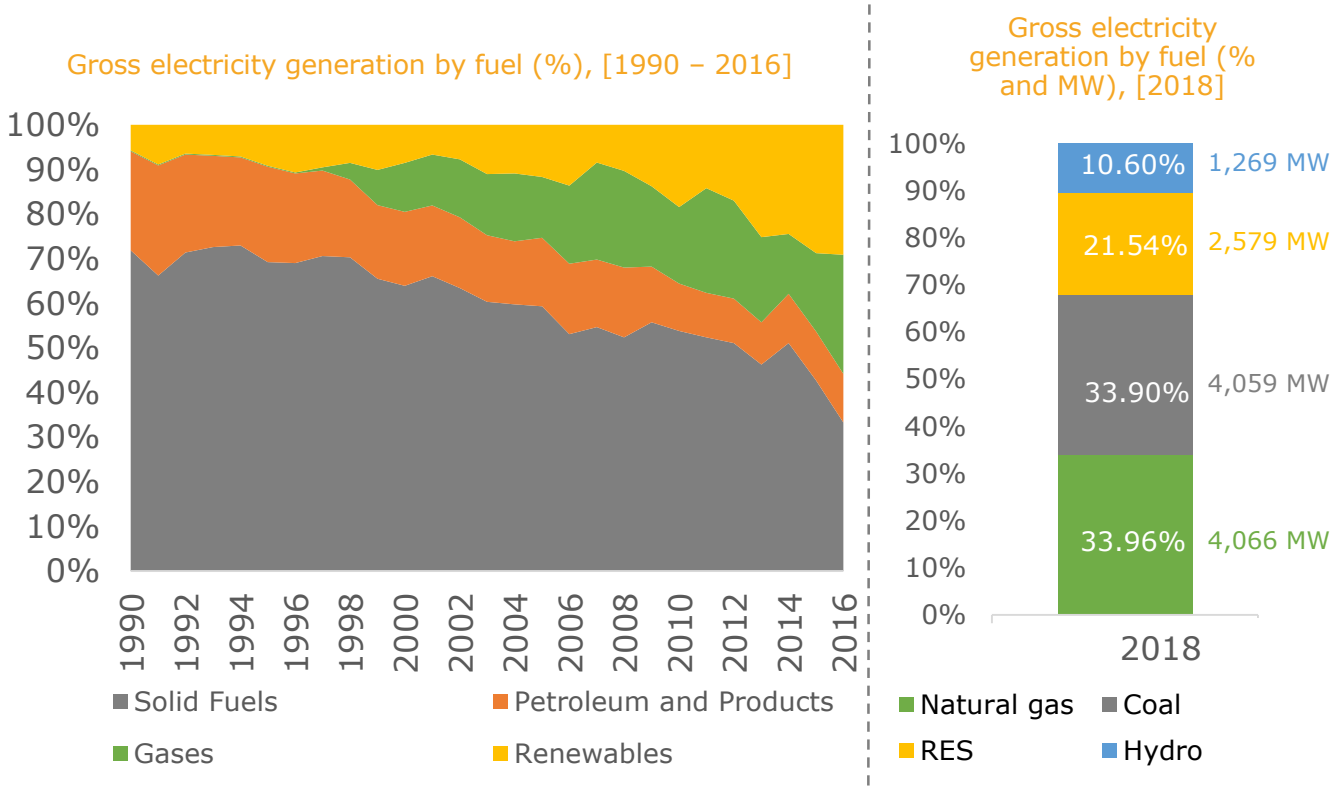
Nowadays, electricity market design must be well suited and adaptive to changes in the underlying generation mix and demand behavior. Across Europe, electricity markets are undergoing a severe transformation. The generation mix is changing as the penetration of renewable generation technologies increases in pursuit of ambitions for power sector decarbonization.

At the same time, electricity demand is also evolving. Greater electrification of heat and transport is increasing overall demand, while the advance of "smart" technologies has the potential to change patterns of consumption.

The conventional model of electricity market design based on dispatching large scale, controllable thermal generation to meet predictable patterns of demand is, therefore, becoming less relevant.

In that context, market design must evolve to reflect this transformation. More specifically, the Greek energy sector is undergoing a series of reforms, especially in the context of aligning the electricity markets with the relevant EU Target Models. Considering the issue of security of supply, Greece uses its own sources for electricity generation at 88.19% while imports of electricity stands at 11.81% for 2018.

Lignite generation is expected to decrease as lignite plants retire, with gas-fired generation and RES expected to further strengthen their position in the mix



Source: Eurostat, HEnEx, HAEE's analysis

Highlights

Greece has made substantial progress in diversifying the electricity fuel mix, especially in the deployment of variable renewable energy, which increased to almost 22% of the total generation in 2018.

Currently, there is no dominant fuel in the generation mix, since natural gas represents 33.96%, coal 33.90% and the remaining is attributed to renewable energy sources (21.58%) and hydroelectric stations (10.6%).

According to historical data, the dominance of fossil fuels in Greece has decreased compared to 1990. While electricity generation from coal and oil decreased by around 50% each, between 2006 and 2016, power generated from renewable sources almost doubled over the same period.

Hydro was the third-largest energy source in electricity generation in 2016, but the main growth in renewables has come from wind and solar power.

In overall, Greece has taken several steps towards liberalizing and deregulating the wholesale and retail power markets to increase competition.

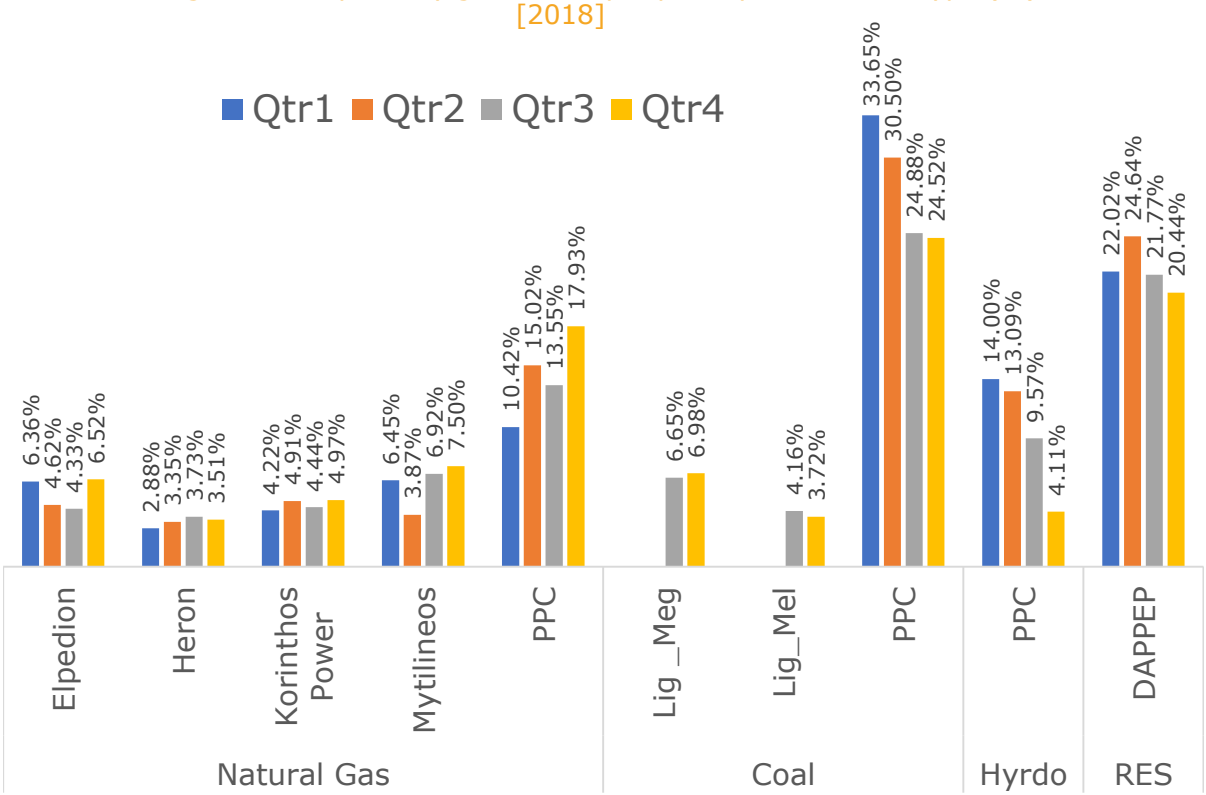
Until the official operation of Hellenic Energy Exchange, the Greek electricity market is structured around a gross mandatory pool with a "technical" algorithm, which co-optimizes energy and reserve at the Day-Ahead stage.

A Capacity Adequacy Mechanism complements the energy market arrangements, and an ex-post market clears deviations.

Greece will be transitioning to the new European Union target market, with Forward, Day-Ahead, Intraday, and Balancing markets.

The incumbent (PPC), still has a dominant share in electricity generation (52,51%, for 2018), while the remaining 47,49% consists of RES and alternative generators

Percentage of total quarterly generation per participant and fuel type (%), [2018]



Source: HEnEx, HAEE's analysis

Highlights

The electricity generation mix of Greece shows some differences compared to the EU average. For instance the use of solid fuels and natural gas is higher, while the use of RES is lower and the use of nuclear power is non-existent.

The liberalization process delivered private investment in gas-fired generation. In 2013 generation from private gas-fired units accounted for 18% of total generation.

However, five years later, during the last quarter of 2018, gas-fired plants of Elpedison (6.52%), Heron (3.51%), Korinthos Power (4.97%), Mytillineos (7.5%) and PPC (19.93%) contributed to 40.43% out of total generation.

According to the medium-term goals of electricity alternative generators, their main goal is to strengthen further their position as leading independent electricity producers in the Greek market.

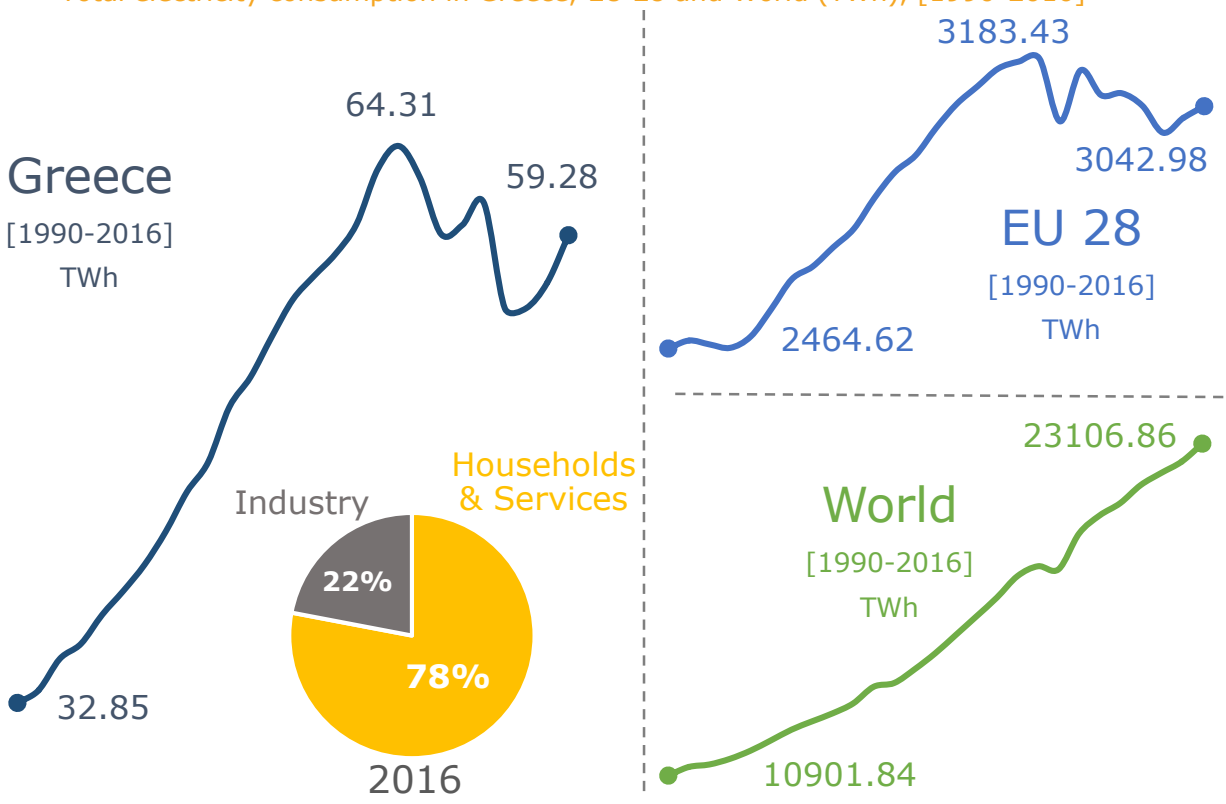
At the same time, PPC owns the biggest share of conventional units (lignite) of the Greek electricity system, contributing 35.22% of the total generation in the last quarter of 2018. PPC has also expanded its gas-fired power plant facilities over the last five years. Production from PPC's gas-fired plants accounted for 17.93% of the total supply in 2018.

The anticipated reduction in the share of lignite production aiming to comply with environmental policies, raises concerns about the supply adequacy that will need to be addressed when progressing with power sector reforms.

Hydro and RES together contributed to the remaining 24.3% of total generation. Over the quarters of 2018, natural gas and RES seems to obtain a significant percentage of total generation, with coal and hydro steadily losing their shares but still holding substantial shares.

Electricity consumption is anticipated to rapidly increase over the upcoming years, in line with the projected economic recovery

Total electricity consumption in Greece, EU 28 and World (TWh), [1990-2016]



Source: IEA, HAEE's analysis

Highlights

Global electricity consumption increases at a faster pace than other energy sectors, due to the electrification of energy uses. Over the past decade, most of the increase in global electricity consumption occurred in China and India.

For the case of Europe, electricity consumption increased sharply from the early 1990s to 2008. Over the last decade, consumption showed a decreased trend until 2014 when it started to increase again.

Electricity consumption can be affected by various factors. For instance, the types of activities (industry, agriculture, tourism), weather conditions (temperature, humidity, sunshine), economic figures (electricity tariffs, average income, GDP), the available technology and social conditions (consumption habits, days and hours of various activities).

Out of these factors, the major reason that affected consumption of electricity in Greece was the economic recession that affected the country over the previous years.

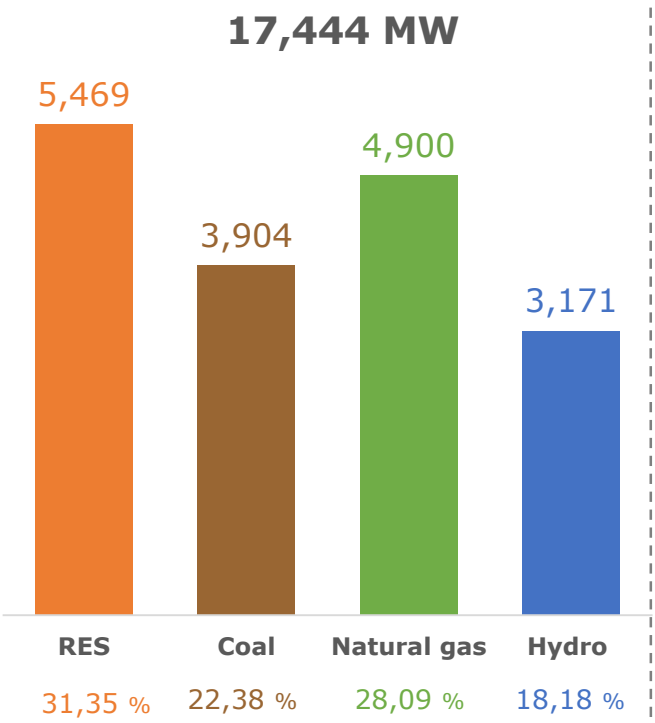
Greece's electricity consumption was increasing steadily until it reached a peak of 64.31 TWh in 2008. Then, a three-year period of decline followed (from 2009 to 2012) in the aftermath of the economic crisis.

Even though consumption seemed to recover slightly after 2012, it then continued its downward trend and reached the value of 55.14TWh in 2014. In 2016 the corresponding level was 59.28TWh showing that it has not fully recovered.

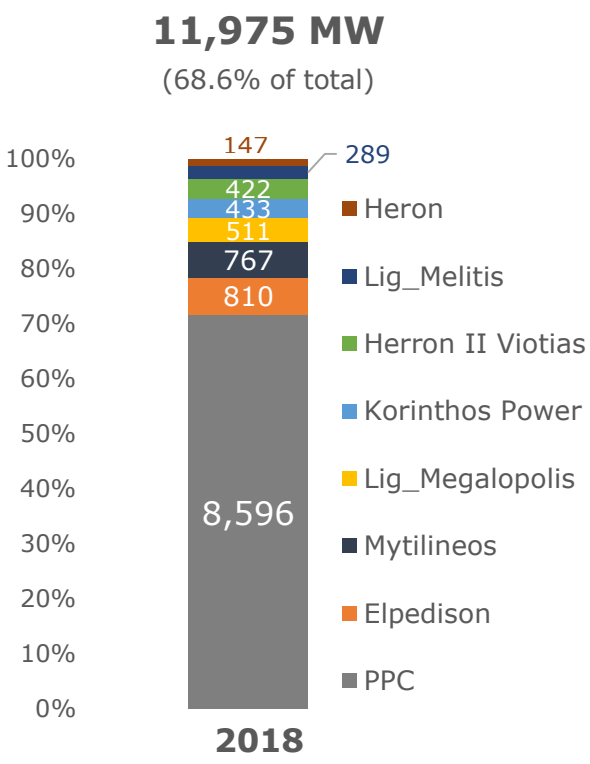
The largest electricity consuming sector is the commercial and residential sector (78%) followed by the industrial sector at 22%. Current electricity consumption in Greece is estimated to be around 5500 kWh per person annually, while in 1990 the corresponding size was about 3000 kWh.

RES and hydro stand at 49.5% of total electricity capacity for 2018, while alternative generators represent 21.5% of conventional units capacity

Total electricity capacity per fuel (MW), [2018]



Electricity capacity of conventional units per producer (MW), [2018]



Source: HEnEx, HAEE's analysis

Highlights

Total electricity capacity for 2018 in Greece was 17.444 MW, out of which 31.35% is attributed to RES followed by natural gas with a share of 28.09%. Next, coal stands for 22.38% of total electricity capacity and finally hydro with 18.18%.

It is obvious that conventional power plants are still crucial for the balance of the system since their capacity stands at 68.6% of total electricity capacity in Greece. Lignite is a significant domestic fossil fuel resource in Greece, and is an important component of Greece's energy security. Greece is the fourth-largest lignite producer in the EU, behind Germany, Poland, and Czech Republic.

Lignite production decreased sharply over the recent years, in line with the reduced demand for coal power generation. At the same time, lignite production costs have been increasing due to the decreasing electricity consumption, rising air pollution, environmental restrictions, and low gas prices.

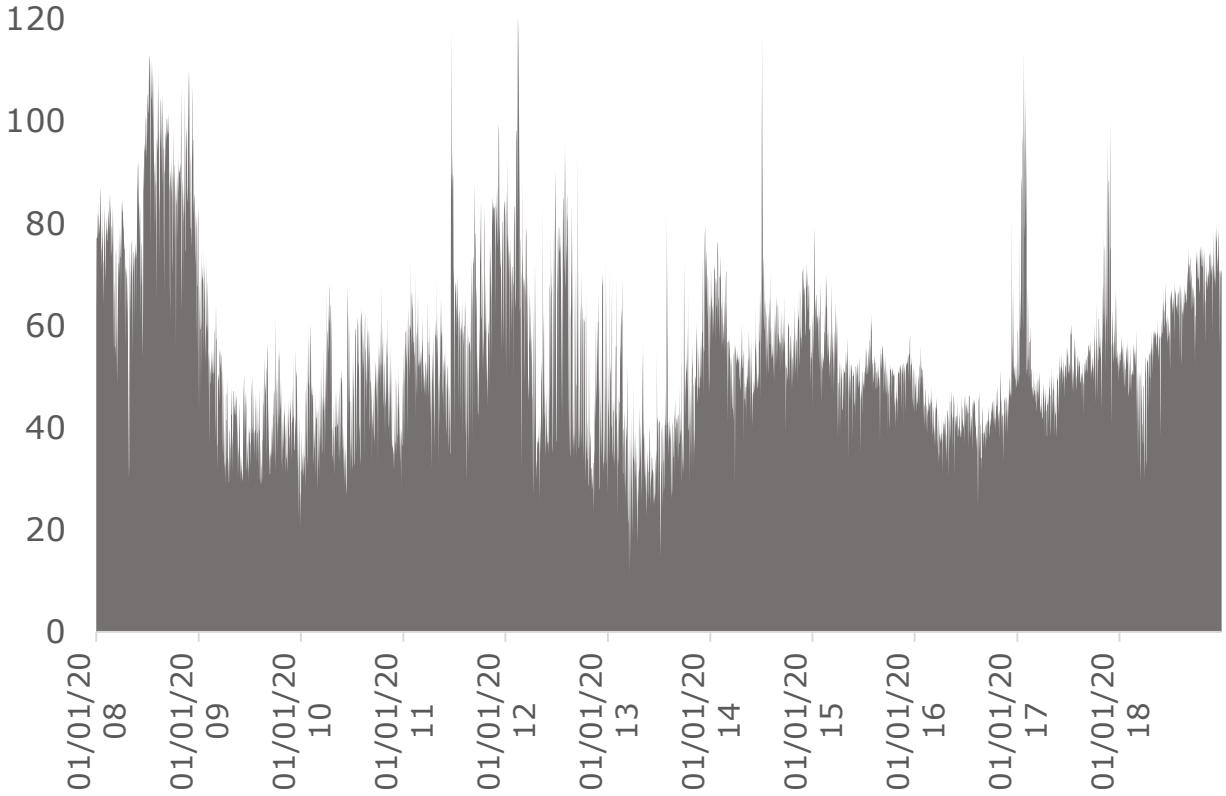
This trend is expected to continue as coal-fired plants are being replaced by plants fueled by natural gas. Due to the economic recovery, that will naturally boost electricity consumption, RES are anticipated to contribute to the increased demand. Greece has a large potential to grow the shares of clean power once its non-interconnected islands (NIIs) become integrated into the mainland electricity system.

Yet, the vertically integrated, state-owned electricity company PPC dominates the electricity sector value chain. It accounts for 71.7% of the installed thermal generation capacity and for about 53.15% of thermal electricity generation.

PPC's share in the Day-Ahead market, includes imports, hydro, and renewable energy sources, as well. PPC decommissioned 913 MW of lignite capacity in the period 2010-16, and plans to decommission another 2112 MW by 2025. However, the company plans to commission two new lignite units with a total capacity of 1 100 MW during the period 2017-25.

As market coupling and interconnections continue to develop, price convergence with the rest EU countries is expected to occur

Daily system marginal price (€/MWh), [2008-2018]



Source: HEnEx, HAEE's analysis

Highlights

Given that energy must be produced when needed and cannot be stored on an industrial scale, wholesale prices are highly sensitive to available production and transmission capabilities.

Greece fully liberalized its electricity prices with effect from 1 July 2013, depending on factors such as: supply and demand, cost of generation, transmission and distribution, and level of taxation.

Electricity prices have followed the same trends as in neighboring countries, with an overall rise over the last four years. Apart from a few random price spikes that occurred unexpectedly over the last decade, wholesale prices in Greece fluctuate around 40 to 60 euros per MWh.

The maximum price ever recorder over the period 2008 – 2018 was in February 2012 when it reached the level of 118 euros per MWh, while the minimum, one year later plummeting at the level of 10 euros per MWh.

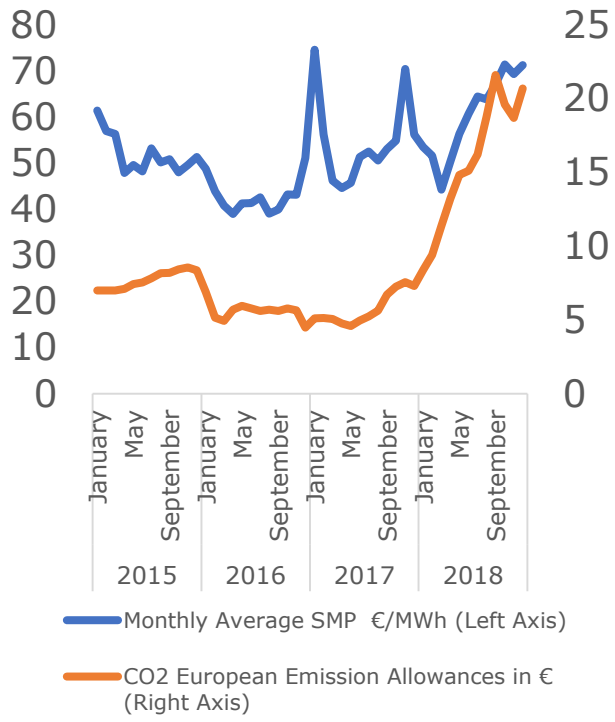
This increased sensitivity of prices fluctuations is anticipated to surge even more as the penetration of RES increases in the system, making market participants vulnerable to those fluctuations.

Despite the full price liberalization, price regulation continues to exist under public service obligations. These include the so-called supplier of last resort and the universal service supplier.

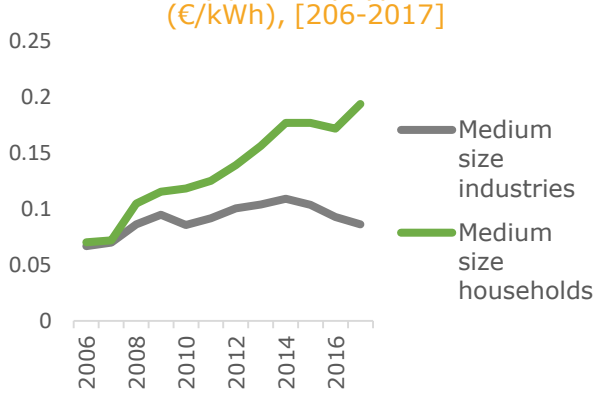
The supplier of last resort provides a temporary supply to customers who lost their previous supplier for reasons that were not their fault. Under the universal service obligation, regulated tariffs are offered to customers that either have not chosen a supplier of their own or are unable to conclude a new contract due to their poor payment record.

The ability to pay the bills for electricity has developed to the greatest challenge for the Greek households

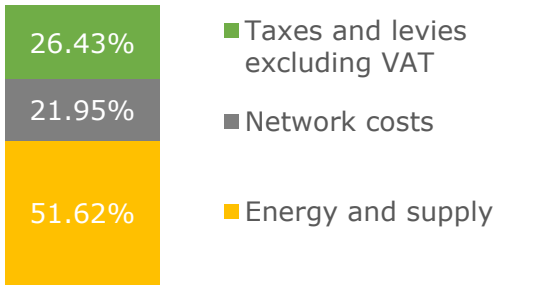
System marginal price and CO2 Prices [2015-2018]



Electricity prices by type of user, (€/kWh), [206-2017]



Electricity prices components (%), [2016]



Source: Eurostat, HEnEx, HAEE's analysis

Highlights

The average price of electricity for household consumption in Greece was 0,18 euro per kWh in 2018 and is relatively close to the EU average. However, EU faces increased prices compared to other continents, since the average price of electricity globally was 0.12 euro per kWh for the corresponding year.

The monthly average system marginal price encountered two sharp spikes during the winter crisis of January 2017 and November 2017. Afterwards, prices dropped slightly back to the levels of 60 euros per MWh, but then in 2018 raised again accompanied by the upswing of CO2 emission allowances.

The cost of fossil-fuel emissions rose to its highest level in more than a decade in Europe, surpassing 20 euros a ton and adding to the cost of electricity across the member states.

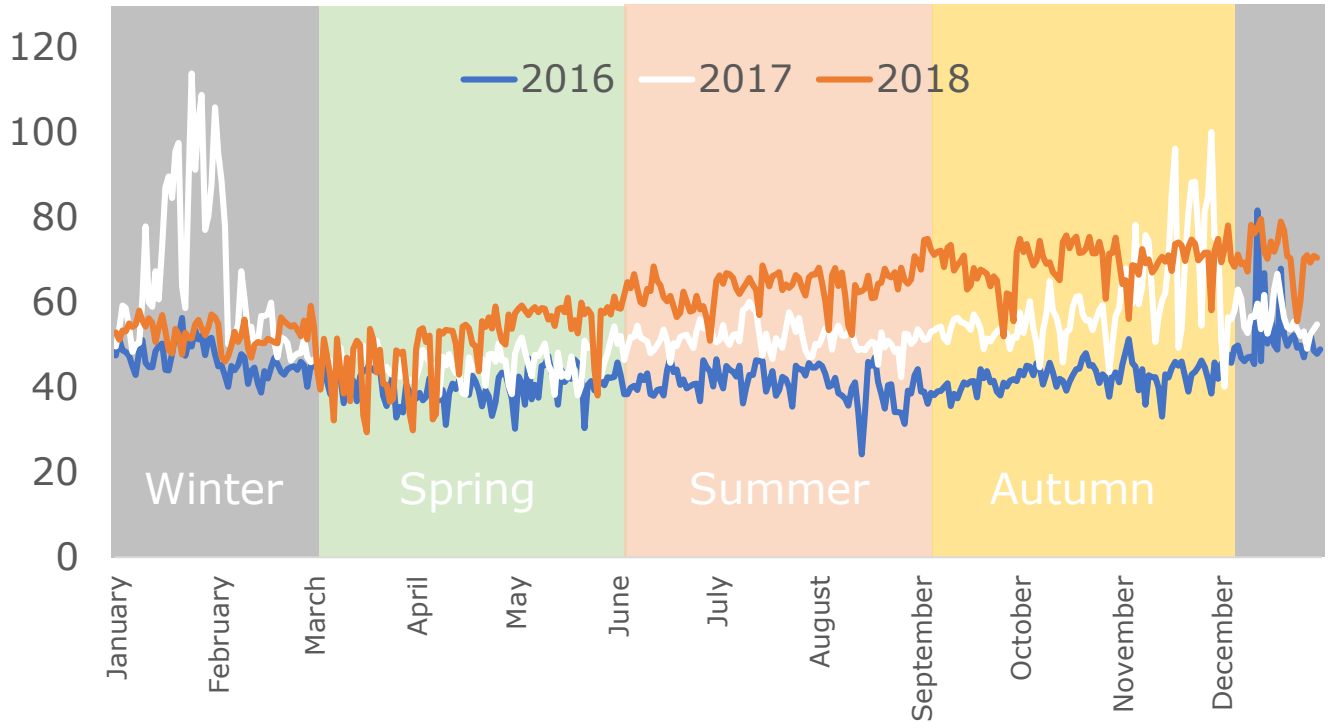
Carbon emission allowances have more than quadrupled from less than 5 euros to approximately 20 euros since the middle of 2017 after European Union governments agreed to cut away a surplus that had depressed prices since the financial crisis that started in 2008. Utilities and industrial polluters need the certificates to cover the greenhouse gas emissions that they produce.

In terms of electricity prices by type of user, historical data reveal that medium size households experience a constant upward trend since 2006, with prices reaching the point of 0,19 euros per kWh. In contrary, prices in medium size industries are relatively stable all over the period at the level of 0,10 euros per kWh. Taxes and levies excluding VAT attribute to 26.43% of the final electricity price, while network cost covers the 21.95% (Appendix provides the map of the Greek electricity network).

The recent European Commission's Report for Energy (2018), showed that markets with sufficient interconnections are more competitive than those that are relatively isolated, such as Greece's and Italy's.

Considering the period 2016 - 2018, there is no apparent trend to justify seasonal volatility in electricity prices of the Greek wholesale market

Seasonal daily system marginal price, (€/MWh), [2016 – 2017- 2018]



Source: HEnEx, HAEE's analysis

Highlights

Aiming to identify the effect of seasonality on prices, the daily system marginal price is plotted over the past three years. In general, there is no clear evidence supporting the seasonality of electricity prices in Greece, since prices seem to fluctuate at constant levels across seasons.

2016 could be broadly characterized by stable low prices, fluctuating between 30 to 60 euros per MWh. 2017 was a year of great discrepancies from the median since both during winter and autumn months, the daily SMP escalated above 100 euros per MWh.

In 2018, prices were higher on average compared to the previous two years but presented lower volatility throughout the seasons.

Compared to the rest of EU members, the average electricity price for households in Greece was 175 euros per MWh and half of this price was attributed for network cost and taxes.

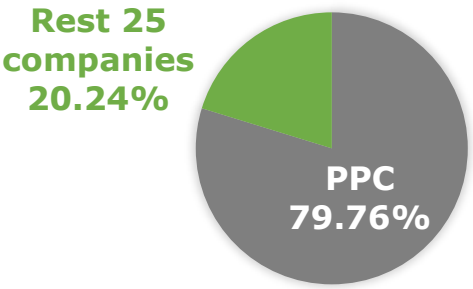
In terms of industrial electricity prices, Greece has one of the highest prices in the EU after Denmark, Italy, Cyprus and Malta. For 2017, the level of this price was 105 euros per MWh with 25% due to network costs and the rest 25% paid for taxes.

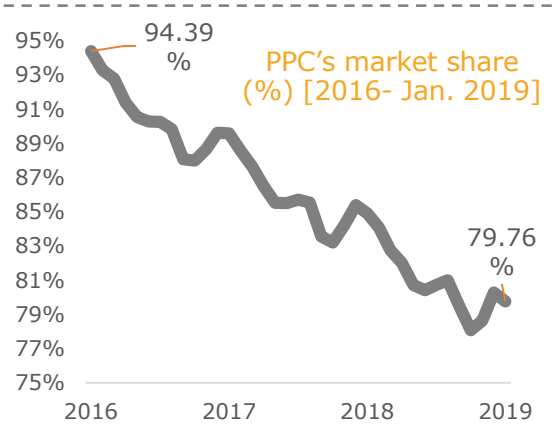
Despite the fact that for competitive reasons most of the EU countries exempt from or face lower electricity taxes and network charges than households, this is not the case in Greece. Lowering electricity taxes from the industrial sector would definitely enhance competition and assist the economic recovery of the country.

In overall, international comparisons continue to show that EU wholesale electricity prices are higher than in the US, Canada or Russia, where power is provided through mostly indigenous hydro and fossil fuels, but lower than China, Japan, Brazil and Turkey.

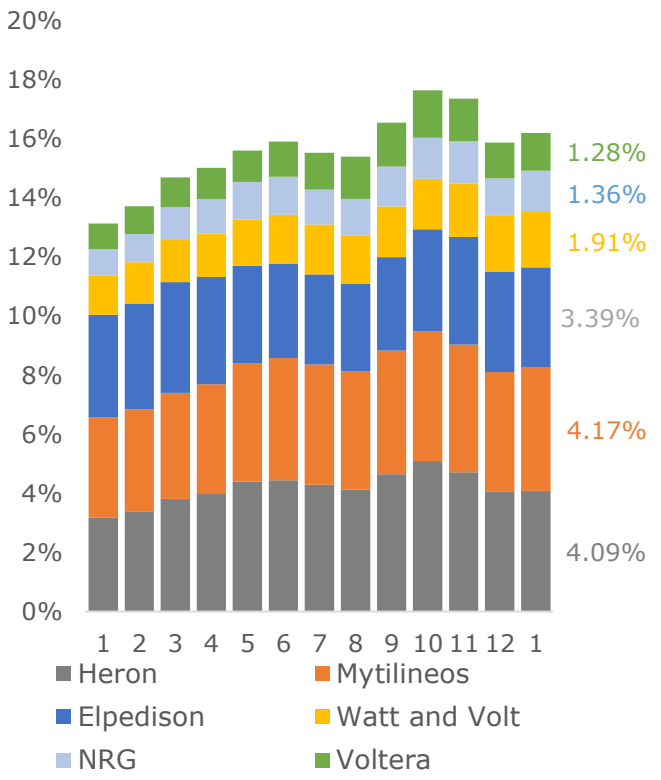
As part of the economic adjustment programme, the share of PPC has to be smoothly reduced to 50% by the end of 2019

Market share (%), [January 2019]





Companies with market share > 1%, [2018 – Jan. 2019]



Source: HEnEx, HAEE's analysis

Highlights

Based on the latest available data, market share in January 2019 was still dominated by PPC at 79.76%. The remaining percentage (20.24%) is shared among the rest 25 active companies, but the majority of this share (80%) is attributed to 6 companies that try to strengthen their position in the retail market.

According to the bailout terms, the introduction of NOME-type auctions, were supposed to serve as the tool to reduce PPC's significant market share. According to this model, PPC is obliged to exclusively sell significant amounts of electricity produced at its lignite-fired and hydropower stations to independent, private-sector competitors through auctions at prices reflecting cost of production.

Under this model, buyers are able to sell these electricity amounts to household and industrial consumers at a discount price, with the objective being to end the monopoly maintained by PPC in the country's two cheapest sources of electricity production (lignite and hydropower).

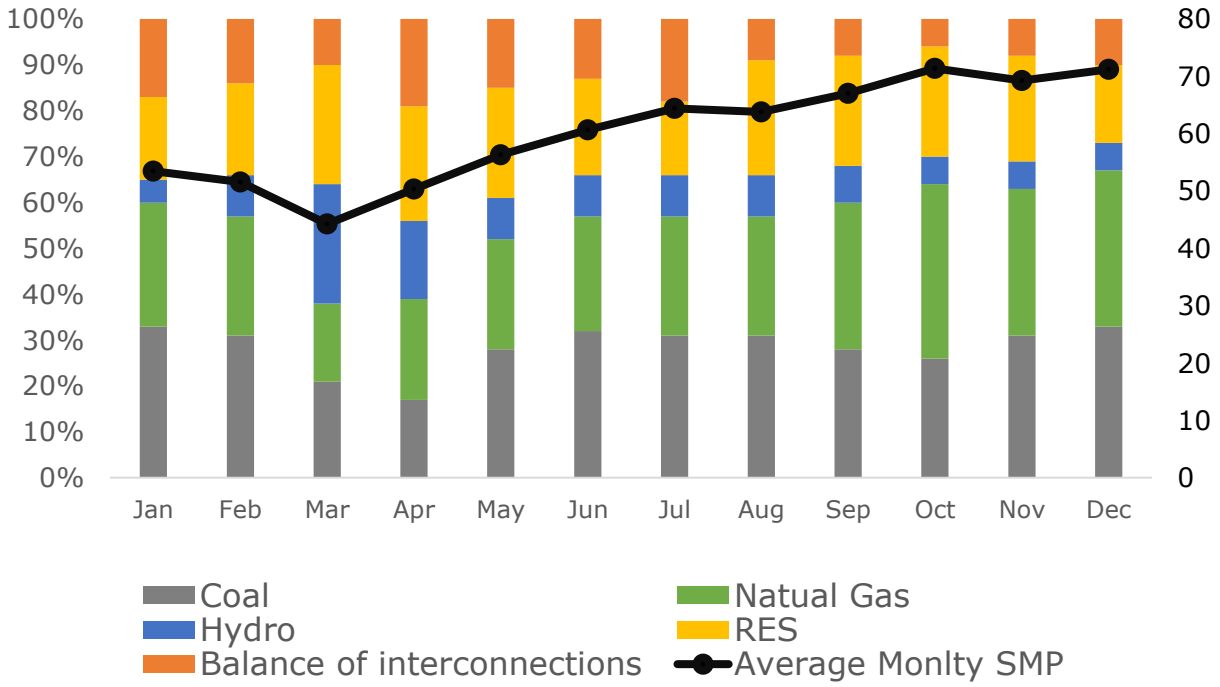
The Regulatory Authority for Energy determines the annual amount of electricity that will be available through auction sales of forward electricity products, while the electricity market operator (HEnEx) conducts the auctions.

In 2016, when the NOME-type model was implemented, PPC's share was 94.39% and the goal was to reach the level of 50% by 2020. After 3 years of implementation, it is reasonable to state that expectations were fairly overestimated since this percentage has only been reduced to 79.76.

In January 2019, the electricity retail market in Greece comprised of six major market players that are mainly generators of gas-fired plants. At the top of the list in terms of market share are: Mytilineos (4.17%), Heron (4.09%), Elpedison (3.39%), Watt and Volt (1.91%), NRG (1.36%) and Voltera (1.28%).

As hydro reservoirs depleted and precipitation decreased during the hot summer, hydro generation decreased and prices increased

Monthly percentage (%) of source of generation that determined SMP (€/MWh), [2018]



Source: ADMIE

Highlights

The wholesale market determines the price at which power suppliers acquire electricity for their retail customers (households and enterprises). Its main parameters are the fuel mix, demand, availability of production units, interconnections with the grids of other markets, and dependence on imports.

The monthly share of different sources of generation that determined the system marginal price reveals that, as dependence on fossil fuels continues to exist, the prices are going to be higher.

This is obvious in the case of Greece, since the increased contribution of hydro and RES during March of 2018, lowered the SMP to 44.28 euros per MWh. When Hydropower lost its previous share (26%) and returned to its ordinary contribution (9%), natural gas and coal reappeared and prices started to rise once again.

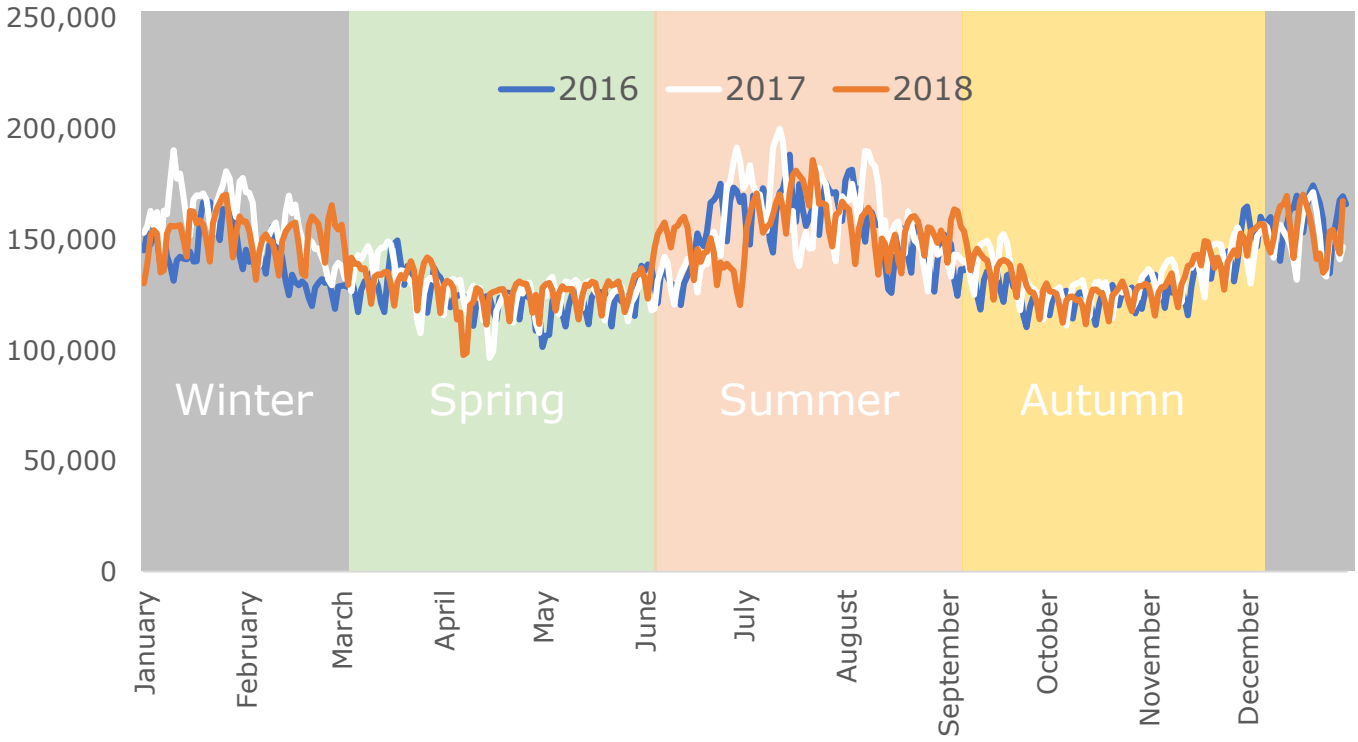
Apart from the composition of the electricity generation mix, the steady increase in prices at the beginning of the summer period was also justified by temperatures being several degrees higher than the long-term daily averages, resulting in increased residential consumption for cooling needs.

The highest prices at the end of the third quarter of 2018 were reported in the United Kingdom at 76 euros per MWh, followed by Spain and Portugal (both 71€/MWh) among interconnected countries. The lowest wholesale prices were reported in Scandinavian countries Sweden, Denmark and Finland, all with prices around 50 EUR/MWh. Still, as a general trend, the average price of electricity for European economies in 2018, follow an upward trend.

Compared to prices in the South-East European region, wholesale baseload prices were the highest in Greece in 2018, at 60 euros per MWh on average, while the average price in Bulgaria was 33 euros per MWh. Finally, average prices for 2018 in Serbia and Croatia were 50 euros per MWh and 55 euros per MWh, respectively.

With the use of smart grids, electricity markets are close to achieve distributed generation with completely integrated network management

Seasonal daily load declarations and losses (MW), [2016 – 2017 - 2018]



Source: HEnEx, HAEE's analysis

Highlights

Typically, electricity demand is higher in the winter and summer than spring and autumn. That is also the case in Greece, since electricity is used both for heating and cooling purposes respectively.

Over the past 5-10 years, electricity grids throughout the world have been going through a period of significant change. Smart grids are changing the way electricity has traditionally been generated, supplied and consumed.

Part of the "smartening" of electricity grid infrastructure, is the collection of large amounts of data that until now did not existed. Smart meters provide such information, which deliver near real time electricity demand for individual residences, as well as other valuable pieces of electrical data such as voltage levels, and power quality.

However, up until recently, energy utilities relied mostly on manual electricity readings, which varied in frequency anywhere between a month and a six-month basis. This is a dramatic shift in the period of collection for domestic electricity consumption.

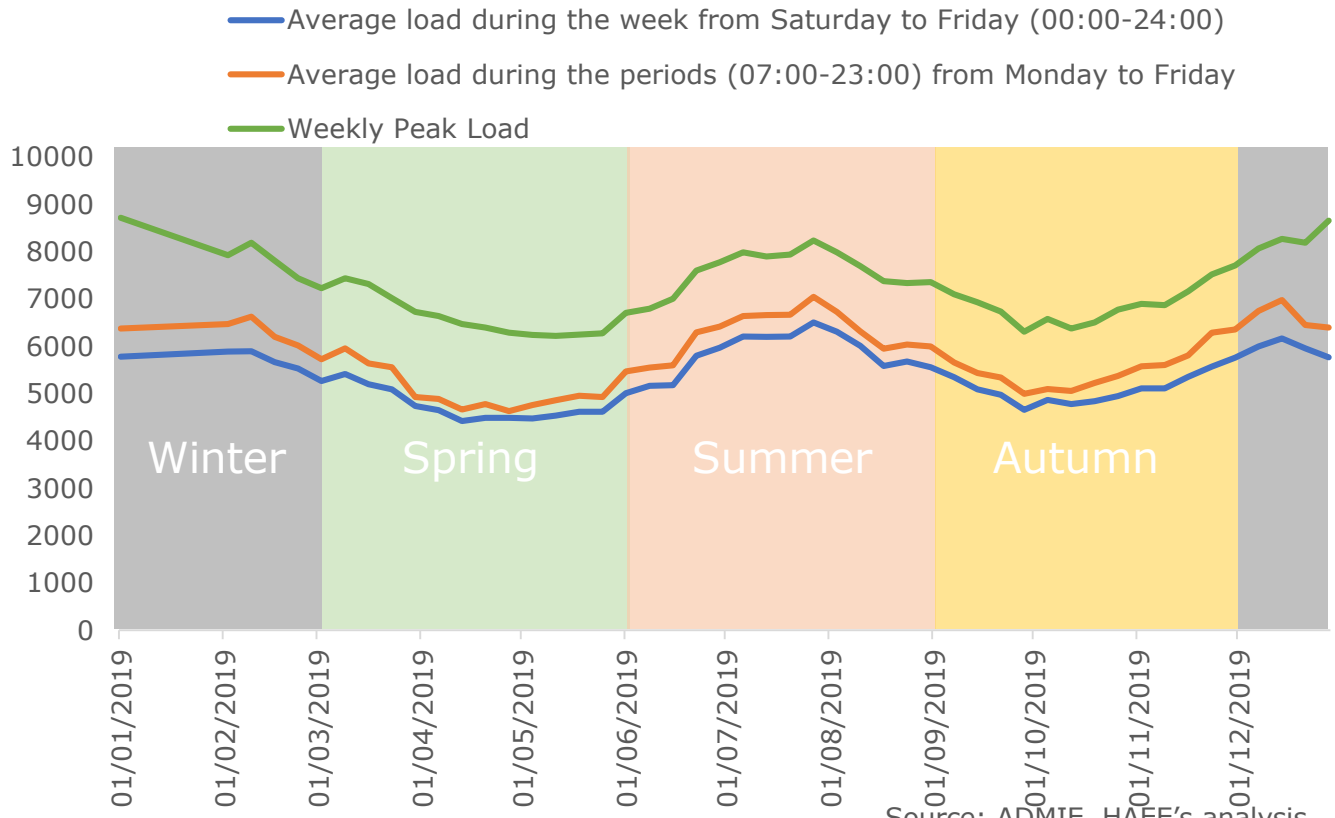
Combining this information with new and existing data sources which describe individual residences and occupant characteristics means that novel approaches to characterizing domestic electricity demand patterns are now possible.

