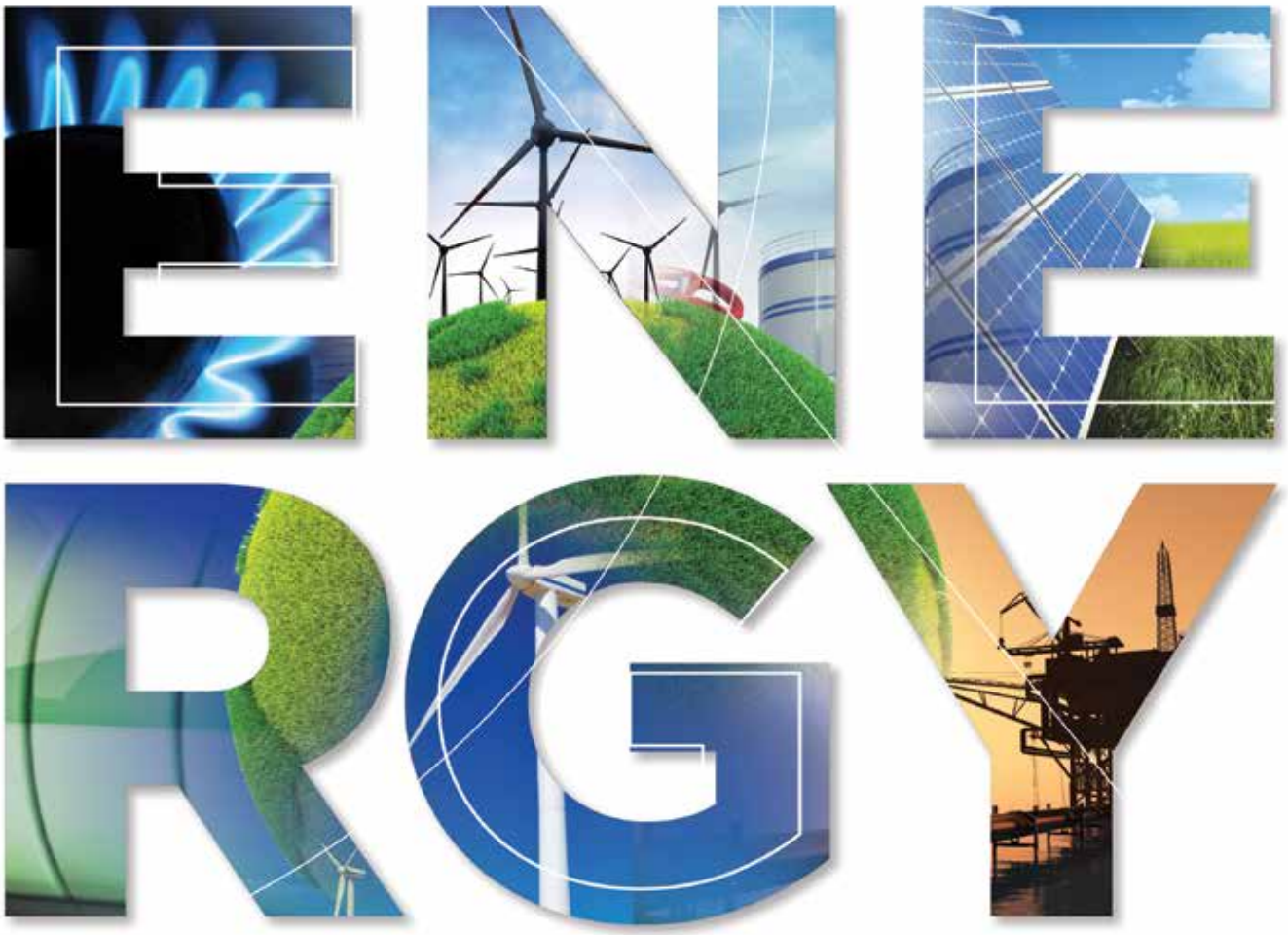
GREEK



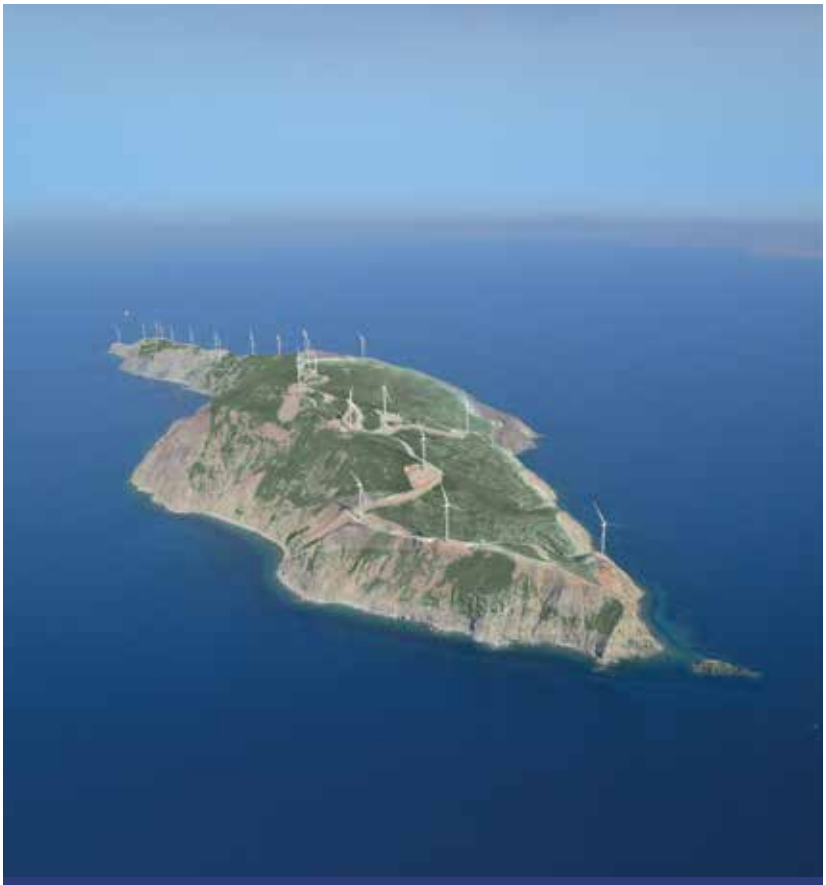
DIRECTORY 2021

The Oil Sector
Natural Gas
The Electricity Sector
Renewable Energy Sources
Energy Efficiency & Cogeneration
The Legal Framework
Research & Development
Business Directory

ENERGIA.gr

Wind Energy Projects

Solar Energy Projects



Wind Farm on Aghios Georgios Island

Hydroelectric Projects

Epirus Waste Treatment Plant

INVESTING IN GREECE INVESTING IN THE FUTURE

For more than 20 years, TERNA ENERGY plays a leading role in clean energy production while carrying out innovative projects for the environment, which contribute to sustainable development.

With a strong portfolio of projects in Greece and abroad, TERNA ENERGY is the largest investor in the RES sector in Greece and the biggest Greek company in the sector worldwide.

Having invested approximately € 2 billion so far, TERNA ENERGY continues its dynamic growth with new investments of 2 billion euros and a goal of 3,000 MW of RES plants by 2025.

For the benefit of the country, the Group's hundreds of employees and associates, and the thousands of shareholders who have put their trust in the company.

TERNA ENERGY
GEK TERNA GROUP
www.terna-energy.com

GREEK ENERGY DIRECTORY 2021

ENERGIA.gr

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Publisher's Forward

By Costis Stambolis
Publisher of Greek Energy Directory 2021

As Energy Transition gathers pace across Europe, and worldwide, so are developments in Greece's energy sector which over the past years has emerged as a pilar of the country's economy and a major pivot of economic growth. Although the energy sector in Greece corresponds to just less than 5% of its GDP its role in terms of investments and as prime mover in cross border economic cooperation is of vital importance.

In addition to enabling the further development and upgrading of energy infrastructure with some €2,5 to € 3,0 billion investment on average per year, a major chunk of funds are now channelled to marketing activities, following electricity and gas deregulation and increased competition at retail level over the last years. Since publication of the 2016 edition of the Greek Energy Directory a number of important changes have taken place in Greece's buoyant energy market. Most noteworthy of which include the government instituted decarbonisation process in power generation, the drive towards much bigger penetration of renewables along with energy efficiency improvement and energy competition at all levels, following the late implementation by Greece of EU's target model in electricity market operation.

Apart from providing in depth information of the current state of Greece's energy market, the **"Greek Energy Directory 2021"** looks ahead in an attempt to forecast energy demand trends and the investment outlook. Authors's response to my request to participate in this year's edition, has been enthusiastic to say the least. However, complications which subsequently arose with the COVID-19 lockdown and the enforcement of preventive measures slowed down the whole preparation of the publication with the result of at least a 6 month delay. We took advantage of the situation and we updated most information so as to include 2020 data where possible.

The "Energy Directory", in spite of its utilitarian title, is not just a directory of companies, individuals and products. It is a lot more as it contains a wealth of information on the broad energy sector. A series of articles and analysis by well known energy experts and senior executives from 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 industry and associations complement the body of knowledge presented in this publication.

I am taking this opportunity to express my gratitude to all authors for contributing well prepared and timely reviews in their particular field of expertise and, of course, I sincerely wish thank the group of companies which through advertising and the publication of "company profiles" helped secure the financial basis which enabled us to undertake and complete this challenging project. I trust that the "Greek Energy Directory 2021" will prove both useful and inspiring for all concerned and currently engaged in one of the most dynamic sectors of Greece's economy.

Costis Stambolis
Publisher · Greek Energy Directory 2021

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Preface

By Kostas Skrekas, Minister for Environment and Energy

The Greek energy sector is currently undergoing a fundamental, green transformation, steadily becoming more resilient, competitive, innovative and socially inclusive. Over the current year, our extensive and well co-ordinated reforms will untap further the potential of renewables, enhance investors' visibility and reinforce citizens' involvement in the energy transition.

Our Prime Minister, Kyriakos Mitsotakis, has strongly emphasized his commitment to climate change mitigation, inspiring ambitious policies and international initiatives. At the Ministry of Energy and Environment, we are particularly proud to have adopted and currently, implementing one of the most ambitious national energy and climate plans in Europe, strongly oriented towards climate neutrality by 2050.

The investments we intend to mobilize by 2030 exceed 44 billion euros. In addition, over the next 5 years, we are going to direct more than 5 billion euros to 21 green actions, via the European Recovery and Resilience Fund.In order to achieve this huge restructuring, we mainly focus on three kinds of fundamental tools:

- well-designed reforms, which will stimulate investments, at the least cost for our consumers,
- innovation, in order to untap the hidden potential of several sectors and exploit their synergies, and
- international collaborations, adding strategic value at times of sensitive geopolitics.

But above all, the key enabler is our citizens.In this sustainable transformation, we are committed to involve all regions, from cities to remote areas, from islands to areas which depend heavily on lignite. Hence, we have developed dedicated policies, taking into account subtle specificities and reflecting our citizens' aspirations.

Our coherent reform plan and its current status can be summarized as follows:

1. We are decarbonizing our energy mix at a faster pace than any other European country, phasing out all existing lignite plants by 2023. It is remarkable that the market share of lignite in electricity production (more precisely, in the net energy balance) dropped to 11% last year vs. 38% in 2015.
2. Renewables have already reached a market share of 29% in electricity production and they will exceed 60% by the end of the decade.
3. Having already conducted 16 renewable tenders for over 2.7 GW of wind and solar plants, which incurred substantial cost reductions, we are now extending technology-neutral auctions up to 2024. We expect shortly the approval of the new scheme by the European Commission. Simultaneously, we are promoting green PPAs for commercial and industrial players, as well as an instrument to address energy poverty.
4. We have simplified significantly the 1st phase of renewables licensing, introducing digitalized, fast and transparent processes for issuing producers' certificates. We proceed with further simplifications, focused on environmental licensing and grid connections, expected to be legislated in June.
5. We actively support natural gas, as the transitional fuel towards decarbonization, and promote gas infrastructure projects, as pillars for energy security and diversification in the region.

The green economy is our only path to dignity and prosperity. We will shape this sustainable future all together, realising new perspectives for each of us and for the next generations.

6. We are upgrading and expanding our electricity networks, in order to enhance the reliability and flexibility of the energy system.
7. We are completing the legal framework, so as to unlock the potential of off-shore wind and energy storage, both batteries and hydro pumping, hence facilitating grid stability.
8. We are promoting energy efficiency, via a huge renovation wave, as well as electric vehicles, with attractive incentives and infrastructure development.
9. We are developing a coherent strategy for the smooth transition of coal regions, with a strong emphasis on sustainable sectors and creation of quality jobs.
10. We facilitate projects that transform our islands into innovation hubs and will co-ordinate their transition via a dedicated committee and transparent financing mechanisms.
11. We are devising a national strategy for hydrogen, hence expanding perspectives for gas infrastructure, renewables, maritime and rail transportation, among other sectors.

Our priorities have already been translated into concrete actions to be funded via the RRF over the next five years. Indicatively, we are directing 1.1 billion € in renovation schemes for residential buildings, 450 mil € for the energy upgrading of SMEs and 200 mil € for public sector buildings.

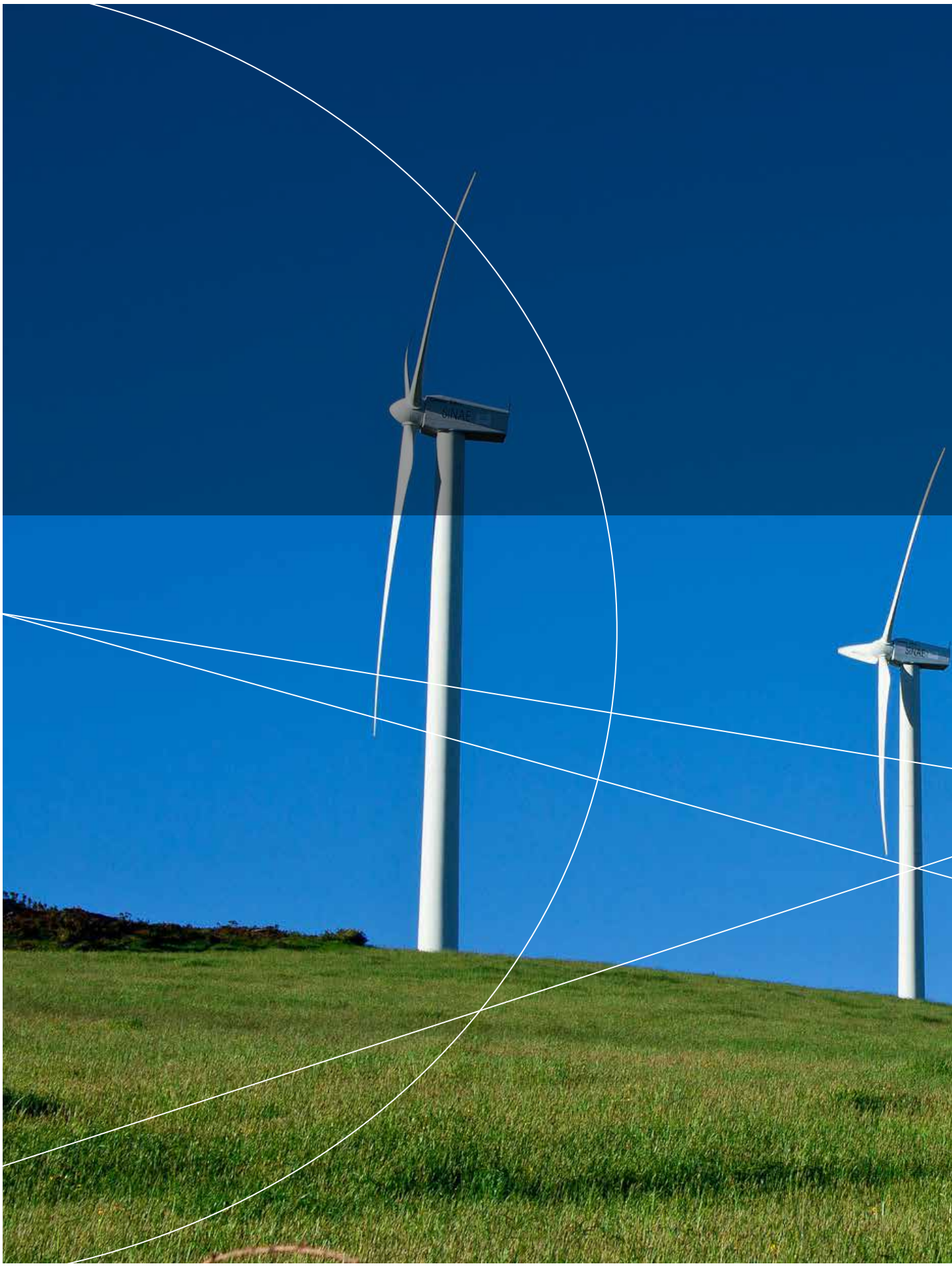
We are reinforcing our energy system via underground cables in areas with special characteristics (60 mil €), the upgrading of crucial lines and the 4th phase of the Cyclades interconnection (195 mil €), as well as network upgrades in forest areas, so as to avert fires (40 mil €). In addition, we are supporting the RES Account with 202 mil €, in order to foster cash liquidity and avert increases in electricity bills.

Furthermore, we are channeling 450 mil € to energy storage and 300 mil € to industrial production units related to e-mobility as well as the first CO_2 storage facility in the country. Simultaneously, we are allocating 224 mil € for the restoration of 16.500 hectares of degraded ecosystems across Greece, including a flagship investment for Mount Parnitha, north of Athens. A further 100 mil € will be dedicated for the protection of biodiversity, 230 mil € for efficient wastewater management, sewage and sludge infrastructure, and 200 mil € for improving water supply, savings and desalination. Moreover, 220 mil € are allocated to the development of 8.660 charging points across the country and the replacement of polluting taxis and buses.

Overall, it is clear that we have devised policies and reforms to accelerate our energy transition in a fair and socially cohesive manner. We are actively transforming our country, day by day, in a hub for green investments, with stable legal and licensing frameworks, fair incentives, simplified procedures and strong international collaborations.

Implementing this extensive and co-ordinated action plan, we are effectively transforming the covid crisis from a socio-economic disruption to a catalyst for sustainable growth, expanding the perspectives of our country and unraveling its competitive advantages on the international level. As the Minister of Energy and Environment, my commitment is to continuously reevaluate our policies beyond conventional technoeconomic analyses, retaining at the center of all our actions our environment and our citizens.

Kostas Skrekas
Minister of Environment and Energy



COMPANY PROFILES

ENERGEAN

Energean is a London-based independent E&P company focused on developing resources in the Mediterranean and UK North Sea. Energean has been the World's first E&P company to commit to becoming a net zero emitter by 2050. The company is transitioned to gas, evaluates Carbon Capture & Stor-age opportunities and has decided to roll out three initiatives across all operated sites in 2021: 1) switching to purchasing "green" electricity 2) introduce a zero routine-flaring policy, 3) establish procedures to reduce methane emissions.

The company has already managed to reduce carbon emissions intensity by 67% on the 2019 position. Energean has set a new target to reduce carbon emissions intensity to approximately 9.5 kg/boe by 2023, which is approximately half the current global average for the oil and gas industry, and represents an 85% reduction on 2019 pro forma carbon emissions intensity.

Energean also strives to meet United Nations' 17 Sustainable Development Goals through its day-to-day operations and a wide range of CSR initiatives. The company has a strong management team focused on disciplined capital allocation, effective project delivery, operational excellence and risk mitigation with a proven track record of delivery and value creation, and well aligned with shareholders through significant shareholdings in the business.

Energean is an operator with a balanced low-cost portfolio of exploration, development and production assets, with operations in nine countries across the Mediterranean and UK North Sea with an excellent HSE track record.

In 2020, 12 million manhours free of Lost Time Injuries were completed in the Karish Development Project in total, namely the "Energean Power" FPSO construction in China, Singapore and other sites, the offshore drilling campaign in Israel and Energean sites in Israel as well. Moreover, Energean recently completed 2 million manhours free of LTI's in all the company's sites in Greece.

The company is building the only FPSO in the East Mediterranean to develop the multi-tcf deepwater Karish, Karish North and Tanin gas fields offshore Israel. Energean has already signed gas sales agreements signed with Israeli offtakers to supply approximately 7.4 Bcm/yr of gas on plateau, which have floor pricing, take-or-pay and/or exclusivity provisions that largely insulate the projects' revenues against global commodity price fluctuations.

Energean is also developing the North El Amriya/ North Idku fields in Egypt, with first gas expected in 2H 2022.

ENERGEAN
OIL & GAS

For more information visit
www.energean.com

The Hellenic Hydrocarbon Resources Management

HHRM SA

The Hellenic Hydrocarbon Resources Management (HHRM SA) manages the national interests in the field of exploration, research and production of hydrocarbons and works methodically in order to enable the development of national resources and especially natural gas, which can contribute to the economic and social development of Greece.

HHRM was founded in 2011 and its only shareholder is the Greek State. The new Board of Directors, appointed by the Greek government in the summer of 2020, consists of executives from the energy, legal, shipping and financial sectors with international experience in countries such as Norway, the United Kingdom, Cyprus, the Netherlands and of course Greece.

The Board of Directors of the Company in collaboration with a team of experts in HHRM, such as geologists, engineers, environmental scientists, lawyers and economists, implements the new vision of the company in the context of the energy transition. The company has undertaken numerous recent initiatives to strengthen environmental and social governance in the sector and to accelerate the exploitation of the country's opportunities to monetize its gas resources, which are intended to contribute significantly to the energy transition. HHRM aims to strengthen international partnerships in green projects and to this effect it has set up a New Ventures department that evaluates related technologies such as CCS, floating wind farms and hydrogen, in an effort to identify the potential synergies that can help achieve the goals of the National Energy and Climate Plan (NECP), while bringing added value to the Greek State.

Recently, through the acquisition of DEPA International Works, HHRM also participates in important infrastructure projects, such as the IGB and East Med pipelines, which will enhance the verticalization of our energy system.

HHRM has the technical knowledge about the hydrocarbon potential of Greece and is the only administrator of the country's hydrocarbons data archive. The strengthening of the available data library with new geophysical and geochemical data, as well as the continuous update of the hydrocarbon potential of the Greece's geological basins, are two of the main priorities of the company.

The new BoD has established several new governance frameworks where Environmental and Social Governance (ESG) constitutes the priority. The company has created strategic synergies with academic institutes, major market players, and government authorities and is working with investors and legislators to leverage its offshore expertise to help accelerate developments in offshore wind and carbon management projects.

HHRM maintains an open-door policy and attractive conditions for potential investors, and looks forward to welcoming new partners for further developing the Greek energy resources.

For more information visit
www.greekhydrocarbons.gr

HHRM
HELLENIC HYDROCARBON RESOURCES MANAGEMENT

KYRIAKIDES GEORGOPOULOS LAW FIRM

KYRIAKIDES GEORGOPOULOS (KG) Law Firm is a leading Greek multi-tier business law firm and the largest in Greece, dating back to 1930's and recognized as one of the most prestigious law firms in Greece. The firm numbers over 100 highly skilled lawyers who are actively involved in the provision of legal services to high profile Greek and international clients in complex and innovative cross-border deals. With offices in Athens and Thessaloniki, our multi-disciplinary teams set the standards for commercially-aware, responsive service in the most complicated and sophisticated legal issues. KG pioneered in the Greek market by becoming ISO certified since 2006 and still remains one of a handful of ISO 9001 certified law firms in Greece.

The firm offers a wide variety of legal services and covers the following areas:

- Agency, Distribution & Franchising
- Art Law
- Banking & Finance
- Capital Markets
- Betting & Gaming, Competition & Anti-Trust
- Corporate & Commercial
- Data Protection & Privacy
- Employment
- Pensions, Benefits
- Energy, Utilities & Infrastructure
- EU Regulatory & Compliance
- Insurance
- Intellectual Property
- Internet & E-Commerce
- Life Science & Healthcare
- Litigation & Arbitration
- Mergers & Acquisitions
- Mining, Oil and Gas
- Private Wealth Structuring
- Public Law
- Public Sector Projects
- Real Estate
- Restructuring and Insolvency
- Start Ups & Innovation
- Tax
- Telecommunications & Media
- Transportation Law White Collar Crime

For more than 50 years KG has been the preferred choice for US and European international law firms seeking local legal counsel in Greece capable for delivering legal services at the most demanding international standards of professional quality and client service.We continue to develop and sustain multi-generational relationships with high-profile partners in major international and global law firms, resulting in the exchange of expertise and intellectual capital that only such enduring relationships can produce.

Our partners and lawyers are prominent participants in international practice law institutions and networks, such as the International Bar Association, the American Bar Association, the Antitrust Alliance, the Employment Law Alliance, the European Employment Lawyers Association, the International Fiscal Association etc. and frequently publish in major international journals and books.

KG is a founding member of South East Europe Legal Group (SEE Legal) – www.seelegal.org, a regional alliance of major law firms from 12 countries in South East Europe, established in 2003. Working together on cross border transactions, SEE Legal is the largest local legal team in South East Europe, with more than 450 lawyers organized in cross - jurisdictional practice groups.

Our firm's performance is consistently ranked highly by the most prestigious of international directories, such as Chambers & Partners Global, Chambers & Partners Europe, Legal 500 EMEA, as well as IFLR1000.

KG also obtained the International Certification «Great Place to Work®» (CERTIFIED by Great Place to Work®), which is awarded to organizations that stand out as selection employers in a competitive talent search market. KG is the first law firm in Greece that obtains the Great Place to Work® Certification after a thorough evaluation conducted by the organization Great Place to Work® Hellas based on the methodology it follows worldwide.

Energy, Utilities & Infrastructure practice

Our firm is well known for having one of the very few practice groups in the country dedicated exclusively to energy infrastructure related projects. We have played a significant role in the liberalization of the electricity and gas market and we continue to be active in most of the privatization initiatives in these sectors whilst our track record of more than 40 years supports our leading role in the market (Greece and the region of south east Europe). Besides our oil and gas expertise, our continuous exposure allowed us to develop an innovative specialization in renewable energy sources (e.g. wind, solar, hydro, biomass, waste to energy, biogas and geothermal).

Our team addresses with success the rapid transformation of the energy sector and continues to lead most of the important and innovative 'country first' transactions and has developed extensive knowledge on the development of energy storage, LNG-to-power, licensing of FSRU's.

Our advice is attuned to our clients' commercial imperatives, as well as the political, technical and stakeholder relationship aspects of our clients' businesses and operations.

We use a multidisciplinary, team-based approach to legal advice and problem solving, combining experience and expertise in regulatory law, mergers and acquisitions, project finance, business and corporate law.

Our Energy, Utilities and Infrastructure practice is appraised by our clients as a Tier 1 Energy Infrastructure practice and is confirmed by the rankings of all international directories, including IFLR, Chambers & Partners Europe and Legal 500.

Our range of services include:

- **Energy Finance**
- **Energy Litigation**
- **Energy Regulatory**
- **Energy Trading**
- **Energy Markets**
- **Environment & Climate Change**
- **Green Bonds**
- **IPOs Energy Finance**
- **M&A and Corporate of Energy Projects**
- **Oil & Gas**
- **Renewables and Clean Energy Technology**

For more information visit
www.kglawfirm.gr

ENEL GREEN POWER Greece

Enel Green Power is the global Enel's Group brand focused on developing and managing renewable energy generation systems with a global presence in 32 countries in Europe, Americas, Asia, Africa and Oceania.

Enel Green Power is a global leader in the green energy sector, operating more than 1,200 plants with a managed capacity of 49 GW across a generation mix, which includes wind, solar, geothermal and hydropower, and is at the forefront of integrating innovative technologies into renewable power plants. Enel Green Power is present in Greece since 2008 operating 59 plants with 481 MW of installed wind capacity, hydro and solar power. The company incorporates in its strategy and business practices the principles of sustainable development and corporate social responsibility, placing the outmost emphasis on safety at work, as well as contributing to the well-being of its employees and the neighboring local communities.

Enel Green Power in Greece is developing a concrete portfolio of wind and solar projects with an estimated capacity >1500MW.

At the same time, it expands its activities in new sustainable and innovative solutions as storage and hybrid projects.

Enel Green Power is a strategic partner that enables communities, companies and the final consumers to move towards sustainable living, driving the shift towards a decarbonized society and actively contributing to the development and wellbeing of the territories where it operates.

Enel Green Power applies the CSV (Creating Shared Value) Model, finding new business opportunities by solving social problems, combining competitiveness with the long - term sustainable value creation.

With its international experience, it also develops custom projects to offer companies the best solutions when it comes to energy generated by renewable sources. Clean energy and sustainable projects, competitive costs and tailor-made solutions are the main benefits of the Power Purchase Agreement (PPA), tools capable of building strong, long-lasting partnerships with business and industrial clients.

enel Green Power

For more information visit
www.enelgreenpower.com

ENSCO

EnSCo is amongst a handful of companies able to trade energy in almost all the CWE and C/SEE countries. In its six years of operation (2015-2021) EnSCo has established itself as a reliable partner in the European energy sector with presence in the major European markets.

EnSCo's Main Activities include:

- Electricity Trade
- The main activity of the parent company (ENSCO AG based in Switzerland) in cross-border electricity trading across Europe.
- Energy Services (provided by the Greek subsidiary EnSCo SA)
- Energy Audits to industrial, commercial and residential sectors
- Energy Conservation (EC) & rational use of energy
- Demand Side Management (DSM) projects
- Small combined heat & power (CHP) project development
- Renewable energy project development
- Electricity Supply Balancing Services
- Small RES and CHP producer representation to the wholesale energy markets

Further Energy Services

In addition to electricity trading EnSCo SA offers a range of integrated energy services including:

- Energy Audits and Consulting
- Diagnosis of present energy use and energy conservation potential
- Hierarchical positioning energy efficiency measures, including: energy conservation (EC), rational use of energy (RUE), demand side management (DSM), building management systems (BMS), combined heat & power (CHP) and renewable energy sources (RES)
- Identification of alternative options for electricity and natural gas suppliers
- Technical and Economic Assessment of high priority projects
- Project Implementation
- Project development, licensing, project design, equipment selection, project management
- Project Implementation Monitoring and Commissioning of Operations
- Technical Personnel Training
- Operations Monitoring during contracted term

For more information visit
www.ensco.eu

EnSCo η
sustainable efficiency

TERNA

TERNA ENERGY was founded in 1997 and is a subsidiary of GEK TERNA Group, one of the largest business groups in Greece and among the first ones to be active in the RES (Renewable Energy Sources) market. TERNA ENERGY, is a major player in the production and storage of clean energy, with activity in the development of wind farms, hydroelectric and pumped storage projects, hybrid systems, solar energy units as well as integrated waste management units.

The company has a strong portfolio of projects that bring the new era to the country's energy map, promote a sustainable social model and provide solutions that help tackle climate change, while at the same time they strengthen the prospects of the economy creating hundreds of well-paid jobs of high expertise.

Having invested about 2 billion Euros in recent years, TERNA ENERGY continues to grow dynamically with new investments of 2 billion Euros channeled in the production and storage of clean energy as well as in environmental and waste management projects. More specifically, the company has already planned the development of new wind farms, energy storage projects with the method of pump storage, as well as onshore and offshore photovoltaic parks.

At the same time, TERNA ENERGY extends its business towards modern applications of circular economy, with projects that bring the new era in integrated waste management, while declaring ready for the new era that rises with additional investments in the development of floating offshore wind farms in the Greek seas.

In total, the Group targets 3,000 MW within the next five years.

TERNA ENERGY
GEK TERNA GROUP

For more information visit
www.terna-energy.com

GREEN TOP ENERGY SYSTEMS

Greentop Energy Systems S.A., is a privately-owned Greek Company, established in 2009. It belongs to entrepreneurs with stake interest on shipping, real estate and construction. Chartered to exploit and develop renewable energy sources from greenfield, the Company mainly focuses on wind and solar projects.

The Company employs highly qualified well recognized professionals with extensive experience and successful carriers in the stream of the Renewable Energy Market and the Construction sector.

Realizing the prospects of renewables in Greece, Greentop exploited various areas with wind and solar potential. Following the required licensing regulations, the Company created a project portfolio of more than 360MW in wind and solar capacity.

In house know-how complimented by certified specialized and experienced outsourcing, analyses and carries detailed assessments and studies ensuring the technical suitability and economic viability of each site and potential project.

For more information visit
www.greentop.gr

GREENTOP ENERGY SYSTEMS S.A.

Clarus ESCo

Ensure the best energy market price for your business with transparency and security.

If you already use e-auctions for procurement in your company, it is time to consider adding procurement of electricity and gas to them. If you have never used e-auctions until now, buying electicity and gas via e-auctions is a good oppportunity to start.

Clarus ESCo, the firm that has developed and operates **allazorevma.gr**, the first price comparison site for electricity and gas in Greece, offers to business consumers (with tariffs "Γ 22" or Medium Voltage) the possibility to procure electricity and gas via an e-auction.

The advantages are significant:

- Speedy proccess, economizing on staff's time
- Full transparency and objectivity
- Review and adaptation, if needed, of the supply contract
- Getting the best market price for the consumption profile of the business
- Advice support for the full duration of the supply contract
- Value based charge

Clarus Energy Services

allazorevma.gr
σύγκρινε, επίλεξε, άλλαξε

For more information visit
www.allazorevma.gr

HELENIC PRODUCTION

Hellenic Production – Industry Roundtable for Growth" was founded in 2017 by small and larger manufacturing companies as well as the country's main manufacturing associations as a joint advocacy initiative aiming at highlighting and strengthening the role of the Manufacturing Industry for a sustainable, competitive, innovative and exports-oriented Greek economy that fosters prosperity and creates high quality jobs.

Both the recent economic crisis and the current pandemic stressed the need for Greece to build a more resilient and diversified economy, based on innovation and exports and with strong presence in tradable goods markets. During both of the crises, the Greek manufacturing sector demonstrated significant resilience, with many small and larger companies managing to innovate, grow and expand into new international markets.

We believe in Greek creativity, in the Greek innovation and export potential based on a tradition of inventive entrepreneurship and highly skilled and talented human capital.

The role of Manufacturing

The industrial and manufacturing sector is at the heart of every modern economy and plays a decisive role in growth, employment and social cohesion. The manufacturing sector in Greece, despite its smaller share in the domestic economy (9% of GDP) compared to the EU average (15% of GDP), plays a major role and has a considerable impact due to very strong multiplier effects. The overall impact of manufacturing is estimated at 30% of GDP and 1/3 of employment.

Our Goals

- To raise the awareness of all stakeholders (government, social partners, opinion makers, public opinion) on the importance of manufacturing industry as a key driver for growth, sustainability, competitiveness and quality jobs.
- To foster a business environment and policies that support a new growth model with a stronger and more competitive industrial sector.
- A medium-term national industrial strategy with specific policy measures is an urgent first step. This should constitute a main and integral part of a national Growth Strategy which aims to shape the future path for a stronger Greek economy.

Membership

"Hellenic Production" has grown fast and from 12 founding members, it now has more than 60. Member companies range from small and local to multinational companies and operate in a wide array of industrial sectors and value-chains such as mining, pharma, cement, metal processing, chemical, paper and packaging, food & beverages, defense, textile etc.

For more information visit
www.hellenicproduction.org

HELLENIC PRODUCTION
INDUSTRY ROUNDTABLE FOR GROWTH

ESSENCON

EssEnCon GP (Essential Energy Consultants) provides effective energy assessments and reliable advices, for real energy reductions to large industries, small/medium businesses and large tertiary buildings, having long experience in:

- Energy studies for buildings, industries and SMEs.
- Energy audits (WTEA & Detailed) for industries and buildings.
- Design & supervision of electromechanical installations.
- Feasibility studies and licensing for CHP & Trigeneration systems and for RES projects.
- Design and implementation of National, European and International Energy Programmes.
- Design of tailor-made energy management systems (ISO 50001) for industries and SMEs.

EssEnCon partners are certified Energy Auditors (C & B class) and Lead Auditors for ISO 50001.

For more information visit
www.essencon.gr

ENTEKA

The ENTEKA group holds a leading position in the field of clean energy. For more than 30 years, it has been producing renewable energy and developing, implementing and managing innovative projects that contribute to sustainable development, with an emphasis on wind farms.

Having made significant investments to date, ENTEKA continues to grow dynamically with new investments, which it implements either exclusively with its own forces, or in collaboration with groups that have an international and strong presence in the field of RES. Through this strategy, the combination of autonomous development and strategic partnerships, it participates in a portfolio of wind projects with a total capacity of over 800 MW (in operation, management or at a mature stage of development).

Thus, ENTEKA is one of the largest independent groups in the field of wind energy in Greece. It is the oldest Greek company in the sector with exclusive activity in Renewable Energy Sources since 1984.

ENTEKA places special emphasis on the maintenance and management of wind farms for their entire life, offering three basic service packages:

1. Integrated Management of a Wind Farm, which includes the complete management of the operation of the wind farm and covers the full range of services for its smooth and efficient operation.
2. Integrated Technical Support of a Wind Farm, which includes all the necessary technical actions for the smooth and efficient operation of the wind farm.
3. Maintenance and Technical Support Services of a Wind Farm, on a case-by-case basis, which cover comprehensive technical support and a full range of individual actions from construction to efficient operation of the wind farm.

For more information visit
www.enteka.gr

ENTEKA
Energy Technologies & Constructions

LAMNIDIS LAW

Lamnidis Law is a boutique law firm based in Athens. Its focus is placed on Energy and Natural Resources, also encompassing all relevant civil, corporate, and administrative matters.

Lamnidis Law currently advises international energy groups, for the development of energy projects in Greece and abroad. The energy portfolio of the clients of Lamnidis Law, comprises of projects of more than a thousand MW, following diverse business models.

The legal team of Lamnidis Law accumulates over 30 years of practice in Greece, Southeast Europe, Middle East, Caucasus, Central Asia, and the area of the B&R initiative. The experience of Lamnidis Law in dispute resolution and international arbitration offered a considerable added value in structuring multijurisdictional projects. What is more, Thomas Lamnidis, had conceived the idea and the modular structure of an international institutional framework for interstate oil and natural gas transportation, which culminated in the INOGATE Umbrella Agreement, signed by 23 Countries and he is honoured to be partner and member of the Executive Committee of IENE.

Further to the above, the legal team of Lamnidis Law displays a considerable track – record in infrastructure, construction, investments, real estate, banking, restructuring of enterprises, privatisations, and M&A projects.

In sum, our in-depth knowledge of national, European, and International law for the above sectors allows us to successfully complete large-scale transactions, involving diverse stakeholders in multiple jurisdictions.

Further to the above, Lamnidis Law has fostered a broad network of lawyers from other jurisdictions, thus being able to implement projects across numerous Countries.

LAMNIDIS LAW

For more information visit
www.lamnidislaw.eu

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1

AN INTRODUCTION TO GREECE'S ENERGY SECTOR

1. An Introduction of Greece's Energy Sector

By Costis Stambolis, Chairman of IENE and Managing Editor of Energia.gr
and Mr. Dimitris Mezartasoglou, Head of Studies, IENE

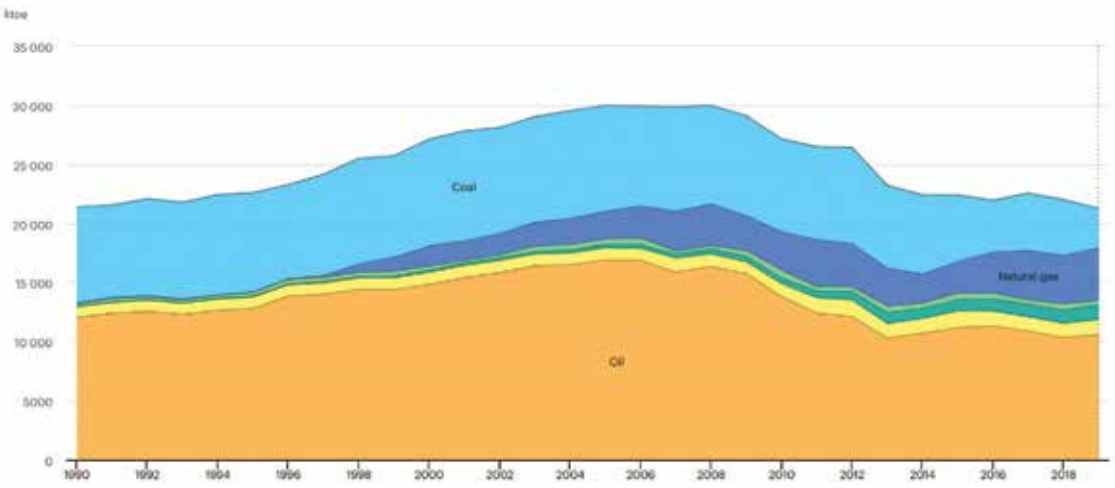
The Energy Market in Greece

1. Introduction

Over the last ten years, Greece's energy sector, in line with economic developments, has suffered from decreased demand, while at the same time there has been a noticeable differentiation of its energy mix. Use of indigenous lignite has been steadily decreasing on account of environmental considerations and its place is being taken by imported natural gas, while renewable energy is gaining ground, especially for power generation. Otherwise, the country, with the exception of substantial exports of refined petroleum products, remains highly dependent on hydrocarbon imports - to the tune of nearly 70% - by now a perennial characteristic of Greece's energy economy.

During the same period, the country has made noticeable progress with energy sector reforms, as the IEA informs us in its latest country review (2017). Restructuring of state owned companies, privatisations and transposing provisions of the third European Union (EU) Energy Package for the liberalisation of electricity and gas markets are key elements of the accomplished energy sector reform over recent years. The efforts of successive governments over the last five years (since the publication of GED 2016) have focused on the development of competitive and financially sound markets which offer choices and low prices to consumers, which are critical elements for regaining economic growth and ensuring long-term economic prospects. (1)

Figure 1 • Total energy supply (TES) by source, Greece 1990-2019



Source: IEA

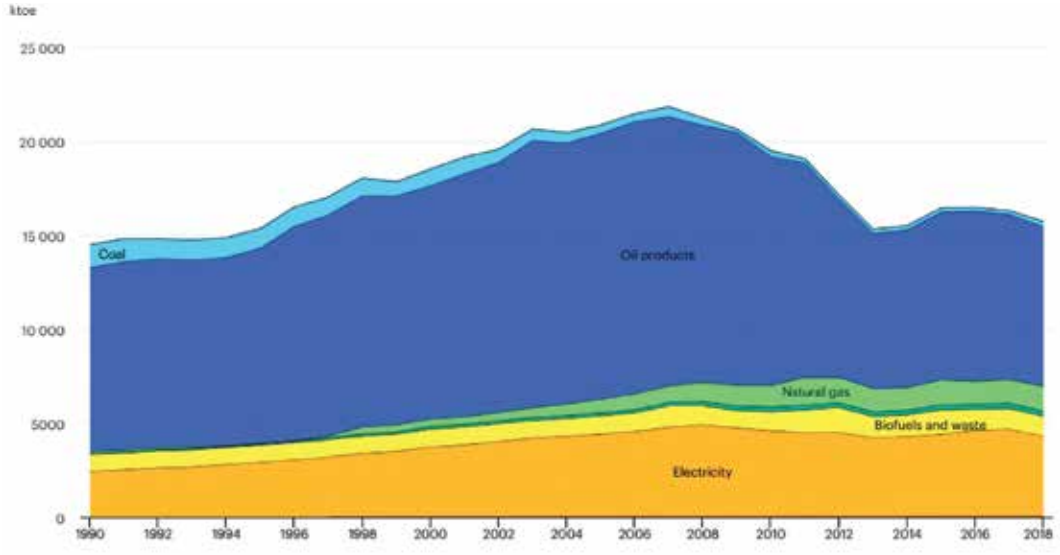
As part of the pursued energy strategy of the last years, Greece managed to achieve the 2020 emissions reduction and energy efficiency targets set by the European Union. This is partly due to its lower total final energy demand and policies in place to promote renewable energy sources and energy efficiency, especially in the building sector.

Over the last 10 years, energy use in Greece has suffered largely as result of the phenomenal economic recession that ravaged the country with an almost 27% loss of its GNP since 2009. Fig. 1 shows Greece's total energy supply by sources between 1990-2019 where the effect of weakened demand, as a result of economic depression, is clearly seen from 2009 onwards. Quite indicatively, final energy consumption in 2018 was at 15,735 kilotons of oil equivalent (ktoe), down 3.5% from 2017.

Figure 2 depicts the share of the various fuels in final energy consumption over the period 1990-2018. Oil products account for the largest share in final use consumption (54.2% in 2018), followed by electricity (27%), RES (8.7%), natural gas (8.3%) and lignite (1.8%).

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

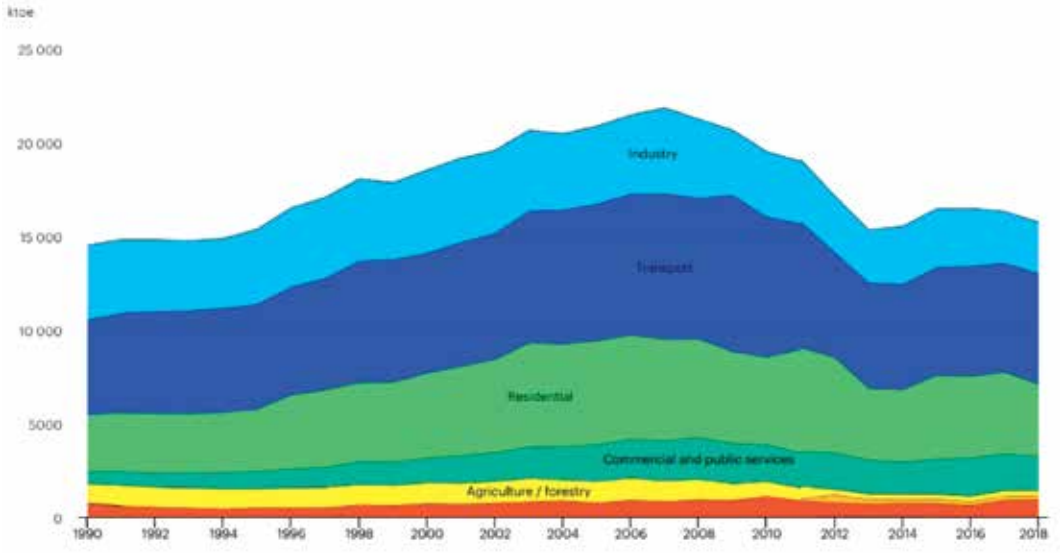
Figure 2 • Final Energy Consumption by Type of Fuel in Greece, 1990-2018



Source: IEA

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

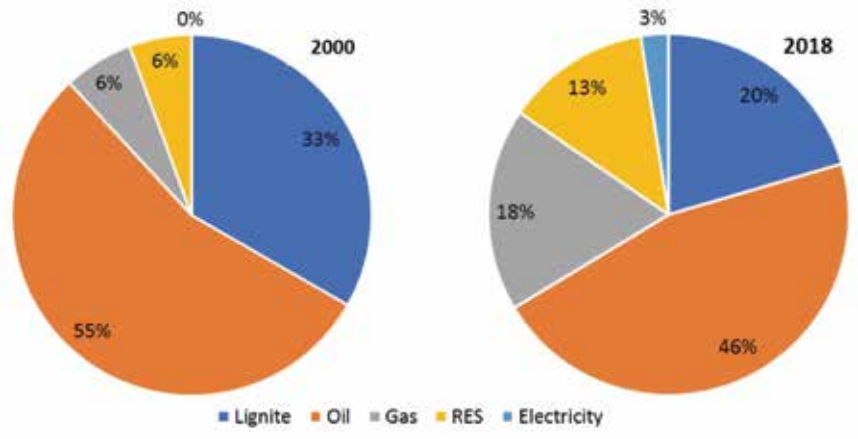
Figure 3 • Final Energy Consumption by Sector in Greece, 1990-2018



Source: IEA

Concerning Greece's total primary energy supply, IEA data for 2018 indicate that crude oil and oil products account for 46%, followed by lignite (20%), natural gas (18%) and RES (13%), as shown in Figure 4 (2). Preliminary figures for 2020 indicate that oil consumption dropped considerably due to the coronavirus pandemic but natural gas use was higher as decarbonisation takes hold and gas is used to replace lignite-fired units for power generation.

Figure 4 • Total Primary Energy Supply in Greece, 2000 and 2018



Source: IEA

2. Energy Security

Based on Eurostat's latest data, Greece's energy dependency is considered high at 74.1% in 2019, compared to EU-27 average at 60.7%. Lignite is the only significant domestic fossil fuel in Greece, though its importance is decreasing in line with climate targets. Use of imported gas is still relatively low compared to other IEA countries, though its share in the total final consumption has doubled over the last decade. Greece has potential to significantly increase the use of gas for power generation, for industrial use and for space heating in the residential sector, by replacing inefficient oil and biomass systems. Greece also has a large potential for renewable energy use, with its wind, solar, geothermal, and biomass resources, which are not yet fully developed. Enhanced exploitation of its renewable energy potential will result in a more-balanced energy mix and contribute towards increased energy security.

Lignite has a record of being a reliable fuel source in the electricity sector, but has had a decreasing trend in electricity generation, compensated for by an increase in the shares of natural gas and renewables. However, it still plays an important role in the security of supply.

However, the role is now being questioned by the present government which is committed to full delignification by 2025, on account of environmental concerns and commitment to much lower emissions by 2030. (3) The relatively high share of oil use in power generation stems from thermal generation on the Greek islands that have no electricity interconnection to the mainland. Greece has initiated large interconnection projects as part of a long-term strategy. The increasing role of gas in electricity generation requires a stronger focus on the security of gas supply. Greece has a small margin of system adequacy and relies on its only liquefied natural gas terminal for flexibility, which resulted in tight supplies during the winter of 2016/2017. The gas emergency response plan proved robust during the gas supply crisis, with power producers switching from gas to oil as requested.

There are several lessons to be learned from the gas crisis that should feed back into electricity and gas market design and the gas emergency plan. Demand response can provide an important source of system flexibility, if its activation is guided by price signals in a market designed to allow prices to reflect the real value of electricity and gas supplies when they are scarce. Price signals will be of growing importance when enhanced interconnections among Greece and neighbouring electricity and gas markets become operational.

Greece is actively involved in several international gas pipeline projects, aiming to establish itself as a gas hub in South Eastern Europe. Already, the TAP project, bringing gas from Azerbaijan to Italy, has been completed, while under construction is the Greece-Bulgaria Interconnector. These pipelines could increase the security of gas supply and would allow expansion of the domestic gas network into unserved areas in a cost-effective manner. In addition, there are two FSRU projects in the pipeline, which are expected to be completed by 2023. They will strengthen gas supply and increase gas liquidity at regional level.

However, the financial and economic viability of these projects needs assessment in a broader European context, to ensure that there will not be any over-capacity, to the detriment of consumer interests. The IEA has encouraged Greece to take a proactive and leading role in co-ordination of planning, trading policies, and regulations of the national markets, to establish a common regulatory framework for a gas hub.

Greece has complied with the IEA 90-day oil stock holding obligation since 2004. Diversification of oil and gas import sources has been successful, although a few import sources still dominate the market. Greece revised its emergency action plan for tackling serious oil supply disruptions in 2013, and included a list of indicative measures such as demand restraint measures, according to IEA's 2017 Report on Greece.

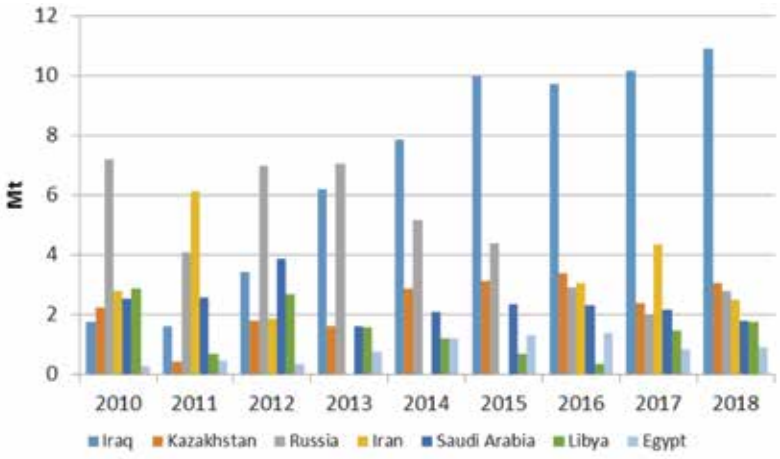
3. Oil and Oil Products

3.1. Oil Production, Imports and Exports

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

Therefore, Greece depends on imports of large quantities of crude oil in order to cover its needs. Iraq was the biggest crude oil supplier to Greece in 2018 with 10.9 Mt, followed by Kazakhstan and Russia with 3.1 Mt and 2.8 Mt respectively (see Figure 5). Imports from Iraq only accounted for 46% of total crude oil imports in Greece in 2018, which amounted to approx. 23.7 Mt (see Figure 6). Imported crude oil is refined into oil products at four domestic refineries. Greece has increased considerably its refining capability in recent years, with exports of oil products at 20 million tons in 2018, according to IEA data[1]. Greece also imports oil products, with imports at 3.8 million tons in 2018.

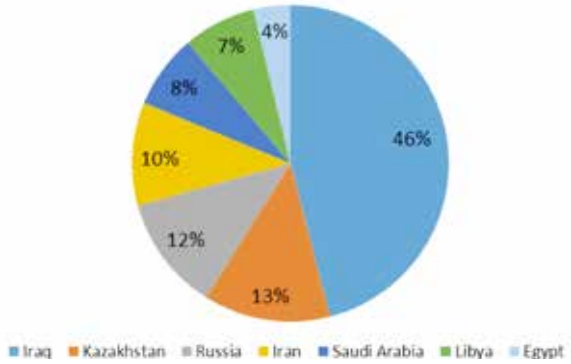
Figure 5 • Greece's Crude Oil Imports by Country, 2010-2018



Source: Greece's Ministry of Energy

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

Figure 6 • Greece's Crude Oil Imports by Country, 2018

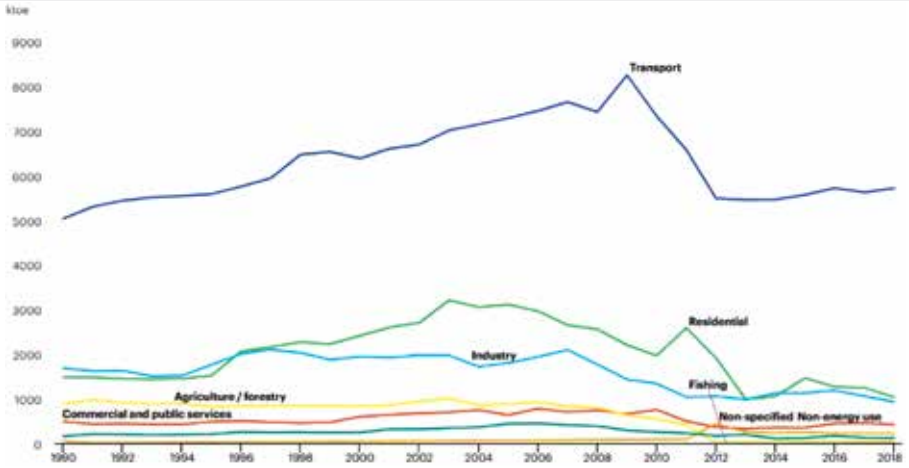


Source: Greece's Ministry of Energy

3.2. Oil Consumption

Over the period 2005-2015, oil consumption in Greece recorded a sudden drop by one third due to the economic crisis of 2008 (see Figure 7) and the Greek financial crisis that ensued, especially after 2009. In recent years, however, oil consumption recovered, rising by 9% between 2013 and 2015, mainly in transport and to an extent in the residential sector.

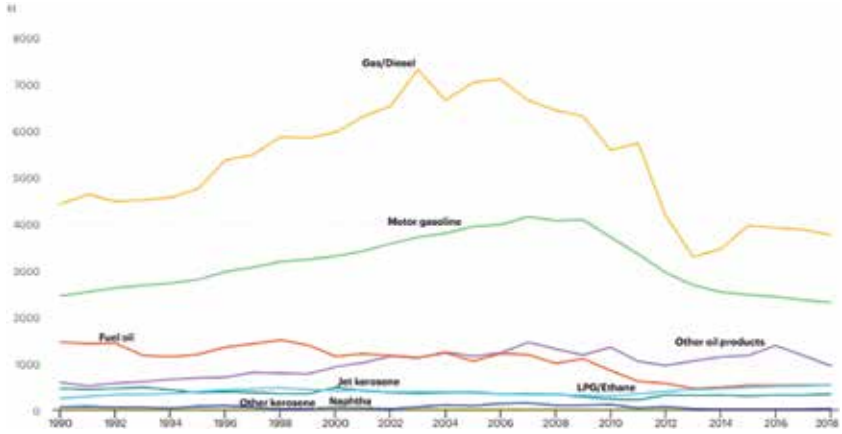
Figure 7 • Oil Consumption by Sector, 1990-2018



Source: IEA (2020)

The transport sector consumed 5.6 Mtoe of oil in 2017 or 50% of total oil consumption. Road transport accounts for 87% of total oil consumption in transport, followed by domestic shipping at 10% and smaller shares for domestic air and railway transport. The transport sector mainly consumes diesel and gasoline, which together account for 62% of total oil consumption in Greece (see Figure 8).

Figure 8 • Oil Consumption by Product, 1990-2018



Source: IEA (2020)

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

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

3.3. The Refining Sector

Imported crude oil is refined into oil products at four domestic refineries (see Table 1). The three refineries that belong to HELPE (Hellenic Petroleum S.A.) are located in Aspropyrgos, Elefsina and Thessaloniki and represent approx. 65% of the country's total refining capacity, with crude oil and oil product storage tanks having a total capacity of 6.65 million cubic metres. HELPE also owns the OKTA refinery in Skopje (Republic of North Macedonia) through its subsidiary, EL.P.ET. BALKANIKI, which is currently mothballed and is used only for stock maintenance. The refinery of Motor Oil at Agioi Theodoroi near Corinth produces the rest in Greece.

In 2019, the utilisation rate of HELPE's refineries in Greece was negatively affected by the completion of the current cycle of operation at the refineries of Aspropyrgos and Elefsina and the temporary suspension of operation for maintenance works at the Elefsina refinery, which were completed in the fourth quarter. Consequently, the production of HELPE's refining sector recorded a slight drop and amounted to 14.2 million tons in 2019. HELPE's sales were impacted commensurately and amounted to 15.2 million tons; exports stood at 7.9 million tons or 52% of total sales, and sales of aviation and shipping fuel were up 5% at 2.8 million tons. (4)

Table 1 • Refineries in Greece

	Hellenic Petroleum (HELPE) S.A.			MOTOR OIL
Ownership	Paneuropean Oil and Industrial Holdings S.A: 42.6% Hellenic Republic Asset Development Fund: 35.5% Institutional investors: 15.3% Private investors: 6.6% Free float: 23.5%			Petroventure Holdings Limited: 40,0%; Doson Investments Company: 8,1%; Free float: 51,9%
Location	**Aspropyrgos**	**Thessaloniki**	**Elefsina**	**Agioi Theodoroi (Corinth)**
Type of Refining	Highly complex: catalytic, thermal, and hydro-cracking; MTBE* production; vacuum distillation	Hydroskimming; vacuum distillation; isomerisation; reforming	Topping: atmospheric distillation only; no vacuum distillation, reforming or desulphurisation	Complex: catalytic and thermal cracking; isomerisation; MTBE production; vacuum distillation; mild hydrocracking; hydrotreating; reforming; lube production; alkylation; dimerisation
Nelson Complexity Index	9.7	5.8	12	11.54
Capacity (Mt/year)	7.5	4.5	5.3	10
Capacity (kb/d)	148	90	106	185
Year established	1958	1966	1972	1972

Sources: IENE, HELPE and Motor Oil

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

Based on data by the Hellenic Petroleum Marketing Companies Association (SEEPE), domestic market's fuel sales were up 0.45%, from 6,655,720 tons in 2014 to 6,685,490 tons in 2018. More specifically, the domestic market's sales of gasoline declined by 8.98% (2014: 2,516,270 tons - 2018: 2,290,214 tons), sales of heating oil grew by 10.62% (2014: 2,363,892 tons - 2018: 2,614,881 tons), while fuel oil sales declined by 13.66% (2014: 208,029 tons - 2018: 179,616 tons). LPG sales rose by 17.28% (2014: 437,955 tons - 2018: 513,623 tons) due to increased use of autogas, kerosene sales dropped by 16.57% (2014: 3,145 tons - 2018: 2,624 tons), and asphalt sales dropped by 27.44% (2014: 158,683 tons - 2018: 115,141 tons). The reduction in the consumption of petroleum products in 2018 compared to 2017 was mainly due to the reduced consumption of heating oil and unleaded gasoline. (5)

3.4. Latest Developments in Hydrocarbon Exploration and Exploitation in Greece

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

1. For the offshore area **"Ionian"** in western Greece, an agreement was signed on April 9, 2019 between the Greek State and the Repsol-HELPE joint venture. Also signed on the same day was the agreement for "Block 10 Ionian Sea" (in the Gulf of Kyparissia) between the Greek State and HELPE.
2. For concession and exploration and exploitation rights of the offshore areas **"Southwest and West of Crete"**, the agreements were signed on June 27, 2019. Earlier, in the first days of July 2018, it was announced that the Total-ExxonMobil- HELPE joint venture had been formally declared as the successful bidder in the international tender held by the Ministry of Energy.

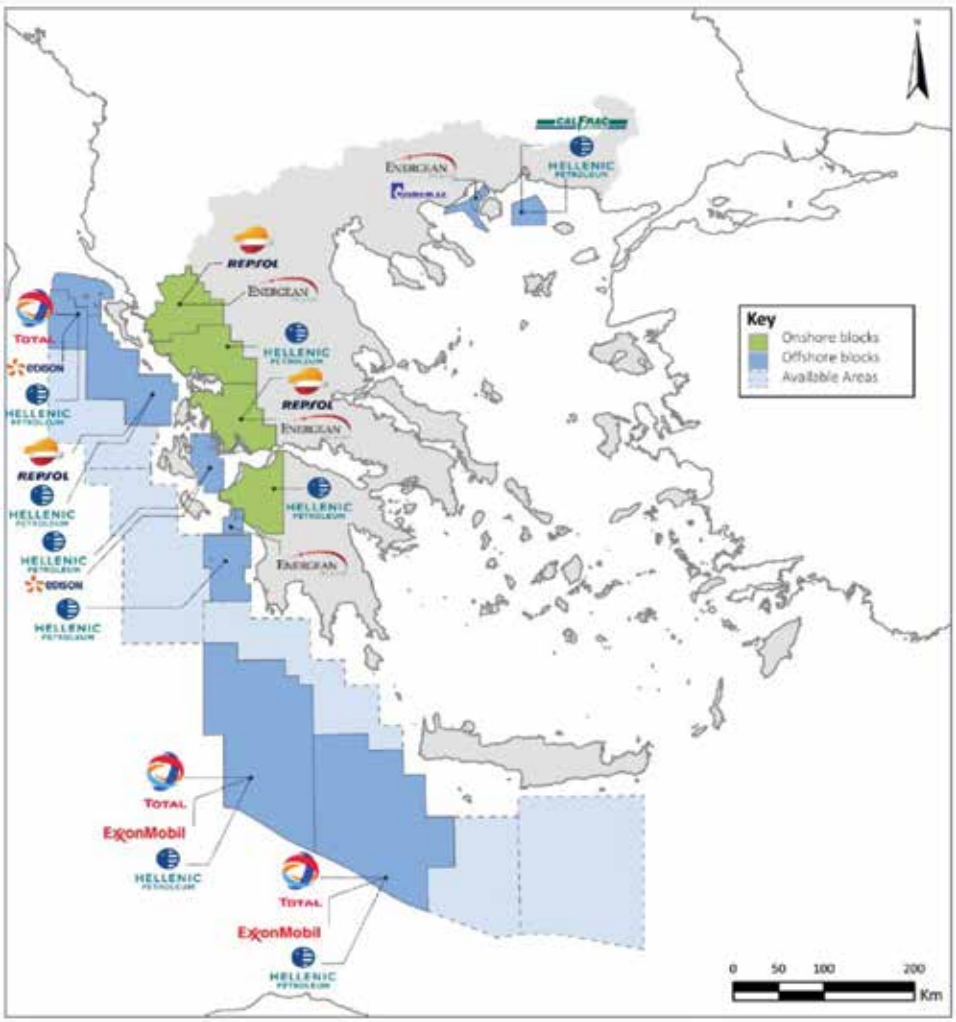
Date of publication in the Govt. Gazette (date when the agreement comes into effect)	Block	Location	Stage	Lessees, assignee, rates of participation
10/10/2019	Southwest of Crete	Offshore	Research	Total (40%, Assignee), ExxonMobil (40%), HELPE (20%)
10/10/2019	West of Crete	Offshore	Research	Total (40%,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

Source: HHRM

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

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

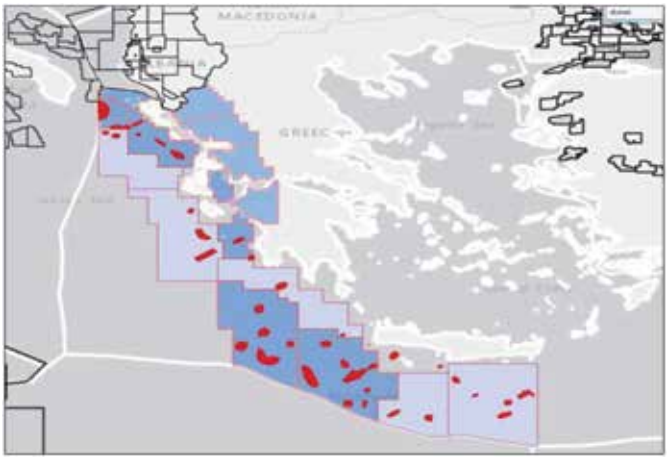
Map 1 • Concession Areas in Greece, December 2019



Source: HHRM

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

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



Source: HHRM

Regarding the area to the west and south-west of Crete, HHRM notes that the potential targets are located in rocks hidden under the seabed, while depths exceed by far 1,500 metres. Average water depth in these areas exceeds 2,500 metres and in many cases it is around 3,500 metres. Technology for drilling at such depths is expected to be available over the next three years, and the companies will decide then whether or not to proceed with exploratory drilling. It is worth mentioning that areas that appear of interest do not necessarily "conceal" hydrocarbon quantities; this can only be confirmed with drilling operations. However, it is encouraging that in neighbouring countries, featuring similar geomorphology, hydrocarbons have been discovered and are already being exploited. (6)

4. Natural Gas

4.1. The Natural Gas Market in Greece

The Greek gas market appears to have recovered in 2019, after the extended period of financial crisis. In parallel, implementation of the actions outlined in the Gas Market Roadmap 2017-2022[2] continued; especially, those that aim at a transition to a fully deregulated market (e.g. reforms in the retail and wholesale markets, and corporate restructuring of supply companies).

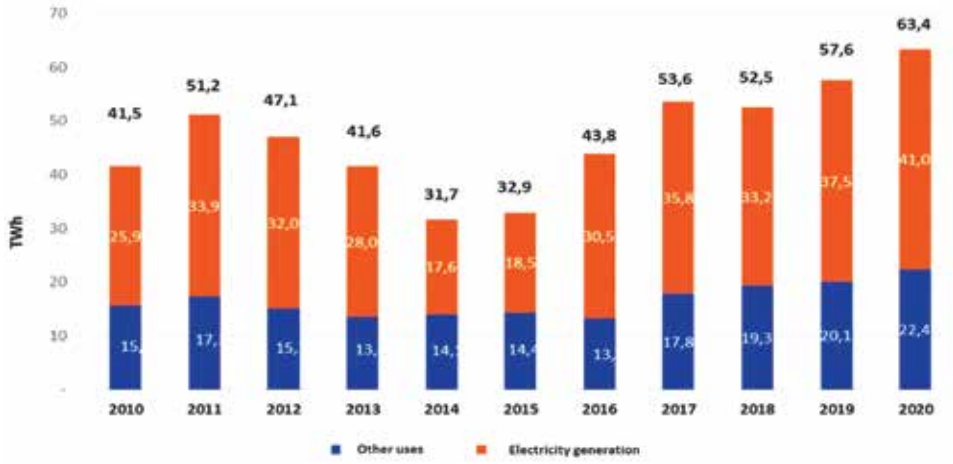
Based on data provided by DESFA , total consumption of natural gas in Greece in 2019 amounted to 57.4 TWh or 4.9 billion cubic metres, up 10% compared to the respective figure for 2018 and up 79% compared to 2014. Therefore, gas consumption in 2019 was the highest since it was first introduced in the country. It is worth mentioning that in 2019 Greece exported to Bulgaria gas quantities amounting to 7.7 TWh. (see Fig.9 and 10)

Figure 9 • Natural Gas Consumption, Imports and Exports in Greece, 2019

Source: DESFA

[2] Govt. Gazette B' 59/18.01.2018
[3] https://www.desfa.gr/userfiles/pdflist/DERY/TT/Leit_Stoix_ESFA_2019.pdf

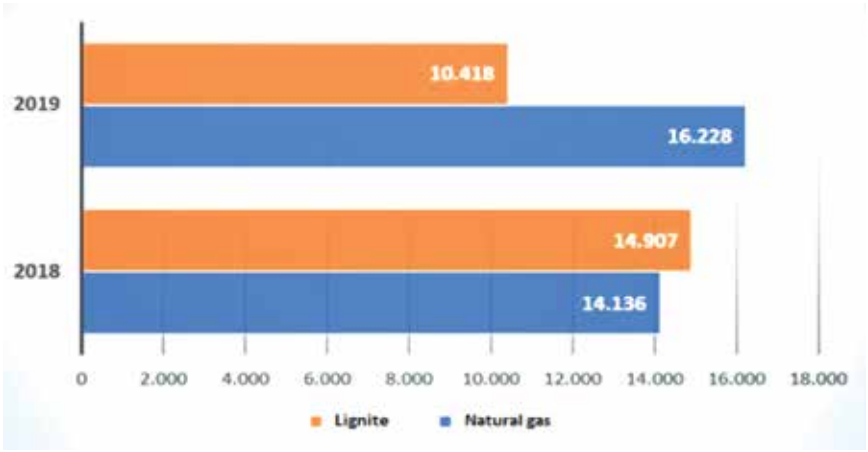
Figure 10 • Evolution of Gas Consumption in Greece, 2010-2020



Source: RAE

The highest percentage of natural gas in 2019, as in all past years, was consumed in power generation by PPC's thermal units and private electricity producers. Indeed, the role of natural gas in power generation rose considerably in 2019 as compared to 2018. As shown in Figure 11, the production of units using natural gas as fuel increased by 15% in 2019 compared to 2018; on the contrary, the electricity generation from lignite was reduced by 30% compared to 2018.

Figure 11 • Annual Production (GWh) of Thermal Stations in Greece, 2018-2019



Source: IPTO

The penetration of natural gas in Greece remained at very low levels in 2018 (8%), compared to the average in other European countries, where it reaches 55% and thus, electricity generation is still the main factor in Greece's gas demand. (7)

4.2. Sources of Gas Supply in 2019

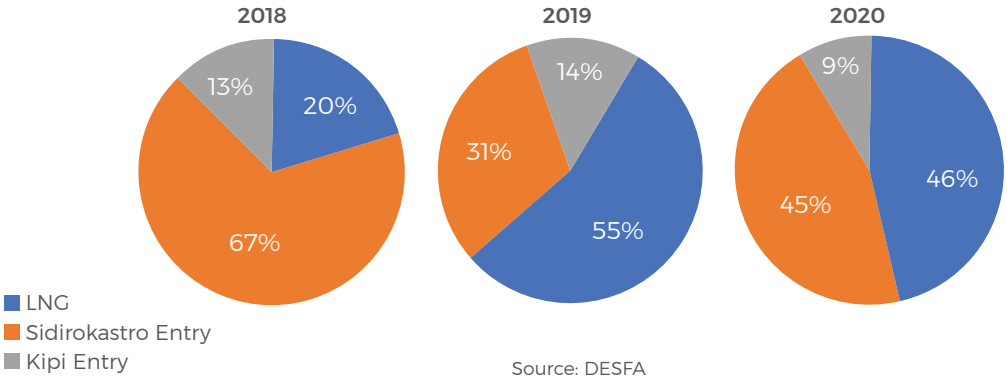
2019 was a reference year for the evolution of the market share between piped gas and imported LNG into Greece. Figure 12 depicts the contribution share of piped gas and LNG over the period 1998-2018.

