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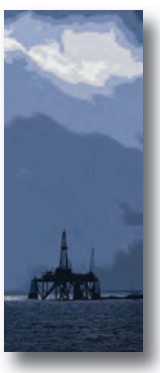
GREEK ENERGY DIRECTORY

2016

The Oil Sector



Natural Gas

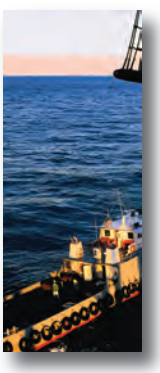
The Electricity Sector

Renewable Energy Sources

Energy Efficiency & Co Generation

The Legal Framework

Research & Development



Business Directory

TERNA ENERGY

GEK TERNA GROUP

TERNA ENERGY is a major player in the Renewable Energy Market and specifically in the development of Wind Parks, in Hydroelectric Projects, Solar Energy Plants as well as Waste to Energy and Biomass Projects, with presence in Greece, Europe and the USA.

The total installed capacity of the Group accounts for 664 MW: 394 MW in Greece, 138 MW in the USA, 102 MW in Poland and 30 MW in Bulgaria, while 274 more MW are currently under development in Greece and abroad.

Overall, the company operates, is constructing or has fully licensed 938 MW of RES installations in Europe and the USA. The company is targeting to reach almost 1,000 MW of RES projects in operation in all countries where it is active, over the following years.

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Greek Energy Directory

2016

Editor:
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GREEK ENERGY DIRECTORY 2016
Published by **EditCom Ltd**

3, Alex. Soutsou, 106 71 Athens, Greece
Tel.: 0030 210 3628457, 3640278 fax: 0030 210 3646144
www.energia.gr, e-mail: info@editcom.gr

Layout: Ariadni Kalokyri

Athens, September 2016

ISSN 2529-0878

Foreword

As Greece is slowly coming out from the worst recession in its history the energy sector is expected to play a key role in supporting a return to economic growth. Apart from providing much needed infrastructure for the use of different forms of energy, ranging from electricity, oil and gas to renewables, energy efficiency and co-generation, the energy sector is attracting much needed investment for new projects, but also for marketing activities following electricity and gas market deregulation and rising competition. The ongoing privatization programme of major state controlled enterprises in electricity and gas is attracting further investor interest together with Greece's effort to exploit its considerable hydrocarbon resources.

"Greek Energy Directory 2016" aims to provide a thorough description of the current state of Greece's energy sector but also project an outlook of likely developments in the years ahead. The industry's response to our request for information and individual contributions through articles and description of company activities, has been overwhelming necessitating postponement of CED's publication, originally scheduled for early 2016. Consequently "Greek Energy Directory 2016" has outgrown its scope and has become a truly comprehensive source of information on Greece's buoyant energy sector.

This Energy Directory is designed to meet the information needs of both the investor and energy entrepreneur alike and the energy professional at large. A series of articles and analysis by well known energy experts and senior executives of the sector's leading companies provide useful background on all aspects of energy related activities in Greece. Furthermore, a well researched list of companies and organizations of the Greek Energy Sector compliments the body of knowledge presented in this publication. Starting back in 1984 when I first published a "Greek Energy Directory", through Heliotechnic Ltd., and then in 2001 when I edited "The Energy Market in Greece", jointly published by ICAP and Delos Communications, the present publication comes to fill an important information gap. I trust that "Greek Energy Directory 2016" will prove both useful and inspiring for all concerned and engaged in one of the most dynamic sectors of the Greek economy.

COSTIS STAMBOLIS
Publisher, *Greek Energy Directory* 2016

Preface

Today we are seeing a favourable situation emerging in Greece's energy sector which, together with the serious institutional changes promoted by the EU in the energy markets, can help towards the implementation of major transnational projects such as the Trans Adriatic Pipeline (TAP), but also assist in the exploration of new energy resources and, the "rediscovery" of existing and conventional ones.

Despite the economic "malaise" which characterizes this period, nobody can ignore the reality of expanding energy needs in Europe. Energy efficiency, energy security, plurality of sources and supply routes, remain extremely important issues because they form an undeniable foundation for both our economic development and stability.

Greece is dynamically and effectively claiming the rightful place she deserves in the fast developing energy environment, in order to enhance its role in the regional energy crossroads. This can be achieved through the implementation of a multidimensional energy policy, within the country and abroad.

Oil, natural gas, electric power, Renewable Energy Sources, energy efficiency and energy conservation are some key areas which this publication aptly covers. At the same time, all of the above are challenging areas, to which we must respond and take decisive steps forward.

Economic growth, employment creation, the attraction of new of investment and the creation of a long term viable productive model, which is immune to the vicissitudes of the global economy, are the main goals within the present energy context. With this aim we intend to develop and adopt appropriate measures and interventions with regard to Greece's energy sector.

The coming years will be years of progress. Beyond TAP, various major energy projects are at different stages of planning and development. Among them, IGB the Greek-Bulgarian natural gas interconnector pipeline, the LNG Offshore Floating Terminal in Alexandroupolis and the upgrading of the existing Revithousa LNG Terminal.

Greece advances along the path of energy cooperation with Cyprus, Israel, Egypt, thus creating new hydrocarbon exploration conditions in the Eastern Mediterranean. Greece also aspires to jointly develop with the above countries the necessary capabilities for natural gas transportation and electricity interconnection link by means of the EuroAsia Interconnector.

Greece encourages the use of multiple energy sources and routes, is open to both options in attracting Russian natural gas via an alternative route and of importing LNG from the US, Iran and other countries.
An extrovert energy policy is part of a broader effort currently underway towards the establishment of a new energy reality. This is vital in order to combat energy poverty. At the same time it is important to introduce cost-cutting measures and control price rises for the benefit of consumers and businesses alike while ensuring adequate and safe energy flows.

Our government is planning to undertake specific measures in order to develop further the domestic natural gas network and expand it in geographic areas of the country where today there is no suitable infrastructure. In this context we have introduced a new operational framework for the natural gas market. At the same time we have been reforming the electricity market on the basis of EU'sTarget Model guidelines while we plan to develop additional infrastructure and interconnections.

Furthermore, the regulatory framework is being enhanced in order to facilitate the use of new energy sources such as solar thermal while we shall soon introduce specific measures for the development of geothermal energy. We have introduced a new institutional framework for Renewable Energy Sources (RES) by removing all past distortions. Recent legislation on energy efficiency reinforces further the regulatory basis of the energy sector in order to achieve concrete, tangible and measurable results.

The promotion of a democratic and socially acceptable energy plan, in which the public, social and private business can coexist harmoniously, having as ultimate goal a horizontal, decentralized and participatory energy infrastructure, remains a central policy goal for our government.

The development of this different model, which involves the transformation of the energy mix, a socially oriented planning by increasing RES penetration, the elimination of fossil fuel dependence as pointed out in COP21 Paris Agreement for climate change, are inextricably linked and co exist with our respect of local communities and the environment.

The energy thread ball unfolds and encompasses significant opportunities which will help us out of the present recession.

PANOS SKOURLETIS
Minister of Environment and Energy

I. Overview of Greece's Energy Sector

An Introduction to Greece's Energy Sector

By **COSTIS STAMBOLIS**, Managing Editor of *Energia.gr* and Executive Director of the Institute of Energy for SE Europe (IENE)

In Greece, like in other OECD countries, energy is one of the most important sectors of the economy corresponding roughly to 5.0% of its GDP. With hundreds of companies active in the broad energy field and employing directly and indirectly, approximately 100,000 people, energy, along with tourism and industry, is considered one of the most dynamic components of the country's economy.

Oil refining and oil product marketing, hydrocarbon exploration and production, power generation, transmission and distribution natural gas imports and distribution, and the large-scale utilization of renewable energy sources in all their forms (i.e. solar, wind, hydro, biomass, biofuels, geothermal) are the main areas of activity, which define the Greek energy sector today. Although Greece imports nearly 65% of the energy it consumes the country is also an important energy provider as it exports refined oil products and electricity to its neighbours in the SE Europe. Reflecting the country's persistent economic downturn over the last six years, energy consumption has suffered accordingly showing a significant decrease of approximately 28%.

The country's energy mix is dominated by oil, almost all of which is imported and which is largely consumed in transport and for space heating in buildings, but also in agriculture and for power generation in several islands. Natural gas, all of which is also imported and was introduced in the country' s energy system only 20 years ago, corresponds to 10% of primary energy consumption, while Renewable Energy Sources (RES), which saw a huge rise in terms of installed capacity in the early part of this decade, now contributes some 12%, including biomass, large hydro and solar/wind, to Greece's energy balance. Over the last few years, the country's energy mix, has been undergoing a significant change with RES and natural gas now claiming a sizeable stake (see *Figure 1* for 2015 primary energy consumption distribution in Greece).

In summary Greece's main indigenous energy sources comprise lignite, a type of low calorific value coal, hydroelectricity and other renewables (i.e. solar, wind, biomass, biofuels and geothermal energy). Greece is also producing limited quantities of oil, while it imports 98.5% of its requirements in the form of crude oil which is refined locally. Some 85% of oil is used for transportation, in agriculture and for space heating and cooling and the rest for power generation in the islands. Greece is also producing limited amounts of biofuel, as part of its obligations in the EU, with the full production absorbed by the local refineries which in turn produce biodiesel. Natural gas, which is a late comer to the energy scene, is totally imported from Russia, Turkey and Algeria in LNG form, and lately from some other destinations. Greece does not use any nuclear power nor has it any plans for developing nuclear power capacity. Without any serious scientific examination or public debate Greece's political parties appear united in a secret pact

to prevent any discussion or even thinking on the matter. Greece is clearly suffering from an untold and deep-rooted phoebic syndrome concerning nuclear power. Nevertheless, the biggest amounts of imported electricity, which correspond to approximately 11.86% of total electricity consumption that comes from Bulgaria and Romania, originate from nuclear power plants in those countries.

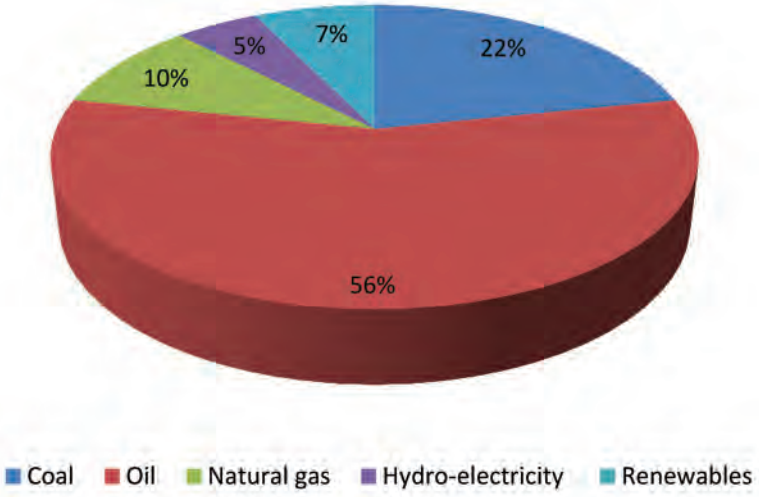


Figure 1: Primary energy consumption in Greece by fuel (2015) (Total=26.2 Mtoe)

Source: *BP Statistical Review of World Energy* 2016

Energy Supply and Demand

In 2013, Greek total final consumption (TFC) reached 15.3 Mtoe registering a sizeable decline of 27.83%, compared to the 21.2 Mtoe consumed in 2008 (see *Figures 2* and *3*). This sharp decline in TFC is fully aligned with the corresponding contraction of the Greek economy during the same period where the cumulative GDP has decreased by 24.8%, from a 2008 peak of 242 billion euros to 182 billion euros in 2013. We should further note that TFC rose by 2.80% per year between 1990 and 2007, while it fell by -4.66% per annum between 2008 and 2013.

TFC is still dominated by oil products, making up roughly 54.0% of the total consumption in 2013. The contribution of natural gas to TFC was 8.05% or 1.23 Mtoe in 2013. The share of coal in TFC was significantly lower (i.e. 1.39%, which corresponds at 0.21 Mtoe) during the same time span. Electricity contributed 27.48% to TFC or 4.20 Mtoe in 2013 with most of it coming from residential (i.e. 1.5 Mtoe), commercial and public services uses (i.e. 1.46 Mtoe). Similarly, biofuels and waste contributed 7.38% to TFC or 1.13 Mtoe in 2013.[2]

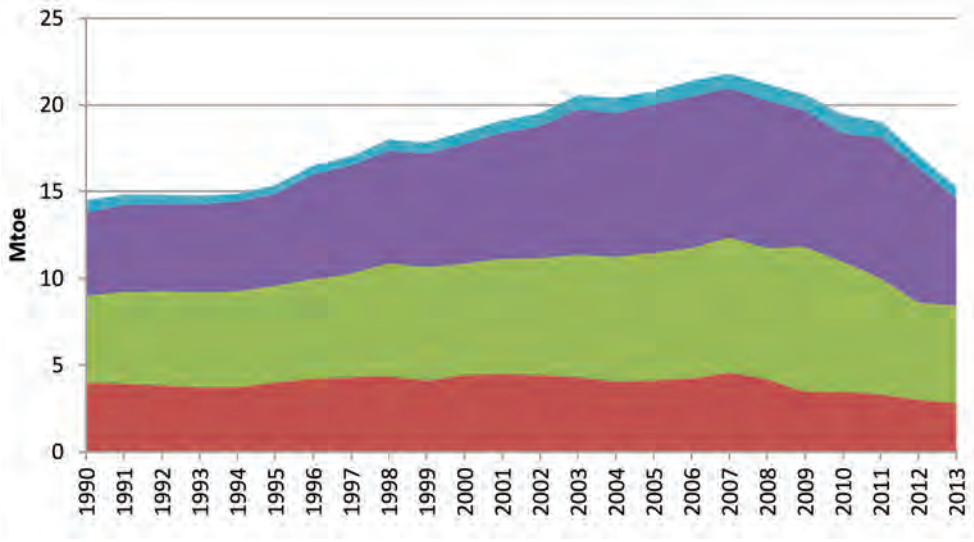


Figure 2: Total Final Energy Consumption* over 1990-2013

*Other sectors include residential, commercial and public services, agriculture/forestry, fishing and non-specified.

Source: IEA

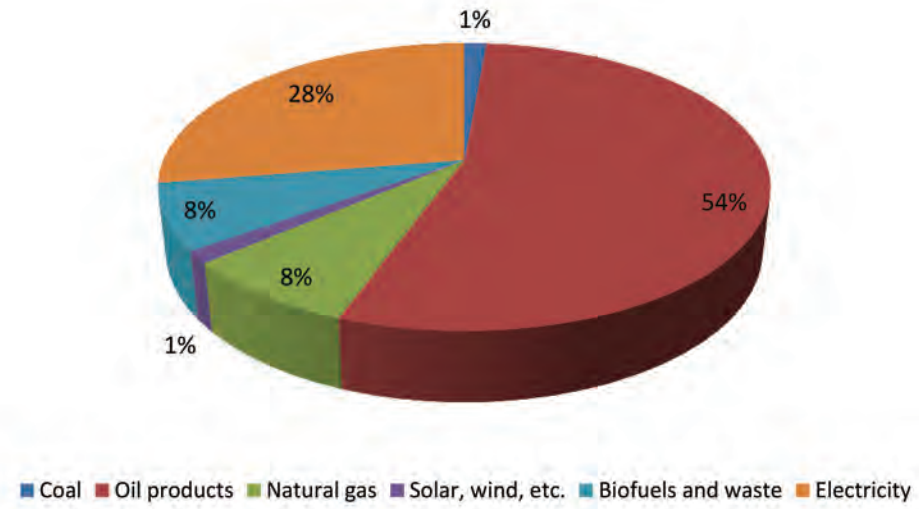


Figure 3: Total final consumption in Greece, per primary energy source (2013) (Total=15,271 ktoe)

Source: IEA

In 2013, Greek Total Primary Energy Supply (TPES) as shown in Figures 4 and 5 reached 23.40 Mtoe. This was a decline of 23.03% over the 2008 level of 30.4 Mtoe. TPES has grown by an average of 2.47% per year between 1990 and 2002, but it grew negatively -1.79% per annum between 2003 and 2013. The dominant energy source remains oil, accounting for some 45% of the Greek TPES in 2013. The country has very little indigenous oil production some 5,000 bpd, all from the Prinos offshore oil field in the Kavala Gulf in the northern Aegean Sea. The most significant change in the fuel mix of TPES has been the increase in the use of natural gas, resulting in stable lignite consumption. Coal, which is largely based on indigenous lignite resources accounted for 8.3 Mtoe (i.e. 27.35% of TPES) in 2008 and 6.98 Mtoe (i.e. 29.83%) in 2013.[3]

Natural gas use is widespread in industry and in power generation but not as strong in the household sector, which lags behind. Gas was first introduced into the Greek energy supply in 1996 and has since seen consistent growth, increasing from 0.14 Mtoe (i.e. 0.64%) in 1990* to 3.23 Mtoe (i.e. 13.82%) in 2013. The share of all renewables in TPES more than doubled between 1990, when they corresponded to 1.1 Mtoe (i.e. 5.15%) and 2013, when they contributed 2.64 Mtoe (i.e. 11.30%). Because of the share of large hydropower plants, the actual production of renewable energy in terms of produced can vary significantly from year to year.[4]

* From 1982 until very recently there was a small gas production from the now depleted South Kavala field near the Prinos oil field.

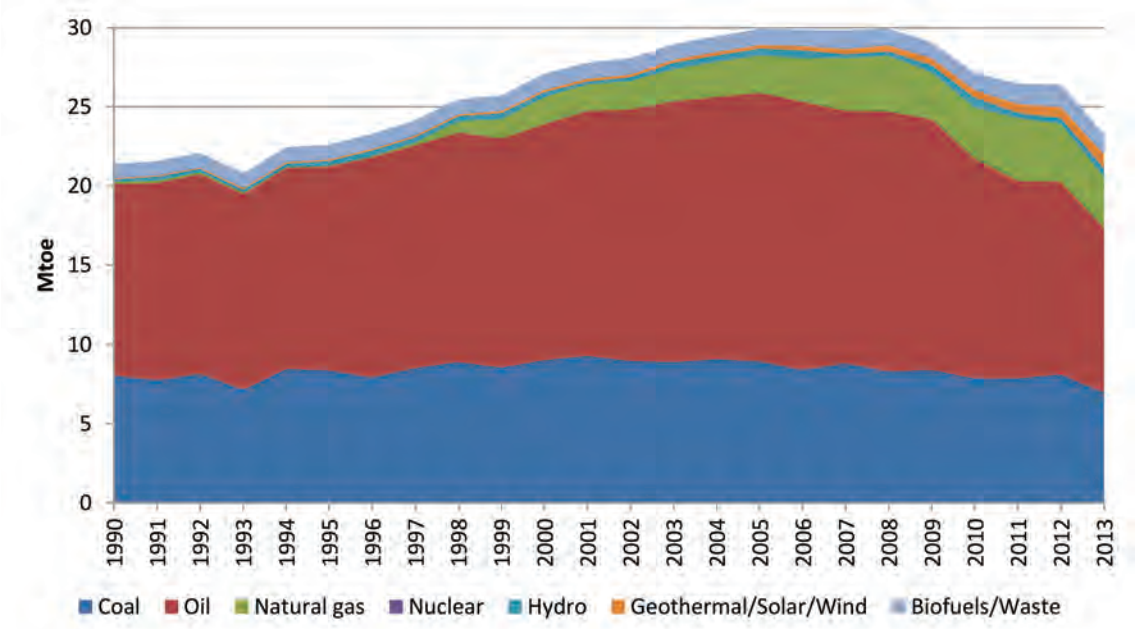
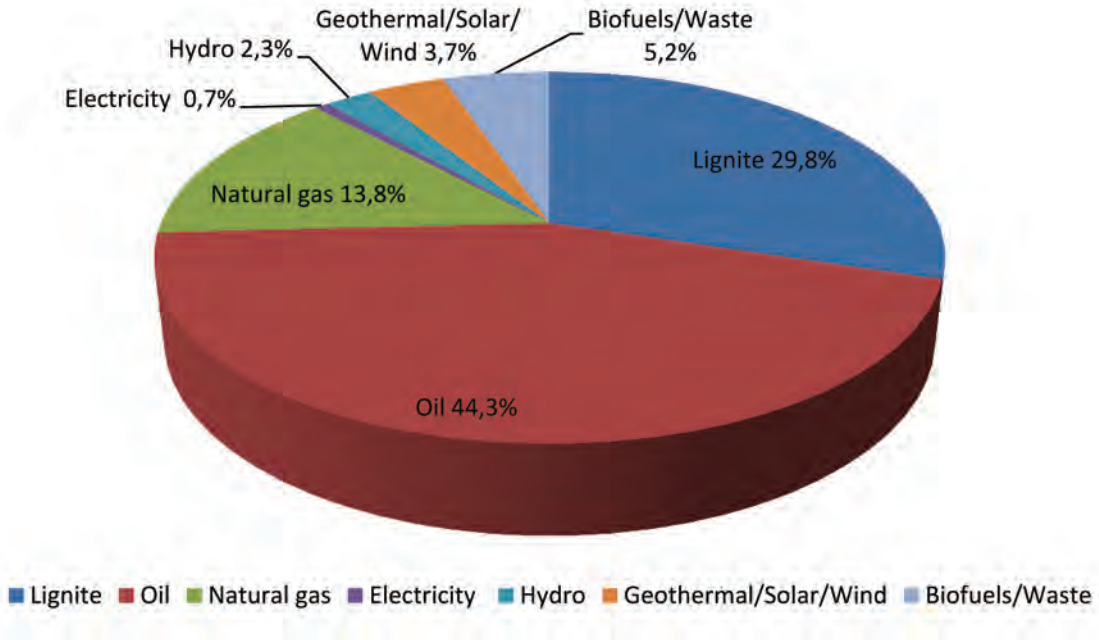


Figure 4: Total Primary Energy Supply* over 1990-2013

* Oil includes the sum of crude oil and oil products. Source: IEA

Figure 5: Total Primary Energy Supply, 2013*



* Oil includes the sum of crude oil and oil products. Source: IEA

The Energy Mix

Compared to other EU countries Greece's energy mix is not at all well- balanced as it is still largely dominated by oil imports, the remnants of a developing economy. As the EU also notes in a recent analysis "The energy mix of Greece shows some differences compared to the EU28 average, i.e. by a higher use of petroleum and solid fuels, while a lower use of gas and no nuclear." Compared to 1995, the share of petroleum and products and solid fuels in gross inland energy consumption decreased (by 11 and 5 percentage points respectively), while the share of gas and – to a lesser extent – renewable energy increased (by 13 and 4 percentage points respectively).[5]

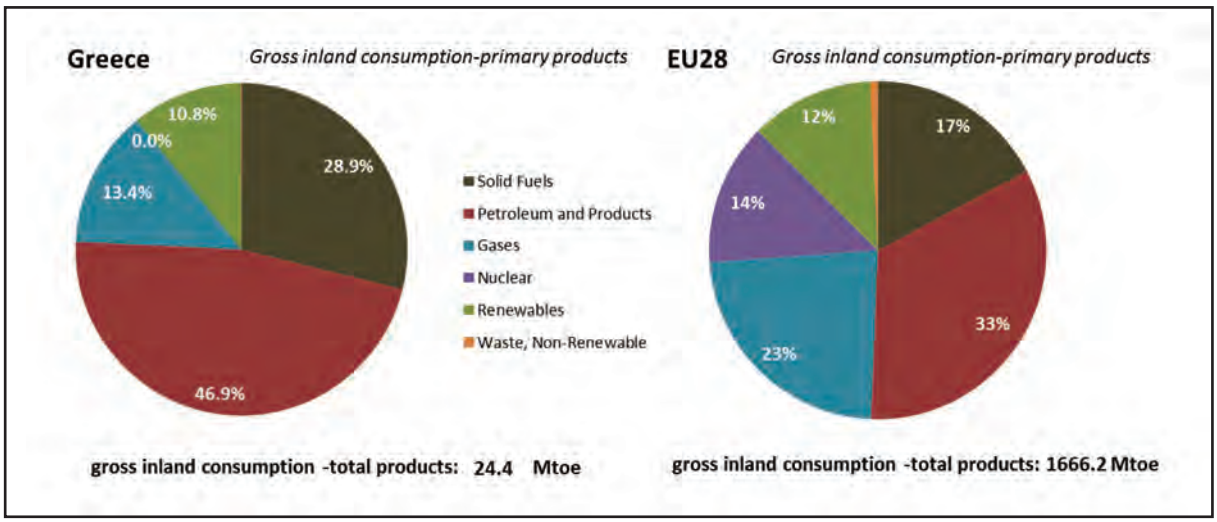


Figure 6: Gross inland energy consumption in 2013 Source: European Commission, based on EUROSTAT

Greece's detailed energy balance for 2013 appears in Appendix I and provides details of primary energy consumption, production and sectorial breakdown. As far as domestic primary energy production is concerned (see Figure 7) it should be noted that it decreased from 9.4 mtoe in 2010 to 9.3 mtoe in 2013, without any radical changes to the main sources of fuels. Thus, coal (read lignite) remained the country's main source of indigenous energy, accounting for more than 72% of energy production in 2013. It should also be noted that the contribution of biofuels and waste exceeds 11% of energy production, while the share of renewables (including large hydro) increased from 21.32% in 2010 to 27.01% in 2013.

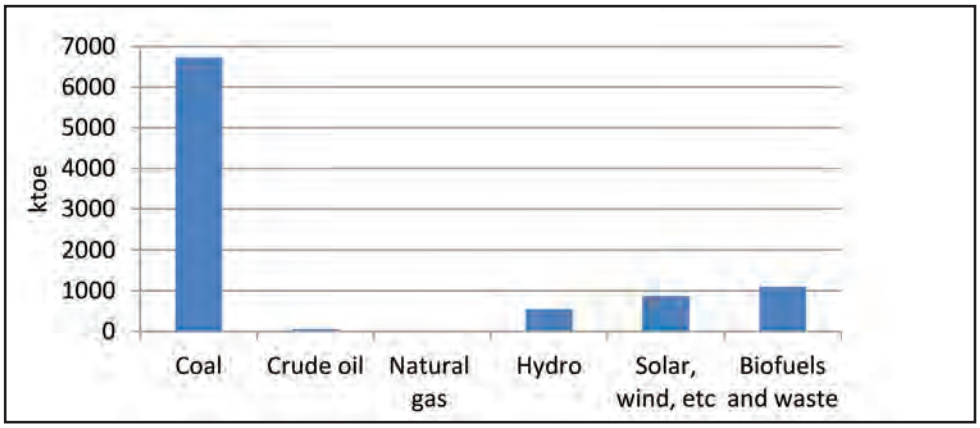


Figure 7: Energy Production in Greece (2013) (Total=9,314 ktoe)

Source: IEA

In general, the Greek energy sector is characterized by limited indigenous resources, as it is shown in Table 1, resulting in huge dependence on external energy sources.[6]

Table 1: Greek Energy Mix (Supply and Consumption) in ktoe Source: IEA

Fuel type	Production	Imports	Exports
Coal	6,728	233	-8
Crude Oil	64	23,111	-148
Oil products	0	3,570	-14,110
Natural gas	6	3,234	0
Nuclear	0	0	0
Hydro	546	0	0
Solar, wind, geothermal	876	0	0
Biofuels and Waste	1,094	144	-16
Electricity	0	498	-335
Heat	0	0	0
Total	**9,314**	**30,790**	**-14,618**

Figure 8: Greece's TPES and TFC (1990-2013) Source: IEA

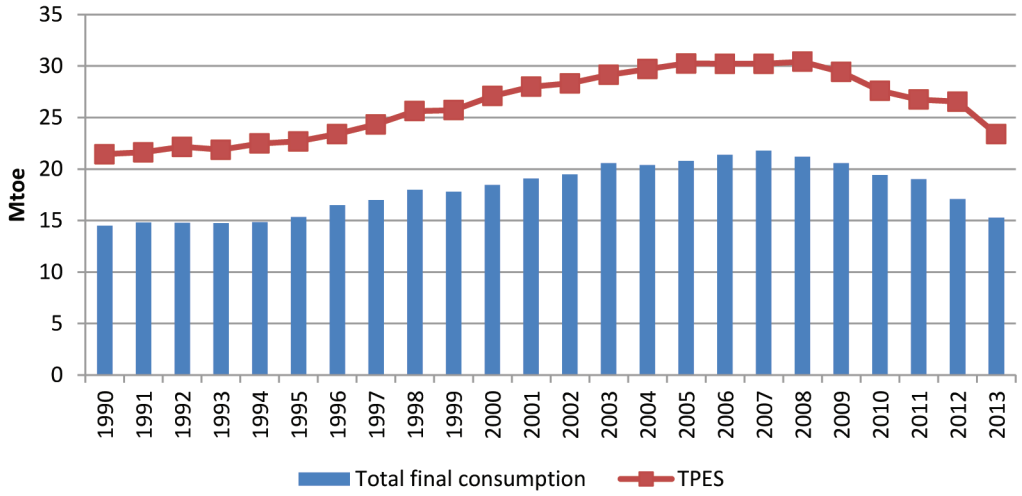


Table 2: Total Primary Energy Supply (TPES) (use), 2013 Source: IEA

(ktoe)	Industry	Transport	Residential	Commercial & Public Serrvices	Agriculture & Forestry	Fishing	Non-energy	Total
Coal	210	0	1	0	1	0	0	212
Crude Oil	0	0	0	0	0	0	0	0
Oil Products	982	5,451	988	193	29	31	329	8,003
Natural Gas	537	13	232	125	0	0	321	1,228
Solar thermal, geothermal	1	0	182	18	5	0	0	206
Biofuels & Waste	128	125	821	26	26	0	0	1,126
Electricity*	977	23	1,500	1,463	233	0	0	4,196
Heat	0	0	42	0	0	0	0	42
Total	**2,836**	**5,613**	**3,767**	**1,824**	**293**	**31**	**650**	**15,014**

Note: The term energy mix means the total final energy consumption in Greece in 2013.

*Includes electricity generated by PV, wind, hydro and electricity imports.

From *Figure 8* and *Table 2*, both of which refer to energy supply and consumption, the share of renewables in TPES appears small compared to the country's RES potential. Greece has a significant unutilized capacity for wind energy, but electricity generation is still largely based on lignite, resulting in relatively high levels of CO_2 emissions.

Energy and development

Over the past decades, it was the development of agricultural and industrial production in parallel with the impressive growth in house development and construction, which largely determined the energy needs of the country and consequently prioritized energy consumption. For example the limited manufacturing activity and lack of heavy industry and the preference for assembly type operations, the total demotion of railway transport, and the parallel huge rise of road transportation for goods and people alike and the unreasonable high energy consumption of the building stock, were the main factors which helped shape the country's energy profile. Although for time immemorial the Mediterranean climate contributed to low energy needs (i.e. mild winters, a prolonged summer period) during recent years this situation has totally changed with respect to energy consumption patterns. It is fair to state that the country's energy needs increased in parallel with the growth of GDP but also because of a re-definition in labour distribution (i.e. sharp rise of the services sector) and a change in consumption habits (i.e. huge expansion of urban centers with corresponding high energy consumption per household). In the middle '90's, in addition to traditional energy sources, such as oil and lignite, natural gas was introduced into the Greek market, while renewable energy sources gradually developed into a main stream energy source.

With the introduction of new parameters for power generation in Greece both in Renewable Energy Sources (RES) and thermal power plants, we observe a change in the pattern of energy supply and distribution. For example, in 1994 Law 2244 introduced for the first time an element of liberalization in the production of electricity from RES installations, mainly wind and cogeneration. The until then unchallenged monopoly of PPC was broken as independent producers were able for the first time to produce electricity and sell it directly to the grid. Later in 1999, law 2773/99 was enacted in accordance with EU Directive 96/92EU, which covered the provisions for the liberalization of the electricity market in Greece The market officially opened on February 19, 2001 with the interest on the part of independent power producers (IPP's) focusing on the construction of new gas fired plants (CCP) with the parallel introduction, by the newly established TSO, of a pool type system for the operation of the daily market. As far as natural gas is concerned, and in accordance with EU directive 98/30, Greece was obliged to liberalise fully its internal market by the year 2006. This is of course did not happen and only recently within provision of Law 4001/2011 and EU Directive 73/2009 the opening up of the gas market has started.

The opening up of the Greek electricity market to competition has been extremely slow with the state controlled PPC having managed to retain its dominant position. This is understandable and should be seen in context since PPC is the state corporation, which has been responsible for Greece's electrification following WWII and the huge infrastructure destruction the country suffered following four years of German nazi occupation and a subsequent five years of civil war. Greece's post war electricity system, which was built by PPC, has been largely based on lignite which is the main fuel used for power generation over the last 60 years and has led to the development of power generation plants located close-by to reserves, with each lignite

mine and plant developed and operated by PPC. Domestic lignite still remains the most important fuel for electricity generation, although the use of natural gas is growing rapidly and renewable energy use is also expected to expand further.

A detailed analysis of the structure and operation of Greece's electricity and gas market is given in sections x and xx respectively where the evolution of both markets is also described. At this stage, it is important to note that although retail electricity prices were fully deregulated in July 2013, the incumbent PPC has only recently lost a 10% market share with a target set, by the EU, for its share to drop to 50% by the end of 2020.

The energy production and consumption patterns, which have developed over the years, reflect the prevailing economic activity and social development of the country. With a relatively small industrial base, contracting agricultural activity, an ever growing tourism sector and the rise of several service type activities (e.g. logistics, telecommunications, financial services, shipping, air transport) the country is characterized by "mild" per capita energy consumption. Some observations concerning the structure of Greece's energy profile are therefore pertinent:

- The efforts of successive Greek governments after WWII to strengthen the competitiveness of industry through the provision of low cost energy, so as to protect the extremely low average income of the population, led to price policies which did not help develop energy awareness nor the promotion of technologies with high energy efficiency. A typical example is the introduction of heat pumps and air conditioning units, where a decrease in their cost, together with a parallel increase in family disposable income over the last 30 years or so has led to an unexpected increase in electricity consumption in the building sector during the hot summer months but also during winter time, when ambient temperatures are generally mild and buildings do not normally require huge amounts of energy for heating or cooling. A unique energy advantage that now tends to disappear as perceived levels of housing comfort and the ease of electric heating/cooling devises has introduced new and highly wasteful, energy consumption patterns.
- Prevailing social behavioral patterns in Greece today are not supportive of familiarization and awareness with energy matters. The way that cities are organized, the daily routine and way of life in general, combined with a provocative lack of respect for public space, do not in general favor the rational use of energy. The mass transportation system in most cities, mainly buses, is below standard; while the average speed of motor vehicles in most cities is generally slow, resulting in high fuel consumption per capita per kilometer. The advent of the metro and tram in the greater Athens metropolitan area (since 2004) brought considerable relief to stranded commuters and rationalized somewhat energy consumption in the urban transportation sector. Now a single metro line is under construction in Thessaloniki, the country's highly congested northern business hub.
- The bulk of goods transportation throughout the country is still undertaken by road. The movement of goods and people by railway lags markedly behind the average European norm.
- The demand for energy for thermal and cooling loads in buildings is considerably higher than in the past, since energy use has not been given adequate attention as a major factor in construction and building maintenance. Indicative of this miserable situation is the fact that the first national regulation for thermal insulation was introduced as late as 1979, and it had only marginal effect in lessening thermal loads, became of highly inadequate applications standards and total look of supervision by the relevant authorities. Only very

recently has the government introduced energy performance standards including energy identity for old and new buildings, and made mandatory energy inspections, by qualified engineers and the issuance of energy certificates

- Cultivation of agricultural land is predominantly in small allotments and with limited output. This situation, in conjunction with increased needs for the pumping of water make the agricultural sector especially energy intensive.

Energy Policy

Greek energy policy is formulated at central government level by the Ministry of Environment and Energy, which is in charge of overall policy formulation.[8] In broad lines, it follows EU directives and targets but there are areas of marked differentiation especially on matters related to market organisation and operation. The Greek Energy Policy can thus be summarized as follows:

- Identify and develop indigenous energy resources, in order to ensure the secure, sustainable and constant supply of the country's energy needs.
- Maintain adequate oil and lignite supplies and develop stocks, secure alternative import sources and routes in order to meet the daily needs of the domestic energy market and also be able to meet demand at times of crisis.
- Promote the penetration of Renewable Energy Sources in the country's energy mix, while increasing its overall energy efficiencies and limit its dependence on the utilization of oil and lignite. This target is also being pursued in the context of EU's 20-20-20 strategy.

Greece's energy strategy is achieved by establishing and improving the necessary regulatory framework, which focuses on the following:

- Development of a plexus of different energy sources
- Construction of oil, natural gas and electricity interconnectors
- Increased utilization of domestic energy resources and reserves
- Decrease dependence on imported energy sources while promoting international partnerships in order to mitigate their associated political risk
- Promote the development of large scale renewable energy resources
- Promote the utilization of clean, efficient and environmental friendly technologies
- Advance the liberalization of the electricity and natural gas markets
- Encourage investments in power generation, upstream oil and gas exploration and midstream infrastructure investments
- Improve energy efficiency in the industrial, transport and residential sector

Additionally, Greece is committed in implementing EU's 20-20-20 strategy that calls for the reduction of its greenhouse gases and final energy consumption by 20% (GHG) compared to its 1990 levels[9], while simultaneously increasing the participation of R.E.S. to 20% of its total energy supply.

Based on the undertakings of the 3rd Bail-out Agreement of July 13, 2015, ratified by the Greek Parliament by Law 4336/2015, the restructuring plan will affect almost all sectors of the Greek energy market with clearly visible impact on the operation and structure of the country's electricity and gas markets and RES. In this sense, it could be argued that Greece's overall rela-

tionship with its lenders is affecting directly energy policy in an attempt to align it with that of other EU states.

The major challenge for the energy market is now to clarify the effective ways for the ad hoc implementation of those reforms. The majority of the Agreement's clauses has already been included in previous phases of negotiations and subsequent agreements and MoUs between the Greek government and its creditors but had not been acted upon. Greece is the recipient of a stricter obligation to address the issue of electricity market liberalization. More specifically, there is a timetable, according to which there should be a reduction of PPC's share in both retail and wholesale markets by 20% by the end of 2017, with the ultimate target of limiting PPC's share to less than 50% by the end of 2020. These large-scale reforms (including also natural gas and renewables) are required in order to comply with the relevant legislation and EU policies. The following Table attempts to summarize the targets Greece must comply with.

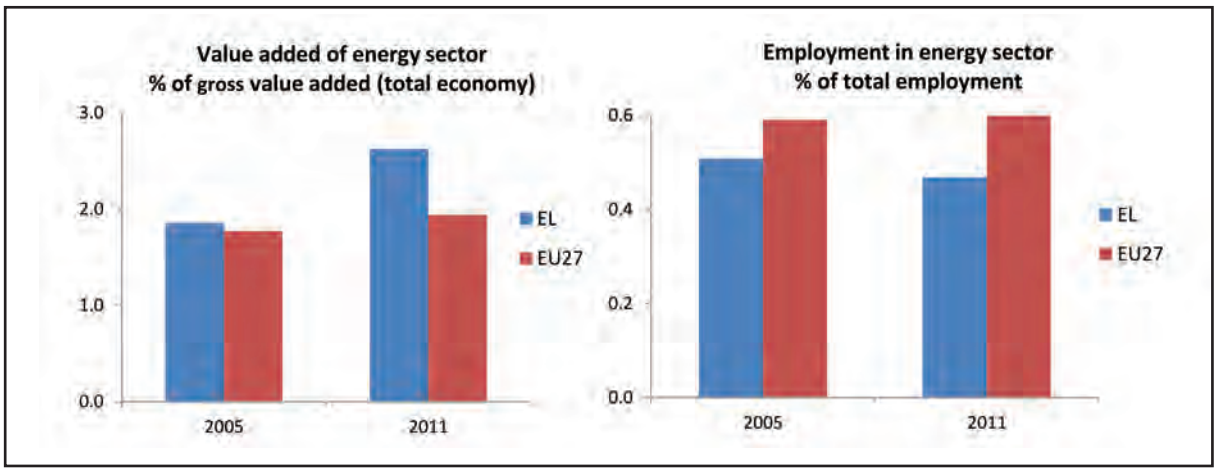
Energy sectors	Description	Implementation schedule	Targets
Natural gas	Liberalization of the gas distribution market	This measure has already been legislated. Law 4336/2015 provides for the gradual implementation of the secondary measures	-Finalization of the liberalization of the gas distribution market. -Eligibility of gas consumers to select their gas supplier. -Gradual increase of the current number of Eligible Customers by widening the eligibility criteria by January 2018. -Activation of entities in the domestic energy market by offering bundled packages for gas and electricity supply in accordance with the relevant model already in force in other European countries.
Electricity	Introduction of limitations to the electricity volumes injected into the Grid	January 1, 2020	-Enhancement of the competition between the participants in the wholesale and the retail electricity market. -Reduction of the cost of the competitive parameters of consumers' electricity bills.
	Opening the electricity supply market	End of October 2015 (already delayed)	-Immediate reduction by 25% of PPC's share in the wholesale and retail electricity market. Greek government may disregard this target and focus on the next one. The opinion of the creditors remain unclear on this. -Reduction by 50% of PPC's share in the wholesale and retail electricity market. -Full compliance of the marginal prices with the relevant EU regulations and coverage of the production cost. -Current status: The share of the independent electricity suppliers in the retail market has currently reached roughly 6%.
	Intervention in the wholesale electricity market	September 2015 (already delayed)	Smooth and safe operation of the wholesale electricity market.
	Cancellation of the discounts offered to industrial customers		Avoidance of abuse of the dominant position of PPC as the sole vertically integrated company having access to local, cheap energy resources.
	Electricity network upgrade		-Efficiency improvement -Enhancement of interoperability -Cost reduction for the consumers
Renewables		By December 2015	Development of a modern, economically viable support scheme for RES in compliance with the recent European directives and principles relating to State Aid in the energy sector.

Table 3: The 3rd Bail-out Agreement and Energy related targets Source: Georgopoulos, K. (November 2015)

The importance of the energy sector

Compared to the EU average, the share of Greece's energy sector in the added gross value has become considerably larger over the last six years, which for a part may reflect the severe economic downturn of the country over the same period. The energy sector's share in total employment has not changed much and stayed slightly below the EU average. The two graphs combined suggest a higher labour productivity which may follow from the relatively high capital intensity of the Greek energy sector.

Figure 9: Value added of energy sector (LHS) and employment in energy sector (RHS)



Source: EUROSTAT – National Accounts

According to EurObserv'ER, in 2013, the share of direct and indirect renewable energy related employment in total employment of the economy in Greece was at about 0.58%, above the EU average of 0.53%.

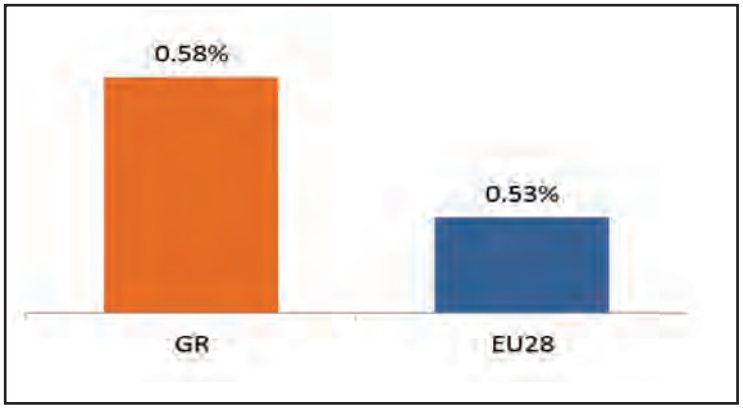
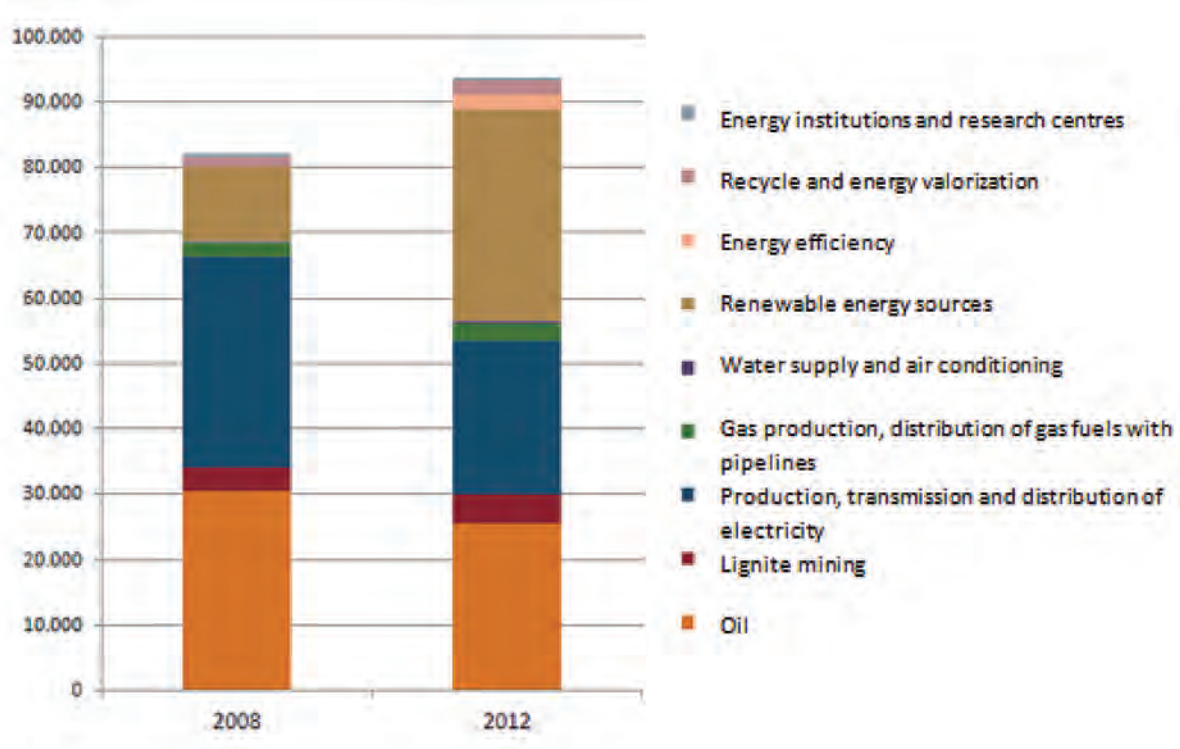


Figure 10: Renewable energy employment in 2013 (direct and indirect jobs as % of total employment)

Source: European Commission, based on EurObserv'ER and EUROSTAT

A recent IENE study also found out that the number of workers employed directly in the Greek energy sector is 2012 amounted to 92,000 and corresponded to 6.5% of the total labour force[10]. *Figure 11* shows employment breakdown per branch of the energy sector in Greece. It is interesting to note that the increase of the workforce between 2008 and 2012 was largely due to an abundance of renewables projects, energy efficiency focused house conversions and a string of new large thermal, (gas-fired) power stations built by IPP's. Since then the renewables industry has contracted with a proportional loss of jobs.

Figure 11: Employment in Greek Energy Sector (in 2008 and 2012)



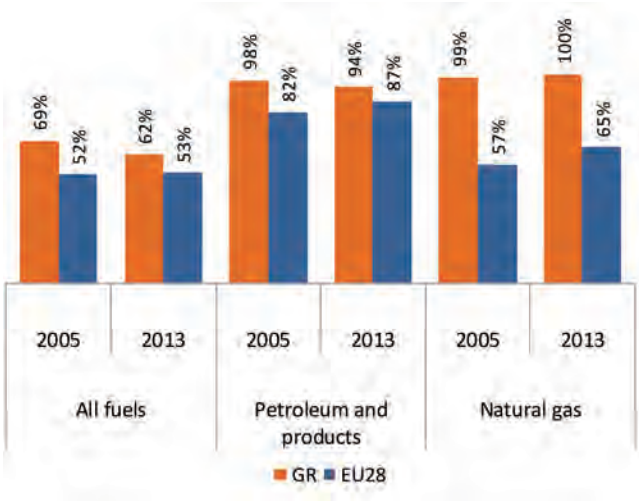
Source: IENE Study Project (M09), *Energy and Employment*, IENE, Athens 2013

Import dependency

Import dependency in Greece remains above EU average, in particular when it comes to petroleum and products and natural gas. As figure 12 shows Greece during 2014 imported oil from a variety of countries and predominantly from Russia, Saudi Arabia and Kuwait. In 2013, the country imported 99.5% of its oil from a variety of suppliers mainly from the Middle East. The country's high import dependency has made its public finances vulnerable to the vagaries of the prevailing high oil prices between 2011-2014. Since then the pressure from the high oil import bill has somewhat lessened as discussed in the analyses presented in the oil Sector of this Directory. Without any notable indigenous oil and gas production, Greece is totally depended on crude oil imports for transportation needs but also for heating its building stock. In 2013, Greece imported 66% of its gas from Russia (85% in 2005)*. The country supplier concentration index is above EU average, but overall, the energy trade deficit (measured in terms of % of GDP) is slightly above EU average.

* Top non-EU gas suppliers table is based on EUROSTAT data. The share of imports from non-EU countries is calculated as the ratio between volumes of imports from that specific non-EU supplier and total imports (from EU and non-EU countries).

Figure 12: Import dependency in Greece (2013)



Top non-EU gas suppliers in 2013 (% in total imports)

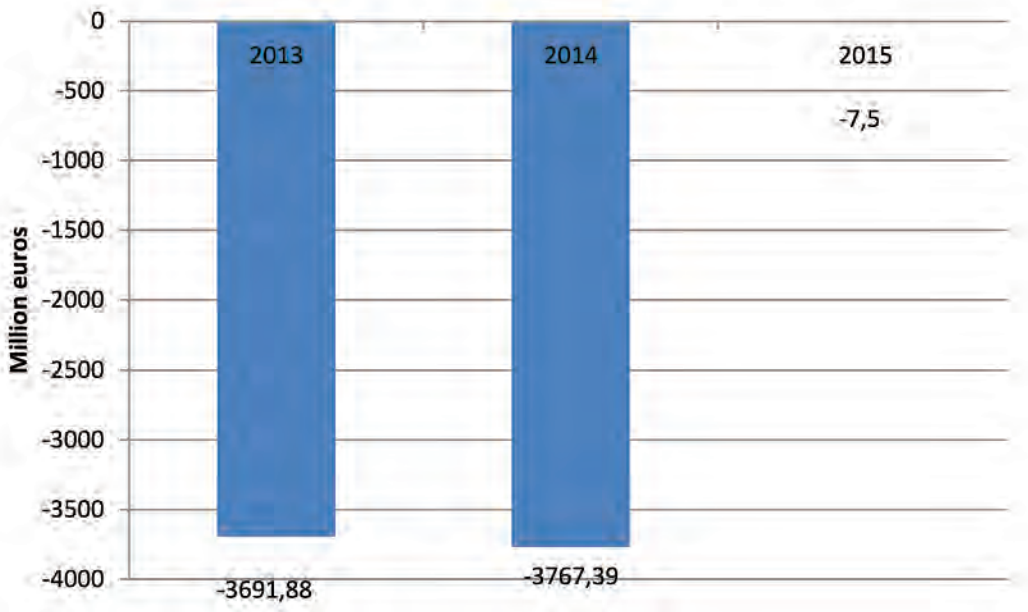
Greece		European Union	
country	[%]	country	[%]
Russia	65.9	Russia	39.0
Turkey	17.4	Norway	29.5
Algeria	16.4	Algeria	9.7
		Qatar	6.7

Source: European Commission, based on EUROSTAT

Trade balance of energy products

The relatively large energy trade deficit points to a huge dependence on imported energy sources, mainly oil and gas. This deficit has proved to be rather persistent over time, with an increase over the 2010-2014 period of both the gas trade and the oil trade deficit. The doubling of the gas trade deficit in GDP terms reflects a change in the country's energy mix. The energy trade deficit reduces the size of the current account surplus which is a vital counterweight for the country's debt deleveraging. However, in 2015 thanks to combination of low international oil prices, which resulted also in decreased gas prices, reduced consumption following the continual contraction of the economy and this parallel increase of refined oil exports, Greece's external balance of payments deficit was reduced almost to zero (see *Fig. 13*) highlighting hydrocarbon's pivotal role in the formation of the external balance payment deficit.[11]

Figure 13: External balance of payments (in million euros) over 2013-2015



Electricity and gas markets

As noted in EC's staff working document on Greece's energy situation[12] and in accordance with the selected indicators, concentration of power generation and gas markets appears high. «Regarding electricity», notes SWP, «there is no true level playing field with the incumbent (PPC) still having a dominant position. New legislation enhanced the independent role of the Regulator to allow it to exert its role to the full and support the implementation of significant market reforms. Whereas the Greek government has now committed to lower the incumbent's market shares with 25% in the short-run and to 50% by 2020, effective measures fostering competition on electricity retail and generation remain to be implemented. Similarly, progress will need to be made in order to converge the Greek electricity market towards the EU target model, such as by introducing forward, intra-day and balancing markets».

Regarding gas, since 2010 new gas suppliers have appeared on the scene and have started importing natural gas by means of LNG, unloading and storing gas directly at the Revithousa LNG terminal. In 2012, 90% of gas was imported by DEPA, the incumbent, and 10% by two other market players. However, a sharp decline was observed in 2013 in the percentage share of gas imports by the other parties. Greece's gas retail markets are still legal monopolies and customers, with few exceptions, are not eligible. Nevertheless, a gas release process has been introduced aiming at market opening and effective competition, which recently has been improved further. Moreover, a new gas law was adopted with a view of fully liberalising the gas retail markets by 2018. Once implemented fully, this will make it possible for Greek end-consumers to be able to benefit from the increased gas-to-gas competition from LNG but also from gas volumes to be imported via IGB, TAP and through cross border gas exchanges.

In Greece the wholesale electricity and gas prices are above EU average. Electricity prices were fully liberalised in July 2013 but no significant entry into the market took place then. However, that situation is changing fast as PPC has lost more than 20% of its household-commercial customers to competition[13]. Electricity prices for household consumers, despite their upward trend, remained below the EU average both in 2013 and 2014. The increases were partly due to the introduction of non-recoverable tax rates but also to a gradual move towards cost recovery and removal of cross subsidies. On the other hand, gas prices for medium-sized households remained high in 2014/2015. Until very recently supplier switching in electricity was largely absent and, with few exceptions, is still legally impossible in gas retail. Consumer satisfaction is low*, at least in the case of electricity. Regarding smart metering, Greece has mandated a large-scale roll-out targeting 80% of electricity consumers by 2020.

Interconnections

In 2014, the interconnection capacity of Greece for electricity was approaching 11%. With new Projects of Common Interest (PCI's), a 15% level is aimed for by 2030. Three electricity interconnections are labelled as PCIs: the interconnection between Bulgaria and Greece and the two sections of the underwater interconnection between Israel, Cyprus and Greece, known as the Euro-Asia interconnector[14]. The Greek network has a central position in South-East Europe with the existing and future connections to Italy, Bulgaria, Turkey and the Western Balkans. Therefore, Greece could actually play the role of a regional electricity hub. The following map shows the country's interactive electricity interconnections.

* 10th Consumer Markets Scoreboard (June 2014), http://ec.europa.eu/consumers/consumer_evidence/consumer_scoreboards/10_edition/index_en.htm

Map: Cross-border electricity interconnections in SE Europe

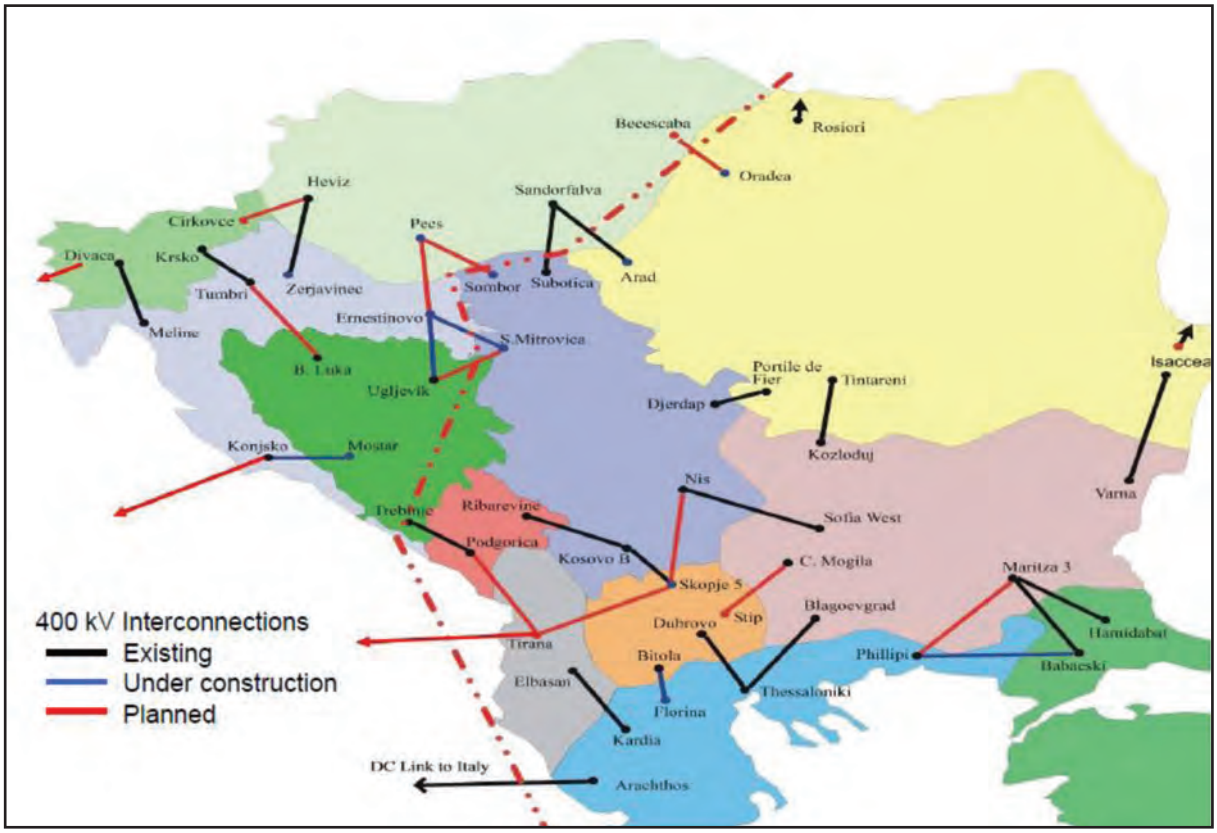
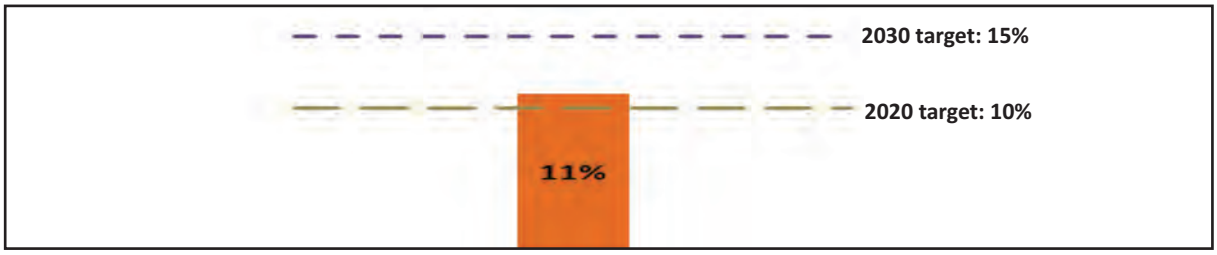


Figure 14: Greece's interconnection capacity for electricity (2014)



Source: European Commission based on ENTSO-E scenario outlook and adequacy forecast 2014

Note: Reference to 2030 target is based on October 2014 European Council conclusions stating that "the Commission will also report regularly to the European Council with the objective of arriving at a 15% target by 2030"

In natural gas the situation is much different as Greece is lacking a similar number of interconnections with neighbouring countries. The country has only two land based interconnections, one in the north with Bulgaria and one in north-east with Turkey. However, the country possesses a third import point through the Revithousa LNG terminal, few kilometers from Piraeus. Greece has the potential of becoming a mini regional gas hub as it is located at the EU entry point of the Southern Gas Corridor, where new Azeri gas suppliers are expected to flow in from 2019 onwards and has also access to LNG and gas supplies from Russia, through the South Balkan pipeline which takes gas to Romania, Bulgaria and the Greece. However, the importance of such a mini hub lies in its trading role since in conjunction with electricity trading the Athens Exchange in cooperation with the Electricity Market Operator (LAGIE) could provide a gas tra-

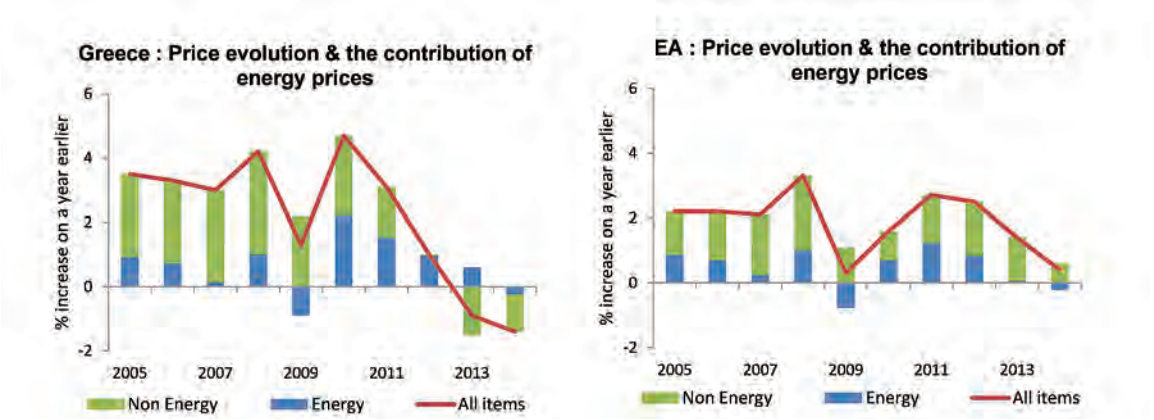
ding platform. On the strength of projects now under development it is anticipated that the North East region of Greece, will have adequate liquidity in terms of shipped gas volumes to support regional gas trading.[15]

Several gas projects are currently planned. The most relevant ones are the interconnector Greece-Bulgaria, (IGB) the Trans-Adriatic Pipeline (TAP) which is now under construction and a new FSRU type LNG terminal to be located offshore in Alexandroupolis. Also there are plans to develop an underground permanent gas storage facility in the depleted South Kavala gas field off the island of Thasos. As Greece currently lacks permanent gas storage facilities, apart from the limited ones to be found in the Revithousa LNG terminal, the development of the South Kavala gas storage facility, to be linked via an existing underwater pipeline to the main gas network, is considered to be a major challenge.

Energy and consumer awareness and vulnerable consumers

Greece's strong dependency on imported energy products implies a bigger impact from the changes in world oil prices on domestic inflation, as visible from the impact of the oil price volatility in the years 2008 – 2010. The severe economic depression has since cut off the knock-on effects of high-energy price expended between 2010 and 2014 in overall inflation.

Figure 15: Price Evolution and the Contribution of Energy Prices



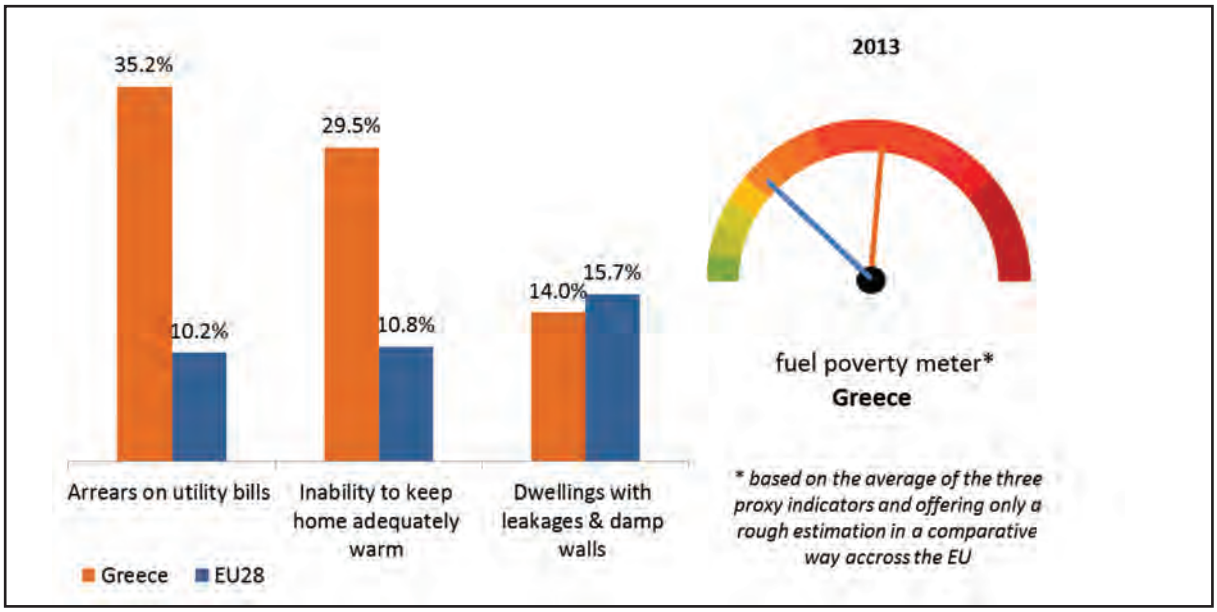
Source:DG ECFIN based on Eurostat

Although domestic energy prices have been kept somewhat low over the last two years (2014-2016), mainly due to the much reduced international oil and gas prices, (but not much reduced due to the imposition of exceedingly high special tax and excise duties) there is a section of the population identified as vulnerable consumers which find it difficult to manage the monthly payments of electricity and gas bills. Hence, Greece today faces a serious energy poverty issue which affects a significant portion of its population.

Based on a EUROSTAT survey on income and living conditions, three proxy indicators have been used to assess fuel poverty. They indicate serious issues in Greece, in particular as regards arrears on utility bills. This was one of the factors leading to liquidity constraints on power generation markets over the last 3 years.[16]

Hence, Greece has defined specific criteria and protective measures for vulnerable consumers. In February 2014, a total of 560,126 customers (9.8% of all residential customers) were benefiting from a social electricity tariff.* Moreover, a subsidy for heating oil and electricity for vulnerable households was launched in 2014. Furthermore, for 2015, a certain quantity of electricity is provided for free for residential consumers facing severe poverty. Further measures to tackle the problem are in hand.

Figure 16: Vulnerable Consumers in Greece



Source: European Commission, based on on EUROSTAT SILC survey

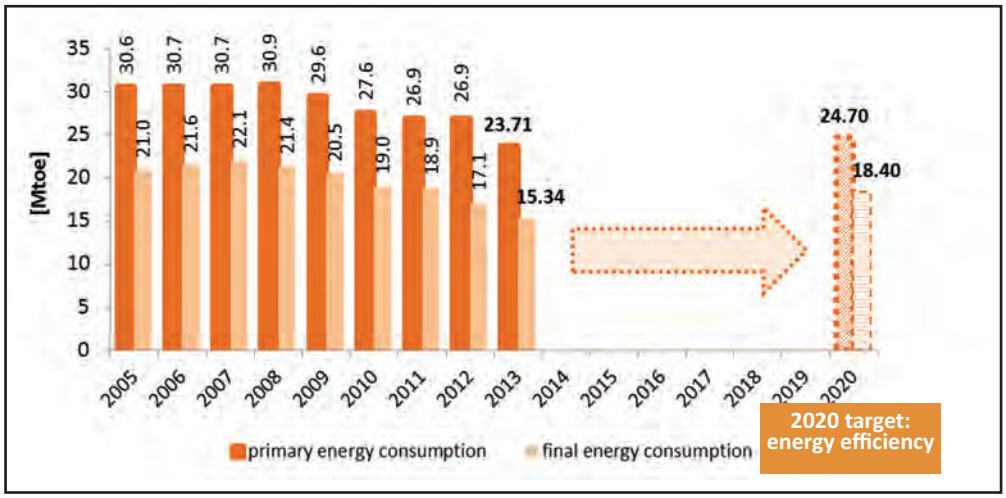
Efficiency and its role in moderating energy demand

As already alluded Greece is an energy wasteful country for all kinds of energy use. Ranging from house heating and cooling practices, to public building maintenance, transport, local authority services and power generation. In this respect and as is explained in detail in the Energy Efficiency section of this Directory, there are significant margins for reducing energy waste through the introduction of energy efficiency measures not just for buildings but right across the board. As the EC reports "Greece's 2020 primary energy consumption target is 24.7 Mtoe or 18.4 Mtoe in final energy consumption which in principle could be easily achieved since 2013 primary energy consumption stood at 23.7 Mtoe, well below the 2020 target".[17]

This is understandable given the huge contraction of economic activity between 2008 and 2015, corresponding to near 26% of the country's GDP. However, as the economy is geared for a modest return to growth from 2017 onwards efforts are needed to keep the primary energy consumption at this level or to minimise its increase when the GDP increases again during the next five-year period.

* DEDDIE S.A.

Figure 17: 2020 Energy Efficiency Target for Greece

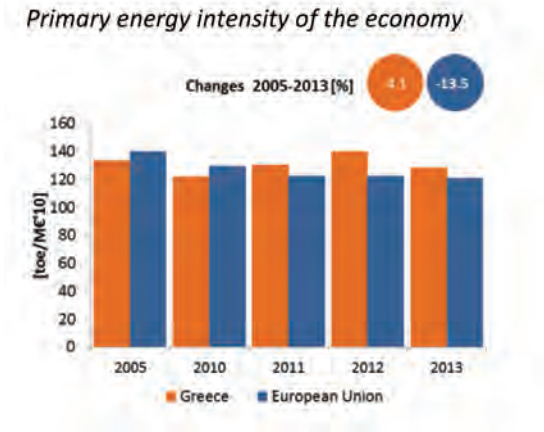


Source: European Commission, based on EUROSTAT and on national energy efficiency targets as declared by the MS under the Energy Efficiency Directive

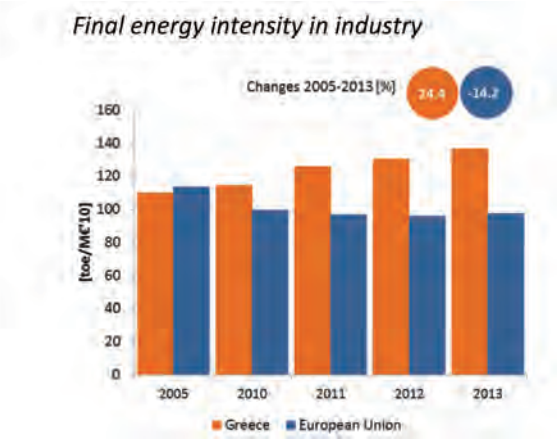
Energy Intensity

Primary energy intensity in Greece is now slightly above EU average, as this indicator decreased more slowly than for the EU average between 2005 and 2013. This could be explained by a more significant decline of GDP as compared to primary energy consumption. Energy intensity in industry remains above EU average, and actually has shown deterioration over the last 5 years, most probably due to the same negative impact of the economic crisis, as EC observes in its 2015 Staff Working Document.

Figure 18: Primary energy intensity of the economy (LHS) and Final energy intensity in industry (RHS)



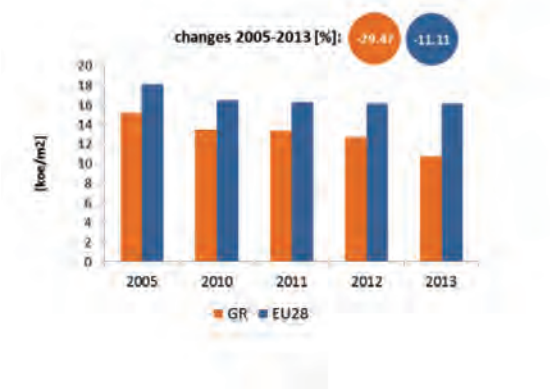
Source: European Commission based on EUROSTAT and European Commission/AMECO



Source: European Commission based on EUROSTAT and European Commission/AMECO

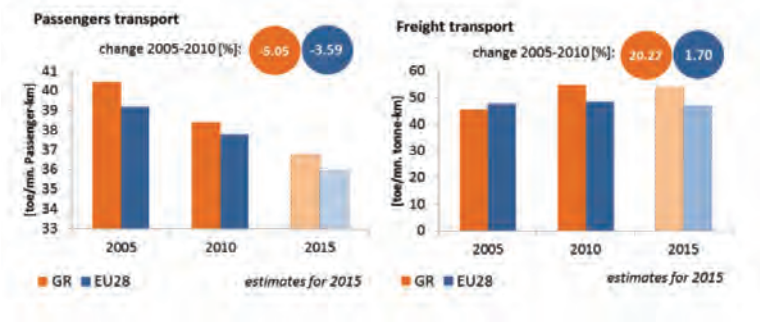
As reported by the EC specific energy consumption by households is below EU average and decreased at a higher pace than the EU average over the period 2005-2013. One of the main determinants of this trend is again attributed to the economic crisis, leading to lower energy demand for households. However, the specific energy intensity of passenger's cars is in line with EU average. While specific energy intensity for freight transport increased faster than for the EU.