For the case of Greece, HEDNO will suggest and promote the appropriate framework for the development of two pilot smart island projects in two different electrical systems (Tilos and Ikaria).

The pilot projects aim to increase RES penetration while ensuring proper operation and management of their electrical systems, reducing operational cost and supporting environmental protection.

Electric loads tend to follow stable and predictable patterns, giving rise to rather low load forecasting errors in relative terms

Yearly load forecast (MW), [2019]



Source: ADMIE, HAEE's analysis

Highlights

The yearly load provided by ADMIE, separates the load into average load during the weekdays, average load during night hours and finally peak load. The predicted pattern is identical to the load declaration patterns of the recent years.

However, as the penetration of RES increases year by year and with the advent of distributed generation such as rooftop solar PVs, load forecasting takes on a new dimension. In some areas, including Greece, distributed PV installations already make up a significant fraction of the total load.

This generation is connected to the distribution network, behind the meter, and can therefore typically not be directly measured or controlled by the utility or system operator. To schedule and dispatch the resources in the bulk power system, system operators need a forecast of the net load, accounting for the impact of distributed generation.

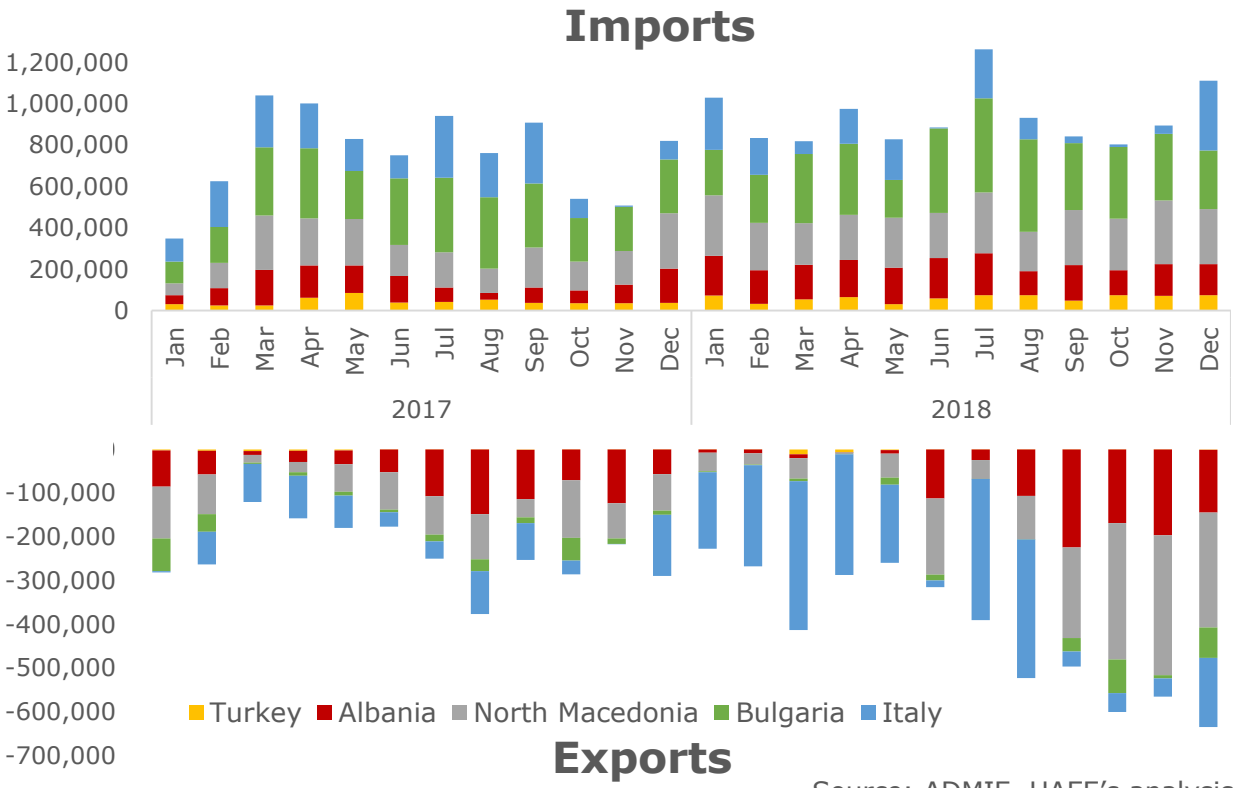
Although the distributed nature of solar PV installations create aggregation effects that reduce forecasting errors, it is still likely that net load forecasts will have larger forecasting errors than traditional forecasts of gross loads, with potential implications for the overall balancing of supply and demand in the grid.

Developing net load forecasts with high accuracy, accompanied by good predictions of the forecast uncertainty, will become of increasing importance as more rooftop PV and other distributed generation sources are added to the power system.

In that context, RES Aggregators, are anticipated to play an important role in eliminating the balancing penalties, since they can act as balancing responsible parties. In order to achieve that, aggregators manage the volumes produced and bought with the volumes sold and consumed. It is straightforward that aggregating more customers improves the relative forecasting performance up to a specific point.

The adequacy of the system is expected to depend significantly on imports, in order for the system to meet adequately the load peaks

Imports and exports with neighboring countries (MWh), [2017-2018]



Source: ADMIE, HAEE's analysis

Highlights

Greece is well connected with neighboring countries and, in addition to domestic power generation, Greece is becoming increasingly active in electricity trade.

Imports are an important source of electricity supply for Greece and this is not a recent phenomenon, but extends in the last fifteen years. During this period, interconnection capacity with neighboring countries has increased significantly.

Electricity imports have increased with new interconnections, although these have large monthly variations. Greece's net electricity imports in 2018 were 8.32 TWh, mainly from Bulgaria (34.72% of total imports), North Macedonia (26.53%), Albania (17.70%), Italy (14.51%) and Turkey (6.55%).

Greece has been a net importer for many years, but also occasionally exports, mainly to Italy (42.84%), North Macedonia (31.96%), Albania (20.25%), Bulgaria (4.51%) and Turkey (0.44%).

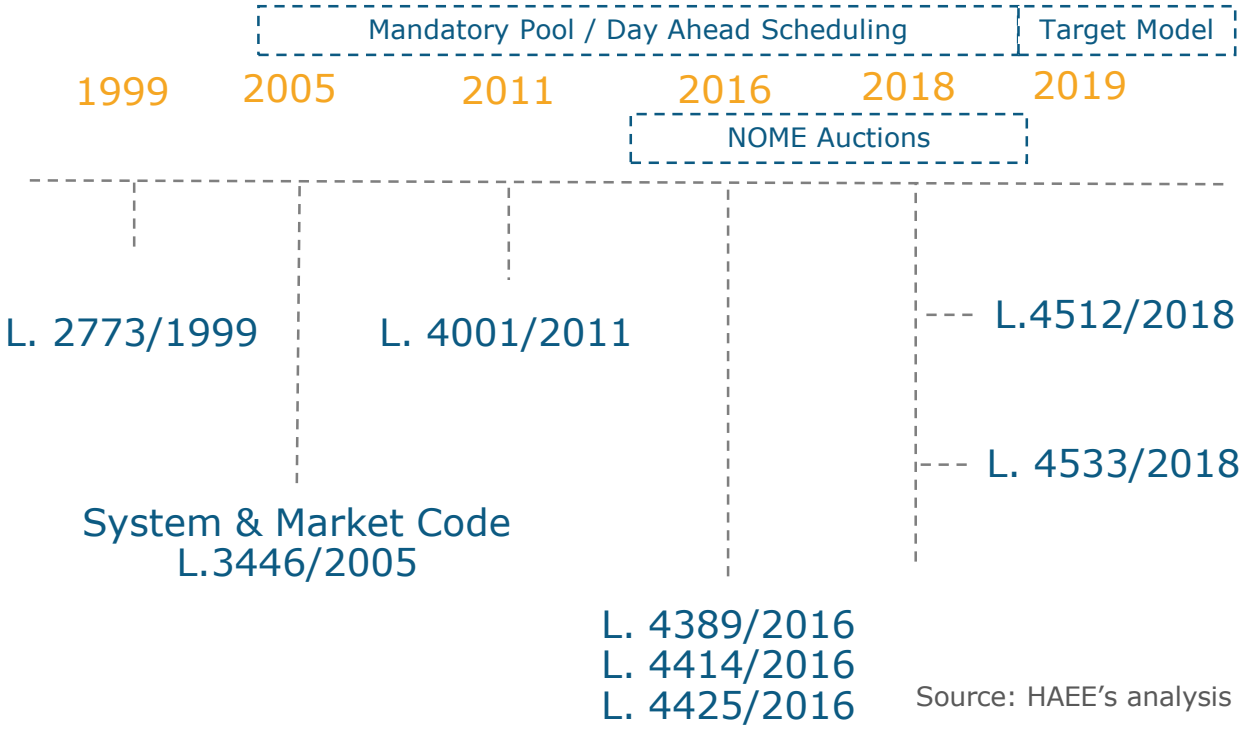
The fluctuations in the volume of electricity imports, can be explained by a number of factors such as the excess of electricity supply in some countries of the Balkan region and the progressively reduced production of lignite fire plants.

It must be noted that especially during the last three years, electricity imports are being carried out mainly for competitive reasons since the price of imported energy is lower than the generation cost of domestic natural gas plants.

However, irrespectively of price-competitiveness reasons, electricity imports in Greece are expected to increase significantly in the next years due to inefficiencies in national electricity production capacities. The two main reasons supporting this argument is the scheduled decommissioning of two old lignite-fired units and the constantly increasing penetration of RES in the system.

Greece's electricity market legislative framework could be characterized as strongly governed by law and regulation

Electricity market legislative framework



Source: HAEE's analysis

Highlights

Law 2773/1999 set the basis for the liberalization of the Greek electricity market and regulated some key points of the national energy policy.

It also introduced the Regulatory Authority of Energy (RAE) with the objective of monitoring and controlling the electricity market. Law 3426/2005 introduced some additions into Law 2773/1999 that accelerated the electricity market liberalization process.

In 2011, the Greek government introduced a comprehensive new legislation in order to transpose the 3rd EU directive into national law and reform the electricity sector. The 3rd Package creates a new regulatory framework to assist the Internal Market for Electricity (IME) and it is legally binding for markets to couple (EU Regulation 714/2009).

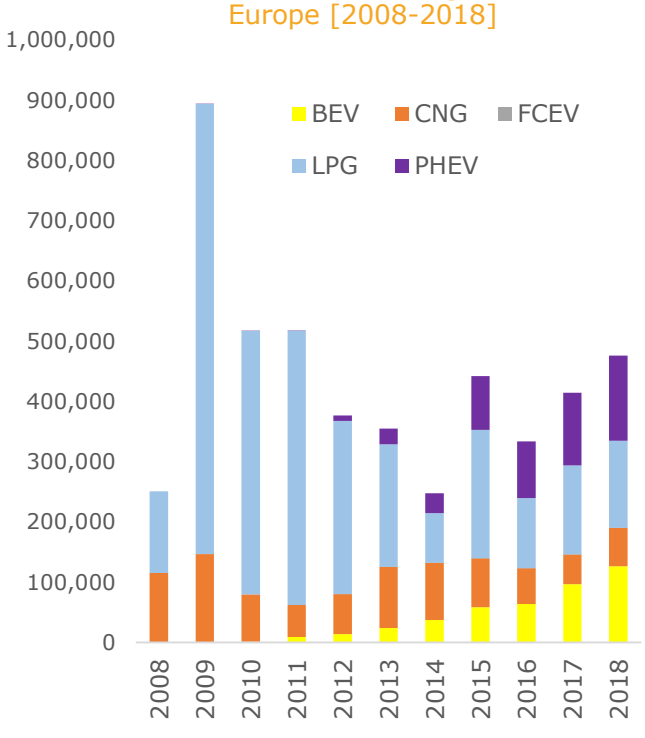
The tools towards the completion of IEM are the following: (i) Undulling, which has already occurred in the Greek electricity market (ii) Third Party Access, which again holds in Greece (iii) Network Codes, that are currently under implementation (iv) Incentives for new infrastructure that are anticipated to increase in the next year and finally the implementation of ACER and ENTSO-E directions and guidelines.

Law 4001/2011 is the foundation of the modern Greek electricity market as it introduced the move from the Independent System Operator model to the Independent Transmission Operator (ITO) model. Moreover, this Law strengthened the energy regulator (RAE), by granting it financial autonomy and a distinct legal personality.

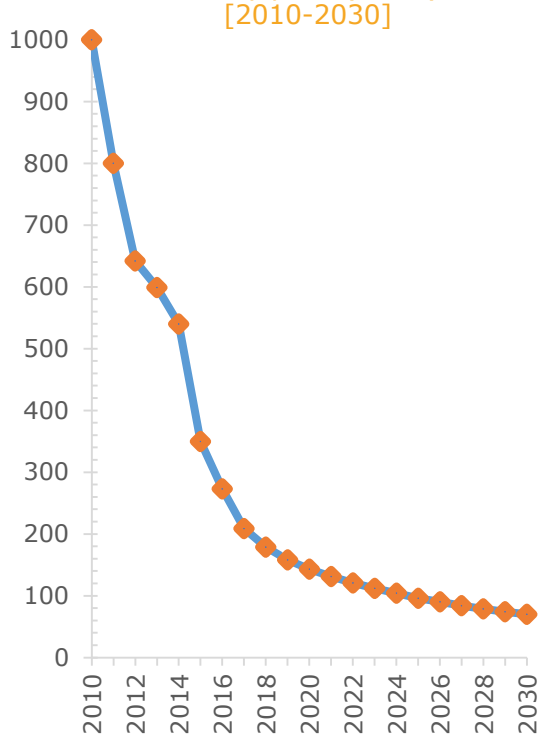
Some additional key provisions of this legislation are: Law 4425/2016, which further strengthens the financial and operational independence of RAE and Laws 4336/2015, 4389/2016 and 4393/2016, which provide the framework for undertaking NOME auctions to enhance market competition and the privatization of the ITO.

Eco-mobility is still at infant stage in Greece, however, over the next decade it is anticipated to gain growing importance

Alternative fuel vehicle registrations in Europe [2008-2018]



Battery price ($/KW), [2010-2030]



Source: Alternative Fuel Observatory, BNEF, HAEE's analysis

Highlights

Incentives in Greece need to be reconsidered and enhanced and follow the approach of countries like Norway and the Netherlands, that have been very successful in terms of eco-mobility penetration in their transportation systems. The following table gives a complete comparative picture of the various fiscal and non-fiscal incentives towards Eco-mobility for all EU countries. As Greece's renewable energy potential is very high, a coordinated shift in the area of e-mobility could facilitate an increase in the use of renewable energy in the system, especially given the sharp decline of battery cost over the past decade. Currently, electric vehicle buyers in Greece benefited only from registration, circulation and luxury tax exemptions.

To achieve higher and quicker penetration, measurable purchase incentives must be in place, considering the lower GDP per capita level of the Greek economy. These incentives should also be directed towards special user groups like Taxi services and public fleet replacement programs. Tax benefits such as higher yearly depreciation rates, lower VAT rates and exemption of vehicle recharging expenses from company tax need to be adopted. Subsidies for private charging installation should also be introduced.

The adoption of dedicated electric vehicle parking positions could also provide incentives in crowded city centers. For the public charging network, there will need to be a well-designed business plan, which must be accompanied with the simplification of the necessary regulatory decisions reducing and specifically defining the bureaucratic procedures. A coordinated transition plan can also be financially supported by several European Union programs, and could even state a formal declaration of completely forbidding the sale of fossil fueled cars at some point in the future. All these challenges should be addressed in a coordinated fashion and provide a road-map for this transition. In this role, sustainable urban mobility plans (SUMPs) could provide a holistic view on the development of all transport modes and offer policies and long-term strategies.

The promotion of both fiscal and non-fiscal incentives in Greece will lead to a sharp increase in the share of electrical vehicles

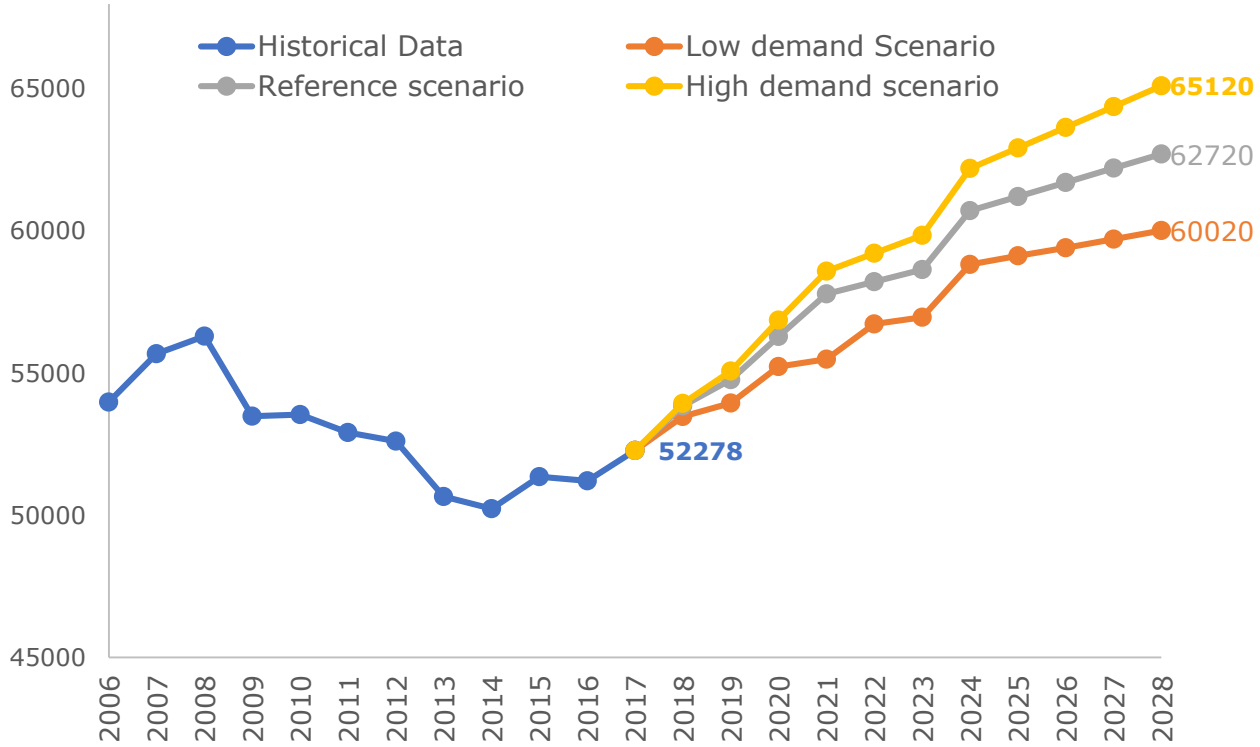
Fiscal and non-fiscal incentives towards Eco-mobility for all EU countries

Country	Purchase incentive or subsidies	Tax benefits and exemptions	Other Benefits (i.e. free parking)	Infrastructure promotion measures	Traffic Regulations (i.e. bus lanes, low emission zones)
Austria	•	•	•		
Belgium	•	•			
Bulgaria	•				
Croatia		•			
Cyprus		•			
Czech Republic		•			
Denmark		•		•	
Finland	•	•			
France	•	•	•	•	
Germany	•	•	•	•	•
Greece		•			
Hungary		•	•		•
Iceland	•	•	•	•	
Ireland	•	•	•	•	
Italy		•		•	
Latvia		•	•		•
Lithuania		•	•		•
Luxembourg		•			
Malta	•	•			
Netherlands		•			
Norway	•	•	•	•	•
Portugal	•	•	•		
Slovakia	•	•			
Spain	•	•	•		•
Sweden	•	•		•	•
Switzerland	•	•			
United Kingdom	•	•	•	•	•

Source: European Fuel Observatory, HAEE's analysis

Regulators need to understand the changes underway and seek new solutions and market designs that can support the transition of electricity market

Forecast of total annual demand for electricity (GWh), [2006-2028]



Source: ADMIE, HAEE's analysis

Highlights

According to ADMIE's projections, demand for electricity during the upcoming years will increase in all different scenarios. This sharp rise, is mainly attributed to the general recovery of the Greek economy that is anticipated to boost electricity consumption, as well.

In order to sufficiently face this upward trend, there are many challenges that need to be considered, since the market is in transition towards a more competitive structure. The previously strictly regulated framework, in which PPC handled all or most of the activities (generation, transmission and retail), is obsolete.

In this context, according to HAAE's estimations, the only financially viable lignite-fired unit that is going to be operational after 2025 is that of Ptolemaida V [660MW] - (considering the necessary investment depreciation and its higher operational efficiency), given that the remaining lignite units will either fail to maintain operational licenses from the EU and/or forced to shut down due to the unbearably high costs of operation due to the increased price levels of CO2 emission allowances.

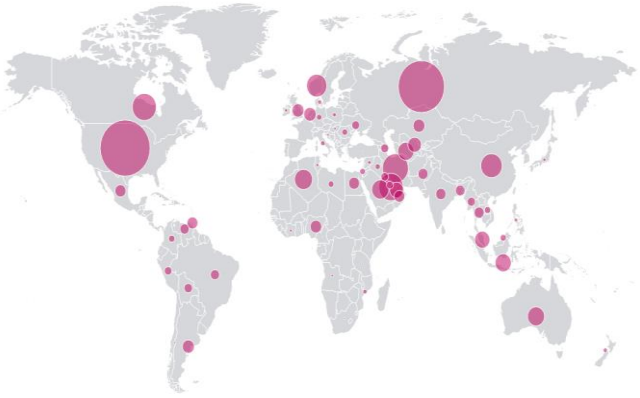
The road towards the Target Model requires rapid changes of market structure within a relatively short time frame, since authorities need to re-organize the wholesale electricity market and tackle any existing flaws. The establishment of Hellenic Energy Exchange, along with the Energy Clearing House will definitely bring significant changes in the market.

Participants need to be prepared for this unknown framework and take advantage of any available tools and products in order to efficiently manage their risk. Despite the fact that the level of competition in retail market is relatively low, significant changes are currently occurring. For instance, the liberalization of non interconnected islands, the imminent coupling with Italy and Bulgaria, the sale of PPC's lignite plants, the new FiP RES supporting scheme, the issue of NOME and the existence of flexible units are only some of the numerous factors affecting the liberalization of the market.

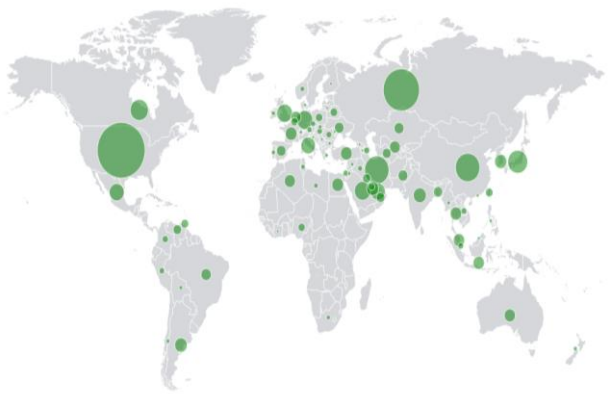
4. Natural Gas

Natural Gas reserves are abundant worldwide and can support the energy transition to a low carbon economy

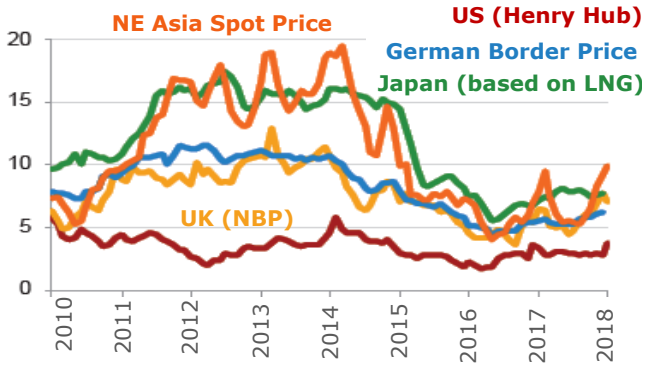
Global natural gas production [2018]



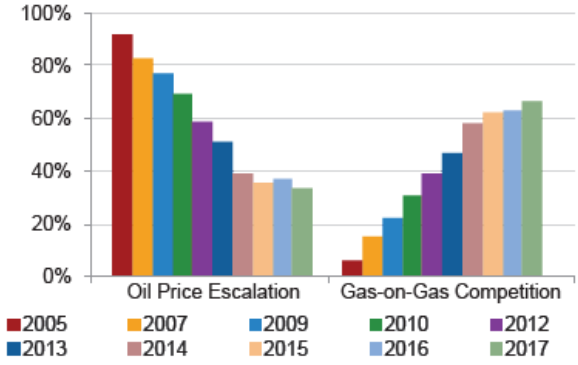
Global natural gas consumption [2018]



Monthly average regional gas prices ($/mmBtu), [2010–2018]



European import price formation (% of price formation mechanism) [2005-2017]



Source: IEA,IGU

Highlights

Natural Gas is a low emission fossil fuel which is produced in abundance through reserves around the world. Due to its low carbon emissions, natural gas is identified strategically as the transition fuel to a low carbon economy.

Its specific characteristics in power production such as the fast ramp up times are placing it as the most appropriate fuel for supporting the development of RES technology.

New technologies have made Natural Gas a globalized commodity. The LNG Market liquidity is rising, allowing the pipeline-free transfer of natural gas to practically all potential consumers around the world. Geographical restrictions on supply as well as dependence on transit countries or source countries are becoming of lower importance.

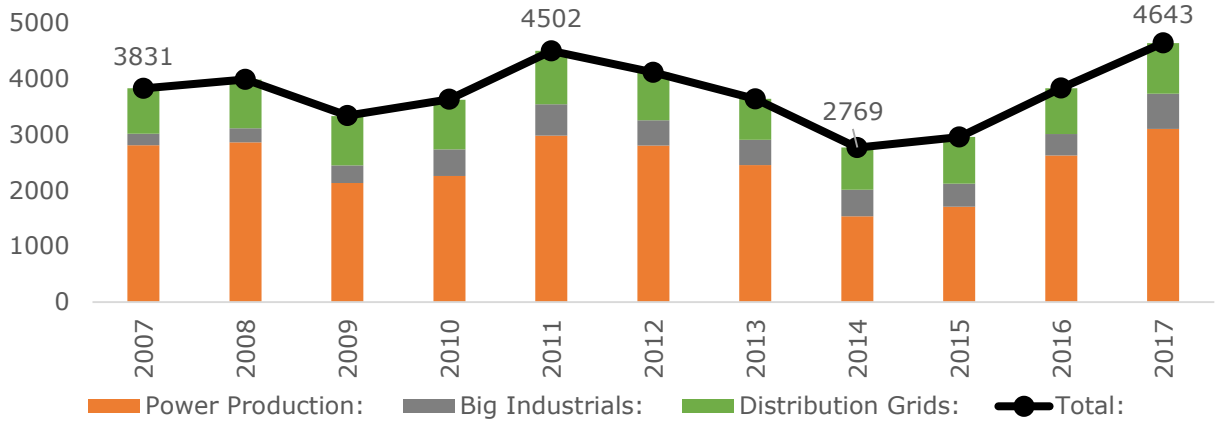
Global Natural Gas indexed-pricing is gaining ground over oil-linked pricing, allowing natural gas to become a commoditized product with its own market dynamics. Storage Capacity through LNG terminals, as well as the variety of sources – suppliers are enhancing the security of supply.

LNG technology is enhancing the security of supply and allows the oil de-linkage of Natural Gas Prices. European Directives and energy policy are perceiving natural gas as a transition fuel.

Moreover, EU is planning to introduce renewable natural gas into the existing pipeline system, through biogas and Sync Gas, envisaging zero-carbon footprint for the future. In addition to the zero-carbon renewable gas, Europe is expecting to enhance the security of supply as the dependence to sources outside EU will be limited.

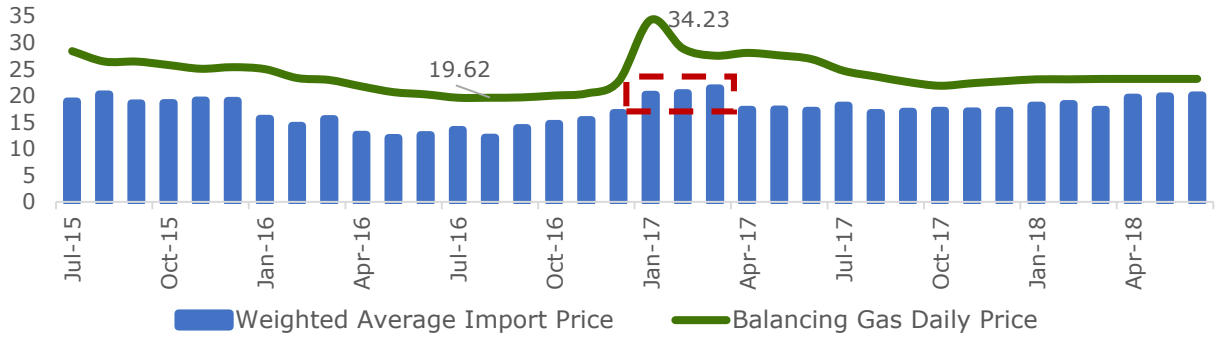
Greek natural gas market is rising again after a steep drop during the economic crisis, being transformed to a fully liberalized market

Natural gas consumption in Greece (mil. Nm3), [2007-2017]



Source: DESFA

Natural gas Prices in Greece (€/MWh), [2015-2018]



Source: RAE

Highlights

The Greek natural gas market has been fully liberalized since 2018, being transformed from a three retail-players market* to a multi-players market. This applies to the retail market as the B2B market has opened earlier. The B2B market (big industrials & big commercials) used to be served mainly by DEPA, being nowadays severely penetrated by independent energy companies. The consumption within the Greek market is rising since 2014 after a steep drop during the first years of the economic crisis. It is estimated to reach 5 bcm during 2019 and 5.5 bcm until 2025.

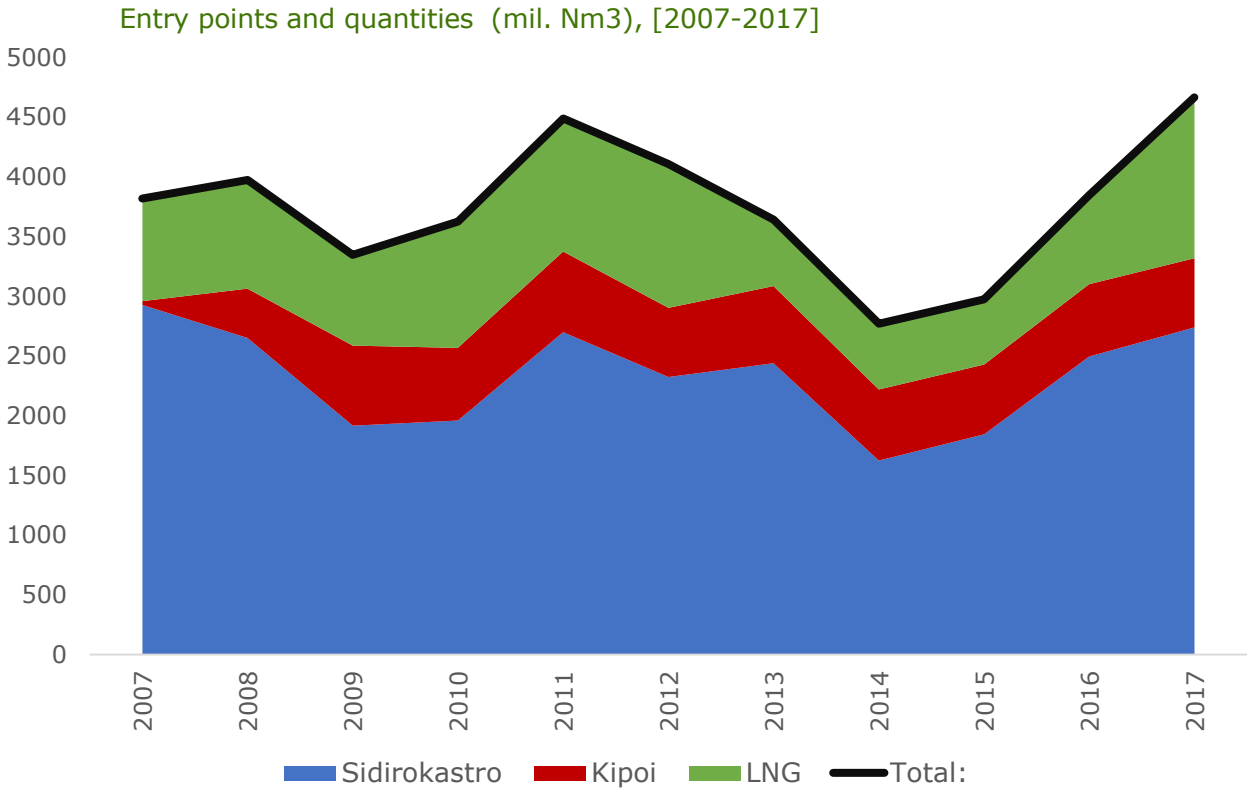
The biggest amount of the new quantities will come from the rising production of natural gas-fired power plants, due to the projected lower penetration of the lignite into the power system. There is a strong interest by 3 energy companies for the construction of new capacity of gas-fired power plants. It is estimated that the additional capacity that the system needs for gas-fired power plants, reaches 1,300 MW.

The majority of the quantities are consumed by power producers. Natural gas-fired power production consumes about 66% of the total gas demand. Retail Market (DSO's areas) consists almost 20% of the market, while the big industrials consume the remaining 14%. With the expansion of the pipeline network as well as the adoption of technologies (CNG/LNG) for the supply of remote areas and customers, the B2B and Retail Market will grow.

The Prices of Natural Gas are susceptible to the market peaks. An example is the first months of 2017 where, natural gas demand reached great peaks, affecting the prices within the domestic Market.

Note*: The Greek natural gas retail market was consisted of 3 players until 2018. The 3 EPAs in the regions of Thessaloniki, Thessalia and Attiki, were both DSOs and retailers having the monopoly of the retail market.

Natural gas entry points are expected to increase and get upgraded facilitating bi-directional flow of natural gas with neighboring countries



Source: DESFA

Highlights

There are three entry points from which natural gas is flowing to Greece. The main entry point is Sidirokastro, at the borders with Bulgaria which brings mainly contracted quantities from Russia through the Ukrainian territory.

The quantities flowing through Sidirokastro are almost 60% of the imported natural gas. Since 2017, the available capacity is auctioned, complying with the EU regulations for cross-border trading, allowing more market players to participate and literally giving space for market liberalization.

At the borders with Turkey lies another entry point at Kipoi. This point represents 12% of the imported Natural Gas, expected to be upgraded for importing larger quantities and having a bi-directional flow. This will allow the activation of other companies (other than DEPA) in the cross-border trading between Greece and Turkey when agreement between EU and Turkey takes place for the allocation of the pipeline capacity.

There is only one agreement in place between BOTAS and DEPA for contracted quantities and until 2018 there was no other agreement of any other company with BOTAS. It is expected that this point will also open for capacity auctions allowing other players to import through the Greek-Turkish borders.

The 3rd entry point is the only LNG Terminal that exists in Greece, in the island of Revithousa near Pireaus. It represents 29% of the imported quantities and it is expected to rise its contribution in the near future.

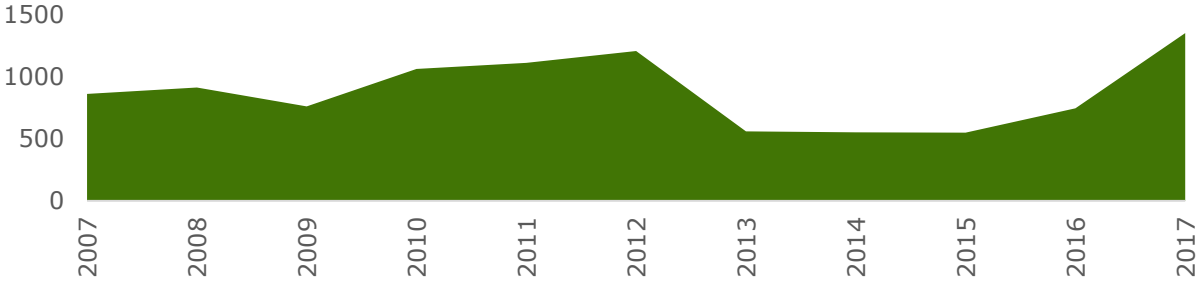
Many players are taking advantage of the recent upgrading of the terminal, allowing both bigger ships to unload and bigger storage capacity. Revithousa terminal is of the greatest importance for the safety of supply to the system as currently it is the only storage facility that exists in Greece.

Existing LNG terminal and future infrastructure will transform Greece to a natural gas hub, increasing the importance of the country in terms of security of supply

Route of Trans Adriatic Pipeline (TAP)

Source: TAP

LNG market in Greece (mil. Nm3), [2007-2018]



Source: DESFA

Highlights

TAP pipeline will be delivered on 2020, bringing natural gas quantities from the Caspian Sea to Europe. Its capacity within the European ground will be 10 bcma. Its operation will enhance the security of supply in the region of Balkans. At the end of February 2019, 87.5% of the pipeline has been installed.

Revithousa LNG terminal expansion will allow the unloading of 260k m^2 ships, reaching an annual capacity of 7bcma. It will increase the LNG storage capacity of Greece. Together with the planned Under Ground Storage in Kavala, which will consist the first and only natural gas storage facility*, they will increase the security of supply in the Greek region.

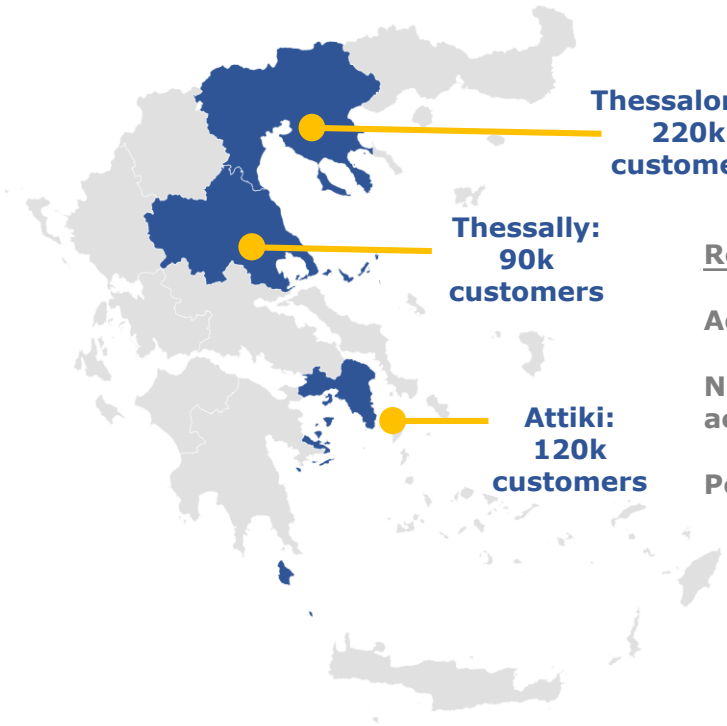
FSRU Alexandroupolis is planned to be constructed in late 2021, having a capacity of 5.5 bcma, planned to be connected with the IGB interconnector, allowing Bulgaria and the rest of Balkans to have access to sources from all over the world enhancing security of supply and reducing the dependence of these countries from the Russian natural gas. The first non binding market test for capacity booking successfully took place in December 2018. The second binding market test is expected to take place during the summer of 2019.

IGB interconnector is going to connect Bulgarian natural gas system with the Greek natural gas system, the TAP pipeline and the FSRU Alexandroupolis. Its capacity will initially be 3 bcma, being able to be upgraded to 5bcma with the installation of a compression station. It is expected to be completed at the end of 2020. Greece will be a transit country for a capacity of more than 22bcma, without including potential future projects such as East Med. The creation of an Energy Exchange along with the abundance of gas quantities passing through Greece, are ensuring higher liquidity.

Note*: Under Ground Storage is also planned at the region of Kavala, where depleted gas fields, can allow the storage of 1bcm. UGS Kavala is a project handled by HRADF and has been already included in the PCI list adopted on 17 October 2017 by the European Commission and the Member States.

Retail market exists mainly in the regions of Thessaloniki, Thessaly and Attiki, yet there is an ambitious plan for expansion of the market through new grid construction and use of CNG/LNG technologies for remote areas

Active customers in the three regions of EDAs, [2018]



Region	Attiki	Thess	Total
Active Customer	120k	310k	430k
Non-users with access	585k	232k	817k
Penetration	36%	54%	43%

Source: EDA Attiki, EDA Thessaly & EDA Thessaloniki, HAEE's analysis

Highlights

There are 3 regions in which natural gas market exists. 2 DSOs are the operators of these three regions. EDA Attikis is in the region of Attiki and EDA THESS is in the regions of Thessally and Thessaloniki. These 2 DSO's have come up after the unbundling of the previous 3 EPA's being both the DSO's and the retailers of the market. Following the opening of the market, the 3 EPAs unbundled to 2 EDA's (DSOs) and 2 retail companies.

The penetration rate in the regions of EDA THESS reached 54% while in Attiki it has reached only 36%. In the EDA THESS regions (Thessaloniki & Thessaly), autonomous heating is dominant, compared to Attiki where, central heating comprises an important share of the existing connections.

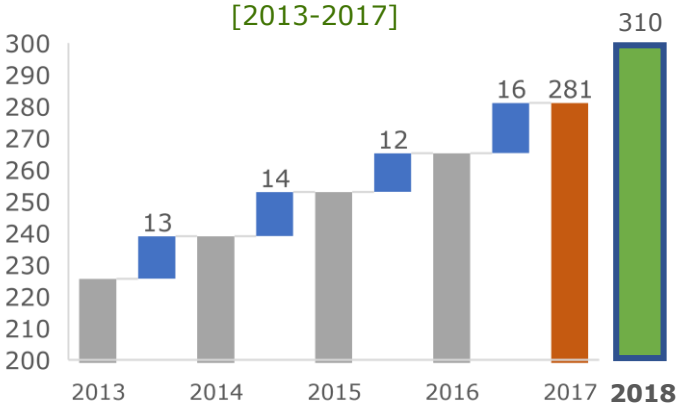
Attiki Region is estimated to have 120k customers (connections), Thessaly 90k customers and Thessaloniki 220k customers. Both DSOs of these 3 regions have announced a 5-year expansion plan which is envisaged to allow the grow of the market. Moreover, they have launched a promotional campaign for new connections, in which the connections cost (related with the DSOs) are not born by the customers.

The rest of Greece regions are under the DEDA DSO. In these regions retail market is still almost non existent. The 5-year plan of the DSO has an ambitious target for grid expansion mainly in the regions of east Macedonia and Thrace.

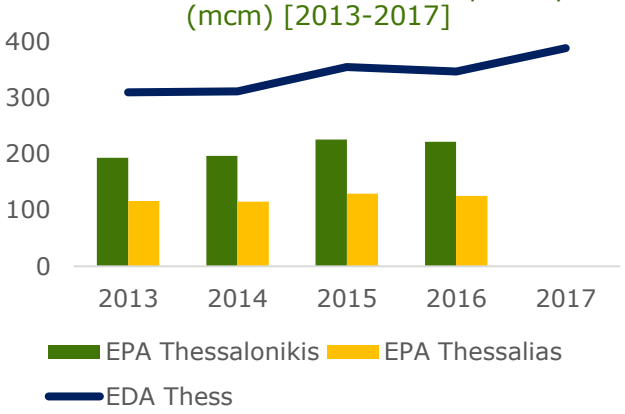
The regions of West Macedonia, west Greece and Peloponnese of the continental ground do not have any grid infrastructure. For many of these areas, there are plans for grid expansion either through the construction of medium and low-pressure pipelines or through the use of CNG / LNG through virtual pipelines. To all 3 DSOs, DEPA is the majority shareholder, a fact that is planned to change in the near future. DEPA owns 51% of EDA THESS, with the rest 49% belonging to ENI. In EDA Attiki, DEPA is the sole shareholder, after the acquisition of 49% by Shell.

The area of Thessaloniki and Thessaly are under "EDA THESS" DSO, being the first areas to have been provided with natural gas

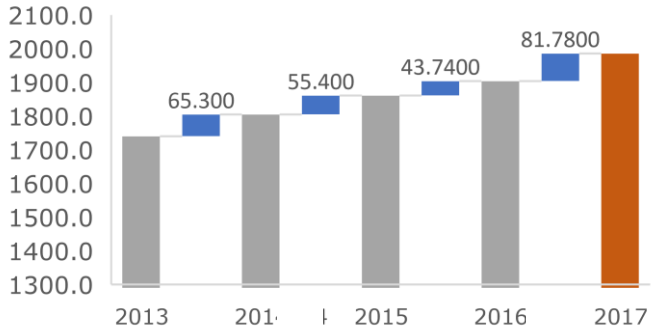
EDA Thess – Number of customers [2013-2017]



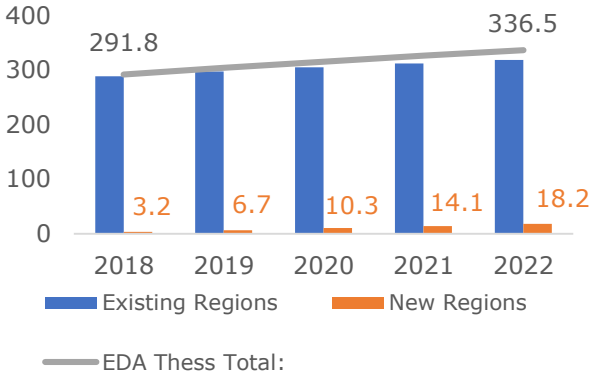
EDA Thess - Total distributed quantity (mcm) [2013-2017]



EDA Thess - 4 Bar grid construction (km), [2013-2017]



Active customers. [2018-2022]



Source: EDA Thess, HAEE analysis

Highlights

The region of EDA THESS (Thessaloniki and Thessally) is the one with the biggest penetration rate and the most active customers. The region includes 12 municipalities in the Prefecture of Thessaloniki and 7 municipalities in the region of Thessaly.