Figure 12 • Evolution of Gas Imports into Greece, 1998-2018

Source: DESFA

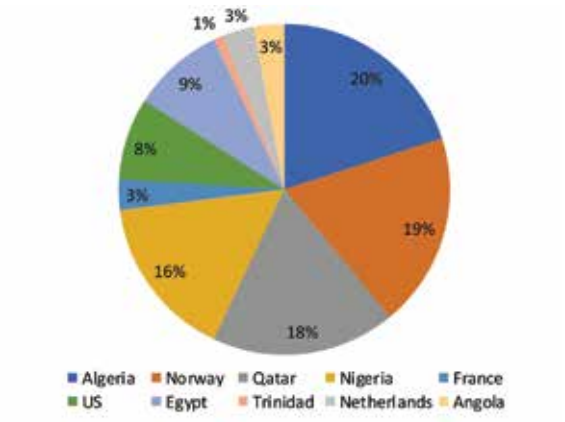
These shares changed significantly in 2019 compared to 2018. More specifically, LNG accounted for 55% in 2019 against 45% for piped gas, when the maximum share of LNG had been 29% in 2010 and 2012. In 2018, LNG accounted for 20%. It is the first time that LNG exceeded in quantity the gas supplied via pipelines. (8)

Figure 13 • Change in the Share of Gas Supply Sources in Greece, 2018-2020



Source: DESFA

Figure 14 • LNG Imports into Greece by Country of Origin, 2019



Source: DESFA

5. Electricity

In Greece, the electricity market until very recently operated on the basis of a pool structure, meaning that the total available power formed a "pool" from which participants in the distribution network drew the electricity they supply to their customers - consumers. Since November 1, 2020, this model changed and the electricity market operates on the basis of the so-called European Target Model.

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

It is worth noting that gas and RES units have started replacing a large segment of lignite production, leading to a considerable increase in total installed capacity for power generation in the last decade thanks to the RES. (9)

5.1. Supply and Demand

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

Power Generation

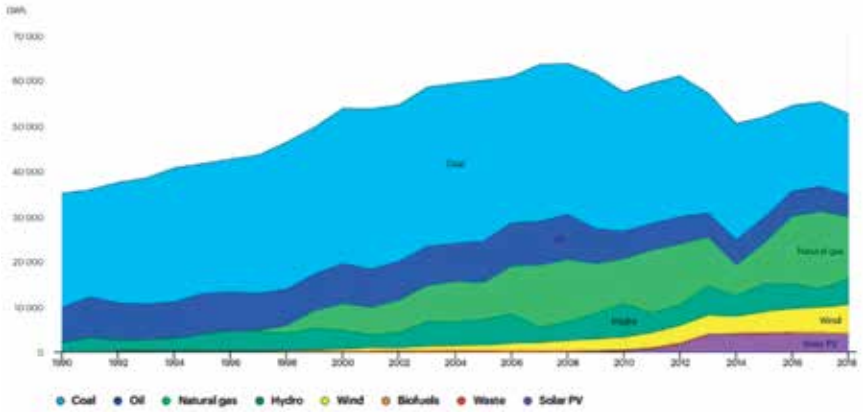
In 2019, Greece produced 42.2 TWh of electricity in the interconnected system, down 6.6% from levels in 2018. Natural gas was the largest source of energy in domestic power generation, accounting for 16.2 TWh in 2019, followed by RES, which increased their share from 11.1 TWh in 2018 to 12.2 TWh in 2019.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

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

Source: IPTO[4]

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

Figure 15 • Power Generation by Type of Fuel, 1990-2018

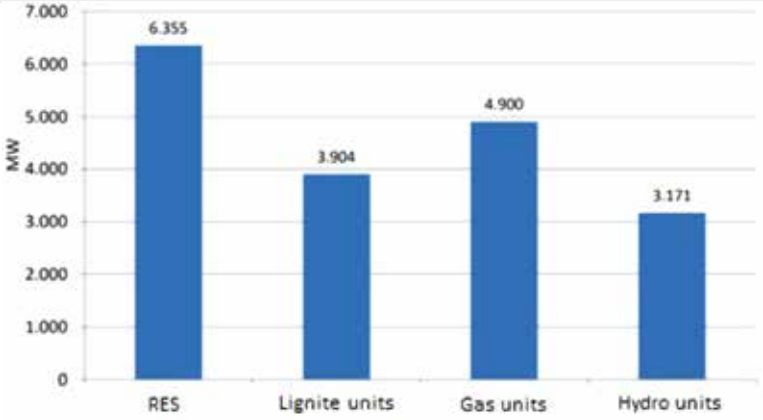


Source: IEA (2020)

Installed Capacity

In 2019, the total installed capacity of power generation units in the Greek interconnected system amounted to 18.3 GW, up 5.2% from levels in 2018 (17.4 GW). RES were the only power generation source that increased its share in domestic installed capacity in the interconnected system in 2019 as compared to 2018, with new installed capacity of 886 MW and total installed capacity at 6.3 GW. In 2019, the total installed capacity of lignite, hydro and gas units remained at the same levels as in 2018, as shown in Figure 15. (10)

Figure 16 • Total Installed Capacity of Units by Type of Fuel in the Greek Interconnected System, 2019



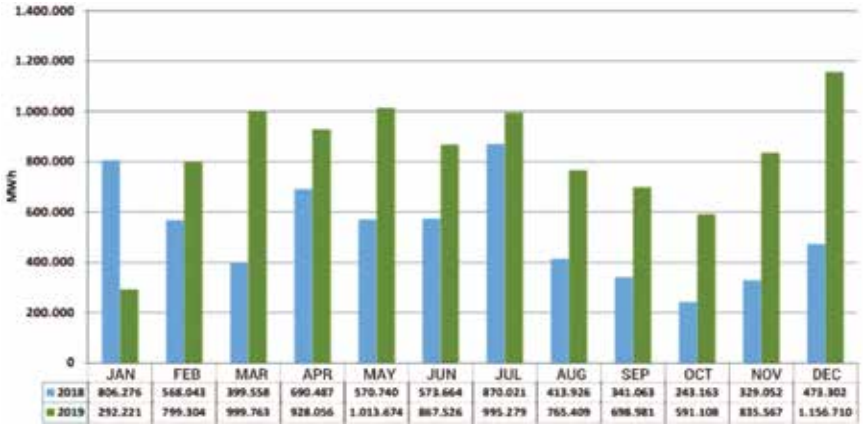
Source: Hellenic Energy Exchange

Electricity Imports and Exports

Greece is well connected to neighbouring countries and apart from the domestic electricity production is increasingly becoming active in power tading activities. However, the interconnection index[5] of the country's power grid is at 9%, i.e. at levels lower than in other power systems in SE Europe as the interconnection indices in Bulgaria and Rumania are at 12% and 11% respectively. Electricity imports increased due to new interconnections, though they vary considerably from year to year. More specifically, electricity imports into Greece amounted to 9.6 TWh in 2019, mainly from Bulgaria, Italy and North Macedonia. Electricity exports amounted to 2.9 TWh in the same year, mainly routed to Italy, Albania and North Macedonia. Greece has been a net importer of electricity for many years, with total net imports in 2019 at approx. 6.7 TWh, covering approx. 13% of the country's needs, based on IPTO's data. It is worth noting that a second electricity interconnection between Bulgaria and Greece is under development and is expected to become operational by 2023. This project is of great importance for the market coupling of both countries, and is expected to increase considerably the interconnectivity of Greece and bring the country closer to the minimum European target of 15% by 2030. (11)

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

Figure 17 • Electricity Balance (MWh) at the Interconnections of Greece, 2018-2019



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

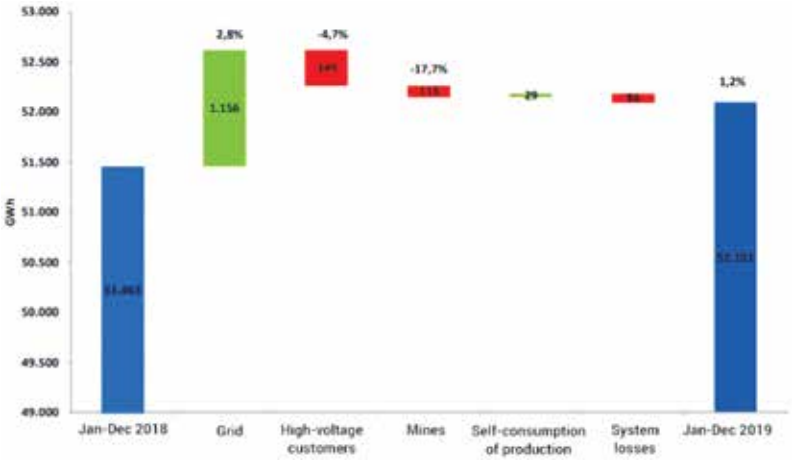
Source: IPTO

Electricity Consumption

Electricity consumption in Greece increased steadily up to the peak of 58.8 TWh in 2008; followed by a 5-year period of decline, from 2009 to 2013, as a result of the prolonged financial crisis. The electricity consumption has recovered slightly in recent years, and in 2019 Greece consumed 52.1 TWh (see Figure 18) in the interconnected system (except of the islands, with 5.6 TWh).

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

Figure 18 • Change in the Electricity Demand (GWh) in the Interconnected System of Greece, 2018-2019



Source: IPTO

5.2. Non-Interconnected Islands

In Greece (mainly in the Aegean Sea), most islands currently obtain electricity from autonomous power generation plants, operating with diesel and fuel oil, and RES units (wind and photovoltaic). These islands have not yet been interconnected with the mainland grid, mainly due to technical and financial difficulties, since interconnections are capital-intensive projects. The electricity market of the Non-Interconnected Islands (NII) now consists of 29 autonomous systems, since Paros and Syros were interconnected in May 2018 and Mykonos in May 2019. Some of these systems comprise several islands (island clusters), and the operation and management of the NII market is undertaken by the Hellenic Electricity Distribution Network Operator (HEDNO) and more specifically by its Island Management Division. According to RAE data[6], peak demand varies among the 29 autonomous island clusters:

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

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

As mentioned above, the NII are usually equipped with units that use diesel as fuel and are expensive, environment-unfriendly, and cannot benefit from the advantage of economies of scale. However, the NII feature excellent conditions for wind and solar energy utilisation. The operation of these types of energy in the islands is complicated by their variability and the need for back-up systems. (12) Based on data provided by the HEDNO's Island Management Division, the total installed capacity of power generation units in the NII was approx. 2.2 GW in 2019, of which 79% concerned thermal stations (see Table 4), increased by 7.4% compared to 2018 levels (2,070.10 MW).

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

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

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

Source: HEDNO

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

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

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

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

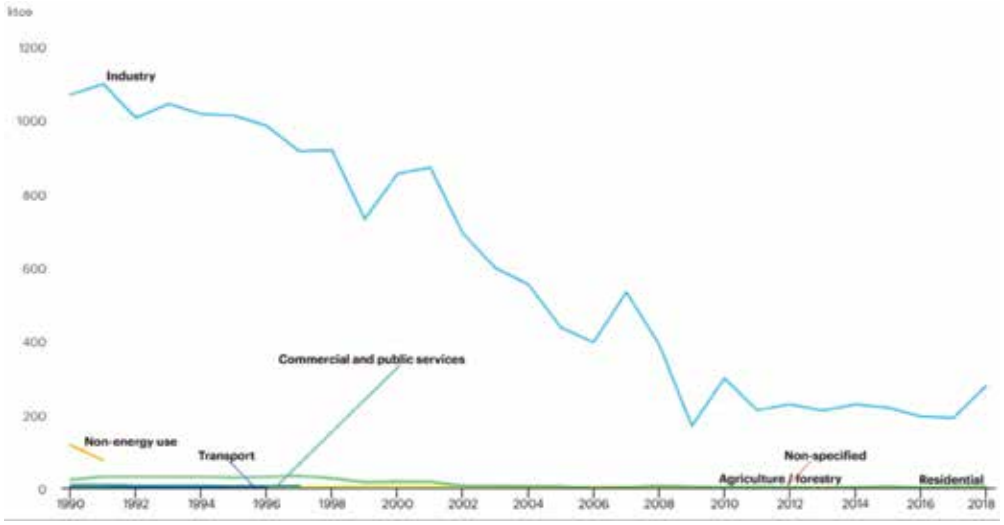
Source: HEDNO

6. Solid Fuels

Until very recently, lignite accounted for a large part of Greek mining activity, a basic fossil fuel and an important element for the country's energy security. Greece is the fourth largest lignite producer in Europe, after Germany, Poland and the Czech Republic. It is the second fuel, after oil, with the largest contribution to the total primary energy supply, but accounts for only a small part of total final consumption by industry. Based on data from the European Association for Coal and Lignite (EURACOAL)[7], lignite production in Greece amounted to 36.5 million tons in 2018, and power generation from lignite was at 14.9 TWh in the same year.

Based on IPTO's data, electricity produced from lignite declined considerably from 14.9 TWh in 2018 to 10.4 TWh in 2019, due to the increase in RES, lower total demand for electricity, and the high cost of emission rights, which makes power generation from lignite uneconomic. In 2020, lignite share on electricity production declined further to 5.7 TWh. Lignite production fell by 50% between 2012 and 2018, in conjunction with reduced demand for power generation from lignite. PPC is the sole owner and operator of the five lignite-fired power stations in Greece, deploying 14 units in total and employing 6,223 workers (4,363 in production plants and mines and 1,860 as subcontractors). Imported hard coal (approx. 0.4 million tons), almost all from Russia, is used in the cement industry.

Figure 19 • Final Lignite Consumption by Sector in Greece, 1990-2018



Source: IEA (2020)

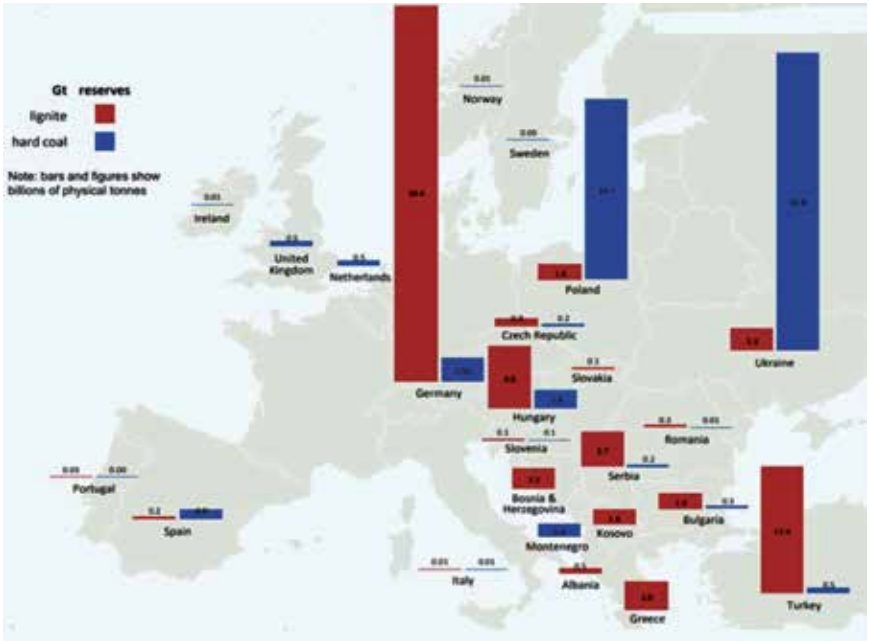
Total confirmed geological reserves of lignite in Greece amount to approx. 5 billion tons. These deposits are geographically dispersed across Greek territory[8]. Based on current technical-economic conditions, the deposits that are suitable for energy exploitation amount to approx. 3.2 billion tons and are equivalent to 450 million tons of oil. The main exploitable deposits are in the regions of Ptolemais, Amyntaio and Florina, with reserves estimated at 1.8 billion tons, in the area of Drama, with reserves of 900 million tons, and in the area of Elassona with 169 million tons. There is also a lignite field with reserves of approx. 223 million tons in the area of Megalopolis, in the Peloponnese.

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

[7] EURACOAL (2020), "Coal Industry across Europe", 7th edition, https://euracoal.eu/library/publications/
[8] https://www.dei.gr/el/oruxeia/apothemata-kai-poiotita

In general, the quality of the Greek lignite is low. Thermogenic power is in the range of 975-1,380 kcal/kg in the areas of Megalopolis, Amyntaio and Drama, 1,261-1,615 kcal/kg in the Ptolemais area, and 1,927-2,257 kcal/kg in the areas of Philippi and Elassona. An important comparative advantage of lignite in Greece is the low sulphur content. (13)

Map 3 • Exploitable Lignite Reserves in Europe



Source: EURACOAL

Greece to Phase Out Lignite

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

The fuel that drove the country's electrification in the post war years is gradually being phased out, in line with EU policy and the country's committments. Already, the Amyntaio I and II and Kardia III and IV lignite units have closed down, while the procedures for the retirement of their personnel are under way, and a Master Plan for the way ahead has now been completed[9]. The Master Plan includes strong tax and development incentives and emphasis on manufacturing, tourism and green energy, to ensure a smooth transition to the post-lignite era for the regions of western Macedonia and Megalopolis.

In February 2020, the Inter-Ministerial Committee responsible for the lignite phase-out appointed Mr. Kostis Mousouroulis, a senior official of the European Commission, as Coordinator of the Just Transition Development Plan (SDAM) for the regions of western Macedonia and Megalopolis. More specifically, the Ministerial Council Act states that Mr. Mousouroulis will be the Chairman of the Coordination Committee, i.e. the Working Group, which, under the supervision of Inter-Ministerial Committee, will draw up and implement the Just Transition Plan and will coordinate the activities related thereto, starting in 2020. It is worth noting that IENE recently completed a special Report[10] on behalf of the SDAM Coordination Committee about the current situation and the prospects of regions in energy transition in Greece.

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

[9] https://www.sdam.gr/sites/default/files/consultation/Master_Plan_Public_Consultation_ENG.pdf

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

Attaining these aims will require full and productive utilisation of all available financing means and sources for the transition into the post-lignite era. In particular, the investments under consideration will enable full utilisation of the resources of the three pillars of the Just Transition Mechanism (Just Transition Fund, Special InvestEU status, Public Sector Credit Facilities), while also advancing the financing of investments via the other sources, by mobilising considerable private capital (leverage). (14)

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

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

Source: NECP

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

It is worth noting that taking into consideration the investment plan as envisaged at this stage, which will obviously be enriched with new investments over time, funding for the total capital cost of foreseen investments, initially estimated at approx €5 billion, is structured as follows:

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

This financing scheme indicates that a considerable part of the investments will be realised through leverage of commercial (bank) loans and securing of equity capital.

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

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

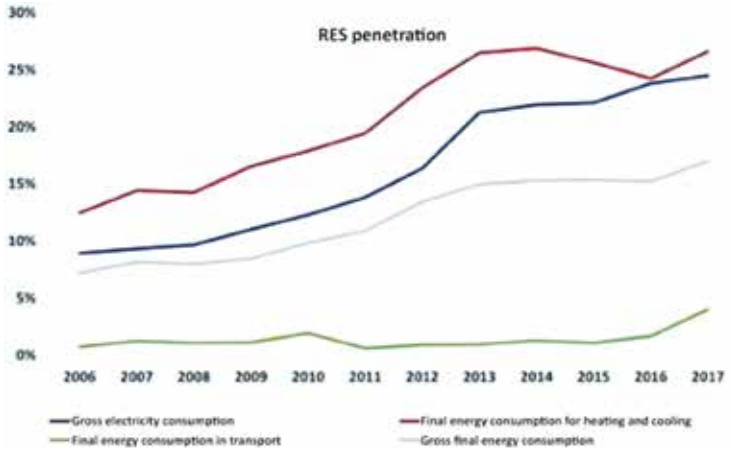
7. Renewable Energy Sources (RES)

The contribution of RES in energy consumption in Greece has shown a significant increase over the period 2006-2017, as their overall contribution in 2017 as a share of gross final energy consumption amounted to 17%, more than doubling the corresponding share in 2006 (see Figure 20), based on NECP's data.

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

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

Figure 20 • Total and Specific Shares of RES in the Greek Energy System on the Basis of EU Methodology, 2006-2017



Source: NECP

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

7.1. Power Generation from RES

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

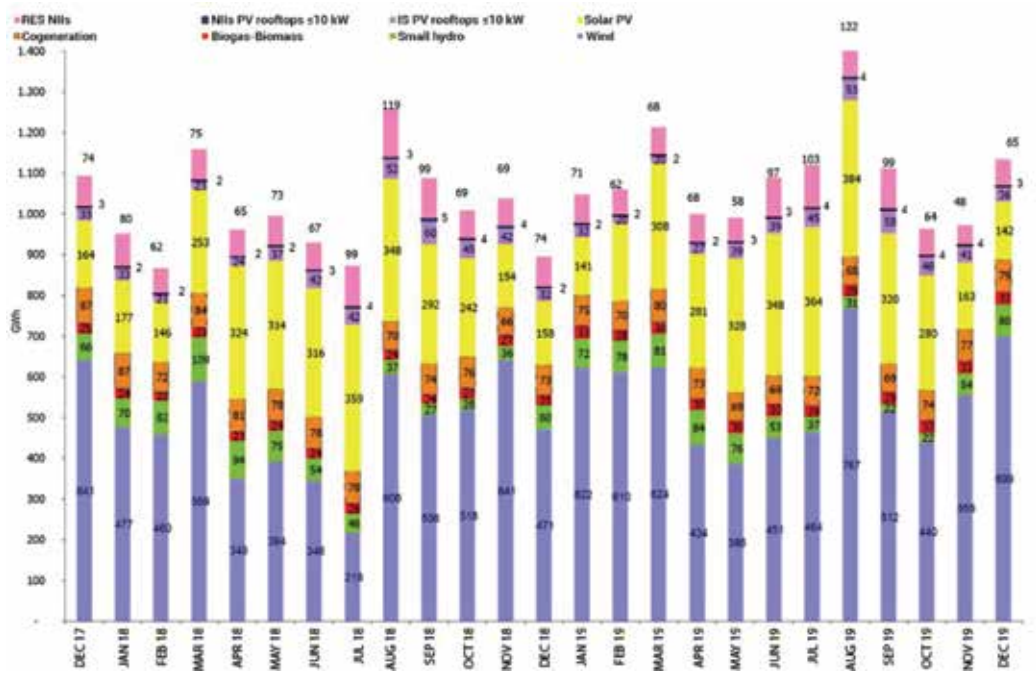
Figure 21 • Power Generation from RES in Greece, 2019-2020

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2019	964	1.019	1.178	958	943	1.003	1.013	1.327	996	868	905	1.046
2020	1.120	1.184	1.287	1.283	1.160	1.079	1.358	1.157	1.470	1.081	1.343	1.278

Source: IPTO

Total power generation in Greece from wind forms interconnected to the system amounted to approx. 6.6 TWh in 2019, and from small hydro units and biogas-biomass stood at 690 GWh and 362 GWh respectively. In addition, the total power generation from cogeneration units and assigned cogeneration interconnected system units stood at 186 GWh and 876 GWh respectively. The electricity generation from solar PV units in the interconnected system was almost 3.2 GWh in 2019 (see Figure 22).

Figure 22 • Power Generation of RES and Cogeneration (GWh) Units and Rooftop Photovoltaic Power Stations ≤10 kW, 2017-2019



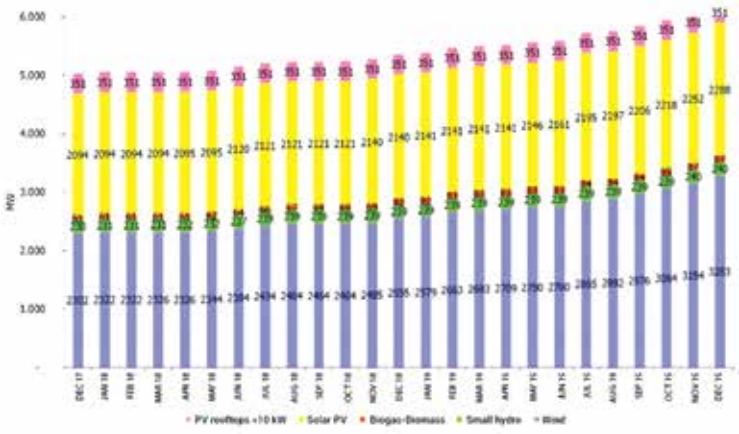
Source: LAGIE (Hellenic Electricity Market Operator)

Greece has significant RES potential, which can contribute substantially to an environment-compatible restructuring of its energy system. This potential mainly comprises solar, wind, hydro and geothermal energy as well as biomass. The ample wind potential is mainly found in the country's island regions (e.g. Crete, Aegean Sea, Evia, etc.), where most wind farms are currently located. The exploitation of Greece's wind potential, in conjunction with improvements in the technologies used in state-of-the-art wind turbines, is expected to contribute significantly towards sustainability, the NECP supports.

7.2. Installed Capacity from RES

Based on data from the bulletin of the Renewable Energy Sources Operator & Guarantees of Origin (DAPEEP) of December 2019 , the total installed capacity of RES units operating in the Greek interconnected system and of rooftop photovoltaic units smaller than 10 kW amounted to 6,249 MW in 2019 (see Figure 23), of which the majority is based on wind (52.5%) and photovoltaic (36.6%) units.

Figure 23 • Installed Capacity (MW) of RES Units Operating in the Greek Interconnected System and Rooftop Photovoltaic Units ≤10 kW, 2017-2019



Source: LAGIE

During 2005-2019, the installed capacity of onshore wind farms increased almost six-fold, and more than 2.9 GW of new power capacity were added to existing plants in Greece (see Figure 24).

2019 - A Record Year for Wind Energy in Greece

2019 was a record year for wind energy in Greece, since 727 MW of new wind farms were connected to the network, almost four times the annual average during the previous decade (185 MW). In addition, the largest wind farm complex, with a capacity of 154.1 MW, was connected in South Evia (Kafireas) by Enel Green Power. (15)

Figure 24 • Installed Capacity (MW) of Onshore Wind in Greece, 1999-2020

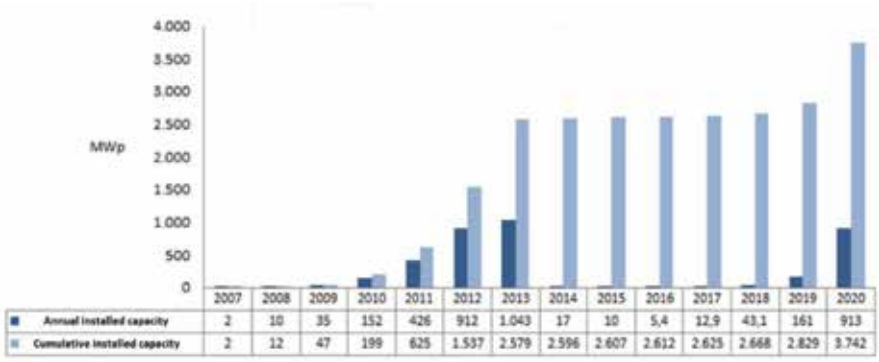
Source: Source: Hellenic Wind Energy Association

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

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

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

Figure 25 • Installed Capacity (MW) of Photovoltaics in Greece, 2007-2020



	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Annual installed capacity	2	10	35	152	426	912	1.043	17	10	5,4	12,9	43,1	161	913
Cumulative installed capacity	2	12	47	199	625	1.537	2.579	2.596	2.607	2.612	2.625	2.668	2.829	3.742

Source: HELAPCO

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

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

Source: HELAPCO

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

7.3. RES in Non-Interconnected Islands (NII)

As discussed earlier, there are currently in operation 29 autonomous island systems in Greece. In these NII, there must be a special focus on using RES for power generation, since there is high potential for their use and they are economically advantageous, since in most NNI both the final average power generation costs and the corresponding variable costs of oil use are very high. In addition, the European Directive 2015/2193/EU has come into force for limiting emissions of pollutants from medium-sized combustion plants for power generation, which will ultimately lead to their elimination from the NII. However, the penetration of RES generation is subject to specific limitations, which are mainly determined by the technical minima of installed thermal units and the maximum permissible hourly penetration of non-controllable RES on the basis of load.

Total RES penetration in the NII is currently close to 21% of power generation, though without capability for further substantial penetration if the above limitations are not addressed, mainly through the application of innovative management technologies, utilising the technology of modern-day RES units with power electronics and/or with the installation and operation of storage systems. However, as a first step, HEDNO is in the process of readjusting its planning for developing state-of-the-art NII electricity systems, with higher RES penetration, modernisation and digitalisation of its infrastructure in the 29 non-interconnected island systems[12].

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

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

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

8. Energy Efficiency and Cogeneration

8.1. Energy Efficiency

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

Most of these measures concerned the improvement of the energy performance of buildings since the building sector corresponds to a large chunk of the country's final energy consumption, currently estimated at approx. 40%. For a detailed account on the progress achieved in the energy efficiency in buildings sector in Greece, see the article by Mr. C. Stambolis and C. Theofylaktos on "Greece's uphill battle to improve energy efficiency in buildings" on page ?.

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

According to the NECP, the objective is to improve energy efficiency in final energy consumption by at least 38% in relation to the foreseen evolution of final energy consumption by 2030, as estimated in 2007 in the context of the EU energy policies; thus, resulting in final energy consumption levels of not more than 16.5 Mtoe by 2030.

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

This rate of improvement of energy efficiency is even higher if adjusted to primary energy consumption, in which case it stands at more than 43%. Hence the overall objective is to achieve an improvement in energy efficiency across the entire energy system, attaining a particularly high level of improvement in terms of how energy is made available for consumption, always in the most cost-effective way. An additional objective is set with respect of the cumulative amount of energy savings to be attained over the period 2021-2030 in accordance with Article 7 of Directive 2012/27/EU on energy savings obligations. According to the available final energy consumption figures, cumulative energy savings of at least 7.3 Mtoe should be achieved over the period 2021-2030. However, the objective will be re-calculated on the basis of the final energy consumption figures for the years 2016-2018. In addition, an objective is set for the annual energy renovation of a total floor area of the thermal zone of central public administration buildings equal to 5,400 square meters, representing just 3% of the total floor area. The need to renovate the existing building stock is indisputable, as this will result in significant energy savings and in cost savings for citizens, and will also improve the comfort, safety and health conditions in the use of these buildings. To that end, it is necessary to establish a central quantitative objective for the renovation and replacement of residential buildings with new nearly zero-energy buildings, which could in aggregate amount to 12%-15% of all residential buildings by 2030. The objective is to have an average of 60,000 buildings or building units upgraded each year in terms of energy and/or replaced with new more energy-efficient ones. This particular objective will contribute significantly towards a major upgrading of the ageing building stock, while at the same time provide a substantial boost to the construction industry through the provision high added value technologies.

Another component for improving energy efficiency, as stated by NECP, is the increase in the use of natural gas in final energy consumption. More specifically, natural gas is expected to be the intermediate fuel for switching to a low GHG emissions model in all final consumption sectors, and may also lead to both improved energy efficiency and lower energy costs compared to other conventional technologies. Achieving higher gas share in all final consumption sectors and, essentially, ensuring its increased use so as to replace part of the current consumption of petroleum products in these sectors remains a constant policy objective. The development of the necessary transmission and distribution infrastructure to allow access to natural gas for higher percentages of end users in the building sector and the further increase in its use in industry and transport are priorities for the forthcoming period. The quantitative objective for this priority is to increase the direct use of natural gas in the final consumption sectors by at least 50% compared to 2017. Finally, improving overall energy efficiency requires that more effective financing mechanisms are planned in order to increase and maximise the current levels of private capital leverage. The active involvement of the financial sector and the promotion of innovative financing mechanisms and market mechanisms, including energy performance contracts, are critical parameters for attaining this objective.

Energy Efficiency in Buildings

In recent years, Greece has made substantial progress in promoting energy efficiency in buildings. Some of the actions taken are summarised as follows:

- The State Regulation for the Energy Efficiency of Buildings (KENAK), which determines the minimum energy efficiency requirements for buildings has been in plan since 2009 and is widely applied
- Designating buildings as being of almost zero energy consumption
- Introducing a system of energy inspections along with the mandatory issuing of Energy Certificates
- A long-term strategy for renewing the country's building stock is in place
- Houseowners have full access to the "Saving at Home" facility, a publicly financed program which enables them to fund energy improvments
- The energy upgrade of public buildings is reimbursed through specific actions, such as the first Energy Saving program for Local Authorities, etc.

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

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

Energy Efficiency in Transport

In the case of transport a priority appears to be the promotion of all different types of electric vehicles, especially in public transport.

In the case of transport, a priority appears to be the promotion of electric vehicles and electricity driven public transport. Through the use of vehicles powered by alternative fuels and electricity, the sharp drop in unit energy consumption per type of vehicle, the use of second-generation biofuels, the complete electrification of railway infrastructure and the increase in the share of track-based modes of transport in the overall transport system it is hoped that, by the end of the next decade, the country will have totally transformed its technological structure and fuel mix used in the transport sector. Finally, given that Greece is a leader in shipping, it is important to promote emission reduction technologies in shipping in compliance with the decision of the International Maritime Organisation (IMO) of April 2018 for a 50% reduction in emissions by 2050, compared to 2008, and totally eliminating emissions by 2100.

8.2. Cogeneration

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

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

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

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

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

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

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

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

According to the Cogeneration Observatory and Dissemination Europe, the potential of Greece is estimated at 11.1 TWh/year of primary energy saving, as per the methodology of the Directive on Energy Saving (27/2012/EC). Considering the implementation of the aforementioned actions possible, the Observatory estimates the potential at 24 TWh/year of primary energy saving and the reduction of CO_2 emissions at 14 million tons. (16)

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

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

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

9. Greece's National Energy and Climate Targets by 2030

Greece intends to use the National Energy and Climate Plan (NECP) as the key tool for developing its national energy and climate policy for the following decade, taking into account the European Commission's recommendations and the UN sustainable development goals. The NECP will be used to identify Greece's priorities and development capabilities in terms of energy and addressing climate change, and provision has been made for a specific roadmap for attaining specific quantitative and qualitative objectives, which will outline policy priorities and measures in a wide range of development and financial activities for the benefit of the society.

The main objective of the NECP is to design, plan and implement socially and environmentally efficient and cost-effective policy measures that will help attain the medium- and long-term national energy and climate objectives, will contribute to economic growth in Greece and will also respond to the challenge of reducing energy costs and, in general, of protecting end users from high prices of energy products and services.

These national energy and climate targets for 2030 are developed by taking into account both specific quantitative obligations undertaken by Greece as a Member State (i.e. targets for non-ETS sectors and for the reduction of national emissions of certain air pollutants compared to 2005) and the characteristics and specificities of its national energy system, the domestic potential for developing technologies and applications, the potential for adaptation, as well as Greece's socio-economic characteristics. This process results in adapting the national objectives to the corresponding core EU ones (i.e. the objectives for sectors that are part of the emissions trading scheme, RES, energy savings), which are finally proposed under this national plan.

Table 10 summarises the revised and more ambitious national objectives both compared to those of the initial NECP draft and the corresponding EU ones.

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

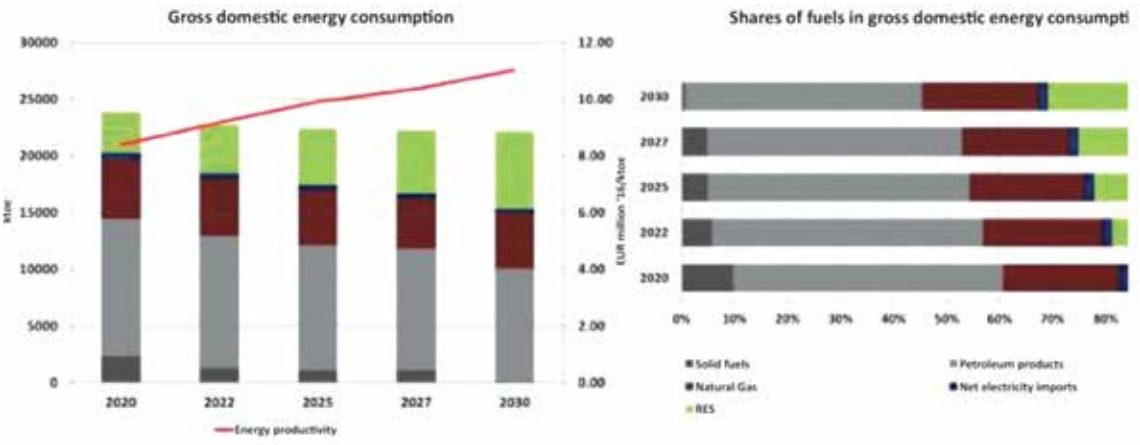
Year of objective: 2030	Final NECP	Initial NECP draft	New NECP objectives compared to EU objectives
RES share in gross final energy consumption	≥35%	31%	More ambitious than the corresponding core EU objective of 32%
RES share in gross final electricity consumption	≈61-64%	56%	
Final energy consumption	≈16.1-16.5 Mtoe (≥38% compared to the 2007 predictions)	18.1 Mtoe (32%) (referring to 17.3 Mtoe without ambient heat)	More ambitious than the corresponding core EU objective of 32.5% and attainment of the objective on the basis of a new EU indicator for reducing consumption compared to 2017
Share of lignite in power generation	0%	16.5%	
Reduced GHG	≥42% compared to 1990, ≥56% compared to 2005	33% compared to 1990, 49% compared to 2005	Identical with core EU objectives and overperformance compared to national commitments in non-ETS sectors

Source: Greece's NECP

In the energy system in total, gross domestic consumption of energy declines, which results in a significant improvement of the cost-efficiency of the energy sector, as shown by the development of the energy productivity indicator (see Figure 2). In particular, energy productivity shows an increase of 31% in 2030 compared to 2020. At the same time, there is a higher RES penetration, which is almost double in the period 2020–2030, while the share of solid fuels is significantly reduced, mainly due to the lignite phase-out of the electricity generation sector.

Meanwhile, petroleum products are significantly reduced due to the withdrawal of the islands' oil-producing plants after their interconnection with the interconnected system and the replacement of the use of petroleum products in the sectors of final energy consumption (buildings, transport) from RES and natural gas.

Figure 26 • Fuel Shares in Greece's Gross Domestic Consumption until 2030 for the Objectives Achievement Scenario



Source: Greece's NECP

10. Greece's Energy Investment Outlook by 2030

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

As analysed in IENE's 2020 Annual Report on Greece's Energy Sector[13], Table 11 summarises the anticipated energy investments in Greece over the next decade (2020-2030). These estimates are based on several assumptions, including that from 2021 and onwards the country will record growth, not recession, with an annual growth rate of 1.5%.

Table 11 • Anticipated Energy Investments in Greece, 2020-2030

	Expected Investments in million €
Oil	7,700
Natural Gas	2,800
Electricity	21,200
Energy Efficiency	11,000
Residential and Commercial Solar Power Applications	1,500
Research & Innovation	1,000
Total	**45,200**

Source: IENE

[13] IENE (2020), "The Greek Energy Sector – Annual Report 2020", https://www.iene.eu/articlefiles/greek%20energy%20sector%20study%202020_eng%201.pdf

11. Greece's Role in SE Europe

The economic crisis that hit Greece during the last decade had as a result the country's GDP fall by 27%, while also weakened its position in the Balkans and the rest of SE Europe. Its economic and diplomatic footprint in the Balkans and SE Europe in general has been hit hard, with key characteristic the large contraction, almost disappearance, its the once strong banking sector that had been developed steadily since the 1990s in all countries of the region, which led to much weakened regional investment initiatives by Greek enterprices.

This disadvantaged position of Greece in the region became particularly evident in the energy sector, where the country was deliberately excluded from specific regional infrastructure projects (eg. Vertical Corridor, BRVA pipeline), while there was a long delay in modernizing the operation of the electricity market through the implementation of EU's Target Model and market coupling.

However, during the same period, due to the timely implementation of investments before 2012, Greece had managed to modernize its infrastructure in the refining and metallurgy sector. Thus, over the last 5-6 years, in the midst of the crisis, Greece became a major exporter of refined petroleum products to all the SEE countries and beyond, as well as an exporter of high quality pipes and electrical cables. From a political and economic point of view, Greece's footprint in SE Europe may have declined during the crisis, but thanks to the competitiveness of specific energy products, there has been an improvement in the balance of payments with several SEE countries.

Despite weakening economic and diplomatic influence in the region, one pillar that suffered relatively small losses was that of energy security. This is due to the progress made in recent years in the design and construction of new gas pipelines, but also energy infrastructure projects in general, which helped improved the geopolitical position of the country and enhance its access to international markets.

All the aforementioned energy projects undoubtedly contributed to the modernization and expansion of the Greek energy potential and set Greece in its path to an environment of low or zero emissions. However, these projects cannot lead Greece to a position that can be characterised as a major energy hub in the region, as erroneously claimed by various energy and political analysts.

It should be noted that the quantities of natural gas that in a few years will pass through Greece to European destinations are quite small, in relation to European gas consumption. More specifically, it is worth mentioning that the gas quantities that the TAP will transport in its first and second phase of operation will correspond to only 4% of European needs, contributing to only a very small differentiation of the current energy mix, which to a large extent depends on imports of Russian gas. Due to the lack of adequate gas production from Azerbaijan in the second half of the current decade and based on contacts already made with Gazprom, it is estimated that TAP, during its second phase of operation, will most likely resort to transport Russian gas, dissolving the myth about the contribution of the TANAP-TAP system to the diversification of European energy supply. (17)

The South Corridor

In any event, the role of Greece in Europe's gas supply is important, especially if we take into account the FSRU type LNG terminals, currently under development, which when build will serve the needs of SE Europe, but they are far from converting the country into a primary regional energy hub.

The opening of the South Corridor for the gas supply from new sources (excluding Russia) in order to meet the growing European gas demand became a priority of the European Commission's energy strategy in the early 2000s. Now, the main target is the diversification of sources and routes in terms of gas supply. The Southern Corridor, in its current state, satisfies the requirement to diversify the gas supply route, but not necessarily the diversification of supply sources.

As IENE has repeatedly argued, through in-depth studies and analyses, there is a new architecture to be considered on how the Southern Corridor is now shaping, with multiple pipelines and LNG terminals, multiple entry points and a number of suppliers (e.g. Azerbaijan, Turkey, Russia, LNG). Due to the failure to secure significant quantities of gas outside Russia and the changing architecture of the Southern Corridor, there is a need for broader discussion in order to redefine and reconsider priorities and expectations (see Map 4).

Map 4 • The Expanded South Corridor

Note: The TANAP, TAP and Turkish Stream have been completed, while BRUA and IGB are under construction. The IAP, the IGI Poseidon in connection with East Med pipeline and IGNM are still in the study phase. Blue Stream and Trans Balkan are existing pipelines.

Source: IENE

With 3.0 million barrels of oil passing daily through the Bosphorus and the port of Ceyhan and with interconnections of gas and oil pipelines with Russia (i.e. Blue Stream, Turkish Stream, Trans Balkan), Azerbaijan, Iran and Iraq and four LNG terminals, which provide about 50 bcm of gas per year (compared to 5 bcm of Greece) for the needs of the internal market, Turkey is currently the main energy hub of the wider region. It is worth noting that TAP is a simple extension of the huge TANAP-SCP pipeline (1,800 km long and with a capacity of 36 bcm), which crosses Turkey horizontally, transporting natural gas from the Caspian to the internal market, but also to TAP. (18)

Table 12 • Anticipated Gas Volumes Through Greece, 2021-2030

Gas projects	Volumes
Through TAP	**10,0 bcm** in 2021 (1,0 bcm in Greece, 1,0 bcm in Bulgaria and 8,0 bcm in Italy) with potential (2030) **20,0 bcm** (2,5 bcm in Greece, 1,5 bcm in Bulgaria and 16,0 bcm in Italy)
Through IGB	**1,0 bcm** (2022) with potential **4,0 bcm** (2030)
Through IGNM	**0,5 bcm** (2023) with potential **1,5 bcm** (2030)
Through Revithousa LNG terminal	**1,5 bcm** (2021) with potential **3,0 bcm** (2030)
Through Alexandroupolis FSRU	**1,5 bcm** (2022) with potential **4,0 bcm** (2030)
Through East Med	**0,0 bcm** (2021) with potential **10,0 bcm** (2030)

Source: IENE

Energy Markets

Also, in relation to SE Europe, the changes that are now taking place in the operation of the Greek electricity market should be emphasized. With the operation of the Energy Exchange, the EU's Target Model was successfully implemented and leads to the integration of the electricity markets of SE Europe. At the same time, the electricity interconnections with the neighboring countries are accelerating, as well as the domestic interconnections of the islands.

A typical example is the EuroAsia Interconnector, the European Project of Common Interest (PCI) that will connect the electricity networks of Cyprus and Israel with Greece through Crete, which will be interconnected with Attica and the European interconnected system, while there is a strong interest in the interconnection of Egypt with Cyprus for access to European electricity markets. This will provide significant social and economic benefits to the citizens and the economy of the countries involved, ending the energy isolation of Cyprus (the last energy isolated Member State of the European Union) and Crete (through "Ariadne Interconnection", 100% subsidiary of IPTO), ensuring security of supply and creating an alternative electricity corridor from the Eastern Mediterranean to Europe. (19)

In addition, special attention should be paid to the interest shown by international energy companies in the field of hydrocarbon exploration and exploitation activities in Greece, creating a positive outlook for hydrocarbon production in the country, on equal terms with those recorded in Israel, Egypt and Cyprus.

With its energy infrastructure under development but limited in size, Greece can only play a minor role at the regional level in terms of Europe's energy supply, failing to emerge as a key regional energy hub. It can, however, emerge as a first-class regional commercial energy hub, if it manages to exploit the comparative advantages it undoubtedly has, and primarily utilises the high-level financial infrastructure it has developed. The first step in this direction was made with the operation of the new markets of the Hellenic Energy Exchange on November 1, 2020, as well as with the imminent activation of the country's gas trading hub within 2021/2022, with the evolution of the balancing platform operated by DESFA (i.e. Hellenic Trading Point).

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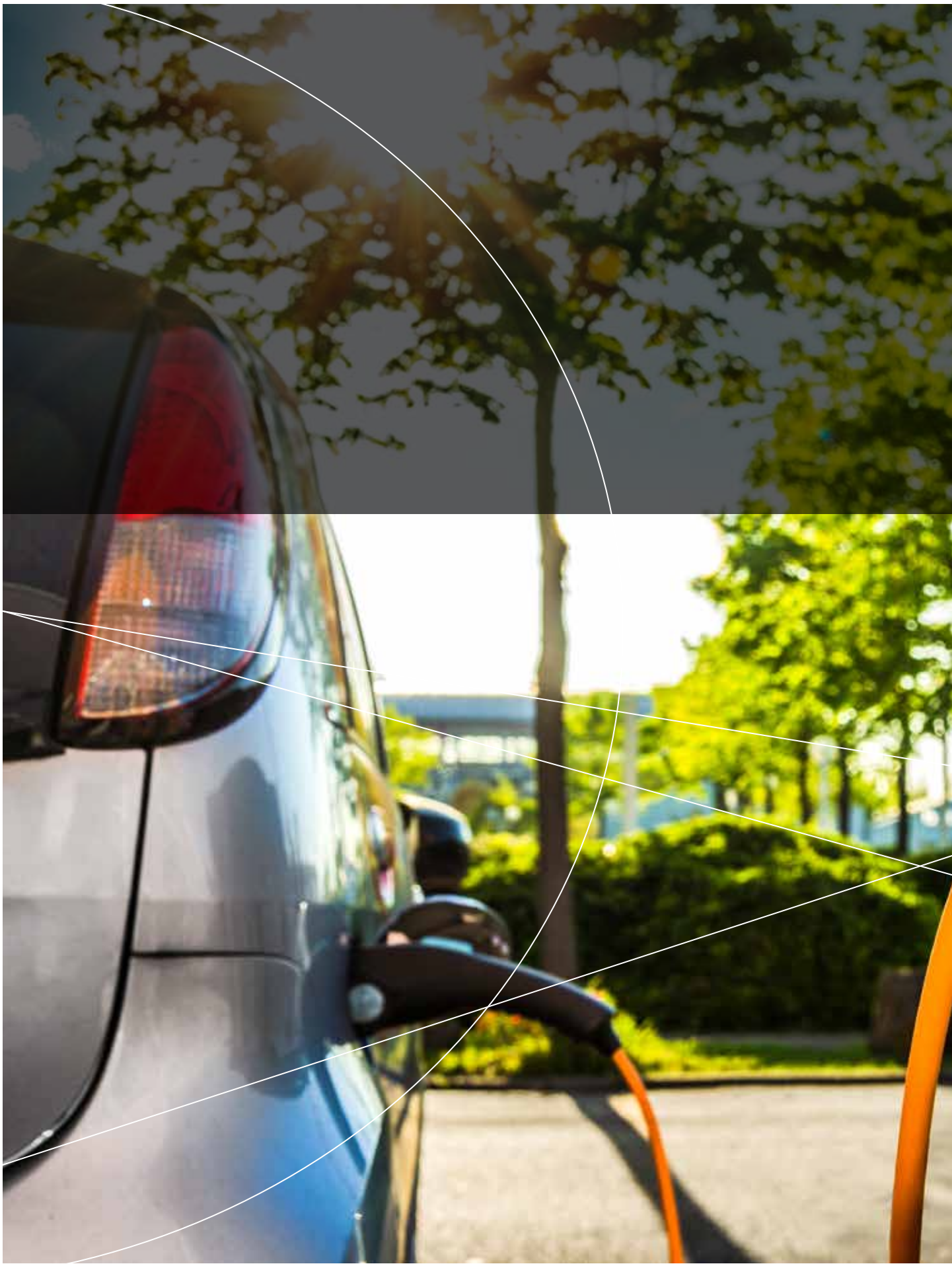


2

DECARBONISING GREECE'S TRANSPORT SECTOR AND THE ROLE OF E-MOBILITY

2. Decarbonising Greece's Transport Sector and the Role of E-mobility

By Ms Alexandra Sdoukou, Secretary General for Energy & Mineral Resources, Hellenic Ministry of Environment and Energy

Before lockdown conditions were imposed due to CoVid-19, nobody had ever imagined that this would allow us to experience a different city and a new daily life: lower emissions, cleaner air, quiet neighborhoods. Now it's time to capitalize on this moment. We have never had a better chance to embark on a journey towards a greener world. This is why we have been working at the Ministry of Environment & Energy, in cooperation with a few other Ministries, on our e-mobility project, adopting the necessary policies that will allow e-mobility to become a reality in our country too. In order to understand how important is the switching to a new and clean way of transport, we should first mention some key statistics. Globally, the transport sector is a major source of air pollution, accounting for 30% of final energy consumption and 20% of greenhouse gas emissions.

The most severe pollution problems are found in densely populated areas due to increased traffic and "urban heat island" conditions being created at such places. In the European Union (EU-28), urban areas account for 72.5% of the population. A recent study by the World Health Organization estimates that 6.5 million people worldwide die each year from air pollution, while in our country 8,500 premature deaths are estimated to have the same route cause, annually.

In Greece, the issue of air pollution in large urban centers is alarmingly worrying, and this is mostly down to the large number of old and polluting vehicles on our roads. Passenger vehicles in particular have an average age that approaches 15.4 years. It is also worth mentioning that 50% of the private vehicle fleet is over 16 years old.

Why E-mobility?

(a) It improves the quality of life in cities, as it helps reduce the premature mortality rates due to air pollution as well as it helps reduce noise levels.

(b) It can serve as a growth pillar, attracting investments, creating added value in the economy and new jobs.

(c) Although E-mobility it is a new technology, it is progressing at a very fast pace and is gaining ground in the global market with about 7 million electric vehicles on the road. This is a result of mainly battery technology improvements and the reduction in batteries' cost by more than 5 times in the last 10 years

(d) It is a key pillar for achieving the goals of Green Deal. In 2040, the fleet of vehicles worldwide is expected to consist of 31% electric vehicles and sales to account for 58% of new passenger cars. A need for 290 million charge points worldwide is also projected by 2040, of which 12 million will have to be installed in publicly accessible areas and the rest in work, residential and commercial areas. The European sales target for 2030 is 6 million electric vehicles per year and for 2040 it is set at 10 million vehicles per year. According to a Bloomberg New Energy Finance study, e-mobility is projected to remove 17.6 million barrels per day from oil demand by 2040

(e) Despite the high upfront cost of an electric vehicle, its use is very cost effective. Just to put that in context, with 50 euros worth of fuel you can travel for about 450 km on a conventional vehicle, while you can travel for more than 2,000 km with an electric one.

Europe has set a clear path towards clean transport. In many European countries, e-mobility is now part of the daily lives of citizens. Currently, 600,000 electric vehicles are sold annually in our continent and there are about 110,000 charge point across Europe, most of which are installed in the Netherlands (27,780), Germany (12,689), the United Kingdom (11,290) and France (8,886).

Following the same trajectory, the Greek National Energy and Climate Plan (NECP) has set a target for a 30% share of electric vehicles in the total registrations of new passenger cars by 2030. Electric vehicles are expected to contribute significantly to the target set for RES penetration in the transport sector for 2030.Their full potential is expected to unfold during the period from 2030 to 2050, as depicted in the Long-Term Strategy for Energy and Climate in Greece, according to which e-mobility will help massively in decarbonizing the transport sector by 2050. Obviously, the benefits of e-mobility in terms of fossil fuel substitution and reduction of greenhouse gas (GHG) emissions will increase as the share of RES in the electricity mix rises, with the target for that being a 61-64% share by 2030 according to NECP.

1 to 3 New Vehicles Sales in 2030 will be Electric. An Ambitious but Realistic and Feasible Target.

Why setting ambitious targets?

We have to set ambitious targets when creating our strategy for the next decade. And we have to do everything we can in order to achieve them. Thus, creating a holistic set of measures and incentives to promote e-mobility is an essential step towards decarbonisation of the transport sector.

Why are these targets realistic?

The targets set in NCEP are realistic and feasible as long as a clear strategy is set toward and specific steps to achieve them are taken. This strategy is simple – kick-starting the market in the next two years, 2020 and 2021 while trying to create a critical mass that is crucial for its future development. For these two years we have set a target of 1,150 and 3,500 new electric car registrations, respectively.

How will we achieve this target?

The first step in order to achieve such EV penetration levels is the development of the necessary regulatory framework.

Creating such a complete regulatory framework is a multi-dimensional problem that required a holistic approach. This is why we - at the Ministry of Environment & Energy - worked closely with many other Ministries, public authorities as well as key stakeholders from the wider EV and energy market, in order to create the first e-mobility parliamentary bill in Greece. As far as other Ministries are concerned, the Ministry of Infrastructure & Transport, the Ministry of Economics and the Ministry of Internal Affairs played a key role in this effort. One should note that there was no existing policy or framework we could use as a starting point. Hence, we had to create everything from scratch, and that was only made possible by joining forces with anyone who could help. Just to give an example, in order to unlock the development of the necessary charging infrastructure, we had to work closely with agencies and stakeholders such as the Fire Brigade, the Hellenic Organization for Standardization (ELOT), the Central Association of Local Municipalities, the Technical Chamber of Greece, just to name a few, on many different issues related to the siting, installation, specifications and technical standards of charge points to be installed in urban environments, buildings, public sector parking areas, and this list goes on.

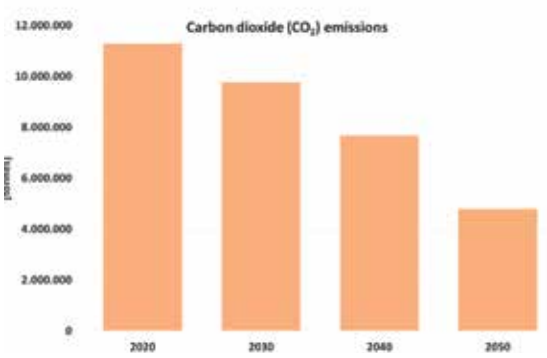
It was of course difficult to coordinate so many stakeholders involved in such a project, but this was made possible because everyone right from the start embraced electrification of transport as a strategic priority. It is worth noting here, that the promotion of e-mobility has been a top priority for the Greek government and the Prime Minister himself, something that helped unite everyone towards the same common goal.

I think that, after all these months of joint effort and tireless work, we are taking a very important first step in the right direction.

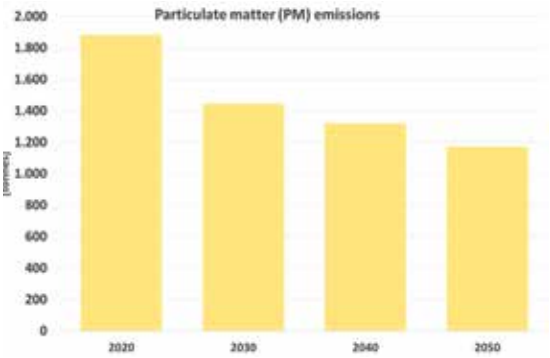
What is the impact of NECP targets to the air pollution in our cities

An impact analysis on the air pollution in Greece, using scenarios that incorporate NECP's e-mobility targets for 2030 onwards, was conducted on behalf of the Ministry of Environment and Energy. The diagrams below show the expected reduction in CO_2 emissions as well as PM emissions in 2030, 2040 and 2050 respectively, if NECP targets for the penetration of EVs are met.

This diagram illustrates how CO_2 emissions due to road transport in Greece are expected to reduce by around 13% in 2020 and by almost 60% in 2050, compared to 2020 levels



This diagram illustrates the expected reduction in PM emissions due to road transport , by more than 20% in 2030 and more than 35% in 2050, compared to 2020 levels.



E-mobility bill

The new e-mobility bill provides a complete regulatory framework for the EV market to grow in our country. The areas of focus of the bill, just to mention few of its key provisions, include:

- Making the purchase of EVs more attractive for businesses
  - Introducing tax based incentives for business that buy or lease low emission vehicles
- Organising the EV charging services market
  - Defining the role and responsibilities of the market players
- Developing the necessary charging infrastructure
  - The installation of charge points in new buildings becomes mandatory
  - Public sector buildings lead the way by installing charge points at their parking areas, soon

E-mobility brings added value to the Greek economy

We provide development incentives (tax deductions, subsidies, reduction of employer contributions, acceleration of licenses) for companies that will develop production units related to the e-mobility sector (e.g. production of batteries and/or charge points) in the lignite regions of Western Macedonia and Megalopolis, as we want to create added value to the Greek economy, by supporting the development of business activity in a new and fast-growing sector

Subsidy scheme for the purchase of EVs

Supporting the new e-mobility bill, the first subsidy scheme targeting individuals and businesses in Greece – the so called "Go Electric" - offers an eco-bonus for the purchase of any type of electric vehicles:

- Electric bicycles,
- Two-wheelers,
- Passenger cars,
- Light trucks (vans) and
- Taxis.

"Go Electric" will be open untill the end of 2021, providing subsidies of €100M during this period. The next phases of this support scheme will be in effect from 2022, while renewing the available budget thanks to resources from the greenhouse gas emission rights' fund, which is part of Ministry of Environment & Energy annual budget.

The purpose of the scheme is to support the development of a zero and low-emission vehicles market. Such vehicles offer significant environmental benefits compared to existing internal combustion engine vehicles as they have greatly improved fuel efficiency. They are still significantly more expensive than conventional ones, thus the subsidies offered by the "Go Electric" support scheme are meant to cover part of the price difference.

Amount of subsidies as well as eligible vehicle categories are illustrated in the following table, together with the type of potential beneficiaries.

Type of Vehicle	Private Individuals Eco- Bonus (up to)	Private Individuals withdrawal	TAXI Eco-Bonus (up to)	TAXI Obligated withdrawal	Business buyers Eco-Bonus (up to)	Business buyers withdrawal
L1e to L4e (bicycles,motorcycles) 20%(moto)/40% bicycle	800 €	400€ (excluding bicycles)	-	-	800 €	400€ (excluding bicycles)
M1 - 15% (taxi 25%)	5.500 €	1.000 €	8.000 €	2.500 €	5.500 €	1.000 €
N1 - 15%	-	-	-		5.500 €	1.000 €
M1 plug in hybrid up to 50g/km – 15%	-	-	5.500 €	2.500 €	-	
N1 plug in hybrid ,up to 50g/km – 15%	-	-	-	-	4.000 €	1.000 €
"Smart" charge point –home wallbox	500 €	-	-	-	-	-

* There is an upper limit on the vehicle's price set at €50.000 before taxes

All the initiatives presented in this article are just the first miles in a long journey towards greener transport and cleaner air. In order to create a clear footpath toward these goals, we are currently working on the "Greek National E-mobility Plan", which will provide the direction of travel for e-mobility.

Many European countries, such as Spain, France and the United Kingdom, have already announced their long-term plans that include big strategic commitments such as the gradual withdrawal of polluting conventional vehicles by 2040 from the market. At the same time, in many cities in Europe, measures are being taken to restrict polluting vehicles from entering city centers.

Finally, if us Fair to state, Greece cannot do anything much different but commit to similar goals. The e-mobility is here and we are at the forefront of technological advances, taking all the necessary actions and policies to help us embrace this new technology aiming towards a low-carbon economy.

Contributor

Alexandra Sdokou

Alexandra Sdoukou is a lawyer, permanent employee at the Management Organisation Unit of Development Programmes (MOU S.A.) under the Ministry of Economy and Development. Since 2004, she is working as legal advisor in the public administration in various positions at the Ministries of Economy, Development and Environment, Energy & Climate Change.

She has been specialised as energy policymaker, working with all Energy Ministers from 2007 to 2015. From 2012 to 2015, she was Head of Cabinet at the Minister of Environment, Energy & Climate Change, competent to develop policy formulation, implementation and monitoring on a wide range of energy and environmental projects. From October 2017, she was Advisor to the President of Nea Dimokratia on energy and natural resources.Alexandra holds a Bachelor of Law degree from Democritus University of Thrace, a Master's Degree LLM in European Commercial Law from the University of Bristol U.K., and a M.Sc. in International & Economic studies from the Athens University of Economics & Business.

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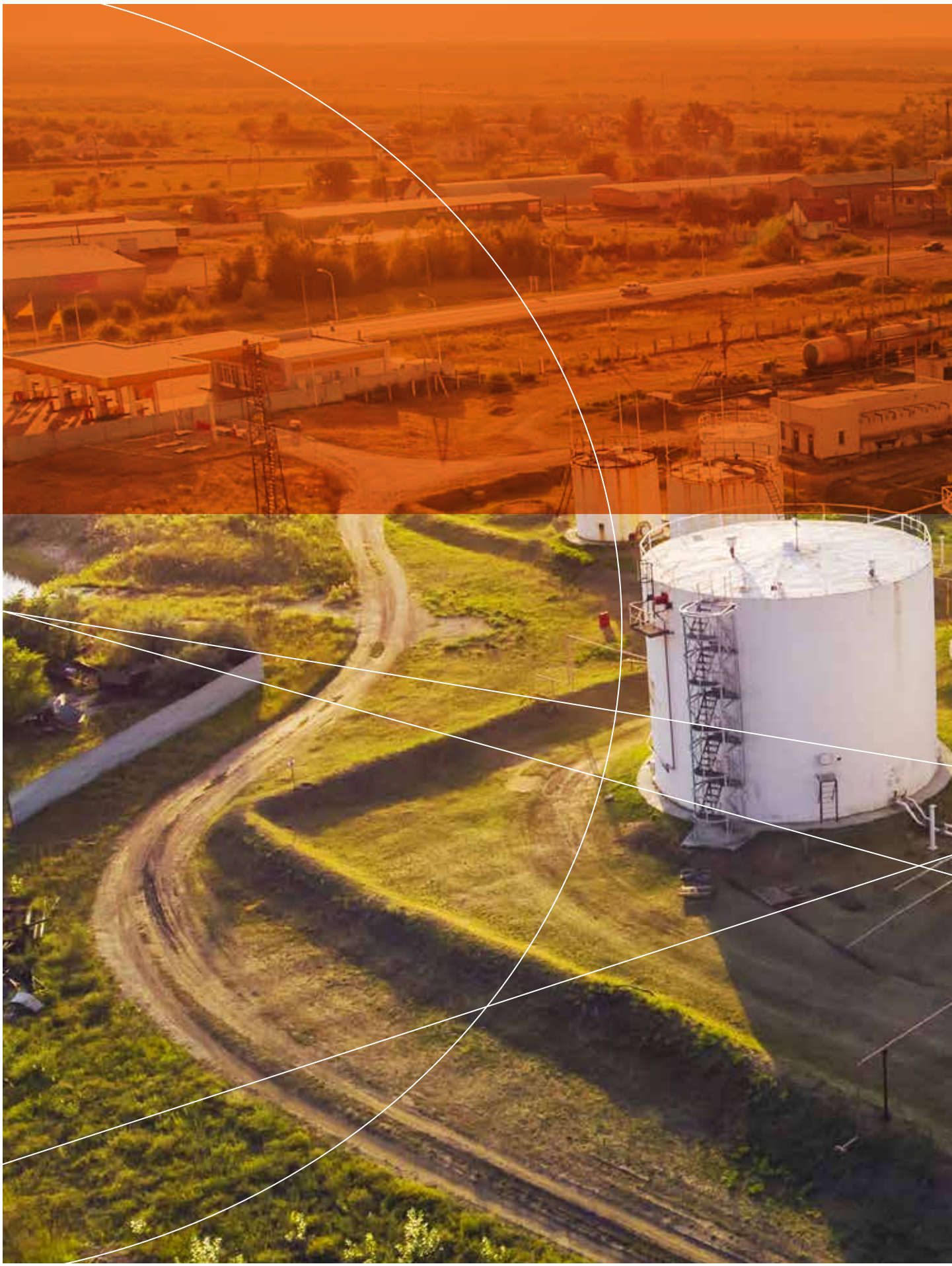


3

THE OIL SECTOR

3. The Oil Sector

New Liquid Fuels and their Role in Assuring a Cleaner Environment

By Ms. Liana Gouta, Group Director, Energy Policy & International Affairs,
Hellenic Petroleum SA

EU refining industry proposes a potential pathway to climate neutrality by 2050

The long-term target of climate neutrality by 2050, set by the European Union in **"Clean Planet for All"**, goes hand in hand with significant economic and technological challenges, that will require huge investments and involve sweeping changes in the current economic and development structure, incurring high economic and social costs for the EU member-states. A variety of technological solutions will be needed to achieve Europe's decarbonisation through a sustainable, efficient and economically viable path.

Against the backdrop of this great challenge facing Europe but also humanity as a whole, the European Refining sector has taken it upon itself to plan its transition and, in June 2020, proposed a **potential pathway to climate neutrality by 2050**. This pathway shows how, Low-Carbon Liquid Fuels can contribute to EU's climate neutrality objective, enabling **every liter of liquid fuel for road transport to be net climate neutral by 2050 and aviation and maritime transport to achieve 50% GHG emissions reductions**.

Setting the scene - The ambition of the European Union to be climate neutral by 2050

We live in an era of rapid changes as far as energy issues are concerned. The latter, we should not forget, are directly linked to climate change and the universal goals set out in the Paris Agreement. As we all know, the EU is the main champion and leader of this battle. With the Green Deal for Europe, the EU Commission President Ursula Von der Leyen declared the climate to be the first and foremost priority of the EU policy making and set the clear aim to achieve a climate neutral, decarbonized economy by the year 2050.

Aiming to turn this ambition for climate neutrality into EU legislation, she brought a proposal for a European Climate Law and is currently working to raise the ambition of the EU 2030 targets, despite the fact that they were only agreed a couple of years ago. In the meantime, all new policies by the European Commission, be it finance or food, are developed and designed around the goal of climate neutrality by 2050; the EU Industrial Strategy, the Circular Economy Action Plan, the EU Biodiversity Strategy, even the Farm-to-Fork Strategy that aims to make food systems more sustainable are shaped around this goal. One thing we can say is that, from now on, there can be no more "business as usual" in any sector of the economy.

All industries, and especially great energy consumers such as the refining, steel, cement and chemical sectors will need to make huge changes in their operating models in order to respond to the demands of our time. This creates the need to come up with new, more energy-efficient production processes that will rely on cleaner energy, new types of raw materials and new technologies. But while the EU's vision for Energy and Climate is being shaped and the principal targets and directions elaborated, the technologies and costs involved for their achievement are still far from clear.

What is certain is that a great many new technologies will have to be developed. Some of them are already at an advanced level of maturity, while others still need to pass the tests of largescale technical applicability and cost effectiveness. Multibillion investments will need to be undertaken at European and national level for the implementation of these changes, while policy makers and legislators are called upon to create an institutional and financial framework that will be supportive to the development of the required technologies.

The role of liquid fuels towards climate neutrality

According to data presented by various international bodies, such as the International Energy Agency (IEA) and the European Commission, fuel demand will continue to increase in the coming years due to rising living standards within the EU. At the same time, transport will remain the backbone of the European economy and we need to ensure our transport system remains competitive, energy-secure and affordable. Fuels will remain particularly important in the heavy-duty road transport, shipping and aviation sectors where alternatives currently do not exist or are more complex to develop at scale.

In addition, society is also demanding solutions for more energy, delivered in new and better ways for a low-carbon future, since the possibility of choosing among many options is always to the benefit of the consumer.

Regarding **road transport**, the plurality of options would entail that consumers will be able to choose the type of vehicle that best serves their needs, always within each person's economic capacity. According to the EU Consumer Survey conducted by Fuelseurope on a sample of 10,000 citizens from 10 different EU countries (including Greece), in September 2019, vehicles with internal combustion engines remain very high in the preference of EU citizens, while factors such as the vehicle's cost, autonomy and the quality of services offered, are the main criteria when buying a car. This is why LCLF will have an important role to play offering customers a choice between low-carbon technologies, delivering secure, reliable and affordable energy and ensuring that carbon neutrality is accessible to all, as LCLF will, for the foreseeable future, provide a low-cost solution compared to the alternatives.

It is certain that the introduction of low-carbon liquid fuels will mark the beginning of a new era, as it will render it possible to continue using internal combustion engines without undermining on the commitment to protect the environment. Hence, consumers will be able to use their conventional vehicle but at a much lower environmental footprint.

Collectively, we need to **create a market for LCLF**, and road transport is for now the only transport mode where this is feasible, because the sector is already heavily regulated and price signals already exist. This market will then enable the LCLF to become competitive. It is only after the completion of this first step that we can address **aviation and shipping.**

Let's look at the **example of aviation**. Currently the fuels used in aviation are almost not subject to any form of taxation. If LCLF were to be introduced now, they would not be able to compete vis-à-vis petrol-based fuels due to their higher price and the lack of strong regulation. This would have an impact on consumers as well as airlines competitiveness.

In the future, EU refineries will be able to market a special category of low carbon fuels called **Sustainable Aviation Fuels (SAF)**, in substitution to kerosene. According to Michael Gill, Aviation Environment Director of the International Air Transport Association (IATA), SAF fuels could eventually achieve an 80% emissions reduction, compared to the conventional aviation fuel, though we are still a long way from reaching that target.

To achieve something like this, economies of scale will need to develop, so that SAF fuels can provide an economically viable alternative to kerosene. IATA estimates that the above would be feasible if the total production of SAF fuels reached 7 billion liters, i.e., 2% of the total aviation fuel consumption. For that reason, the Association's primary objective is for SAF fuels to represent 2% of the total consumption by the year 2025. It should be noted that, in August 2019, Finnair's planes running on SAF fuels (14% SAF content) flew over the Atlantic, saving 32 tons of CO_2 in just 2 flights, while other companies are currently planning similar initiatives.