Figure 19: Final energy consumption in residential sector (LHS) and Specific energy intensity for passenger cars and freight transport (RHS)



Source: European Commission based on Odyssee database

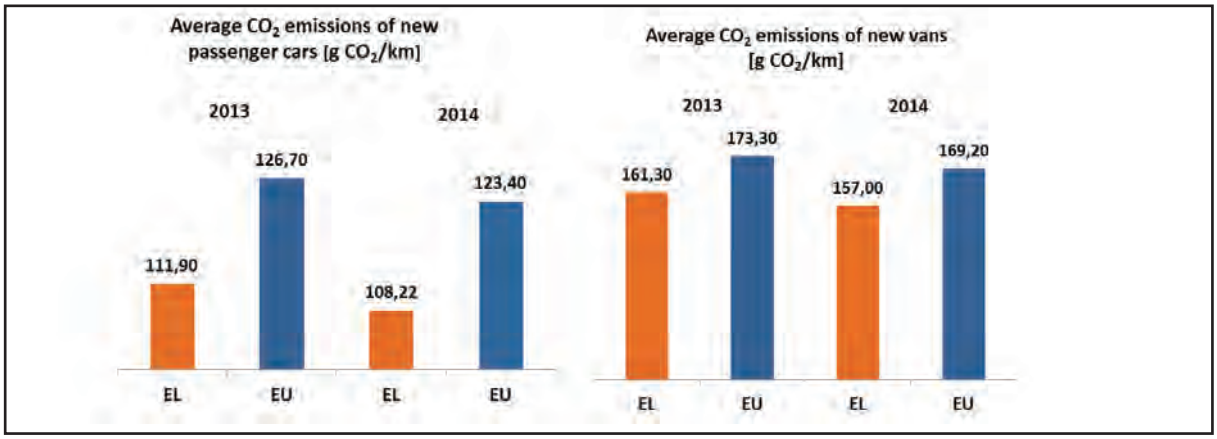
* Statistics on energy demand for passengers and freight transport are not available and model estimates have been used instead. These issues should be borne in mind when comparing energy intensity in freight or passenger transport between Member States, which should be regarded as merely indicative.



Source: PRIMES model background data and estimations based on EU Commission and EU MS inputs

It should be noted that EU legislation sets mandatory CO_2 emission reduction targets for new cars and vans. By 2021, the fleet average to be achieved by all new cars is 95 grams of CO_2 per kilometre. For new vans, the fleet average is set at 147 g/km by 2020.

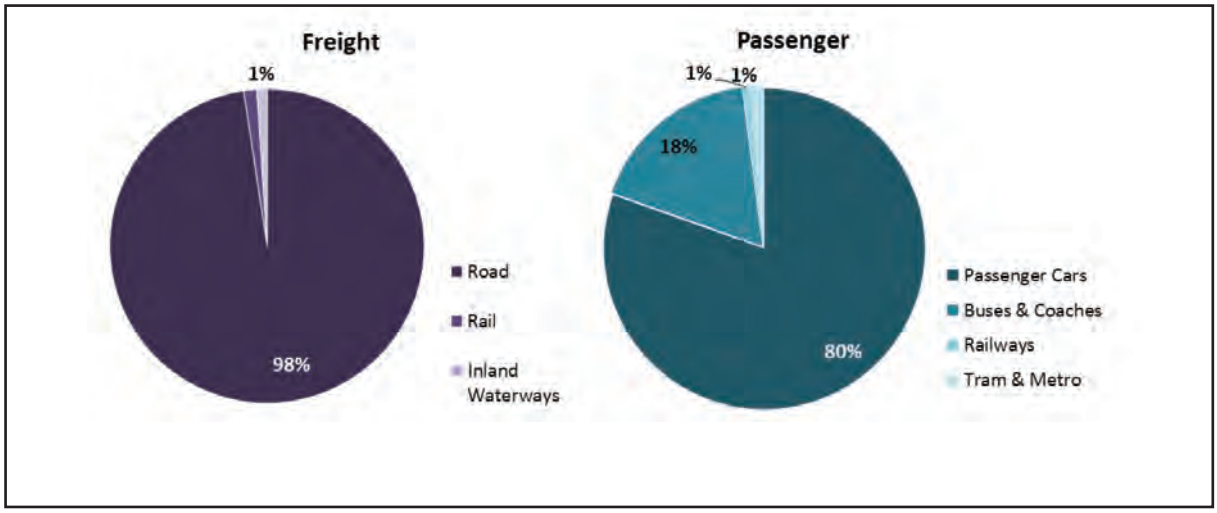
Figure 20: Average CO_2 emissions of new passenger cars (LHS) and new vans (RHS)



Source: European Environmental Agency. 2014 values are provisional. 2013 EU average refers to EU-27.

Regarding transport performance in EU-28, the inland freight modal shares are 71% by road, 17% by rail, 7% by inland waterways and 5% by pipelines. The respective inland passenger modal shares for Greece are reported as 82% by private car, 9% by buses and coaches, 7% by railways and 2% by tram and metro[18]. As we have already pointed out, freight and passenger transport in Greece is almost exclusively performed by road transport and consequently it will be extremely difficult to reduce CO_2 emissions from transportation to conform with EU requirements.

Figure 21. Modal share Greece



Source: Eurostat and EU transport in figures 2015. Data refers to 2013. Modal shares based on tonne-kilometres for freight sector and passenger-kilometres for passenger sector, freight data based on activity within country territory. Estimates are made when data is missing.

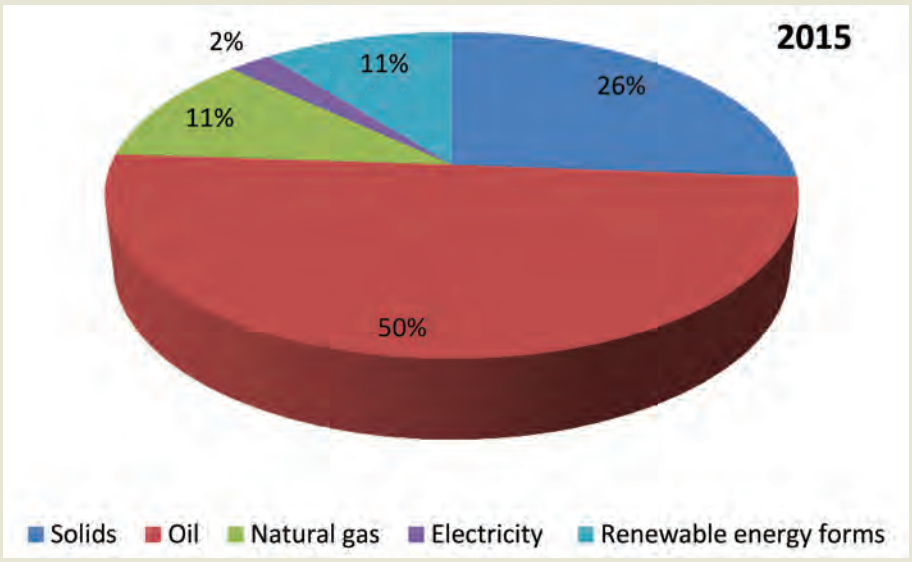
Greece's energy prospects

The analysis that preceeded and the detailed information that was provided on the various facets of the energy sector shows in a most explicit manner the great diversity which can be found in Greece's energy landscape in terms of resources, both indigenous and imported, energy utilization, market organisation and consumer interests. Looking ahead, say over the next 10 years or so, and based on current trends we can safely predict that this diversity in energy supplies, exploitation, distribution and marketing will increase further thus transforming the energy sector from a pure service provider into a market driver, on par with tourism, industry and financial services, with profound implications in its contribution to economic growth. (Cont. p. 36).

CURRENT AND FUTURE ENERGY MIX IN GREECE

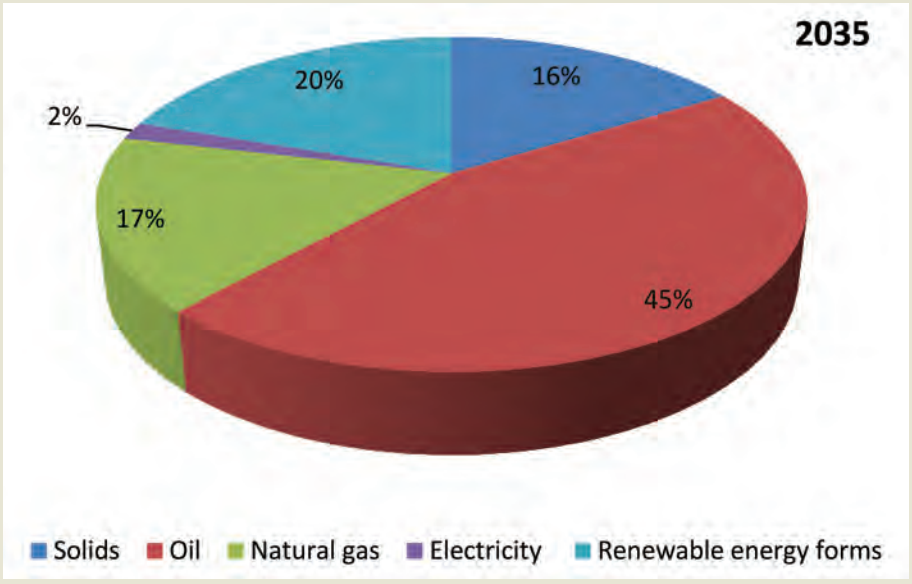
Figures 1 and 2 present the current and future energy mix in Greece in 2015 and 2035 respectively, as abstracted from IENE's latest study "South East Europe Energy Outlook 2016". Both figures illustrate that there will be a 5% decline in oil consumption and a 10% fall in the consumption of solids in 2035, thus highlighting the route towards decarbonisation in Greece, while natural gas and renewable energy sources are expected to increase their shares by 6% and 9% respectively, with the exception of electricity which will remain stable. However, it is worth mentioning that a 16.7% fall in the total gross inland consumption is anticipated in Greece; from 25,916 ktoe in 2015 to 21,587 ktoe in 2035 and this declining trend will apparently continue throughout our projection period up to 2050.

Figure 1: Gross inland consumption in Greece (2015) (Total=25,916 ktoe)



Source: IENE study *South East Europe Energy Outlook 2016*, Athens 2016

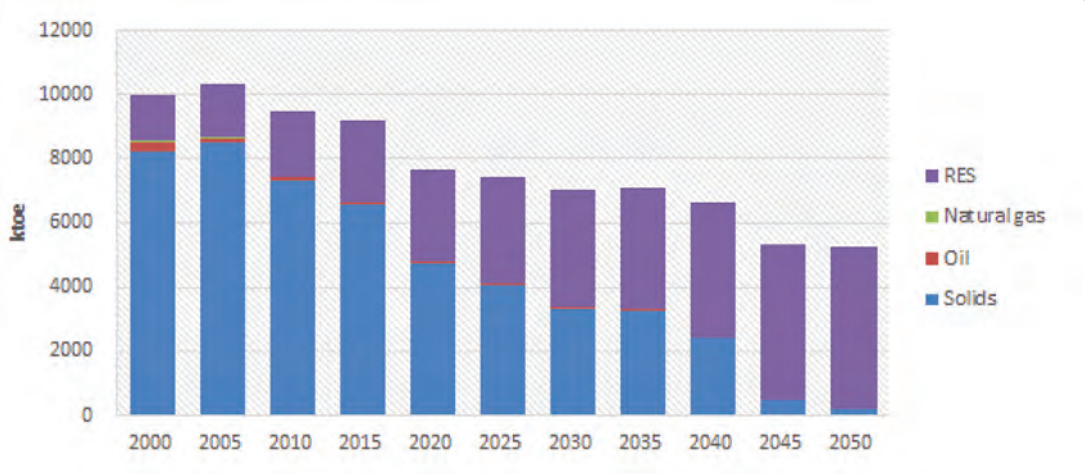
Figure 2: Gross inland consumption in Greece (2035) (Total=21,587 ktoe)



Source: IENE study *South East Europe Energy Outlook 2016*, Athens 2016

As seen in *Figure 3*, the primary energy production of Greece consists mainly of solids and renewable energy sources and demonstrates a heavily decreasing trend. It starts at more than 10,000 ktoe in 2005 and decreases steadily until 2045 to 5,330 ktoe for a total reduction of about 48%. The production from renewables increases from 1,668 ktoe in 2005 to 5,073 ktoe in 2050, while the share of solids decreases from almost 8,500 ktoe in 2005 to 184 ktoe in 2050, leaving renewable energy as the sole primary energy production fuel form in Greece.

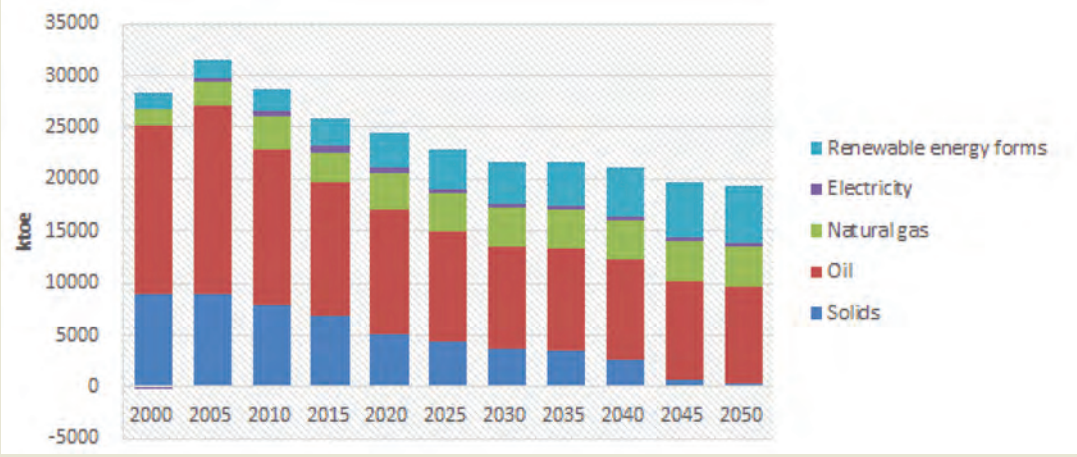
Figure 3: Primary energy production in Greece



Source: IENE study *South East Europe Energy Outlook 2016*, Athens 2016

The gross inland consumption, as depicted in Figure 4, shows a significant reduction of 38% starting from 31,410 ktoe in 2005 and falling below 20,000 ktoe from 2045 onwards. Solids are gradually eliminated while oil consumption is reduced by half, from 18,119 ktoe in 2005 to 9,377 ktoe in 2050. Demand for natural gas increases slightly in the period 2015-2020 from 2,832 ktoe to 3,625 ktoe and remains steady thereafter. Renewable energy forms are the only fuel form the consumption of which steadily increases for all years up to 2050. Starting at 2,746 ktoe in 2015, they reach 5,541 ktoe in 2050, recording an increase of slightly above 100%.

Figure 4: Gross inland consumption in Greece



Source: IENE study *South East Europe Energy Outlook 2016*, Athens 2016

In terms of **energy resources**, Greece is blessed with a high potential of inexhaustible renewable energy sources ranging from solar, which provide both thermal energy and electricity, wind, biomass, hydro (mini and large plants) and geothermal with the last two of vital importance to RES development in view of their significant storage capability. In addition, Greece, like other countries in the Balkans, has sizeable lignite deposits, third largest in Europe after those of Poland and Germany, which are used extensively for power generation. Therefore, and in view of the COP21 agreement of EU's GHE reduction targets, to which Greece is committed, the big challenge in the years ahead will be the continuation of power generation from lignite with a market improvement in plant efficiency and in parallel the introduction of CCS/CCU policies supporting such plans. The target is to generate sizeable amounts of lignite-based electricity with less overall CO_2 output.

Furthermore, several hydrocarbon plays have been discovered in different parts of the country over the years although estimates of recoverable reserves vary considerably. Greece is currently producing limited amounts of crude oil but has the potential of producing considerably more once exploration activities can be fully developed. Last but not least from a resources angle, Greece possesses limited amounts of good quality proven uranium reserves in northern Greece. Seen in context it can be safely concluded that Greece has a rich and highly diversified energy resource base which if fully exploited could reduce considerably the country's high dependency ratio.

Whereas only few years ago, when our major study on 'the Energy Market in Greece' was published in 2001, the market was dominated and controlled by huge state corporations, today there are hundreds of new players active in the whole energy spectrum. In thermal power generation we now have four independent power producers (IPP's), tens of independent electricity suppliers and electricity traders, literally hundreds of independent RES producers and of course thousands of household photovoltaic producers. Lately electricity consumers are having a choice regarding their supplier as electricity tariffs have been fully deregulated since 2013 resulting in number of new suppliers which sell electricity to both households, commerce and industry. All this is resulting into a fast transformation of the electricity and gas markets so that in few years the entire energy market place will be fully reorganized driven by competition based on quality and cost.

These changes are having also a profound effect on **the consumer** who apart from having now a choice on his or her energy provider, he or she has become more acquainted with energy as a resource concept and service. The introduction by the EU over that last ten or so years of energy performance criteria for buildings has certainly helped towards this direction as household owners have become far more aware of energy criteria in the daily operation of their buildings.

In short the energy landscape in Greece is changing fast. On the one hand the energy mix will tend to become more diversified with the further penetration of RES and natural gas and on the other the energy market operation is being transformed with the emergence of actual competition among energy providers. All this will undoubtedly support the greater utilization of the country's energy resources and the further strengthening of the sector as a vital component of the economy.

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A P P E N D I X

Energy Balance for Greece, 2013

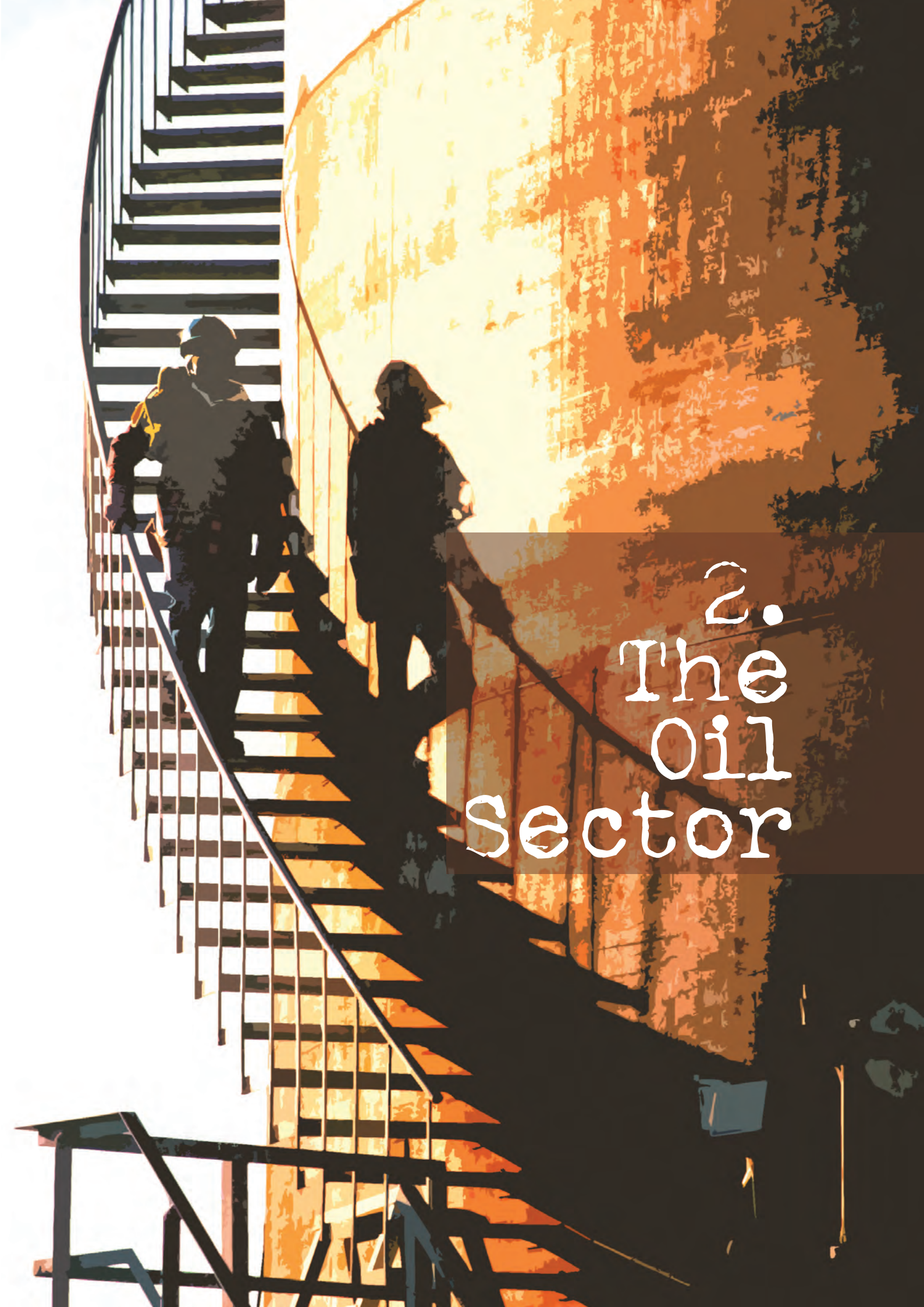
Ktoe on a net calorific value basis	Coal*	Crude oil*	Oil products	Natural gas	Nuclear	Hydro	Geothermal, solar, etc.	Biofuels and waste	Electricity	Heat	Total**
Production	6728	64	0	6	0	546	876	1094	0	0	9314
Imports	233	23111	3570	3234	0	0	0	144	498	0	30790
Exports	-8	-148	-14110	0	0	0	0	-16	-335	0	-14618
International marine bunkers***	0	0	-2121	0	0	0	0	0	0	0	-2121
International aviation bunkers***	0	0	-674	0	0	0	0	0	0	0	-674
Stock changes	27	406	280	-4	0	0	0	1	0	0	709
TPES	**6981**	**23432**	**-13054**	**3235**	**0**	**546**	**876**	**1223**	**162**	**0**	**23401**
Transfers	0	376	-374	0	0	0	0	0	0	0	2
Statistical differences	-47	82	101	-21	0	0	0	3	0	0	116
Electricity plants	-4419	0	-1039	-1763	0	-546	-670	-10	3968	0	-4478
CHP plants	-2302	0	-247	-206	0	0	0	-82	944	42	-1852
Heat plants	0	0	0	0	0	0	0	0	0	0	0
Gas works	0	0	0	0	0	0	0	0	0	0	0
Oil refineries	0	-23890	24256	0	0	0	0	0	0	0	367
Coal transformation	0	0	0	0	0	0	0	0	0	0	0
Liquefication plants	0	0	0	0	0	0	0	0	0	0	0
Other transformation	0	0	-1	0	0	0	0	-4	0	0	-5
Energy industry own use	0	0	-1384	-17	0	0	0	0	-543	0	-1944
Losses	0	0	0	0	0	0	0	0	-335	0	-335
TFC	**212**	**0**	**8258**	**1229**	**0**	**0**	**206**	**1128**	**4196**	**42**	**15271**
Industry	**210**	**0**	**982**	**537**	**0**	**0**	**1**	**128**	**977**	**0**	**2836**
Transport	**0**	**0**	**5451**	**13**	**0**	**0**	**0**	**125**	**23**	**0**	**5613**
Other	**2**	**0**	**1496**	**357**	**0**	**0**	**205**	**875**	**3196**	**42**	**6173**
Residential	1	0	988	232	0	0	182	821	1500	42	3767
Commercial and public services	0	0	193	125	0	0	18	26	1463	0	1824
Agriculture/forestry	1	0	29	0	0	0	5	26	233	0	293
Fishing	0	0	31	0	0	0	0	0	0	0	31
Non-specified	0	0	255	0	0	0	0	3	0	0	258
Non-energy use	**0**	**0**	**329**	**321**	**0**	**0**	**0**	**0**	**0**	**0**	**650**
of which chemical/petrochemical	0	0	192	321	0	0	0	0	0	0	514

* *The column of coal also includes peat and oil shale where relevant; that of crude oil includes crude oil, NGL, refinery feed stocks, additives and other hydrocarbons.*

** *Totals may not add up due to rounding.*

*** *International marine and aviation bunkers are included in transport for world totals.*

Source: IEA



2. The Oil Sector

An Overview of Greece's Oil Market

By **COSTIS STAMBOLIS**, Managing Editor of Energia.gr and Executive Director of IENE

As we pointed out in our introduction, oil represents the biggest fuel input in terms of primary energy supply and final consumption in the country's energy sector. Indeed, oil supply amounted to 10.38 Mtoe (2013 IEA data) corresponding to 44.35% of total primary energy supply, while final oil consumption stood at 8.26 Mtoe corresponding to 54.08% of total energy consumption.[1] With the exception of almost 5,000 barrels per day produced from the country's only oil producing field at Prinos, off the island of Thassos in the northern Aegean (see contribution by Mathios Rigas on "A New Era for Greece's Upstream Sector" p. xxx), Greece imports all the rest. On the basis of 2015 data Greece's current internal primary oil consumption was 303,000 b/d, 98.5% of which was imported.[2]

Greece's huge oil input dependency is the result of a fast developing internal oil market over the past decades with oil being the prime fuel for transportation but also for space heating. Greece's crude oil imports in terms of quantity as well as their countries of origin are shown in Figures 1 and 2 respectively. Meanwhile from 1998 onwards successive governments in Greece suspended all efforts to explore the country's not insignificant hydrocarbon resources and therefore no new oil production became possible. Meanwhile, the country continued to import and consume more and more oil. The development of Greece's oil consumption over the last 15 years is shown in *Table 1*.

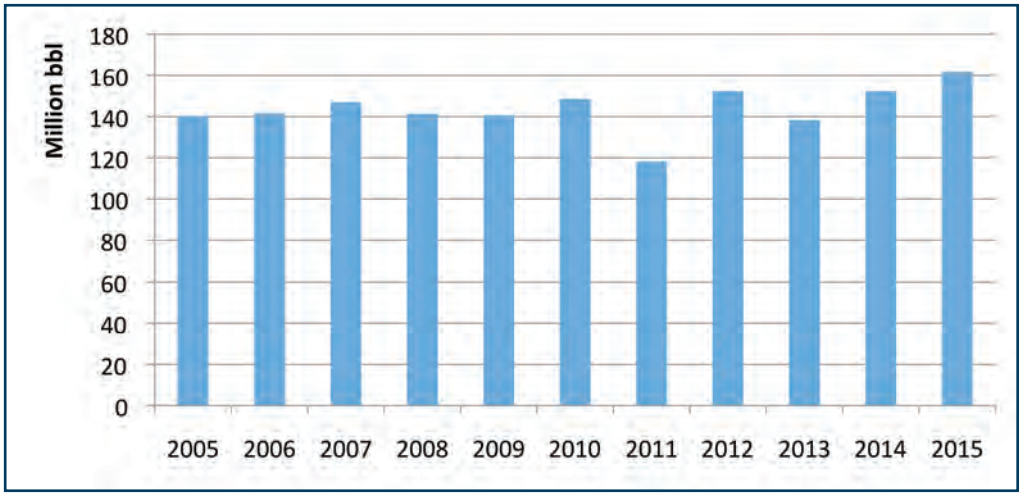


Figure 1: Greece's crude oil imports over 2005-2015

Note: *Figure 1* refers to annual volumes of Greece's crude oil imports (Intra $ Extra EU). Source: Eurostat

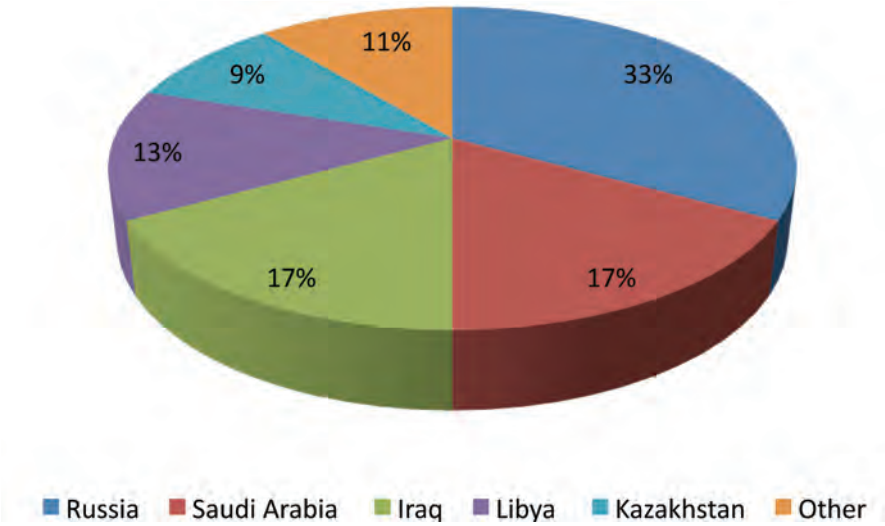


Figure 2: Greece's crude oil imports by country of origin (2012) Source: IEA

Year	In thousands barrels per day	In millions tons
2000	398	19.9
2001	403	20.1
2002	406	20.3
2003	396	19.7
2004	426	21.3
2005	412	20.1
2006	434	21.3
2007	435	21.4
2008	414	20.4
2009	398	19.5
2010	369	18.1
2011	348	17.0
2012	312	15.3
2013	395	14.5
2014	294	14.4
2015	303	14.8

Table 1: Greek (primary) oil consumption 2005-2015

Source: *BP statistical Review of World Energy,* BP, London, 2016

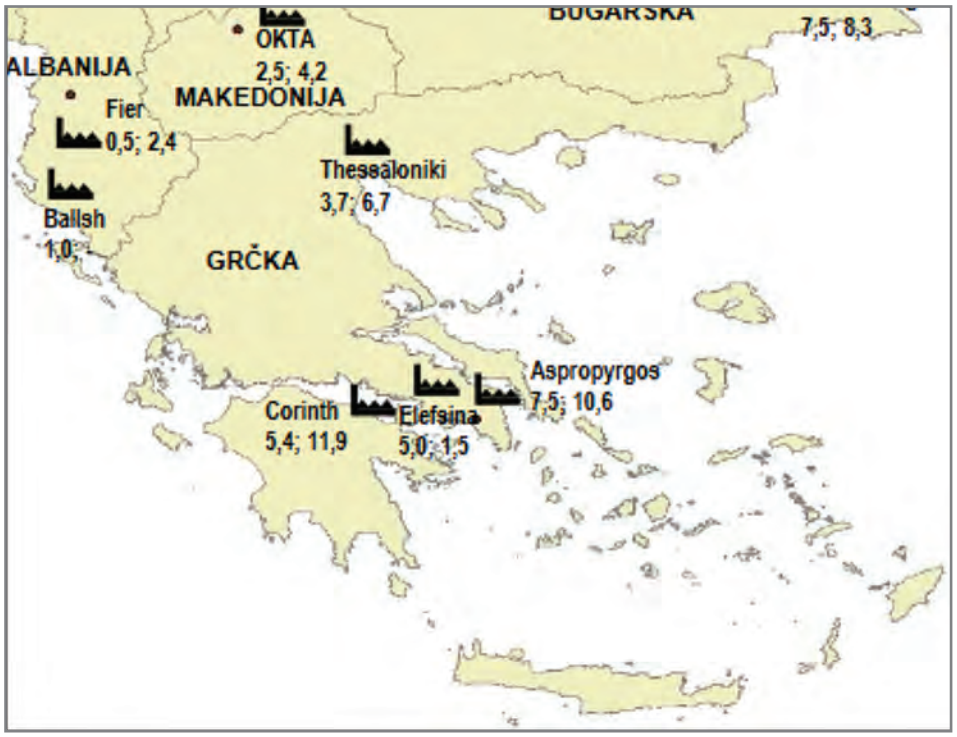
Since 2008 oil consumption has been steadily decreasing, a trend which became painfully apparent from 2009 onwards as the country's economy went on contracting with almost 25% of GDP lost in less than 5 years[3]. The 30% drop in consumption between 2007 and 2015 had an unprecedented effect on retail activities with oil trading companies experiencing an almost 40% drop in income and with most of them reporting losses for several years on a row, while necessitating the closing down of more than 2,500 filling stations all over the country out of 8,500 which had been in operation before 2008[4]. In spite of depressed income and financial problems experienced by most oil trading companies there has been surprisingly little consolidation in the sector. The structure and operation of the country's retail oil sector is discussed in detail in an article by Dimitris Mezartasoglou on "Greece's Retail Oil Market" (p. xxx).

Refining

Greece's most significant contribution and strategic advantage in the oil sector, seen from the regional perspective of SE Europe, is to be found in refining. Indeed one could easily argue that Greece's refining activity constitutes one of the country's key energy assets. Greece's two refining groups, Motoroil S.A. and Hellenic Petroleum S.A., between them operate four refineries (Motoroil's Agioi Theothoroi refinery near Corinth and HELPE's refineries in Aspropyrgos, Elefsis and Thessaloniki) with Hellenic Petroleum owning a fifth refinery, (OKTA) located in Skopjie in FYRO Macedonia (see *Map 1*). The four Greece based refineries, which between them are capable of refining about 518 thousand barrels per day, not only satisfy 100% of domestic needs but are also net exporters. Indeed, over the last few years exports of refined oil products from Hellenic Petroleum and Motoroil have been directed mostly to neighbouring countries including Turkey, Italy, Bulgaria, Serbia, Albania, FYRO Macedonia, Kosovo, Cyprus, Lebanon and Egypt.

Table 2 shows the main technical and production characteristics of Greece's four refineries and *Table 3* contains some indicative figures covering the last five-year period of domestic oil consumption, refined oil product exports and corresponding income. The marked drop in international oil prices over the last two years (2014-2016) has helped refineries in Greece increase their sales margins which in turn has resulted in increased profits for both groups in HELPE's 2015 Annual Report, it is reported that the "FCC* refining margin was $6.5/bbl in 2015, compared to $3.3/bbl in 2014"[5], while Motor Oil's 2015 Annual Report says that the "company blended profit margin was $52.7/metric tonne in 2015, as compared to $20.6/metric tonne in 2014"[6].

* Fluid catalytic cracking (FCC) is one of the most important conversion processes used in petroleum refineries. It is widely used to convert the high-boiling, high-molecular weight hydrocarbon fractions of petroleum crude oils to more valuable gasoline, olefinic gases, and other products (Gary et al., 2007)[7].



Map 1:
Oil Refineries
in Greece

Source:
Energy Institute
Hrvoje Požar (2015)

Table 2: Main Charachteristics of Oil Refineries in Greece (2015)

	Hellenic Petroleum S.A Motor Oil Hellas			Motor Oil Hellas
OWNERSHIP	Paneuropean Oil and Industrial Holdings S.A: 42.6% Hellenic Republic Asset Development Fund: 35.5% Institutional investors: 15.3% Private investors: 6.6% Free float: 23.5%			Petroventure Holdings Limited: 40.0% Doson Investments Company: 8.1% Free float: 51.9%
LOCATION	**Aspropyrgos** (Athens area)	**Thessaloniki**	**Elefsis** (Athens area)	**Ag. Theodoroi** (Corinth area)
Refinery type	Highly complex: catalytic, thermal, and hydro-cracking; MTBE* production; vacuum distillation	Hydroskimming; vacuum distillation; isomerisation; reforming	Topping: atmospheric distillation only; no vacuum distillation, reforming or desulphurisation	Complex: catalytic and thermal cracking; isomerisation; MTBE production; vacuum distillation; mild hydrocracking; hydrotreating; reforming; lube production; alkylation; dimerisation
Nelson Complexity Index	9.7	6.9	11.3	11.54
Capacity Mt/annum	7.5	4.5	5.0	4.5
Kb/d	148	93	100	180
Year established	1958	1966	1972	1972

**MTBE: Methyl Tertiary Butyl Ether*

Source: IENE, 2015 *Annual Reports of HELPE and Motor Oil*

Table 3: Greek Oil Market Fundamentals (2010-2015)

	2010	2011	2012	2013	2014	2015
Net oil imports-crude and products (in bill. €)	-8.60	-11.13	10.22	6.91	6.28	4.21
Refined oil product exports (in bill. €)	4.90	6.19	7.43	9.49	9.05	6.71
Total Oil imports (crude and prod ucts) (in bill. €)	13.50	17.31	17.65	16.40	15.33	10.92
Domestic consumption of oil products (in million tons per year)	9.40	8.55	7.40	6.12	6.20	6.56

Sources: Bank of Greece, ELSTAT

The Upstream Sector

Although Greece's oil industry in the traditional sense of upstream activity can only be regarded as minor with "Energean Oil and Gas" being the only oil producing company, the country's importance in the region's oil sector is significant thanks to its extensive refining infrastructure. Furthermore, the clear export orientation of the two refining groups, which has been strengthened over the last five years, a period of declining sales in the domestic market, is helping Greece re-establish its energy footprint in SE Europe.

Should Greece be able to continue uninterrupted its hydrocarbon research activities, following a restart of hydrocarbon exploration work in 2011, with further seismic work and exploratory drillings, both within the boundaries of established concession areas and in new ones, it is possible on the basis of currently estimated reserves that the country in less than 10 years from now could be in a position to produce enough oil and gas to cover a substantial part of its domestic consumption requirements. Should such a fortuitous outcome become possible, and in conjunction with the present important refining activity, Greece's role as major oil and gas regional player will be further enhanced with the country becoming a crucial oil industry hub in the East Mediterranean. Table 4 shows in summary form the estimated deposits of Greece's known oil and gas fields.

Biofuels in Greece

Biofuels are the fuels produced from biomass, which are derived from organic products such as trees, plants and agricultural and urban waste. Biomass can be used for heating, electricity generation, and transport fuels. Biofuels are considered as renewable fuels having the characteristic of lower CO_2 emissions in their total lifecycle in relation to conventional fossil fuels. During their combustion, these fuels emit approximately equal amounts of CO_2 with the corresponding petroleum products.

Field	Date	Company	Estimated reserves or resources (in million barrels)	Category
East Thassos I	1971	Oceanic-Colorado	350.0 In place	Contingent resources Heavy oil
East Thassos II	1971	Oceanic-Colorado	80.0 In place	Prospective resources
Babouras	1971 /72	Oceanic-Colorado	150.0 In place	Prospective resources
Stavros	1971 /72	Oceanic-Colorado	122.in place	Prospective resources
NikeI	1971 /72	Oceanic-Colorado	60.0 In place	Prospective resources
NikeII	1971 /72	Oceanic-Colorado	63.0 in place	Prospective resources
South Kavala (natural gas)	1972	Oceanic-Colorado	950.0 millionm^3 gas	Depleted Gas field
Amodes (heavyoil)	1972	Oceanic-Colorado	45.0	Contingent resources
Athos	1972	Oceanic-Colorado	45.0	Contingent resources
Prinos	1972 2015	Oceanic- Colorado Energean	60(1) 11,7	Proven recoverable Remaining recover.
West Katakolo	1982	DEP/EKY	4.0-8.0	Contingent resources
AlikesZakinthou	1984 /85	DEP/EKY	35.0(2)	Contingent resources Non recoverable
Epanomi (natural gas)	1987	DEP/EKY	450.0 million m^3 gas	Contingent resources
Prinos- North Prinos	2015	Energean	3,3	Remaining recoverable reserves
Patraikos Gulf	1998 /99	Enterprise Oil - Triton	–	Prospective
Ioannina Region	1998 /99	Enterprise Oil - Triton	–	Prospective
Prinos-Epsilon	2015	Energean	15.2 (39.0)	Recoverable reserves (in place)
Total recoverable reserves (proven)			30.2	
Total contingent reserves			94-98	
Total in place and prospective reserves			703	

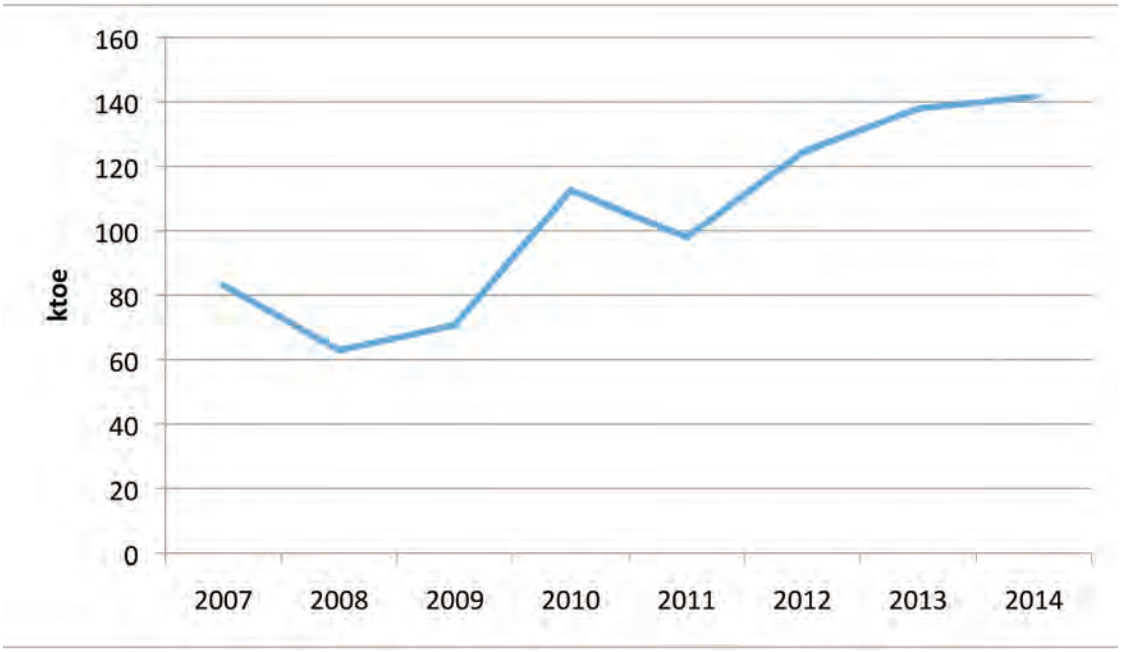
) Some 116 million barrels of oil had been recovered by the end of 2014.
stimated original reserves in place: 290 mmbbl
2) Asphalt contingent resource base has been found but considered to be
on exploitable due to environmental and technical constraints

Table 4: Hydrocarbon Discoveries, Fields and Prospects in Greece[8] Source: IENE

The Greek national policy on biofuels satisfies the country's commitment to achieve the EU targets in order to reduce CO_2 emissions, more specifically in the transport sector. In Greece, biodiesel is used as liquid biofuel and substitute for automotive gas oil, and bioethanol, in a very small degree.

Over 2009-2013, the production of biodiesel has almost doubled, according to Eurostat's data. More specifically, Greece produced 141.6 ktoe of biodiesel in 2014, which corresponds to 1.26% of the total EU-28 production of biodiesel.

Figure 3: Biodiesel production in Greece (in ktoe) Source: Eurostat (2016)



Regarding biofuels in Greece, the road transportation sector consumed the highest percentage (87%) of total consumption of biofuels in 2013 (see *Figure 4*)

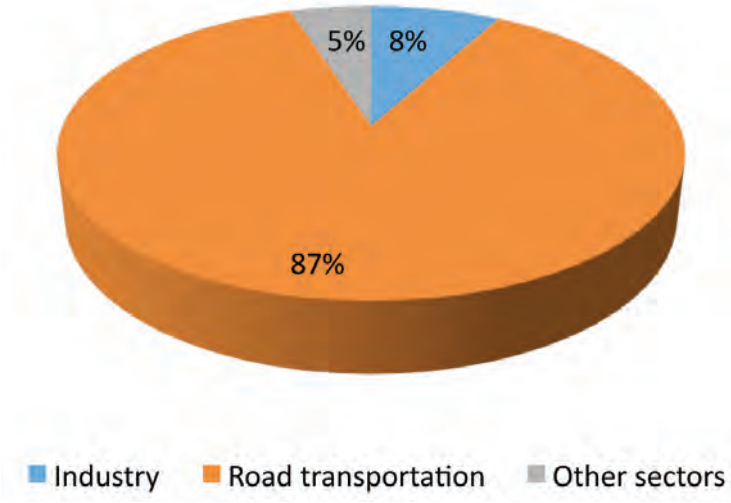


Figure 4: Biofuels consumption in Greece per sector (2013)

Source: ICAP (2015)[12], Eurostat

Over the last few years, biodiesel in Greece is premixed in a small percentage with other quantities of available automotive gas oil. The required annual amounts come from Greek energy crops and raw materials, which are fully absorbed and converted into biodiesel in several manufacturing units that operate in Greece. The remaining amounts are produced either from imported raw materials in domestic units or they are imported as a final product from other EU Member States.

The mixing rate is steadily improving. The mixing rate by the end of 2005 was 2.5%, which rapidly increased to 4.5% and in early 2010, it reached 6.5%. Moreover, in early 2013, Greece used for the first time B7 fuel, which is a type of automotive gas oil that consists of biodiesel at a percentage of 7%. The B7 fuel is available from any petrol station within the Greek territory and the fuel blending is made either from oil refineries or the companies that import automotive gas oil before placing it in the Greek wholesale oil market.

The total quantity of biodiesel that was mixed with automotive gas oil reached approximately 140 million liters in 2015, according to Dimakis and Sotiropoulou (2015)[9].

According to EU Renewable Energy Directive requirements, the mandatory RES target for Greece is set at 18% of total national energy consumption. According to Law 3851/2010 "Accelerating the development of Renewable Energy Sources to deal with climate change and other regulations in topics under the authority of MEECC", the national target for RES is set at 20% of final energy consumption by 2020 (increased from the 18% set out in EU regulation Directive 2009/28/EC). This objective is specified in 40% participation of RES in electricity, 20% in heating and cooling and 10% for transport.

The National 2020 target and estimated trajectory of energy from renewable sources (read biofuels) in transport is as follows.

Table: National 2020 targets and estimated trajectory of energy from RES in transport

%	2005	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
RES-Transport	0.02%	1.7%	3.3%	4.1%	4.8%	5.6%	6.3%	7.1%	7.8%	8.6%	9.4%	10.1%

Source: RECOIL (2013)[11]

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Hellenic Petroleum, A Market Leader in SE Europe

By **GREGORIOS STERGIOULIS**, CEO, Hellenic Petroleum S.A

Founded in 1998, HELLENIC PETROLEUM is one of the leading energy groups in South East Europe, with activities spanning across the energy value chain and presence in 7 countries.

The Group's range of activities includes:

- Supply and Refining of crude oil and Trading of petroleum products, both in Greece and abroad.
- Fuels Marketing, both in Greece and abroad (leading position in all market channels through EKO and Hellenic Fuels and strong position in Cyprus, Montenegro, Serbia, Bulgaria, FYROM).
- Petrochemicals/Chemicals Production and Trading (possession of the only vertically integrated petrochemicals production complex in Greece that produces polypropylene, with significant export orientation).
- Oil & Gas Exploration and Production (exploration and production rights of hydrocarbons in the offshore area of West Patraikos Gulf in West Greece, Arta-Preveza and Montenegro).
- Power & Gas (operation of two combined cycle natural gas technology plants with a total capacity of 810 MW, through ELPEDISON, a joint venture with the Italy's EDISON - 35% participation in DEPA/DESFA Group, the main natural gas supply company-DESFA in sale process).
- Renewable Energy Sources (portfolio exceeding 200 MW in various development stages).

Hellenic Petropeums operations in SE Europe

- Provision of Consulting and Engineering services to hydrocarbon related projects (Asprofos Engineering).

The Group owns and operates three refineries in **Aspropyrgos, Elefsina** and **Thessaloniki** which account for approximately 65% of the country's total refining capacity. Their coastal location and high complexity give them the competitive advantage of easy access to and processing of all types of crude oil that are available in the region. Furthermore, the logistics infrastructure offers a storage capacity of 6.65 million m^3 for crude and products.

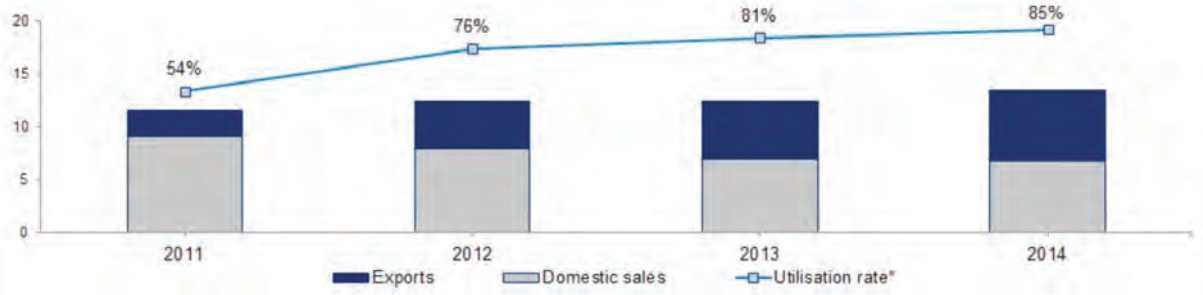
The Group has successfully completed **a 5-year investment plan** amounting to €3bn, including the upgrade of the Elefsina Refinery, the largest private manufacturing investment in Greece worth **€1.4 billion**. The new refinery has a significant impact on the Group's profitability, while accruing multiple benefits for the **environment**, the **employment** and the **national economy**. The Elefsina refinery has a refining capacity of 100,000 bbl/d.

It is a strategically important refinery for the Group due to its high storage capacity (3,3million m^3 of crude oil and petroleum products) and the logistics infrastructure for imports and exports management, including a large private port and a tank truck loading station. The refinery is connected to the terminal in Pachi, Megara and the Aspropyrgos refinery through a pipeline network. The investment also reduced emissions, thus significantly improving the **environmental impact**. Specifically, sulfur dioxide (SO_2) emissions decreased by 70.2%, nitrogen oxide ("NOx") emissions by 11.6% and particulate matter (PMS) emissions by 84.2%.

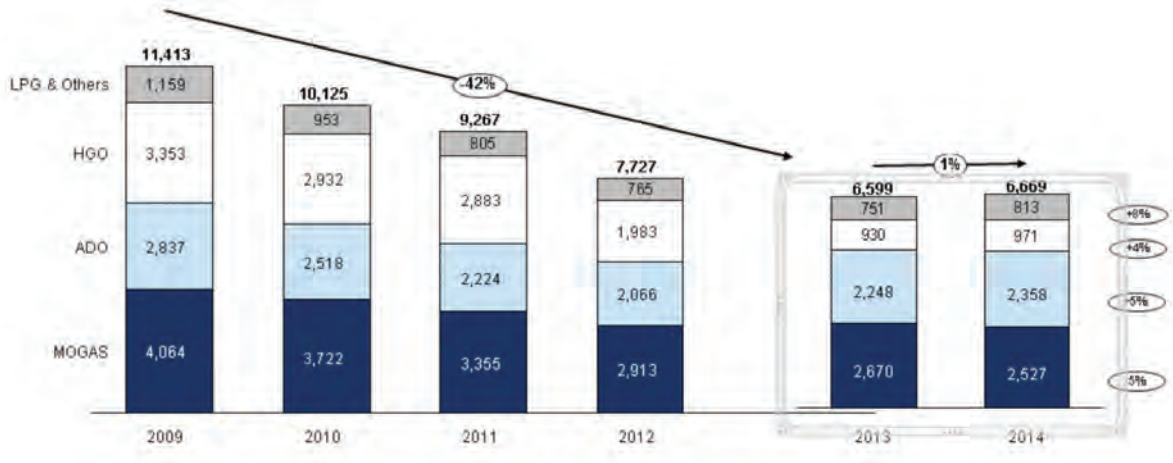
The operational optimization of the Elefsis refinery has significantly contributed to the improvement of the Group's results while strengthening its **export oriented strategy**. The upgraded Elefsina refinery started commercial operation in the second half of 2012 and completed optimization of all units during 2013. The refinery has reached almost **100% utilization,** with many units exceeding their design specifications. Middle distillates yield (diesel, jet) exceeded specifications and reached 75%, leading the respective yield at Group level to 52%. This has

positively contributed to the Group's refineries' operating performance, with the yield of high added value products standing amongst the highest in the European refining industry, highlighting the **competitiveness** of the Group's asset base.

It is also worth noting that the Group has become the most important diesel exporter in the Eastern Mediterranean region. In 2014, HELPE's exports reached 6.7 million tons and **exceeded 50%** of total sales.



With regard to the domestic fuels marketing sector, Group sales were significantly affected mainly due to low demand levels and market liquidity problems. More specifically, within the sector, fuel consumption in Greece has declined steadily over the last few years. More specifically during 2009-2013, the overall domestic fuels demand was reduced by almost 40%. As a result, the number of petrol stations and industrial customers contracted, with 2,400 petrol stations, and four fuel marketing companies, exiting the market over the last five years. But in 2014 we saw the first signs of recovery after a prolonged period of decline.



Despite demand decline in the Greek market, HELPE's networks and commercial and industrial businesses saw an improvement in operational performance. The Group has maintained its leading position in the market, increasing its share in key products, while growing profitability by supplying competitive and quality fuels and lubricants. On this note, the Group has successfully completed the launch of two innovative differentiated products, the new EKO Diesel Avio and BP Ultimate Diesel.

The Domestic Marketing Division recently completed its restructuring programme with the merger of the Groups' two trading companies, EKO and Hellenic Fuels (1700 service stations in Greece) into a single legal entity. It is anticipated that the merger will achieve an optimized organizational structure of management and staff and a reduction of Groups' operational expenses.

It is important to mention that over the course of the last five years, and operating within a difficult economic environment, with serious liquidity problems, the Group has successfully implemented a comprehensive transformation programme in order to improve its performance across all its businesses.

The Group's main **strategic priorities** are as follows:

- optimisation of the refineries' operations
- fully realise synergies and benefits arising from the newly upgraded Elefsina refinery
- increase competitiveness in domestic and international marketing
- procurement optimization
- organisational restructuring
- process simplification
- reduction of the operating cost base
- further develop its Human Resources base
- provide support to social oriented programmes and activities

Safety, Environment, Social Responsibility and the Development of its employees are basic principles and areas in which Hellenic Petroleum will continue to invest with consistency and responsibility. Through ongoing training programmes, and the acquisition of knowhow, new skills and competencies are developed within HELPE, while embedding a shared Group culture with **Competitiveness, Sustainable Development and Excellence**, being its core characteristics.

The Group's strong results were accomplished, to a large extent, due to the continued development of its human resources and the high level of expertise of its employees', as well as the adoption of principles and rules, which conform to a **sustainable development strategy.**

The continuous improvement in competitiveness is regarded as key priority for Hellenic Petroleum Group and of vital importance, in order to retain its course as one of the most dynamic energy groups in Southeast Europe and the Mediterranean. Hellenic Petroleum will continue in its path of enhanced competitiveness with strong export focus, thus mitigating the consequences of the current economic downturn and so continue in its path to profitability.

Gregorios Stergioulis, CEO, HELLENIC PETROLEUM S.A. Born in Karditsa, Greece in 1956, he studied Chemical Engineering in the University of Leeds, from where he graduated with a Master of Science degree. He worked in various industrial enterprises, both in England and in Greece and since 1984, has served in several managerial positions in the Hellenic Petroleum Group Refineries, the most notable being that of the Elefsina Refinery Upgrade Project coordination, between 2008 and 2014. He has published technical articles and books on specialized topics and has been the instructor in conferences and technical seminars. He speaks Greek, English and French. He has two children.

Hydrocarbons E&P sector: When the vision becomes a reality

By Dr **SOFIA STAMATAKI**
Professor of Reservoir Engineering and Oil Well Technology, National Technical University of Athens, ex Chairman & CEO, Hellenic Hydrocarbon Recourses Management S.A

So far Greece is not recognized as an oil producing country. The country still remains a basically underexplored province of SE Europe and the East Mediterranean area, as a result of a combination of risks related to its geological complexity on the one hand and its political and financial development model on the other.

However, hydrocarbon exploration goes back to the late '30s, but a more systematic exploration was undertaken following the foundation, in mid-70's, of the Public Petroleum Corporation, a public authority established to exercise the state's rights over hydrocarbons.

In 1996 the 1st Licensing Round was launched while further exploration work and surveys continued up to 2000.

Significant findings resulted from all previous activities as shown in *figure 1*.

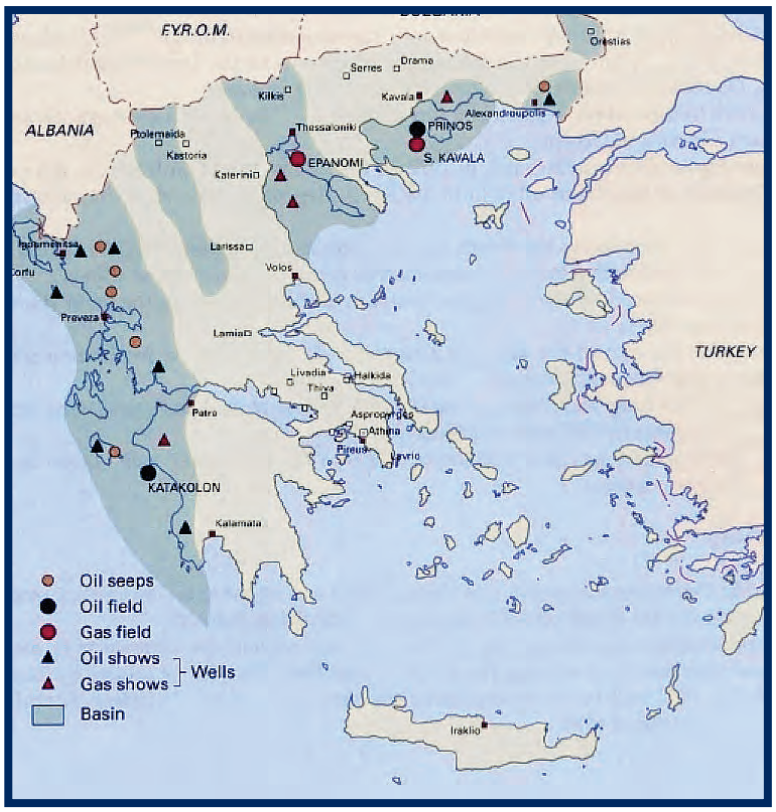


Figure 1. Oil seeps, Gas shows and Field discoveries

- Mapping of thick sedimentary basins.
- Oil & gas shows in many wells and seeps at surface.
- The discovery of the "Prinos" oil field, the South Kavala gas field, the Epanomi gas field in the north and the Katakolo oil field in the west.

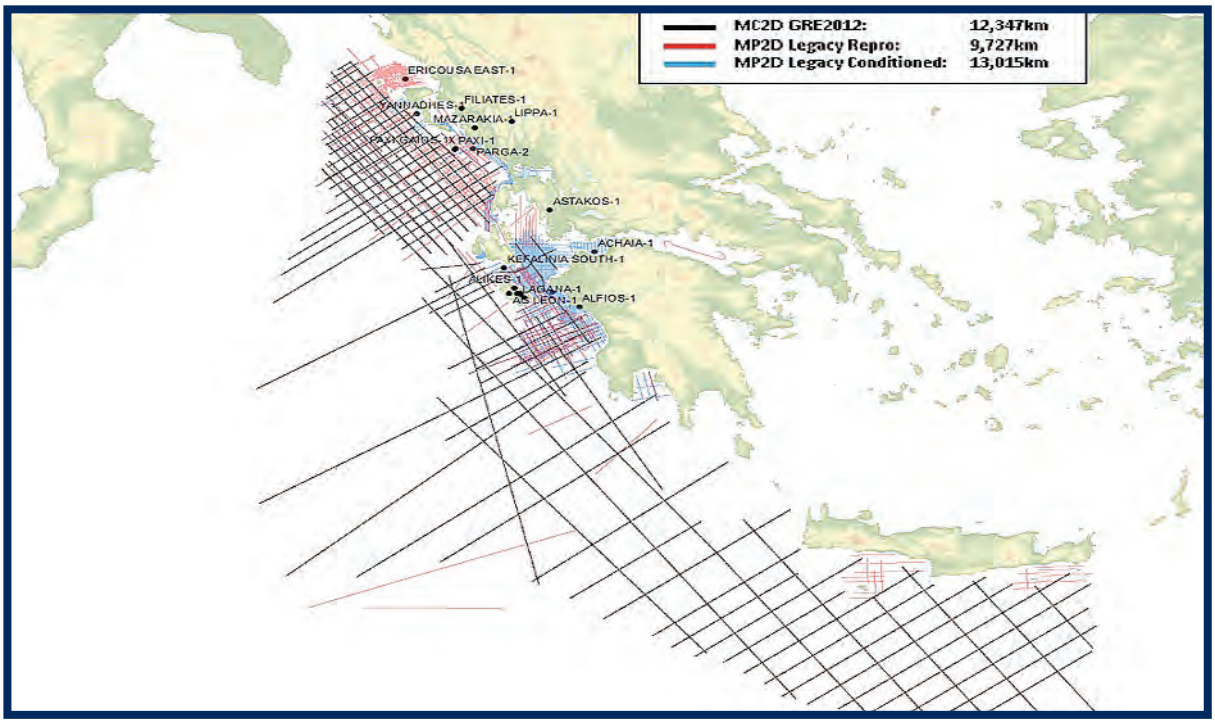
Since 2011 a new chapter in the country's oil and gas E & P commenced. **New strategy and new** policy implementation tools were introduced such as:

1. An up to date legal framework that allows Greece to adapt to the modern requirements and regain the ground lost over the last fifteen years.
2. A competitive and investment attractive fiscal regime
3. New data acquisition, processing and interpretation
4. Elaboration of a modern lease agreement model
5. Implementation and execution of specific actions in certain areas of particular interest, which merit further attention for exploration in order to assess their potentiality with regard to possible oil and gas resources.

Consequently, the 1995 hydrocarbons law which was enacted in compliance to the European directive was fully modernized in 2011 through the introduction of the all inclusive Law 4001/2011. The new legal framework provides for all the legal tools which are necessary in order to rapidly promote the exploration & production of Greece's hydrocarbons, while it offers an investment friendly platform, incorporates developments and international best practices and establishes the new competent state authority for upstream licensing, namely the Hellenic Hydrocarbon Resources Management S.A. – H.H.R.M. S.A.

An extensive multiclient seismic survey that was performed during 2012-2013 by the Norwegian company PGS in an offshore area of **225,000 sq. km in** Western Greece and South Crete, provided high quality 2D seismic data based on the use of the PGS GeoStreamer (streamer length 10km) and GeoSource which allow imaging of both shallow and deep, below Triassic evaporite, targets.

The **Greece Mega Project,** as it is now called, comprises 35.000 km seismic lines of new 2D data, reprocessed legacy and "conditioned" legacy data tied to available wells and creates a uniform dataset cube.



In addition, and with the assistance of PGS and BeicipFranlab, an extensive interpretation report was prepared based on all available information from the area, covering everything from regional geology to hydrocarbon potential estimation. Drilling data has also become available from 19 onshore & offshore wells ranging in depth from 800 to 4000 meters. The acquisition of the new data, the reprocessing of the legacy ones and their integrated interpretation constitute the data base which oil companies can use to evaluate the whole area and consequently any specific block, and hence examine all parameters that each company takes into account in order to take final decisions.

Since 2012, three international tenders have been launched for exploration and exploitation in certain areas of the country, as shown in figure 3:

1. The "Open Door" tender (2012), for the blocks "Ioannina", "Patraikos Gulf (west)" and "Katakolo" in Western Greece (blocks in red color of figure 3). Lease Agreements were successfully signed and ratified by the Greek Parliament in October 2014. The Lessees are already on board and their work programme is performed according to the mutually agreed contractual terms and timeframe.

2. The International Tender based on **Individual initiatives for expression of interest** (2014**),** for three onshore blocks, "Arta-Preveza", "Aitoloakarnania" and "NW Peloponnese" in Western Greece (blocks in yellow color of figure 3). The evaluation of the offers has been completed and the preferred bidders were officially announced on February, 4, 2015.

3. The **2nd International Licensing Round** for 20 blocks in offshore Western Greece and South of Crete which was announced in November 2014. The delineation of the blocks was based on the following key parameters: the exploration maturity and the potential prospectivity as it has been assessed up today (plays/leads/prospects identified, estimated risk & depth of potential targets etc), the water depth, the density of available data which is decreasing from the north to the south, as well as the environmental issues and findings of the performed Strategic Environmental Assessment. A buffer zone has been applied around islands and the coastline. Certain areas of interest had to be sacrificed, but this was a conscious choice. Tourism and exploration of hydrocarbons are two very important economic activities that can and should coexist. To this purpose, all possible protective measures must be taken from the very beginning.

There were three offers for blocks 1, 2 and 10. At the moment, the evaluation procedure of the submitted offers is still ongoing.

The draft model lease agreement that forms the basis of the agreement between the two parties has been released to the companies in order for them to be able (a) to take into consideration all the details in the design of their economic models and (b) to consider the commercial terms and the accounting procedure regarding the allocation of various types of expenses. **So, that the "rules of the game" are well established and known to all in advance.**

Figure 3. Map of the onshore and offshore blocks

The aforementioned tenders have been structured to meet the basic criteria and principles for petroleum rights allocation as those which are specified in the Greek Petroleum Act:

- The rights of prospecting, exploration and exploitation of hydrocarbons belong exclusively to the State and their exercise is always for the public benefit.
- The petroleum resources shall be managed for the benefit of the Greek economy and the Greek society as a whole.

At the same time, we should not forget that in a way hydrocarbon resources are a gift of nature. Their exploitation can become an important productive sector with significant strategic and economic consequences. Taking advantage of this gift and in order to achieve economic results and at the same time maintain social benefits this requires investment, continuous effort, patience and caution**.**

The main objective was and still remains the establishment of an open and stable upstream market and the maximization of the economic and social benefits obtained from the exploitation of petroleum resources through **the licensing policy** and the **resources management system.** Consequent to that is, of course, the development of national knowledge and expertise regarding all different industrial sectors while paying great attention to the environment, health and safety.

An efficient allocation system should use transparent selection criteria and the bidding parameters must clearly reflect the objectives that the government wishes to follow. Never forget that at the time of allocation, neither the government nor the investors know the true value of the available blocks. All agreements, either lease agreements or production sharing ones are both risk type agreements. **Progressive fiscal systems** allow government and investors to reduce the risk and to correct inefficiencies resulting from imperfect information or lack of data at the time of allocation.

Concerning **the licensing policy, this should be** based on a non-discriminatory and competitive system with main criteria the good understanding of the geological area of interest, the technical expertise of the applicant, its financial capacity and its environmental protection capability and records.

Therefore, the technical capability of the Applicant, and especially of the Operator, are evaluated based on a number of records that prove its past and current E&P activities, plus its record on environmental protection, the experience of its key personnel and of course its past behaviour for licenses that have been granted to him.

As far as the fiscal regime applied for, this should be oriented toward the achievement of a competitive upstream market on an international basis and, alongside, aim to:

- encourage companies to develop even small fields,
- provide the government with early revenue from the development of a project (government early revenues even from the first barrels of oil or gas),
- motivate E&P investment,
- balance regional asymmetries,
- effectively compensate costs and risks especially in immature areas,
- stimulate the exploration and development in deep waters,
- support local communities – finance any type of existing or future environmental and development initiatives on a regional level.

To enhance the value of the area of interest, the work programme (extent, timeframe and commitment) becomes one of the biddable items since it can affect the quality and the level of exploration investment in the area. In parallel, the lease agreements must offer to both parties the possibility to jointly address and resolve serious issues both in terms of exploration and exploitation strategy and programme and to exchange ideas for mutual benefit.

The resources management system should follow a stepwise exploration with transparency, continuity and stability and with a clear role of the State. A system that can attract international participation by oil companies and, at the same time, be able to achieve a balance between company participation and the gradual building of domestic knowledge and in house expertise.

In order to achieve the above, a strong public administration sector is required; capable of understanding and incorporating policy, appreciating the specific characteristics of the areas of interest and of course the market characteristics.

Only in such a way can the State define efficient inter-temporal exploration policies, assess the geological risks which affect the level of competition and at the end manage to formulate allocation strategies that can reflect the risk profile for the particular time period involved.
In order to be able to safeguard the state's interest the relevant administration must be able to understand the changes in the market, especially in terms of prices, which is a significant factor in explaining the variability over time the number and size of bids for the same geological basin, particularly in frontier and immature areas, as well as **market segmentation** i.e. the behaviour of oil companies and their strategies to tolerate different risks for different types of exploration.

Above all, environmental protection and safety shall always remain important guiding principles. Greece as a member of the European Union is committed to all relevant international protocols, agreements and EU legislation, actively encouraging best oil practices and adopting the 2013/30/EC Off Shore Safety Directive, the draft law of which was recently announced open to public consultation. Moreover, in every case, either onshore or offshore, special care must be taken to protect tourism and the country's unique environmental heritage and physical resources.

During the last year and especially from the mid of 2015, the international oil industry has been undergoing significant changes in view of the new price environment. The sharp fall of oil prices, the significant reduction of investment budgets of oil companies and their internal redeployment, the dynamic comeback of Iran to the world oil markets and the effect that this comeback shall have on the oil market, create a new environment that needs to be carefully assessed.

The new conditions, despite the positive impact they may have in many areas of the economy, they have a negative overall effect for the exploitation of hydrocarbons. The question of course remains if Greece can take advantage of this lull in global oil exploration activity in order to prepare and organize adequately its relevant administration so as to take advantage when prices rebound and the market recovers.

Following closely the evolution of the oil market, it is possible to exploit this "window of opportunity period" to move on and take a series of actions that are absolutely necessary and will contribute to the effective organization of Greece's upstream sector:

1. Completion of staffing and organization of HHRM and securing the necessary financial resources for a long-term operation. In this sense HHRM must become a proper public authority capable of carrying out the full range of activities as foreseen in its constitution. Especially now that there are five concessions running, with three in the final stage of agreements and the rest under evaluation. Consequently, the evaluation system and the supervision mechanism must be ready very soon.

2. Preparation/drafting of the environmental, health and safety regulations and guidelines: comparison with international practices, guidelines and implementation of plans in case of emergencies, both onshore and offshore.

3. Organization, digitization, management and security of the hydrocarbons' archive. This forms a national wealth of data and information gained through exploration activities over many decades and it must be preserved and utilised in the most modern and efficient way.

4. Upgrading of the quality and quantity of available data for the offshore areas as shown in Figure 3. Indicatively, 2D seismic lines infill where the existing grid is pretty sparse, targeted 3D seismic programmes in sub areas of high interest, additional geological and geophysical "readings" in the area. Such actions can serve to further deepen the interpretation and geological understanding of the area under consideration but also help, to enhance the information and data available to oil companies when our country returns to the oil market. Therefore, the interest must be kept high and the available information available should be continuously upgraded.

5. Focus on developing regional cooperation with neighbouring countries with the aim of exchanging experience at technical level but also to create a regional shield in the areas of environmental protection and safety.

It is not an exaggeration to say that our vision has become a reality since a new market, in the upstream sector, has been established. For our country it is more than necessary to maintain this endeavour and to incorporate it in an overall reconstruction plan of its productive sector. The dynamism of this sector is quite high while its development, within the constraints of the present legal and administrative framework, can lead to significant public revenues, new direct and indirect activities and the creation of new jobs.

Professor **Sofia Stamataki** holds a Diploma in Mining Engineering and Metallurgy from National Technical University of Athens-NTUA (1979) and a PhD in Petroleum Engineering from Heriot-Watt University, Edinburgh U.K.(1986). Since 1988 she has been member of the academic staff of Mining Engineering Department (NTUA) and in 2002 was elected Professor of Reservoir Engineering and Oil Well Technology. She has been teaching undergraduate and postgraduate courses in the areas of oil well technology, petroleum engineering and geothermal fields engineering and has supervised more than 40 Diploma Theses and 9 PhDs. Professor Stamataki has served as Director of Mining Division for 6 years and School Chairman for 4 years. She also holds the position of the Director of the Laboratory of Applied Geophysics that incorporates the units of well technology and petroleum engineering. She has established several co-operations with universities and research centers and has been involved to and/or supervised more than 20 research projects funded by EU, National Organizations and Private Sector, most of them related to oil and gas engineering. Author of more than 80 publications in scientific journals and invited speaker at a number of important international conferences and institutions. Advisor to the Minister of Industry (1995) on Petroleum Policy Aspects and on the preparation of the 1st Hydrocarbon Licensing Round. Committee Member of ELFORES for the development of Geothermal Energy. Head of Experts Committee for the conversion of South Kavala natural gas field to gas storage facility. Chairman of the committee for editing the institutional framework for the establishment of the Hellenic Hydrocarbons Management Company S.A. and the updating of the Petroleum Act. Deputed Chairman of the advisory committee for the Non-Exclusive Seismic Surveys offshore Western and Southern Greece. Deputed Chairman of the advisory committee for the Open-Door invitation for granting and using authorizations for the exploration and exploitation of hydrocarbons in Western Greece.