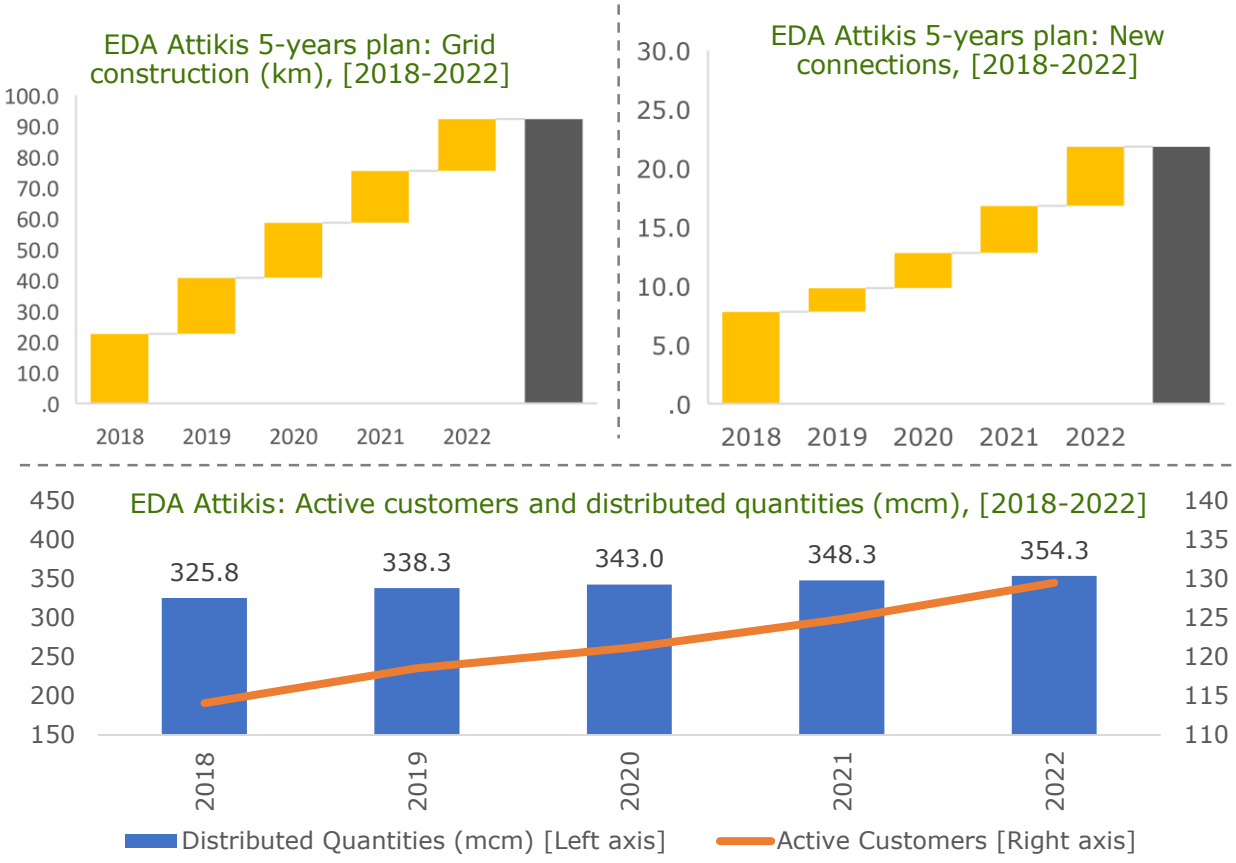
EDA THESS's 5-year plan for the period of 2018 – 2022 has been approved by RAE. The expansion of the grid includes also the supply of regions outside the medium pressure pipeline system, through CNG technology. There are 3 compression stations operating currently. One is in the industrial zone of Sindos, one is operating in Larissa and one in Trikala in the region of Thessaly. It is planned that through CNG, 5 new areas will be supplied with natural gas in the region of Thessaloniki and 10 new areas in the region of Thessaly.

Virtual Pipeline has already been established in the regions of Thessaloniki and Thessally. Regulation allows retail customers of these regions to have access to natural gas on an equal economic basis, as the costs of virtual pipeline is dispersed to all active users. This is ensuring the satisfactory penetration rate for these areas as natural gas is affordable and competitive compared to the other fuels used so far.

The 5-year plan of EDA THESS is designing a grid expansion of 370km (205km in Thessaloniki and 105km in Thessaly) until 2022, reaching a final number of customers of almost 360k. This is translated to a 25% customer base expansion. The distributed quantities at the end of 2022 are estimated to reach 427 mcm compared to 377 mcm at the end of 2018.

The cost of the total investment of the expansion of the Network is estimated at 95.6 million euros, which are intended for investments in Distribution Networks (4-bar, 19-bar, reduction stations, decompressors CNG, other additional investments in the Network) and investments related to new connections (service lines, gas points, cash installation).

The area of Attiki is under "EDA Attiki" DSO, being the area with the lowest penetration rate and therefore with the greatest dynamic for market expansion



Source: EDA Attikis, HAEE analysis

Highlights

Natural gas import and trading in Greece was initially introduced by Law 2364/1995. In order to comply with the European instructions and regulations, Law 3428/2005,concerning the liberalization of natural gas market, was enacted.

Since January 2017, EDA Attikis operates as the operator of the natural gas distribution network in Attica, under the provisions of L.4001/2011 considering the operation of the gas market.

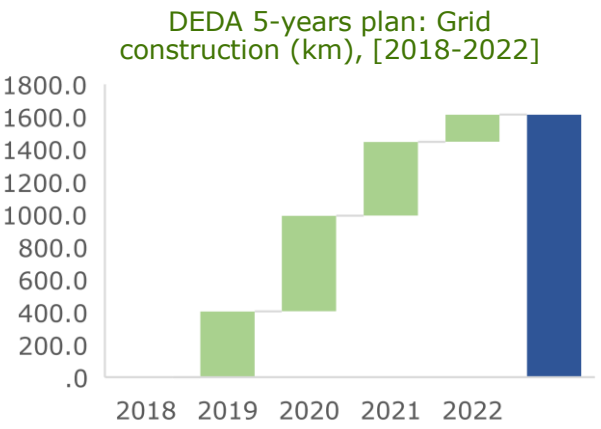
According to the new legal framework, the environment of the retail gas market was reshaped, and the distribution and trading activities, as they were applied until recently by the DEPA, were separated and created two autonomous administrative and operating companies.

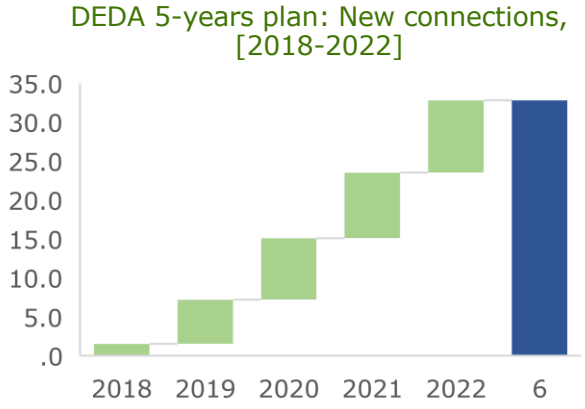
The areas of Attiki covered by the existing distribution network include 52 municipalities in the Prefecture of Attiki. The existing distribution network covers around 55% of the road network with buildings in the areas of Attiki where there is the basic infrastructure (medium pressure network) for further network development.

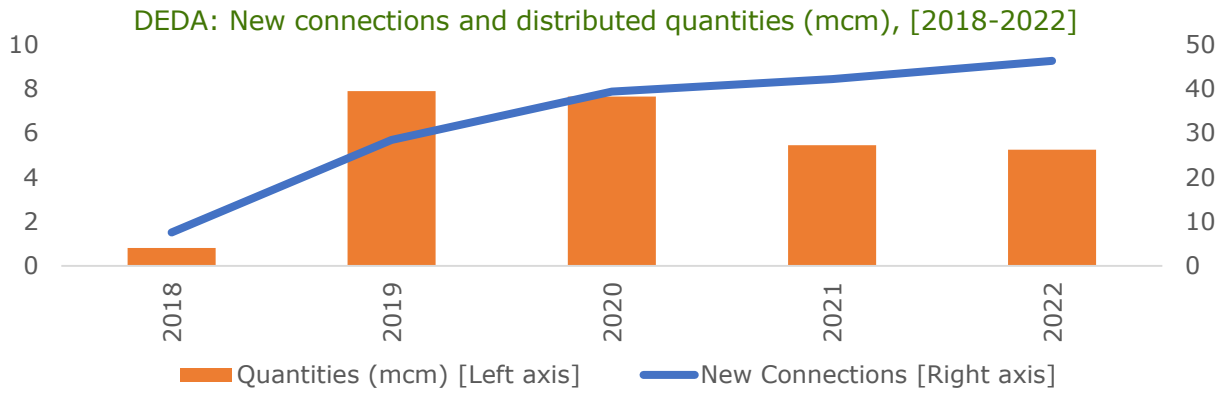
EDA Attiki is planning to construct 92km of pipelines until 2022, adding an additional number of 22k customers, which is a 20% market expansion. The penetration rate of natural gas in the region of Attiki is low, reaching only 33%. The potential of the retail market seems to be greater as the grid length reaches according to HAEE's estimations a market of more than 500k users.

The main goal of the 5-year plan is mainly focusing on the "densification" of connections on the existing gas network. In this way, an increase in the utilization of the distribution network is envisaged to be achieved. The distributed quantities in the end of 2022, are expected to reach more than 354 mcm compared to 326 mcm in 2018. The planned investment cost is estimated to reach € 20 millions.

"DEDA" is the DSO for the rest of Greece. Retail market is almost non existent and the Grid expansion plan is the most ambitious of all







Source: DEDA, HAEE's analysis

Highlights

DEDA is the DSO of the regions of the rest of Greece. Rest of Greece can be considered as all the regions except the 3 regions of the other two DSOs. So far, the retail market on these regions is almost zero, having mainly industrial customers.

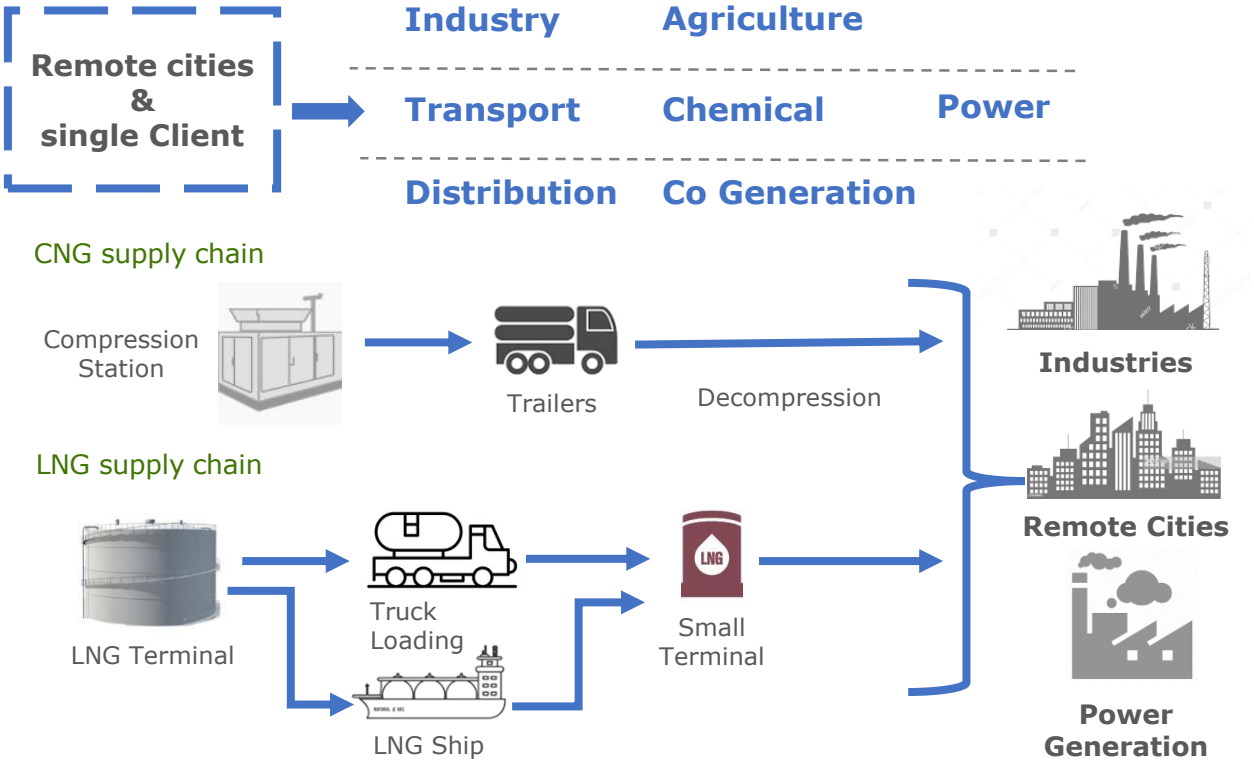
DEDA has designed the most ambitious 5-year plan until 2022, compared to the other two DSOs. This is reasonable as the areas of DEDA do not have developed grid. The funds required for the construction of the distribution infrastructure are approximately estimated to be 50% from the ESPA 2014-2020 (Partnership Agreement for the Development Framework) through the Regional Operational Programs (ROPs) of the respective regions, 35% by borrowing from international credit institutions and the remaining 15% from equity funds.

DEDA is planning to construct 1600km of pipelines in continental Greece and the islands, planning to reach 33k new customers until 2022. Eastern Greece & Thrace with a new grid of 493km, Central Macedonia with 336km, Eastern Macedonia with 237km and Western Greece with 150km, are the areas with the biggest planned grid construction.The investment plan will be accomplished in two construction periods . The first concerns the expansion and construction of a network in 18 cities of the three regions of Central Greece, Central Macedonia and Eastern Macedonia and Thrace. The second expansion of the distribution network will be in the regions of Western Greece and Western Macedonia. In certain areas where the network expansion is not economically viable, the supply of Natural Gas will be achieved through LNG and CNG.

Out of the 33k new connections, 29k will come from these four regions. Common fact for all four regions is that they have a significant per capita consumption due to the climate conditions, and for the 3 of them, high pressure pipeline system is either existent or planned to be constructed. The expected quantities to be delivered on 2022 are estimated to be 135mcm.

CNG & LNG technologies can offer reliable solutions to remote areas in which pipeline construction is costly, and at the same time are considered as ideal technologies for the expansion of the market to the islands

CNG/LNG potential market



Source: HAEE's analysis

Highlights

Greece specific geographic characteristics have hindered the expansion of the pipeline grid to certain remote areas and islands. CNG & LNG technologies seem to be ideal for natural gas to reach these areas.

Through these technologies, DSOs can provide natural gas to areas where the market is inexistent, and the construction of medium pressure pipeline grid does not make an economical sense. By doing so, they may also create the conditions for the market to become mature and as a result an investment in medium pressure pipeline construction for the connection of these areas to become economically viable.

Moreover, individual suppliers/providers of natural gas, will have the chance to provide big industrial consumers with gas, allowing the reduction of the energy costs, given that the use of diesel fuel is dominant for these industries.

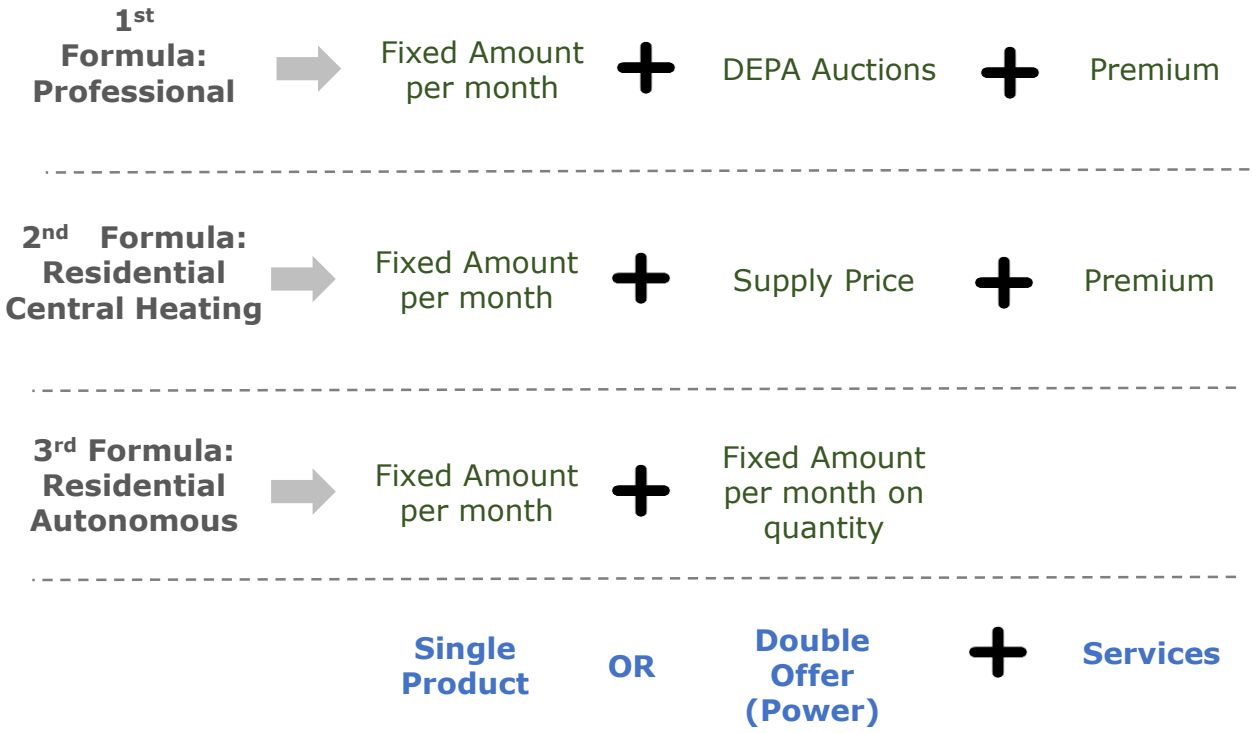
Currently there are 3 compression stations that operate in Thessaloniki, Larissa and Thessaly, providing CNG to city grids which are not connected with the natural gas system. These compression stations do not belong to the DSOs and they could potentially be utilized by suppliers for the provision of natural gas to individual customers.

Moreover, there are 12 compression stations for natural gas vehicles along the route connecting Athens and Thessaloniki. LNG truck loading is not an option currently, as there is no relevant infrastructure constructed in Revithousa terminal. It is planned for such infrastructure to be constructed in the near future allowing more efficient and economical penetration to the remote areas and customers.

Islands are also ideal areas for LNG supply. Specifically, concerning the field of Power Production, LNG can substitute the current fuels used such as Mazout and diesel. This can take place especially to islands that are not planned to be interconnected with continental Greece.

The retail market consists of more than 8 active suppliers some of which have started selling quantities in the B2B market before 2018

Pricing formulas used by Greek natural gas suppliers



Source: HAEE's analysis

Highlights

The retail Market is fully open to competition since 2018. Since that point, many power suppliers have entered the market. The type of companies which are active in the market were mainly power utilities (producers and suppliers of electricity) and electricity retail suppliers.

Except for the 2 dominant companies (Zenith & Aerio Attikis), there are currently more than 8 suppliers actively providing products and services. Most of these companies are also offering dual offers, combining electricity and natural gas offers.

The main pricing principles of the market participants are not yet sophisticated and remain simple. One of the two common pricing formulas offered by suppliers, is based on the DEPA auctions. It is the most transparent way of pricing as the results of the auctions are public and there is a common reference point.

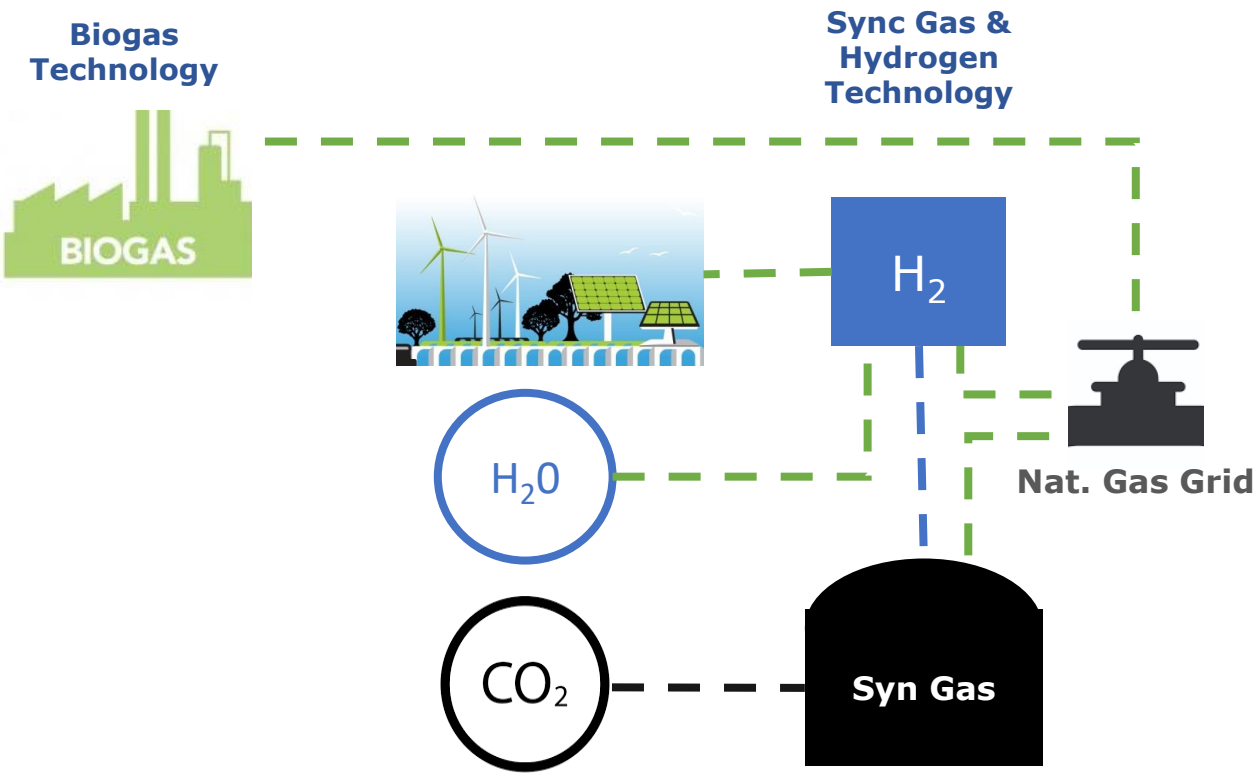
DEPA is the public corporation of natural gas, being dominant in the wholesale and retail market. Since the liberalization of the market, DEPA is conducting auctions for part of the wholesale quantities sold, offering a window of supply for retailers to acquire natural gas at low cost and be competitive.

The second most-common pricing formula is based on the cost of supply of the supplier. The supply price is announced after the pricing has taken place. There is no common reference point for comparison through this formula as the supply cost differs among suppliers. Customers have no reliable means of comparing prices.

The third formula used is based on a fixed price, which does not change according to the supply cost or the level of competition in DEPA auctions. It is the clearest formula existing and it resembles the pricing offered in electricity market in which Greek market is used to operate.

Future technologies around natural gas are coming to bridge the gap to a zero-carbon transition

Penetration of biogas and sync gas into the natural gas grid



Source: HAEE's analysis

Highlights

Biogas is considered to be a mature technology already. According to the new Renewable Energy Directive of the EU, among the new targets set, there is an end target of 14% renewables in the transport sector by 2030.

This target aims to promote the further deployment of electric mobility, but it also includes a sub-target of 3.5% for advanced biofuels and biogas. The target is legally binding for the member states.

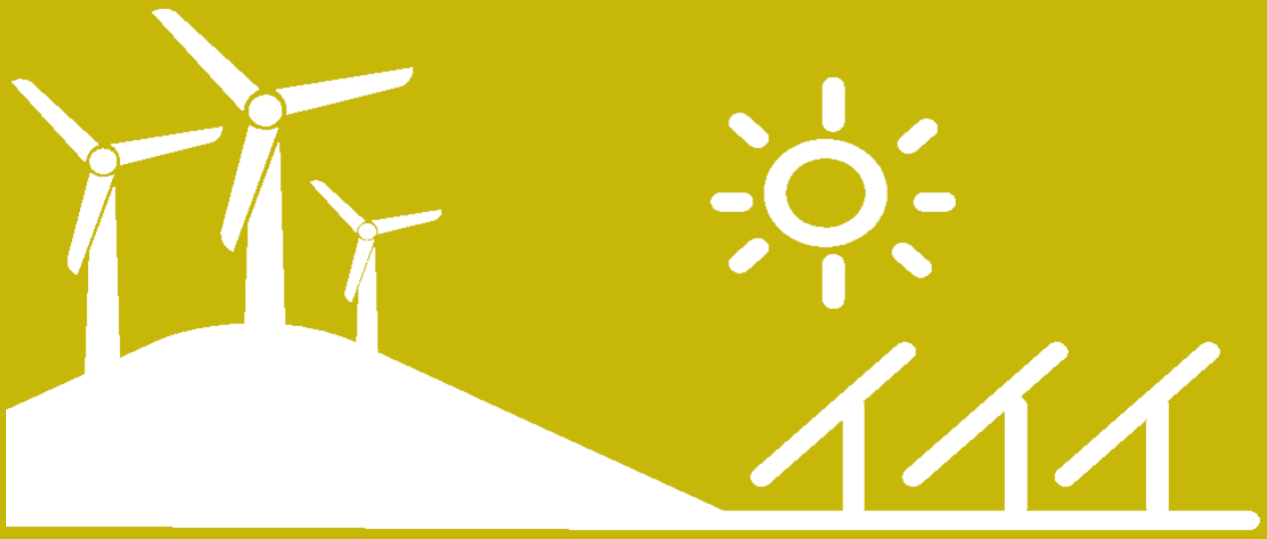
Biogas is planned to substitute fossil natural gas, being transported in the same grid infrastructure that natural gas is already using. The target is to reach a natural gas system of renewable natural gas. Biogas starts being acknowledged worldwide as one of the most upfront technology for upgrading waste to valuable fertiliser and renewable energy.

Syn Gas is also a totally new renewable source. It is produced from a mixture of carbon monoxide, carbon dioxide, and hydrogen and it can be also used in the existing natural gas infrastructure. Syngas has 50% of the energy density of natural gas. It cannot be burnt directly, but is used as a fuel source. The other use is as an intermediate source to produce other chemicals.

The generic raw materials used for gasification (creation of syngas) are coal, petroleum-based materials, or other materials that would be rejected as waste. Some of the examples of syngas production include gasification of coal emissions, waste emissions to energy gasification, and steam reforming of coke.

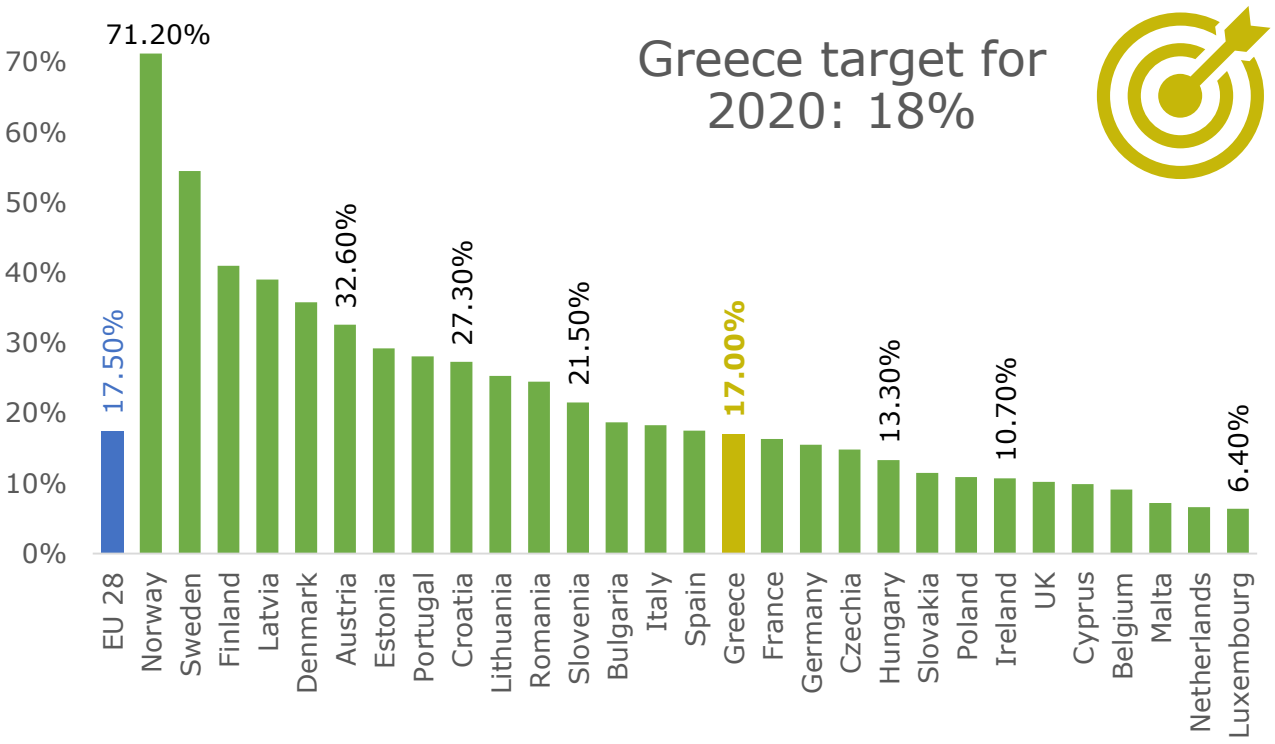
The adoption of Syn gas could not only support the decarbonization of the economies, but potentially could become part of the solution for the waste treatment. Specifically in Greece, these technologies could potentially be implemented, given that waste management is an issue for which no credible solutions have been applied.

5. Renewable Energy Sources



Greece shows a high potential for exploiting renewable energy technologies in all sectors of final consumption

Share of energy from renewable sources in the EU Member States (%), [2017]



Source: Eurostat, HAEE' analysis

Highlights

The use of Renewable Energy Sources (RES) is seen as a key element in energy policy for the reduction of fuel imported dependence from non-EU countries. Besides that, RES assist in the reduction of emissions from fossil fuel sources, and the decoupling energy costs from oil prices.

Directive 2009/28/EC on promotion of the use of energy from renewable sources established accounting criteria for the 2020 targets on renewable energy sources. Almost half of the European Union's 28 member states have already hit, or are close to hitting, their 2020 renewable energy targets.

However, there has been a gradual slow-down in the increase rate of renewable energy use across the EU. The countries that have already completed their corresponding targets are: Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, Italy, Hungary, Lithuania, Romania and Sweden.

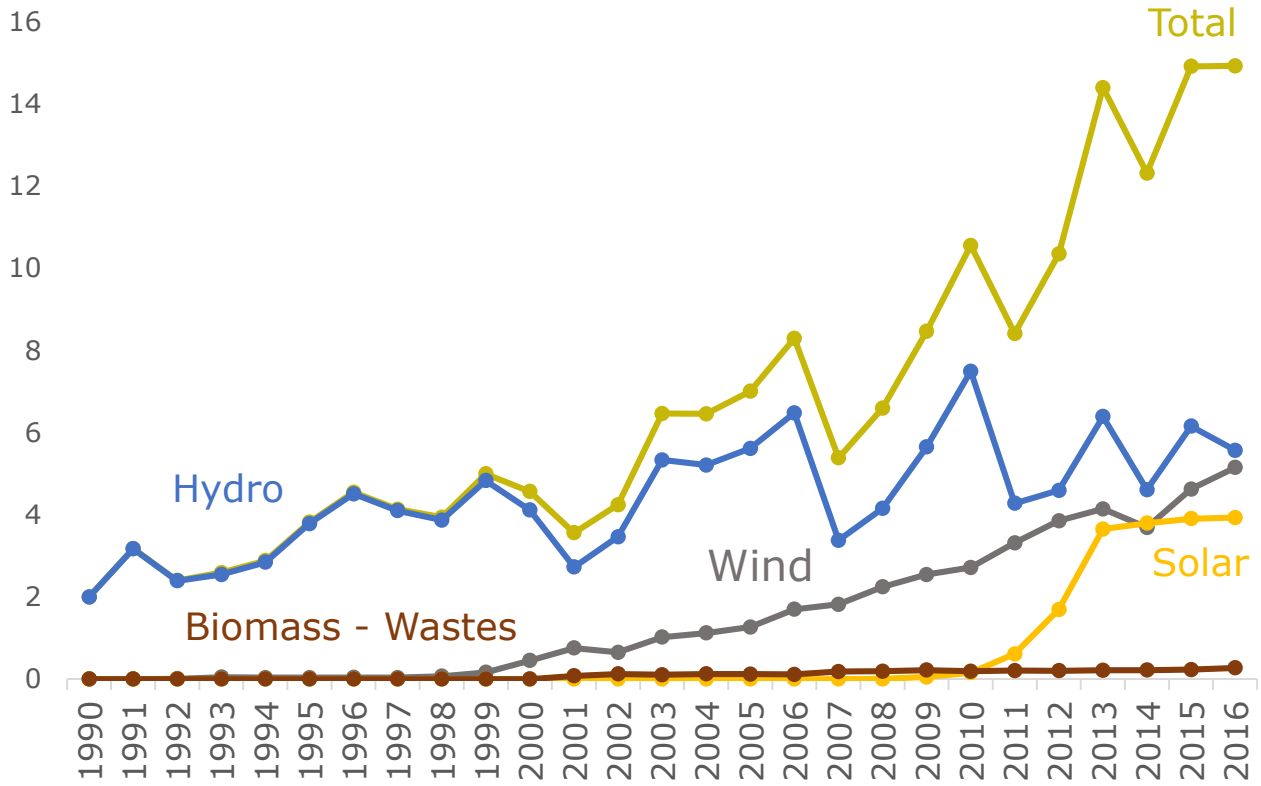
Close on achieving their energy goals are Austria, Greece and Latvia. Greece's progress in the share of RES in the country's overall energy mix shows that the target of 18% in 2020 is difficult to be achieved if investments remain at current level. In Greece, the sector of RES is regulated by numerous provisions of various laws that have been adopted for the transposition of the EU directives into national laws.

The national targets for 2020 for RES, are set as follows:

- Contribution of the energy produced by RES to the gross final energy consumption: 20%
- Contribution of the electrical energy produced by RES to the gross electrical energy consumption: at least 40%
- Contribution of the energy produced by RES to the final energy consumption for heating and cooling: at least 20%
- Contribution of the electrical energy produced by RES to the gross electrical energy consumption in transportation: at least 10%

Over the past years, a significant effort has been observed towards increasing the share of RES in electricity generation

Historical data of RES electricity generation in Greece (TWh), [1990-2016]



Source: IEA, HAEE's analysis

Highlights

Greece is a privileged country, as far as the exploitation of RES is concerned, due to its geographic position. The RES potential in Greece is mainly attributed to the favorable wind energy and solar conditions which have been evaluated as extremely advantageous.

Renewable energy sources capture a significant share of electricity generation in Greece. This is the result of the rapid growth in wind and solar installed capacity that occurred during the past decade and the overall decrease in total electricity supply.

At the beginning of the 1990s, electricity generation was mainly driven by hydroelectric plants, whereas wind turbines emerged a decade later and gradually increased their share. Law 3468/2006 provided the first clear legislative framework to assist the generation of electricity from solar power and transposed the Directive 2001/77 of the European Parliament into national Law, setting a high priority in promoting the energy production from RES.

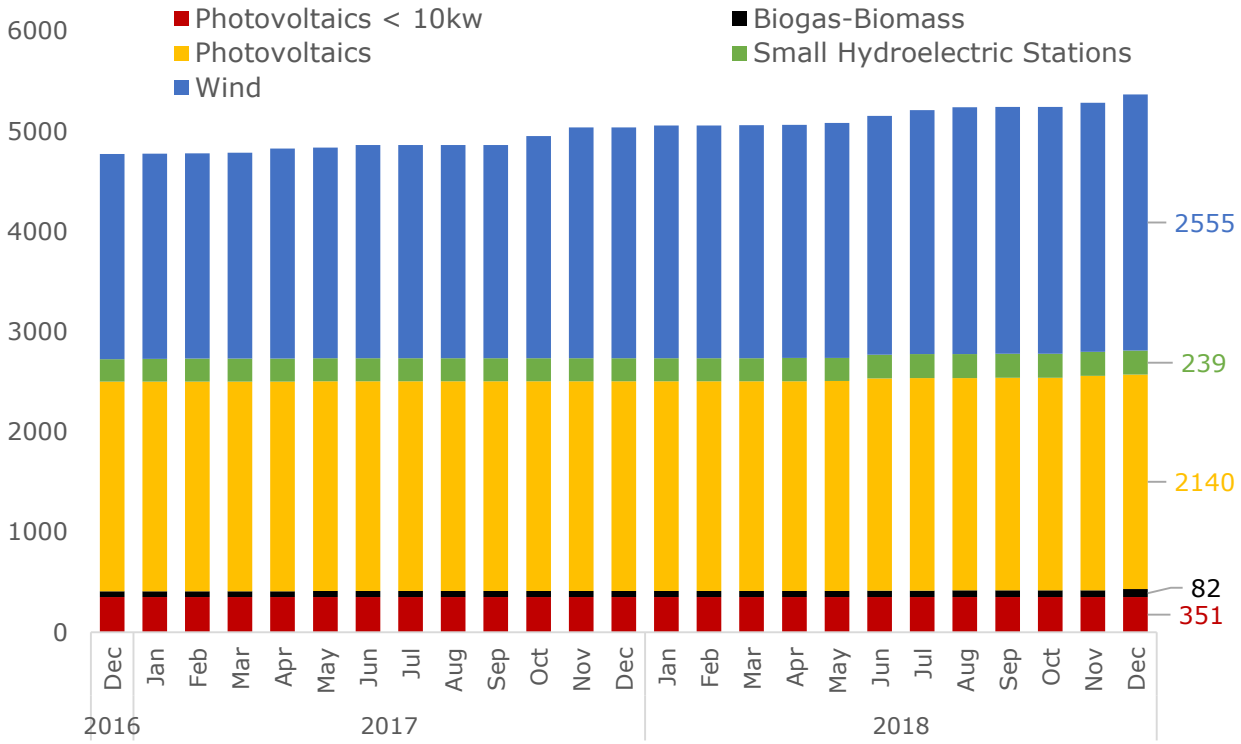
Since then, the evolution of photovoltaics in the system has been impressive. Yet, this "solar boom" entailed a significant deficit in the Special Account for Renewables from which RES producers are paid for their output.

Wind power generation increased from negligible levels in the late 1990s to 5.1 TWh in 2016, equal to 10.5% of the total electricity generation. Solar power achieved an even more impressive growth, experiencing a nearly twenty-five-fold increase from 0.16 TWh in 2010 to 3.9 TWh in 2016.

Hydro power has consistently accounted for the largest share of renewable electricity, but with substantial annual fluctuations. Hydro power production was 5.5 TWh in 2016, equal to 11.4% of the total generation. Greece has a small share of electricity from biofuels, counting for less than 1% of the total electricity generation.

The process of reforming and strengthening the RES support mechanism aims to increase investment confidence for RES projects in Greece

Installed Capacity of RES in Greece by type (MW), [Dec 2016 - Dec 2018]



Source: DAPEEP, HAEE's analysis

Highlights

In 2017, the previously upward trend in installed capacity continued, mainly driven by wind power installations. 2018 proved to be the second best year for wind power installations after 2011, with the deployment of 253MW new capacity reaching 2555 MW in total.

Solar power installations accompanied by the rest of RES in Greece remained relatively stable. The solar power sector covered nearly 7% of the country's electricity needs with a total installed capacity of 2,461MW (2140MW in Solar parks and 351 MW in Photovoltaics (PVs) with capacity lower than 10kw), bringing Greece to one of the highest places worldwide in terms of PV contribution to total electricity demand.

Apart from solar power (both small and large installations) which are relatively stationary over the past two years, biogas-biomass and small hydroelectric stations show a small increase.

Historically, despite the strong interest from investors and the beneficial financial incentives for installation of RES, their growth rate could have been even greater, but the uncertainty of potential investors for the sustainability of the RES support mechanism delayed significantly their penetration to the system.

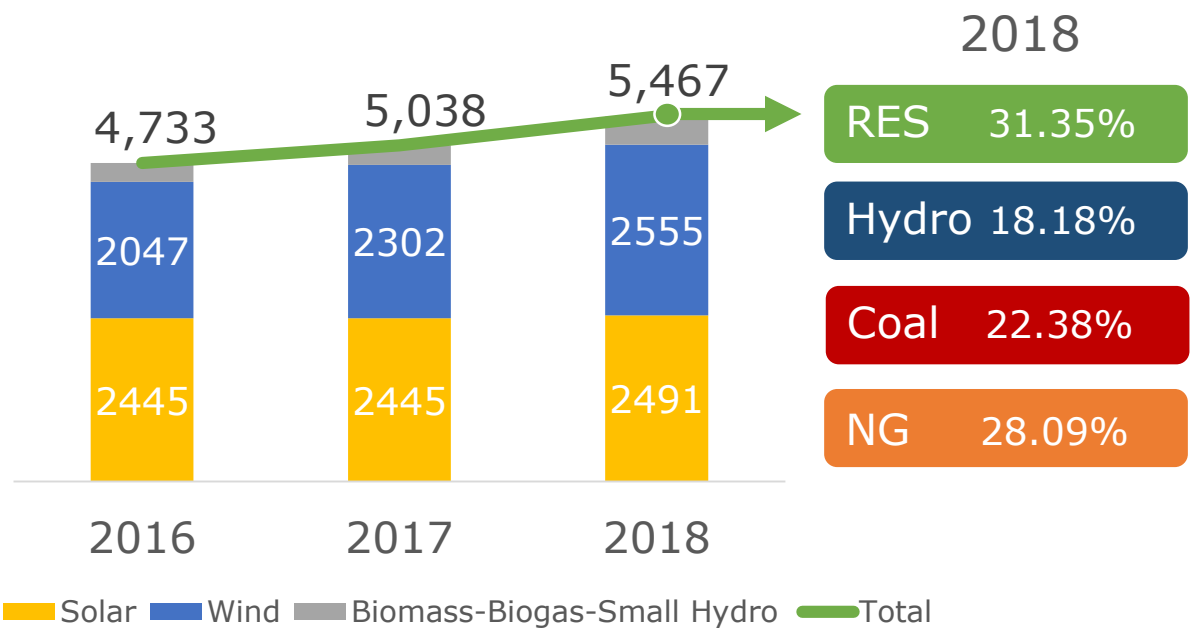
Over the recent years, a series of regulatory measures has been adopted aimed at assisting RES penetration, such as reducing the time required in the license process.

Thanks to the favorable Feed-in-Tariffs (FiTs) supporting scheme and decreasing technology costs the country managed to achieve a significant growth in wind and solar photovoltaics.

According to the new RES support scheme, operating aid will be granted for the electricity generation from RES in the form of a sliding Feed in Premium, in addition to the market price that will be formed in the market.

In 2018, RES and hydroelectric stations contribute to 49.53% of total installed capacity in Greece, while conventional units cover the remaining 50.47%

Installed capacity of RES by year and type in Greece (MW), [2016 - 2018] and percentage of RES capacity out of total [2018].



Source: DAPEEP, HAEE's analysis

Highlights

Total RES installed capacity, excluding the percentage of hydroelectric sources (18.18%), contributes to 31.25% of total installed capacity in the system, with natural gas (28.09%) and coal (22.38%) covering the remaining percentage.

From 2017, RES and CHP plants are awarded with a sliding FiP through tenders, which are "technology-specific". The Ministry of Environment and Energy shall issue a decision concerning the capacities available for each technology for each subsequent tender.

In December 2016, a pilot tender for PV took place. The tender included two categories of PV installations, following a two-stage process with specific price and volume caps. In 2018, two tenders for PV and wind energy took place.

Sliding Feed-in-Premium is granted until the full depreciation of the specific RES plants and is based on a differential value that will consider the revenues from its direct participation in the electricity market.

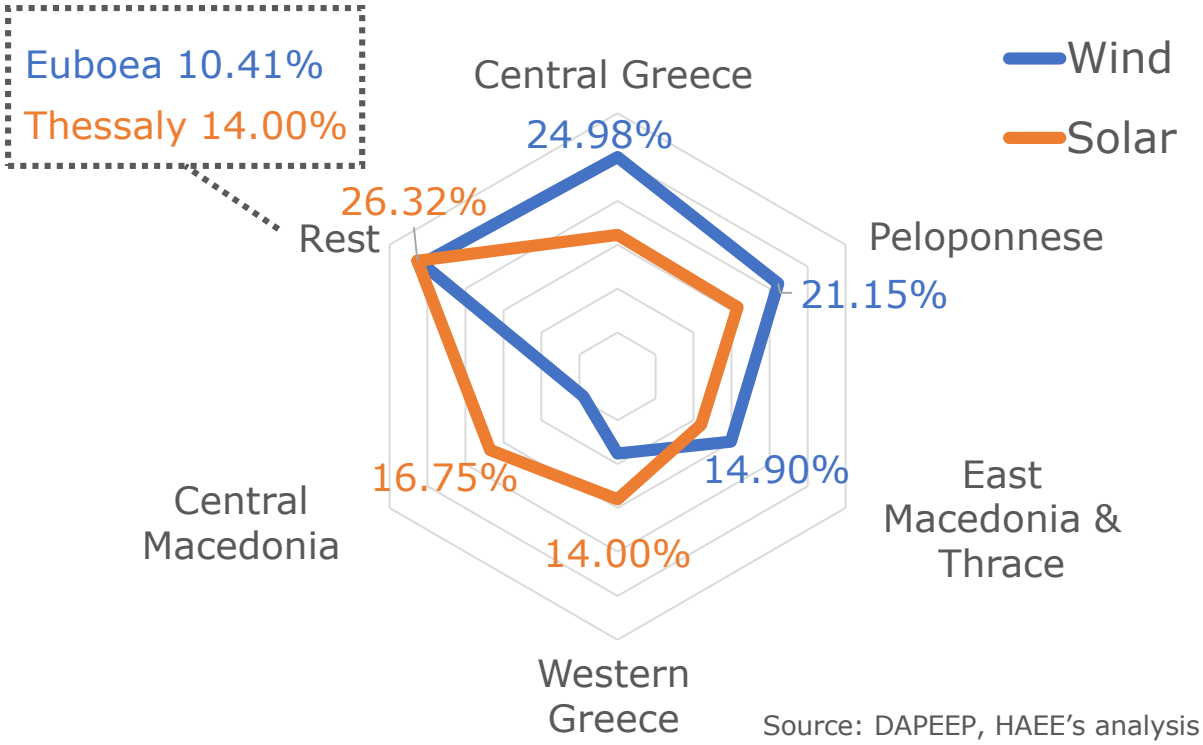
By the time Hellenic Energy Exchange starts its official operation, RES plants will be subject to specific obligations and balancing responsibilities. Exceptions from the sliding Feed-in-Premium will apply to the projects of less than 3MW for wind plants and 500kW for the rest RES technologies. These categories will continue to be supported by the FiTs scheme.

The Development Law 4414/2016 that came into force in July 2016, foresees support for CHP plants, small-scale hydro-power plants, and self-production using other RES in a form of an income tax relief and stabilization of income tax coefficient.

Net metering is available for all RES for autonomous producers, while "virtual net metering" is applicable to PV and small wind power plants only in certain cases.

Five regions in Greece cover almost 74% of the total installed capacity for both wind and solar power

Installed capacity by region (%), [2018]



Source: DAPEEP, HAEE's analysis

Highlights

Greece consists of 9 geographic regions that offer highly exploitable area with growing capacity over the last years. For 2018, Sterea Ellada attracted almost 25% of investments in wind farms and 16% of total PV installations.

Second in the list of most attractive regions comes Peloponnisos that represents 21% of the wind farm capacity and 16% of the PV installations. The third region in rank is East Macedonia and Thrace covering 15% and 11% respectively for the two technologies.

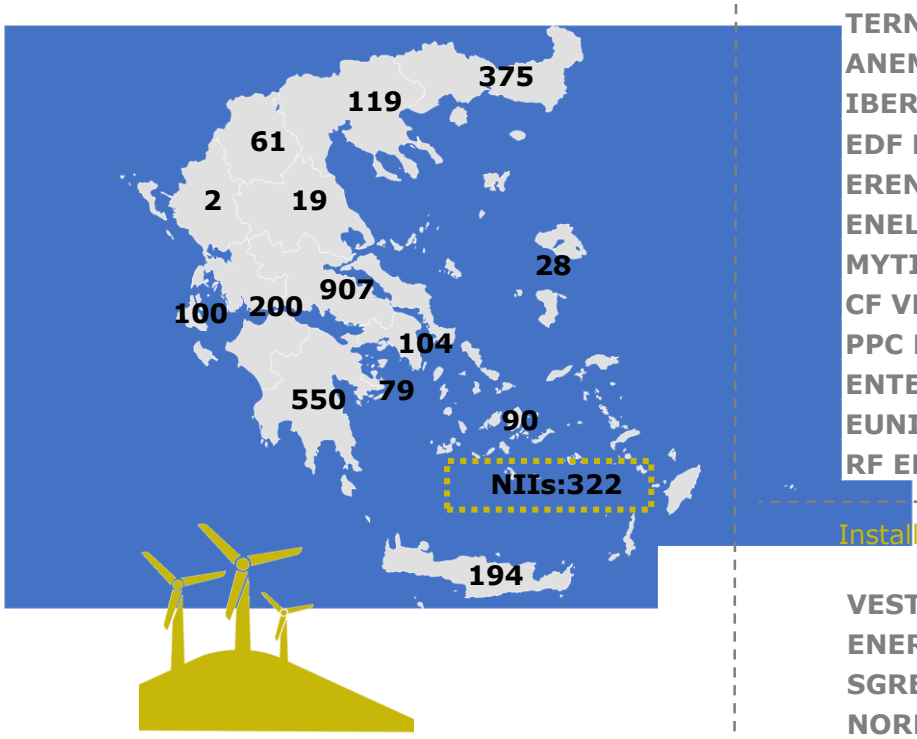
The two regions where the PV percentage is higher than the wind percentage are West Greece and Central Macedonia. Specifically, 17% of PV parks is located in Central Macedonia, where only a limited amount of wind capacity is installed (4.5%). West Greece occupies 14% of wind and 9% of solar capacity respectively. Out of the remaining percentage the two cases worth mentioning is the region of Thessaly that provides 14% of the total Solar power and the island of Euboea which covers 10% of total Wind installed capacity.