But it is not just aviation. Shipping, heavy duty road transport and the chemical industry, sectors that have become so central for our daily comfort, rely exclusively on liquid fuel consumption.

The refining sector's pathway towards the transition to low-carbon economy has been designed step by step: By 2050, at the latest, every liter of liquid fuel for road transport could be net climate neutral

The EU refining industry is already engaged in a low-carbon transition. The **Clean Fuels For All** proposed pathway, announced in June 2020, is sharing continuity with the Vision 2050 of the Refining Sector, the result of two years of hard work by European refineries participating in FuelsEurope, the EU-wide association. The aim of this project is to pave the way through which Refining can become part of the solution and contribute to the goals the EU has set by assuming the important share that the sector has. It is also important to note that Refining was the first industrial sector to submit a comprehensive proposal that looks ahead to the year 2050.

According to Vision 2050, EU refineries can evolve into energy hubs supplying the market with low-carbon energy solutions and products. These low carbon liquid fuels are sustainable liquid fuels of non-petroleum origin, with no or very limited CO_2 emissions during their production and use, compared to fossil-based fuels. They are currently blended with fossil fuels and their share in the fuel sold at the pump will progressively increase. The carbon intensity of the fuels will depend on the share of LCLF blended in the end-product. The enabling technology set for LCLF includes sustainable 1st Generation biofuels, hydrogenation of vegetable oils/waste and residues, Biomass-To-Liquid, advanced biofuels and e-fuels, as well as CCS and clean hydrogen applied in refineries.

The refining sector has already integrated groundbreaking technologies, such as the use of biofuels and Hydrotreated Vegetable Oils (HVO) into its production process, while in the next few years sustainable and advanced biofuels will be used more extensively. Capitalising on this technological know-how and flexible infrastructures, it will increasingly switch to new feedstock, such as biomass, renewables, waste and captured CO_2 to progressively reduce net carbon emissions of liquid hydrocarbons.

Based on the work of the Refining industry to date, the sector is ready to hit the ground running. The **Clean Fuels For All Pathway** requires an estimated €30 to €40 billion investment over the next ten years and the creation of a number of biofuel and e-fuel plants that could produce up to 30 MToe/y in 2030, with the first-of-a-kind biomass-to-liquid and e-fuel plants coming into operation no later than 2025. By 2050, availability of 150 Mtoe of LCLF would cut over 400 Mt CO_2/y. Add Carbon Capture & Storage (CCS) and the capture of emissions in biofuel production, and, in combination with electrification and hydrogen technologies, road transport reaches climate neutrality.

Many of these technologies are currently being developed in pilot projects and partnerships. However, a combination of critical technologies must be deployed in many plants across Europe to deliver LCLF at scale. These include sustainable 1st Gen eration biofuels, advanced biofuels, biomass-to-liquid, hydrogenation of vegetable oils/waste & residues, and e-fuels, to replace fossil CO_2 by biogenic or recycled CO_2, as well as CCS and green hydrogen applied in refineries, to reduce the carbon footprint of fuels manufacturing.

Moreover, fuels of this kind will be produced in refineries that have undertaken investments to reduce emissions during production. The refinery of the future will differ substantially from the one we know today, as it will be part of a greater industrial complex that will be supplying the market with low-carbon energy solutions and products.

EU reining industry 2050 potential scenario (%GHG red. vs 100% fossil)

Low-carbon liquid fuels and electrification/hydrogen in road transport will sit side by side: Their supplementary roles

Electromobility is one of the most interesting new technologies that is set to gain a lot more ground in the passenger car market. Promoting electromobility has become one of the principal objectives of policy makers at a national, European and peripheral level. The refining sector acknowledges the many advantages this technology has to offer. There are, in fact, several refining companies that have included it in their portfolios, HELLENIC PETROLEUM -the first Group that installed charging points in fuel stations- being one of them.

It is important though to remember that this technology can mainly be applied to road transport. And even there, in addition to practical matters regarding autonomy and the existence of a sufficient recharge network that need to be addressed both from a technical and from an economic point of view, several issues need to be taken into consideration: the high promotion costs associated with electromobility, part of which will have to be passed on in a fair manner; the fact that electric cars rely on the use of batteries, meaning that their proliferation could create new dependencies for raw materials used in the production of batteries; the actual environmental footprint of an electric car, based on the electricity energy mix available in each country and the type of vehicle and batteries used throughout its life cycle.

There is no doubt that all new technologies need support and a suitable framework in order to mature and have the chance to develop on a large scale. Therefore, what is most urgently required, is to allow all low-carbon technologies to play their part in protecting the environment and in transforming the road transport sector. In the same way that electromobility has been backed up both at legislative and at economic level, legislators need to actively support new low-carbon liquid fuels. Not the least since, due to their wider-ranging application that extends beyond the road transport sector, the development of new, low-carbon fuels will have a multiple effect on the economy. The introduction of these fuels will have much greater environmental benefits, having an impact also on the major sectors of aviation and shipping with their ever-increasing demand, as well as the production of chemicals. It is, therefore, expedient for legislators and policy makers to create a framework that will provide innovators with the means and the necessary "space", within which all technologies that could lead to a reduction of carbon emissions may be developed. One of the risks we are facing nowadays is to let the enthusiasm over certain technologies create distortions, by preventing other new technologies from being applied to important sectors of the economy.

LCLF in a nutshell

LCLF will smooth the deployment cost of electric energy distribution and fast charging infrastructure in road transport, by providing flexibility and alternative sources of low-carbon energy using mainly existing facilities. They will reduce the pressure and cost of achieving complete fleet turnover to ensure climate neutrality, while supporting a just transition across Europe.

Once the lead market of road transport has spearheaded the development and deployment of low-carbon technologies, the new fuels will be available for the progressive decarbonisation of aviation and shipping, enabling the groundwork for cutting up to 50% of CO_2 emissions in aviation and maritime fuels by 2050. Fuels used in aviation, shipping, heavy duty transport, and the production of chemical products -which are the basis for a great many products we use every day- will still be vital for the EU economies and societies, since no alternative technologies have been developed for these sectors so far.

The enabling framework by the EU policy makers and legislators

Low-carbon fuel technologies warrant the attention of EU policy makers and legislators, as they could provide solutions that will be applicable to the entire transport sector and not just to individual sections. The EU refining industry stands ready to step up collaboration with other industries and with EU policymakers, to take bold climate action together. The suggested pathway contributes not only to transport fuels, but also to the feedstock for the petrochemical industry. Industries such as agriculture, chemicals, forestry, waste and recycling, including many SMEs, will play an important role in building the necessary LCLF value chains and assets. At the same time, policymakers, NGOs and academia, car and truck industries, aviation and maritime, and customer groups will all have a role in developing the markets with the right definitions and parameters. Civil society at large will have to be engaged through open, transparent and fact-based dialogue.

In order to deliver climate neutral transport by 2050, it is critical that the EU policymakers establish a high-level dialogue in 2020 with all concerned stakeholders to create the necessary policy framework. The following key policy principles are central to delivering the 2050 climate –neutral ambition and should serve as a starting point for discussion:

- The creation of a market for LCLF, providing an incentive for fuels with a lower carbon footprint with respect to conventional ones. The CO_2 standards in vehicles would need to factor-in the actual CO_2 benefits provided by LCLF compared to fossil fuels.
- Support mechanisms for investors, both in terms of access to public and private funds, and of favourable fiscal treatment, as well as very low or zero taxation for low-carbon fuels, to facilitate fuel pricing that is both socially acceptable and able to make a business case for investments. This also implies that the EU taxonomy for sustainable activities must fully recognise the strategic importance of the transformation of the refining industry.
- The mitigation of investor risk through robust, stable, science-based sustainability criteria for all feedstock and processes, as well as ensuring the stability of the regulations impacting feedstock availability, demand of LCLF, and capital and operating costs.

It is expedient for legislators and policy makers to create a framework that will provide innovators with the means and the necessary "space", within which all technologies that could lead to a reduction of carbon emissions may be developed".

Refining is ready to play its part and remains open to cooperation with policy makers, the industry and the society to make Low Carbon Liquid Fuels be part of the solution. Europe, the economy and the society needs that. It is ambitious but feasible.

Contributor

Liana Gouta

Liana Gouta is the Group Director of Energy Policy & International Affairs at HELLENIC PETROLEUM Group of Companies, and alternate Board member of the European Petroleum Refiners Association, with many years of ample experience in several Managerial positions in the petrochemical industry, such as Energy Policy, Change Management, Operations & Process Design, Product Development, Industrial Safety, Health and Environment and Quality Management. Chairwoman of Downstream Committee at IENE, Institute of Energy for South - East Europe. Also worked as a Parliamentary Advisor in European Parliament, on Industry, Energy, Environment & Regional Development (2005-2007). Invited by the US State Department (2009), to represent Greece in the "International Visitor Leadership Programme" (IVLP), as one of 10 Environmental Policy makers in EU on "Development of Green Technologies and Policies in the post-Carbon Age". Socially engaged in Women Empowerment and President of Women Managers & Entrepreneurs-Macedonia Section of Hellenic Management Association (2011-2017). Awarded by the Google Developers Group and the Women Techmakers Greece (global Google's initiative) for her support and contribution to have more Women in Technology. Honored to be selected as one of the "Women Changing Greece" presented in the mini-documentary series of the US Embassy Athens and Huffington Post on the occasion of International Women's Day (2017), as part of the US State Department's global campaign #BeBoldForChange. Served as President of Constantinos Karamanlis Institute for Democracy-Northern Greece Branch. Speaker in numerous conferences with more than 300 articles and interviews in media (TV, radio, newspapers) on Energy, Environment, Growth & Competitiveness, Entrepreneurship, Women Empowerment. She holds a Chemical Engineering Degree with Honors (valedictorian), while she had many academic distinctions during her studies. Married, mother of two children.

Delivering the Energy Transition in the COVID-19 Era

By Mathios Rigas, Energean Group CEO

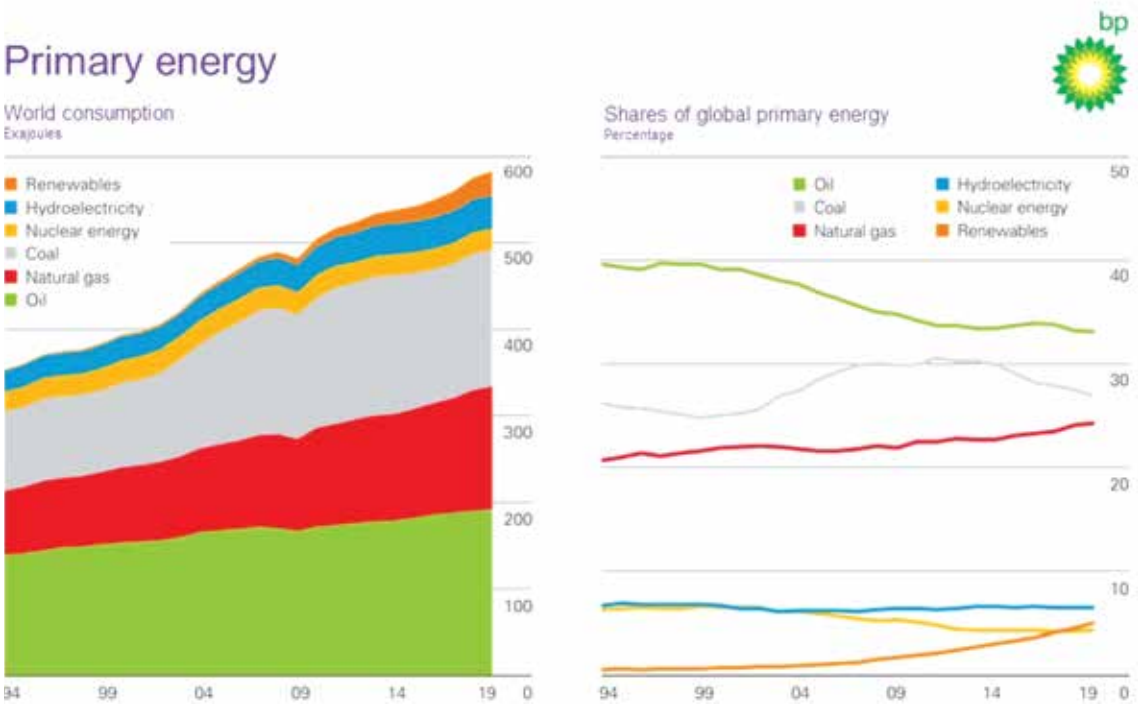
The global economy is learning to live with the COVID-19 virus and tries to defeat it with the necessary vaccinations. New trends dominate supply and demand of products and new rules apply in terms of their transportation, as well as on people's communication, work, travelling and planning. No single unified way of dealing with the crisis has been identified while governments dealt with the first wave, as states have used totally different approaches.

But what seems to be clear is that the second wave was handled almost in an identical manner: no general lockdowns but only partial interfeences and localised measures, as governments are frightened that their economies would not stand another complete shutdown in activities and an even more dramatic recession would hit everyone in such an eventuality.

The pandemic has already had substantial impact on energy consumption. The International Energy Agency estimates predicts that the latter fell by 4% in 2020, that is the largest decline since World War II and the largest ever absolute decline Global energy demand is set to increase by 4.6% in 2021, more than offsetting the 2020 contraction, while demand for all fossil fuels is set to grow significantly. Coal demand alone is projected to increase by 60% more than all renewables combined, underpinning a rise in emissions of almost 5%, while global oil demand is set to remain around 3% below 2019 levels, despite an expected annual increase of 6.2% in 2021. Natural gas demand is set to grow by 3.2% in 2021, propelled by increasing demand in Asia, the Middle East and the Russian Federation, while renewables, the only energy source that grew in 2020, is set to increase across all key sectors – power, heating, industry and transport – in 2021. The power sector leads the way, with its demand for renewables on course to expand by more than 8% .

The dominant role of natural gas

There is no doubt that there is a significant change in consumption trends, but still the bigger picture remains the same: fossil fuels will be dominating primary energy demand and consumption for the foreseeable future, as their impact remained quite high in 2019 compared with renewables:



Source: BP Review 2020

According to BP's Statistical Review of World Energy 2020, oil accounted for more than 33% of the total primary energy consumption in 2019, coal for 27% and natural gas more than 24%, an old time high, showing the bigget increase among fossil fuels. Despite the fact that renewables counted for more than 40% of the total increase in 2019 energy consumption, they still supply only 5% of global primary energy consumption, with hydro and nuclear providing the remaining 6.4% and n 4.3% respectively.

Thus, fossil fuels will maintain their dominant role in the market, while natural gas has emerged as the leading energy source driving the energy transition. The main purpose of any energy policy should be to secure sufficient, affordable and clean energy for the economies as a whole and each consumer individually.

At Energean, we decided to focus on gas since 2016, with the acquisition of the Karish and Tanin reservoirs, in offshore Israel. In addition, the acquisition of Edison E&P perfectly aligns with Energean's strategy. The enlarged group has an operational presence in nine countries and becomes one of the largest E&P companies in the Mediterranean with over 1 billion boe of 2P reserves and 2C resources, of which more than 70% is gas Indeed, this focus on gas will help deliver the energy transition, for example in Israel through the phasing out of coal, and conserve the wonderful and environmentally sensitive area that we live in.

Our commitment to becoming net zero emitters by 2050

We are immensely proud of the fact that Energean was the first independent E&P company globally to commit to becoming a net zero emitter by 2050. As part of this commitment, we are running an ambitious but realistic carbon intensity reduction plan in the context of which, in 2020, we managed to decrease carbon emissions intensity by 67% compared with 2019. Our goal is to decrease scope 1 and 2 emissions on a kg CO_2/boe basis by 85% by 2023, that is to reduce carbon emissions intensity to approximately 9.5 kg/boe by 2023, which is approximately half the current global average for the oil and gas industry.

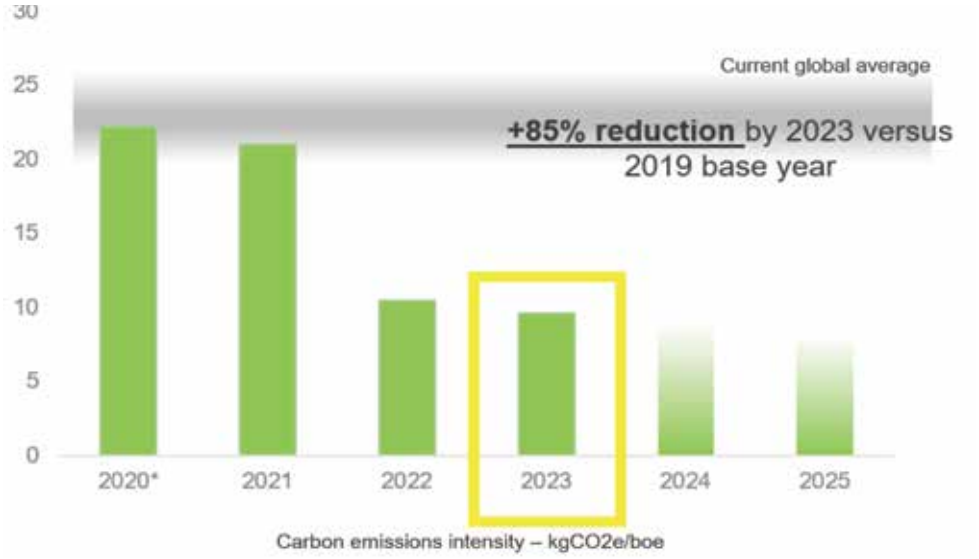
It should be noted that we have already agreed with Greece's PPC to purchase for the Prinos asset electricity that is generated 100% by renewables. This agreement has driven a 100% reduction in the asset's Scope 2 carbon emissions and an approximate 45% reduction of Scope 1 & 2. Similar agreements are already in place for our operational bases in Israel and Croatia.

We remain fully committed to our net zero target and in 2021 we will roll out three initiatives across all of our operated sites:

i) switching to purchasing "green" electricity;

ii) introduce a zero routine-flaring policy; and iii) establish procedures to reduce methane emissions.

Energean's Plan to Reduce Emissions · Rolling Three-year Emissions Target



We are also engaged in the Carbon Disclosure Project (CDP) in 2020. Submission resulted in a B rating, putting Energean among the best performing third of companies within the sector. We are also a proud signatory of The United Nations' Global Compact, the world's largest voluntary CSR initiative, and are fully committed to transparency and adherence to the UN's Sustainable Development Goals. In addition to this, I have recently signed Prince Charles' "Terra Carta", an initiative of sustainable development that encourages cities to become more involved in greater sustainability and biodiversity and strive for a lower carbon footprint, and is pursued by the Prince's Trust organisation. I have also signed a letter to the British Prime Minister, along with 150 leaders from public life, business and civil society organisations in the UK, calling on the British government to structure its COVID-19 recovery around the UN Sustainable Development Goals (SDGs) to which is Energean is fully committed.

As a result of the decline in the energy consumption, global energy-related CO_2 emissions fell by more than 6% in 2020, reaching their lowest level since 2010. The expected increase in energy consumption for 2021 underpins a rise in emissions of almost 5%, or 1 500 Mt. This expected increase would reverse 80% of the drop in 2020, with emissions ending up just 1.2% (or 400 Mt) below 2019 emissions levels. This development should not put at risk the sustainable future and the target of limiting global temperature rise to 1.5oC above pre-industrial levels.

Gas will ensure that the path to a sustainable future will not be at stake and that the economies of the world will have sufficient and affordable energy at their disposal.

Eastern Mediterranean: the “new North Sea”

The Eastern Mediterranean has become an industry hotspot, having witnessed several world-class natural gas discoveries in recent years which attracted the majors and leading independent E&P players alike. Over 60 Tcf of gas has been discovered offshore Cyprus, Egypt and Israel, and we are confident that there are more discoveries to be made. With all this gas, the region can definitely play a significant part in the diversification of gas supply sources to Europe. Thus, we consider it really important that the necessary infrastructure is built to allow for the transportation of gas from the Eastern Mediterranean to southern Europe.

Energean is currently investing more than $2 billion in the Mediterranean, in the gas developments of the Karish and Karish North fields, offshore israel, and the NEA/NI fields, offshore Egypt.The Karish Development is approximately 90% in terms of infrastructure completed physically. “Energean Power” will be the first FPSO to operate in the region. The FPSO will have a capacity of 8 Bcm/year and will enable us to commercialize the fields and any future discoveries in a fast and economic manner.

We have already signed firm agreements to sell 7.4 BCM per year to IPPs and large industrial consumers in Israel.

The “Energean Power” FPSO at the Admiralty Yard in Singapore

Moreover, we participate in the East Med Gas Forum, the establishment of which aims to enhance competitiveness, optimize infrastructure and harmonise regulation, whilst building a sustainable, cost-efficient energy market that will actively benefit the economies and populations of the Eastern Mediterranean.

We strongly believe that the oil & gas sector can substantially contribute to the recovery of the economies in the Mediterranean in the post COVID-19 era. Countries such as Greece should also side with ‘upstream producers’, not just energy ‘importers’, for the benefit of their economies, especially in the post COVID-19 era. It is not reasonable, due to environmental concerns, to ban exploration, development and production when neighbouring countries keep exploring, developing, and producing. The reasonable thing to do is to take advantage of the opportunities that natural resources provide you with, as well as being present in all decision making processes from an operational perspective to ensure that the strictest HSE rules are followed.

Our committment; exploring and developing resources, decreasing environmental footprint

We remain committed to exploring and developing the natural resources of any countries we operate in. In that context, we have launched a Business Plan to rescue Prinos, Greece's sole hydrocarbon producing asset, which has been dramatically hit by the pandemic and secure its future by achieving carbon neutrality.

Recently, the European Commission approved a 100-million euros state aid support for the rescue of Prinos. The support will take the form of (i) a public guarantee on a commercial loan of around €90.5 million to be contracted by Energean and (ii) a subordinated loan amounting to €9.5 million by the Greek State. The proceedings will be used mainly for the completion of the development of the Epsilon field, while technical interventions to increase production in Prinos will also be implemented. Our Business Plan does not only aim at ensuring that the operations will remain alive, but also guaranteeing that the activities in the Gulf of Kavala will continue by becoming greener and by rationalizing their operating costs, so that they will not be hugely influenced by volatility oil prices in the future.

Moreover, we have submitted to the Greek Government a plan to turn Prinos into Greece's first Carbon Storage Plant. This investment which will be followed by the production of clean blue hydrogen that will help Greece and the industries in the country to significantly reduce their environmental footprint. We also participate in the ongoing tender launched by the Hellenic Republic Asset Development Fund for an Underground Gas Storage Project in Northern Greece that the Greek government is planning to build. It is worth noting that Energean was the first company to propose the implementation of this project ten years ago.

A new era of growth

In the last three years, Energean has achieved impressive growth, evolving from an oil producer in Greece to the largest Independent E&P company in FTSE 250 in the London Stock Exchange, The Energean IPO was the biggest on the London Stock Exchange in 2018 and was the first flotation of an oil and gas producer on London's main market since January 2017. The Company raised $460 million from the listing, which, along with a $1.4 billion credit facility agreement was used towards the development of the Karish and Tanin fields, offshore Israel. We completed the Edison E&P acquisition and made the sole commercial gas discovery in the Eastern Mediterranean – namely, the Karish North Field. We successfully drilled three development wells in the Karish field, we have also drilled three development wells in the Epsilon field, which offer hope for the survival of Prinos.

Even more importantly, we have maintained our excellent HSE track record by achieving 12 million man-hours with no Lost Time Injuries in the construction of the FPSO, completing two years with no Lost Time Injuries in the drilling campaign in Israel as well as on all Energean sites in Greece, and by having blue flags awarded to the beaches of Prinos and Hof Ha Carmel in Israel, which are adjacent to our operations.

The future seems to be even brighter. Regardlless of the problems that Prinos is facing, following the completion of the acquisition of Edison E&P around 70% of our production will be sold under long-term gas sales agreements that will safeguard our future revenues against oil price volatility. We will continue to own and operate the majority of our asset base, and are well-funded for all of our projects: earlier this year, our subsidiary, Energean Israel Finance Ltd. successfully completed a $2.5 billion bond issuance at extremely attractive rates, significantly extending the average maturity-profile of our debt. We now own 100% of Energean Israel that owns the Israeli fields, we have sanctioned the Karish North and the NEA/Ni gas developments offshore Israel and Egypt respectively.

Our 2021 working interest production expected to be 36.0 - 41.0 kboepd. The Karish field is expected to come on stream in mid-2022, while in the same year we will commence our 1 billion boe growth programme in Israel. We have set medium-term production target of over 200,000 boe/d. and we will evaluate any opportunities that offer sustainable growth both for our shareholders and our stakeholders. Energean has proven that success is guaranteed where there is vision, values and effective, flexible and realistic strategy, as well as knowledge of the particularities of the regions you operate in and a sincere relationship and coordination with local communities.

In a nutshell, Energean is described by the word ETHOS that identifies the set of beliefs, ideas and values about the social behavior and relationships of a person or group. Our values are underscored by our corporate principles, which are the following:

- Being ethical and responsible
- Being transparent and accountable
- Creating an attractive workplace and being an employer of choice
- Mitigating environmental impacts and minimising our footprint
- Supporting local communities

This is our day-to-day ETHOS, our guide in the years to come.

Contributor

Mathios Rigas

Mathios Rigas is a founding shareholder of Energean. He is a Petroleum Engineer with a combination of oil & gas and investment banking experience. He has been the CEO of the Group since 2007 and has led Energean to successful listings on the London Stock Exchange and the Tel Aviv Stock Exchange, and a couple of transformational deals, namely the acquisition of the Karish and Tanin fields, offshore Israel, in 2016, and the acquisition of Edison E&P in 2019. Under his leadership, Energean has been able to secure $3bn financing for its projects and become the first E&P company in the world ever to commit to becoming a net zero emitter by 2050. Being a leader of a rapidly growing E&P group, Mr. Rigas won the 'Executive of the Year' at the Oil and Gas Council's Awards of Excellence in 2018. Prior to setting up Energean, Mr. Rigas spent 18 years in investment banking and private equity investments in oil & gas, project finance and shipping (Capital Connect Value Partners, Piraeus Bank's Shipping Investment Banking division). As Vice President of Shipping, Energy & Project Finance at Chase Manhattan Bank in London (1993-1999), Mr. Rigas arranged financing in excess of US$5 billion, mainly in the oil & gas sector. He holds a Degree in Mining and Metallurgical Engineering from the National Technical University of Athens and an MSc / DIC Degree in Petroleum Engineering from Imperial College.

Opportunities and Challenges in Greece's Hydrocarbon Sector

By Aristofanis Stefatos, CEO of Hellenic Hydrocarbon Resources Management S.A. (HHRM S.A.)

Exploration history in a nutshell

Evidence of working hydrocarbon systems in Greece date back to the 4th century BC, when the historian Herodotus wrote about the presence of oil seeps on Zakynthos Island, Western Greece, as well as in Carthage (in present-day Tunisia), and mentioned oil extraction from wells in Arderrica (in present-day Iran). During the course of the 20th century, various efforts resulted in the temporal exploitation of the asphalt field in Zakynthos, and the discovery of the Prinos field complex in 1973, followed by the oil and gas discovery of Katakolon in 1981 and the minor gas discovery in Epanomi in 1987. As of today, about 430 mmboe have been discovered in 6 offshore fields (Prinos, Prinos North, South Kavala, Epsilon, Katakolon and Epanomi). All fields and discoveries lie within a short distance from the shoreline and five (5) out of the six (6), including the biggest field (Prinos with STOIPP of 291 mmbbls), lie in the North Aegean Sea.

At first glance the results may not be representative of an exciting prosperous hydrocarbon province, however, upon closer look these results are easily explained as the consequence of unsystematic and incomplete efforts, all interrupted and inconclusive due to various reasons. The most focused and systematic exploration efforts, conducted by international companies holding concession rights, took place in the 1970's and early 1980's in the north Aegean. From a technical point of view, these efforts can be considered successful since they proved commercial volumes of oil and gas and significant additional potential along the northern shorelines of Greece in the Aegean Sea. However, despite the positive results, most of the area has remained unexploited for almost 40 years, due to tensions with neighboring Turkey.

Between the 1980's and 2002, the efforts focused mainly in the Axios basin (onshore Thermaikos gulf) and along the west coast. The minor gas discovery in Epanomi (circa 17Bcf), proved a working hydrocarbon system along the onshore eastern flanks of Thermaikos gulf. Other onshore wells were not successful, but offshore wells were not drilled to test the remaining basin highs and the area remains underexplored. The minor oil and gas discovery (c. 40-50 mmboe in place) a couple of kilometers offshore Katakolon, proved a working system for both oil and gas.

The discovery lies across the Zakynthos straights on the other side of the Keri asphalt field. Six (6) exploration wildcats were drilled onshore in 2000 and 2002, with 5 of them discovering traces of oil and gas. It is worth noting that the two wells in Etoloakarnania and the two wells in NW Peloponnese encountered multiple levels with oil and gas traces. A seventh well planned to be drilled offshore in the west Patraikos gulf was never spudded but the same target has been revisited and is expected to be drilled in 2023 (W. Patraikos concession). The 2002 exploration efforts were then interrupted as a consequence of three events, the low oil prices at the time, the acquisition of one of the operators and the privatization through the stock listing of the Greek state oil company (Hellenic Petroleum).

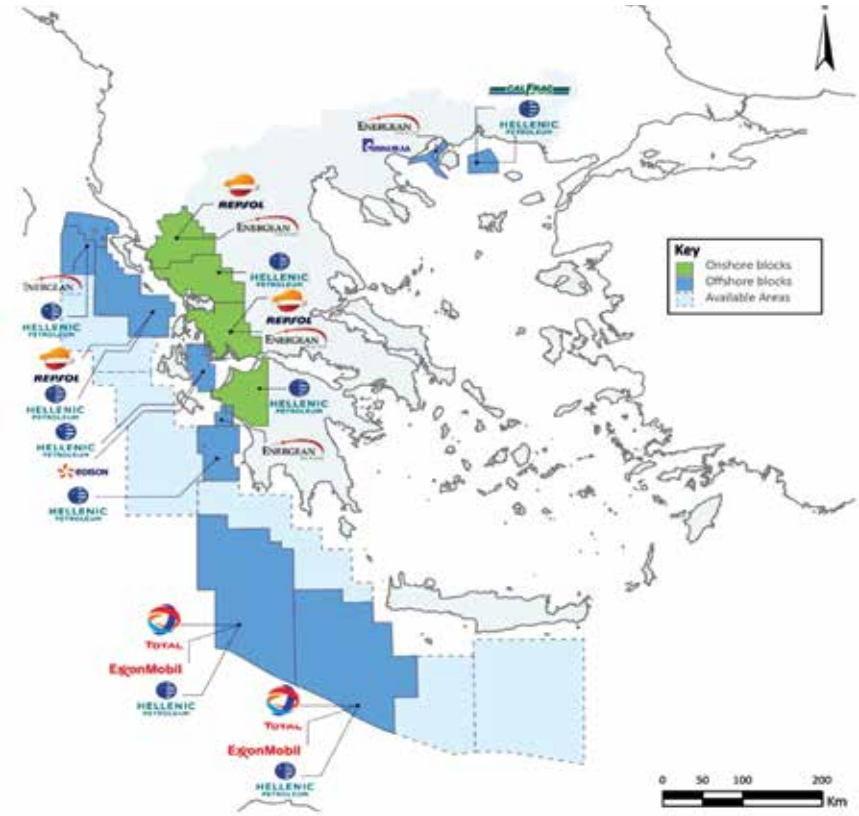
The revival of exploration

The ongoing and most recent exploration phase in Greece started in 2007 with the enactment of Law 3587/2007 by which the Greek State revoked all concessions to DEP/DEP-EKY/HELPE, and transferred the relevant competence to the State. The legal framework (Law 2289/95) was modernized with the enactment of Law 4001/2011 (Chapter B) and a relatively attractive business environment was established. In this context, the Ministry of Environment and Energy (then YPEKA, now YPEN) proceeded to an International Public Invitation to participate in multiclient seismic campaigns within the maritime zones in Western and Southern Greece. After the seismic survey was completed by PGS in 2012, an international tender was announced for the concession of twenty (20) offshore plots in Western Greece (Ionian) and south of Crete. YPEKA also proceeded to the direct concession by the Greek State of its rights for exploration and exploitation of hydrocarbons through the process of "open invitation" (open door) in three areas for which concession contracts were finally drawn up: Patraikos gulf, Ioannina and West Katakolo.

Law 4001/2011 (Chapter B) provided for the establishment of the "Hellenic Hydrocarbon Resources Management Company SA (HHRM SA)" which was established by Presidential Decree 14 (ΦΕΚ 21/13.02.2012). In addition, the Ministry of Environment and Energy (then YPEKA) in 2014 announced an International Tender (upon request) for the land areas "Arta - Preveza", "Etoloakarnania" and "Northwestern Peloponnese". The International Tender was completed successfully with all areas been awarded. The following year, HHRM SA, launched an international licensing round for the offshore blocks along the west coast and all the way to south of Crete. Two concessions agreements were established for "Block 2" northwest of the island of Corfu along the maritime boundary with Italy and for "Block 10" in Kyparisiakos gulf, offshore west Peloponnese. Two years later through an expression of interest process, 2 consortiums including major IOC's and NOC's, applied, and eventually got awarded three additional blocks. The "Ionian block" in the central Ionian sea and the "West of Crete" and "South West of Crete" blocks.

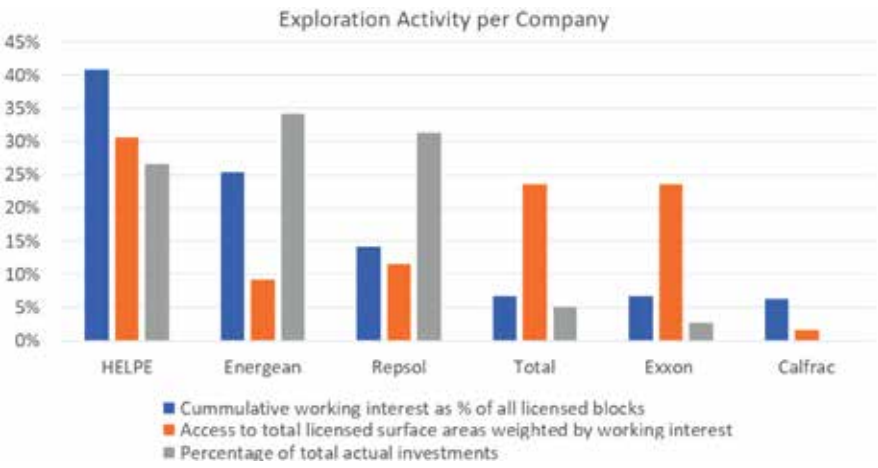
Currently, there are 9 offshore and 4 onshore concessions, with 6 participating E&P companies operating in Greece (Figure 1). One concession is in the Production stage (the Prinos field complex) and one more is in the Development/Exploitation stage (the Katakolon oil and gas discovery), whereas all other areas are in the Exploration stage. Energean is the only operator, with a 100% working interest in both production and development concessions in Greece. Without taking into consideration the production concession of Prinos, Hellenic Petroleum (HELPE), a partially state-owned company, has the greatest share of concession licenses awarded. HELPE exceed a cumulative 40% share of all awarded blocks and, similarly, it has the highest access to total licensed surface areas (surface area access weighted by working interest).

Figure 1 • Map of Greece with all concession blocks as per January 2021



Up to year-end 2020, Repsol was the company that had invested the most while operating two onshore and one offshore block along western Greece. With the acquisition of Edison completed by end 2020, Energean became the operator with the highest upstream investments in the country and the 2nd biggest owner of working interest shares. However, contrary to its high working interest share, Energean ranks after Total and Exxon with regard to its access to total surface area. This is due to both Total and Exxon having a significant working interest in the blocks to the West and South West of Crete. These two deep water offshore blocks extend over 20 000 km^2 each and constitute some of the most promising exploitation provinces in Greece. Preliminary estimations based on a very sparse seismic grid have indicated the presence of structures with a size potential of several Tcf's of gas. In the area, a combination of carbonate and clastic plays is thought to be working and despite the lack of drilling data from this area, the availability of mud volcanoes and samples taken over them, suggest that hydrocarbons have been generated and are present in this area.

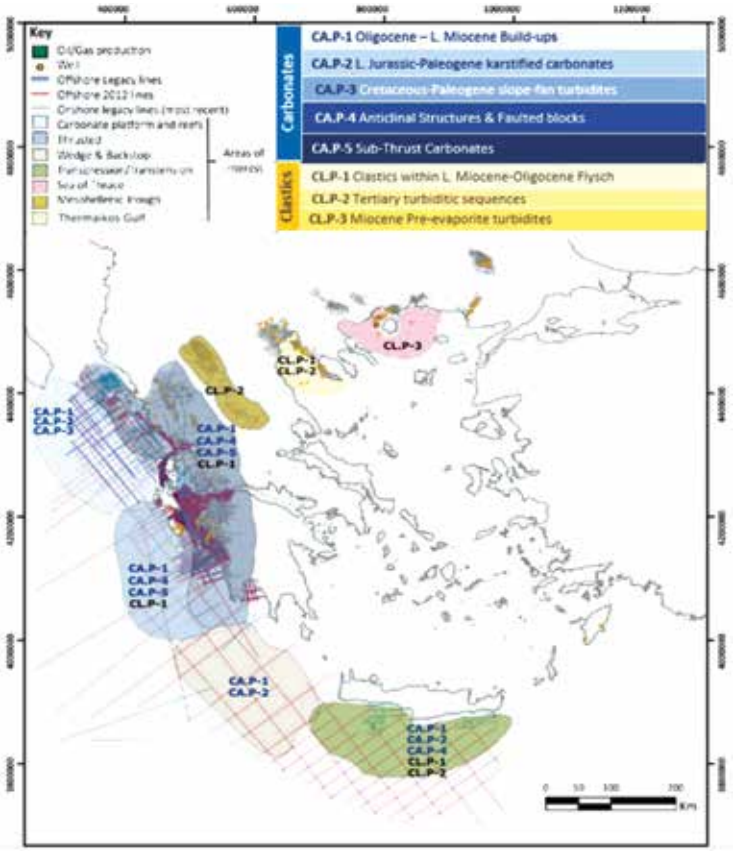
Figure 2 • Active E&P companies in Greece, and the distribution of exploration market share



In the map of figure 3, we present seven (7) geological provinces, and the corresponding hydrocarbon plays we anticipate being present. Five plays are within the carbonates and include Oligocene to late Miocene reefs, Jurassic and Paleogene age karstified carbonate rocks, Cretaceous to Paleogene slope-fan calciturbidites as well as anticlines, faulted blocks and sub-thrust carbonate rocks. The clastic plays on the other hand comprise late Miocene to Oligocene age flysch deposits, tertiary turbiditic sequences and pre-evaporitic turbidites of Miocene age.

The Hellenic Hydrocarbon Resource Management (HHRM SA) has compiled a data archive that includes 12500 km of 2D multiclient seismic data, acquired in 2012 and reprocessed to PSDM in 2018 by PGS. In addition, it includes legacy 2D seismic data, comprising 9000 km of reprocessed and 13000 km of conditioned data. Although certain areas are well covered by dense grids of 2D seismic, it is worth noting that at least along the offshore west coast and the west & southwest of Crete area, the available 3D seismic data covers a mere 1.2% of the total licensed area of around 55 000 km^2. This very sparse seismic coverage (corresponding to limited imaging coverage of the subsurface) allows speculations regarding the actual number and size of the tentative traps and thus the true potential of the area. HHRM, is currently evaluating possibilities for new data acquisition and will explore any plausible scenario for promoting the area.

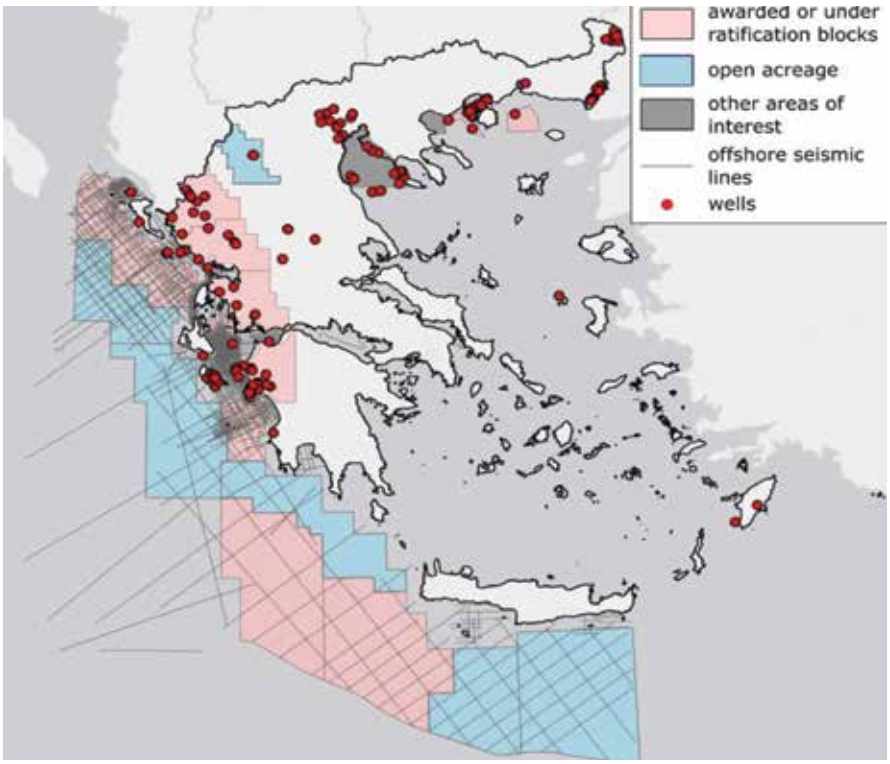
Figure 3 • Map of Greece with the distribution of expected hydrocarbon plays and seismic line coverage across the country



Besides the seismic data, HHRM has been building an archive of drilling information and well core data. Today, there is a partially complete record of about 165 wells (see figure 3), which, besides the dedicated wild cat drillings, also includes shallow boreholes and other test wells. We consider very interesting the fact that despite the record being incomplete and including wells most likely not related to organized exploration drilling, 106 out of the 165 wells (64%) have hydrocarbon shows and discoveries. It should also be noted that some wells appear to be drilled at the end over even outside of 2D seismic grids and that there are occasions with dry well clusters over areas without discoveries or shows, while at the same time areas with shows do not have additional wells drilled.

There are three ways for a company to engage in the exploration of new acreage in Greece. These are through (a) announced tendering rounds, (b) open-door process and (c) expression of interest. The open-door process for already announced blocks is the most expedient way, however, the expression of interest is also an attractive alternative since it is also quite expedient and allows for the interested party to define the area. Areas available for open door applications are illustrated in the map of figure 4. Namely, these areas include the western sector of the Ionian Sea, the blocks south of Crete and the Grevena onshore block to the north.

Figure 4 • Map of Greece, illustrating active leased blocks and open areas. Red dots mark the location of the wells database



An exceptional safety record

For more than 40 years of exploration and production activities, Greece has enjoyed an exceptional track record of zero major accidents and environmental incidents. In 2016, the 2013/30/EU Directive for the safety of offshore hydrocarbons operations was transposed into the Greek legislation by Law 4409/2016, which appointed HHRM S.A. as the Competent National Authority. Today, National and European safety frameworks are fully implemented and HHRM in close cooperation with the operators in Greece, ensure that the best practices of the industry are constantly adopted. Following the vision of strengthening regional cooperation in key sectors such as offshore safety, HHRM has launched an initiative to organize the Mediterranean Offshore Authorities Forum (MOAF), with the participation of the competent authorities for offshore safety from EU Mediterranean countries (Croatia, Cyprus, Greece, Italy, Malta, Spain and Portugal). Through such and other initiatives, HHRM aims to encourage continuous improvement in the safety and the reduction of the environmental footprint of offshore oil & gas operations in the Mediterranean region.

Importance of infrastructure

Due to its geography, Greece is a natural energy corridor, that bridges the East Mediterranean significant gas reserves with the Balkans and the European energy markets. The importance of Greece as an energy hub is further manifested not only by the major investment plan for the East Med pipeline but also by the significant infrastructure in place and under development. Besides the refining capacity delivered through the 4 refining units, and the Revithousa LNG terminal, the

country is expanding its internal gas network while emblematic cross border projects like the TAP pipeline have just become operational. In addition, the Greece – Bulgaria pipeline interconnection is progressing fast while the sanctioning of the Alexandroupolis FSRU terminal, establishes a new focal point for the delivery and distribution of LNG to the north of the country.

As the country proceeds with its ambitious plan to completely phase out coal by 2028, we anticipate the growth of the gas market in parallel with the renewable energy sources and the need for Carbon Capture and Storage projects that will progressively become more and more relevant. This is because even though Greece has the privilege to a significant potential for renewable energy sources (RES), the associated high costs demand a balancing act with the growth of the very price competitive gas market, while recent investments on coal fired plants cannot be easily written off. The gas market in Greece is currently depending solely on imports. It is thus our opinion that as we move forward, the social pressure to explore and develop our untapped gas potential will continue to grow. Furthermore, considering that Greece is a peninsular country with an archipelago of about 3000 islands, and famous for its strong winds, we also expect that a particular RES that will flourish is the floating offshore wind farms.

On the eve of the energy transition, Greece offers a combination of opportunities for complimentary energy projects that can deliver low CO_2 emissions and economic robustness. Being situated in a geographically critical area and having an untapped hydrocarbon potential, significant infrastructure, and complimentary low CO_2 emission projects creates an investment opportunity that cannot be overlooked. Our challenge will be to ensure that we deliver on an efficient and timely manner to our society's needs.

A few words about HHRM

Hellenic Hydrocarbon Resources Management S.A. (HHRM S.A.) was established in 2011 (L.4001/2011 Chapter B). HHRM manages with consistency, transparency, and flexibility on behalf of the Greek State its exclusive rights on prospecting, exploration and exploitation of hydrocarbons, in compliance with the European and national legislation. For further information please visit the website page http://www.greekhydrocarbons.gr.

Contributor

Aristofanis (Aris) Stefatos

Aristofanis (Aris) Stefatos is the Managing Director of the Hellenic Hydrocarbon Management Company (HHRM SA). He holds a PhD in geology & geophysics, a master's degree in Environmental Oceanography and a bachelors in Geology. For the last 15 years he has held senior and top management positions in private E&P companies in Norway and has been a founding partner of four Norwegian companies within the broader E&P sector. Through his 24 years of work experience, Mr. Stefatos has also worked with the technical maturation of exploration prospects and drilling. He has worked in geological basins in Europe, North America, Indian ocean, West Coast of Africa, and South East Asia. He has a proven track record of 5 oil and gas discoveries in the Norwegian and the Barents Sea. In 2019, he received the honor of serving as the honorary consul of Greece in Bergen.

Review of Upstream Developments in SE Europe and in the South East Mediterranean

By Dr. Yannis Bassias, Energy Consultant and former President and CEO of HHRM

Introduction

The dynamics of the global energy environment in the foreseeable future are largely based on natural gas while these are supported by the current drive of alternative energy sources. Consequently, a significant increase in the production of gas is expected, and this will act as a key driver in the international energy market over the next five to ten years. Exports and imports of oil and gas across the world continued to fuel market growth during 2018-2020 and most countries in SE Europe and the East Mediterranean continued their efforts to develop their significant potential. It is estimated that global oil demand by 2026 will rise to 104 MMbbl/d and natural gas will continue to expand its share across major markets.

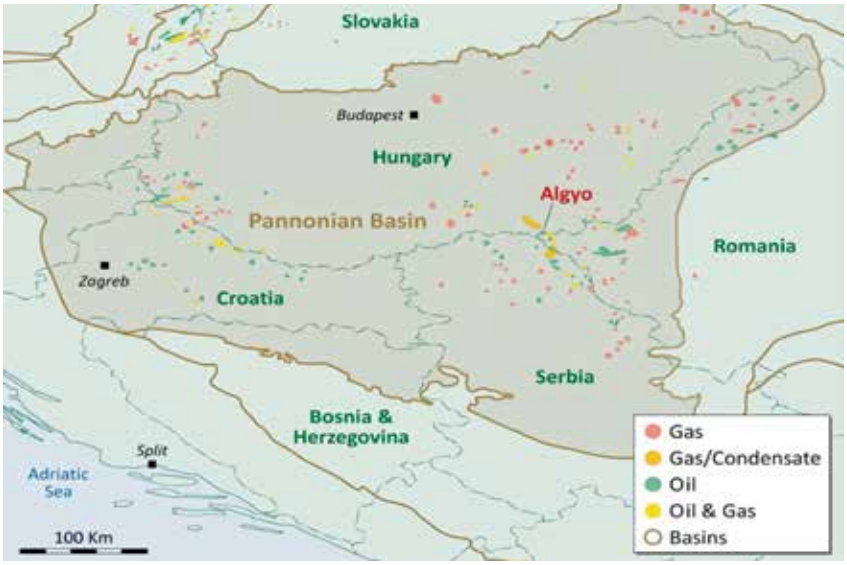
With the 2020 pandemic the oil and gas industries are undergoing even more rapid transformation across the world. Oil and gas companies will need to expand their production to meet emerging demand in the years ahead. The innovations brought by new technologies allowed unconventional drilling to enhance production and new business models and services have evolved rapidly contributing to the cost reduction of operations. Exploration of underwater gas deposits and energy developments are now interconnected and most future scenarios are sea based. Although the pandemic has hit hard the economy with the downsizing of exploration budgets, the shift to renewable energies and renegotiation of deals will support global demand for hydrocarbons in the coming years. Several large producers including Exxon Mobil, ConocoPhillips, BP, Royal Dutch Shell . and Total embraced market-based policies in order to limit emissions (1).

According to the IEA (2), gas will continue to act as a bridge fuel to energy sources for decades, unless major technological advances take hold and real alternatives emerge somehow. In that sense, exploration and production of gas fields in SEE and the East Mediterranean are expected to provide an opportunity for the companies working in the oil and gas midstream industry as more pipeline and storage infrastructure will be required. Within this complex environment a number of drilling campaigns were undertaken in 2019-20 focusing mostly on proven core basins and on few frontier unproven basins around the world. In 2021/2022 hotspots will include basins in Mexico, Brazil, US Gulf of Mexico and the Middle East. However, mature provinces in Angola, Gabon, the UK North Sea and Egypt still have very significant potential, and newcomers Namibia and Suriname may surprise (3). The Levant basins host two major gas targets in Zeus, offshore in Israel and Block 9-1, offshore in Lebanon.

The Adriatic and the Dinarides

Over the last two years SEE countries on average were more than 60% dependent on oil and gas imports for covering their energy needs. According to the Balkans and Black Sea Association (2019), Romania and Croatia decreased their crude production while Albania, Hungary and Turkey increased theirs. Refinery throughputs were up by 11%, excluding Bosnia and Herzegovina and Serbia. Gas production decreased by 3% in Croatia, Romania, Serbia, Hungary, Turkey and Ukraine. On the other hand, gas demand decreased overall by 5% but with rising consumption in Croatia, Greece, Georgia and Hungary and a decrease in Bulgaria, North Macedonia, Romania, Serbia, Turkey and Ukraine. Five gas pipelines are under construction or in the design phase. Croatia, Hungary and Romania launched new tenders for onshore exploration blocks. Croatia, Boznia-Herzegovina, Montenegro and Albania, in the eastern part of the Adriatic, have over the past years, through licensing rounds, granted onshore concession and offshore areas for hydrocarbon research and exploitation while deep water exploration activities continued outside the Adriatic and the Dinarides mostly in the EastMed and the Black Sea (4,5). The technical exploration success rate in the eastern European Pannonian Basin over the last three years (4) (Fig. 1) ranged between 83% and 94%, while the commercial oil and gas success rate was at least 50%. The Pannonian Basin stretches over Bosnia, Croatia, Slovenia, Austria, Hungary, Slovakia, Ukraine, Romania and Serbia with a multitude of jurisdictions even if most countries are EU members (7). Formal licensing rounds in Bosnia and Herzegovina and Romania offered blocks in the Pannonian Basin in 2020, following Croatia's success in 2019. In addition to former state players such as MOL, INA, NAFTA and NIS, just four oil companies have operated exploration wells in the Pannonian Basin recently. ADX, Aspect, Serinus and Vermilion, all of whom have had success, mostly in finding gas deposits. They have built a portfolio of assets across Croatia, Hungary and Slovakia, taking advantage of underinvestment in the Pannonian Basin and the opportunity to apply modern technology at low cost.

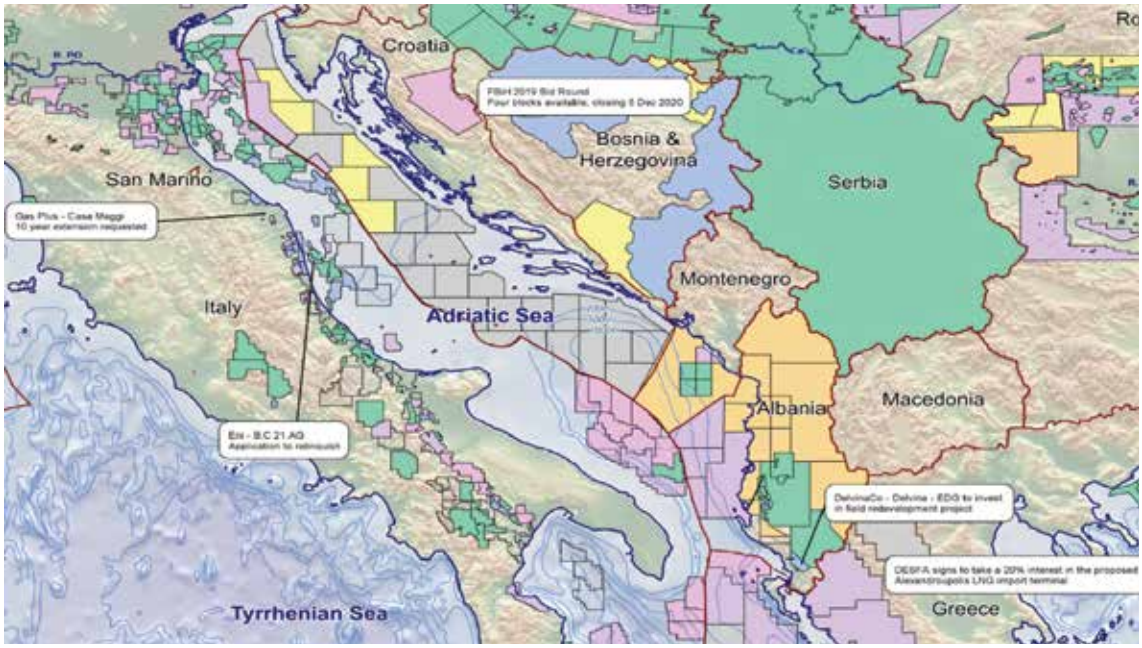
Figure 1 • Discoveries in the eastern European Pannonian Basin



Source: Croatian Hydrocarbon Agency, 2020 (5)

Reported flow rates are in the range 1.4–17.2 MMcfgpd with a typical individual pool size being modest at 20 Bcf. Reservoir depths average 2,200m and drilling costs are relatively low. The key to success seems to be the application of modern techniques, in particular 3D seismic hunting for DHI's, across a multiplicity of reservoir targets in a structured basin where the risk on hydrocarbon source and migration is low. In 2006 the US Geological Survey estimated a mean Yet-To-Find of 1.1 Bboe for the basin, with an upside of 2.2 Bboe. Croatia, Montenegro and Albania have proven petroleum systems offshore while Croatia and Albania have production in shallow water depths. The water depths of the concessions in the Adriatic Sea are for Croatia mostly less than 300m and for Montenegro between 50 and 250m (7) (Fig. 2). Croatia had also gone ahead in 2014-2015 to award tenders for some of these regions, but the sudden drop in the price of led to withdrawals by the industry.

Figure 2 • The Adriatic Sea (from Enverus Asset Evaluator, November 2020) (7).



The Eastern Mediterranean

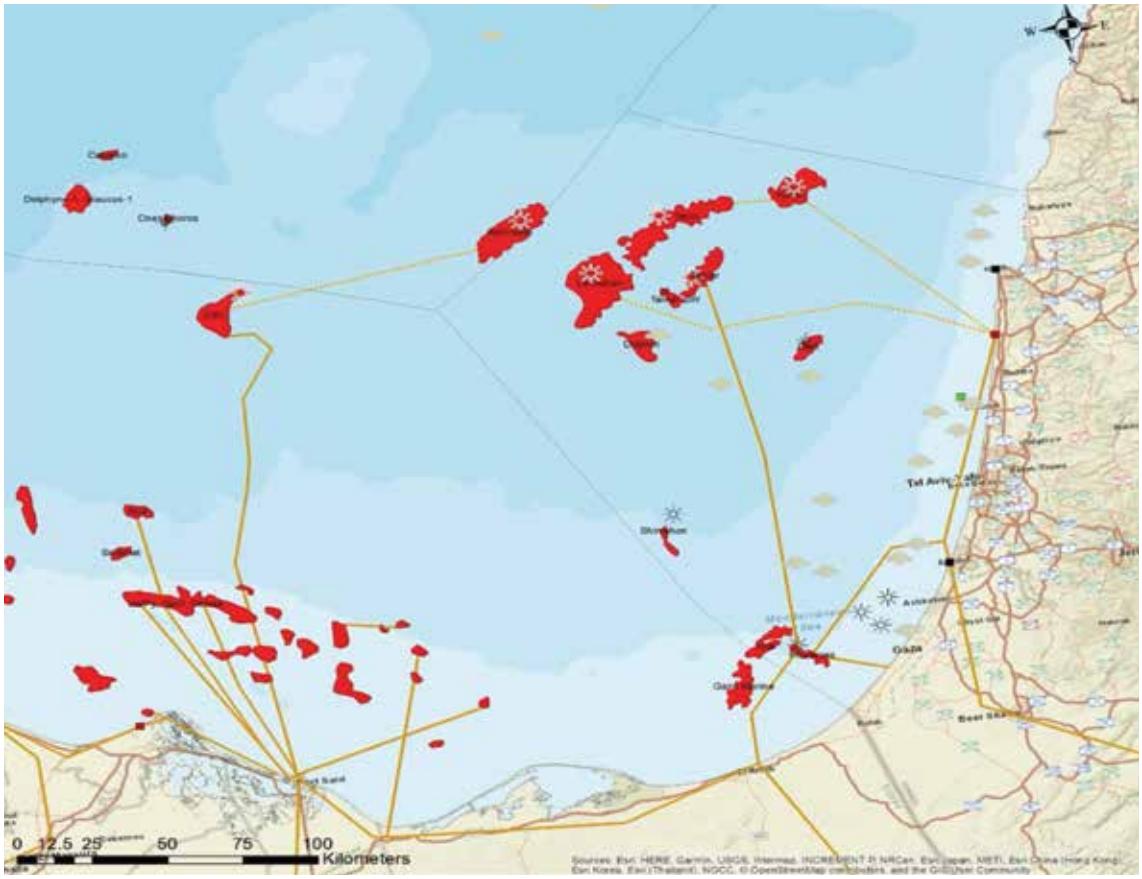
The Eastern Mediterranean has lately become a center for exploration, production and transport of hydrocarbons. The total gas reserves discovered over the last decade in Egypt, Israel and Cyprus are estimated at 80 TCF (trillion cubic feet) with two dominating large producing fields, Zohr in Egypt (30 TCF) and Leviathan in Israel (22 TCF) (Fig. 3). While investment in exploration and production (upstream) continued, the industry remained cautious of the large investments needed to develop and transport hydrocarbons (midstream) because the total current exploitable volumes of natural gas in the Mediterranean are not yet sufficient to support long-term investments. As a result, more discoveries are needed to support large midstream investments.

After certifying the commerciality of these two fields, in the case of Zohr (Egypt), natural gas started flowing to Egypt in just two and a half years after the discovery. Similarly, the Tamar (Israel) sends gas through an undersea pipeline to Israeli land based facilities. The recent development plans for the production and transmission of gas from the Karis and Tanin, Aphrodite, Kalypso and Glafkos reservoirs could in the coming years be linked to facilities in Egypt, Cyprus or to major pipelines under consideration such as the East Med one (8). Similarly, the discovery of maritime Gaza in coastal Palestine is on standby, while Lebanon proceeded in 2020 with its first offshore exploratory drilling. Average water depths of the explored areas in the eastern regions of the Mediterranean vary from 1200 to 1500 meters, up to 2000 meters in the western part of the Black Sea and much deeper, up to 3000 meters in the southern Ionian and south of Crete (Fig. 4). This has significant technical and economic implications for the exploration and production of hydrocarbons in Greece and neighbouring offshore Libya and Turkey.

By the end of 2020, almost all countries in the Eastern Mediterranean and the Adriatic had or were planning to have FSRU facilities, while in the case of Egypt we have two fully operational liquefaction plants which produce and export LNG.

Needless to say, there will soon be an overconcentration of facilities. In order to re-gasify the liquified gas it needs to arrive by vessel from nearby or remote areas outside the Mediterranean where most liquefaction plants operate. It is estimated that world investment in all types of LNG facilities over the next ten years would be close to $1 trillion. But the decline in consumption and the recession affected many ongoing or planned construction projects. It will be difficult to figure out which way the scale will tilt in two years, i.e., LNG facilities or additional offshore pipelines in the South-East Mediterranean. Furthermore, the development of SSLNG (Small Scale Liquified Natural Gas) technology may add a new parameter.

Figure 3 • The Eastern Mediterranean exploration, production and transport of hydrocarbons in 2019 (8)



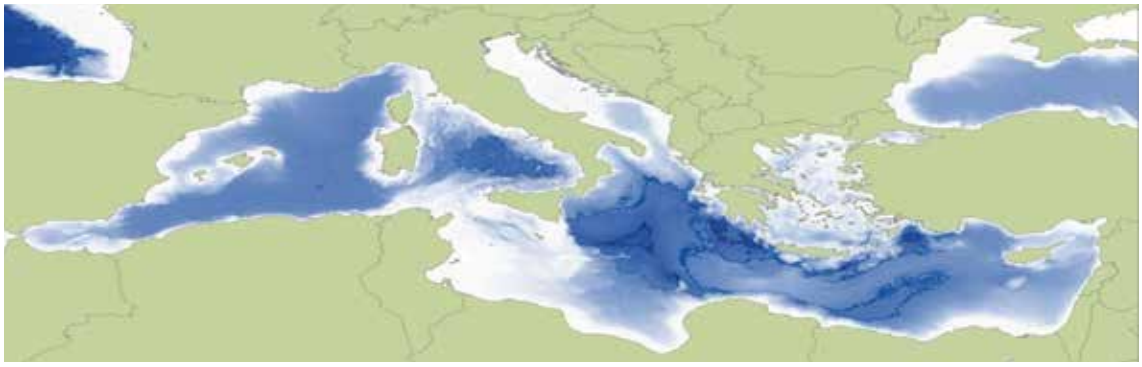
Clouds=oil and gas shows/dry wells
Small stars= sub commercial discoveries
Dashed brawn lines= possible pipelines
LNGgreen spots= FSRU
Large stars= commercial discoveries
Red stars= over 2 TCF of gas red spots=
Bold brawn lines= gas pipelines

A major project in the region, the East Med Pipeline, which will link the East Mediterranean to Europe via the East Med and Italy would cost over EUR 7 billion or more while the financing of new liquefaction LNG terminals in the Mediterranean would cost around EUR 3 billion (9). Both methods are costly if we were to make the existing volumes of natural gas discovered in the Southern Mediterranean globally competitive. Alternatively, the existing liquefaction facilities in Egypt will continue to operate, and they are competitive and sufficient to realistically absorb much of the available natural gas produced in the region.

However, most of the new gas to be produced in Egypt over the next years, will primarily serve the needs of its fast-expanding domestic market, while the extra gas volumes to be produced in Israel will be mostly destined for export. In Cyprus, the structures of Glafkos, with an estimated 5-8 TCF of gas in deep rocks below 2,000 meters of water, the 4.5 TCF of "Aphrodite" and the 6 TCF of the "Calypso", are three discoveries of roughly similar size that do not meet the economic criteria for managers to proceed with production and transport (Middle East Petroleum and Economic Publications, 2019, Upstream Oil and Gas, March 2019).

In the case of the Aphrodite field a decision was lately taken to transport its gas directly to one of the two liquefaction plants in Egypt. At this stage and in view of the great uncertainty in the decision-making process, decisions have to be made based on a 90% success probability, - rather than a 50% probability which until recently was the norm - which greatly reduces the chances of commercial utilization in the immediate future (10).

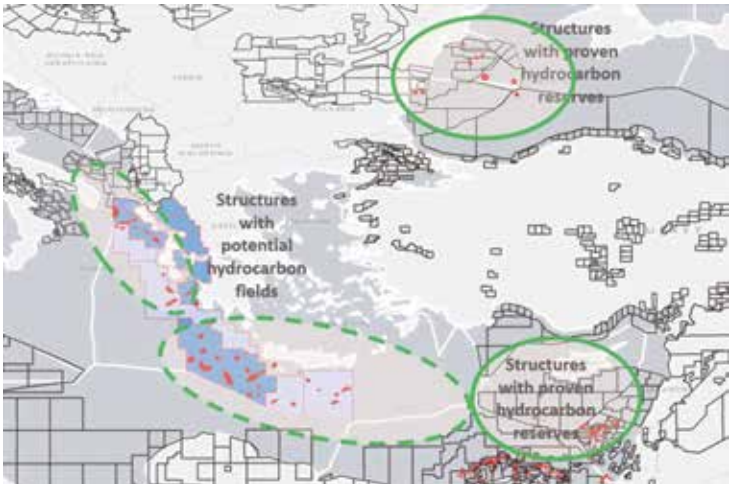
Figure 4 • Average water depths in the eastern regions of the Mediterranean



Average water depths in the eastern regions of the Mediterranean vary from 1200 to 1500 meters, up to 2000 meters in the Black Sea and much deeper, up to 3600 meters in the southern Ionian and south of Crete. Simplified from "Morpho-bathymetric synthesis of the Mediterranean Sea, CIESM and IFREMER, 2012".

Looking at the long term, besides natural gas and possibly oil deep beneath the bottom of the Southeastern Mediterranean, mud volcanoes and hydrates are present on the sea bottom due to the release of methane or due to its retention in the ice of the surface layers of the sea bottom. All three types of gas presence, presently exploited with deep drilling, will be of interest to the industry for the next 30-40 years. In the case of Greece, within the next decade renewable energy sources will most likely cover on average a 40% share at power generation and hydrocarbons, especially gas, will play a key role in the energy transition as is the case with the continued imports of liquefied natural gas. Over the next decade these imports will increase from 6 to 10 BCM per year to balance the phasing out of lignite, the reduction in oil use and the low efficiency of renewable sources. As Greece is likely to be the common gas recipient from future production but still struggles to make important strides in its deep-water exploration acreage (Fig. 5), Turkey, Israel and Egypt will vie for dominance in supplying an ever-richer gas mix to the European markets. Egypt is emerging as a regional gas regulator importing and exporting gas with infrastructure and demand developing constantly. On the other hand, reversing gas through the Askhelon-El-Arish line from Israel to Egypt could be the first step to large gas volume sales through new pipelines in the future. At the same time Israel, Greece and Cyprus have agreed (they signed an official intergovernmental agreement on January 2, 2020) to work together in developing and ultimately building EastMed gas pipeline to run from Israel to Greece, via Cyprus, eventually landing in the south part of Italy (3).

Figure 5 • The estimated gas resources

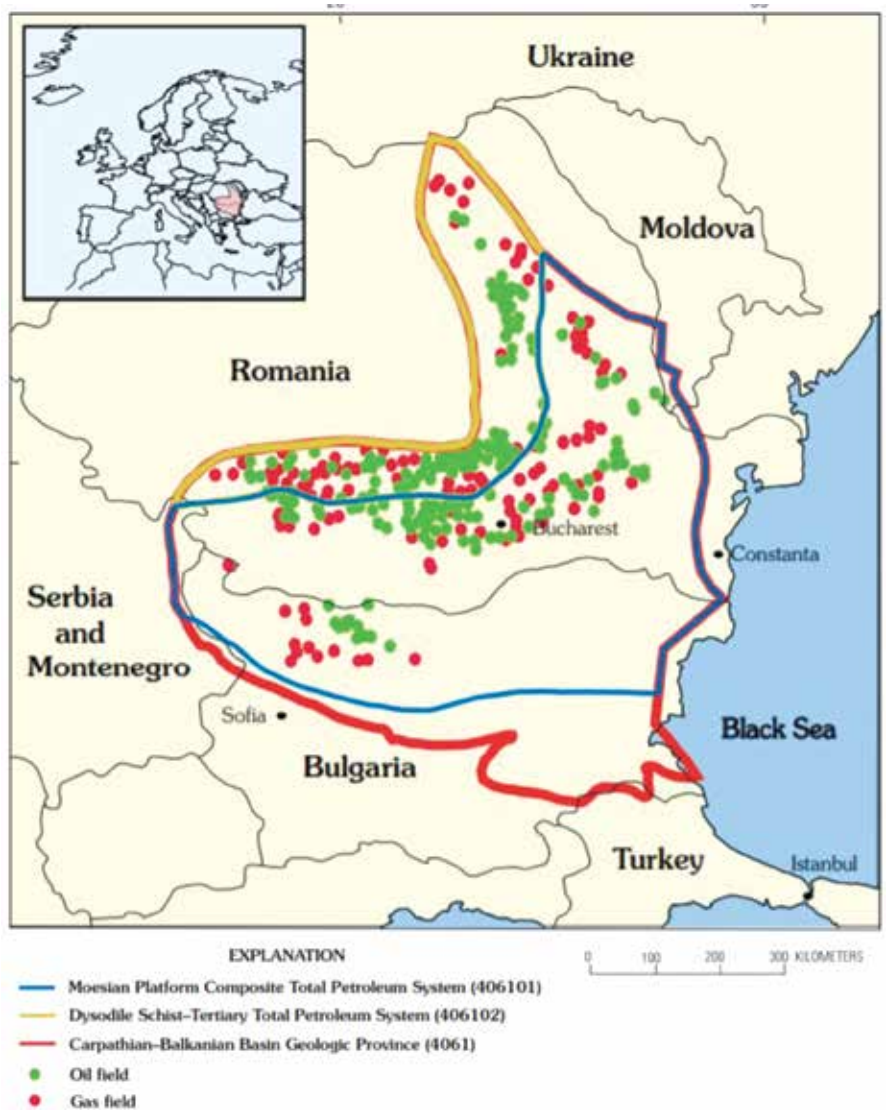


The estimated gas resources from 30 potential leads west, southwest and south of Crete and from the Ionian Sea are between 70 and 90 TCF (12 to 15 Bboe). This may increase the potential of gas reserves in the Southeast Mediterranean and push the edge of the future gas province further west (10).

Eastern Balkans

The Carpathian–Balkanian Basin Province lies in northern Bulgaria and southern and eastern Romania (11) (Fig.6). The western and northern parts of the province are dominated by a series of extensive nappes that form much of the Carpathian Mountains chain, whereas the eastern and southern parts are characterized by a relatively stable structural platform containing several intraplatform basins. Petroleum is produced mainly in these northern and western parts. On the basis of known petroleum volumes (amount produced to date plus remaining reserves), the Carpathian–Balkanian province has a total of 5.9 billion barrels of oil, 7.3 trillion cubic feet of gas, and 100 million barrels of natural gas liquids, for a total of 7.2 barrels or oil equivalent (11).