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ενέργεια για Ζωή

A New and Full of Challenges Era in the Upstream Sector

By **MATHIOS RIGAS**, Chairman and CEO, Energean Oil & Gas

The upstream sector in Greece undoubtedly stands at a critical crossroads which will determine its future for the years to come. On one hand, there is the sharp decrease in oil prices which are now 60% lower since April 2014, while there is no fundamental sign that market conditions will revert to their former state. On the other hand, there are several ongoing programmes focused on the development of Prinos oil field and the start of the exploration of new and promising areas in Western Greece.

The oil price collapse has resulted in significant losses for upstream companies worldwide. Investment projects of hundreds of billions of dollars have been postponed or cancelled and analysts estimate that this decrease has reached 25% y-o-y, which is the greatest drop since the mid 80's. Moreover, the layoffs in the sector have already exceeded 400,000, while recent research reveal that the trend continues in 2016 for the oil companies.

The revival of Prinos and the Western Greece challenge

Despite the adverse conditions, Energean Oil & Gas, Greece's only oil producer, continued to invest during 2015 in Greece. Energean has revived the Prinos oil field with 2P reserves standing at 30 million barrels - a 15 times increase compared to 2007 when Energean took over the license.

Energean has already invested US$ 300 million during the last 8 years and has achieved the following:

- Kavala Oil has been acquired and restructured.
- Four jack-ups have been mobilized and the drilling of six wells has been completed in the Gulf of Kavala.
- Energean Force, the first offshore Greek drilling rig, has been acquired and undergone full refurbishment in the Perama Shipyards.
- A 3D seismic survey over the Prinos License was carried out in 2015, the first one in the Aegean since 1997.
- The establishment of new scientific force has been supported through Energean's collaboration with the Technical University of Eastern Macedonia and Thrace (TEI Kavala), which runs the only Oil & Gas Technology Department in Greece.
- The exploration programmes in the blocks of Katakolo and Ioannina have started,

while bids for the Aitoloakarnania and Arta/Preveza blocks have been submitted.

- More than 150 permanent job positions have been created in Kavala and Athens, while more than 300 employees worked in Perama during the refurbishment of the rig.

- The Greek State and the state-owned companies have received more than 130 million euros, while specifically the society of Kavala has benefited more than 110 million euros deriving from Energean's activities.

- At the same time, Energean has acquired two licenses in Egypt, has reached an agreement, subject to the approval of the parliament, for two offshore blocks in Montenegro's first offshore round and has been seeking investment opportunities in Israel and Croatia.

Looking into the future, Energean's new 200 million euro investment programme includes:

- The drilling of fifteen wells in total in the Prinos, Prinos North and Epsilon fields in the Gulf of Kavala which is in progress.

- The development of the Epsilon oil field through the installation of a new unmanned platform.

- The maturation of 27 million barrels of contingent resources into reserves in the Prinos license through the submission of development plans aiming to maximize recovery from the Prinos field.

- The identification of new exploration targets through the processing and interpretation of the 3D seismic survey acquired in the summer of 2015.

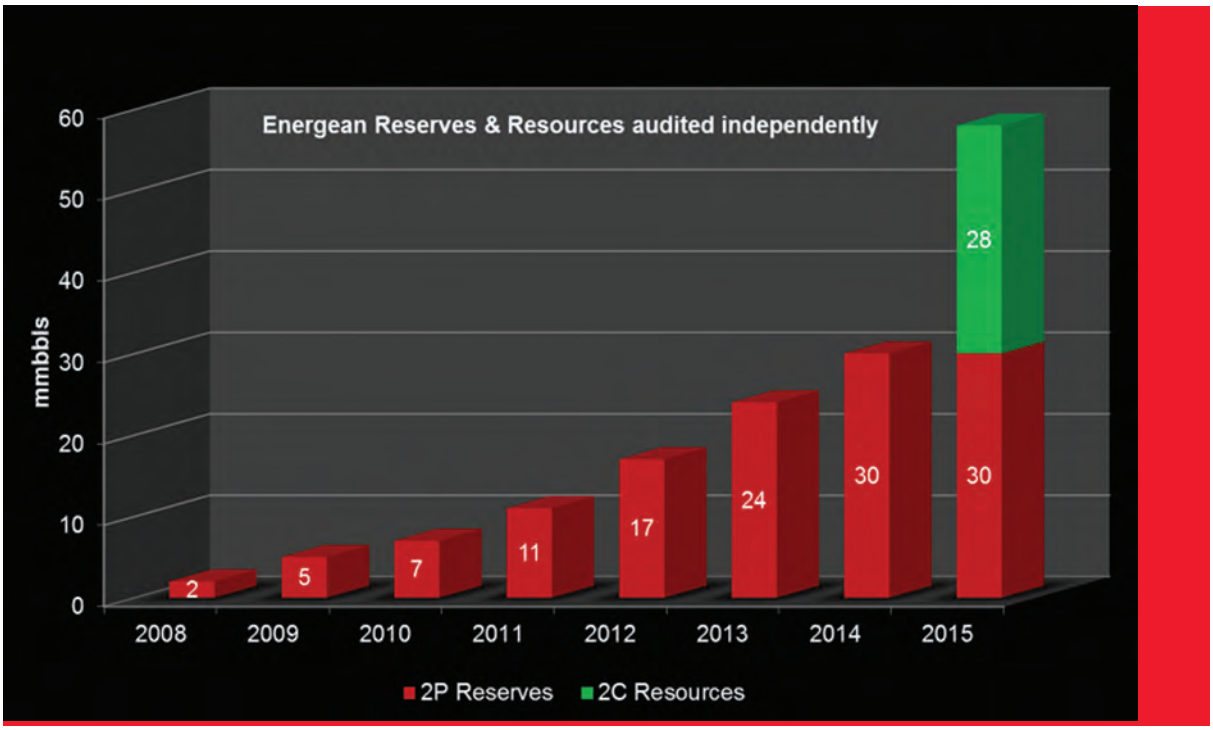
- The further enhancement of recovery from the Prinos oil field through the use of EOR techniques.

- The development of the proven offshore hydrocarbon field of Katakolon, which may be confirmed as a key for the development of the upstream sector in the wider region of the Western Greece.

- The completion of the first exploration phase in the Ioannina onshore block.

Moreover, Energean has submitted to the Greek state the development of an Underground Gas Storage in the almost depleted South Kavala natural gas field, which will contribute to turning Greece into an energy hub in the wider region. The implementation of the proposed US $350-400 million investment would:

- Upgrade Greece's geostrategic role.
- Create strategic security natural gas reserves.
- Strengthen the country's position when negotiations with its suppliers are underway.
- Establish a new source of supply for the benefit of the competition, the consumers and the national economy in general.



Energean has established partnerships with major companies of the oil & gas sector such as BP, with an offtake agreement for the entire oil production of Prinos; Schlumberger, for technical services; Ocean Rig, with which Energean has formed a JV in order to seek opportunities in deep and ultra-deep waters; and Prime Marine, an affiliate company with a major role in the transportation of oil products globally.

Can Greece become an energy hub?

Energean has managed to keep Greece on the global map of hydrocarbon producing countries and has played a leading role in the reopening of the E&P sector in Greece that remained inactive for over 15 years. Greece aims to become an Energy Hub and this will require substantial investment in infrastructure to connect Greece both with energy sources such as the new discoveries in the Levantine basin, but most importantly to the European gas market. This requires political stability and regional cooperation with the neighboring counties. Gas will undoubtedly play an increasingly important role in the energy world particularly after the recent Paris agreement on Climate Change and Greece has a unique opportunity to become the pillar of stability in a very unstable region, attracting foreign investment that is the only way for the Greek economy to exit the financial crisis.

In addition, Greece needs to exploit its own natural resources through continuation of the policy which offers attractive terms to E&P investors given that competition for investment opportunities in a $40/bbl environment will make frontier areas less attractive to major international E&P companies.

So, what are the next steps for the Greek Government in order to attract investors? The answer is not simple, but there are two principles to follow. First, provide investors with confidence that Oil & Gas exploration is a priority, thus:

- Accelerating funding and staffing of the Hellenic Hydrocarbon Resources Management S.A. (H.H.R.M S.A.)
- Completing on time any public tender for hydrocarbons exploration and exploitation.
- Offering solutions and related approvals to investors in “business time”
- Guaranteeing stable fiscal terms

- Securing the market from the intervention of established interests which try to create obstacles to those who are determined to invest in the development of the E&P sector

Secondly, promote the real opening up of the gas market by implementing EU guidelines through:

- The diversity of supply
- The establishment of long term contracts
- The encouragement of new investments in exploration, production, storage and transport of gas and LNG.
- The promotion of the South Kavala UGS and other major infrastructure projects

Energean is emerging as a regional champion with presence in Greece, Egypt, Israel, three countries already in close cooperation in the energy sector. Energean's Prinos success story proves that despite challenges imposed by the oil price drop, the volatile political environment, environmental concerns and the tourist activity, Greece offers exciting investment opportunities for long term investors, as it is an underexplored EU country with significant exploration potential, a stable oil & gas investment environment and an easy monetization of E&P assets.

For Greece, Prinos is the example to follow and Energean's experience in operating successfully for over 35 years, an asset for the country's evolution to a new energy sector.

Mathios Rigas is founding shareholder of Energean Oil & Gas and since 2007 has served as the company's Chairman & CEO. He is a Petroleum Engineer with a combination of oil & gas and investment banking experience. Prior to setting up Energean Oil & Gas, M. Rigas spent 18 years in investment banking and private equity investments. Between 2001 and 2007, Mr. Rigas was Managing Partner of Capital Connect Venture Managers, a Private Equity fund in Greece with investments in innovative enterprises in IT, Healthcare, Waste Management and Food Industries. From 1999 until 2001 he was in charge of Piraeus Bank's Shipping Investment Banking division. Prior to that (1993-1999) he was Vice President of Energy & Project Finance at Chase Manhattan Bank in London where he arranged oil & gas financings in excess of $5 billion. His career started at Arthur Andersen in 1991 as a consultant in the energy sector. He holds a Degree in Mining & Metallurgical Engineering from the National Technical University of Athens and a MSc/ DIC Degree in Petroleum Engineering from Imperial College in London.

Greece's Retail Oil Market

By **DIMITRIS MEZARTASOGLOU**, Research Associate, IENE

Greece's retail oil market is characterized by great diversity in terms of participating companies, market composition and infrastructure development over the years. Far from static, Greece's oil market reflects to a large extent the overall behaviour of the country's economy on both its upward and downward turns. Although the oil volumes in the local market have constantly decreased over the last eight to nine years and the number of pump stations has contracted, the market remains well supplied with hundreds of companies operating all over Greece.

Retail Oil Market Structure

The following information fully describes the current oil market status in terms of company type and numbers.

- **2** refining companies, which between them operate 4 refineries
- **24** Petroleum Marketing companies holding a type A license, with storage and trading facilities throughout Greece
- **30** companies holding a type B1 or/and B2 license for marine or/and jet fuels, with facilities for the replenishment of ships in harbors and with stations for the replenishment of aircrafts in almost 25 airports. 15 of these companies also hold a type A license.
- **33** companies holding a type C license – namely license to trade LPG, with installations or/and LPG bottling plants. 5 of these companies also hold a type A license.
- **24** companies holding a type D license – namely license to trade Asphalt. 9 of these companies also hold a type A license.
- **1** company holding a License to Transport via Pipeline. The company is activated in the transport of Jet fuels from the Refineries at the E. Venizelos Airport
- Approximately **5,600** service stations (displaying companies' trademarks in their majority)
- Approximately **1,000** Heating Oil Resellers

The Greek oil industry is regulated by Law 3054/2002 (as amended by Law 3335/2005) and by the relevant Licensing Regulation. The oil retail market is the last linkage in the supply chain of fuel market (see Figure 1) and provides a large number of petrol stations, currently amounting to about 5,600 in Greece. Based on the population of Greece, there is 1 petrol station per 1,900 inhabitants, while the average equivalent in the EU is 1 petrol station for every 3,800 inhabitants (SEEPE, 2016).

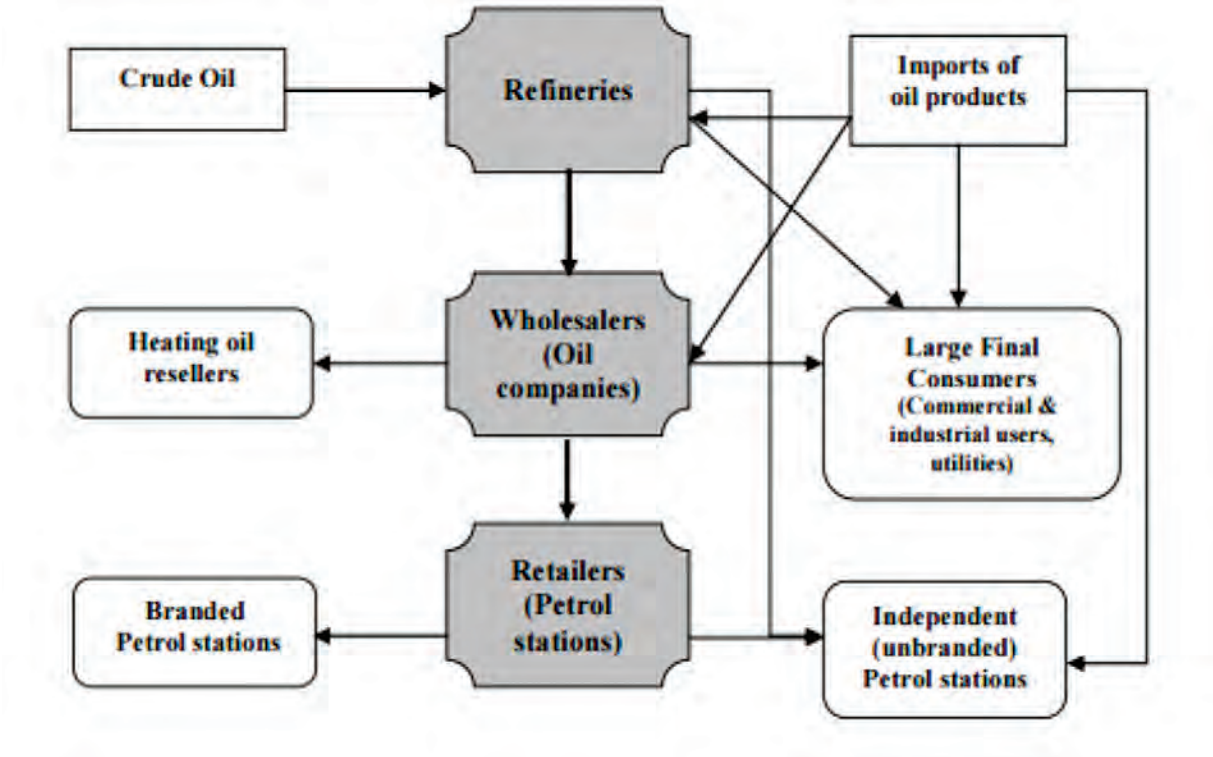


Figure 1: Structure of the Greek Oil Sector *Source: OECD (2013)*

Figure 1 also presents the distinction between branded and independent petrol stations. In turn, branded petrol stations can be divided into three categories: **(a)** Company Owned Company Operated (COCOs) in which the oil marketing companies own and operate them, while the pump price is determined by the oil marketing companies, **(b)** Company Owned Dealer Operated (COCOs) in which the oil marketing companies own them, but their operation is managed by the petrol station operator as an independent entrepreneur, who also sets the resale price and (c) Dealer Owned Dealer Operated (DODOs) in which the petrol station operator owns and manages them as an independent entrepreneur, setting freely the pump price. The independent petrol stations are unbranded and they can obtain fuels either directly from the refineries (see Table 1) or from oil marketing companies. CODOs and DODOs categories constitute the majority of the branded petrol stations and only a small percentage belongs to COCOs category (ICAP, 2015).

The large number of petrol stations in Greece is mainly attributed to the peculiar spatial nature of the country, which is dispersed into many inhabited islands, but also includes many remote mountainous communities. Given the above, it becomes apparent that the Greek oil companies can't easily control the retail segment of the market just by decreasing prices at the pump stations of their network as a response to increased local competition. Further, it is noteworthy that most of the petrol stations are located close to the Attica region and account for half of the total turnover of the relevant retail market. Beyond the petrol station operators, there is a small number of traders (roughly 2,000), known as resellers, who mainly sell heating gas oil directly to small final consumers (Fafaliou and Polemis, 2012).

The geographical position of each petrol station plays a particularly important role. Each petrol station has some features of geographical monopoly, which may allow it follow or precede on

pricing tactics, compared to the neighbouring petrol stations. In the oil marketing companies, Greek legislation forbids imposing a resale price of oil products from the petrol stations. An exception is the petrol stations that operate in the name of the same company.

The independent financial operation of each petrol station does not necessarily guarantee their survival in a difficult economic period, such as the present one. Several petrol stations have recently closed and the sector is already suffering the consequences of the prolonged recession, raising reasonable concerns for the potential indebtedness of numerous oil companies. It is worth mentioning that the number of petrol stations in Greece was 8,200 in early 2008, while this number decreased to 6,245 at the end of 2014.

The determination of oil product prices in the internal market

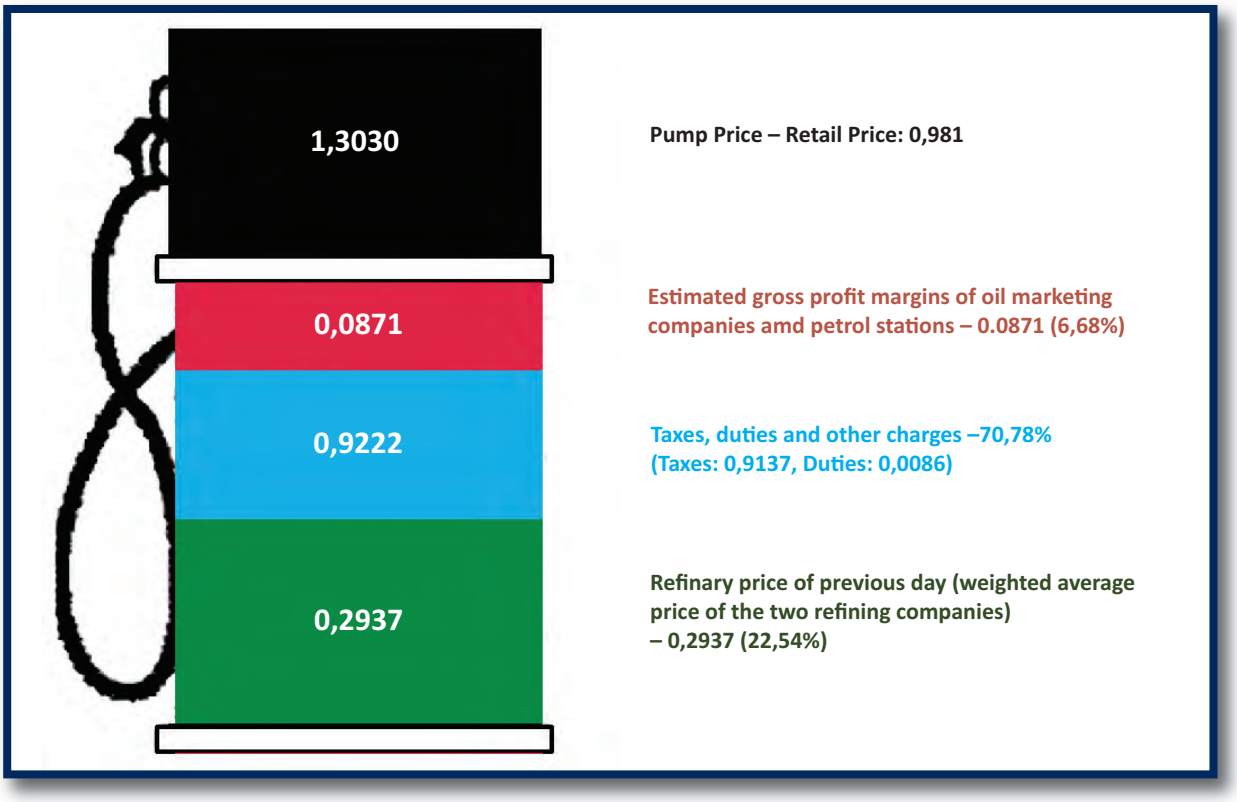
The pricing of petroleum products in the internal market takes place in three stages: from refinery to oil companies, from oil companies to the retail license holders (petrol stations and heating gas oil dealers) and to large end consumers, and from holders of retail licenses to end consumers. Fuel taxes in Greece, as in any other EU member state, are the most important part in the price formation. Taxes and duties include: **(a)** Special Consumption Tax (SCT *), **(b)** parafiscal tax**, and (c) the Value Added Tax (VAT***).

However, it should be mentioned that due to a number of factors, such as increased transportation costs, inadequate investments in the area of oil refineries and speculation through derivatives and other forms of futures contracts, there is an additional burden in the prices at which oil refineries buy crude. These prices are set in the international market, with small price deviations for each country globally. Hereafter, the price formation for Greek consumer starts, having already incorporated each kind of overcharges, speculations and distortions of international oil market.

The formation of retail prices of petroleum products in Greece consists of three main segments:

- the price at which petroleum products are sold at the refinery gate
- taxes and duties
- gross profit margins of oil marketing companies and petrol stations

Figure 2: Formation of average retail price of Eurosuper 95 in Greece (€/lt) – March 4, 2016



Source: Greek Ministry of Development and Competitiveness (2016)

* SCT's rate is a fixed amount for each fuel type and is expressed at €/1,000lt for petrol and heating gas oil.
* A tax levied on a specific product or service through which a government raises money for a specific purpose. The money raised is usually paid to a body other than the national tax authority.
* VAT's rate is defined by the sum of ex-refinery price and all the other tax burdens. It is noted that the reduced VAT rate was deprecated from 1/10/2015 for the islands Rhodes, Santorini, Mykonos, Naxos, Paros and Skiathos. The VAT rate is currently 23% from 2010 (ICAP, 2015).

As shown in Figure 2, taxes and duties and ex-refinery prices**** are the biggest contributors to the formation of domestic retail prices relative to the gross profit margins of oil marketing companies and petrol stations. In the case of Eurosuper 95, the amount of taxes and duties constituted the largest part of the final retail price at 1.30 €/lt on March 4, with a percentage of 70.8%, while the ex-refinery price and the gross profit margins of oil marketing companies and petrol stations contribute 22.5% and 6.7% respectively to the final retail price. As shown in Figure 3, Greece has the 8th most expensive retail price (including taxes) of Eurosuper 95 in the EU-28, higher than the EU-28 average price, which stood at 1.15 €/lt.

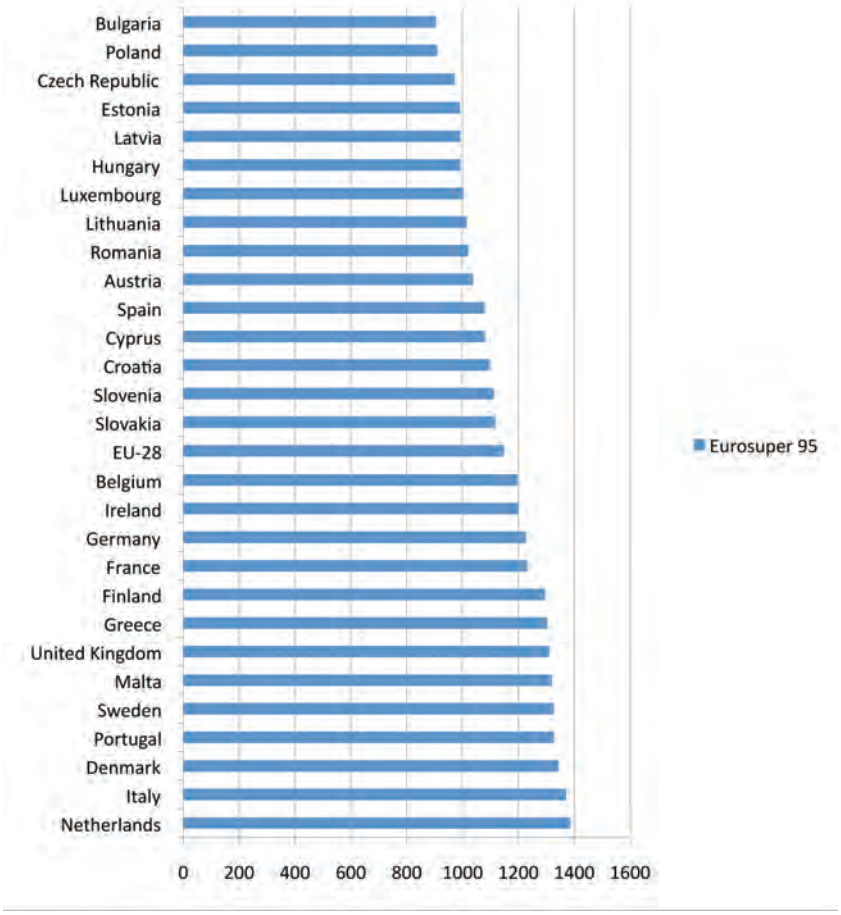


Figure 3: Eurosuper 95 (weekly prices €/1,000lt with taxes) – March 7, 2016

Source: ec.europa.eu

Similarly, in the case of automotive gas oil, the amount of taxes and duties constituted again the largest part of the final retail price at 0,981 €/lt on March 4, with a percentage of 53.2%, while the ex-refinery price and the gross profit margins of oil marketing companies and petrol stations contribute 35.8% and 11% respectively to the final retail price (*Figure 4*). As shown in *Figure 5*, Greece has the 19th most expensive retail price of automotive gas oil (including taxes) in the EU-28, lower than the EU-28 average price, which is 1.03 €/lt.

**** Ex-refinery price is the price payable by the oil marketing companies to the refining ones in order to get the petroleum products.

ENERGEAN
OIL & GAS

Company profile

Energean Oil & Gas is a private E&P company focused on Greece, the Adriatic, the East Mediterranean and on N. Africa, and is the only oil & gas producer in Greece with a 35-year track record of operating offshore and onshore oil & gas assets in environmentally sensitive areas.

The company has a balanced portfolio of assets with production from the Prinos and North Prinos oil fields in NE Greece, reserves of 30 million barrels (2P) audited by ERC Equipoise, 28 million barrels of contingent resources (2C) and significant exploration potential in the licenses held in Western Greece and Egypt, which provide the basis for future organic growth.

Energean holds a 100% working interest in the Prinos and South Kavala development areas within the Prinos Basin, offshore Northern Greece, in the Gulf of Kavala, where it produces oil & gas. It also holds a 100% working interest in the Ioannina onshore block, Western Greece, as well as a 60% working interest (Operator) in the Katakolo offshore block where oil and gas were discovered and tested in the ’80s.

The company has been selected as the Preferred Bidder for the Aitoloakarnania onshore block in Western Greece, while it has also submitted a bid for the Arta/Preveza onshore block of the same wider area.

Energean is also the Operator in the West Kom Ombo block, Upper Egypt, where it holds a 60% working interest, and it has also submitted bids for three blocks in the Adriatic, offshore Montenegro.

Energean has contributed more than 260 million euros to the national economy and the local society of Kavala and has created 140 new direct job positions and triple indirectly during the 8-year recession of the 2008-2015 period. Moreover, the company has invested over $300mm in the E&P sector during 2007-2015, helping new scientific and technical human force to emerge ahead of the upstream sector development in Greece’s new areas.

The company is executing a $200mm new investment programme for 2015-2018, aiming to increase production up to 10,000 barrels per day. The rig “Energean Force”, which was purchased from KCA Deutag and has undergone full refurbishment, is conducting the new drilling programme which consists of 15 wells at the Prinos, Epsilon and Prinos North oil fields. The investment programme is supported by Energean’s supply ship “Valiant Energy.

The company’s cash flow is supported by an off-take agreement with BP for the entire Prinos production. Energean’s assets are supported by established offshore and onshore infrastructure consisted of three offshore oil platforms, one gas platform and a comprehensive onshore plant with storage, offshore loading, de-sulphurisation and power generation facilities. This infrastructure network allows quick and low cost monetization of the reserves.

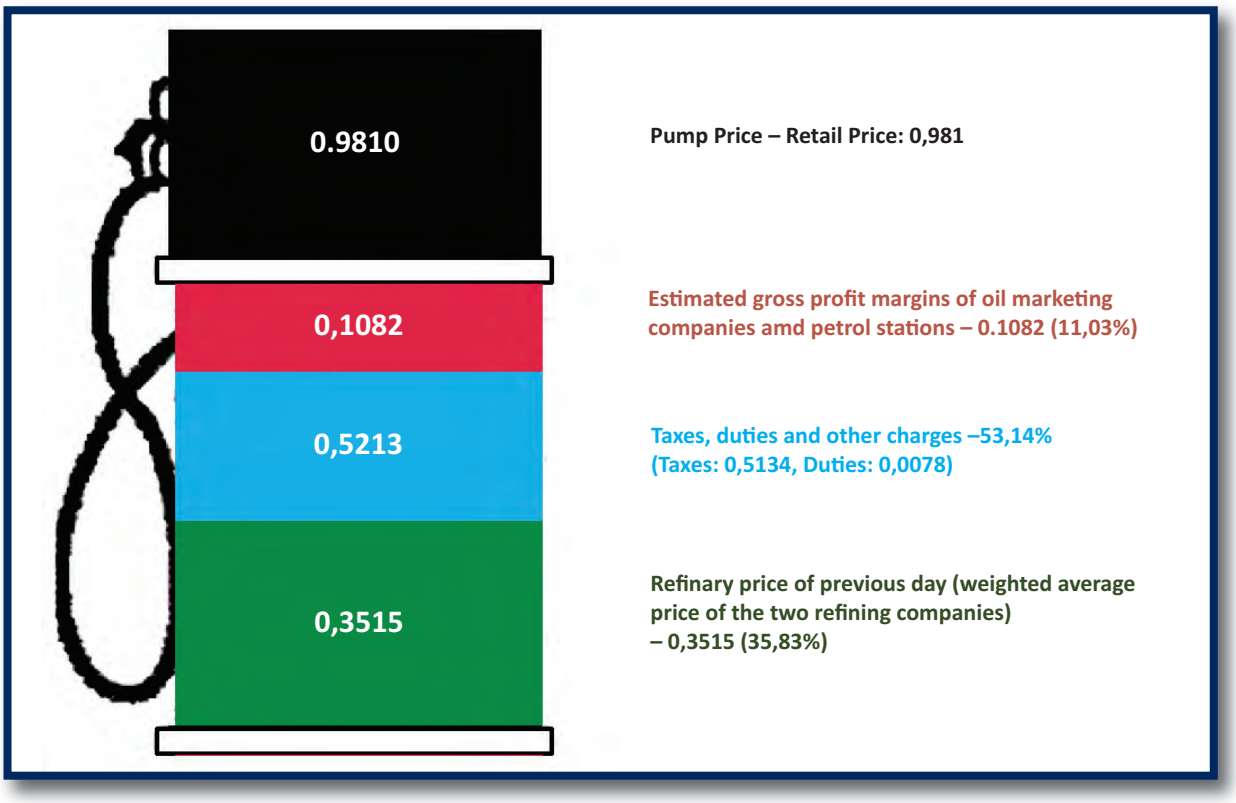


Figure 4: Formation of average retail price of automotive gas oil in Greece (€/lt)–March 4, 2016
Source: Greek Ministry of Development and Competitiveness (2016)

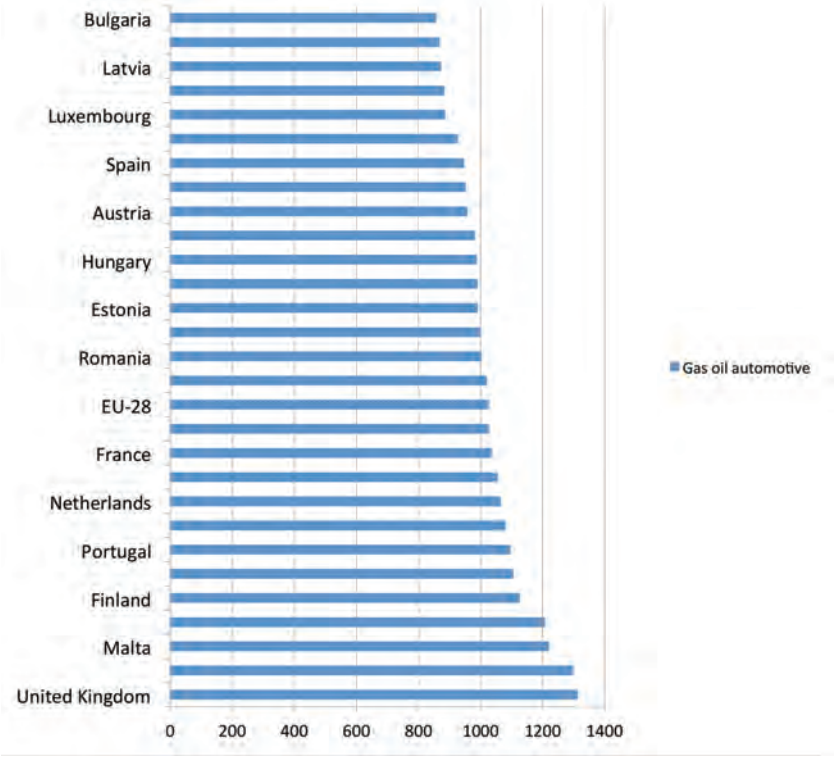


Figure 5: Automotive gas oil (weekly prices €/1,000lt with taxes) – March 7, 2016

Source: ec.europa.eu

The gross profit margins of oil marketing companies and petrol stations are not stable. They depend on several factors, such as: **(a)** the geographical location of the final point of sale and in turn the transportation costs that burden the company, **(b)** the volume of consumption per product, **(c)** the credit policy which the oil marketing company applies in the network of its petrol stations, **(d)** financial costs, **(e)** investment in equipment in petrol stations and **(f)** additional management costs (rental deposits), according to ICAP (2015).

According to Eurostat and Wood Mackenzie, fuel taxes contribute 6% to the total Greek tax revenues, while the taxes on fuels contribute on average 7% of EU member state tax revenues.

Retail market structure

Greece's oil market needs are served by two refining companies, Hellenic Petroleum (HELPE) and Motor Oil. The intermediate suppliers include wholesale oil companies (e.g. Avin Oil, Shell Hellas, Coral and Cyclon Hellas that are owned by Motor Oil, EKO and Hellenic Fuels which are owned by HELPE, Aegean Oil, MAMIDOIL JETOIL, Elinoil, Revoil, etc.) and the retailers (e.g. petrol stations). Almost all wholesale oil companies belong to the Hellenic Petroleum Marketing Companies Association (SEEPE) (see note at the end of the chapter).

HELPE's marketing business is based on its Greek subsidiaries EKO and Hellenic Fuels (former BP Hellas). The network of EKO is comprised of a total of 909 petrol stations, while Hellenic Fuels operate 800 petrol stations under the BP brand. The market share of the two subsidiaries improved significantly in 2015 for most of the products. In transport fuels, total market share exceeded 30% (HELPE, 2016). In 2016, HELPE Group agreed with the BP plc. the extension of the exclusive use of the BP brand for ground fuels in Greece until the end of 2020, with the possibility of further extension until the end of 2025.

Motor Oil is the only shareholder of Avin Oil following the purchase of 100% of its shares in March 2002, in the context of the company's listing of its shares on the Athens Stock Exchange. The acquisition of Avin Oil provided Motor Oil with a strong arm in the retail sector of fuels and lubricants since the acquired company ranked fourth among its competitors in the Greek market with a market share of approximately 10%. The retail network of Avin Oil comprises of 450 gas stations in Greece (Motor Oil, 2016). In June 2015, the retail fuel business of Cyclon Hellas (a network consisting of approximately 200 retail petrol stations throughout Greece) along with the related assets were transferred to Avin Oil by means of a share capital increase and subsequent amendment of Article 5 of the Memorandum and Articles of Association of the latter. The combined market share of Avin Oil (after the integration of the petrol stations under the Cyclon Hellas trademark) amounts to approximately 12%.

ICAP has estimated the market shares (based on quantity) of some of the major oil marketing companies in accordance with the main petroleum product type, and Tables 2-7 illustrate them. In 2014, it is estimated that Coral had the largest share (about 20%) in the gasoline market, followed by EKO (about 18%) and Hellenic Fuels (roughly 13%).

Companies	*Market shares*
Coral	*≈20%*
EKO	≈17%-18%
Hellenic Fuels	≈12%-13%
Aegean Oil	≈10%-11%
Avin Oil	*≈9%*
Revoil	*≈9%*
Elinoil	*≈7%*
Mamidoil Jetoil	*≈6%-7%*

Table 1: Shares of petroleum retail companies in the gasoline market (2014)
Source: ICAP (2015), based on market estimates

In the automotive gas oil market, EKO is estimated that it has the largest share (about 25%), followed by Coral (about 21%) and Avin Oil (roughly 13%). Similarly, in the heating gas oil market, EKO and Coral possess the highest shares (about 13% and 11%, respectively in 2014).

Companies	*Market shares*
EKO	≈24%-25%
Coral	≈20%-21%
Avin Oil	≈12%-13%
Hellenic Fuels	≈10%-11%
Elinoil	≈9%
Mamidoil Jetoil	≈9%
Revoil	≈7-8%

Table 2: Shares of petroleum retail companies in the automotive gas oil market (2014)
Source: ICAP (2015), based on market estimates

Companies	*Market shares*
EKO	≈12%-13%
Coral	≈10%-11%
Revoil	≈10%
Hellenic Fuels	≈8%-9%
Elinoil	≈8%-9%
Avin Oil	≈7%

Table 3: Shares of petroleum retail companies in the heating gas oil market (2014)
Source: ICAP (2015), based on market estimates

Companies	*Market shares*
EKO	≈19%
Elinoil	≈13%
Avin Oil	≈6%
Coral	≈2%-3%

Table 4: Shares of petroleum retail companies in the fuel oil market (2014)
Source: ICAP (2015), based on market estimates

Companies	*Market shares*
EKO	**≈38%-39%**
Shell & MOH Aviation Fuels	**≈34%**
Avin Oil	**≈2%-2.5%**

Table 5: Shares of petroleum retail companies in the aviation fuel market (2014)
Source: ICAP (2015), based on market estimates

Companies	*Market shares*
Petrogaz	**≈30%-31%**
Coral Gas	**≈28%-29%**
EKO	**≈14%**
FGAS EU	**≈6%**
Hellenic Fuels	**≈3%**

Table 6: Shares of petroleum retail companies in the LPG market (2014)
Source: ICAP (2015), based on market estimates

According to the information presented in the above tables, EKO holds the largest share (approximately 19%) in the fuel oil market as well as in the aviation fuel market (about 39%). To sum up, EKO has the largest share in 5 out of 7 markets (it also holds the largest share in the market of international marine bunkers) and LPG market is the only one where it takes the third place, with a market share of about 14%.

Regarding the volume of sales, Table 8 illustrates domestic demand figures per petroleum product category during the period between 2011 and 2015. The aggregate domestic demand, after a continuing fall up to 2013, stabilized in 2014 and increased in 2015, for the first time since 2006, reaching 12 million tonnes. The bulk of the rise of domestic demand is attributed to the increase of consumption of heating gas oil.

Product Category	2011	2012	2013	2014	2015
Lubricants	96	84	112	94	89
Asphalt	115	99	126	159	154
LPG	345	386	425	438	473
Aviation Fuels	1094	964	967	1074	1102
Gasoline	3311	2898	2670	2524	2458
Fuel Oil	4026	3265	3265	3097	2985
Gas oils/Diesels					
Heating Gas Oil	2837	1924	935	968	1389
Transport Diesel	2192	2352	2519	2635	2729
Bunker Gas Oil	917	537	540	563	630
Total	**14933**	**12940**	**11559**	**11552**	**12009**
% change y-o-y	-7,1%	-13,3%	-10,7%	-0,1%	3,9%

Table 7: Domestic demand figures, per product category in thousand tones (2011-2015)
Source: Motor Oil (2016), SEEPE (2016)

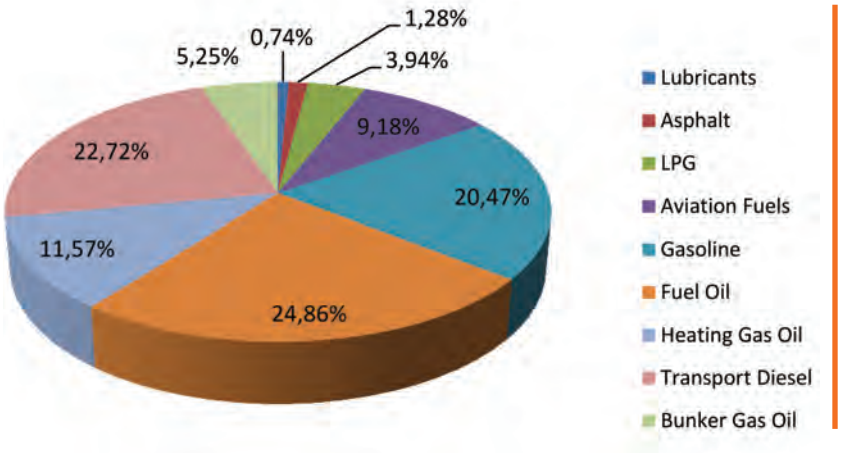


Figure 6: Greek retail oil market product breakdown, 2015

Source: Motor Oil (2016), SEEPE (2016)

Due to the increase of the Special Consumption Tax (SCT) applied on gasoline prices, an increase in the LPG consumption was noted as an alternative fuel for vehicles. The decrease in gasoline consumption started in 2010, following the increase of the SCT from 410 €/1,000lt to 670€/1,000lt and continues up until today because of the reduction of the disposable income combined with the increased number of new car registrations with diesel engine.

Part of the fall in gasoline demand was offset in 2013 and 2014 by the recovery of transport diesel consumption on the back of the reduction of the SCT, which was effected in 2012 (from 412 €/1,000lt to 330 €/1,000lt) as well as the decision by the Greek Government to lift the prohibition of diesel engine cars in the two major cities of Greece (i.e. Athens and Thessaloniki). In 2015, the increase of transport diesel consumption exceeded the decline of gasoline consumption (Motor Oil, 2016).

The SCT of heating gas oil was increased in 2011 from €21 to 60 €/1,000lt and to 330 €/1,000lt in 2012, leading to a sizable fall in heating gas oil consumption as households turned to alternative means for heating. In 2014, the SCT of heating gas oil was reduced to 230 €/1,000lt, a fact that contributed to a moderate increase of the consumption in 2014 and a sizeable increase in 2015.

The weakening demand for fuel oil is partly attributed to the recession of the domestic industrial sector as well as natural gas penetration.

Oil products	2010	2011	2012	2013	2014	2015
Super	112,822	64,834	38,211	16,519	4,289	2,662
Unleaded	3,422,408	3,119,072	2,829,437 2	2,580,832	2,495,740	2,349,848
Super unleaded 98/100	162,247	105,186	75,192	72,613	86,852	105,025
Heating gas oil	2,908,247	2,818,939	1,965,436	959,233	967,746	1,388,665
Automotive gas oil	2,488,048	2,188,854	2,185,909	2,298,541	2,441,950	2,513,318
Low-sulphur mazut	213,347	174,771	288,762	194,296	207,643	199,180
High-sulphur mazut	88,453	79,302	15,286	299	387	1,274
Total	**9,395,572**	**8,550,958**	**7,398,233**	**6,122,334**	**6,204,608**	**6,559,971**

Table 9: Consumption of oil products (in million tons per year) Source: Hellenic Statistical Authority (2016)

Difficulties in the Greek oil (retail) market

The Greek market of petroleum products has certain structural problems in the entire supply chain. For instance, the institutional framework needs significant improvement. Some of these problems are not directly related to the price formation in the short term, but make prices uncompetitive, as they distort market operation and limit competition.

To start with, customs procedures contain a strong degree of bureaucracy and a minimum level of automation. For instance, the requirement of physical presence of a customs official at the customs clearance of oil products from refineries to the domestic market limits the possibility of supply in non-working hours. The introduction of electronic monitoring of flows and random customs checks is expected to bring higher flexibility in the supply, with multiple benefits for the consumer. Meanwhile, total clearance at regular periods is technically feasible without any loss of revenues or revenue shortfall for the public.

Fuel smuggling is a major problem in Greece, with fiscal, social and environmental impacts. Fiscal due to significant revenue losses in taxes and duties, social due to the unfair competition it creates, and also environmental, since in most cases special-purpose fuels, such as marine oil, are used illegally, with negative effects on the environment and the health of citizens.

There are several ways of fuel smuggling: **(a)** use of heating gas oil in motor vehicles, **(b)** virtual display of a ship that is being loaded with fuel, while at the same time this does not occur, **(c)** delivery of smaller fuel quantities to a ship than the displayed ones, **(d)** counterfeit fuel exports and their replacement with water and **(e)** illegal fuel imports (Lois, 2015). Also, illegal proceeds from smuggling can easily be used for other illegal purposes and thus strengthen corruption phenomena.

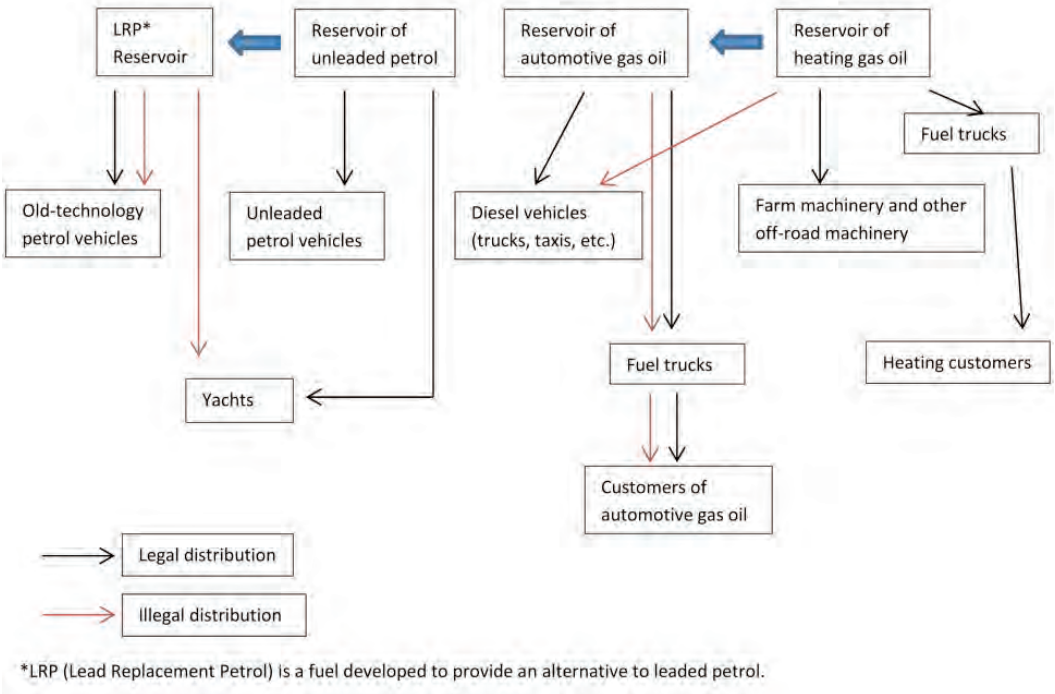


Figure 7: Description of fuel smuggling mechanism at retail level in Greece Source: Lois (2015)

SEEPE tried to estimate the revenue losses for the Greek government due to fuel smuggling through the implementation of three scenarios. It concluded that the revenue losses in 2014 were ranging from €125 million in the most conservative scenario, up to €300 million in the most extreme scenario, but the latter was estimated as unlikely. The most likely scenario led to the conclusion that the government losses were about €225 million the same year.

The immediate implementation of measures to eradicate fuel smuggling in Greece will increase significantly government revenues, contribute to the fight against corruption and strengthen the sense of justice. At the same time, the fuel market will be able to attract investment and bring development.

An important component of profiteering in Greece is fuel adulteration. More specifically, according to a survey conducted by the National Technical University in 2007, adulterated gasoline was available in 5.2% of petrol stations inspected in the Attica region. In Eurosuper 100, the fraud rate was almost 10%. Higher is the percentage of adulteration in diesel; stood at 10.3% for the Attica Basin, according to the same survey. The fuel adulteration takes place either at storage or transportation facilities or at petrol stations. Moreover, the case of oil theft is observed mainly in heating gas oil where in residential, commercial and industrial deliveries, all the quantity is not fully delivered (Mardas, 2014).

In view of its geographical position and the fact that Greece's economy has been severely affected due to recession over the last few years, the domestic oil market might emerge as a strong growth area in the coming years. SEEPE highlights that if there is a healthy competition environment, which would attract major international groups to invest in Greece, the value of these investments could even surpass the state revenues from the fight against fuel smuggling.

The restriction in the issuance of new vehicle registrations for private fuel trucks, the obligation that the oil marketing companies must hold a maximum number of fuel trucks separately per fuel type and the setting of tariffs in public fuel trucks by the State, all these further hinder the prospect of minimizing the cost of supply.

Furthermore, the lack of organized spatial planning and the often unjustified reactions of local communities to the installation of new storage facilities for oil products have emerged as a very substantial problem. The difficulties in developing storage facilities in different parts of the country do not allow improvement and rationalization of the distribution system of oil products for cost-effective and secure supply of the entire country.

Heating gas oil

The reduction of the SCT of heating gas oil is a common target of both the state and all stakeholders. The huge social problem created had a negative impact not only on households (some of them left without heating during the last two years), but also on the environment, since many Greek citizens used a variety of dangerous alternative heating fuels. The reason the government proceeded with the equation of the SCT between heating gas oil and automotive gas oil was to control smuggling. Apart from this, the government adopted a series of other measures. The fuel input - output system is undoubtedly the most important measure that will lead to a significant reduction of tax evasion and unfair competition. However, this system has not

been completed and as a result, it may not fully operate at all petrol stations but only in certain areas. Therefore, the completion in the operation of the fuel input - output system in all petrol stations and the implementation of all institutional measures are necessary conditions for reducing SCT.

Security of supply

Greece meets its stockholding obligation to the EU and the IEA by placing a stockholding obligation on oil industry. Importers of crude oil or oil products destined for the domestic market as well as large end-users (such as power plants) are required to hold oil stocks with a volume equalling 90 days of their net imports in the previous year. The supervision and control of compliance with the stockholding obligation is undertaken by the General Secretariat for Energy and Climate Change in the Greek Ministry of Environment and Energy.

Compulsory oil stocks in Greece are kept in emergency reserves storage tanks, which are required to meet specific standards. However, this does not mean that operational and/or commercial stocks must be kept separately. In practice, compulsory stocks are commingled with operational and/or commercial stocks. The certification of emergency reserves storage tanks is undertaken by the General Secretariat for Energy and Climate Change. Indicatively, in November 2015, the annual cost of maintaining emergency oil stocks in certified storage reservoirs reached an average of 64.18 €/1,000lt for storing gasoline, at 62.32 €/1,000lt for storing oil and 55.86 €/1,000lt for storing heavy fuel oil, also known as mazut.

Conclusion

The impact of the decline in international oil prices on the retail prices of petroleum products and the attempts at confronting current difficulties in the local retail market, such as the removal of distortions, are important factors, among others, for the development of the internal oil (retail) market. In addition, the tax policy in the fuel sector is another key factor, which is also important for fuel price formation, as any increase of the tax burden directly affects the demand of fuels. However, the severe liquidity problems in the Greek oil market, the reduced purchasing power of consumers and the projected low demand for fuels leave little optimism about the future of the industry.

About SEEPE

The Hellenic Petroleum Marketing Companies Association (SEEPE) has been operating since 1977 and represents 12 Petroleum Marketing Companies that distribute 90% of liquid fuels and other oil products of Greece and that employee, directly or indirectly, dozens of thousands of employees.
SEEPE's mission is the development of positions and the handling of issues referring to the smooth operation of the oil industry in Greece. The Association contributes with constructive and specialized advice and suggestions to organizations and the State.
Purpose

The main purpose of the Association is to inform its members of proposed changes in the legislation and to help form and advocate the industry's position.

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3. Natural Gas

Developing Greece's Natural Gas Market and the Role of DEPA as a Regional Player

By **THEODOROS KITSAKOS**, CEO, Public Gas Corporation (DEPA)

Amid a new and exciting political and economic environment, DEPA aims to extend the existing Greek gas market, as well as enhance the country's role as a bridge between three continents. The long-term challenge and goal for DEPA is to transform into a regional player through its participation in international projects that will help bring natural gas and energy security in the region. Naturally, this effort has to be based on a solid foundation. More specifically what the company has achieved so far in Greece can be summarized as follows:
Advancing the Greek market as a stepping stone

DEPA is now looking to remodel its commercial approach according to the country's current economic situation. This means a strategy that is customer-oriented, compatible to social needs, developmentally driven, contractually flexible and pricewise agile. At the same time, DEPA aims at an active management of its customer portfolio, a settlement of accumulated customer debt, as well as a broader operating field outside Greece.

Regarding the Greek market, DEPA is relying on a two-pronged strategy that includes the expansion of the pipeline grid, the transfer of CNG/LNG through trucks to western part of Greece and to remote areas.

For the period of 2016-2024, DEPA has set the following development milestones:

- supplying gas to 16 cities (prefecture capitals) plus some smaller remote cities and industrial areas, all located in the four (4) main regions of Greece, namely Eastern Macedonia-Thrace, Central Macedonia, Central Greece-Evia, Western Greece.
- The length of the new low pressure distribution networks and service lines to be constructed by the end of 2021 will be about 1300 km, in addition to the 450Km of the already existing network.
- The number of consumers expected to be served by the above network in the next 10 years is estimated as follows:

  - New Residential connections: 140.000
  - New Commercial connections: 19.000
  - New Industrial connections: 350

It should be noted that on 12/05/2016, the Economic Policy Council of Ministers of the Greek government, decided to include the distribution networks expansion projects in the regions of Eastern Macedonia-Thrace, Central Macedonia and Central Greece-Evia, within the list of the projects proposed to be financed by the "Junker plan" (see Investment Plan for Europe). However, a funding gap of around 74 mil € expected to be amended by the current PCA (Partnership and Cooperation Agreement) 2014-2021, still remains. DEPA believes that commencing the construction works during the second quarter of 2017 is a feasible task, provided that the project is assisted by the aforementioned financial subsidies.

Furthermore, DEPA's management recently met the Commissioner for Regional Policy, Corina Crețu, in Brussels, in order to discuss among others the expansion of the network through CNG and LNG in the Junker package as the project has already been approved by the Greek government. This investment, worth 280 million euros, has been included in the list comprised of the first 42 projects proposed for European funding.

DEPA expects that through this ambitious expansion plan, the anticipated new consumption for the next 15 years will be around 8 bcm, resulting in an average consumption increase of 0,7 to 0,8 bcm/year and a subsequent reduction of over 50 Ktons of emitted CO2. At the same time, more than 1.600 jobs are expected to be created during construction, whereas operating those networks requires at least 800 new permanent jobs. Midterm development includes the gas supply of new locations and regions (islands, Epirus, Western Macedonia etc). Adoption of innovative new techniques for supplying urban areas and individual consumers located far from the National Transmission System (eg Livadia, Karpenissi, Orestiada, Amfissa, Patras, scattered hotels, greenhouses and industrial units) are also to be introduced by using Compressed Natural Gas (CNG) and Liquefied Natural Gas (LNG).

Last, but not least, DEPA is continuing to advance the use of natural gas as a transportation fuel. During the first semester of 2016, consumption doubled compared to last year.

Active involvement in various international projects

The region of SE Europe is on the verge of becoming a hub for natural gas originating from Central Asia and, in the future, from areas such as the Eastern Mediterranean, Turkmenistan, even Iran. Given the importance of these new sources for the EU energy security and diversification of routes and supplies, existing and planned pipeline projects like the Southern Corridor and the IGB are critical for the needs of the countries of the region, especially in the Balkans, where Russian gas has been dominant so far.

It should be noted that DEPA is a significant stakeholder of the Southern Corridor as a buyer of Shah Deniz 2 gas and as a sponsor of IGB.

DEPA is a good example when it comes to the EU's energy security strategy. Since DEPA already imports natural gas through different sources such as Russia, Algeria and Turkey, it satisfies the major European criteria that call for at least three different suppliers in order for a market to have enough diversification. As for the future, DEPA is eyeing possible new imports of LNG from places such as the USA, Qatar and other markets. Together with upcoming pipeline projects, such as TAP, new and interesting supply opportunities are emerging that will shape the market in SE Europe and Greece in the following decade.

When it comes to the important pipeline projects in the region, DEPA and its partners in Bulgaria have made significant progress in the last few months for the realization of IGB, to interconnect the networks of the two countries. The IGB project is being developed by ICGB AD, a 50-50 joint venture between IGI Poseidon SA and Bulgarian Energy Holding. DEPA and Italian Edison each hold a 50% of IGI Poseidon's shares. The project has been designated as a PCI (Project of Common Interest) by Brussels and in May the first phase of the market test (the Expression of Interest phase) was concluded with nine non-binding Expressions of Interest received by ICGB AD. A total aggregate capacity of 4.3 bcm/y was requested for gas transportation services in firm forward mode from Greece to Bulgaria and approximately 1 bcm/y was requested for gas transportation services in firm reverse mode from Bulgaria to Greece during the Expressions of Interest Phase. Once the 2nd binding phase ends in early autumn and confirms the level of actual booked capacity, construction can start in the next year with first gas expected to flow in 2019.

During the ceremony for the commencement of the TAP pipeline in May, ministers and European officials underlined the importance of IGB, which will be linked to TAP in the future. The second phase of the market test is expected in June 2016, while talks are also in progress on the possibility of constructing an LNG terminal in Alexandroupoli, which will also contribute natural gas to IGB, further strengthening its position as an important regional project.The interconnector is expected to provide an alternative source of gas to NE Europe countries.

Another major project of interest for DEPA is the Eastern Mediterranean Pipeline, or EastMed. It is a long pipeline that will connect the recently discovered gas fields in the Levantine Basin in the Eastern Mediterranean with mainland Greece. IGI Poseidon recently received a grant of 2 million Euros from the EU CEF program in order to conduct pre-FEED studies for the project, which has also been designated as a PCI as it is expected to contribute greatly to European energy security. In June, IGI Poseidon SA signed a cooperation agreement with Noble Energy related to the finalization of the EastMed's Pre-FEED activities exploring the capability of the project to carry natural gas exports from major deposits discovered in the East Mediterranean region.

In the new era, DEPA engages skills, expertise and practices towards the efficient pursuit of international energy diplomacy. At the same time, DEPA considers the transportation and monetizing of the energy resources of the Eastern Mediterranean and neighbouring nations as a great opportunity, despite the inherent complexity and geopolitical risk of that particular region. The opening of a new Energy Corridor through East Med is fundamental for Europe's energy security providing source, route and supplier diversification.

Furthermore, DEPA aims to realize the Interconnector Greece-Italy (IGI Poseidon) (from the Thesprotia region in Greece to Otranto in Southern Italy), to be developed by the Greek company IGI Poseidon S.A., equally owned by DEPA and Italy's Edison. DEPA considers IGI Poseidon as a mature project, ready to take FID as soon as gas resources/routes are secured. IGI Poseidon may transport natural gas from Russia or alternatively from Iran, East Mediterranean, Middle East and/or Caspian areas (Kurdistan, Iran, Turkmenistan) to Italy and Europe.

It should also be noted that, in February 2016, DEPA, along with Gazprom and Edison, signed a memorandum for the construction of a pipeline from Russia to Italy through Greece. This project, is expected to incorporate existing work completed by DEPA and Edison for the IGI pipeline.

DEPA is also participating in the Poseidon Med project with the goal of expanding the use of natural gas as a shipping fuel. The project has already entered its second phase and DEPA plans to incorporate it to its own strategy for small-scale use of LNG in order for gas to reach remote regions and islands in Greece.

Contributing to economic growth and energy security

DEPA, as the largest natural gas importer and distributor in Greece, finds itself in a good position to take advantage of regional and international developments in order to upgrade its status. Its long-term strategy is compatible to European energy policy, since natural gas is considered a "bridge" fuel on the way to sustainability, while, at the same time, energy security calls for a multitude of different supply sources for any given market. The fact that both IGB and East Med have been assigned PCI status underscores this fact.
Since DEPA satisfies those criteria, it can proceed freely with its planning when it comes to expansion in the Greek market and international cooperation for ambitious pipeline projects. In this way, DEPA aims to contribute to Greek economic growth during a difficult time, but also to provide new solutions to consumers and neighbouring countries alike.

Theodoros Kitsakos was born in Athens in 1953. He holds a degree in Chemical Engineering and is specialized in Industrial Chemistry. During his 34-year successful international career (including 27 years within the British Petroleum Group), he has worked as Managing Director and Sales & Marketing Manager in Petrochemicals and in Industrial Chemistry. He has worked in Greece and abroad, more specifically, in Europe and Emerging markets (Turkey, Middle East, and Northern Africa). He also has an extensive experience as Project Leader of projects of international strategic importance in the energy sector. Moreover, Mr. Kitsakos is also specialized and actively involved (amongst other issues) in matters regarding geopolitics, energy diplomacy, research and management of hydrocarbons, as well as in oil and chemical industry. He is fluent in various languages. Mr. Kitsakos is married and has one son.

DESFA

Hellenic Gas Transmission System Operator S.A.

ACTIVE DEVELOPMENT POWER

DESFA (Hellenic Gas Transmission System Operator) was established on 30th of March 2007, following the provisions of Greek Law 3428/2005 on liberalization of the natural gas market, which incorporated the Directive 2003/55/EC in national law.

DESFA is 100% subsidiary company of DEPA S.A (Public Gas Corporation of Greece) and has a full and exclusive right to the operation, management, maintenance and development of the National Natural Gas System (NNGS) and Revithoussa Liquefied Natural Gas (LNG) terminal.

The LNG Terminal of Revithoussa was added to the system and commissioned in February 2000 to receive and store LNG and to vaporise and inject gas into the NNGTS. After its 2nd upgrade, which is in progress, the total storage capacity will increase from 130.000 to 225.000 m3 to the benefit of both competition and security of supply.

DESFA provides regulated services for the transmission of natural gas and a number of non-regulated services, such as cool down of LNG carriers and technical support for gas measuring devises.

DESFA, in order to meet current challenges in the energy market and meet its business goals, implements a new business strategy based on the following:

- **Efficient and effective Management of Assets and Liabilities**
- **Reduction of operational costs**
- **Enhancement of entrepreneurial extroversion and new markets penetration**
- **Personnel training**

DESFA, through its Corporate Social Responsibility (CSR) programme, goes beyond typical compliance with the spirit of the law; it pursues a harmonic cooperation with all its stakeholders, including consumers, em- ployees, investors and communities and aims to achieve a positive impact not only on the firm's interests, but on the social good, as well.

Overview of the Greek Natural Gas Market

By Dr. **GEORGE PAPARSENOS**, Energy Consultant, ex CEO DESFA

National Energy Strategy and Policies

For many years, Greece has not managed to define and introduce an "official" national energy strategy and energy policy that covers the entire energy system, including the natural gas sector, and the interactions with other non energy systems. The meaning of "official" is related to comprehensive, scientific analysis of the energy system, sponsored by the Government itself, involving public consultation and approval by the Greek Parliament. The objective of such national energy strategy and energy policy would have been the maximization of the net benefits of the Greek Economy, by prioritizing alternative strategies and policies, within the strategic energy framework and individual energy policies of the European Union and by observing all the legal commitments of Greece towards it and other international organizations. An obvious outcome of such maximization would have been to optimisse use of the natural gas in the Greek energy mix.

Basic directions and actions

However, accounting for the implementation of natural gas projects and various actions and measures in Greece during the last years, as well as for the statements, policy texts, studies, development and business plans, etc, issued by officials of the Government, as well as of public and private natural gas organizations and companies, basic directions and actions of natural gas strategy and policy in Greece could be configured. These directions and the associated actions, with different degrees of maturity and strong interaction among them, are as follows:

a) to cover the natural gas demand in Greece, under normal and emergency conditions

By increasing the transportation and distribution capacity of natural gas all over Greece, via physical or virtual pipelines

By expanding the use of natural gas in the land and water transport

By increasing the capacity at entry points, including the storage capacity and send-out capacity of the existing lng terminal at the island of Revithoussa, as well as the development of underground gas storage

By enhancing the rational operation of the National Natural Gas System (NNGS)

By developing the plans to deal with the security of natural gas supply as well as emergency situations of Greece

By securing natural gas supply contracts and affordable prices

By developing domestic natural gas production

b) to effectively liberalize the Greek natural gas market

By transposing the European Union legislation into the Greek legislation and effectively applying it

By developing and applying all the necessary secondary legislation in the form of codes, standard contracts, regulations, etc

By imposing on the Greek Public Gas Corporation (DEPA) auctions for the release of capacity at the pipeline entry points as well as of gas quantities held by DEPA

By further privatizing natural gas companies in which the state holds a majority stake

c) to contribute to the security of the natural gas supply of the Balkan region and the European Union, as well as to the rational operation of the respective natural gas markets

By participating in the development of gas interconnections with the neighboring countries with backhaul or reverse physical flow

By participating in large international gas transit projects and large regional gas interconnection projects

By upgrading the existing lng terminal and/or developing new lng terminals in Greece

By establishing Greece as a natural gas hub for the Balkan region

By participating in and contributing to the works of international or European Union collective organizations related to natural gas (e.g. IEA, ENTSOG)

Demand

Natural gas was first introduced in Greece in 1997. Following a period of growth, the natural gas consumption reached a peak of 4,6 bcma in 2011, representing then 14,3 % of gross inland energy consumption, which was much smaller than the respective average figure of 23,8% (2011) in the European Union. Since then, due mainly to the recent economic crisis in Greece, the natural gas consumption declined reaching 3,7 bcm in 2013 (13,3 % of gross inland energy consumption) and 2,8 bcma in 2014. It is expected that the consumption will recover and remain in the range of 3,4 to 3.8 bcma during the next decade (against 2012 estimations of 6,0 to 7,0 bcma).

The main driver of the natural gas consumption has been the power generation. Currently, twelve gas fired power stations are in operation and will remain so in the next decade, with total

installed electricity capacity of 5240,8 MW_e. The load factor of this capacity, which is currently very low, is highly dependent on the economic situation of the country and the particular policies implemented in the electricity sector. The remaining part of natural gas consumption has been more or less equally split between industry on the one hand and household, services and transport on the other hand. It is expected that this pattern will remain the same during the next decade with power production at the level of 56 % and the other two sectors at the level of 22 % each.

Supply

The domestic production has been negligible. Natural gas is currently imported through three entry points, according to the table below.

Entry point / Place	Type of Gas/ supplier, contracted volume in 2010, bcma / year of contract expiry	Annual imports in bcma / % of total importsd	Existing Technical Capacities in MNm³/d	Technical Capacities after the 2nd Expansion of Revithousa lng Terminal in MNm³/d
Sidirokastro/Greek-Bulgarian border station	pipeline gas from Russia/ Gazexport, **2,0** / 2026	I,62 – 2,70/ 54 – 66,9	10,8 (9,6[a])	10,8 (9,6[a])
Kipi/Greek-Turkish border station	pipeline gas from Azerbaijan via Turkey/ BOTAS, **0,71**/ 2021	0,58 –0,68/ 14,2 – 21,2	4,3 (2,3[b])	4,5 (2,3[b])
Agia Triada/ Revithousa island lng station	lng from Algeria/ Sonatrach, **0,68**/ 2021 and the lng spot market	0,56 -1,20[c]/ 15,3 – 29,3	12,5	19,2
Total		2,79-4,49/	27,6 (24,4)	34,5 (31,1)

GAS ENTRY POINTS TO GREECE

[a]Certified by the Bulgarian side
[b]Certified by the Turkish side
[c]respective values for DEPA only, 0,41– 0,86
[d]import figures for period 2010 - 2014

During the period from 2010 to 2014, the annual maximum daily consumption ranged from 16,8 (5.2.2014) to 22,3 MNm³/d (9.2.2012). During the next ten years, it is estimated that it will range from 16,1 (2016) to 20,4 MNm³/d (2025). The available technical capacities of the existing entry points, under normal conditions, secure, with a high degree of probability, the coverage of the annually maximum daily consumption in Greece, especially after the completion of the 2nd expansion of Revithousa LNG terminal (expected Dec. 2016), as shown in the table. The respective situation will further improve following the implementation (a) of planned investments by DESFA, the Greek TSO, in compression stations and (b) of transit pipelines through Greece, currently under construction or planning (e.g. TAP, IGB, etc) under normal or reverse flow mode. The table also reveals that restrictions imposed by the conditions of the gas networks of neighboring countries should be overcome.

Issues of security of gas supply

The dependence of Greece on imported Russian natural gas is high. The associated risk is even higher accounting for the supply of Greece with Russian gas through a feed pipeline that crosses the Ukranian territory. During the January 2009 and winter 2012 Russian gas supply crises due, respectively, to the Russian-Ukranian dispute and the harsh climatic conditions, the Greek gas system showed better resilience than in other countries in the region. Under the current conditions of the Bulgarian and Turkish gas systems, in a gas crisis, the two border entry points to Greece may become simultaneously unavailable. Since the time of latest crisis, the competent authorities, the Regulatory Authority for Energy (RAE) and DESFA have developed, respectively, a preventive action plan to enhance the security of supply of the country and a plan to respond to emergency situations. Greece should continue its efforts, within the European Union energy strategic framework, (a) to increase its gas system resilience in dealing with supply crisis by developing and promoting plans and actions on a regional and pan-European level, and (b) to diversify supply sources, routes and counterparts. In addition to the Caspian region and North Africa, Eastern Mediterranean, Irak and Iran provide new opportunities for diversification, in addition to lng spot markets.

DEPA held a monopoly on gas imports until May 2010 and continues to dominate imports. DEPA sources gas through long term contracts and spot lng purchases. According to the above table, the long term contracts cover a total of 3,4 bcma until 2021. Accounting for (a) the expected gas consumption during the next decade and afterwards, (b) the operation of lng spot markets in which DEPA and other shippers since May 2010 have been active, as well as (c) the additional pipeline imports that could be used to fill the gap between demand and supply under long term contracts, DEPA should examine to reduce the contracted annual volume of gas it imports from Russia. Such a reduction would also ease (a) DEPA from getting penalties for absorbed gas quantities which would have been smaller than certain threshold imposed by the take-or-pay type of contract and (b) the dependence of Greece on imported Russian gas.

Transit pipelines

Greece in interested in exploiting its geographical position and becoming a key transit country for gas to the Balkan and Southern Europe region. Several transit pipelines are currently at different stages of planning, design or implementation. The most advanced is the Trans Adriatic Pipeline (TAP) with a capacity from 10 to 20 bcma, which, crossing Greece and Albania, will bring Caspian gas to Italy, in 2020. The final investment decision has been taken in 2013 and preparatory activities for the construction of the pipeline are underway. The operation and management of the Greek section of TAP will be undertaken by DESFA according to an agreement between TAP and DESFA, signed in 2013. Other transit pipelines are: (a) Interconnector Turkey Greece Italy (ITGI) with gas possibly sourced from Iraq and Iran. All the technical studies of ITGI are completed. (b) EastMed with gas sourced from the Eastern Mediterranean basin (and possibly Greece, if the exploration programmes, planned or underway, in concession blocks, onshore and offshore, lead to gas production). It is at the stage of feasibility studies, (c) Southern European Pipeline (SEP,Turkish Pipeline) with Russian gas, which replaced the South Stream. Through a non binding agreement, interest was recently expressed by Russia and Greece for the SEP.

The transit pipelines should always be connected with the NNGS to provide Greece with further security of gas supply and more gas liquidity, which is an important step for the creation of a wholesale market and a gas hub in Greece. Additionally, they will feed the Interconnector Greece Bulgaria (IGB), a pipeline with transportation capacity of 3 to 5 bcm, that will enable the Greek gas market to physically and virtually link with the gas markets of Bulgaria, Romania, the western Balkans and the rest of Europe. Other gas sources for the IGB will be the existing Revithoussa lng terminal, especially after its current expansion, and the two lng terminals in northern Greece, sponsored by DEPA and GASTRADE, at the stage of design and permit issuing. The IGB is in advanced stage of design and the final investment decision is pending.

The interest of Greece in large pipeline and LNG gas projects in its region is backed by the prospects for the employment of Greek technical personnel and the involvement of companies with large capacity, in Greece, (a) in manufacturing onshore or offshore gas pipelines and other gas equipment (b) in providing services in design, construction, supervision and auditing of gas projects, as well as, in operation and maintenance of gas facilities.