Despite the diversity of regions in terms of installed capacity, there are many barriers to RES growth that are still present. For instance, the time-consuming procedures for obtaining certificates from various Public Services.The development of spatial planning could facilitate the competent authorities in the provision of the relevant certificates. Next, citizens should be sufficiently educated about the need to develop RES and their impact on environmental issues.

Another factor hampering the further deployment of RES is the inability of existing local networks to absorb the capacity of RES, a procedure that is broadly characterized as consuming and costly, especially when it comes to high voltage network extensions. The specific issue exists mainly in Thrace, Euboea and Laconia, where there is a large wind potential.

Thanks to the progress of technology, wind energy is the cheapest option for new power plants

Cumulative wind capacity by region (MW), [2018]



Installed MW per wind energy producer, [2018]

TERNA Energy	536.1
ANEMOS (ELLAKTOR)	285.6
IBERDOLA Rokas	250.7
EDF HELLAS AE	238.2
EREN GROUP	210.9
ENEL GREEN POWER	200.5
MYTILINEOS GROUP	153.5
CF VENTUS	85.0
PPC Renewables	67.5
ENTEKA	67.0
EUNICE	60.6
RF ENERGY	60.4

Installed MW per manufacturer [2018]

VESTAS	1483.6
ENERCON	621.8
SGRE	538.7
NORDEX	150.1
OTHERS	34.4

Source: HEDNO, ELETAEN, HAEE's analysis

Highlights

By the end of 2018 the total RES installed capacity in Non Interconnected Islands (NIIs) was 483 MW, out of which 322MW were attributed to wind farms.

In 2018, the Greek wind power sector comprised of ten major market players operating wind parks of total 2,2 GW capacity. Greece's top five wind energy groups are: Terna Energy (536MW), Anemos (286MW), Iberdrola Rokas (251MW), EDF (238MW) and EREN (211MW).

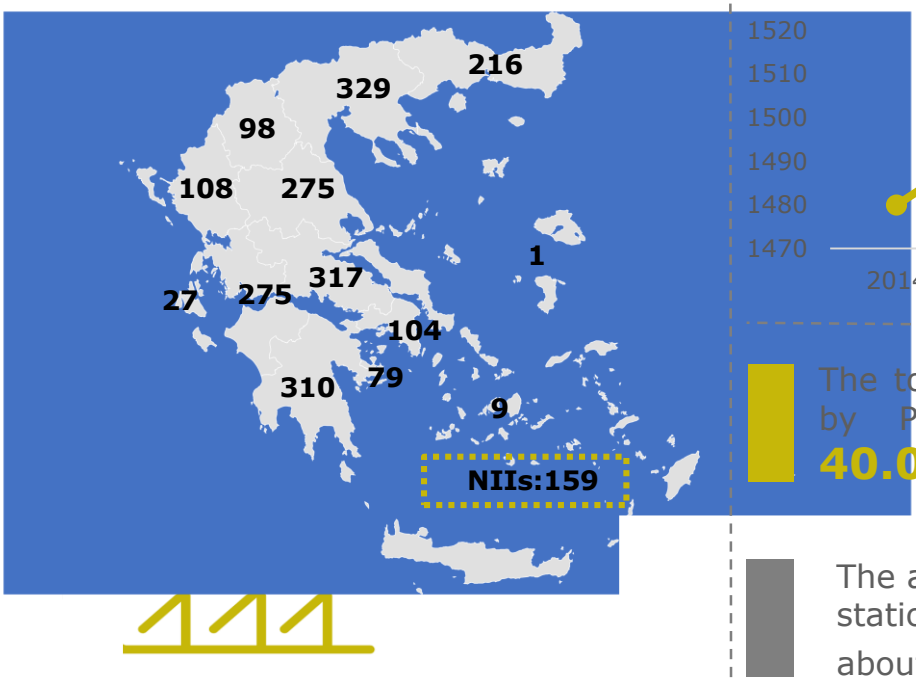
Installed capacity per manufacturer for 2018 is dominated by four major companies: Vestas (52%), Enercon (22%), SGRE (19%) and Nordex (5%).

The main milestones and licenses for a wind energy project in Greece, issued sequentially, are:

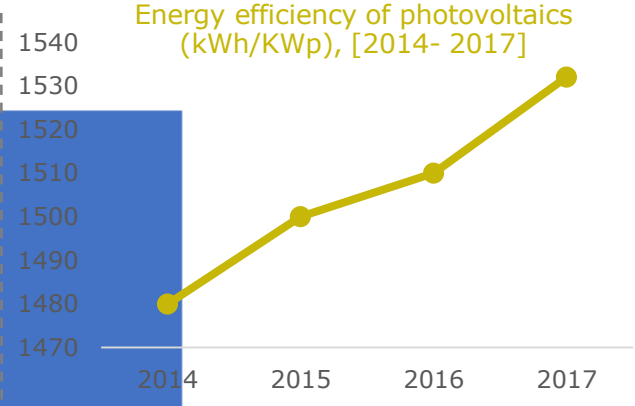
- The Production License, which in practice constitutes "a project feasibility approval".
- The Approval of Environmental Terms or otherwise Environmental Impact Assessment (EIA) Approval.
- The binding Grid Connection Offer (GCO), which is issued after EIA Approval and secures access to the electrical grid. It specifies the point of the grid where the wind power plant will be connected, the required works for this purpose and their costs.
- The Installation License. The competent authority is bound to issue the Installation License, as far as a binding Grid Connection Offer has been obtained and various formal prerequisites -all being subject of proper preparation and of the discretion of the investor to execute them (payment of taxes, fees, land-use right etc.)- have been met. The Installation License grants the right to proceed with the construction of the project.
- The Operation License is the final License of a wind energy project and is issued after the construction and successful start up of the power plant.

Massive growth of solar power will offer valuable support in various appliances in society, industry and business

Cumulative solar PV capacity by region (MW), [2018]



Energy efficiency of photovoltaics (kWh/KWp), [2014- 2017]



The total land area occupied by Photovoltaics is about **40.000** acres

The area occupied by lignite stations and lignite mines is about **253.000** acres

Source: DAPEEP, HEDNO, HELAPCO, HAEE's analysis

Highlights

Greece's high levels of solar irradiation, and especially in its southeast regions, provides the country an indisputable advantage in the course of achieving its goals to produce more clean energy.

The solar power sector covered nearly 7% of the country's electricity needs with a total installed capacity of 2,461MW (2,302 MW interconnected system, 159 MW NIIs).

NIIs cannot benefit from the cost advantage of large-scale generation capacity and are commonly equipped with diesel-fueled generators, which are expensive and not environment friendly. However, NIIs possess excellent conditions for even greater growth of solar and wind power.

Photovoltaics in Greece occupy 0.12% of total agricultural land or 0.03% of total country's land. According to Helapco, the agricultural area left uncultivated is 92 times larger than the area occupied by photovoltaic parks.

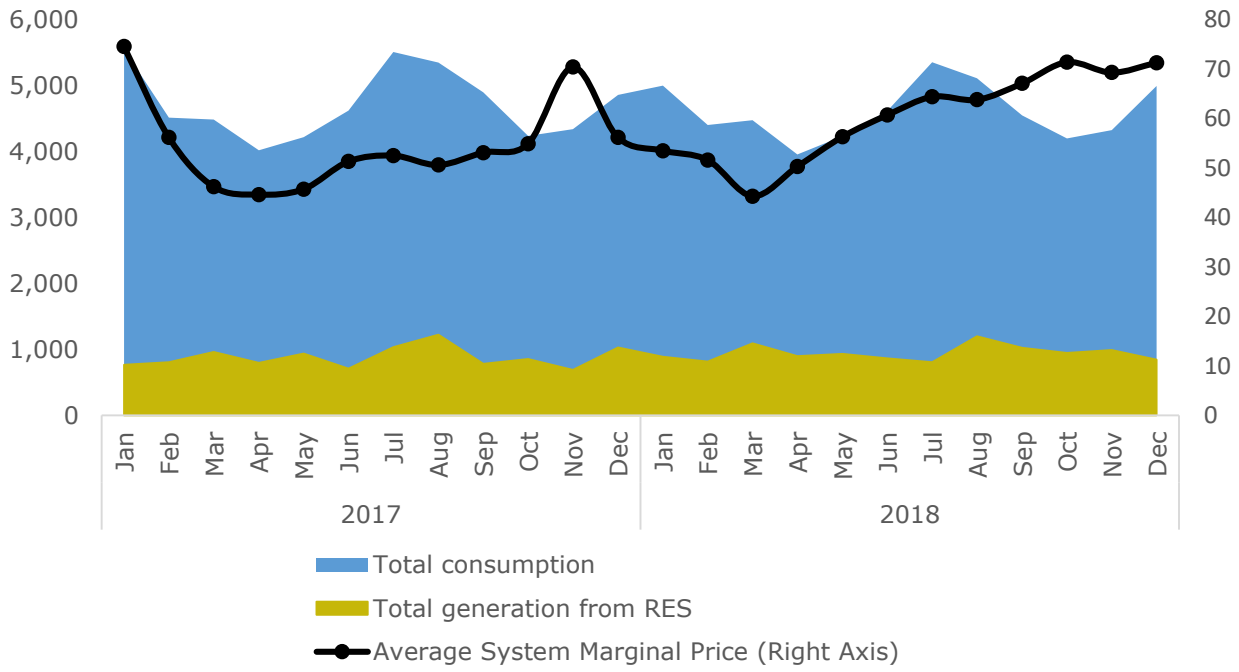
Despite the fact that energy efficiency of photovoltaic systems is constantly evolving, their most significant drawback today is considered to be their high acquisition cost.

The relatively large capital required to be invested in the purchase of PV systems, combined with the large depreciation period of the investment hampers their further expansion to large scale investments.

Although the cost of installing various photovoltaic systems is declining rapidly, it has not yet reached levels that, in the short run, can be competitive with other, conventional power generation technologies.

Despite the stochastic nature of RES, their contribution to electricity demand is 19.7% on average for 2017 and 2018

Total electricity consumption (GWh), total electricity generation from RES (GWH) and average system marginal price (€/MWh), [2017-2018]



Source: DAPEEP

Highlights

Based on the seasonal observation of electricity consumption, it is obvious that during winter and summer months the total electricity demand increases. Despite the stochastic nature of RES, they contribute to this increased demand all over the year in a quite significant rate (19.7%) and even more during the summer months.

For the case of Greece, the correlation between the variation of the average SMP and the total electricity consumption is 26.28% for 2017 and 2018, while correlation between the average SMP and RES generation is 21.28%.

Due to the fact that RES do not have a stable and predictable production, as this depends on weather conditions, its increasing penetration creates greater volatility in the formed market prices, which threatens the balance of the electricity market.

As the framework in Greece moves towards the participation of RES in the wholesale market without any support by stable tariffs, the issue of price volatility will become more and more important. For instance, negative prices and price spikes are anticipated to occur as the penetration of RES increases.

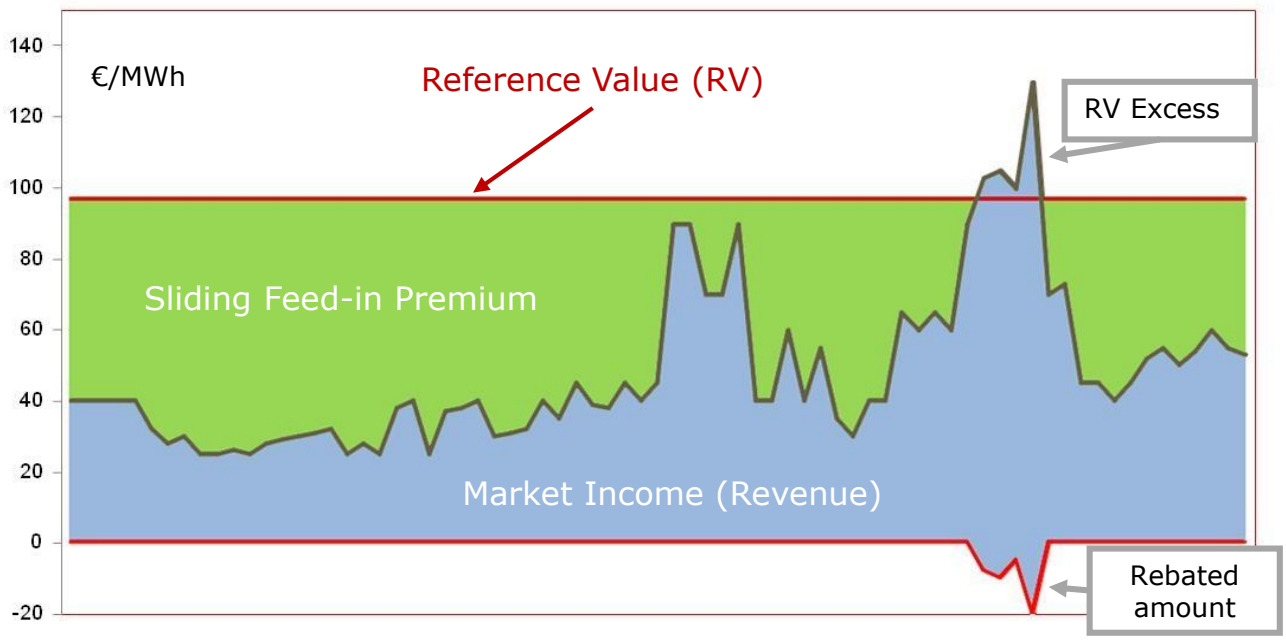
Aiming to deal with this uncertainty, it is also important for Greece to explore renewable energy sources beyond Solar and Wind and to increase their usage in the non-electricity sector.

Greece is already late in exploiting its rich biomass potential. It is estimated that the exploitation of the technically exploitable biomass could meet even 20% of the country's total electricity needs.

A variety of opportunities for generation of electricity from biomass exist, but in many cases, waste and sewage are simply discarded in the environment, accompanied with all the negative consequences.

Since 2016, a new support scheme for renewable projects has been adopted, based on Feed-in Premiums (FiP)

Snapshot of the FiP based support scheme



Source: HAEE's analysis

Highlights

Until 2015, the development of renewable projects was regulated by a feed-in tariff (FiT) scheme, in which investors were compensated by a pre-defined tariff for a period of 20 years. This tariff was set according to a Power Purchase Agreement (PPA) between the project company and the market operator, providing this way a protected environment for investors.

Since the start of 2016, a new renewable support scheme has been introduced. In compliance with the European Commission guidelines on State Aid for Environmental Protection and Energy 2014-2020, renewable projects that had not signed a PPA until 2015, would be, from that point forward, remunerated through a new Feed-in Premium (FiP) mechanism.

According to the FiP mechanism, renewable projects receive a premium, in the form of a variable (sliding) premium, on top of their income from the market. This amount is calculated on a monthly basis and its sum with the reference market price results to a total price, which is called Reference Value (RV). Reference market price is calculated as the hourly system marginal price increased by the value corresponding to other wholesale market mechanisms, if existed.

For 2016, the Reference Value (RV) was defined by law at a specific price according to the project type and specifications (e.g. wind, solar, hydro etc.), but from the start of 2017 and onwards, it is defined per each project through auctions that are organized by the Regulatory Authority of Energy (RAE).

The Reference Value (RV) that is defined for every project, remains valid for a period of 20 years (contract with the Electricity Market Operator).

In case that the market income of a project exceeds its Reference Value (RV), the differential amount is rebated to a special RES account.

During the last two years, three auctions for renewable energy projects have been held by the Regulating Authority for Energy (RAE)

Source: RAE, HAEE's Analysis

Highlights

After 2017, the Reference Value is being determined by an auction system that has been launched by the Regulatory Authority for Energy (RAE) and has been approved by the European Commission SA. 48143 (2017/N), C(2017) 9102 final/4.1.2018.

The auctions are being carried out electronically (online) and during this two-year period (2017-2019) a total of three auctions has been completed.

The first auction took place on July 2, 2018 and was divided in three different categories. 'Category I' included small PV projects (P≤1MW), 'Category II' larger PV projects (1MW≤P≤20MW) and 'Category III' wind energy projects (3MW≤P≤50MW). In this auction, a total of 183 projects (all categories) participated and 2143 offers were submitted. The overall RES awarded capacity was 277.32 MW.

The second auction was on December 10, 2018 and intended to include Categories I,II and III as the first auction. Nevertheless, the auction for Category II projects was decided to be cancelled by RAE. During this auction, the total awarded capacity was 61.94 MW for small PV projects and 159.65MW for wind projects.

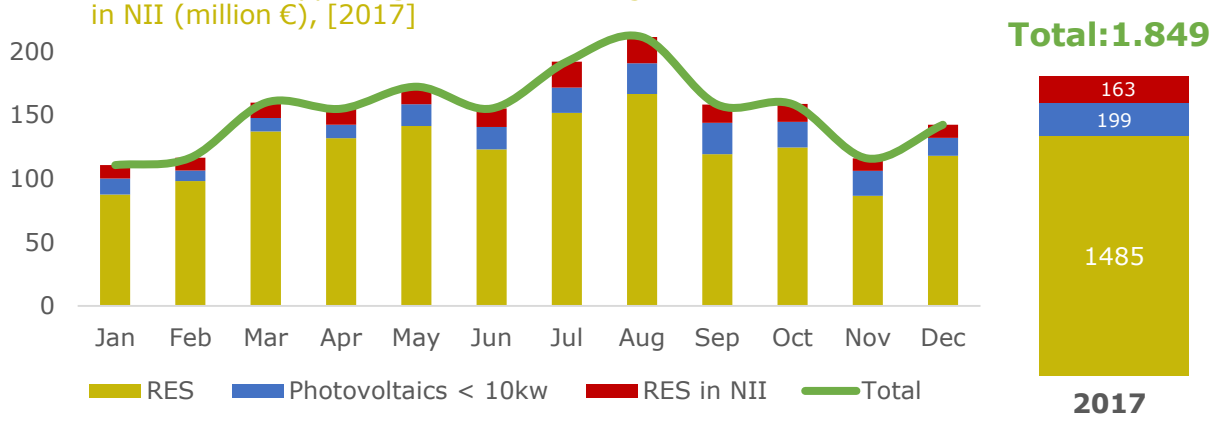
The second auction revealed a significant decreasing trend in the reference value bids on both solar (PV) and wind projects.

The last auction was held on April 2019 and concerned wind projects above 50MW, PVs above 20MW and projects with common connection point. The auctioned power was 455.56 MW and 8 projects were involved, with a total capacity of 637.78 MW.

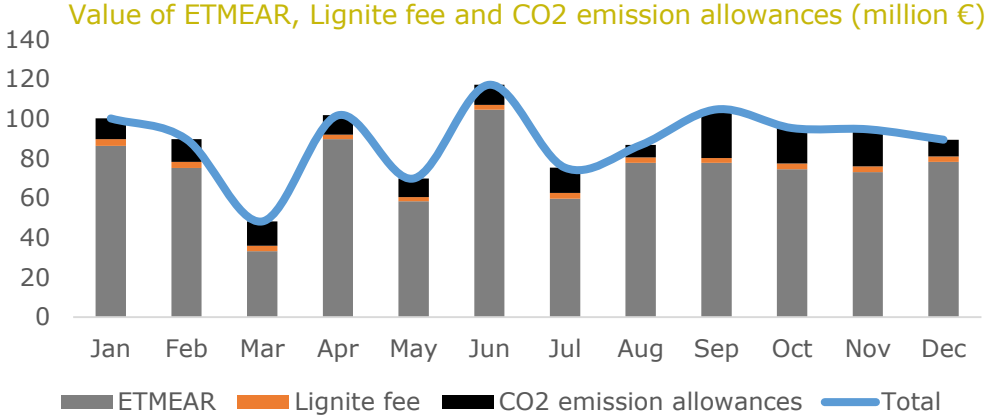
Some facts worth noticing during the last auction was the rejection of PPC's 200MW large PV project as well as the agreement of the lowest RES price ever in Greece at 53€/MWh. This bid was made by EDF for a 60MW PV project in Voiotia.

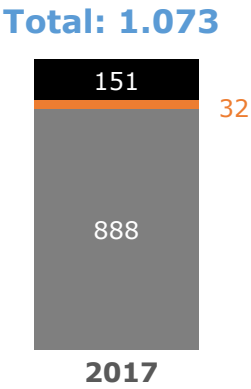
The new RES support scheme is anticipated to reduce the cost burdened by the society

Value of RES supporting scheme including Photovoltaics <10 kw and RES in NII (million €), [2017]



Value of ETMEAR, Lignite fee and CO2 emission allowances (million €), [2017]





Source: DAPEEP, HAEE's analysis

Highlights

The Day Ahead Scheduling (DAS) concerns the input from the units of RES & CHP. For 2017, DAS reached the level of 485 billion euros while for 2018 it is estimated to be 538 billion euros. The amounts are calculated when DAPEEP clears the DAS by multiplying the declared quantities by the corresponding SMP.

The total value of RES supporting scheme in Greece for 2017 was 1.8 billion euros. As expected, the value varies across months with higher figures met during the summer period. On the other hand, the, aggregate value of ETMEAR, lignite fee and CO2 emission allowances exceed the level of 1 billion euros.

According to the legislation in force, ETMEAR fee is intended to compensate the electricity producers from RES. It is the society's contribution on reducing CO2 emissions through the promotion of RES.

In essence, ETMEAR was imposed to cover the high prices of electricity from RES. At a time when the wholesale market prices ranged from 45 to 60 euro per MWh, the wind price was at roughly 92 euros per MWh and the PV price close to 300 euros per MWh. The specific fee is design to be replaced by the green certificates market.

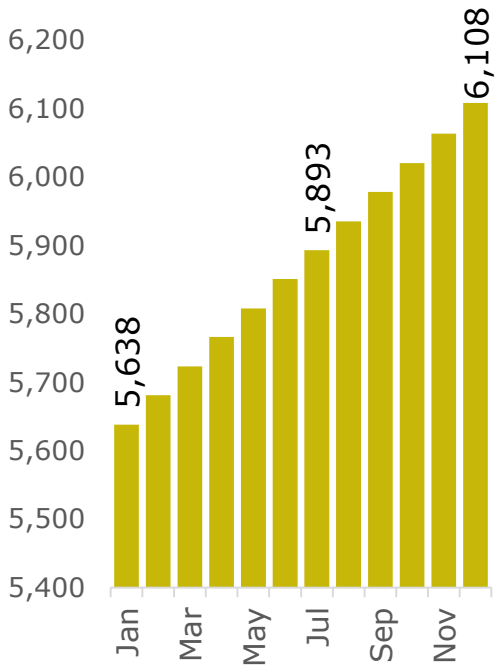
According to the National Energy and Climate Plan published in 2019, the investments in electricity production from RES are expected to add over 12 billion euros in value to the economy from 2020 until 2030.

The Plan also projects the creation of over 15,000 full-time jobs over the ensuing 25-year period.

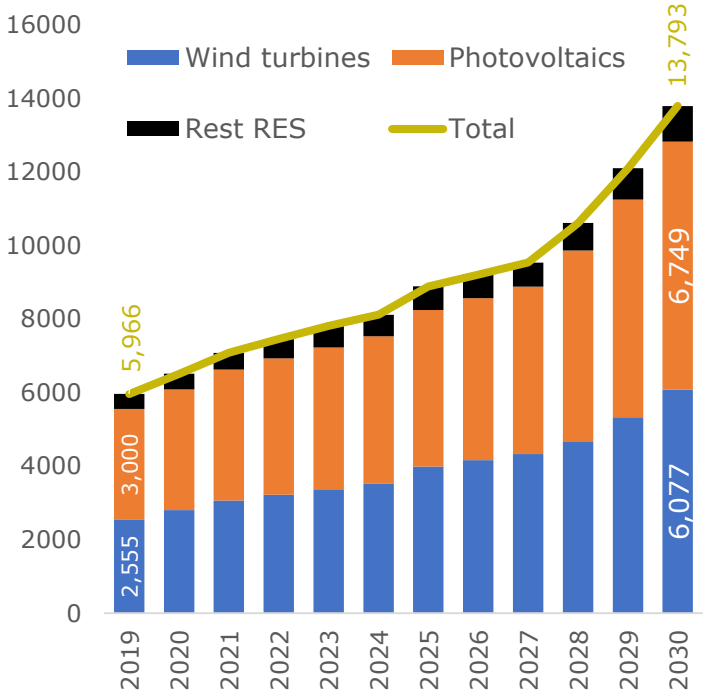
However, one issue that need to be tackled is the financing of RES projects, that mainly comes from the four Greek main banks and multilaterals since foreign commercial and investment banks are still absent from the market.

Compared to current levels, solar power installed capacity is expected to grow by 51% in 2027, while wind power installed capacity to grow by 69%

Short-term forecast of RES installed capacity in Greece (MW), [2019]



Long-term forecast of RES installed capacity in Greece (MW), [2019 – 2030]



Source: DAPEEP, ADMIE, HAEE's analysis

Highlights

According to the estimations of DAPPEP, ADMIE and HAEE installed capacity of RES in Greece is expected to grow by 13.6% every year reaching the amount of 13,793MW in 2030.

The national capacity target for wind energy is 3000 MW until 2020, without including offshore wind power projects. 2,6GW of new wind and solar tenders are anticipated to come in the next three years (already started in July and December 2018).

The second regular wind and PV state aid auction held on December 2018 resulted in: the award of all of the capacities for two of the three categories of renewable energy system RES projects, a significant (up to 26%) reduction in the reference prices compared with the initial reference prices and the cancellation of the auction for large PV projects by the Regulatory Authority for Energy due to insufficient competition.

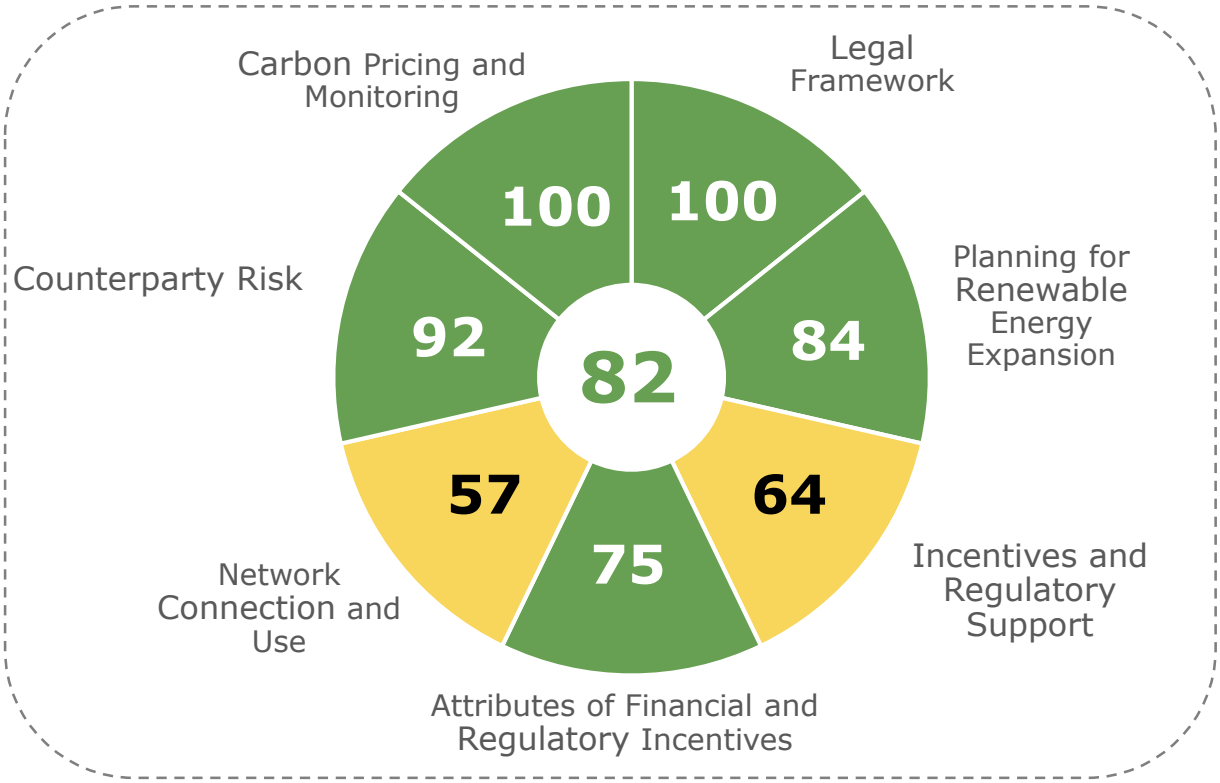
The total amount of new investments in the RES electricity sector for the next decade is estimated to generate a benefit in the domestic added value of over 12 billion euros.

In the next decade, the National Energy and Climate Plan defines specific policy measures for the promotion of RES :

- Promotion of RES technologies and achievement of zero aid for competitive units
- Proper licensing and spatial planning
- Promotion of scattered RES systems and empowerment of the participating role of local societies
- Integration of RES in energy networks
- Minimum RES regulatory requirements to meet energy needs in the building sector
- Enhancement of the use of RES systems to meet heating and cooling needs
- Coupling of energy sectors to enhance optimal penetration
- Promotion of the use of biofuels in transport
- Promotion of the use of electricity and other RES fuels in transport

The new support scheme extensively reforms the existing support scheme in line with the European Commission guidelines

Grading of RES indicators (max:100) [2017]



Source: RISE, HAEE's analysis

Highlights

Based on the Regulatory Indicators for Sustainable Energy for 2017, Greece achieved a relatively sufficient grade (82/100) for the country's overall outcome in terms of specific categories. The two sectors that need further improvement are (i) Network connection and use (57/100) and (ii) Incentives and regulatory support (64/100).

Recently significant developments took place in the Greek RES sector:

- Law 4414/2016 introduced Feed-in Premiums (FIPs),which in most cases, replaced the Feed-in-Tariff(FiT).
- All wind farms (with the exception of wind farms with capacity<3MW and demonstration projects) entering commercial or trial operation after January 2019 in the interconnected system, are required to participate in the wholesale energy market and are paid as per market plus a variable FiP (difference between RES market price and set price or Reference Tariff (RT)).
- From 2018 onwards, RTs are set through an auctioning process.
- Wind farms entering commercial or trial operation in the NNIs after January 16, , continue to access a FiT-based scheme (compensated through RTs), provided that such islands remain on I/C or do not have a fully operational daily electricity market.
- New FiP and FiT contracts for wind farms will cover a 20-year period
- The joint auctions for 400MWof wind projects over 50 MW and solar over 20MW

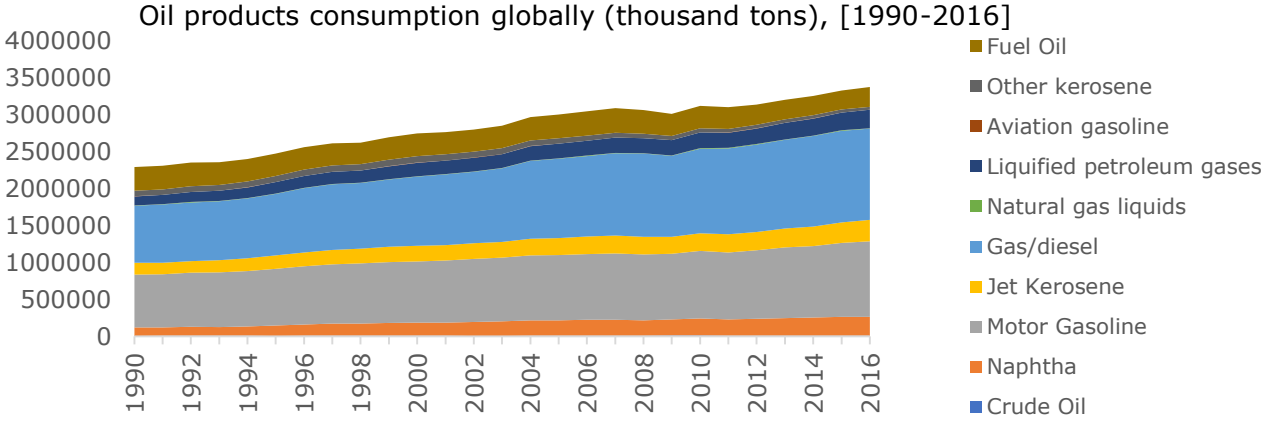
When RES reach certain levels of maturity, the responsibilities of RES producers will gradually change their behavior, transforming them from passive into dynamic players. RES Aggregators are anticipated to play a crucial role on this transformation.

Further development of RES market will be achieved with the enhancement of financing new projects and in parallel with additional simplification of the licensing policies that prevents both domestic and foreign investments.

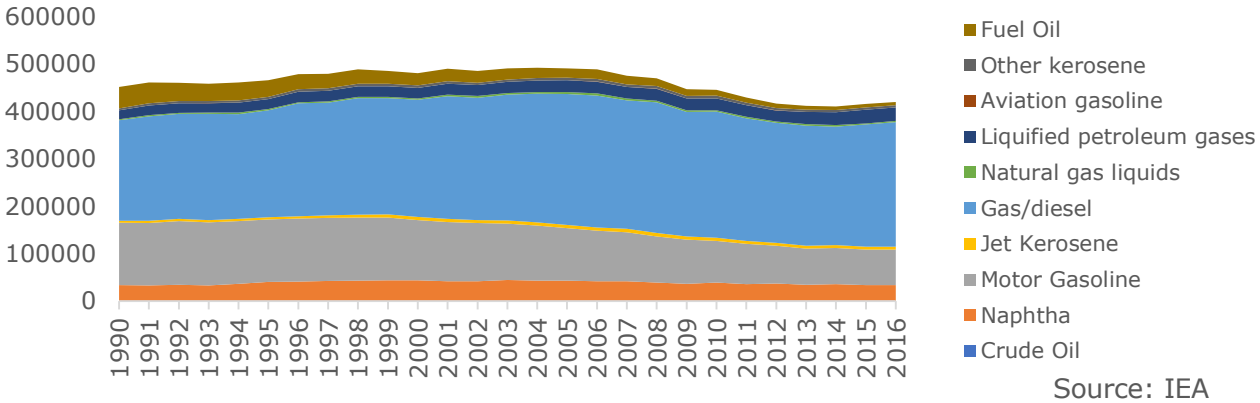
6. Oil

Global oil demand is estimated to grow within 2019, mainly driven by the better economic conditions worldwide

Oil products consumption globally (thousand tons), [1990-2016]



Oil products consumption in EU 28 (thousand tons), [1990-2016]



Source: IEA

Highlights

Oil products consumption during the period 1990-2016, both in terms of global and European consumption was dominated by gas/diesel and motor gasoline. Interestingly, despite the fact that the total oil consumption faces an upward trend globally, this is not the case for European countries. Following the 2008 crisis, the Eu oil consumption follows a relatively descending trend.

In 2017, global oil demand continued to grow, showing a year-on-year (y-o-y) demand growth of 1.7% compared to 2016. This grow was mainly a result of the global healthy economic conditions and the relatively low oil price environment. The majority of the oil demand gains was spotted in the middle distillates, diesel oil, jet kerosene and naphtha.

Middle distillates received strong support from industrial activities in OECD countries, while light distillate demand improved due to higher utilization rates for naphtha crackers. On the other hand, global residential fuel oil demand was reduced.

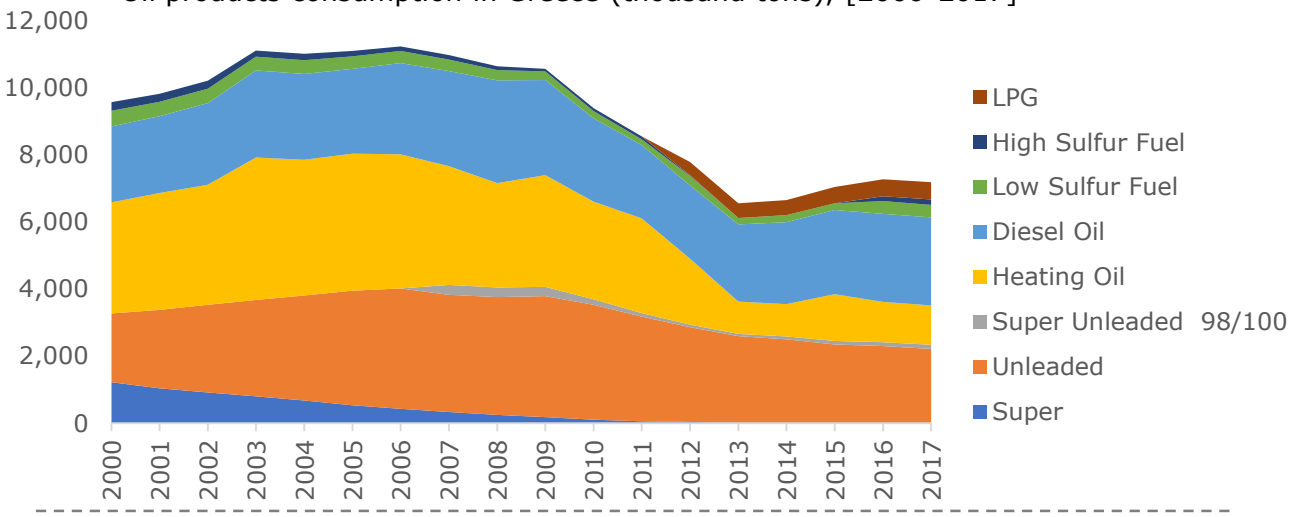
Global oil demand is estimated to have increased by another 1.66% in 2018, compared to 2017, amounting to a total consumption of 98.85 million B/d. The North America region appears to have the highest demand growth with an increase of 1.2%.

European oil consumption also increased in 2017, showing an approximately 1.4% y-o-y growth. This increase was due to the strong improvement of several countries' economies, the steady development of the European manufacturing sector, some additions to vehicle stock levels and the cold weather conditions throughout the year. The majority of the EU demand growth was located in the industrial fuels and transportation sectors.

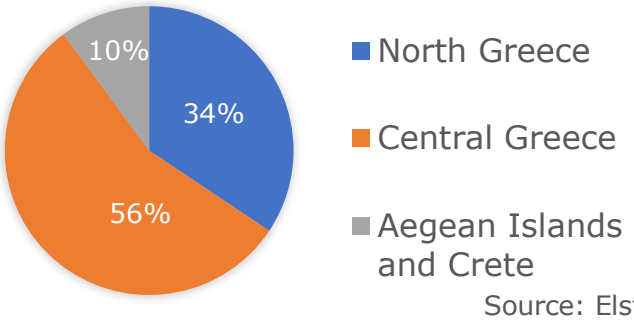
Estimates reveal that further increase in the world oil demand is expected in 2019, with the first indications revealing an increase of 1.45 million B/d, exceeding a total consumption of over 100 million B/d.

Oil consumption in Greece is showing a slight upward trend, after a steep fall during the first four years of the economic crisis

Oil products consumption in Greece (thousand tons), [2000-2017]



Oil products consumption share by region (%), [2017]



Source: Elstat, HAEE's analysis

Highlights

The trend for oil consumption in Greece has been decreasing over the last decade (including the amount used in the electricity generation), mainly due to the severe economic crisis that affected the country's aggregate demand and consumption.

However, oil consumption has slightly recovered in the last few years, with a 9% increase in 2016 compared to 2013 levels. This rise is mainly attributed to the residential sector.

Total domestic oil consumption in Greece decreased during 2017 (approximately 1.1% y-o-y change), mainly because of the decreased consumption of Unleaded gas compared to 2016 (-3.4%). The total consumption amounted to 7,186 thousand metric tons. Oil products used in the transportation sector (diesel oil, Unleaded and Super Unleaded) hold the largest share out of total oil consumption, accounting for approximately 69% of the overall amount.

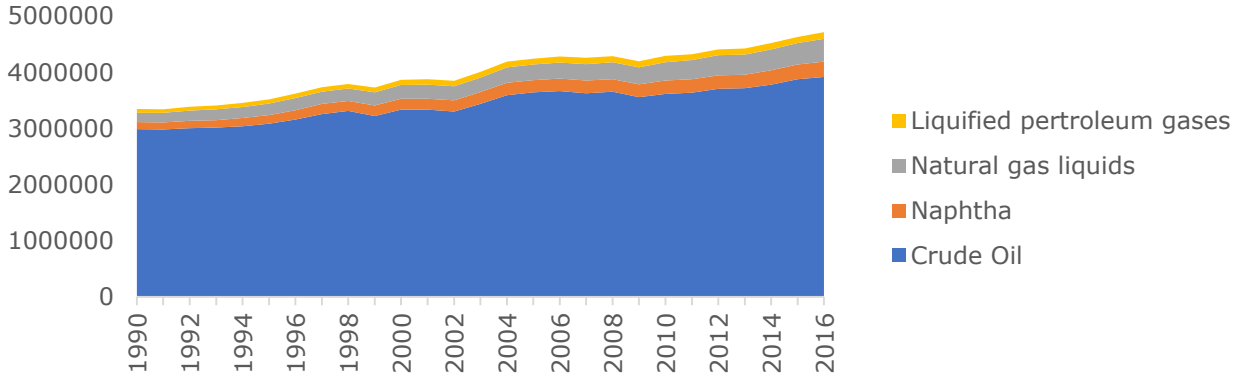
The highest amount of oil consumption is spotted in Central Greece with a 56% share of the total amount. Attica (I Central Greece) and Central Macedonia (in North Greece) are the two regions with the highest oil products consumption with 2,102 and 1,300 thousand metric tons respectively.

The share of Central Greece on the total consumption, can be explained by the population concentration to this area as more than half of Greece's population is concentrated in Central Greece

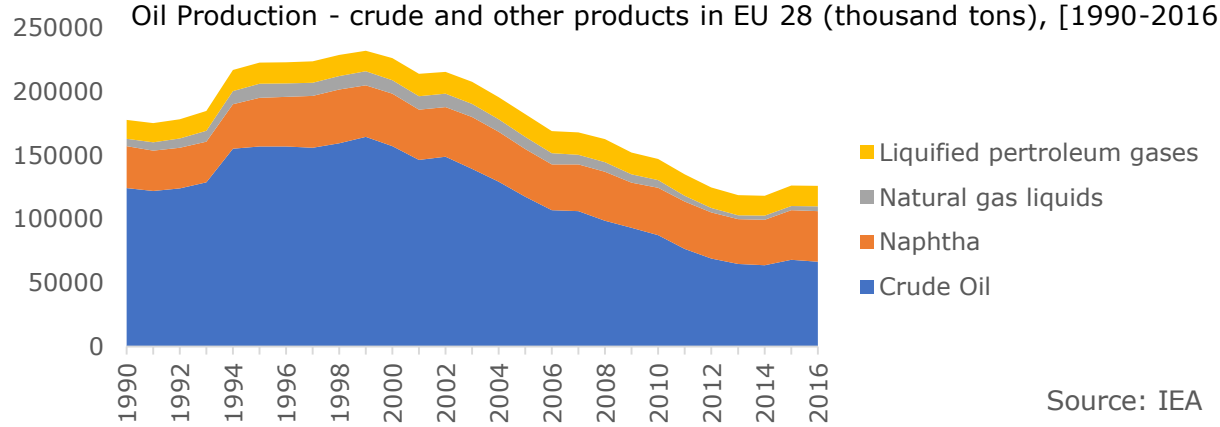
Oil consumption in the islands, which consists 10% of the total consumption, is mainly driven by power generation. This is due to the non-interconnection of these islands with the continental Greece. It is expected that, the planned interconnections that are going to be completed in the near future, will significantly reduce the usage of oil fuels for power generation of the islands.

The European Union has reduced its crude oil production as indigenous supplies are limited, still world production continues to rise steadily

Oil Production - crude and other products globally (thousand tons), [1990-2016]



Oil Production - crude and other products in EU 28 (thousand tons), [1990-2016]



Source: IEA

Highlights

The global oil liquid supply showed a 0.74% y-o-y growth in 2017, despite the decrease in the OPEC (Organization of Petroleum Exporting Countries) crude oil production. The non-OPEC liquids supply was increased by approximately 0.87 mb/d, mainly driven by the OECD Americas and specifically the US and then, Canada.

On the other hand, the oil supply from China and Middle East decreased. The decrease in the OPEC crude oil production was mainly caused by Saudi Arabia, Venezuela and Kuwait.

Regarding the OECD Europe region, the annual oil supply slightly decreased. This was caused mainly by the reduction of North Sea's oil production due to some unexpected technical problems in the Goliat oil field, the longer platform maintenance duration and the natural declines of the mature oil fields.

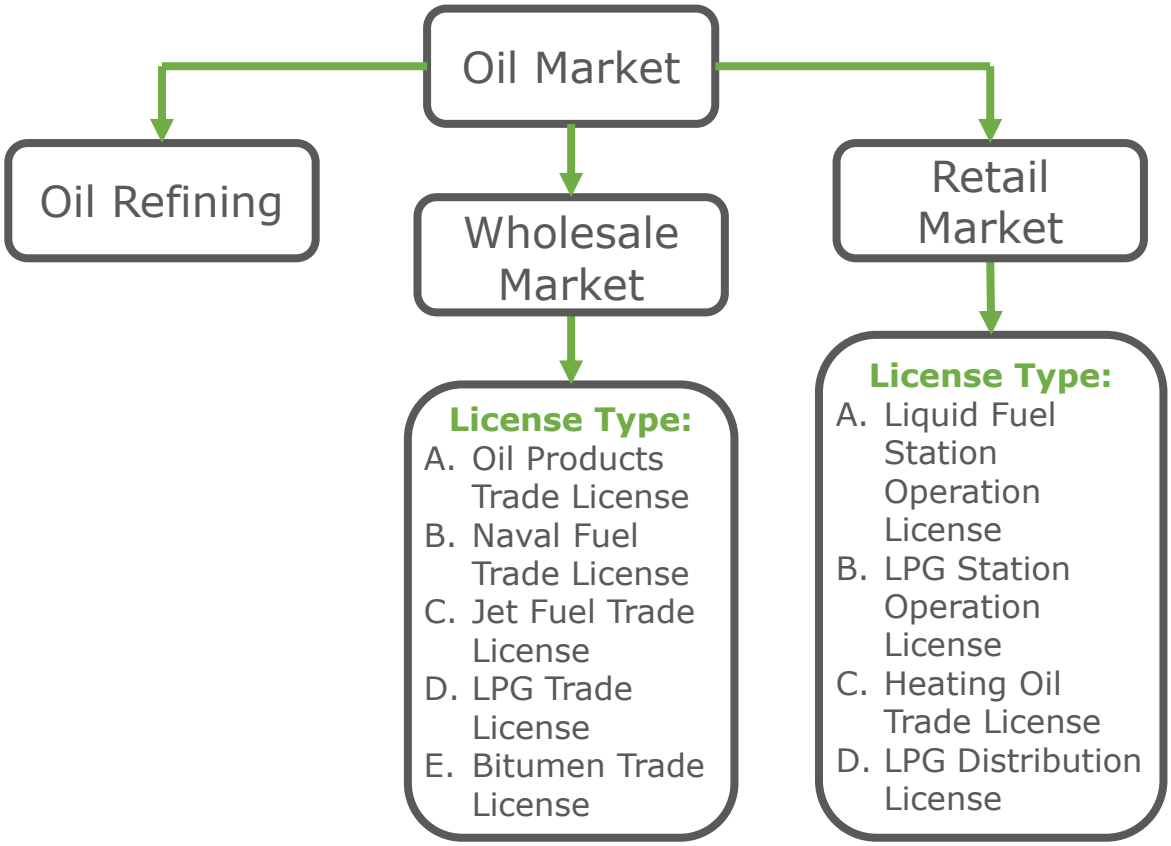
In 2018, crude oil supply is estimated to have increased, mainly due to the increased production in the US (shale oil) and some other non-OPEC countries. Nevertheless, the US reimposed a series of economic sanctions to Iran (that had been briefly relaxed since the 2015 nuclear deal), that reduced Iran's oil production and exports, significantly affecting the Mediterranean region. Moreover, Venezuela's oil production continued its sharp 2-year decline, hitting its lowest supply level in the 7 decades, at 1 million B/d.