Figure 6 • Carpathian–Balkanian Basin Province (4061)

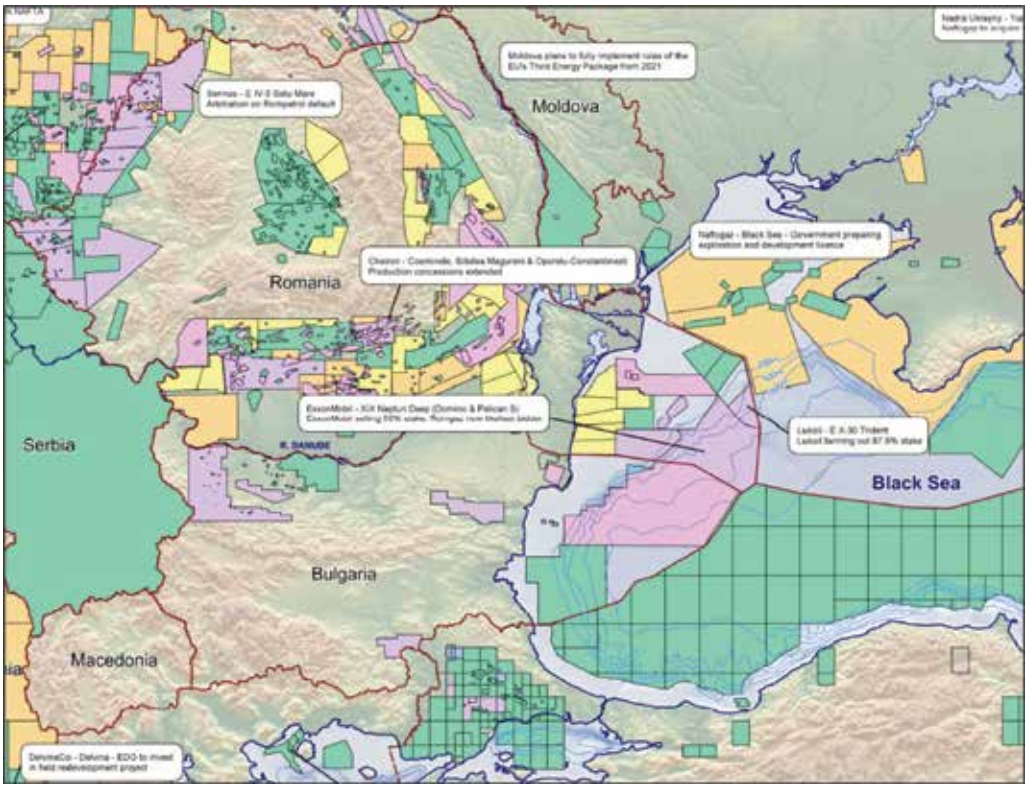


Carpathian–Balkanian Basin Province (4061), Romania and Bulgaria, showing boundaries of the Moesian Platform Composite Total Petroleum System and the Dysodile Schist–Tertiary Total Petroleum System and locations of oil and gas fields (Source: USGS Bulletin 2204–F) (11)

Western Black Sea

As exploration and development in the Northwest Europe region continues to recede, oil companies are pushing the search for oil and gas into regions that previously had not been considered as promising and today attract offshore oil and gas exploration and development activities. The Black Sea remains one of the largest underexplored rift basins (Fig.7) in the world and there are still controversies concerning the regional geology. Success will ultimately depend on the better understanding of several geological uncertainties such as the timing of basin formation, uplift of the margins, and of facies distribution. These are key factors for the understanding of reservoir, the source rock presence, the quality and the timing of migration of hydrocarbons relative to trap formation. The Black Sea basin, has renewed interest from global new, with new fields being developed and major pipelines being installed.

Figure 7 • Eastern Balkans and Western Black Sea acreage



From Enverus Asset Evaluator, November 2020) (12)

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Contributor

Yannis Bassias

Dr Yannis Basssias has 30 years of experience in the international oil and gas exploration. From 2016 to 2020, he was the President & CEO of HHRM (Hellenic Hydrocarbon Resources Management), the state company managing and supervising the oil & gas exploration and production projects in Greece. From 2012 to 2016, he advised several companies in EEZs of the Indian Ocean, Equatorial America and West Africa on geological and legal aspects of frontier hydrocarbon basins. From 1997 to 2012, as president of Georex group, when he demerged the exploration assets from the service activities and established technical subsidiaries in France, United Kingdom, Tunisia and the Republic of Congo. Managed database projects on CIS reservoirs, data mergers for Total, PetroFina and Elf, seismic data transcription for Snpc and Esso. Between 1996 and 2000 he directed evaluation teams for the development of oil and gas interests in Texas and Colombia. Before joining the petroleum industry, Mr. Bassias had an academic career at the Free University of Berlin and was also Associate Professor in the National Museum of Natural History in Paris.

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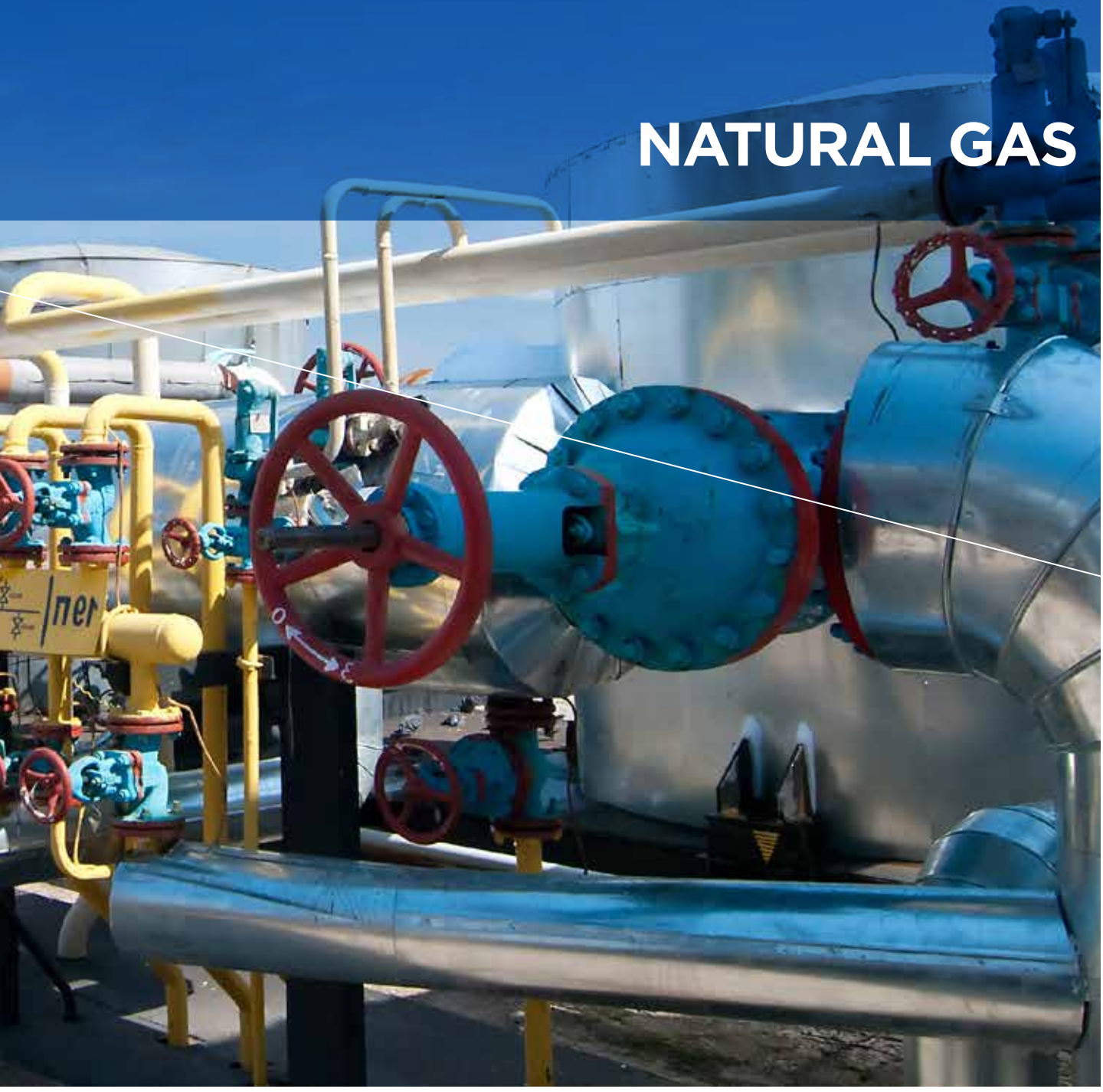
NATURAL GAS



4. Natural Gas

DEPA Establishes its Leading Position in the Greek Energy Market

By Konstantinos Xifaras, Chief Executive Officer, DEPA COMMERCIAL S.A.

The energy sector is facing significant challenges, both in Greece and in Europe. Market liberalization facilitates the penetration of new players and puts more pressure on companies to reduce their costs and diversify their products in order to cope with the new, increasingly competitive environment.

At the same time, the climate crisis is putting pressure on states to accelerate their pace towards energy transition. The European Green Agreement has already laid the foundations for a climate-neutral Europe by 2050, while in Greece the new National Energy and Climate Plan brings forward lignite phase-out and raises the targets for renewable energy production.

Besides, the geopolitical instability in our region makes it imperative to build new infrastructure that will diversify energy sources and supply routes and offer safe transport of natural gas from the rich deposits of the Eastern Mediterranean to European markets.

In this highly volatile environment, DEPA has successfully completed its transformation into a modern integrated energy company, while ensuring workplace peace. At the same time, it has improved its competitiveness by promoting a flexible organizational structure capable of keeping up with developments in the industry, while at the same time being able to always meet the increasing market demands through continuous upgrading the skills of its manpower.

Furthermore, the company enters into flexible outsourcing partnerships that allow the diversification of its products and services, the expansion of its retail activities and of its international commercial presence, through targeted sales in the markets of Southeast Europe.

In the same spirit, DEPA expands the use of natural gas by deploying Small Scale LNG smart technologies and promotes the use of LNG as a marine fuel in the Eastern Mediterranean by building an innovative carrier vessel that will supply the ports of the wider region. Moreover, through its nationwide network of CNG service stations (FISIKON), DEPA makes the environmentally friendly and cheaper gas fueled transportation accessible by more consumers in more regions of the country.

Thus, DEPA not only endured the pressures of the COVID-19 pandemic, but also managed to increase its market share, reduce prices and return tens of millions of euros to its customers, thanks to the successful renegotiation of its long-term supply contracts with foreign energy giants.

Looking forward, the company's business plan involves the implementation of substantial investments in wind and solar energy, with the objective to create a "green" portfolio of more than 200 MW and invests in promising alternative energy sources, such as hydrogen. DEPA is a founding member of the European Alliance for Clean Hydrogen which is working on attracting investments in hydrogen and fuel cell technologies and is also taking initiatives to create the first hydrogen refueling plant in our country.

Concurrently, the company is enhancing its involvement in major international projects that strengthen Greece's energy security and transform it into a natural gas hub throughout SE Europe. DEPA has assumed a leading role in the development of the EastMed pipeline that will transport gas from the Levantine fields to European markets, as well as in the new LNG FSRU Terminal in Alexandroupolis - one of the largest energy infrastructures implemented in our country in recent decades, with a budget of more than €370 million which will distribute natural gas from all over the world, thus contributing decisively to the security of energy supply, not only of Greece, but also of Europe.

These two major projects will operate in full synergy with the Greece-Bulgaria Natural Gas Interconnector (IGB), now under constraction, another pipeline of strategic importance whose development DEPA accelerates both in the Greek and the Bulgarian sections.

Summing up, by taking initiative on all fronts, DEPA has maintained its leading position in the Greek energy market, through the improvement of its operations and expansion of its activities, while developing the infrastructure that will guarantee the energy security of our country and upgrade its geopolitical position.

Contributor

Konstantinos Xifaras

Konstantinos Xifaras is the Chief Executive Officer of DEPA COMMERCIAL S.A. and has extended experience as a researcher and business consultant, as well as in leadership positions, in both private and public sector organizations. In September 2019, he was appointed Chief Executive Officer of DEPA at a crucial turning point for the company in view of the privatization process and the corporate transformation. Following that, the renegotiation of all supply contracts was implemented and DEPA evolved into an integrated energy company, whilst implementing critical decisions and serving its strategic role in the energy landscape of the wider region of Southeastern Europe and the East Mediterranean. He is a graduate of the Department of Production Engineering and Management of the Technical University of Crete (TUC) and is specialized in Operational Research. Today, Mr. Xifaras is the Vice Chairman of the Technical Chamber of Greece, the Secretary of the Greek National Committee in the World Energy Council (WEC), as well as the Greek National Representative in the WEC. He is one of the 18 Co-Chairs of the European Clean Hydrogen Alliance and member of the Governing Board of Eurogas.

Challenges and Prospects in the Global LNG Industry: The Growing Role of LNG in SE Europe's Gas Supplies

By Spyros Paleoyannis, Founder and Managing Partner at MEDGAS & MORE SERVICES Ltd and former CEO of DEPA SA

Introduction

2020 will be remembered as the year of the great reversals and big surprises in the energy sector and not only. First, because of the fast spreading of the COVID-19 pandemic worldwide which caused a catastrophic disorder in the socioeconomic life and created an unsafe environment, full of uncertainty and inconvenience. These unprecedented conditions drastically affected and radically change the pattern of daily life, work, travel, consuming, entertaining etc. etc. as well as the way of doing business.

Second, because of the deeper awareness of the risks connected to climate change, which led to the need to accelerate the energy transition process. It is now widely understood that we cannot continue consuming more than one and a half of what our planet can regenerate and consequently, the transition towards a low carbon economy must happen the soonest possible. The fundamental questions however are: which is the best way to achieve the 2050 carbon neutral targets? Which are the best policies and practices in relation to the appropriate energy mix, so that to secure a smooth transition? and finally, how to achieve not only the targets but also the lowest bearable energy transition costs?

Under such challenging circumstances, the entire energy sector, including the gas/LNG industry and market, was seriously affected from both the pandemic and the energy transition progress: The pandemic halted gas and LNG demand globally for many months in 2020 (not affecting however the path of change and transformation in the market), and at the same time, the gas/LNG industry fully realized (perhaps for the first time), that the exact role of gas and LNG during the energy transition is still unspecified, but certainly this process will inevitably lead to a non-negligible reduction of demand (not knowing for the time being however, the range, the starting time and the path of such reduction).

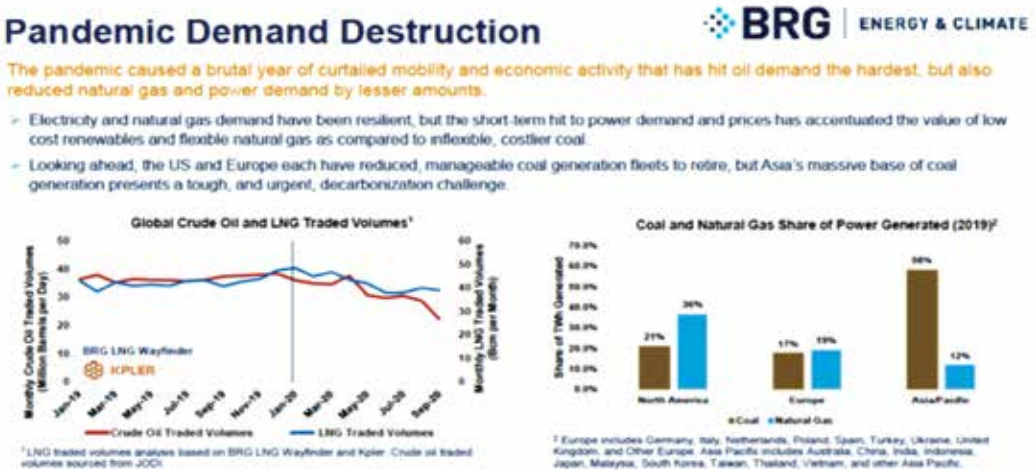
In other words, substantial new uncertainties and challenges were added in 2020 for the LNG industry. But as it was mentioned in the beginning of this article and will be discussed later, literally the "last mile' of 2020 hid big surprises and reversals. Hence, there is a need for a deeper view of the global LNG industry and market.

In addition to the COVID-19 pandemic and energy transition related challenges as mentioned above, the LNG industry also faces several other significant challenges including weak market fundamentals, structural & market changes, digital transformation, regulatory issue and risks, project financing obstacles, technological and social acceptance issues, and finally, geopolitical issues occurred from local tensions and/or from the competition of global players.

Few further details are given below for some of the above challenges, while other ones will be discussed later.

COVID-19 pandemic: the following figure shows its impact to the energy sector:

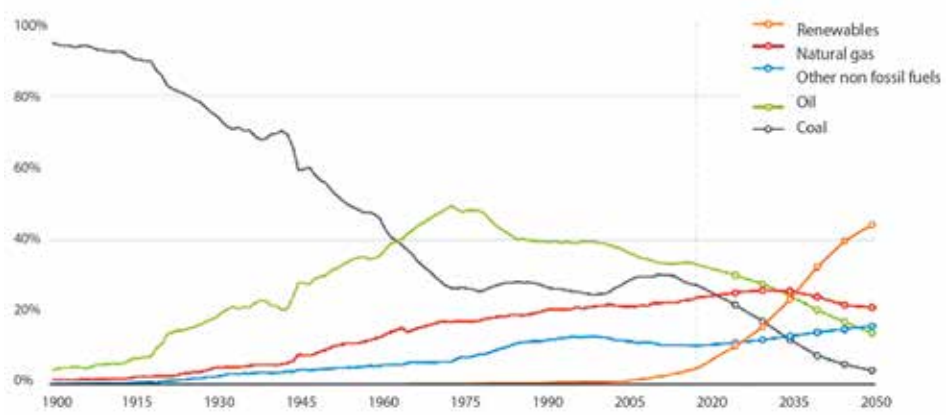
Figure 1 • Impact of COVIV-19 pandemic in the energy sector in 2020



Source: BRG presentation at Virtual World LNG Conference, 2-4 Dec 2020

Energy Transition: gas is no longer considered as "fuel of choice" and as such it not only faces criticism from ecologists and environmentalists, but there is also rising competition from RES and other "greener" energy sources. Indeed, there is a vital need and an unprecedented pressure for the LNG industry to adopt decarbonization strategies by employing biogas, syngas, and "blue" hydrogen production (in combination with carbon capture and storage technologies and synergies) as well as other carbon offsetting practices if it is to survive in the next decades, since energy transition leads rapidly to a fundamental shift in the global energy system (see Figure 2 below).

Figure 2 • Transition to a low-carbon economy will cause radical shifts in the energy system



Source: BP Energy Outlook 2020

Digital transformation: as it happens today across industries and geographies. there is a strong pressure for innovation and intensive use of digital technology across the LNG industry's functions and operations, as well as a vital need for the development of customer-centric business models and services.

Regulatory issue and risks: there are legislative restrictions and strict market-based regulatory rules for the development of new gas and LNG infrastructure, for mandatory TPA access and reasonable tariffs, capacity allocation procedures etc., which must effectively be followed and applied.

Project financing obstacles: the climate change and RES supporting policies mainly in the EU led to serious obstacles and even exclusions of both upstream and midstream gas projects' financing from European and commercial financial institutions. We should mention the recent decisions and/or internal trends at EIB, EBRD, Barclays and HSBC. It is well known that the gas and LNG industry is capital intensive one and needs a long-term horizon (usually 20-25 years) to develop new supply infrastructure, otherwise there is neither an appetite nor a willingness to invest in new capacity under such uncertain conditions.

Technological and social acceptance issues: worth to be mentioned that indeed, there are several technical and technological challenges in relation to deep water drilling, deep water pipelines laying, FLNGs, FLNG to Power, FSRUs, "breaking the bulk" technologies (e.g., small-scale LNG), along with issues related to the growing resistance from local societies to accept upstream and mid-stream investments in their "backyard".

Amid such a challenging, risky, and quickly changing business environment, it is important to take a detailed look at the status and key figures of the global LNG industry as it has evolved until today.

According to the International Group of LNG Importers' 2020 Annual Report at the end of 2019 the global LNG industry was stood as follows:

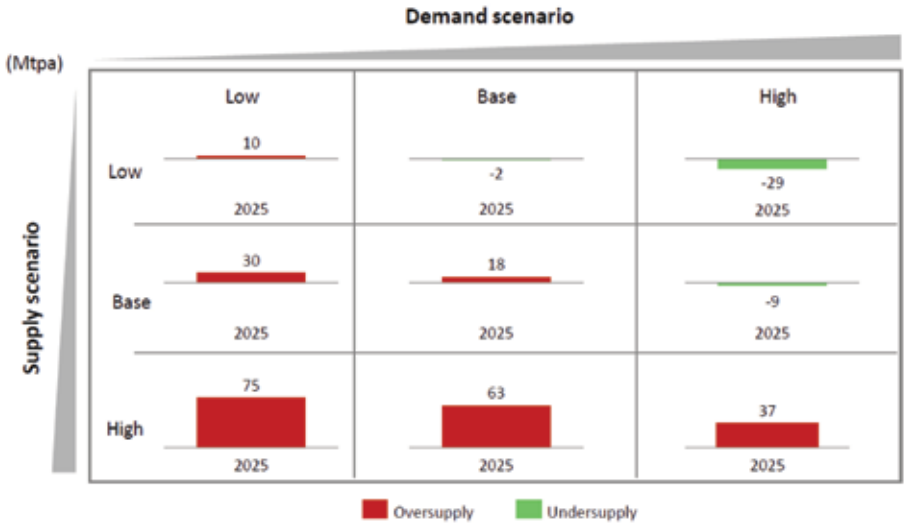
> Key figures 2019

- 354,7 mt of LNG imported vs 313,8 mt in 2018, namely 13% growth.
- 21 LNG producing countries, with top-5 exporters Qatar, Australia, USA, Russia, and Malesia
- 42 importing countries, with top-5 importers Europe (85,9 mt), Japan (76,9 mt), China (61,7 mt), S. Korea (40.1 mt) and India (24,0 mt).
- 427 mtpa total liquefaction capacity, including 4 FLNG production units in operation, namely the Cameroon FLNG (Cameroon), the Satu FLNG (Malesia), the Tango FLNG (Argentina) and the world's largest one the Prelude FLNG (Australia)
- 920 mtpa total regasification capacity
- 69% of the global LNG demand is in Asia.
- 41% of global LNG volumes supplied from the Pacific Basin.
- 119 mt of LNG, corresponding to 34% of its total trade were imported on a spot or short-term basis.

> Latest developments in LNG supply side

According to IGU LNG World LNG Report 2020, 42,5 mtpa new LNG capacity were added to global liquefaction potential and projects of a total liquefaction capacity 70,3 mtpa reached FIDs in 2019 (contrary, in 2020 only one project, the SEMPA ENERGY's Costa Azul LNG in Mexico, reached FID). The same year, LNG projects of total liquefaction capacity 123,3 mtpa were either under construction or sanctioned for development. The above developments in the supply side, along with the already existing oversupply capacity and the expected moderate LNG demand growth lead to the conclusion that the LNG glut will continue in the market most likely beyond the mid of current decade (see Figure 3 below).

Figure 3 • Market will be oversupplied highly likely till the mid of 20s



Source: IEF-BCG Background Material in IEF-IGU Ministerial Gas Forum, 2020

> Latest developments in LNG demand side

In the demand side, imports reached 355 mt in 2019 (from 100 mt in 2000) and according to SHELL are expected to double by 2040. Time will tell us whether this forecast is an optimistic one or not.

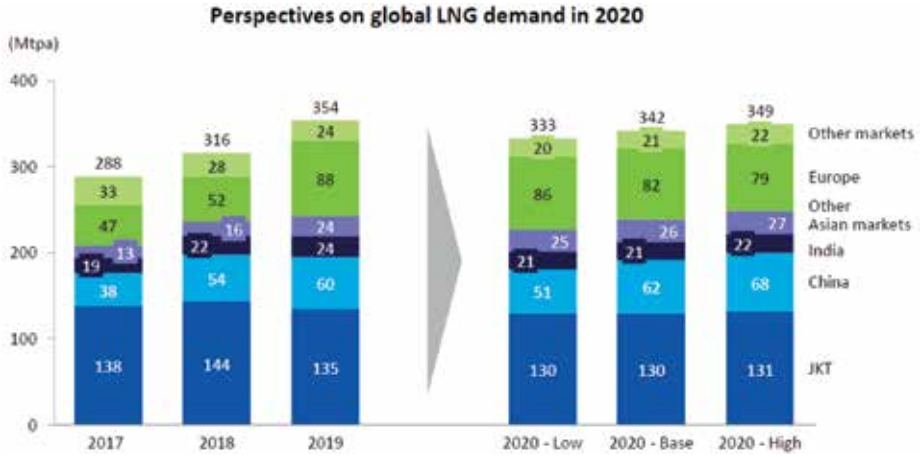
Traditionally, the bigger LNG importers are in Far East (Japan, Korea, and Taiwan), although in 2019 Europe emerged temporally as the world winner. In 2025 however, it is projected that the top-5 LNG importers will be China, Japan, Europe, India, and Korea.

As it has already been mentioned, literally at the end of the last year, there was a strong rebound of the global LNG demand, partially due to exceptional low temperatures in North East Asia, but also due to economic growth in China, Taiwan, India, and some other smaller developing markets.

Contrary in Europe, the demand of LNG, although unusually high in the first semester of 2020, was finally lower than 2019, because of a sharp fall of the demand in the second semester and the diversion of LNG cargoes to Asia due to arbitrage.

Overall, despite the impact of the COVID-19 pandemic, the aggregated global LNG demand in 2020 was finally more or less comparable to 2019 one (a little bit higher of the 2020-High scenario in Figure 4 below).

Figure 4 • 2020 Global LNG demand was comparable to 2019 one



Source: IEF-BCG Background Material in IEF-IGU Ministerial Gas Forum, 2020

> Developments in LNG transportation

Shipping is a key element of the LNG value chain management. At the end of 2019, after the addition of 42 newbuilding LNG vessels during the year, the global LNG fleet consisted of 541 active LNG vessels, including 34 FSRUs, while the 2020 global LNG orderbook accounts for 126 vessels, some of which are FSRUs. The above figures may look like a more than enough shipping capacity for the smooth LNG supply of the global market, but the reality was quite different as it become evident in late 2020, since the above capacity was not sufficient to cover the peaked LNG demand situation occurred.

The unprecedent increase of the winter LNG demand in North East Asia, along with some other bottlenecks i.e., shortages in LNG carrier's availability (many of them had already been used by traders for LNG storage when prices were still at extra low levels), restrictions in Panama Channel passages etc., have boosted the LNG carriers charter rates at record high. It has been reported that spot rates for Tri-Fuel Diesel Electric Propulsion LNG carriers reached $350.000 per day in the second week of 2021 from only $20.000 per day in June 2020. The delays at Panama Canal are likely to be extended until March 2021, thus preventing a major correction in the current spot charter rates.

> Evolution of LNG prices over the last two years

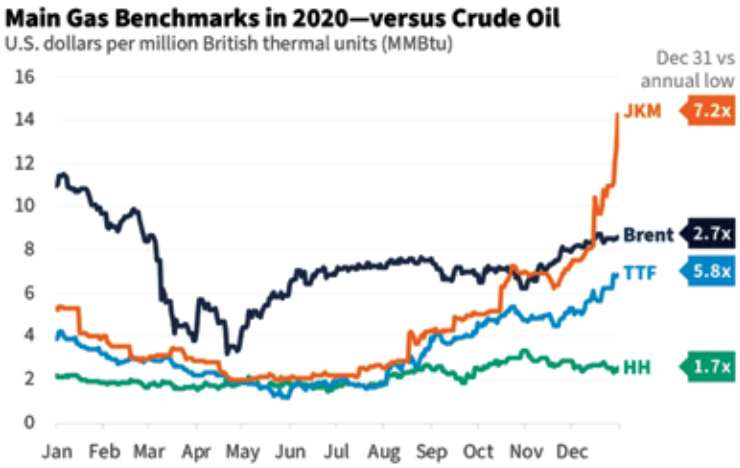
The combination of the existing LNG market oversupply along with the poor global gas demand due to lockdowns, resulted in a slump of the gas/LNG prices since the mid of 2019 and indeed they grabbed the bottom in 2020 (even below $2 per MMBTU).

During the same period, there was also another, particularly important, development in relation to LNG prices: the significant price convergence at the main world's hubs (HH, TTF) and the main regional markets (USA, Europe, and North East Asia). This development was a clear signal that under certain conditions LNG could drive the integration of markets.

Such an extremely low LNG price environmental for a longer period may be very pleasant for the buyers and consumers but there is no doubt that it is also very unpleasant for the producers and the LNG industry's investors and lenders. This reality, along with the cancelation of many LNG cargoes by buyers due to force majeure reasons (i.e., the pandemic), forced certain LNG producers in USA, Australia etc. either to partially cut production or to shut down their liquefaction plants (regardless the reasons they claimed for such a development).

But suddenly in the middle of last December (2020), due to unusual cold weather in Asia and Europe and simultaneous bottlenecks and shortages in LNG ships, in Panama Canal passages, in market liquidity etc. the persisting for months low price environment literally disappeared, especially in Asia and to a lesser extent in Europe, sending the LNG prices in unprecedented high levels. The latest dramatic boost of LNG prices accompanied with the rapid divergence of the world main hubs and regional spot gas prices are shown in the Figure 5 below. It is worth to mentioning that the situation became even worse in the first two weeks of 2021. Prices of spot LNG cargoes for North East Asia markets, (if, and when such cargoes could be found in the market), reached to record high levels exceed by far $30 per MMBTU (a transaction at $39,5 per MMBTU has been reported). Lately through (1Q 2021) there are some encouraging signals showing that LNG prices have started to de-escalate.

Figure 5 • Evolution of main gas benchmarks in 2020



Source: Bloomberg

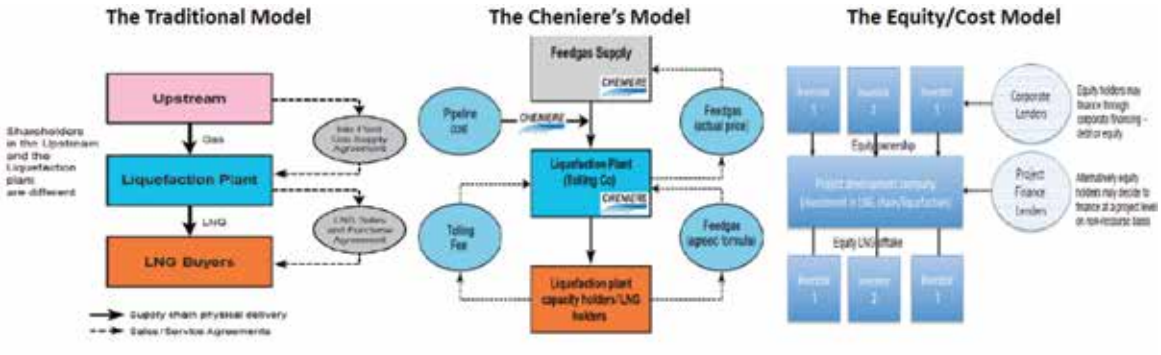
Structural changes and market transformation developments

During the last few years, several, particularly important trends, and structural changes have been observed across the value chain reshaping the LNG market and affecting both producers and buyers. Such developments referred both to LNG trade (new trade players, new contracting arrangements and pricing mechanisms, flexible transactions practices etc.) and to the evolution of new LNG business models. The following list shows the main trends and changes evolved in the LNG trade during the last years:

- Gradual fall of the average duration and volume in the LNG contracts
- Rise of destination free and volume flexible LNG contracts, mainly due to US LNG
- Growth of LNG contracts with hub indexed pricing mechanisms
- Growing role of LNG 'intermediates', including portfolio players and LNG traders, who are helping to disaggregate source from destination.
- Increase of bargaining power of buyers, due to LNG oversupply.
- Rise of the spot & short-term LNG trade due to commoditization, rising flexibility and liquidity in the market.

Similarly, as it can be seen in the Figure 6 below there were some interesting movements in the LNG business models which today tend to establish new ways in the LNG industry, by creating room for new participants and players across the value chain.

Figure 6 • Business models in the LNG industry



Source: David Ledesma & Mike Fulwood, Senior Research Fellows at OIES

As the global LNG market and the business environment are becoming more and more competitive, pressures on margins are forcing LNG companies to increase their share in the value chain, usually by building scale and operational flexibility. At the same time however, due to climate change policies and the growing competition from RES, the LNG companies also considering small-scale projects and while adopting bulk-break strategies aiming at expanding the LNG supply in off-grid locations and/or customers, de-centralized power production, land transportation and bunkering.

Furthermore, as already mentioned, LNG companies have been investing in digital technologies to optimize operations across the value chain, reduce costs and enhance customer satisfaction by offering integrated LNG services solutions. Portfolio players and LNG traders are continuously seeking innovation and market opportunities through arbitrage, pricing, infrastructure, and financing models to differentiate from their peers. Global presence, financial strength, access to capital, logistical know-how, carbon offsetting practices and risk management/hedging capabilities are key drivers of growth for all LNG companies (particularly for portfolio players and LNG traders).

The growing importance of LNG in SE European gas supplies

During the last decades, SE Europe and Eastern Mediterranean have attracted the attention of many global energy players, who were seeking investment opportunities in both upstream & midstream projects, including LNG ones.

It is particularly underlined that until very recently, that the situation which prevailed in the regional gas market was completely frustrating due to numerous vulnerabilities.

- Indigenous gas production in the region had started to decline and was thus unable to meet regional gas demand.
- Nearly all countries in the region had an extremely high import dependency on a single gas supplier (100% in many cases)
- Markets in the region remained national with limited integration, lack of cross border trade and bi-directional gas flows.
- The region had a low level of interconnectivity, insufficient LNG and UGS capacity and finally,
- Regulatory regimes were ineffective (divergent in many cases) causing numerous obstacles for the development of a competitive regional gas market.

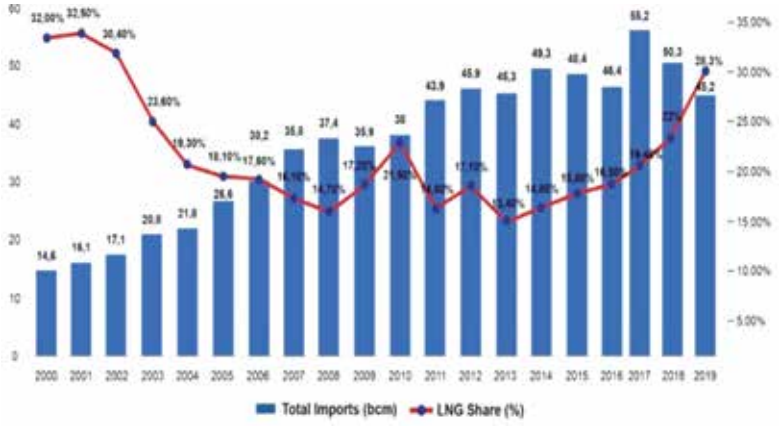
Thanks to the last decade's multilevel regional initiatives and the strong investment interests, the energy picture in SE Europe and Eastern Mediterranean regions have changed dramatically.

The significant gas discoveries in Eastern Mediterranean (Aphrodite, Leviathan, Tamar, Zohr, Calypso and other smaller gas fields), along with the implementation of highly important gas supply pipelines and interconnections (e.g., TANAP, TAP, Turkish Stream, IBR, IGB) and LNG receiving infrastructure projects (e.g, Revithousa upgrade, Kirk, and other FSRUs) have gradually transformed the region's energy identity, enhanced its gas supply security and promoted regional gas market integration (see Figure 7 below).

Figure 7 • Existing and planned gas supply infrastructure in SE Europe and Eastern Mediterranean

In particular, the remarkable increase of the region's LNG re-gas capacity of the last few years, has provided substantial opportunities for diversified LNG supplies both from sources in proximity and remote ones. Thus, despite the growing role of RES and the consequent shifts in the energy mix, LNG is clearly emerging as "transition fuel" for SE European and Eastern Mediterranean countries. Turkey and Greece are the pioneers in the above developments since they are the main LNG importers in SE Europe. Turkey, having massively invested in LNG receiving terminals (both onshore and FSRUs), benefited from the last two years LNG glut and low prices. More specifically, in the country there are today four LNG receiving terminals namely the BOTAS' Marmara Ereglisi LNG Terminal (onshore with a capacity of 5.9 mtpa), the private Aliaga Egegaz LNG Terminal (onshore with 4.4 mtpa capacity), the ETKI FSRU located close to Izmir and the biggest in the world FSRU the BOTAS' Dörtyol in Hatay with a storage capacity of 263.000 Sm^3 LNG and maximum send-out capacity 20 million Sm^3 per day. The figure below shows the growing share of LNG in Turkey's gas supplies over the last years.

Figure 8 • Evolution of gas/LNG imports in Turkey



Source: "How Turkey benefits from global LNG glut" Ezer Ozadil, Atlantic Council

Similarly, Greece thanks to Revithousa LNG Terminal has a completely different gas supply security level compared with the other countries in the Balkans. This strategic asset allowed the country to painlessly overcome the consecutive Russian-Ukrainian crisis and gas supply interruptions in the recent past. After the upgrade of the terminal (it has now a storage capacity of 225.000 m^3 and 18 million m^3 per day send-out capacity), Greece not only benefited from the LNG oversupply and low prices, but also it is now closer to its strategic ambition to become an LNG gate for SE Europe and beyond.

Figure 9 below shows the evolution of Greece's gas supplies and confirms that LNG imports have significantly increased over the last years (especially in 2019). The same trend continued in 2020 according to official data on the website of the Greek gas TSO DESFA.

Figure 9 • Evolution of gas/LNG imports in Greece

Source: DESFA, Development Study for the years 2021-2030

The forthcoming new LNG terminals (all FSRUs) in Alexandropoulis (Greece), Saros Bay (Turkey), Vassilikos (Cyprus) and the (less mature one) Motor Oil's Dioryga Gas in Korinthos (Greece) are expected to contribute to a further increase of the role and share of LNG in the region. Finally, the SSLNG technology improvements and applications could offer new consumption opportunities in SE European countries since they would enable additional LNG supplies in off-grid areas, in decentralized power production, in road transportation (see the European initiative "Blue Corridors") and in bunkering (e.g., The Rhine-Main-Danube rivers LNG project and the Poseidon Med II project).

Conclusions

Despite the existing challenges and the negative implications arising from the COVID-19 pandemic and energy transition, the global LNG industry shows remarkable signs of both resilience and agility and thus LNG seems to have a bright future as "transition fuel" in the decades to come. However, for such a perspective to hold there are some fundamental assumptions: First, the industry's effective response to current market, regulatory, financial, technological, and innovative requirements/ transformations, Second, the industry's ability to adopt efficient and cost affordable decarbonization strategies by employing biogas, syngas, H2 production technologies and synergies as well as other carbon offsetting practices and, Third, the industry's capacity to quickly rebalance the current market oversupply with demand by accelerating and expanding further the use of LNG in new geographical areas and consumption categories. In SE Europe, there have been and will most likely continue to be implemented a number of critical gas and LNG infrastructure projects which will allow LNG to play a growing role in the energy supply of the region in the years to come.

Contributor

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Spyros Paleoyannis holds a Degree in Chemistry and Master of Business Administration with a specialization in strategic and energy management. Today, he serves as Managing Partner at MEDGAS & MORE SERVICES LTD, a consultancy firm based in Cyprus. He had worked for years at Public Gas Corporation of Greece (DEPA) S.A, as a Vice Chairman and Deputy CEO (2009-2014) and CEO (2014-2015). He has been a member of the Executive Management Committee of the International Group of Liquefied Natural Gas Importers (GIIGNL) (2014-2015) and he has served as Deputy Chairman at IENE (2003-2009). He has also been a non-executive member of the Board of Directors in DEPA's subsidiaries IGI Poseidon and ICGB EAD and senior executive in other enterprises of Greece's private and public sector.

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The Role of Gas in the New European Energy Environment and the Importance of the East Mediterranean

By Dr Charles Ellinas, Senior Fellow, Global Energy Center, Atlantic Council

The European Green Deal (EGD) featured prominently when the Commission President Ursula von der Leyen presented EU's €750billion Recovery Plan from the Covid-19 pandemic on 27 May. This is described in a document with the befitting title of "Europe's moment: Repair and Prepare for the Next Generation". The Plan will give priority to building renovation, renewables and hydrogen, as well as to clean mobility and waste management. It is aiming for a climate-neutral and digital EU future, but there is no direct reference to supporting natural gas.

This is on top of the EU's updated seven-year €1.1trillion budget, that will also be geared towards supporting the green and digital transitions.

The EC promised to roll-out renewable energy projects, especially wind and solar, needed to generate electricity to kick-start a clean hydrogen economy in Europe. Even though it is not clear how much of the funds will be earmarked for green initiatives, analysts estimate these at more than €100billion.

Von der Leyen summed up the opportunities the Plan offers: "The recovery plan turns the immense challenge we face into an opportunity, not only by supporting the recovery but also by investing in our future: the EGD Deal and digitalization will boost jobs and growth, the resilience of our societies and the health of our environment…We can now lay the cornerstone for a union which is climate neutral, digital and more resilient than ever before."

Is there a Future for Gas in the EU?

At first sight natural gas faces an uncertain future in EU's Recovery Plan.

But a day after its presentation, Klaus Borchardt, deputy director-general European Commission (EC), categorically confirmed at an Atlantic Council webinar on European energy security that natural gas has a future in the EU, at least for the next ten years. However, at the European Gas Conference in Vienna in January, he also said Europe has all the gas it needs and does not need any more large import pipelines.

At the same Atlantic Council webinar, Ditte Juul-Jørgensen, EC director-general for energy, added that "the role of gas will be much smaller than it is today, but that's 2050. That's 30 years from now."

On top of that, the European Investment Bank (EIB) announced in November last year that it will stop funding fossil fuel projects, including natural gas, from the end of 2021. It will also limit approvals of new fossil fuel projects before 2021 to projects that are already under appraisal by the EIB. A decision that could pose long-term challenges for the gas industry in Europe.

Another setback for gas is that EU member states agreed on 25 June that the 'Just Transition Fund', part of the EU Recovery Plan, will exclude support for natural gas.

Borchardt's confirmation is reassuring for existing gas projects, allowing sufficient time to adjust during transition. But it is not enough for recently constructed projects or new gas projects that need a 20-year life to recover investments. And EIB's decision makes it that much harder. EC's policies for the longer-term future of gas in the EU need clarity.

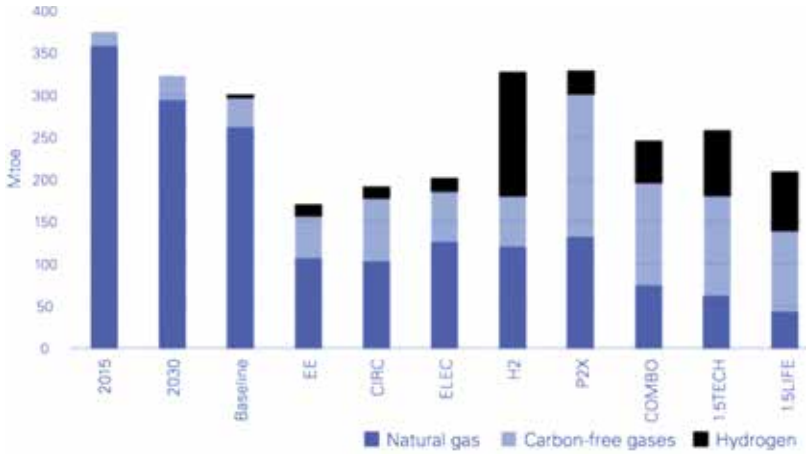
Natural gas provides about a quarter of EU's energy needs. Without further clarification and with the advent of the EGD, these uncertainties will deter construction of new projects to supply gas to Europe, eventually risking shortages of gas supplies. This could become especially problematic if effective transition to green energy takes longer than envisaged. In any case, gas is still essential for industrial sectors like steel, chemicals, aviation and heavy-duty transport that are too expensive or difficult to electrify. BP's Energy Outlook forecasts that Europe will still need almost the same amount of gas in 2040 as it was consuming in 2017.

This is what led eight EU member-states - Bulgaria, Czech Republic, Greece, Hungary, Lithuania, Poland, Romania and Slovakia - to defend the role of natural gas during transition towards climate neutrality. They called for "combined electricity-gas solutions" during transition to net-zero emissions by 2050. They fear that they may be left with stranded assets, but they also fear the massive investment required for renewables.

But environmental activists and NGOs reacted strongly, warning them over green-washing. They are urging the EC to stop any support to natural gas and related infrastructure.

The EC expects that electricity will meet 53% of EU's energy demand by 2050. That leaves over 40% for other energy carriers such as gaseous fuels that the EC says will have to be decarbonised in order to reach climate neutrality by 2050. EC scenario studies show the potential future role gases – natural gas, biogas and waste gas, synthetic methane and hydrogen - could play in the longer-term in EU's energy system (Figure 1). Clearly the role of natural gas is expected to diminish.

Figure 1 • Gaseous fuels consumption in the EU to 2050



Source: Source: NGW/European Commission

On the other hand, the International Energy Agency (IEA) forecasts that gas will retain a critical role in global primary energy to 2040, even if the EU goes in the opposite direction. The rest of the world sees it as a cheap, plentiful and lower-emission energy source, hastening the shift away from coal. Its share is expected to grow to about 25% in IEA's STEPS scenario, and to about 20% in SDS, by 2040.

But gas companies could benefit from EU's drive to shift to hydrogen use. Most hydrogen used today, about 76%, is produced from natural gas, with green hydrogen amounting to only 1% due to high costs. Further development of this technology, combined with carbon capture and storage (CCS), and further reductions in unit costs could extend the life of natural gas, and use of gas infrastructure, well into the future.

However, there are concerns that building hydrogen infrastructure will take time. Jonathan Stern, director Oxford Institute of Energy Studies, said at a EURACTIV webinar "I think this could take us a lot of time, just as it has taken us a lot of time for natural gas." He added that it took 30 years to build a functioning EU-wide market for natural gas.

In the meanwhile BP and other EU-based major companies are asking that the recovery is used as an opportunity to accelerate transition to net-zero. Given that EU member-states are in the process of evaluating the Recovery Plan, there is still time – during the inevitable negotiations – to modify its details.

Global oil and gas

The major international oil and gas companies (IOCs) saw huge profit reductions at the end of the first-quarter of 2020. In fact ExxonMobil reported its first loss, $610million, in over 30 years and Shell cut its dividend by two-thirds, for the first time since WW2.

Since then, with Covid-19 in full swing, oil and gas markets deteriorated even further, plagued by a massive drop in demand and unprecedentedly low prices hitting the IOCs badly. The oil and gas industry is in crisis. Second-quarter results are expected to be even worse than the first.

These dire developments have forced the IOCs to cut spending in 2020 by between 20%-50% and more is expected next year. It is likely to take 2-3 years before normality returns. Between now and then the industry will undergo consolidation and restructuring.

Inevitably, IOCs will be investing their reduced budgets on core business and areas with high returns – not in frontier areas. This was the message from a webinar organized by the Oil & Gas Council on 25 June, with the title 'There is no future in frontier exploration,' with the argument from a financier that "we do not need any more oil an gas, we have plenty.' Despite the slump, a key priority for the IOCs is to safeguard profitability and maintain dividends, expected by their shareholders.

And while all this is happening, the pressure from environmentalists and renewables is increasing. While oil and gas experience a slump in demand due to the impact of the Covid-19 pandemic on the global economy, the IEA confirmed in its recent 'Global Energy Review' that renewables demand is increasing, putting even more pressure on a beleaguered sector.

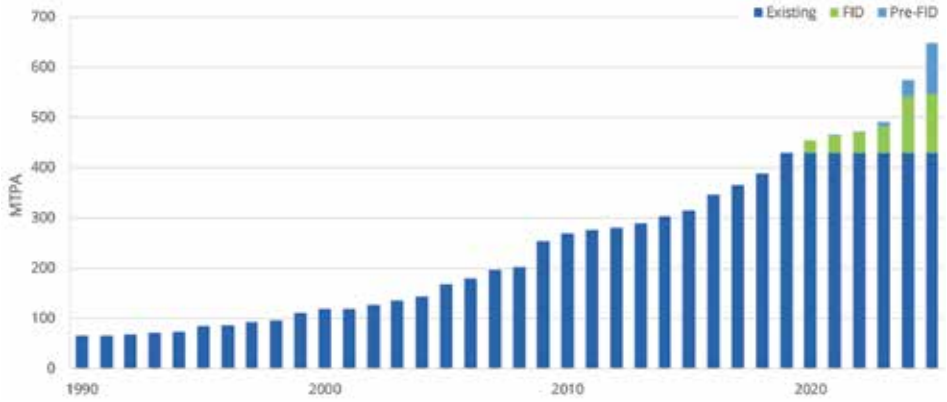
Seeing the writing on wall, the European IOCs have embarked on programmes for a decarbonized future. With a long-term uncertainty over the future of oil and gas demand, and the resilience of the industry no longer assured, they are growing their green business. Eni is the latest to join the club, looking to eventually have less oil in its portfolio, by building its renewable capacity.

There is now a growing view that the reduction in oil demand is likely to endure beyond Covid-19. Bernard Looney, CEO BP, told the FT in May that the pandemic crisis is "adding to the challenges of oil in the years ahead", likely to usher-in "peak-oil" demand in the 2030s.

The LNG market

The global LNG market was in trouble before Covid-19 as a result of oversupply. The pandemic made it that much more difficult due to its impact on the global economy. In its Gas 2020 report, the IEA expects this to reduce global gas demand in 2020 by 4% - the first such reduction for a long time. In addition, the rapid growth in LNG supplies over the past few years - with demand for LNG not responding in-tandem to enable a balanced market at an acceptable price to all – has been driving oversupply, resulting in the current ultra-low price environment (Figure 3). The IEA forecasts in its Gas 2020 report that with more LNG coming into the market, and with global demand taking years to recover, there will be longer-term overcapacity and oversupply. With liquefaction projects currently in construction and record projects announcing FID in 2019, global LNG supplies will carry-on growing for the next five years (Figure 2). In addition, Qatar LNG has reconfirmed its plans to expand its liquefaction capacity by 30mtpa (million tonnes/annum) by 2025, with another 19mtpa to be added by 2027. This is the world's most cost-competitive source of LNG. As a result, something like 186mtpa new LNG capacity are likely to come into the market by 2027.

Figure 2 • Global liquefaction capacity development to 2025



Source: IGU/Rystad Energy (Dec. 2019)

Following recovery from Covid-19, LNG demand will carry-on increasing in Asia. But with China giving priority to domestic energy resources, largely because of energy security concerns as a result of the worsening relationship with the US, its future LNG demand growth is under question. Nevertheless, it is estimated that global demand may increase by 100-150mtpa by 2027. As a result, LNG oversupply may extend well into the 2020s keeping prices low. With global LNG markets getting increasingly competitive, shorter-term contracts and spot deliveries will become more common over time. By May/June spot LNG prices in Europe, Asia and the US converged to around $2/mmbtu (million btu) (Figure 3). Even though these are expected to rise post-Covid-19, the looming oversupply means that prices will not reach levels that would make East Med gas competitive. It is within this very challenging backdrop that the future of East Med gas must be viewed.

Figure 3 • Global gas prices in 2020

Source: NGW/S&P Global

Impact on East Med

With such low prices, Asia might no longer be a market for East Med gas. And with the application of the EGD, the EU is becoming even more challenging for gas.

In the East Med, projects and drilling are struggling faced with the impact of the pandemic, an over-supplied gas market and much reduced IOC spending. Egypt's Idku LNG plant has been unable to sell LNG since March because of low prices and Zohr gas production is down one-third.

Commenting on this recently, Professor Jonathan Stern, founder of Oxford Institute for Energy Studies, and with first-hand knowledge of East Med, was blunt. He said "I was very dubious about East Med gas even at pre-2019 prices. Now forget it." He added that that by the time any new East Med gas would theoretically be ready to export to Europe, possibly only by the late 2020s, EU CO_2 constraints would add further costs and complexity. He advised "East Med resource holders need to concentrate on supplying to the region."

Wise advice with which I fully concur. I have been saying as much in my articles, but it is reassuring to see this reconfirmed by such a renowned expert.

Cyprus energy future

With the IOCs postponing drilling and activities in its EEZ into 2021 – should conditions allow it - Cyprus energy is entering an uncertain future. Many would like to think that with the Covid-19 pandemic over, normality will return next year, drilling will resume and Cyprus energy plans will get back on-track.

But with the global hydrocarbons industry in crisis, this is unlikely to happen. There is a huge oversupply of oil and gas - as a result of low demand partly due to the economic impact of Covid-19 - and prices are extremely low.

In addition, post-Covid-19 continuing exploration in Cyprus EEZ, considered to be a frontier area, may no longer be a priority for the IOCs. With the expectation that global gas markets will remain oversupplied and prices will stay low, this is exactly what may happen.

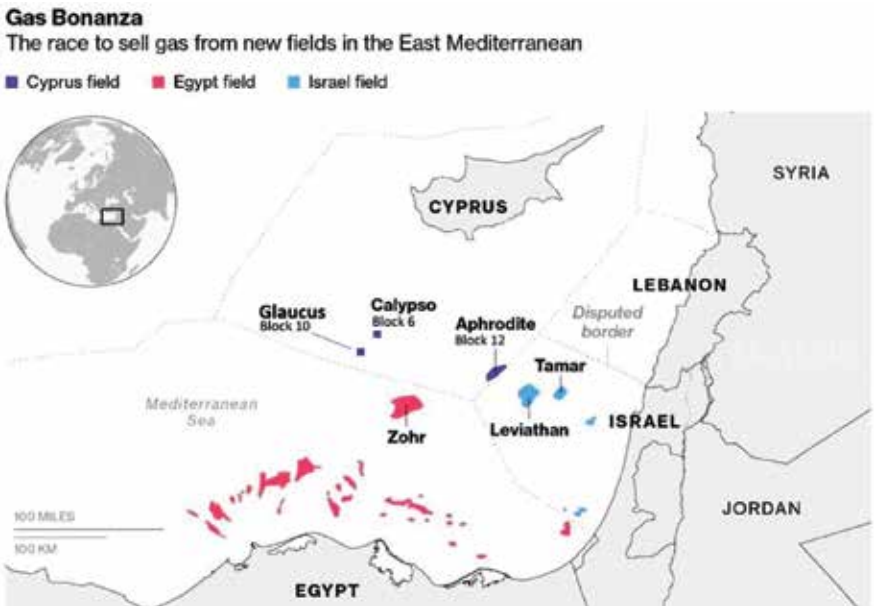
Moreover, with the development of already discovered gas-fields challenged by high costs and low gas prices, as a last resort, the IOCs may consider divestment. This would be a serous geopolitical, but also economic, blow to Cyprus. The riches expected to be made out of Cyprus' EEZ may never materialize.

This is also what renders Turkey's continued escalation of disputes and provocations in Cyprus EEZ futile and anachronistic. And so are statements that the route of East Med gas to markets is through Turkey. Given global markets and prices, this is not viable, even if it ever became politically possible.

Aphrodite in need of fresh thinking

As expected Noble Energy, the operator of Aphrodite, is putting development of the gas-field (Figure 4) - discovered in 2011 - on-hold. Noble confirmed this mid-June. It said that, while it remains true to its commitments in Cyprus, it is reconsidering the field's development plan in the light of difficult global markets.

Figure 4 • Cyprus discovered gas-fields



Source: Bloomberg

Noble intends to enter into negotiations with the government to agree a new development timetable. But ominously, it indicated that this would depend on global market conditions, gas demand and prices. Coupled with David Stover's - CEO Noble Energy – statement on 8 May that "At Noble, we will not invest capital at less than acceptable returns, and we will preserve our resources for a better future," this is worrying. Postponing development of the gas-field into the depths of time is not for the benefit of Cyprus. This means that Cyprus will be locked into importing LNG for a long time, and paying for it through high electricity prices, at a time when its own gas – three gas-fields with 350bcm (Figure 4) – remains unexploited, buried in the depths of the East Med.

How dependable is Noble

At the end of the first-quarter on 2020, Noble announced a net-loss of $4billion and 53% cuts in its 2020 spending. This was on top of losses during the past three years. Simply-Wall-Street states that with a loss of $1.5billion at the end of 2019 and a trailing-twelve-month loss of $5.2billion, analysts do not expect Noble to return to profitability until 2022. And even then, only if, on average, it grows 80% year-on-year. But with low oil and gas prices expected to persist, this would be extremely challenging to achieve. Should the business grow at a slower rate, it will become profitable later than 2022. Noble also has high debt, with its debt-to-equity ratio at 164%. Typically, debt shouldn't exceed 40% of equity, and the company has exceeded this considerably. The importance of this is that higher debt obligations pose a risk, but also limit the ability of the company to borrow and invest in new developments.

Simply-Wall-Street reports that at the end of March 2020 Noble had $8.47billion of debt, up from $6.56billion a year ago. With cash limited to $1.40billion, it had a net-debt of about $7.07billion. In addition, its liabilities totaled $10.3billion more than the combination of its cash and short-term receivables – not a healthy balance sheet.

Worryingly, about 50% of its updated capital expenditure amount was spent in the first-quarter, leaving only about $400million for the rest of 2020. It is likely that cuts in spending will be extended into 2021.

Noble's future is not necessarily being put into question by such figures, but its ability to invest is. These are not the healthy figures required to invest in a project of the size of Aphrodite.

But it is not only Noble that has limitations. Its partner Delek is facing real survival problems, to the point that it may be unable to continue as a going concern. The company is selling assets so that it can pay its massive debts. This may include Delek Israel. Another possibility is for Delek to put its Aphrodite share on sale to help it in its fight for survival.

And on top of this, the situation in Egypt does not help either. Egypt's Idku LNG plant has been unable to export LNG since March due to the prevailing, ultra-low, prices.

Noble's and Delek's problems, combined with Idku's inability to export its LNG, do not bode well for the future of Aphrodite. This may require new thinking and new investors. But if nothing changes, investors are unlikely to be forthcoming. They will need to be able to see a clear route to future gas sales. With global gas markets facing long-term oversupply and low prices, it leaves domestic and regional markets.

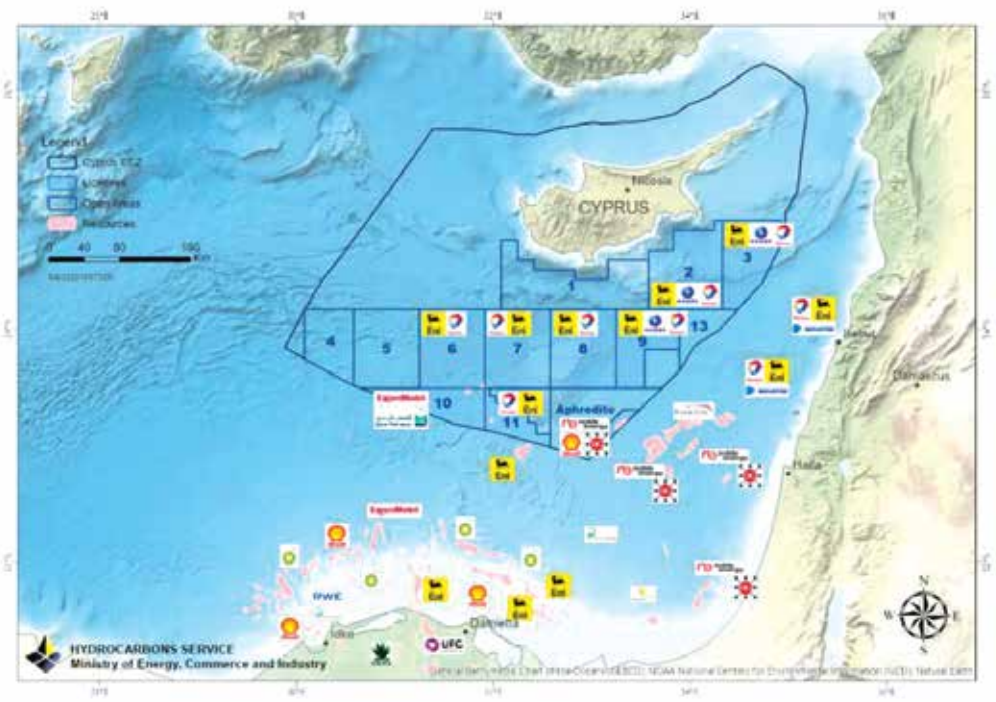
There are possibilities, but need facilitation and promotion by the government. But sadly Cyprus is going in the opposite direction. With the sanctioning of the LNG import project, Cyprus has been locked in long-term commitments that push development of Aphrodite even further away.

And with Europe going increasingly green, through the EGD, and with EU carbon emission targets being raised to levels attainable only through the adoption of renewables at the expense of gas, the future is challenging.

Impact on the rest of Cyprus' EEZ

It is not only development of Aphrodite that faces challenges, but the resumption of exploration and drilling in the rest of Cyprus' EEZ (Figure 5) is also becoming increasingly challenging.

Figure 5 • Licensed blocks in Cyprus' EEZ



Source: Cyprus Ministry of Energy

ExxonMobil's first-quarter results were very disappointing, reflecting the crisis being faced by the global hydrocarbons industry. According to S&P Global, it has now lost its top spot among the IOCs to Shell.

All companies in Cyprus EEZ, including Shell, Total, Eni and Noble, had disappointing first quarter results and have all announced major spending cuts. They are also restructuring and divesting of non-core assets, taking actions to safeguard their balance sheets.

The failure to make a discovery in Lebanon, after all the hype, will weigh heavily in Eni/Total's plans in the region. It is possible that they will eventually return to complete appraisal drilling of Calypso. With gas quantities expected to be around 3tcf, a possible development path may involve a subsea tie-in to the Zohr gas-field, for onward export to Egypt, should this prove to be viable. But continuing with further, costly, exploration drilling in Cyprus EEZ is another matter. It remains to be seen whether this would fit into Eni/Total's post-crisis plans.

With the IEA forecasting persistent longer-term gas and LNG overcapacity and oversupply, low prices are likely to persist for the rest of the decade, making it very difficult for expensive East Med gas to secure sales in global markets. In such an environment, Cyprus' EEZ may not be crucial to the future plans of the IOCs and will not get priority. Delays are very likely to extend beyond 2021 and probably longer.

Cyprus energy future

The alternative option of exporting East Med and Cyprus gas to Europe through the EastMed gas pipeline, on-and-off in the news, is equally challenged for the same reasons as before. Even though the required gas supplies are available, it still needs to secure gas sales contracts in Europe. With gas demand in Europe expected to be declining as we approach 2030, due to the impact of the EGD, and prices staying low, competition from plentiful and much cheaper gas makes such a project highly challenging.

The Covid-19 pandemic will leave the island in a very difficult economic situation for years to come. On top of it, with Aphrodite gas inaccessible, Cyprus is embarking on a costly project to import LNG. It is galling for Cypriot people and industry to have such an asset remaining unused – as is its vast solar power potential - while they are being asked to continue paying high electricity prices for years to come, without any hope for change.

Cyprus urgently needs a revised, post-Covid-19, energy strategy. Existing plans have been completely overtaken by irreversible global events beyond its control. The future lies in maximizing domestic and regional market options.

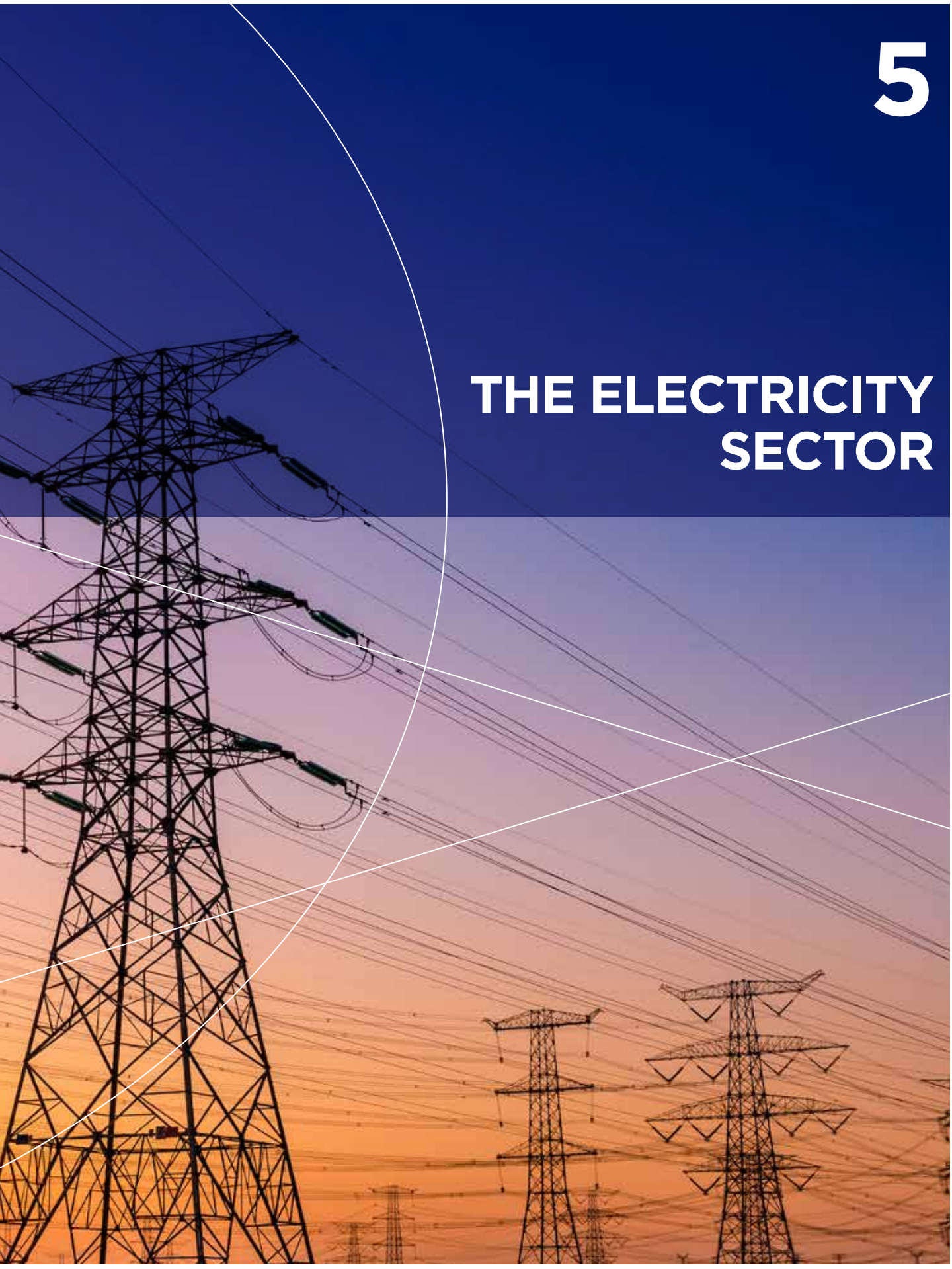
Contributor

Charles Ellinas

Dr. Charles Ellinas has over 35 years of experience in the oil & gas sector in senior management positions. He is the CEO of e-CNHC (E-C Cyprus Natural Hydrocarbons Company Ltd), providing management and advisory services in the oil & gas and energy sectors in Cyprus and the region, contributes to the successful development of these sectors for the future of Cyprus. Prior to this, as CEO of KRETYK he was responsible for implementing Cyprus government's strategy for the development of its hydrocarbons sector. Until 2012 he was the Director of Mott MacDonald for 25 years and the Managing Director of Mott MacDonald's Oil, Gas & Petrochemicals business world-wide.

5

THE ELECTRICITY SECTOR



5. The Electricity Sector

Hellenic Energy Exchange and its Vital Role in Greece's Energy Market Operation

By Dr. George Ioannou, Chief Executive Officer of Energy Exchange Group (EnEx)

The Hellenic Energy Exchange is the enabler of the electricity market transformation in Greece. Its new activities in years 2020-21 are some of the most expected developments in the Greek energy market and its operational success is the cornerstone of the paradigm shift in the implementation of new tools and methods for the evolution and monitoring of the energy landscape.

A little history – The steps towards a common European Electricity Market

The liberalization of energy markets in Europe began in the 1990s in an attempt to unify the European internal markets, promote price convergence across all of them, and maximize overall social welfare. Towards this goal, the European Commission has initiated the development of a well-functioning internal European electricity market, which is commonly characterized as the "Target Model" and has been gradually adopted by the national energy regulators. In addition, EU Regulation 2015/1222, has established the Guideline on Capacity Allocation and Congestion Management (CACM), which establishes a framework for the adoption of identical provisions at the national legislative level.

Within this new environment, many EU countries have successfully established power exchanges (PXs hereafter), through which cross-border transactions can be executed in a transparent and reliable manner, ensuring greater liquidity in energy markets, while providing a competitive environment for the benefit of all stakeholders. The development of PXs offers many advantages beyond market liquidity and competitive platforms, such as easier access, lower transaction costs, elimination of counterparty risk, neutrality, price reference, clearing and settlement services, etc.

The Price Coupling of Regions Initiative

Given the ongoing coupling among various regions in Europe, we are likely to witness significant steps towards integration among energy markets in the coming years. To facilitate this process, the European PXs have developed a single price coupling solution, which is used to calculate the electricity prices across Europe, respecting the capacity of the relevant network elements. This initiative aiming at the integration of the European electricity markets is called Price Coupling of Regions (PCR) and its adoption has brought forward an important Pan-European achievement, i.e., the development of a single price coupling optimization algorithm used by PCR members, "EUPHEMIA" (Pan-European Hybrid Electricity Market Integration Algorithm). In 2018, HEnEx joined the PCR Initiative and became the eighth PCR Member alongside EPEX SPOT, GME, Nord Pool, OMIE, OPCOM, OTE and TGE. Currently, PCR is used to couple the following countries: Austria, Belgium, Bulgaria, Czech Republic, Croatia, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Italy, Ireland, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain and Sweden.

An integrated European electricity market promotes increased liquidity, transparency, efficiency and social welfare: A market with a lot of power traded "in and out" leads to depth in the market and helps the market price discovery process. An efficient price formation mechanism produces reliable price signals and provides sufficient incentives for investments. Thus, the establishment of the Hellenic Energy Exchange (HEnEx hereafter), is an enabler towards compliance to the European paradigm and a catalyst for the electricity market transition in Greece.

Interconnections of the Greek Electricity System

The Greek power system is currently connected to several neighboring countries including Italy, Bulgaria, Albania, North Macedonia and Turkey. Figures 1 and 2 present the progress of the volumes of energy imports/exports traded so far within the former (DAS) and the current (Target-Model) market designs (Target Model data as of November 2020). These volumes are expected to increase due to further interconnection capacity construction and upgrades, which are planned for the following years; e.g. the new 600 MW interconnection line with Bulgaria, the new submarine interconnection cable with Italy and the Euro-Asia interconnection with Cyprus.