Gas storage

Gas storage in Greece is currently limited to two tanks at the Revithoussa island LNG terminal with combined storage capacity of 130 thousand m^3 of LNG. This storage capacity covers about four days of peak demand (at 17,8 MNm^3). The increase of gas storage at the Revithoussa LNG terminal with a third tank of 95 thousand m^3 of LNG, by December 2016, will extend the period of peak demand coverage by 80 %, thus decisively strengthening the security of gas supply of the country, but will also contribute to the flexibility of the operation of the terminal and to the competition among gas shippers, as it will allow smaller shippers to make use of the terminal. However, undermining the above reasons for increasing the storage at Revithoussa LNG terminal, pressure will be exerted on DESFA to make allowance for some commercial use of the new LNG storage. Further pressure will be exerted on DESFA to make better use of its assets at the Revithoussa LNG terminal and provide new services, such as: (a) feeding virtual pipelines, that is, loading large LNG vehicles and small LNG vessels for isolated areas of the country (b) loading vessels with LNG as transport fuel or as cool down medium. Therefore, DESFA will have to address the issues (a) of splitting these services into regulated and non-regulated services and (b) of examining and, at a later stage, possibly taking a decision to (b1) further expand the LNG storage capacity at Revithoussa through an FSU or FSRU solution and/or (b2) participate in the conversion of the offshore field of Kavala into an underground gas storage, which will also operate.

The quality of the NNGS and its expansion

The increase of gas storage at the Revithoussa LNG terminal is part of a larger investment at the terminal, called 2nd expansion, which is currently at the construction phase (completion December 2016) and also includes:

- Send-out capacity increase from 1000 m^3 LNG/h to 1400 m^3 LNG/h (or from 5,1 bcma to 7,1 bcma) to cover (a) higher peaks, (b) disruptions of supply and hydraulic balance of the gas system
- LNG carriers capacity increase for allowing access to Revithoussa to almost all the carriers available

- Creation of conditions for (a) loading of large LNG vehicles and small LNG vessels for isolated areas (b) loading vessels with LNG as transport fuel or as cool down medium.

The 2nd expansion of Revithoussa LNG terminal is the last large project, according to the Development Plan of the NNGS, which is under construction.

The NNGS consists of 1459 Km of high pressure pipeline, the two border stations and the Revithoussa LNG terminal, six operation and maintenance centers and various other installations. The NNGS connects the three entry points with the large gas consumers and the EPAs gates. According to the independent technical due diligence of the NNGS, implemented in 2012 in the framework of privatization of DESFA, the NNGS is a state of art facility, with sophisticated design, constructed, operated and maintained according to the best practices and thus of low level of maintenance capex requirements.

There are regions in Greece (e.g. western Greece, Greek islands) that do not have access to natural gas. This is translated into fewer opportunities for their sustainable development in relation to areas of Greece with access to natural gas. To overcome this disadvantage, and accounting for the small and isolated loads that do not economically justify expansion of the NNGS though physical pipelines, more emphasis in the plans of DESFA, as well as of DEPA, is currently given to the development of virtual pipeline solutions, due also to the advancement of new micro-scale gas technologies. The application of new gas technologies holds also for other sectors (e.g. transport). In general, as stated in the previous section, new regulatory challenges arise

Legal framework

Greece is natural gas market is governed by the 2011 Gas Market Law (Law 4001/2011 and subsequent modifications) and secondary legislation. The law transposed the EU Directive 2009/73/EC into the Greek Legislation, and replaced Law 3428/2005, that had transposed previous EU directives. Among the key stipulations of the law are the effective unbundling of DESFA, the transmission system operator from DEPA, the major natural gas supplier; a fully regulated regime for third party access (TPA) to gas infrastructure; a regulatory governance system of the gas market; approval of all commercial agreements between DESFA and DEPA by RAE; approval of the Ten-year Development Plan for the National Natural Gas System by RAE. The plan is drafted annually by DESFA. RAE is also mandated to monitor and evaluate the implementation of the plan; public service obligations for the providers may be imposed by Ministerial Decree of the competent energy ministry. To be fully effective, the implementation of primary legislation (Gas Market Law) required secondary legislation. Following a long period in which the competent authorities (Energy Ministry, RAE) were highly inactive in promoting it, in April/May 2010 the secondary legislation was eventually introduced. The main pieces of the secondary legislation that allowed new gas shippers, in addition to DEPA, which was the sole user by then, to enter the Greek gas market, are as follows:

- The Code for the management of the NNGS, owned, operated and maintained by DESFA.
- The Standard Contracts between DESFA and a prospective shipper for the transmission of natural gas and the use of the facilities of the Revithoussa lng terminal
- The Regulation of Measurements at the NNGS

- The Regulation of tariffs of regulated short term services provided by DESFA
- The Natural Gas Supply License Code

Since then, the secondary legislation is revised periodically with the introduction of improvements (e.g. new tariff regulation based on the entry-exit model, virtual nomination point) and new services provided by DESFA (e.g. interruptible contracts for forward and backhaul flow), and the liberalized Greek gas market functions smoothly without problems, in accordance with the stipulations of the Greek Gas Market Law and the 3rd energy package of the European Union (e.g. DESFA has been certified as Independent Transmission Operator by RAE, a charge for the security of supply has been introduced after approval by RAE).

Challenges for creating wholesale market and cross border trade

However, the forthcoming application of pan European network codes on gas balancing (1/10/2015) and capacity allocation mechanisms (1/11/2015) in gas transmission systems will grove to be real test of competence for the Greek gas market and the main entities involved (RAE, DESFA, suppliers, etc), as new respective regimes are introduced, which are different from the existing ones. The new opportunities for cross border trade that arise offers several challenges, especially for new and small traders without balanced portfolio of supply contracts, and should therefore be carefully addressed and exploited. Additionally, the Greek state with the competent authorities (Energy Ministry, RAE, DESFA) and with strong cooperation with all the factors of the Greek gas market should take all the measures for the application of the basic directions of the European Gas Target Model, proposed by the Council of European Energy Regulators. These directions are as follows:

- Development of a functional gas wholesale market. Today, the transactions are based on bilateral contracts with physical delivery between the suppliers and the eligible customers
- Connection of the wholesale markets.
- Security of gas supply and viable investments

Significant steps towards the connection of the gas markets of Greece and Bulgaria have been: (a) the realization of physical reverse flow from Greece to Bulgaria at the border station Kula-Sidirokastro, with capacity of 1 MNm^3/d. Depending on investments on both sides of the border, the reverse flow capacity could further be increased. (b) the provisions of the Greek Code for the management of the NNGS for physical and backhaul reverse flow at uninterruptible and interruptible modes. However, the Interconnection Agreement, that could further improve the technical cooperation between the two transmission operators, has been pending for many years and the involvement of the European Commission seems to be necessary. Without any doubt, the realization of the IGB, will further contribute to the connection of the two markets. The case with Turkey, including the realization of reverse flow from Greece to Turkey, seems to be more difficult because Turkey does not abide by the European acquis and definitely the involvement of the Greek government and the European Commission to connect the wholesale markets of Greece and Turkey, according to the European rules, seems inevitable.

Competition

From May 2010 to May 2015, five new shippers, (two as independent suppliers, two as large

industrial consumers and one as power producer), imported to Greece a total of 1,75 bcm. This amount represents 9,5 % of the total imports of 18,5 bcm over the same period. All the imported gas by the new shippers was in the form of LNG, with a large range from 0,04 bcma (2013) to 0,48 bcma (2011), that reflect the fluctuation of the spot market LNG price against the pipeline gas import price in Greece. Since November 2012, the Greek Competition Authority imposed on DEPA regular auctions for the release of capacity at the pipeline entry points as well as of gas quantities held by DEPA (10 % of the total supplied quantity to clients). An official written assessment of the effectiveness of the particular measure has not yet been published. Unofficially, it has been known that (a) so far, there has been no response for the release of capacity. (b) so far, no gas supplier has participated in the gas release auctions. Instead, a number of 20 to 30 large consumers per auction have participated which contracted 35 – 40 % of the auctioned gas quantity. After July 2014, the latter figure has been improved following implementation of proposals made by RAE for the modification of the respective auction process. The measures of the Greek Competition Authority have not been successful regarding the increase of competition among suppliers. However, the gas release had a positive impact on the gas prices of the small number of participants in the auctions at the expense of DEPA profits. Additionally, the gas market seems to get accustomed to auctions, a tool well suited to the transparent and competitive operation of the markets.

Distribution

In order to develop distribution networks in the residential areas of the country and provide clients with natural gas, the Greek state instituted, established and operated three local distribution companies (EPAs) in the areas of Attici (Athens), Thessaloniki and Thessaly. The total number of connected consumers increased by 39 % from 2010 to 2014 and, according to the operational plans of EPAs, is expected to further increase by 33 % from 2014 to 2018. By exercising an exclusive right to form new EPAs and after an approval by the European Commission, DEPA extended the same model for three new EPAs in the areas of (a) Sterea Ellada and Evia, (b) Central Macedonia and (c) Eastern Macedonia and Thrace. The result of international tenders held in 2012 and 2013 was that no private company expressed interest in participating as investor in a new EPA.

In line with the EU legislation, EPAs were granted 30-year derogation from third party access in the concession areas. EPAs have so far been supplied exclusively with natural gas from DEPA up to a certain annual quantity, which, until now, has not been exceeded. Further to this, each residential, commercial and industrial consumer with annual consumption not exceeding 100 GWh (HHV) was exclusively supplied by the respective EPA. All the above restrictions on the right of a large number of consumers, including the EPAs themselves, to select the supplier of their choice, explain the limited presence of new shippers in the areas of EPAs. During the last three years (2012 - 2014), the accumulated consumption of gas in the three EPAs amounted to 1,64 bcm, but new shippers covered just a small portion of 4,9 %.

However, in the framework of the third agreement between the Greek government and its creditors (12 July 2015), law 4336/2015 amends the Gas Market Law by, up to 2018, gradually ceasing the above mentioned exclusive rights of DEPA and EPAs, unbundling the management of the gas distribution from the commercial activities, extending the right to select the gas supplier of their own choice to all customers and in general streamlining the Greek gas retail market with the principles of the 3rd energy package of the European Union.

End-user prices

The end-user prices in households and industry peaked in 2012. Since then, there has been a gradual reduction of these prices in 2013 and 2014. According to Eurostat, the reduction of prices was 21,6 % and 19 %, respectively, in households and industry, between 2012 and 2014. Such a positive outcome was caused from (a) the reduction of import prices DEPA achieved from the long term supply contracts after negotiations with Sonatrach and Gazprom (b) the reduction of transmission tariffs imposed by the New Tariff Regulation, which was put into force on 1/2/2013, and new arrangements in the Code for the management of the NNGS. The transmission tariffs reduction, which exceeded 35 % against the previous ones, was possible after the rational financial management of DESFA during the period 2010 – 2012, which led to annual operational savings of 17 million euro. Despite the mentioned reductions, the end-user prices in Greece in 2014 were still higher than the average respective prices in the European Union, by 11% and 27 %, in households (0,080 €/KWh in Greece against 0,072 €/KWh in EU-28) and industry (0,047 €/KWh in Greece against 0,037 €/KWh in EU-28), respectively. Especially in the case of industry, only Finland had higher end user prices than Greece. In the first semester of 2015, the import gas prices in Greece remained at the same level as at the respective period in 2014.

Industry structure and privatization

In practice, the gas sector remains dominated by DEPA (in wholesale and retail markets, trade and international projects) and its subsidiaries, DESFA (in natural gas transmission and LNG receipt, temporary storage and gasification) and the EPAs (in gas distribution). DEPA is 65 % owned by the Greek State and 35 % by Hellenic Petroleum. DEPA was founded in 1988 with the mission to introduce natural gas to Greece.

DESFA owns the gas transmission and LNG infrastructure and is responsible for its operation, maintenance, management and development. DESFA is 100 % owned by DEPA. DESFA was founded in 2007. Following the requirements of the 3rd energy package of the European Union, it has effectively been unbundled from DEPA according to the model of Independent Transmission Operator. Consequently, DESFA remains 100 % owned by DEPA, but will be subject to heavy regulation and permanent monitoring by RAE to ensure non discriminatory system operation. The adopted model of unbundling is very cumbersome, bureaucratic and expensive in comparison with the model of ownership unbundling.

DEPA holds a 51 % of the shares in each EPA. The 49 % of the shares is held by private companies or consortia of them that also manage the operation of EPA. A new structure of the gas retail market is expected up to 2018 as result of the application of the respective provisions of law 4336/2015.

As part of the privatization programme, adopted in June 2011, in the framework of the first agreement between the Greek government and its creditors, as a measure to reduce the heavy public debt, the State has pledged through a special purpose organization, the Hellenic Republic Asset Development Fund, (a) to sell all the stakes of DEPA, including those of the Hellenic Petroleum (b) to sell all the stakes of DESFA, including those of the Hellenic Petroleum, with the exception of 34 %, that will be held by the State (c) to develop the offshore field of Kavala as an underground gas storage. Both the sale of DEPA and the development of the offshore field of Kavala have been unsuccessful. Regarding the sale of DESFA, SOCAR, the Azeri state oil and

gas company, submitted a final binding offer on the 1/8/2013 to buy 66 % of DESFA shares against M€ 400. The acquisition of shares of DESFA by SOCAR is still pending awaiting the approval of the European Commission (General Directorate for Competition). The long process of disposing shares of DESFA reveals lack of appropriate preparation from the competent Greek authorities and, especially, ineffective handling of the respective issues from the European Commission.

Final remarks

Since April / May 2010, Greece has managed to adopt and apply successfully the 3rd energy package of the European Union to the Greek gas market. New shippers entered the gas market putting on end monopoly to DEPA's. The market not only operates smoothly but gradually incorporates also new improvements. This is in sharp contrast with what has happed in the Greek electricity market.

However new challenges arise for the near future: (i) The adoption and successful application of the basic directions of the Gas Target Model with the pan European codes and regulations for the creation of wholesale markets and cross border gas trade. All facets of the Greek gas market should adapt to the new conditions. (ii) The liberalization of the retail gas market that is the objective of the respective provisions of recent law 4336/2015. New business opportunities arise in combination with the electricity retail market.

Care should be given that (a) RAE is always staffed with qualified personnel, (b) the know-how and transfer of funds from international organizations, especially those of the European Union, be secured by active following and participation in their decisions making and works, and (c) all companies, public and private, extend their business plans to cover needs not only of the internal Greek gas market, which is small and will remain so in the next decade, but also of the respective markets of the regions surrounding Greece. This leads inevitably to a reorientation of the goals of these companies and to their restructuring.

The competent Ministry, in addition to the development of an "official" national energy strategy and energy policy, could play a decisive role if it (a) adopts meritocracy as a governing principle in selecting the management of the public organizations and companies and (b) facilitates their pursuit for effectiveness and efficiency through the improvement of laws, their organisation, operation and management .

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Meeting Security of Supply and Gas Market Integration Challenges in South Eastern Europe: and The Role of Greece

By **SPYROS PALEOYANNIS**, Energy Consultant, ex CEO, DEPA

There is no doubt that during the last years, South Eastern Europe has been at the center of European and international interest, mainly because of the ongoing developments in the energy sector.

Due to the proximity of the region to both traditional and alternative gas sources, nearly all gas transport routes to Europe, either under construction or under development, include many of the region's countries, and thus there is a strong possibility for one or two of them to become new gas hubs and/or gas gateways to Europe in the future.

From a purely geographical point of view, Turkey and Greece certainly have an advantage in such a scenario.

South Eastern Europe, as a significant energy consuming part of Europe, faces a number of realities and challenges as regards its future needs for natural gas, mainly connected with the supply-demand equation, energy security and sustainability, but also its market characteristics and vulnerabilities.

The adjacent countries of South Eastern Europe recognize the benefits of developing a strong base of interconnected gas infrastructure, thus establishing a regional energy integration that actually contributes to the enforcement of a European energy market. Momentum is building for South Eastern Europe to move into that direction.

However, despite the efforts to create a secure and competitive energy market in the region, gas markets still remain national, with little integration, limited cross border gas flows and trade and with no gas-to-gas competition at all, mainly due to the lack of sufficient gas interconnectors, LNG and UGS facilities. To complete the picture, the region is facing declining local gas production and high dependence on a single gas importer.

The above mentioned vulnerabilities have become more obvious in the course of the last years due to the consecutive crises in Ukraine, during which (especially the one in 2009) the interruption of Russian gas deliveries was extremely painful for a number of South Eastern European countries.

Nevertheless, due to low energy demand per capita and poor gasification status in many countries in the region, in the Balkans there is the potential for an increase of gas consumption in the future and thus South Eastern Europe represents an attractive market for both traditional and alternative gas suppliers. This reality also explains the intense and very often geopolitical competition between powerful players in the international arena.

In this environment, there are two significant gas transport projects currently under construction with pivotal strategic importance to South Eastern Europe:

- The Southern Corridor, dedicated to transport Azeri Gas to Europe and
- The TurkStream/Greek Stream, designed to transport Russian gas via Greece to Europe

The Southern Corridor is fully backed by the EU and US, with the Americans strongly opposing the second pipeline (TurkStream), simply because it is going to transport Russian gas.

Geopolitical competition aimed at increasing influence and control over gas sources, transport routes and markets is, of course, understandable.

However, from a regional gas consumer point of view, this competition has only limited meaning. The real interest and concern of the countries in South Eastern Europe is for each country to have at least three supply sources and transport routes available in order to enjoy a diverse gas supply portfolio (especially if it includes both pipeline gas and LNG) and thus an acceptable level of energy security. Moreover, with more than one supply option, gas consumers in the region would enjoy lower gas prices due to gas-to- gas competition in the regional market.

Greece has a realistic national energy strategy which also involves a regional dimension. This strategy is aimed at enhancing the country's and the region's energy security by diversifying gas supply sources and also by supporting any possible gas transport route to or through South Eastern Europe, as well as any available gas flows that may reach the region.

Spyros Paleoyannis was born in Greece in 1953. He is married and has two children. He holds a degree in chemistry and a Master in Business Administration with a specialization in strategic and energy management. Today he is an Independent Energy Consultant. In the past he has worked for years at Public Gas Corporation of Greece (DEPA) S.A. He joined the company upon its establishment in 1988 and has since held various high level managerial positions namely Head of the Company's Strategic Planning and Development Department (1991-1993), General Manager (1993-1996), General Director of Trading Division (1997-2004), Senior Advisor to CEO (2005-2009), Vice Chairman and Deputy CEO (2009-2013) and CEO (2014-2015). He has also been a non-executive member of the Board of Directors in DEPA's subsidiaries IGI Poseidon and ICGB EAD from 2010 till end 2015. He has also been a member of the Executive Committee of the International Group of Liquefied Natural Gas Importers (GIIGNL). In the past, he has been member of the Board of Directors of Public Petroleum Corporation of Greece (DEP) SA (today Hellenic Petroleum SA), General Manager in Asprofos Engineering SA, as well as senior executive in other enterprises of Greece's private and public sector. Also, in the period 2003-2009 he served as Deputy Chairman of the Institute of Energy for South East Europe (IENE).

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Overview of East Med Hydrocarbons Sector

PROGRESS ACHIEVED SO FAR AND FUTURE PROSPECTS

By Dr **CHARLES ELLINAS**, CEO, e-CNHC

Any hopes that 2016 will be better than 2015 for the hydrocarbons sector are being dashed by the lingering problems of global oversupply and weak demand.

In the East-Med 2016 will be dominated by the development of Zhor, and potentially the discovery of more gas, and the gyrations around the development of Leviathan.

Developments in Cyprus will be dominated by and revolve around the solution of the Cyprus problem (Cyprob). Indications are good and expectations are building up. Aphrodite, further drilling, gas exports depend on this.

1. The oil&gas industry

As a miserable year for the oil-industry came to a close, any relief oil companies might feel will be tempered by the knowledge that 2016 is shaping-up to be even worse. The consensus is that by the end of 2016 oil-prices may rise to $50 per barrel.

For oil&gas producers, 2016 will be a year of further cost-cutting, restructuring, refinancing when possible, and in some cases bankruptcy when it is not. In the East Med for companies that are exclusively focused on production and have weak balance-sheets, such as Noble, 2016 will be tough.

2016 might be even more difficult for gas-prices, with huge quantities of LNG coming into what is already an over-supplied market. Gas prices will stay low, hovering around $5-6 per mmBTU, making life for the LNG industry very difficult. With more new LNG still to come, this will persist well into the 2020s.

With the advent of shale oil and gas, renewables, energy efficiency and new technology, such as fracking and solar efficiency, there is a view that in terms of energy the world is entering an era of plenty. In addition the world is becoming more energy-efficient, needing significantly less energy per unit of GDP than it did 20 years ago and will need even less in the future. As a result, oil, gas and even coal prices will stay low for a long time. The message from the FLAME 2016 conference in Amsterdam was that low prices are here to stay[17].

The emphasis in East Med will be on production projects that have quick and healthy paybacks, such as Zhor, while limiting exploration and longer-term developments. For Cyprus this means deferring expensive drilling as long as possible.

Gas-producers in captive domestic markets, such as Egypt and Israel, will fare better as prices are less dependent on global oil&gas price factors. Turkey is almost completely dependent on imports, with the cheapest gas price being $10 per mmBTU. This makes it a viable market to export East Med gas provided Cyprob is solved!

2. Further drilling

Cyprus granted a two-year extension to ENI's lease of Blocks 2, 3 and 9, Fig. 1, but further drilling appears to have been left well into 2017. ENI's priority in 2016 will be appraisal and development of 850 bcm Zhor, Fig. 2.

Noble ended up selling half of its stake in Block 12, and Aphrodite, to BG on the cheap and with Shell, as owners of BG. They have relinquished the remainder of Block 12 in May, when the license expired, and will now concentrate of developing Aphrodite.

Total is faring better and is planning drilling in Block 11 late in 2016, with good prospects.

A third licensing round has been announced to include blocks 6, 8 and 10, see Fig. 1. It is expected that new licenses will be awarded early next year[1].

Fig. 1 Cyprus EEZ

3. Development of Zhor

This promises to be the East-Med's major highlight in 2016. ENI has already restarted drilling and, having negotiated good prices[2], it plans to embark on a fast-track development programme in 2016, with first gas expected end 2017.

Appraisal drilling is already confirming that Zhor is a giant reservoir[3] and it is likely to lead to the discovery of more gas beneath Zhor. There are also good indications that there is oil at greater depths, possibly extending into Cyprus EEZ, into Block 11, *Fig. 2*. This could more than justify Total's readiness to extend their lease by two more years.

Egypt will be at the center of East-Med oil&gas activities in 2016[4,5,6]. With the newly-negotiated gas-prices BP and other gas companies will be progressing exploration and development of their assets. 2016 may see the emergence of new gas-fields helping Egypt achieve its goals of

becoming self-sufficient by 2020 and to restart LNG exports by 2022.

Shell is expected to progress development of its already producing shale gas prospects in Egypt and, following completion of its acquisition of BG, we will know how it intends to operate in Egypt. Given the huge reduction in its 2015 profits, its decision to pull out of an Abu Dhabi project, shelf a gas project in Canada and let over 10,000 staff go, it looks difficult.

The fly-in-the-ointment may be Egypt's ability to pay the debt it owes the oil&gas companies and more recently to its LNG suppliers. If this problem goes unchecked it will affect Egypt's credibility. Combined with persistent terrorist threats it could affect further investment in 2016.

4. Development of Leviathan

Israel approved a gas regulatory framework agreement that embraces exports from Leviathan in May 2016[16] , after the High Court decision on 27 March[7] suspending it. The Court declared the stability clause in the agreement as unconstitutional, giving the government one year to sort it out, but leaving the remainder of the agreement intact. This issue has now been resolved[16] paving the way for development of Leviathan, *Fig. 2*.

Fig. 2 Zohr and other gas fields in East Med (c/o *The Economist*)

Despite news about Leviathan gas sales contracts with BG (now Shell) in Egypt, commercial and geopolitical challenges may thwart this, even as the ban by Egypt on gas import negotiations with Israel, following the ICC arbitration award[8], appears to be lifted. The main, and preferred, market for Leviathan gas will be Turkey.

The current negotiations between Turkey and Israel are expected to bear fruit and diplomatic relationships should be normalized in 2016, enabling negotiations for gas sales to proceed[9]. This would place Cyprus in a strong position as such a pipeline will have to pass through its EEZ[10]. It could also affect development of Aphrodite.

5. Cyprus and Aphrodite

The saga of exporting Aphrodite gas to Egypt will probably come to an end in 2016 challenged by the economics of low LNG and gas prices in Europe, which will last well into the 2020s. Then it will all depend on the progress of Cyprob, with the following possibilities:

No Cyprob solution: With the possibility of gas sales to Egypt gone and an LNG plant at Vasilikos being a long-term option, due to low prices, the only other options left may be FCNG or FLNG. But neither of these has been considered seriously so far despite their merits. So, 2016 may see development of Aphrodite back on the planning table, with gas exports receding well into the 2020s.

With Cyprob solution: First, there will be the 'minor' issue of setting up a federal system, and given that no preparation has been done for hydrocarbons much may be needed to arrive at a workable system. In the meanwhile, Israel and Turkey will progress subsea gas pipeline export negotiations more seriously in the knowledge that a deal with Cyprus may be possible[9]. Cyprus will then need to negotiate itself into the deal so that it can export Aphrodite gas to Turkey through the same pipeline, *Fig. 3*. Given Turkey's needs for alternatives to Russian gas, it could accommodate all gas Israel and Cyprus are able to export to it. And this could be as much as 25bcm per year for 20 years. What an incentive for Turkey to help solve Cyprob!

In the longer term, possibly well over ten-years, with more gas discoveries and a price recovery, LNG exports from Vasilikos may return as an option.

Fig. 3 Israel to Turkey gas pipeline

6. Cyprus and Israel

To unlock the above, Cyprus and Israel will also need to finally conclude their long-standing negotiations on the Unitization Agreement. Who knows, the prospect of gas sales contracts might help focus the minds in 2016!

Politically the recent Cyprus-Greece-Israel summit in Nicosia was a success[11], but the energy projects discussed are commercially challenging, with limited chances to materialize.

Referring to the energy sector Israel's Prime Minister Netanyahu stated that they agreed on developing a gas pipeline that will link the Israel and Cyprus hydrocarbon gas-fields to Greece and from there to Europe.

Even though this pipeline is included in EU's list of projects of common interest (PCI), it is a dream, some call it a pipedream, as by the time it delivers gas to Europe the cost would be double current gas prices.

There are compelling reasons to take the Cyprus-Israel relationship much closer and the summit contributed to this. The serious prospect of a solution of the Cyprus problem, Turkey's quest for alternative sources of gas, as a result of its deteriorating relationship with its main gas-supplier Russia, and the deteriorating situation in Syria, open up opportunities.

But Russia is not standing still and it has already expressed interest in strengthening its strategic links with Israel, including gas, which may undermine exports to Turkey[12].

7. East Med gas hub

Gas trading hubs are well established throughout western EU but elsewhere the concept is often misunderstood, especially around East Med.

A hub requires a deregulated gas market, where suppliers are free to produce or import energy and buyers are free to chose their suppliers, which is not the case today in East Med countries.

Cyprus is the only EU member-state in the East Med region, fully aligned to EU regulatory systems and has the potential in the longer-term, especially given its strategic geographic location, to become such a hub. Creating an East Med gas hub could benefit all countries of the region to better exploit their gas reserves. It is in EU's interests to support such a scheme. Clearly, the political benefits of cooperation in the energy sector would be immense for the East Med, which has always been characterized by inherent political fragility and tensions[13].

In an area fraught with geopolitical and gas export risks[14], longer-term regional cooperation is required to ensure the effective development of East Med hydrocarbon resources as a whole[15].

8. A need for realism

There is a need for realism and pragmatism throughout the eastern Mediterranean. If it is to secure export markets, then the development of East Med gas, whether in Egypt, Israel or Cyprus, will have to be competitive in a European gas price environment. And, faced with the ch-

allenge posed by the arrival of US LNG, it will have to meet some tough time schedules as well.

There are opportunities for the region to export its gas, but not at any price and at any time! Sooner than later East Med and Cyprus will have to face and meet commercial realities if they are to succeed.

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Charles Ellinas. Over 35 years experience in the oil & gas sector in senior management positions. Currently CEO of e-CNHC (E-C Natural Hydrocarbons Company), providing management and advisory services in the oil & gas and energy sectors in Cyprus. A lot needs to be done and the aim of the company is to contribute to the successful development of these sectors for the future of Cyprus. Prior to this, as CEO of KRETYK was responsible for implementing Cyprus government's strategy for the development of its hydrocarbons sector. Until 2012 he was a Director of Mott MacDonald and the Managing Director of Mott MacDonald's Oil, Gas & Petrochemicals business world-wide.

Strengthening Energy Security in Greece and the Region: The Alexandroupolis FSRU Terminal

The Greek Energy Company GASTRADE S.A. is developing an offshore LNG Floating Storage & Regasification Terminal together with a pipeline connecting the terminal to the Greek National Natural Gas Transmission System NNGTS.

The natural gas stored and re-gasified on the floating unit, will be transmitted trough the pipeline system for consumption in the markets of Greece and the South Eastern European countries.

The Alexandroupolis LNG FSRU project constitutes a new natural gas entry point into Greece and a gateway to the European markets, in particular the markets of SE Europe, such as Bulgaria, Romania, Serbia, FYROM and further Hungary and Ukraine.

An LNG FSRU similar to the one to be used for the Alexandroupolis Floating LNG terminal

Technical and Economic Characteristics

The main technical and economic characteristics of the project are as follows:

The project will be located in the sea of Thrace, 17,6 km southwest of the town of Alexandroupolis in northeastern Greece. (see map)

The storage capacity on the floating unit will be of 170.000 m^3 LNG and the project's sustainable gas send-out capacity of 6,1 bcm p.a. Total pipeline length is 28 km of which 24 km subsea and 4 km onshore. The system connects to the NNGS through an M/R station to be operated by DESFA (the Greek Transmission System Operator).
The project's total investment cost is estimated at € 380 mil.

Project Description - Highlights

- The project feeds into the Greek National gas transmission system (NNGS) and to the Greek market, hence enhancing the National Security of Supply and offering alternative supply options to Greek consumers and competitive cost.

- Furthermore it offers direct access and a new gas supply route to Bulgaria and onwards to Romania, Serbia, FYROM and further to Hungary and the Eastern European gas markets all the way to Ukraine, through the Interconnector Greece – Bulgaria (IGB) and the other regional interconnectors (e.g. Bulgaria – Romania, Bulgaria – Serbia, Bulgaria – FYROM, Romania – Hungary, etc.) which are either in operation or planned as part of the European Gas Network Interconnections System. Clearly, the project interrelates and complements IGB supporting its viability and operationality.

- To this extent, the project offers supply diversification, enhances energy security, introduces new pricing methodology and promotes competition in the SE European markets.

- The project will be able to link, feed into, support and provide alternative supply to the future South Corridor Gas Projects (Trans Adriatic Pipeline - TAP) and access the Western European Markets and the West Balkans Gas Ring, hence supporting the South Corridor strategic initiative. Hence there are positive synergies between TAP and the Alexandroupolis LNG project.

- The Alexandroupolis LNG-FSRU project has the potential to supply the large and fast growing Turkish market

The project is strategically located to supply the Balkan countries through the IGB pipeline and other European countries through TAP. For these reasons it attracts the interest of both new LNG producers such as the U.S. and the East Med (Israel, Cyprus) and existing ones such as Qatar, Egypt, Algeria, etc.

The location of the Alexandroupolis LNG Floating terminal is convenien for accessing the regional gas markets

The project also supports the Vertical South-North gas corridor in SE Europe, linking the Aegean to the markets of Central Europe via the Interconnectors Greece-Bulgaria, Bulgaria-Romania and Romania-Hungary.

The project's geopolitical importance has grown as a result of the Ukraine crisis, the cancellation of the South Stream pipeline and Russia's decision to discontinue transit flows through Ukraine as of 2019, which has raised the level of concern within the E.U. with regards to the energy security and the uninterrupted gas supply of European markets, especially of those which lack alternative supply sources and routes, such as the countries of SE Europe.

In this context, the project has been nominated as one of the 27 most critical projects for the European Supply Security Strategy (DG Energy, 28.05.2014), has been included in the CESEC initiative conditional priority list and contributes to the main corridor of gas supply to SE Europe from Greece to the North identified within the recent LNG and storage strategy prepared by the European Commission.

The project enjoys the support of the local communities and is being developed with consideration to local and national sensitivities, safety and in line with the strictest environmental standards (Environmental and Safety (SEVESO II) licenses obtained).

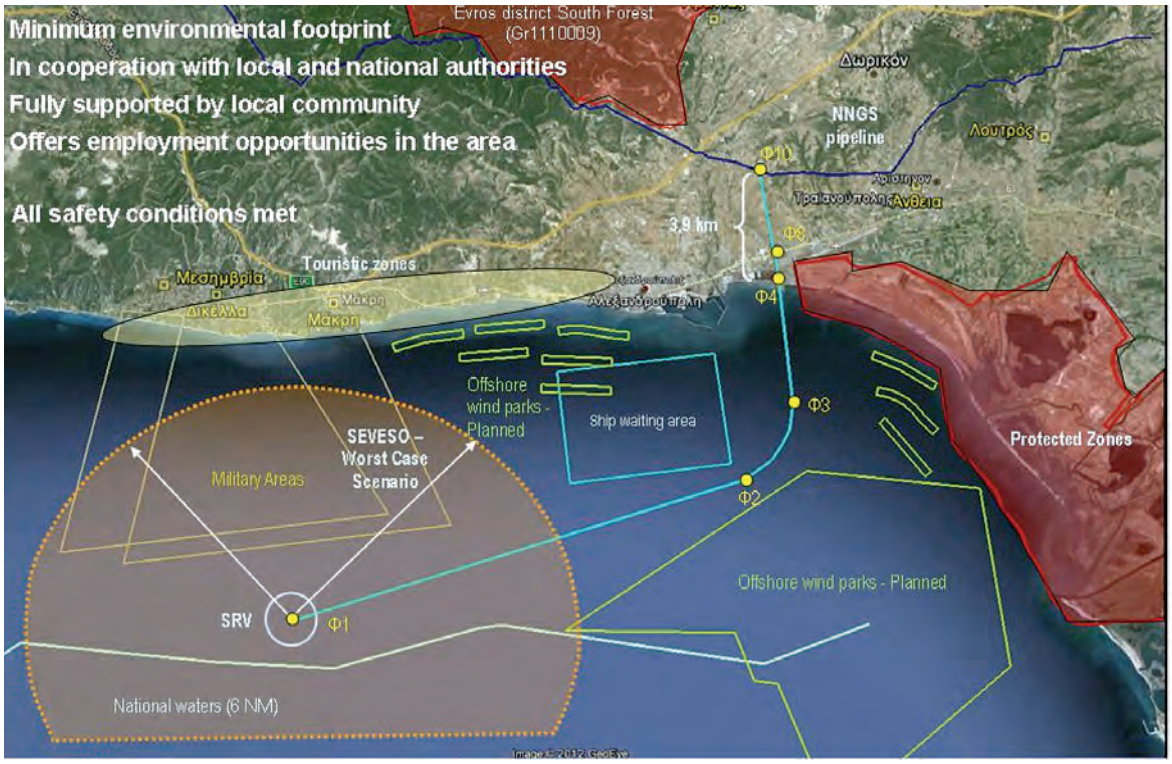
The Alexandroupolis Floating LNG terminal ensures direct access to Greece's national gas transmission system and easy access to regional interconnectors

It considerably upgrades the economy of the area of Alexandroupolis supporting the local labor market and economic activities in a wide range of sectors. At national level, the project supports the creation of a regional energy hub, promotes national security and contributes to the national economy.

Licensing

The licensing process for the project commenced in December 2010 and was fully concluded in January 2015. The LNG Alexandroupolis Project has received all the required licenses including:

- The Independent Natural Gas System license (Feasibility License)
- The approval of SEVESO II study
- The approval of ESIA and the issuance of the relevant Environmental terms
- The granting of access rights to the Shore, Sea bed and Sea area
- The issuance of the Installation Act
- The Installation license



The position of the Alexandroupolis FSRU complies fully with all environmental regulations

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The Project is ready to commence construction

The project renewed its PCI (Project of Common Interest) status from E.C. (reg. 347/2013) for the period 2015-2017 which besides maintaining its status of high strategic priority for the European Union, makes it eligible for grants and favorable financing tools and terms from the EU controlled I.F.Is such as EIB and EBRD. The project has received already grants for studies from the Connecting Europe Facility (CEF) for the performance of the FEED and the preparation of the EPC dossier.

The project is also included in the list to be considered for 2014-2020 NSRF (ESPA) which allows for additional state aid from National and EU funds

The project can be the earliest available alternative supply infrastructure in the region, ahead of any other planned project in the region.

The commercial operation of the project can start as early as in 3Q2018.

Note: GASTRADE is the Project Promoter, License Owner, Project Developer and Project Operator. GASTRADE is not involved in the actual trading (supply and/or marketing) of gas which enters/exits the Terminal.

Natural gas as a driver for growth of the Greek economy

Due to the developmental policy of DEPA, natural gas has become easily accessible for enterprises, industries, residential consumers, services and bodies. By providing reliable, quality and low-cost services to consumers and implementing an ambitious but also realistic investment plan, DEPA has become the leader in the natural gas sector.

With the help of infrastructure works and international partnerships with the biggest representatives of the sector, such as Gazprom, BOTAS, and Sonatrach, it has ensured the long-term and secure supply of the country. Its participation and support in the construction of interconnectors – IGI (Greece – Italy), East Med (Eastern Mediterranean), IGB (Greece – Bulgaria) – and the floating Aegean LNG terminal constitute investments of strategic importance which reflect the Group's vision for substantial contribution to the competitiveness of Greece.

DEPA responds to the challenges of a continuously changing environment and successfully continues the implementation of its operational program which includes:

- **the expansion of the natural gas networks** and **the development of CNG/LNG satellite systems** for the supply of remote areas, islands and individual consumers;
- **the establishment of station infrastructure** for vehicle fueling;
- **the expansion of international co-operations** for the supply of natural gas at low prices in Greece and the upgrading of secure supply.

Natural gas

Natural gas has won the trust of residential and business consumers, which is shown in the continuously increased use by **households**, **enterprises** (industries, manufacturers', hotels, restaurants etc), **public services** and **private** and **public vehicles**. Safe, more affordable by 40%-70% compared to other fuels, clean and easy-to-use, it can be used for heating and air conditioning, hot water supply and cooking, while it also offers autonomy to users as it is available 24h/day and is accurately billed based on individual consumption. Natural gas has also been gaining ground in transportation both in private cars and the preferences of enterprises for their commercial fleets, mass transportation means and taxis.

"Green fuel" is moreover the basic promotion tool of the European target 20/20/20 for the environment.

Natural gas is the basic energy choice for industries with direct and indirect thermal needs, improving the units' competitive position. The use of natural gas in the **industrial sector** contributes to the decrease in the operational cost for fuel management; it improves the quality of products; and restricts environmental pollution. In Greece, the total percentage of using natural gas in the industry, in areas where there is no network, is close to or/and exceeds 90%.

Natural gas is fast penetrating the power generation sector after the deregulation of the **electricity** and natural gas markets. The combined cycle and electricity-heat cogeneration plants make the best possible choice both in terms of energy saving and generation cost and environmental impacts.

Natural gas is considered by scientific institutes in Europe and North America the safest fuel while it contributes to the growth economy as it is a competitive fuel, whose use offers opportunities for entrepreneurship development. By introducing natural gas in the energy balance, employment opportunities, with emphasis in specialization in specific sectors, have been established and are expected to further expand.

Gas-powered driving

Individuals and professional drivers enjoy the advantages of affordable and ecological transportation. Low pollutant emissions of the "green" fuel and cost saving, over 50%, are the basic incentives to use natural gas in personal and professional transportation.

According to recent studies, companies, in Greece and abroad, using **professional fleets** (passenger cars, light/heavy trucks etc) reduce their expenses by using natural gas (CNG) up to 66%. For the same reasons, the number of gas-powered **taxis** in Athens and Thessaloniki, **public buses** (OSY) (currently more than 600), **refuse collection trucks** of Attica municipalities (more than 110) and of course **passenger cars**, as most big car industries have launched makes with natural gas engines, is on the increase.

DEPA's contribution in the development of gas-powered driving is of decisive importance as, upon the conclusion of the institutional framework (stations' operation, conversion of gas/petrol driven vehicles into duel fuel vehicles), it is the first one to invest on the effort of developing a network with fueling stations. Many natural gas stations, with the trade name FISIKON, are currently providing services for the vehicles in the biggest Greek cities and the Athens-Lamia-Thessaloniki road axis, while a big number of such stations is either in the licensing phase or under construction. DEPA, wishing to further contribute to the development of gas-powered driving, is participating in subsidy programs for buying commercial gas-powered vehicles, available by the biggest car dealers in Greece.

The advantages of gas-powered driving

The following are included in the main advantages of the green fuel:

- **Low cost:** The global average for the fuel cost shows that driving a gas-powered vehicle achieves over 50% saving compared to a vehicle using gas and 30% saving compared to a vehicle using petrol.
- **Energy saving:** A kilo of Natural Gas contains much more energy compared to a liter of all other liquid fuels. More specifically, 1 kilo of natural gas used as fuel is energy equivalent to 1.5 liters of gas, 1.3 liters of petrol and 2 liters of liquefied petroleum gas.
- **Environmental friendly:** The use of natural gas emits -25% CO2, -35% microparticles, -75% aromatic hydrocarbons and -53% nitrogen oxides (NOx) compared to unleaded petrol.

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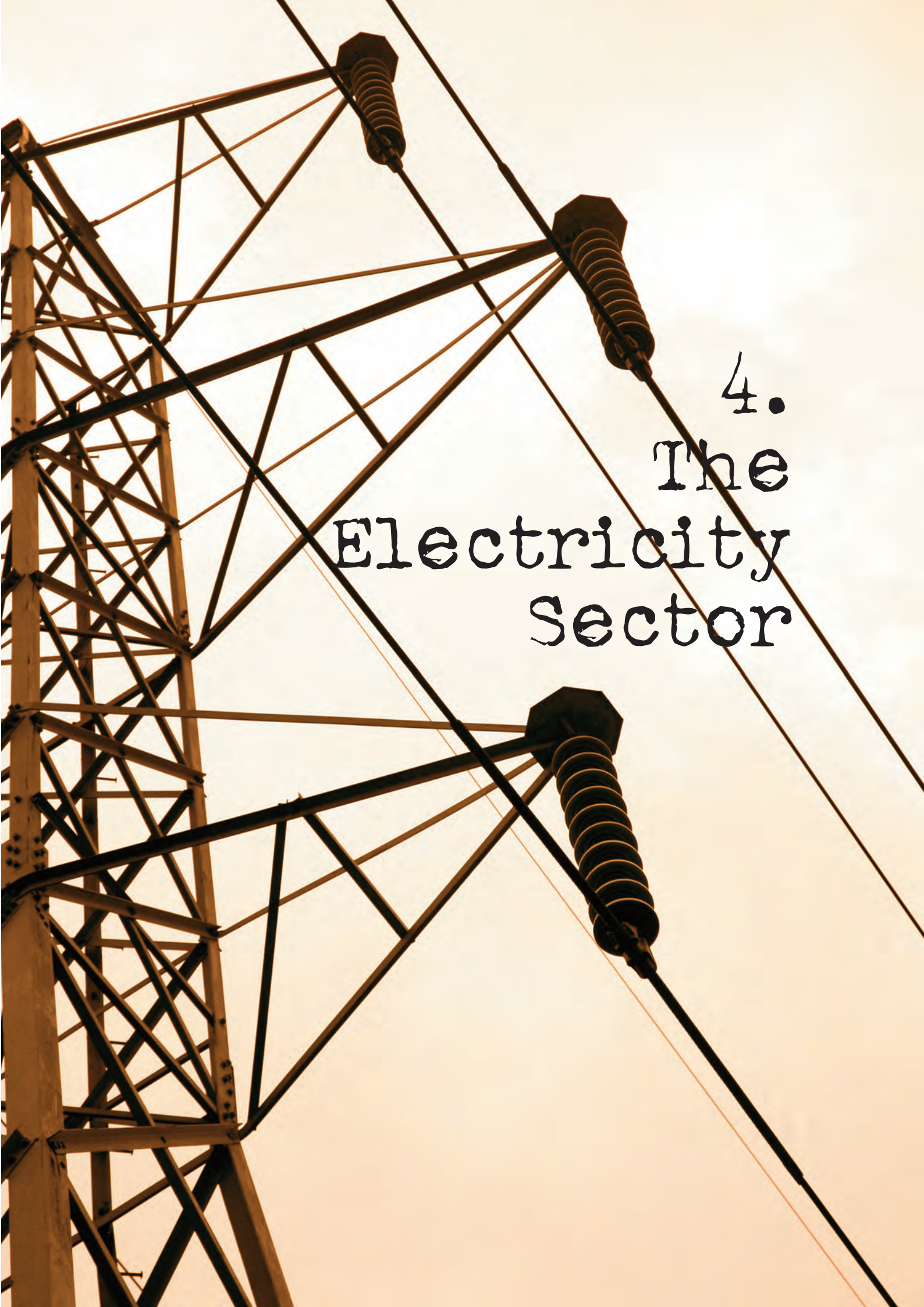


4. The Electricity Sector

The Greek Electricity Market

By **TASOS MASTRAPAS**, Research Associate, IENE

Market Structure and Entities

Until recent Greece's electricity market was a monopoly with the Public Power Corporation (PPC), a fully owned state company being the incumbent having full central of power generation, transmission and distribution. This situation to change in the early part of the first decade of the 21st century. Two fundamental changes accused between 2000 and 2005. Firstly a new legal framework was introduced in line with EU directives aiming to unbundle market operation but also to secondly PPC was listed in the Athens Exchange in the subsequent flotations so that the management structure slightly changed while much greater transparency and accountability was introduced liberalize to electricity market and this create competition. A number of new entities were farmed such the Regulator, the Transmission System Operation and Market Operator which fully describe below.

The Greek electricity market liberalisation framework was introduced by law was set with the law L.2773/1999. Market liberalization means the introduction of competition into specific market segments. Electricity production and supply (retail market) activities were considered appropriate to operate in a competitive environment, so that the consumer benefits from competition. In contrast, the market for electricity transmission services was assessed as a natural monopoly, as it is not economically advantageous to build additional networks and therefore the involvement of several companies was deemed unnecessary at that time.

Participants in the newly created market environment, include companies that have received production, supply or trading license and exercise the corresponding activity. Market players "meet" every day in the wholesale market, in which the producers participate in order to sell electricity, while suppliers intend to buy energy for covering their customers' needs. Consumers are free to choose the company that will supply them electricity.

The bodies that have been created, so that the proper market operation is achieved, include the Regulator (RAE), the Transmission System Operator (ADMIE), the Distribution Network Operator (DEDDHE) as well as the Market Operator (LAGIE).

RAE: The Regulatory Authority for Energy (RAE) is an independent administrative authority, which was established on the basis of the provisions of L. 2773/1999, which were introduced within the framework of the harmonization of the Hellenic Law to the provisions of Directive 96/92/EC for the liberalization of the electricity market. Its main responsibility is to supervise the domestic energy market, ensuring among others the fair and efficient operation of the elec-

tricity sector. It determines or approves the rules of the electricity market and investigates suspected cases of abuse and market manipulation. RAE also sets the prices for the services provided in the non-competitive market segments.

The role of RAE was upgraded from 2011 onwards, by strengthening its decision-making powers regarding the regulation of electricity and gas markets. This development was in line with the Third European Energy Package, which empowers the national energy regulators as "guarantors" of well-functioning energy markets.

From February 2012 onwards, an ITO (Independent Transmission Operator) model (as opposed to an ISO) was adopted for the Greek market and this implied the re-structuring of the former TSO into two discrete entities:

a. The Electricity System Operator (**ADMIE**), which owns the network, as a subsidiary of PPC, and conducts the real time dispatch, the clearing of **the imbalance market** and the settlement of all other charges or payments. ADMIE, which was established under L.4001 / 2011, is also responsible for the operation, maintenance and development of the national Transmission System, ensuring the country's supply of electricity in a safe, efficient and reliable way. In 2012, the Regulatory Authority for Energy (RAE) certified ADMIE SA as the independent power transmission system operator.

b. The Market Operator (**LAGIE**), also founded by N.4001 / 2011, operates the day-ahead market, conducts its clearing, and establishes into contracts with renewable producers. From whom it buys all electricity produced on a priority basis. The total volume of the electricity produced and imported is sold to LAGIE. Subsequently, the electricity suppliers buy electricity from LAGIE and then resell it to the final consumer. The Market Operator maintains also the register of Market Participants.

DEDDIE: The Distribution Network Operator was established in 2011, as a 100% subsidiary of PPC. The distribution network ownership remained with PPC, although its operation was assigned to DEDDIE. It is also responsible for the maintenance and development of the electricity distribution network in Greece, ensuring at the same time the transparent and non-discriminatory access of all network users to it.

Power Generation

Market liberalization and the introduction of competition in electricity production activity led to the gradual entry of new market players, hence known as Independent Power Producers (IPP's). This entry began in 2004, when the first private power plant was put into commercial operation. This development signaled the official opening of electricity production liberalization in Greece. Today, seven companies are active in the power generation market, with PPC, although with a reduced market share, maintaining its dominant position. Further changes in the structure of the market were accelerated by the highly dynamic penetration of RES, which took place mainly in the period 2008-2013.

The following table shows the IPP's, their installed capacity and the percentage on the total installed capacity:

#	Company	Installed Capacity (MW)	%
1	ELPEDISON S.A.	799	5.92%
2	PROTERGIA S.A.	433	3.21%
3	ALUMINIUM S.A.	334	2.47%
4	PPC S.A.	10,927	80.96%
5	HERON S.A.	148	1.10%
6	HERON II VIOTIAS S.A.	422	3.13%
7	KORINTHOS POWER S.A.	433	3.21%
	Total	13.496	100%

Table 1. Power Generation Market Participants Source: LAGIE

Between them companies own several thermoelectric and hydroelectric power plants. More, specifically, PPC has an energy portfolio that includes 19 lignite, 4 oil, 16 hydropower and 8 gas fired power plants while the IPP's operate 9 gas fired plants.

In addition to power generation by thermal power plants. There is considerable electricity output injected into the system which is produced by Renawable Energy Sources (RES). In Greece the total installed RES capacity as od December 2015 stared at 4.586 Mw operating with interconnected system.

Table 2 presents in detail the installed capacity of the units of each technology, as well as their proportion on the total installed capacity in the country's interconnected system:

#	Fuel	Installed Capacity (MW)	%
1	Lignite	4,456	24.64%
2	Oil	698	3.86%
3	Gas	5,170	28.59%
4	Hydro	3,173	17.55%
5	RES	4,586	25.36%
	Total	18,082	100%

Table 2. Installed Capacity per Technology Source: LAGIE

The share of each fuel in the total production (fuel mix) for the period January-December 2015 is shown in Fig.1:

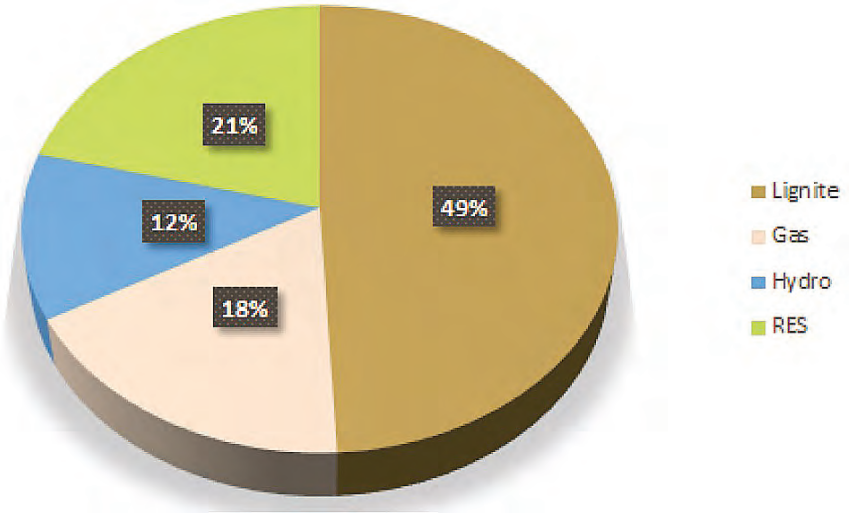
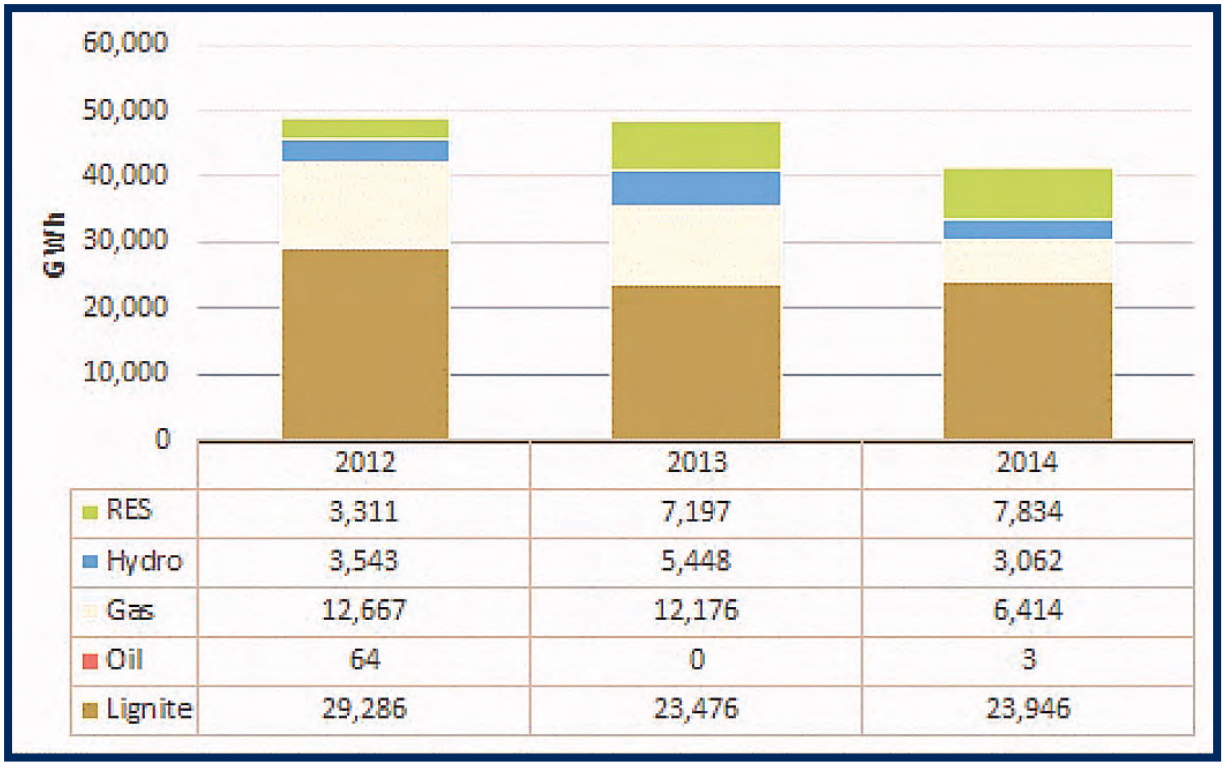


Fig. 1 Fuel Mix (January – December 2015)

Source: LAGIE

During this period, lignite plants produced 16.763 GWh, gas-fired units contributed 6.113 GWh, hydro units injected 3.996 GWh while RES generation reached 6.995 GWh.

It is worth mentioning that over the last three years the power generation from lignite and gas-fired power plants has been significantly reduced. These two types of fuel saw their production limited from 30.000 and 13.000 GWh respectively in 2012 to 24.000 and 6.500 GWh in 2014. In contrast, the large penetration of RES during the same period resulted in an increase of their percentage in the fuel mix from 7% in 2012 to 19% in 2014. Figure 2 presents in detail the electricity generated by fuel over the last three years:



	2012	2013	2014
RES	3,311	7,197	7,834
Hydro	3,543	5,448	3,062
Gas	12,667	12,176	6,414
Oil	64	0	3
Lignite	29,286	23,476	23,946

Fig. 2 Electricity Production by Technology (GWh)

Source: LAGIE

The formation of market shares in electricity production is of particular interest. The market share of the incumbent (PPC) averages 70% in recent years. IPPs are now limited to a share of less than 8%, the RES producers have watched their share grow every year. Figure 3 illustrates market share development per category of producer:

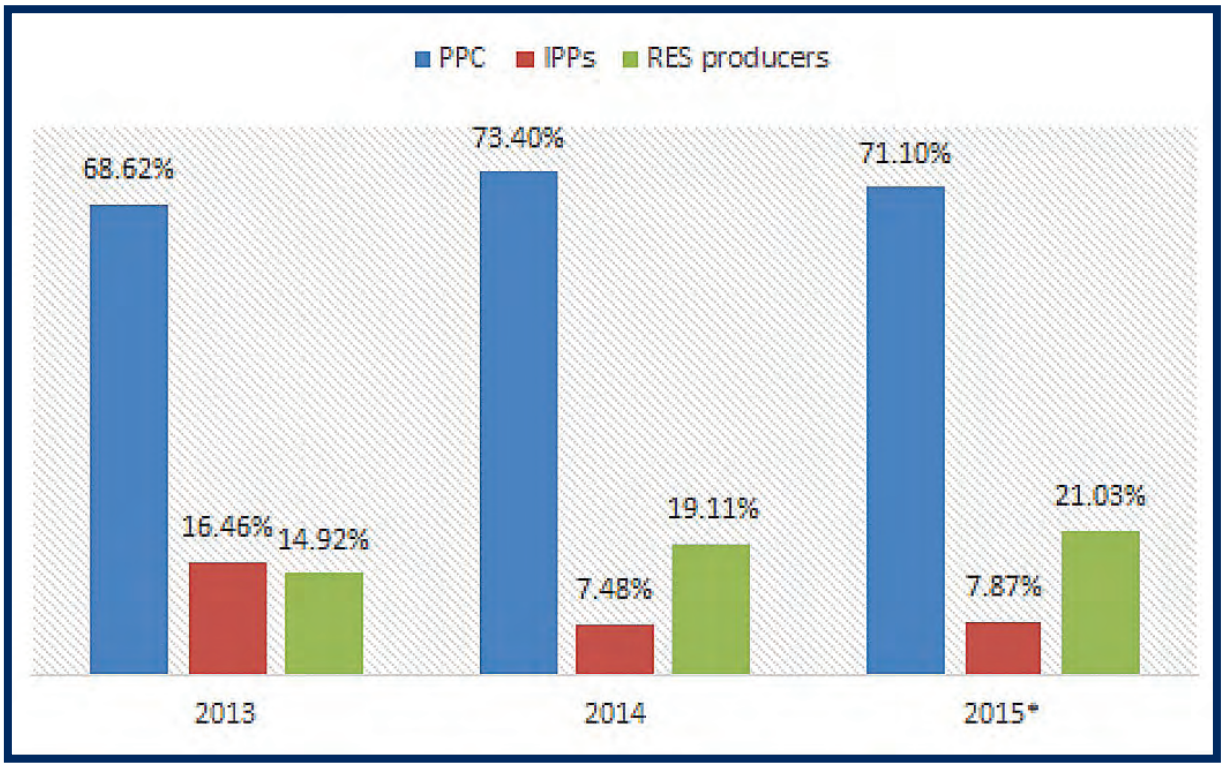


Fig. 3 Market Shares of Electricity Producers Source: LAGIE (* January - October)

Wholesale Market

Market Design and SMP

The Greek wholesale electricity market has been organised as a pure mandatory pool since its inception in 2005. The market design includes a day-ahead market and a balancing mechanism that follows and involves two distinct settlement processes:

- The settlement of the day-ahead market, in which each generators' payments (suppliers' charges) are computed, based on the Systems Marginal Prices (SMP) prices and the plant schedules derived from the day-ahead dispatch (load declarations submitted).
- The settlement of imbalances, in which deviations from day-ahead schedules are charged or compensated, depending on whether they are exogenous or reflect the TSO' dispatch orders.

According to this model, mandatory offers in the day-ahead market are submitted by producers for all their power and corresponding load declarations for the entire demand are given by suppliers. Bilateral physical delivery contracts between producers and suppliers are not allowed (mandatory pool) under current market operation rules.

The System Marginal Price (SMP) is the price on which the electricity market is cleared. It is the price paid to all those who inject energy into the System and paid by all those who request electricity from the System. SMP is determined through a uniform price auction, reflecting the offer of the most expensive unit dispatched so that predicted demand is satisfied. More specifically, production units are classified according to their bids in ascending order, starting with the lowest price offered for a fixed amount of energy and resulting in the higher bid price. At the point where the offered amounts of energy cover the requested electricity load at a corresponding price the SMP is determined. A cap of 150 €/MWh has been imposed on generators' offers.

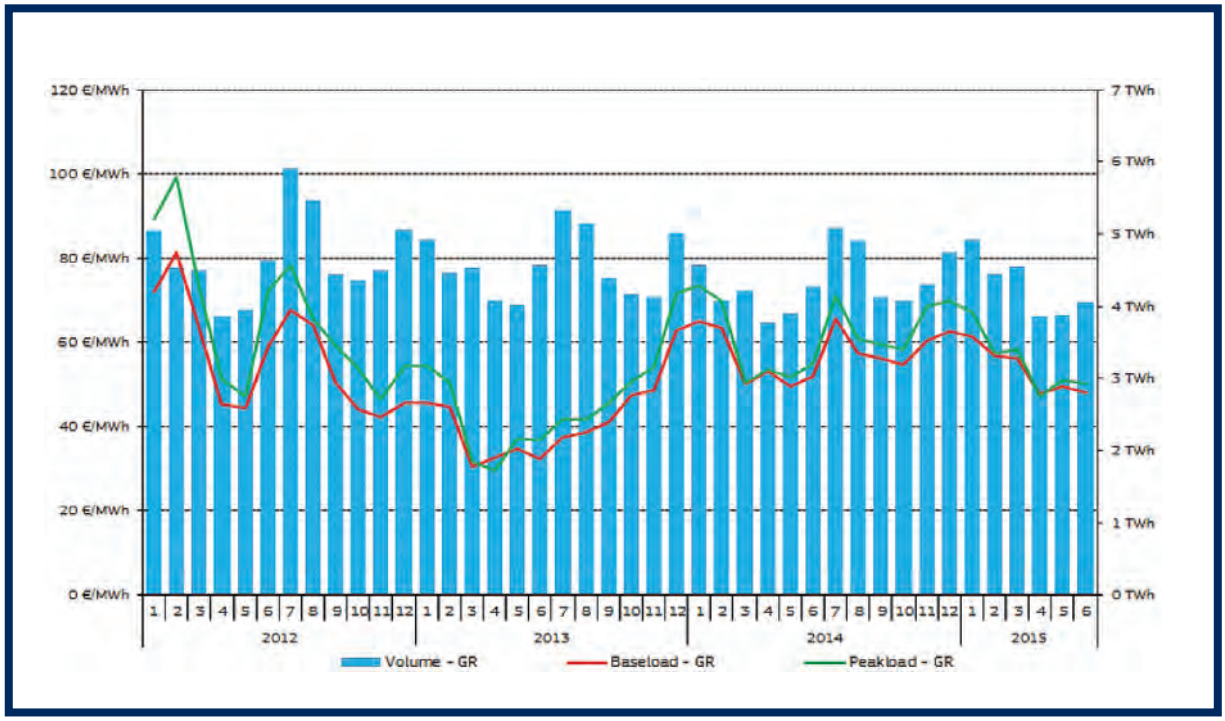


Fig.4 Monthly Traded Volumes and Prices in Greece (2012-2015)

Source: Quarterly Report On European Electricity Markets, EC

Electricity Trading

Greece participates in international electricity trading using 400 kV interconnections with all neighbouring countries, namely Albania, FYROM, Bulgaria, Italy and Turkey. The transfer capacity of the interconnection lines is allocated to traders through auctions held daily, once a month and once a year by ADMIE and other bodies.

Through these interconnections, significant quantities of electricity are transported on a daily basis. More specifically, during the 12 months of 2015 imports reached 9.86 million MWh. The greatest part came from Bulgaria (3,95 million MWh), followed by FYROM (1,92 million MWh), Italy (1,87 million MWh), Albania (1,52 million MWh) and Turkey (0,6 million MWh).

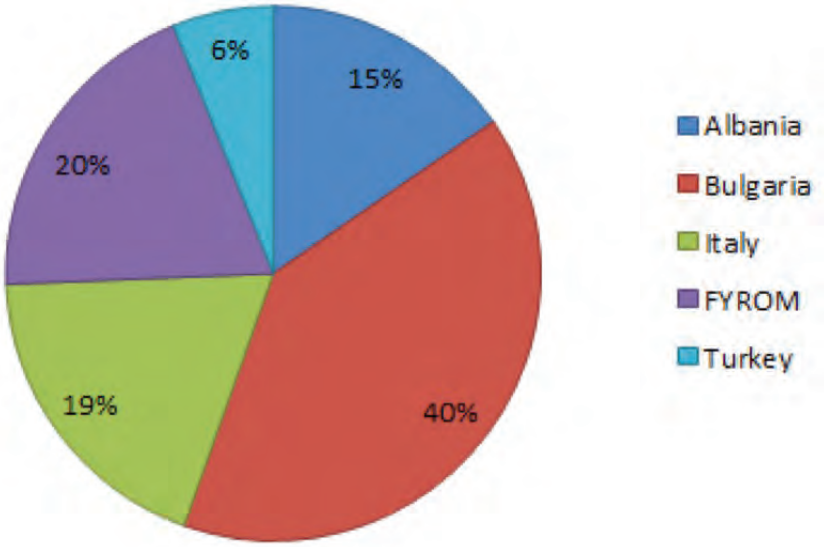


Fig. 5 Electricity Imports (January – December 2015)

Source: I
ENE (based on LAGIE data)

Electricity exports were clearly less than imports during the same period, as 1,53 million MWh were exported through the five interconnections. Italy was the main destination of exports with 800.665 MWh. Turkey was second export country with 371.270 MWh, while smaller volumes were transported to FYROM (168.869 MWh), Albania (151.846 MWh) and Bulgaria (37.480 MWh).

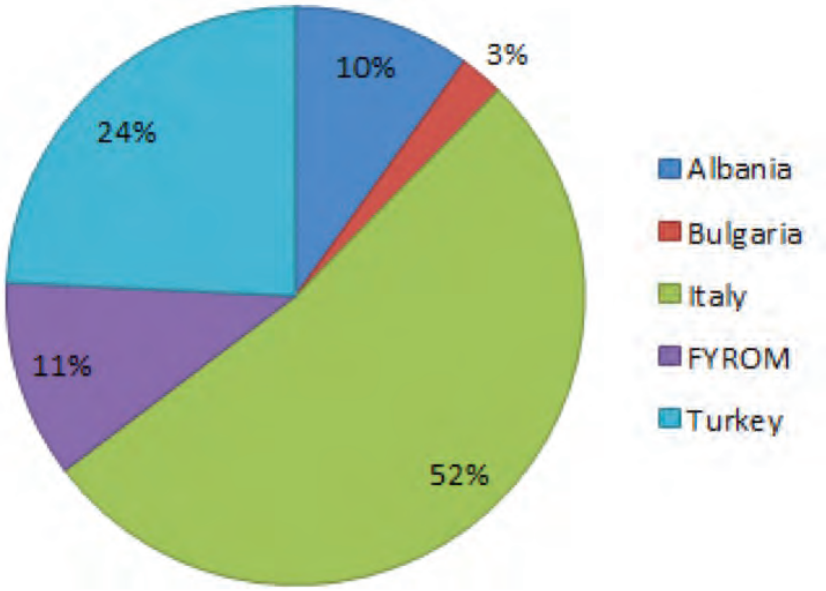


Fig. 6 Electricity Exports (January – December 2015

Source: IENE
(based on LAGIE data)

More than 30 companies were active in 2015 in electricity trading the country's interconectors. These companies held either supply or trading license and are included in the relevant registers kept by the Market Operator (LAGIE).

Figure 7 shows the 10 most active importers of electricity, which are responsible for 81% of imported volumes of electricity. Among them are PPC, which imported 27% of total energy, the Slovenian GEN-I as well as Alpiq and Axpo, based in Switzerland.

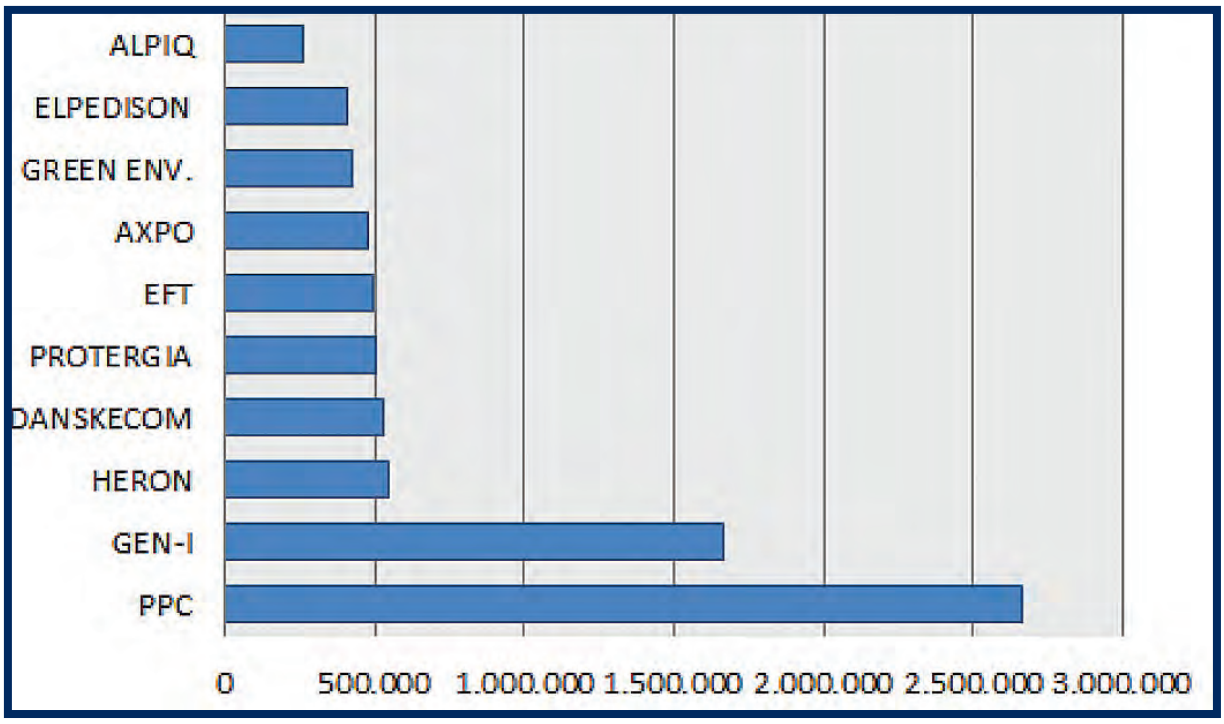


Fig.7 Largest Importers of Elektricity in MWH (January– October 2015) Source: IENE (based on LAGIE data)

Slovenian GEN-I was the export leader in the first 10 months of 2015, followed by Danske Commodities and Ezpada, based in Aarhus-Denmark and Zug-Switzerland respectively. These three companies made 65% of total electricity exports during the period January-October 2015.