Europe is one of the smallest oil producing continents. Russia is the largest oil producer in Europe. Other major oil-producing countries in Europe are Norway and the United Kingdom. Russian oil production rebounded sharply last year, after Vienna Agreement output cuts were unwound.

Norwegian oil production is on the cusp of a second expansionary phase. Output is set to grow by 0.6 mb/d by 2024 when it will reach 2.5 mb/d, the highest since 2008. As many as 20 development projects are under way on the Norwegian Shelf.

The Greek domestic oil market consists of three different sectors and is dominated by two refining companies

Domestic Oil Market Structure



Source: HAEE's analysis

Highlights

The Oil Refining sector consists of 4 refineries, which are owned by two different companies, HELPE and Motor Oil. The whole Greek oil market is principally served by these two refining companies and their subsidiaries in the wholesale and retail markets.

Over the recent years, the refineries have invested in complex programs and strongly increased their competitiveness. Therefore, during 2011-16, Greece's crude oil imports increased by over half, while net exports of oil products increased by almost six fold.

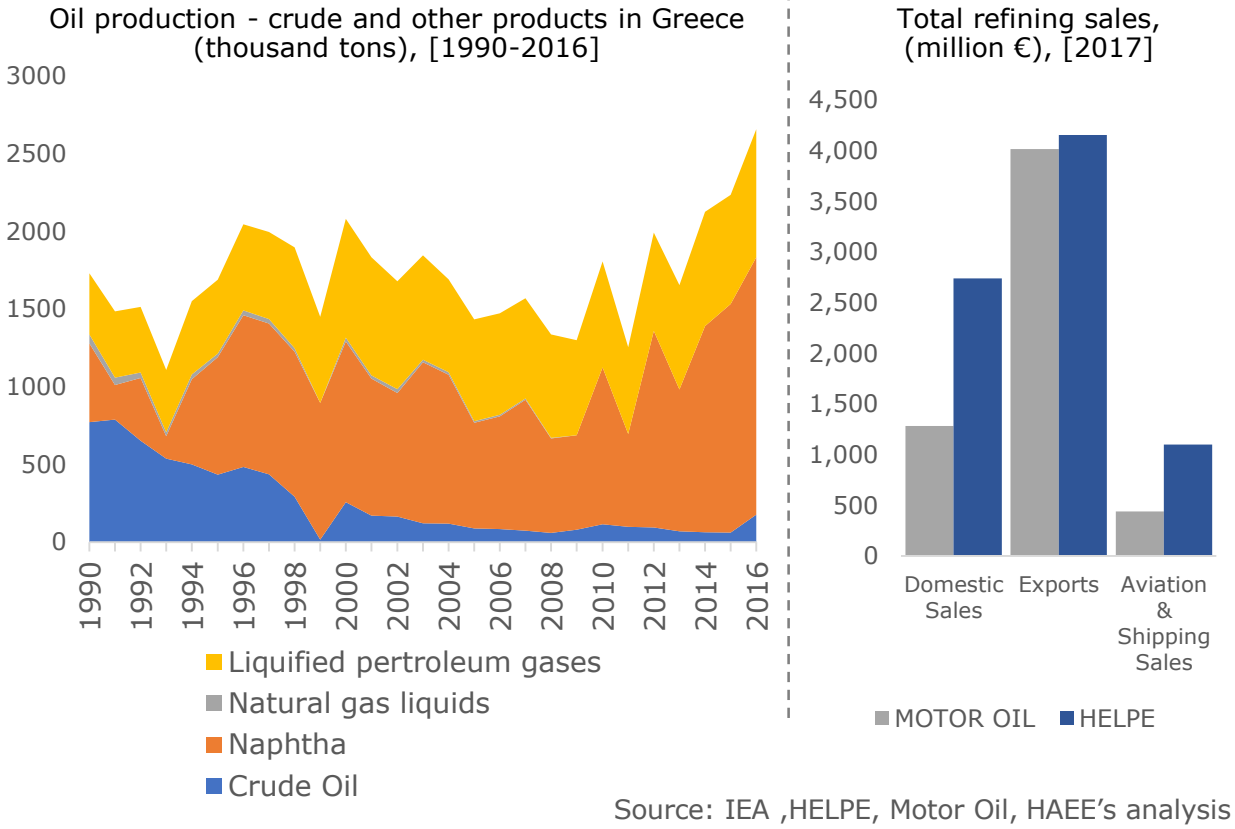
In the wholesale petroleum sector, over 53 companies operate, holding 80 licenses, with HELPE currently holding a wholesale market share of about 65%. To stimulate competition and encourage economic growth, Greek governments have reduced entry barriers into the downstream petroleum market.

More specifically, laws (4172/2013, 4223/2013, and 4447/2016) have reduced the minimum capital and storage capacity required for applicants for an oil trading license.

Regarding the retail market, HELPE merged its two retail companies (EKO and Hellenic Fuels) in 2016 into one company which accounts for over 30% of the market. Motor Oil's subsidiary (Avin Oil) alongside the Shell network (which is owned by Motor Oil) account for another 32% of the total retail market.

The Greek market appears well supplied, with 7,500 retail service stations, despite a significant reduction mainly due to the economic crisis and the resulting consumption fall. There is, on average, one retail station for about 1,400 inhabitants compared to a European Union (EU) average of 3,800 inhabitants per station (in 2015). This is partly explained by Greece's unique terrain, consisting of many islands and scattered isolated mountainous regions.

Greece's oil production is insignificant compared to the country's overall consumption, yet its refining capacity is substantial



Source: IEA ,HELPE, Motor Oil, HAEE's analysis

Highlights

Domestic crude oil production can be considered as insignificant compared to the corresponding increased oil consumption. Therefore, the country is overly dependent on large crude oil imports. Iraq was the largest supplier of crude oil in 2016, with 10 Mt, followed by the Russian Federation with 7 Mt. These two countries accounted for over half of the total crude oil imports to Greece.

Private company Energean Oil & Gas SA is the country's current only oil producer. The two producing offshore fields, Prinos and North Prinos, are located in the North Aegean Sea, in eastern Greece. Prinos and North Prinos have a cumulative production of 11mmbbls and 4.6 mmbls respectively.

Nevertheless, despite the limited crude oil production, there is a considerable production of Naphtha and Liquified Petroleum Gases (LPGs).

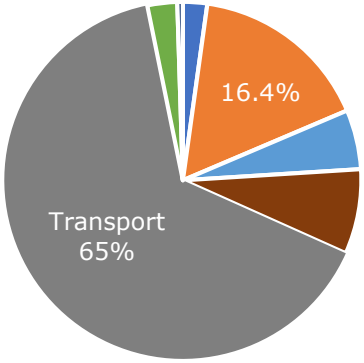
There are currently four domestic operating refineries, which have considerably increased their refining output during the last years, with a resulting six fold growth in the oil products net export over the last five years.

Three of the refineries are owned by HELPE and are situated in Aspropyrgos, Elefsis, and Thesalloniki. These refineries account for about 65% of the total refining capacity, while the last refinery is owned by Motor Oil, covers the remaining 35% of the capacity and is located in Agioi Theothoroi, near Korinthos.

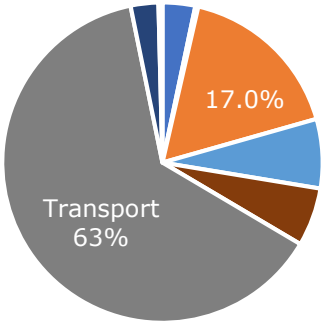
The majority of the domestic refining products are exported to foreign countries and predominately in Europe. Both refining companies (HELPE and Motor Oil) present similar export rates while domestic sales and sales in the aviation & shipping sector are currently dominated by HELPE. In that context, the increased export of oil products correlates with the recent growth in crude oil imports in recent years.

The transport sector consists the biggest source of oil consumption globally, as well as in Europe and Greece

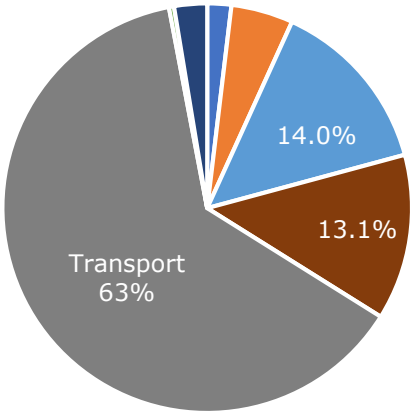
Share of oil consumption by sector globally (%), [2016]



Share of oil consumption by sector in EU 28 (%), [2016]



Share of oil consumption by sector in Greece (%), [2016]



- Commercial and Public Services
- Non-energy use
- Residential
- Indystry
- Transport
- Agriculture/forestry
- Non-specified

Source IEA, HAEE's analysis

Highlights

The largest oil consumption sector globally is the transport sector. The transport sector's oil consumption is more than 60% of the total oil consumption. The same pattern appears in Europe as well as in Greece.

In EU within the transport sector, road transport consists the main consumer with 47.8 %. The other two sectors of transport consumption are shipping and aviation with 8.2% and 9% respectively

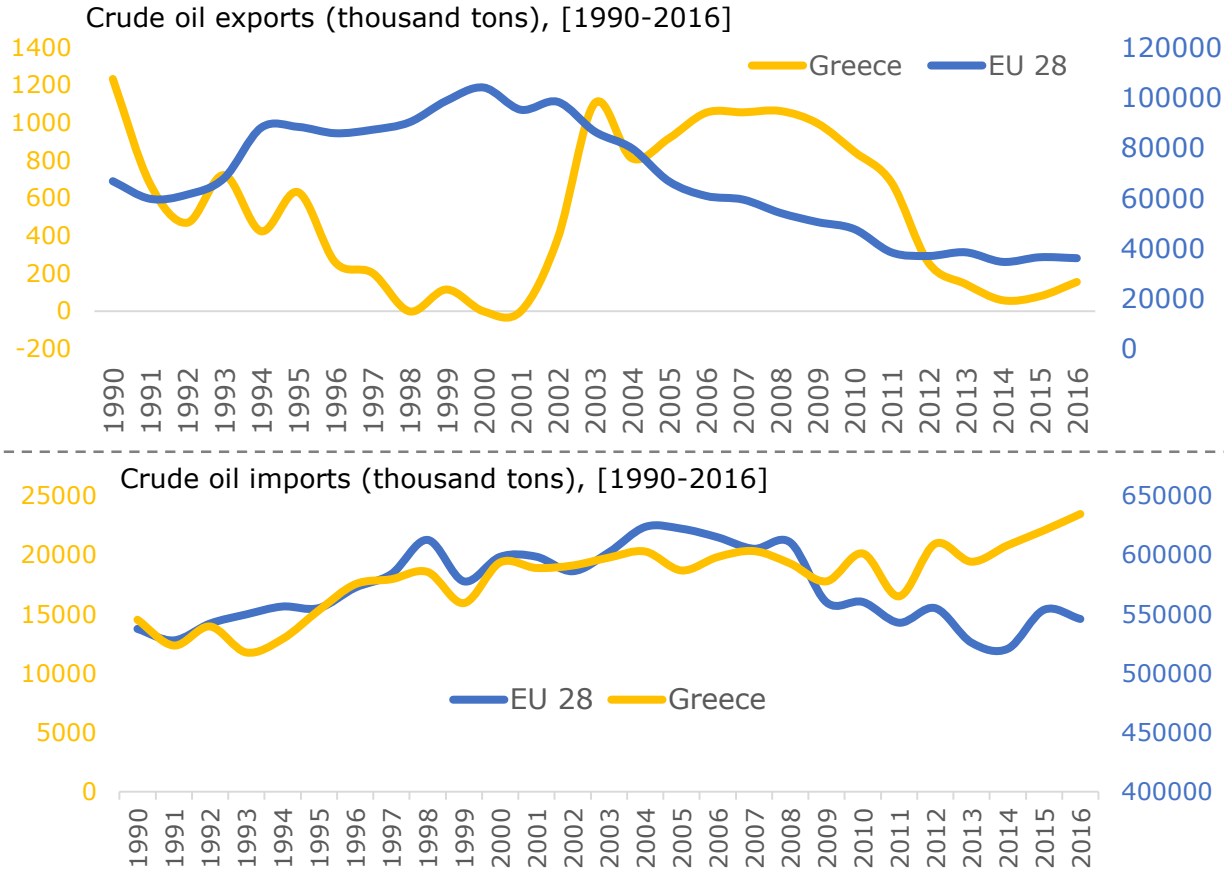
Moreover the non energy use globally and in Europe is the second biggest consumer, consisting more than 16% of the total consumption. Petroleum products are also used for non-energy purposes, which is the second highest sector of consumption after transport. Non-energy consumption includes, for example, bitumen for road surfaces, the use of lubricants for reducing friction as well as the use of oil products in the chemical industry for chemical properties rather than energy content (combustion). In Greece, non energy sector consists only 5%.

On the other hand the industrial consumption in Greece represents 13% of the total oil consumption, which together with the 14% of the residential sector, are covering one fourth of the total consumption. This can be explained by two parameters.

The first is that there are continental areas in Greece which do not have access to natural gas, and as a result have as a sole option the consumption of oil. This applies both for the industries that need thermal energy for their manufacturing activities, and residential customers which use oil as a heating fuel.

The second parameter concerns the islands of Greece, for which there is no access to other fuels as well. The islands use refined oil products for power production (for the non interconnected islands) and for heating and other uses. Both globally and in Europe, oil products for industrial and residential use, respectively consist one tenth of the total production.

Though the transition to alternative sources of energy has started, dependency on imports of crude oil and petroleum products remains high



Source: IEA, HAEE's analysis

Highlights

There was a slight increase in the dependence of the EU countries on imports of fossil fuels (gas, solid fuels and oil) from non-EU countries. Oil imports from non-EU countries raised from 52.1% to 53.6%, between 2005 and 2016. In 2016, oil accounted for 59.2% of total net imports.

The extremely high external dependency of the EU has to be seen in a context of higher exposure to supply risks as dependency from supply sources in geopolitically unstable regions has increased.

In absolute terms, there was a decrease of 8% in the net import of fossil fuels between 2005 and 2016. Between 2005 and 2016, net imports of oil decreased by 11 %. In 2016, net oil imports accounted for 86.7% of oil-based gross inland energy consumption plus bunkers. Besides, the majority of the imported oil is crude oil which is then refined in the EU.

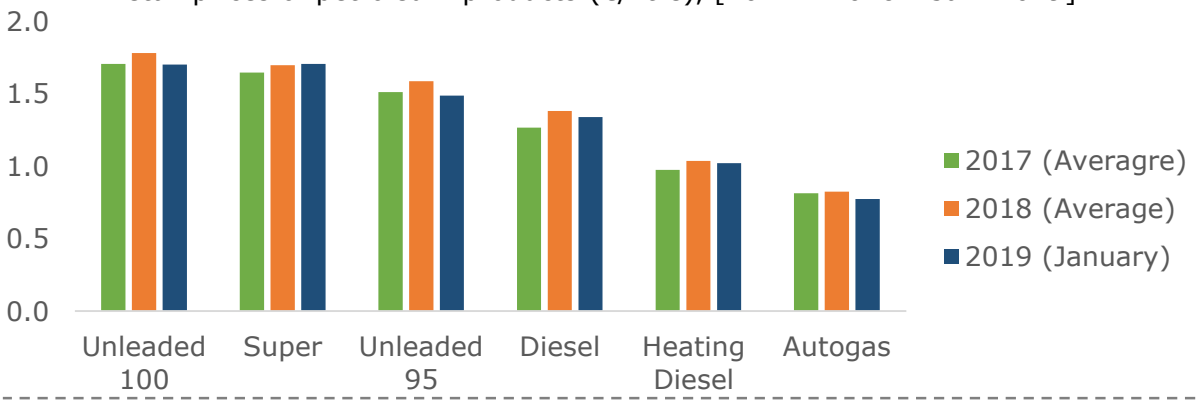
In Greece, an increase of the crude oil imports is observed since 2013, which has been growing in 2017 and 2018 as well. This is due to the increased production of the two refining companies existing in Greece, for which the biggest share of oil products is exported.

Crude oil production in Greece, represents a small portion of the Greek consumption, yet this share is rising. Energean Oil, which is currently the sole crude oil producer in Greece has increased its production during the last years.

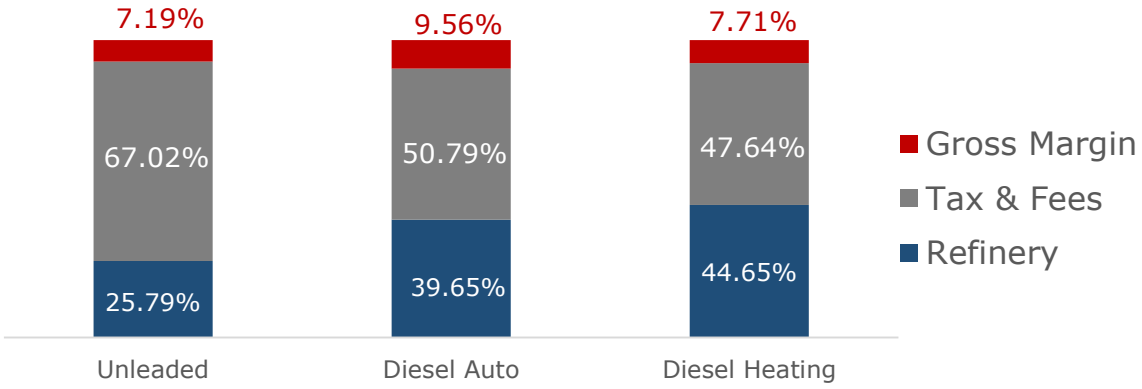
Dependence on oil in the EU during periods of high oil price shocks has led to economic instability. The price spike in 2008, raised price inflation in the majority of EU's countries. Hence, the European Commission has put in place some measures to reduce the risks of dependency and improve Europe's energy security. Through the Oil Stocks Directive, EU Member States are obliged to hold stocks of oil to reduce the effects of supply shortages.

Retail prices of oil products are burdened with heavy taxes, which represent in most cases more than 50% of the final consumer price

Retail prices of petroleum products (€/litre), [2017 – 2018 – Jan. 2019]



Oil prices breakdown (%), [January 2019]



Source: Elstat, HAEE's analysis

Highlights

A relatively low volatility of retail prices is observed during the previous 3 years. Within 2018, there was a small increase in the final prices in Greece, in almost all petroleum products. The price trends have been decreasing during the last 3 months of 2018 and over the beginning of 2019.

Fuel taxation in Greece has increased in recent years and is one of the highest in the EU, as well as the contribution of petroleum products tax to the revenues. Considering the January of 2019, unleaded is burdened with a tax of 67% on the final consumer's price. The respective percentage for diesel auto is almost 51% and for diesel heating 47%.

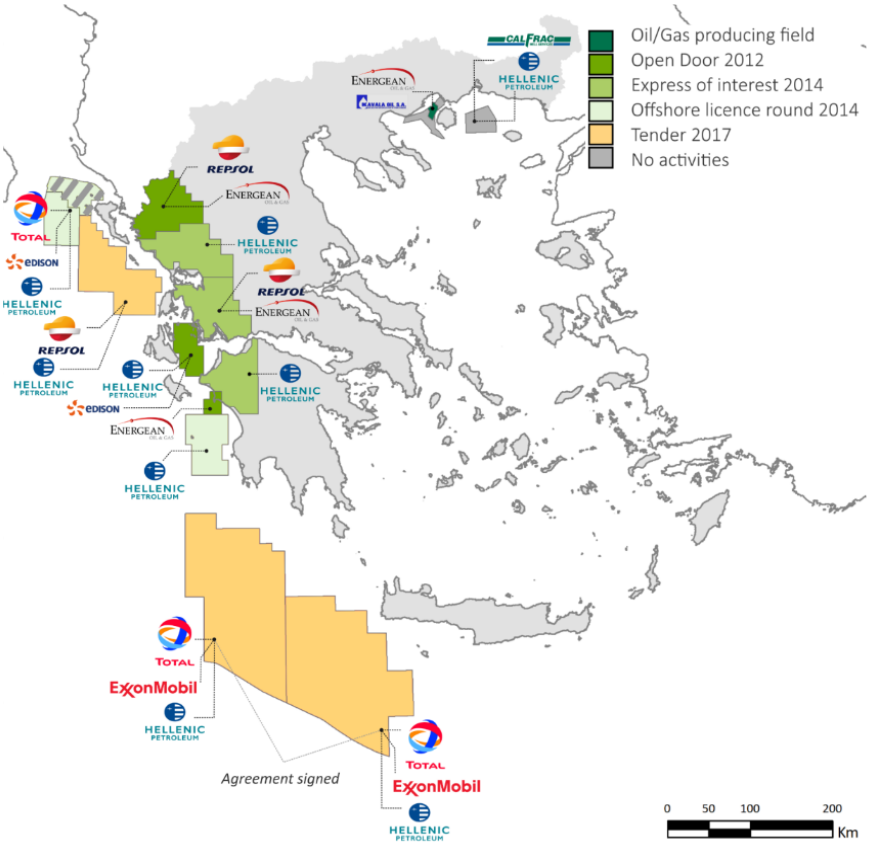
Greece has on average the 3rd highest final gasoline price in all 28 EU countries. Excluding duty and taxes, Greece is in the 10th position. The contribution of fuel taxes to national revenues is extremely important for all European countries. Slovenia (12%) has the highest contribution of fuel taxes to revenues with Denmark being in the lowest position (3%). The corresponding rate for Greece stands at the level of 8%.

There are specific regions of Greece where, oil fuel prices are much higher than the average. These regions are mainly the islands and remote areas, where transportation is more difficult and expensive.

The Gross Margins of the retailers are remaining relatively steady during the years. These margins remain at the levels of 7% to 10%. According to the most recent data, diesel prices for Greece from 31-Dec-2018 to 08-Apr-2019 stand at the average value of 1.37 euros with a minimum of €1.34 on 07-Jan-2019 and a maximum of €1.41 on 08-Apr-2019. For comparison, the average price of diesel in the world for this period is 1.20 euros. The same upward trend holds for gasoline prices, that increased from 1.5 euros at the starting of the year to 1.63 per litre in April 2019.

A number of new oil exploration and development blocks could lead to further investment and increased domestic production

Exploration and discovery, [March 2019]



Source: HHRM

Highlights

According to Hellenic Hydrocarbon Resources Management (HHRM), there are currently 13 oil exploration blocks. The exploration zones consist of 4 onshore blocks (Aitoloakarnania, Ioannina, Arta-Preveza and NW Peloponnese) and 9 offshore blocks (Katakolon, Patraikos Gulf, Sea of Thrace Concession, West of Crete, Southwest of Crete, Block 1, 2, 10 and Ionian).

Apart from the exploring blocks, Energean Oil and Gas SA is currently developing the West Katakolo Exploitation area, part of Katakolo block, having a 100% working interest. This area covers 60 km2 and NSAI has audited 10.5 mmbls 2P reserves in the block, while Energean SA expects production from the block to start by 2019/20.

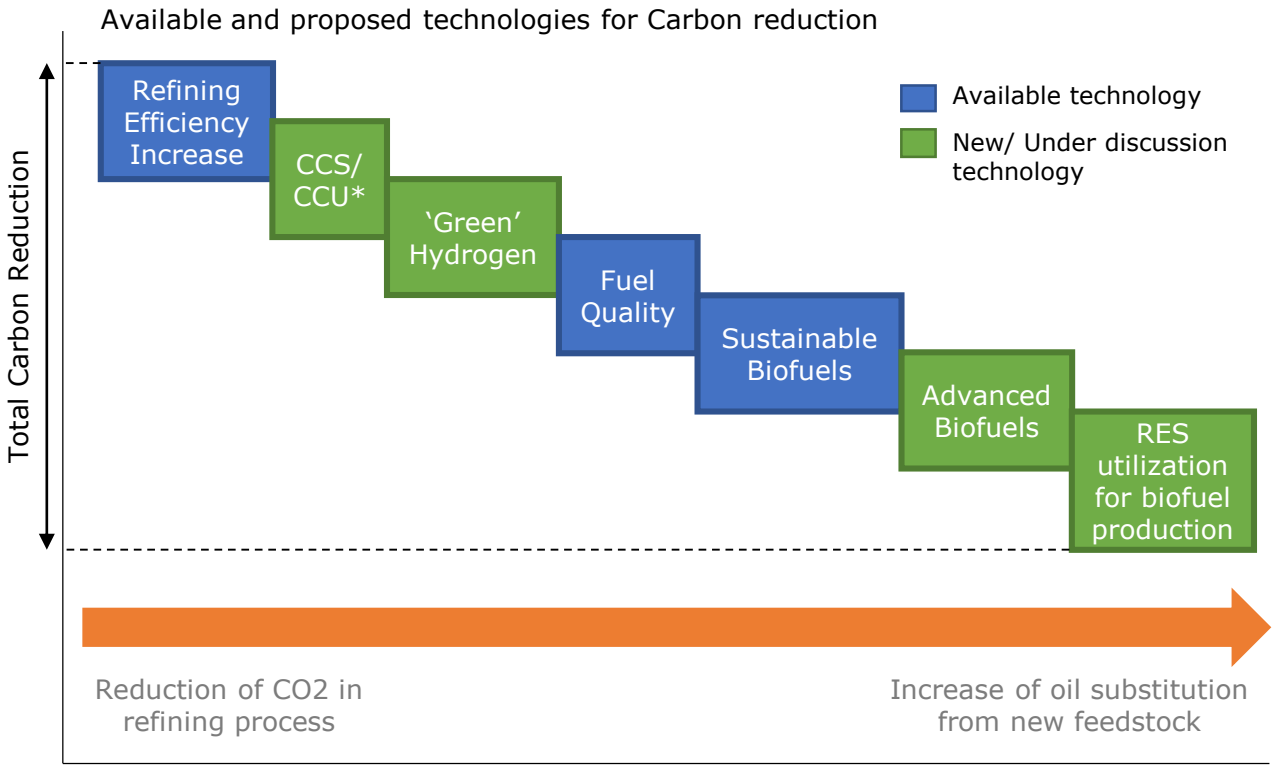
Domestic oil production from the new exploration and developing blocks is expected to be increased but not to an extend to significantly reduce Greece's import dependency. Nevertheless, the confidence shown by investors in the Greek economy could be an important catalyst for further investment in the energy sector and beyond.

It is therefore critical for Greece to reach an early conclusion of the ongoing licensing rounds and to ensure the shortest possible time delay in the call for bids, the announcement of winners, and the signing of licenses.

According to HHRM, exploration will progressively move in the next years from north to south and from shallower to deeper water depths. The existence of multinational giant corporations, such as Total, Exxon Mobil, Repsol and Edison in the west side of Greece, reveals the high potential that Greece offers.

Given the increased depth, especially for the 2 blocks on the west side of Crete, the challenges that need to be suppressed are enormous since it could reach the level of 3000 meters. At the same time, progressive improvement of deep and ultra-deep drilling technologies are observed, with all the consequences that this may signify.

Refining sector is expected to evolve in a way that mitigates climate change by adopting new low-carbon technologies in the following years



*CCS: Carbon Capture and Storage
CCU: Carbon Capture and Utilization

Source: Fuels Europe, HAEE's analysis

Highlights

The refining system is expected to have a vital role in the transition to the low carbon economy as the global demand for liquid hydrocarbons will continue to grow in the following years.

As a result, refining industries are required to develop new business plans and evolve in order to gradually reduce the liquid hydrocarbon CO2 emissions. This can be achieved by the utilization of alternative raw material mixes (such as biomass, waste and captured CO2) in a very efficient manner.

This evolution of the refining sector could be divided in three different steps-phases: Early stage, Evolution stage and Future stage.

In the early stage, the objective is to achieve a low emission operation. The product mix will be oil-based with a partial low-carbon content in order to meet the energy and GHG (Greenhouse Gas) regulations and targets.

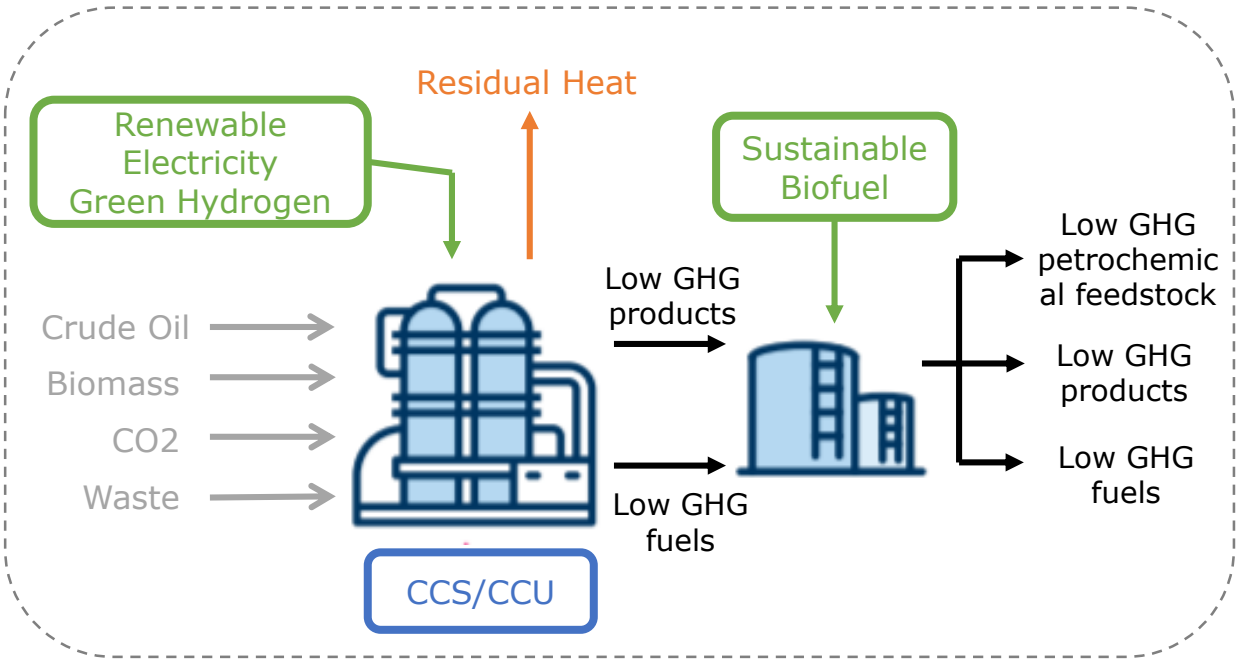
During the Evolution stage, low-emission components are expected to be gradually introduced. The refineries' co-processing low-carbon feedstock will gradually transform and the product mix will consist of a higher ratio of low-emission products.

In the future stage, refineries are estimated to become efficient manufacturing centers, potentially integrated in a cluster of industries processing a variety of feedstocks and products. CCS and CCU are expected to play major roles while the product mix will be based on low-emission fuel.

It is worth noting that the cost of this evolutionary procedure is likely to be high and as a result, a policy framework and appropriate measures must be in place in order to protect the international competitiveness of the EU refining industries.

Future refineries are expected to become hubs for the production and distribution of low-emission products and raw materials

Future refinery conceptual overview



Source: Fuels Europe, HAEE analysis

Highlights

Refineries will find ways to reduce CO2 emissions through a combination of operational measures, targeted investments, and by taking advantage of external opportunities. Some key discussion points are presented below.

Low-grade heat resulting from refinery operations could be used to produce electricity for both internal and external consumption. The extension of heat-pump technology to achieve higher temperatures and alternatives to electric power could also be a point for development

Closer integration with other industries such as petrochemicals, which are often located within the same industrial hub, could also be pursued. This can also provide further options for energy efficiency measures such as shared utilities that can lead to better optimization of heat, steam and power.

The refining system could reduce its carbon emissions through the use of low-carbon electricity, either generated within the refinery or imported. Several refineries are engaged in projects aimed at using or producing the so-called "green hydrogen", i.e. hydrogen produced from renewable electricity.

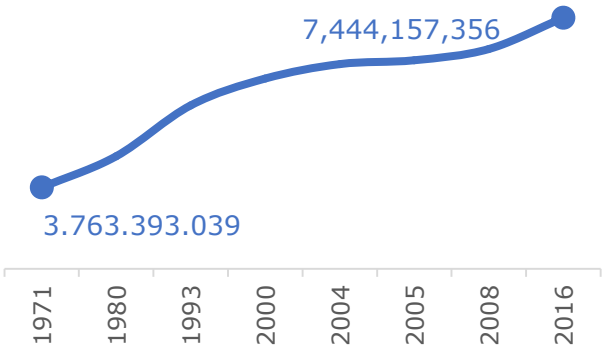
This provides the double advantage of lowering emissions from fuels and other refining products, while at the same time allowing the storage of excess renewable electricity generated when supply exceeds demand.

Carbon capture storage and utilization have been widely identified as the leading technologies to mitigate climate change. Applied to refinery flue gases, CCS and CCU could play a major role in the energy transition when used by refineries located in clusters with other industries. Finally, the development of alternative fuels for production and for distribution is also an area of high interest for companies.

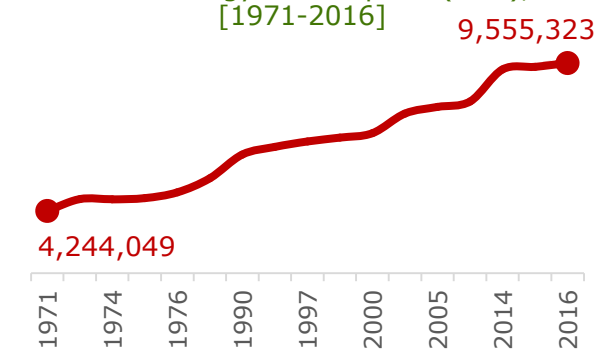
7. Energy Efficiency

Increasing population across the world leads to higher energy consumption, and consequently energy efficiency becomes a priority

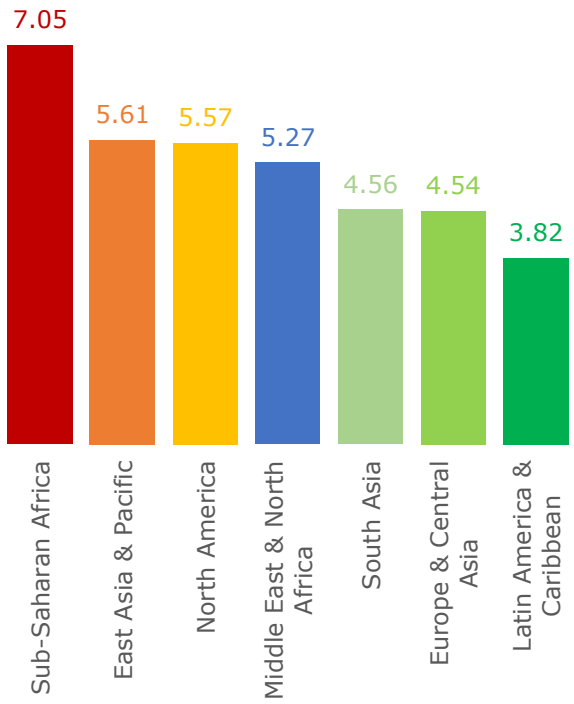
World population, [1971-2016]



Global energy consumption (ktoe), [1971-2016]



Global energy efficiency by region (MJ/$), [2015]



Source: World Bank, IEA, HAEE's analysis

Highlights

Global energy consumption followed an upward trend from 1971 to 2016 and in the same period of time world's population almost doubled, enhancing the need for additional energy and challenging the human sustainability. However, the remedy for this threat is well-known and is called energy efficiency. Energy efficiency can be defined as the aggregated energy used for the production of 1 unit of GDP and varies among different regions of the world.

Sub-Saharan African countries use approximately 7 MegaJoule for the production of 1 GDP unit while the East Asia & Pacific countries, North America countries, and Middle East & North Africa countries use approximately 5,5 MJ less for the same GDP production (2015). On the other hand, more energy efficient regions such as South Asia and Europe & Central Asia use 1 MJ less for the same GDP production. Finally, Latin America & Caribbean countries are appeared to be the most energy efficient using only 3,82 MJ/$.

The comparative efficiency of some regions against other should not be interpreted as a general component of efficiency, seeing that coordinated effort in the whole world is required so as to meet the desired levels of energy consumption. Nevertheless, specific regions have more distance to cover in order to meet the predefined restrictions.

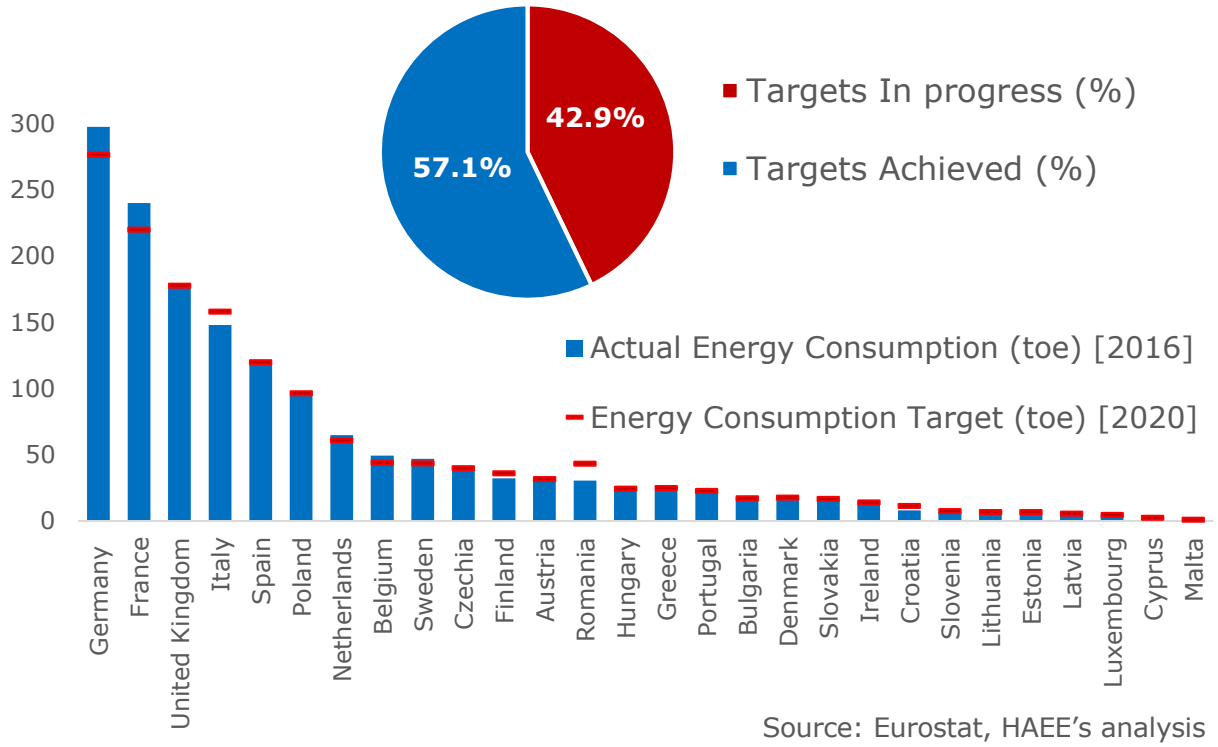
Nowadays, global energy consumption continues to rise mainly due to Asia's growth (and subsequent energy consumption) in countries such as China, India, Malaysia, and Indonesia. Moreover, USA's energy consumption remains stable and Europe's growth slightly increases the global energy demand.

Europe not only is the sole continent which complies with the international standards for energy efficiency but also enacts extra restrictions by setting specific energy targets for 2020, 2030 and 2050. The aggregated European target for energy efficiency is divided into a separated goal for each country.

The majority of EU countries already meet the energy consumption targets set by European Union for 2020

Chart: Energy consumption and the corresponding national target by country (toe), [2016]

Pie: The percentage of countries which have already achieved their national target (%), [2016]



Source: Eurostat, HAEE's analysis

Highlights

EU has committed to reduce energy consumption by 20% until 2020, which is translated into no more than 1.483 Mtoe of primary energy consumption. The corresponding number for 2016 was 1.547 Mtoe (4% higher) and the trend for primary energy consumption is upward. Therefore, more effort is required for target completion.

The percentage of countries that have already achieved their national energy target was 57% in 2016, and undoubtedly financial crisis played a crucial role in their energy efficiency performance. On the other hand, 43% of EU-28 countries should take additional measures for energy efficiency so as to meet their goals until 2020.

The most energy consuming countries such as Germany, France and United Kingdom appear significant divergence between actual energy consumption and their target. Moreover, Netherlands, Belgium and Sweden could be categorized as the second less efficient countries in terms of energy reduction.

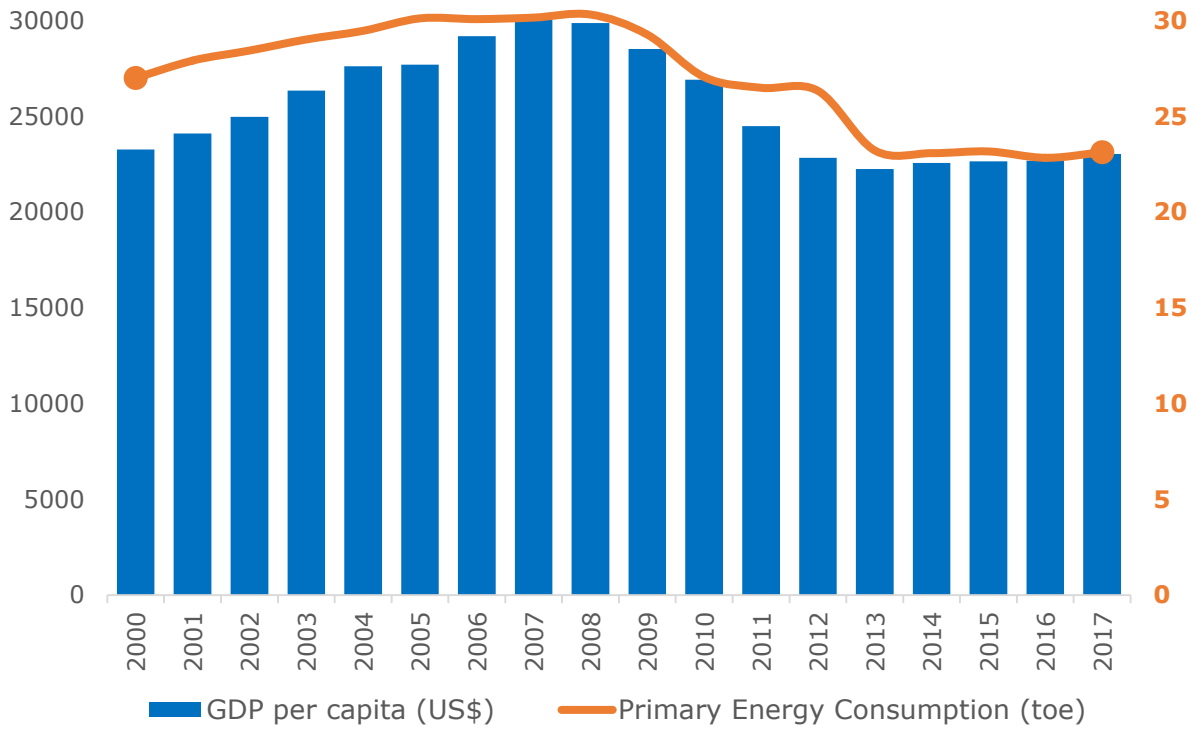
Italy, Romania, Finland and Croatia have managed considerable decreases in primary energy consumption and consequently lead the Europe in this particular category. Nevertheless, the source of this efficiency is questioned due to economic crisis; if the financial crisis is the actual driving force of energy reduction, then efficiency constitutes a statistical result and further effort will be needed in the future.

Policy followed by European Union is expected to be stricter for 2030 (32,5% improvement in energy efficiency) and 2050 (carbon free economy), thus EU countries will be forced to change the structure of their economies in order to be transmitted into an energy-efficient world.

Greece belongs in the countries which have achieved their energy target by 2020 and is ranked 15th in a total of 28 European countries as far as the energy consumption is concerned.

Economic crisis decreased the economic activity in Greece and secured the achievement of the national energy target for 2020

GDP per capita (constant 2010 US$) & primary energy consumption (toe) in Greece, [2000-2017]



Source: World Bank, Eurostat, HAEE's analysis

Highlights

Among EU 28 countries, Greece has experienced the largest reduction in energy consumption which declined by 23.6% during the 2006-2016 period.

From 2000 to 2007 the GDP per capita increases, but beyond this point and until 2013, the GDP sharply falls due to the visible aftermaths of financial crisis. From 2014 to 2017 there is a slight recovery in the economy which is translated into a steady and slow increase in GDP per capita.

In the corresponding period, the primary energy consumption rise as well, peaking at 30,31 toe in 2008. Due to the influence of financial crisis in 2008, primary energy consumption follows a downward trend with a high decrease in 2012 (12%). The consumption between 2013-2017 remains stable.

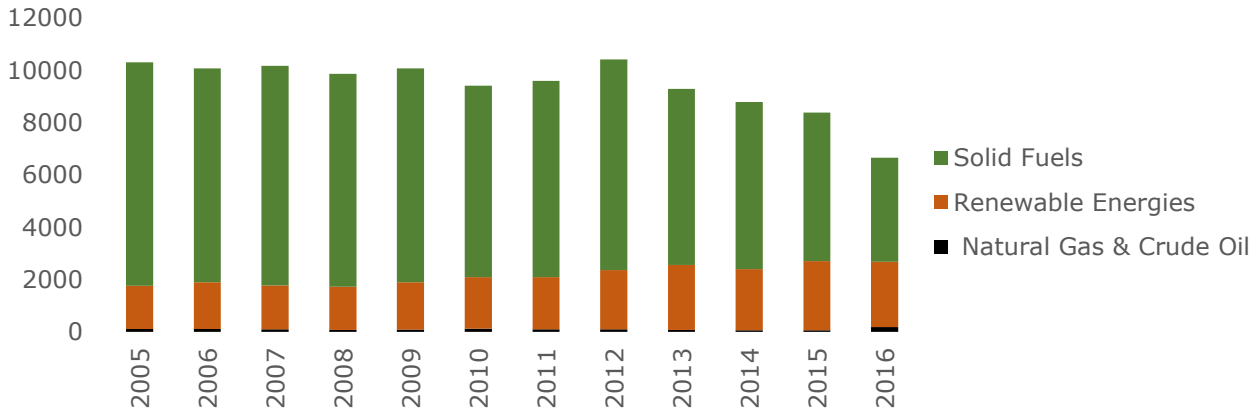
The interplay between GDP per capita and energy consumption reveals that energy efficiency in Greece, as in the majority of EU countries that have achieved their targets, is an output of decreasing economic activity and it does not reflect the transformation of Greek economy into an energy efficient country.

It should also be noted that despite the apparent efficiency which is visible in the study of GDP and energy consumption, there are no other elements to indicate energy efficiency in Greece. Therefore, the theory according to which the efficiency is only an output of the crisis, gains robustness in the case of Greece.

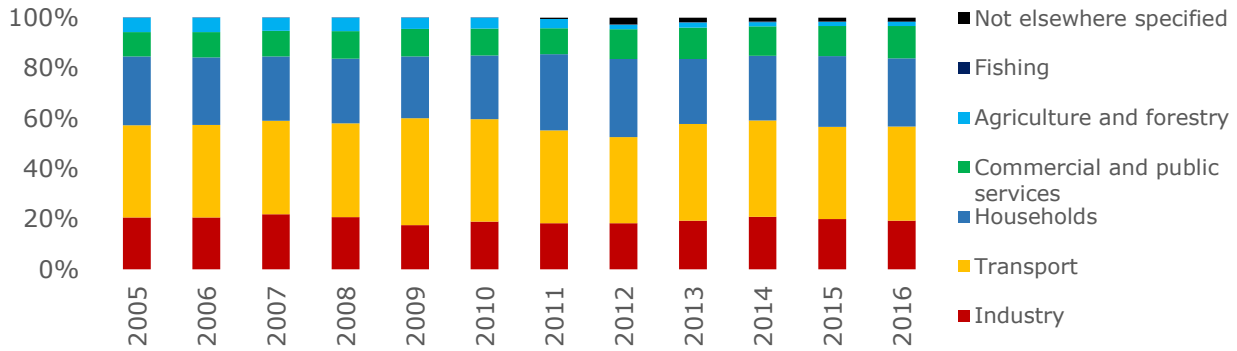
Reductions in energy consumption as depicted above are far away from equal distributed among different sectors of the economy, with some sectors contributing more in efficiency and other being less energy efficient. Additionally, the variety of fuels used in the production process is very wide and, as a result, the transformation of the economy in an energy-efficient way requires the modification of fuels used, to renewable sources of energy.