Figure 1 • Evolution of imports to the Greek power system

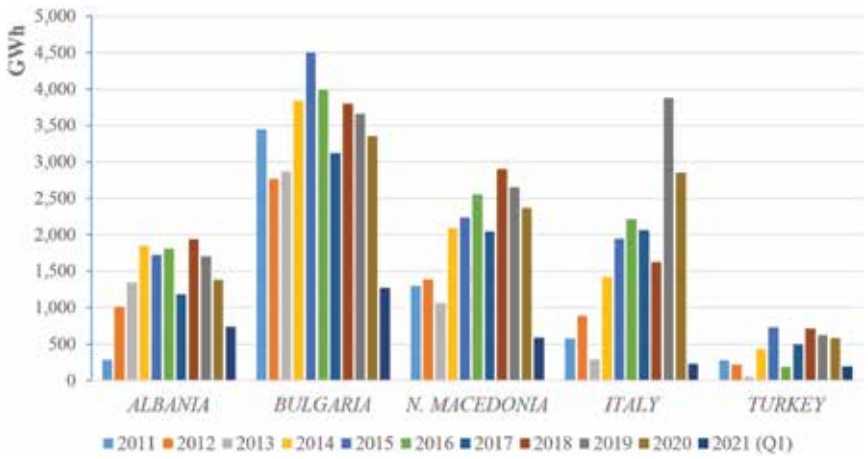
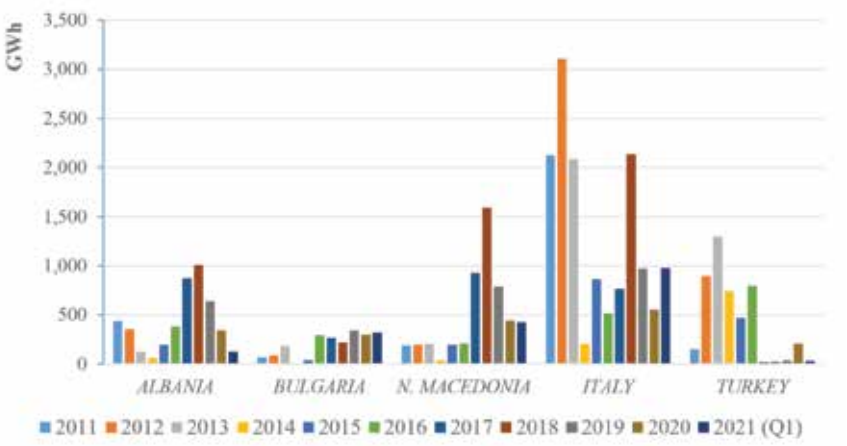


Figure 2 • Evolution of exports from the Greek power system



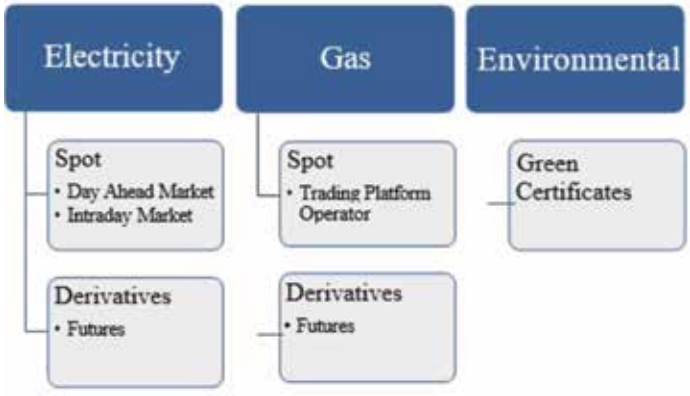
Within this framework, price coupling guarantees the overall welfare and optimal use of all resources, including interconnection capacity. Implicit allocation of capacity requires no a priori purchase of transmission rights for coupled interconnections, thus removing unnecessary risks of trading cross-border capacity and electricity separately.

The establishment of the Energy Exchange Group

Greece has introduced numerous steps towards the liberalization and deregulation of its wholesale electricity market. One of these steps was the establishment of the Energy Exchange Group (EnEx Group) which comprises two companies: the Hellenic Energy Exchange S.A. (HEnEx S.A.) and the Energy Exchange Clearing House S.A. (EnExClear S.A.).

HEnEx was founded in June 2018 as a spin-off from the electricity market branch of LAGIE S.A., which was the former Electricity Market Operator. HEnEx focuses on the operation of Spot and Derivatives Energy Markets, including power, natural gas and environmental markets. HEnEx's goal is to create an one-stop-shop for trading energy in the area. Its shareholder structure is diverse and features major stakeholders of the energy and financial markets (DAPEEP, ATHEX, IPTO, EBRD, CSE and DESFA). This facilitates synergies and knowledge transfer, both crucial for establishing HEnEx's markets successfully. EnExClear is a 100% subsidiary company of HEnEx and was founded in November 2018 to perform risk management, clearing and settlement functions for Spot Energy Markets (currently for Day Ahead and Intra-Day Power Markets). EnExClear acts as the central counterparty for these markets, interposed between market participants to guarantee financial reliability.

Figure 3 • Target markets of HEnEx



New Electricity Markets in Greece

Within the power industry, several markets are available, extending from long-term to short-term and real-time system operation, in order to optimally schedule entities and resources. Figure 4 summarizes this electricity markets sequence. HEnEx is operating the electricity Derivatives market and the electricity Spot markets (Day Ahead and Intra-Day Markets), while IPTO, the Hellenic Electricity TSO, is operating the Balancing Market.

Launching the New Electricity Market

The recent regulatory changes (trading & clearing rulebooks, new products, process / timing changes) along with the infrastructure changes (use of PCR System & EUPHEMIA Solution Algorithm) ensures the compliance of the Greek markets with the European price coupling paradigm. The new electricity Spot markets were officially launched by HEnEx on November 1st 2020 while the electricity Derivatives market is already in operation since March 26th 2020. On December 15, 2020 the Day-Ahead Market started operating in coupled mode with the other European Markets through the Greece-Italy interconnection (implicit allocation of transmission capacity). Bulgaria also joined the European market coupling on May 11th, 2021 through the Greece-Bulgaria border. Coupling with other neighbouring bidding zones may follow later on.

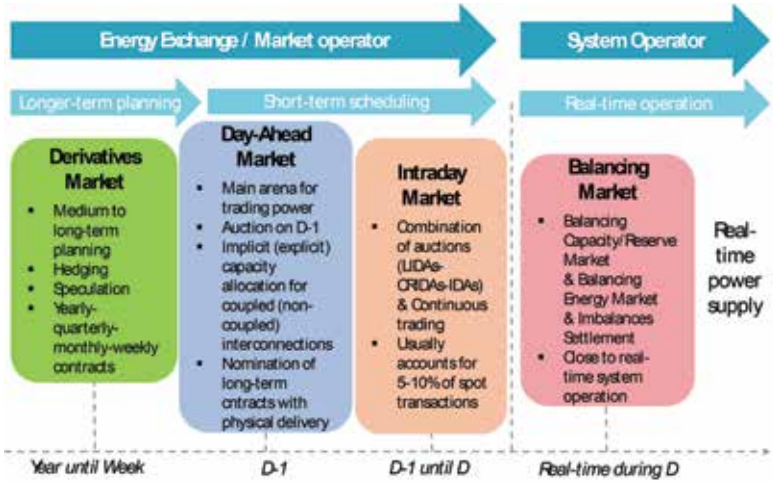
It is anticipated that the new markets will lead to increased competition, greater transparency and an integrated market for the benefit of participants and end consumers.

The Derivatives Market

The Derivatives market offers trading on standardized Futures under MiFID II Regulation using products with both base-load and peak-load profiles. The market started with limited (monthly) products offering; in November 2020 more products (quarterly/yearly) were added along with optional physical settlement for Day-Ahead Market Participants. In April 2021 trade registration was also added as an additional feature, i.e. pre-agreed trades among participants can now be part of an organized market, cleared by an EMIR compliant central counterparty.

The Derivatives market brings companies from both the financial and the energy sector on the same trading floor. Energy market participants (producers, suppliers, traders, RES producers/ aggregators) can use derivative products to hedge against unforeseen prices in the physical (Spot) market. Additionally, hedging price exposure and having a discrete forward price signal can help companies make medium-term plans, formulate new business cases and expand their activities, which, in turn, could benefit end-customers. Speculation is also a valuable market practice; it helps increase liquidity and enhances the market price discovery process.

Figure 4 • Electricity markets sequence



The Day-Ahead Market

As in most countries, the auction-type Day Ahead Market is the main Spot Market for trading energy quantities and scheduling hourly load/generation profiles. It may also be used for position fine-tuning after the Derivatives Market as well as registration of physically settled Futures positions and OTC contracts.The optimization algorithm, EUPHEMIA, guarantees a level and familiar playing field for all Participants. The allocation of cross-border capacity is performed endogenously by EUPHEMIA (implicit allocation) and not through separate auctions (explicit allocation). The endogenous allocation of capacity is optimal given that the algorithm maximizes the social welfare by taking into account the orders of the Participants submitted on a pan-European level as well as the available capacity between the bidding zones participating in market coupling. Price coupling on the Day-Ahead Market required the development and certification of Local Trading Systems, strict adherence to PCR timings and procedures, a multi-month testing procedure with Energy Exchanges and System Operators, both at regional and pan-European level.

The Intra-Day Market

The Intra-Day Market is used for position correction and/or further fine-tuning, and aims at the reduction of imbalances (thus reducing the financial exposure) prior to the TSO-managed Balancing Market. For example, in case of power plant outages or changes in demand, Market Participants can update their trading position. The ability to submit more accurate short-term RES forecasts facilitates the RES Producers' and RES Aggregators' activities and helps them handle their stochastic nature, thus reducing risk exposure and allowing for further integration of intermittent renewable production. Flexibility providers can maximize the use of their resources while contributing to energy balance.

The Greek Intra-Day Market establishes a hybrid model using both auctions and continuous trading. Currently, three Local Intra-Day Auctions (LIDAs) are carried out on a daily basis for the Greek bidding zone. Price coupling will also take place on an intra-day basis when Local Intra-Day Auctions (LIDAs) are substituted by Complementary Regional Intra-Day Auctions (CRIDAs) and Continuous Trading (XBID). The transition from LIDAs to CRIDAs is expected to take place on September 21, 2021, together with Italy and Slovenia. In the beginning of 2022, continuous trading will follow, while CRIDAs will continue to operate as an instrument complementary to continuous trading. The continuous trading matching will be executed using the XBID algorithm, offering the ability to trade up to one hour before actual delivery on a pan-European level.

Clearing Houses & Market Monitoring

Transactions in HEnEx's markets are cleared by two Clearing Houses, which bring transparency and security to the market. EnExClear for the Spot Markets (DAM & IDM) and ATHEXClear (the Clearing House of the ATHEX Group) for the Derivatives Market are responsible for providing central counterparty clearing services (CCP) and take on the risk of default of the counterparties' transactions by undertaking the role of the buyer vs. each seller and vice versa, for the clearing and settlement of the financial side of transactions. Both Clearing Houses manage the counterparty default risk exposure by applying a proactive risk management model. The provision for daily settlement (in both Spot & Derivatives markets) of transactions allows for less capital requirements for Participants and more efficient working capital management.

HEnEx, as NEMO of the Day-Ahead & Intra-Day Markets and Operator of Derivatives Market, is supervised by the Regulatory Authority for Energy (RAE) and the Hellenic Capital Market Commission (HCMC). It operates under an extensive European regulatory framework (REMIT, MiFID II, MiFIR, MAR, EMIR), which offers transparency and fairness to the market and enhances the market monitoring process. At the same time, as operator of the above markets, HEnEx provides a level playing field to the participants and ensures that appropriate mechanisms are in place in

order to guarantee trustworthiness and meaningful market price signals. To achieve this HEnEx works in two directions. The first pillar is to provide transparency, which is achieved by publishing the information required for the participants to develop their strategy and by sharing market results with the public in a clear and straightforward manner. The second pillar is monitoring by collecting and analyzing the transaction data in order to ensure that all participants behave in a manner consistent with the regulatory framework.

Natural Gas Trading Platform

Apart from electricity, HEnEx is already working, in collaboration with DESFA, towards the establishment of a Gas Trading Platform compliant with the EU Regulation 312/2014. Currently, Greece lacks an organized wholesale market for natural gas, while trades are mainly performed based on bilateral contracts with physical delivery among participants. DESFA, the Hellenic Gas TSO, procures the system balancing needs using a Balancing Platform as an interim measure under the above Regulation. In the new Trading Platform, anonymous transactions between gas market Participants will take place, creating a robust market and providing marginal prices for the purchase and sale of natural gas in a transparent environment that inspires confidence to the market. A robust and efficient gas market is expected to benefit all NG Stakeholders, who will soon have the possibility to trade on standardized products, according to their needs, within an efficient and safe market environment. This is especially important for gas-fired electricity producers who will be able to trade and hedge in both relevant markets, i.e. electricity and gas. Initially, natural gas products will be available for the Spot market. Natural Gas Products for the derivatives market will be introduced later on.

What does the Future hold?

Last year (2020) brought forward many developments in the Greek electricity market and beyond. The Energy Exchange Group was, and is, at the cornerstone of most of these progressive steps, and is expected to offer “peace of mind” for all stakeholders in this sector. 2020 will be remembered as the turning point in the way electricity is traded in our country, and has laid the ground for all future developments in terms of interconnections and energy trading evolution. Thus, the localities and peculiarities of the Greek market will tone down and the pan-European perspective will prevail, in the path towards the establishment of a true, efficient and effective energy hub is the South-East Europe and Eastern Mediterranean. The current year (2021) is the period where the new electricity market will actually be consolidated with consumers starting to feal the benefits.

Contributor

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Dr. George Ioannou is the Chief Executive Officer of the Energy Exchange Group. He is also Professor of Operations Management at the Department of Management Science and Technology of the Athens University of Economics and Business (AUEB), and Director of the Management Science Laboratory of AUEB. He served as Director of the International MBA Program of AUEB and Assistant Professor at the Department of Industrial and Systems Engineering of Virginia Tech. He received his diploma in Mechanical Engineering from the National Technical University of Athens, and his M.Sc./DIC in Robotics and Automation from Imperial College, UK. He was a GRA at the Institute for Systems Research (University of Maryland, USA) where he received his Ph.D. in Mechanical Engineering. He is the recipient of the Microsoft Excellence in Education Award and has been honored with many Excellence Awards for his MBA courses and innovative developments. He was a member of the Board of Directors of Hellenic Railroads SA, of the Innovation Council at the Ministry of Development, of AUEB’s Senate and of AmCham’s Innovation Committee, and has served as Head of the Evaluation Committee of Information Society SA, and Academic Coordinator of the Energy Club of AUEB’s MBA International.

Greece's Electricity Market: The First Six Months of the Target Model

By Andreas Petropouleas, Director of Energy Management, ELPEDISON

How did we get here?

Greece's electricity industry since the '50s was organized as a state owned monopoly. The incumbent Public Power Corporation (PPC) owned all the assets and the infrastructure. In 1996 a long journey towards liberalisation has begun in order to comply with the European Directives. In 2005 the first independent power generators began operation. The then newly found Greek Market was vastly dominated by the incumbent and until 2020 operated as a Mandatory Pool with the following characteristics:

- **Only one market (Day-ahead) both for energy and reserves**
- **Central dispatching**
- **Co-optimization of energy and reserves**
- **Technical Characteristics of the generators taken into account by the algorithm**
- **Bids below Variable costs were not allowed**
- **A set of extra mechanisms was introduced in order to compensate for market inefficiencies such as Cost Recovery Remuneration and Shut Down remuneration**

The European Internal Energy Market

Europe started discussions regarding the implementation of an integrated competitive energy market since the early 1990s. The third energy package entered in force in 2009 and aimed at improving the functioning of the internal energy market and resolving structural problems. Since then the Electricity and ACER Regulation have been revised.

Figure 1 • Brief history of the actions for the development of an integrated Energy Market

In order to harmonize and liberalize the EU's internal energy market, measures have been adopted to address market access, transparency and regulation, consumer protection, supporting interconnections, and adequate levels of supply. These measures aim to build a more competitive, customer-centered, flexible and non-discriminatory EU electricity market with market-based supply prices.

The European Commission has presented a strategy for reaching a resilient Energy Union that has five pillars:

Security of Supply	Integrated Internal energy market	Energy Efficiency	Emission Reduction	Research and Innovation

The European "Target Model"

The Term "Target Model" refers to the current design of the EU's electricity markets in order to achieve the Integrated Internal Electricity Market. It is based on two broad principles:

1. The development of integrated regional wholesale markets in which prices provide price signals for investment decisions
2. Market coupling based on the so-called flow-based model

With the implementation of the Target Model Europe aims to achieve effective competition and increased liquidity, optimal use of interconnectors, support for the participation of RES in the market and the provision of risk mitigation tools to all participants.

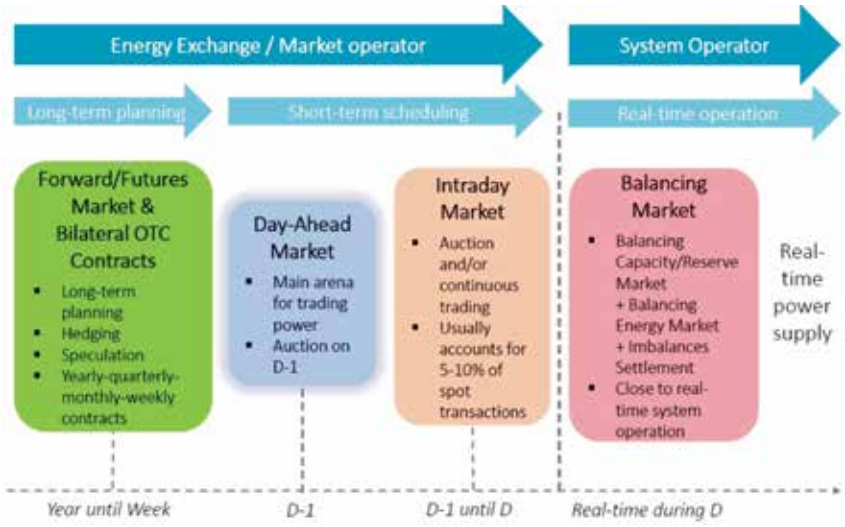
Currently most Day-Ahead markets are coupled and the cross-border transmission capacity is allocated in the most efficient way with the use of a common algorithm maximizing the social welfare. The next steps foreseen are the coupling of the 4MC region (Czech-Slovak-Hungarian-Romanian market areas) and Poland to the rest of the region.

Figure 2 • Single Day-ahead Coupling (SDAC)

The Greek Target Model

The introduction of the European Target Model was under discussion for considerable years and after many delays and postponements it went live on November, 2020 in a rather rushed way after a limited period of testing.

Figure 3 • Market Design of the Greek Target Model



Four distinctive Markets were created in Greece in line with the high level design of the European Target Model:

Energy Derivatives Market-operated by the Energy Exchange

The energy derivatives market was established in March 2020; some months earlier than the go-live of the other markets. The derivatives market offers financial derivatives contracts based on the average of the Day-Ahead Market Clearing Price with the option of arranging the physical delivery of power on the DAM through the submission of priority offers.

At the moment there is one market-maker (PPC) and the liquidity is rather limited. The products traded are monthly, quarterly and yearly for base and peak delivery.

Market Participants have also the option of registering OTC contracts on HENEX in case they want physical delivery/offtake.

Day-Ahead Market-operated by the Energy Exchange

DAM is the main market of the Target Model where most of the energy is traded. It is a pure energy market with economical only criteria. The market is an auction with marginal pricing and the participation for producers is obligatory. Cross border capacity is allocated implicitly for coupled interconnections and explicitly for the other borders. Since 15/12/2020 the Greek DAM is coupled with the Italian one and with the Bulgarian one since 12/5/21.

Intraday Market-operated by the Energy Exchange

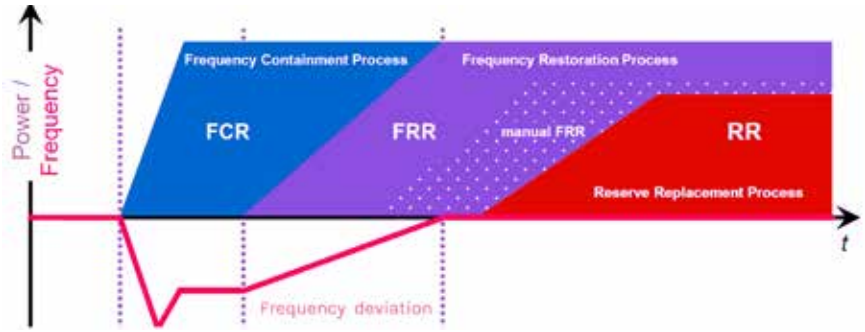
At the moment there are three local intra-day auctions (LIDAs) where participants may correct their positions with limited liquidity. The next steps for the intraday market are the transformation of the local intraday auctions to regional ones (CRIDAS) and the launching of the continuous trading with XBID.

Balancing Market-operated by IPTO

The balancing market includes the balancing capacity market, the balancing energy market and the imbalance settlement process. Participation for producers is obligatory.

The Balancing Market reflects the actions taken by TSOs to keep the system balanced. Unplanned deviations between the commercial transactions of participants and the actual generation and production data may jeopardize the system and need to be addressed by the TSOs. To be able to address such incidents. The Independent Power Transmission Operator (ADMIE) procures capacity reserves that are activated within defined time limits after the occurrence of an imbalance frequency deviation.

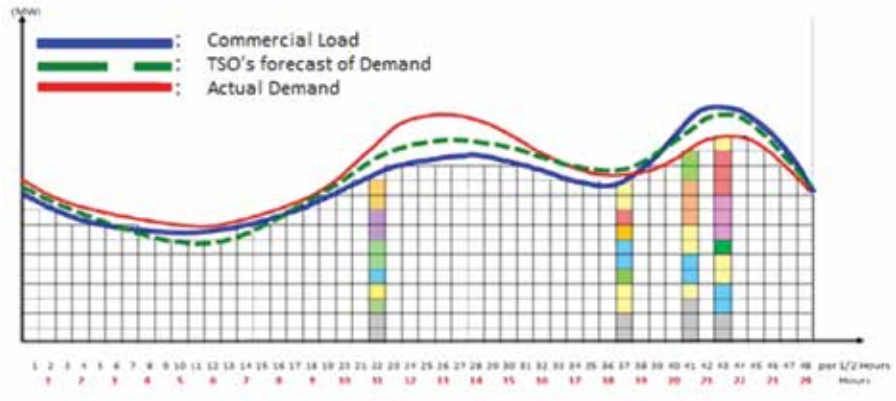
Figure 4 • Load Frequency control processes



The main causes of the deviations between the commercial schedules of market participants and the actual ones are the following:

- Deviations from demand forecast
- Deviations from RES forecast
- Damages of Production Units or Transmission System elements
- System's constraints
- The process of procurement of capacity reserves

Figure 5 • Example for Demand Deviations



Comparison to the previous model

The model of the mandatory pool was highly regulated with many limitations and prices did not represent the actual value of energy. The main differences with the Target Model are the following:

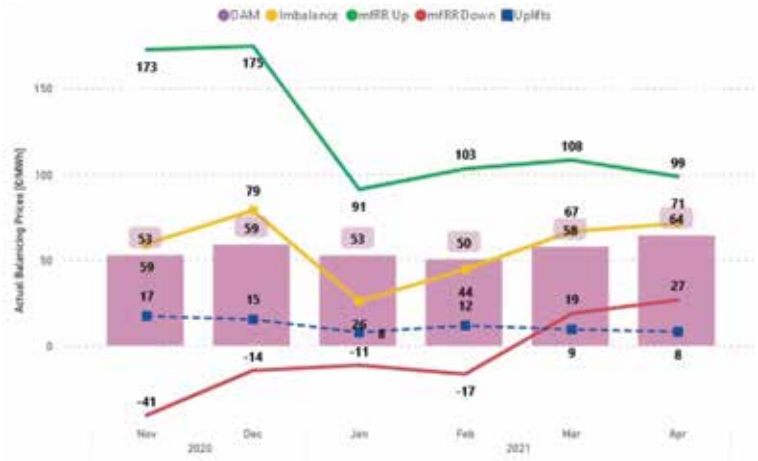
- The previous model comprised of a single day ahead market with the simultaneous trading of energy and ancillary services.
- The previous Day Ahead Scheduling (DAS) solution respected the technical constraint of the units while in the current model producers are responsible for having feasible market schedules
- Market participants may now use more complex order types such as linked and exclusive block orders.
- The previous price limits were {0€/MWh, 300€/MWh}. The limits in the DAM now are {-500€/MWh, 3.000€/MWh}. In the Balancing Market the limits initially were {-4.240€/MWh, +4.240€/MWh}. A few months after the launch of the Market the floor of the balancing energy was set to 0€/MWh until the resolution of the Peloponnese constraint. The cap for the balancing capacity is 3.000€/MW.
- In the mandatory pool producers could not bid below their variable costs
- Due to the inefficiency of the old system some "out of the market" mechanisms have been introduced (cost recovery and shut down mechanism). These mechanisms have been abolished in the new market. These costs were socialized through uplifts accounts.
- The uplift accounts for the Balance Responsible Parties have been restructured

One of the main characteristics of the old model was inherited by the new one. The Greek market remains largely based on the central dispatching model. Producers submit offers for each unit distinctively and then ADMIE issues orders to each unit based on optimization offers.

The first months of the Target Model

The Target Model in Greece went live on 1/11/2020 after a very limited period of testing and dry-runs. Tests with the market participants for the Balancing Market began in August 2020 and lasted less than three months. This period was more an overall operational test of the IT systems and less a dry-run period which would allow Participants and ADMIE to analyze the outcomes and prepare for the market. Admittedly the markets started without any major technical issues. However, the Regulatory Authority of Energy (RAE) has not yet implemented a Market Surveillance and Monitoring System which is crucial to prevent unfair competition by market players.

Figure 6 • Greek Prices since the go-live of the Target Model on 1/11/2020



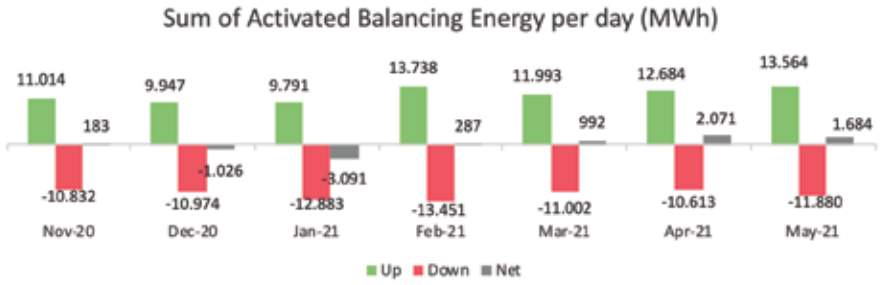
During the first months it became evident that the Transmission System's inefficiencies created high volumes of Balancing Energy which subsequently caused high costs for the system. The main cause of the high balancing volumes was the congestion in the Peloponnese area. Moreover the go-live coincided with a period of generation scarcity in Greece with 3 CCGTs unavailable and limited hydro reserves which pushed upwards balancing prices.

Day Ahead prices have been remarkably low in the first months of 2021 compared to other European countries and considering other commodity prices. This points towards a market inefficiency and indicates price damping since the actual cost of some units is systematically not recovered by the market. During January and February 5-6 lignite units were operating despite the high CO_2 prices. The operation of the lignite units also caused irregularities in the Balancing Market. The optimization algorithm favored less expensive units and ADMIE enforced "Generic Constraint" conditions on them to keep them running. This means that the units run constantly despite their high cost. At times this caused further imbalances to the system.

ADMIE is responsible for creating the operation program of all production units based on the Integrated Scheduling Programming process. ADMIE uses an optimization algorithm in order to minimize costs. During the first months of operation of the model ADMIE "by-passed" this algorithm with the use of generic constraints. This means that some units were either dispatched or kept out of operation, not on the basis of economic criteria but as priority units. ADMIE used this method to deal with the congested area of Peloponnese but also to keep lignite plants in operation.

The inclusion of some units in the ISP schedule by ADMIE displaces other units and causes simultaneous activations on both directions, which are not linked to the real-time operation of the system. Activations on both directions cause high balancing costs to the system which is not the result of participants' imbalances, such as erroneous forecasts of demand or RES. For this reason, the cost is not recovered through the imbalance settlement and it is socialized through an Uplift Account, which all suppliers pay.

Figure 7 • Daily Average upwards and downwards activations of Balancing Energy



The implementation of the Target Model in Greece addressed some of the previous system's inefficiencies. The new balancing market better reflects the value of the electricity in real time to cover any imbalances caused due to poor forecasts and to the stochastic nature of demand and RES production. Balancing prices in principal need to be able to spike so that producers have the possibility to recover their fixed costs. Moreover the capacity market which was underrated within the previous market design now has grown in value.

Despite the improvements from the previous market design the new system still has certain flaws. Market Participants are still reluctant to use power derivatives to hedge their portfolio (sell or buy). Consequently, the liquidity in the Greek Derivatives Market is still very low. Greek futures are also traded in EEX without the option of physical delivery with slightly greater liquidity. In both exchanges there is zero interest for medium-long term delivery periods

Trades have been done only for the next months and quarters and some for the next calendar year. This is due to the immaturity of the market, and due to the manipulation of the Day Ahead Market. The absence of long-term price signals discourages new investments in new capacity and leaves suppliers without risk mitigation tools. Moreover the absence of a Market Surveillance mechanism from the Regulatory Authority together with the high interventions in the Balancing Market by ADMIE create an unfriendly environment for investors.

The way forward

The Power Industry is undergoing a radical transformation not only in Greece but around the world. This rapid transformation changes market conditions for new investments, leading to concerns that electricity markets as they existed in the past may not provide sufficiently effective invest¬ment signals to ensure the adequacy resource of the system. When examining market design to ensure resource adequacy for future decarbonised power systems, ancillary services play an increasingly important role relative to current power systems which have a large proportion of conventional power plants. Future power systems with a high penetration of weather dependent (wind and solar) generation will need to have an evolved operational policy to ensure system secu¬rity. As the constituent generation mix in the system will be radically different from today in many countries, the market design will need to ensure that there is adequate supply to meet demand. Moreover, the market should provide incentives for units to support TSOs in optimising the frequency, voltage, and other services that they can provide. This will be neces¬sary to ensure that the system is not just adequate in terms of capacity but also adequate in terms of the overall resources available to securely operate the power system.

Greece has set ambitious targets for RES participation in the energy mix in 2030 in order to meet the target of 35% participation of RES in the country's final energy consumption. Greece has committed to shut down all the remaining lignite plants by 2023 except of the new Ptolemaida V lignite plant which will probably be converted to a CCGT in 2026. This decommissioned capacity needs to be replaced by flexible efficient CCGT units which will support the energy transition to a decarbonized future. However, the expected drop in the wholesale prices in a RES dominated market may discourage private investors.

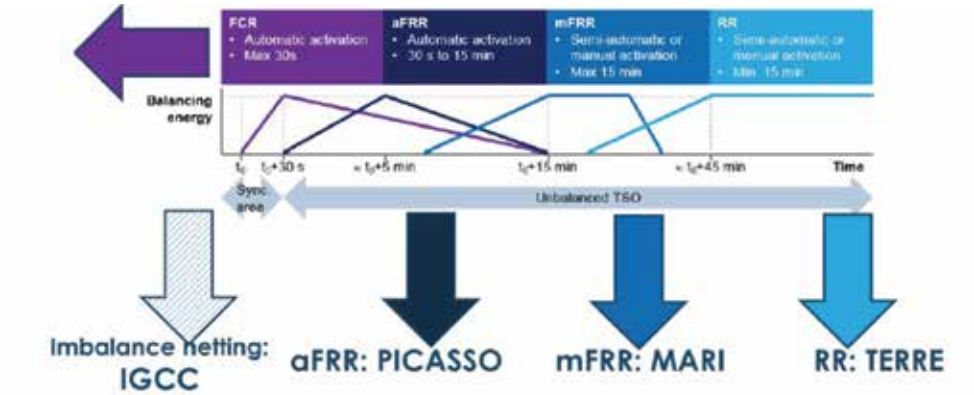
The launch of the Target Model Markets in Greece on 1/11/2020 was a long awaited step closer to the Integrated European Electricity system. The Day Ahead Market soon became coupled with the Italian in December 2020 as well as with the Bulgarian one early in May 2021. The next milestone is the participation of Greece in the Single Intraday Coupling (SIDC) which enables the continuous cross border trading in Q1-2022.

Significant changes are expected also in the Balancing Market. The EU Electricity Balancing guideline defines the framework for a common European cross border balancing market. In this context Greece participates in projects by European TSOs which aim towards an efficient pan European balancing mechanism:

- **MARI**, the European implementation project for the creation of the European m-FRR platform. According to the updated project timeline (Apr2021) the m-FRR platform is expected to go live in Q3 2022. ADMIE is going to initiate the discussion with RAE to ask for derogation until Q3 2024 (source: ENTSOe)
- **PICASSO** Platform for the International Coordination of a-FRR and Stable System Operation (PICASSO) is the lead project on design and implementation of the a-FRR platform. The first TSOs are expected to be connected to the platform in Q3 2021 and the platform is scheduled to go live in Q3 2022. According to the latest project timeline (Oct 2020) ADMIE will join the platform in Q3 2022

- **International Grid Control Cooperation (IGCC)** is the lead project on the design and implementation of the Imbalance netting platform. The main goal of this platform is to reduce the overall volume of activated balancing reserves in Europe and the national balancing markets, avoiding the simultaneous activation of the frequency restoration reserve (FRR) in opposite directions. IGCC was launched in October 2010 as a regional project and has grown to cover 24 countries (27 TSOs) across continental Europe. Greece, Bulgaria and Romania are expected to join IGC within 2021.
- **TERRE**, Trans-European Replacement Reserves Exchange is the lead project on the design and implementation of the Replacement Reserves platform. Greece is participating as an observer member.

Figure 8 • Overview of the balancing platforms



Contributor

Andreas Petropouleas

Andreas Petropouleas has MSc in Finance & Banking, Athens University of Economics and Business (AUEB), MSc in Electrical Power Engineering, University of Manchester Institute of Science and Technology (UMIST), BSc & MSc in Electrical and Computer Engineering, Democritus University of Thrace (DUTH), Since February 2010 he works at ELPEDISON S.A. (Joint Venture of EDISON SpA & HELLENIC PETROLEUM S.A.) as its Energy Management Director. In this context he is in charge of the management of the commercial operation & economic optimisation of the current asset infrastructure (Two Power Plants of 830MW installed capacity), the management of the Dispatching Team/Strategy, together with the management of Natural Gas wholesale activity as well as the Cross Border Activity (IT, South East Europe) & CFDs. From June 2005 to January 2010 he was Commercial Manager of ELPEDISON Power S.A. (Former: Thessaloniki Power S.A). He was responsible for the commercial organization and business development of the first IPP, 400MW CCGT, in Greece. From January 2003 until June 2005 he worked in the Hellenic Transmission System Operator (HTSO) as a Senior Energy Analyst in the Power Exchange Department responsible for wholesale and retail market measurements. From June 2001 until January 2003 he was Project Engineer of TITAN Cement S.A. with responsibilities involving system studies, design and project management of new projects of the TITAN Cement factories in Greece and abroad. From November 1999 until June 2001 he worked in ALSTOM (Greek Branch) as a Sales Engineer. His responsibilities involved promotion of Power Generation and T&D products like: Medium voltage Indoor and outdoor Switchgear for primary and secondary distribution, Distribution and Power transformers, M.V & H.V Substations. Furthermore, was responsible for the after sales service and customer care of MV & HV transformers. He served as Member of the Transmission and Distribution Networks committee of National Technical Chamber (TEE) of Greece (2005 -2008). He contributed in the Master Plan research into the International airports of Corfu in cooperation with the Spiekermann GMBH (consulting engineers). (1999). He worked for the Business Plan of the Ithaca Airport in cooperation with the Spiekermann GMBH (consulting engineers). (2001). He worked at M.A.K as Energy Systems Engineer participated in electrical-mechanical studies with a total budget of 1.000.000 Euro. (1998-1999).

The Need to Urgently Reduce the Energy Cost of Greece's Energy Intensive Industries

By Mr. Antonis Kontoleon, Chairman of the Board of Hellenic Union of Industrial Energy Consumers (UNICEN)

The contribution of industry to GDP growth and employment growth is crucial for the recovery of the economy, especially in the post-pandemic period. This finding is reinforced by the fact that in Europe the percentage of industry participation in GDP exceeds 15%, while in our country it barely reaches 9%. We therefore understand that the transition to a balanced development model, which will be based on a strong and competitive industrial base, must be a national goal of immediate priority, so that the economy can recover faster after periods of crisis affecting the country's economy, mainly due to the export orientation of industry.

In this regard, Greece should immediately follow the example of European countries and formulate a coherent and effective industrial policy, to highlight the role of industry and attract productive investment of added value, making full use of the possibilities of establishing state aid mechanisms of the country's industry, based on the current European legal framework and removing the distortions in the energy market, which put Greek companies at a disadvantage compared to their European competitors.

It is questionable what hinders the formulation of such a policy. Perhaps the answer lies in the fact that a key condition for supporting the international competitiveness of energy-intensive industries is the rationalization of electricity costs at the level of prices borne by their European competitors.

In the electricity market there are entrenched conflicting economic interests, namely the state monopoly, private power generators and RES producers, which seek to maintain their privileges and maximize their profits.

The Greek electricity market in the last five years, on the one hand remains the most expensive in Europe, on the other hand its prices for energy-intensive industries are maintained at a level 40% higher than the average of European markets.

Those who believed that the operation of the new market, within the framework of the target model, would in itself create conditions of competition, which would bring market prices directly to European levels, were refuted. The main reason for the high prices of electricity in the Greek market is located in the structural characteristics of the market. The change in the fuel mixture with a simultaneous increase in the penetration of RES is not enough on its own to create conditions of elementary competition, in order to avoid oligopolistic behaviors in the market, such as those observed mainly in the first 2 months of operation of the new market.

According to the reasoning of RAE decision 54 / 14.01.2021, it is implied that not only were there specific cases of price manipulation in the balancing market, but also serious omissions in market planning. Indeed, "In any case, RAE will further explore the possibilities of restoring normal market operating conditions from its inception, while investigating any Administrator failures or Participant strategies that may have contributed to the emerging problem."The effort to present the high costs of the balancing market continues strongly · on the one hand as "reasonable" as it reveals "the real value of electricity", on the other as a consequence of the central dispatch model and not the bidding strategy followed by the participating producers in the balancing market.

Because, referring to the central dispatch model, they try to avoid the comparison with the corresponding costs of the European balancing markets, as such a comparison will reveal the obvious manipulation of the prices attempted in the Greek market. At the same time, there is a concerted effort, by all vertical producers / suppliers without exception, to increase the industrial tariffs in the Medium and High Voltage with the reason of the increased costs in the balancing market.

In the same context is the effort of PPC to impose increases of up to 40% in the HV industries, citing the operation of the new market, forgetting that only with the participation of the hydro, it automatically becomes the big winner of the launch of prices in the balancing market. Also, the attempted unplanned reduction of lignite production by 2023 and the development of RES with unrealistic goals, will have significant effects on the cost of the electricity market. The continuation of the development of RES without market rules but with guaranteed prices favors only large international and local interests and even to the detriment of the ordinary consumer, as it maintains and increases the deficit of the Special RES account.

European energy-intensive industries, which operate in competitive markets, ensure competitive, stable prices through long-term bilateral contracts, which they sign with big power generators, which in turn ensure the continuous operation of their units. In conclusion, if for our country the goal is to reorganize the productive economy and attract productive investments of added value, ensuring competitive energy costs for the industry should be a first priority.

In this regard, there is a clear need to take measures to ensure the competitiveness of the country's major industries that are exposed to international competition, with interventions in all the individual parameters that shape the final energy cost, with emphasis on the following:

1. measures which will aim at creating conditions of substantial competition in the market and encouraging the participation of demand.
2. Streamlining regulated charges under the Commission's State Aid Guidelines in the fields of energy and the environment as well as the approved practices of other European countries.

Contributor

Antonios Kontoleon

Antonios Kontoleon has a diploma in Mechanical-Electrical engineer NTUA, 1979. Since 1982, he has worked as an expert in many senior potitions in leading companies: Heracles Cement Company (1982-2012), Maintenance and New projects Manager (1989-2008), Energy Director (2006-2012). Board Member (2010- 2019, Chairman of the board (2019-today), SIDENOR S.A, Energy consultant (2012- today).

A New Approach in Energy Storage and the Role of Batteries

By Lambros Bisalas, Chief Executive Officer, Systems SunlightN)

The Covid-19 pandemic is accelerating the sweeping international changes that were set in motion before the virus took hold – changes that concern our response to climate change and the need to protect the environment.

The far-reaching repercussions to public health and the ensuing economic crisis reconfirmed that the European Green Deal passed by the EU in 2019 and the Paris Agreement of 2015 on keeping the increase in the planet's temperature significantly below 2o Celsius and limiting it to 1.5oC, are the only solutions for ensuring a sustainable future for the planet.

Thus, in 2020 we saw the EU's leaders agree to raise the target they had announced a year earlier in the Green Deal: to reduce greenhouse gases by 55% by the year 2030. The EU wants to be the first climate-neutral continent by 2050, and to achieve this goal, the European Green Deal of 2019 is accompanied by a plan for $3 trillion in investments over the next decade.

In USA, the hopes for sustainability through green development were revitalised by Joe Biden's election. The first decree the new president signed was on the USA's return to the Paris Agreement. Biden's plan for a "Clean Energy Revolution" calls for $1.7 trillion in investments over the next decade in research and upgrading of infrastructure to produce clean energy. The USA, too, is now on the path to climate neutrality by 2050.

Greece is another frontrunner in the collective effort to limit climate change. The goals it has set in its National Plan for Energy and the Climate provide for a 55% reduction in greenhouse gas emissions by 2030, with renewable energy sources accounting for 35% of end consumption. This means that, in 10 years, renewable energy sources will produce 60% of our country's electricity. A focal point for consolidating green forms of energy is electric mobility and energy storage through the development of modern technologies, and especially batteries.

These tectonic shifts are bringing renewable energy sources and energy storage systems to centre stage so that we can achieve these goals. Elimination of CO_2 emissions, by shifting all energy sources to wind and solar replacing petrol engines for electric in all forms of transport, cannot be achieved without the batteries that store electricity. Batteries make clean energy available at any time – even at night and on cloudy days. Battery is now on the limelight of clean energy efforts.

The clean energy revolution is also sparking a rapid growth in research and development (R&D) to find technologies and innovations that will accelerate our transition to the green era. Private corporations are leading the way in creating ground-breaking innovation around the world.

Our company, SUNLIGHT, a leading technology company in the production of batteries for energy storage industry, will play a key role for Europe in this movement.

SUNLIGHT and 41 other companies, amongst them industry leaders such as Tesla and BMW, are participating in the European Battery Alliance, which recently was approved for €2,9 billion funding by the European Commission through the second wave of "Important Projects of Common European Interest" (IPCEI). The funding for R&D projects will come directly from the states participating in the project, France, Germany, Austria, Belgium, Croatia, Finland, Greece, Poland, Slovakia, Spain and Sweden. And according to the European Commission, this programme also aims to "unlock' €9 billion from private investors. SUNLIGHT's total investment amounts to €105.26 million, with the approved funding amounting to €49.9 million, 47% of the total cost of the project.

Through this project SUNLIGHT is entering a "club" of a selected European companies that will revolutionize batteries through investments in new cell production in Europe, across several sectors and applications. Our unique proposition in innovation now meets the needs of the industrial sector from supply chain to even automotive applications in the future. With our new plans through support of our significant investments we are confident that we shall achieve a critical differentiating factor, as this will give us a competitive advantage amongst our competitors in Europe. Sunlight will place its its focus in cell production supported by brilliant minds that will staff our new Research and Development Center.

The large investment of 200 million euros that Sunlight is planning in Western Macedonia with the construction of an industrial electric park will not only revitalize the region in the post-lignite era but will contribute towards building a new production model that our country needs. A sustainable model with Greek industry expanding into foreign markets with new products beyond the traditional ones that we have been manufacturing until now.

The production of energy storage systems for electric vehicles with low environmental footprint and high technological standards will strengthen Greece's "brand" of Greece. And Sunlight, which is one of the leaders in this sector, owns the know-how.

The SUNLIGHT research project scope as selected among many companies in EUBATIN, aims at developing innovative lithium battery technologies for the energy storage sector, focusing on new technologies that will usher in a clean energy future. In that context we are creating a new R&D center in Athens, supplementing and strengthening our existing R&D Center in Xanthi. Our goal is to move ahead to test production of innovative lithium cells (FID) with a small environmental footprint. The R&D Center aims at developing lithium technology-based applications for city buses, shipping, and storage of energy produced by RES. In tandem, it is already designing batteries for the robots used internationally in new-generation logistics centers. Our project is expected to create over 200 new direct jobs in Greece and impact over 800 jobs in the near future.

Sunlight is the first Greek company to be part of a proposal in the context of IPCEIs, which are part of the EU's overall actions for promoting cooperation on research and development in the battery sector.

This project enhances the promotion of European cooperation and highlights the important role of a Greek company in the growing, competitive European battery value chain. The industry's transition to clean and circular economy is a critical part of the European Green Deal, which recognizes that "the Commission will continue to implement the strategic action plan and support the European Battery Alliance with initiatives leading to a large-scale pooling of funds in the form of Important Projects of Common European Interest." Additionally, the project is in line with the priorities of the Greek National Plan for Energy and the Climate, which promotes research and innovation in the development and recycling of lithium batteries and their application in electric mobility.

Enormous Room for Growth in the Energy Storage Market

We are continuedly monitoring our markets and seeing enormous room for growth in several sectors in the battery and energy storage market. The global battery/energy storage system market is projected to expand at a compound average growth rate (CAGR) of 32.8% from 2020 to 2025, reaching $12.1 billion by 2025, up from $2.9 billion last year. Moreover, the global battery management system (BMS) market is expected to increase from $4.1 billion in 2020 to $10.8 billion in 2027, for a CAGR of 14.9% during this period.

Sunlight is a clear innovator in this market. Our proprietary BMS technology has a number of unique advantages, such as Active Balancing, protecting the battery from additional critical parameters, as well as accesible operating condition data. There are also major opportunities in the shipping sector. According to projections, the global market for maritime transport batteries will increase to $812 million over the next five years, from the current $250 million. The adoption of lithium ion batteries will absorb much of the outlay, as costs continue to fall. Policy factors, including the goal of the International Maritime Organization (IMO) to reduce total annual greenhouse gas emissions in the sector by at least 50% by 2050, are fostering interest in the electrification of vessels and the port infrastructure required to charge vessels' batteries.

Supply chains are also within our focus. At Sunlight, we have developed solutions for industries and large enterprises that have made it their top priority to reduce CO_2 emissions within their supply chain.Technologies such as smart controls enable enterprises - through proper energy management - to enjoy energy savings 24/7 and make direct use of solar energy. Energy management systems like the ones being developed by Sunlight can decide when to use solar energy to provide electricity, when to store energy or when to supplement with electricity from the power grid during cheaper, off-peak hours. The great potential for the development of energy storage systems is also apparent from how dynamically this market is growing in the U.S., one of the countries we are active with a subsidiary company which is our largest assembly line abroad.

The executive director of the International Energy Agency (IEA), Dr. Fatih Birol, has said that the major green investments by the U.S. could reach the point where Renewable Energy Sources become the largest global source of energy by 2022-2023, ahead of previous IEA projections for 2025. The trend towards combined development of solar energy and energy storage projects in the U.S. is surging ahead.

According to a recent study from the energy department of Lawrence Berkeley National Laboratory, the portfolio of hybrid installations and projects under development exceeds 19GW (4.6GW installed capacity and 14.7GW under immediate development). The authors of the study found that the combination of batteries with production of Renewable Energy Sources offers a "significant potential value premium" in wholesale markets and that in some cases the added revenue from the addition of a four-hour battery to solar energy can exceed the additional cost.

We Transform in Order to Exploit the Bright Future of our Market

Our industry is experiencing a real a rapid revolution across development, environment and distribution.

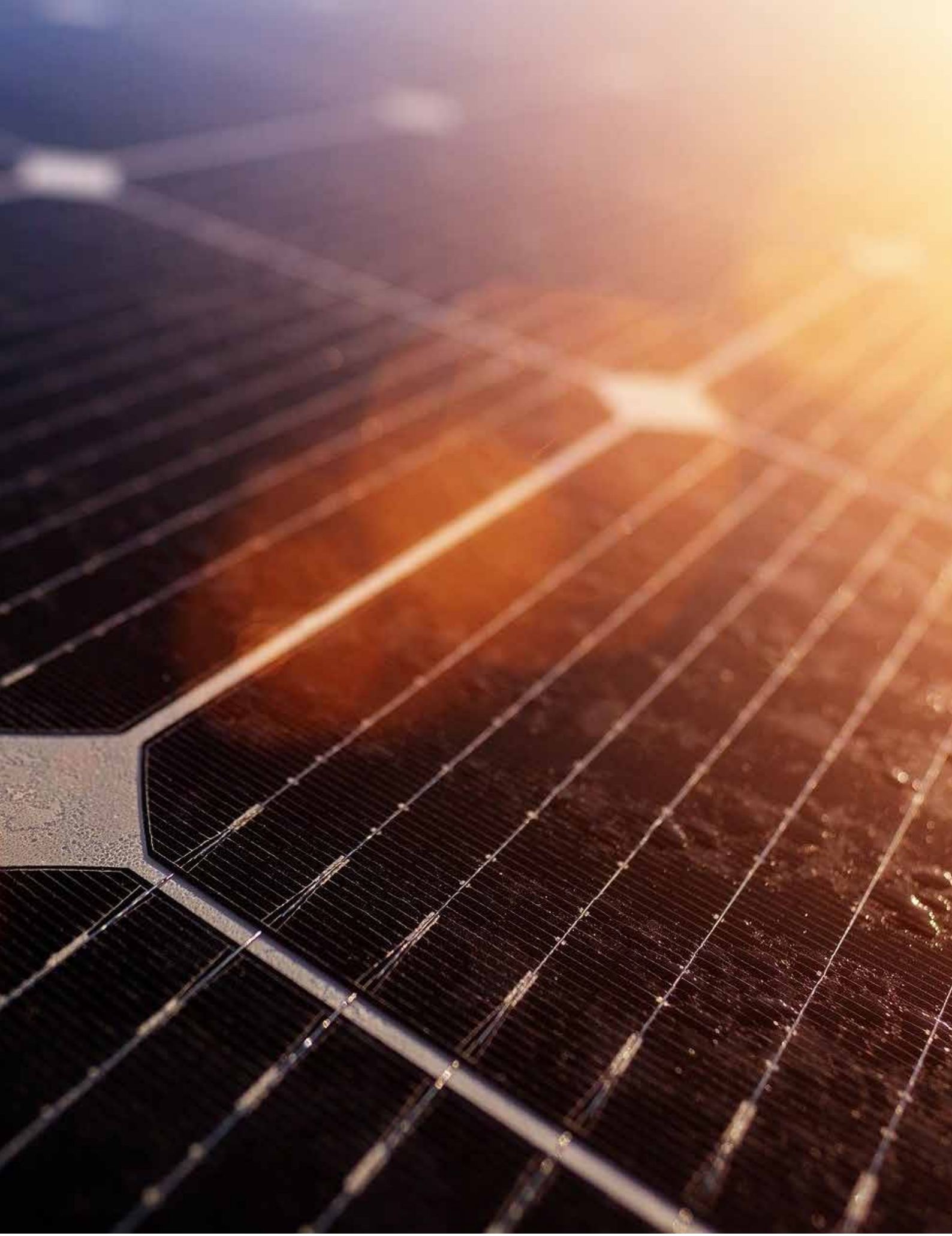
In SUNLIGHT we are all working hard to successfully transform our company from a pure industrial battery manufacturer to a technology agnostic company and to give our customers and strategic partners the freedom to move and operate on their own terms. To mark this transformation, we renewed our entire corporate identity and we are supporting our whole ecosystem to adapt to the new posed by technology disruption. Through the adoption of our new tagline "POWER IS KNOWLEDGE," we are stating that our main pursuit is to create an organization whose power is based on knowledge and an in-depth understanding of the market's needs and challenges, wanting to offer "smart" solutions that empower employees, customers, partners and the people in the communities where we are active.

With the vision of being a power source for the world, providing knowledge-based energy, Sunlight is cultivating the environment that will help it meet the challenges of the future. The company's mission is to achieve data driven knowledge, and to transform this knowledge into innovative products and applications.

Contributor

Lambros Bisalas

Lambros Bisalas is the Chief Executive Officer (CEO) of SUNLIGHT. He also serves as Executive Director of SUNLIGHT Board of Directors and holds the position of Managing Director of Sunlight's European Battery Assembly in Italy. With 12 years' experience of the Sunlight business under his belt, operating across the financial and sales divisions of SUNLIGHT's international subsidiaries, he has risen through the ranks with extensive knowledge about the company. Prior to being appointed CEO, Mr. Bisalas served as Sunlight's Chief Commercial Officer (COO), leading critical areas around sales and product management and playing a key role in the development of Sunlight's revolutionary series of "smart" Lithium batteries Li.ON FORCE. Mr. Bisalas has graduated Harvard's Business School Advanced Management Program. He holds a BSc in Business Administration from Panteion University, an MBA from IMD Business School.



PPC Renewables

Having constructed and currently operating more than 30 wind farms, 18 small hydro plants, large PV parks and a hybrid power plant with total installed capacity exceeding 230MW, PPC Renewables has a significant position in the Greek renewable energy market aiming to be a driver in the transformation currently ongoing in the country.

PPC Renewables is the only company in Greece active on all forms of Renewable Energy Sources, namely wind, solar, hydroelectric, geothermal, biomass while targeting through a combination of organic growth and strategic partnerships to further expand its portfolio in innovative technologies such as offshore floating wind farms and floating PV.

With sustainable development as our guideline, our philosophy is to create Shared Value by giving back to the local communities and the environment proactively beyond conventional obligations. Sustainable development and business planning in alignment pave the strategic path to our quest to lead the energy transformation in Greece.

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Evaluation of Electricity Suppliers by the Users of allazorevma.gr

Will the Alternative Suppliers be Able to Retain their Newly Acquired Customers?

By Athanasios Ghikas, Chairman, Clarus ESCo

The retail electricity market in Greece has been in a state of growing competition for the past five years. Although at the time of writing of this report the market share of the incumbent is still at a dominant 63% (78% of meters), about 1,2 million consumers have switched to alternative suppliers.

Allazorevma.gr, the first price comparison site of electricity prices in Greece, has been active since October 2015. During that time it has been monitoring not only the prices but also the quality of the services provided by the suppliers via an ongoing feature of the site which enables users to evaluate their supplier (current or former). This report summarizes the responses of the survey as of April 2021.

Before we proceed with a brief presentation of the results, certain qualifications must be noted.

The sample on which the results are based consists of valid responses received in the last 12 months (May 20 to April 21). Valid responses are the ones which are fully completed/ submitted and the email of the respondent has been confirmed. Only one response (the most recent) per respondent within the period is included in the sample. The sample includes evaluations of all active suppliers (including the incumbent) that have gathered enough responses to make the results statistically significant. The results are presented in a benchmarking format – there is no differentiation between suppliers.

It should be emphasized that the survey focuses on residential and small commercial consumers (92% of the respondents are residential and 8% small business consumers) and the sample is biased to the extent that the users of the site (more than 750,000 unique users so far) are not representative of the population. Yet, we believe that the results are meaningful and useful, as the users of the site are probably among the most sophisticated consumers and therefore potential opinion leaders.

The results of the survey are presented in the tables below. The evaluation focuses on three areas:

The questionnaire concludes with two additional generic questions:

- The main reason for switching
- The willingness to recommend the supplier to others

The first group of five questions pertains to the pricing and contractual policies of the suppliers.

Evaluation of the Pricing Level of the Supplier

A surprising result indicating that a substantial majority of consumers are not convinced that the price they are charged is lower than the market.

ANSWERS	
VERY LOW	8%
LOW	23%
SAME AS MARKET	28%
HIGH	27%
VERY HIGH	13%

Evaluation of the policy on guarantees/deposits

The customers seem to be happy with the policies regarding deposits. This reflects the emphasis of suppliers in promoting such policies.

ANSWERS	
NO GUARANTEE REQUIRED	20%
NO GUARANTEE (UNDER CERTAIN CONDITIONS)	32%
LOWER THAN PREVIOUS SUPPLIER	15%
EQUAL TO PREVIOUS SUPPLIER	19%
EXCESSIVE GUARANTEE	15%

Compliance of supplier with contract

This is an important and disturbing result. Almost half of the respondents seem to suspect (rightly or wrongly) that their supplier does not comply with their own contract. Use of confusing marginal price charges are the most probable cause.

ANSWERS	
NO SURPRISES	56%
MINOR SURPRISES (errors - corrected)	17%
SUBSTANTIAL DEPARTURES (unexplained new charges)	28%

Price stability

One more interesting and disturbing result. A majority of respodents either are not informed about price variabilty or accept non fixed prices.

ANSWERS	
YES, FOR THE DURATION OF CONTRACT	43%
YES, FOR A DURATION SHORTER THAN THE CONTRACT	4%
NO	28%
I DON'T KNOW	25%

Penalty for early termination of contract

A large majority of consumers take no notice or do not care about early contract termination penalties. This may lead to major future surprises.

ANSWERS	
ACCEPTABLE	13%
ANNOYING	15%
UNACCEPTABLE	14%
DON'T KNOW/NONE	59%

The second group of questions involves an evaluation of the quality of communication between the customer and the supplier.

Fast and efficient customer service

Respondents seem to be reasonably happy with the customer service so far.

ANSWERS	
SWIFT AND EFFECTIVE	12%
SATISFACTORY	34%
ADEQUATE	24%
PROBLEMATIC	20%
UNACCEPTABLE	9%

Bill that is easy to read and understand

Consumers seem to be satisfied with the quality of the bills they receive. This is quite surprising and can only be explained by the lack of alternative impressions. An expert's opinion would be that the bills in the Greek market are confusing and in some cases misleading.

ANSWERS	
COMPLETELY CLEAR	25%
RELATIVELY STRAIGHTFORWARD	42%
RATHER COMPLICATED	21%
PRETTY CONFUSING	10%
INCOMPREHENSIBLE	2%

Payment option

This is probably the best feature of the market. Suppliers have made it easy to pay the bills- and their customers are appreciating it.

ANSWERS	
VERY EASY	46%
EASY	45%
SOMEWHAT COMPLICATED	5%
HARD	2%
VERY HARD	1%

Handling of late payments/cases of inability to pay

Given the anecdotal evidence and the market conditions, one would expect that customers would have issues in such situations. It seems though that the suppliers are handling it quite successfully.

ANSWERS	
COMPLETELY REASONABLE	11%
GOOD	19%
ADEQUATE	17%
UNACCEPTABLE	11%
NOT APPLICABLE	43%

The third group of three questions involves an evaluation of the switching process.

Speed of Transition/switching

The response to this question is a tribute to both suppliers and the network operator, although there is still room for improvement.

ANSWERS	
VERY FAST (LESS THAN 5 DAYS)	22%
REASONABLE (UP TO 15 DAYS)	62%
RELATIVELY SLOW (UP TO 25 DAYS)	11%
VERY SLOW (MORE THAN 25 DAYS)	5%

Smoothness of transition/switching process

The response to this question is a tribute to both suppliers and the network operator, although there is still room for improvement.

ANSWERS	
VERY SIMPLE	24%
SIMPLE	37%
AS EXPECTED	30%
COMPLICATED	6%
UNNECESSARILY COMPLICATED	3%

Handling of special circumstances (Change of tenant, reconnection)

Even relatively complicated switching processes are handled in a satisfactory manner.

ANSWERS	
IMPECCABLE	11%
SATISFACTORY	41%
PROBLEMATIC	11%
UNACCEPTABLE	6%
NOT APPLICABLE	31%

Additional generic questions:

If you switched recently to a new supplier, which one of the following was the MAIN reason?

Search for lower price dominates as expected. Search for a fixed price comes second.

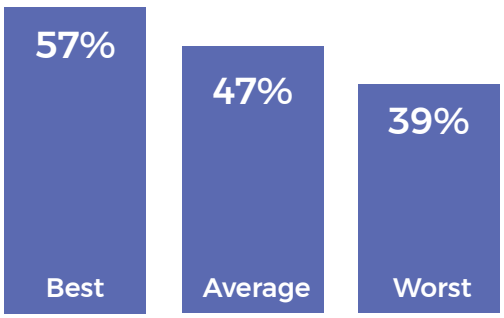
ANSWERS	
LOWER PRICE	68%
FIXED PRICE (NO MARGINAL PRICE CLAUSE)	12%
OFFER OF ADDITIONAL PRODUCT/SERVICE	9%
NOT SATISFIED WITH SERVICE OF PRIOR SUPPLIER	5%
FINANCIAL STRENGTH OF NEW SUPPLIER	3%
RECOMMENDATION FROM FAMILY/FRIENDS	2%

Finally, the respondents are asked whether they would recommend their supplier to others.

This is a surprisingly low "willing to recommend" result. The majority of respondents would not recommend their current Supplier. Our hypothesis is that this is due primarily to variance between expectations and actual results.

ANSWERS	
YES	47%
NO	53%

For this question, the benchmarking results among the suppliers are shown below:



The best supplier in terms of recommendations by his/her customers gets a 57 % positive recommendation rate. The average gets 47% and the worst only 39%.

Conclusions

Our overall interpretation of the survey results so far is summarized as follows:

As expected, consumers switch supplier mainly to benefit from lower prices – but they are not convinced that they are getting the expected benefit. Probably the main reason is the confusion created by the structure of the price offerings of the suppliers.

It seems that for the moment, consumers are not particularly unhappy with the service they are receiving from the suppliers. This is reasonable, given that the prior status was almost zero and therefore the expectations low. We do not expect this situation to last as the market matures.

The good news is that, in spite of anecdotal evidence to the contrary, the consumers seem to be overall reasonably happy with the switching process to the credit of all involved – suppliers and the network operator.

But the most important finding of the survey, which is no good news for suppliers, is that almost half of the respondents would not be willing to recommend their supplier to others. This probably has to do with the discrepancy between expectations and reality regarding the pecuniary benefits. This should be disturbing for the alternative suppliers as it could lead to low retention rates. They are in danger of losing customers at a rate that is much higher than anticipated when they calculated the cost of acquiring them.

Contributor

Athanasios Ghikas

Athanasios Ghikas is the founder of Clarus ESCo a company that developed and operates the first price comparison site for electricity in Greece, allazorevma.gr. He started his career as engineer in the distribution unit of the Public Power Corporation. He then worked as consultant. He is an Electrical Engineer and holds an MBA from Columbia Business School in New York, where he studied as a Fulbright grantee. He has been a visionary of "smart energy" for the past 39 years. This is documented by the letter he sent to his superiors in 1982 as a young distribution engineer of the Public Power Corporation, suggesting that the Company starts experimenting with electronic meters and marginal pricing of electricity. A letter that went unanswered.

6

RENEWABLE ENERGY SOURCES

6. Renewable Energy Sources

RES and Innovative Technologies to Lead Electricity System Transformation

By Ioannis S. Chadjivassiliadis, past Chairman of IENE

1. The Evolution of the Power System in Greece

The development of the electricity system in Greece from the beginning (1950) has been based on local energy sources, hydro and lignite, with a contribution of oil. In the islands' systems the power generation has depended completely on oil. The full electrification of the country (more than 99.99%) was achieved within three decades, by 1980. At the end of last century natural gas was introduced (1998) in Greece's power system in order to substitute oil and during the last two decades together with renewables they have substituted progressively a significant part of the lignite based power generation. A small penetration of renewables into the islands' power systems has been achieved in order to substitute oil, while ten small islands depend entirely on oil. Total electricity demand in the mainland system together with the interconnected islands reached 52.2TWh in 2019, with 20% share of lignite and 31% of natural gas; in total more than 51% is based on fossil fuels, while 19% of electricity was imported from neighboring countries.

The installed capacity of fossil fuel power units and large hydros is presented in the Table below.

Power Generation Capacity in Greece (as Jan. 2020)

Mainland Power System and Interconnected Islands				
Technology	Installed Capacity (MW)		Under Construction	
Lignite	14 Units	3,904	1 Unit	660MW+140MWh_{th}
Natural Gas CCGT	11 Units	4,753	1 Unit	826MW
Natural Gas OCGT	3 Units	147		
Large Hydro	16 HP Stations	3,171		
Total	11,975		1,486MW	

In addition, there are 29 power systems on the islands, including the large ones such as Crete and Rhodes, with 1,757MW of total installed capacity mainly based on oil power generation units and some renewables, mainly wind and solar PV. During 2019 the total demand of these islands supplied by the 29 autonomous power systems reached 5,561GWh, of which RES was 967GWh, that is a 17.4% penetration rate. Thus, the total electricity demand in Greece for 2019 was 57.7TWh, from which about 27% was supplied by RES.

According to the National Plan for Energy and Climate Change (submitted to the EC in January 2020), in the period 2021-2030 the withdrawal of all lignite units is foreseen (with 2028 being ultimate date), with most of them having to shut down (3,904MW) by 2023. Moreover, an ambitious target for RES penetration into the power system of more than 61% by 2030 is foreseen. This requires a huge transformation of the power system with RES and natural gas as the main sources for power generation. For the non-interconnected islands' systems, the target for RES penetration should be higher to replace a great percentage of the oil used today.

More ambitious targets for RES penetration in the power system should be expected for 2040 and 2050 leading to 100% penetration for power generation, and in addition the use of RES in conjunction with green hydrogen production for a net-zero target energy sector.

Therefore, the transformation of the energy sector should be carried out progressively over the next three decades aiming at net-zero emissions. The most challenges being in the transformation of the electricity system, especially on greatest how a 100% penetration of renewables can be achieved by new concepts and innovative technologies, for clean and affordable electricity to the economy and society.

2. RES, New Concepts and Innovative Technologies for the Power System

Wind and solar photovoltaic with a huge/unlimited potential globally are the main energy sources towards the electricity transition to an emission-free energy system. Distributed generation by solar PV in the urban environment and large wind and solar PV units (utility-scale) taking advantage of economies of scale will be mainly developed for the electricity system. The technology development and the expansion of the market during the last decade led wind and solar PV to a significant lower levelized cost of power generation, in comparison with the fossil fuels and nuclear. Moreover, the running cost of RES is negligible and almost constant in comparison with that of fossil fuel units. Thus, the power generation cost of the RES potential in an area depends mainly on the investment cost. In general, renewables have the capacity to lead the societies and the economies to sustainable development in a proper and affordable and safe way.

Advanced technologies in power generation, power electronics and control systems for wind and solar PV systems, contribute to their excellent integration into the electricity networks. The integration of the RES power systems into the operation and management of the electricity network supports a higher RES penetration and smooth operation. The introduction of ICT (information and communication technologies), AI (artificial intelligence) and other technologies

under development, as well as the digitalization of the electricity networks will support a high penetration of RES with valuable services to consumers. In addition, new techniques, such as DSR (demand side response) may increase the RES penetration and optimize the operation of the electricity system. An important aspect of the advanced wind and solar PV systems technologies is their capacity to offer valuable ancillary services to the network.

High capacity international interconnections of the electricity system are of great importance for the operation of the market and for the management of the large penetration of renewables, due to the intermittent character of solar and wind power generation, such as in the cases of surpluses or shortages of RES power generation. Large hydros offer an excellent opportunity for high RES penetration with water reservoirs at any time, which is another form of renewable energy. They have a flexibility with dispatchable power, to cover the shortages of RES power generation and at the same time to provide ancillary services to the network.

Pumped storage with power electronics offer a high capacity electricity storage with high flexibility to manage the RES in the case of high penetration. They have the capacity for storage in the cases of surplus RES generation, or to power supply in the case of shortages. Such pumped storage systems have been developed to operate in conjunction with nuclear power stations due to the lack of flexibility of these units in load balancing. Therefore, in the case of withdrawal of nuclear power stations the relevant pumped storage will be used for renewables, as is the case in Japan, Germany etc. In Greece, two hydros of 699MW total capacity with the ability of reversible operation have been used in the past to support the operation of the lignite-fired units above the minimum power limit during low-loads periods (e.g. during nights). Both hydros can be used in future as storage facilities for combined operation with wind and solar PV, supporting high RES penetration.

Advanced electricity storage systems provided by lithium batteries are under development for motor vehicles and for electricity systems, as distributed small storage units or large utility-scale ones, to cope with the intermittent character of wind and solar energy. Battery storage systems with a capacity of 4 to 8 hours discharge (in the nominal power) and bidirectional inverters with advanced control systems can manage the power generation from wind and solar so as to cover the demand, day and night, and to offer excellent ancillary services to the network. A higher penetration of RES can only be achieved by means of an appropriate storage system. However, for a 100% target RES and clean electricity system (net-zero target in electricity) an inter-seasonal storage system is absolutely necessary.

Furthermore, the production of green hydrogen through electrolysis by RES and storage to cover shortages in power generation during the year could be a real solution. In this direction there are significant efforts for the production of green hydrogen with large units using RES (P2G, power to gas) for other non-electrical uses; that means another energy carrier parallel to electricity, in place of natural gas, for zero emissions.

In future the electricity system will become the main energy carrier as demand will increase and the expansion of uses to other sectors, such as in transport, heating etc, are going to be electrified. Therefore, a great challenge is to cover all electricity demand by RES, as well as to produce green hydrogen for non-electrical uses. The new electricity system based on RES, that is mainly wind and solar PV, will function on power electronics (used in power generation systems) and on storage systems, with lack of inertia, taking advantage of their fast-response and multiple roles.

This means that a lack in inertia of the future electricity systems should be expected, without the rotating mass of the large conventional thermal units powered by fossil fuels. In the current electricity systems, the control strategies for normal operation and stability in transient conditions, as well as for protection issues, are based on the inertia of the power generation units. New concepts based on advanced technologies should be developed to meet these demands. However, it should be pointed out, that large storage systems by lithium batteries and bidirectional inverters provide excellent ancillary services to the system, especially in frequency and voltage regulation quickly due to the lack of inertia, much better than the ones provided by large hydro, where time is needed to move a high mass of water.

3. The Transformation of the Electricity System

The improvement of energy efficiency and the further exploitation of renewable energy sources are the main pillars for the energy transition, with multiple social, economic and environmental benefits. Renewables should be used both for electrical and non-electrical purposes. (e.g. for solar water heating, heating/cooling, biofuels etc.) and thus, the appropriate policy measures are necessary.

Renewables, mainly wind and solar PV, and the relevant storage systems will become the main components of the electricity systems during energy transition. The targets for 2030, the green deal and the expected targets for 2050 are dealing with a clean electricity system, that is 100% RES penetration (net-zero target). Therefore, RES should replace all power generation provided by fossil fuel and cover the expected increase in electricity demand for the year 2050, which is estimated to a level of about 50% higher than today (Greece, 2020), as everything is going to be electrified.

Taking into account the low capacity factor of wind (about 30% for onshore installations, 26% the average in the EU) and solar PV (about 19%) a huge installed capacity is needed to cover demand, estimated at three to four times higher than the present thermal power generation units capacity.

The connection and integration of this high wind and solar PV capacity to the grid require a major expansion of the network with new lines and new substations for this multiple capacity, including storage systems. That is the transformation of today's electricity system by introduction of new ideas and innovative control systems for a reliable and efficient electricity system with affordable prices to the consumers.

The new electricity system is characterized by the full integration of RES into the operation and management of the network, by the flexibility provided for power generation, transmission, distribution and demand, and by the resiliency in case of extreme weather conditions, hacking and cyberattacks. All these characteristics contribute to a more reliable electricity system with high quality electricity supply and lower number and duration of power interruptions.

In order to achieve this transformation a new architecture of networks is needed to transform today's passive network into an active network, changing power moving in one direction to power that can from now on move in all directions, by introducing new ideas and digitalization.

For the energy transition during the next three decades a huge amount of capital for investment is required, for new power generation capacity by RES and for the replacement of old units, for storage facilities, the transformation of the grid to a more interconnected grid with new concepts and innovative technologies, as well as for the upgrade and expansion of international interconnections.

Additional investments are necessary for the production of green hydrogen, higher capacity of RES power generation, in electrolysis, storage and transport/distribution of hydrogen, in order for the entire energy sector to be emission-free.

During the energy transition the gradual transformation of the electricity market should be considered, adapted to the transformation of the electricity system. New tools and new concepts should be developed, which are necessary for the operation of the grid and the market. Some tools for virtual utility/aggregator regarding the distributed generation, or virtual battery/aggregator for the distributed storage systems under development should be considered. Moreover, the batteries of the electric vehicles could be used by the network operator as a virtual battery for charging or discharging to optimize the operation of the network with mutual benefits.

Several studies and specific studies at that are needed before any action is taken to support investments in more efficient and advanced systems. Moreover, research initiatives and actions in parallel with the studies, will facilitate the energy transition to the right direction with multiple benefits.