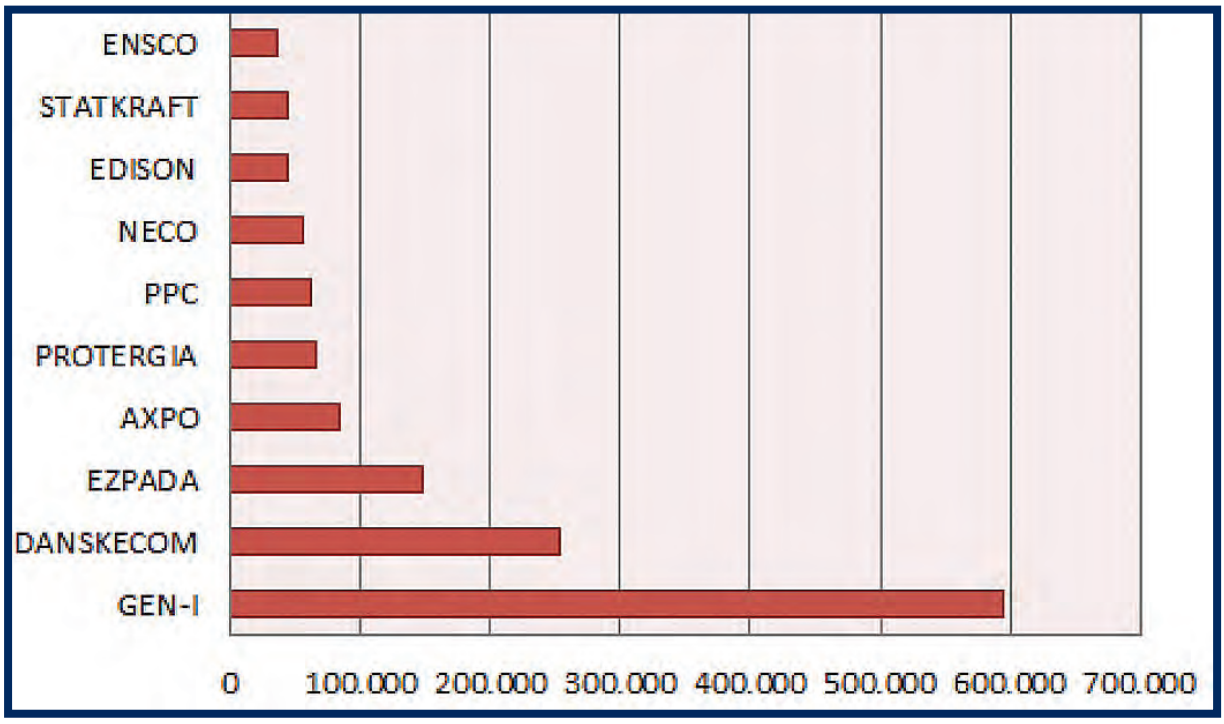


Fig. 8 Largest Exporters of Electricity in MWh (January – October 2015) Source: IENE (based on LAGIE data)

Retail Market

The liberalization of the electricity market in Greece has brought competition in the retail market, as well allowing consumers to freely choose their electricity supplier. Since 1.7.2004 all consumers, apart from households, may freely choose their supplier. This right was recognized for households in 1.7.2007, with the exception of consumers based in the non-interconnected islands.

The Electricity Supply Code, after its last update in January 2013, regulates the rights and obligations of customers and electricity suppliers. More specifically, the Code determines the procedures for the submission of electricity supply offers, the basic pricing principles, the procedures for changing supplier as well as dispute resolution process between supplier and customer.

Market Size

Electricity consumption in the Greek Interconnected System remained relatively stable throughout 2014, recording a small decrease in overall consumption of 0.6%, in comparison to 2013. This decrease is the result of years of continuing economic recession, which has caused an overall decline of about 9% in the total electricity demand in the Interconnected System, over the 5-year period 2010 - 2014. Overall, in the domestic electricity market for the interconnected system, the total number of customers in 2013 was 6.555.067 and their total consumption reached 46.163 GWh. Figure 9 presents the evolution of total consumption, including the non-interconnected islands, over the last 5 years.

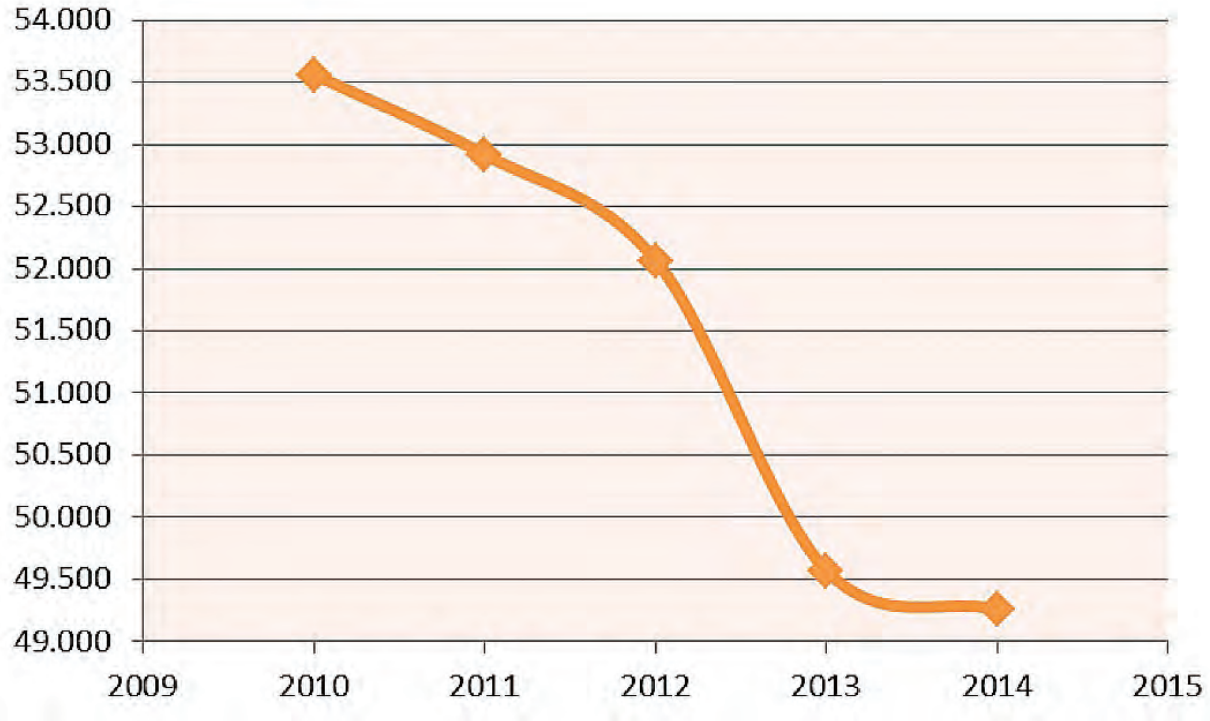


Fig. 9 Electricity Consumption in Greece (GWh) Source: IENE (based on LAGIE data)

Market Players

In recent years, following a long maturity process, at both institutional and organizational level, the Greek retail electricity market "opened up", resulting in the entry of new players. Participants in the retail market are companies that have obtained, upon request to RAE, a license of electricity supply. The relevant Register of Suppliers, which is kept by the Market Operator, currently includes 18 supplier companies. Among these, eight companies are currently actively involved in the market, covering the electricity needs of their clients.
In the Greek electricity retail market, alternative providers have recently stepped up their efforts to broaden their customer base and take away market share from the dominant market player, i.e. PPC. Indeed, a drop in PPC's market share in the retail market has been observed in recent months, as revealed by Figure 10:

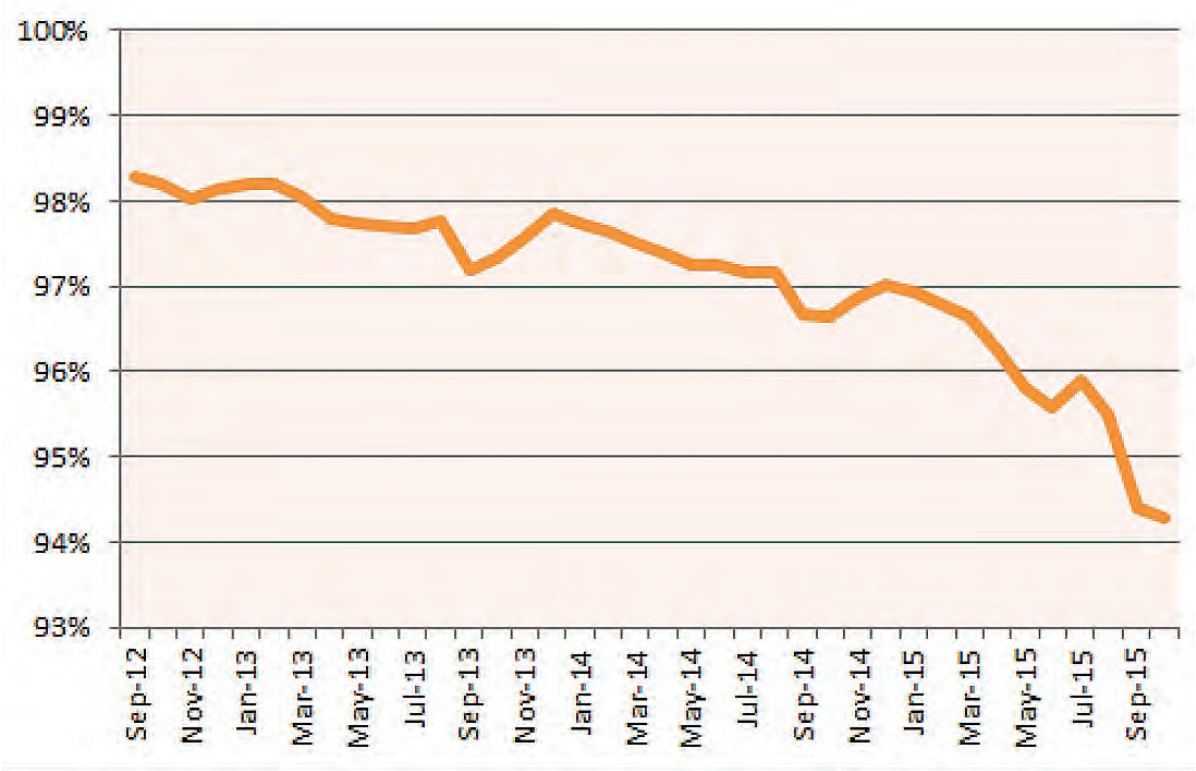


Fig. 10 PPC's Market Share in Retail Market Source: IENE (based on LAGIE data)

The PPC's market share in October 2015 reached 94.29%, down by 3.9% compared to October 2012.

Besides PPC, the other seven power providers involved in the retail market include the following companies: Heron, Elpedison, Protergia, Green, Watt & Volt, NRG and Volterra. Their market share ranges from 0.2% to 2%. Alternative providers have seen lately their customer portfolio grow and this makes them optimistic about the development of a less concentrated market. Figure 11 shows the market shares of alternative electricity suppliers in October 2015:

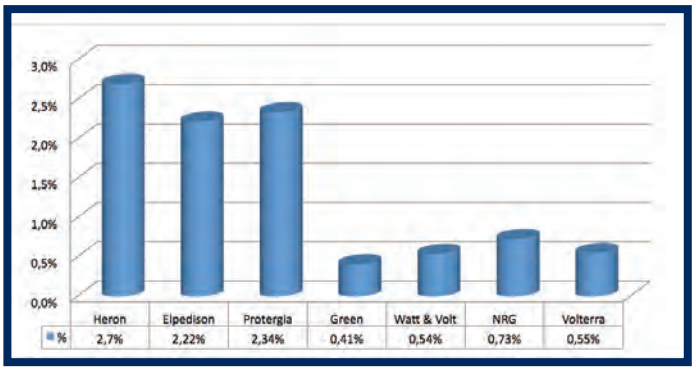
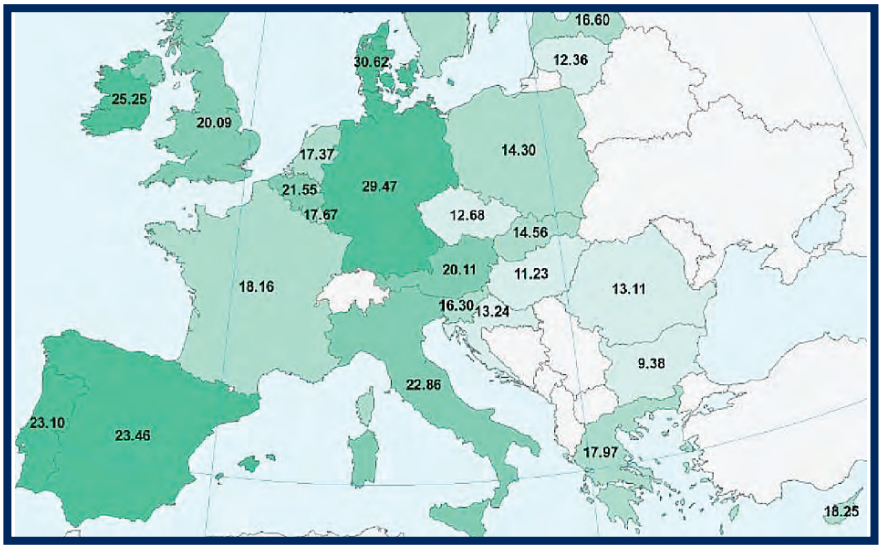


Fig. 11 Independent Electricity Suppliers Market Shares in Greece (July 2016)

Source: IENE (based on LAGIE data)

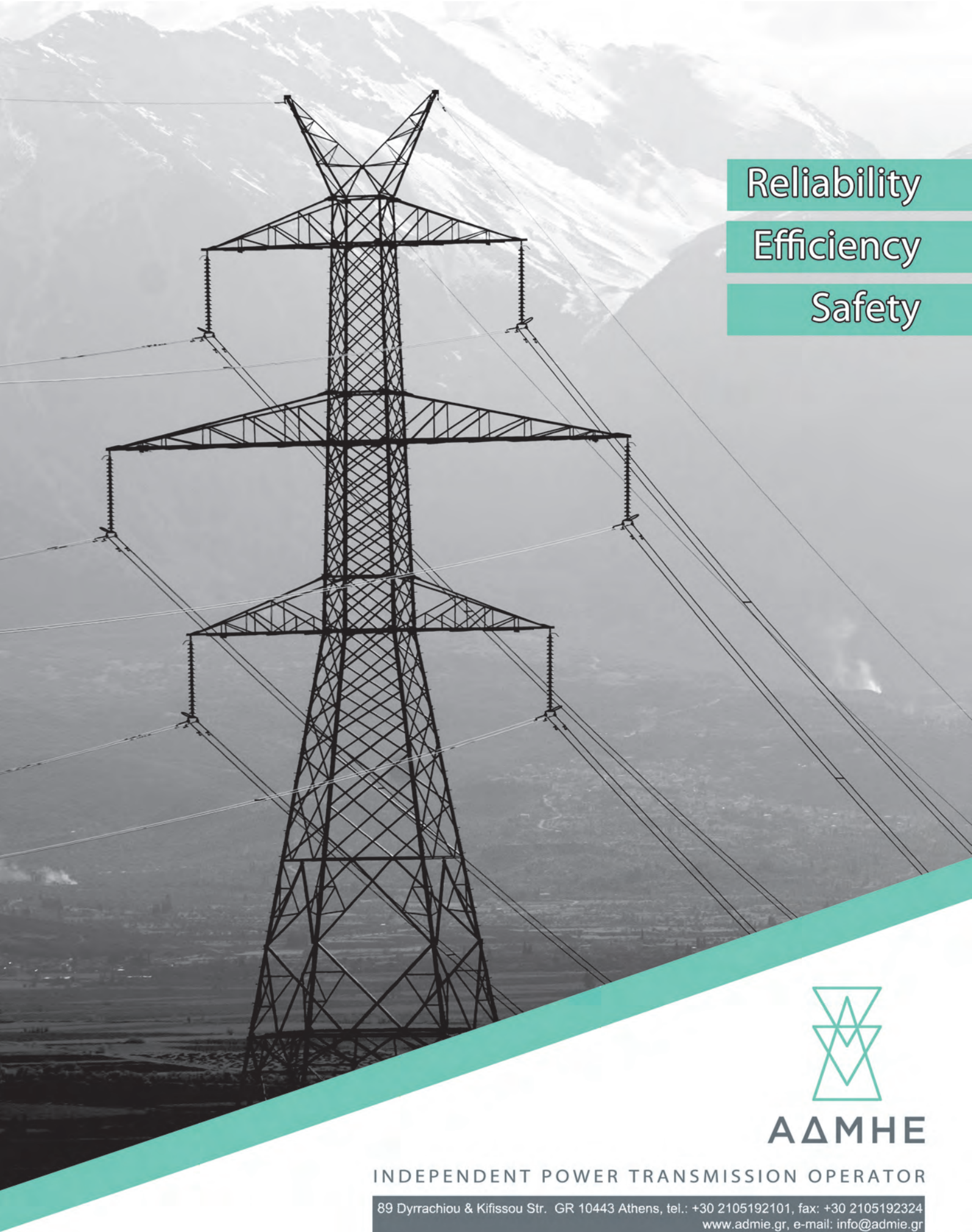
Retail Electricity Prices

The map below shows the estimated quarterly average retail electricity prices paid by households in Europe, having medium level of annual electricity consumption (between 2,500 kWh and 5,000 kWh - Band D_C), in the second quarter of 2015. Retail electricity prices include all taxes and are estimated by using the Harmonised Consumer Price Indices (HICP), based on the time series of twice-yearly retail energy price data from Eurostat. A typical Greek household pays 17,97 c€/kWh, which is approximately the average European retail electricity price for household consumers.



Retail Electricity Prices (2nd Quarter of 2015)

Tasos Mastrapas, Research Associate, IENE, holds a diploma in Electrical and Computer Engineering from University of Patras. He has also graduated from Athens University of Economics and Business, attending an MSc in Applied Economics and Finance, during which he implemented a master thesis under the subject "Competitive Electricity Markets". He is now PhD candidate at E3MLab of National Technological University of Athens. Anastasios has a 5-year working experience in the energy sector, specialized mainly in the development of RES projects. As Research Associate of the Institute of Energy for SE Europe, he was the main contributor of the study "Underground Gas Storage Facilities and alternative LNG routes in Greece and SE Europe", assigned by Regulatory Authority of Greece (February 2015). Anastasios is member of Technical Chamber of Greece and Energy Inspectors Register while he writes articles for *energia.gr*.



Reliability

Efficiency

Safety

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INDEPENDENT POWER TRANSMISSION OPERATOR

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The Key Role of PPC in Shaping Greece's Energy Future

By **EMMANUEL PANAGIOTAKIS**, Chairman and CEO, Public Power Corporation (PPC)

Rapid socio-political developments in the broader region are shaping a new economic and business environment which is having an immediate impact on the energy sector. There are significant opportunities in electricity but also challenges which will have to be addressed accordingly so that Greece can avoid the dangers; this can be achieved by selecting the appropriate choices, strategies and policies in order to reap the corresponding benefits.

Natural gas is also expected to become an important factor. Newly planned and currently under construction pipelines will change the domestic market conditions with immediate impact on the electricity market. The Euro-Asia Interconnector, recently heralded as a viable mid-term prospect, will create the conditions for importing electricity produced from natural gas in Israel and – prospectively Cyprus - into Greece and Europe.

These factors will inevitably put pressure on the already problematic – in terms of supply-and-demand – Greek electricity market. These problems are likely to become even more acute due to an increase in electricity interconnections planned within the Target Model framework and the energy integration of the E.U.

Will Greece's energy future be characterized by increased, in relation to today, energy imports and energy dependence with a decreased participation of domestic sources? For many reasons, the answer must be emphatically negative. This is why the right choices must be made now, today.

Choices that will increase energy efficiency and primarily energy savings but will also minimize market distortions and contribute to the rationalisation of the country's energy balance. National energy planning is an overiding necessity.

We must increase electricity consumption but with an escalation in its use in an efficient and environmentally friendly manner, such as transport and in conjunction with the expansion of island interconnections which will drastically decrease oil dependency. At the same time, there must be significant growth of RES, among others as an indigenous resource of vital importance while avoiding the mistakes and distortions of the past.

In relation to lignite, another significant domestic resource; its production must remain at appropriate levels and be produced by state of the art plants which will secure security of supply, maintain electricity prices at controlled levels and produce electricity more efficiently with

much reduced GHG emmissions. The Ptolemaida V thermal power station is being constructed within this framework and this is what we are aiming too for Meliti II, both planned to replace old, redundant units.

Developments, of course, also create great opportunities. Indicatively allow me to mention the developing Turkish market, Egypt's requirements for electricity and infrastructure in conjunction with the dynamic potential of RES, apparent opportunities in Iran and the Balkan countries. Greece's geographical position, its good relations with most of the neighbouring countries the technical and constructual expertise of Greek companies are truly important advantages that must be utilised to the fullest.

Within this framework PPC can play a leading role and this is our aim. It can become the vehicle for breaking into the nearby markets. This aim does not stem only from the fact that in order to survive it must undoubtedly compensate for domestic losses, due to imposed measures for the deregulation of the market, by expanding its activities beyond Greece's borders. It stems mainly from its technical and organisational potential and experience, in combination with a strong Brand Name and the trust it enjoys because of these particular characteristics. Alongside its collaborations with other Greek companies it can undoubdly create great value for the country.

There is, however, a fundamental precondition for this: The redevelopment and expansion of its corporate structure primarily through the elimination of the current labyrinthine web of interactions with the state that cancels out any potential for commercial growth and expansion.

The state in its capacity as main shareholder must clarify PPC's current role. We no longer live in previous decades when due to monopoly conditions this role was pretty much self-explanatory: electrification of the country and utilisation of domestic – lignite and hydro – energy resources. Today, an effective PPC is absolutely necessary for the security of electricity supply,

controlled prices and the smooth operation of the market. It is also a massively important and valuable growth factor for the country's economy, through its domestic commercial activity, as well as through its access to other markets. Therefore, it must be given the means to fulfil its mission successfully.

In relation to productivity and efficiency, I find the dilemma 'public or private' Company misleading. The very history of PPC proves that a state company can be highly efficient given the appropriate means and policies. During a period of 10 years (between 1955and 1965), PPC acquired and incorporated 430 private companies. In the following 10 years it achieved the miracle of the electrification of Greece: from approx. 50% of the country to 97%. No private company could have achieved this.

Let us therefore look at the case of PPC as a national bet that must be won.

Emmanuel Panagiotakis has been the Chairman and CEO of PPC since April 2015. He has been working in PPC since 1974, holding for the past 20 years senior managerial positions in the fields of Human Resources, Organization, Training, Health & Safety and in the Planning & Performance Department of the Distribution Network Division. E. Panagiotakis has been responsible for organizational and operational issues including, among others, the internal organizational structure as well as the institutional framework of corporate governance. He has also been a member of the executive committee that was responsible for the unbundling of distribution network divisions and the implementation of the organizational and operational structure of the new Distribution Network Subsidiary, HEDNO S.A. He is a graduate of the Mechanical -Electrical Engineering Department of the National Technical University of Athens and holds a Diploma in Management from Henley Management College.

Greek Electricity Market at Crossroads

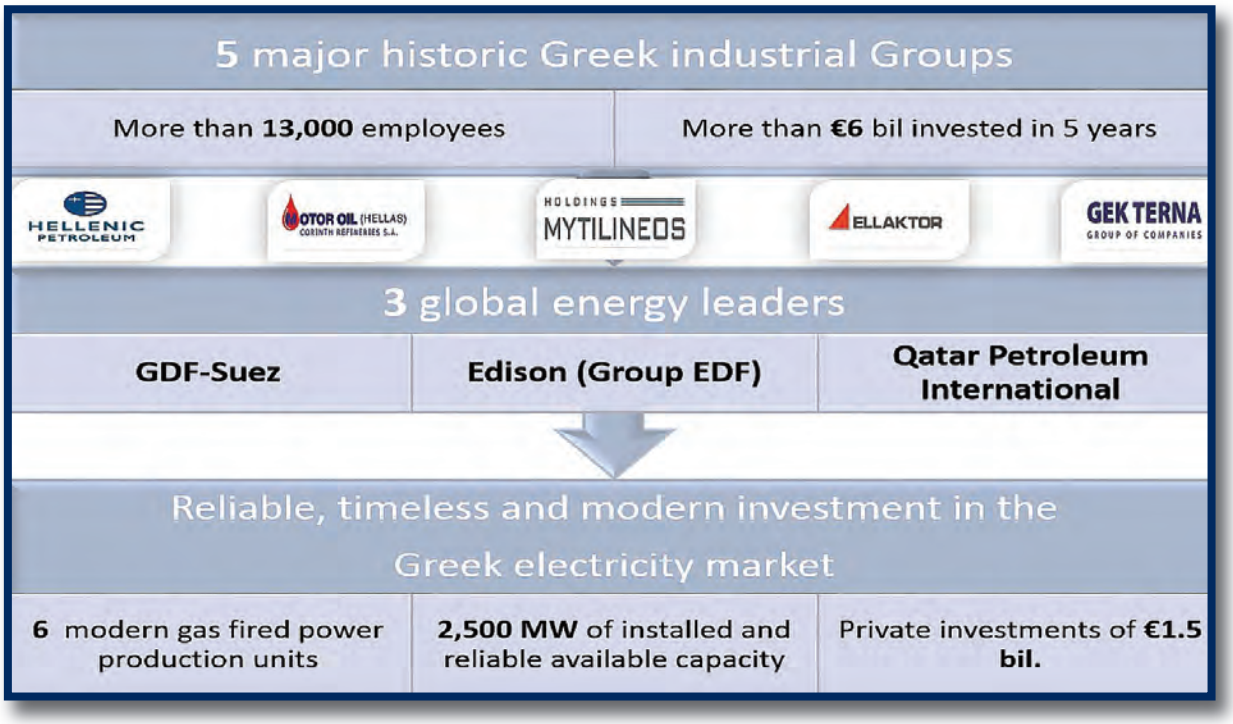
By Dr **GIORGOS STAMTSIS**
General Manager of the Hellenic Association of Independent Power Producers

Greek electricity market is as unique as it gets, one could argue. It is characterized by a series of paradoxes that justifiably make the Greek power market a case-study on a European level and enable it to stand out amongst all other relevant markets, even within the particularly differentiated energy region of South Eastern Europe. It is not that other markets do not share some of the characteristics that the Greek electricity market has, but rather that the Greek power market manages to combine all these 'particularities' altogether and for a very long period of time, despite the framework set by the European Acquis, as well as recent efforts for the creation of an Energy Union.

Indicative of this uniqueness are statements by EU officials from DG Competition, stating that *"The lack of competition in the Greek electricity market is unique and one of the most characteristic in the EU (…), both with regards to its extent as well as in terms of its duration"*. And there is no exaggeration element in this observation.

The Greek electricity market has only been liberalized "on paper" since 1999. The Greek parliament voted into power a law liberalizing the market but the Authorities failed to introduce the necessary measures that would allow the actual opening of the market. Consequently, 17 years after the legislative liberalization of the market, PPC (Public Power Corporation) has practically still exclusive access and exploitation of domestic energy resources (lignite –large hydro) and private companies operating in the market fail thus to compete on equal terms. The result is that PPC controls 90% of the retail market, making Greece one of the most closed markets in electricity at European level.

Meanwhile, under the assumption that a competitive market would emerge and that, since the Greek State would have to proceed with the effective implementation of EU Directives, third parties would eventually gain access to all available energy resources (including lignite and large hydro) and would be able to form an energy portfolio according to their strategy and not according to a limited access to energy resources, Greek and foreign investors decided to initiate their active participation in the market. In this context, the largest private energy companies in Greece (Hellenic Petroleum, Motor Oil Hellas, Mytilineos Holdings, ELLAKTOR Group, GEK TERNA) together with their partners GDF-Suez (now ENGIE), Edison and Qatar Petroleum International, implemented amidst the financial crisis significant investments of €1.5 billion in six cutting-edge natural gas power plants, and established three vertically- integrated utility companies, Elpedison, Protergia and Heron.



Their aim was and remains the supply of secure and sustainable electric power at affordable and competitive prices to households, businesses and industries in Greece.

The entry of the Independent Power Producers (IPPs) in Greece's electricity sector, significantly benefited both consumers and the economy, since they contributed to:

- Putting an end to black-outs from 2010 onwards, as they added ca. 2,500 MW of reliable capacity to the starved for energy National Electricity System
- Savings in customers' bills of more than €200 mil/year through the replacement of the production of the old and expensive oil-fired units in the Interconnected System by the production of the modern and cheaper gas-fired units
- Larger penetration of RES, due to the technical characteristics of gas-fired units which provide the System with the required flexibility to cover the variable output of intermittent RES (wind, solar)
- Achievement of Greece's environmental targets for CO_2 emissions
- Empowerment of DEPA and DESFA, through the addition of a guaranteed clientele which funds their growth

Their investment though state-of-the-art gas-fired power plants was the first step of a strategy aiming to create new vertically-integrated utilities with a balanced energy portfolio that consequently would be able to compete with PPC on a level playing field.

Unfortunately, the first step was never followed by a second, as the Greek State and pertinent authorities (RAE, Transmission System Operator), never established a fully open, competitive and completed market framework and conditions.

Instead, there is a multi-year delay in the abolition of market distortions created by the super-dominant position of the state owned incumbent, and in the creation of the appropriate market mechanisms that would remedy market failures, allowing the wholesale and retail market to reflect at any time the real value of energy. The significance of these market failures and the urgency to proceed with much-needed structural reforms in the Greek electricity market, becomes evident if one considers that the large majority of the measures introduced in the context of the 3rd MoU (signed in August 2015), as far as the energy sector is concerned, are related to the liberalization of the power market and to the introduction of basic market mechanisms.

On the market opening front, the supplemental MoU (signed in June 2016) foresees "the authorities will agree with the Institutions, endorse in KYSOIP and publish the design of the NOME system of auctions, with the objective of lowering by 20 percentage points the retail and wholesale market shares of PPC by 2017, and to bring them below 50 percentage points by 2020. Moreover, as a prior action the relevant legislation introducing the NOME mechanism in the Greek electricity market, including all relevant powers for LAGIE and RAE, will be adopted. The first auction will be held in September 2016 (key deliverable), with quantities to be auctioned in 2016 equal to 8% of the total volume in the interconnected system in 2015 and deliveries to start in the 4thquarter 2016".

In the view of the Hellenic Association of Independent Power Producers, NOME auctions are a first and significant step towards the liberalization of the retail market. However, it is a transitional measure which expires in 2019. Thus, independent suppliers may assume a high risk on how they will continue serving, after 2019, their extended customer base when there will not be available any further NOME products. Moreover, NOME auctions do not alter the limited competition in electricity production which can only be achieved when third parties have the realistic possibility for direct control of any available energy resource (i.e. lignite, large hydro, gas, RES and imports). Furthermore, it is crucial that the threshold price of NOME auctions to be attractive, compared to the wholesale market price,in order for the relevant products to have any value for the independent suppliers and allow competitive energy portfolios.

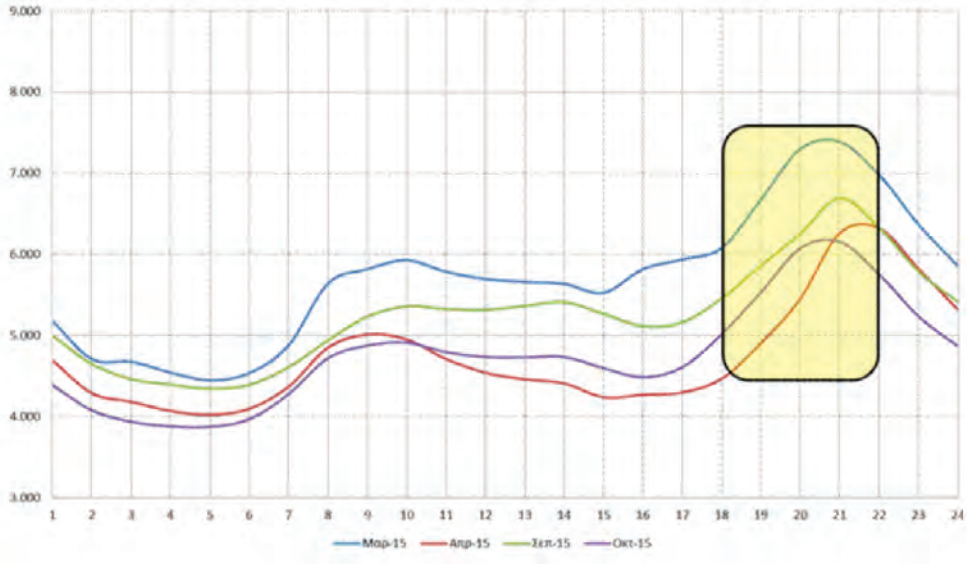
Apart from the liberalization issue, which of course is crucial, the supplemental MoU includes among its key issues, the pre-notification to the European Commission (EC) of the permanent capacity remuneration mechanism which should succeed the Transitory Flexibility Remuneration Mechanism (approved by the European Commission on 31.03.2016 and legislated by the Greek parliament in May 2016 starting its operation on 01.05.2016).The inclusion of such a measure in the MoU becomes even more interesting, if one considers that generally the European Commission is very reluctant in approving the implementation of capacity markets mechanism in European electricity markets. Why is then the EC stressing the need for such a capacity market in the Greek electricity market?

The European Commission has for the first time included the capacity markets in the latest guidelines on state aid for environment and energy. By doing so, EC intends to set a European-wide framework for the implementation of capacity markets so that this market design change will not hinder the path towards the internal energy market. Along with the peak demand chal-

lenge, the Guidelines also pay attention to the flexible generation capacity which is needed to cover the renewables' intermittency on daily basis. Consequently, the European Commission recognizes the value and necessity of long-term capacity and flexibility markets, as long as they are compatible with EU rules and do not hinder competition or cross-border cooperation. In April 2015, EC launched a sector inquiry regarding the capacity mechanisms (existing and planned) in eleven member states. The interim report of this inquiry (April 2016) illustrates that even if the member states will improve the functioning of the electricity markets it is still possible that some residual market and regulatory failures will remain and this fact will require the introduction of a capacity and/or flexible capacity market along with the energy market so as to safeguard the security of supply.

Because of the financial crisis and the consequent decrease in demand Greece has marginal capacity adequacy, as far as the peak demand snapshots are concerned. This became crystal clear during the summer of 2015, when demand reached almost 10.000 MW, even though having capital controls in place. It is worth noting, also, that during the most challenging periods for the System (winter and summer months), operation of all efficient gas-fired units is required in order to cover demand. More importantly, according to the recent (June 2016) adequacy study of the Greek TSO (ADMIE), Greece will probably face challenging situations regarding traditional capacity adequacy by the end of this decade. In ADMHE study's base scenario the Loss of Load Expectation (LOLE) figure exceeds in 2020 the satisfactory threshold of 2.4 hours per year. But probably more attention should be paid to the dry- hydro-conditions and the two-CCGTs-decommissioning scenarios of that study where the LOLE figure varies between 5.7 and over 50 hours/year in the period 2017-2021. Additionally, in July 2016, ENTSO-E (the network of European TSOs) has published its new mid-term assessment of Pan-European adequacy. This study provides for the first time an assessment of the risks to security of supply and the need for flexibility over the next ten years. As far as Greece is concerned, the study's base scenario points to an average LOLE value of 1.6 hours/year (maximum LOLE value calculated for Greece

Demand of the Greek Interconnected System (total load minus RES production connected at medium voltage and low voltage). March, April, September and October 2015.



Source: ADMHE

at 4.7), while the criterium used in this study is setby ENTSOE at 1 hour/year. The next mid-term studies of ENTSO-E are expected to be further amended and investigate in more detail the System's flexibility needs.

The above mentioned conclusions of the numerous adequacy studies have some basic drivers: Aged lignite-fired units withdraw due to environmental restrictions and consumption increases as a result of the interconnection of the islands (Cyclades, Crete) and the anticipated future growth of the Greek economy. Additionally, the large and constantly increasing penetration of intermittent RES in power production creates increased needs for flexible capacity resources. The following graph provides a picture of the flexible capacity challenge that the Greek System Operator, on daily basis, has to deal with.

Today, the Greek power market has to put a lot more effort so as to complete the market design, comply with the principles of the internal energy market and the Energy Union and consequently be part of a European-wide, open and competitive electricity market.

For this to happen, it is of paramount importance to safeguard the conditions that will allow the existence and the development of competition in the market by fixing market and regulatory failures, and removing abusive practices in the market. A steady regulatory framework in the electricity market, which by nature encompasses long-term investments, is critically needed. For this reason, it is vital to avoid discontinuities and unilateral changes in the regulatory framework, as this harms the trust of investors, hampers the implementation of new ventures and the maintenance of existing investments in power generation and supply, and eventually undermines the security of the country's energy supply.

Dr. **Giorgos Stamtsis** was born in 1974 in Germany and holds a Diploma in Electrical Engineering from the Aristotle University of Thessaloniki, while he has an Engineering Doctorate (Dr.-Ing.) from the Universität Duisburg-Essen in Germany. He has extensive experience in the energy sector, focusing on electricity. Since January of 2014 he holds the position of General Manager of the Hellenic Association of Independent Power Producers (HAIPP), having served as Deputy General Manager in HAIPP during the period 2012-2014. From 2010 until 2012, he was a Senior Advisor to the General Secretariat of Energy and Climate Change in the respective Greek Ministry, while he has previously worked as Commercial and Trading Manager in Endesa Hellas (2007-2010) and in the Energy Supplies & Trading department of Mytilineos Holdings (2005-2007). He is a member of VDE, of Eurelectric's WG for Wholesale Market Design and of the Technical Chamber of Greece. Dr. Stamtsis is General Manager of the Hellenic Association of Independent Power Producers.

The Importance of Energy in Industrial Production in Greece and the Role of UNICEN

By **CONSTANTINE COUCLELIS**, Chairman, UNICEN

Greek industrial production relies heavily on energy. Steel, aluminium, copper, cement, chemicals, fertilizers, paper, glass and other energy intensive industries form the backbone of the Greek manufacturing industry that feeds the domestic "light" industry and contributes greatly in Greek exports.

Energy intensive industry exports represent 18.2 % of industrial exports and 15.4 % of total Greek exports (excluding petroleum refined products) in the period 2007- 2014. Traditionally export oriented, the energy intensive industries have intensified their export efforts since the beginning of the present depression, five years ago. Operating in particularly adverse conditions, facing the collapse of the domestic market, rising fiscal, energy and financing costs, they have succeeded not only to maintain but very often to increase their exports compared to pre-crisis levels.

By becoming increasingly extrovert, Greek manufacturing companies had to improve their international competitiveness, by reorganizing, re-engineering, merging their operations. However, external factors such as the high costs of energy in a non-competitive energy market are beyond the control of individual companies.

To address the common need of creating a competitive energy market, 14 large and medium sized manufacturing companies founded in 2010 **"UNICEN", the Hellenic Union of Industrial Consumers of Energy**. UNICEN has grown to a 27 member organization that represents large, medium and small manufacturing companies that share a common characteristic: High energy intensity.

For these companies energy costs are the most important cost element and a key component of international competitiveness. Energy costs (electricity, natural gas & fuel oil) may represent up to 50% of manufacturing costs while exceeding labor costs.

UNICEN represents the energy intensive industries before the competent Greek and foreign authorities and participates in public consultations concerning decisions and legislation on matters of energy policy.

A recent ROLAND BERGER study has proved beyond doubt that the cost of electricity for energy intensive industrial users is much higher (30% to 70%) in Greece than in other major European

member states. The cost disadvantage is more pronounced if we compare Greek prices with those of our main East European competitors. EUROSTAT statistics and GAZPROM announcements converge to the conclusion that natural gas prices are 30% to 40% higher in Greece than the average European prices for industrial customers.

UNICEN is analyzing the cost structure of the final electricity and natural gas prices to the industrial consumers, in order to determine excessive charges and inefficiencies and propose solutions for more efficient charges, taking into account the provisions of the European energy directives and the Greek energy legislation on one hand and the consumption characteristics of the energy intensive industries on the other.

In this respect UNICEN has come with proposals for the streamlining of the electricity and natural gas excise duties that are today 5 to 10 times higher than the European minimum rates that are paid by most of our European energy intensive competitors.

Compensation for CO2 leakage and the Community guidelines on State aid for environmental protection are important areas of initiative where UNICEN can assist the authorities in shaping a competitive environment for Greek industry in line with similar actions taken by all the other member states.

The introduction of an interruptibility service for the electric system in Greece is one more measure - applied by most EU countries - that re-enforces the stability of the system and which can result in cost savings for some industries that have the necessary flexibility to execute on very short notice an interruption request of the system operator.

Other regulated costs such as Grid charges, Utility Service Fees, Renewable energy charges, interconnection costs are also critically analyzed by UNICEN and proposals are made to reduce such costs.

Concerning the supply cost of electricity and natural gas in the present state of the market, characterized by a supply monopoly, UNICEN has been consulting with PPC (Public Power Corporation S.A.) , DEPA (Public Gas Corporation of Greece S.A.), RAE (Regulatory Authority of Greece) and the ministry of Energy, in order to establish cost-based electricity and natural gas tariffs and thus pave the way for industrial customers to negotiate with PPC and DEPA on the basis of their particular consumption and company profile, in line with the provisions of the Greek energy legislation.

Greece is in a long process to liberalize its electricity markets, abolish the inefficiencies of the present system and implement the European target model. A liberalized energy market that allows large industrial customers to sign long term bilateral contracts with energy suppliers and secures their effective access to the European energy hubs will in principle result in lower energy prices for intensive energy customers.

UNICEN is actively participating in the consultation process, aiming at a system that will combine competitive energy prices with security of supply. It is however our serious concern that during this transitory period that may last several months or even years, the prices of electricity will not explode, as a result of partial – inefficient liberalization. For this reason, until the process of liberalization is fully completed and functional, we have proposed to apply the French

NOME system of electricity auctions in order for industry to have direct access to the most competitive energy sources (lignite and hydro).

The natural gas market is undergoing a liberalization process. UNICEN has stressed the need to accelerate this process.

Till a year ago it was practically closed to free competition for industrial consumers and prices paid were 40 % higher than the European average and up to 100 % higher than the price paid by our main competitors.

These prices, the highest prices in the EU- 27, were the result of a monopolistic market structure and the highest in the European Union Excise Duties.

No more than 10 large industrial customers with annual consumption of over 100,000 MWh were “eligible “ to choose their supplier: in reality, their only choice was that of importing LNG from the Revythoussa terminal, given that the capacity of the pipeline linking Greece with Bulgaria and Turkey is bound. In addition importing LNG from Revythoussa is only a theoretical possibility, since the smallest ship-load of LNG corresponds to the annual consumption of a large industrial consumer and must be received and consumed - due to lack of adequate storage facilities - within 28 days, which is impossible.

The remaining industrial consumers - the backbone of Greek industry with annual consumption of less than 100,000 MWh each were “non - eligible “ and were operating in the monopoly environment of DEPA and local distributors (EPA), thus paying an even higher price for gas. Greece is the only Member - State of the EU that does not consider “eligible” all gas consumers.

To partially compensate for the high gas prices resulting from the monopolistic market structure DEPA implemented a system of gas auctions.

In 2014, the liberalization process started with the choice given to “eligible” consumers to sign unbundled gas supply and transportation contracts, paving thus the way to multiple suppliers. Last October the eligibility of business gas consumers was broadened to all industrial customers operating in areas where DEPA was the gas distributor. However, the liberalization process that was planned to be completed by the end of 2014 with the broadening of eligibility to industrial customers operating in the local distributor (EPA) areas has not yet been implemented.

The broadening of the eligibility of industrial consumers remains a top priority for UNICEN. The creation of a wholesale market and easier access to LNG and pipeline gas imports are a necessity for creating a more efficient natural gas market.

In conclusion, the structure and the inefficiencies of the Greek energy markets result in non-competitive prices for the Greek industries and especially for the energy intensive manufacturing companies. It is essential to carefully plan and implement a liberalization process that will not result in an increase of the already high energy prices in the interim, which would have devastating implications on the energy intensive industries for which the cost of energy represents the main factor of international competitiveness. The completion of such liberalization should result in lower, competitive energy costs. In this context UNICEN will continue to play an active role.

Constantine Couclelis, Chairman, UNICEN. Energy Director of the Viochalco Group of Companies (Steel, Aluminium, Copper, Cables) and Member of the Board of Directors of ELVAL S.A., Chairman of the Board of Directors of UNICEN (Hellenic Union of Industrial Consumers of Energy), Member of the Board of Directors of: SEV Council for Sustainable Development, Hellenic Union of Listed Companies. Studies: M.B.A. University of Chicago, License ès Sciences Écono-miques (Économétrie), Université de Genève.

Company profile

EDISON

Energy for Europe

Thanks to 130 years of history, we're a leading energy company in Italy and Europe

Overview

Founded in 1884, Edison is Europe's oldest energy company. Today, it's a leading energy player in Italy and Europe with operations in the **supply, production and sales of electric power and hydrocarbons** (natural gas and crude oil). Since 2012, the company has been part of EDF (Electricité de France) group.

Edison employs 3,101 people with operations and activities in **Europe** (Italy, Greece, UK, Norway, Croatia, Bulgaria, Romania, Hungary, Belgium and Turkey), **Africa** (Algeria), **Middle East** (Egypt and Israel), **Southern America** (Falkland Islands).

Electric power

Edison has an installed capacity of 7.7 GW thanks to a generation fleet of **47 hydroelectric plants, 21 thermoelectric plants, 35 wind farms, 9 photovoltaic systems and 1 biomass plant in Italy**. In 2014 it produced 17.6 TWh of electricity thus covering 6.7% of Italian production.

In **Greece**, through **Elpedison** (Joint Venture with Hellenic Petroleum and Ellaktor), Edison is the second largest electricity company in the country. Greek activities include an operative 400 MW CCGT power plant in Thessaloniki and a 420 MW CCGT facility in Thisvi.

Elpedison serves today more than 30.000 customers, having built a sound customer portfolio comprising households and business customers from almost all market segments.

Hydrocarbons

The company has an integrated presence in the hydrocarbons sector from production to importation, distribution and sale of natural gas and crude oil. The Group has hydrocarbons **reserves of 347 million cubic metres**, thanks to **127 concessions and permits in Italy and abroad**. Its hydrocarbon Exploration and Production activities are in Italy, Greece Algeria, Croatia, Egypt, Falkland Islands, Israel, Norway and UK. While in 2014 the gas supply portfolio of Edison is **13.2 billion cubic metres**.

In **Greece**, Edison recently started activities in the hydrocarbons sector, developing a regional vision extended throughout the Mediterranean basin. Following an international tender (Greece Open Door 2012), the concession "West Patraikos" in the Gulf of Patras has been awarded on 15 May 2014 to Edison in consortium with Hellenic Petroleum (operator) and Petroceltic.

Edison participated on 14 July 2015 with other international partners in the exploration bid round for several sea areas, which is under evaluation by the Greek Government. These investments in the E&P will also contribute to develop indigenous resources.

Gas infrastructures

Edison is playing a leading role in the development of new infrastructures to import natural gas for Europe and Italy. The **Adriatic LNG Terminal** in Italy, the first offshore facility of this kind in the world, became operational in 2009 being able to import 8 billion cubic meters of natural gas a year, equal to 10% of Italy's natural gas needs.

Edison is involved in the development of several major gas pipeline projects all included in the list of Projects of Common Interest at European level for their significant contribution to enable the gradual build-up of the Energy Union by integrating the energy markets in Europe, by diversifying the energy sources and transport routes.

In cooperation with other major companies (Sonatrach, Enel and Hera) Edison is developing the **Galsi pipeline** (8 billion cubic meters of natural gas a year), which will link Algeria with Sardinia and Tuscany.

Edison is also partner with DEPA in **IGI Poseidon SA**, a Greek company in charge of the development of three gas pipelines in the framework of the Southern Gas Corridor:

- **The Poseidon pipeline**, with a capacity up to 14 billion cubic metres of natural gas a year, will link the Italian and Greek gas networks crossing the Ionian Sea. The project in cooperation with other projects on the area, among these the South European Pipeline (SEP) and EastMed Pipeline, will allow to diversify the routes and sources of supply to EU according to the pillars of the European energy strategy;
- **The IGB pipeline**, with a capacity of 3-5 billion cubic metres of natural gas a year, is a pivotal infrastructure interconnecting the Bulgarian and Greek networks. The final investment decision of IGB pipeline project was signed on 10 December 2015;
- **The EastMed pipeline**, with a capacity of 10-20 billion cubic metres of natural gas a year, will directly connect the newly discovered gas resources in the East Mediterranean area to the European gas system.

Edison, through controlled companies, also manages regulated activities (**gas transportation, storage and distribution**) and runs 3 gas storage centres in Italy.

Company profile

Italian market

In 2008, Edison entered the Italian residential market with a sales package to supply electric power to families. A year later, Edison broadened its sales package for families with the addition of natural gas. Currently, Edison has more than 1.5 million customers in Italy.

Our businesses at a glance (as of December 31st 2014)

Electric power

17.6 TWh of net electric power production
Edison covers **6.7%** of Italian power production
7.7 GW of total installed capacity
47 hydroelectric plants
21 thermoelectric plants
35 wind farms and **9** photovoltaic systems

Hydrocarbons

13.2 billion cubic meters of gas sales
Edison covers **22.5%** of Italian gas demand
127 concessions & exploration permits in Italy and abroa
3 gas storages and **1** LNG terminal
46.2 billion cubic meters of hydrocarbons reserves

Financial Highlights of the Edison Group (at 12-31-2014)

(in millions of euros)	2014
Sales Revenues	12,325
EBITDA	814
EBIT	292
Net result for the Group	**40**

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Hellenic Electricity Transmission System: Current status and development outlook

By **EMMANOUIL KORONIOTAKIS**, Chairman, Indipendent Power Transmission Operator (IPTO)

1.Introduction

The Independent Power Transmission Operator S.A. (under the distinctive title "ADMIE" or "IPTO"), is a 100% subsidiary of the Public Power Corporation (PPC) S.A., set up in compliance with the EU Directive 2009/72/EC regarding the legal and functional unbundling of the monopoly Transmission and Distribution functions of vertically integrated undertakings participating in the electricity sector. The provisions of the Directive have been integrated in the Greek legislation with Law 4001/2011, which stipulates the establishment of IPTO according to the Independent Transmission Operator (ITO) model.

Based on the provisions of the said law[1], on 1st February 2012 IPTO undertook the role of the Operator of the Hellenic Electricity Transmission System (HETS or "System"), under which it performs the duties of operation, control, maintenance, development and construction of the mainland and interconnected islands Electricity Transmission System, the operation of the Electricity Market (with the exception of the Day Ahead Scheduling) and the RES management, as well as the connection of new users and the interconnection with neighboring Systems. IPTO, therefore, secures the uninterrupted supply of electricity in the interconnected system with electricity according to the principles of sustainability, and further promotes free competition in the Hellenic Electricity Market with transparency and by ensuring access to all users.

IPTO's compliance with the requirements governing the Independent Transmission Operator model was certified by the Regulatory Authority for Energy (RAE) with its final decision in December 2012[2].

IPTO is a member of ENTSO-E and participates in other European Organizations (for example MEDTSO) with the purpose of developing rules of common action which are mainly related to the unification of the European Electricity Market, including the planned expansion to SE Europe and the Mediterranean region.

2 Existing Transmission Assets

BRIEF DESCRIPTION OF THE HELLENIC TRANSMISSION SYSTEM

The Hellenic Electricity Transmission System (HETS) consists of 400kV and 150kV overhead Transmission Lines, underground and submarine cables, Extra High Voltage Substations and 150kV Substations.

The Transmission Lines, with a total length of 11,365 km, are divided into overhead (10,950 km), submarine (223 km), and underground (192 km). The vast majority of the underground Transmission Lines is installed mainly around and inside the big urban centers of Athens and Thessaloniki.

The mainland system is connected via 150 kV submarine cables with the Ionian Islands (Corfu, Lefkada, Kephallonia, Zakynthos) and two of the Cyclades Islands Andros and Tinos. At the same time, a 150 kV interconnection to additional islands in the Cyclades (Syros, Mykonos, Paros, Naxos) with the mainland System is under construction.

Furthermore, the Transmission System includes 25 Extra High Voltage Substations (400/150/30kV) and 304 substations of 150kV/20kV (step-up, step-down, switching and connection).

The 400 kV System is connecting the major production areas to the main load centers; it covers the whole mainland territory (except Peloponnese) and the main interconnections.

The Hellenic Electricity Transmission System is presented in *Figure 1*.

International Interconnections

The Hellenic Electricity Transmission System is in parallel and synchronous operation with the interconnected European System under the general coordination of ENTSO-E. The parallel operation of the European System is achieved through interconnectors, mainly 400 kV, to the Systems of Albania, FYROM, Bulgaria and Turkey. Furthermore, it is connected with an asynchronous link (through submarine DC 400 kV interconnector) to Italy.

The topology of existing and under development interconnections is shown in *Figure 2*, where the existing, under construction, scheduled and under study interconnections are shown in different colors.

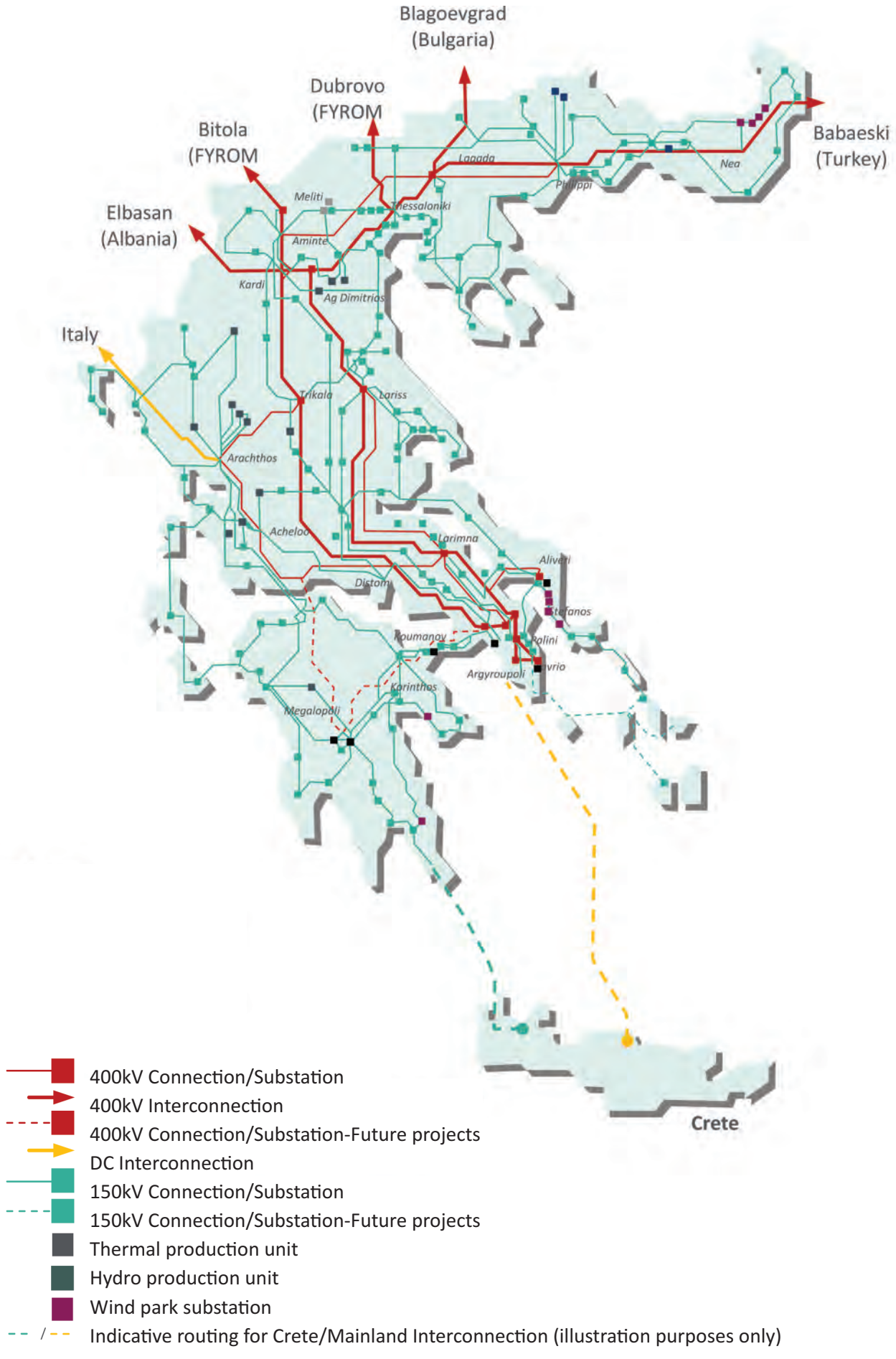

Figure 1: Map of the Hellenic Electricity Transmission System

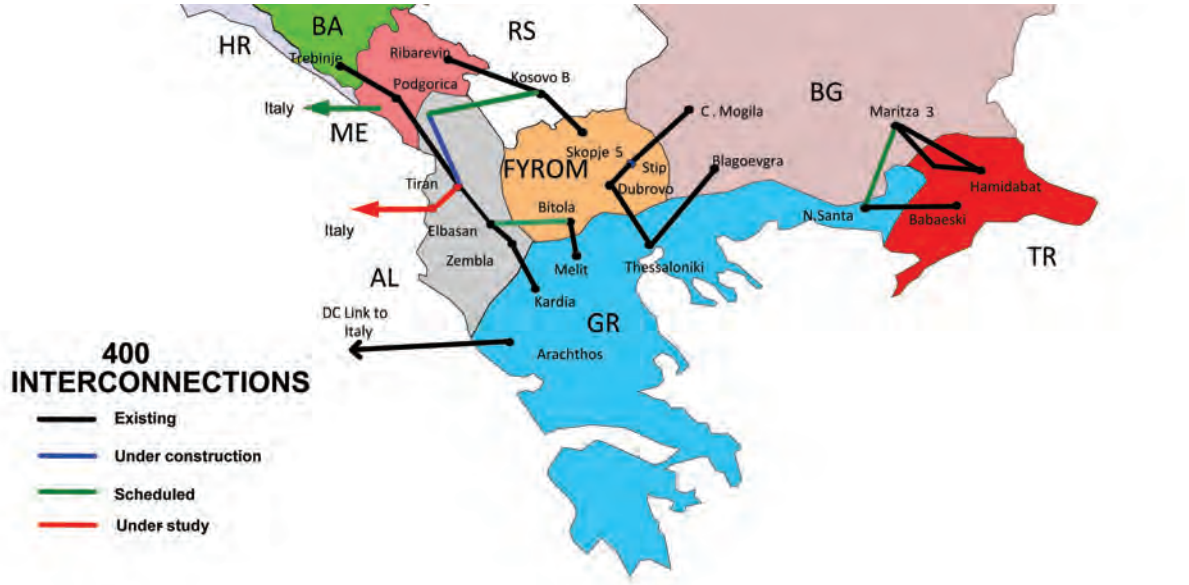

Figure 2: Diagram of the Interconnected Systems of the SE Europe

The above interconnections significantly contribute to the security of the Transmission System and allow the integration of the Hellenic electricity sector to the European electricity market.

3. System Planning & Development

According to the current legislation[3], IPTO is responsible for the development of the transmission system on the mainland and the interconnected islands. More specifically, the responsibility for the development of the System includes:

- planning of the System development and the preparation of a Ten-year Network Development Plan on an annual rolling base's, in order to secure the ability of the System to safely respond to reasonable demands of electricity transmission,

- provision of access to the System to all stakeholders (consumers, producers, traders etc.) and

- implementation of the new transmission projects according to the Ten-year Network Development Plan, including the connection of users (consumers, producers).

3.1 TEN-YEAR NETWORK DEVELOPMENT PLAN (TYNDP)

In compliance with the provisions of Law 4001/2011, IPTO operates, exploits, maintains and develops the Hellenic Electricity Transmission System (HETS) so as to ensure, the country's electricity supply in a safe, efficient and reliable manner but also maintain the long-term ability of the system to respond to reasonable requirements for electricity transmission under economically viable conditions. Minimization of environmental impacts is also a main concern. In this frame, IPTO compiles on an annual rolling basis the Ten-year Network Development Plan (TYNDP), which is published and open for public consultation at the end of each year. Following the results of the consultation, the TYNDP is submitted to the Regulator (RAE) for approval by the end of March. The TYNDP is then subject to a new public consultation process, organized by RAE. Upon completion of this process the TYNDP is accordingly revised by IPTO and approved by RAE.

The currently officially valid TYNDP is the one referring to the period 2017-2026, which was approved by RAE on 4 August 2016 and published on the Government's Gazette as of 17 August 2016.

3.2 RATIONALE BEHIND THE TYNDP

The release of the current TYNDP coincides with a very difficult period for the country due to the on-going economic recession. As a result of the recession, a significant decrease of electricity demand and transmitted power in the HETS has been observed over the last six years. A similar decrease in demand is foreseen in the next decade.

The decrease in electricity demand, combined with the increase of dispersed generation, leads to a significant decrease in the energy and power transmission requirements in order to cover the electric loads in the Transmission System. Therefore, there is a possibility for some transmission projects, mainly related to serving Distribution loads, to be rescheduled but without negative effects on the System's security.

Under this framework, the main drivers for System development are the need for the accommodation of the significant penetration of energy produced by Renewable Energy Sources (RES) and the interconnection of the islands to the mainland Transmission System. According to the national targets set for RES participation at RES in power generation (40% by 2020)[7], significant transmission enhancements are needed to accommodate future RES exploitation. Significant progress has been achieved in the accomplishment of these targets over the last few years. Meanwhile, IPTO, in cooperation with the Distribution Network Operator HEDNO, has already issued a significant number of Binding Connection Offers for RES power stations[2]. These power stations –along with the ones already operating– exceed the intermediate targets for 2014 in total power, and specifically the photovoltaic (PV) ones which have already exceeded the targets of 2020. Further development of the System, as planned for the next decade, will be able to overbalance the targets set for 2020 for all RES technologies, with regard to power transmission capacity.

The interconnection of the Aegean islands with the continental System is also a significant priority. Their interconnection increases reliability of supply, reduces electricity production costs, improves the environment and enhances the exploitation of the high RES potential of the non-interconnected islands. On the other hand by ending the "electrical isolation" of the Aegean islands, EU's unified internal energy market is expanded. In this framework, IPTO is currently proceeding with the implementation of the Cycladic interconnection, the first phase of which is planned to be completed within 2017 [4,5].

Another significant target set in the TYNDP is the interconnection of Crete so as be ready at the start of next decade. This project is of high importance, due to the high loads (power and energy) of the island, but also because of its rich RES potential. The project is technologically complex and requires high investment expenditure and therefore requires careful planning in order to reap the expected benefits[6].

ENTSO-E has scheduled certain actions for the coordinated planning of a European Transmission System which shall allow the increase of RES's share in electricity generation (at higher

levels, i.e. 80%) up to 2050. The target is the creation of Electricity Highways and their design –planning at 5-year stages starting from 2025 up to 2050. In this effort, IPTO participates in a relevant consortium with System Operators– members of ENTSO-E, Universities, Research Institutes and companies of the energy sector.

The mass penetration of units with stochastically varying production utilizing RES potential, mainly wind and photovoltaics (PV), introduces increased variability and requires appropriate planning of the conventional production mix so as to ensure its high "flexibility" by means of units which have the ability of fast ramping up/down allowing frequent start-ups and shut-downs. A significant increase of the pumping hydro plants is also required. At the same time, the capabilities offered by the developing information and telecommunication technologies should be exploited so that, with the simultaneous formation and implementation of the appropriate market mechanisms, the active participation of demand in the production-demand balance is facilitated.

Moreover, the TYNDP includes System development projects and the basic philosophy applied in their design, configuration and planning. More specifically, the TYNDP includes the description and scheduling of the System development projects related to:

- the required in-depth reinforcements of the System, such as new Transmission Lines (T.L.), T.L. upgrading, new Extra High Voltage Substations (EHVS/S) and Substations (S/S) as well as extensions of existing EHVS/S and S/S required for the safe power transmission anticipated during the considered period.

- the necessary projects for the improvement of System operation and cost-efficiency, such as reinforcements of existing EHVS/S and construction of new T.L. for the optimal accommodation of System Users.

- the connection to the System or/and the upgrading of new interconnecting T.L with neighboring countries.

- the projects for the connection to the System (T.L and S/S) of new Power Plants and new High-Voltage (H.V.) Consumers (H.V. Customers and Distribution Network Operator) for which relevant connection studies have already been elaborated.

The implementation schedules of the TYNDP projects reflect their construction planning, taking into account a "reasonable" period for the issuance of the required licenses, the completion of expropriations, the realistic design and construction capabilities of IPTO and its control and supervision abilities. However, a major obstacle preventing the timely implementation of transmission projects is a continuously increasing public opposition. In all European countries, even after the successful completion of time-consuming consultation procedures for environmental licensing, transmission projects encounter significant reactions often leading to re-planning, considerable delays due to local reactions and litigations with a consequent increase of the construction cost.

The most important projects included in the current TYNDP are listed in *Table 1*; the relevant locations are shown in *Fig. 3*.

	PROJECT	TIMING
1	New 400 kV OHL Lagadas – Philippi	**2017**
2	First 400 kV branch to Peloponnese (OHL Megalopoli – Patras – Acheloos)	**2018**
3	Skiathos island interconnection	**2019**
4	Crete interconnection (Phase I)	**2020**
5	Second 400 kV branch to Peloponnese (OHL Megalopoli – Korinthos – Koumoundouros)	**2021**
6	New 400 kV interconnector to Bulgaria N. Santa (GR) – Maritsa (BG)	**2021**
7	Cycladic Islands interconnection (Phases A, B and C)	**2022 (2018 for Phases A and B)**
8	Crete interconnection (Phase II)	**Crete interconnection (Phase II)**

Table 1: The most important projects included in the TYNDP, expected to be implemented in the coming years

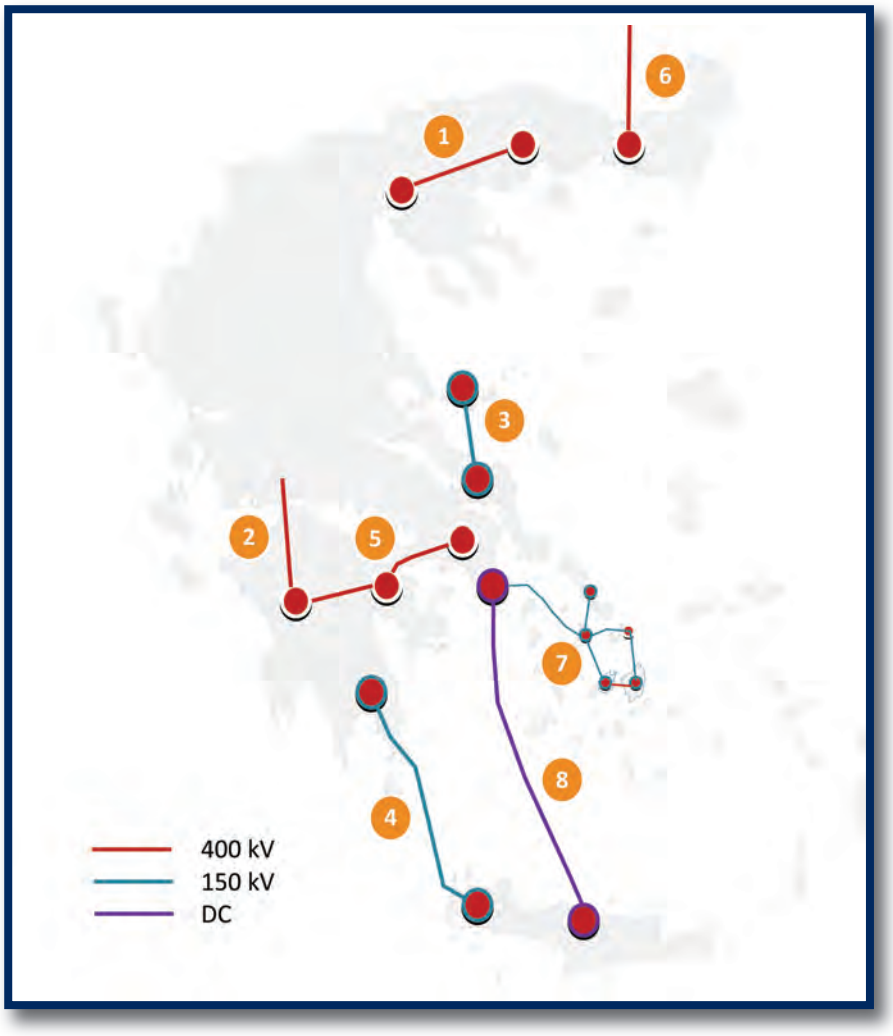

Figure 3: Location of the projects as shown in Table 1

Referances

1 Law 4001/2011 “Study for the operation of Energy Electricity and Natural Gas Markets for Research, Generation and transmission networks of Hydrocarbons and other regulations”, GG A’ 179/22.08.2011
2 “Grid Code of the Hellenic Electricity Transmission System”, RAE’s decision 57/31.01.2012
3 “National Action Plan to achieve 20% RES contribution in the final energy consumption up to 2020”, MEECC, July 2010
4 “Cyclades Interconnection with the Continental System – Final Report”, HTSO – PPC – RAE work group, Athens, May 2005
5 “Update of strategic study for islands’ interconnection with the System – Final Report”, RAE – NTUA, Athens, November 2008
6 “Development of Crete’s Electric System – Interconnection with Continental System”, HTSO – PPC – RAE work group, Athens, March 2011
7 Minister’s Decision, No Φ1/οικ. 19598/1.10.2010, “Decision about the aimed installed capacity ratio and its allocation in time between various Renewable Energy Sources technologies”, GG B’ 1630/11.10.2010

ABBREVIATIONS

APS : Autonomous Power Station
EHV : Extra-high voltage
EHVS/S : Extra-high voltage substation
ENTSO-E : European Network of Transmission System Operators for Electricity
H.V., HV : High Voltage
HETS : Hellenic Electricity Transmission System
HTSO : Hellenic Transmission System Operator SA
M.V., MV : Medium Voltage
MEECC : Ministry of Environment, Energy and Climate Change
Network : Distribution Network
NTUA : National Technical University of Athens
PPC : Public Power Corporation SA
PV : Photovoltaic
RAE : Regulatory Authority for Energy
RES : Renewable Energy Sources
S/S : Substation
SGI : Services of General Interest
SHP : Small Hydroelectric Plant
System : Transmission System
T.L. : Transmission Line
TYNDP : Ten-Year Network Development Plan
W/F : Wind Farm

Emmanouil Thr. Koroniotakis, Electrical Engineer, Chairman of IPTO. He was born in 1959 in Chania – Crete. He received his diploma in 1983.During his military service he worked as Research Engineer in the “Electronic System research group” of the National Defense Research Centre. He worked in the private sector as a Research and Production engineer until 1987.
He joined PPC S.A. in 1987, having served in various positions of responsibility. From 2011 to 2015 he was the head of Cable Projects of ADMIE S.A (IPTO). From May of 2015 he is the Chairman and Deputy CEO of IPTO.
He attended and received special training in Inventory Control Issues, as well as, in the fields of Insulation and Fiber optics technology. He has a long experience in Electricity Transmission projects and significant involvement in major Electrical Interconnections projects such as the Greece – Italy interconnection, interconnection of Ionian Islands and the Cycladic interconnection. He had decisive contribution to the establishment of the Fiber Optic Network in PPC’S Transmission System.
He is the author of various papers in topics related to above mentioned activities in National and international Conferences.
He is a member of the Administrative Council of the National Conferences Committee of CIGRE and member of the Study Committee B1 (SC B1 Insulated Cables) of International CIGRE.
He was a member of the Administrative Council of the Engineering Association of PPC.

Company profile

ELPEDISON has emerged from the collaboration of the HELLENIC PETROLEUM Group, one of the largest commercial and industrial energy groups in South-East Europe, EDISON, Europe's longest running energy company and one of the largest in Italy and the Greek Group ELLAKTOR, leader in the construction sector.

ELPEDISON, with its two privately-owned combined cycle Power Plants in Thisvi Viotias and in Thessaloniki, is the first independent power producer in Greece. The installed capacity of both the plants is 820 MW and the cost of the investment was about € 500 million. The operation of these power plants has contributed considerably to the stability of the Greek Power System.

ELPEDISON is a friendly, environmental responsible and reliable alternative power supplier, which has already achieved a leading role in the Greek energy market by offering competitively priced products and sophisticated services to residential and businesses customers.

For residential customers, ELPEDISON has formed a new product series called "Energy Family" and "Energy Family Plus", covering the different energy needs and requirements of the households in Greece. For business customers, either commercial or industrial, who are connected to Low Voltage, ELPEDISON offers the products portfolio of "Energy Premium" and "Energy Premium Plus". In addition, for businesses which are connected to Medium Voltage, the company offers the competitive products of "Energy High" and "Energy Low" as well as personalized packages, effectively covering the different profile of each customer's consumption.

Alongside the broad products portfolio and its competitive prices, proves ELPEDISON offers a wide range of services to its clients, leveraging the know-how of its shareholders as well as the technology developments. The "myelpedison" services are provided both electronically, via the website www.elpedison.gr, as well as via mobile phone.

In addition, ELPEDISON provides high quality customer support, ensuring the satisfaction of its customers. ELPEDISON, considers that high quality "Customer Service" and "Custom Care" are they most important attributes of its operation. The company's goal is not only to satisfy the energy needs of the customer but also to ensure the creation of a long-term relationship with him, always on the basis of credibility and mutual trust.

ELPEDISON also operates in the Electricity Trading sector, covering the wider European market. The field of activity includes cross-border exchanges in electricity between the Greek system and neighbouring countries, namely Italy, Albania, FYROMacedonia, Bulgaria and Turkey.

Thanks to the know-how and experience that has been inherited from its parent companies, but also the considerable experience of its specialized staff, ELPEDISON aspires to become one the leading companies in the field of energy supply, offering competitively priced energy products and high quality services, in a stable and dependable way, understanding in depth the needs of its customers.