Energy consumption in Greece varies significantly among different fuels and sectors

Primary energy consumption by fuel (toe) [2005-2016]



Final energy consumption by sector (%) [2005-2016]



Source: Eurostat, HAEE's analysis

Highlights

The reduction of GDP is definitely the major factor that guides Greece in the completion of its energy target, but also additional factors played vital role in this direction and one of them is the considerable changes of fuels used in the economy.

Solid fuels are the major energy source in Greece, but their intensity has been reduced significantly. In particular, solid fuels have been diminished by 53.5% from 2005 to 2016 and have been partially substituted by renewable energy sources which in the same time-horizon have been increased by 52.2%.

It is evident that in absolute values the reduction of solid fuels is not equal to the increase of renewable energies. What is more, the combined impact of nuclear heat, natural gas and crude oil in energy use of Greece is limited, seeing that they constitute only 3% of the final energy consumption.

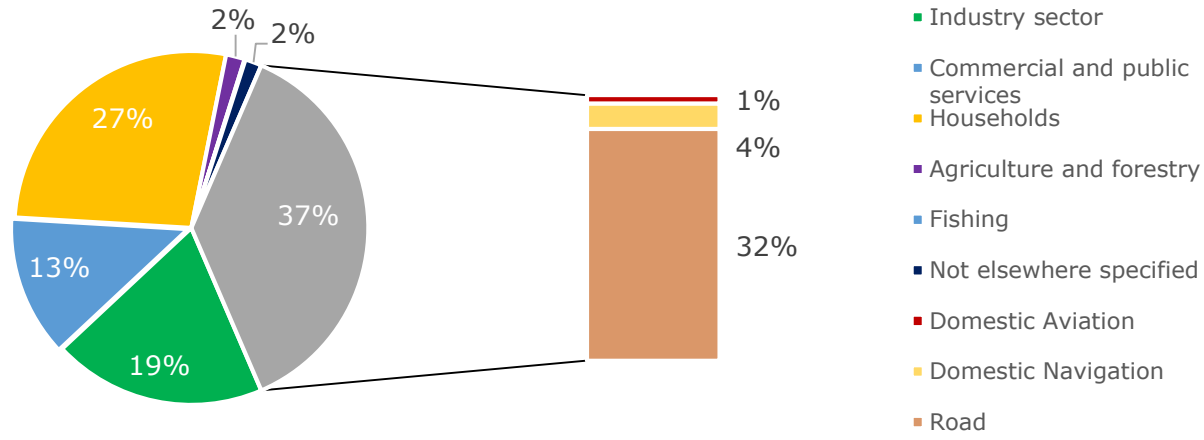
Some sectors of the economy consume higher proportion of aggregated national energy and especially transportation is the leading sector in energy consumption with an average share of 38% between 2005-2016. Considerable percentages exist for households and industry as well, with average percentages of 27% and 20% respectively for the last decade.

Commercial and public services sector participate in final energy consumption with a percentage of 11% in average, while fishing, agriculture, forestry and the remain sectors of the economy use only 4% of the final energy consumption.

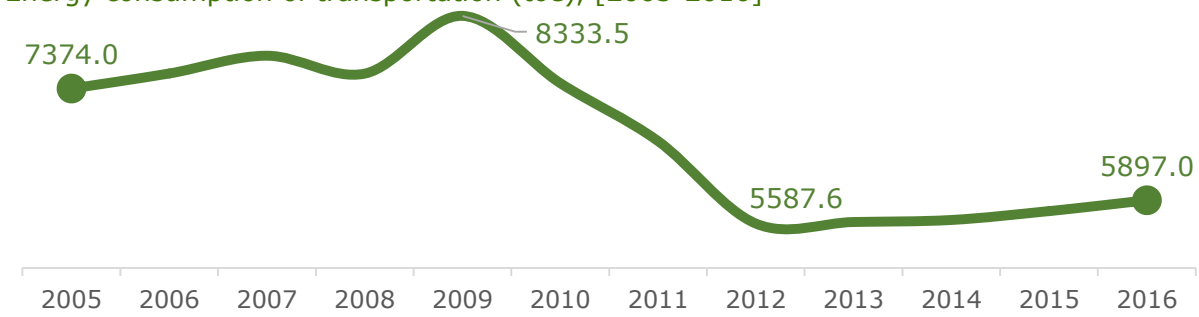
It can be observed that there are no significant differentiations in the way the energy is distributed among the sectors of the economy during 2005-2016 period. However, the consumption and consequently the efficiency inside each sector is of great interest, on the grounds that it reveals the specific fields that require improvement.

Transportation constitutes the most over-consuming sector of the economy as far as the energy is concerned

The sources of transportation energy consumption in Greece (%), [2016]



Energy consumption of transportation (toe), [2005-2016]



Source: Eurostat, HAEE's analysis

Highlights

In 2016, transportation sector consumed 37% of the primary energy consumption in Greece, while the representative numbers for households and industry consumption were 27% and 19% respectively. Additionally, commercial and public services used 13% of the energy and the other sectors of economy (including agriculture, forestry and fishing) consumed 4% of the energy.

Focusing on transportation (the leading sector of energy consumption in Greece), the 37% of the total consumption corresponds to 32% road consumption, 4% domestic navigation and 1% domestic aviation. Rail's consumption percentage is approximately zero.

It is obvious that energy improvements in road transports will multiply the efficiency in Greece, seeing that road transports are responsible for 5.093 toe of energy consumption which represents 32% of the aggregated energy consumption and 86% of transportation's energy consumption.

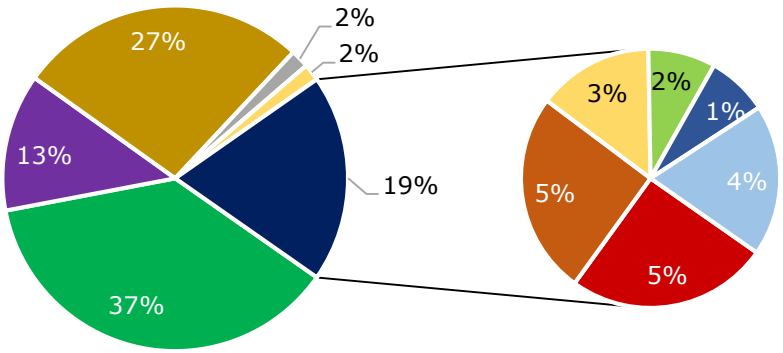
Electric vehicles should be promoted in order to minimize the energy consumption in road transports and contribute to energy efficiency. However, the regulatory framework in Greece should be revised in order to be considered as appropriate for the dominance of electric vehicles in the Greek transportation sector.

Energy consumption in transports follows an upward trend from 2005 and reached a maximum point of 8.333,5 toe in 2009. Beyond this point, the financial crisis led to an extensive decrease from 2010 to 2012 (30%) but after 2013, the energy consumption recovered and started to increase steadily.

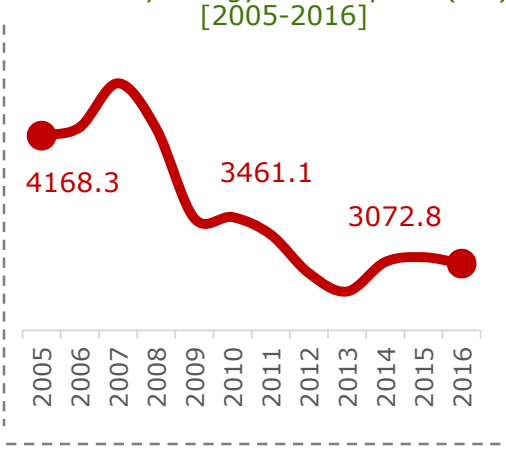
Overall, transportation and industry are the main consuming sectors of the economy in Greece and further effort in energy efficiency is required on those sectors.

Improvements to specific industry sectors could lead to higher energy efficiency

The sources of industry energy consumption in Greece (%), [2016]



Industry energy consumption (toe), [2005-2016]



- Transport sector
- Households
- Not elsewhere specified
- Non-Metallic Minerals
- Construction, Iron and Steel
- Not elsewhere specified
- Commercial and public services
- Agriculture and forestry
- Non-ferrous metals
- Food, Beverages and Tobacco
- Minning and Quarrying, Chemical

Source: Eurostat, HAEE's analysis

Highlights

In 2016, industry sector consumed 19% of the primary energy consumption in Greece, while the representative numbers for households and transportation consumption were 27% and 37% respectively. Additionally, commercial and public services used 13% of the energy and the other sectors of economy (including agriculture, forestry and fishing) consumed 4% of the energy.

Focusing on industry, the 19% of energy consumption corresponds to 5% non-metallic minerals, 5% non-ferrous metals, 3% food, beverages & tobacco, 2% construction, iron and steel, 1% mining and quarrying, chemical and petrochemical and 4% to other sectors that they have not been elsewhere specified.

There are several policies for energy efficiency in Greek industry including programs such as relocation of businesses and industrial parks, support for the improvement of energy efficiency in manufacturing businesses, green enterprises and other. Not only additional measures but, also more participation from the side of businesses, are needed for the improvement of energy efficiency.

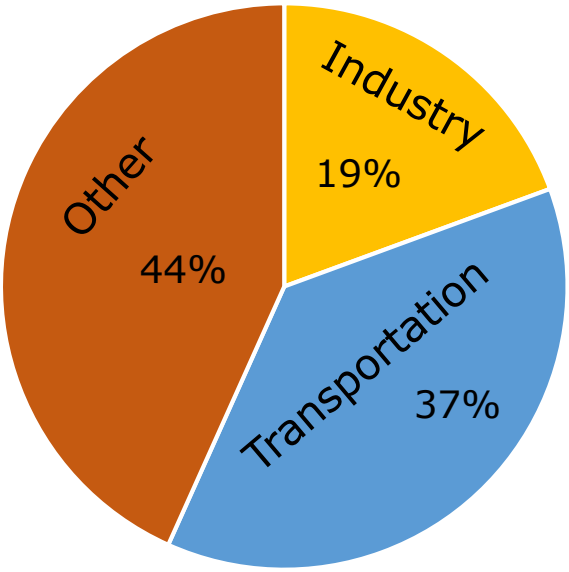
Industrial sector could play a vital role in the recovery of Greek economy, seeing that national businesses could develop comparative advantage related to their efficiency in energy use.

Industry energy consumption picks at 4.616,9 toe in 2007 and beyond this point begins to decrease. In 2009 there is a minimum point of 3.461,1 toe and the consequences of financial crises lead to an even smaller level of 2835,2 toe in 2013. In the most recent years, there is stability and a slight increase at 3.072,8 toe of energy consumption.

Apart from transportation and industry, the other sectors of economy absorb 44% of the aggregated energy.

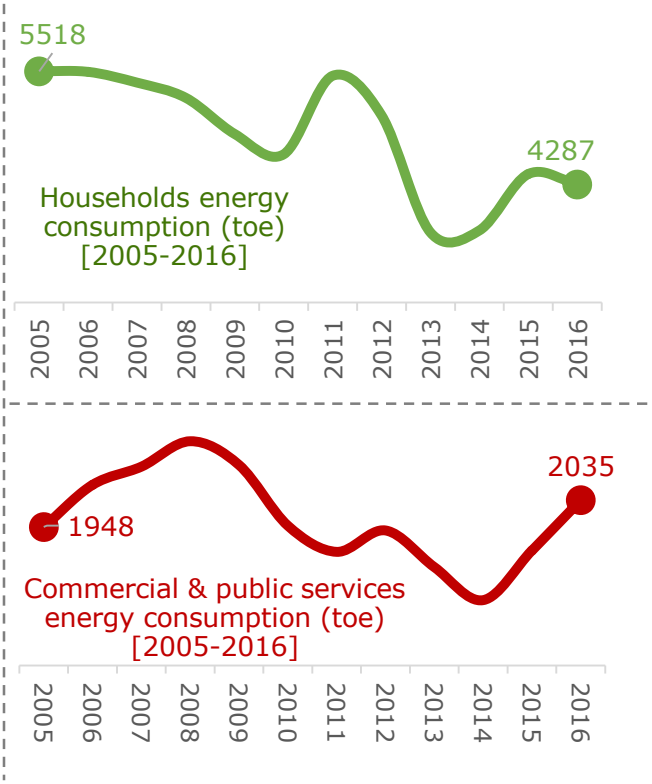
Except for industry and transportation, sectors such as commercial & public services and households, consume the highest proportion of energy in Greece

Final consumption of energy by sector in Greece (%) [2016]



Other includes households, commercial & public services and other sectors of the economy that are not separately specified

Decomposition analysis of other sectors in Greece (toe) [2005-2016]



Source: Eurostat, IEA, HAEE's analysis

Highlights

Households consumption of energy present fluctuations during 2005-2016. Particularly, the consumption value starts at 5.518 toe in 2005 and continuously decreases until 2010, where it reaches a minimum of 4.615 toe. After that point there is a one-year increase of 18,5% in 2011.

From 2012 and onwards, household consumption of energy reaches the minimum point of the decade in 2013 mainly because of the climate conditions of the country. After that point, it continues to increase until now.

The notable decreases in energy consumption of households exist mainly because of the climate conditions of the country and its financial position, rather than efficiency measures and policies that should have been properly designed and applied.

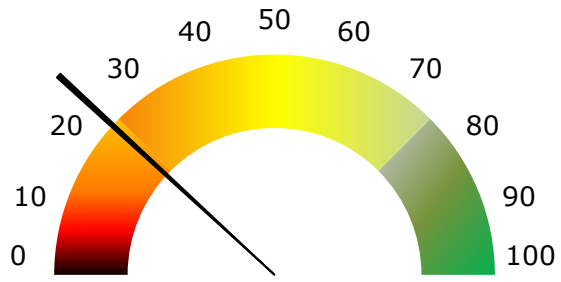
Commercial & public services consume less energy compared to transportation, industry and household sectors but in absolute values, improvements on this sector could imply remarkable progress in energy efficiency.

From 2005 to 2008 the energy consumption increases from 1.948 to 2.225 toe which is translated into a 12.2% rise while 2.225 toe constitutes the decade peak. During 2009-2011 the consumption of commercial & public services sector decreases by 13% and the following year rises again to 1.937 toe. In 2014 the sector experiences its decade lowest value at 1.712 toe and after that point the energy consumption continues to increase.

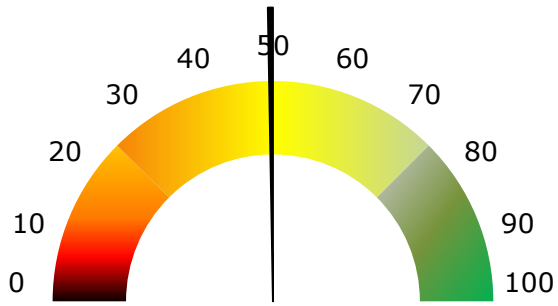
Households and commercial & public services constitute more than the 40% of energy consumption in Greece. It is interesting to note that, the two values are not correlated since the fluctuations depicted in the graphs are quite different. Higher energy efficiency in all sectors requires more policies and effort both from the government and the public.

Despite the achievement of 2020 national target, Greece performs relatively poorly in energy efficiency indicators

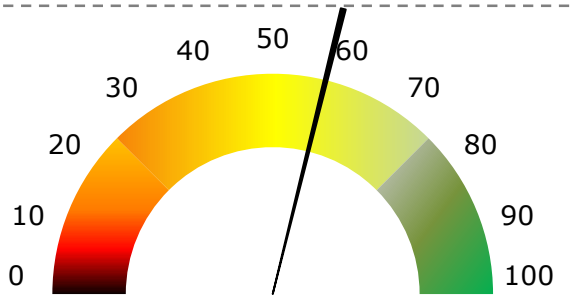
Energy efficiency Indicators for Greece (%), [2017]



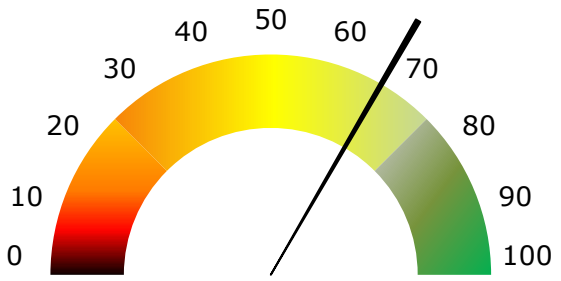
Finance Mechanism for Energy Efficiency (%)



Energy Efficiency Entities (%)



Minimum Energy Efficiency Performance Standards (%)



National Energy Efficiency Planning (%)

Source: RISE, HAEE's analysis

Highlights

Specific indicators illustrate the performance of all countries in energy efficiency and the results from Greece are alarming.

Greece has been rated with 24% for the existence of finance mechanism for energy efficiency in industry, households and commercial services sectors, due to the lack of tax incentives, green and energy efficiency bonds, energy savings agreements, and vendor credit for energy efficiency activities.

In energy efficiency entities the rating reaches 50% due to the positive behavior of the country to adopt to energy strategies and standards of EU for energy efficiency. Nevertheless, there is a lot of distance to be covered in energy auditing and management, building and designing energy efficiency and financing energy efficiency programs.

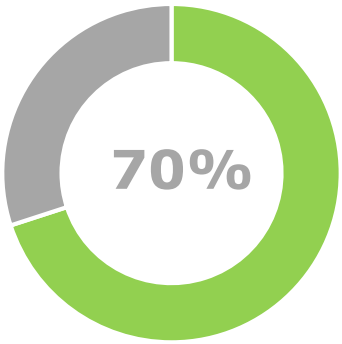
Minimum energy efficiency performance standards have been rated with 58% in Greece due to the adoptions of energy standards in categories such as refrigerators, heating, lighting equipment, industrial electric motors and other industrial equipment. Further improvements needed in light vehicles for which there is no regulatory framework yet.

In national energy efficiency plan Greece performs slightly better with the ranking reaching 67%. The rating is based on the existence of legislation and national plan for energy efficiency which Greece follows due to the obligations against Europe. However, a significant drawback is that national energy target is not divided into separated goals for each sector of the economy.

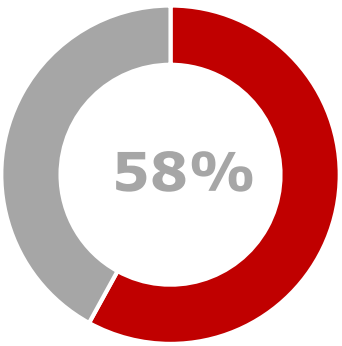
In Greece, the existing energy efficiency policies should be revised, and new laws for energy efficiency should be enacted. Furthermore, the provision of incentives is decisive in the energy efficiency outcome.

The inadequate provision of incentives and mandates for energy efficiency in Greece

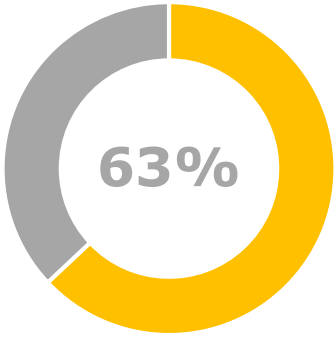
Incentives for energy efficiency among different sectors in Greece (%)



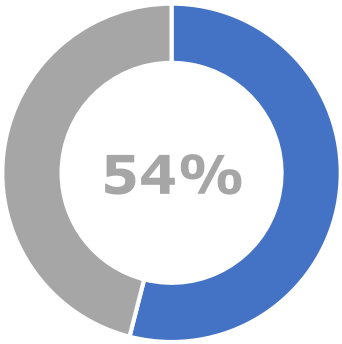
EE incentives from electricity rate structures (%)



Incentives and mandates: Industrial and Commercial End Users (%)



Incentives and mandates: Public Sector (%)



Incentives and mandates: Utilities (%)

Source: RISE, HAEE's analysis

Highlights

In the last decade Greece have managed to increase the number of incentives for energy efficiency but this process should be accelerated in the near future in order for the country to meet its national targets for 2030 and 2050.

As far as the electricity rate structures are concerned, Greece concentrates ratings which reach 70%. The policy has been designed for the residential customers to face increasing block rates while commercial and industry customers face constant (uniform) block rates.

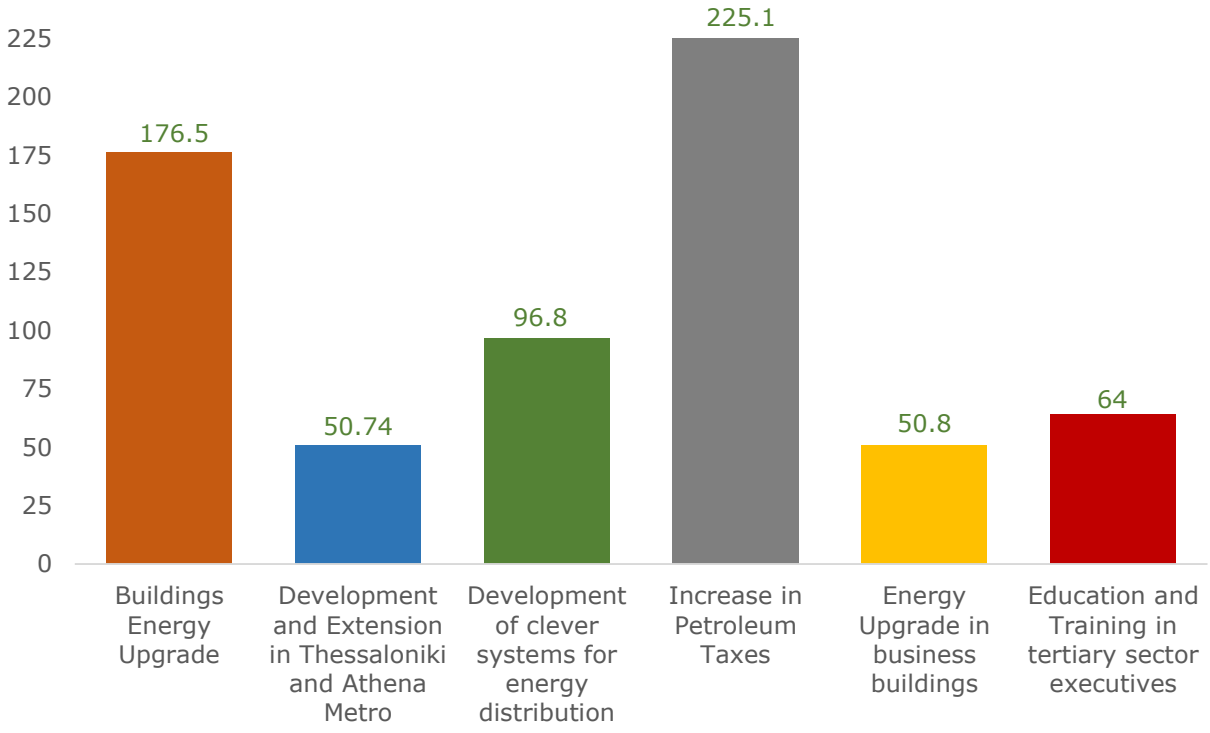
The mandatory audits, progress reports and penalties in the case of non-compliance with the available policies, for energy-efficiency in large consumers, are the decisive factors for the 58% rating in incentives and mandates in industrial and commercial end users category. On the other hand, there are no energy-management systems or specific targets and there is also the significant absence of performance recognition policies.

In public buildings there are binding energy saving obligations and there is also a reporting mechanism to enforce savings in the public sector. However, the lack of a mechanism for updating periodically the technological advances in energy efficient products and services can be detected. Therefore, the ratings for incentives and mandates for public sector is currently at 63%.

In utilities sector, the rating of incentives and mandates for Greece is 54% and it is based on the absence of a) analysis for energy efficiency, b) energy savings targets, c) penalties for non-compliance with mandatory requirements and d) implementation of energy efficiency activities. Furthermore, apart from public budget financing, there are no other available mechanisms to recover energy-associated costs. The restruction of the economy through necessary reforms is vital for energy efficiency and the compliance of Greece with 2050 energy targets.

The compliance with energy efficiency targets requires a concrete national plan which specifies the sources of energy savings

Energy savings plan by source in Greece (Ktoe) [2014-2020]



Source: Ministry of Environment & Energy, HAEE's analysis

Highlights

Greece has introduced energy measures and incentives that promote energy savings in order to achieve its national target until 2020. The majority of those policies has been applied from 2014 and will continue to be applied until 2020, with at least a 4-year extension until 2024.

Increase in petroleum taxes seems to be the most efficient measure and has resulted in energy savings of 225,1 Ktoe. However, the objective of this measure is controversial, seeing that it also results in high taxes collection.

Buildings energy upgrade includes funding which aim to enhance the thermal insulation and the provision of hot water in the residential buildings and is provided by loans with low interest rates. It is expected to be applied in 150.000 residences with aggregated savings of 176,5 Ktoe.

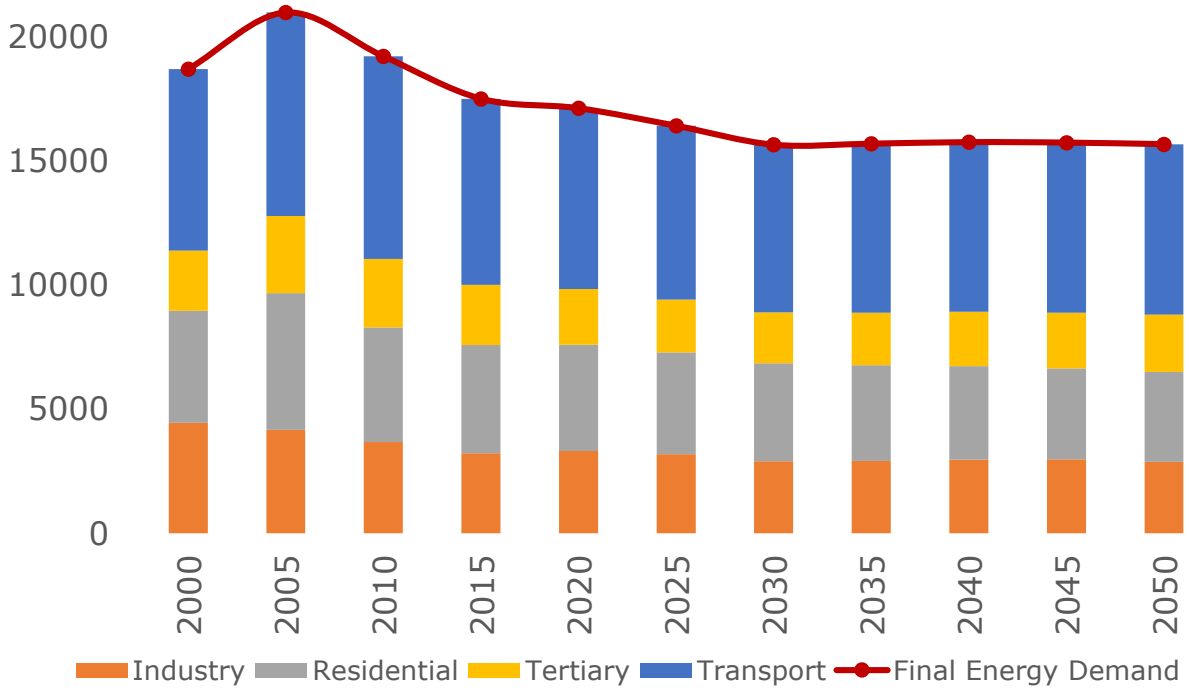
Furthermore, clever systems for energy distribution, and especially those who target electricity, will cause 96,8 Ktoe reductions and their contribution in the future energy savings will be definitely vital.

The development of Thessaloniki's subway and the further expansion of Athens subway by 2024 are expected to save 21,4 and 29,34 ktoe respectively, on the grounds that public transportation will be boosted, and private transportation will be limited.

Additionally, energy upgrade in business buildings involves, among others, installment of energy management systems, renewable energy sources systems and upgrades in lighting systems. The energy savings from this source is expected to reach 50,8 Ktoe in 2020. Education and training in tertiary sector executives is another crucial factor for energy savings which and will save 64 ktoe by 2020 according to current predictions.

By 2050, Greece should simultaneously increase its GDP and reduce energy consumption, in order to be both financially stable and energy efficient

Projections for aggregated energy demand, industry, transportation, tertiary & residential sectors consumption (toe) [2000-2050].



Source: Eurostat, HAEE's analysis

Highlights

EU countries have committed to reduce their carbon dioxide emissions by 40% until 2050 in relation to their emissions in 2005.

The current projections for energy efficiency in 2050 are far away from the desired levels. Despite the downward trend, based on today forecasts the aggregated energy consumption in 2050 will be 15,657.4 toe which corresponds to 25.3% less consumption than 2005.

Particularly, the transportation sector will continue to dominate the energy consumption and will face the lowest decrease from 2005 to 2050, that is 16.2%. A high reduction of energy consumption is expected to be observed in the industry sector with 31% less energy consumption (1.285 toe in absolute values).

Residential sector will face the highest decrease which is 34.2% and is translated into 1.885 toe less energy consumption in absolute values. The energy consumption in the tertiary sector will be approximately 2300 toe in 2050 which is about 26% less than the respective 2005 value.

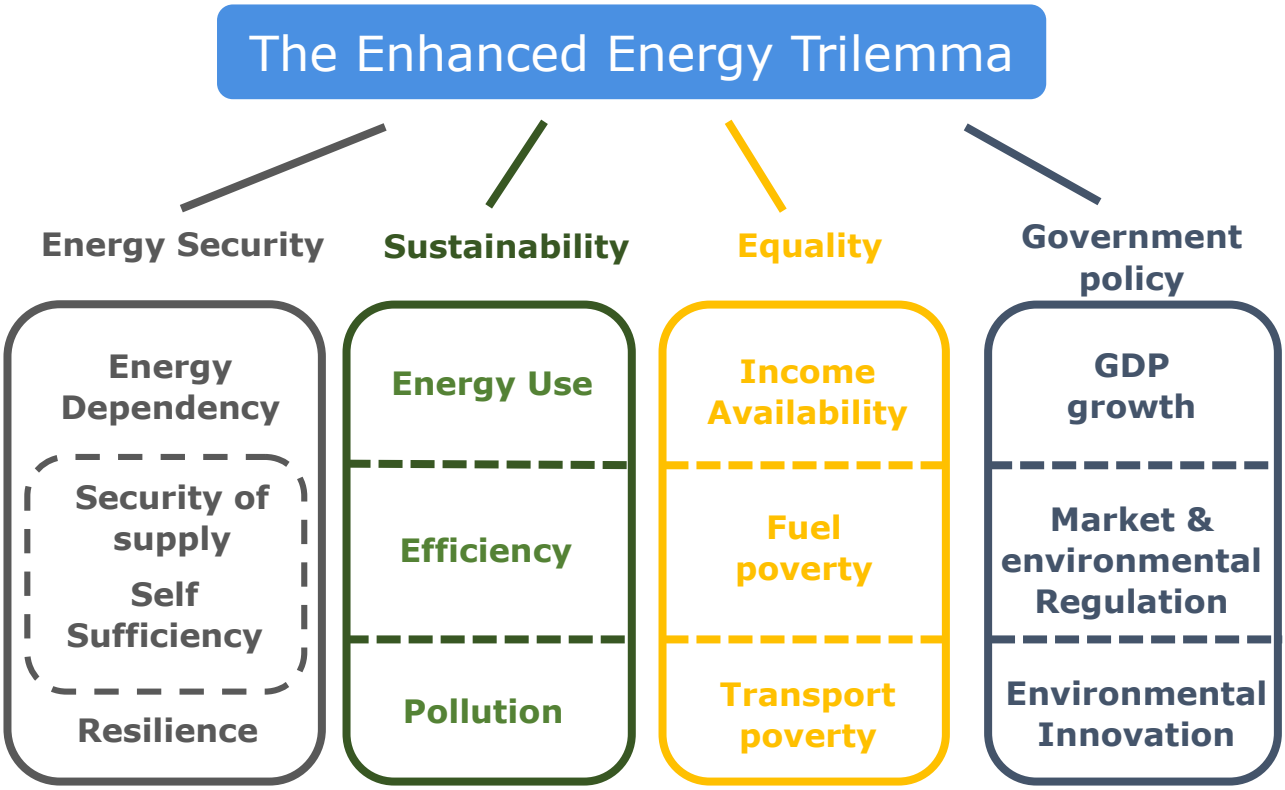
Although EU members have began to take measures in order to tackle climate change by reducing their energy consumption and their subsequent emissions, more policies, incentives, mandates and mechanisms should be applied for further energy efficiency.

The next few years will determine the future in energy consumption and Greece must begin immediately to transform the economy in an energy-efficient way.

Despite major growth in renewables, global emissions are still rising, demonstrating once again that more urgent action is needed on all fronts. Namely, developing all clean energy solutions, curbing emissions, improving efficiency, and spurring investments and innovation including carbon capture, utilization and storage.

8. Trilemma

The enhanced energy trilemma describes the management of energy security, environmental sustainability, equality and government policy



Source: HAEE's analysis

Highlights

The energy trilemma concept is multidimensional and describes the management of energy security, environmental sustainability and energy equality. In this analysis we ranked OECD countries in terms of their achievements in these dimensions evaluating the time period from 2005 to 2015.

We also considered a fourth dimension which describes the outputs of government policy decisions on GDP growth, market openness and innovation. In total we used 20 different indicators across the four dimensions.

Energy security describes a country's ability to continue its normal operations covering its energy needs. This means that, the less energy-depended a country is to energy sources outside its control, the possibility of a disruption in energy flows diminishes and security increases.

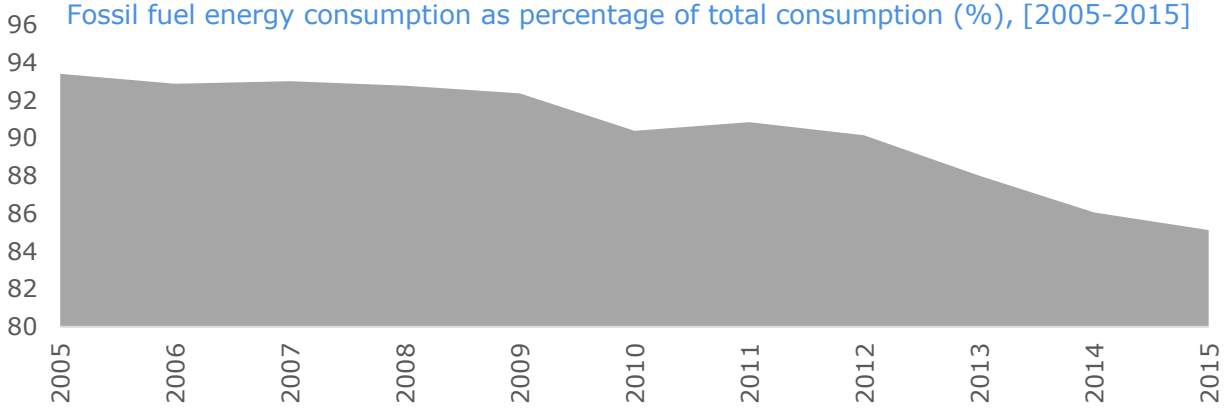
The level of self sufficiency also increases a country's energy independence. Resilience describes the ability to counter-act or adapt to disruptions in terms of diversification of the energy mix, the microstructure of the economy, the quality of its energy networks and more.

The sustainability dimension describes the use of energy to produce an economic output as efficiently and with minimum pollution as possible. Achieving energy security and being sustainable does not automatically make the available energy attainable for all members of an economy or equally distributed among them in a way that covers their needs.

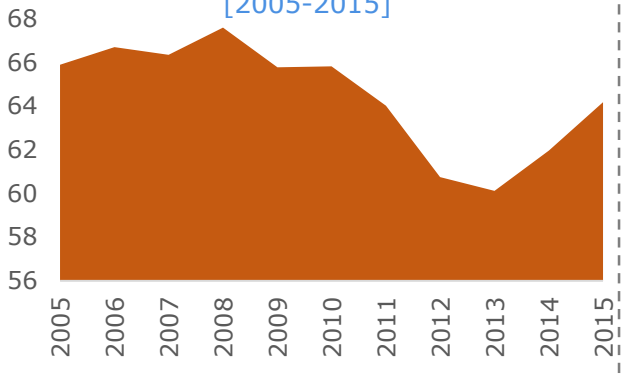
For this reason we calculated relative purchasing power indicators to evaluate the effect income availability and price levels have in terms of the fuel poverty issues in the OECD countries taking into account the distribution of income. This chapter highlights selected indicators for Greece and the resulting positions the country achieved in each dimension throughout the time period.

Improvements in Greek energy security measures occur mainly because of the reduced economic activity due to the country's economic crisis

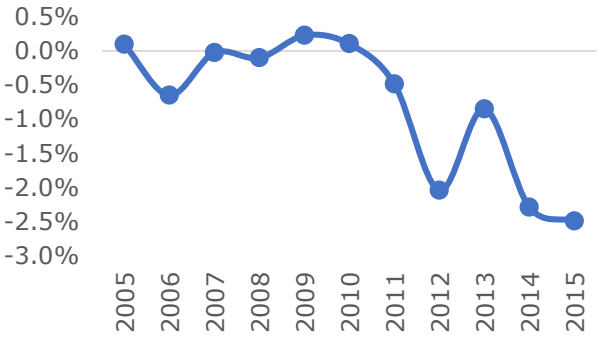
Fossil fuel energy consumption as percentage of total consumption (%), [2005-2015]



Energy imports, net (% of energy use), [2005-2015]



Five year geometric average of change in energy use per capita (%), [2005-2015]



Source: World Bank, HAEE's analysis

Highlights

A major aspect of the energy security theme is the percentage of net energy imports considering the country's energy use. It is evident that the greater the percentage the higher the exposure to possible disruptions in flow or price volatility and thus more energy-depended and less energy-secure.

Domestic energy sources include lignite which accounts for a significant percentage of electricity generation as well as RES such as hydro-power, wind, solar energy and biomass. Almost 61% of Greece's primary energy needs are covered through imports with the remaining 39% being covered through domestic energy sources. Imported energy sources are mainly petroleum products and natural gas.

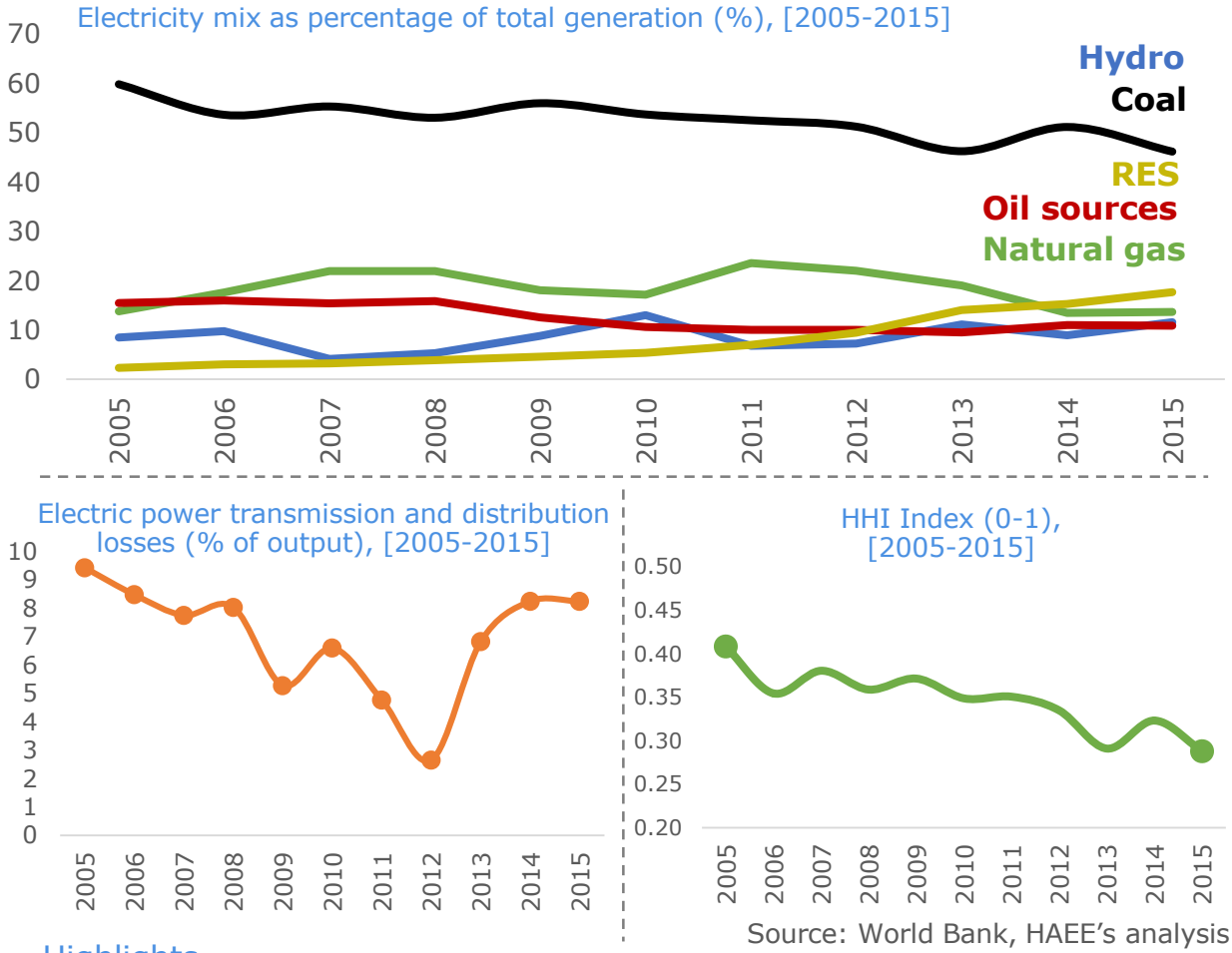
The reduction on both net energy imports and the percentage of fossil fuel consumption is indicative of the results of the economics crisis after 2008. The percentage of total energy consumption coming from fossil fuels provides an indication of the country's exposure to price and volume fluctuations, especially when a country is a net importer and not a producer.

Greece reduces its energy imports by about 5% between 2005 and 2013 as an outcome of reduced economic activity before recovering in 2015. Especially after 2010 the five-year average per capita energy use becomes consistently negative indicating the severity of the crisis.

In terms of net energy imports, Greece remains in the same group with countries like Austria, Chile, Finland, France, Germany, Hungary, Slovak Republic, Slovenia and Switzerland, which net imports range around 40-70% of their energy use.

Greece retains a high fossil fuel consumption along with most of the OECD countries. Exemptions are Iceland, Estonia and Sweden where fossil fuels energy consumption is less than 40% of total energy consumption. Finland, France, Switzerland, Norway, New Zealand are over 40% but below 60% with the rest using as much as 97%.

Diversification of the electricity fuel mix improves as the share of RES displaces coal



Source: World Bank, HAEE's analysis

Highlights

The indicator of electric power losses was improving ahead of the crisis for Greece (until 2008). Following 2012, and while the economy reduces its negative momentum, it returns to the pre-crisis levels.

During the period of analysis, the energy diversification indicator (HHI index) of the electricity fuel mix improves (lower levels indicate improvement) as the dominance of coal in the energy mix is reduced and renewables (other than hydro) increase.

It is important to note that the HHI indicator measures equality of share among the sources that make the electricity fuel mix. Thus, if the share of renewables and coal were reverse this indicator would remain on the same level due to the same diversification of the mix, although that from an environmental and sustainability perspective, it would be highly favorable.

If the diversification is not adequate, a disruption in energy flows may not be effectively and efficiently counteracted. This is evident for instance in 2007 where the sharp decrease of hydro energy is compensated by an increase in the use of gas and coal in the mix.

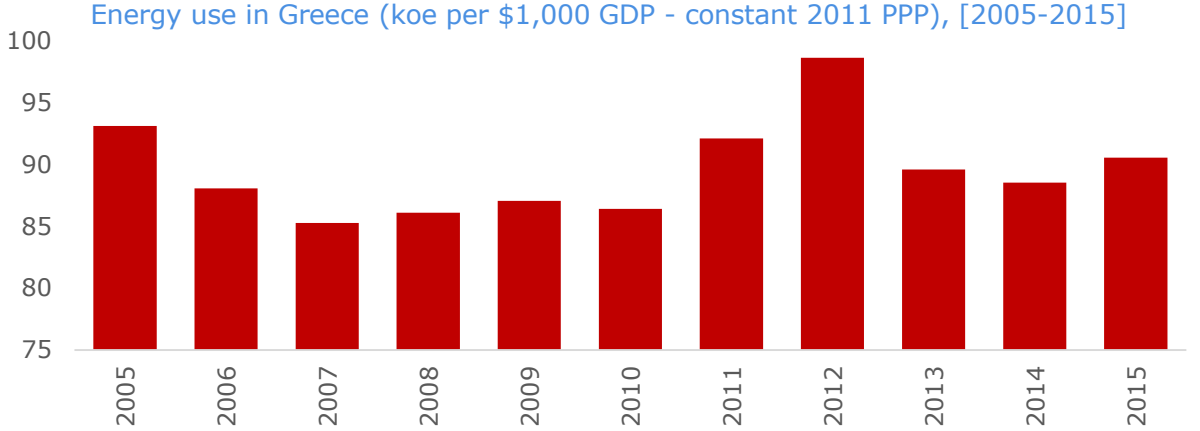
Certainly, if an optimum diversification can be achieved through renewable sources (combined with some form of energy storage) then it can be also sustainable.

It is interesting to highlight that countries like Iceland, Sweden and Estonia, which have less than forty percent of total consumption coming from fossil fuel, have a bad diversification index value which indicates a concentration in the electricity fuel mix.

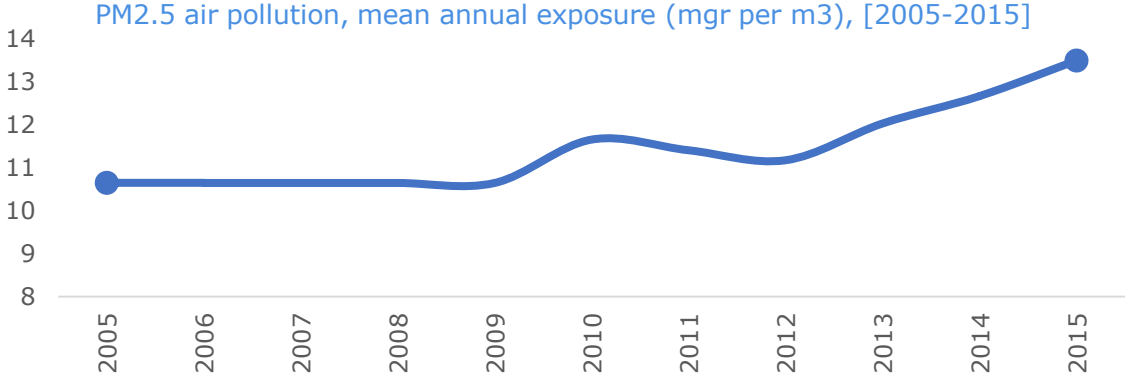
Norway has the worse HHI performance by far, as almost all of the electricity is produced through hydropower. Despite the fact that it is environmentally friendly, this type of production creates resilience issues in case of extreme weather events.

Greece achieved a reduction and then a stabilization of its energy use per GDP, ranking below OECD average levels

Energy use in Greece (koe per $1,000 GDP - constant 2011 PPP), [2005-2015]



PM2.5 air pollution, mean annual exposure (mgr per m3), [2005-2015]



Source: World Bank, HAEE's analysis

Highlights

Greece is below the OECD average of about 100 Koe throughout the time period under scrutiny. Yet, its energy use per GDP remains higher than countries like Switzerland, Ireland, Denmark, Turkey, Italy, Portugal, Spain and even Germany. With the exemption of Iceland most of the OECD Countries use between 50 to 180 koe per $ 1000 of GDP.

The ultimate goal for all countries is to become more energy efficient in their production and less energy intense. This aspect makes them more energy secure as well, since higher demand is satisfied with the same amount of energy. Hence, this is translated as a smaller effect from price and volume fluctuations.