4. The Transition of the Island Systems

In Greece the transformation of the islands' electricity systems is a priority, because they are based on oil with high emissions, local environmental problems and high cost. The additional cost to the consumers from the island systems was 676 million € in 2018. For these reasons, higher targets in RES penetration than in the mainland system should be considered. All the energy needs in these islands should be covered by renewables and mainly by electricity based on wind and solar PV, such as water desalination, transport, space heating/cooling and others.

High penetration of RES can be achieved by their integration into the operation and management of the network. Such networks use DSR (demand-side response), digitalisation and smart meters, storage facilities by lithium batteries and bidirectional inverters, and advanced control systems. Moreover, the concepts and principles of Microgrids should be introduced for a reliable operation at any case. A target for RES penetration of about 90% on an annual basis for small islands' systems and more than 70% for the medium and large size systems is effective. A curtailment of the RES power generation for some hours seasonally could considered for better economic results. A target of 100% wind and solar PV penetration for a net-zero target can be achieved with inter-seasonal storage facilities, probably by hydrogen in the future.

The diesel units can be used as back up and for contribution in the case of less RES generation seasonally (mainly in some cases in winter). This transformation should be based on market forces through competitive procedures for a new operator of the power generation system. The new operator will provide the needed investment in RES power generation, back up diesel units, storage facilities and advanced control and management system. The Distribution System Operator will be responsible for the operation and management of the network, the digitalization and the introduction of advanced systems for control, efficient and smart management.

This is a major transformation in the operation of the current systems, where a new legal framework for the islands' systems is necessary. Furthermore, this transformation will be based on detailed studies for each island's system, siting studies for wind and solar PV installations, public acceptance, support and contribution of the regulatory authority and of the network operator (HEDNO SA), which is the current operator of the islands oil-based power generation systems. This transformation of the islands system as above, is suggested for all islands's systems, even if they are connected or scheduled for interconnection with the mainland grid.

The interconnection of some islands to the mainland national grid is an attractive idea, both from an economic and environmental aspect. Interconnections of some islands in the East Cyclades are already in operation and the extension to the rest of the islands is scheduled. The interconnection of Crete is also in progress: one AC line to Peloponnese has already being installed (2021) and another line HVDC/VSC to Attica is under implementation (2023). However, the capacity of these

interconnections is considered inadequate for covering the present and future demand in Crete with the necessary reserves, and thus, fossil fuel power generation will still be necessary until 2030 as a latest IENE study has shown.

The interconnection of Crete is considered as an extension of the European interconnected electricity system to SE Europe and the East Mediterranean, where initiatives for the interconnection of Cyprus, Israel and Egypt through Crete have already been expressed. Thus, the capacity of the interconnection of Crete with the mainland system should be increased by 1GW (probably in the Crete-Peloponnese leg) in order for these interconnections to be effective. Such interconnections will improve the reliability of power supply to Crete and the Southern Greece System, where no other interconnection exists.

Independently of the plan for the interconnection of the islands with the mainland system, the development of RES and storage systems with advanced control systems and using of the concept and principles of Microgrids is recommended in order to improve the reliability of power supply in the case of any failures in the submarine cables.

5. What is Needed – Recommendations

Following the Paris Summit in December 2015 and the Agreement for Climate Change there is an ongoing global energy transition. In the EU there are ambitious targets and the "green deal", and every member-state has elaborated its National Plan for Energy and Climate Change with targets for 2030. The crucial question for Greece is how we can achieve the targets by maximizing the benefits. The high electricity prices in the Greek market, the highest in the EU, is a drawback for a competitive economy and for the consumers.

Therefore, the energy transition is an opportunity to improve the competitiveness of the electricity sector and to move electricity prices closer to the EU average. The favorable RES potential in Greece is a decisive factor in order to improve competitiveness.

- Firstly, we need relevant studies: several types of studies and specific studies. A good example for the EU is California in the United States and the role played by the California Energy Commission (CEC). For any decision or any measure taken by the State there are several studies and research projects to back it up in order to have a clear idea about the impact and the benefits, because "research powers the future". In Greece, the legislative procedures are very poor and in some cases the impact is negative. Thus, relevant studies and an impact assessment are a valuable tool, as well as some good examples and lessons from international good practices before any decision is taken. Innovative technologies must be introduced and the concept of smart cities, smart islands etc. should be developed. Following the National Plan for 2030 we need Implementation Plans during the decade up to 2030 with evaluation in time intervals of the progress and the assessment of the results.
- An important task is the siting arrangement for RES and especially for wind and solar PV applications for the period up to 2050, that is for some tens of GW for each source. This is an important step for the development of large applications taking advantage of economies of scale, while siting arrangements will facilitate the bureaucratic procedures.
- A simple legal framework for RES implementation, one specifically for each energy source, should be elaborated and adopted. Rationalization and streamlining of the legal and regulatory framework is needed with the investors in mind because they can save money (soft costs) and time, thus creating a very attractive and friendly environment for investment.
- Following the siting arrangements for RES, the grid operators should prepare the studies for the expansion of the grid. So, the network operators must be ready for any extension of the grid with new substations for the connections of RES to the grid. Moreover, the introduction and deployment of innovative technologies in the network management, especially in the distribution network should be considered. For this reason, the creation of an R&D and I (innovation) unit by the network operators for research activities is useful and necessary.

- There is a long way ahead in the energy transition with high foreseen investments and the relevant steps that should be made carefully, based on the studies' results to maximize the benefits. It is not "business as usual" and we need as soon as possible an initiative by the government and the Regulatory Authority to start the transition aiming at specific targets with the expected benefits.
- An urgent initiative is needed for the transformation of island systems, as it is presented above, because the technology is available and the benefits are significant. Moreover, this new technology "know-how" from island systems can be used in the mainland system for high RES penetration.
- In the mainland system, according to the targets and anticipated demand, an annual average of installed new utility-scale units of more than 0,5GW for wind and 1GW for solar PV up to 2030, should be planned and achieved. This is more than three times the current rate of applications and for this reason siting arrangements and a new simple legal framework for RES are necessary for a good start, as well as the use of some new tools, like PPA for new applications. Greece's depleted lignite fields offer much needed land for solar PV applications, as well as available arid lands in the country side. The 699MW available hydro as pump storage can be used when there is a significant surplus of RES generation, expected towards the end of the decade.
- The grid operators (i.e IPTO and HEDNO) have an important task and they must be prepared for new RES connections to the grid and for the development of control strategies for high penetration of RES. Moreover, some new concepts and advanced technologies, such as fault location, isolation, smart grids, smart cities, and smart meters should be used, especially by the distribution grid operator, considering the benefits of consumers. The transformation of the electricity system requires substantial research new tasks, new skills, new jobs and roles.

For all the above actions there are a human resources available in Greece today with the necessary skills, and they can be employed to move the electricity system to the future with the expected benefits.

Contributor

Ioannis S. Chadjivassiliadis

Ioannis Chadjivassiliadis with a diploma in Mechanical and Electrical Engineer of the NTUA and he is an expert in the development of the renewable energy sources and sustainable power systems. He worked for the Public Power Corporation (1962-1990) as director of power plants. From 1975 in charge for the development of wind and solar energy projects for power generation with the successful first in Europe Windpark of Kythnos (1982) and the biggest hybrid by wind and solar PV with innovations. 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. Founding Member of the European Wind Energy Association (EWEA, 1982), founding Member and Chairman (2013-2019) of IENE. Recipient of the "Prize Aeolus" Award, by the Hellenic Wind Energy Association- (2009), of the "2010 PES Chapter Outstanding Engineer" Award, by the IEEE Power & Energy Society, "Certificate of Outstanding Contribution in Reviewing", by Elsevier Reviewer Recognition, Energy Policy, 2017.

The New DAPEEP – Green Energy, Environment, Sustainable Development

By Yiannis Yiarentis, Chairman of BoD & CEO, Renewable Energy Sources Operator & Guarantees of Origin (DAPEEP)

Introduction

In the modern energy world, which is characterized by high volatility, groundbreaking innovation and diverse business activity, Energy Sources Operator and Guarantee of Origin (DAPEEP) has a key role. DAPEEP's mission is to implement environmentally efficient policies for the country's energy transition to an economy of reduced greenhouse gas emissions but also to create and ensure a safe investment climate for potential investors in which the necessary investments will be made. At the same time, it must achieve the widest possible social acceptance for Renewable Energy Sources (RES), environmental policy and energy transition. Guided by the updated National Plan for Energy and Climate (NPEC) for the complete lignite phase out of the country by 2030, DAPEEP has to redefine the priorities of the company. Since the new management asumed its duties (August 2019) DAPEEP set up the new goals and perspectives in order to become a leading actor in Green Energy, Environment, and Sustainable Development in order to assist Greece in achieving its goal, the de-carbonization of the Greek economy. There has already been a remarkable success mainly in returning back to normal the compensation to RES producers and the "just in time" and without any delay repayment of the obligations of DAPEEP to producers.

Green Energy

Utilizing its capacity as

1. Counterparty with Investors/Producers of RES and High Efficiency Electricity & Heat Cogeneration Stations (HEEHCS) with which it has concluded, during the past, contracts for the sale of electricity as provided in law 3468/2006 or concludes in the present contracts for operational support type Fixed Price Operating Aid Contracts (FPOAC) and Differential Enhancement Functional Aid Contracts (DEFAC) according to the provisions of law 4414/2016
2. Exclusive Administrator of the RES & HEEHCS Special Account, according to article 40 of the law 2773/1999 for the Interconnected and Non-Interconnected System for the financial and accounting management of the account and the compensation on a monthly basis of the producers RES & HEECS in Greek
3. Operator of the RES & HEEHCS stations in the Electricity Market (EM/Target Model) and the submission of injection bids per technology / loss zone and operating system zone (North - South)

DAPEEP plays a leading role in ensuring the penetration of green energy in the country's energy mix. In the context of the innovative changes promoted in the field of RES by the new legislative and regulatory initiatives of the Ministry of Environment & Energy (MEE), DAPEEP uses the existing responsibilities and its specialization to become a "one-stop shop" not only to simplify the licensing process of new RES stations but also to promote investments in green energy in general. In order to better respond to its role DAPEEP gradually adopts the application of the methodology of the ESSA standards of in organizing its internal functions.

1. Eliminating unnecessary actions

2. Standardization

3. Simplification

4. Automation

In infrastructure, the Operator upgrades the INFORMATION SYSTEM OF RES & HEEHCS STATIONS in which the energy and accounting clearance of the RES & HEEHCS units are carried out today and is essentially accompany the existence of producers of RES & HEEHCS. It's the system that includes, according to the existing institutional and regulatory framework, the most up-to-date snapshot of the Register of RES & HEEHCS units, maintains registered the basic identity and functional characteristics of each RES & HEEHCS welcomes the measurements from the power station and ultimately prices and compensates RES producers. In this existing Information System, the necessary interventions and extensions will be made in order to welcome in the future, in the capacity of the only licensing interface, the new potential RES producers.

In this information system, a single platform can be implemented in which the economic operator, ie the physical or legal person, who wishes to include a new RES or HEEHCS station in the Register of RES & HEEHCS Units, will enter and submit his application and will upload the necessary legal documents which will be accessible to all bodies in charge of the individual licensing procedures. The automation of the system will give a crystal picture, with transparency, data protection and online information of the investor about the course of his application and the path that will be followed.

Environment

Utilizing its capacity as

1. Auctioneer of the Hellenic State for the Rights of Greenhouse Gas Emissions, where in the framework of the implementation of Directive 2003/87 / EE on the establishment of a Community system for marketing rights to greenhouse gas emissions, represents the Greek State in auctions in the transitional platform of the Hellenic Energy Exchange (HEE) and manages accounting revenues from the respective auctions,
2. Responsible for the compensation(balancing) of indirect emission costs, where it has undertaken the implementation of the national mechanism for compensating indirect emission costs for sectors of companies and sub-sectors exposed to a significant risk of Carbon Leakage,
3. Responsible for the process of inclusion of potential beneficiaries in reduced Special Emission Reduction Fee (SERF) charges, where through the implementation and management of an appropriate information system has taken responsibility for the inclusion of potential beneficiaries in the categories of reduced SERF charges of article 4 of MEE No. 76979/4917 ΦΕΚ Β'3373 / 31.08.2019

DAPEEP aspires to play a leading role in implementing policies to protect the environment and reduce greenhouse gas emissions which are part of the electricity management sector.

On this basis and within the framework of the EU Directives on the Transmission Rights Trading System, it has a distinct (separate) role in the implementation of the national policy to reduce carbon leakage in the period 2013-2020 and at the same time actively participate in the emerging new Community framework for tackling coal leakages in the period 2021-2030 by assisting the Greek State in consultation with the EU.

Responding to the requirements of the new regulatory framework of MEE for the rationalization of reduced SERF charges in energy-intensive industries, that are at high risk of carbon leakage, the DAPEEP is in the final stages of implementing the Information System platform that will manage the Register of Beneficiaries of Reduced SERF (e-Registry). This platform, which is based on cloud computing technologies and uses web services of the General Secretariat of Information Systems (GSIS) will manage the computational load of submitting and evaluating applications for reduced SERF of potential beneficiaries (250,000 beneficiaries: 2019-2028), in accordance with EU Energy and Environment Guidelines. The Electronic SERF Register will be updated on an annual basis. It will document and certify the eligibility of potential beneficiaries of reduced SERF. Simultaneously, it will calculate the Unique SERF Charge of potential beneficiaries based on quantitative indicators from the energy and economy numbers of the past three years. According to the new regulatory framework of MEE and the EU guidelines based on the updated Electronic Register, the Regulating Authority will calculate with transparency and impartiality the SERF Charge of all of the national wide producers.

Given that the Community Regulatory Framework for Limiting Carbon Leakage (either in the case of indirect emission cost compensation or in the case of reduced financial support for RES) provides for the implementation of energy efficiency measures by the respective beneficiaries, DAPEEP is utilizing its expertise in evaluating the energy efficiency of HEEHCS stations, develops interoperability issues related to energy audits to save energy. On this basis and responding to the planning of MEE to finance projects and actions aimed at improving energy efficiency in final consumption, in accordance with the provisions of Article 20 of Directive 2012/27 / EU, the Operator actively participates in the formation of the institutional framework of the competitive processes in energy efficiency. These measures are expected to contribute to the leverage of funds from the parties involved in the energy market, to the strengthening of their business activity and to the reduction of the cost of achieving savings units.

Sustainable Development

Utilizing its capacity as is defined by law as Energy Sources Operator and Guarantee of Origin from RES and HEEHCS for the interconnected system (L. 3468/2006) DAPEEP proceeds with the operation, maintenance and update of the unified Information System (MD n.D6/F1/8786/2010) which is the Electronic Register of Guarantees of Origin in Greece.

Furthermore, DAPEEP will have a leading role in implementing policies that ensure sustainable development through the promotion of green certificates certifying that the final energy used is green. On this basis, since 2019 DAPEEP has joined the European Association of Issuing Bodies (AIB) and from December of the same year DAPEEP became member of the European Association of Operators of Guarantees of Origins.

European Operators have recognized the high level of know-how of DAPEEP executives and as a result in 2020 they assigned to it the chairmanship of the EECS Unit of EIB Unit. It is a very high distinction for DAPEEP, which following a Pan-European Conference, the solemn declaration of DAPPEP as a member of the EIB took place together with the assumption of the Presidency. Although COVID-19 may have postponed the actual conference the honorary distinction has been made and provides a compass for the future course of the Guarantees of Origins activities.

That is not all. Since 2019, a year of significant developments for the System of Guarantees of Origin in Greece and especially in September of the year, for the first time DAPEEP determined and published the energy mix of each Supplier of electricity, allowing in this way the offer alternative products as far as the origin of the electricity to the final consumers is concerned. The calculation of the Energy Supply Mixture resulted in an increase of domestic use of GOs to improve the origin of electricity in final consumption by 64% (2019 to 2018). Respectively, the recognition of Greek Guarantees of Origin in Europe thanks to the actions of DAPEEP, resulted in the export of 1 million GOs in 2019 and 0.7 million only in the first quarter of 2020, despite the technical problems that prevent export to countries that their Registers receive GOs exclusively electronically, through the European cross-border trade platform operated by AIB (AIB HUB).

Within the current year, it is planned to remove the technical restrictions on the cross-border trade of Guarantees of Origin with the implementation by the DAPEEP Information System that will make possible the interconnection of the Greek Registers with the AIB HUB.

In the future and in implementing of Directive 2018/2001 / EU, which will be incorporated into national law by July 2021, the statute of Origin Guarantees will extend to biogas and hydrogen. DAPEPEP, with its experience in the management of the Greek GO Register for electricity and as an active member of the EIB, an association that leads in the formation of the emerging and dynamic GO market for biogas and hydrogen, is ready to become the national issuer Guarantees of Origin.

Moreover and as far as GOs of electricity is concerned, DAPEEP aspires to play the role of Environmental Market Operator, so that the management of organized markets for the purchase and sale of Origin Guarantees ensures the continued availability of additional resources to enhance penetration and also ensure environmental protection.

Conclusion

Finally, I would like to stress that DAPEEP will not stop here, because the vision of its management aims at making the company a central pillar for Renewable Energy Sources in Greece various. Initiatives will soon follow together with programs that will strengthen the role of the company but also its intervention in the energy landscape of Greece.

Contributor

Yiannis Yiarentis

Yiannis Yiarentis is currently the CEO and the Chairman of the BoD at DAPEEP S.A., which is the state company authorized to operate the Renewable Energy Sources in Greece, handling 14.000 RES production contracts and 2 billions budget annually. During 2013-2015 he was the CEO and the Chairman of the BoD of ADMIE, the company which is the Utility company operating the Electric Transmission System in Greece. His work experience in top managerial roles within Energy sector in Greek and Multinational companies supported by his academic background in Petroleum Chemistry, Engineering and Sustainable development helped him to result significant results through his 30 years carrier. He represented Greek State in several European Committees (ENTSO-e, MED-TSO), also being member of the Greek National Counsils.

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PPC's Pioneering Role in the Development of Renewable Energy in Greece and Today's Challenges

By Konstantinos Mavros, Vice President and CEO, PPC Renewable

A significant energy transformation is currently taking place, globally. According to IRENA, 2020 was a global record year, in terms of new renewable energy capacity additions of more than 260GW, reflecting the critical role of RES towards the energy transition[1]. The development of renewable energy and energy efficiency projects and the enhancement of electrification are the main drivers for the promotion of this energy transition and the enhancement of socio-economic development. Electrification creates new challenges and opportunities for further growth in the energy market. Electromobility, application of heat pumps in buildings and electrolytes for the production of "green" hydrogen are technological practices that are expected to become commercially viable on a large-scale, soon. The existing energy transition in conjunction with the extensive further application of electricity in energy systems is expected to be the main driver to boost investment in new RES projects.

In December 2020, the Council of the European Union reached an agreement on a general approach on the proposal for a European climate law, including a new EU greenhouse gas emissions reduction target of at least 55% by 2030 compared to 1990[2]. Regarding the current national energy policy, the updated National Energy and Climate Plan (NECP) sets ambitious National targets and, in particular, at least 35% RES share in gross final energy consumption, with the corresponding RES target in gross final electricity consumption, at least 60%. These targets may further be aligned with the revised climate goals set at a European Union level and with current market potential. Thus, the implementation of significant investments in RES projects is at the core of the current energy transition in Greece with the estimated investments reaching EUR 9 billion during the current decade.

In addition, the lignite phase out, by 2028, further strengthens the role of RES in Greece. In this constantly changing energy environment, PPC Renewables, being a wholly owned subsidiary of the largest Greek power utility, Public Power Corporation (PPC), is expected to play a critical role, with an RES projects portfolio than 7GW at various stages development and maturity.

[1] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Apr/IRENA_RE_Capacity_Statistics_2021.pdf

[2] https://www.consilium.europa.eu/en/press/press-releases/2020/12/17/council-agrees-on-full-general-approach-on-european-climate-law-proposal/

PPC Renewables is active in all forms of renewable energy, contributing significantly to the utilization of inexhaustible and renewable resources in the country and focusing its strategy on innovation, sustainable development, and environmental protection, hence continuing PPC group's pioneering RES development since the 80s. Ever since, PPC Renewables has strengthened its portfolio of wind projects and maintained its innovative role through the implementation, for the first time in Greece, of a comprehensive renovation plan (repowering) of old wind farms in the Aegean islands. The company has also proceeded with organic growth of wind and small hydro projects as well as JVs, such as the recent acquisition of 45% out of approximately 70 MW wind farms from Volterra (a subsidiary of the AVAX group). In the field of photovoltaic (PV) energy projects, PPC Renewables participated in the tender procedures organized by the Regulatory Authority for Energy (RAE) during years 2019 and 2020, and secured a FiP reference price for new PV projects of 241MW located in the Lignite Fields of Western Macedonia and Megalopoli. PPC Renewables aims to further strengthen its position in the Greek small hydroelectric market through the deployment of an investment plan that incorporates the construction of three new projects within the next 24 months, with a total budget of around €20 million.

In the field of geothermal energy, PPC Renewables puts high in its priorities the utilization of the four high enthalpy geothermal fields in Greece located in various islands as well as in the interconnected system via a JV with a recently selected strategic partner. Finally, biomass derived electricity is also present in the Group's business plan, further exploiting the long-standing expertise in thermal power plants. In addition, PPC Renewables has already submitted to the Regulator applications for energy production licenses for storage facilities with batteries of c.1GW (approx. 3GWh p.a.). The conclusion of strategic partnerships constitutes another integral part of the group's strategy, where PPC Renewables is already examining its potential collaboration with strong market players, having already signed MoUs with major multinational energy companies. In this context, the possibilities of cooperation are examined with the aim of the joint construction and development of RES projects in Greece, putting emphasis on wind and PV projects. Within this framework, in place PPC's BoD recently approved the Head of Terms for the cooperation between its PPC Renewables and RWE Renewables GmbH, aiming at the joint contribution and development of PVs plants with a total installed capacity up to 2 GW through a Joint Venture (JV).[3]

PPC Renewables is expected to play a leading role in the deployment of RES projects in Greece through the implementation of its integrated business plan. The development of new utility-scale PV projects in the lignite fields of Western Macedonia and Megalopoli are landmark investments that will contribute to the company's organic growth, as well as lead the market. In addition, PPC Renewables is exploring the possibility of developing new projects of innovative RES technologies,

including among others offshore wind and floating PV technologies, and participating in the new electricity market, under the Target Model, that is already in force since November 2020. In particular, the 39 MW PV project of Arcadikos Ilios I, part of a total 50 MW PV project, located in Megalopolis will become the first major RES project in Greece that will operate within the Target Model's framework through a bilateral power purchase agreement (PPA) signed with the parent company (PPC S.A.) without securing a reference price through auctions organized by RAE. The investment plan of PPC Renewables envisages that the total installed capacity of its RES portfolio will reach, or even exceed, the level of 1.5 GW by 2023, contributing to the increase of the company's share in the Greek RES market, from 2% today to 15-20% in the coming years.

PPC Renewables is dynamically positioned in the energy market through the realization of significant investments in new RES projects which are expected to act as a catalyst for the achievement of the national clean energy goals and the current energy transition, guided by fair and sustainable development for society, as well as guarantee protection of the environment.

Contributor

Konstantinos Mavros

Konstantinos Mavros has significant and diversified experience in the broader energy sector and the fields of corporate finance and technology. He has worked in the past in the Renewable Energy Sector, and has been leading companies in the technological field. He has also co-founded a Venture Capital fund supported by the European Investment Fund. He is an active member and holds key positions in several international professional and academic associations and has been a visiting lecturer at the Athens University International MBA program. Mr Mavros holds a Masters' degree in Finance from Imperial College London and has completed high level executive education programs at Harvard Business School.

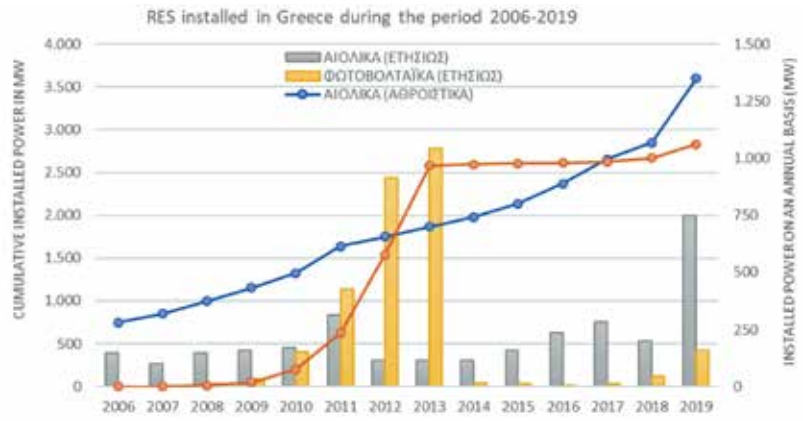
[3] https://www.dei.gr/en/anakoinwseis/xrimatistiriaka-etairikes-prakseis-katavoli-merismatos-ka/stock-news-2021/egkrisi-sumfwnitikou-sunergasias-metaksu-dei-anane

Evolution of Renewables Investments in Greece - Wind Energy in the New Electricity Market

By Panagiotis Ladakakos, Chairman of Hellenic Wind Energy Association (ELETAEN)

The sector of Renewable Energy Sources (RES) showed significant growth during the last fifteen years in Greece, despite the deep financial crisis which faced the country. According to the publicly announced data by the Hellenic Wind Energy Association (ELETAEN) the construction of new wind farms remained stable during the first half of the previous decade but its growth rate accelerated afterwards. 2016 with new wind installations of 234MW and 2017 with 282MW were until recently the third- and second-best annual performances after 2011 which was be a record year with 314MW. However, we notice a significant increase of pace during the last two years which evidences the shift of the Greek market to a more mature market with several new players entering the field. More specifically, 2019 marked an all-time record with almost 750 MW of new wind capacity being installed and connected to the national grid while for 2020 it seems that the new installations will exceed 500MW.

Figure 1 • Installed Power (MW) of RES in Greece during the period 2006-2019



Source: Hellenic Wind Energy Association[1] and Hellenic Association of Photovoltaic Companies[2].

Table 1 • Installed Power (MW) of RES in Greece during the period 2006-2019

Year	Wind (Cumulatively)	Photovoltaic (Cumulatively)	Wind (Annually)	Photovoltaic (Annually)
2006	750	0	146	0
2007	850	2	100	2
2008	997	12	147	10
2009	1.155	47	158	35
2010	1.323	199	168	152
2011	1.637	624	314	425
2012	1.751	1.536	114	912
2013	1.866	2.579	115	1.043
2014	1.979	2.596	113	17
2015	2.136	2.606	157	10
2016	2.370	2.611	234	5
2017	2.652	2.624	282	13
2018	2.849	2.668	197	44
2019	3.597	2.828	748	160

Source: Hellenic Wind Energy Association[1] and Hellenic Association of Photovoltaic Companies[2].

[1] https://eletaen.gr/wp-content/uploads/2020/07/2019-hwea-statistics-greece-upd-6-2020.pdf

[2] https://helapco.gr/wp-content/uploads/pv-stats_greece_2019_2Apr2020.pdf

At the same time we observe that investments in photovoltaic (PV) stations have shown an impressive growth since 2010, which peaked in 2013, due to the attractive compensation price of energy produced at that time and the strict deadlines available to the photovoltaic investors to realize their investments. This shift of investors to PV investments was combined with a temporary reduction (but not zeroing) of wind investments during the period 2012-2014. Since 2014, the substantial withdrawal of incentives for new PV investments has led to market stagnation, while again in the last years there is a renewed interest for PV investment sector with the participation of a significant number of investors in auctions held by the Regulator (RAE).

In total, during the previous decade, it is estimated that new investments in wind farms in Greece reached four billion Euros. Across the RES sector, new investments exceeded nine billion Euros. Apparently, these investments were mainly financed by the domestic banking system, which despite its problems during the crisis years, continued to show confidence and to finance the RES sector in Greece.

Figure 2 • Cumulative investments in the RES sector in the period 2006-2019 (in millions of Euros)

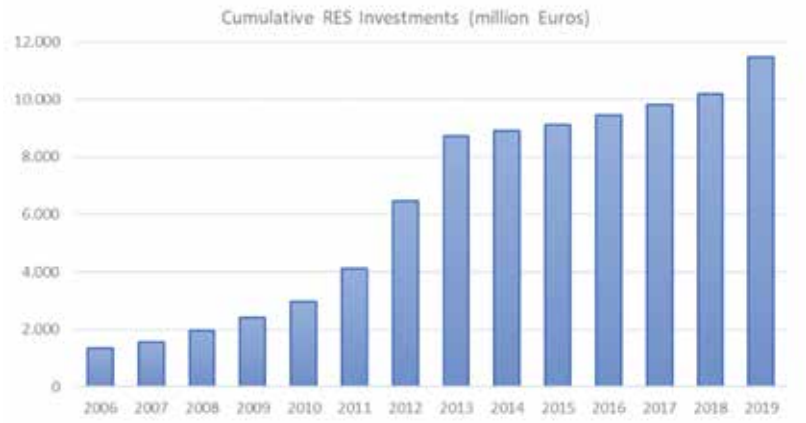
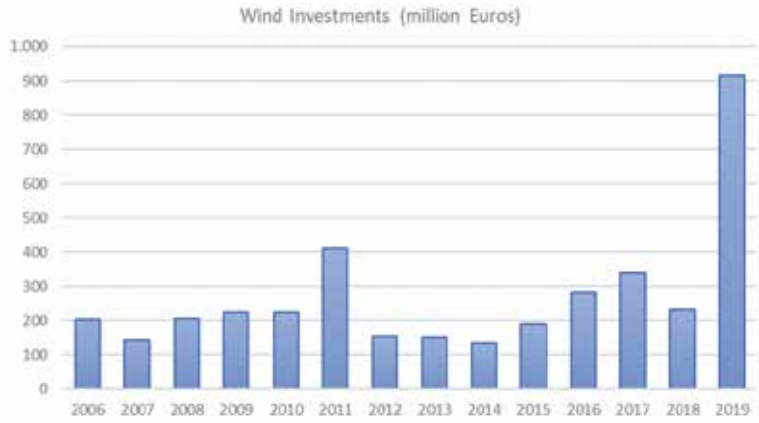
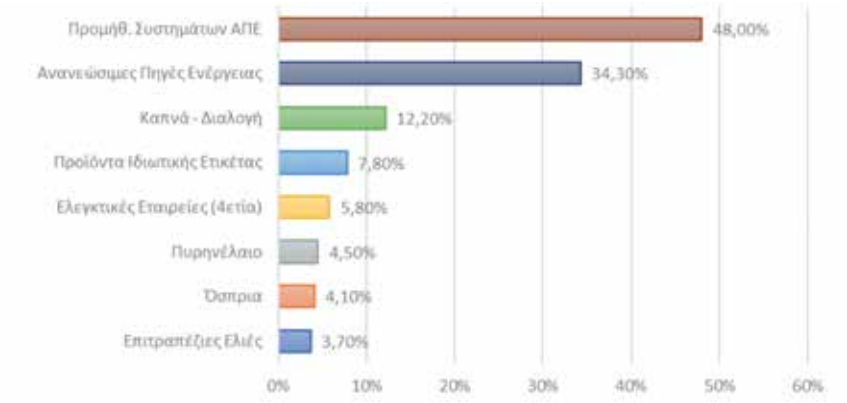


Figure 3 • Annual investments in wind farms in the period 2006-2019 (in millions of Euros)



The resilience of the wind energy sector, and in general of renewables, during the years of Greece's economic crisis is confirmed by the results of the sectoral ICAP study entitled "The Consequences of the Crisis in the various Sectors of the Greek Economy", published in July 2014, i.e. in the middle of a very troublesome period for the country. According to the results of this study which examined 87 industrial sectors and products: "The best performance concerns the RES sector, which showed an impressive increase especially in the period 2011/2012, due to the favorable conditions of the institutional framework (high energy compensation prices)."

Figure 4 • Sectors with the highest growth in 5 years according to the ICAP study, July 2014



It is obvious that investments in renewables and especially in wind farms are considered worldwide as an attractive option due to its fundamental characteristics. Those characteristics protected the wind energy sector in Greece during the crisis years and are recently causing a new round of huge investment appetite despite the fact that the feed in tariff regime is no longer in place and prices of electricity have decreased dramatically after the introduction of auctions over the last years. More specifically:

According to the institutional framework that remained in force until the end of 2015:

- Wind investments were not exposed to commercial risks. This is due to the dispatching priority of all energy produced at a fixed price for 20 years, for all RES investments that signed a Power Puchase Agreement (PPA) until the end of 2015.
- The cash flows of wind investments are predictable with certainty thanks to their characteristics.
- The average amount of electricity produced per year can be accurately predicted before the implementation of the investment, as it depends on the given wind potential of the installation site that remains on average quite stable during the 20 years lifetime of the investment. Thus, the guaranteed sale of the entire production at a fixed price for 20 years, implies accurate predictability of expected revenues.
- The annual costs are also fully contracted / predetermined for the entire duration of the investment, as they are not subject to changes in fuel prices as is the case with conventional power plants, as long as the energy source is free and renewable.

The above characteristics ensure stable and predictable profit margins for wind farms and stable cash flows to their shareholders. However, from 2016 and onwards, several of the above "certainties" changed in order to gradually expose a mature technology like wind energy into a competitive free electricity market: One of the most important factors of stability, the guaranteed sale prices that contributed to the development of wind investments, changed by the provisions introduced by Law 4414/2016. Significant changes were also introduced in the way wind farms were operating in the electricity market as well as in the compensation scheme for projects that had not signed a PPA by 31.12.2015. The changes brought by Law 4414/2016 were not unexpected by investors since the framework applied was more or less following similar examples in other EU countries with the ultimate aim of achieving a unified European market during the current decade. Under this new regime, the operation and consequently the revenues of wind farms and RES in general are now based on two -in essence- distinct axes:

- The income they will earn from their direct participation in the electricity market.
- The second - in addition to market participation - source of revenue for a wind farm or RES plants in general, is the feed-in-premium it will receive during its operation for the energy produced.

The feed-in premium mechanism, is considered more suitable to optimize the participation of wind energy in the market. In particular, it can create incentives for more efficient management of wind parks (peak production, installation in areas with higher local electricity prices if applicable), more efficient network management and better provision of ancillary services.

Moreover, the new mechanism is more compatible with the liberalized market model. While this feature alone is not necessarily an advantage, it is a fact that the feed-in-premium mechanism better integrates the value of electricity into the overall compensation received by RES. Moreover, the new market design encourages competition between technologies and production units.

With the provisions introduced by Law 4414/2016, from January 1, 2016, RES electricity plants that had not signed a PPA's until the end of 2015, participate in the daily electricity market. This means that the compensation of the generated electricity is done with the hourly price of the daily electricity market, which is determined competitively, plus a premium. The amount of the premium is such that its sum with the hourly market price has a minimum fluctuation around a Reference Price. For 2016, the Reference Price was administratively determined by Law 4414/2016 at 98 € / MWh, while from January 1, 2017 it is determined through an auction system undertaken by the Regulatory Authority (RAE).

In addition, the new wind farms which will participate in the daily market, must predict and declare the power they will produce in the next day and will be penalized in case of discrepancies. They also have to pay the so-called balancing cost and generally these projects have "market obligations" like all other power stations. It is clear that these new investments will operate in an environment that is not protected, as it was by the end of 2015 and is no longer completely predictable.

RAE's competitive processes (auctions) involve wind farms with a capacity greater than 3 MW, while the smaller units receive a fixed compensation price equal to the Reference Price. The reference price of the projects that are exempted from the obligation of tenders, is modified by a decision of the Minister of Environment and Energy, following an opinion submitted by RAE, which is issued within the first quarter of each calendar year. This decision determines the Reference Values that apply to power stations from RES that initiate operation after the first day of the following calendar year of the year of issuance of the above decision of the Minister of Environment and Energy. For the last three years, RAE has been conducting auctions for submission of bids by RES plants including wind farms, in order for them to be included in a support regime in the form of Operational Aid of article 7 of Law 4414/2016. RAE has conducted such 13 such tender procedures applied to more than 2,700 MW of wind and photovoltaic plants.

Figure 5 • Selected RES power in the 13 tender procedures carried out by RAE

Especially for wind farms, the first auction was held in July 2018 and the most recent, fifth in a row, was held in July 2020. According to the results of the July 2018 auctions, which were published in No. 649 / 2018 Decision of RAE, it appears that in Category III (Wind power plants 3 MW <P ≤ 50 MW), the weighted average selling price of electricity was 69.53 € / MWh, in the tender procedure of December 2018 the weighted average price was 58.58 € / MWh (No. 1230/2018 Decision of RAE), in the tender procedure of July 2019 the weighted average price was 67.32 € / MWh (No. 705/2019 Decision of RAE), in the tender procedure of December 2019 the average weighted price was 57.74 € / MWh (No. 1246/2019 Decision of RAE) and in the tender procedure of July 2020 the average weighted price was 55.67 € / MWh (No. 1142/202 0 Decision of RAE).

In the figures which follow statistical data from RAE's auctions are presented showing the significant and continuous de-escalation of the compensation prices of wind and PV parks in Greece.

Figure 6 • Average Energy Price per year & tender procedure (€ / MWh)

Figure 7 • Development of tenders in the context of competitive procedures for PV, source RAE

	Jul-18	Dec-18	Jul-19	Dec-19	Jul-20
Mean	71,17	66,60	62,77	59,98	49,80
Ceiling price	85,00	81,71	69,26	66,02	63,00
Max	80,00	68,99	67,70	65,99	62,45
Min	62,97	63,00	61,95	53,82	45,84

Figure 8 • Development of tenders in the context of competitive procedures for wind farms, (source RAE)

	Jul-18	Dec-18	Jul-19	Dec-19	Jul-20
Mean	69,53	58,58	67,31	57,74	55,67
Ceiling price	90,00	79,77	69,18	68,25	63,00
Max	71,93	65,37	69,18	61,94	57,70
Min	68,18	55,00	59,09	55,77	53,86

Figure 9 • Development of bids in the context of common competitive procedures, source RAE

Looking ahead, wind energy is expected to play a dominant role for Greece to be able in order to achieve its energy and climate targets. More than 500MW of new wind installations should be connected to the grid on an annual basis I the current decade. The ultimate target is to fully decarbonize the country's electricity system by 2050, something which seems extremely difficult with the current structure of the electricity system.

However, already from last year, partly due to the Covid19 pandemic, Greece's electricity network experienced some unprecedented circumstances of high wind penetration during which the country's electricity system performed without any problem. Indicative reference is made to high wind energy penetration that approached 70% of the demand (68,8%, 6.11.2020, 03:00 – 04:00 CET), the fact that for 1235 hours during last year the wind energy penetration was above 30% and if we consider all variable RES the same figure is 2865 hours (for penetration above 30%) and 429 hours (for penetration above 50%). These figures are encouraging but we should not forget that in order to achieve the ultimate targets, numerous and significant reforms are required both at technical and institutional level.

Contributor

Panagiotis Ladakakos

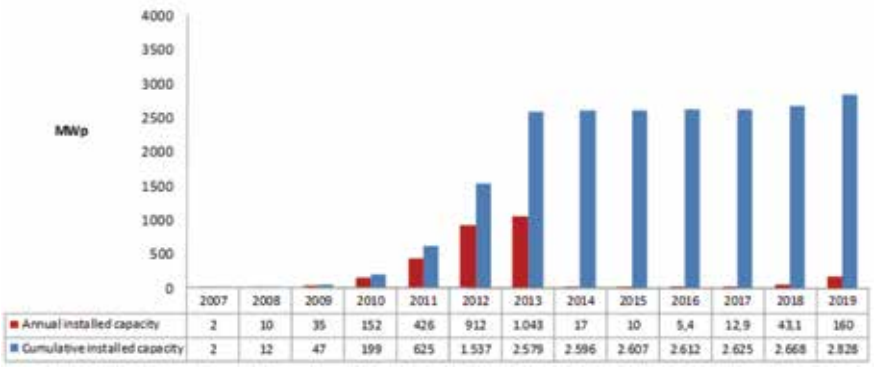
Mr. Panagiotis Ladakakos is President of the Hellenic Wind Energy Association (HWEA) and Managing Director in companies of the ENTEKA Group. He has a degree in Electrical Engineering from the National Technical University of Athens and specializes in Renewable Energy Systems and Electrical Networks. During the last 25 years, he managed the Development, Construction and Operation of a large portfolio of windfarms and photovoltaic plants in Greece working in close collaboration with large multinational firms. He is also investor in several renewable projects. Mr. Ladakakos possesses valuable research experience during his Ph.D. studies in the Department of Electrical & Computer Engineering of NTU Athens and his activities as a Research & Development engineer for the Greek Center for Renewable Energy Sources (CRES) and in the Renewables Department of the Public Power Corporation where he worked in the first years of his career. He has also studied Economics and Marketing in the Department of Operational Research & Marketing of the Athens Economics University.

The Prospects of Photovoltaics in Greece

By Dr. Sotiris Kapellos, President, HELAPCO

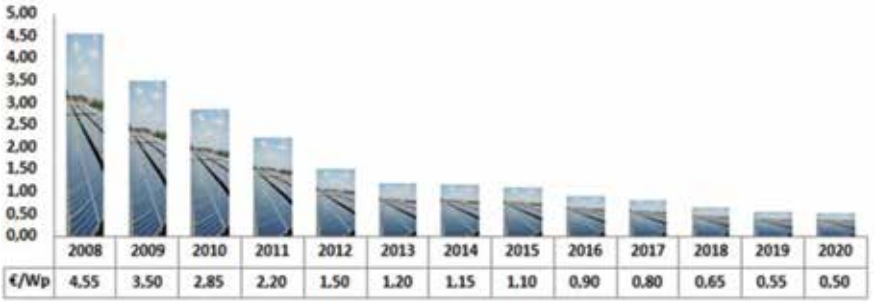
Despite the Coronavirus pandemic and a series of lockdowns in many countries, the PV markets continued to grow in 2020. More than 115 GW of new PV capacity was added in 2020 worldwide. In Greece the situation looks even better. The Greek PV market doubled its newly installed capacity compared to 2019. The reason is that the tsunami of investments was slowed down but not stopped by the pandemic, and this is going to be the case in the coming years as well. PV has become the cheapest electricity source almost everywhere, and low cost means a huge advantage compared to fossil competitors or even other renewables.

Greek PV market development



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

Average PV CAPEX in Greece (systems>1 MWp) including grid connection



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
€/Wp	4.55	3.50	2.85	2.20	1.50	1.20	1.15	1.10	0.90	0.80	0.65	0.55	0.50

Furthermore, PV has become a mainstream asset in terms of energy planning. According to Greece's National Energy and Climate Plan (NECP), the installed capacity of photovoltaics will be at least 7.7 gigawatt by 2030. Since we currently have a bit more than 3 gigawatts, installed, and the already auctioned capacity is 1.3 gigawatts, this creates room for more than 4.3 gigawatts of PV to be installed by 2030, creating an average of 400-500 megawatts of installed PV capacity per year. This is very good for the Greek economy and for the solar market as well. This extra capacity entails more or less €2.5 billion worth of investments in solar PV alone. The good news is that, due to higher targets for CO_2 reductions in the EU, as a result of the recent Green Deal presented by the Commission, RES targets are also expected to increase in the next couple of years. We expect that the new overall target for PV till 2030 to be over 10 gigawatts.

The pros and cons of the Greek PV market

There are several pros and cons that should be considered by investors looking into the Greek PV market. As for the advantages, Greece is a southern EU country due to which solar radiation is much higher compared to northern EU countries. As a result, the investment yield is also higher, and the performance of investments is comparatively better as well; we have higher income for the same capacity in Greece. Another benefit is the cost of land for the development of PV projects. Whether this is through the acquisition or leasing of land, regardless of whether it is privately or publically owned, the cost of land in Greece is lower compared to its northern EU counterparts. As a result, the operational cost of PV investments with respect to land use and the installation of projects are lower. Last but not least, and for the most part, project development costs are also comparatively lower in Greece vis-à-vis northern countries. Conversely, there are a number of challenges that still need to be overcome:

To begin with, we lack clear guidelines with respect to the possible uses of land. Greece does not yet have an official land registry. This is in the process of being clarified and a large number of maps have been produced over the past two years to clarify land usage across the country. A second issue is the lengthy duration of licensing procedures due to which investors cannot predict when they will be able to obtain all necessary permitting and approvals required for a project's development and implementation. With that said, it should be noted that Greece's country risk has been reduced drastically compared to what it was two or three years ago as a result of the financial crisis, and this is reflected by the fact that the attractiveness of the market has increased tremendously. The number of foreign investors that are considering investing in the market and actively seeking projects is, to a certain extent, unprecedented surpassing the so-called golden period between 2010 and 2013, when we had a surge of investments in installed capacity.

We also have a mature market in terms of know-how and human capital, with qualified people who fully understand these investments and can support the development of photovoltaic projects in all their phases. Likewise, we have manufacturers that can produce the equipment needed for PV projects ranging from mounting structures and cables across to electrical interconnections.

As for other issues, particularly concerning medium-sized investors – entailing projects between 500 kilowatt and 1 megawatt – the issue is that there are not many available connection points for these smaller projects to connect to the medium voltage grid. And while this is a major issue for this level of investment, it could be tackled by unifying projects to buffer the additional costs associated with the construction of a substation to enable them to connect to the high voltage grid. However, this is not a very easy task and is something that has never been done before. Yet it could work. For the moment, and hopefully over the next two to four years, we do not anticipate any problems in this respect for large projects – encompassing projects greater than 40 to 50 megawatt – because these power plants can connect to the high voltage grid and the construction of a substation could be easily absorbed within the cost of the project (economy of scale).

The second wave of PV development

The new cycle of photovoltaics' investments in Greece started towards the end of 2016, with the first pilot auction, and the next one having taken place in 2018. There was increased interest in the next two years. This growing trend of investors' interest has led to a new attractiveness of the Greek PV market during the past two years. In 2019 things had matured for the wider Greek renewable energy market and investors realised there were good prospects. The reality is there are very few markets, from an international perspective, where you can find such a comparatively low risk combined with the low levels of investment required to develop projects. This is especially true when you look back five years; investment costs have dropped significantly. Medium-sized domestic investors, in particular, have seen a drop-in investment costs and income, while their return on investments has remained the same.

In addition, in the spring of 2019, a new feed-in tariff model was announced for the medium sized projects and the new institution of "energy communities" attracted mainly domestic investors. This last route to the market has further heated up this second cycle of the Greek PV market.

The lower prices are very beneficial to consumers because the cost of energy production is lower compared to what it was previously. If we look back at the feed-in tariff era, the cost of the electricity generated by producers was remunerated, on average, at a rate of €250 per megawatt hour in the end of 2014. Now, based on the last auction in mid-2020, the cost has at reduced to €45 per megawatt hour, representing fivefold decrease while posing a remarkable improvement for end consumers cost reduction.

As far as the investor side is concerned, investment costs have fallen as much as 90% compared to 2010, as a result of the decrease in the cost of PV panels. So, the decrease of the cost of electricity production and the reduction in the remuneration of producers has been complemented by a decrease in investment costs, creating a balance between investment costs and remuneration. Yet, this decline favours consumers the most because investors' income and the performance of these investments is positive.

While the landscape is still appealing to investors, returns are not what they were five years ago when we had a double digit internal rate of return (IRR) on investments in renewables. This now oscillates between six and seven percent in Greece, with expectations set on the IRR of projects converging with northern European levels, which vary between three to four percent. So, we have lowered the cost and return on investments and this is beneficial to consumers, while still presenting an interesting opportunity for prospecting investor companies.

PV in a commercial environment

Since 2019, all new operating PV power plants have established agreements with an aggregator that is in turn participating in the Energy Exchange on behalf of producers. While producers have the right to represent their own projects directly to the Energy Exchange, this doesn't make commercial sense unless producers have a critical mass of power plants (e.g. 50 megawatt or more). Through the aggregators' participation in the market, the electricity market will become increasingly more open and liberalised, slashing down production costs and consequently lowering consumer retail prices.

But in order for these effects to materialise including the financial products associated with the energy market (futures, options etc.), at least two years will have to elapse for the market to mature and sufficient liquidity to be present.

In the near future, besides the market transitioning into a free market, producers will be able to sell energy directly through the Energy Exchange, which means they will bid in terms of both capacity and price. Now, projects that participate through the auctions system only bid on the energy capacity they're going to produce.

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Secondly, there will also be business-to-business (B2B) contracts that enable producers to directly sign contracts with large consumers. This will be done either through the over the counter market, bilateral agreements, or through the Energy Exchange. Alternatively, renewables' producers will be able to directly sell the produced energy to energy providing companies, establishing long term agreements, which will consequently sell to the final customer (retail). Ultimately, the idea is that these transactions will become increasingly more frequent which means the cost of energy will decrease through competition.

Mega-projects: the new trend

There is obviously an apparent move towards bigger projects (mega-projects), which is reflected in the project licence applications that were submitted in 2018, 2019 and 2020. Hence, we have very big projects on the one hand, with each one contemplating several hundred megawatts of installed capacity, and the medium-sized sector on the other.

The figures show that the market is moving towards the former. And while there is still room for the development of mega-projects, as long as the number of projects increases so will competition and consequently the investment risk. This risk is unproportionately higher for medium-sized projects and it is difficult to manage. However it can better be managed by mega-projects. The latter have the means to hedge or mitigate this risk; the bigger the company the wider the spectrum of mechanisms it has to mitigate the risk.

Another change we're going to see in the market relates to energy storage. I'm confident many incoming investments will include storage facilities, while this is an area that is likely to attract big investors, to enable producers to boost their production when there's no light or the sun doesn't shine. This will allow producers to achieve better pricing during periods of lower electricity demand.

On the other hand, market aggregators are also going to play a major role within the scope of consolidation. Medium-sized projects are going to become concentrated into clusters, either through aggregators or by way of their acquisition by investors seeking to increase their portfolio.

Last but not least, we are awaiting specific legislation to be enacted regarding energy storage. This is expected in the first half of 2021. This legislation will regulate both small and large storage systems (often called behind-the-meter and in-front-of-the-meter respectively). While storage behind the meter enables producers to boost their production towards hours when renewables cannot produce, storage in front of the meter caters to companies that would like to support the energy grid, to avoid blackouts, circuit cuts, and other technical issues.

Contributor

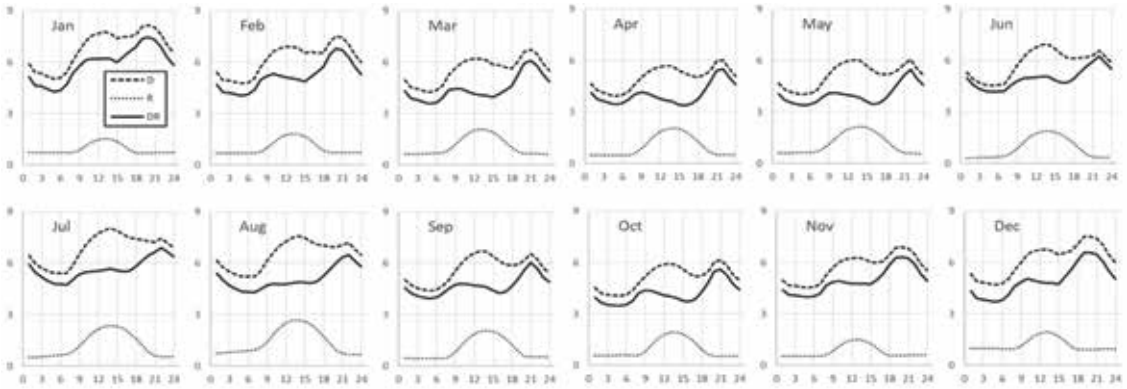
Dr. Sotiris Kapellos

Dr S.Kapellos is a graduate of the Chemical Department of the University of Athens. He received a PhD on the field of Physical Chemistry from the same Institution. Between 1993 and 2007, he had the opportunity to fill various managerial posts within the BP Hellas Organization: Quality, Health, Safety and Environment, Human Resources, Customer Services, Pricing and Credit, Retail Fuels District Manager Northern Greece. In 2007, he is appointed as the CEO of BP Solar Hellas, to setup the new business. Since 2010, he works for ELPE Renewables (100% owned by HELPE Group). He currently holds the position of the Operation and Development Director of the company, being a BoD member of the company. The current RES portfolio of ELPE Renewables is comprised of 796 MW of PV, 77 MW Wind and 10 MW Biomass, of which 19 MW PV and 7 MW wind in operation. In February 2020, the acquisition of a 204 MW PV project in Kozani is signed to be constructed and connected to the Grid in 2021. This is the largest RES in Greece and one of the largest PV projects in Europe. Dr.S.Kapellos has been, on behalf of HELPE, the Lead Negotiator and the Project Manager of the currently under construction Kozani Project. Dr.S.Kapellos has published several scientific articles in international magazines during his academic career and several articles on subjects related to RES, Solar Technology and Energy Policy for newspapers, relevant magazines and e-media.

The Available Electricity Space for RES Investments is Finite by Default

By Dr. Stelios Loumakis, President, Hellenic Association of Photovoltaic Energy Producers (SPEF)

Electrical space available in the Greek interconnected system as well as per line is finite and rather inadequate compared to the currently appearing investment interest for new renewable (RES) projects and especially PVs in the country. Overall interest in terms of applications reach about 100 GW of installed capacity, out of which ~70% are photovoltaics.NPEC, namely Greece's National Plan for Energy and Climate towards 2030 provides specific targets for RES penetration as well as per technology. At RES total level the target for 2030 in order to meet the goals set, requires, new capacity of 9 GW. For PVs the target for 2030 is 7.7 GW from ~3 GW currently in operation. Beyond NPEC, its targets and limitations, we present below an analysis from a Loumakis et al's paper regarding the load situation in the Greek interconnected system for the year 2017 on an average hourly per month basis, making the case more easy to understand for the average reader. Let us also underline that according to NPEC, electricity demand in 2030 is estimated at ~62 TWh, namely not significantly higher from today's levels due to energy saving programs running in parallel.



Daily average variation on a monthly basis for 2017: D = demand, DR = demand minus RES, R = renewables. Horizontal axis = time of average day, Vertical axis = energy rate in GWh/h. As shown in the above load charts for the Greek interconnected system, demand hardy peaks at 8-9 GW. Furthermore, even if all conventional power plants were theoretically phased-out, something currently impossible due to system stability and security reasons, the additional "active" margin for new RES penetration according to 2017's consumption profile (NPEC as told predicts that electricity consumption during 2030 will rise only by ~15% compared to today's levels due to energy saving programs) would be on average between 3–6 GW. This added active margin is for sure narrow compared to expressed investment interest for new RES capacity that exceeds 100 GW.

However, one would notice that RES installed capacity is not identical with their actual real time power generation. Indeed, but in this sense, one should not confuse the annual, monthly or even daily average capacity factor of RES plants with its real time values. Especially for PVs this confusion could lead investors to major systematic failures, since at least in Greece there are lots of nation wide sunny days, where all PVs during noon time reach simultaneously 70-90% of their maximum capacity factor. Moreover, in many of these sunny days and hours there is significant wind production as well, since Greece is not only sunny but windy as well.

Finally, let's not forget that the assumption for complete conventional unit withdrawal is for the time being groundless, but it has been made just to simplify to the average reader the understanding of some of the insurmountable technical constraints which exist in the system's ability to receive RES investments, at least without production curtailments and/or storage.

In the above simplified example, let us now try to add the factor of massive electricity storage and redefine some of the critical thresholds for the system. Suppose, then, that economically storage technologies and solutions are available and mature (so as not to triple the wholesale cost of electricity) and that they are functionally perfect, meaning that they offer full storage ability and zero losses of stored electricity. Through meeting these conditions, it naturally means that annual electricity demand in the country, approx. 62 TWh according to NPEC during 2030, could then be covered exclusively from RES. Taking into account all the rest non-wind and non-PV RES installations (i.e. Large and Small Hydro plants, Biogas, etc) that could offer around 5-6 TWh of electricity per year, a capacity of about 30 GW of wind and PV installations (50-50 distribution) would theoretically suffice to cover the rest of demand in the country. To this amount, one can then add some increments for the losses. However, in principle it is sufficiently illuminating Greece's potential to incorporate new RES investments under full and perfect storage conditions, namely zero-loss / curtailment of their generation. In Greece's interconnected system some 7 GW of wind and PV plants are currently operating, so the theoretical remaining margin for new such projects, under these conditions, is limited to around 23 GW. So, the important information for investors is that available electricity space in Greece -driven by local demand- for new RES capacity is already tight (23 GW) compared to investing interest that reaches 100 GW. This is critical, unless new investors participating in the wholesale electricity market are prepared to withstand severe curtailments in their production, even if full storage solutions become available. We do not feel, however, that this is the case in their business plans.

Contributor

Dr. Stelios Loumakis

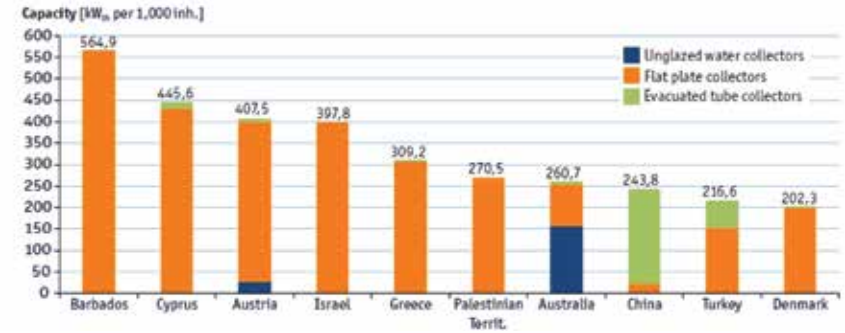
Stelios Loumakis was born in Athens he graduated Chemical Engineer, National Technical University of Athens (NTUA), in 1992. At post-graduate level he has been awarded the degree of Master of Business Administration (MBA) from Portsmouth University of U.K. and since 2019 he holds a PhD from NTUA accomplishing a doctoral thesis in the field of Electricity Market Operation and Renewables Penetration. Furthermore he has attended dozens of seminars and courses in technical, financial and managerial field while many of them related to photovoltaic technology and PV plant design. He is a member of TEE (Technical Chamber of Greece) since 1993 and he made his military service in the Hellenic Navy. He started his professional career at late '80s in parallel with his studies in the family business, for decades involved in exports of garments to the European markets. During '90s he developed a new department trading OTC para-pharmaceuticals, diagnostic tests and health products both in Greece and Cyprus. Later on he worked for five years as an executive in Marketing and Sales in the leading multinational company Sara Lee Household & Body Care Hellas AE and later to the Greek industrial bread and food company Karamolegos AE. Back in business he was involved for five years in the rapidly expanding sector of organized bread and food retail in co-operation with the food and bread industrial company Katselis ABEE. 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 and was connected to the grid in April 2008. Furthermore, acting as consultant, he enjoys valuable business, engineering, techno-economic and arbitration experience (member of RAE list of arbitrators) in the field of wholesale electricity market and renewables (indicative clientele SPI Energy, EYDAP, Attica Finance Consulting, Interphoton Group, EasyPower a.o.) and is the President of the Hellenic Association of Photovoltaic Energy Producers (www.spef.gr) since December 2011. SPEF is the official business and scientific association founded in 2009 that represents in Greece power generating organizations from PVs. Due to this role he enjoys extensive experience and presence with articles, technical studies, law proposals, participation in public consultations and speeches in several highly esteemed conferences local and abroad. During 2014-2017 he has been an active member of ACCI (Athens Chamber of Commerce and Industry) Business Angels Network, supporting business development in several other sectors.

The Solar Thermal Market in Greece and its Outlook

By Costas Travasaros, President of Solar Heat Europe/ESTIF, European Solar Thermal Industry Federation and President of Prime Laser Technology

Greece is one of the most successful countries worldwide in using solar thermal energy. For many years, the number of installed solar collectors per capita has been among top five in Europe.

Top 10 countries of cumulated water collector installations per 1,000 inhabitants in 2018 (relative figures ins kW$_{th}$



IEA-SHC 'Solar Heat Worldwide edition 2020

By the end of 2019, a total capacity of 3407 MWth, corresponding to 4867500 m^2 of solar collectors, was installed in the country.

Greece's solar thermal market started 45 years ago. At that time, almost all Greek households were using electric heaters; thus, the rising price of electricity has helped the market to develop. The electric water heater is still the main competitor to the solar water heater.

The dominant solar thermal product was then, and still is, the thermosiphon type water heater.

Many companies started in these years. The advertising campaigns launched by larger firms as BP (at that time) brand Calpak helped a lot in the initial phase. The Greek Solar Industry Association –EBHE – was created in 1978.

The market was rising steadily, as in many countries, in part due to the oil crisis. In1984–86 a large advertising campaign supported by the Greek government and the implementation of VAT by the end of 1986 boosted the sales up to 218.000m^2. There were about 300 manufacturers of solar systems at this time. Nearly all the systems were produced locally, except for some which were imported from Israel. Low interest loans and tax credits were available and contributed to market growth. Then the market consolidated; the efficiency and reliability of the products improved, considerably, and the number of manufacturers decreased. Mandatory standards were introduced at the national level by the end of the eighties. The solar systems' laboratory of 'DEMOKRITOS'and the Centre for Renewable Energy Sources (CRES) have since been cooperating closely with the manufacturers and have contributed decisively in this direction.

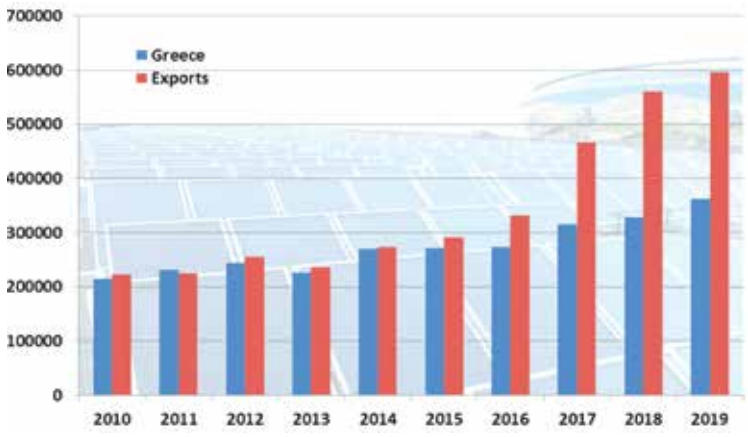
Several demonstration projects have been carried out. One of the very first at the 'Solar Village',at Pefki suburb in Athens, built in 1987 and reliably operating for many years, with 435 dwellings and approximately 1.700 inhabitants, featuring several solar systems for hot water production and space heating, cogeneration, heat pumps etc. There are also several demonstration projects for process heating in the diary, wine, textile dyeing/finishing, rice drying and tannery industry. Some of them were installed on a guaranteed performance basis.

Many solar thermal systems are also installed in hotels and in industries, athletic centers and greenhouses. Since 1993, the domestic market has fluctuated between 150.000–200.000m^2 of collectors, annually depending on the new building construction, electricity prices, incentives etc.

Having reached a certain level of experience and quality and facing difficulties in the home market, some of the manufacturers turned to product development, assisted by EU-supported R&D projects, and to exports. The success of these pioneers has motivated other companies as well. By 2001 more than 40% of the solar collector production of EBHE members was exported, starting from very low percentage (less than 5%) in 1991. Currently exports account for 60% of the production.

The economic crisis between 2009-2017 resulted in a very large drop in new building construction which was about 50% of sales. However, this drop was covered by the increase of sales in existing buildings as an energy and money saving investment and in most renovated buildings.

Greek Production m^2



The main reasons for the success in solar thermal utilisation in Greece are as follows:

- The conventional source of water heating is electricity, with higher costs than fuel oil or gas, leading to shorter payback periods for installed solar systems
- Most houses have a flat roof, enabling the easy installation of an inexpensive thermosiphon solar water heater
- Favorable climatic conditions
- State support during the start-up phase of the solar thermal industry
- Involvement of dedicated individuals at the early stages of solar thermal

The competition among Greek companies and a correct appraisal of the economic recession and the market situation between 2010 and 2018, led to lower retail prices for thermosiphon systems. In addition, energy prices surged: taxation of heating oil led to an increase of its price by more than 120%; electricity prices rose due to high indirect fix costs like municipal and renewable fees and carbon taxation. Only natural gas remained comparatively affordable, but the gas grid covers less than 30% of the Greek households. Hence, solar hot water production remained an attractive affordable option. Moreover E-commerce and broad distribution network including large electric and home appliances chains make it easy to buy a solar system increasing competition and leading to been lower prices. Last but not least, one should also consider the environmental concerns in significant parts of Greek society, especially in the more dynamic part of the population, between 30 and 50 years of age, which are the main consumers in the building sector. Installed solar thermal systems in Greece avoid yearly more than 3.200.000 tCO_2. Apart from those historical reasons, the following parameters led to the rising trend of the Greek market over the last years:

- Favourable legislation signals governmental support. The installation of a solar thermal system to cover at least 60% of hot water was made mandatory for every new building according to the Energy Efficiency Building Regulation Code.
- In the last few years there is an increase in new buildings after a decade of recession accompanied with a strong increase in renovating existing building stock.
- The installation of a solar thermal system for hot water production was funded by up to 70% by the "Saving Energy at Home I and II" programs.
- The roof-installation of a residential photovoltaic system is allowed only upon the prerequisite that a solar thermal system is installed for hot water production

The Greek Solar industry Association-EBHE played a very important role for the success of the Greek Solar Industry. Market statistics and dissemination of information about National and International policy and market trends kept the members updated. EBHE was a founding member of the European Solar Thermal Industry Federation (Solar Heat Europe) and promoted European Standards for solar thermal applications.

CEN TC-312 is the only CEN Technical Committee under Greek secretariat. The secretariat is co-financed by EBHE. The European/ISO standards developed help to overcome barriers to exports imposed by national standards. Further EBHE supported the development of a voluntary third-party certification mark for solar thermal products. The Solar Keymark is a CEN/CENELEC European mark scheme, dedicated to solar thermal collectors, solar thermal systems, storages and controllers. The Solar Keymark is demonstrating to end-users that a product conforms to the relevant European standards and fulfils additional requirements. The Solar Keymark aims at reducing trade barriers and promotes the use of high quality solar thermal products in the European market and beyond. It is used in Europe and increasingly it is recognized worldwide.

EBHE holds key positions at European level, including the presidency of ESTIF/Solar Heat Europe, Chairman and secretariat of CEN TC-312 and the general management of Solar keymark.

List of importing markets for a product exported by Greece in 2019

Greek companies are adapting to the changing markets worldwide. Thermosiphon type of systems are the most successful type worldwide offering a competitive advantage to the experienced manufacturers. Greek exports are rising all over the world competing with local brands and mainly with Chinese, Turkish, Israeli, German and Austrian manufacturers. The high quality and the applied technologies of Greek solar systems and the reliable co-operationan bucking of manufacturers has helped establish a good reputation. A distinguished characteristic is that almost all Greek companies are exporters, which is not the case of competitors from other countries.





The typical solar system is a thermosiphon type, closed loop with antifreeze protection. It is equipped with a 2,5m^2 highly selective flat plate collector and a hot water storage 150 l.

The cost of the average system is 800 €, corresponds to about a month's salary. It covers about 90% of the hot water demand of a family. The payback just is 3 to 4 years. An immersion heater 4 kW provide on demand the rest when sun is not enough to fulfil the needs.

Apart of the energy saving, the avoided CO_2 emissions equal to the emissions of the family car.

1.600.000 households in Greece save yearly 500.000.000 €.

Solar thermal is the only local renewable industry of Greece. Every Euro invested in solar thermal creates more jobs than any other renewable of fossil energy investment.

Solar space heating is a rising market in Greece. A hybrid heating system, based on priority of solar heat is the most cost effective and environmentally friendly solution. Every square meter of collector will deliver yearly about 400 kWh for heating and hot water, covering a large part of the needs. Excess capacity in the summer can provide cooling when small cooling devices will become competitive.

Solar cooling is already a reality for larger systems. An excellent example is a warehouse cooling system at SARANTIS cosmetics. 2700m^2 collector area is reliably suppling energy for more than 20 years already. Payback period was just 7 years.

Solar thermal is the only renewable industry of Greece. Every Euro invested in solar thermal creates more jobs than any other renewable of fossil energy investment. Most of the solar thermal manufacturers are small and medium enterprises. Many of them are family owned, second generation. Research and Innovation is becoming difficult as usually there is no R&D department. Further the funding opportunities in Europe and in Greece are not supporting equally the low and medium temperature applications, targeting mainly to higher temperatures. Development of materials, production methods, components and systems is vital for the future of the sector. The profitable sector is increasing its investments in machinery and technology and is ready to grasp the opportunity of any legislative and financial support.

Energy consumption in EU households

Source: ec.europa.eu/eurostat 2017

The market potential in Greece is very large. Solar domestic hot water systems and solar space heating can cover 30% more than already foreseen in the National Plan for Energy and Climate. A renovation Wave can offer an excellent vehicle for solar thermal integration as priority. Together with other decentralized renewables such as PV, and modern biomass will contribute to the decarbonization of energy in the building sector which accounts for the larger part of energy use in EU, complimenting energy saving measures.

Digitalization of solar thermal will play a major role for the future, allowing smart sector integration. What a thermosiphon offers to the electricity network by replacing about 1600 kWh of electricity by a solar installation on a yearly basis, is a large energy saving for the country. Thus excellent Demand Side Management (DSM) measure. In many cases, as in Crete or other non-grid connected islands, it helps avoid investments in pick capacity and postpones decisions for installing new generating units or expanding network. Furthermore, electricity price is lower than cost, for those cases. So its reducing the burden shared by the consumers. Unfortunately those benefits are taken for granted by utilities (PPC and the network operator) and the authorities and they don't pay anything towards promoting of solar thermal systems use. Digitalization opportunities for new and installed solar thermal systems are huge. They can play a major role in grid flexibility by utilizing the existing hot water storage and the integrated electric back up element. Smart meters enable low voltage demand to participate in reserve and ancillary services market through load aggregation. Thermal solar systems come always in a package with storage which is already included in the cost. They reaction can be very fast. Several projects in Europe are already utilizing electric water heaters and other devices as heat pumps in this direction.

This can maximize benefits for all; public interest, network operator, supplier and consumer.

Contributor

Costas Travasaros

Costas Travasaros studied Mathematics at University of Athens and Mechanic at technical school. In 1979, during his studies, started his private business in sales and installation of solar thermal systems. In 1984 moved as sales manager of FOCO solar, becoming shareholder in 1986 till 2005, leading exports and R&D. Since 2006 is a founding partner and general manager of Prime Laser Technology, an innovative Greek manufacturing company that specialises in solar thermal absorbers and is active in both local and international markets. He served as President of the Greek Solar Industry Association is 90's, chairman of TC 312 and in November 2018 was elected President of Solar Heat Europe.

The Role of Biomass in Achieving Greece's New Clean Energy Targets

By Anthony Gerassimou, Mech.-El.- Nav. Engineer MSc, President of Board, the Hellenic Biomass Association (HellaBiom)

About Hellabiom

The Hellenic Biomass Association (HellaBiom) is a non-profit organization and one of the main National Associations in Greece in the sector of Renewable Energy Sources, active since the 1990s. HellaBiom is a full member of the European Bioenergy Association "Bioenergy Europe".

HellaBiom objectives include the following:

- **Promotion of scientific research on sustainable biomass valorization.**
- **Provision of consultation and educational services to stakeholders involved in biomass utilization and development at regional and national levels.**
- **Cooperation with companies, government bodies, scientific and academic institutions, clusters and market regulation authorities on the appropriate application of European standards and directives on biomass-related issues.**
- **Undertaking of surveys in the bioenergy field and the contribution to annual statistical reports of the European bioenergy counterpart association "Bioenergy Europe".**
- **Fair promotion of interests of the bioenergy market stakeholders in Greece.**

Sustainable Biomass: A Useful Tool to Tackle Crisis at Multiple Levels

Taking into account the current Covid-19 pandemic and the imperative for governments and societies to face its socio-economic consequences on one hand, and the adopted resolution on the European Green Deal by the European Parliament for Europe to become the first climate-neutral continent by 2050 on the other, the role of sustainable biomass in bioenergy and bioeconomy applications could not have been more timely and crucial.