Electricity Market and the Role of LAGIE

By **MICHAEL E. PHILIPPOU**, Chairman and CEO of Hellenic Electricity Market Operator (LAGIE)

The Hellenic Electricity Market Operator - the state owned company under the name "LAGIE S.A."- has been well established for the high quality services it provides to the electricity sector and to the energy intensive industry entities. LAGIE S.A. operates and manages Greece's electricity market and its associated systems and mechanisms and it fulfills various roles while its duties and obligations are expected to expand significantly in the immediate future.

I. The Electricity Market

Today LAGIE S.A. operates the Hellenic Day Ahead Electricity Market as the Electricity Market Operator. Acting as a Central Counter Party (CCP), LAGIE S.A. is responsible for the Clearing & Settlement Procedures of the Day Ahead Market and has being applying successfully an in-house Risk Management Algorithm and Mechanism. On top of the above, LAGIE S.A. is also the Administrator of the Day Ahead Scheduling Participants' Registry.

According to the standing legislative framework (L.4001/2011)and in the course of fulfilling its duties, LAGIE S.A. is expected to facilitate the integration of the internal electricity market by undertaking all necessary measures, within its statutory power, so as to ensure the implementation of the provisions of Directive 2009/72/EC.

With respect to the organization and governance of the internal electricity market in particular, LAGIE S.A. has been appointed as the sole Nominated Electricity Market Operator (NEMO) responsible for the Market Coupling of the Day-Ahead and Intraday electricity markets according to article 4 of EU regulation 2015/1222 that sets out the guidelines for Capacity Allocation and Congestion Management.

With regard to electricity markets operation, LAGIE S.A.'s responsibilities are expected to expand in the immediate future, given that starting from 31/12/2017 (L.4336/2015) and following the design and the implementation of the corresponding infrastructure, LAGIE S.A. will operate three distinctive markets (Forward, Day Ahead and Intraday Markets) as it applies to all EU Power Exchanges and Market Operators towards the "Target Model" implementation.

In the context of implementing EU regulation 1227/2011 (REMIT) regarding the integrity and transparency of the wholesale electricity market, LAGIE S.A. has been certified from the Agency for the Cooperation of Energy Regulators (ACER) as the Registered Reporting Mechanism-RRM and as such has undertaken since 7/10/2015 the submission to ACER of reports including all transaction data of the Day Ahead Market, on behalf of the Hellenic Energy Market participants,. As of 7/4/2016, when the second phase of reporting transaction data of bilateral contracts was initiated and in order to service all market participants in the Hellenic territory, LAGIE S.A. extended its services as RRM so as to provide all market participants with reports for their bilateral contracts for electricity and natural gas as well.

II. System of Renewable Energy Sources (RES) and High Efficiency Cogeneration of Heat & Power (CHP)

As the Counterparty of Investors/Producers of Electricity from RES & CHP stations, LAGIE S.A. enters into Power Purchase Agreements (PPAs) (as per article 12 of L.3468/2006) for the purchase of electric energy (MWhs) produced from RES and CHP plants in the interconnected system. LAGIE S.A. is also the Administrator of the RES & CHP plant registry. In addition, LAGIE S.A. the Administrator of the RES and CHP Special Account as per article 40 of L.2773/1999, manages the account financially and issues, on a monthly basis, the relevant report which also includes a two-year forecast of the account balance. By using the hourly predictions of the Independent Power Transmission Operator SA (ADMIE) concerning energy injection from Roof PVs, RES and CHP into the distribution network and the transmission system, LAGIE S.A. represents the corresponding producers by acting as an Aggregator in the Day Ahead Market and by submitting on behalf of them zero-priced energy offers per system zone (North-South).Moreover as a Clearing House of electric energy produced from roof PVs (per supplier) and RES/CHPs (per station), LAGIE S.A. is responsible for the settlement of transactions in the context of the relevant FiT bilateral contracts while in the near future it will undertake to operate the new RES's support scheme.

III. Hybrid System of Dispatched High Efficiency CHP units

LAGIE S.A.is also the Administrator of the System of Dispatched High Efficiency CHP Units. High Efficiency CHP Units participate in both previously mentioned systems I and II i.e. partly in the wholesale electricity market and partly in the system of RES and CHP. These power plants are listed in the «Dispatched Units Registry» that is administered by ADMHE S.A. and have entered into the «Supplementary Energy Transaction Contract of High Efficiency CHP Dispatched Unit» with LAGIE S.A., possessing an «Approved Technical Addendum». The legislative framework covering the operation of production units of the Hybrid System of Dispatched High Efficiency CHP Units was deemed necessary according to the provisions of article 197 of L. 4001/2011 which provided priority rights, during load allocation, to all High Efficiency CHP Units irrespective of their capacity. The content of Article 197 of L.4001/2011 became more elaborate by MD749/ 22.03.2012 (*Government's Gazette* no. 889 B') and MD23278/23.11.2012 (*Government's Gazette* no. 3108 B'). In order to ensure the reliable and transparent operation of the Hybrid System, LAGIE S.A. has created and is also the administrator of the CHP Certification, Verification and Inspection Bodies'Registry.

IV. Guarantees of Origin and Energy Disclosure Systems

LAGIE S.A. is the appointed issuing body for Guarantees of Origin (GO), which are issued for electric power generated from RES and CHP in the Domain of the Hellenic Interconnected System (L. 3468/2006). It is also responsible for the implementation and operation of the GO Information System (MD Δ6/Φ1/οικ.8786/2010), which supports in a secure, accurate and anti-fraud manner the operation of Guarantees of Origin Registries. The GO Information System serves the GO Registries of all three issuing bodies appointed in different Domains in Greece: LAGIE S.A. for the Interconnected System, DEDDIE S.A. (DSO of the non-Interconnected Islands) for the non-Interconnected systems and CRES for the autonomous electricity generation stations. In addition, LAGIE S.A. as the competent body for electricity disclosure ensures that every single MWh produced is taken into account only once, not only within Greece but also across Europe, by being in collaboration with the Association of Issuing Bodies (AIB). In this context LAGIE S.A. acts as the Administrator of the Suppliers Electricity Disclosure System, and by taking into account the GOs cancelled and the Country's Residual Mix, calculates the contribution of every energy source and the respective environmental impact in each Supplier's fuel mix, and provides each supplier with the necessary information which he is in turn obliged to make known to his portfolio of clients (as per L.4001/2011). In the future, LAGIE S.A. aspires to play the role of the Environmental Markets Operator and through the operation of organized markets for Guarantees of Origin to ensure additional resources for promoting RES penetration and enhancing environmental protection.

V. Auctioneer of the Hellenic State for the Greenhouse Gas Emission Allowances

In the process of implementing EU Guideline 2003/87/EC which refers to the establishment of a common system for the trading of greenhouse gas emission allowances, LAGIE S.A. has undertaken, since 12.10.2014, the role of the Auctioneer of the greenhouse gas emission allowances allocated to Greece, thus representing the Hellenic Republic in the auctions performed in the common auction platform of the European Energy Exchange (EEX). The EEX is an energy exchange based in Leipzig, Germany. It develops, operates and connects secure, liquid and transparent markets for energy and commodity products. At EEX, contracts on Power, Coal and Emission. Allowances as well as Freight and Agricultural Products are traded or registered for clearing.

Alongside EEX, EPEX SPOT, Powernext, Cleartrade Exchange (CLTX) and Gaspoint Nordic are also members of EEX Group. Clearing and settlement of trading transactions are provided by the clearing house European Commodity Clearing (ECC). EEX is part of Deutsche Börse Group.

VI. Carbon Leakage Compensation System

Since 09.12.2014, LAGIE S.A. as the Administrator of the Carbon Leakage Compensation Mechanism has undertaken the implementation of the compensation mechanism for the indirect cost of emissions of companies that belong to sectors that are exposed to considerable risk of carbon leakage and has also undertaken the role of the Provider of State Aid for the provision of the relevant financial aid for the period 2313-2020 (JMD ΑΠΕΗΛ/οικ. 21906/09.12.2014, Government's Gazette no3304 B'). In order to ensure the reliable and transparent operation of the Carbon Leakage Compensation Mechanism, LAGIE S.A. has created and acts as the Administrator of the CLCS Verification Bodies'Registry

In accordance with its Articles of Association and within its scope, LAGIE S.A. carries out its tasks in the public interest in the sense that the company supports the operation of the Electricity Energy Sector and of the relevant Day Ahead market as well as of the energy intensive industry. LAGIE S.A. by operating the Hellenic Electricity Market efficiently and through its Risk Management Procedures and Mechanism, which protects the market from unreliable participants, acts in the best interest of Greek consumers. On one hand LAGIE S.A. has the obligation to mitigate financial risks while on the other hand it has the responsibility to organize financial markets, where energy related and environmental products can be traded, according to the country's EU obligations. Consequently, it becomes imperative for LAGIE S.A. to be allowed to operate in a flexible and effective manner in order to fulfil its mission.

LAGIE S.A. must be able to employ the necessary scientific personnel in order to respond to its new duties and pass on the know-how of its executives in a developing sector that holds much promise with respect to new investments.In this way it will contribute to the national economy and also assist in curbing the so called "brain drain" of qualified young Greek scientists abroad.

In conclusion, LAGIE S.A. must have the operational flexibility of private sector entities, as stipulated in L.4001/2011, and must also be able to proceed with PPPs (Public- Private Partnerships) especially designed for the expansion of electricity, natural gas and environmental markets in the geopolitically sensitive Balkan area, including transnational agreements that are necessary for the viability and development of energy sector businesses for the benefit of the Greek consumer, the domestic industry and the national economy in general.

Michael E. Philippou was born in Athens, Greece in 1959. He received his Diploma in Electrical Engineering in 1982 from the University of Patras and his Master's degree in 1986, from Clarkson University, Potsdam, New York USA
During 1986-2001 he worked for Public Power Corporation of Greece (PPC SA) in several positions of responsibility, main of which are: Chief Dispatcher at the National Energy Control Center, Design Engineer, one of the Project Managers of the modern National Energy Control Center in Kryoneri, Attica, and Support Engineer of National Energy Control Center Information Systems for Production Unit's Automatic Control (Automatic Generation Control-AGC).
His professional involvement with LAGIE SA began in 2001 (HTSO SA at that time) being in several high ranking positions with duties relative to Electricity Market, Cross-border Trading, Renewable Energy Sources, Guarantees of Origin & Energy Disclosure Systems, Cogeneration and Regulatory Affairs, whilst in 2009 he was appointed Director of the Day Ahead Scheduling Operations Department. Following the spin-off of the HTSO, he remained at LAGIE S.A. and immediately assumed the duties of Executive Director of Power Exchange Department. He has also served as regular member in the Market Committee of European Network of Transmission System Operators for Electricity (ENTSO-E), from its foundation until January 2012.
As from the 8th of March 2016 he is the President & CEO of LAGIE S.A.

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an agile energy trade company active in C&SE Europe

The Role of Electricity Trading in Safeguarding Greece's Electricity Supply

By **CONSTANTINOS ATHANASIADIS,**
Chairman, Hellenic Association of Electricity Trading & Supply Companies (HAETSC)

The Greek electricity market has been structured as a mandatory pool as a first step to facilitate its gradual liberalization. The pool is supposed to moderate the ability of the incumbent to build barriers of entry to competition and facilitates the establishment and operation of multiple participants throughout the chain (production, wholesale, retail). However, 16 years after the first law for the liberalization of Greek electricity market, there have been few new developments.

Competition in generation is limited since Independent Power Producers (IPP's) operate only gas fired plants, with PPC being the only producer with lignite fired and large hydro plants. This separation has been directly or indirectly dictated by Government decisions and delays. In 2009 the Government decided overnight to remove hard coal from Greece's energy mix and in the years that followed no new lignite field was tendered. This has led to a conviction of Greece from the European Court of Justice for allowing monopolistic practices and restricting equal access to low cost generation to all market participants. The initial proposal from EC was for PPC to sell at least 30% of its lignite fired and large hydro generation infrastructure. The Greek Government understanding that such an action was highly problematic under the current financial situation where assets are difficult to be valued at fair prices, proposed to implement a model based on the French NOME act and ARENH price. Its application aims at increasing the competition in retail market through improved access to low cost generation.

The Greek retail market has been fully liberalized since July 2007, when households were also allowed to freely switch suppliers. However, this liberalization is only in theory, as the incumbent player still holds more than 95% of the market. Alternative suppliers have faced multiple barriers to entry during the past years, because of distortions in the Greek electricity market. During the past 2 years parts of these distortions were removed (though not always without causing new ones). The Greek "NOME", when and if applied, could assist in the increase of competition if properly designed and priced.

Cross Border Trading is the only sector where liberalization is successful and competition is present. Based on last available data from the Electricity Market Operation (LAGIE) during the period of January to July 2015 there were 32 companies active at the Greek borders that traded a total volume of nearly 8.1GWh. The incumbent company had a market share below 25% and there were 12 companies with market shares ranging from 2% to 17%. Lately there has been a lot of discussion about the role of cross border trading in the operation of the Greek electricity system, its contribution, the effects on prices, etc.. Throughout the years cross border trading has been "accused" of controversial effects. There have been voices claiming that imports are expensive and lead to higher prices. On the other end, some claim that imports are zero priced and thus "substitute" local production, leading to devaluation of local investments. Net imports during January to July 2015 equalled to 22% of the production mix, with 37% lignite fired, 10% gas fired generation, 12% from large hydro and 19% from RES and Network production. During the same period in 2014 net imports equalled to 15% of the production mix, with 46% lignite fired, 13% gas fired generation, 8% from large hydro and 18% from RES and Network production. Many claim that imports have "forced" part of low cost lignite fired generation to operate at lower levels, thus increasing the prices. However, this is not possible in the way that the Greek electricity market is structure today. The hourly Greek wholesale price (System Marginal Price – SMP) is calculated based on an algorithm using merit order and aiming at the lowest possible daily price in order to increase the social benefit. At the end of the day, it does not matter what the actual bid is, as only bids leading to higher social benefit will be accepted and then paid at the SMP. At the same time, the drop in the energy mix from 13% to 10% for gas fired generation was not caused by increased imports, but mostly by the abolition of the cost

recovery mechanism (through which IPP's were monthly paid) in July 2014, which has left the gas fired plants totally exposed to the market, even when ordered to dispatch for system stability reasons.

Trading, even at the current minimal operation at cross border level, has always contributed to the stability and smooth operation of the Greek electricity system. When cfross border trading is allowed to operate without major distortions, it safeguards that Greek prices remain within cost reflective limits. Traders always aim to transfer electricity from lower priced regions to higher priced ones. As demonstrated in a number of occasions in the past few years, when Greek SMP prices were increasing (even at hourly level), trading was there to "correct" excessive pricing and lead SMP to lower levels. In addition, if due to particular conditions in the Greek market, SMP was staying at extremely low levels (which usually have negative effect in generation sustainability), cross border trading helped increase them at reasonable levels through higher exports. Hence, cross border trading has always operated as a true "balancing" power for Greek electricity prices.

However, this is not the only, and possibly not the most important contribution of electricity trading. One of the main concerns of all companies active in sales is how to hedge their end consumers' portfolio. The Greek electricity market is limited to Day Ahead Market without the presence of any forward market (either financial or physical) that could allow Suppliers to hedge themselves against Day Ahead volatility. Cross border trading offers this valuable service, as Suppliers have the opportunity to conclude long term contracts that meet their demands. Currently, based on LAGIE data, all alternative suppliers have high degree of hedging limiting their exposure to the variations of SMP. Hence, allowing them to apply lower safety margins and thus offer more competitive prices to consumers.

The planned transformation of the Greek electricity market to a structure and operation compatible with the Target Model will allow trading to increase its contribution to the stability and liquidity of the Greek electricity system. The new markets to be introduced (e.g. intraday, balancing, etc.) can offer great opportunities to apply tools already present in other European countries so as facilitate ADMIE's operation, while at the same time allowing RES to grow (profitably) at market terms, offering medium and large consumers better prices through market based Demand Response, allowing generation to hedge their production, etc. Trading is a crucial pillar of our electricity market, which if allowed, can facilitate its liberalization while offering tools with increased benefits throughout the chain.

Konstantinos Athanassiadis, Chairman ESEPIE. Mechanical Engineer, holding B.Sc. (Eng) Engineering with Business Finance of University College London and M.Sc. Engineering with specialization in Engineering Management of City University. With 17 years of international experience, having undertaken consultancy projects in different sectors, both in Greece and abroad. Since 2008, he holds the position of Regional Manager of GEN-I Athens, which quickly became the largest alternative trader of electricity in Greece, with active participation in the development of the Greek market. Since September 2014 he holds the position of Chairman of the Board of the Hellenic Association of Electricity Trading & Supply Companies (ESEPIE). ESEPIE has been actively participating in the development of the Greek electricity market and the transition to a new framework compatible with EU Target Model.

5. Renewable Energy Sources

Renewable Energy Applications in Greece: Challenges and Opportunities

By **JOHN CHADJIVASSILIADIS**, Chairman, Institute of Energy for SE Europe (IENE)

Technology development and concern for the environment pave the way for the extensive exploitation of renewable energy sources to cover the demands of modern society and the economy in a sustainable way, notably through the production and use of heat, production of biofuels for transport and power generation. The high penetration of RES into the energy mix together with energy efficiency actions are the main drivers of the energy sector towards a sustainable future.

Greece is pioneer in Europe in solar thermal systems since the 70's and in wind energy and solar photovoltaics for power generation since the 80's. However, RES applications for power generation by the private sector were much delayed and a finally started in the mid of 90's with significant actions and problems during the two past decades.

1. Production and use of heat

The applications in this field are considered of high priority for the country, taking into account the multiple economic, social and environmental benefits. In general, these applications have low budget investments with high local added value and short payback period, thus creating high number of jobs per invested capital while they contribute to regional development.

It should be further pointed out that there are favourable conditions in the country for passive solar architecture and active solar thermal systems. A specific industrial branch with "know-how" and standards has developed for the manufacturing of high quality solar collectors and domestic hot water systems for the local market and for export, with thousands jobs. Although there is a local market for solar thermal systems, the applications are lagging behind the county's potential. An appropriate strategy with ambitious targets is absolutely necessary for further penetration of solar thermal systems in the household sector, in the tertiary sector, in industry and agriculture with priority in the islands to substitute electricity generation based on oil.

Greece has an important geothermal potential of low enthalpy at a small depth, dispersed in the mainland and the islands, for attractive thermal applications. Institutional and supporting measures for further use of geothermal energy in agriculture and district heating are reccomeded. Moreover, ground source heat pumps for heating and cooling in buildings should be promoted.

The biomass for heat production and use is associated with the collection and storage of agricultural and forest biomass and residues, as well as with the production of pellets and their market development. This biomass is mostly used for space heating in a traditional way while partly is also used for industrial processes. By introducing the appropriate facilities, there is a potential for production and use of pellets for space heating and industrial processes and thus, efforts and measures are needed to this direction.

Another important area concerning environmental and energy aspects, where Greece lags behind other European countries, is the use of the municipal solid waste, after the recycling phase, for energy purposes. A good practice would be the production or use of fuels for industrial thermal processes and combined heat and power generation. Thus, new ideas and environmentally friendly practices should be introduced in the management and processing of the municipal wastes for energy purposes, also following best European practices.

2. Production and use of biofuels

International community efforts for sustainable development are focused on the substitution of fossil fuels by renewables, which can also introduce multiple benefits. The role of biomass, especially, is very important, as the global biomass production must cover the needs for food for both human and animals, the needs for raw materials from the chemical industry to produce goods, for construction, and for the increasing energy demand.

New technologies are being developed to increase the biomass production and its efficient transformation to alternative energy forms. The production of biofuels for transport is now based on energetic crops, but second and third generation of this technology will enable biofuel production from non-food biomass in the near future.

Policy measures addressing the production of biomass and biofuels in the country and further penetration of biofuels in the transport sector will bring additional income to the farmers and create new jobs with economic and social benefits, while it will improve the security of energy supply.

3. Power generation by RES

Greece has a significant potential in all forms of renewables, capable of creating an appropriate and efficient mix. Intermittent energy from solar photovoltaics and wind energy can be combined with hydro and flexible fossil fuel plants with low emissions. There is an exponential development of RES technologies and applications worldwide, leading to lower capital costs, low and almost stable running costs and high reliability and availability of the facility. The global investments in RES are ranking in the first place for power generation over the last years and the same is expected in the future. Centralized generation is clearly in decline, including the retirement of coal power plants, in a way to decentralize and decarbonize electricity production. It is obvious that the new era of renewables has begun, not just because it is green, but because it is cheaper compared to fossil fuels.

Therefore, power generation is now moving towards its democratization: from the utilities with the large central power plants of the last century to a large number of owners of small-size dispersed renewable units. However, this transition requires a reasonable time. Ambitious targets

for immediately replacing fossil-fuel power plants can lead to rush actions and this must be avoided.

High RES penetration require network and market transformation adapted to the dynamics of the power sector in the long-term, covering a wide range of the societal and economy needs with affordability, sustainability, high reliability and quality of power supply. A new architecture in the design of the electricity grid should be introduced, based on new ideas and innovations to transform the passive grid into an active one. The crucial parameter for RES is the easy access and connection to the grid system and their integration into the network, towards the future networks of the 21st century.

The integration of modern RES technologies in the operation and management of the grid is the main goal using effectively the ICT (Information and Communication Technologies). New concepts of smart grids and microgrids contribute to an efficient operation and management of the system under a high RES penetration. Smart grids and a new electricity market structure will improve the operation, efficiency and resilience of the system, while optimising energy resources and investments.

Basic characteristic of the future electricity systems will be the flexibility in power generation, transmission, distribution and loads. Large interconnections, storage facilities, effective DSM (demand side management) techniques, interactive communication between consumers and grid operators, accurate forecasting models, security models against cyberattacks, advanced control strategies and management tools and a new structure of the electricity market are among the necessary actions. Moreover, the necessity to move to a more interconnected system in Europe for the management of the system and the operation of the market should be emphasized. The electric vehicles with their storage facilities can be used as an extension of the grid management by ICT with mutual benefits.

There is a long way in the transformation of the electricity system with RES, but the efforts must start now to avoid additional costs later. A vision with targets and a long-term energy planning based on specific studies are absolutely necessary for Greece. The successful transformation of the electricity sector and its competitiveness will be based on innovations and skilled staff, including R&D actions to increase the local added value. Moreover, new services and business models for the utilities in a sustainable way seem to be necessary.

A big challenge in the short to medium term is the phasing out the use of oil for electricity production in the Greek islands and replace it through high production from RES. This can be achieved through interconnections to the mainland grid, which are also of high importance not only for the Greek but also for the European system. Cyclades islands and Crete are the first candidates for such interconnections. At the same time, the autonomous electricity system based on oil in medium-size islands can be transformed to RES integrated systems having the oil as supplementary source, while for small-size islands the autonomous system should be based on RES with a diesel unit back-up.

Technological, political and regulatory measures are needed to move toward a truly integrated power system with even greater connectivity with solar and wind mainly in a way that helps the overall system stability, market operation and viable grid operation. Substantial amounts of investment are needed during the next decades for the development of future electricity net-

works. In this respect, a road map for infrastructure investments and market design would be helpful.

In conclusion, a vision and a long-term strategy with targets for RES development in the country should be elaborated. Moreover, a new institutional framework minimizing soft costs and delays and removing the barriers is needed, having in mind the best European and international practices. A well-structured plan for RES applications will create a large number of new jobs with substantial economic and social benefits in the long-term, improving the competitiveness of the country and strengthening the security of energy supply.

John Chadjivassiliadis, President of IENE. Dipl. Mechanical and Electrical Engineer of the NTUA (1960) is expert in the development of the renewable energy sources and sustainable power systems. Worked for the Public Power Corporation (1962-1990) in the department of power generation, he was director of power plants, and project manager in large power plants. From the mid-1970s John was in charge of the development of wind and solar energy projects for power generation with the successful Windpark of Kythnos, the first in Europe (1982) and the biggest hybrid by wind and solar PV. Since 1990, he is consultant engineer in energy, especially in the renewable energy sources, energy efficiency and sustainable development. For many years he served as an expert in evaluating research proposals and programs, coordinator and technical assistant of large research projects for RES integration into the networks within the European Commission research programs.
John Chadjivassiliadis has been a scientific committee member in a number of European and international conferences, invited lecturer in international events and conferences where he presented over 80 papers. H e is founding Member of the European Wind Energy Association (EWEA, 1982), member of national and EU missions for international cooperation in scientific research and technology, founding Member and Secretary General of IENE, National Representative in the Mirror Group of the European PV Technology Platform, Member of the Scientific Committee of the Hellenic Association of Mechanical and Electrical Engineers, Major in Reserve of the Hellenic Army in the Technical Corp. He is the recipient of the «Prize Aeolus» Award, for his contribution in wind energy development, by the Hellenic Wind Energy Association-member of EWEA (2009), as well as of the «2010 PES Chapter Outstanding Engineer» Award, for his contribution in renewable energy research and development by the IEEE Power & Energy Society, PES Greece Chapter.

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Greece: In Urgent Need of an Investment Shock*

By **GEORGE PERISTERIS**, CEO, GEK-TERNA Group

From the moment that the economic crisis hit Greece, I have not stopped pointing out that the only way to reduce and subsequently reverse the negative effects and detrimental impact of the recession is a widespread Investment Shock.

The country is in need of a real investment shock in order to "breathe" again, to jump-start the economy, to produce and maximize domestic added value, creating in the process thousands of new jobs, and, thus, provide a solution to the huge social problem of unemployment. The country is bleeding every day because of unemployment.

Meanwhile, in our country, foreign investments have been bestowed almost messianic dimensions. Of course, foreign investments are necessary. But the catalysts, those who are at the fore-front of the quest for creating an investment wave, are always the domestic investors.

In every country in crisis, the first who dare to invest are the local entrepreneurs, only to be followed by the foreigners, as has been documented by a relevant World Bank study. But in Greece, the domestic investors are being pushed aside and forced to quit all efforts to implement local investments and to move overseas (!).

Our Group has invested more than 1.5 billion € in Greece during the crisis, and, against all demons, has actively supported the Greek banking system by continuously maintaining the sum total of our disposable assets in Greek banks.

What our Group and other Greek investors, who continue to support our national economy, request is for the government to finally make a serious effort and commitment to boost investments.

The government must finally take some decisions, as the days and months pass by and nothing is moving on the investment front. Let me be more specific on this:

Is the government in need of large scale development projects with important domestic added value and multiplier effects for the economy, the environment and employment, or does it pre-

*This text is based on a speech Delivered on 1 December 2015, at the 26th Annual Conference on "The Greek Economy" organized by the American-Hellenic Chamber of Commerce

fer to promote only small, fragmented projects of low economic impact, leading to a waste of resources and increased environmental burden?

By adopting miserable approaches, without vision and planning, like the promotion and support of only small RES installations or of other scattered and ad-hoc small scale projects, neither an investment shock can be achieved, nor the environment can be protected.

Some speak of the need for environmental protection. Who would disagree? Obviously, environmental protection is a top priority. However, who should decide on how to go about it? The constitutionally coordinated State or a variety of local interest groups with an alternative view of reality?

Also, there are certain regulations which are incomprehensible and discourage productive investments. For example, additional taxation is imposed on anyone who deals specifically with certain minerals in the primary and secondary sectors (mining and production); thus, finally it pays more to deal with any kind of imports than to delve in substantial manufacturing activities with increased domestic added value.

Energy and the environment should be the priority areas for the implementation of large scale, domestic-added-value-oriented, high employment investment. In this context particular attention should be given to environmental investments of increased energy valorization capacity, for example in the treatment of waste, district heating, etc.

Domestic energy sources, above all the environment-friendly renewables and the energy infrastructure needed for their large-scale integration in the national energy system, should form the core of our national investment effort, as is the case throughout Europe, the United States, and the rest of the world.

If we do not take advantage of the country's huge competitive advantage in RES (significant, largely unexploited wind, hydroelectric and solar potential - among the highest in the world), where else shall we channel our investments on?

Allow me to stress that, at some point, that the State must end the artificial overrating of public support for RES and their defamation through ETMEAR – a levy allegedly imposed on energy consumption for the mitigation of air pollution – which, instead of supporting RES, in reality increases the income of electricity suppliers and has been repeatedly used as a tool to patch up every conceivable hole in the operation of the national electricity market and which has nothing to do with RES.

In this context I would like to refer to the conclusions of a recently published study of the Council of the European Energy Regulators (CEER), according to which Greece had the third lowest, actual subsidy level (in € / MWh) throughout the EU for all renewable technologies other than photovoltaics in 2012 and in 2013; during the same period Greece featured the highest electricity supply cost from the wholesale market in the EU.

But, let me go beyond these general observations and remarks on investment strategy and present specific facts and figures, in terms of simple but impressive numbers:

One of the biggest, if not the most important problem for power generation in Greece, is that the installed conventional power plants in the mainland (totaling 13.200 MW) are currently 'trapped' both geographically (weak or no links with the Greek islands or with neighboring countries) as well as production-wise (drastic reduction in domestic demand due to the economic crisis).

As a result, these stations are forced to underperform for long periods of time (while imports are inflated), they are devalued economically (especially the non-amortized, technologically advanced, combined cycle natural gas stations) and, finally, a substantial part of them are driven deterministically to temporary or permanent suspension of operation (closing down). This, however, will jeopardize the country's security of supply in electricity as soon as demand recovers, which is expected to occur within the ensuing couple of years.

At the same time, a huge potential for electricity generation from RES in many islands of the Aegean (onshore and offshore), which exceeds - according to reliable estimates - 10.000 MW (mainly wind, and P / V), remains untapped.

Today, only 500 MW RES are installed and operate in the non-connected islands of the Aegean. Thus, while Europe is "thirsty" for green energy and sets ambitious relevant quantitative targets for 2020 and 2030, Greece, which has abundant renewable energy potential, is unable to exploit and to channel it towards high demand / consumption centers, both nationwide and abroad.

As if this were not enough, the electricity demand in the Aegean islands continues - for decades now - to be covered by local, obsolete, highly polluting and uneconomic oil - fired power stations (1.500 MW in total) in conjunction with expensive gen-sets and open cycle gas turbines. Long power outages and black-outs both during the summer holiday season as well as during the winter are a common occurrence in the non-connected islands of the Greek archipelago. This system costs 800 mil € each year to the national economy and to the Greek consumer, who pays them in full through the special public utility service charges (ΥΚΩ) incorporated in his / her electricity bill.

In my view, the optimal solution is the implementation of a fast-track development / investment program over a five-year horizon (until 2020) for the electrical interconnection of all Aegean islands with the mainland.

Such a development program, which has great financing potential through grant awards and low interest loans from both the PCI Program and the Juncker Plan and excellent prospects of strong private sector participation, through partnerships with the government, has a total cost about 4 billion €.

This means that the entire investment can be amortized in only 5 years, through the ΥΚΩ alone (800 mil. € / year), which will be abolished forever as a burden to the consumers upon operation of the interconnections.

Moreover, the aforementioned integrated investment program for the interconnection of the Aegean islands to the mainland offers many additional benefits for to economy, in terns of growth, creation of employment, protection of the environment, security of energy supply,

etc., a detailed presentation of which goes beyond the scope of this intervention.

These are the undeniable facts and data that clearly demonstrate the direction of efforts and institutional initiatives the State needs to take in order to attract investment in our country. Relevant actions should be swift and intensive.

By contrast, what does Greece do as a State? I would say that we are looking away to other, less important and peripheral matters. For example, it has become a huge governmental issue what the ownership structure of the national TSO will be, sidelining the debate and the decisions on matters of essence such as what, how, when and with what funding the (whatever) TSO will be able to implement the energy infrastructure and interconnection projects that are critical for the country, for the economy, for employment and for the environment, and which I alluded to earlier.

It is high time that long awaited responses, decisions and actions by the State on this most important subject are provided. Because for every day that passes by, the damage (high YKΩ and electricity charges, increasing environmental burden, growing unemployment, etc.) is paid by the Greek people.

But, as usual, it seems that we rather talk about growth than act on ways to achieve it; and then, inevitably, we have to face the unpleasant consequences….

George Peristeris, CEO GEK TERNA S.A., Chairman TERNA ENERGY S.A. Born in Athens, Greece in 1957, received his degree in Civil Engineering in 1980 from the National Technical University of Athens. His professional involvement with TERNA S.A. began in 1981. From 1982 through 1984 Mr. Peristeris was the Construction Director of major construction projects. In 1984 he became Chairman and Chief Executive Officer of TERNA S.A.
Major achievements through his career include:
In 1993 TERNA S.A. IPO in the Athens Stock Exchange.
In 1997 he founded TERNA ENERGY S.A. to enter the renewable energy production sector. TERNA ENERGY is since a leading company in RES in SE Europe. IPO in Athens Stock Exchange 2007.
In 1999 GEK and TERNA consolidated, forming GEK TERNA Group.
In 2000 he was elected President of the Hellenic Association of Renewable Energy Producers.
In 2002 he became Chairman of GEK TERNA S.A.
In 2003 HERON THERMOELECTRIC S.A. was established to become the first privately owned Greek thermoelectric plant, which was followed by the establishment of HERON II.
He is actively involved in the construction sector as well as in the electricity production sector especially from Renewable Energy Sources. The company operates wind farms in Greece, Bulgaria, Poland, and the U.S.A.

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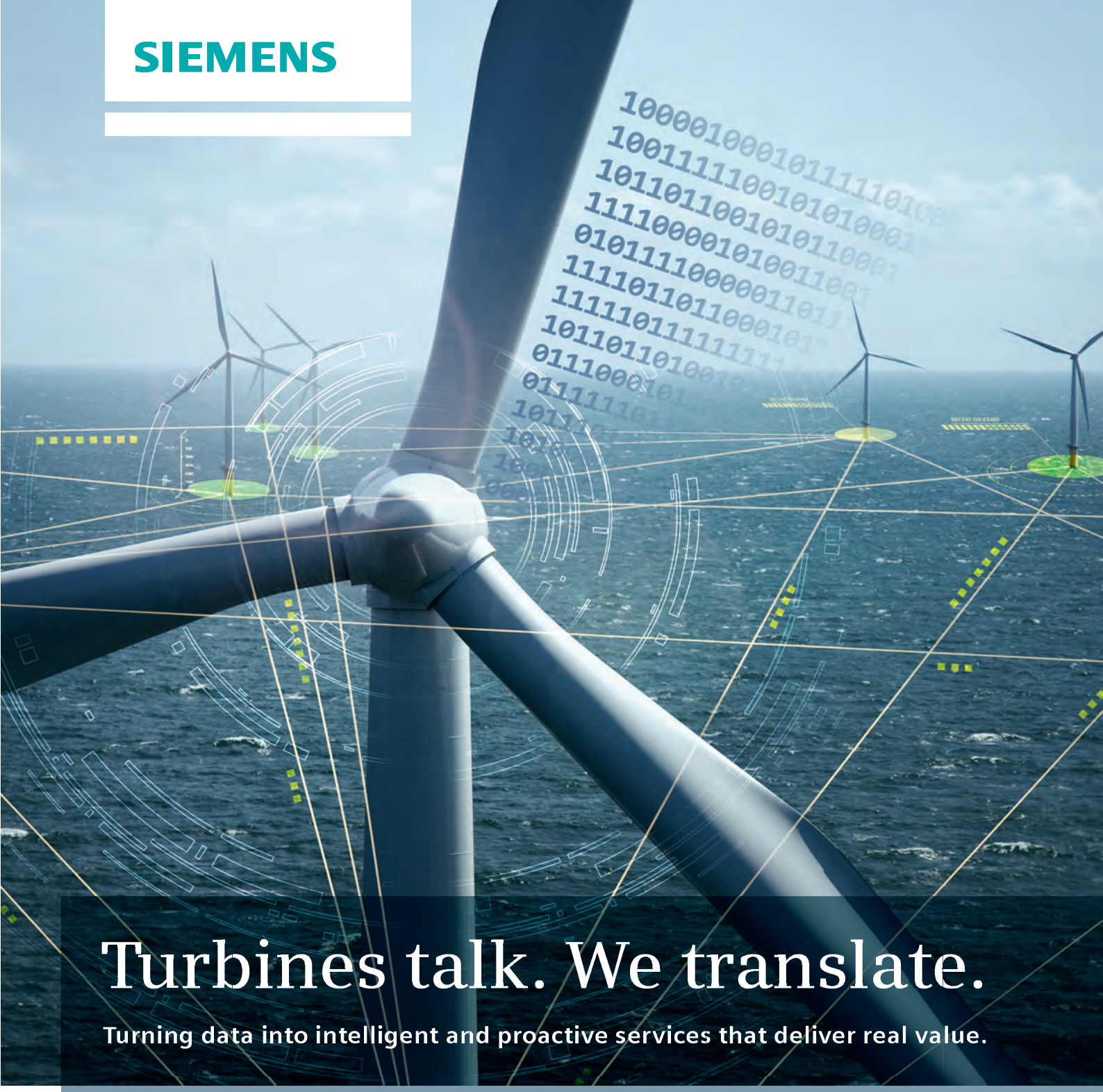

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The Rebooting of the Greek PV Market

By Dr **SOTIRIS KAPELLOS**, President, Hellenic Association of Photovoltaic Companies (HELAPCO)

PV development in Greece is currently undergoing a **transitional phase from an incentive-driven to a market-driven environment**.

Greece has been offering high **feed-in-tariffs (FiTs)** for PV since 2006. This generous support scheme has skyrocketed the market, especially during 2011-2013. However, due to market overheating, a series of drastic measures have been introduced to resolve the liquidity problems (including drastic cuts of feed-in-tariffs and retroactive taxes on income raised by PV investors).

In August 2012, the Greek Ministry of Energy put on hold authorization (approval) procedures for new PV projects. The suspension was finally lifted in March 2014. In the meantime, the market has decreased considerably from an impressive 1 GWp in 2013 to practically zero in 2014 and 2015.

According to the current regulations (in place since April 7th 2014), up to 250 MWp of new PV systems will be eligible for support (including 50 MW of approved fast-track projects) every year in the period 2014-2020. Adding the capacity which will be compensated through a newly introduced net-metering scheme, the overall new PV capacity till 2020 is expected to be ca. 2 GWp.

During the golden era of PV development, some **5 billion € were invested in PV** in Greece. Greece ranked **5th worldwide** with regard to **installed PV capacity per capita in 2014**. In 2014, **ca. 7% of electricity demand in Greece was covered by PV,** bringing Greece to the **second place worldwide** with regard to PV contribution to electricity needs**.** During the peak growth period, some **58,000 jobs** (direct, indirect and induced) were supported by PV development.

Net-metering: the backbone of the current market

The Greek authorities have introduced legislation to facilitate net metering for solar PV arrays, allowing installations up to 500 kWp. The Greek net-metering scheme (decided on December 30th, 2014 and activated as of May 2015) is applicable to all solar PV systems that aim for self-consumption, thus expanding to both rooftop and ground-mounted systems.

The upper limit for residential net-metering PV installations in Greece's mainland grid is set at 20 kWp. However, in commercial applications where the required load exceeds 20 kWp, the new net-metering scheme allows for installations that exceed the 20 kWp limit and reach up to half

the maximum contractual consumption power agreed between the consumer and the energy provider. In this case, net-metering systems can reach up to 500 kWp. Moreover, for either governmental or non-governmental not-for-profit organizations (e.g. universities and hospitals), the net-metering law allows for PV installations that fully cover the organization's electricity power needs (i.e. the maximum contractual consumption power agreed between the consumer organization and the energy provider). In this case too, a net-metering PV installation cannot exceed a maximum capacity of 500 kWp. Regarding Greece's autonomous (off grid) electricity grids (e.g. islands that are not interconnected to Greece's mainland grid) the upper limit for net-metering installations is set at 20 kWp. An exemption to this rule is the island of Crete, where consumers can install systems up to 50 kWp. Energy compensation for net-metering owners will be taking place on an annual basis.

HELAPCO's proposals for a new support scheme

HELAPCO played an important role in introducing the new net-metering scheme. It also calls for the redesigning of the overall support schemes for PV, in order to offer meaningful incentives for systems over 500 kWp, as the current feed-in-tariffs for such systems are not sufficient to attract any investors. **HELAPCO has proposed a support scheme in line with the new EU Guidelines on State aid for environmental protection and energy 2014-2020** (2014/C 200/01). Under this scheme, systems <500 kWp will be eligible for **feed-in-tariffs**, while larger systems will be compensated with a **feed-in-premium**. As of 2017, **competitive bidding processes** will apply.

Dr **S. Kapellos** is a graduate of the chemical department of the University of Athens, Greece (1986). In 1991 he received his PhD on the field of Physical Chemistry from the same institution. In 1993 he was hired by BP Hellas SA as chemist in the Perama Lubricants and Fuels Quality Control chemical laboratory. Since then he had the opportunity to be positioned at various posts within the BP Hellas organization: Quality, Health, Safety and Environment Manager (1995), Human Resources adviser (1998). In 2000 he moved to the Fuels Retail Business as Customer Services, Pricing and Credit Manager and in 2004 to Northern Greece as Retail Fuels District Manager North. In 2007 when BP Solar is established as a new business within BP Hellas, Dr. S.Kapellos was appointed as the leader (CEO) of the new organization, in order to setup the new business. The new solar business of BP in Greece acquired 12% market share in 2008. As a result of the acquisition of BP Hellas (December 2009) by Hellenic Petroleum (ELPE) Group, he moved to ELPE Renewables (100% owned by ELPE Group), contributing to the development of the Renewables Sector of ELPE, as Development Director. The current RES portfolio of ELPE Renewables is 150 MW of photovoltaic projects and 25 MW Biomass, of which 1.4 MW PV in operation. A 6.8 MW wind park was acquired in 2013. Dr. Kapellos published several scientific articles in international magazines during his short academic career. He has written a number of articles on subjects related to safety, hygiene and environment and in the last years on photovoltaics and on Energy for newspapers, relevant magazines and e-media. Since 2008, he has been elected member of the board of the Hellenic (Greek) Association of PV companies (HELAPCO) and since April 2013 Chairman of the board of the Association. He is ELPE Renewables BoD member.

Developing Greece's Biomass Potential

By **ANTHONY GERASSIMOU**,
Mech.-El.- Nav. Engineer MSc, President Hellenic Association of Biomass (HELLABIOM)

ABOUT HELLABIOM

Hellenic Biomass Association is the oldest and among the most prestigious Renewables Associations in Greece and a full member of the European Biomass Association (AEBIOM). In general, HELLABIOM targets the promotion of bioenergy and biomass exploitation throughout the country and supports the relevant scientific research and dissemination of information on bioenergy while it promotes various biomass processing technologies.

BIOMASS AS AN EXCEPTIONAL TOOL FOR SUSTAINABLE DEVELOPMENT

Taking into account the current harsh social and economic situations in the country, the benefits associated with bioenergy & bio-products development are even more emphasized, since they drastically optimize various social and economical aspects and figures.

A. Environmental Benefits

Elimination of greenhouse gases emissions. The energy exploitation of biomass is considered worldwide as a carbon neutral process, since the emitted amount of carbon dioxide in the flue gases is almost the same with the one that had been previously absorbed by biomass during the photosynthesis process.

Sustainable Forest Management. Forest biomass recovery is not only harmless for forest areas but, on the contrary, when it is implemented under the rules of good practice and sustainability, it facilitates forestry growth while, at the same time, forest residues management prevents from the wildfire hazard

Less biomass (e.g. tree pruning & cuttings) and **organic effluent** (e.g. cheese whey, olive mill wastewater) discharge in sensitive ecosystems with consequent multiple positive effects on nature protection and conservation

B. Financial Benefits

Support of the country's energy independence and consequent improvement of the commercial balance due to reduced imports of fossil fuels

Boost of Regional Development through the implementation of new investments in rural areas, especially in regions with low rates of employment and limited financial capability, where the need for new sustainable business efforts is urgent

Mobilization of the financial activities of SMEs and support of the local industry. Bioenergy offers a great alternative activity field for agricultural and forestry cooperatives, enabling their participation in new investments and reassuring their feasibility

Supply of heat in competitive prices, both for residential and for industrial consumers, through the establishment of CHP and district heating plants fed with biomass

C. Social-technological Benefits

1. **Creation of thousands of new jobs,** especially in rural areas, through the establishment of multiple energy plants and short rotation coppice plantations

   According to OEDC (2012) the number of jobs associated with renewable energy projects is;

Technology	Job Positions/MW (operation & maintenance)
Wind	
onshore	0,2
offshore	0,2
PV	0,3
Hydro	
Large scale	0,3
Small scale	2,4
Geothermal	0,4
Biomass with CHP	3,0

   The abovementioned table agrees with the actual EU data, where it is stated that biomass is responsible for the creation of the larger number of jobs in the EU compared to the other RES, with a percentage accounting almost 40% of all renewable job positions.

2. **Significant contribution to decentralized power generation**. Bio-power plants are base-load plants thus their operation can lead to minimal power losses in the grids and **thus facilitate power system stability**

EU BIOENERGY STATUS

According to the official EU data, biomass is gaining constantly grand in terms of its participation in EU-28 energy mix;

- **Almost 20% of renewable power production in the EU** results from biomass exploitation (mainly from CHP plants)
- **Almost 90% of renewable heat production in the EU** results from biomass exploitation
- EU is the largest wood pellet producer worldwide, since it produced more than 13,5 million tons of solid biofuel in 2014
- **Power production from solid biomass resources in EU exceeded** 81.500 GWh in 2014
- **More than 14.500 biogas plants were installed in the EU** in 2014, with a total capacity of almost 7,8GWe.

GREEK BIOENERGY STATUS

Despite its significant biomass potential, Greece has exploited only slightly this valuable alternative source of energy and its development has been made only in small and slow steps. It is estimated that the exploitation of the technically available amount of biomass could cover almost the 25% of the country's total power demands**.**

Biogas: Around 50 MWe is the installed power capacity from biogas in Greece today, resulting mainly from the operation of landfills (landfill gas) or from wastewater treatment plants (WWTPs).Less than 5 MWe are attributed to agricultural biogas plants

Liquid Biofuels: Greece is among the very few EU Member States where no ethanol fuel is produced from biomass. Even biodiesel, which is produced in more than 10 biodiesel plants, derives from the processing of agricultural feedstock materials (1st generation biofuel)

Solid Biomass: A typical factor which clearly indicates the very poor exploitation of biomass in Greece, is that no power from solid biomass is produced across the country (only in Malta and in Cyprus we have the similar situation). Apart from incineration, which is the conventional solid biomass conversion technology to energy, other much more effective and environmentally friendly processes, like gasification and syngas combustion, are also in an immature state of development (even though there are some applications for such investments mainly for wood chips)

Pellets: With a production potential of more than 130.000tpy but real production of just over 36.000 tons in 2014, it is clear that the required infrastructure for further biomass pellet penetration exists

Advanced synthetic fuels-Fischer Tropsch fuels: Even though biomass conversion to synthetic fuels is a relative new technology, a lot of research and pilot efforts are being implemented during the last decades in order to make it more mature and technically feasible. While across the EU there are several demonstration plants which study and develop advanced biofuels processes in Greece the research in this field is rather limited and focused on the efforts of certain research teams (in NTUA, CERTH, etc.)

ESSENTIAL REQUIREMENTS FOR BIOENERGY GROWTH

Power generation from biomass. Withdrawal of the upper capacity levels which were set into force with the 4254/2014 law (40 MWe total installed capacity of power from solid biomass and 50 MWe total installed capacity for biogas power). Reintroduction of the previously stated limit of at least 350 MWe of power from biomass until 2020 (a target which also is in agreement with officially stated EU RES targets).

Feed-in-Tariffs from biomass; Biomass in not at all responsible for the deficit reported by Electricity System Operator (LAGIE). The Greek State tried to solve this issue with the elimination of Feed-in-Tariffs. This is totally unjustified for bioenergy projects, and therefore it is of the highest concern to re-set the Feed-In-Tariffs to the levels of the previous renewable energy Law 3851/2010.

Exemption of all bioenergy producers from new extra taxes aimed at relieving the energy cost of heavy industries

Subsidization for replacing conventional oil or gas burners/boilers with biomass ones, especially for areas with no access to the natural gas transportation system

Identification of various official institutions-laboratories for solid biofuels certification, preferably in co-operation with the Ministry of Energy &Environment like CRES, CERTH, HELLABIOM, Universities, Certified Private Companies etc. able to control, measure and certify the various biomass solid fuels.

Establishment of an official database of certified Solid Biofuels Producers and Traders in order to secure that only safe to use and legally produced biomass is being traded across the country

Harsh implementation of the existing environmental legislation for the proper management of agricultural residues, so that these materials can be led to energy production plants instead of disposed in various sensitive ecosystems thus deteriorating them while at the same time they are responsible for very high penalties from the EU leveled at the Greek State due to improper waste management

Support of research and development efforts by various Greek institutions for the development of advanced biofuels from residual materials, in order to gradually create the required know-how capable of converting the research results to new added-value investments for the Greek economy.

Consequently the fall exploitation of the multiple benefits provided by the biomass sector, is not only an action of environmental responsibility and awareness, but is also a unique chance to reform the whole rural economy with new sustainable investments creating thousands of new job.

Anthony Gerassimou was educated at the National Technical University of Athens, Mechanical Engineering Section (MSc). He has been a free lance Engineer and a Contractor of Public Works for many years in Greece participating in numerous projects. In 1988 he founded ITA Group of companies, of which he is now the Chairman, and which currently covers a wide range of activities relating to energy and the environment, offering “turn-key” projects, including all development stages of a project, from initial studies up to financing, management, construction, operation and service as well as equity participation in various fields, such as: Renewable Energy Sources, Biofuels, Desalination with the use of wind energy, Cogeneration of Heat & Power implemented in conjunction with District heating and State-of-the-Art Glass Greenhouses, Modern Units of dehydration for the production of animal feed, Treatment of Solid, Liquid and Contaminated Waste, Trading of Electricity, Fuels and Emission Rights. He currently holds various positions in relevant Associations, such as Chairman of the Hellenic Association of Biomass (HELLABIOM), Chairman of the Hellenic Association of Desalination and Water Treatment, member of various professional Greek Chambers and Associations related to RES and CHP. He is also the President of the Technical University (TEI) of Central Macedonia.

Greece's Small Hydro Potential, Current Applications and Development Prospects

By **ELIAS KAKIOPOULOS**, Secretary General, Hellenic Small Hydropower Association (HSHA)

1. Introduction

Small Hydro Power Plants (SHPPs) are the modern equivalent of a **traditional watermill.** The mountainous Small Hydro Power Plants (corresponding to about 80% of all Small Hydro Power Plants) exploit the altitude difference of small water streams, using the existing available water flow **(run of the river plans)** without water storage, allowing the flood to by-pass above the water intake with no need of storage. SHPPs with small available head are mainly located in large streams and have usually small reservoirs, but they don't alter the geomorphology of the hydrant location, substantially.

It can be said that SHPPs represent the most mature RES technology, featuring the biggest efficiency in energy conversion of natural resources into electricity. For this reason, the utilization of small hydropotential witnesses a global boom that is consistent with the overall interest in the use of all RES.

SHPP Igoumenitsa-Gitani 2,06 MW

The Greek RES sector

The energy market in Greece is suffering from a chronic lack of medium and long-term policy by successive Greek governments. Dominant factors include the sovereignty of political interests regarding natural gas and fossil fuels in general, the prevalence, in the context of RES interests', of foreign countries that are technology sellers and obvious distortions of the SMP (System Marginal Price-ΟΤΣ) calculation. In short the Renewable Energy Sector in Greece remains underrated and still does not form part of central government planning.

2. SHPPs today

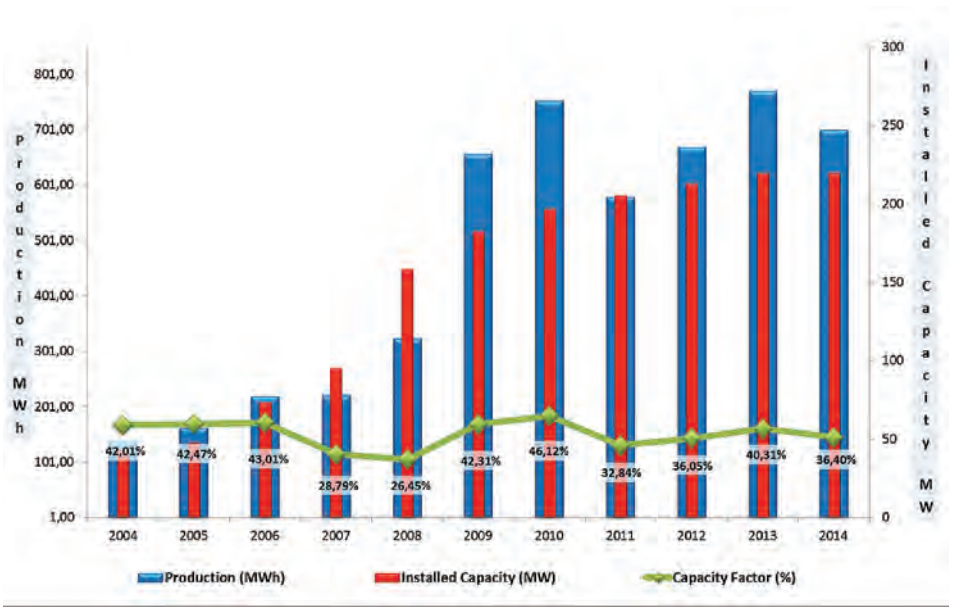
In the national Interconnected Power System (LAGIE data), on 31.12.2014, some 105 SHPP's were in operation with a total installed capacity of 220,42 MW. For the year 2014, the annual energy production of the sector was 701 GWhs. According to the official data of the Hellenic Electricity Market Operator S.A. (LAGIE), in 2014, SHPPs represented only **4.34% of the total installed capacity of RES installations**, contributed by **7.23% of the total energy production of RES**, while they were reimbursed with **3.54% of and the total payments from the Special RES Account (E.L.APE.)**.

SHPP Achaia-Patra-Glafkos 3,7 MW, in operation since 1922

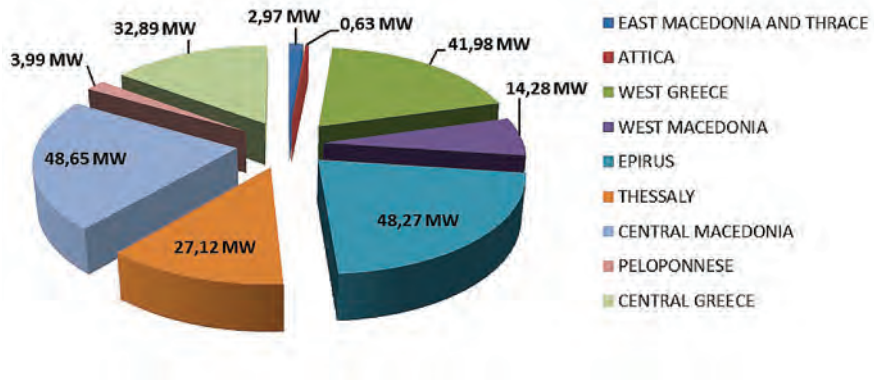
The figures regarding SHPPs for the year 2013 were almost the same with 2014, whereas in 2012 these figures were: **participation in the total RES energy production of 10.2%, and participation in total payments at 4.9%.** The difference between year 2012 and years 2013 & 2014 is clearly due to the fact that the installed capacity of SHPPs increased only by 3% during that period, while the total installed capacity of (all) RES increased by 39% (mainly due to PV installations).

It is worth noting that the technical and economic small hydropotential of Greece is estimated at around 2,000 MW, which means that only 11% of this capacity has been exploited; a figure that is very far from the average exploitation of the sector in the EU-27, which in some cases reaches 90%.

The national goal for 2020 regarding SHPPs is 350 MW which is unreasonably low as for the potential of the industry, but also in view of the significant comparative advantages of SHPPs, compared to other RES, the most important of which is the **lowest energy production cost**.



Production (MWh), Installed Capacity (MW) and Capacity Factor (%) of SHPPs in operation, in Greece's Interconnected System for 2004-2014.



Allocation of Installed Capacity (MW) of SHPPs in operation, in Greece's Interconnected System on 31.12.2014 per region of Greece.

3. European Projects related to the SHPPs

Stream Map Project

Stream Map was a project coordinated by ESHA (ESHA was the 2nd level Association of all European 1st level Associations) and co-financed by the IEE Programme of the European Commission under the responsibility of the EACI. It run from 2009 to 2012 and provided information on the opportunities and challenges that the hydropower sector is facing in the EU-27 today.

STREAM MAP

The Stream Map aimed at:

1. Providing information and analysis of the current status of the sector.
2. For the first time ever, detailed data concerning energy, market and policy data were gathered to a central **HYDI (Hydro Data Initiative)** database which is free to access for the public. These data were for all the 27 EU Member States starting from year 2007.
3. Based on the collected data a roadmap for the small hydro sector was prepared together with recommendations for the future with a view of the 2020 targets set in the RES Directive.
4. Influencing National Renewable Energy Action Plans on their choice of the RES mix.
5. Offering regular advice and information at local and national level on the sector's development and needs.

Small hydropower	2005	2007	2010	2011***	2012***	2013***	2014***	2020
Total installed capacity (MW)	*48,16*	*95,5****	*196,8****	*205,33*	*212,93*	*219,84*	*219,75*	*350***
Generation (GWh)	*164*	*223*	*753*	*580,62*	*669,38*	*771,03*	*701*	*1,148*
Number of power plants	*45*	*47*	*96*	*100****	*103*	*105*	*105*	*175*
*Potential (GWh)**	*6,306*	*6,283*	*5,953*	-	-	-	-	*5,445*

** Only economic potential (GWh) with environmental constraints*
*** According to the Low for 20-20-20*
**** Updated data which are not used in the central HYDI database of Stream Map*

GREECE

1. Key Figures
2. Industry and Markets
3. Legislation and Incentive Schemes:

Small hydropower	2010	2011***	2012***	2013***
Number of companies	*70*	*173*	*173*	*175*
Employment	*443*	*554*	*698*	*686*
Civil works (estimation)	*n/a*	*n/a*	*n/a*	*n/a*
Average investment cost (€/MW)	*2,000,000*	*2,000,000*	*2,200,000*	*2,200,000*
Average O&M cost (as % of total investment cost)	*1 - 3*	*1 - 3*	*1 - 3*	*1 - 3*
Average civil works cost (as a % of total investment cost)	*~50*	*~50*	*~50*	*~50*
Average cost per kWh produced (€)	*0.47*	*0.47*	*0.47*	*0.47*

**** Updated data which are not used in the central HYDI database of Stream Map*

3. Legislation and Incentive Schemes:

Average duration of authorization and licensing procedure: ~8 years (updated data)

Support scheme: In Greece, the support scheme that is in place for SHPPs is the Feed-in Tariff (FiT). The respective law says that the FiT from SHPPs plants with installed capacity up to 15 MWe which are constructed without any capital grants from the state is 105 €/MWh while for SHPPs plants which are constructed with grants from the state is 85 €/MWh.

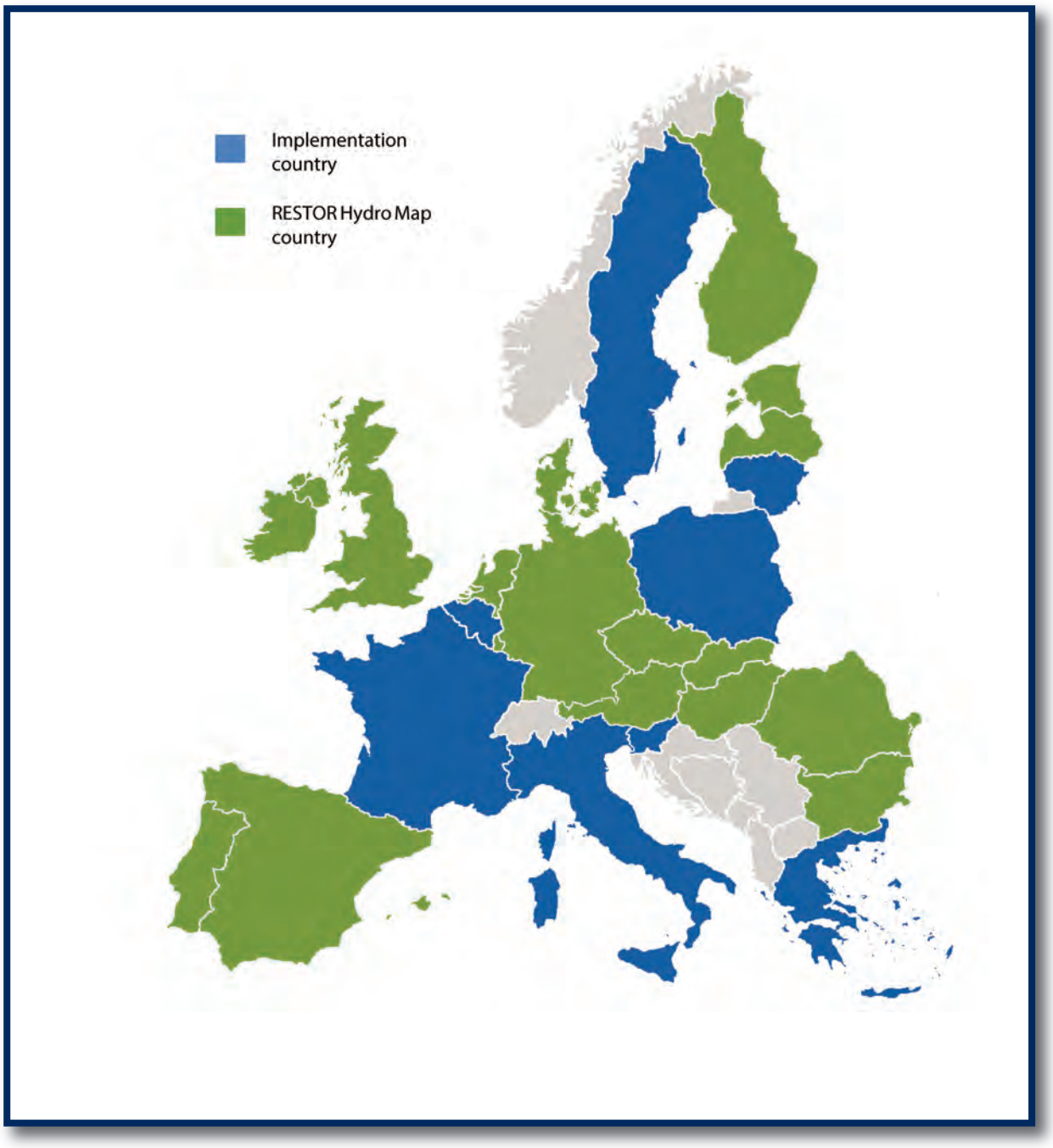
Future Prospects and Recommendations

- Simplification and unification of administrative-licensing procedures.
- Radically change the procedure of appealing the SHPPs investment or licensing procedure in The Council of State, and eliminate the ability for everyone in doing so. Set high amounts as a guarantee in order to appeal (which will not be returned if the appeal is lost).
- Ministerial Decision 518/05.04.11 should be radically reformed.
- The targets of the Law concerning the 20-20-20 obligation for SHPPs should be revised from the current 350 MW for 2020 to 1,000 MW for 2020, thus exploiting 50% of the high potential that is estimated at 2,000 MW.
- Resolve all standing issues for the transposition and implementation of the WFD Directive (60/2000) in the Greek legal system and of the management studies of water districts under this Directive, the soonest possible.

RESTOR hydro

RES Transforming Our Regions (RESTOR) Hydro is a European project aiming at increasing renewable energy production from small and micro hydropower, by identifying and restoring suitable historical sites, mills and hydropower stations that are currently inoperative. It covers the whole EU-27 region. Restoration programs will be implemented in eight selected target countries: BELGIUM, FRANCE, GREECE, ITALY, LITHUANIA, POLAND, SLOVENIA, SWEDEN.

Unrealized potential for small and micro hydropower generation exists in Europe's thousands of historic mills, water wheels, inoperative hydropower stations, weirs and other lateral structures in rivers.



Repowering abandoned sites results in the generation of hydroelectric power, both for local use and for injection to the European electrical grid. This simultaneously leads to increasing electricity production from renewable sources, energy independence and grid stability. The **RESTOR Hydro project** identifies the most relevant sites suitable for refurbishment and stimulates investment through the development of a market-driven model for regional cooperatives. Identification and refurbishment follow specific methodological guidelines, taking into account environmental, economic and social aspects.

RESTOR Hydro enhances the Stream Map project.

4. HSHA Positions, Views and Proposals

The Hellenic Small Hydropower Association (HSHA) has dealt with the major issues of the sector by submitting its views, in the form of letters to relevant bodies, participating in public consultations by issuing press releases or in private meetings with sector stakeholders. Among the various topics, the most important are the following:

Interruptibility (special levy for the security of supply), where HSHA expressed its full, well-documented opposition on the issue.

Position of Public Power Corporation S.A. for ETMEAR (Special Duty for diminishing of CO_2), **where the HSHA submitted a full analysis and documentation of arguments demonstrating that the SHPPs do not burden the consumer but rather reduce the cost of energy billed to the consumer being at the same time cheaper than other conventional units that are displaced.**

HSHA's position on the review of the new energy mix, **where the HSHA submitted a full analysis stating that the targets of the Law for the 20-20-20 target for SHPPs should be revised from the current 350 MW for 2020 to 1,000 MW for 2030, thus exploiting 50% of the country's high potential that is estimated at 2,000 MW.**

Electric grids & terms of connection, bank guarantees to keep the permanent terms of connection to the grid, and levy for keeping the production licenses. The issue of common-collective terms for grid connection and the inability to connect projects to the electric grid is a huge problem for the industry. However, the measure of returning bank guarantees in order to keep active the permanent terms of connection to the grid and the relevant application of the measure of annual payment in order to keep the production licenses, formed new conditions in the market. The "cleanup" conditions of the grid from inactive applications and projects create the prerequisites for the potential connection of new SHPPs to the grid, in areas where there were already saturated. But on the other hand, the levy for keeping the production licenses, adds another financial burden to the time-consuming licensing of SHPPs.

Cost of water usage. The SHPPs are affected by the issue of "cost of water usage", which has been instituted but not applied. A constant request of HSHA is to exclude by means of law and not with verbal promises the SHPPs from that cost, that will be an additional financial burden to the already lowest FiT given to the SHPPs, since the SHPPs do not consume - in any way - water.

HSHA has requested for accounting unbundling of individual RES technologies in the special RES Account (E.L.APE). Thus, the cash flow for each RES technology will be made crystal-clear and will be self-evident which technology creates deficit and which doesn't. In addition, it is necessary to be able to allocate the deficit among all RES technologies, to the degree that this is created from each technology.

The Average Variable Cost (MMK) of thermal units to be paid directly by PPC to the Hellenic Electricity Market Operator S.A. (LAGIE) and to be available in the Special RES Account (E.L.APE), at any time. **This MMK should be paid immediately and without any delay, to all RES technologies. The rest of the payments, up to the FiT, should be paid for each technology separately**, according to the rate that money flows into the Special RES Account (E.L.APE). This

methodology will benefit the most efficient technologies which will hence stop cross-subsidizing the less efficient ones. So, the deficit of the Special RES Account (E.L.APE) will be allocated to technologies that have really created it, and as a result, all individual technologies will be costed accurately (since the cost of delay in payments will burden only the technologies that contribute to the delay in the first place).

The FiT (Feed-in Tariff, standard offer contract) method of reimbursing RES production is a policy mechanism designed to accelerate investments in RES, making them truly bankable. FiT provides long-term contracts (20 yrs) to RES producers, and the calculation of FiT is based on the cost of product for each RES technology separately. **HSHA is in favour of maintaining the FiT mechanism for the foreseeable future**, especially now, that the Greek economy is in recession.

Ilias Ap. Kakiopoulos was born in Athens in 1971. He is married and has children. He graduated from the Mathematical Dept. in 1993, while he received his MBA degree from ALBA Business School with a Major in Finance in 1994 and his M.Sc. in Financial Analysis and Banking from the University of Piraeus in 2006. He is fluent in English and understands French. In the past, he has been repeatedly awarded prizes from the Hellenic Mathematical Association (EME). In the period from 1994 to 2005 he has worked in many positions at the Group of the Athens Stock and the Athens Derivatives Exchanges, developing new products, running combined IT and Finance projects, taking part in the initiation of the derivatives market in Greece and being responsible for the clearance of the derivatives trades at a market level. Moreover, he has worked in Insurance Companies at the Asset Management and Risk Management areas. From 2005 until today, he is the major shareholder of Energiaki Drasi AVETE and responsible for the everyday working flow of the company and its strategic development. The company owns, studies and develops Small Hydro Power Plants (SHPPs) and PV Solar Parks all over the Greece. In parallel, from 2005, he offers his services in the Risk Management area in big financial organizations. From 2010 until today, he is elected General Secretary in the "Hellenic Small Hydro Association (HSHA)". Moreover, he is a member of the "Institute of Energy for S.E. Europe (IENE)", in the "Hellenic Mathematical Association (EME)", in the "Hellenic Cancer Society" and in the "ALBA Business School Alumni Association". He has published many articles concerning both the production of energy through Small Hydro Power Plants and aspects that deal with Finance, while he is a frequent speaker in conferences that deal with energy topics.

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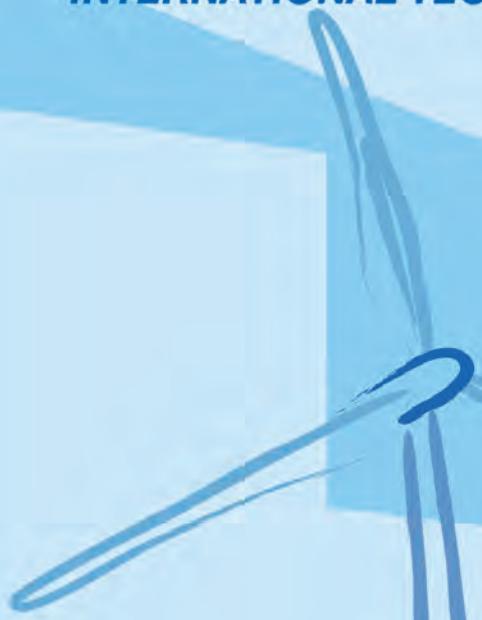

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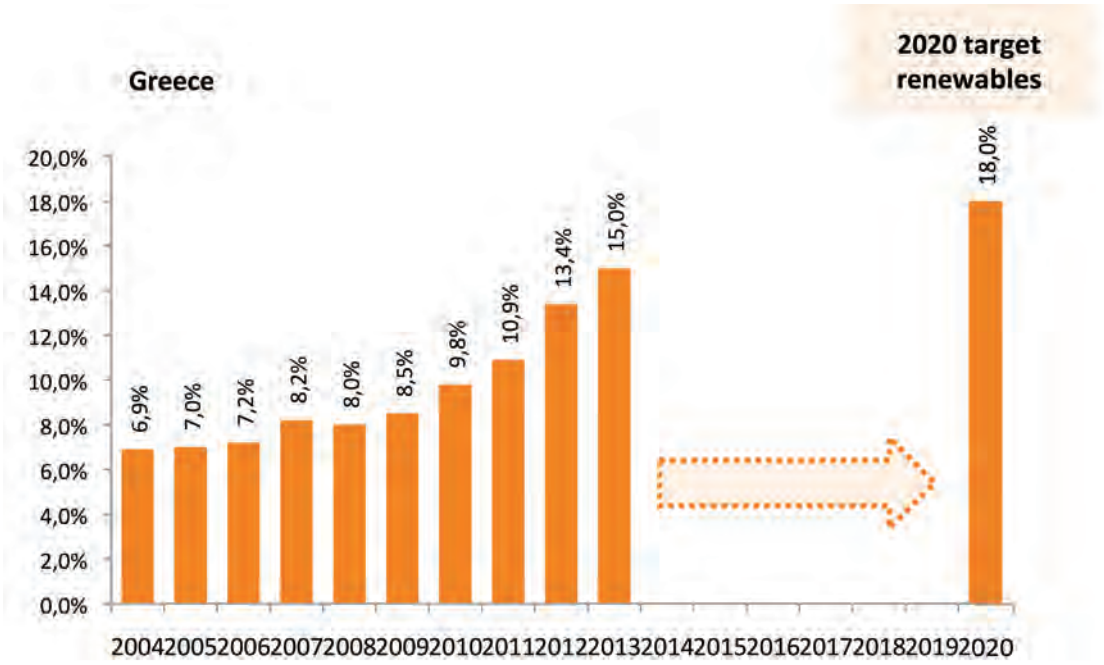
Greece's Renewable and Photovoltaic Market in Transition

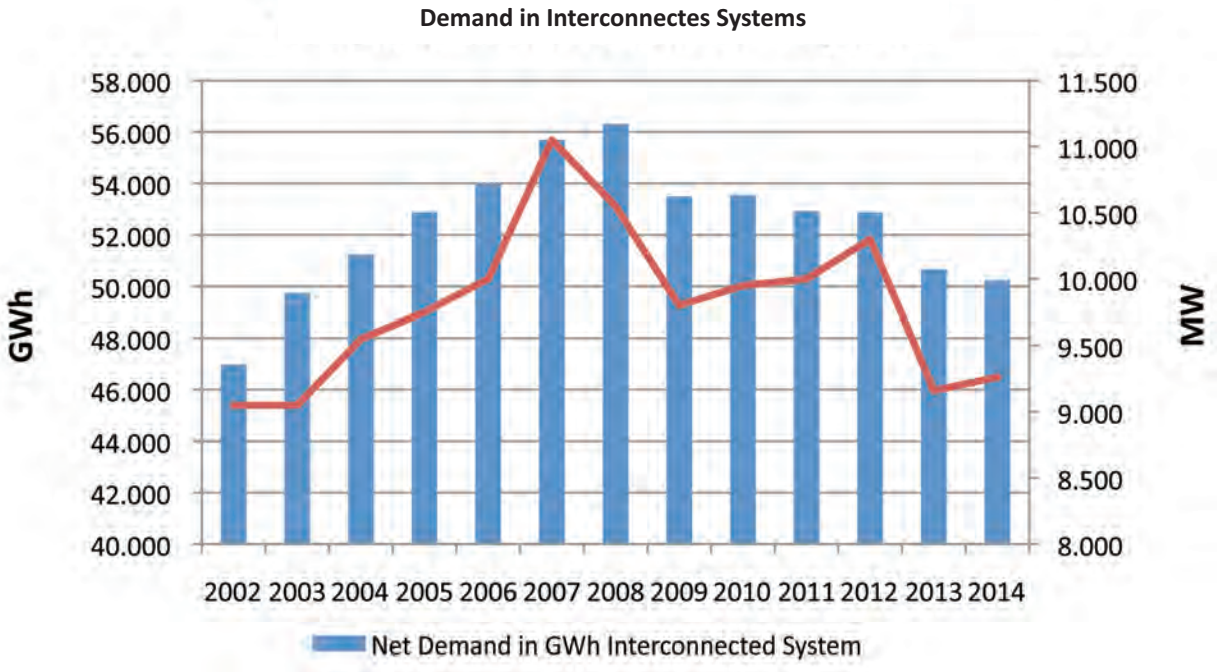
By **STELIOS LOUMAKIS**
President of the Hellenic Association of Photovoltaic Energy Producers (SPEF)

Greece has moved rather fast towards its national 2020 target for renewables during previous years, although economic recession and credit crunch continuously put severe obstacles into projects realisation. As shown in a recent EC report, Greece in 2013 was already enjoying a contribution of 15% renewables in its total energy mix, while its target for 2020 is at 18%. This achievement was fueled by a differentiated renewable mix mainly consisting from hydro, wind and photovoltaic electricity. Photovoltaics in particular already fulfilled their 2020 target for 2.2 GWp, since their installed capacity today is at 2.5 GWp.