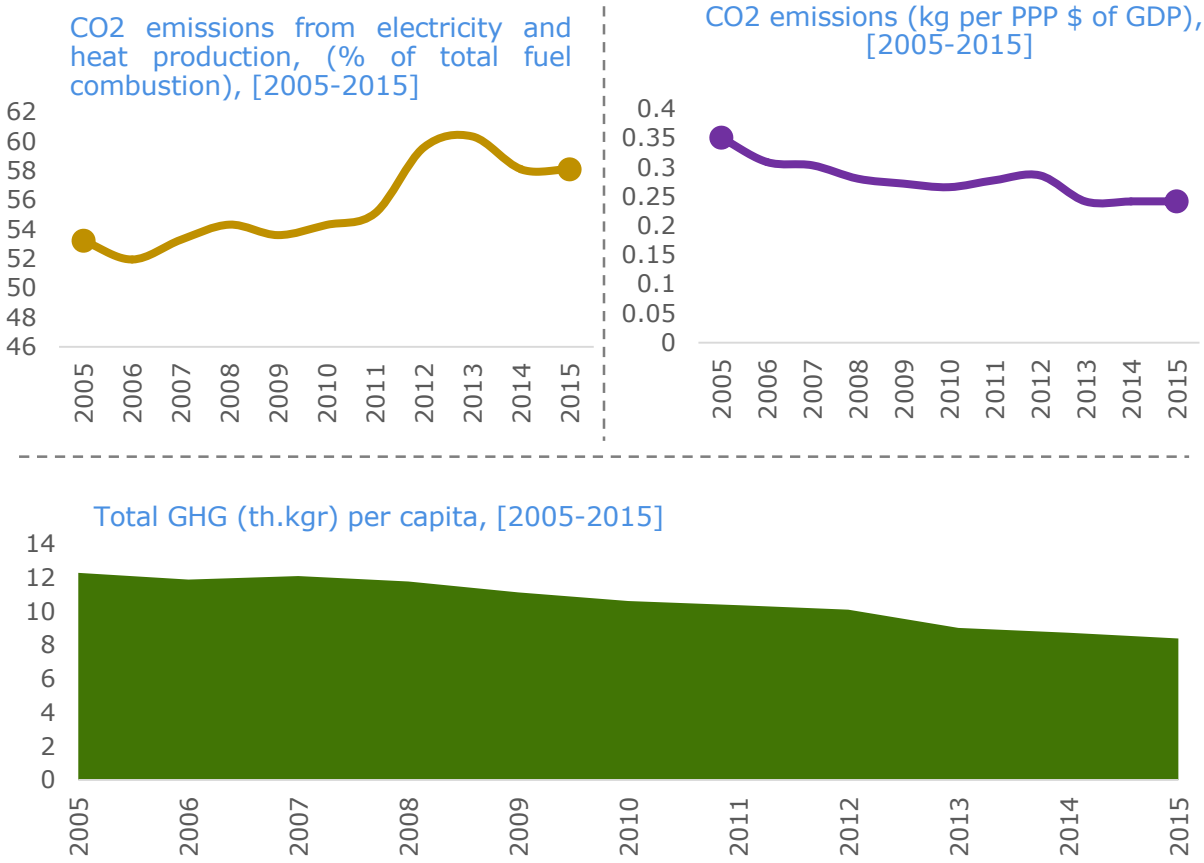
In general, most of the OECD countries achieve either a reduction or stabilization of their energy use per GDP. For Greece, exposure to particle matter increased after 2012, reaching the OECD period average in 2015. This could be attributed mainly to the lower quality fuel used for heating during winter months and the increase of electricity use for heating.

A steep increase in heating costs has led many Greeks to switch from heating oil to wood-burning, and at the same time the aftermath of this use was the increased levels of air pollution from wood smoke, that affected the biggest cities of the country.

Reduction of Particulate Matter (PM) and especially PM2.5 is extremely important as it is a major life-threatening factor especially in highly populated areas. Unfortunately, overall very few OECD countries improved their 2005 emissions. In contrary, most of the countries in our sample, increased their emissions, especially after 2010.

The loss of GDP in Greece between the period 2008 - 2013 exceeds 25%. The effects of this shattering recession that the Greek economy faced, could be easily observed in all major indicators of our analysis.

Even though carbon intensity and total Greenhouse emission declined, CO2 emissions from electricity and heat production increased



Source: World Bank, HAEE's analysis

Highlights

Although Greece's carbon intensity steadily improved as total CO_2 per GDP and total Greenhouse gases per capita declined consistently, the percentage of CO_2 emissions from electricity and heat production increased substantially, especially after 2012. In 2005 the share of CO_2 emissions from electricity and heat production stood at the level of 53%, while at its peak in 2013 it reached 60% of total fuel combustion.

We consider the latter indicator as relatively more essential for our analysis. Due to the increasing electrification needs from sources like heat pumps for building heating, electric vehicles and other sources, this indicator can highlight if for example a reduction of CO_2 from transport is counter-acted from an increase in CO_2 from electricity production.

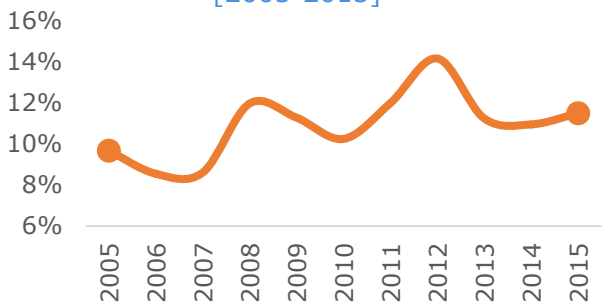
Total GHG, since it is weighted by capita, provides an indication of how each country pollutes relative to its size. This indicator can highlight current and future developments in terms of pollution. For Greece, we observe a slight reduction in absolute terms that has two readings.

Firstly, a small country in terms of population could be more polluting than a larger one due to several reasons. Available income per capita and degree of industrialization could be two straightforward examples affecting the outcome. Secondly, if a country in absolute terms is a major polluter and due to its larger population appears to have a better performance from less polluting countries but with smaller populations, this could also indicate the greater potential for future pollution.

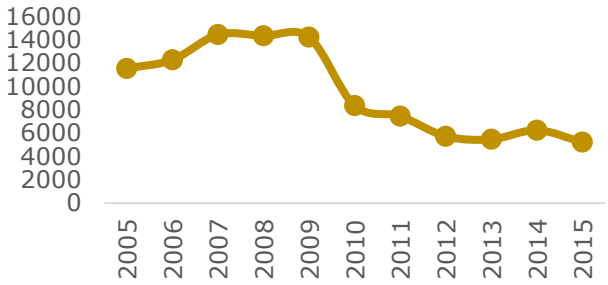
This could be easily justified if we consider other factors like an increase in available income. For the rest of the OECD countries, Estonia has the highest CO_2 intensity and the highest CO_2 emissions from electricity and heat production. In total GHG gases per capita, Australia is the worst performer followed by Luxembourg, United States, Canada and New Zealand, all above 15 thousand Kg per capita.

The impact of the economic crisis in Greece was so severe that more than half of the transport fuel purchasing power was lost

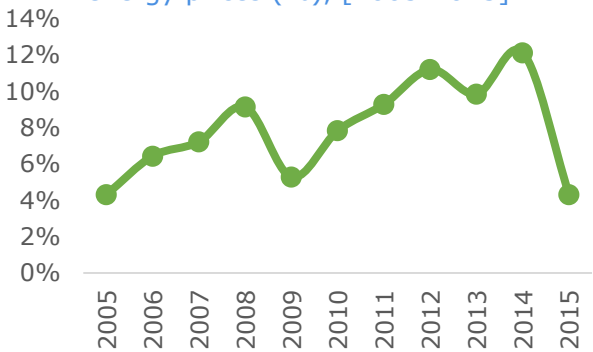
Relative purchasing power of energy (%), [2005-2015]



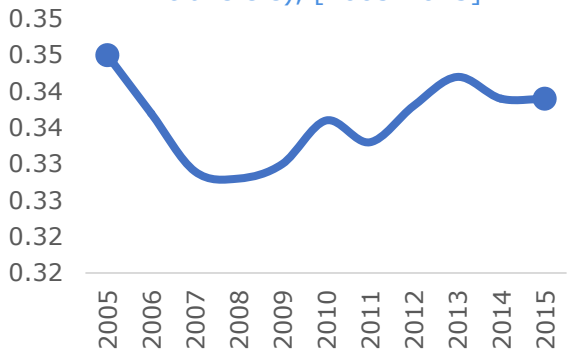
Relative purchasing power of transport fuel (Litre), [2005-2015]



Five-year geometric average of household energy prices (%), [2005-2015]



Gini (disposable income, post taxes and transfers), [2005-2015]



Source: OECD, HAEE's analysis

Highlights

Relative purchasing power of energy describes the percentage of household expenses on electricity gas and other fuels relative to their median disposable income.

This indicator reflects the actual impact that energy consumption has on income while implicitly considering aggregately any changes in energy prices (and taxes affecting them), income level or volume of energy purchased due to a "warm" winter or household choices.

In times were this relative percentage exceeds 10%, consumers are considered to be under pressure from fuel poverty. For Greece after the start of the economic crisis in 2007-2008 this measure was consistently above the threshold of 10% reaching a peak of 14% in 2013.

Furthermore, relative purchasing power of transport fuel is calculated by dividing the median income by the mean pump price of gasoline and diesel. This measure is relevant to fuel poverty as there is evidence that households will reduce other costs in order to sustain mobility, since it is related with employment opportunities and income creation.

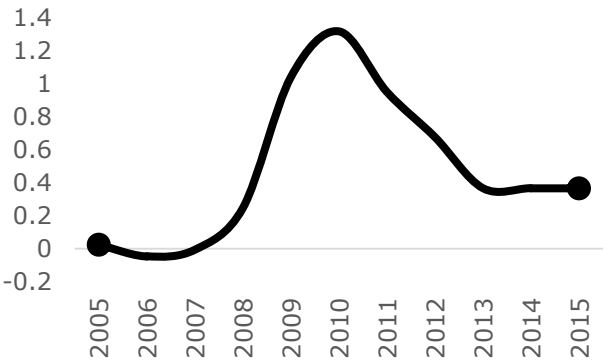
The impact of the economic crisis in Greece in this indicator is of such a magnitude that more than half of the transport fuel purchasing power was lost.

At the same time, household energy prices are continuously increasing as portrayed by the five-year geometric average, putting even more pressure to purchasing power.

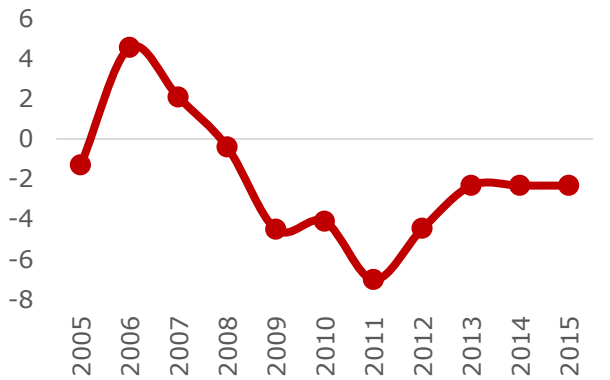
Finally, the Gini indicator which measures inequality in the distribution of income (lower values are preferred), deteriorated after the burst of the economic crisis and remained until 2015. The specific measure represents indirectly the effect that energy policies have on a country's income inequality.

Government policies aiming to pollution reduction, market openness and innovation, represent true policy commitments

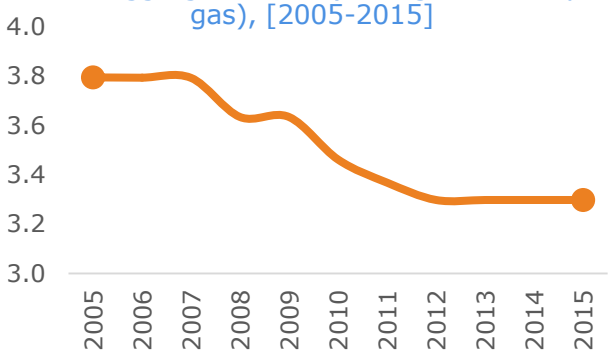
GDP adjustment for pollution abatement (%), [2005-2015]



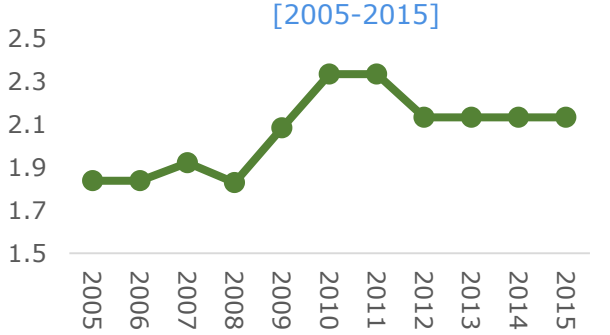
Environmentally adjusted multifactor of productivity growth (%), [2005-2015]



GDP aggregate ETCR (average electricity, gas), [2005-2015]



Environmental policy stringency [2005-2015]



Source: OECD, HAEE's analysis

Highlights

To evaluate the efficiency energy policies, we take into account the GDP adjustment for pollution abatement which presents a positive - when resources have been diverted to pollution abatement - or negative – when growth was at the expense of environmental quality, percentage correction over the nominal GDP. This measure offers a monetization of pollution impact.

Considering the case of Greece, due to the observed pollution reduction, GDP adjustment for pollution abatement was increasingly positive throughout the crisis, stabilizing after 2013. Currently, as the economy recovers the specific indicator is gradually reducing towards zero.

The indicator of environmentally adjusted multifactor of productivity, measures a country's ability to generate income accounting for consumption of natural resources and production of pollution. Thus, for Greece the negative sign indicates a reduction of GDP growth due to the higher pollution and output and natural resources use.

The gap between the two indicators in combination represents the contribution of inputs to output growth. Therefore, the larger the gap, the greater the contributions of labor, produced capital and natural capital to output growth. On the other hand, the smaller the gap, the more output growth depend on productivity gains.

The aggregate Energy, Transport Communications and Regulations (ETCR) quantifies the openness of markets. Greece was above the middle score of 3 out of 6 but improved over the years (lower levels indicate improved performance).

Finally, the Environmental Policy Stringency is used to define the degree that environmental policies put an explicit or implicit price on polluting or harmful behavior in general. In this case, higher values are preferred as it is positively associated with GDP and innovation in the energy sector and negatively correlated with CO_2 emmisions.

The adverse effect that economic crisis had on Greece, is reflected at the government's budget for environmentally related R&D

Source: OECD, HAEE's analysis

Highlights

The last two indicators of the government policy dimension account for the environmental innovation effort of a country. Initially, the environmental-related R&D budget includes among others research directed to the measurement, control, prevention and elimination of pollution.

Interestingly, Greece reduced its budget on R&D even before the wake of the crisis. A trend which stopped in 2011 and eventually reached the OECD average (the only exception in our sample is New Zealand, which can be considered an outlier since, its average budget exceed 9% throughout the time period).

Recently, the upward trend continued since R&D expenditure in Greece reached the levels before 2005, standing as a new all-time high. Based on this, Greece ranks 19th among the EU28 member states along with Ireland and Spain.

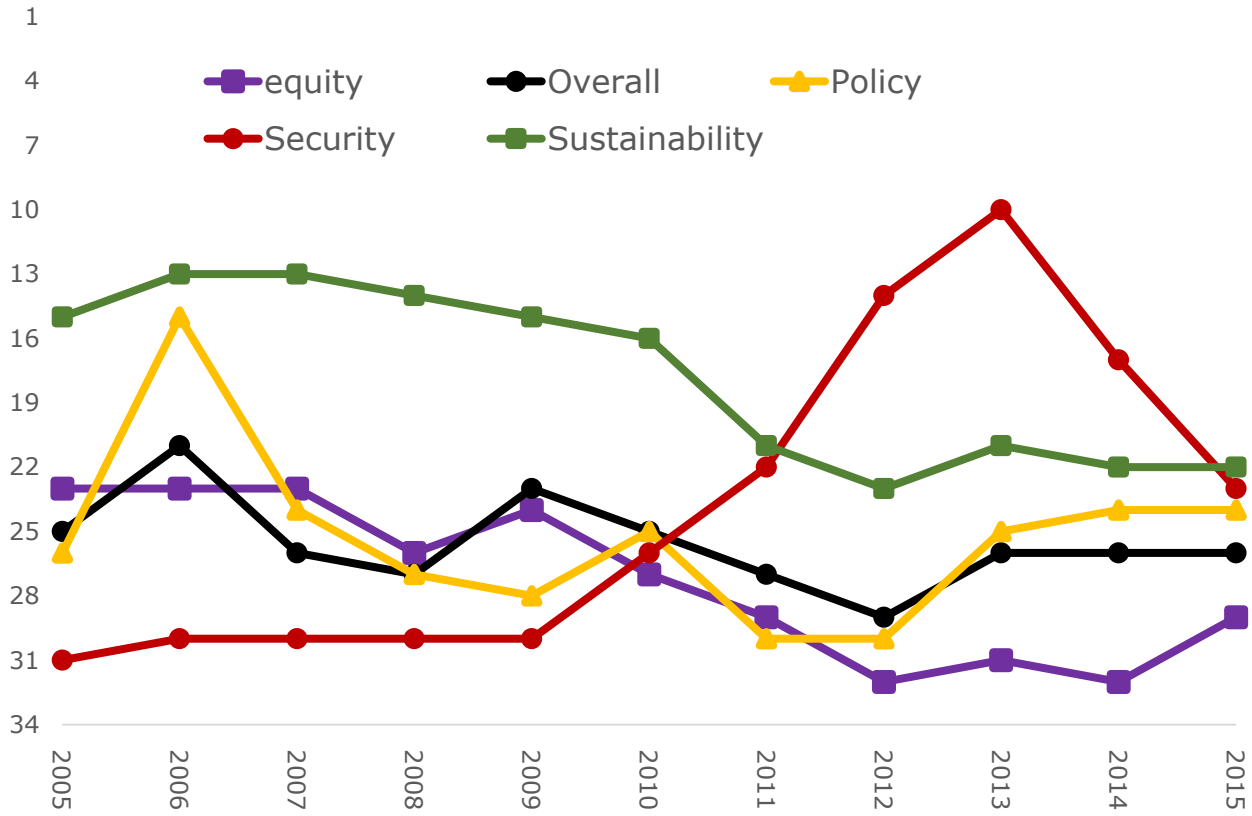
The relative advantage in environmental technology indicator is that it, represents the level of country's innovation relative to the rest of the world. A value of higher than 1, which expresses the world average, indicates a specialization or advantage in "green technologies" relative to rest of the world. A value less than one indicates a technological underperformance.

In this metric, Denmark is consistently the top performing country with Chile close by. Switzerland and Ireland appear as the worst performers. These indicators provide an indirect view of the overall outcomes of government decisions regarding energy policies.

The median percentage of the R&D budget that is observed for the period 2013-2015, puts Greece in the 22nd position for the considered time period. Once again, Greece should improve the specific indicator since it is crucial for exploiting the country's comparative advantage, meaning the relatively big percentage of highly educated adults that until recently preferred to work abroad.

Equity has the worst performance due to the deterioration of purchasing power and rise of fuel prices with slight signs of a recovery in 2015

Enhanced trilemma rank – Greece (position among OECD countries) [2005-2015]



Source: HAEE's analysis

Highlights

Considering the period 2005-2015, the ranking achieved by Greece among all OECD countries for the four categories is summarized in the Overall trend. It is important to note that every year the position of each country was evaluated against improvements in all other countries.

This means that even if a country manages to improve its performance on all the measured indicators by 10%, in case all other countries achieved the same improvement, then it would present the same relative performance as in the previous year and thus not change its position in the rank despite of the absolute improvement.

Regarding the case of Greece, the country's overall performance deteriorated on average reaching its 2005 score a decade later. In terms of sustainability after the crisis the improvements in emissions where not strong enough to outperform the rest of the OECD countries resulting in the 22nd position in 2015.

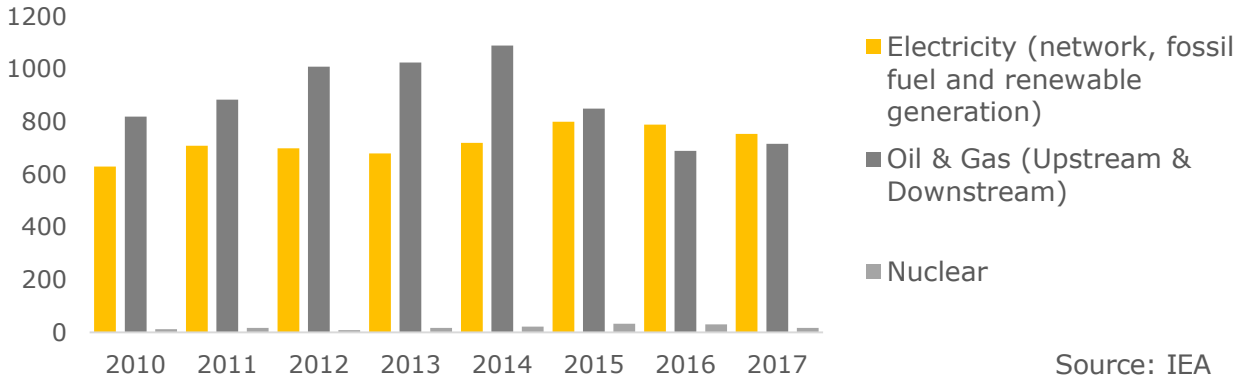
Government policy outcomes, remained on about the same level due to similar performance relative to the rest of the countries in the group. Improvements in security are mainly driven by the economic crisis and the contraction of the economy which resulted in a smaller exposure to the measured indicators. By far equity has the worst performance due to the deterioration of purchasing power and rise of fuel prices with little signs of a recovery in 2015. Even before the economic crisis Greece ranked in the last ten positions, however, in 2015 it dropped in the last three positions.

Overall, Greece continues to struggle balancing the four sides of the enhanced energy trilemma, with a deteriorated energy equity ranking, and weaker energy security and environmental sustainability performances. Compared to the total sample of OECD countries, Scandinavian countries tend to outperform all others in terms of the specific analysis.

9. Investments

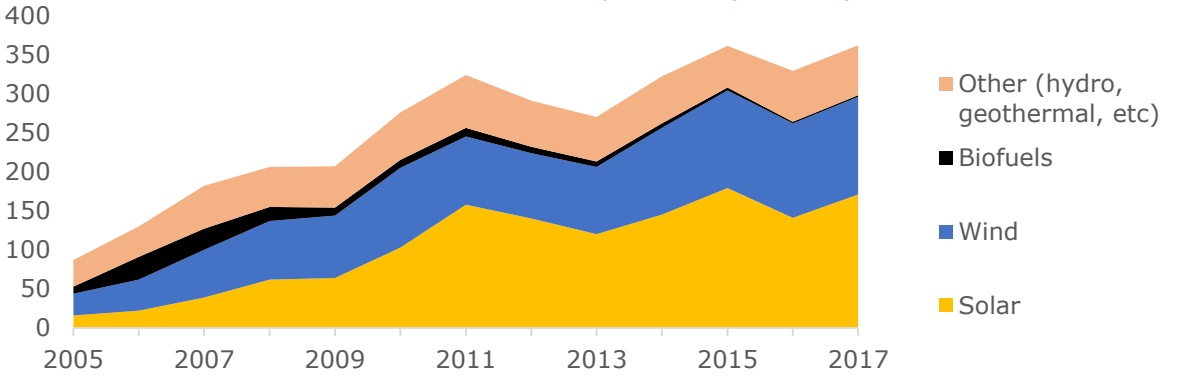
Investments are crucial in order to enable the transition to a low carbon energy supply by the year 2050; A Global Overview

Global new energy investments by sector (billion $), [2010-2017]



Source: IEA

Global new investments in renewables by sector, (billion $), [2005-2017]



Source: Bloomberg, HAEE's analysis

Highlights

Corporations continue to provide vast amount of money for energy investments, with diverse financing options. Improvements in standardization, aggregation and credit assessment for small-scale projects facilitated record issuance of green bonds of 160 billion dollars in 2017.

This is assisting energy efficiency developers and distributed solar PV projects to gain access to finance from the capital markets and electric vehicle buyers to get loans from banks.

Global energy investments have declined in absolute terms, driven by the general reduction in investments towards both the oil and gas sector. In contrast to this trend, investments in electricity generation remained stable and relatively high, overcoming, for the first time in 2017, the corresponding gas and oil investments. During the same period (2017), investments in nuclear represented 1.16% of the total amount invested globally.

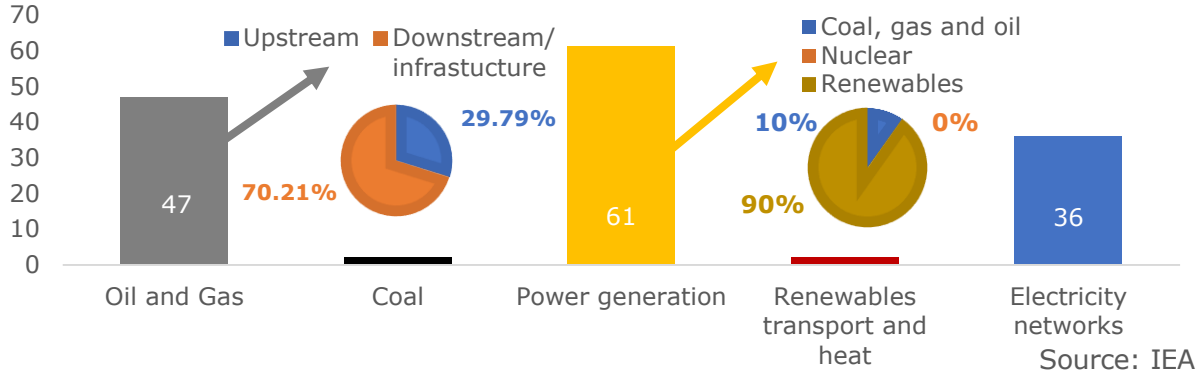
Apart from the global investments in electricity, oil and gas, a significant investing effort appeared in the energy efficiency field. Specifically, in 2017, $236 billion were spent globally on improving energy efficiency, mostly in the building sector where growth was driven by the installation of efficient heating, cooling and lighting systems, but also in the transport and industry sectors.

Total energy investment worldwide, including capital spending on energy supply and improvements in end-use energy efficiency, has amounted to approximately 1.8 trillion dollars or 1.9% of global GDP. Electricity kept its position as the leading sector for energy supply investment in 2017,with the overall share of fossil fuels rising for the first time since 2014.

According to BNEF, Global investment in renewable (clean) energy amounted to $361.7 billion in 2017, with China holding a 40% share of the total amount.

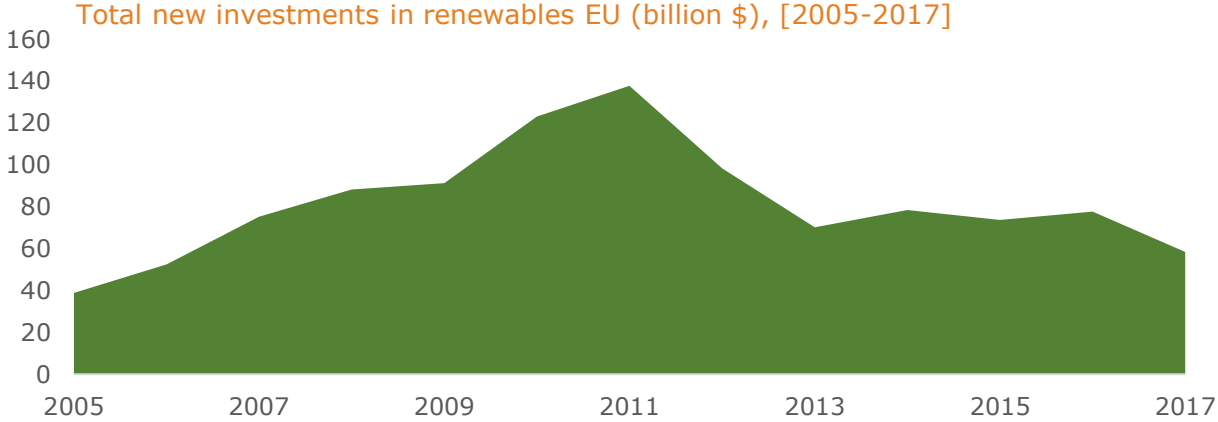
European energy investments is on a growing pattern, mainly boosted by better debt financing terms

Energy investment by fuel in Europe, (billion $), [2017]



Source: IEA

Total new investments in renewables EU (billion $), [2005-2017]



Source: Bloomberg, HAEE's analysis

Highlights

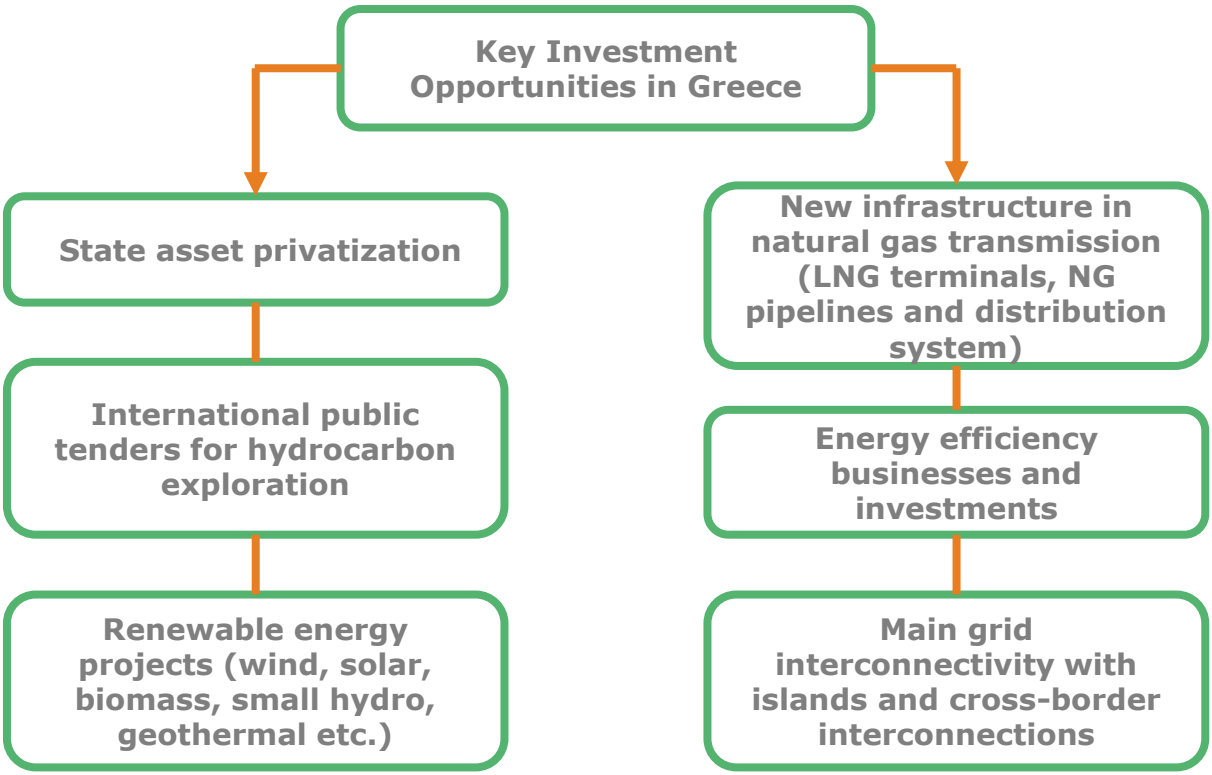
Energy investments in Europe for 2017 were mainly directed towards three categories. (i) Oil and gas industry accounting for 47 bill. $ (or 31,7% out of total), (ii) power generation for 61 bill.$ (or 41.2% out of total) and (iii) electricity networks for 36 bill.$ (24.3% out of total). In line with IEA estimations, the total amount of money invested in the European energy sector in 2017 were 148 bill.$. The remaining 4 bill. $ (2.7%) were invested in coal, transport and heat.

An interesting outcome of the above analysis is the fact that out of the total 47 bill.$ invested in the oil and gas sector, the 70.21% was directed towards the downstream industry and infrastructure while the remaining 29.79% was absorbed by the upstream industry. Considering the case of power generation, as expected, the allocation of new invested funds was as follows: 90% in renewables or 55 bill.$ in absolute terms, 10% in coal, while nuclear industry did not attract any new funds. Better debt financing terms helped to lower generation cost for new offshore wind by nearly 15% over the past 5 years.

Despite the fact that total new investments in renewables are facing a downward trend, according to the European Investment Bank (EIB), the promotion of sustainable energy is a key EU policy objective and an important sector for EIB financing, signaling an upward trend in the coming years.

In general, EIB's energy lending focuses on energy efficiency, renewable energy, energy networks, as well as related research and innovation. In the transition to a low-carbon global economy, EIB have also introduced an Emissions Performance Standard which is applied to all fossil fuel generation projects to screen out investments whose carbon emissions exceed a threshold level which reflects existing EU and national commitments to limit carbon emissions. To justify the above, only during 2018, loans of EIB helped to construct some 26 000 km of power lines and generate 15228 MW of electricity, out of which more than 86% generated from renewable energy sources.

Greece can offer a variety of investment opportunities in the energy sector, since the recently upgraded regulatory framework speeds up the procedures and reduces any legislative barriers



Source: Enterprise Greece, HAEE's analysis

Highlights

Some recent significant investments and strategic alliances that occurred in the Greek energy market can be grouped in three categories.

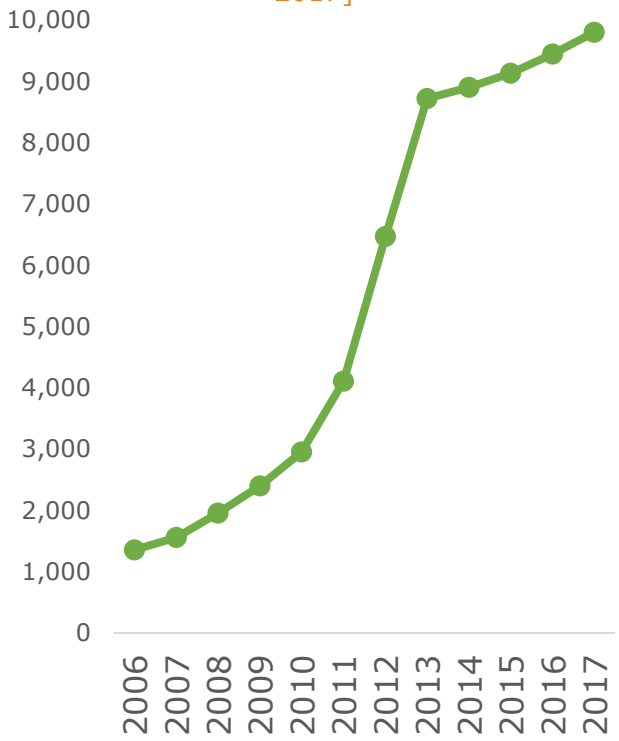
The first includes the placements of strategic investors in Greece such as the acquisition of an interest in the Heron II power plant by Qatar Petroleum International (QPI), in agreement with Greek company GEK Terna. The acquisition of the 24% stake of the Independent Power Transmission Operator (ADMIE) by China State Grid for €320 million and more recently the joint acquisition from a consortium of three European TSOs, namely Snam, Enagás and Fluxys, of a 66% interest in DESFA, for €535 million.

The second category of significant energy investments in Greece consists of placements from investment funds. For instance, US Third Point LLC entered into the share capital of Energean Oil & Gas through an equity capital injection of $60 million. EuroEnergy, the renewables investment arm of the Lybra Group, completed the sale of a portfolio of owned or managed wind assets in Greece to Fortress Investment Group LLC as part of a transaction totaling approximately 300 million euros. Canadian investment fund Fairfax Holdings acquired a 5% stake of Greek industrial energy group Mytilineos for $41 million and US York Capital Management acquired a 10% stake of GEK Terna for €100 million.

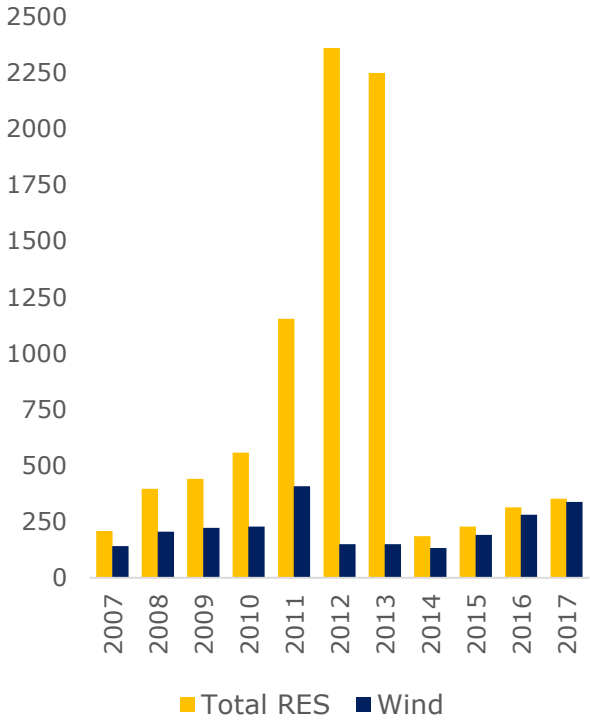
The third category includes strategic alliances and investment plans between international and local groups that are likely to occur in the following decade in Greece. For example, Chinese Shenhua Group proceeded with a €3 billion investment plan, by entering into a co-operation agreement with Copelouzos Group to develop RES projects and upgrade lignite units. The Oil & Gas major TOTAL, which already has presence in Greece in renewable energy investments through its participation in EREN, is currently exploring the potential of multibillion investments in the upstream oil and gas sector.

Greece has the largest potential of both solar and wind power generation in the wider region of South-Eastern Europe

Cumulative RES investments in Greece, (million euros) [2006-2017]



Total annual RES (Wind, PV, Hydro) investments in Greece (million euros), [2006-2017]



Source: ELETAEN, HAEE's analysis

Highlights

Total RES investments in Greece, followed a modest upward trend during the period 2006-2010 with balanced investments between Wind and PV. Next, a significant growth occurred during 2011-2013, mainly driven by investments directed towards PV. Over the period 2014-2017, investments related to wind power accounted for more than 80% of total RES investments.

However, due to the significant prospect for solar exploitation in Greece, investments towards PV in the coming decade are projected to overcome again the corresponding investments in Wind.

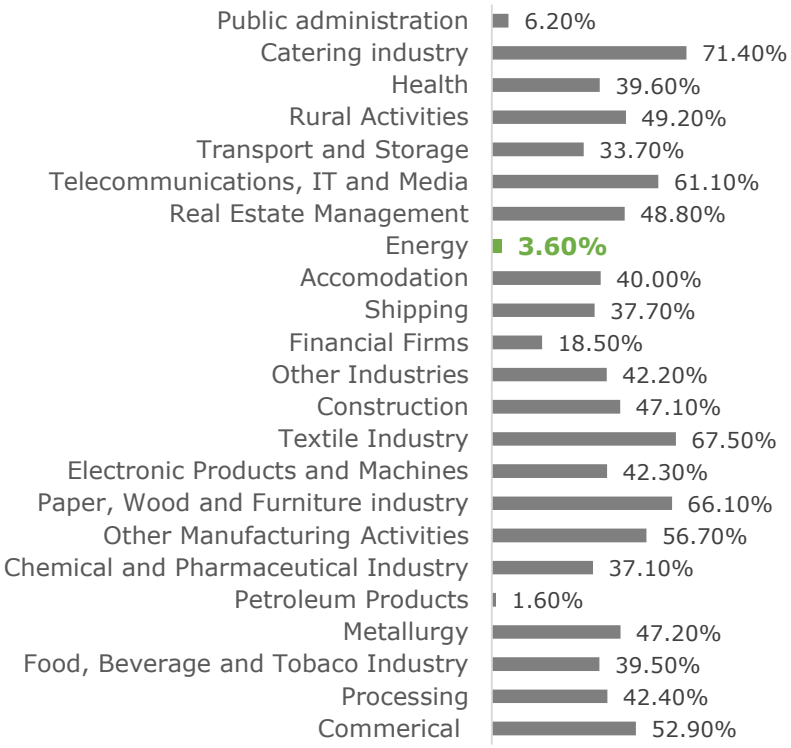
This tendency included investments in new assets, refinancing transactions, mergers and acquisitions at project and corporate level, public market transactions, and private equity raise. The technology is seen by policy makers and market participants as a major driver for moving beyond fossil fuels and conventional power assets. Cost competitiveness and reduced risk perceptions have brought in domestic and international market players looking to diversify their portfolios and align with their sustainability targets.

According to a recent report published by Wind Europe (Financing and Investment Trends, 2018), the wind industry invested €65bn in Europe during 2018. Considering the case of Greece and based on the projections of the recently published draft on National Energy Planning, wind energy installed capacity is seen almost tripling to 6.4 GW in 2030 from 2.4 GW in 2016, as is PV capacity, to 6.9 GW from 2.6 GW in 2016, while hydropower capacity, including the main power utility PPC's big units, is forecasted to achieve a milder increase to 3.9 GW from 3.4 GW in 2016.

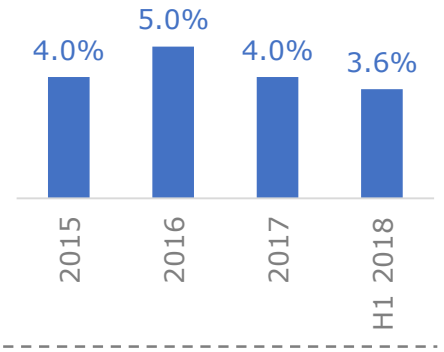
Based on the above, wind energy sub-sector's production is expected to increase to 14,933 GWh in 2030 from 5,146 GWH in 2016, PV output is forecasted to rise to 10,514 GWh from 3,930 GWh in 2016, and hydropower production is expected to grow to 6,269 GWh from 5,603 GWh in 2016.

The Greek banking system prefers to provide loans on the robust Greek energy sector, since its NPE percentage is considerably low

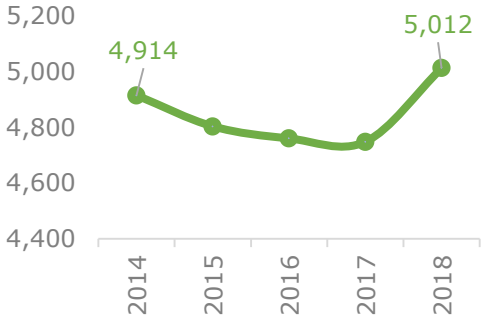
Non performing exposure by sector in Greece (%), [H1.2018]



Non performing exposure of the energy sector (%), [2015-2018]



Outstanding loans in the energy sector (mil. €), [2014-2018]



Source: Bank of Greece

Highlights

The Greek banking system plays a crucial and long-term role to the growth of energy sector. The total outstanding loans increased substantially in 2018 after a slight decrease from 2014 to 2017, following the upward investing trend in the energy sector, since the new upgraded regulatory framework and the simplification of the legislative procedures as it has mentioned above.

On the other hand, energy sector is also a preferable investing target for Greek banks due to the low level of risk which followed a downward trend at recent years. More specifically the percentage of Non Performance Exposure (NPE's) of the energy sector has not exceed 5% from 2015 to the first half of 2018, when Greek economy faced an enormously NPE's problem which at this period reach approximately 50%.

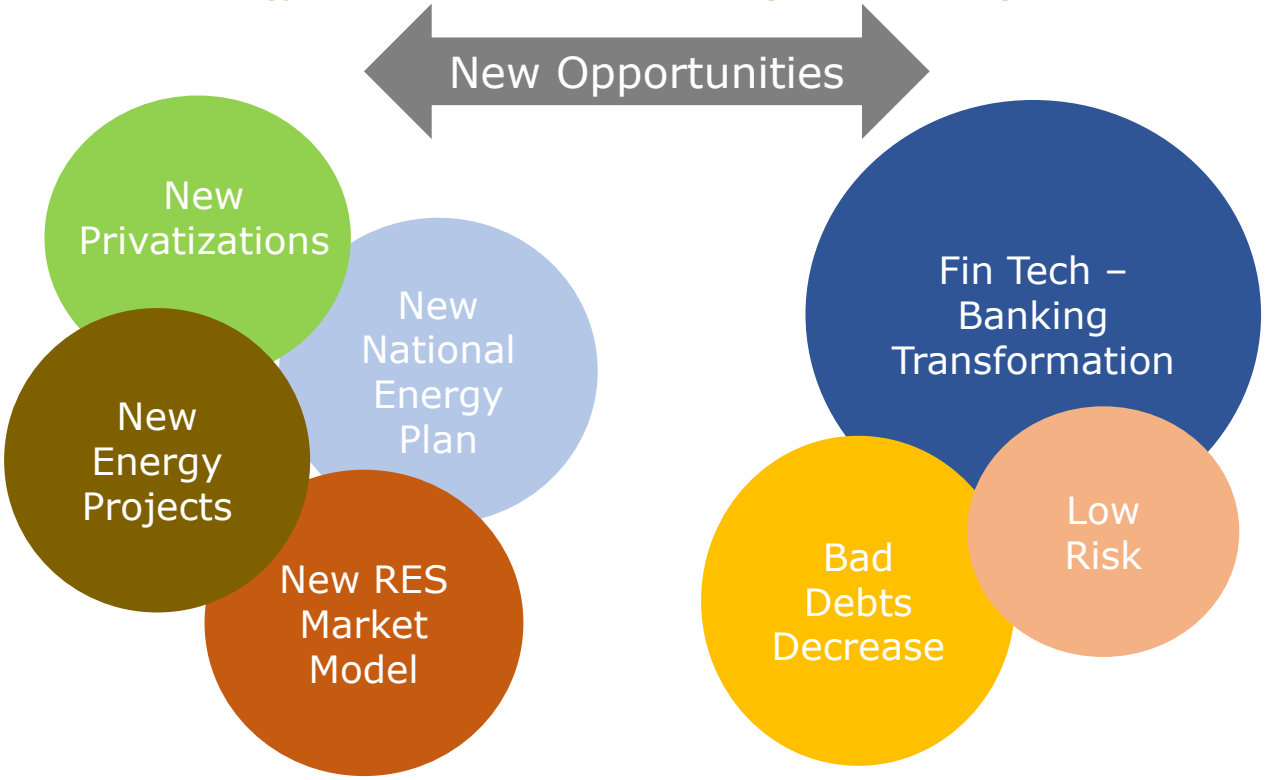
According to the latest "Overview of the Financial System" providing by the bank of Greece (2018), increased percentages of NPE's are recorded in the sectors of Catering (71.4%), Telecommunications, IT and Media (61.1%), Rural Activities (49.2% %), Construction (47.1%), Manufacturing (42.4%) and Tourism (40%). On the other hand, the lowest percentages were observed in the Energy (3.6%) and Petroleum (1.6%) sectors.

Low levels energy sector's risks has to do to basically with the nature of companies' business. More specifically, a high proportion of debt has been driven to big traditional energy companies, to others which develop energy infrastructure projects and finally to entities which develop and operate RES projects.

The solvency of these three categories remains high in a long-term basis mainly for two reasons. The first is the market position of these companies and the significance of their strong presence to the Greek economy. The second reason is the regulated character of their operation, counting as well the projected cash flows and the sufficient collaterals which are usually offered regarding the case of RES projects.