The energy derived by Biomass has a number of advantages at national, regional, and international level. Bioenergy is sustainable in economic, social and environmental terms. It fosters rural development, it creates stable, long-term jobs throughout the whole supply chain, and it address the acute environmental problem of organic waste contamination.

More specifically, **Bioenergy** positively **contributes to the following areas:**

Fulfillment of Sustainability Criteria. Upon the deployment of the Renewable Energy Directives (RED and RED II), environmental sustainability criteria now exist for all types of bioenergy, rendering it the only form of energy with a guarantee of sustainable sourcing, irrespective of the geographic origin of the biomass.

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. At the same time, forest residues management prevents wildfire hazards, enhances biodiversity protection, conserves soil quality and maintains carbon stock in the forest.

Reduction of open fires (e.g. tree pruning and cuttings in fields, agricultural residues in croplands) and **containment of organic effluent** (e.g. cheese whey, olive mill wastewater) discharge in sensitive ecosystems with consequent multiple positive effects on nature protection and conservation.

Support of the country's energy independence and consequent improvement of the trade 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, limited financial capability and energy poverty issues, where the need for new sustainable business efforts is urgent.

Mobilization of the financial activities of small and medium enterprises (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 heating and cooling in competitive prices, both for residential and for industrial consumers, through the establishment of CHP and district heating and cooling plants fed with biomass.

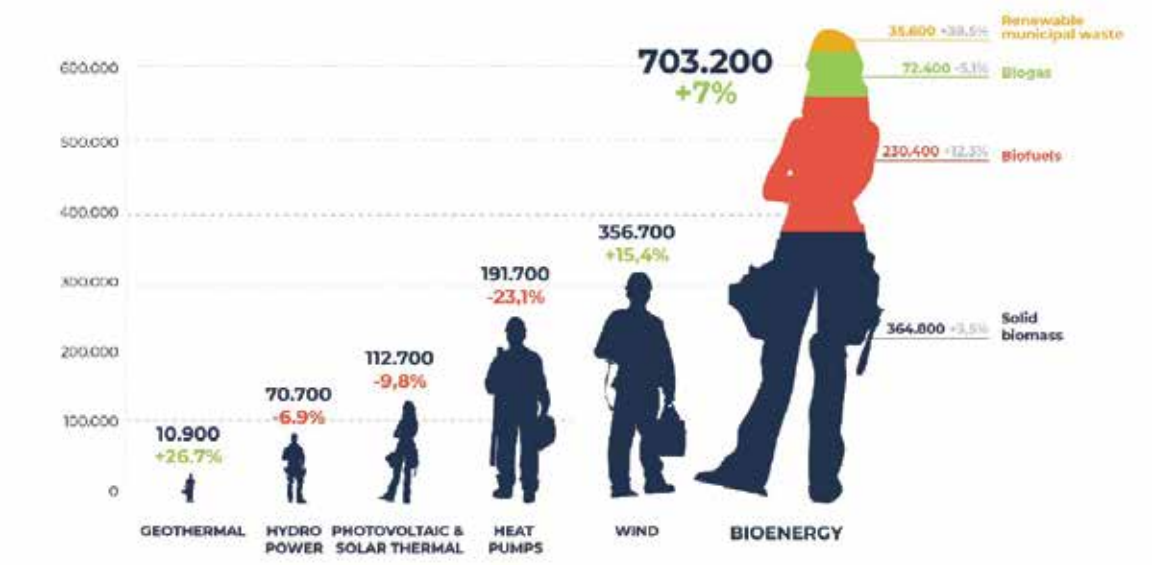
Decentralized and flexible power generation and availability. Biopower plants are in principle baseload plants, thus their operation can lead to minimal power losses in the grids. Biomass is highly adapted for seasonal balancing, counterbalancing the lower power production of solar and wind energy, which further enhances **power system stability.**

EU Bioenergy Status

According to the latest official EU data sourced by Eurostat and the European Bioenergy Association "Bioenergy Europe", energy derived from biomass is constantly gaining constantly ground in terms of its participation in EU-28 energy mix. The total value of the Bioenergy sector in the EU-28 has been recorded in the range of 60,6 billion € in 2017.

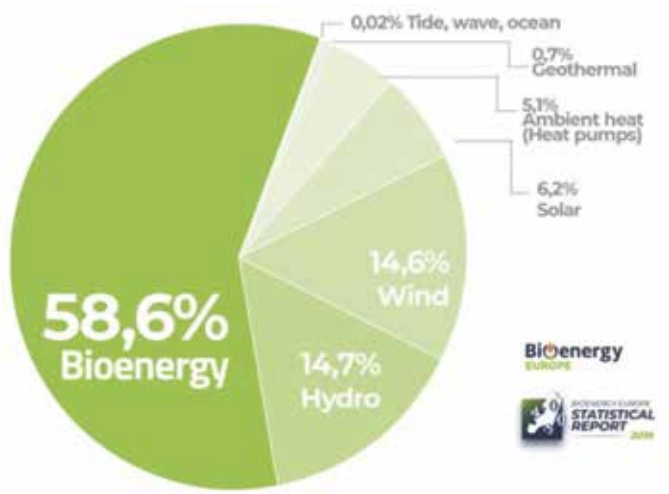
- **Employment Status.** Across the EU, the Bioenergy sector offers almost as many employment positions as all the other renewable energy sectors (added together) do.

EU-28 Employent Distribution in Renewable Energy in 2017



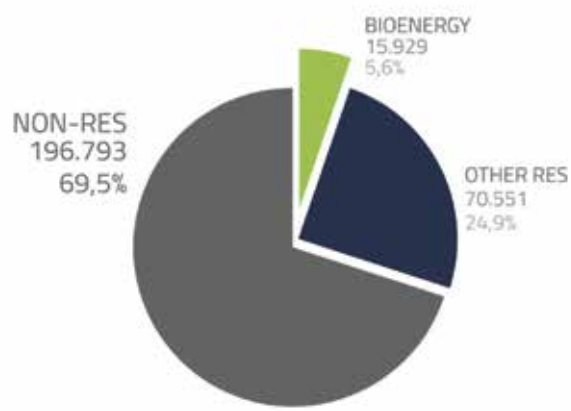
Source: Eurostat, shares 2017

Distribution of Renewable Gross Final Energy Consumption in the EU28 in 2017

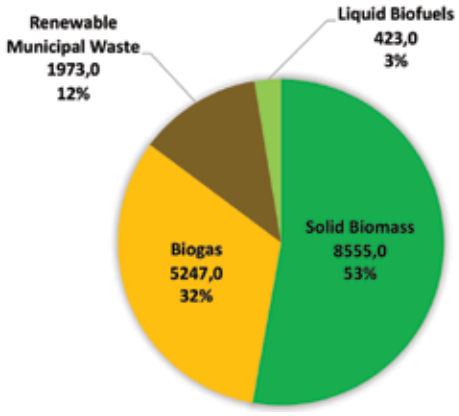


- Today **Bioenergy is the main renewable energy in the EU.** Bioenergy accounts for almost 60% of the European renewable gross final energy consumption in all energy sectors (electricity, heat and transport fuel).
- **Bioelectricity.** The gross electricity generation in EU-28 from Bioenergy (equal to almost 16.000 ktoe) accounts for 5,6% on total energy sources and about 18% of all renewables. Considering gross electricity generation from biomass by type in EU-28 in 2018, Solid Biomass accounted for 53% on total gross Bioelectricity generation, followed by Biogas at 32%, Renewable Municipal Waste at 12% and Liquid Biofuels at 3%. The total bioelectrical installed capacity of all types of biomass plants in EU-28 in 2018 amounted to approximately 43,5 GW.

EU-28 share of Energy from Renewable Sources in the total gross electricity generation



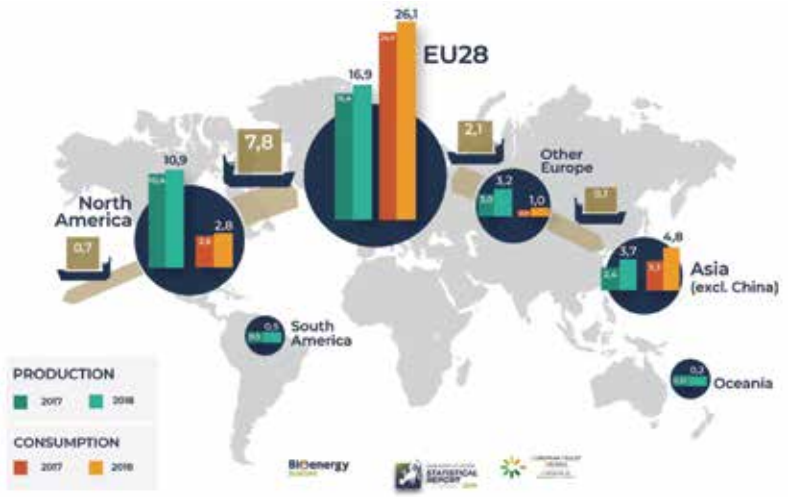
Gross electricity generation from Biomass by type in the EU-28 in 2018 (KTOE)



Source: Eurostat, Bioenergy Europe Statistical Report 2020 (Bioelectricity)

- **Bioheat.** Almost 87% of total renewable heat consumption in the EU results from biomass exploitation, making bioenergy a key driver in the decarbonization of the heating sector. The residential sector accounts for 50% of total bioheat consumption.
- **Biofuels for Transport.** EU transport is still heavily dominated by fossil fuels. In 2017 oil represented 93% of final energy consumption in transport, while renewable fuels account for about 5%. Sustainable biofuels and biomethane account for 89% of renewable energy in transport.
- **Pellets.** EU-28 is the largest wood pellet producer worldwide, since it produced almost 17 million tons in 2018. At the same time, it remains the largest market, consuming more than 26 million tons.

World Pellet Map and Tradeflows (in 2018 million tonnes %)



Source: EPC Survey 2018 Hawkings Wright, Futuremetrics, FAO)

- **Biogas.** European biogas market is well established, while consumption has grown 25 times since 1990 reaching in 2017 approximately 17.000 ktoe produced in more than 17.500 biogas plants.
- **Biomethane.** New biomethane plants have started operations in several EU countries, almost tripling their number since 2011 up to 540 plants in 2017, generating 19 TWh of biomethane.

Greek Bioenergy Status

According to the latest National Energy and Climate Plan (NECP), Greece has set ambitious national targets for Renewables until 2030:

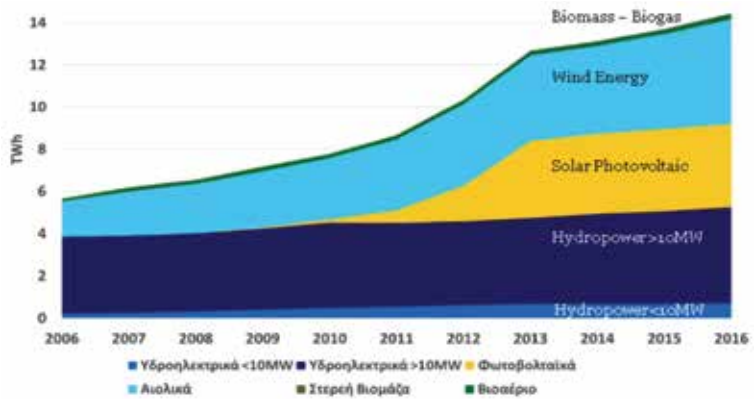
- ≥35% RES share in the final gross energy consumption.
- ≈61-64% RES share in the final gross electricity consumption.
- ≥43% RES share in heating and cooling final consumption.
- ≥19% RES share in final consumption for transport.
- ≈16,1-16,5 Mtoe final energy consumption.
- ≥55% GHG emissions reductions (compared to 2005) for the sectors included in the ETS (Emissions Trading System).

In this transition, bioenergy has an important role to play. Despite its significant biomass potential, Greece has exploited only slightly this valuable alternative source of energy and its development has been achieved only in small and slow steps. The NECP for Greece acknowledges that the valorization of biomass for energy and fuel production has to take into consideration domestic agricultural activities, competition on land usage and the possibility of formulation of viable supply chains. The plan provides that, within the energy transition period, emphasis will be placed on more efficient applications of biomass utilization for the Greek economy and society, based on sustainability criteria and sustainable management practices. Emblematic policies under development include the promotion of use of advanced biofuels and the utilization of biomethane production through injection into the natural gas grid.

Bioelectricity: The installed power capacity from biomass and biogas in Greece (January 2020) is approximately 89 MW. Biogas plants (landfill gas installations, waste water treatment plants and agricultural biogas plants) account for about 76 MW. Solid Biomass plants (incineration and gasification) account for about 13 MW of installed electricity capacity. The current bioelectricity share in total RES electricity generation does not exceed 3% (very low compared to almost 17,5% in EU-28 in 2018, according to the latest "Bioenergy Europe" Bioelectricity Report). Therefore, there is yet much to achieve by the Greek Bioelectricity sector in order to be in line with the respective progress made in the EU. Yet, the recent decision of the Ministry of Energy and Environment (March 2020) about the curtailment in feed-in-tariffs in all categories of new Biomass and Biogas

power plants as of 2022 seems to be incompatible to the ambitious target set to achieve a cumulative value of 300 MW of installed electrical capacity from biomass and biogas by 2030. Such a projected growth should eventually correspond to a rate of more than 20 MW of new installed bioelectrical capacity per year.

RES Electricity Generation in Greece

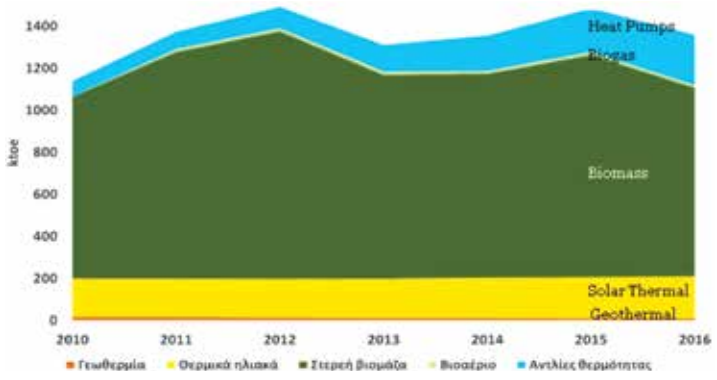


Source: National Energy Planning CRES 2019

- **Biofuels for Transport:** Greece is among the very few EU Member States where no ethanol fuel is produced from biomass yet. According to 2018 data, biodiesel production amounts to 140.000 kiloliters (about 1,7% of total transport fuels) and is provided by 16 biodiesel plants (accounting for 98% of quota) and by 5 importers (2% of quota). The domestic feedstock processed to derive biodiesel are seed oils (mainly sunflower), cotton seed and used cooking oils (UCOs). Significant increase in RES contribution in transport in the coming years is expected due to biofuels, renewable gases (as for instance biomethane) and electromobility.
- **Bioheat:** According to the latest data (CRES 2018), a total consumption of 2.500.000 tons of fuel biomass contributed to an equivalent bioheat generation of 34,7 PJ. The share of domestic heating sector in the biomass fuel mix has been about 80%, with main fuels being firewood, wood pellets, agro-pellets and olive peats. The remainder 20% of biomass fuels were consumed in industry, with main fuels being agro-industrial waste (cotton ginning residues, fruit kernels, nut shells, rice husks, etc.), olive peats and residues of the olive oil refinery process, as well as wood-processing industry residues.

During recent years, there has been considerable effort to introduce standardized solid biofuels (wood pellets, wood briquettes) and modern certified heating systems for the domestic and industrial heating sectors in Greece in order to gradually substitute old and inefficient biomass appliances which burn unprocessed biomass of lower heating value and increased moisture. This is expected to substantially improve air quality in the coming years. Bioheat remains the greatest contributor to Renewable Heat in Greece.

RES Heat Production in Greece



Source: National Energy Planning CRES 2019

- **Pellets:** With a production potential of more than 130.000 tons per year but actual wood pellet production of just 40.000 tons in 2018 by 24 operating pellet plants in Greece, it is clear that the existing infrastructure is currently underutilized.

Since the wood pellet market in Greece is still undergoing its initial introductory steps and consumption development is not as steep as it was in other European markets in their respective early market stages, almost 80-85% of wood pellet consumption corresponds to small-to-medium scale residential heating units (stoves, boilers). On the other hand, wood pellet penetration in the professional and industrial bioheat generation sectors is still slow and due to the large quantities required by industrial plants, factory owners tend to seek feedstock mainly through low-cost imports at larger quantities rather than higher cost local production at smaller quantities (e.g. sunflower husk pellet imports from neighbor Balkan countries and former CIS countries are quite common). Having said that, if sustainable forestry management practices, harvesting and logistics methods for agricultural residues improve in future, then there might be serious opportunities to feed local factories from local agricultural by-products (agro-pellets) or mixed bio-pellets (woody and agro-based). Especially, tree pruning (e.g. resulting from olive trees or vineyards) is expected to be a biomass source increasingly entering the feedstock mix with promising chances of being a commercial and industrial boiler fuel.

Electricity generation or CHP applications by agro-based densified biomass (i.e. in larger diameter pellets, briquettes or pucks) is still almost non-significant in Greece. Notably, solid biomass power generation plants at the moment in Greece are using as fuel biomass in its raw form (e.g. cotton stalks, wood bark and trimmings). However, as new biomass power plant permits are gradually being granted by authorities, there is a very conservative estimate for CHP generation to start using pellet feedstock beyond 2020, especially resulting from lower-cost feedstock. Wood pellet usage as biofuel in power plants looks rather unlikely, unless it is sourced at suitable prices as a secondary biofuel in co-firing or gradual substitution applications at certain power plants of Public Power Corporation (PPC-DEI) phasing-out fossil lignite.

Wood pellet consumption, covering its needs by both the local production and imported products and currently remaining at a range of 90.000 tons per year, is expected to follow a steeper growth during the following years, provided the heating oil price does not decrease. The current Covid-19 crisis had as repercussion the lowering of heating oil prices, which in turn influenced the demand for wood pellets in the short term.

For boosting the pellet market, it has to be noted that fuel quality is very important, thus stricter quality control audits and spontaneous checks have to be made by the competent authorities, so that end-users become more confident to the products (appliances and biofuels alike). With the proper renewable incentives provided by government authorities to substitute or retrofit fossil fuel heating and hot water generation boilers by wood pellet ones, with better understanding of certified wood pellet benefits (both locally produced and imported) on the part of consumers, stronger cooperation spirit among all bioenergy market stakeholders and further development of the market with the aid and initiatives of Biomass Associations and Research Centers, it might be realistic to reach a total wood pellet consumption market size of about 200.000 tons by 2025.

Advanced synthetic 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 also developing and focused on the efforts of certain research teams (in NTUA, CERTH, etc.).

Essential Requirements for Further Bioenergy Growth in Greece Development Sectors

The challenges faced for the successful expansion of Bioenergy use in Greece's energy system can be summarized as follows:

- Lack of efficient supply chains for feedstock pre-treatment and transport.
- Limited public awareness.
- Non-uniform social acceptance.
- Environmental licensing complexity and ambiguity.
- Inefficiency of Greek policy framework (gate fee).
- Absence of spatial planning for biomass plants.
- Complicated structure of public services – Bureaucracy.
- Financing difficulties for bioenergy projects, due to recurrent economic crises, but also partly attributed to the fact that financial institutions do not assess the total benefit of a bioenergy project by adding the quantified non-financial (socio-economic and environmental) benefits to the financial ones.

All the above issues, despite the short-term turbulence and delays caused by the current pandemic, are expected to be addressed by authorities, stakeholders and local communities within the next post-crisis period. Potential areas of the Biomass sector for further development include the following:

Power generation from Biomass

- The pace of new biomass and biogas plants' introduction in the energy system has to become faster, especially as bioenergy solves environmental problems and contributes to circular economy, along with providing reliable, clean energy all the year round.
- Acceptance of bioenergy plants by local communities is also crucial.

Usage of agricultural residues for solid biofuels' production

- Combination of heat generation (esp. at industrial scale) with waste management.
- Reduction of open fires in fields.
- Competitive domestic fuel in rural areas as opposed to imported fossil fuels.
- Additional source of income for groups of farmers forming logistics' supply chains and working as energy biomass harvesters (energy communities and co-operatives).

Short rotation coppice (SRC) for woody Biomass

- Production of high-quality biomass fuels under scheduled patterns.
- Reduction of illegal logging.
- Usage of less productive soils.
- Enhance trading and manufacturing of forestry machinery.
- Certification and export opportunities in countries seeking competitive biomass.

District Heating and Cooling using Biomass

- Ideal choice for small-scale towns and municipalities having no access to competitive fuels.
- Can be combined with biogas plants.
- Reduction of energy poverty.
- Opportunity to build local supply chains where farmers can be both feedstock suppliers and heat consumers.

Framework for Biomethane production and injection into natural gas grid

- Partial substitution of imported natural gas from locally produced renewable gases transformed to Biomethane.
- Interchangeability of fuels for space heating, hot water generation and cooking.
- Utilization of low value waste streams to generate higher value energy carrier.
- Transport fuel for company lorries and municipal vehicles.

New generation of liquid biofuels from ligno-cellulosic bioethanol

- Production of equivalent transport fuel (bioethanol) from plant and renewable materials.
- Important field of research and innovation.
- Opportunity of economic development for rural areas with ligno-cellulosic materials like straw.

Pellet production

- Enhance viability and fair competition of pellet production plants by reducing VAT value for wood pellets to 6%, as applies for electricity, natural gas and district heating.
- Incentivize retrofitting and substituting the old stock of heating appliances with modern biomass heating systems and appliances in domestic and industrial heating applications, which comply with stricter standards in terms of efficiency and emissions for improvement of ambient air quality.
- Promoting pellet production is particularly important right now for reasons of sustainable and protective forestry management, since forest wildfires and insect diseases become 'the norm' in Mediterranean and European forests. In fact, preventing sick trees from decaying and harvesting residues from forests aids in avoiding the emission of greenhouse gases to the atmosphere, as well as the propagation of forest fires and diseases.
- Heating with pellets is, over the lifetime of the installation, cheaper than heating with fossil fuels, which renders pellets the perfect ally to tackle energy poverty.

Conclusion

The new clean energy targets for Greece for the current decade 2020-2030 and beyond can only be achieved through the full exploitation of the multiple benefits provided by the biomass sector. Within the new energy and environment landscape which is being shaped, sustainable biomass can be the solution to many challenges and the power tank of many concurrent activities of the circular bioeconomy of the future.

Contributor

Anthony Gerasssimou

Anthony Gerassimou was educated at the National Technical University of Athens, Mechanical Engineering Faculty (MSc). He has been a freelance 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. ITA Group 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 feasibility studies up to financing, project management, construction, operation and service as well as equity participation in various fields, such as: Renewable Energy Sources, Bioenergy, 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 Production Facilities 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 Biomass Association (HellaBiom), Chairman of the Hellenic Association of Desalination and Water Treatment, member of various professional Greek Chambers and Associations related to RES and CHP.

The Role of Small Hydro Plants in Achieving Higher RES Penetration in Greece's Energy System

By Ilias Kakiopoulos, Secretary General, Hellenic Small Hydropower Association (HSHA)

Introduction

Small Hydro Power Plants (SHPPs) are the modern equivalent of a traditional watermill. They have many comparative advantages not only in relation to investments in other, energy, sectors of the economy, but even, compared to other RES.

The mountainous Small Hydro Power Plants (corresponding to about 80% of all Small Hydro Power Plants) exploit the large or medium altitude difference of small mountain streams, using the existing available water flow (run of the river plans) without water storage reservoirs, allowing larger or flood flows to bypass freely above the water intake without storing water. SHPPs with small available head are mainly located in large streams and have usually small reservoirs, but they don't alter substantially the geomorphology of the hydrant location,.

It is noted that the SHPPs have the highest degree of efficiency in the conversion of natural resource energy (water) into electrical energy, which approaches or even exceeds 75%.

It can be said that SHPPs represent the most mature RES technology, while they remain one of the cheapest RES technology and clearly feature the biggest efficiency in terms of capacity factor for the energy conversion of natural resources into electricity. For this reason, the utilization of small hydropotential witnesses a global expansion that is consistent with the overall interest in the use of all RES.

SHPP AGORIANI – 1.90MW

The Greek RES sector

Today, the energy market in Greece is undergoing a rapid transformation as a result of decarbonation and the growing participation of RES in the electricity grid . The Greek government tries to boost the RES sector and to enable the installation of as many GW as possible. The Renewable Energy Sector in Greece is now part of the Agenda and part of the central governmental planning, but of course a lot of effort is needed in still order to compete against fossil fuels.

In Greece, the SHPPs are represented by **HSHA (Hellenic Small Hydro Association)**, which was founded in 2010 and is the sole representative of the industry, locally and abroad, while the vast majority of the local producers are members of HSHA. It is no exaggeration to state that the HSHA does a great job, since it is the meeting point of all stakeholders, both producers and the State. Through fruitful discussions, a lot of barriers to entry have been lifted, and the sector gradually becomes very attractive to investors.

SHPPs today in Greece

In the National Interconnected Electricity System (Renewable Energy Sources Operator & Guarantees of Origin - DAPEEP SA data), on 31.12.2020, 126 SHPPs were in operation with a total installed capacity of 245.25 MW. Over the last 3 years (2018-2020), the average annual energy production of the sector was 649 GWhs. According to official data provided by DAPEEP SA, in 2020 (Nov), SHPPs represented 3.29% of the total installed capacity of RES installations, contributing 3.53% of total RES energy production, while they were reimbursed with 2.20% of the total payments of the Special RES Account (E.L.APE.).

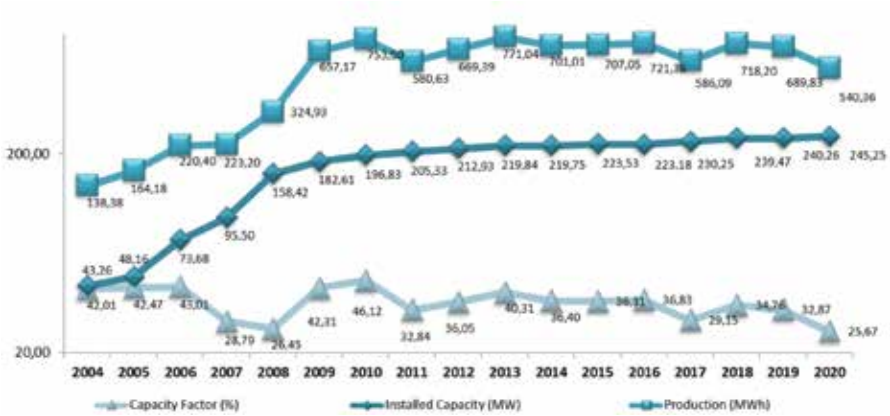
SHPP ANTARTIKO – 0.84MW

The figures regarding SHPPs two years back in 2018 were as follows: **participation in the total RES energy production was 4.27%, and participation in total payments stood at 3.65%.** The difference between 2018 and 2020 (Nov) is clearly due to the fact that the installed capacity of SHPPs increased only by 1.65% during that period, while the total installed capacity of all RES in the country increased by 24.18% (mainly due to new PVs and Wind Farm installations).

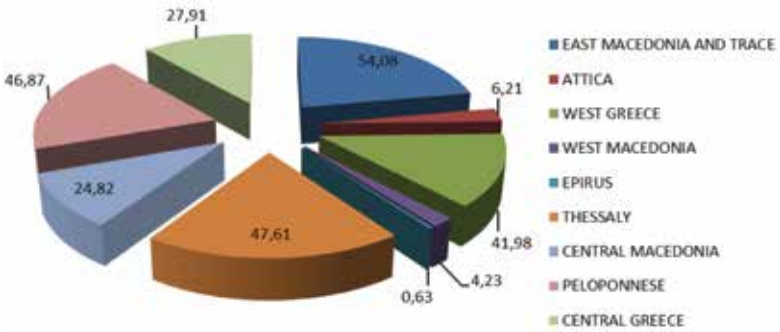
Thus, based on the aforementioned data of recent years, it appears that today's growth of SHPPs in Greece is very small, which is contradictory with their big potential. It is worth noting that the technical and economic small hydropotential of Greece is estimated at around 2,000 MW, which means that only 12% 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 Action Plan for Energy & Climate (ESEK, NOV19 version), sets as a national goal for 2030 vs 2020 regarding SHPPs an increase in their capacity of +300 MW, and this increase is in combination with Large Hydro. These extra 300 MW are unreasonably low in view of the potential of the Small Hydro industry in Greece, but also in view of the significant comparative advantages of SHPPs, compared to other RES, the most important of which are the **constant low energy production cost and the relative stability (i.e. non stochastic at a big extend) of production.**

Production (MWh), Installed Capacity (MW) and Capacity Factor (%) of SHPPs in operation, in Greece's Interconnected System for 2004-2020.



Allocation of Installed Capacity (MW) of SHPPs in operation, in Greece's Interconnected System on 31.12.2020 per region of Greece.



The European Dimension of the SHPPs

HSHA, in collaboration with the European Federation of Renewable Resources (EREF) but also via the European Small Hydropower Sector (EREF SMALL HYDRO CHAPTER) monitors developments at European level. Great effort is being made at the EU to formulate the new Water Framework Directive in such a way that it will not make the construction of new SHPPs in Greece prohibitive. The aim of the Directive is binding on all EU Member States, unless some exceptions apply under strict conditions and their justification is contained in the Local River Basin Management Plans. According to Article 4.7 of the Water Framework Directive, EU Member States do not infringe this Directive when:

- failure to achieve good status is the result of new modifications, or
- the inability to prevent degradation is the result of new sustainable human development activities, while, the strict conditions that must be met are the following:

(a) take all possible measures to mitigate the adverse effects of SHP installation

(b) explain the reasons for modification within the River Basin Management Plans (the review of objectives and the Management Plans are reviewed and updated every six years),

(c) the reasons for the modification are of public interest and/or the environmental benefits are offset by the benefits to human health, safety and sustainable development; and

(d) when the objectives served by the modifications cannot be achieved by other means, (which would constitute significantly better environmental choice).

In Greece the legislation partially covers all these restrictions while all the necessary measures have been taken to comply with it in the framework of the Revision of the River Basin Management Plans.

HSHA has also taken initiatives, towards the European Commission's DG Environment, concerning environmental legislation for SHPPs in NATURA areas

HSHA also participates very actively in the annual global technology exhibition for SHPPs - RENEXPO -, which takes place every November in Salzburg.

In terms of percentage the utilization of the available hydroelectric potential in Greece is currently at ~12%, while, according to data from international organizations the corresponding figures for EU-27 are higher than 70% (in some countries even higher than 90%) while all countries plan to increase SHP contribution to 20% by 2025.

Indicatively, we should mention that today in Greece there are 126 SHPPs, in operation, while in neighboring Italy there are 2,500 SHPPs, in Austria about 3,500 SHPPs, while in the whole EU-27 area there are more than 26,000 SHPPs currently installed.

It is clear that all developed and developing countries in Europe and in the world are supporting the development of SHPPs, prioritising them, before any other energy source, due to the obvious advantages of this technology.

In order to make more positive the investment environment for SHPPs, special mention was made for SHPPs in Greece's National Energy and Climate Plan (ESEK):

"The challenges for the development of small hydroelectric projects are big, as their installed capacity is estimated to more than double in the next decade and by 2030, contributing significantly to the high share of RES in gross electricity consumption. Especially for the projects that are exposed to multi-year licensing procedures, the existence of a clear framework with continuity is necessary in order to achieve maximum participation in this category of projects".

The above declaration is in line with the state directions, as they were expressed through the statement of the Water Resources Committee of the Hellenic Parliament on 26.05.2016 with says:

"....the Committee considers that it is absolutely necessary to promote the development of Small Hydroelectric Projects and the removal of unscientific licensing barriers and formally supports the development of SHPPs, stating that the development of Small Hydroelectric Projects (SHPPs) is an absolute priority for the country."

HSHA Positions, Views and Proposals

The Hellenic Small Hydropower Association (HSHA) deals with the major issues of the sector by submitting its views, in the form of letters to relevant bodies, participating in public consultations, issuing press releases or discussing the issues at hand in private meetings with sector's stakeholders.

The main problems of the SHPPs as of today, are the unequal, unfair and excessive rigor imposed on their environmental licensing which has resulted in the adoption of a highly complex and time-consuming licensing framework.

Among the various topics, under consideration the most important proposals tabled by HSHA can be summarized as follows:

1. HSHA's position on the review of the energy mix, **is that the State target should be revised to 1,000 MW allocated to SHPPs by 2030, thus exploiting 50% of the country's high potential which is estimated at 2,000 MW.**
2. **The recall of Ministerial Decision YA 196978/05.04.2011 (ΦΕΚ Β' 518)** that established additional spatial criteria for SHPPs. By this Decision, unprecedented and horizontal spatial criteria were set retroactively, which apparently lacked any scientific documentation and prevented the Small Hydro Sector from any significant growth.
3. **The radical change of the licensing framework**, the codification and simplification of licensing legislation and the radical acceleration of licensing procedures is should be addressed as a matter of priority.
4. **Improving of the environmental licensing process.** The most important impact on the simplification of the environmental licensing of **SHPPs** (and all RES projects) will be accomplished by the modification of **Ministerial Decision YA** 1958/2012, and specifically the simplification/ change of the classification criteria that determine the environmental category of projects in order to transfer a number of projects to a lower environmental category. Experience so far has showed that in particular, the **SHPPs** are simultaneously included in several environmental categories of criteria from which the highest ranking environmental category results. However, many of the criteria and limits that are set are unnecessary, either because different limits have been set in the Special Spatial Plan of RES, or because the criteria are overlapping.
5. **There must be absolute priority on the access of SHPPs to the electrical grid.** The scarcity of the grid is one of the biggest problems which RES face today. Since the SHPPs need more time than other RES to be licensed, when they reach the end of the whole process they do not find grid availability to be connected. This reality makes the licensing of the SHPPs unproductive, and should be lifted. Moreover, the grid should be "cleaned-up" from inactive applications and projects in order for more free space to be created.
6. **The need for a grid,** upgrade, by the Hellenic Electricity Distribution Network Operator (HEDNO) – This a top priority especially in view of the fast pay back period for all concerned.
7. **Implementation of the market of guarantees of origin** (purchase of green energy certificates).
8. **Provision for the compatibility of the present environmental licensing, with the renewal of the SHPPs operating licenses after the expiration of their 20-year contract,** in order to ensure the continuation in the operation of existing projects, (which is a necessary condition not only for keeping attractive the SHPPs industry but also not to waste productive installed capacity).
9. **Exemption from environmental licensing for small projects, with a capacity <= 500 kW,** which usually are projects operated by local authorities or water supply or irrigation organizations but also of individuals for coverage/utilization of strictly local resources. This request is justified, since today the existing exemption from environmental licensing for other RES is at 1 MW, which means that even low-capacity SHPPs begin their licensing process with an overwhelming time disadvantage versus other RES, which most often leads to the inability to book space in the grid (which has meanwhile been occupied by the other RES) and ultimately results in project cancellation.
10. **Exemptions for the SHPPs from the obligation to obtain a Certificate from RAE, for very small projects, with capacity <= 300 kW.** This will contribute to the implementation of small and decentralized projects, reducing the current prohibitive development costs, helping maximizing the utilization of available potential and contributing to the creation of many small regional development investment plans. The current existing limit of exemption from a Certificate from RAE is 50 KW, and has no value, what so ever because of zero investment interest, (since the fixed development cost of such a project makes them financially loss-making).
11. **Radically change the procedure of appealing the SHPPs** investments or licensing procedure in The Council of State, and eliminate the ability almost for everyone to be able to appeal, by setting high amounts as a guarantee for an appeal, which will not be returned if the appeal is lost. Thus, only the truly important cases - and from stakeholders who are legally entitled to do so - will be heard by The Council of State appeals board.

Storage

Storage appears to be the new trend for future projects. Although it is early, HSHA has this parameter in mind, in order to be able to take advantage of it, when the costs of storage will become lower.

The SHPPs can serve as general projects of water resources management - hydraulic networks for irrigation, watering and sewerage

In recent years, the rapid growth of population in the cities has led to the construction of hydraulic networks that are often very energy-intensive, while on the other side **there has been a strong interest to recover "hidden" hydraulic energy, which in many spots in the hydraulic networks is substantial.**

For this reason and given the criticality of the issue of water resources management in Greece, the use of hydraulic networks must be combined - in parallel - with other uses, such as energy production.

In this context, the utilization - through SHPPs - of the existing hydraulic energy or the recovery of the destroyed or "hidden" hydraulic energy in all water transmission and distribution networks is an effective step for **multi-purpose water management**, having in advance ensured positive results and very positive contribution in the whole issue of optimal water resources management.

The SHPPs can satisfy all uses of water, without changing its quality characteristics. On the contrary, the turbulence of the water inside the turbine creates additional oxygenation of the water, thus greatly improving its quality. Besides, the recovery of hydraulic energy of water distribution networks from SHPPs inside cities can be undertaken with minimal environmental effects while the same time paying attention to the local architecture.

It is important to mention that such a vision has a huge multiplier interest and huge application potential throughout the country, since it can bring a real revolution in the country's energy policy creating the conditions for the coexistence of concepts such as multi-purpose optimal water management, co-operation between institutions and local government, operation of energy communities, regional development, multi-stakeholderism, adoption of new standards for project implementation, reciprocity, local and regional development and moreover there will be more than obvious positive effects in terms of regional development and job creation.

SHPP PIERION - 1.14MW

Conclusions

SHPPs can contribute to the emergence a green growth model, which is one of the main drivers of economic growth nowadays and which is the new strategy for overcoming the economic crisis, strengthening social cohesion, protecting the environment and tackling climate change, through positive economic growth.

The years 2020 and 2021 are proving to be absolutely critical, in view of the milestone achieved so far, with introduction and the application of new regulations in the energy market. Regulations which in combination with the National Action Plan for Energy & Climate (ESEK, NOV19 version), the Target Model (introduced on Nov. 1, 2020) and the modification of the special spatial framework of RES should be a practical proof of the State effort to promote and strengthen the development of SHPPs, as one of the energy and development pillars of the country.

Contributor

Ilias Ap. Kakiopoulos

Ilias Ap. Kakiopoulos was born in Athens in 1971. He is married and has 3 children. He graduated from the Mathematical Dept. of the University of Athens 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. Ilias Ap. Kakiopoulos 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 the elected General Secretary of the "Hellenic Small Hydro Association (HSHA)". Moreover, he is a member of the "Institute of Energy for S.E. Europe (IENE)", of the "Hellenic Mathematical Association (EME)", in the "Hellenic Cancer Society" and 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.

Distributed Energy Resources Management Systems (DERMS) - Application in the Lesvos NIIPS

By Georgios Stravopodis, Product Manager smart-grids at EMTECH SPACE P.C.

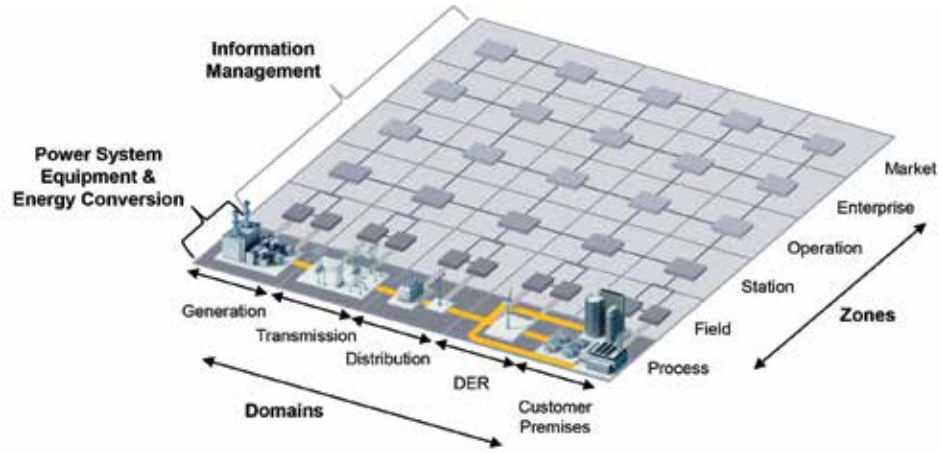
Introduction to DER and DERMS

The on-going energy transition towards a sustainable energy future has three identifiable trends:

- **decarbonisation by using clean renewable energy sources (RES) as the primary supply to reduce greenhouse gas emissions;**
- **decentralisation (or distributed generation) by using small power generation units closer to demand that are more efficient, reliable, resilient and sustainable than centralised plants and**
- **digitalisation by increased digital devices and connectivity that impact all industries and enables innovative business models.**

These trends transform the traditional electricity grid with power and data flowing to all directions, creating a new paradigm known as the Smart Grid. A single definition for this concept does not exist, however, a Smart-Grid Architecture Model (SGAM) has been proposed {1} for standardization of use cases definition and interoperability. The smart-grid is modelled into a two-dimensional plane visually represented in Figure 8.

Figure 8 • The Smart-Grid Architecture Model plane



The electrical process is segmented into domains with large resemblance of the traditional supply chain (generation, transmission, distribution, consumption) however with a new domain "between" distribution and customer premises: **Distributed Energy Resource (DER)**. DER represent distributed electrical resources directly connected to the public distribution grid, applying small-scale power generation technologies (typically in the range of 3–10 MW). DER assets can be renewable generation – such as solar or wind – or non-renewable, such as a small diesel generator. DER can function autonomously or they can be aggregated to create a virtual asset. New DER capacity additions are expected to exceed 500GW by 2030 {2}. As an increasing share of DER connects to Distribution System Operator (DSO) grids, there is a growing need for observability and power management to help DSOs maintain security of supply, lessen demand forecast errors and solve congestions in their grids. As many DER assets are customer owned, successful DER integration will be implemented through the convergence of operation technology and information technology that will provide them with insight and DER control. Connected digital systems will enable utilities to know what DER exist in their system, where they are located and how they are performing in real-time.

An example of such new/emerging systems is a **Distributed Energy Resource Management System (DERMS)**. A DERMS is a hardware and software platform to monitor and control distributed DER in a manner that maintains or improves the reliability, efficiency and overall performance of the electric distribution system. DERMS are enabled by an information and communication technology (ICT) infrastructure {3}. The core DERMS capabilities include the features seen in Table 1. However, depending on the use case, a DERMS offering may have augmented features in the domains of physical network management and end user integration (e.g. demand response).

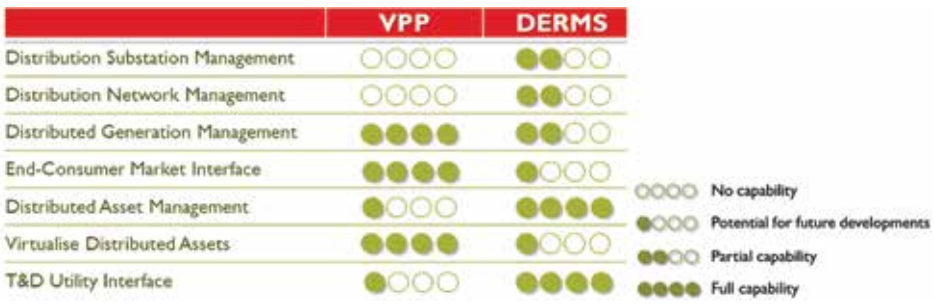
Table 1 • DERMS features – core and augmented

Physical Network Management			Core DERMS Capabilities			End User Integration		
Integrated system planning	Power flow analysis	State estimation	DER monitoring forecasting	Aggregator coordination	DER Optimization & dispatch	Demand Response	Advanced Metering Infra-structure	DER Gateway

DERMS are an emerging product category and global DERMS implementation spending is estimated to reach $946.6 million annually by 2027 at a compound annual growth rate (CAGR) of 19.8% {7}.

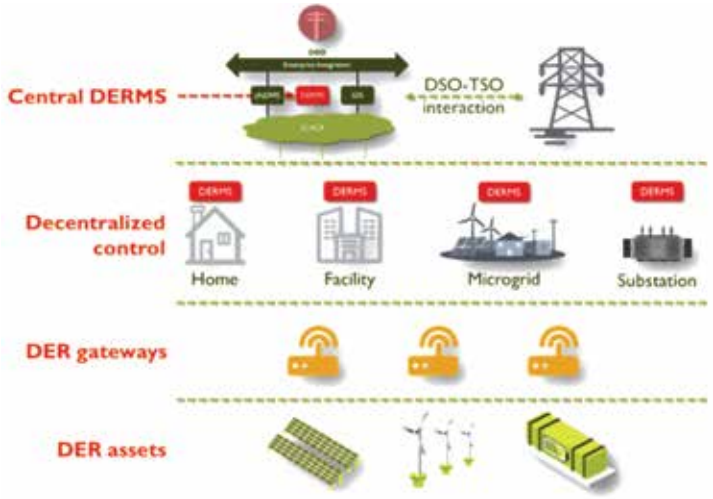
DERMS have common functionalities with another innovative business model of aggregating DER like renewables and batteries: a Virtual Power Plant (VPP or Aggregator). The core value proposition offered by a VPP is that they can deliver power without the physical conventional/centralized asset (plant). As an example, if a utility may need only 10MW of power, it may deploy a 500MW gas plant. A VPP can either find places to reduce load so the 10MW won't be needed at all or it can generate this power by dispatching PV or wind facilities or by discharging batteries {4}. VPPs are more suited for market participation and a comparison of the two systems can be observed in Table 2.

Table 2 • Comparison between VPP and DERMS (source: {5})



The Electric Power Research Institute (ERPI) in order to deal with such systems' complexity and placement of intelligence (central vs distributed control) proposes a federated architecture approach {6} with levels of components and control (depending on the use case). An author's adaptation can be observed in Figure 9.

Figure 9 • A DERMS federated architecture approach (author's adaptation found in {6})



DER gateways are devices for each DER asset or site that connect them to the DERMS and integrate them to the control centre. DER gateways are utility or aggregator owned thus providing system-wide uniformity as they are deployed and replaced/upgraded together. However, they have short longevity (compared to DER assets) as the telecom technologies they rely upon, are rapidly changing. One level up in this architectural approach are the decentralized control use cases with some examples (non-exhaustive) presented in Table 3 where in most cases the DERMS has the role of a dedicated Energy Management System (EMS).

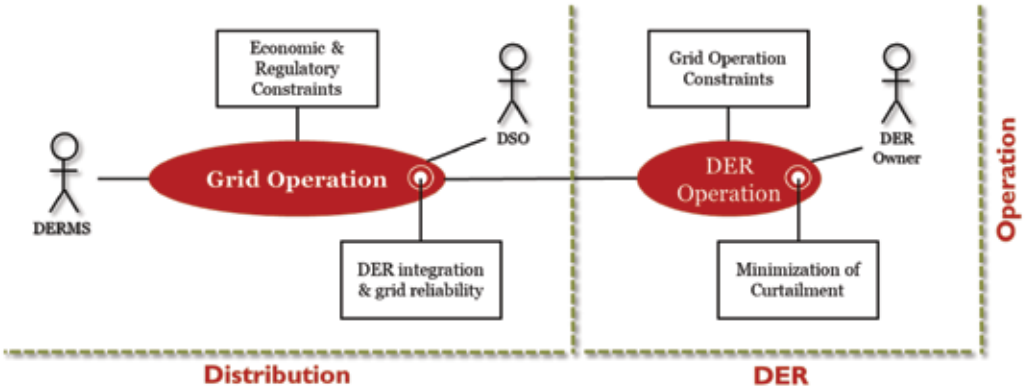
Table 3 • DERMS decentralized control use cases

DERMS decentralized use cases	Application
Home	Home Energy Management System (H-EMS): Manages the customer's behind-the-meter resources and optimizes the bill.
Facility	Commercial: Facility Energy Management System (F-EMS) & Industrial: Industrial Control System Interface to facility control systems and/or plant operators to manage the customer's behind-the-meter resources and optimize the bill.
Microgrid	Community Energy Management System (C-EMS): Optimizes the utilization of community resources, increases self-consumption and reduces power demand. Microgrid Energy Management System (M-EMS): Provides resilient backup power when disconnected and grid services when connected.
Substation	Feeder-Level: Improves reliability with feeder-level optimization and system resiliency through feeder-level microgrids.

The centralized control DERMS use cases refers to downstream DER large-scale group level control by the DSO with large data exchanges and computations. A DSO DERMS primarily connects and interacts with the Distribution Management System (DMS) but it can interface with other enterprise applications like the Geospatial Information System (GIS) for discovery of new interconnections and maintenance of the present status and settings of DER in the field. Centralized DERMS may have human operators where user-interfaces should provide map views, real-time status and alarms supported by modules for user administration and cybersecurity. Furthermore, they can interface with other aggregators and facilitate TSO/DSO coordination for provision of bulk system services.

The business relationships of actors (roles and systems) mainly involved for exploitation of a centralized DERMS are depicted (following SGAM) in Figure 10: DERMS is an actor-system required for the business process of Grid Operation managed by the actor-role of DSO. This process is under economic and regulatory constraints and in this context is targeting DER integration while maintaining grid reliability[1]. Connected to this process is the DER Operation process of the DER Owner actor-role that is under grid operation constraints and is targeting minimization of produced energy curtailment (or maximum economic benefit).

Figure 10 • Business relationships for a centralized DERMS case



As far as standards for integration and data models, these differ from each connection side {6}:

a. Enterprise side to DERMS: IEC 61968-5:2020 (data elements) and IEC 61968-100:2013 (application integration).

b. DERMS to DER: IEC 61850, Sunspec, Modbus, DNP3, IEEE2030.5, OpenFMB.

EMTECH's approach

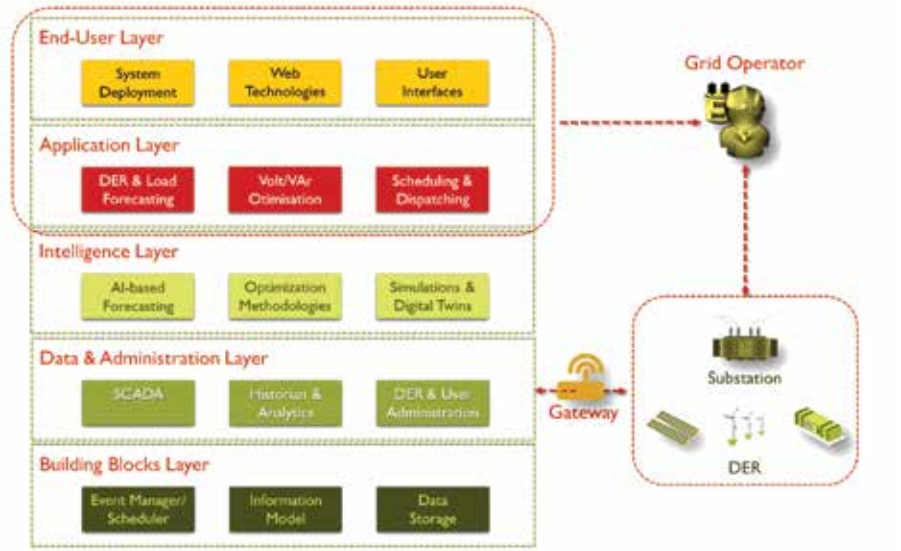
In EMTECH SPACE P.C. (EMTECH), we have been involved in smart-grid management and optimization since 2008. EMTECH has already designed and developed in-house iReact (TRL-9) for optimized capacitor bank management in HV/MV distribution substations. iReact is currently installed in more than 150 substations all over Greece contributing to power losses reduction (annual average 8%) in the transmission lines and released capacity at peak system demand (annual average 14%).

EMTECH has a strong innovative mind-set for smart-grid challenges and frequently engages in research and innovation activities – this has been recognised at EU level as the company has received funding through the European Innovation Council Accelerator to conduct a feasibility study for a DERMS development ("iReact-NG" - now called iDERgridy) {9}.

In this context, using our own building blocks for heterogeneous data sources, varying representations, real time and historic information, temporal & spatial aggregation, bridges to other environments and other features, we build upon a layered architecture that can serve varying use cases – one of them being a decentralized DERMS. Such an architecture can be observed in Figure 11.

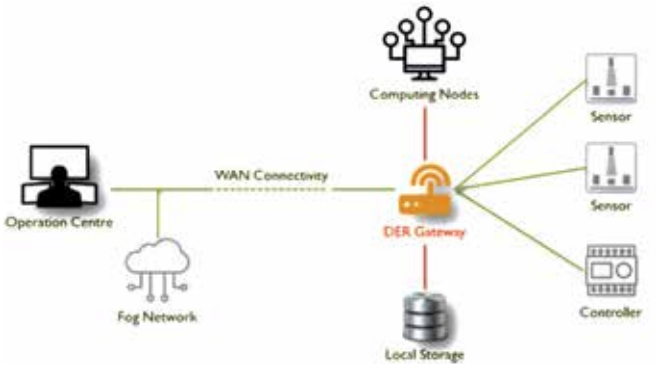
[1] Grid reliability as well as the push to offer more customer choice, were equally at the top of concerns (59%) to utilities according to research performed by West Monroe & GTM Research {8}

Figure 11 • EMTECH's layered architecture for DERMS application



Apart from the required functionalities in the Data & Administration Layer (e.g. SCADA), we are also offering a DER gateway to facilitate easier and uniform DERMS adoption by end-users. Our gateway has advanced features that enable connections to sensors and other field controllers, local data storage and edge/fog computing capabilities (Figure 12).

Figure 12 • EMTECH's DER Gateway features



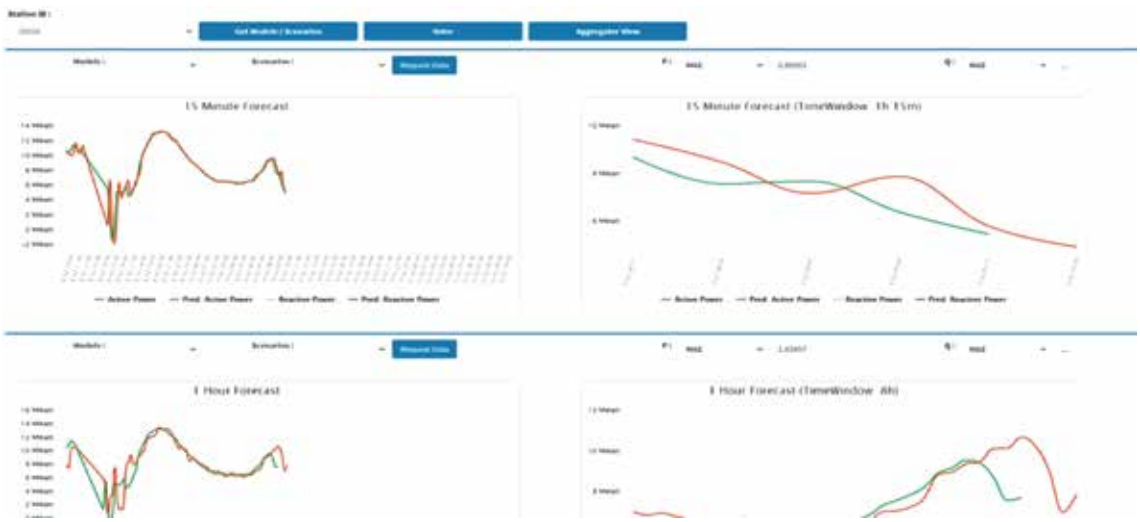
In the Intelligence Layer a variety of open-source and proprietary tools are employed to achieve objectives around forecasting and optimisation. For electrical grid optimisation we use the pandapower {10} module that is open-source and allows the dynamic configuration and execution of various approaches. Furthermore, we extend the module's capabilities through interfacing with other programming environments (e.g. MATLAB) thus exploiting optimization and control algorithms not usually available in open source tools. In this layer we also provide support for simulations either by writing a specific one (e.g. for a photovoltaic plant) or by integrating existing frameworks. In this context we can simulate power grid topologies thus creating a Digital Twin of the system. Then with real grid data (coming from the actual sensors) we can develop complex tools such as what-if scenarios and root-cause analysis.

In the application layer, depending on the use case the applications may differ. EMTECH has recently developed applications for Load Forecasting, Volt/VAr Optimisation and Scheduling & Dispatching of assets.

Our **Load Forecasting** application performs active (P) and reactive (Q) power demand predictions for multiple time horizons spanning from 15 min to day-ahead (24 hr.) taking into account external numerical weather predictions (Figure 13). A variety of methodologies are employed from linear regression to Artificial Neural Networks and Support Vector Machines. Each demand model can be trained with different datasets for each station/node usually referring to a specific geographic location or region, which we call scenarios.

The scenarios concentrate on a variety of aspects such as intra-day patterns, weekend vs weekday, weather patterns, etc. resulting to the creation of multiple models for each node. For this reason, a Voter (algorithm) has been created responsible to select the best prediction from each model. Each model is measured for its performance by calculating and storing metrics such as MAE, MAPE, MSE and R in order to create a data set for further analysis and visualization via another user interface.

Figure 13 • EMTECH's Load Forecasting application

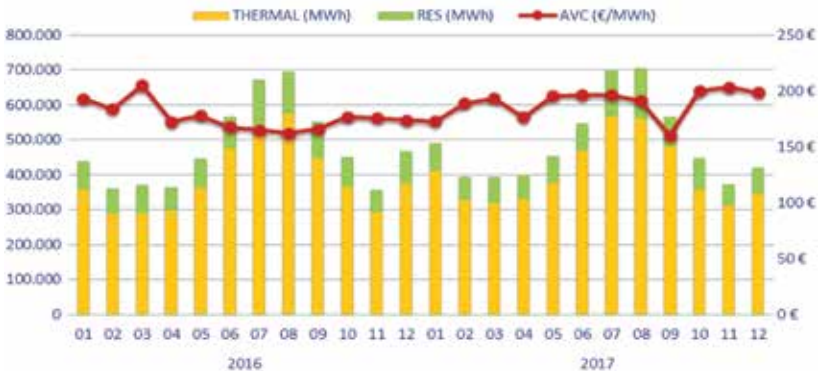


Volt/VAR Optimization (VVO) is an application to optimally manage system-wide voltage levels and reactive power flow for efficient distribution grid operation. VVO is achieved by determining the best set of control actions for all voltage regulating devices and reactive power (VAr) control devices to achieve one or more objectives without violating any of the fundamental operating constraints (voltage & load limits, etc.). By having in place all required components at field and station zones (SGAM partitioning), through communication standards and information models, our VVO is implemented by defining the grid topology, constraints, operational scenarios, objective functions and KPIs. Then the solver is executed by iDERgridy and evaluation is performed for grid's performance before and after the optimization.

Isolated grid use case – The island of Lesvos

One of the decentralized use cases of interest to EMTECH is community microgrids/isolated grids. Especially for remote communities which are far from the main electrical grid, electricity is produced with generators running on fossil fuels such as diesel, thus emitting greenhouse gases. The production costs of these generators are very high, even 5 times higher than the production costs of a power plant used in an integrated network – such case are the Greek non-interconnect island power systems (NIIPS) - Figure 14. A large number of isolated grids exist on the 2200 EU inhabited islands of nearly 15 million inhabitants and with a total fuel cost over 3bn€ annually.

Figure 14 • Thermal, renewable and average energy production cost in Greek non-interconnected island power systems 2016-2017 (source: {11})



For this reason, RES integration in the production mix is considered a preferred route. However, as RES generated power fluctuates due to weather conditions, isolated grids need balanced supply of electric power in response to demand. For this reason a system for sophisticated energy management is required (scheduling and dispatching of assets) that can take into account the RES stochastic nature as well as energy storage systems and the upcoming electrification of transportation (e.g. electric vehicles charging infrastructure).

We have also developed a compact Energy Management System (EMS) suitable for this use case and we intend to demonstrate (Sep. 2021) the whole iDERgridy suite for the **power system of Lesvos** (simulated). The Lesvos NIIPS is powered by thermal stations of 75MW (base load units), wind farms and photovoltaics of around 14MW and 9MW capacity respectively. All grid operator's as well as DER assets are mapped with combined SCADA/GIS functionality – "real-time" view can be observed in Figure 15.

Figure 15 • LESVOS NIIPS SCADA/GIS in EMTECH's iDERgridy

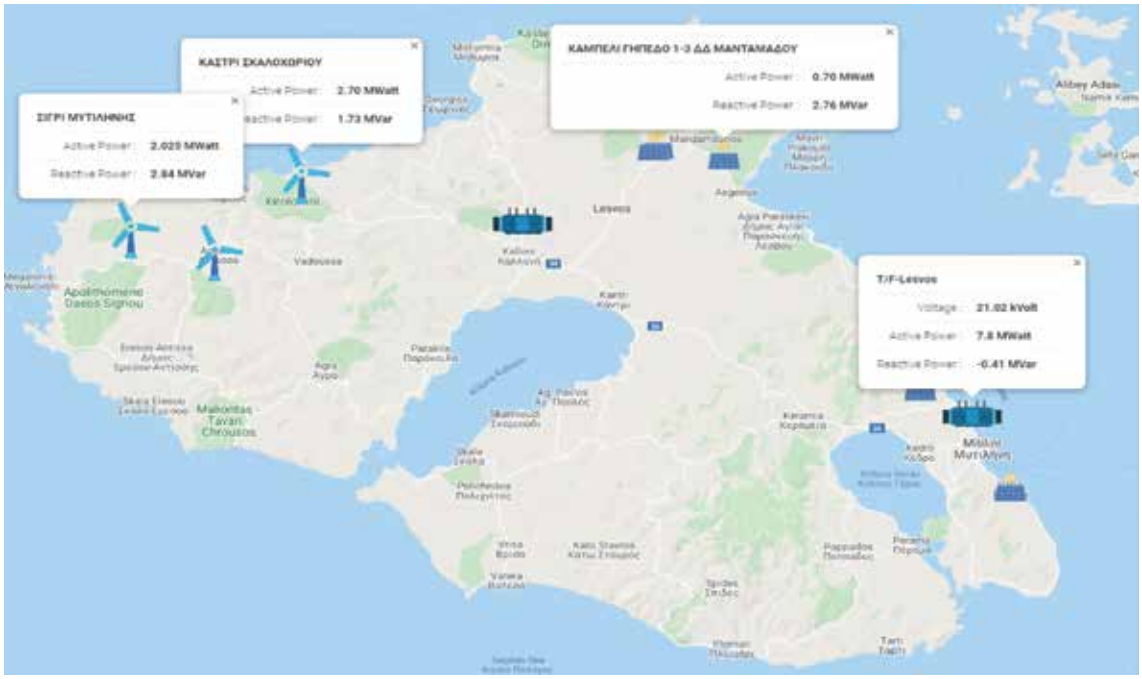


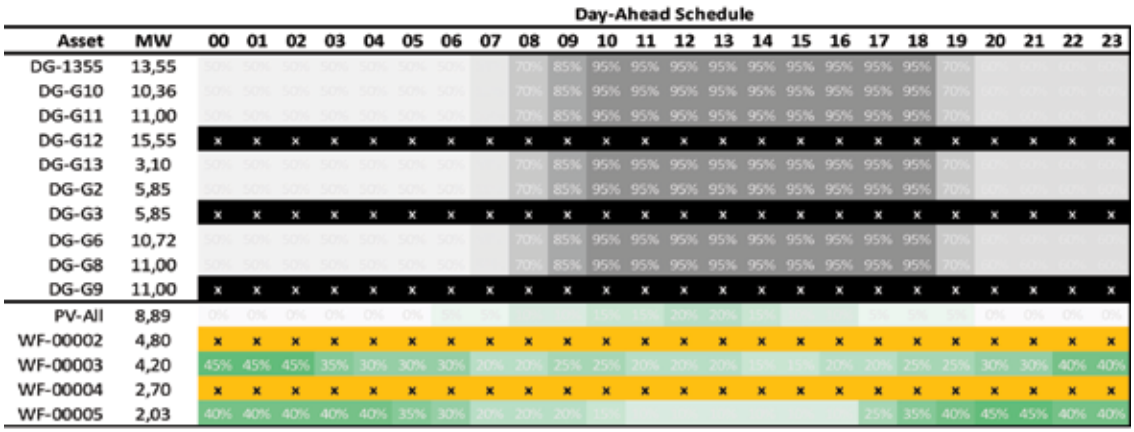
Table 4 • Lesvos demand, peaks and shortage/excess for the 2019-2023 period

Year	2019	2020	2021	2022	2023
Demand (GWh)	309,8	313,9	318,0	322,0	326,1
Winter peak (MW)	70,18	71,10	72,02	72,93	73,85
Summer peak (MW)	66,18	67,10	68,02	68,93	69,85
Winter generation capacity (MW)	84,41	84,41	84,41	84,41	84,41
Summer generation capacity (MW)	75,00	75,00	75,00	75,00	75,00
Largest unit capacity (MW)	12,50	12,50	12,50	12,50	12,50
Winter shortage/excess (MW)	1,73	0,81	-0,11	-1,02	-1,94
Summer shortage/excess (MW)	-3,68	-4,6	-5,52	-6,43	-7,35

In order to meet the supply shortage, the worst case scenario of acquiring two new thermal generation units of 12MW for this period, leads to a total cost of 100 million euros with 83% accounting for fossil-fuel costs.

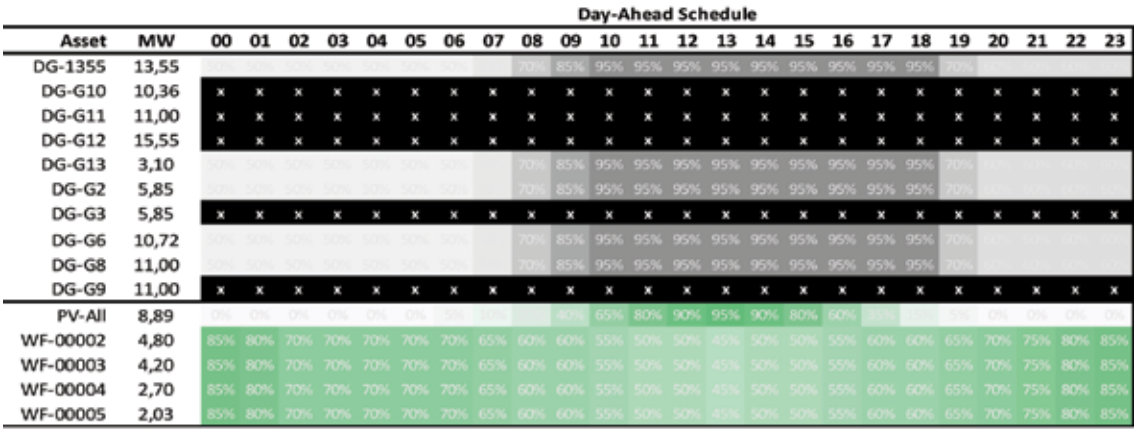
A generation cost minimization objective (other objectives can be emissions or technical losses reduction) will be set for the Lesvos NIIPS taking into consideration diesel generators, photovoltaic parks, wind farms as well as hypothetical energy storage systems like batteries and hydro-pumps and with varying costs per asset type. Thus from a business-as-usual monolithic day-ahead schedule where thermal generation covers most of the demand (Figure 16) our system will create an optimized one, where renewables increase their clean energy injection while maintaining grid stability (Figure 17).

Figure 16 • Business-as-usual day-ahead schedule of available assets



		Day-Ahead Schedule																							
Asset	MW	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
DG-1355	13,55																								
DG-G10	10,36																								
DG-G11	11,00																								
DG-G12	15,55	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DG-G13	3,10																								
DG-G2	5,85																								
DG-G3	5,85	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DG-G6	10,72																								
DG-G8	11,00																								
DG-G9	11,00	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PV-All	8,89																								
WF-00002	4,80	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WF-00003	4,20																								
WF-00004	2,70	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
WF-00005	2,03																								

Figure 17 • Optimized day-ahead schedule of available assets



		Day-Ahead Schedule																							
Asset	MW	00	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19	20	21	22	23
DG-1355	13,55																								
DG-G10	10,36	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DG-G11	11,00	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DG-G12	15,55	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DG-G13	3,10																								
DG-G2	5,85																								
DG-G3	5,85	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
DG-G6	10,72																								
DG-G8	11,00																								
DG-G9	11,00	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
PV-All	8,89																								
WF-00002	4,80																								
WF-00003	4,20																								
WF-00004	2,70																								
WF-00005	2,03																								

The savings potential is substantial: with a renewable energy increase of over 30% in the island's energy mix, we expect at least an average production cost decrease of 20%: for a typical yearly demand of 310GWh and an average production cost of 130€/MWh, such a decrease could result to savings over 8 million euros per year.

If you are interested in participating in the scheduled demonstration, please contact us at info@emtech.global to receive an invitation.

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Georgios Stravopodis

Georgios Stravopodis acts as EMTECH's Product Manager for smart-grids portfolio handling also its growth aspects. He has been the lead author of several awarded proposals for EU and national funded research and innovation activities. He is currently the Coordinator of two relevant national projects (General Secretariat for Research and Innovation – "Research-Create-Innovate") and participates in Horizon 2020 relevant projects as a member of the BRIDGE initiative (working groups for Business Models and Replicability & Scalability). Amongst his core competences are organizational efficiency (low-code application development advocate) and strategic management of innovation (e.g. blockchain applications for the energy sector). He acquires a BSc. in Physics and an MBA.

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7

ENERGY EFFICIENCY AND COGENERATION

7. Energy Efficiency and Cogeneration

The Enhanced Role of Cogeneration in the new Revised Energy Efficiency Directive, is Key for the Successful Renovation of the Building Stock in EU and Greece

By Costas G. Theofylaktos, Dipl. Mechanical Engineer, MSc, President of Hellenic Association for the Cogeneration of Heat and Power (HACHP)

The renovation of the European - and therefore of the Greek - building stock will be one of the crucial issues, which should be thoroughly addressed by EU's energy policy makers, in order to achieve the goals of the ambitious European "Green Deal" Agreement and for putting Europe on a sustainable path to recovery, following the end of the COVID-19 pandemic that swept the globe and hardly hits Europe.

To pursue this ambition for both energy profits and economic growth, the European Commission (EC) published on 14th of October 2020, a new strategy to strengthen building capacity renovation, entitled "A wave of renovation for Europe - Green building, creation jobs, improving lives (COM (2020)-662)"or as it is known "Renovation Wave" [1].

This policy aims to double annual renovation rates over the next ten years, where these renovations will improve the quality of life of people living and using buildings, reduce greenhouse gas emissions in Europe and create up to an additional 160,000 "green" jobs, mainly in the construction sector.

[1] https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en

Today, buildings account for more than 30% of emissions and energy consumption in the European Union (EU). More than 75% of buildings in the EU are inefficient, due to heat leakage from their envelopes, the use of outdated and inefficient heating and air conditioning systems, or, in most cases, both. Given that more than 90% of the existing building stock will remain in operation by 2050, this poses major challenges for the decarbonisation of Europe. With almost 34 million Europeans unable to keep their spaces adequately heated, the renovation of buildings is also a major response to "Energy Poverty", which ultimately aims at the health and well-being of vulnerable people, while reducing their energy accounts.

The success of the Renovation Wave requires a holistic approach to building renovation, where energy efficiency must be firstly applied to both the supply and demand sides and this is a guiding principle.

Characteristically, Renovation Wave states that *"No solution will be enough to address the enormous challenge of building decarbonisation. Energy efficiency, renewable energy sources, "green" electricity, high-efficiency cogeneration and district heating / cooling all have a very important role to play. Europe must step up its ambition and implementation of a more efficient, robust, integrated, cleaner and more affordable energy in buildings."*

Renovation Wave presents significant opportunities for the resumption of the EU economy following the COVID-19 pandemic, offers significant assistance to Europe in fulfilling its Paris Agreement commitments and by creating a healthy and comfortable environment to every European citizen.