Another significant dimension in the path forward the (RES) further increase in RES use is the drastic decline of their installation costs (mainly in photovoltaics and at a portion in wind farms), that have brought new projects very close to grid parity. New photovoltaic installations effective 1/1/15 are not considered under the well-known feed in tariff (FIT) remuneration scheme anymore, since a feed in premium (FIP) model based on wholesale electricity price is applied

now (law 3734/2009). According to EU guidelines all new RES projects from 1/1/16 and at wider range from 1/1/17 should be remunerated under more competitive schemes (FIP, auctions, direct access to the wholesale market, etc), excluding only new small installations (for photovoltaics this is defined to new projects under 500 kWp), that is allowed to continue following FIT in case a member State wishes to. However, Greek State till today hasn't yet announced any new scheme and that puts high risk on new RES projects that will be interconnected after 1/1/16 regarding the compatibility and compliance of their remuneration with the new EU guidelines. Even if new photovoltaics since the beginning of 2015 are already in FIP, this doesn't mean full compliance with EU guidelines at the whole size range, since in bigger projects above 1 MW of installed capacity, remuneration is meant to be the outcome of a competitive mechanism and not under a FIP scheme especially after 1/1/17. In front of this situation there are some "talks" about offering a transitional period where mature projects would be allowed to keep the old support scheme for a short period of time, presumed that they would be constructed and interconnected during this short period. Another issue is what would be considered as "maturity" for new projects, meaning to what stage of licensing this corresponds (i.e. fully licensed projects with Power Purchase Agreement signed). Although transitional periods are generally considered as a fair mean towards market changes, on the other hand the experience in Greece is negative. During the end of 2012 – 2013 law 4093/2012 created tremendous excesses in PV growth rate due to the transitional period offered prior abolishing FIT holding mechanism (18 to 36 months from PPA up to plant interconnection). PV installed capacity was doubled in only 4 months compared to its previously developed (for 6 years) size, leading to serious financing problems of special RES account and market operator together with high "black market" trade in licenses that investors followed in order to ensure old tariffs. However, EU guidelines as far as time frame and size of new RES projects concerned are quite specific, so theoretically there is no room for deviations that would later on be characterized as illegal state aid and cancel the remuneration scheme retroactively for these new projects. EU guidelines on the contrast, are a rather positive pan-European context that puts the investor to the procedure -prior developing his RES project- to consider and undertake part of the regulatory risk (in remuneration prices and/or absorbed quantities of electricity produced from these new projects) that reflects the challenges of the road to RES high increase and



saturation, meaning that RES electricity production is not an end in itself but is a mean to cover real time demand. Under this context excesses in RES growth beyond real electricity demand will mitigate and this is in favor of a healthy market on the long term.

On the other hand electricity demand in Greece is declining for seven years in a row both in terms of energy and power, mainly due to the deep economic recession the country is facing accompanied by energy consumption saving programs that are followed according to EU directives (there is a national target for 20% energy saving until 2020 compared to 1990 levels and this target is growing to 30% for 2030). Since the long expected economic growth has yet to come, RES contribution will increase faster than expected based only on the evolution of their capacity, since electricity market pie is shrinking. Total electricity producing capacity in Greece, both RES (7.8 GW) and thermal (10.2 GW) is about 18 GW while peak demand, as can be seen in the chart, hardly exceeds 9.5 GW. This macroeconomic environment in electricity market surely affects new RES and puts serious challenges towards flexibility in market participation where EU guidelines also describe. As a conclusion PV and RES further growth will be different from the past not only because EU guidelines tell so, but because the whole environment is different.

What we can see as a general viable context coming for new RES projects, is practically a corridor of annually added new capacity according to real electricity demand needs, auctioned between investors that will be allowed to bid for the selling price of the electricity produced (its total level or difference from wholesale price) judging as well what percentage of absorption their production might have. Bigger projects above 10 MW will participate in the day-ahead market according to “target model” receiving some premium trough green certificates or other additional mechanisms.

Stelios Loumakis. Born in Athens he graduated Chemical Engineer in National Technical University of Athens (NTUA) in 1992. At post-graduate level he has been awarded the degree of Master of Business Administration (MBA) from Portsmouth University of U.K. At present he is a PhD candidate in NTUA elaborating a thesis in the field of Electricity Market Operation. He started his professional career in the family business involved in exports of garments to European markets. He worked for five years as an executive in Marketing and Sales in a multinational and later a Greek industrial company producing fast moving consumer goods (FMCG) and food products. As a businessman he was also involved in the rapidly expanding sector of organized food retail. In 2006 he entered the field of power generation through photovoltaic (PV) technology. He pioneered in Greece developing centralized PV plants. His company’s first centralized PV plant was one of the first of its kind in the country. He also enjoys extensive consulting experience in the wholesale electricity market and RES. Stelios Loumakis is the President of the Hellenic Association of Photovoltaic Energy Producers (www. spef.gr). SPEF is the official business and scientific association that represents in Greece power generating organizations from PVs.

The Elusive National Treasure

GREECE'S WIND ENERGY POTENTIAL, CURRENT APPLICATIONS AND FUTURE OUTLOOK

By Dr. **IOANNIS TSIPOURIDIS**
Renewable Energy Consultant Engineer, Chairman & C.E.O., R.E.D.
Pro Consultants S.A., Renewable Energy Development Professionals

In the 80's, when the sector, represented then by the Public Power Corporation, was taking the first wind energy development steps in Greece, amidst general indifference for the technology and its future, we were beginning to realize the treasure that was contained in Aiolos' breeze: the wind potential in Greece was simply excellent! Indeed a blessing to count.

Soon, thanks to the work carried out at our educational institutes and later at the Center for Renewable Energy Sources (CRES) and gradually by many private concerns, we and everyone else came to appreciate the "Wind Eldorado" that was begging to be explored, for the benefit of the country.

As 25 years have gone by and the wind potential of our country remains largely unexploited, let's examine, for the umpteenth time, the causes behind this lack of development, in the hope that perhaps it is the last time that such account is considered useful.

The wind energy potential being the wind potential that can be turned into useful energy is limited by a number of physical and non-physical factors.

The physical factors are more obvious and easier comprehendible. They include land availability, spatial planning restrictions, ease of access to potential sites, grid availability, electrical system technical restrictions and limitations, technological limitations etc.

But these are all measurable and in essence they do not limit wind energy development, but rather they define the physical boundaries of a development framework.

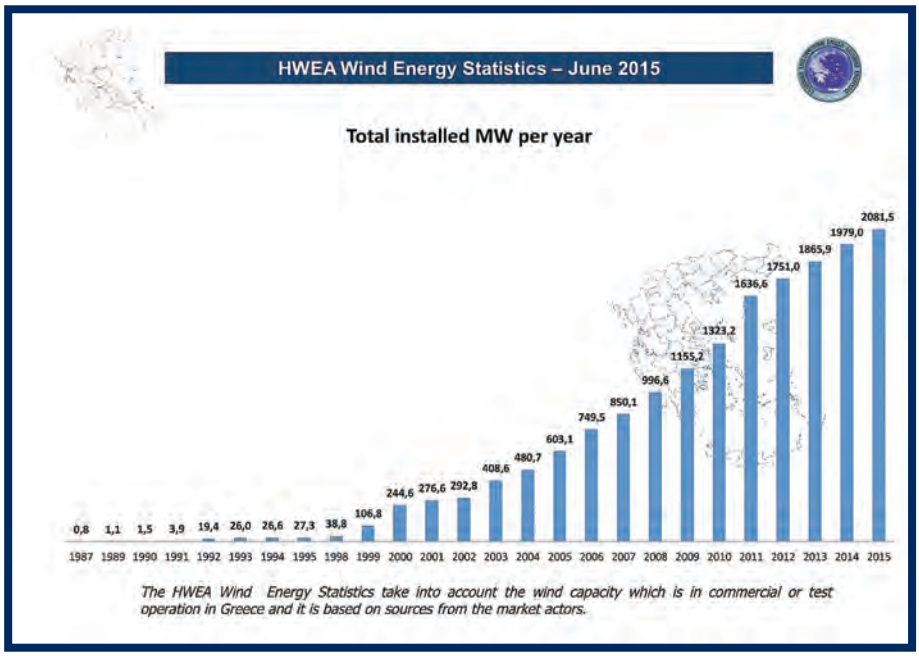
A framework, whose legal and regulatory dimensions were set by the European directives 77/2001 and 28/2009, promoting production of electricity from renewable energy sources (RES), as a high European Union (EU) priority for several reasons, including the security and diversification of energy supply, environmental protection and social and economic cohesion. The fundamentally crucial intervention made by the 2009 Directive, was that it established mandatory national targets for the overall share of energy from renewable sources in gross final consumption of energy and for the share of energy from renewable sources in transport by 2020. Greece's target was set at 18% of final energy consumption to come from renewable energy sources.

The road map to the achievement of these mandatory targets by 2020 included 7.500 MW of wind energy installations, constituting over 70% of the total RES target, a de facto recognition of the wind potential available.

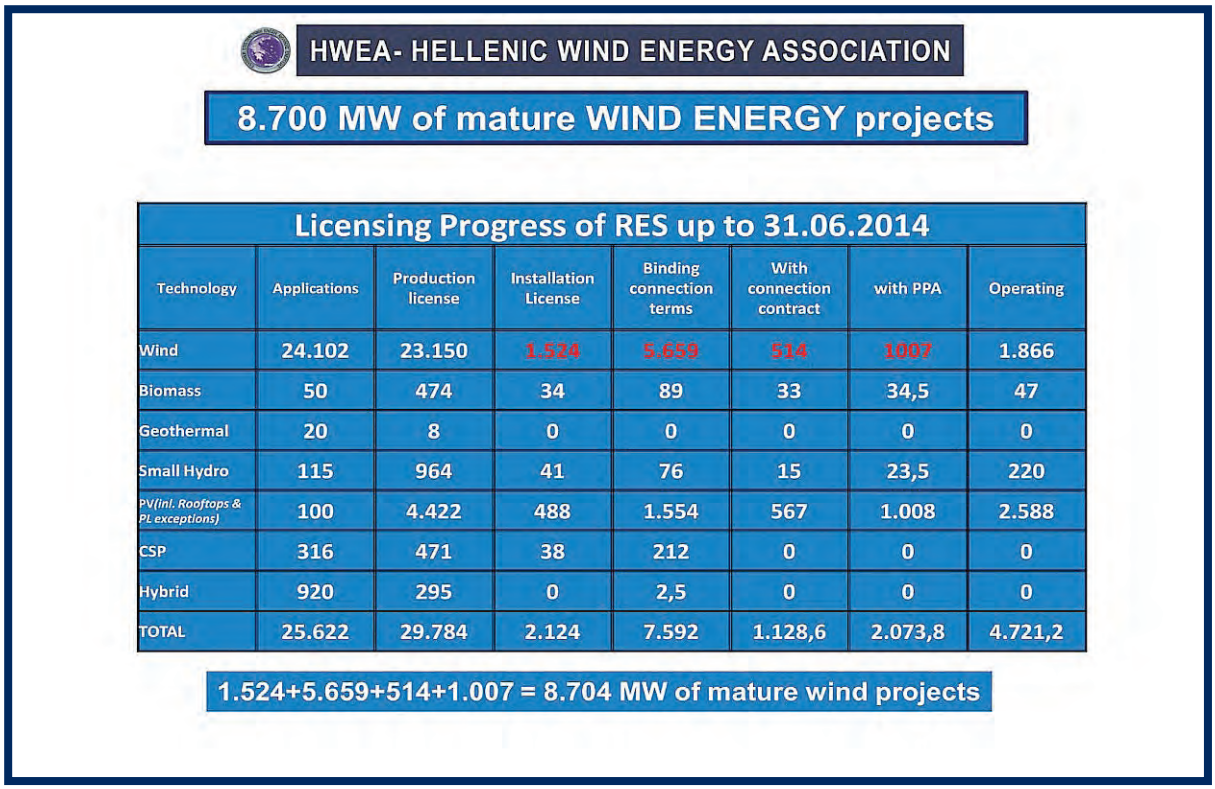
Considering that the 2020 RES target, is but an intermediate target and higher and more ambitious targets for 2030, 2040 and 2050 must and will follow, in the framework of the global effort to curb climate change and attain a zero carbon economy by 2050, the value of the wind potential available becomes even more apparent. Studies have shown that the wind energy potential of the Aegean can be the power house of the region. It can be a unique economic driver. It constitutes one of the few pillars the much desired economic development can be built on.

Yet hard facts and figures paint a different story.

Having installed the first ever European wind park on the island of Kythnos in 1982, today we are struggling to keep up pace with our European partners and neighbours. With an intermediate target set at 4.000MW for 2014, we just managed, in the spring of 2015, to cross the 2.000 MW mark!!!



This truly disappointing development is made worse, if one considers the investor interest in wind energy, shown in the table below:



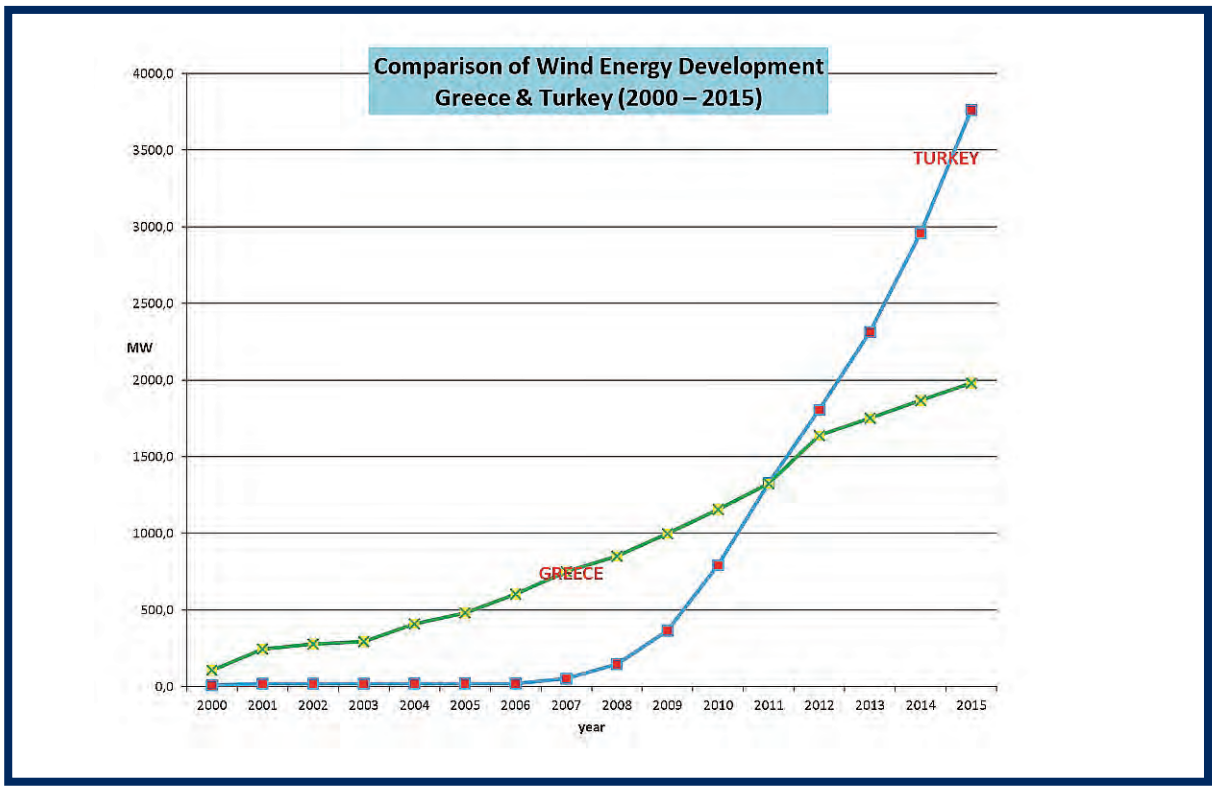
Close to 9 GW of wind energy projects are at various stages of maturity, ready to begin construction!! Yet the annual installation rate is struggling to stay above the 100 MW mark.

Although the prospects for 2015 and 2016 seem to be greatly improving, compared to the period 2012-2014, still they are a long way from the power installation figures required to achieve the modest 2020 target.

It becomes apparent that there are forces at play that block the exploitation of this natural, abundant, truly national energy resource.

The obstacles to wind energy development in Greece have been analysed thoroughly and adequately more than enough times, so that a mere reference to them suffices: beaurocratic legal framework and licensing procedure, reaction of local communities and last but definitely not least, absence of any sort of political commitment. With a few notable exceptions the majority of politicians and ministers pay lip service to RES development but do not go further than that.

Political commitment is the most important of all drivers. Evidence the following diagram comparing wind energy development between Greece and Turkey. Strong political commitment in the last decade in Turkey has led to an installation explosion, the benefits of which are evident in its economy.



The prospects

In mid 2015 in the daily news, the signs of the energy future are more than evident. And they all point to one direction: the greater and faster development of Renewable Energy Sources.

- COP21 in Paris is expected to be a game changer and tackling climate change to become number one priority for most nations. It already is for many.

- Norway a country rich in fossil fuel resources has decided to divest from fossil fuel and invest in sustainable energy solutions and climate change solutions. Many institutions and multinational firms are following suit.

- Saudi Arabia is planning to become a leader in Wind and Solar Energy!

- In Denmark wind energy covered 140% of its electrical needs and exported clean energy to its neighbours.

Yes the future still looks green as the development of renewable energy sources becomes a global obligation in order to rise to the climate change challenge.

Wind energy development prospects in Greece are more than excellent. They are unique. But until this is realised by the State we will continue to live in the era of lignite thermal stations and island diesel powered stations.

The volume of economic activity which will result by the development of 10 GW of wind energy projects, including offshore wind parks and the associated island interconnections and energy storage stations, is of the order of 20 billion euro.

Can a government which signed a new bailout agreement (July 2015) afford to ignore this? Wind energy and renewable energy prospects remain excellent under the hot Mediterranean sun and the cool Aiolos breeze, waiting, as they have always done, to be unlocked.

Dr. **Ioannis L. Tsipouridis** was born in Paranestion, Drama, Greece in 1952 and was educated in the United Kingdom, at the University of Leeds, in the period 1971-1980: B.Sc. Chemical Engineering on Local Education Authority grant, M.Sc. in Fuel and Energy on Science Research Council grant, Ph.D. in Solar Energy on Science Research Council grant (awarded in 1988). Starting with his M.Sc. thesis, he has worked all his life, for the development of Renewable Energy Sources (R.E.S.), as an energy engineer. Simultaneously he has been active in promoting R.E.S. development policies as Chairman of Hellenic Wind Energy Association (ELETAEN). He is currently Chairman & CEO of R.E.D. PRO Consultants, which he set up after leaving PPC S.A., a consultancy active in the fields of renewable energy and climate change. (Feb 2010-Feb 2013). On February 2010 he was appointed, with a 3 year contract as Chief Executive Officer of Public Power Corporation Renewables (PPCR S.A.), a 100% subsidiary of PPC S.A. (Oct 2009-Jan 2010) In Autumn of 2009 he took the position of the Director of the office of Deputy Minister for Energy Yannis Maniatis, in the Ministry of Environment, Energy and Climate Change (YPEKA), in charge (mainly) for renewable energy matters. (2007-2009) From 2007 to 2009 worked as RES consultant and editor of a commercial energy magazine *Energy Point* published by Periodikos Typos. He was awarded in 2009 the «Oikopolis» prize, given for contribution to environmental protection by the NGO «Ecocity». (mid 2010 to 2013) He was a member of the Board of Directors of CRES, the Center of Renewable Energy Sources of Greece (CRES). (1995-1996) He worked in Lovech Bulgaria, as the Regional Energy Expert of a European Union PHARE programme, coordinated by the Energy Policy Unit of the National Technical University of Athens (NTUA). (1984-2006) In 1984 he joined PPC's (Public Power Corporation) Direction of Alternative Energy Sources, where he worked in the development of PPC's Demonstration, Pilot and Commercial Renewable Energy Sources projects (mainly Wind Energy, but also Solar, Geothermal and Biomass). He held various positions and was involved in all project development stages (planning, licensing, contracting, financing and construction). He left in 2006, when the Direction was dissolved. (1982-1984) From mid 1982 to 1984 he was the Head of the Athens branch of an Energy equipment company, specializing in solar water heaters and energy stoves. The branch was responsible for the Attica area and the Aegean islands. (1981-1982): Served his military service in the Navy in the Public works department, involved in the study of central solar water heaters system's and sewage treatment unit's installations. (1987-to date): he is an active member of the European Wind Energy Association (EWEA) since 1987 and has served twice as Vice President and many as Board member. (1990-June 2015): From 2003 to 2010 and 2013 to 2015 he was the President of the Hellenic Wind Energy Association (HWEA), which he cofounded in 1990 and has served as Secretary General (1991-2001) and Vice President (2001-2003 and 2010-2013). For his contribution to ELETAEN and to the development of wind energy in Greece, in 2011 the Hellenic Wind Energy Association awarded him the «Aiolos» prize. He is creator and Editor of "Anemologia" (1999 – to date), the official Journal of the Hellenic Wind Energy Association. He is married to Ina Argyriou, CEO of Christian Dior's subsidiary in Greece, and they have 3 children & 3 grandchildren.

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ENTEKA

ΕΝΕΡΓΕΙΑΚΗ ΤΕΧΝΟΛΟΓΙΑ & ΚΑΤΑΣΚΕΥΕΣ

Company profile

ENTEKA is the oldest Greek company specialized in wind energy and generally in renewable energy sources. It was established in 1984 and holds a vast experience and detailed knowledge of the Greek energy market. Today it is a group of specialized companies with main activity the implementation and design of Renewable Energy Sources and Energy Saving.

ENTEKA undertakes and executes successfully each stage for the development of wind energy projects: design & development, study, financing, construction, project commissioning, maintenance, operation. It should be particularly marked, the ability of the company to offer Operation, Maintenance and repair of wind farms, 24 hours a day, across Greece.

ENTEKA focuses its activities in the Wind Energy sector but it extends to the field of energy and environmental technologies as well. Besides its specialized constructing activities, ENTEKA acts as a high-quality consulting group of companies, offering comprehensive services in the development, operation and management of energy-technology projects.

Moreover, ENTEKA is an investment company with interests in wind and solar energy projects, independently or in collaboration with third parties.

The main units of ENTEKA are: i) the Project Development & Research Sector covering and preparing all studies, wind measurements, licensing and other project development activities and ii) the Construction, Operation and Maintenance Sector, including technical personnel and work on construction sites.

ENTEKA offers:

- **Complete installation, construction and interconnection of wind and photovoltaic parks (W / P)**
- **Construction of Wind Farms "turn-key project"**
- **Maintenance of the electromechanical equipment**
- **Continuous 24h Tele-monitoring combined with Repair Unit and immediate restoration of operation of the W/P equipment.**
- **Management and Operation of Wind Farms in accordance with production guarantee contracts.**

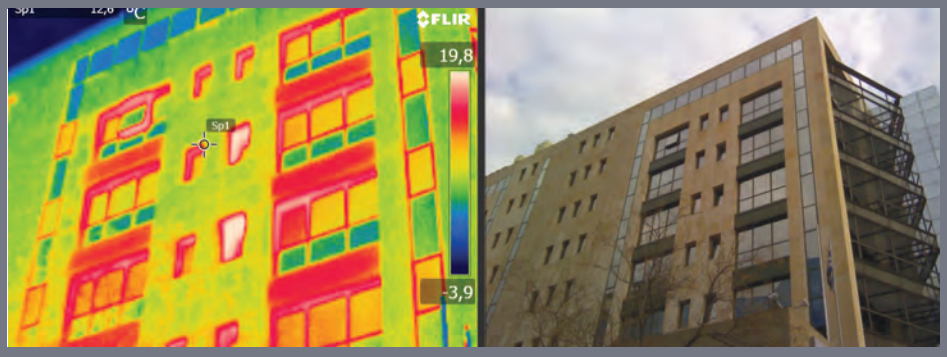
ENTEKA has the necessary electromechanical equipment, tools and spare parts required for the construction, maintenance and handling repairs of all the W/P and solar set under its control and monitoring.

Since 1984, EN.TE.KA has undertaken a large number of energy projects of the installation of 205 wind turbines with 165 MW and 3 photovoltaic parks with an installed capacity of 5,2 MW. It also has developed and is developing numerous wind and solar projects. Equally important is also the number of economic and technical studies or licensing studies for third parties.

Company profile

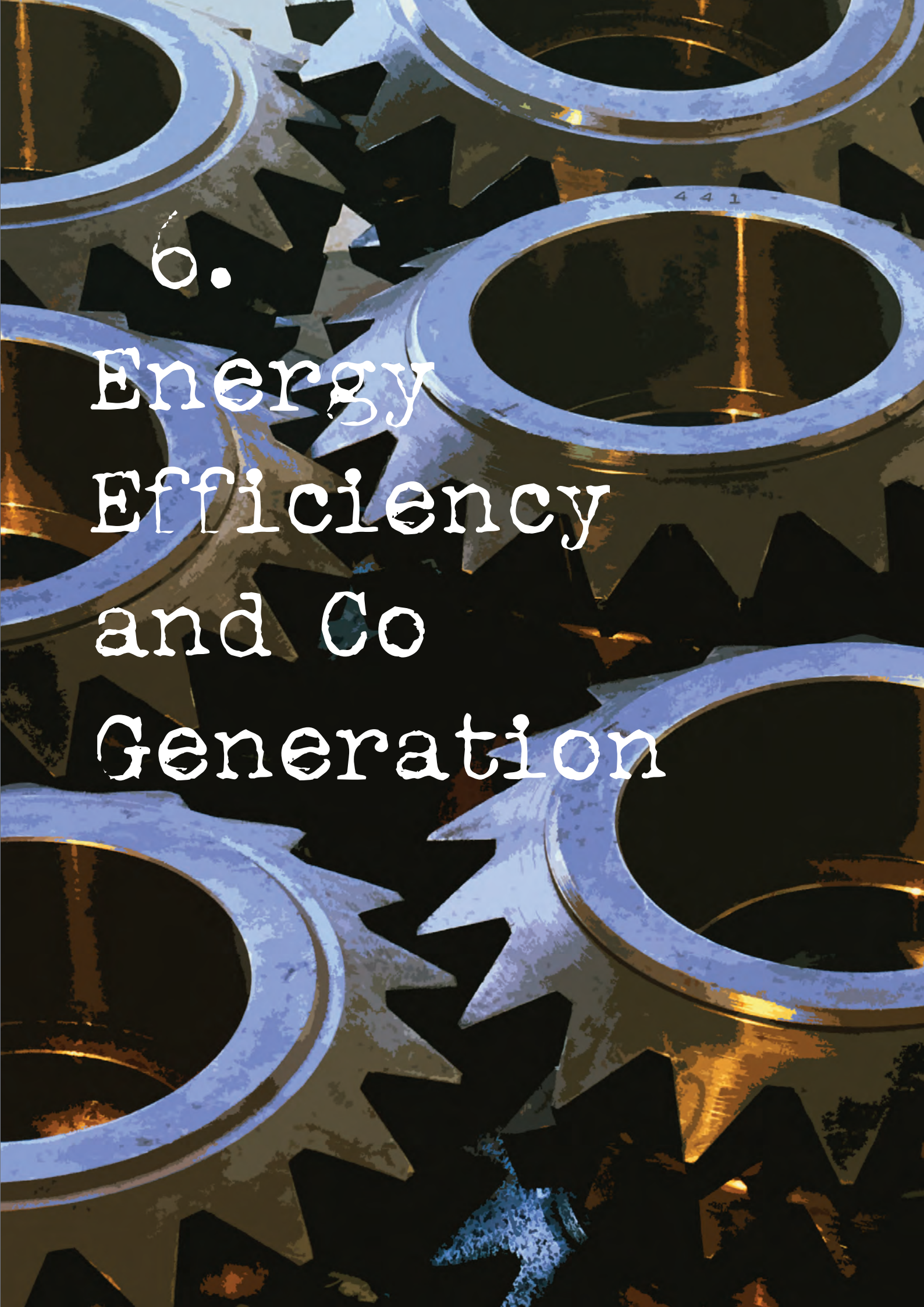
EUDITI Energy and Environmental Design LTD

EUDITI Ltd was founded in 2003 by leaders in the field of renewable energy and energy efficiency, for whom the propagation and consolidation of renewable energy, energy saving technologies and the protection of natural resources is a life mission. EUDITI conducts studies, provides consultancy services, executes research and development projects, and constructs prototype systems for energy supply and water supply. The company has extensive knowledge and experience in energy investment projects and provides reliable and complete services to investors. During the last ten years EUDITI developed over 100 renewable energy projects, totaling over 145 MW, out of which the great majority has been financed, constructed and is now in operation.



Services are provided mainly to the private sector but the company has also worked for municipalities, the Regulatory Authority for Energy, the Greek Government and in EU funded projects. The majority of EUDITI's customers are not based in Greece. During the last ten years EUDITI had customers based in Belgium, Portugal, Spain, Switzerland, Cyprus, Philippines, Nigeria and UAE. EUDITI is a shareholder of EUDITI Middle East (engineering company registered in Dubai, UAE involved in energy efficiency and renewable energy in buildings.

EUDITI LTD is a registered Energy Service Company (ESCO) according to Greek law and is certified according to ISO 9001.



6. Energy Efficiency and Co Generation

Cogeneration of Power and Heat in Greece

By **CONSTANTINOS THEOFYLACTOS**
Chairman of the Hellenic Association for the Cogeneration of Power and Heat, HACHP

For at least two decades the European Union, in its battle against Climate Change, has been taking all necessary measures for the promotion of Energy Saving in all sectors – Industry, Buildings and Transport – and, always, its main ally has been the Cogeneration of Heat and Power (CHP). There are many reasons for this; anyone involved in energy matters knows that CHP technology has been proved to work by:

1. Contributing to the saving of primary energy by at least 20%, a particularly important factor in the era of imported fossil fuels.

2. Decentralising the often inefficient Greek power generation system, contributing to the stabilisation and energy saving from losses during the transmission and distribution of electricity.

3. Contributing to the balancing between power generation and demand during peak periods, reducing the danger of electricity network black-outs.
4. Contributing to the reduction of emissions responsible for the greenhouse effect and the achievement of the targets of the Framework Agreement for Climate Change.

5. Creating employment at local level and improving the competitiveness of the business in which it is installed.

A very important factor which makes CHP different to RES is that CHP units are not normally independent Electricity and Heat production enterprises but exist within the framework of the production process. CHP units enhance competitiveness and contribute to the reduction of operating costs in every sector they are used (farming, industry, hospitals, tourism, retails, domestic, etc.).

The present state of the Greek energy market however, as a result of the economic environment of the past six years, makes any thoughts around new investments in the CHP sector in Greece, completely improbable. The most prohibiting factor is that today, almost none of the private CHP investments that happened with the support of all CFSs to date are operating, or, at best, they are under functioning. In many European countries cogenerated electricity in relation to the total production on electricity exceeds 40% (e.g. Denmark 50%, Finland 40%, etc.), but in Greece the percentage has remained stagnant at 2.0-2.5% for decades, despite funding from

the second and third Community Framework Support programme, NSRF and Development Laws.

The situation for CHP in Greece is hindered further and in addition to the bad financial climate by other causes that relate directly or indirectly to CHP as these are listed below:

It should be noted that within a decade (2006-2016), six pieces of legislation concerning CHP have been announced. This absolute fragmentation of laws and ministerial decisions are a hindrance for any investor. There is a serious need for simplification of the legislative framework and the proposal by the HACHP is **the creation of a Legislative Framework exclusively on CHP/ HPHPCS (High Performance Heat and Power Cogeneration Stations)** that would cover all aspects connected to this technology and strongly supported by EU Directive 2012/27/EU. This would also require the disconnection, from a technological aspect and at a legal level of RES from CHP since it must become apparent that these are two different technologies; one that relates mainly to the production of "green" electrical power and a second that relates to primary energy saving technology.

Also currently absent from the legislation is Trigeneration (Heat-Cold-cogenerated Power from the same system) despite its importance. The benefits of Trigeneration, especially during the summer, are massive since they would help reduce power demand peaks and the risk of possible black-outs.

At a legal level, one must also point out the absence of a *"standard network connectivity contract with co-producers of micro CHP (up to 50 kW_e)",* an issue that relates mainly to HEDNO (Hellenic Electricity Distribution Network Operator), and which has not been resolved despite numerous attempts by HACHP.

Lastly, another very important issue is the establishment of a "new" HPHPCS tariff regime differentiated from that noted in Law 4254/14 which brought about an important blow to attempts to promote HPHPCS in Greece.

In order to explain the situation is it worth noting that in 2010, the then Development Ministry in collaboration with HACHP proposed a reimbursement method for Cogenerated Power from HPHPCS units, effused into the Network by studying "best practice" examples from other EU member States with similar characteristics to Greece. This collaboration resulted in the establishment of a typology for HPHPCS using Natural Gas with the creation of a clause rate.

This policy operated until 2014 when there was an overall upset by the so-called "new deal" law or Law 4254/14. This new tariff method contained in Law 4254/2014, in HACHP's view is wrong and scientifically ungrounded, and requires important corrections in order to become functional.

HACHP's basic points of disagreement in relation to Law 4254/14 that also relate to serious scientific mistakes are:

1. "New" categories of HPHPCS have been introduced that have no practical application, e.g. the combined cycle heat recovery type with capacity below 1 MWe (world first!) Everyone knows that such stations are at least 100 MWe

2. It is not clear why there is a distinction between types of different HPHPCS since almost the same efficiency degrees and similar fixed parts are applied to all despite the relevant technologies being very different in efficiency levels, cost per installed MWe, etc.

3. The complicated way for calculating Natural Gas Price Customisation has no natural or practical sense and is scientifically mistaken since when all the mathematical sums have been performed the denominator is the product of “conventional type thermal system performance” over “electricity HPHPCS system efficiency”!

4. The individual efficiencies referred to in Law N.4254 / 14 correspond to provisions with a higher electrical efficiency than thermal, only possible in combined cycle plants! The performance scores are contrary to both Greek and corresponding EU legislation. Although the introduction / provision for remuneration against the cost of purchasing CO_2 emission rights is in the right direction, the 0.37, coefficient which has no scientific significance needs to be dropped.

The most important characteristic of the regulation of HPHPCS invoicing to be forward in Law 4254/14 is that it precipitates the sales price of the produced energy by 20 to 25% because of unfounded and unsubstantiated rumours that supposedly CHP investments generate excessive profits, at the same time as many units have closed for operational reasons or have “switched” to using boilers!

HACHP’s realistic and immediately applicable proposals for the support of CHP are synopsised below:

New sales prices for energy produced by CHP for the System and Network, that can be changed in accordance to international fuel prices. HACHP has studied and can submit a specific calculation formula based on domestic natural gas prices, a basic fuel in the CHP sector also connected to international petroleum process. As a basic principle we believe that the new sales pricing should secure that the relative price of electrical energy sold to IPTO/HEDNO from the CHP unit in relation to the price of natural gas is consumes must be at the level of 3.5-4 to 1 in order for CHP units to be financially sustainable.

HACHP also proposes:

1. Motives and measures for the conversion of CHP units into HPHPCS and the promotion of HPHPCS on islands with LPG (with new tariffing policy).

2. More favourable access conditions for CHP users to natural gas networks, especially with respect to the transmission and distribution charges (power part of the gas invoice). Because CHP by nature is a technology that serves and is dimensioned based on thermal loads in accordance to EU Directive 2012/27 / EC, this results in it being assessed as a “peak time” consumer by DEPA and DESFA and paying huge sums every month to be able to operate. The exception of CHP units from payment of transmission and distribution costs in natural gas invoices or the arbitrary increases that DESFA has lately required from co-producers, must be implemented immediately with changes in the natural gas calculation rates.

3. Subsidising of the connection costs of CHP plants with the natural gas network and the grid, both for private facilities, and the public sector.

If these corrective moves are not implemented immediately by the State it is more or less certain that:

- Currently operating CHP units will shortly terminate their operation as they are already unprofitable.

- New investments in the CHP sector will not be realised; as a result Greece's path towards the realisation of its commitments for the reduction of CO_2 emissions and the demands of the Lisbon Agreement will become long and hard, and

All the above will lead to Greece's non-compliance with the commitments that result from EU Directive 2012/27/EU "for the promotion of Energy Saving" and are contained in Law 4342/2015 voted recently.

This will be another lost opportunity!

Constantinos Theofylaktos is a USA trained Mechanical Engineer with an MSc from the University of Evansville, Indianna, and has 25 years experience in the energy sector. Constantiinos's special interests includes cogeneration and RES and was for many years chairman of Greece's Cogeneration Association and also member of the executive council of COGEN Europe. Until recently he was chairman and CEO of the Athens based Centre of Renewable Energy Sources (CRES).

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The Energy Performance of Buildings in Greece

By **CONSTANTINOS A. BALARAS**
Ph.D., Group Energy Conservation, Institute for Environmental Research & Sustainable Development, National Observatory of Athens

Introduction

The total number of buildings in Greece amount to ~4.1 million[1] of which 3.78 million are exclusive-use buildings, with 2.99 million residential buildings (or 79.2% of the building stock). Mixed-use buildings reach ~330,000 of which the main uses are residential dwellings (77.5%) and store-offices (16.0%). The evolution of final energy consumption in Greece is illustrated in Figure 1, including the latest officially-reported data for 2013. The total final energy consumption reached 15.3 million tonnes of oil equivalent (Mtoe), dropping over the 2012-13 period by -11%. Hellenic buildings accounted for 36.6% of the total final energy use[2] and reached 5.6 Mtoe following a notable decrease by -23% from the 7.3 Mtoe in 2012. The observed variations are partly due to the prevailing winter conditions, expressed by the heating degree days (HDD), the deep economic recession and the tax increase on heating oil imposed in 2012. These externalities have a direct impact on building occupants' behavior forcing them to reduce operational energy costs, even at the expense of proper indoor thermal conditions.

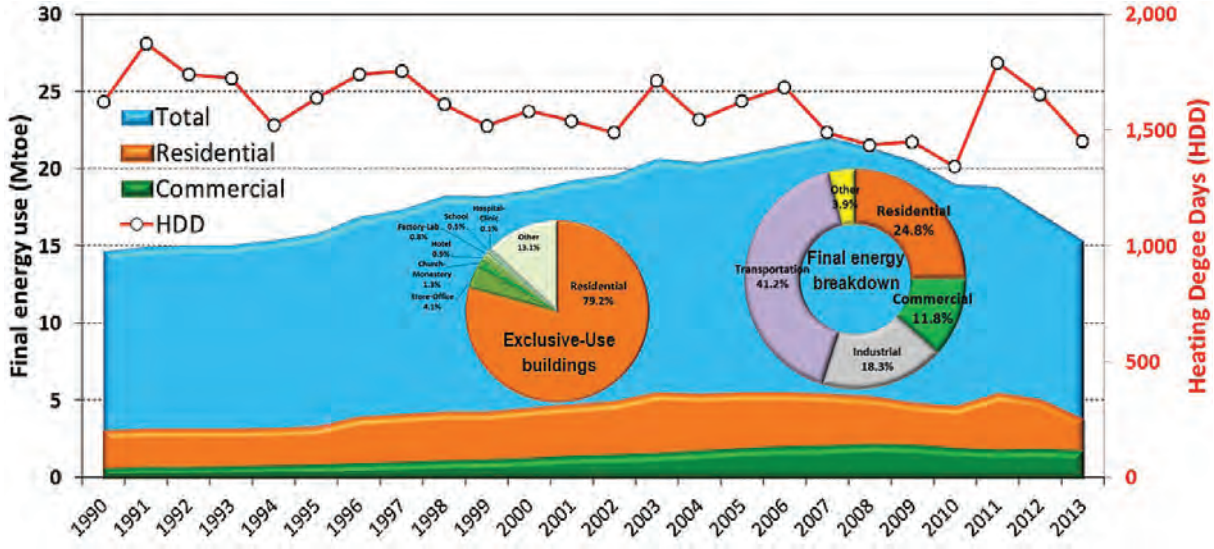


Figure 1. Total final energy consumption in Greece and contribution of the residential and commercial sectors (main y-axis). The line corresponds to the average HDD (secondary y-axis). The embedded graphics refer to the most recent data. (Source of data: ELSTAT; Eurostat 2015)

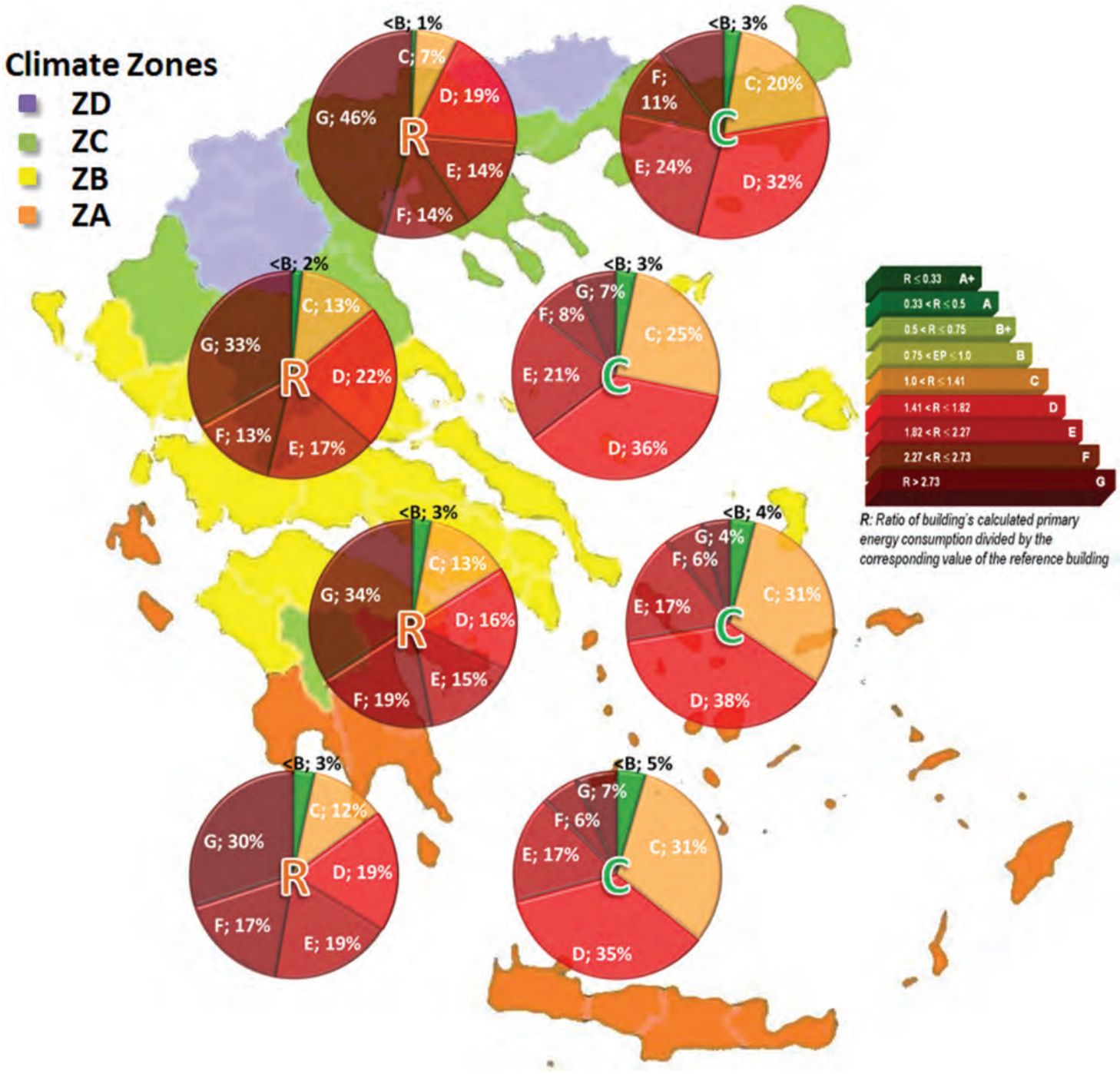
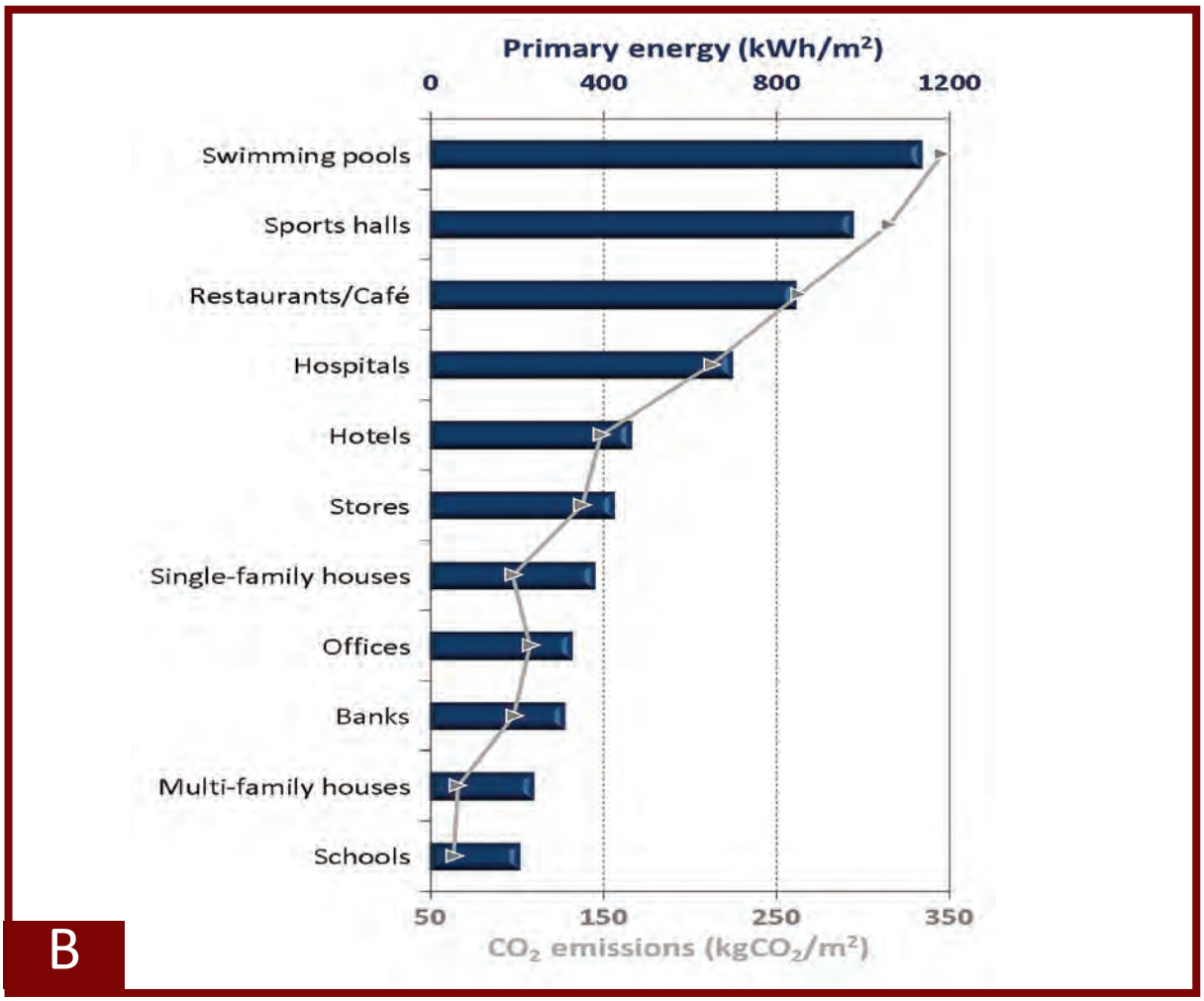


Figure 2.
a) Distribution of building energy-class ratings for residential (R) and commercial (C) buildings at the four climate zones. The color-coded key identifies the different energy-classes.

b) Calculated primary energy use (kWh/m^2 shown with bars) and CO_2 emissions (kgCO_2/m^2 shown with a grey line) for different end-use buildings. (Source of data: buildingcert).



The annual average thermal energy use averages 10,244 kWh per household, of which 85.9% for space heating, 4.4% for domestic hot water (DHW) and 9.7% for cooking[3]. Heating oil (63.8%) remains the main fuel source for space heating, while 12.4% use electricity, 12% biomass and 8.7% natural gas. The annual average electrical energy use per household is 3,750 kWh, which is mainly used for cooking (38.4%), white appliances (28.9%), DHW (9.4%), lighting (6.4%), cooling (4.9%) and space heating (3.0%). For DHW, 74.5% of households use an electric thermosiphon, 37.6% have solar collectors and 25.2% use the central heating system. In 2013, the Hellenic residential sector accounted for 24.8% of the total final energy consumption or 3.76 Mtoe[2], of which 63.7% is used for space heating, 17.3% for cooking, 10.2% for appliances and equipment, 5.7% for DHW, 1.7% for lighting and 1.3% for cooling[3]. The final energy consumption in commercial buildings reached 1.8 Mtoe in 2013, but detailed breakdown information is very limited.

National Status of EU Legislation

Over the years, transposition of relevant EU Directives in Greece has been slow. The European Directive on the Energy Performance of Buildings (EPBD 2002/91/EC) was enforced in 2010 by KENAK[4], introducing higher thermal insulation and system efficiency standards. The EPBD recast (2010/31/EC) was introduced by a national law (N.4122/2013) that covers the general regulatory framework and provisions[5]. The inspections of heating and air-conditioning systems are

still struggling for full-scale implementation, which should be completed by early 2017. The work for the minimum energy performance requirements and nearly zero energy buildings have not yet been initiated nor defined, as of the end of 2015.

Transposition of the European Directive on the promotion of the use of Renewable Energy (RED 2009/28/EC) was introduced by a national law (N.3851/2010). The minimum levels for the use of energy from renewables in new or major refurbished buildings have been set at 60% of the load for DHW, which has also been adopted in KENAK. In most recent developments, the Energy Efficiency Directive (EED 2012/27/EU) was transposed in to national law (N.4342/2015) in early-November 2015.

Energy Performance from EPCs

In line with the EPBD mandates, over 650,000 energy performance certificates (EPC) have been issued in Greece, when buildings or building units are sold or rented out for the first time to a new tenant. The available data from the national registry of EPCs (buildingcert) constitutes a valuable resource for gaining an insight on the energy performance of existing buildings. Dwellings account for ~85% of the issued EPCs and they are dominated by the lowest energy-class label, e.g. 34% are ranked at an energy-class G, while only 3% are ranked at a B-class or higher (Figure 2a). The average calculated total primary energy use is 261.6 kWh/m^2 while the CO_2 emissions reach 70.3 kgCO_2/m^2. Commercial buildings exhibit relatively better energy-class rankings (i.e. 37% have a D-class energy label), averaging 461.2 kWh/m^2 and 146.8 kgCO_2/m^2, with large variations depending on the end-use of the buildings (Figure 2b).

Potential of ECMs

About half of the buildings in Greece have no kind of thermal protection, since the majority of them were built prior to 1980, the year that the first Hellenic building thermal insulation regulation was introduced. The implementation of energy conservation measures (ECMs) for the refurbishment of inefficient buildings is a logical path forward in order to extend the useable lifespan of the existing building stock, improve living conditions and lower energy bills for occupants, while supporting the national efforts to meet the EU 2020 targets and the plans towards 2030.

Over the years, several studies have been performed to quantify potential energy savings, reaching the same conclusion, i.e. there is a very large potential for improving buildings' performance. According to the recent national energy efficiency action plan [6], the 2014-2020 cumulative energy savings target is set at ~3.3 Mtoe or approximately 19% of the total final energy consumption in 2012, with total new annual savings of ~0.9 Mtoe. Amongst the various policies, ECMs in buildings are anticipated to have the most significant contribution (~58%) towards meeting the national goal. In particular for the residential sector, where most measures are planned for implementation, the total energy savings for the period 2014-2020 are estimated at ~1.9 Mtoe.

An investigation of 18 individual ECMs to reduce space heating and DHW energy use in Hellenic residential buildings has revealed several priorities that result to high primary heating energy savings with low pay-back periods[7]. As expected, the addition of thermal insulation depends on the building's construction period, e.g. wall or roof insulation is recommended for pre-1980

buildings, which are considered without thermal insulation. For HVAC systems, the use of local natural gas boilers and high performance heat pumps, always improve the buildings' energy-class ranking. Reduced infiltration and the use of thermostatic controls are recommended for buildings with good thermal protection and high system efficiencies.

However, it has long been recognized that there may be significant deviations amongst calculated versus actual energy use in the design of new buildings or estimated savings as a result of implementing ECMs. This may be due to a multitude of reasons including deviations from the assumptions of normative calculations. Data analysis from thousands of EPCs that contained actual energy consumption has revealed some useful insight that can be used to derive empirical adaptation factors in order to correct predictions to better reflect the actual energy use. For example, using data from over 8500 EPCs for dwellings, the ratio of actual to calculated primary energy consumption averages 0.56 (i.e. 44% lower energy use than calculated). Coupling these findings with representative building types, one can then assess different modernization scenarios with a building stock model[8].

Findings from field surveys of actual energy consumption "before" and "after" the implementation of popular ECMs in dwellings reveal some additional benchmarks for documenting their effectiveness under real operating conditions (Figure 3). The weather corrected actual primary energy use intensity averages 68.5 kWh/m^2 before the ECMs to a post value of 52.4 kWh/m^2, with specific energy savings averaging 17.7%, although actual values vary widely for specific applications in different building construction periods, depending on occupant behaviors.

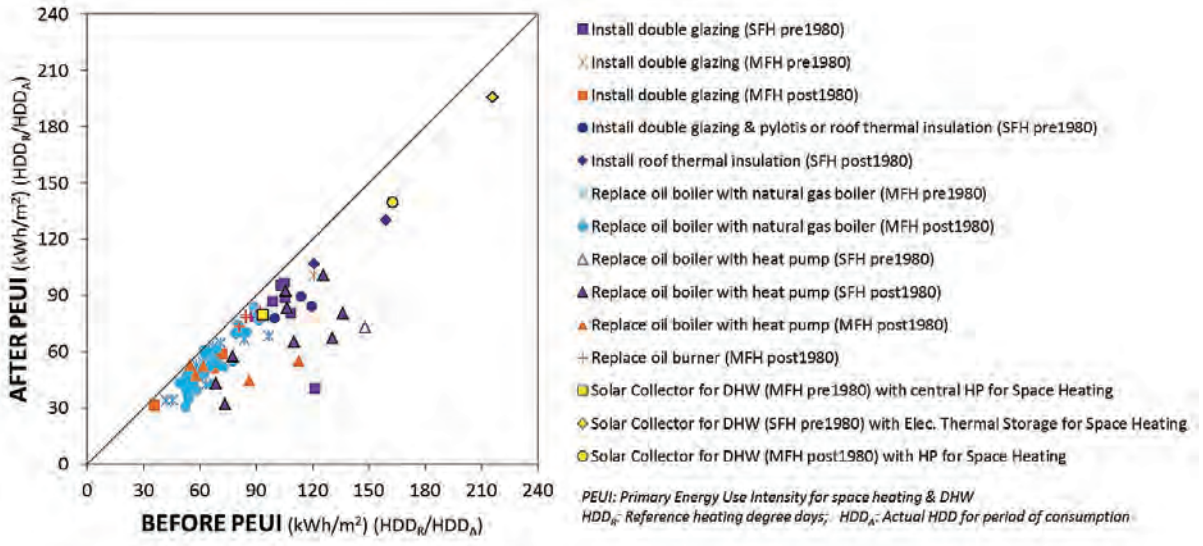


Figure 3. Weather corrected primary energy use intensity in dwellings "before" vs "after" the implementation of popular ECMs in single-family houses (SFH) and multi-family houses (MFH) for different construction periods. The 45-degree line (i.e. x=y) identifies a case when the actual energy use "before" and "after" is identical, i.e. there are no savings.

Along these lines, a multinational effort in a European project (www.episcope.eu) is paving the way by developing a conceptual framework for assessing refurbishment processes of European residential buildings in a transparent and effective way. The approach is based on the TABULA building typologies, already available for 20 European countries (http://episcope.eu/building-

typology/country), in order to handle the diversities for assessing different modernization scenarios for large building portfolios or building stocks on a regional and national basis.

ACKNOWLEDGMENTS

The national EPC registry (www.buildingcert.gr) has been developed and is maintained by the Hellenic Ministry of Environment & Energy, in collaboration with CRES. The Ministry is thankfully acknowledged for allowing access to the EPC database. The analysis performed herein does not necessarily reflect the opinion of the Ministry.

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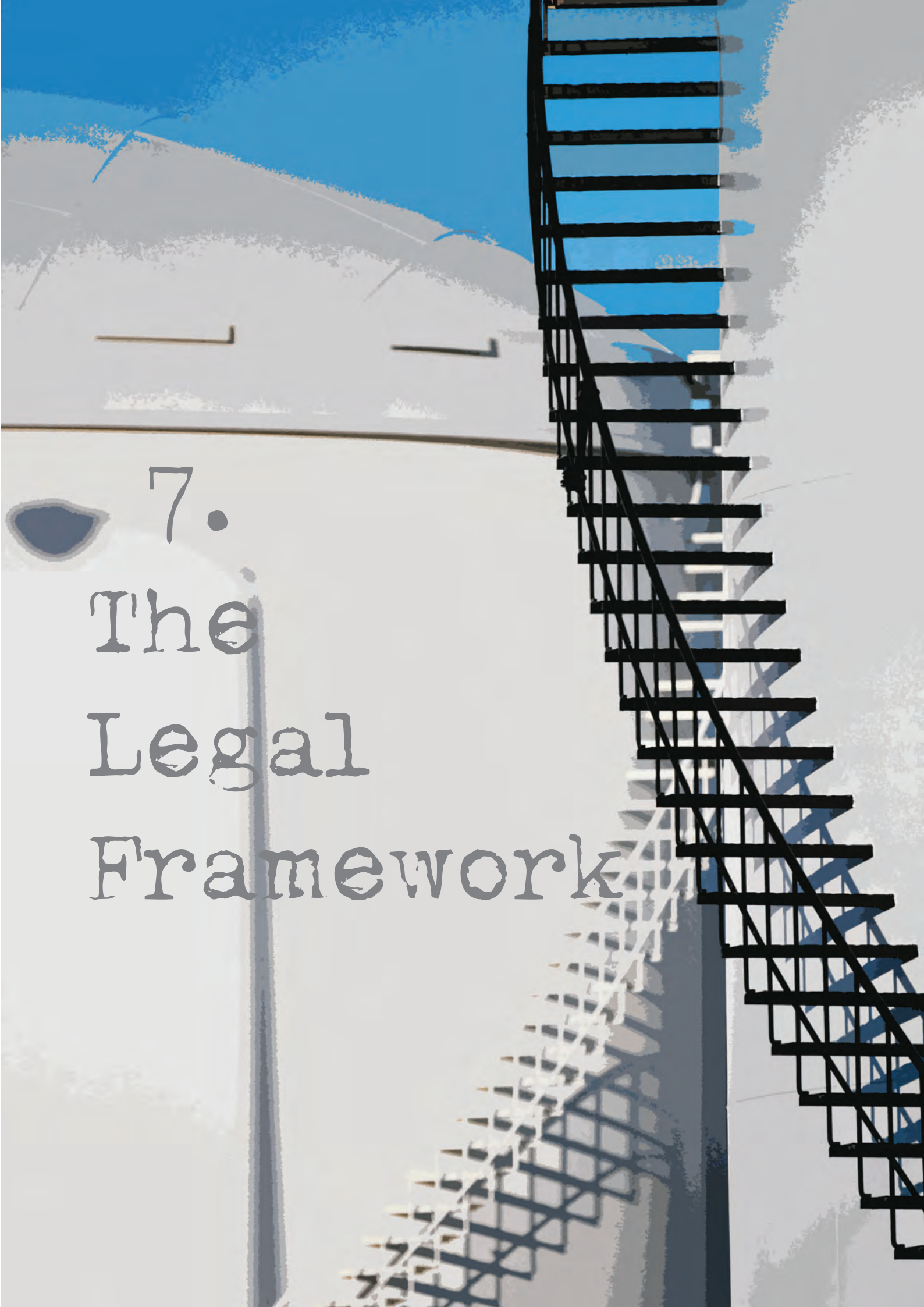

7. The Legal Framework

Greece's Legal Framework on Energy

By **GUS PAPAMICHALOPOULOS**, Senior Partner, KG Law Firm

GREECE

1. Introduction to the energy market

Greece's strategic geo-economic location, between energy producers in the Middle East, North Africa, and the Caspian Sea region, as well as on the vital transport routes of the Aegean Sea and the Eastern Mediterranean, characterises it as the expanding hub between East and West. Greece has initiated crucial, major ventures in oil, gas, and alternative sources that put the country at the heart of the Southeast European energy axis.

Greece's comprehensive energy policy, which seeks to establish sustainable, competitive, and secure sources of energy, has put forth an encompassing regulatory and market framework for the energy sector. This, in combination with Greece's wide-ranging investment regulatory framework, provides for exceptional opportunities for investment.

2. Electricity

2.1 Market overview

Greece embarked on the liberalisation of the electricity market in 1999. Subsequently, the legal framework was revised in order to comply with the provisions of European Union legislation and to incentivise private investment and competition.

The Public Power Corporation ("**PPC**") used to control Greece's electric production, transmission, and distribution. Since the entry into force of the Electricity Market Liberalisation Law, 37 per cent of the Greek power market was legally opened to competition. The law enabled the entry of third-parties to compete with the PPC and required that tariffs cover all costs and provide a reasonable profit. As a result, the generation, distribution, and retail operations of the PPC were unbundled, and the independent transmission system operator, the Hellenic Transmission System Operator ("**HTSO**"), was established.

The Greek government passed in 2011 a new energy law that, amongst other things, implemented the EU's Third Energy Directive and paved the way for increased competition in the country's energy markets by advancing the unbundling of the incumbent public companies as well as by giving the country's regulator much stronger powers. As a result, the responsibilities

of the HTSO and the PPC were unbundled and distributed to new subsidiaries.

Since the domestic market is still in its development stages, the expansion and modernisation of the network is viewed as the first priority; therefore, and taking into account the present conditions, the model of the Independent Transmission Operator was deemed appropriate. For this reason, the market's progress cannot directly be comparable to already matured markets.

Under the current economic conditions, and pursuant to the agreement Greece entered into with the IMF and EU on financial assistance, complete market liberalisation has been highly prioritised and is one of the main pillars of the economic model in Greece. This liberalisation is to be achieved through the privatisation of state-owned assets (including the Public Gas Corporation, a large stake in the ITO, small stake in the PPC, and the establishment of a "small" PPC to be sold to private investors) and through fully opening the electricity market to private investors.

2.2 Regulatory overview

The main legislative acts regulating the Electricity market in Greece are Law 2773/1999 "On the liberalisation of the Electricity Market", Law 3175/2003 which amended Law 2773/1999, the Electricity Transmission System Operation and Power Exchange Codes (Grid Codes), Law 3426/2005 "On the Acceleration of Electricity Market Liberalisation", Law 3468/2006 "On the Production of Electrical Energy from Renewable Energy Sources", Law 3851/2010 "On the Acceleration of the development of RES and the Climate Change", and finally Law 4001/2011 On the Operation of the Electricity and Natural Gas Energy Markets and for the Research, Production and Transmission Networks for Hydrocarbons and other provisions". These are accompanied by a series of secondary legislation in the form of Regulations, Ministerial Decisions and other Administrative Acts, issued on the basis of the provisions of these Laws, which set the electricity market rules (organisation and operation) and the fundamentals and restrictions of the market organisation, whilst they also establish the power exchange.

The government bodies and institutions which oversee and regulate the Electricity market are:

a) The Regulatory Authority for Energy ("**RAE**") established under Law 2773/1999, which is the independent authority that promotes and safeguards the liberalisation of Greek Electricity and Natural Gas markets, supervises and monitors the operation of all sectors of the energy market, and advises the competent authorities on the necessary changes to be made to secure compliance with competition rules and consumer protection;

b) The Ministry of Reconstruction of Production, Environment and Energy, which is principally responsible for the formulation and implementation of Greece's energy policy vis-à-vis its international and Community obligations;

c) The Ministry of Regional Development and Competitiveness, which can indirectly affect energy matters through its monitoring of prices of petroleum products and, perhaps more significantly, through its responsibility of administering European Union Cohesion Funds;

d) The Public Power Corporation ("**PPC**" or "**DEI**" as per its Greek initials), Greece's dominant electricity producer and supplier, and owner of the Distribution Network.

e) The Hellenic Distribution Network Operator ("**HDNO**" or "**DEDDIE**" as per its Greek initials), a wholly owned subsidiary of the PPC in the form of a Société Anonyme, which is the operator of the Distribution Network and as such shall be responsible for all activities relating to electricity distribution activities.

f) The Independent Transmission Operator ("**ITO**", or "**ADMIE**" as per its Greek initials), a wholly owned subsidiary of the PPC in the form of a Société Anonyme, which is the owner and operator of the High-Voltage Transmission System, responsible for its operation, exploitation, development and maintenance. In accordance with the relevant EC Regulations, special provisions have been included in the Energy Law securing the independent and non-discriminatory operation of the ITO.

g) The Electricity Market Operator ("**EMO**" or "**LAGIE**" as per its Greek initials), a Société Anonyme wholly owned by the Greek State (100 per cent), which is responsible for the operation of the electricity exchange market.

2.3 Regulated electricity market activities

According to Law 2773/1999, as amended and in force, the main activities which fall under the general term "Electricity market" are the sale and purchase of electricity and all related commercial activities (such as generation, transmission, distribution, supply, import and export etc.). In order for these activities to be lawfully performed, interested parties must obtain the relevant licensing.

2.4 Material licences for electricity generation

Under Greek electricity legislation, the development, construction, commissioning and operation of a power plant is extensively regulated by a number of legislative acts (including voluminous secondary legislation).

More specifically, Law 4001/2011 "On the Operation of the Electricity and Natural Gas Energy Markets and for the Research, Production and Transmission Networks for Hydrocarbons and other provisions" (the "**Energy Law**") together with Law 2773/1999 "on the Liberalisation of the Electricity Market" (the "**Electricity Law**") as amended and in force today, transposed the relevant EU Legislation into domestic law and set out the framework for the licensing of power generation facilities in Greece.

Against the above legal framework (the Energy Law, the Electricity Law and subsequent secondary legislation), the licensing process can be divided into three basic phases (milestones):

a) 1st Milestone: the issuance of the Electricity Generation Licence;

b) 2nd Milestone: the issuance of the Installation Licence, in conjunction with the Environmental Licensing of the respective facilities; and finally,

c) 3rd Milestone: the issuance of the Operation Licence, which follows the connection of the power plant to the Grid, its physical completion and successful trial operation.

The above milestones and associated licences are without prejudice to any other ancillary requirements which may be prescribed by the general legislation, *e.g.* building permits, health and safety legislation etc., which may run in parallel or as a prerequisite to reaching the next milestone.

2.5 Trading and supply of electricity

The operation of the electricity market is mainly regulated by the Grid Codes, as in force, which establish a mandatory wholesale daily market ("**Pool**") for power exchanges between market participants (*i.e.* Power Producers, Electricity Suppliers and Eligible Customers, as defined in the Grid Codes, the latter two being the Load Representatives) and a capacity assurance market. According to the provisions of the Grid Codes, all Power Producers holding power generation licences for power plants ("**Units**") registered with the Registry of Units are required to submit, for each Dispatchable Unit, a separate and fully binding Energy Injection Offer for each Dispatch Period of every Dispatch Day and for the entire available generation capacity of the Unit. The energy produced by a Power Producer has to be injected into the National Grid through its mandatory sale to the EMO, which, as per the currently applicable legislation in force, still remains the sole electricity off-taker in Greece. Currently, no private Transmission Systems exist in Greece.

In short, the operation of the Pool is comprised mainly by the following functions:

a) Day Ahead Scheduling ("**DAS**"), which precedes each Dispatch Day (24h; divided into 24 equal hourly Dispatch Periods beginning 00:00) and is conducted by the EMO based primarily on the following parameters:

- Load Nominations (MWh/h) from Load Representatives (on \
behalf of their Customers), from Suppliers for Exports (EUR/MWh/h) etc.;
- Energy Injection Offers (EUR/MWh/h) from Producers with Dispatchable Units per Unit for the entire available generation capacity of the Unit, from Suppliers and Self-supplied Customers for Imports, and from the EMO regarding the RES Units of the RES Law with dispatch priority against feed-in tariffs;
- Water Resources Management Statements from Hydro and Hydro Pumping Units;
- Reserve Energy Injection Offers from Producers with Dispatchable Units and from the EMO itself for Ancillary Services Contracted Units;
- Total or Partial Non-Availability Statements from Producers with regard to their Units;
- Techno-Economic Statements from Producers regarding their Generation Units; and
- Estimated System Constraints, Foreseeable Reserve Needs and Ancillary Services, including Interconnections available capacity etc.

b) Dispatch Procedure, which comprises the scheduling for the operation of Generation Units

(Dispatch Schedule) and the real time Dispatch of Generation Units by virtue of Dispatch Instructions from the EMO.
The EMO prepares daily the Day Ahead Schedule where the total anticipated load during the following Dispatch Day per Dispatch Period is contrasted to the Energy Injection Offers submitted by Producers for the same period. In particular, Energy Injection Offers by thermal power Producers should reflect no less than their Minimum Variable Cost, meaning mainly their fuel cost, which should be open to auditing by RAE.

Day Ahead Scheduling thus results in a uniform System Marginal Price ("**SMP**") per Dispatch Period (SMP in EUR/MWh/h).

This mandatory pool model, however, is scheduled to be changed. There is currently an ongoing consultation on the complete restructuring of the wholesale electricity market (initiated by RAE) in order to move from a mandatory pool to the European Target Model ("**ETM**"), which shall enable bilateral agreements between market participants. This restructuring process, which is part of the complete liberalisation of the electricity market, is targeted for completion at the end of 2014.