The next day for Greek banking system is to provide a set of new investment opportunities that could assist win-win potentials in the market

The new energy framework in line with the challenges of the banking sector



Source: HAEE's analysis

Highlights

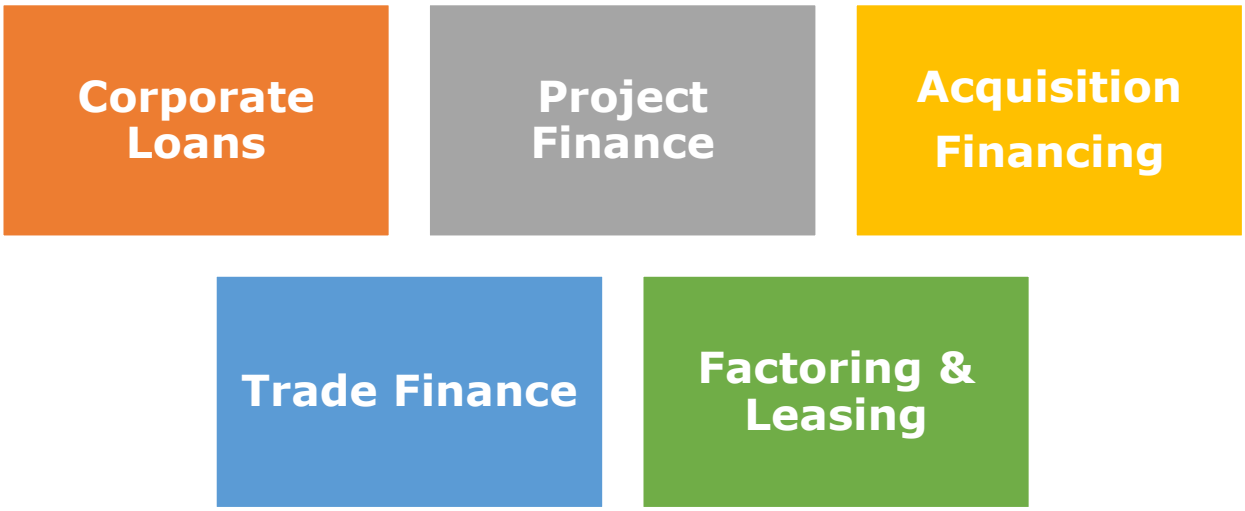
Some of the recent developments shaping the increased interest that the Greek energy sector attracts are (i) the new energy projects both in Transmission and Distribution systems (for both electricity and gas), (ii) new projects in power generation (both in RES and convectional), (iii) the increase of energy efficiency investments and (iv) the upcoming privatizations of major energy companies (like DEPA). Moreover, combining the aforementioned developments with the digital and operational transformation of the Greek banking system, the intense effort for the reduction of NPE's by the 2020 and the preferable banks' participation to the energy investments due to the low credit risk, seems to create a great opportunity for a win-win potential situation between two sectors' participants.

On the other hand, the new National Energy Plan of Greek economy which scheduled to be implemented by 2030, is also a very promising and provides a preferable modification for the Greek Banks. As discussed earlier, the total investments of the decade between 2020 to 2030 estimated up to approximately €32 billion targeting to strength the competitiveness of energy companies and also the Greek economy in general. The greatest proportion of these new projects refers to energy efficiency, RES electricity generation and infrastructure which are already the main targets for banks. The investment interest of the banks is evident even from the current decade. Based on the above, the important role of the banking sector in this development will be a crucial aspect by 2030.

Finally, the recent modification of the RES market seems to be a positive step towards a mature and competitive environment for all the participants. The new biding procedure for the RES licenses has already created a new market operation for the stakeholders, given that the RES projects remain a preferable and promising sector. Banks which are still a key player for RES development, assess positively the new market operation due to its competitive character, which is going to attract new investors and regulate specific distortions (such as the previous RES special account deficit).

The key financial instrument in Greek energy market is borrowing at Corporate level, while Project Finance and Acquisition Financing are gradually increasing their position

Various financing facilities



Source: HAEE's analysis

Highlights

Corporate loans is the main financing tool for the largest and most traditional energy groups and companies in Greek economy, composing the greatest part of their current outstanding exposure. In our days the corporate financing continues its strategic role for Greek energy companies due to the increasing engagement and interest of major global lenders (such as EIB, EBRD and other foreign Banks), offering lower financing costs and more funding opportunities.

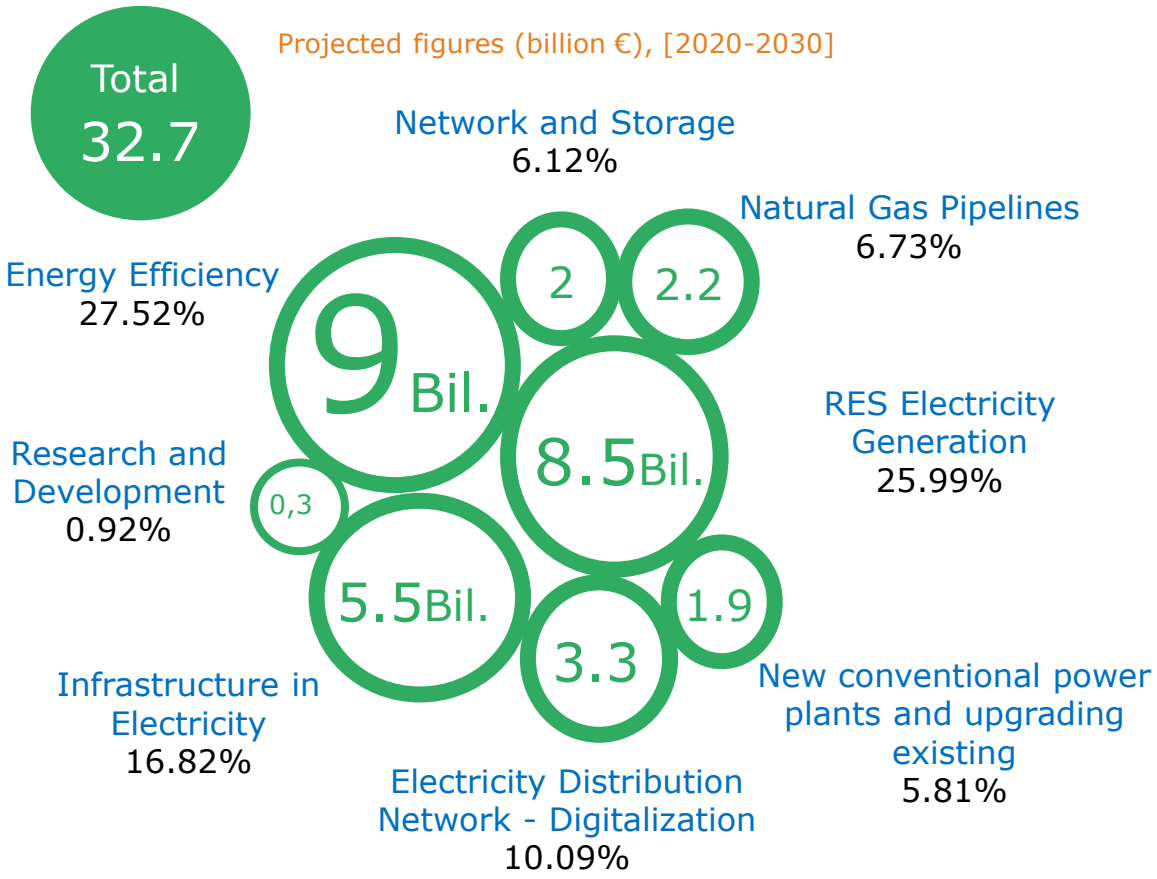
Project finance is also a basic and very useful funding solution capable especially for the development of Renewable Energy Investments in the Greek economy, offering non-recourse funds (financing of new SPV's).

This kind of funding is also preferable not only for companies which need a non-recourse source of new debt but also for lenders' side due to the high and sufficient collaterals which basically coming to the potential energy produced cash flow of the investments.

Acquisition financing is an another specialized way to support new investors who intend to invest in Greek economy, acquiring an established energy company (such as the recent case of DESFA). In these cases, Banks and private investors act together in a cooperative basis in order to form the appropriate capital structure (Debt and Equity) for a new company which is going to acquire partially or totally the targeted energy company.

On the other hand, banking products such as L/G's and L/C's (Trade Finance), Factoring and Leasing seems to have a secondary but also a crucial role to the development and the operation of energy companies. More specifically, in the following years Leasing is expected to have an increasing role to the RES development as it has happened in the rest of EU Countries. Regarding the role of Trade Finance, the new RES Market Model is going to increase their usage since L/G's are crucial for the companies' participation to the biding process.

Investment plans considering the period 2020-2030 embody the country's international commitments aimed at tackling climate change



Source: Draft National Energy Planning (2018)

Highlights

Achieving medium and long-term national energy goals through policy measures on energy and climate dimensions, is anticipated to mobilize a series of significant investments, by strengthening the competitiveness of the economy and employment.

According to the forecast of the recently published draft of National Energy Planning (2018), expected total investments for the period 2020-2030, on the main axes of design are anticipated to reach 32.7 billion euros.

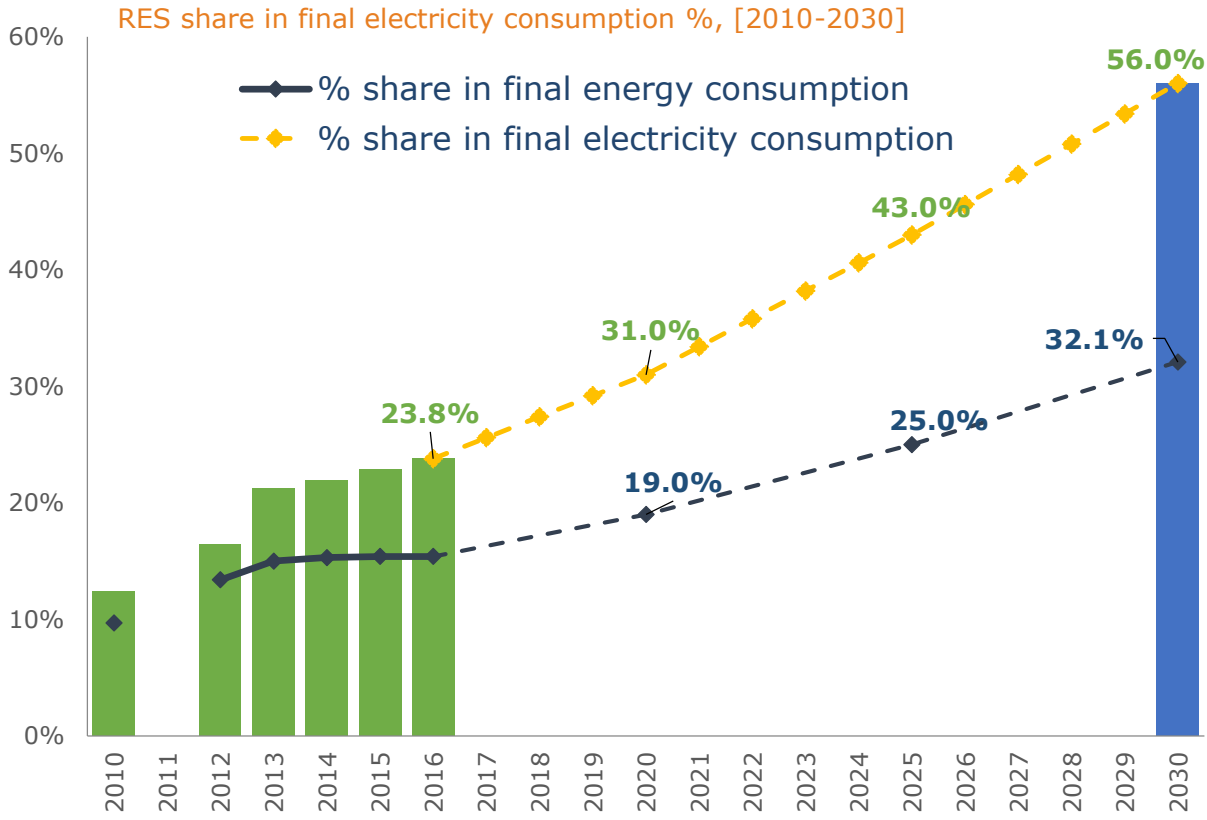
Energy efficiency is the sector that will probably attract the greatest proportion of the imminent investments since in absolute values is projected to reach 9 billion euros or 27.52% of the total investments. Next, investment in electricity generation provided by RES is ranked 2nd in the list, since 8,5 billion euros are forecasted to be invested in the particular sector for the period 2020-2030.

Besides that, 5.5 billion euros for electricity system infrastructure, 1.9 billion euros for new power stations and upgrades of existing facilities, 3.3 bill.€ for distribution network development and digitization projects, 2.2 bill.€ for cross-border natural gas pipelines, 2 bill.€ for natural gas networks and storage units, 300 mil.€ for research and innovation are expected to be invested.

In addition, the draft, envisages the investments to contribute in reducing greenhouse gas emissions by 63% and ensuring energy savings of 32%. These funds are expected to make a significant contribution both to the national economy and to the protection of consumers from fluctuations in energy product prices through increased competition in energy markets.

Under the draft plan, the investments in electricity production from RES are expected to add over EUR 12 billion in value to the economy from 2020 to 2030. The plan also projects the creation of over 15,000 full-time jobs over the ensuing 25-year period.

Greece is expected to create energy investment opportunities due to the availability of RES potential and the ongoing sizeable infrastructure projects



Source: Draft National and Climate Plan 2030, Ministry of Environment and Energy

Highlights

Under the Target Model instructions, RES generators could sell electricity directly in the market and would be subject to balancing responsibilities, unless no liquid Intra-day market exist. Moreover, nowadays operating aid is granted as a premium (FiP).

Based on the new framework, participation in the market is certainly translated to more opportunities for additional income, through market optimization techniques and provision of balancing services. Hence, the RES generators can outsource the new obligations to services provided by the RES Aggregators. At the same time, this structure lurks additional risks and costs.

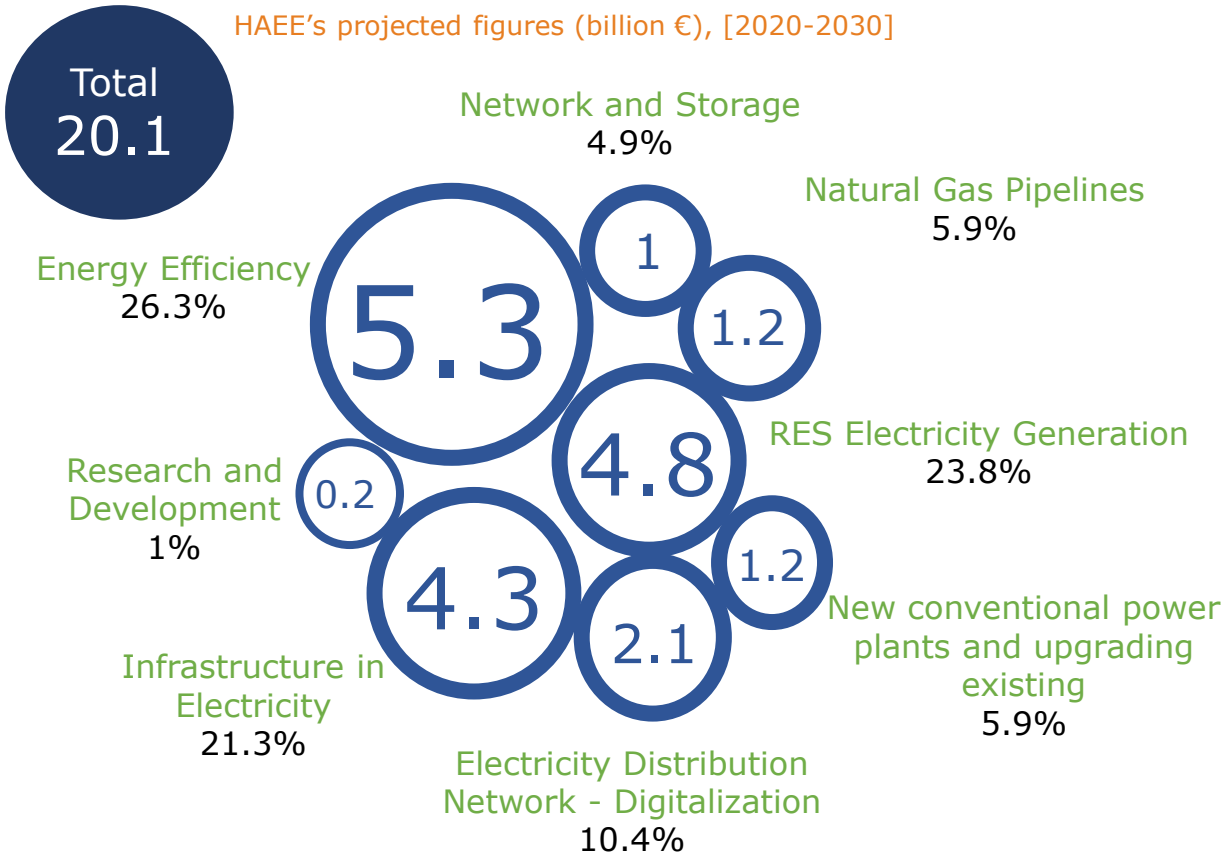
In addition, Greece should definitely simplify the procedure of production licensing, a fact that would directly allow the country to fully exploit its energy resources and develop a strong local supply chain supported by large international interconnections.

The role of the regulator in renewables area regarding the licensing process could be divided in three stages that hold for all projects, apart from the small ones which are exempted from the production license procedure. In general, more than 20 authorities are involved during the licensing progress. The absence of a concrete timetable is also another critical issue that authorities need to tackle.

According to RAE, the main risk factor that affected the Greek RES sector over the previous decade was country risk. The specific risk nowadays is relatively low since the Greek economy shows sizeable sings of stability and recovery.

A different issue regarding RES investments is the existence of retroactive policy, since there is need for a stable long-term RES strategy and governmental tax policy. In addition, grid issues exist as well, since insufficient grid capacity represents a major problem for RES projects that are usually located in areas with a weak grid infrastructure (mainland and non-interconnected islands).

According to a realistic revision by HAEE, the projected investments regarding the period 2020-2030 will reach 20.1 billion euros



Source: HAEE's estimations

Highlights

According to HAEE's estimations the figures provided by the draft National Energy Planning are relatively overoptimistic. In contrast to the projected values, the research team of HAEE estimates that during the period 2020-2030, the total amount of investments in the energy sector would equal 20.1 billion euros (almost 40% lower than the announced projections).

This more realistic estimation, assumes that almost 2 billion euros of new investments per year will be allocated among the various sectors. Overall, the allocation of the funds is in accordance with National Planning, however, absolute terms vary significantly.

Considering only the energy efficiency packages, they are anticipated to equal approximately 300 million euros per year for the period 2020-2030, accounting for 3 out of the total 5.3 billion. The remaining amount will be covered by funds directed towards the increase of energy efficiency in various industries.

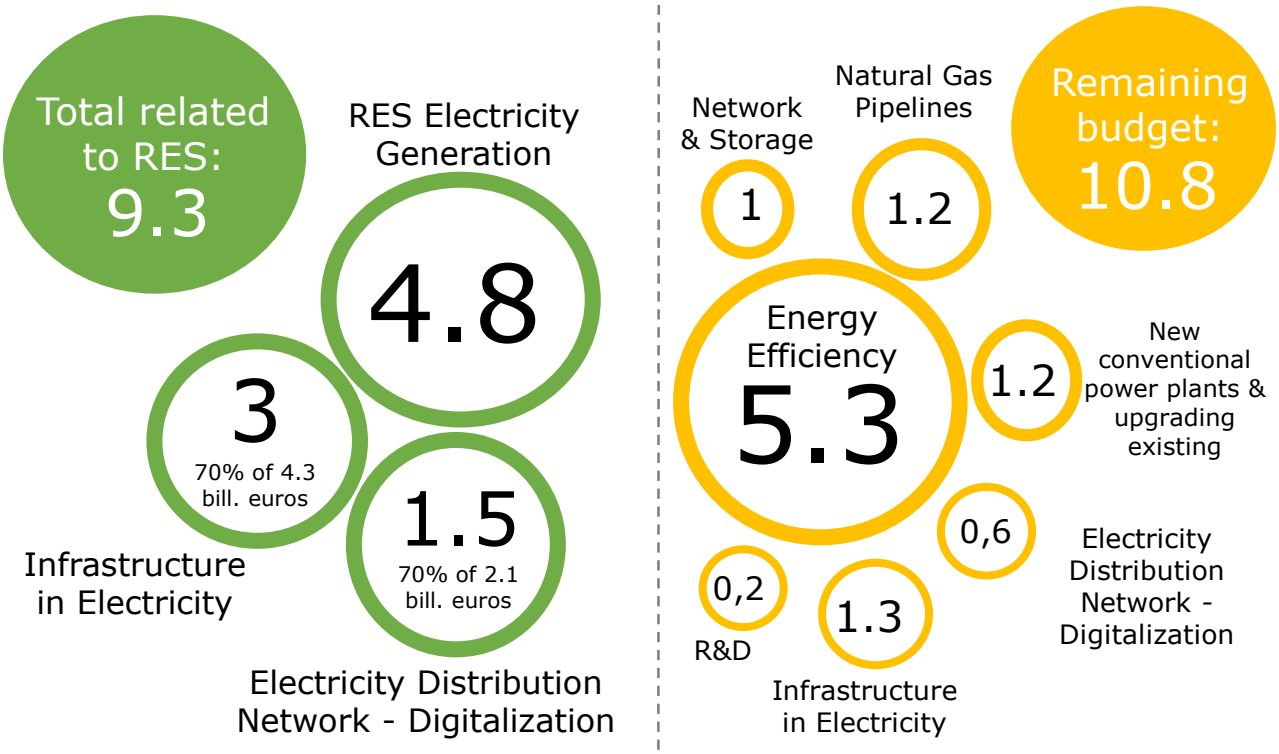
Financing of investments with a positive environmental and social impact is also the major goal of the European Investment Bank (EIB), which is committed to support transformational investment in Greece. EIB launched the largest energy efficiency financing initiative to date in any European country, under the Private Finance for Energy Efficiency program.

Furthermore, the European Bank for Construction and Development (EBRD) will also engage Greece, in expanding the private sector's role in the energy industry, enhance regional integration and improve quality of utility services.

In line with that, according to HAAE's estimations, investment in electricity infrastructure will reach 4.3 billion euros. The two aforementioned categories represent almost 50% of the total projected investments.

Total investments related to RES stand at 46.2% out of the total amount projected to be invested in the Greek energy market by 2030, based on HAEE's realistic revision

Fragmentation of projected figures (billion €), [2020-2030]



Source: HAEE's estimations

Highlights

According to HAEE's estimations the total amount to be invested related to RES is expected to be 9.3 billion euros. Based on the official announcements of ADMIE regarding the long-term forecast of RES installed capacity, investments in this sub-sector are projected to reach 4.8 billion euros. Infrastructure in RES accounts for the 70% of the projected amount (4.3) in the broader electricity sector, yielding 3 billion euros. Next, during the next years, distribution and digitalization related to RES will attract 1.5 billion euros in total, a figure that represents again the 70% of the total amount invested in the sub-sector.

Apart from the funds that are anticipated to be directed towards the broad RES market, other investments in electricity infrastructure include the interconnectors of Crete-Attica (expected to be completed in 2023) and Crete-Peloponnese (expected to be completed in 2021). Moreover, this category includes the development of infrastructure in Non-Interconnected Islands, as well.

Regarding electricity distribution and digitalization, smart Grids constitute one of the main drivers for economic growth. Through HEDNO´s investment plan that focuses on the transition of the Network into a Smart Grid, new business opportunities are created for many Greek businesses especially SMEs that will be given the opportunity to develop new applications and solutions.

The remaining 10.8 billion euros, represent investments in the broader energy sector. For instance, natural gas pipelines amount includes the aggregate projections counting for the remaining TAP funds, the IGB and the network expansions announced by EDA Thess, EDA Attikis and DEDA, which are expected to approximately 1.2 billion euros.

Finally, the 1.2 billion euros invested in conventional power plants, based on our estimates, include among others, the construction of two new gas-fired power plants (660 MW each).

10 Trends shaping the current and future policies around the Energy sector

Looking forward

Based on a recently published Report provided by the European Commission (European Political Strategy Centre, 2019), 10 Trends are shaping the current and future polices around the energy sector. Aiming to keep pace with those trends, national authorities in Greece should focus on reforms and developments that are necessary in order to comply with this constantly changing environment.

Trend No.1 – Climate change: European cities are already on average 1°C warmer than in the 20th century. What has been initially seen as a distant, next-generation problem full of uncertainties, climate change is now an observable phenomenon. Global warming has already reached 1°C above preindustrial levels and is increasing at approximately 0.2°C per decade. Weather-related disasters – from hurricanes and wildfires wiping out forests and towns, to typhoons and heavy floods, or severe droughts and extreme heatwaves – are already proliferating around the globe forcing countries to develop expensive climate adaptation strategies, next to climate mitigation ones. Environmental degradation linked to traditional energy production and consumption patterns is also creating new health risks. Air pollution, which already causes more than 400,000 Europeans to die prematurely each year, is set to get worse as climate change further magnifies the effects of pollutants.

Trend No.2 - Renewables and Storage: Renewables will shortly be cheaper than fossil fuels and are expected to dominate the energy mix. Boosted by an ambitious policy and regulatory framework, as well as binding targets, the EU continues to lead the penetration of renewables, with renewable energy sources now representing at least 17% of final energy consumption in Europe, on track towards the 2020 target of 20%.This growth has enabled a reduction in the overall share of fossil fuels in the EU's gross energy consumption: from 81% in 1995 to 72.6% in 2016, even though absolute figures remained constant. Renewables penetration rates in Europe are expected to accelerate further, reaching 32% by 2030. The integration of additional renewables into the existing energy system is the main barrier to their large-scale deployment. While still in its infancy, battery storage is happening and set to play a key part in the future of the renewable energy industry, by enabling the storage of surplus energy that currently goes to waste. Stronger growth in renewable energy is supported by the fact that both solar and wind power are becoming significantly more competitive. Costs of solar have fallen by 70% since 2010.

Trend No.3: - Clean technologies: Clean technologies are opening up major new opportunities for industry and investors, even if capital markets are slower to align with the climate economy. Today, private firms are exploring and applying climate-oriented business models, often with the strong conviction that these will be good for the bottom line. Of course, public finance continues to play a key role, in particular to crowd in private funding and help carry riskier projects. Global markets for climate-friendly businesses and technologies have already grown to close to one trillion euro annually. The European battery market alone is projected to be worth 250 billion euro per year by 2025. This trend is expected to accelerate, driven by strong growth in emerging economies. Low-carbon technologies are also becoming a major trade commodity, with the EU benefiting from significant positive trade balances. During the period 2012-2015, EU exports of clean energy technologies reached 71 billion euro, exceeding imports by 11 billion euro.

Trend No.4 - Green Economy: Environmental economy is growing faster than the overall economy. The clean economy has been growing considerably faster than the overall economy over the past fifteen years in the EU, both in terms of value added and jobs. In the EU, the number of renewable energy jobs reached 1.4 million in 2017 and is expected to increase, with the creation of up to 1.5 million net jobs by 2030. On the other hand, many traditional, fossil fuel-based industries are struggling: While the fossil fuel sector provided jobs for 30 million people globally in 2017, it is set to lose 8.6 million jobs by 2050. In most cases, new jobs created in the clean economy will be created for different skills profiles to those jobs that will become obsolete. In the automotive sector for instance, jobs are already shifting in favor of IT specialists, power electronics, and recycling and battery technologies. Skillsets across Europe are trailing. The renewable energy and clean tech industry is already facing shortages, whether in the wind sector, where there is a shortage of maintenance skills, or the solar photovoltaic industry, where manufacturing experts and installation technicians are lacking.

Trend No.5 - Energy efficiency: Energy efficiency has become the world's 'hidden fuel'. The growing world economy will require more energy, but consumption consumption is expected to grow less quickly than in the past, at 1.3% per year over 2015-2035 compared with 2.2% per year in 1995-2015. This is because energy intensity (energy usage in relation to gross domestic product) improvements are speeding up – leading also to improved carbon intensity. In fact, Europe has already succeeded in decoupling economic growth and greenhouse gas emissions, with total emissions decreasing by 22% between 1990 and 2017, even as the EU's combined GDP grew by 57.5%. The acceleration of energy efficiency improvements largely reflect a shift in policymaking from supply-side issues to the demand side. Today, a third of the world's energy consumption is covered by mandatory standards and regulations, compared with just 11% in 2000. Energy efficiency solutions also bring everyday economic benefits, which are all the more important for people living in precarious conditions or exposed
to energy poverty. A global leader on energy efficiency, the EU is nearing its target of improving energy efficiency by 20% by 2020, although recent years have seen a resurgence in energy consumption levels.

Trend No.6 - Digitalization: Digitalization is driving an energy revolution, yet it does not come without risks. In 2016, global investment in digital electricity infrastructure such as smart grids, which use digital technologies to enable two-way communication between utility providers and customers, amounted to 40 billion euro. This was almost 40% higher than investment in gas-fired power generation worldwide (30 billion euro). Energy tech start-ups are popping up the world over, attracting some 5 billion euro in 2017 in corporate venture capital and growth equity. Importantly, since 2015 this increase has been driven by IT companies, rather than energy, transport or utility companies. The growing involvement of digital platforms is driving the development of new services and apps that serve to optimize society's energy consumption, cut costs and reduce carbon footprint. As such, digitalization is giving rise to a new generation of empowered consumers, able to control their energy consumption in real time – e.g. shifting demand to times of cheaper prices.

Trend No. 7 - Decentralization: Electrification, renewables and digitalization are giving rise to a new generation of small producers; but it's not without challenges. The rapid global deployment of renewable technologies – solar in particular – means that millions of consumers around the world are now able to produce their own electricity – from rooftop solar panels, for example. While most coal, gas and nuclear power plants are owned by big utilities, the ownership structure for renewables is more diverse. This is partly because individual renewable installations tend to be much smaller. While a typical European nuclear power plant has a capacity of around 2,000 megawatts, and coal power plants have an average capacity of 700 to 1,000 megawatts, the average solar energy project size in Europe in 2015 was 3-8 megawatts. This allows more investors to enter the energy sector, creating a more competitive energy market.

Trend No. 8 - Emerging Markets Growth: As energy demand surges in Asia, it is also driving innovation. Driven by rapid economic growth, energy consumption is growing fastest in the Asia and Pacific regions. China already surpassed the United States as the world's largest crude oil importer in 2017 and IEA projects that it will become the world's largest consumer of oil by the early 2030s. China is also expected to account for more than a quarter of all the worldwide growth in gas consumption between 2015 and 2040. At the same time China is also the world's largest greenhouse gas emitter, surpassing the combined carbon contribution of both the US and the EU. The Asia Pacific region as a whole is now responsible for nearly 50% of global carbon dioxide emissions. This rapid growth is also driving major investments in renewables and in energy efficiency, as China and other countries in the region seek to keep their swelling energy bills under control and their citizens demand cleaner air. China and India are set to stand for almost half (46%) of the projected growth in renewable energy markets between 2015 and 2021. Moreover, China has become the world's largest destination of investment in the energy sector, standing for one-fifth of global energy investment in 2017. Combined with an ambitious government-supported industrial strategy, this has enabled the country to rapidly transform itself into a leading global center for clean tech manufacturing. It has already taken over the solar photovoltaic sector. It leads by far on electric vehicles sales. And is set to dominate global battery cell manufacturing, feeding about 70% of the global Li-ion batteries market by 2020.

Trend No.9 - Security of supply: New supply risks emerge as the energy value chains go global and the clean tech revolution increases reliance on new materials. Security policies in the energy sector have traditionally evolved around pipeline diplomacy and hard security issues affecting the supply of oil and gas. While this will remain a concern in the medium term, the balance is shifting. On the one hand, the globalization of gas markets and rising shares of liquefied natural gas mean import sources can be diversified more easily. On the other hand, the rise in renewable energy enables a shift to local production, helping to decrease import dependency. However, this will take time and could be accompanied by new dependencies that will need to be managed in Europe's external and trade relationships. Indeed, the large-scale production and deployment of batteries, wind turbines and other clean tech solutions will require uninterrupted supply of specialized raw materials like rare earths and cobalt at low cost, most of which, however, are not produced in Europe but must be imported – in some cases from countries with less stable political regimes. In this context, trade partnerships are expected to play central role, as is the application of circular economy principals (recycling and reuse of materials and components).

Trend No. 10 - Decarbonization: Net-zero emissions is no longer a mere dream, since innovation is gradually needed to erase our carbon footprint. Those renewable technologies that are already mature, like solar, hydropower or wind, are expected to enable the EU to cut its greenhouse gas emissions by up to 90% by 2050. But in order to make the final step towards net-zero greenhouse gas emissions by 2050, other innovative technologies will be needed, such as artificial photosynthesis, carbon capture and storage and advanced manufacturing for energy-intensive industries, or precision farming and advanced biofuels. Energy storage technologies and low-emission options for airplanes will also need to be further developed. The private sector has been raising the game in recent years, consistently accounting for more than 75% of EU investment in clean energy research and innovation, and increasing annual spending from some 10 billion euro to over 16 billion euro in the past decade. Yet, despite its strong research base and its large public research budget for clean energy technologies (second largest after the United State), the EU ranks last among major economies in terms of investments per GDP. Furthermore, insufficient access to finance, in particular venture capital, combined with high capital costs and excessive red tape mean that Europe all too often fails to bridge the gap from research to market. Technological leadership is key as those who set the standards are also those who later control the markets.

Conclusion

HAEE's Greek Energy Market Report of 2019 consists of an extensive review of the majority of energy related topics. As a core activity, the report aims to present international best practices and both global and European energy trends, while contrasting the latter to the Greek energy market landscape.

Greece is currently experiencing a period of **steady growth**. Real GDP growth reached 1.9% in 2018, projected to strengthen to 2.2% of GDP in 2019 and 2.3% in 2020. Domestic demand and in particular private investments is expected to become the driver of growth in the coming years. Moreover, the country's government bond yields continued their downward trend, reaching the lowest levels seen in more than thirteen years. More specifically, Greece's 10-year bond yield reached 3.36% in April 2019.

In that environment of broad recovery, the **Energy Market** in Greece has significant growth potential in terms of its marketability and efficiency. Energy security supply and the diversification of the supply sources and routes remain priorities and the most significant foreign policy tools. Over the previous years, Greece has made significant efforts to advance energy sector reforms in a challenging environment of declining consumption and constrained finances.

A key element to increase competition and remove pricing inefficiencies, is the launching of the Target Model. Progress has been achieved here as well, as the relevant rulebooks have met regulatory approval. Furthermore, the national regulator (RAE) is preparing supplementary decisions to set up the working structure of the composite markets. **Hellenic Energy Exchange** and the spin-off company for clearinghouse have already been established, so the initial elements will soon be in place to start with the setting up of functional Forward, Day-Ahead, Intraday and balancing markets in electricity.

Yet, competition continues to be restricted due to the dominant position of the State-owned energy company PPC (Public Power Corporation), which accounts for the vast majority of retail and wholesale supply. The current situation makes it harder considering the country's goal towards decarbonization and efficient market liberalization. However, there are already signs of improvement. The French-inspired Nouvelle Organisation du Marché de l'Electricité-type (NOME) auctions, set up to increase competition in **Electricity** market and facilitate fair access of alternative suppliers to the fuel mix. The abovementioned measure contributes towards the reduction of PPC's dominance, though due to various inefficiencies in its architecture, it remains below the ambitious levels set.

Regarding the **Natural Gas** market, the restructuring and partial privatization of DEPA, the State-owned gas company should allow more competition and further unbundling of gas supply and distribution. Currently, the retail market is consisted of more than 8 active suppliers some of which have started selling quantities in the market since 2018.

Furthermore, Greece has the potential for solar and wind generation to be upgraded, but in order to do so, the country requires both a level of investment support and a market that makes best use of them. The **Renewable Energy Sources** support account is now in surplus, due to the strong increase of the revenues originating from the trading emission scheme (ETS). A further positive development has been the launch of RES auctions, following a standstill in the market for a few years, which are designed to last until 2020. These auctions take place regularly (the first was in July 2018, the second one in December 2018 and the third in April 2019), allowing for some uptake of solar and wind energy into the grid and helping investment in this area.

In terms of total primary energy supply, **Oil** is the largest source, accounting for approximately 50%, however Greece has experienced a large reduction in its total oil consumption during the last decade. Still, dependency is high since there is a small amount of indigenous oil production and most of the crude oil amount is imported. Nevertheless, a growing interest in upstream exploration and production offers an opportunity to increase domestic oil production.

Moreover, Greece has implemented a series of **Energy Efficiency** policies, the majority of which are due to the harmonization of the Greek law to the requirement of European Commission's Energy Efficiency Directive. The most notable policy is the energy efficiency obligation program, which is designed to assist Greece in achieving its energy savings targets. However, energy efficiency is highly linked with energy consumption and this interplay might affect the measurement of efficiency, since energy consumption in Greece has fallen significantly following the economic and financial crisis in 2008.

Next, the report includes a detailed analysis regarding the positioning of Greece in terms of the enhanced energy **Trilemma**. Greece's performance is in the lowest positions among the OECD countries. The major highlight is the issue arising from equity, as this dimension affects social cohesion and quality of life. Given that the goal of every economy is to achieve competitiveness, a greater opening of the market without compromising environmental protection, will help to increase productivity gains and reduce the use of finite natural resources. In addition, Greece should explore utilizing even more its considerable renewable energy capacity which can also increase its energy security.

Above all, the strategic geographic location of Greece, in combination with its abundancy of Renewable Energy potential indicate that the country can be a key player in the EU energy mix and is anticipated to provide significant **Investment** opportunities in different energy sectors. Greece is currently emerging as a key player in the transportation of energy from East to West, ensuring security of supply through gas pipelines, liquefied natural gas terminals and international electricity interconnections. Despite the structural issues, climate and geographical positioning gives Greece a chance to become a strategic energy hub, through the development of major infrastructure projects with the neighboring countries. These projects require significant investments that would allow Greece to maintain momentum in energy market reforms.

Considering the current levels of electricity capacity in Greece and including the additional capacity that PPC's new coal-fired unit V in Ptolemaida will add to the system, the total amount equals to approximately 12,660 MW. One-third of this value is the capacity that is currently provided by coal-fired units that are anticipated to be replaced by 2025. Based on current consumption levels (60TWh), there will be a significant gap of 4,000MW that could be covered by two gas-fired power plants (660 MW each) and RES (remaining 2,800 MW). Due to the lower efficiency of RES and using a multiplier of 3, we conclude that the system will require approximate additional capacity of 8,400 MW by 2030. If we include in the latter figure the existing 6,000MW of RES capacity, the total amount provided by RES in the system sums up to 14,400 MW. In other words, given the future developments that Greece will face, in terms of the decarbonization goals, the amount of RES in the system is estimated to be more than doubled by 2030.

However, the replacement of lignite units by RES is not going to be as straightforward as the above analysis assumes. Hence, HAEE estimates that following 2025 a couple of lignite units will continue to operate, ensuring security of supply in the system, since the investments towards RES will come at a slower pace. The factor that could possibly invert this tendency is storage that could assist the flexibility and resilience of the system. The above estimation supports the fact that two additional gas-fired power plants could fit in order to ensure a well-functioning electricity market. In that context, Greece needs to face any future challenges by embracing and taking on new roles. Aiming to keep pace with the evolution of new technologies for smart grids and digitalization, Greece should upgrade, modernize and adopt its assets and systems.

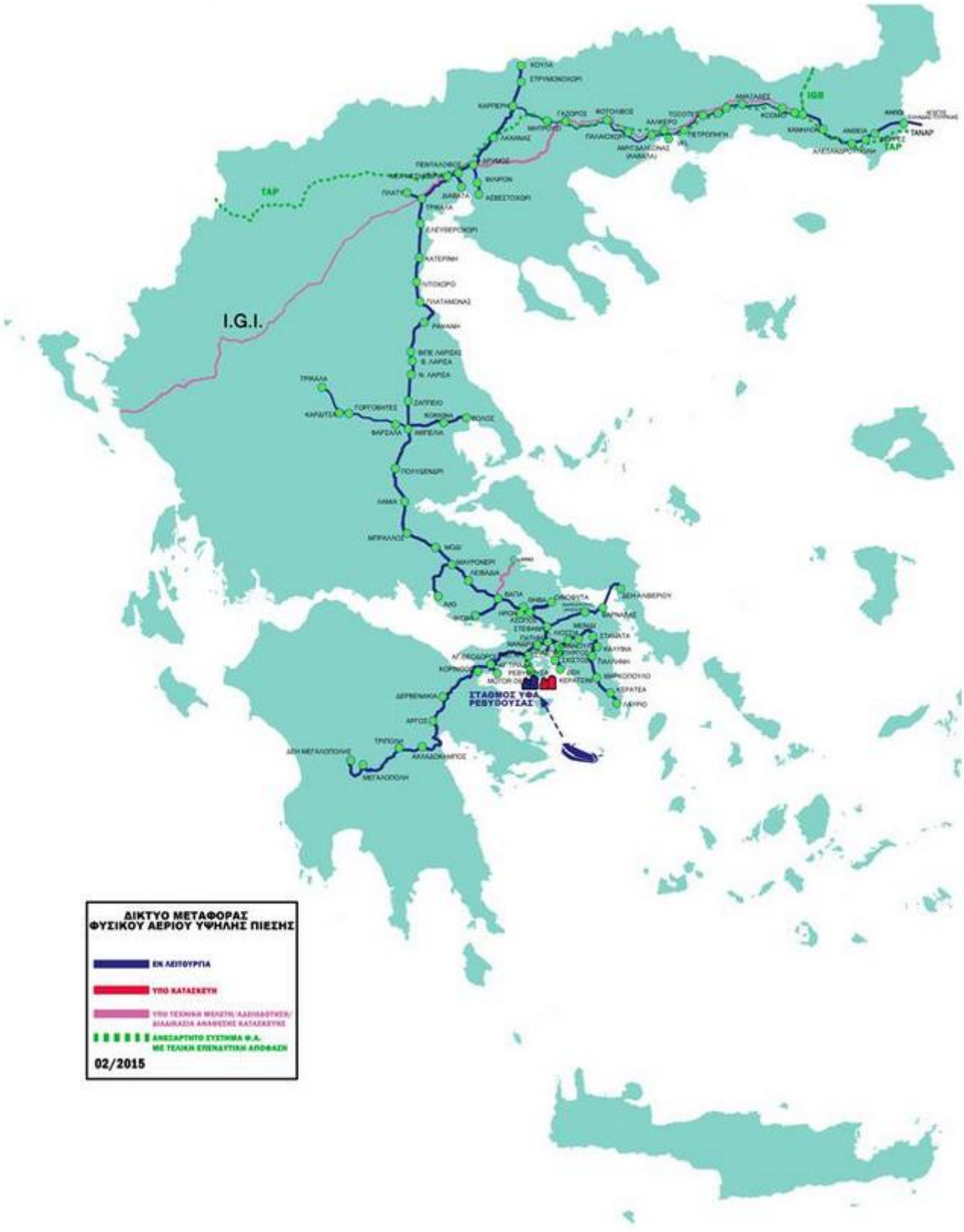
In summary, the Greek Energy Market Report 2019, identifies both the current status of the energy market but also highlights the potential and the challenges that have to be overcome. Even greater effort will be required if Greece is to achieve its longer-term energy goals. The creation of competitive and price-responsive energy markets will be critical to ensure long-term economic prospects while putting the country solidly on a path to a low-carbon economy.

Appendix

National Electricity Transmission System

Source: ADMIE

National Natural Gas Transmission System



Source: DESFA

Data Sources

https://www.worldbank.org/

https://ec.europa.eu

https://ec.europa.eu/eurostat

https://www.iea.org/

https://www.oecd.org/

https://about.bnef.com/

https://www.igu.org/

http://www.rae.gr

http://www.enexgroup.gr/

https://ape.dapeep.gr

http://www.admie.gr/

https://www.deddie.gr/en/

http://www.desfa.gr/

http://eletaen.gr/en

http://helapco.gr/en/

http://iobe.gr/

http://www.statistics.gr/

https://www.greekhydrocarbons.gr/

Useful links

Ministry of Environment and Energy
http://www.ypeka.gr/

Ministry of Finance
https://www.minfin.gr/

Regulatory Authority for Energy
http://www.rae.gr/old/en/

Centre for Renewable Energy Sources and Saving
http://www.cres.gr/kape/index_eng.htm

Hellenic Republic Asset Development Fund
https://www.hradf.com/en/fund

Hellenic Competition Commission
https://www.epant.gr/en/

The Independent Power Transmission Operator
http://www.admie.gr/nc/en/home/

Natural Gas System Operator
http://desfa.gr/

Energy Exchange Group
http://www.enexgroup.gr/nc/en/home/

Hellenic Electricity Distribution Network Operator
https://www.deddie.gr/en/i-etaireia/profil

Acronyms and abbreviations

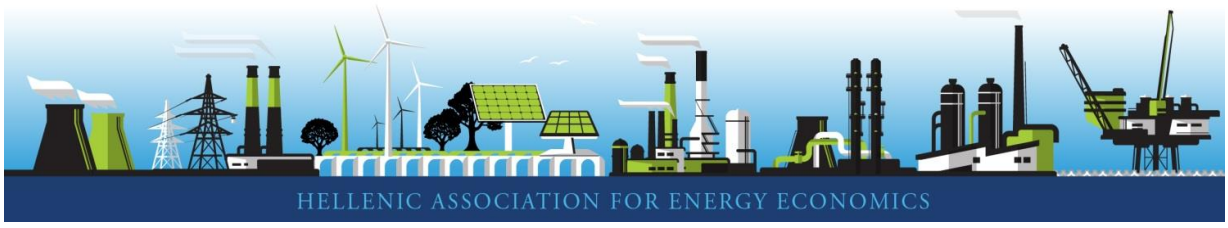
ADMIE	Independent Power Transmission Operator
CRES	Centre for Renewable Energy Sources and Saving
DAS	Day-Ahead scheduling
DEDA	Gas Distribution Company Rest of Greece
DEPA	Public Gas Corporation S.A.
DESFA	Hellenic Gas Transmission System Operator
DSO	Distribution System Operator
EC	European Commission
ETMEAR	Existing renewable energy source levy
ETS	Emissions Trading System
EU	European Union
FiT	Feed-in Tariff
FiP	Feed-in Premium
FSRU	Floating Storage and Regasification Unit
GDP	Gross Domestic Product
HCC	Hellenic Competition Commission
HENEX	Hellenic Energy Exchange
HEDNO	Hellenic Electricity Distribution Network Operator
HELPE	Hellenic Petroleum
HHRM	Hellenic Hydrocarbon Resources Management S.A.
HRADF	Hellenic Republic Asset Development Fund
IPP	Independent Power Producers
ITO	Independent Transmission Operator
LAGIE	Hellenic Electricity Market Operator
LNG	Liquefied Natural Gas
NII	Non-Interconnected Island
NNGS	National natural gas system
NOME	Nouvelle Organisation due Marché de l'Electricité
PCI	Project of Common Interest
PPC	Public Power Corporation
PV	Photovoltaic
RAE	Regulatory Authority for Energy
R&D	Research and Development
TFC	Total Final Consumption
TPES	Total Primary Energy Supply
TSO	Transmission system operator

Units of measurement

bcm	billion cubic meters
CO2	carbon dioxide
GJ	gigajoule
GW	gigawatt
kL	kilolitre
km	kilometre
ktoe	thousand tonnes of oil equivalent
kW	kilowatt
kWh	kilowatt hour
m3	cubic meter
mcm	million cubic metres
Mt	million tonnes
MtCO2	million tonnes of carbon dioxide
MtCO2-eq	million tonnes of carbon dioxide equivalent
Mtoe	million tonnes of oil equivalent
MW	megawatt
MWh	megawatt hour
tCO2	tonne of carbon dioxide
toe	tonne of oil equivalent
TWh	terawatt hour

Hellenic Association for Energy Economics (HAEE)

The Hellenic Association for Energy Economics (HAEE - www.HAEE.gr) is a non-profit research and professional organization acting as an interdisciplinary forum for the exchange of ideas and experiences among energy experts. It acts as an independent consulting body for national and international organizations to whom it provides a broad contribution on issues related to energy, economics, policymaking and theory.



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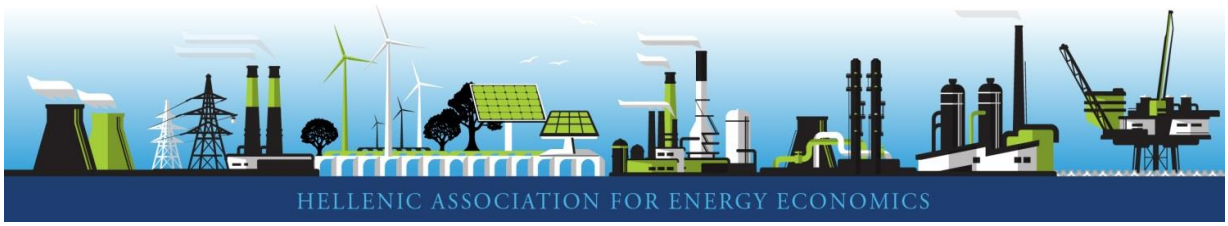

Greek Energy Market

Report 2019

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