In addition, one of the matters set out in the consultation is the use of auctions with regard to the lignite electricity production of the dominant power producer, the PPC, in order to enhance competition in this cost-effective power source. These auctions are envisaged to take place in accordance with the NOME model, as is currently the case in France.

2.6 Transmission and grid access

The Electricity market is divided into two different systems: the mainland, interconnected grid and, as they are referred to, the "non-interconnected islands". However, several islands of the Cyclades group are scheduled to become interconnected with the mainland grid system through submarine cables by 2016. The distinction between the two systems is important because different rules are applicable for each system (for instance, authorisations in the non-interconnected islands are granted upon tender procedures, whereas such a procedure is not necessary for the mainland grid system).

According to the provisions of the Electricity Transmission System Operation Code, all power producers are entitled to gain access to the System or the Network under specific financial and technical terms concerning the connection of the power plant to the electricity grid, as such, are determined by the relevant Operator in the Connection Terms Offer.

At a later stage, power producers enter into a Connection Works Agreement with the relevant Operator of the System or the Network, which describes in detail the connection works required for the connection of the generation facilities to the grid, along with the financial and technical terms of the connection.

In order to participate in the wholesale electricity market, either to sell electricity (as producers) or to purchase electricity (as suppliers), participants must apply to be registered on the participant register kept by the EMO. By being registered in this register, participants enter into (i) the "DAS Transactions Contract" with the EMO and (ii) the "System Operator Transactions Contract" with the ITO.

3.Renewable energy

3.1 Market overview

Renewable energy plays a significant part in the Greek energy production, and was initially based primarily on large scale hydropower stations operated by the PPC.

To establish security and diversification of its energy supply, as well as to ensure environmental protection and sustainable development, Greece has established key priorities and binding policies related to the production of electricity from renewable sources, and it promotes the establishment of power using renewable energy sources.

Increasingly, renewable energy sources play an important role in Greece's energy production profile. Greece has reached almost 15 per cent energy consumption from RES and the total installed capacity from RES has reached 4,118 MW. The increase has mainly been led by photovoltaics ("**PVs**"), wind parks and hydropower stations, while the other RES technologies have not shown significant progress, mainly due to the economic crisis and difficulties in securing the necessary financing. Significant efforts must still be made though in order to reach the national targets which have been set for the production of power through RES.

Based on the EU mandate (Eel, 140/2009) and the latest law on RES Development (3851/2010) the national target for RES by 2020, states that the energy produced by RES will contribute 20 per cent of the gross final energy consumption, whereas the electric power produced by RES will contribute at least 40 per cent of the gross electric consumption. The aforementioned targets are to be achieved through a mix of measures related to the implementation of policies in the field of energy efficiency and the large penetration of RES technologies, both in electricity production and heat supply.

The Ministry of Reconstruction of Production, Environment and Energy has estimated that the implementation of the above targets would require an investment of EUR 12 billion over the next decade. The recent global economic crisis generally, and Greece's debt crisis specifically, affect the country's growth rate. However, Greece follows a long-term plan to reform and modernise its energy sector and it has taken several steps along this direction by revealing a number of competitive advantages, such as:

- A comprehensive regulatory framework for energy investment;
- Excellent potential of every renewable energy resource;
- Attractive investment incentives;
- Renewable energy project development at competitive costs; and
- Continued expansion of the energy market for spin-off markets in manufacturing energy technologies.

3.2 Support schemes

Law 3851/2010 on RES Development, as well as several other amendments in the existing RES legislative and regulatory framework, aim to simplify the licensing procedure, rationalise the feed-in tariff scheme in order to, on the one hand, be able to keep projects financially attrac-

tive while, on the other hand, not overburden consumers, tackle specific barriers at the local level, and immediately advance certain key projects, all for the advancement of power production by RES and for the attainment of the targets set.

In Greece, electricity generation through renewable energy sources is mainly promoted through a guaranteed feed-in tariff. Law 3468/2006, as amended and in force, differentiates RES electricity producers according to whether or not they are located on a Greek island *i.e.* whether or not they are connected to the mainland grid. RES power plants also enjoy dispatch priority to the Grid.

Part of the costs of the feed-in tariff system are borne by all consumers of electricity, who are obliged to pay a RES duty, which is added to their electricity bills.

The feed-in tariff is limited in time. The power purchase agreement has a duration of 20 years and may be extended by agreement between the parties. This additional agreement shall be concluded three months prior to the agreement's expiry date at the latest. Agreements regarding solar-thermal systems have duration of 25 years.

However, within the new market framework, which will be established for the operation of the wholesale electricity market, it may be reasonably expected that the RES energy market will need to be adjusted in order to abide with the new rules and market regulations. Although none of the reform options currently under examination by the Greek State explicitly provides that the current RES support schemes will also need to be re-evaluated and amended, it is the expectation of most of the key market players that the adaptation of a bilateral market structure, which RAE currently examines to implement with regard to the wholesale electricity market, will also be extended to the RES market as well. The introduction of such an option for the RES producers will also be in compliance with the obligation of the Greek State, under the provisions of its recent loan agreements, to re-examine the viability of the currently existing RES support schemes and make them more compatible with the current economic and market conditions. However, the implementation of such an option would require significant investments for the upgrade of the national grid in order to become compatible with the European networks and enable also the exportation of RES energy under bilateral agreements with foreign off-takers.

Another financial instrument umbrella for the promotion of RES (with the exemption of PVs) is the National Development Law (Law 3299/2004) which covers all private investments in Greece in all sectors of economic activity, which governs the terms and conditions of direct investment in Greece and provides for incentives, available to domestic and foreign investors, depending on the sector and the location of the investment. In February 2011, the new Development Law for supporting Private Investment for Economic Growth, Entrepreneurship, and Regional Cohesion, was voted and passed by the Greek Parliament in order to improve the tax benefits for investors selecting this option of investment support. This Law has a strong regional character, in that the level of public support strongly depends on the particular geographic region, within which a private investment is to be implemented. In the past, investors could select one of three forms of investment support: cash grants/leasing subsidies, wage subsidies and tax benefits. As per the latest amendment of the new Development Law, the tax benefit has been increased to match the level of the cash grants/leasing subsidies, a substantial benefit for investors.

Within the new market framework, which will be established for the operation of the wholesale electricity market, it may be reasonably expected that the RES energy market will also need to be adjusted in order to abide with the new rules and market regulations. Although none of the reform options currently under examination by the Greek State explicitly provides that the current RES support schemes will also need to be re-evaluated and amended, it is the expectation of most of the key market players that the adaptation of a bilateral market structure, which RAE currently examines to implement with regard to the wholesale electricity market, will also be extended to the RES market as well. The introduction of such an option for the RES producers will also be in compliance with the obligation of the Greek State, under the provisions of its recent loan agreements, to re-examine the viability of the currently existing RES support schemes and make them more compatible with the current economic and market conditions. However, the implementation of such an option would require significant investments for the upgrade of the national grid in order to become compatible with the European networks and enable also the exportation of RES energy under bilateral agreements with foreign off-takers.

4. Natural gas

4.1 Market overview

The Greek natural gas market is still in the early stages of development and the Greek State is heavily involved in the industry through direct or indirect ownership. Natural gas is a relatively new fuel in Greece, introduced into the Greek energy market over a decade ago. Natural gas demand is projected to increase significantly (to 20 per cent of the total energy demand in 2015) as it gains a progressively more important market share in power generation, as well as in the industrial, residential and commercial sectors.

Piped Natural Gas sales from Russia began in 1996 and from Turkey in November 2007, while Liquefied Natural Gas ("**LNG**") sales from Algeria began in 1999 on the basis of respective long-term supply contracts. Prior to this, the establishment of the high-pressure natural gas transmission system ("**NNGTS**") and LNG terminal facilities resulted from a decision by the Greek State in 1992 to modernise its energy industries and diversify the country's energy sources through the introduction of natural gas.

Greece is seeking to broaden its natural gas imports by sourcing natural gas from countries such as Azerbaijan, and is cooperating with several nations that are constructing pipelines. Azeri gas is scheduled to be transported via Turkey through the Trans Adriatic Pipeline ("**TAP**"), after the signing of a Memorandum of Understanding between Greece, Albania and Italy and the selection of this pipeline by the administrative consortium of the Shah Deniz gas field. This pipeline is designed to connect with the main line of the NNGTS and to provide for the transportation of natural gas from Greece to Italy via Albania.

In addition, there has been an agreement on the implementation of the IGB (Interconnector for Greece-Bulgaria) pipeline. This can potentially be used as a starting pipeline for exporting Arabian LNG from Egypt, Algeria and the Persian Gulf to the Balkans and Central Europe.

In 1988 a state-controlled natural gas company named Public Gas Company ("**DEPA**") was established and was granted by virtue of Law 2364/1995 the rights for planning, constructing and exploiting the NNGTS and the regional distribution networks, the rights to import and export

natural gas, as well as the rights to sell natural gas to the regional gas distribution and to supply companies of large end-users.

However, following the introduction of Law 3428/2005, (the "**Gas Law**") in 2005, all rights related to the construction and exploitation of the NNGTS have been conferred to an independent system operator ("**DESFA**"), which was established in 2007, while all of DEPA's exclusive rights pertaining to the import, export and trade of natural gas have been abolished. These activities have been rendered available to any party interested in such "main natural gas activities", without any licensing requirements.

Pursuant to the gas sector legislation, the exercise of natural gas activities within the territory of the Greek State constitutes a public utility and is performed under the supervision and regulation of the Minister of Reconstruction of Production, Environment and Energy. In general, the Greek policy regarding gas related issues focuses on the following main directions:

- ensuring security and continuity of supply;
- protecting consumers;
- ensuring the promotion of free competition and environmental protection; and
- promoting the implementation of energy-efficient and economical, effective practices by the licensees.

The above supervision and regulation competencies of the Minister of Reconstruction of Production, Environment and Energy are exercised in consultation with RAE, as the independent administrative authority for the energy sector. Following the enactment of the Energy Law, RAE's role is now considered compatible with the role of the natural gas market regulator provided by the third EU Gas Directive (EU 73/2009). The competencies granted to RAE refer to the regulation of both the electricity and natural gas market, in compliance with the respective EU Directives.

Finally, pursuant to the Energy Law, DESFA is vested with the exclusive authority for the operation of the NNGTS and is granted the exclusive and non-assignable rights of programming, constructing, owning and exploiting the system. Under the same law, DESFA also enjoys the rights of storage (including the management of LNG terminal facilities that constitute part of the national natural gas transportation system) and the processing of natural gas by means of this system. Therefore DESFA, upon its establishment, was granted a single ownership and operation licence with regard to the NNGTS for an initial period of 50 years. At the end of 2013, the Greek government, within the framework of privatising its stake in a number of energy companies, selected, through a tender process, the State Oil Company of the Azerbaijan Republic (SOCAR) as its strategic partner in DESFA by offering 66 per cent of DESFA's share capital.

Currently, since the market has been liberalised, DEPA is no longer the only entity which imports and trades in natural gas. New market players have entered, and the interest in doing so is high; Greece offers a unique advantage for those involved in the business of natural gas, because of its own increasing consumption needs, and because of its potential to act as an access point for the needs of Southeast and mainland Europe.

4.2 Regulatory overview

Until recently, the Greek natural gas market was essentially regulated by Law 2364/1995 (as amended by Laws 2528/1997 and 2992/2002). This legislation arguably conformed, to a certain extent, to the fundamental EU guidelines in the sector. However, the most crucial and significant step towards natural gas market liberalisation came with the relatively recent enactment of the Gas Market Law (Law 3428/2005), which implemented the EU Second Gas Directive (2003/55/EC) before the lapse of the derogation period granted to Greece as an emerging market under Directive 98/30/EC. The Energy Law which was enacted in August 2011 transposed the third EU Energy Package into national legislation and replaced some of the provisions of the Gas Market Law. Among other things, the abovementioned laws provide for:

- the development by private investors of independent natural gas transportation systems, LNG installations and storage facilities;
- the liberalisation of supply on the basis of an authorisation procedure;
- third party access to the national natural gas transportation system, including LNG and storage facilities, on the basis of published tariffs;
- accounting unbundling;
- the establishment of a natural gas spot market; and
- the extension of the regulator's powers with respect to the natural gas market.

Although a lack of specific details relating to the natural gas legislative framework proved to be a critical factor in delaying the full liberalisation of the market, it appears that this framework has now been completed with the approval of a series of secondary legislation such as the Gas System Code, the Users' Registry, standard contracts and tariffs regulations. This brings further uniformity and stability in the natural gas market.

4.3 Regulated natural gas market activities

According to the provisions of the Gas Law and the Natural Gas Licences Regulation, the supply and distribution of natural gas to Eligible and non-Eligible Customers, as well as the construction and operation of Independent Natural Gas Transmission Systems, are permitted only to the holders of the respective Licence, which is granted by RAE.

The initial term of these licences depends on the licensed activity and ranges from 20 to 50 years. Upon request of the licence holder, the licences may be renewed for the same time period.

Any other sale, purchase, import and export activities of natural gas activities are conducted freely.

4.4 Exploration and production

Natural gas still represents a small percentage of Greece's primary energy consumption, but demand is projected to increase significantly, rising to 20 per cent by 2015, as it gains a larger market share in power generation and the industrial, residential and commercial sectors. Al-

though Greece's natural gas demand by population size is significantly below that of other European countries, its projected 10-year compound annual growth rate for natural gas consumption is the highest among the EU-15 states. In Greece, 99.5 per cent of the petroleum that is used is imported, while only 0.5 per cent is locally produced.

Even though Greece has had legislation concerning the research, exploration and exploitation of hydrocarbons for many years, it only recently started taking more advanced steps to improve its productivity in this area.

The research, exploration and exploitation activities for hydrocarbons are regulated by Law 2289/1995, which was significantly revised by the Energy Law, introduced in August 2011.

In accordance with the United Nations Convention on the Law of the Sea, as ratified by Law 2321/1995, the right to research, explore and produce hydrocarbons existing in onshore areas, sub lakes and submarine areas, where the Greek State has either sovereignty or sovereign rights, belongs exclusively to the Greek State. Their exercise shall be for the benefit of the public. Following enactment of the Energy Law and by virtue of Presidential Decree 14/2012 the state company Hellenic Hydrocarbons Resource Management ("**HHRM**" or "**EDEY**" as per its Greek initials) was established to deal with certain matters relating to the management of the process of research, exploration and production of hydrocarbons as well as the announcement of tenders and tax motives to attract investors.

Foreign and Greek companies may submit their requests for research activities directly to HHRM, since HHRM will announce the relative tenders in short notice on companies' requests. The law is referred also to the "open door" tender procedure. Last but not least, the Energy Law includes flexible motives to attract investors.

For more information on the exploration and production of natural gas please see the description of the relevant legislative framework applicable to all types of hydrocarbons below (Upstream Oil).

4.5 Transmission and access to the system

The national natural gas transportation system (high-pressure pipelines) has already been commissioned but the distribution system (medium and low-pressure pipelines) is still in the development stage.

The NNGTS includes the main high-pressure natural gas transmission pipeline from the Greek-Bulgarian borders to the prefecture of Attica, the high pressure branches linking various areas of the country with the main pipeline, including the branch connecting the main pipeline with the Greek-Turkish borders, the LNG facility at the island of Revythoussa, as well as additional facilities and infrastructure that service the entire NNGTS.

Natural gas is injected to the NNGTS through the following three entry points:

1. Sidirokastro located at the Greek-Bulgarian border;
2. Kipi Evros located at the Greek-Turkish borders;

3. Agia Triada on the coast opposite of the island of Revythoussa.

The Energy Law requires DESFA to provide system users with access to the NNGTS in the most economic, transparent and direct way for as long as they wish. It must conclude contracts with system users for transportation and the use of storage and LNG facilities. Such contracts are based on model contracts, the provisions of which are determined by means of Ministerial Decisions following the approval of the tariffs by the Minister and RAE.

Access to the System may be refused if:

- there is a lack of capacity pursuant to the special provisions of the system's operating code;
- access to the system could prevent DESFA from fulfilling its public service obligations; or
- serious economic and financing difficulties occur owing to contracts containing "take or pay" clauses.

DESFA must specifically substantiate such a refusal and must communicate its decision and reasons to the authority and the user. DESFA is responsible for balancing the system load - these duties are specified in the system's operating code. In addition, DESFA may conclude load-balancing contracts with suppliers following a tender, according to non-discriminatory and transparent procedures and with due respect for market rules. DESFA will also carry out congestion management at the entry and exit points of the system based on market mechanisms and in accordance with transparent criteria, as defined in the operating code, in order to promote non-discriminatory competition between users.

With regard to independent natural gas transportation systems and storage facilities, the operator must conclude contracts for the use of such systems with users, pursuant to a model contract prepared and published by the operator following the approval of the authority and in accordance with the provisions of the respective system's operation code. Access to such systems may be refused only for reasons of capacity or where such access might prevent the operator from fulfilling its public service obligations (unless it is exempt by law from offering such third party access).

DESFA is required to prepare periodical 10-year system development studies for the expansion of the national natural gas system. Such plans must be submitted to, and approved by, the Minister and RAE.

Distribution

The Greek residential and commercial market for natural gas is relatively new when compared to most EU countries. There is a limited distribution network which existed for town gas in Athens dating back to the 19th century, which has been used to distribute natural gas since January 1998.

With the support of funding from EU programs, DEPA has already undertaken and completed the construction of substantial medium and low-pressure pipeline infrastructures in the coun-

try's three most densely populated regions (Attica, Thessaloniki and Thessaly), which have since been transferred to regional gas distribution and supply companies ("**EPAs**"), established jointly by DEPA's wholly owned holding companies ("**EDAs**") and private investors, following a tendering process.

DEPA is adopting a similar approach, supported by the Greek State and EU-funded programs, to develop distribution networks in new regions of the country (the north and central part).

The construction and operation of distribution networks in the rest of Greece require a distribution licence, issued following an application under the Energy Law. RAE may grant a distribution network licence upon the application of the interested party, unless state aid or other applications for the same area are involved, in which case the law provides for a tender process, rather than a simple evaluation of the respective application.

All distribution and supply companies are required to provide suppliers with access to their distribution networks for the supply of eligible customers, provided that such access does not violate the legislation in force or the respective distribution licences and does not endanger the safe operation of the network.

4.6 Trading and supply

Natural gas supply companies, as well as distribution companies, are entitled to supply customers with natural gas in their respective areas of jurisdiction pursuant to the terms and conditions of their respective supply and distribution licences.

Other activities, including wholesale trading and the import and export of natural gas, are not subject to licensing requirements. The Minister's oversight and the RAE's opinions and market monitoring in relation to each licensee's compliance with the terms of its licence constitute the official supervisory framework.

Physical trades in natural gas are determined on the basis of specific provisions in the NNGTS operation code prepared by the operator of the relevant transportation system (*i.e.* the national transportation system or an independent system). Further conditions are determined by the model transportation contracts which give to a gas undertaking access to the national system in order to supply an eligible customer. Given the relatively undeveloped state of the domestic gas market, the completion of financial trades in gas follows the principles that apply to physical trades under natural gas supply contracts. Thus, the physical delivery of a quantity of natural gas (as certified by the system operator) determines the basis upon which the related financial trades are completed.

System users (*e.g.* importers or suppliers) are able to procure transmission services from the respective system operators irrespective of the natural gas, while customers will pay an access charge for the use of distribution and transportation networks bundled with the commodity. Retail consumers located within the operating areas of a particular distribution and supply company will purchase natural gas and the related transmission and distribution services as a bundled product, as the company will act as both the local distribution system operator and the regional supplier of non-eligible customers.

DEPA no longer enjoys the exclusive right to purchase, import and export natural gas. Such activities are open to any party interested in the principal natural gas activities that can be undertaken without a licence.

4.7 LNG and storage capacity

LNG terminals constitute energy infrastructures of strategic importance for Greece, as they allow the further diversification of supply sources, provide further supply security and strengthen Greece's impact on the energy environment of the wider region.

Greece has one LNG import terminal. The terminal is located on the island of Revythousa, 45km west of Athens. Historically, LNG supplies were imported solely by DEPA under a contract with Algeria's Sonatrach; however in the spring of 2010 the first two privately owned LNG shipments entered the system. The LNG is stored in two tanks with a total capacity of 130,000m³. It is then regasified in special installations and afterwards it supplies the NNGTS.

The Revythoussa LNG facility is an additional entry point of the NNGTS and contributes significantly to the security of supply through its storage capacity, as well as through the possibility it offers to the Greek market to diversify its supply sources. The LNG facility consists of:

two storage tanks, with a total capacity of 130,000m³ LNG (useful capacity 126,500m³);
vaporisation units with total capacity of 1,000m³ LNG/hour (approximately 14 million Nm³/day (normal cubic meters);
a twin offshore pipeline 600m long and 24 inches in diameter, which connects the LNG terminal with the NNGTS; and
facilities for unloading ships with maximum length of 290m, draught which does not exceed the difference (12.7m – 10 per cent of vessel draught) for berthing and under keel clearance (distance between the keel and the sea bottom) of at least one meter.

The Ministry of Reconstruction of Production, Environment and Energy examines the possibility of international partnerships for the construction of a second LNG Terminal in Northern Greece. It is soon expected that the Hellenic Republic Asset Development Fund ("**HRADF**" or "**TAIPED**" as per its Greek initials" will announce the opening of a tender process for the long-term concession of the underground gas storage area in South Kavala, where the Greek State is expected to receive significant revenue not only through the initial concession price but also through its participation in the future revenues of the concessionaire.

According to relevant studies, the South Kavala site can store up to one billion cubic meters of gas and supply up to four million cubic meters of natural gas to the network per day (or 40 per cent of the daily consumption in the country) for a period of 90 days.

Furthermore, RAE recently also approved a floating LNG terminal in the northern Aegean, comprising of an offshore delivery and regasification station, which shall inject the natural gas into the NNGTS through an underwater pipeline.

According to DESFA, the storage facility will contribute greatly to the energy security in Greece and in neighbouring countries linked to its gas network.

5. Upstream oil market

5.1 Market overview

In Greece, 99.5 per cent of the petroleum that is used is imported, while only 0.5 per cent is locally produced. Even though Greece has had legislation concerning the research, exploration and exploitation of hydrocarbons for many years, it only recently started taking more advanced steps in order to improve its productivity in this area.

The rights to research, explore and exploit hydrocarbons located in the national soil, lakes or sea reside solely with the State's public sector, and the use of these hydrocarbons must always benefit the State. The Greek State has the power to assign research rights to third parties; exploration and exploitation rights however, are granted through a tender process.

Hydrocarbons research may be conducted through any possible means, including drilling. Exploitation of hydrocarbons refers to their mining and treatment, while exploitation does not include refinement procedures.

The areas designated for research, exploration and exploitation are set out by the Minister of Reconstruction of Production, Environment and Energy, and they usually have a rectangular shape. They can be determined by using the geographic coordinates of latitude and longitude, though in some cases the areas are determined from the shape of the country's border as well as from the coastline.

5.2 Regulatory overview

The research, exploration and exploitation activities for hydrocarbons are regulated by Law 2289/1995 which was significantly revised by the Energy Law, introduced in August 2011.

The Hellenic Hydrocarbons Resource Management company, the HHRM, has been established and is concerned with all matters relating to hydrocarbons. This company shall publish, following approval by the Minister of Reconstruction of Production, Environment and Energy, invitations for offers for hydrocarbons research in the Official Gazette of the Government and in the Official Journal of the European Union. The deadline periods for the submission of applications may not be shorter than 90 days, and the application must include:

- the specified area;
- the terms and obligations of the licensee;
- the reasons (criteria) for the applicant's choice;
- the price of the submitted state fee;
- letter of guarantee of good performance from a bank which operates lawfully in a European Union Member State;
- the deadline to grant the licence;
- any other relevant information.

The exploration area for hydrocarbons may not exceed 4.000 square kilometers when it comes

to land based research, and 20.000 square kilometers for aquatic research. The relevant licence is valid for 18 months.
Upon receipt of the research licence, its holder must submit to the Ministry of Reconstruction of Production, Environment and Energy the following:

(i) the research programs divided into specified periods;

(ii) upon the expiration of the research programs, the licensee must submit copies of the technical and scientific information and findings acquired during this research;

(iii) three months from the expiration of the licence, the licensee must submit an analytical report accompanied by official data and information, along with the analytical search result.

The State may lease the right to research and exploit hydrocarbon areas either through a stand-alone contract agreement or a distribution agreement for the ultimate production which includes the research and exploitation rights.

5.3 Hellenic Hydrocarbons Resource Management S.A.

The HHRM was established in 2012 by virtue of a Presidential Decree and is concerned with all matters relating to hydrocarbons.

The HHRM's terms is 99 years from the time of publication of the Presidential Decree establishing it. Its tasks include, indicatively, the following:

- to act on behalf of the Greek State, and to manage in its stead the exclusive rights of research, exploration and exploitation of hydrocarbons in land and the waters;
- to manage, control and monitor the agreements signed by the State or for the benefit of the State with third parties;
- to submit opinions to the State concerning the exclusive right to manage the research, exploration and exploitation of hydrocarbons;
- to collect and evaluate information concerning the country's hydrocarbons capacity;
- to collect, process, save, evaluate and manage data and information which has been acquired in the past or which will be acquired in the future during research on the country's hydrocarbons capacity, its uses and potential development;
- to submit proposals to the Minister of Reconstruction of Production, Environment and Energy on areas to grant licences for hydrocarbons research, exploration and exploitation, as well as storage areas for natural gas and CO_2;
- to prepare and conduct tenders, and to publish them in the international energy market in order to attract petroleum companies;
- to evaluate applications submitted for these tenders;
- to grant the research licenses;
- to negotiate the terms for the granting of licences for hydrocarbons research, exploration and exploitation;

- to make suggestions to the Ministry of Reconstruction of Production, Environment and Energy on the approval of annual works schedules and budgets, on drilling, geophysical and other research programs of the development project, as well as on the sponsor's obligation;
- to perform economic valuations of the areas which are to be licensed in the future, to estimate potential investment dangers and to perform studies for the development of oil reserves;
- to cooperate with the Ministry of Reconstruction of Production, Environment and Energy, the relevant competent authorities of the European Union and other organisations and educational institutions;
- additional obligations may be assigned to it by the Ministry of Reconstruction of Production, Environment and Energy.

The establishment of the HHRM is considered as the first basic step towards the exploitation of the oilfields of Greece.

5.4 Material provisions of the hydrocarbons legislation and other licensing regulations

The sponsor(s) may be physical person(s) (individuals) or legal entities, operating on their own or in cooperation with one or more other such individuals or legal entities. In addition, they must be nationals of Greece, a European Union member or of a third country as long as this third country has a reciprocity agreement with Greece;

With entering into the lease (agreement to rent), the sponsor(s) undertakes the responsibility to perform studies and to take actions necessary to research, explore and exploit hydrocarbons and their by-products. The sponsor(s) also undertakes to assume all costs (materials, staff, etc.) and risks associated with the project;

Part of the annual hydrocarbons production is given to the sponsor(s) to cover expenses. The remaining is divided among the sponsor(s) and the employer according to specified and agreed upon percentages;

The research period, which is specified in the lease, may not exceed seven years for land areas and eight years for sea/underwater areas. This time period may be renewed for a period equal to half of the originally granted time period.

6. Forthcoming developments in the Greek energy sector

Greece has a liberalised energy market which has evolved in the last decade into an energy hub and represents an important sector of the country's economy. Electricity and gas agreements with major European, American and Asian companies have positioned Greece as a point of reference in the region, and a number of energy projects linked to wider geopolitical moves and to the largest global economic players are expected to be implemented in Greece. Despite the current economic crisis and its impact on the Greek economy, a number of recent developments and significant reforms across all sectors of the economy have put Greece on a new course. The restructuring and modernisation of the Greek State has caused the markets to start to respond favourably.

Concurrently, the Greek government is reforming the Greek economy by providing a wider range of innovative investment tools to investors who want to explore new investment opportunities across several economic sectors.

6.1 The electricity market reform

Within the framework of the Third Energy Package and under the guidance of the European Commission and the IMF to promote measures to reform pathogenic structures of the domestic wholesale electricity market, Greece is currently in the process of evaluating several options in order to proceed with a complete restructuring of its electricity model and to conform with the rules for market integration, based on the ETM for electricity. The restructuring of the Greek electricity market is expected to also affect the RES market which may need to adopt innovative support schemes in order to comply with the new market rules and regulations and become more compatible with the current economic and market conditions.

The fact that the ETM, which is promoted by the European Union, is strongly influenced by the north-west European market raises significant challenges for the Greek market, the design of which is fundamentally different from the approach used in north-west Europe.

To address these challenges, RAE has initiated a consultation as to how the Greek State can best secure the safe and smooth transition of the Greek electricity market into the ETM.

As part of the consultation process, RAE has proposed three different high-level options under which Greece would comply with the requirements of the ETM. These are: (i) the adaptation of the current Greek model (Adaptation option); (ii) the north-western European Power Exchange Model (NWE option); and (iii) the mixture of forward bilateral agreements with a pool used for the Day Ahead Market (Hybrid option).

These actions of the Greek State show how the view that the RES market must conform to the tendencies existent throughout Europe has been adopted, as the flexibility to maintain the current favourable FIT scheme no longer exists. The implementation of the electricity market reforms is expected to bring the desired results along with the certainty and stability to this market which has been recently absent.

6.2 Privatisation of Energy Companies

One of the main tenets of IMF/EU economic assistance to Greece is the complete liberalisation of the energy market, both in terms of regulation and ownership. As such, the Greek government is in the process of privatising its stake in a number of energy companies, including the PPC, the ITO, DEPA, DESFA and the Hellenic Petroleum ("**ELPE**"), through the assignment of its interest in the abovementioned companies to the Hellenic Republic Asset Development Fund ("**HRADF**").

While the tender process for the privatisation of DESFA was concluded with the selection of Socar as the strategic partner of the Greek State and the signing of the relevant agreement (as process which is still ongoing with the involvement of the European Commission), the first attempt to privatise DEPA was unsuccessful. However, as natural gas gains a larger market share, DEPA is expected to be well positioned to play an important role in the region, and it is therefore expected that the second privatisation attempt will be successful, especially since DEPA, following an investigation performed by the Hellenic Committee on Competition, has recently

implemented a number of actions indicated by the latter in order for DEPA to allow for increased competition in the field of natural gas and to make its responsibilities and obligations clear to all market players.
PPC is also set to be privatised. More particularly, the Greek State intends, at a first stage to offer 17 per cent of its share in the PPC to private investors through an international public tender. At a next stage a "small" PPC is intended to be established with a portfolio including all current activities of the PPC which will then be offered for sale to private investors. As the dominant electricity producer and supplier, PPC's position within the Greek energy market is vital. This, coupled with its relatively low market value (a result of the financial crisis), makes the privatisation of this company a very appealing investment opportunity.

In addition, the PPC has explored the process of privatizing a 66 per cent stake in the ITO which runs about 11000 kilometers of high voltage power lines across the country, eagerly anticipated by high profile international market players and international private funds. The sale of the ITO may not be part of Greece's obligations under the memorandum, but it does comply with EU energy laws that demand standalone grid operators instead of grids as part of a public power company.

Finally, 2015 is expected to see the HRADF opening the tender process for the long-term concession of the underground gas storage area in South Kavala, where the Greek State is expected to receive significant revenue.

6.3 Hydrocarbons Research

The first decisive step towards the commercial exploitation of possible oil reserves in Greece was recently made by the MEECC, when in July 2013 it announced the two consortiums led by Energean Oil (Energean Oil and Gas - Petra) and ELPE (ELPE-Edison- Petroceltic) which won the tenders for the research and exploitation of hydrocarbons in the areas of Ioannina and the Gulf of Patra in western Greece respectively.

Meanwhile, the results from the seismic surveys by the Norwegian company Petroleum Geo-Services ("**PGS**") in the Ionian Sea and south of Crete created reserved optimism for the location of hydrocarbon reserves, which led to the announcement of two separate tenders. The first tender, based on individual expressions of interest for three onshore blocks in Western Greece, had a deadline for the submissions of offers of February 6, 2015. Hellenic Petroleum submitted an offer for the Northwest Peloponnese block, Energean Oil submitted an offer for the block in the Etoloakarnania area, and both companies submitted offers for a block in the Arta-Preveza area. The results of this tender are expected no earlier than mid-July 2015.

The second tender, based on a call for tenders for 20 offshore blocks in the Ionian Sea and south of Crete, has a deadline for the submissions of offers of July 14, 2015. Interest in these blocks is high and many international players are expected to participate in these tenders.

The drilling for oil and natural gas reserves in Greece may not only increase the country's revenues but also end its dependence on oil and gas imports, on which it spends billions of euros each year.

Conclusion

Despite the current financial crisis and unlike other sectors of the economy, the energy field continues to experience increasing growth with the full support of the Greek government and of both domestic and foreign-private investors. Initiatives taken by the government to ease the regulatory framework and to comply with the European directives on the complete liberalisation of the market, along with the positive reaction of investors to large scale investments opportunities in energy, define the energy market in Greece today. The developments described above are the focal point of a comprehensive energy policy which seeks to promote existing clean energy projects, modernise and expand the energy-related infrastructure, diversify sources of energy by exploring new energy possibilities through hydrocarbons research and create new job opportunities and technological innovations.

Gus Papapmichalopoulos, Partner of Kyriakides-Georgopoulos Law Firm and Secretary General of IENE. Gus heads the Energy, Infrastructure and Utilities Practice Group. His main area of expertise is on the energy industry and he has been involved in the liberalization of the Greek electricity market and gas market. Due to the complexity of the issues associated with the electricity market regulations he advises on major regulatory issues of the electricity, natural gas and RES market. As a business lawyer focusing on the energy sector, key international energy companies investing in Greece have mandated Gus in the early stages of their investment program for the implementation of important energy projects (infrastructure projects such as oil and gas investments, the licensing and development of gas pipelines, the establishment of power generation plants, wind parks, low pressure gas distribution networks, etc). Another element of his practice is the public sector-privatization projects, in which he has acted for both the Greek State and the private sector (e.g. privatization of State-owned companies, concession agreements, public private partnerships relating to parking stations, toll roads, etc). Project finance is a strong section of his practice, since major local financial and credit institutions and private equity funds are instructing the team for the financing of energy infrastructure projects. Gus also serves as one of the managing partners of KG Law Firm, has acted as co-chair of SEE LEGAL Group for two years and currently serves as General Secretary of the Institute of Energy of South East Europe (IENE).

Practice Areas: Corporate Law, Energy, Natural Resources and Utilities, Public Law – Environmental Law, Public Sector Projects.

Quotes & Awards: He is ranked as a leading lawyer in the IFLR1000. Gus Papamichalopoulos is ranked as a leading lawyer in Chambers & Partners Europe and Chambers & Partners Global. «This “world-class team” of energy specialists receives extremely high praise from clients for its skills in regulation and negotiation. With a wealth of experience in this sector, the firm provides prompt delivery and a “wonderfully professional and hugely practical” service. Gus Papamichalopoulos is regarded as an energy pioneer who possesses an intimate knowledge of the regulatory framework».

G. Papamichalopoulos remains a "well-respected and well-known" energy practitioner, with many peers placing him at the top of the market”.

Professional Associations: Member of the American Bar Association (1998). Member of the Athens Bar Association since (1991). Member of the International Bar Association (1995). Member of the Board and General Secretary of the Institute of Energy of South East Europe – IENE. Education: Aristotelian University of Thessaloniki (LL.B) Languages: Greek and English.

Company profile

Institute of Energy for South-East Europe

The Institute of Energy for South-East Europe (IENE) is an independent and non-profit regional organization based in Athens and active in the whole energy sector of SE Europe.

IENE's mission is to promote a broader understanding of the key energy issues in the region and provide a suitable platform for the exchange of views and information, open to professionals, companies, stakeholders and others who are actively involved in the energy field. IENE wishes to actively contribute to a better understanding and optimum use of energy resources, with respect to the environment and by formulating appropriate energy strategies and policies.

IENE's vision is to establish itself as the leading energy think tank of the region and at the same time provide a highly credible range of services including research, assessment studies, sectorial surveys, educational activities and event organisation. These services are offered primarily to its members, but also to government and industry and other relevant stakeholders. As part of its vision IENE is committed to a cleaner environment and the rational use of energy with the involvement and co-operation of leading energy experts from all different countries in the region.

The timely dissemination of information and analysis is an integral aspect of IENE's work with the aim of facilitating the understanding of central policy and complex technical issues thus helping to promote public debate. IENE is active in the whole energy spectrum and the subjects which it studies include electricity, oil and gas, renewables, energy storage, cogeneration, energy efficiency and clean energy production based on conventional fuels.

Membership to IENE is open to all energy professionals and companies active in the energy sector. IENE members receive regularly expertly written newsletters and other reports with latest information on regional and global energy developments.

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8. Research & Development

Energy Research & Development in Greece

By **NICHOLAS SOFIANOS**, Research Coordinator, Institute of Energy for SE Europe

Vigorous, well-funded research activity and infrastructure are the bedrock for long-term innovation and economic growth. However, the effects that the recent financial crisis has had on the Greek economy and society are devastating and Greek science and research is undeniably in a critical condition. With official unemployment close to 27%, youth unemployment exceeding 60%, Greece has probably suffered more than any other European country. Six successive years of recession, which shrunk the country's gross domestic product (GDP) by more than 25% since 2007, have been enough to strangle almost every economic activity. In these circumstances, Greek science has recurrently been sending emergency signals and many scientists are now strenuously warning about the acuteness of the situation. Underfunding, chronic structural deficiencies and lack of proper evaluation are acutely harming Greek science and research.

Nevertheless, even amidst this crisis, Greece's research system still shows signs of excellence compared with those of fellow European countries, for example, in terms of securing grants from European research funding bodies and the country's contribution to the top 1% of most-cited papers in the world. This resilience of the scientific output in the tough economic environment is, among other factors, founded on the traditionally large percentage (above 80%) of Greek students that decide to pursue university education, thus forming a strong base for scientific research and development.

However, funding for research and development (R&D) in Greece, at the moment is only around 0.6% of the GDP, which is considerably below EU standards. The largest part of research funding comes from the EU (Framework Programme plus Structural Funds), which also reflects the “openness” of the Greek R&D researchers to international collaborations. Further EU funds are also provided for the exploitation of new knowledge and research results, and financial incentives are established for the construction of technology parks and high-tech firm incubators.
In Greece research in the energy sector is conducted through academic Institutions and non-academic research centers and covers the following areas: low-carbon heat and power; decarbonization, alternative fuels and energy sources for transport; CO2 management, oil and gas technology, RES technologies, smart cities and communities; smart grids; energy efficiency, energy policy and modeling.

Special mention should be made to CERTH as it is one of the leading research center in Greece and is listed among the TOP-25 institutions in the E.U with the highest participation in competitive research grants. CERTH includes two institutions active in energy: the Chemical Process Engineering Research Institute (CPERI), which conducts R&D and innovation activities in the fields of science related to energy conversion, and the Institute for Solid Fuels Technology and Applications (ISFTA). The latter is the main Greek organisation promoting R&D in solid fuels and their by-products. As far as energy policy is concerned, CRES, the Greek national center for renewable energy sources, is the national coordination center for the RES sector, the rational use of energy and energy efficiency. It is supervised by the Ministry of Environment, Energy and

Climate Change. Other government funded institutes and research centres with strong impact on the Greek research sector include N.C.S.R. Demokritos, the Institute of Geology and Mineral Exploration (IGME), the National Observatory (GREC) and others.

Regarding academic activities several R&D teams and laboratories specialize in high level energy research. One of the leading academic teams is the E3M-Lab of the National Technical University of Athens (NTUA). The Lab specializes in the field of energy systems analysis and economics, macroeconomics and environmental economics by using and developing large-scale mathematical models based on advanced techniques of Applied Econometrics, Operations Research and Computer-based Information Systems. The laboratory offers policy analysis studies, consulting services, energy and environmental policy for the European Union and other world regions. The laboratory has accumulated extensive experience in power systems planning, power regulation and economics and investment analysis.

A prominent, non-governmental, research body is the Athens based Institute of Energy for SE Europe (IENE). The IENE is a leading energy think tank focusing on the SE European region. IENE provides a wide range of services covering qualified information and analysis, research, assessment studies, sectorial surveys, educational activities and event organization. As part of its vision IENE is committed to developing high level research and analysis capabilities, with the involvement and in cooperation with leading energy experts from all different countries of the region.

Finally, according to latest information, the Greek government seems eager to establish by the end 2016, the first research agency, the Hellenic Foundation for Research and Innovation (HFRI), with a loan from the European Investment Bank with energy studies to be included in the foundation's list of activities. Greece has received a loan of 180 million euros from EIB in order to set up this foundation and thus boost scientific research, with the Greek government ready to contribute another 60 million euros to the project over the next two and a half years.
Considering the above developments, the only way forward for Greece today is to increase investment in human resources and infrastructure, coupled with organizational reforms and a change of government attitude towards research; with coordinated action by government and external bodies, especially in industry and independent minded research teams.

The following is a list of all research institutes (governmental, non-governmental, academic) involved in energy work and operating in Greece today.

Nicholas Sofianos (Mphil Development Studies, University of Glasgow, Scotland) has been working for IENE since December 2007 where he is currently Research Coordinator. He has carried out research on several energy sectors such as electricity, natural gas and RES market. He was IENE's coordinator in the EU funded GEOFAR project. He has also strong interest in energy policy issues. He is Assistant Editor of "Energy Matters" (Monthly Newsletter of IENE) and of the "South East Europe Energy Brief" (a series of monthly IENE Newsletters). He is also the author of several articles, papers and studies on energy and he has participated as a speaker in several conferences, seminars and workshops in Greece and other European countries. He is a member of the Institute's Board of Directors (BoD) and member of IENE's Geopolitics Committee.

Energy Research in Greece

A. Government Funded Institutes and Research Centers

ATHENA - RESEARCH AND INNOVATION CENTER IN INFORMATION, COMMUNICATION AND KNOWLEDGE TECHNOLOGIES
Tel.: +30 2106875300
Fax: +30 2106854270
ADDRESS: Artemidos 6 & Epidavrou, 151 25 Maroussi
Website: www.athena-innovation.gr
e-mail: info@athena-innovation.gr

CENTER FOR RENEWABLE ENERGY SOURCES AND SAVING (CRES)
Tel.: +30 2106603300
Fax: +30 2106603301/302
ADDRESS: 19th km Marathonos Ave, 19009, Pikermi Attiki
Website: www.cres.gr
e-mail: cres@cres.gr

FOUNDATION FOR RESEARCH AND TECHNOLOGY-HELLAS (FORTH)
Tel.: +30 2810391500-2
Fax: +30 2810391555
ADDRESS: 100 Nikolaou Plastira str., Vassilika Vouton, Heraklion, Crete GR – 700 13 / Postal ADDRESS: P.O. Box 1385, Heraklion, Crete GR - 711 10
Website: www.forth.gr
e-mail: central@admin.forth.gr

HELLENIC CENTRE FOR MARINE RESEARCH (HCMR)
Tel.: +30 2291076462
Fax: +30 2291076323
ADDRESS: Street Address 46,7 km Athens Sounio ave. P.O. Box 712, P.C. 19013 Anavyssos Attiki
Website: www.hcmr.gr
e-mail: webadmin@hcmr.gr

INSTITUTE OF ENVIRONMENTAL AND SUSTAINABLE DEVELOPMENT (IERSD)
Tel.: +30 2108109122
Fax: +30 2108103236
ADDRESS: I. Metaxa & Vas. Pavlou, GR-15236 Penteli
Website: www.meteo.noa.gr

INSTITUTE OF GEOLOGY AND MINERAL EXPLORATION (IGME)
Tel.: +30 2131337000-3
Fax: +30 2131337440
ADDRESS: Sp. Loui 1 C Input (Olympiako Xorio) Axarne 13677 Athens
Website: www.igme.gr
e-mail: dirgen@igme.gr

INSTITUTE FOR RESEARCH AND TECHNOLOGY OF THESSALY (I.RE.TE.TH)
Tel.: +30 24210967409
Fax: +30 2421096750
ADDRESS: Dimitriados 95 & Pavlou Mela 383 33, Volos
Website: ireteth.certh.gr
e-mail: admin@ireteth.certh.gr

NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS" *
Tel.: +30 2106503002
ADDRESS: Patr. Gregoriou E' & 27, Neapoleos str., 153 41, Agia Paraskevi, Attica
Website: www.demokritos.gr
e-mail: communications@central.demokritos.gr

* Solar & Other Energy Systems Laboratory
http://www.solar.demokritos.gr/
* Institute of Nuclear & Radiological Sciences and Technology, Energy & Safety (INRASTES)
http://www.ipretea.demokritos.gr/

NATIONAL DOCUMENTATION CENTRE
Tel.: +30 2107273900-3
Fax: +30 2107246824
ADDRESS: 48 Vassileos Constantinou Avenue, 11635, Athens
Website: www.ekt.gr
e-mail: ekt@ekt.gr

NATIONAL OBSERVATORY OF ATHENS – ENERGY CONSERVATION GROUP (GREC)
Tel.: +30 2108109122
Fax: +30 2108103236
ADDRESS: I. Metaxa & Vas. Pavlou, 15236 Penteli
Website: www.energycon.org

B. Independent Institutes and Research Centers

GREEK INSTITUTE FOR COPPER DEVELOPMENT
Tel.: +30 2104898298
ADDRESS: Piraeus 252, 177 78 Tavros, Attica
Website: copperalliance.eu/gr
e-mail: info@copperalliance.gr

HELLENIC INSTITUTE PASSIVE BUILDING
Anastaseos 112 and Pindou Avenue
156 69 Papagou
Tel.: (+30) 211 408 11 09
www.eipak.org
e-mail: info@eipak.org

HELLENIC RESEARCH CENTRE FOR METALS S.A. (ELKEME)
Tel.: +30 2262604400
Fax: +30 2262604358
ADDRESS: 56th km Athens-Lamia Nat. Road, 320 11 Oinofyta Viotia
Website: www.elkeme.gr
e-mail: info@elkeme.gr

INSTITUTE OF ENERGY FOR SOUTH-EAST EUROPE (IENE)
Tel.: +30 2103628457, 2103640278, 2103624245
Fax: +30 2103646144
ADDRESS: Alex. Soutsou 3-10671 Athens
Website: www.iene.eu
e-mail: secretariat@iene.gr

C. Academic Institutions

NATIONAL TECHNICAL UNIVERSITY OF ATHENS

Department of Electrical and Computer Engineering

- E3M-LAB (ENERGY - ECONOMY - ENVIRONMENT MODELLING LABORATORY)

Director: Professor Pantelis Capros
Tel.: +30 2107723629
Fax: +30 2107723630
ADDRESS: 9, Iroon Politechniou Street 15 773 Zografou Campus, Athens
Website: www.e3mlab.ntua.gr
e-mail: kapros@central.ntua.gr

School of Mining and Metallurgical Engineering

- LABORATORY OF APPLIED GEOPHYSICS

Director: Professor Sofia Stamataki
Tel.: +30 2107722067-68-71
Fax: +30 2107722063
ADDRESS: School of Mining & Metallurgical Engineering National Technical University of Athens 9 Iroon Polytechneiou str., 157 80, Zografou, Athens
Website: www.metal.ntua.gr
e-mail: secretary@Tmetal.ntua.gr

- LIGHTING LABORATORY

Director: Professor Frangiskos V. Topalis
Tel.: +30 2107723506
Fax: +30 2107723627
ADDRESS: 9 Iroon Poytechniou St. Zografou 157 80 Athens
Website: lighting.ece.ntua.gr

- HIGH VOLTAGE LABORATORY

Director: Professor Ioannis A. Stathopulos
Tel.: +30 210772 3582
Fax: +30 210772 3504
ADDRESS: 9, Iroon Politechniou St. Zografou Campus 15780 Athens
Website: highvoltages.ece.ntua.gr
e-mail: stathop@power.ece.ntua.gr

School of Chemical Engineering

• LABORATORY OF THERMAL TURBOMACHINES
Director: Professor Constantinos Mathioudakis
Tel.: +30 2107721638
Fax: +30 2107721658
ADDRESS: National Technical University of Athens Laboratory of Thermal Turbomachines 9, Iroon Polytechniou Polytechnioupoli Zografou 15780 Athens
Website: www.ltt.ntua.gr
e-mail: kmathiou@central.ntua.gr

• LABORATORY OF INDUSTRIAL & ENERGY ECONOMICS
Director: Professor Yannis Caloghirou
Tel.: +30 2107723283
Fax: +30 2107723155
ADDRESS: National Technical University of Athens School of Chemical Engineer Zografou Campus 15780 Athens
Website: liee.ntua.gr
e-mail: liee.ntua@gmail.com

• THERMODYNAMICS AND TRANSPORT PHENOMENA LABORATORY
Director: Professor Emeritus Dimitrios Tassios
Tel.: +30 2107721128, 2107721134, 2107721502
Fax: +30 2107723304
ADDRESS: National Technical University of Athens Dept. of Chemical Engineering 9, Heroon Polytechniou St., Zographou Campus, 15780, Athens
Website: ttpl.chemeng.ntua.gr
e-mail: secretariat@chemeng.ntua.gr

• UNIT OF ENVIRONMENTAL SCIENCE AND TECHNOLOGY
Director: Professor Maria Loizidou
Tel.: +30 2107723106, +30 2107722334
ADDRESS: National Technical University of Athens School of Chemical Engineering Unit of Environmental Science and Technology 9, Iroon Polytechneiou St., Zographou Campus 157 73 Athens
e-mail: mloiz@chemeng.ntua.gr
Website: www.uest.gr

School of Mechanical Engineering, Section of Thermal Engineering

• LABORATORY OF THERMAL PROCESSES
Director: Professor Athina Stegou-Sagia
Tel.: + 30 2107721255
Fax: + 30 2107723976
ADDRESS: School of Mechanical Engineering Department of Thermal Engineering National Technical University of Athens 9 Iroon Polytechniou Str., Zografou 15780. Office: Mechanical Engineer's Building E -2nd floor
Website: courseware.mech.ntua.gr
e-mail: asagia@central.ntua.gr

UNIVERSITY OF PIRAEUS

Department of International and European Studies

• MASTER PROGRAMME IN ENERGY STRATEGY, LAW & ECONOMICS
Director: Professor Nikolaos E. Farantouris
Tel.: +30 2104142731
Fax: +30 2104142779
ADDRESS: Master Program in Energy Secretariat 80, Karaoli & Dimitriou St. 185 34 Piraeus
Website: www.des.unipi.gr
e-mail: des-secr@unipi.gr

PIRAEUS UNIVERSITY OF APPLIED SCIENCES

Technological Education Institute of Piraeus

• SOFT ENERGY APPLICATIONS & ENVIRONMENTAL PROTECTION LABORATORY
Director: Professor John Kaldellis
Tel.: + 30 2105381237, 2105381467
Fax: + 30 2105381467
ADDRESS: T.E.I. Piraeus P.O. Box 41046, 12201, Aegaleo Athens
Website: www.sealab.gr
e-mail: jkald@teipir.gr

• OPTIMISATION OF PRODUCTION SYSTEMS LABORATORY
Director: Professor Emilia Kondili
Tel.: +30 2105381430
Fax: +30 2105381430
ADDRESS: P. Ralli St. and Thivon 250 P.C. 122 44 Aigaleo Athens
Website: ikaros.teipir.gr/OPS
e-mail: ops@teipir.gr

ARISTOTLE UNIVERSITY OF THESSALONIKI

Department of Electrical and Computer Engineering

• POWER SYSTEMS LABORATORY
Director: Professor Grigoris Papagiannis
Tel.: +30 2310 99.6392
Fax: +30 2310 99.6023
ADDRESS: Egnatia Str., University Campus, Dept. of Electrical & Computer Engineering, 54124, Thessaloniki
Website: http://ee.auth.gr
e-mail: info@ee.auth.gr

• LABORATORY OF APPLIED THERMODYNAMICS
Director: Professor Zisis Samaras
Tel.: +30 2310 996072
Fax: +30 2310 996019
ADDRESS: Aristotle University of Thessaloniki, PO Box 458 - GR 541 24 Thessaloniki
Website: http://lat.eng.auth.gr
e-mail: info@meng.auth.gr

• LABORATORY OF FLUID MECHANICS & TURBOMACHINERY
Director: Associate Professor Kyriakos Yakinthos
Tel.:+30 2310996072
Fax: +30 23109960 12
ADDRESS: Egnatia Str., University Campus, Dept. of Electrical & Computer Engineering, 54124, Thessaloniki
Website: www.meng.auth.gr
e-mail: info@meng.auth.gr

• LABORATORY OF HEAT TRANSFER AND ENVIRONMENTAL ENGINEERING
Director: Professor Nicolas Moussiopoulos
Tel.: +30 23109960 11
Fax: +30 23109960 12
ADDRESS: Egnatia Str., University Campus, 8th floor, Building D, School of Engineering, University campus, 54124, Thessaloniki
Website: http://aix.meng.auth.gr
e-mail: infolhtee@aix.meng.auth.gr

DEMOCRITUS UNIVERSITY OF THRACE

Electrical and Computer Engineering Department

• POWER SYSTEMS LABORATORY
Director: Professor Mixail Danikas
Tel.: +30 2541079527
Fax: +30 2541079526
ADDRESS: Power Systems Laboratory Electrical and Computer Engineering Department Democritus University of Thrace University Campus, Xanthi - Kimmeria, (Building B) 67100, Xanthi
Website: http://she.ee.duth.gr
e-mail: asafig@ee.duth.gr

School of Engineering Department of Production Engineering & Management Faculty of Materials

• MECHANICAL DESIGN LABORATORY
Director: Associate Professor Pantelis Botsaris
Tel.: +30 2541079878, +30 2541079325
Fax: +30 2541079878
ADDRESS: 12 Vas. Sofias str., Office 107 Central University Campus, 67100, Xanthi
Website: http://medilab.pme.duth.gr
e-mail: panmpots@pme.duth.gr

Environmental Engineering Department

• NON-CONVENTIONAL ENERGY SOURCES LABORATORY
Director: Assistant Professor Costas Elmasides
Tel.: +30 2541079876,+30 6974447972
ADDRESS: Vas. Sofias 12, 67100, Xanthi
Website: www.env.duth.gr/labs/energy
e-mail: secr@env.duth.gr

UNIVERSITY OF PATRAS

• RENEWABLE ENERGY LABORATORY
Director: Professor Emeritus Panayotis Yianoulis
Tel.: +30 261099744
ADDRESS: Physics Department Building B, 2nd floor University of Patra's University Campus, 26504, Rio
Website: www.physics.upatras.gr/~rel/ index.html
e-mail: glefther@physics.upatras.gr

• CENTER FOR RESEARCH AND APPLICATIONS OF NONLINEAR SYSTEMS (CRANS)
Director: Professor Tassos Bountis
Tel.: +30 2610997381
Fax: +30 2610997381
ADDRESS: Department of Mathematics,

University of Patras 26500 Patra
Website: www.math.upatras.gr/crans/ index.html
e-mail: bountis@math.upatras.gr

Electrical and Computer Engineering Department

- LABORATORY OF ELECTROMECHANICAL ENERGY CONVER

Director: Professor Emmanuel C. Tatakis
Tel.: (+30)2610996412
Fax: (+30)2610997362
ADDRESS: Electromechanical Energy Conversion Laboratory University of Patras Electrical and Computer Engineering Department University Campus of Patras, 26504 Rio
Website: www.lemec.ece.upatras.gr

NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS

- THE ENERGY AND CLIMATE CHANGE POLICY CENTRE (KEPA)

Director: Professor Dimitrios Mavrakis
Tel.: +30 2107275732, +30 2107275809
Fax: +30 2107275828
ADDRESS: KEPA building, University Campus, Ilisia, 157 84 Athens
Website: www.kepa.uoa.gr
e-mail: epgsec@kepa.uoa.gr

Department of Environmental Physics

- METEOROLOGY, BUILDINGS ENVIRONMENT RESEARCH GROUP

Director: Professor Mattheos Santamouris
Tel.: +30 210-727 6830
Fax: +30 2107276791
ADDRESS: University of Athens, Department of Physics, Department of Environmental Physics and Meteorology University Campus Zografou Ktirio PHY-V, 15784 Athens
Website: http://env.phys.uoa.gr
e-mail: emoutziki@phys.uoa.gr

UNIVERSITY OF THESSALY

Department of Mechanical Engineering

- LABORATORY OF ALTERNATIVE ENERGY CONVERSION SYSTEMS

Director: Professor Panayiotis Tsiakaras
Tel.: +30 2421074081
Fax: +30 2421074050
ADDRESS: Panagiotis Tsiakaras Head of Laboratory of Alternative Energy Conversion Systems University of Thessaly Department of Mechanical and Industrial Engineering 38334, Pedion Areos, Volos
Website: www.mie.uth.gr
e-mail: tsiak@mie.uth.gr

TECHNICAL UNIVERSITY OF CRETE

School of Environmental Engineering

- ENERGY MANAGEMENT IN THE BUILT ENVIRONMENT RESEARCH LABORATORY (EMBER)

Director: Professor Denia Kolokotsa
Tel.: +30 2821037808
ADDRESS: Energy Management in the Built Environment Research Unit Faculty of Environmental Engineering, Technical University of Crete Technical University Campus, Kounoupidiana, 73100 Chania
Website: www.ember.tuc.gr
e-mail: dkolokotsa<at>enveng.tuc.gr

- RENEWABLE AND SUSTAINABLE ENERGY SYSTEMS LABORATORY

Director: Professor Theocharis Tsoutsos
Tel.: +30 2821037825
ADDRESS: University Campus, Kounoupidiana 73100 Chania
Website: www.resel.tuc.gr
e-mail: theocharis.tsoutsos@enveng.tuc.gr

School of Mineral Resources Engineering Division of Minerals Exploitation

- SOLID FUELS BENEFICATION AND TECHNOLOGY LABORATORY

Director: Professor Despina Vamvouka
Tel.: +30 2821037603
ADDRESS: Technical University of Crete, School of Mineral Resources Engineering, 731 00 Chania, Crete
Website: www.mred.tuc.gr
e-mail: vamvuka@mred.tuc.gr

School of Electronic and Computer Engineering (ECE)

- ELECTRIC CIRCUITS AND RENEWABLE ENERGY LABORATORY (ECRESL)

Director: Professor Kostas Kalaitzakis
Tel.: +30 2821037213
ADDRESS: School of Electronic and Computer Engineering, Technical University of Crete Akrotiri Campus 73100 Chania, Crete

Website: www.elci.tuc.gr
e-mail: vicky@ece.tuc.gr

TECHNOLOGICAL EDUCATIONAL INSTITUTE OF CRETE

- WIND ENERGY LABORATORY AND SYNTHESIS ENERGY SYSTEMS

Director: Professor Dimitrios Christakis
Tel.: +30 2810379200
ADDRESS: Stauromenos, Zip code:71004, Heraklion Crete
Website: www.wel.teicrete.gr
e-mail: dhr@cs.teicrete.gr
School of Applied Sciences

- DEPARTMENT OF ENVIRONMENTAL AND NATURAL RESOURCES ENGINEERING

Director: Associate Professor Nikolaos Lydakis
Tel.: +30 2821023058
Fax: +30 2821023003
ADDRESS: Romanos 3 Halepa, POBox 89 PSEs Chania, Anapafseos 10, Chania, Crete 73135
Website: www.chania.teicrete.gr
e-mail: info@chania.teicrete.gr

UNIVERSITY OF WESTERN MACEDONIA

Department of Mechanical Engineering

- LABORATORY OF FLUID MECHANICS AND TURBOMACHINERY (LoFMaT)

Director: Associate Professor Antonios Tourlidakis
Tel.: +30 24610 56682
ADDRESS: Mpakola and Sialvera, 50100, Kozani
Website: https://lofmat.wordpress.com
e-mail: lofmat.uowm@gmail.com

TECHNOLOGICAL EDUCATIONAL INSTITUTE OF ATHENS

Electrical and Computer Engineering Department

- ENERGY APPLICATIONS AND ENERGY SAVING SYSTEMS LABORATORY

Director: Professor Antonios X. Moronis
Tel.: +30 2105385307
Fax: +30 2105385306
ADDRESS: T.E.I. of Athens Department of Energy Technology Engineering 17, Agiou Spyridona 12210 Egaleo
Website: www.teiath.gr
e-mail: energytechnology@teiath.gr

TECHNOLOGICAL EDUCATIONAL INSTITUTE OF EASTERN MACEDONIA AND THRACE

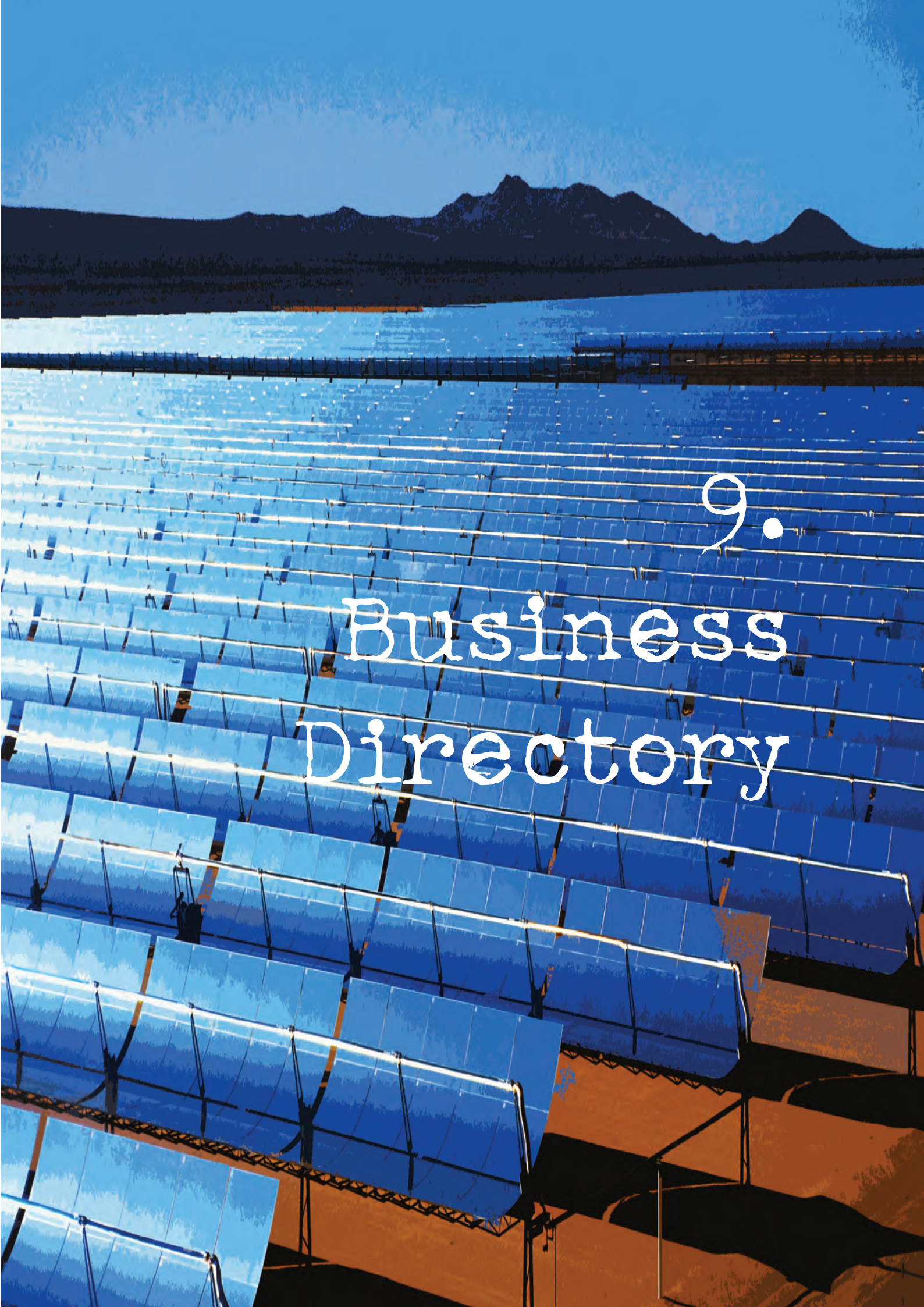
School of Technological Appliances

- DEPARTMENT OF TECHNOLOGY OF OIL AND GAS

Director: Professor Evangelos Kargiotis
Tel.: +30 2510462396
Fax: +30 2510462348
ADDRESS: TEI of Eastern Macedonia and Thrace, Department of Technology of Oil and Gas TE and Mechanical Engineering Direction Engineering, Agios Loukas 65404, Kavala
Website: http://petrotech.teikav.edu.gr
e-mail: ptsec@teiemt.gr

INSTITUTE FOR SOLID FUELS TECHNOLOGY & APPLICATIONS

Director: Professor Emmanouil Kakaras
Tel.: +30 2463055300, +30 2463054679
Fax: +30 2463055301
ADDRESS: 1st ptolemais office: 4th km. Ptolemais - Mpodosakeio Hospital (Region of Kouri) - P.O. box 95 - 502 00 Ptolemais
Website: www.lignite.gr
e-mail: isfta@lignite.gr



9. Business Directory

State Entities and State Controlled Organisations in the Energy Sector

MINISTRY OF ENVIRONMENT AND ENERGY

Environment Division
ADDRESS: 17 Amaliados str. 115 23 Athens
Tel.: +30 213 1515000
Fax: +30 210 6447608
Energy Division
ADDRESS: 119 Mesogeion Av.
Tel.: +30 210 6969501
Fax: +30 210 6969849-850
Website: www.ypeka.gr

REGULATORY AUTHORITY FOR ENERGY (RAE)
ADDRESS: 132 Pireus Ave., 11854, Athens Greece
Tel.: +30 2103727400
Fax: +30 2103255460
e-mail: info@rae.gr
Website: www.rae.gr

OPERATOR OF ELECTRICITY MARKET S.A. (LAGIE)
ADDRESS: Kastoros 72 str., 18545 Peiraeus
Tel.: +30 211 8800700
Fax: +30 211 8806766
e-mail: info@lagie.gr
Website: www.lagie.gr

INDEPENDENT POWER TRANSMISSION OPERATOR (ADMIE)
ADDRESS: 89 Dyrrachioustr, Athens, 10443
Tel.: +30 210 5192101
Fax: +30 210 5192324
e-mail: info@admie.gr
Website: www.admie.gr

HELLENIC ELECTRICITY DISTRIBUTION NETWORK OPERATOR S.A.(DEDDIE)
ADDRESS: Perraivou 20 &Kallirrois 5, ATHENS GREECE
Tel.: +30 21 09281600
Fax: +30 210 9281698
e-mail: infodeddie@deddie.gr
Website: www.deddie.gr

HELLENIC GAS TRANSMISSION SYSTEM OPERATOR S.A. (DESFA)
ADDRESS: 357-359 Mesogeion Av. 152 31 Chalandri
Tel.: +30 210 6501200
Fax: +30 210 6749504
e-mail:desfa@desfa.gr
Website: www.desfa.gr

PUBLIC POWER CORPORATION (PPC)*
ADDRESS: 30 Chakokondyli Str. 10432, Athens
Tel.: +30 210 52930301
e-mail: info@dei.com.gr
Website: https://www.dei.gr

*The state has a controllingshareholding interest of 51%

PUBLIC GAS CORPORATION (DEPA)*
ADDRESS: 92, Marinou Antipa Ave., Iraklion Attikis 141 21 Tel.: +30 210 2701000
Fax: +30 210 2701010
Website: www.depa.gr

*The state has a controlling shareholding interest of 65%

HELLENIC PETROLEUM GROUP*
ADDRESS: 8A Chimarras str., 151 25, Maroussi
Tel.: +30 210 63 02000
Fax: +30 210 6302510, +30 210 6302511
Website: www.helpe.gr

*The state has a controlling shareholding interest of 34%

Energy Industry Associations in Greece

ENERGY ASSOCIATION FOR NATURAL GAS
Tel.: +30 210 28 31 118
e-mail info@esfa.com.gr
Website: www.esfa.gr

FEDERATION OF RECYCLING AND ENERGY RECOVERY INDUSTRIES AND ENTERPRISES
ADDRESS: Ethn. Antistaseos Ave 57, Chalandri 152 31
Tel.: +30 210 6931 011
e-mail: info@sepan.gr
Website: www.sepan.gr

GREEK ASSOCIATION OF RES ELECTRICITY PRODUCERS (GAREP)
ADDRESS: 9 Anagnostopoulou Str., 106 73 Athens
Tel.: +30 210 6968543
e-mail: perakis@terna.gr
Website: www.hellasres.gr

GREEK SOLAR INDUSTRY ASSOCIATION
ADDRESS: 96, Iroon Polytechniou Ave., 18536 Piraeus
Tel.: +30 210 4286227
Fax: +30 210 4286228
e-mail: info@ebhe.gr
Website: www.ebhe.gr

HELLENIC ASSOCIATION OF ELECTRICITY TRADING & SUPPLY COMPANIES
ADDRESS: 9 Anagnostopoulou Str., 106 73 Athens
Tel.: +30 210 3670400
e-mail: info@esepie.gr
Website: www.esepie.gr

HELLENIC BIOMASS ASSOCIATION (HELLABIOM)
ADDRESS: 9 Anagnostopoulou Str., 106 73 Athens
Tel.: +30 210 3670400
e-mail: info@hellabiom.gr
Website: www.hellabiom.gr

HELLENIC ASSOCIATION FOR THE COGENERATION, HEAT & POWER
ADDRESS: Ioustinianou 7, 114 73 Athens
Tel.:+30 210 8219118
e-mail: hacchp@gmail.com

HELLENIC ASSOCIATION OF INDEPENDENT POWER PRODUCERS (HAIPP)
ADDRESS: 124 Kifissias Ave. & 2 Iatridou Str., 115 26 Maroussi
Tel.:+30 210 8184629
e-mail: info@haipp.gr
Website: http://haipp.gr/en

HELLENIC ASSOCIATION OF PHOTOVOLTAIC COMPANIES
ADDRESS: 11 Fidiou Str., 106 78 Athens
Tel.:+30 210 9577470
Fax: +30 210 9707440
Website: www.helapco.gr

HELLENIC ASSOCIATION OF PHOTOVOLTAIC ENERGY PRODUCERS
ADDRESS: 3 Dimokratias Str., 115 21 Pefki
Tel.: +30 210 6854035
Fax: +30 210 6854035
Website: www.spef.gr

HELLENIC PETROLEUM MARKETING COMPANIES ASSOCIATION
ADDRESS: 46 Ionos Dragoumi Str., 115 28 Athens
Tel.: +30210 7291050-051
Fax: +30 210 7245172
Website: www.seepe.gr

HELLENIC ASSOCIATION OF MICRO HYDROPOWER PROJECTS
ADDRESS: 23 Agias Lavras Str., 141 21 Iraklio Attikis
Tel.:+30 210 2811917
Fax: +30 210 2837372
e-mail: grammateia@microhydropower.gr
Website: http://esmyehellas.blogspot.gr/

HELLENIC WIND ENERGY ASSOCIATION
ADDRESS: 306 Kifissias Ave., 152 32 Chalandri
Tel.:+30210 8081755
e-mail: eletaen@eletaen.gr
Website: www.eletaen.gr

PANHELLENICASSOCIATION OF INSULATION COMPANIES
ADDRESS: 11 Terpsihoris Str., 155 62 Cholargos
Tel.:+30 210 6521112
Fax: +30 210 6521112
e-mail: info@psem.gr
Website: www.psem.gr

PANHELLENICASSOCIATION OF PETROLSTATION OPERATORS AND TRADERS (POPEK)
ADDRESS: 10 Amerikis Str., 106 71 Athens
Tel.: +30 210 3614995-6
Fax: +30 210 3616454
e-mail: popek@popek.gr
Website: www.popek.gr

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*__Editor's Note:__ The aim of the *Energy Company Directory* is to list the main companies involved in energy related business in Greece. In compiling the Company Directory every effort has been made to check the accuracy of the information presented. Towards this end we worked closely with various industry associations and professional bodies, a separate listing of which has also been included.

In addition we have carried out independent searches and on many occasions we checked listed information directly with the companies concerned. However, because there appears to be considerable mobility in the energy sector with new companies opening up and with others which cease trading, there are bound to be some omissions or even inaccurate information. We apologise for any inconvenience experienced by our readers and we undertake to correct any misleading or wrongfully presented information in the next edition of the Directory and of course in the updated electronic version of this publication to be released in 2017.

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Website: www.ita-sa.gr

INTERPLAST
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MARAC
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Website: www.michanodomiki.gr; www.ecoenergia.gr

PPC RENEWABLES
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Website: www.ppcr.gr

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Heating & Cooling Equipment

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AID ENGINEERING
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CORAL ENERGY SA
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Lubricants

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ELDON'S SA
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CALDA ENERGY
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GAS PIPE
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TERNA Energy S.A.
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