Promoting Energy Efficiency (EE), along with a serious integrated local planning unlocks the benefits of Cogeneration of Heat and Power, CHP, and this is, among others, one main guideline of the Renovation Wave.

Throughout EU, many cities and households rely on CHP to provide reliable, efficient and affordable heat and electricity for their buildings and Renovation Wave focuses on energy efficiency in both heating, cooling and on-site electricity production. For this reason, policy makers should take, seriously, into account the benefits of CHP, in terms of Network stability and of the effectiveness of the electricity System.

CHP produces more than 70% of the heat provided by district heating systems in EU. The high efficiency CHP, HECHP, in combination with district heating/cooling systems can reduce CO_2 emissions, by 70% for a city of 250,000 inhabitants, while by providing electricity on-site simultaneously supporting the local electricity Network. Also, the Cogeneration of heat & power from μ-CHP units (<50 kWe) with fuel cells, installed at homes and small and medium enterprises (SMEs) can enable consumers to produce their own "clean" heat and, at the same time, their "flexible-green" electricity.

CHP contributes to the adequacy of the electricity system, providing efficient electricity, especially in periods of high demand, due to the extensive use of heat pumps or of low wind or solar radiation, which benefits both consumers and local electricity networks. Cogeneration also supports the increasing penetration of renewable energy sources, RES, in the building sector, ensuring that these valuable resources are not wasted.

Energy Efficiency (EE) has undeniable benefits for energy consumers, for the Economy and for tackling climate change. However, despite efforts to promote energy saving, EE lags the objectives set by EU, for 2020. The recent evaluation by the EC of the National Energy Climate Plans of the M-S-27[2] shows that national commitments to EE are not sufficient to achieve the goals set for 2030.

[2] NECP for Greece: https://ypen.gov.gr/energeia/esek/

To ensure that, the new revised EED, which will probably be published in 2021 and will be harmonized with the national legislations in 2022-23, should be able to achieve the objectives for 2020 and 2030. So, it must define that both primary and final energy savings as complementary objectives. This can be achieved only if the new Directive is aligned with the first principle of the Regulation 2018/1999[3] of EC, which states that it must:

(1) Promotes the energy efficiency on both energy demand and supply of sides,

(2) Improves energy efficiency in conversion, transmission and energy distribution.

In order to establish common competition rules in various EU measures, the new EU EED should target both the primary (PES) and the final energy savings (FES), in terms of objectives, measures and implementation.

For enhancing energy efficiency in both the heating and cooling systems (H & C), Comprehensive Assessments (CA) (see existing EED-Article 14) offer the opportunity to identify key solutions for the modernization of the H & C systems, of different sectors, promoting strategic planning at local level.

The new revision of the EU EED should ensure that:

(1) Comprehensive Assessments will be better synchronized with the new policy tools, especially with the NECP of each M-S,

(2) Local authorities should be involved in all stages of the CA process,

(3) The proposed solutions for H & C, identified in the CAs, should be supported through concrete measures and funding policy, with full usage of the important role of CHP, which is a serious solution for EE and with significant untapped potential, from 2030 onwards.

Today, the CHP provides 11.3% of electricity and 16.5% of heat in the EU, with more than 70% of the CHP to be of low carbon content and by using RES, saving up to 47 Mtoe (~ 13% of the EU 2020 target). This is translated into CO_2 reductions of up to 250 Mt (~ 20% of the EU GHG 2020 target).

According to the CODE2 project,[4] funded by the EU and with the participation of HACHP, in 2030, HECHP could deliver 20% of the EU electricity and 25% of its heat, with increasing usage of RES. If this achieved, this could further reduce CO_2 by up to 350 Mt, representing ~1/3 of the effort to achieve at least 55% GHG reductions, by 2030.

Despite the growth potential and benefits identified, the current EED[5] was undoubtedly ineffective in promoting HECHP. In order to address these effects, the following proposed measures, which are fully taking into account of the benefits of CHP, are presented below including:

(1) Primary energy savings (PES) and emission reduction of CO_2,

(2) Higher efficiency by the electricity sector, avoidance of losses and reinforcement of the Network for adequate Systems, demand response, mitigation of power peaks, due to the penetration of electromobility into the electricity system of each M-S, in coming years.

Also, the energy balances should be transparent, when heat is wasted, in inefficient energy conversion in order to further promote CHP. Similarly, the heat recovery from waste would be according to the definition of "waste heat" given in the RE Directive, known as REDII[6], while allowing the on-site use of the waste heat. In this context, HECHP must be given priority over inefficient heat generation, in order to avoid heat wastage. Where the installation of a HECHP unit is not possible, then, the "waste heat" must be fully supported.

The current EED, Article 14.5/7, should be enhanced by more effective way, e.g. mandatory study of introducing the installation of a CHP unit, each time newly installed or renovated thermal plants in buildings, as boilers, steam boilers, etc., are planned. This will enhance the penetration of the very small CHP (<50 kWe) in the thermal systems of the buildings.

[3] https://eur-lex.europa.eu/legal-content/EL/TXT/PDF/?uri=CELEX:32018R1999&from=EN

[4] http://www.code2-project.eu/

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2018.328.01.0210.01.ENG

[6] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv:OJ.L_.2018.328.01.0082.01.ENG

Article 7 of the current EED, in its revised form, must enable the CHP and the District Heating and Cooling systems (DHC) to calculate their PES, as binding obligation of energy savings, in order to ensure common rules of competition with those heating solutions saving final energy (e.g. boilers and heat pumps). Alternatively, an additional PES target should be considered.

It is accurate to state that if there is political will by energy policy makers, both at European and national level, and the role of CHP is strengthened, in the new revised EED, CHP can play a catalytic role for the renovation of the European building stock and, therefore, there are chances for EU to achieve its objectives of reducing emissions of GHG, set for 2030, and Europe to enter to a "Climate Neutral Economy" by 2050.

The Hellenic Association of CHP, HACHP[7], considers that the Cogeneration sector is ready to meet the climate and energy aspirations of the EU and claims that a stable and consistent policy framework is needed by adopting and creating common competition rules between various solutions, with the ultimate goal the complete decarbonisation of European building stock.

Contributor

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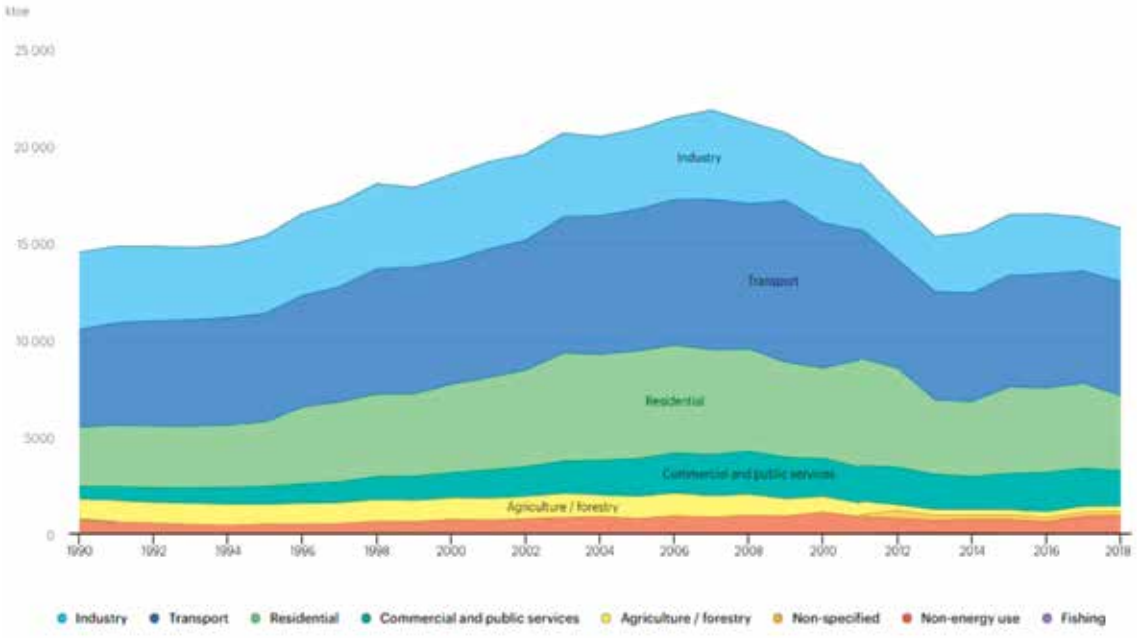
[7] http://hacchp.gr/

Greece's Uphill Battle to Improve Energy Efficiency in Buildings

By Costis Stambolis[1] and Costas Theofylaktos[2]

The building sector in Greece is responsible for a significant part of the country's energy demand and consumption. According to energy data (2018) buildings in Greece, (commercial, public and residential) were responsible for 6,012 ktoe, which corresponds to 39.63% of the total final energy consumption. This is proportionally higher than other sectors including transport and industry (See Fig.1) . In this sense, improving the overall energy efficiency of the building stock is a major challenge and hence a lot of attention and corresponding funds are being channeled by the Greek government and the EU in this direction.

Figure 1 • Final Energy Consumption by Sector in Greece, 1990-2018



Source: IEA

Although the significant role of buildings in the country's overall energy consumption is well known and documented over the past 50 years very little effort was actually made to improve their efficiency until recently. In this respect we should note that the first regulation to improving energy efficiency in buildings was introduced in 1979 and concerned the mandatory use of thermal insulation in all types of buildings. The Thermal Insulation Regulation required the consultant engineer or architect to achieve low U-values for the building's envelope, according to its geographical location. Without a proper supervisory mechanism very few buildings were constructed in Greece, after 1979, which incorporated a thermal insulation study resulting in poor performance and systemic heat losses especially in commercial and public sector buildings. (1)

Subsequent efforts to improve the situation resulted in additional legislation and corresponding regulations (e.g the 1998 Ministerial decision on reducing carbon dioxide emissions, measures and terms for the improvement of energy efficiency of buildings, known as KOXE, which conformed to EC's SAVE Directive93/76/EE) but without much success since neither the central government or local authorities had organized the necessary supervisory system and implied services for the enforcement of energy efficiency rules.

[1] Chairman of ENE and Managing Editor, energia.gr

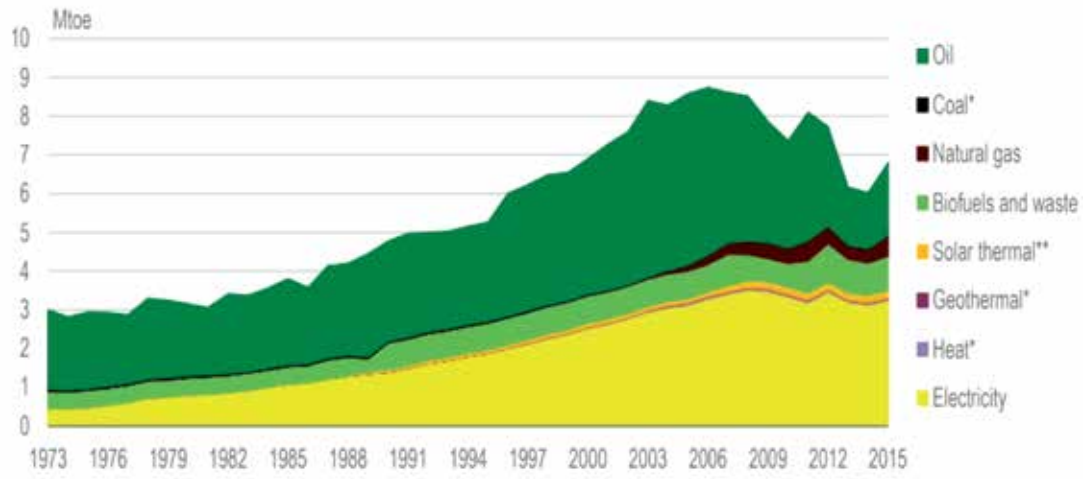
[2] Secretary General of IENE and Chairman of the Energy Efficiency Committee

In the coming years and until 2010 a number of supplementary legislative measures were introduced but without any practical effect apart from allowing a number of new energy saving techniques such as solar water heating, photovoltaics and natural gas heating systems to be integrated in the energy efficiency improvement definitions and provisions. (2)

Energy Performance for buildings becomes mandatory

Then, in 2010, we have a major milestone through the introduction, via Ministerial Degree (MD) 5825/9.4.2010, of a brand-new legal framework titled, **"Adoption of Energy Performance of Buildings Regulation"**, known through its Greek acronym as KENAK and refers to the standard ISO 13790 as well as other international standards that define all the parameters related to the Greek requirements.(3) Since the implementation of EPBD, there were not any specific regulations in place in Greece, regarding the energy performance and the evaluation of buildings, except the Thermal Insulation Regulation (TIR), introduced back in 1979, and the five (5) Technical Codes, related, among other issues, with the installation of heating and cooling systems and of distribution of natural gas to buildings, issued by the Technical Chamber of Greece (TCG) in 1987. (See Fig. 2)

Figure 2 • TCF in residential and commercial sectors by source



Source: IEA (2017a), World Energy Balances 2017, www.iea.org/statistics/

* Negligible.

** Solar thermal only. Electricity generation from rooftop photovoltaic installations is not included.

Note: The commercial sector includes commercial and public services, agriculture, forestry, and fishing.

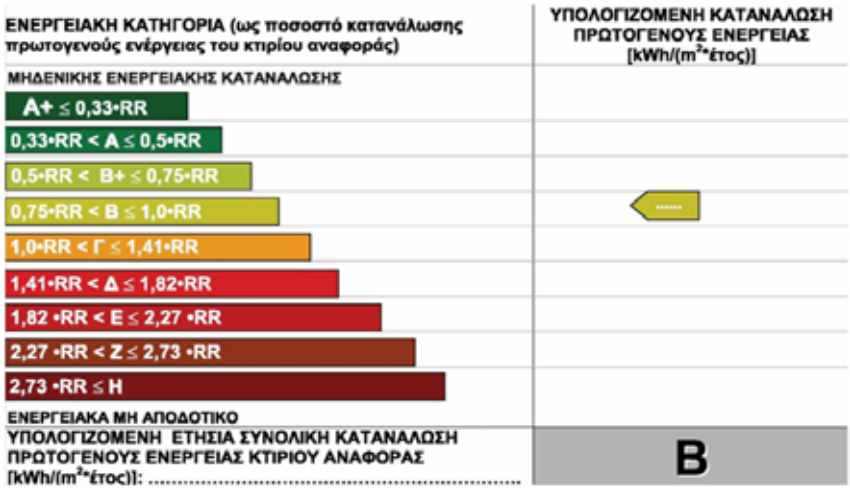
In April of 2010, in compliance with the Directive 2002/91/EC, the Ministry of Environment, Energy and Climate Change, YPEKA-MEECC, which was responsible for the national EPBD, and the, TCG, launched the *"Regulation on the Energy Assessment of Buildings KENAK"*, in accordance with the L.3661/2008, adopted in 2008. (4) According to KENAK, the energy evaluation of the building determines the energy efficiency, following a series of detailed analysis. Following the MD 5825/2010, the concept of "a reference building" was introduced, as a building having the same shape, orientation, and usage and operation characteristics, with the building under consideration. The rating of the building in the energy efficient indicator is defined by an energy performance certification that specifies different energy level classes, related to the different climatic zones and the type of use of the building. This indicator is expressed in kWh/m² per year.

Figure 3 • The climate zones in Greece

Source: IENE – Working Paper No. 21

Nine different categories, from A+ to H, classify the energy efficiency of the examined building. Three categories above category B (B+, A, A+) indicate the most competitive energy efficient buildings. The classification of the building in the rating scale is calculated based on the primary energy consumption of the examined building. Figure 4 shows an example of the energy scale indicator, in Greek.

Figure 4 • Energy Scale Indicator



Source: Ministry of Environment and Energy

Moreover, each certificate provides the total CO_2 emissions of the building. Recommendations of alternative options for energy saving and information related to the improvements on the energy efficiency of the building are proposed by the energy inspectors, in order to inform the owners for upcoming energy efficiency investments, in order to improve the energy performance of their building. Buildings under energy inspection would be either new buildings, existing buildings or under major renovation and buildings or apartments for sale or leasing.

For the implementation of EPBD, it was necessary to create a special software tool, in order to calculate the energy performance, rate the building and finally lead to the "Energy Efficiency Certificate". The TCG, with the partnership of National Observatory of Athens (NOA), developed the software TEE-KENAK. (5) The certificate's validity is for ten years. Buildings under major renovation are required to be certified again, at the end of the work programme, in order to evaluate their energy efficiency.

In case that false information is reported, , a penalty is applied to the energy inspector and the owner too by the specified authorities of YPEKA. Regarding the owners, in case the construction does not meet the requirement of the certification, the building would be considered as an illegal construction and the building must be reviewed and upgraded, in order to improve its performance, according to the minimum requirements of the KENAK.

With the adoption of Law L.3851/2010, Greece set its target to cover 20% of its national energy consumption from Renewable Energy Sources (RES) by 2020; 2% above the mandatory level of 18%, set by Directive 2009/28/EC. This objective would be achieved through collaborations and energy efficiency measures known as “green development” that would increase the penetration of RES technologies in electricity production. Based on the L.3851/2010 specific regulations were established for the use of RES in KENAK. (6) Regarding the new legislation, new initiatives encouraged the use of RES in energy consumption, electricity production and contribution in heating and cooling. Additionally, special programmes and financial incentives for photovoltaic installation, up to 10 kWe were provided in the household sector and small businesses.

It was then decided that new buildings and the ones under major renovation should stipulate a minimum required level of energy from renewable sources. According to the new regulations, 60% of the domestic Hot Water production should be covered by using solar thermal collectors or alternative renewable energy production systems (i.e. GHPs). In addition, KENAK, also, defines the inspection of boilers and of the air-conditioning systems of the building, in order to promote the overall improvement of energy performance of the Greek buildings.

EU nationally- funded energy efficiency programmes

During the 2007-2013 period, and under the Community Support Framework period, known as ESPA, Greek government launched a number of programmes, aiming towards the improvement of energy efficiency in buildings. A detailed presentation of the programme os made in an IENE Working Paper, published in December 2014. (7) In brief, during 2007-2009, two major programmes provided economic incentives for improving energy efficiency in the residential sector, namely:

- The programme “Changing your Air-Conditioner”, aimed for the replacement of old and energy-consuming split air-conditioning units, which run on summer 2009 and led to the replacement of more than 140,000 split-units, all over Greece, with new ones with inverters;
- The “Energy Efficiency at Household Buildings” programme for the insulation of walls and roofs, the replacement of windows/doors (frames/glazing), and the upgrading of heating and hot water supply equipment. This co-financed programme concerned buildings.
- Installation of high-efficiency CHP units, operating with natural gas, in conjunction with cooling systems, in hospitals.
- Demonstration projects for the use of RES and the application of energy-saving measures in existing public primary and secondary school buildings.
- Demonstration projects for the use of RES and energy saving in public buildings.

The following are the most important energy efficiency programmes for buildings which were undertaken during that time period:

"Exikonomo" I - Energy Efficiency measures in municipal buildings

In 2009, the (former) Ministry of Development introduced a programme named "Exikonomo" for municipal buildings, for municipalities with a population of more than 10,000. This programme aimed at the reduction of energy consumption in urban environments, focusing on municipal buildings and the upgrading of communal areas. At the same time, the programme, through the implementation of technical interventions and actions, promoted the sensitization and mobilization of citizens, local government and entities on the benefits of energy efficiency.

The programme's total budget amounted to 100 mil €. The maximum eligible total budget proposal for each municipality was a function of its population (based on 2001 census).

Exikonomo II

This particular programme started to unfold, in 2011, under of the "Environment and Sustainable Development" programme and related to energy saving measures in existing municipal buildings and infrastructures for municipalities, which did not participate in the original "Exikonomo" programme. The following actions were carried out in the context of this programme:

(a) Interventions in buildings and infrastructure: energy renovation of the building envelope, including thermal installation, energy upgrade of electrical & mechanical installations, upgrading of artificial lighting systems and installation of energy management systems,

(b) Support of other relevant actions such as the use of the services of a technical consultant and engineering services, energy efficiency studies, energy audits and publicity.

"Exikonomo Kat'Oikon I" - Energy efficiency for residential buildings

The, then, Ministry of the Environment, Energy and Climate Change (YPEKA-MEECC), having completed the legal framework for the application of energy efficiency measures in buildings, developed a set of financial incentives, with co-financing from the European Union, for the implementation of energy efficiency upgrading interventions in residential buildings. Therefore, this programme which commenced in 2010 was based on the European energy efficiency buildings legislation and regulations, whereby the possibility exists for funding, provided through the European Regional Development Fund, to apply energy efficiency measures and promote renewable energy use in the residential sector, whereby it allows the possibility of spending from EU's structural funds in order to finance incentive schemes related to these tasks. So, this co-funded programme provides incentives to citizens to improve the energy efficiency of their home, saving money and energy and increasing their market value.

Eligible buildings were houses, apartment buildings and individual apartments that satisfied a number of criteria:

- The building to be situated in an area, with market zone price lower or equal to 2.100 €/m^2.
- The buildings should have been classified under the Energy Performance Certificate (EPC) in a category lower than or equal to D.

The project's total cost was approximately 400 mil €. Based on these funds, each region was entitled to a different economic allotment. Owners were eligible for funding based on their personal incomes. The incentives included free or low-interest loans and grants up to 30% of the approved budget. Table 1 shows analytically the three main categories of beneficiaries and the corresponding incentives in order to participate in the programme.

Table 1 • Categories of Beneficiaries for House Energy Improvement Financial Support Schemes

Beneficiaries	A1	A2	B
Personal Income	P.I. ≤12.000€	12.000€ <P.I. ≤ 40.000€	40.000€ <P.I. ≤ 60.000€
Family Income	F.I. ≤ 20.000€	20.000€ <F.I. ≤ 60.000€	60.000€ <F.I. ≤ 80.000€
	70% Subsidy	35% Subsidy	15% Subsidy
Incentives	30% Interest-free loan (interest rate subsidy 100 % to 31.12.2015)	65% Interest-free loan (interest rate subsidy 100 % to 31.12.2015)	85% Interest-free loan (interest rate subsidy 100 % to 31.12.2015)

Source: Ministry of Environment and Energy

The programme provided 4/5/6-year loans, with or without a guarantor, without mortgaging the property, direct loan repayment without charges, and immediate payment to suppliers/ contractors through the banking system, without the involvement of householders. With the approval for participation in the programme, the bank deposited 40% of the total budget at the beginning of the works. For admission to the programme an energy audit was required, before and after intervention, the cost of which was covered 100% by the programme upon successful implementation of the project. Moreover, the programme covered expenses for a project consultant fee up to €250. For the implementation of interventions, no construction license was required, except in very special cases. The maximum eligible budget of interventions, including VAT (24%) should not have exceeded €15.000 per property. The admission to the programme was on a continuous basis until exhaustion of funds for each region.

The energy savings achieved by the interventions of this particular programme corresponded to an upgrade of the energy class, or savings of 30% of the energy consumption of the reference building. Eligible interventions concerned:

(a) Installation of insulation in the building envelope including the roof and the pilotis.

(b) Replacement of window frames and glazing, including the fitting of shading systems.

(c) Upgrade of the heating and hot water heating system.

"Prassina Domata" - Green Roofs

This is just one more imaginative programme whose scope was to improve somehow energy efficiency in a number of public buildings. The programme titled "Green Roofs in Public Buildings" was a separate initiative of the Ministry of Environment and the Centre for Renewable Energy Sources and Saving (CRES), under Priority Axis 1 "Protecting the Atmospheric Environment & Urban Transportation-Managing Climate Change-Renewable Energy" Operational Programmes, OP, "Environment and Sustainable Development" 2007-2013" (EPPERAA), co-financed by the Cohesion Fund.

The specific actions of this programme included:

- Achieve energy savings in public buildings, throughout the year (summer and winter)
- Improvement of thermal, visual and environmental conditions in public buildings
- Improving the microclimate of the wider area, where the building is situated.
- Reduction of air pollution
- Minimize and, eventually, reverse urban climate conditions (ie. Thermal islands).

The target groups included public buildings such as ministries, municipality centers, other public entities, private legal entities etc, with a total budget of €20 mil.

"Building of the Future" Programme

Another ambitious programme meant to improve the energy efficiency of Greece's building stock, the "Building of the Future", was initiated by the YPEKA. In the framework of this programme, which started in 2011 and was meant to last until 2020, provision was made for 39,210 energy interventions in buildings (houses, apartments, commercial buildings), while the benefit of savings for citizens was estimated at about €9 billion.

Implementation of the programme would allow the country to achieve its goals of 20% energy saving by 2020 and provide a pivot for building construction, materials and energy products. The main idea behind the programme was that the companies selling building construction materials and related goods could voluntarily offer discounts to property owners carrying out energy efficiency upgrades of their homes and business premises. The Ministry was also pressing ahead with procedures for implementing greater tax relief for this type of investment through certificates to be submitted along with one's tax statement. In the "integration of advanced and mature technology actions" of the Programme incentives were given for six types of home improvement for residences and five in other types of buildings.

The following interventions were foreseen: replacement of windows and doors with higher specification types, replacement of single- with double-glazing, installation of solar panels for water heating, installation of 'green' roofs on dwellings, insulation of roofs, and insulation of facades in dwellings, replacement of conventional heating systems with new high efficiency systems, installation of advanced energy monitoring systems.

Two other minor programmes which were approved during the 20-12-2014 period included:

(a) Green Urban Neighbourhood Pilot Programme at "Agia Varvara"

The demonstration project, entitled "Green Neighbourhood", with a budget of €7 mil, involving an energy upgrade of four residential apartment building blocks, situated in this suburb of Athens to almost zero energy consumption with the optimization of the local micro-climate.

(b) Green Island "Agios Efstratios"

The scope of this programme, with an initial budget of €9 million, was to stimulate research, innovation and entrepreneurship, through a combination of actions related to a remote island in the Aegean Sea. The focus of the programme was the application of RES technologies and energy saving measures. Table 2 presents a summary of all above programmes. The number of units launched, and funds disbursed. In total energy efficiency prospects were supported to the tune of € 486,3 mil.

Table 2 • Summary of EU funded Energy Efficiency Programmes in Greece (2009-2014)

Programme Description	Number of building units	Funds disbursed (in million Euros)
Exikonomo at Local Authorities (2012-2014)	64	32.7
Exikonomo II at Local Authorities (2013-2014)	15	6.13
Exikonomo kat' Oikon (save at home), 2011-2014	39.210[1]	392.8
Green Roofs in public buildings (2012-2014)	36	9.42
Replacement of Air Conditioning units with more energy efficiency ones	136.000 installed units	45.25
Total Funds disbursed	**486,3 million Euros**	

(1) Number of houses which actually introduced measures to improve their energy efficiency

Source: Ministry of Environment and Energy

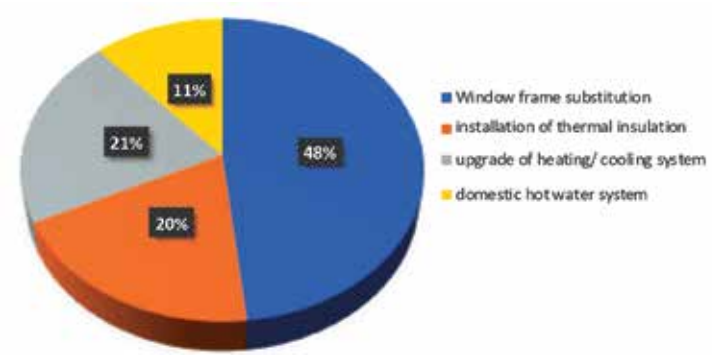
Valuable time and funds lost during 2015-2017

Although highly successful in terms of appeal among house owners, judging from the massive response and the funds dispersed, the "Exikonomo Kat' Oikon I" programme was not continued after its expiry in 2015, although the EC had indicated that EU funds were available if the Greek government would only file a request. The problem was that the newly elected (January 2015) left-leaning government of Syriza did not believe then in the need to introduce or encourage energy efficiency improvement measures. The view, at the time, was that subsidizing energy efficiency measures in buildings and handling public money to promote houseowners, should not be facilitated.

The new "Exikonomo Kat Oikon II" programme

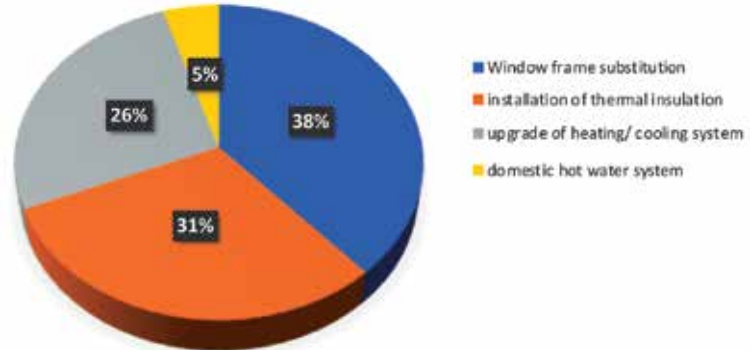
It took two full years for the Syriza government to be convinced of the usefulness of energy efficiency and it was only in March 2018 that it finally introduced a new nationwide energy efficiency programme known as "Exikonomo Kat' Oikon II" with a €400 million budget. (8) The programme commenced in the summer of 2018 and is still ongoing, having in the meanwhile been adopted by the right-leaning New Democracy government, which came to power in the summer of 2019. The programme, which has now been renamed as "Εξοικονομώ – Αυτονομώ" ("Exikonomo – Autonomo"), is slated to run until the end of 2021 and so far, a total of 45.600 successful applications have been approved corresponding to total, geared investment, of approx. €700 million. The approved applications correspond to 250.000 individual house interventions, meaning that more than five interventions were applied to each application. (9) The two Figures (5 &6) provide some interesting information on the type of intervention such as the installation of double glazing, thermal insulation, upgrade of the heating/cooling system etc.not be facilitated.

Figure 5 • Percentage of number of interventions by type of intervention



Source: Ministry of Environment and Energy

Figure 6 • Percentage of budget by type of intervention



Source: Ministry of Environment and Energy

Energy efficiency improvement prospects for Greece's building sector

Experience acquired over the past 10 years, a time period during which an organized effort to improve the energy performance of buildings was undertaken, shows that the overall problem associated with the poor energy performance in Greece's building sector is mainly organizational, due to institutional and societal barriers rather than a technical one. The way in which the construction and ownership of houses is financed, the poor spatial organization of buildings within the urban environment, the poor design of most buildings, the dominant vertical apartment type habitation model and the general lack of concern by the population at large for the maintenance of communal space are among the main factors which contribute to a widespread indifference as far as building and living standards are concerned. Wrong building orientation, lack of open and green spaces in the vicinity of houses and apartment blocks, a poor apartment blocks and indifferent design practices, disregard of thermal insulation and shading practices, combined with the installation of inefficient heating and cooling devices, are additional factors which has led to the construction of buildings largely characterized by poor energy performance. Therefore, in order to improve the performance of buildings in Greece, a much broader effort needs to be undertaken focusing on education, social development, improved design practices and effective inspection methods.

The question of Energy Efficiency in the building sector

When it comes to applying energy efficiency measures and techniques in Greece's building domain, there are certain serious obstacles -and apparently some of them insurmountable- which need to be identified and discussed. In short, we have to deal with the following problem areas when tackling energy efficiency in the built environment in Greece:

(i) There appears to be a serious lack in energy education and energy awareness among large parts of the population. With the exception of few examples in secondary education such as courses taught in the IEK/ EPAL training centers there has never been a consistent effort by the state aiming at energy efficiency, especially in the building sector.

(ii) There is a widespread notion that electricity should be provided "as low-as possible" to all households and to that end some government policies are not helpful. Sometime now a special "social" low tariff (highly subsidized) is offered to supposedly needy households, which currently exceed 500,000, but this measure is extensively abused. Such government policies contribute in cultivating an anti-energy efficiency mentality so that the householder is not bothered to find out, let alone apply, energy conservation measures.

(iii) Greece's post war construction model based on the typical apartment block (polikatikia i.e., multihabitational building), where individual apartments are owned by different families and householders, is not supportive for a communal type decision making process which is necessary if energy efficiency measures, in order to be effective, need to be applied for the whole building structure and not just to individual apartments. Given the highly selfish and suspicious character of the average Greek house owner a consensus among the different apartment owners cannot usually be reached and therefore plans to apply for available grants cannot proceed easily.

(iv) Bioclimatic considerations are completely lacking in the design and construction of 99.5% of building stock in Greece. Even if the architect or engineer involved is favorably inclined to use bioclimatic criteria in most case their initiatives in this respect are overridden by the ill-defined financial considerations of the house owner. Only very lately such myopic attitudes have started to change under pressure from economic distressful conditions, as a result of the present economic downturn, which has made the public more aware of the high energy costs involved in running a modern household.

(v) A widely acclaimed mandatory thermal insulation measure applied to all new constructions introduced by the government in 1979, and, hence, in force through the General Construction Code (TOK) until very recently was not applied as prescribed- due to lack of in situ inspection provisions- with the result that most buildings have sub-standard insulation. Usually engineers, architects and building contractors in order to avoid costs, do not apply the full insulation procedures while house owners rarely insist in the application of adequate thermal insulation practice.

Proposed Remedies

1. Introduce legislation with regard to the management of apartment blocks in order to tackle approval procedures for the management of heating- cooling and improvement of energy performance.
2. Further simplify and streamline grant application and approval procedures for EU backed financial assistance, while broadening at the same time the applicant base of eligible households.
3. Organize large scale information campaigns on a regular basis in order to increase public awareness on matters related to energy efficiency and energy conservation.

Conclusions – Key messages

Over the last ten years (2010-2020) Greece has made an organized and consistent effort to improve the energy efficiency of its existing building stock but also introduce rigorous energy conservation measures for all new buildings. The cornerstone of this effort was the energy certification of buildings following the launching and implementation of the "Regulation on the Energy Assessment of Buildings" (KENAK), in 2010, in compliance with EU Directive 2002/91/EC. Pursuant to this regulation and equally important was the introduction of the practice of Energy Inspection for Buildings, undertaken by accredited Energy Inspectors who are responsible for classifying buildings according to their energy-efficiency status but also for supervising schemes of energy efficiency improvement.

Successive governments in Greece from 2009 until now having recognized the great importance of energy efficiency in the building sector sought the necessary advice and support from the European Commission in implementing various changes both at legal, institutional and practical level. In this context successive Greek governments applied for EU's structural funds and obtained the necessary support which enabled them to provide wide ranging incentives for energy efficiency in the building sector as part of a series of specific programmes as described in this paper. The overall result of these programmes in terms of completed projects and amount of funds absorbed from the EC can only be described as positive. During the ten years (until the end of 2020) of running these programmes Greece absorbed approx. €850 mil. with more than 85.000 successful applications for various types of buildings for Energy efficiency improvement and 136.000 replacement of air conditioning units. The overall impact in terms of energy savings needs to be defined and IENE is in this process of carrying out this exercise.

In reviewing these programmes, a number of observations are relevant:

(i) The impact from the execution of the above EU funded programmes for improving the energy efficiency of buildings, especially in the residential sector, has been considerable and has helped mobilize a much broader interest in energy efficiency techniques and their application in newbuilds. Consequently, huge interest has resulted in households on how they can benefit from the introduction of energy efficiency improvement techniques with or without subsidized financial support.

(ii) The introduction and application of well-organized and well-coordinated programmes aimed at mass audiences for the energy efficiency improvement of buildings has proved that if a financial assistance programme is well planned and with minimum state interference it can be implemented fairly quickly, and actual results delivered. Therefore, the decision to appoint a single intermediary, i.e. banks, for the management of the programmes proved, in retrospect, a wise decision for all concerned.

(iii) There is scope for further work in the building energy efficiency sector in Greece with or without EU financial support. The usefulness of EU funding has been amply demonstrated in energy saving terms and therefore it would be for the benefit of the state to encourage the spread of energy efficiency improvement in the building sector by allocating certain state funds, primarily to support soft loans and cover energy inspection costs.

(v) There is a clear need for the measurement of energy efficiency gains in different types of buildings by undertaking specific studies on a series of buildings which have benefited from the application of energy efficiency measures as part of the above-described programmes (in the residential and public buildings sector). This is of vital importance in the context of the formulation of a national energy strategy and the need to account for potential energy savings in the building sector at country level.

(vi) The government needs to appoint and support a national coordinator (other than the Ministry) who will undertake to spearhead the overall effort for energy efficiency improvement in buildings and also to act as a vital information point to house owners and building managers.

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8

THE LEGAL FRAMEWORK

8. The Legal Framework

A Concise Overview of Greece's Legal Framework on Energy

By Dr. Eugenia Giannini, Lawyer, Eugenia Giannini and Associates Law Firm

Background to Greece's legal framework on Energy

Law No **2773/1999** set the basis for the liberalization of Greece's electricity market and regulated some key points of national energy policy and also introduced the Regulatory Authority of Energy (RAE). RAE monitors and controls the electricity market. The granting of licenses for electricity production and the construction of power stations is governed by Law No 2773/1999, as amended by Laws No **2941/2001, 3426/2005,3468/2006, 4001/2011.**

Law No **3175/2003** provided for the creation of a mandatory daily (pool) market for all sellers and buyers of electricity in the interconnected Greek network which comprises mainland Greece and certain Greek islands.

Law **3426/2005** introduced some additions into Law No 2773/1999 that accelerated the electricity market liberalization process. It also, modified the authorization regime for generation and supply of electricity and foresaw the separation of distribution network activities from other PPC activities.

Law **4001/2011** introduced a new regulatory framework to assist the Internal Market for Electricity and is the main piece of legislation currently governing the operation of energy markets in the electricity and natural gas sectors in Greece, including the activities the production, supply, purchase, transportation and distribution of natural gas and electricity.

Specifically, Law **4001/2011** focused on the separation of transmission and distribution activities from generation and supply activities in the electricity and gas sector.

Also, Law **4001/2011** strengthened the **Energy Regulator Authority** (RAE) whose competences and duties are established in **article 60** (as modified by article 24 law 4513/2018 and art. 54 law 4602/2019).

Law **4389/2016** introduced auctions whereby PPC was obliged to sell electricity term products through physical delivery to alternative electricity suppliers.

Law **4425/2016** further strengthened the financial and operational independence of RAE.

Law **4512/2018** paved the way for the replacement of the mandatory pool model by a Day-Ahead Market, an Intra – Day Market, a Balancing Market and an Energy Derivatives Market.

Furthermore, Law **4685/2020** introduced a fundamental reform in energy licensing and the regulatory regime, dealing with administrative inefficiencies of the previously applicable rules and providing a safe legal environment for the prospective investors.

Energy production technologies - National Legal framework

Lignite

First and foremost was L.D **4029/1959** whereby PPC was granted the exclusive Research & Exploitation rights of the Megalopoli deposits. Under L.D 210/1973 (Mining Code) an initial environmental review is required as well as an Environmental Conditions Approval.

By Law No **134/1975** (art. 3 par.3), PPC acquired on an exclusive basis all Research & Exploitation rights of the already merged with PPC, LIPTOL. The provisions of these laws caused the issue of Exclusive rights to Mine and Exploit Lignite at Community level. It is worth noting that the European Commission ruled that L.D 4029/1959 art. 22.1 and Law 134/1975 art.3.1 were in breach of art. 86.1 and 82 of the E.C.Treaty, while the Hellenic Republic maintained the measures in question by not granting rights for any worthwhile deposit, despite to private companies the opportunities provided by the Mining Code.

Article 3(3) of Law No 134/1975 was repealed by Article 36(3) of Law No 3734/2009.

In 1996, Law No **2414/1996** on the modernization of public undertakings, permitted the transformation of PPC into a company limited by shares, but still held by the State as sole shareholder. PPC was then transformed into a limited liability company on 1 January 2001, in accordance, first, with Greek Law No 2773/1999 on the liberalization of the electricity market. The Hellenic Republic holds 51.12% of the shares. Under Article 43(3) of Law No 2773/1999, the State's shareholding in the capital of the applicant may not in any case be lower than 51% of the shares with voting rights, even after an increase of capital. This provision was repealed by art. 1 of Law **4092/2012.**

PPC is considered dominant in the supply of lignite in Greece. The adoption of Law No **3175/2003** set developments in the electricity market with the granting of licenses to entities other than PPC for the construction of new power stations. Thus, Greek legislation granted no exclusive right to PPC, either concerning the exploitation of lignite or the production of electricity from that combustible or from other fuels.

Under Law No *4262/2014* the Greek legislative system has been adjusted to EC law requirements with regard to the Prospecting of Mines and Exploitation rights granted to private individuals.

Pursuant to Law **4533/2018** PPC was forced to divest from its two biggest lignite fired plants with a combined installed capacity of 900MW selling the latter to private investors through an international public tender[1].

Under art. 104 of Law No **4685/2020**, in strength from January 1, 2019 and to the detriment of electricity producers using lignite, who own or have been granted in any way rights of exploration and exploitation of lignite, a special fee 1,40 euros per megawatt hour (€/MWh) of electricity produced from lignite was levied.

[1] The tender took place (twice) but no credible sellers emerged and PPC retained ownership of the power stations

A key part of the National Energy and Climate Plan is to gradually phase out the use of lignite, which includes the decommissioning of all existing lignite units by 2023, except the Ptolemaida V unit, (now under construction) which will be retired by 2028[2].

Petroleum

Law 1571/1985 on Petroleum Products Market Regulation was the first attempt by the state to gradually deregulate the oil market. Until than the Greek state had the exclusive right of suppling petroleum products and derivatives.

Following that, it was Law 3054/2002 which provided set for organization of the petroleum market and other provisions and aimed at enhancing competition, modify the emergency stock system so that competition should not be affected, monitor the petroleum transportation system as to avoid contraband trace incidents, and also encourage transparency and efficiency.

The following are the most important provisions of Law 3054/2002, (as have been modified).

Art.2: Sets out the principles of Petroleum Policy.

Art. 3: Provides definitions, (as amended by Laws 3423/2005, 3769/2009, 4203/2013, 4062/2012, 4093/2012, 4111/2013, 4602/2019, 4685/2020), among which the definition of Petroleum Products (Par. 1. 1), which are classified under 6 categories.

Art. 4, as modified by Law 3423/2005 and Law 4602/2019: it sets that the activities of Refining, Disposal of Biofuels, Marketing, Retail, Transportation by pipeline of petroleum products and Bottling of Liquefied Petroleum Gas (LPG) are allowed only if the respective licenses have been granted. Licenses for Refining, Disposal of Biofuels,

Trade and Transport by pipeline of crude oil and petroleum products are granted by permission of the Minister of Development and Investment. It also provided that the conditions imposed by Law 3054/2002 and the Licensing Regulation are respected; a person (or legal entity) may receive more than one License (art. 4 par 6). If the same person holds more than one License, he (or entity) is obliged to keep separate accounts for each activity for which a license has been granted.

By Art.5, as modified by Laws **3335/2005, 4254/2014**, a Refining License is permitted only to legal entities Societe Anonymes established in E.C territory. Also, it sets the right to supply crude oil and petroleum derivatives to Licensed for trading entities, big final consumers, army and supply consortiums.

According to Art.5A, as modified by Laws **3423/2005, 4062/2012, 4093/2012, 4441/2016, 4447/2016, 4602/2019**, a Biofuels Supply License is permitted to licensed Societe Anonymes, limited legal entities and Agricultural Consortiums and Unions operating in E.C territory which have the right to import Biofuels and Renewable fuels and to trade them in Greek territory.

By Art. 6, as amended by Laws **4447/2016, 4602/2019**, a trade license for crude oil and petroleum products shall be granted to a legal entity, in the form of a public limited company or a limited liability company or a private capital company or other similar form, as long as this entity is domiciled in a member state of the European Union.

[2] The Efforts towards and Challenges of Greece's Post-Lignite Era: The Case of Megalopolis, MDPI, Sustainability 2020, 12, 10575

The trade license holder has the right to supply petroleum derivatives to Retail Licensed entities or to Big Final Consumers or final consumers providing storage capacity. The Prerequisites for licensing are as follows:

1. Escalation of minimum share capital depending on sales volumes of the past year,
2. Insurance coverage for risks and damages due to failure to fulfill administrative regulations.
3. Storage capacity: Escalation depending on sales volumes of the past year.
4. Transportation capacity: Transportation vehicles and means should be licensed also, under secondary legislation by YPEKA. For liquefied fuels : the Licensed entity should provide a stock of 30.000 refills with a trademark.

By Art.7 Retail License is granted to physical and legal entities as amended by Laws 3190/2003, 4441/2016.

Art. 12, as amended by Laws **4123/2013, 4361/2016**, set obligations for maintaining sufficient reserves Art. 16, as amended by Law **4093/2012**, predicts criminal sanctions

In general, Laws **4172/2013, 4223/2013 and 4447/2016** reduced entry barriers into downstream petroleum market in order to encourage competition economic development. Specifically it reduced the minimum capital and storage capacity required for applicants for an oil trading license.

Natural Gas

Law **2364/1995** introduced natural gas imports and trading in Greece.

Law **3428/2005** enacted the liberalization of the natural gas market.

- **Article 7 Law 3428/2005** ordered the creation of the Independent Gas Transmission Operator (DESFA) as the Operator of National System of Natural Gas, as a Private Legal Entity, provided with the exclusive right for the operation, management, exploitation and development of the National System of Natural Gas (ESFA).
- **Article 21 Law 3428/2005** introduced local Gas Transmission Companies, (EDA). These were three private companies in Attica, Thessaloniki and Thessalia, that could conduct open international tenders to find private investors to whom they could provide participation of up to 49% (in the EPA under creation - Procurement Companies (N) Gas), in which Greece's Public Gas Corporation (DEPA) will participate with 51% of the share capital.

Law **4001/2011** defined the operation of the gas market (articles 60-93). The environment of the retail gas market provided for was reshaped and the distribution and trading activities, as they were applied until recently by DEPA, were separated and two autonomous administrative and operating companies were created.

The activities for the production, supply, purchase, transport and distribution of natural gas, as well as storage and liquefaction of Natural Gas the gasification of and liquefied natural gas within the Hellenic Territory shall be exercised in accordance with the provisions of that law. More specifically:

- **Article 2 Law 4001/2011** gives the definition of ASFA the Independent System of Natural Gas

and distinguishes it from the National System of Natural Gas (ESFA). As stated in Article 2, in order for an installation to be considered as a 'natural gas system' it must fall under the scope of application of the ASFA or ESFA. Any natural gas system that does not meet the requirements stated in the definitions of 'transmission system', or 'LNG installations' or 'storage installations' of Article 2 Law 4001/2011 cannot be regarded an Independent as System of Natural Gas (ASFA).

- **Article 63A Law 4001/2011** presents the Special Provisions for the National Transmission Operator of the Natural Gas Network **(DESFA SA)**,
- **Article 67** concerns the functioning of the national system of Natural Gas (recently modified by article 18 law 4643/2019)
- **Article 68** states DESFA Responsibilities as follows: (mainly) Transport Contracts, Contracts for LNG facilities, Contracts for use storage facilities, (modified by art. 24 law 4513/2018)
- **Article 69** establishes the Code of National Transmission Operation of the Natural Gas system (as modified by article 24 paragraph 4 law 4513/2018 and article 17 para 15 law 4203/2013)
- **Article 73** deals with Input (power) security, as modified by art. 24 law 4513/2018
- **Article 74** sets the conditions under which an ASFA can be licensed in accordance with a decision taken by RAE, (including the right to build as well as to own an Independent NG System), based the following criteria: (a). public interest, (b). technical and financial adequacy of the applicant, (c). enforcement of free competition, (d). investment perspective requirement.
- **Article 75** allows for an open bid for the entitlement of an ASFA license (in cases where ASFA is required due to public interest, security of supply, or due to special requirements related to a specific location)
- Pursuant to **Article 77**, only a legal entity licensed under Article 74 can become an ASFA Operator.
- **Article 78** defines the responsibilities of an ASFA operator regarding the operation, maintenance and utilisation of ASFA. Some key responsibilities are: publishing user price lists, drawing up an annual maintenance plan, a business continuity plan, planning new investments, and submitting quality and maintenance reports to RAE annually.
- **Article 80:** Distribution of Natural Gas License: Open offer based on the decision of the Ministry (YPEKA).
- **Article 81:** Supply of natural gas: only by licensed legal entities and only by eligible customers (i.e customers licensed for electricity generation (cogeneration of electricity and energy).
- **Article 84:** Resale of natural gas: Right granted to Eligible Customers.
- **Article 85:** Code of Natural Supply to Eligible Customers: Publication based on a decision by the Ministry (YPEKA) following a recommendation by RAE. Basic provisions include: conditions for the supply of natural gas, and listing of facts on the basis of which the cancellation of a contract can be justified.
- **Article 88:** Pricing of specific activities.
- **Article 90:** Regulation of licenses

Law 4001/2011 has been modified by **Law 4203/2013 article 17; Law 4336/2015 articles 1-10; Law 4337/2015 article 16; Law 4414/2016 articles 22-24, 27-29 and 30-32; Law 4423/2016 article 55; Law 4425/2016 article 15; and Law 4513/2018 article 24.** Also:

- **Law 4203/2013 Article 17 par. 12**, modified article 2 of law 4001/2011 inserting additional categories for protecting natural gas consumers.
- **Law 4336/2015 Article 2 par. 2**, modified article 73 of law 4001/2011 in the pursuit of harmonisation to the EU Regulation 994/2010.
- **Law 4223/2013 Article 55 par. 8**, replaced paragraph 4 of art. 85 of Law 4001/2011 and extended the application of the provisions of Law 3175/2003 regarding the Take or Pay clause.

- **Law 4512/2018 Article 96**, introduces new articles in law 4001/2011 concerning the reorganization of the Greek electricity market and the operation of an Energy Exchange, as well as more specific provisions in relation to the approval by RAE of operating expenditure budgets of the Energy Exchange and the Liquidation Body.
- **Law 4546/2018 Article 40 par. 1**, modified art. 77, 80C, 81, 84, regarding (EnEx Clear) the authorization of natural gas system of transmission, operation and resale.

More recently: Law 4602/2019 provided for the split of DEPA into commercial and infrastructure activities (art. 53 modifying article 80 of law 4001/2011), according to which the same person is not entitled to exercise any direct or indirect control or activity over an undertaking operating in Greece -for the production or supply of natural gas- and at the same time to exercise any control or right to a Natural Gas Distribution Network Operator or a company that owns or controls the Natural Gas Distribution Network. The same restriction applies to the members of all Board of Directors of DEPA.

Law 4602/2019 as amended by Law 4643/2019 which privatised DEPA (article 16-18 modified article 80 of the law 4001/2011) was divided into three separate legal entities.

Law 4643/2019 aims at liberalizing the Greek energy market, modernize the Public Power Corporation (PPC), privatize the Public Gas Corporation (DEPA) and update the support for renewable energy. It also transposes the EU Regulation 1227/2011 on Energy Market Integrity and Transparency.

Renewable Energy Sources (RES)

Law 3468/2006 - Provided the first clear legislative framework to promote the generation of electricity from Renewable Energy Sources and embodied Directive 2001/77 of the EU into the national legislation, placing energy production from RES in high priority. Among the main pillars of the Law are the provisions concerning the Electricity Production License, the RES & CHP Plants Installation and Electricity Supply, Electricity Invoicing, and Green Certificates as well. Practically, L. 3468/2006 enhanced the framework of Feed-in Tariffs for Producers of electricity from RES and inserted provisions for the framework of Net Metering and Virtual Net Metering too.

L. 3468/2006, has been followed by several acts since its initial implementation, among which:

Law 3734/2009 – which determined the factors framing the CHP production while inserting in the national legislation Directive 2004/8/EC, also focusing on this matter. In parallel the Law inserted some new provisions on the process invoicing power generated by PV's.

Law 3851/2010 – on the acceleration of RES development for combating the climate change and further provisions on issues regulated by the Ministry of Environment, Energy and Climate Change., which added to provisions on the national RES integration target, and further determined the licensing procedures and the invoicing of RES.

Law 4001/2011 – on the operation of Energy Electricity and Natural Gas Markets, which embodied Directive 2009/72/EC regarding the common rules on the internal electricity market. The provisions of this law, further affected, among others, the framework of the Special Account for RES and CHP (Art. 143).

Law 4014/2011 – which set the framework of environmental licensing and divided the projects and activities of energy production, that are possible to cause severe environmental damage, into two categories (A and B) according to which, the environmental licensing procedure is being implemented accordingly.

Multiple legislative acts followed, amending particular provisions of the above lans, within their context in the years which followed, such as **L. 4042/2012, L. 4062/2012, L. 4093/2012, L. 4152/2013, L. 4203/2013, L. 4254/2013, L. 4254/2014, L. 4342/2015.**

Then, crucial legal acts followed, as mentioned hereafter.

Law 4414/2016 – established a new framework for the support, promotion and development of RES and CHP investments by inserting the system of Feed-in Premium which replaced in most cases the previous one of Feed-in Tariff (Art. 3,5 and 9). In that framework, the Law set the Special Purchase Price as well as the Reference Price, the difference between which would lead to the sliding feed-in-premium (FiP). The Law also, foresaw that particular categories of projects that would remain eligible for conducting PPAs under the FiT system (Art. 10), while several more would enter into operation under participating into auction processes conducted by RAE (Art. 7). Then, L. 4414/2016 set the provisions regarding the participation in the market for those systems located on Non Interconnected Islands, for which it was determined that they would be eligible for FiTs until the interconnection of the island to the mainland grid (Art. 8 and 11). In addition, it included measures of support for all combined heat and power plants, small- scale hydro power plants and self- production, using other RES, in a form of an income tax relief and stabilization of income tax coefficient.

Law 4513/2018 – regulated the establishment and operation of Energy Communities. In further expanding the notion of VNM, energy communities refer to the creation of civil associations with sole goal the promotion of solidarity and innovation in the energy sector, by boosting projects on energy production from RES, energy storage technologies, prosuming and energy efficiency.

Law 4602/2019 – further limited the number of RES projects entering into FiT contracts, in which a person or legal entity may directly or indirectly participate, provided, however, that the specific RES technology is eligible to participate in the respective competitive auctions, aiming to tackle potential attempts to circumvent the mandatory auctions rule (Art. 72). In addition, Law 4602/2019, as amended, set a special legal framework for geothermal power in order to determine the proper conditions for the optimal utilization of the country's geothermal capacity (Articles 1-24).

Law 4643/2019 – It provides for the further liberalization of the energy market and the modernization pf PPC, L. 4643/2019, as set in Chapter E. This is an important input concerning the regulation for supporting the generation of energy from RES. In particular, it provides for the participation or RES projects in the wholesale electricity market without them operating under the support system provided by L. 4414/2016 (Art. 20), while it developed the necessary points framing the establishment of PVs by professionals in the agriculture sector (Articles 24 and 25), and harmonized the national legislation to the EU Regulation 2019/943 regarding the balance responsibility in the system (Art. 26).

Law 4685/2020 – the most recent environmental law by now, includes important provisions on modernizing and simplifying the respective regulation in order to, inter alia, promote RES investments. Under that prism, the First Chapter of it (Article 1-9) amended several provisions of L. 4014/2011 and de-regulated the process of environmental licensing by making the steps of it, either faster, less or simpler than before. Further, the Law's Second Chapter (Articles 10-25) shaped Phase A of RES licensing, by also determining the conditions under which it could be completed, simpler to be followed. In this framework it is important that the Production License for electricity produced from RES and CHP is replaced by the Certificate of Producer of electricity from RES and CHP (Art. 11) and the Certificate of Producer of electricity from Special Projects (Art. 19), as they have been defined by the provisions of Law (Art. 10). In addition, Art. 18 of this law, sets the initial provisions for the creation of the Regulation for the above certificates. The rest of the Law's provisions regulate, inter alia, issues such as the management of protected regions, by also setting zones for particular activities within these (Articles 26-49) and the waste management (Articles 83-95).

Law 4759/2020 – on the Modernization of Spatial and Urban Planning Legislation, follows a similar pattern towards the simplification of the respective framework in total, and adds the category of strategic investments, as established in L. 4608/2019, as those taking place on units of electricity generation units from RES, under specific conditions, such as that they consist of innovative projects, with a budget of at least 50.000.000 euros and a common connection point to the National Electricity Transmission System. To fulfill the "innovative" factor the projects need to include storage systems, green hydrogen, off-shore wind and PV parks, RES interconnecting regions by submarine cables, and hybrid units for electricity generation from RES, on the Non-Interconnected islands. (Article 161).

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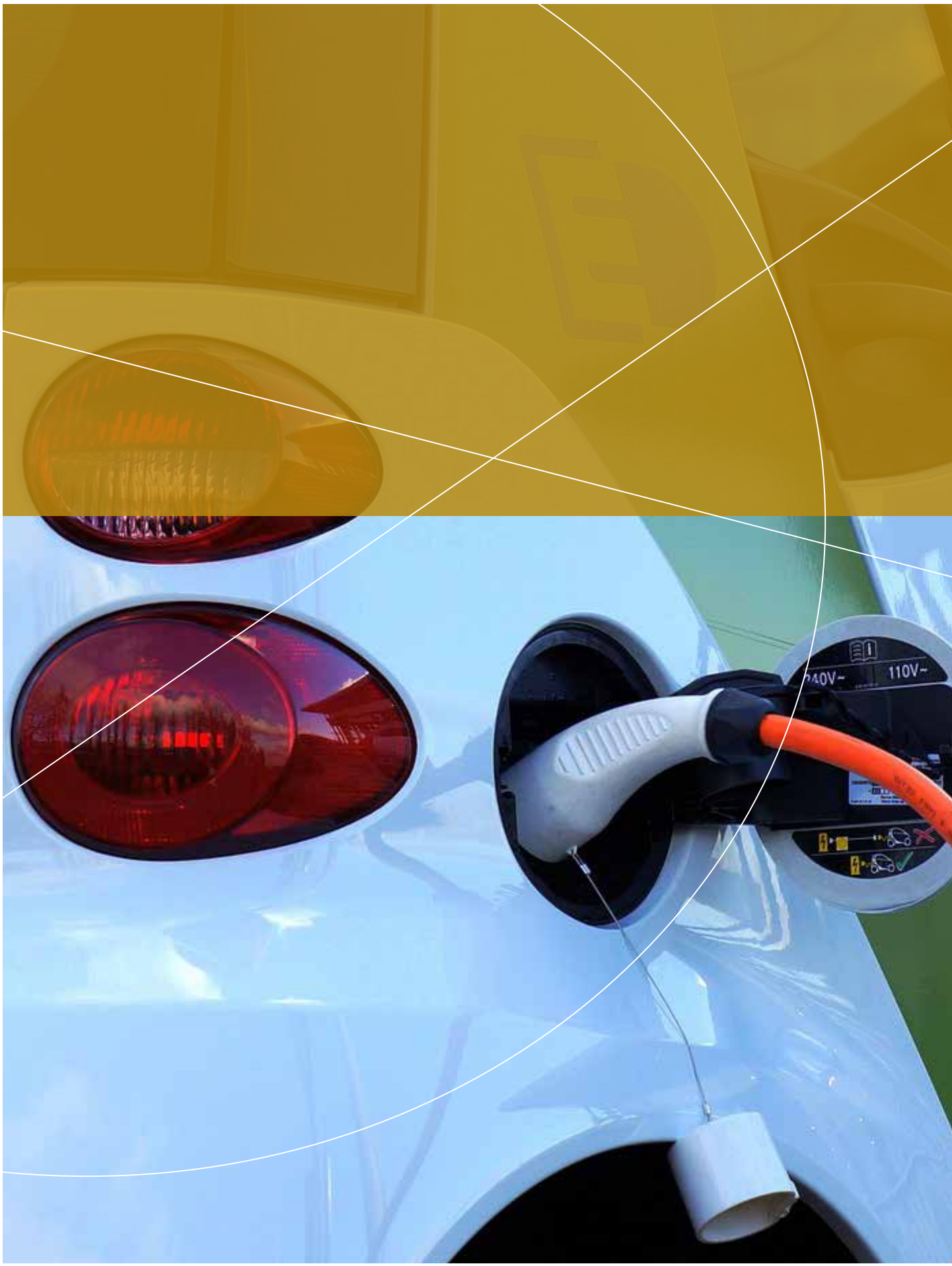
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9

ENERGY RESEARCH AND DEVELOPMENT IN GREECE

9. Energy Research and Development in Greece

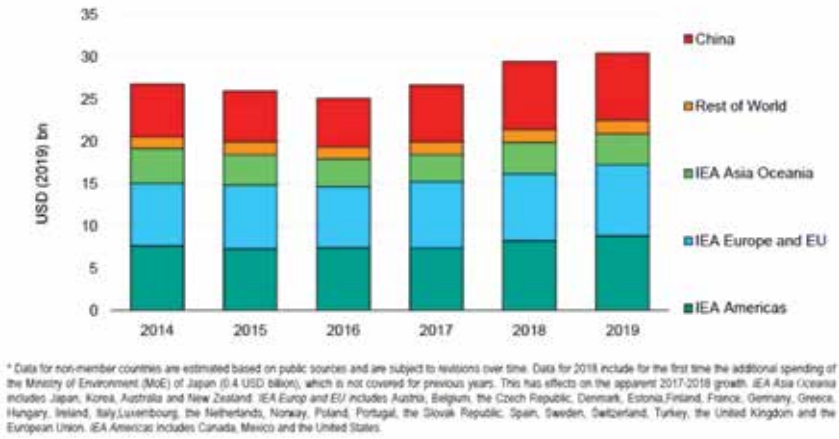
Energy Research & Development (R&D) in Greece

By Dimitris Mezartasoglou, Head of Research, Institute of Energy for SE Europe (IENE)

A Global Overview

According to IEA's latest "Energy Technology Research, Development and Demonstration (RD&D) 2020" report, the estimated global public energy RD&D budget reached about $30.4 billion in 2019, as shown in Figure 1, confirming the increasing trend since 2017 after several years of decline. The growth was mostly supported by Europe and the United States, while public spending in energy R&D stabilised in China after two years of strong growth and ahead of the country's next five-year plan.

Figure 1 • Global public energy RD&D budget*, 2014-2019

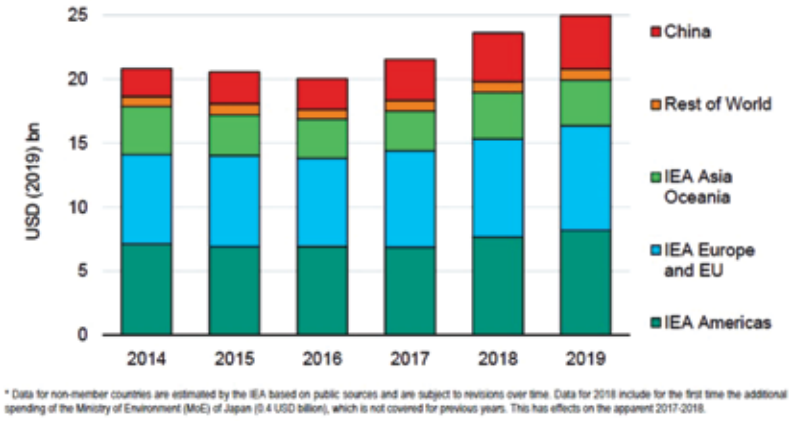


* Data for non-member countries are estimated based on public sources and are subject to revisions over time. Data for 2018 include for the first time the additional spending of the Ministry of Environment (MoE) of Japan (0.4 USD billion), which is not covered for previous years. This has effects on the apparent 2017-2018 growth. *IEA Asia Oceania* includes Japan, Korea, Australia and New Zealand. *IEA Europ and EU* includes Austria, Belgium, the Czech Republic, Denmark, Estonia,Finland, France, Germany, Greece, Hungary, Ireland, Italy,Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the European Union. *IEA Americas* includes Canada, Mexico and the United States.

Source: IEA

Under Mission Innovation (MI[3]), fifteen IEA member countries and the European Union, as well as key emerging economies, such as Brazil, China, India and Indonesia, pledged in 2015 to seek to double public clean energy R&D spending over five years. While there are differences between IEA and MI classifications and countries, IEA data show that estimated global public low-carbon energy RD&D spending rebounded in 2016 following two years of decline and it has been on the rise since then, reaching a new high in 2019 at about $25.0 billion (see Figure 2). Similarly to total spending, this growth was driven by increasing budgets in Europe and the United States, followed by China. Notably, public spending in low-carbon energy R&D grew faster than total energy R&D budgets, at a nearly 6% year-on-year growth rate. These encouraging trends, however, warrant further examination in 2020-2021 as the impacts of the Covid-19 pandemic on global energy systems, including on public low-carbon energy R&D budgets, unfold.

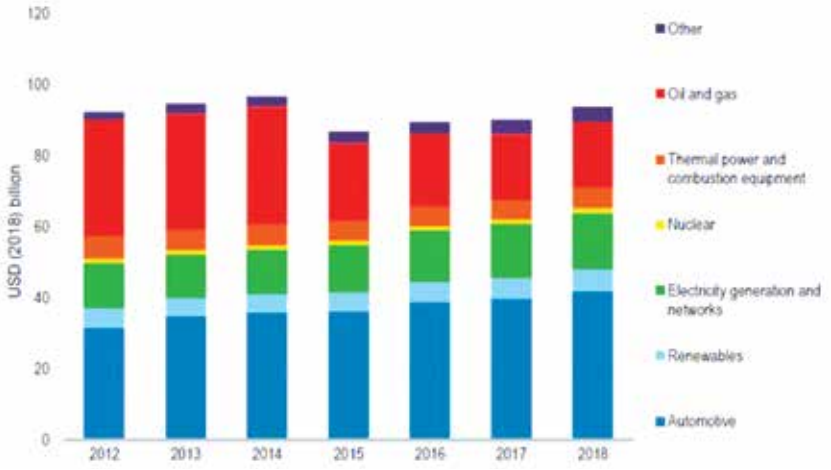
Figure 2 • Global public low-carbon energy RD&D budget*, 2014-2019



Source: IEA

Published data for R&D budgets by listed corporations globally show that these are the largest single source of funding for energy R&D, despite lower spending in recent years. The sample of listed companies active in energy technology sectors for which 2018 data is currently available increased their annual energy R&D spending, by around 4% (including automakers), as shown in Figure 3. The total energy R&D spending of this sample reached nearly $94 billion in 2018. Excluding transport, a third of the total corporate energy R&D is estimated to have been allocated to low-carbon sectors, according to the IEA.

Figure 3 • Global corporate R&D spending in energy-related sectors, 2012-2018



Source: IEA

[3] Mission Innovation is a global initiative to accelerate clean energy innovation.

Corporate R&D spending by companies in the oil and gas and other fossil fuel extraction sectors showed 1% growth in real terms in 2018, the first increase in R&D spending in this sector since 2014. Spending remains 45% below 2014 levels and is not rising significantly as a share of revenue, based on IEA data.

While the rebound of oil and gas company R&D budgets is sluggish, that of electricity generation and supply companies continues to increase. Siemens and General Electric occupied the top spots in the list of the highest global energy R&D spenders, with Petrochina dropping out of the top three for the first time in a decade. Four of the top ten are Chinese companies and five are in the electricity sector.

Automakers, who typically have much higher R&D budgets than energy companies in absolute terms and as a share of revenue, continue to increase their R&D spending as government policies and competitive pressures drive higher spending on energy efficiency and electric vehicles. Automakers' were the biggest contributors to the growth in corporate energy R&D spending technologies in 2018. This trend is notable among major European and US car and auto parts companies, whose R&D spending rose by around 7% on average in 2018, compared to 4% for Japanese and Korean firms. However, the increasingly global presence of Chinese automakers is reflected in their R&D spending, which rose more than 20% on average y-y.

Unlike public R&D, many of the major companies active across the energy system devote no more than one-tenth to one-third of their total R&D budgets to new technologies, with the bulk of spending going to incremental improvements of existing technologies and product development.

R&D in Greece

Between 2009 and 2013, Portugal, Italy, Ireland, Greece and Spain were in danger of defaulting on their sovereign debt, and of bringing other Eurozone countries down with them. The EU and the IMF bailed out Greece, Ireland, and Portugal, ushering in an era of economic austerity that wrought wide-ranging social and political consequences. One result was that many workers, especially the young, left their home countries in search of better economic opportunity elsewhere.

In 2019, Greece launched Rebrain Greece, a programme that offered 500 professionals working abroad between 28 and 40 years old a job and a pre-tax monthly wage of €3,000 if they return to Greece and "bring with them the know-how gained abroad, innovations and fresh ideas". The Greek government committed to covering 70% of these salaries, with companies contributing the other 30%.

Now, many of the SE European countries, including Greece, hurt by this so-called "brain drain" are implementing policies to incentivize their citizens to come home. From tax relief to wage subsidies, these countries have one message for those who left: You can come back now and help your country improve its R&D activities in several sectors, including energy.

Currently, gross domestic expenditure on energy related research and technological development in Greece is expected to double over 2017-2030, reaching 0.13% of the GDP by 2030, compared to 0.06% in 2017, based on data from Greece's National Energy and Climate Plan (NECP)[4].

In Greece, energy R&D is mainly conducted through academic institutions and non-academic research centers and covers the following areas, among others: low-carbon heat and power, decarbonization, alternative fuels and energy sources for transport, CO_2 management, oil and gas technology, RES technologies, smart cities and communities, smart grids and islands, energy efficiency and cogeneration, energy policy and modelling.

[4] European Commission (2019), "Greece's National Energy and Climate Plan", https://ec.europa.eu/energy/sites/default/files/el_final_necp_main_en.pdf

[5] https://www.certh.gr/root.en.aspx

Special reference should be made to the Centre for Research and Technology (CERTH)[5] as it is one of the leading research centers in Greece and is listed among the top-25 institutions in the EU with the highest participation in competitive research grants. CERTH includes two institutions active in energy: (a) the Chemical Process & Energy Resources Institute (CPERI)[6], which conducts R&D and innovation activities in the fields of science related to energy conversion and (b) the Institute for Solid Fuels Technology & Applications (ISFTA)[7]. The latter is the main Greek organisation promoting R&D in solid fuels and their by-products.

As far as energy policy is concerned, the Center for Renewable Energy Sources and Saving (CRES)[8] is the national coordination center for the RES and energy efficiency sectors, which is supervised by the Ministry of Energy and Environment. Other government-funded institutes and research centres with strong impact on the Greek research sector include the National Centre for Scientific Research "Demokritos"[9], the Hellenic Survey of Geology & Mineral Exploration (HSGME)[10], the National Observatory of Athens (NOA)[11], etc.

In addition, the Hellenic Foundation for Research and Innovation (HFRI-ELIDEK)[12] is a non-profit legal entity governed by private law through which a profound reforming effort is being undertaken in the field of Research and Innovation in the country. The Foundation aims, at a first stage, at providing funding for research programmes, including energy and environment, and grant scholarships; thus, promoting the policy for Research and Innovation in Greece. Beneficiaries are usually Greek Universities, research and technological institutes. HFRI's initial budget amounted to €240 million for the period 2016-2020, provided both by the European Investment Bank (EIB) under favourable terms (€180 million) and the Greek Public Investments Programme (€60 million). The Foundation is a financially independent entity and operates under the auspices of the Alternate Minister of Education, Research and Religious Affairs.

Furthermore, several R&D teams and laboratories specialize in high-level energy research activities. One of the leading academic teams is the E3-Modelling[13], which 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 company offers policy analysis studies, consulting services, energy and environmental policy for the European Union and other regions around the world, while it has accumulated extensive experience in power systems planning, power regulation and economics and investment analysis.

Energy research also takes place in numerous academic institutions around Greece. For instance, EPU-NTUA[14] is the oldest establishment in Greece to offer decision support services on energy policy issues at urban, national, regional and international level. Over the years, EPU-NTUA has become a real master in all policy and technological aspects of energy and environment, providing scientific advice to governments, authorities and companies in Greece and abroad.

In addition, the Technical University of Crete has a number of educational programmes that focus on raw materials, including metals, industrial minerals, petroleum, coal, natural gas and geothermal energy, which play a major role in the economic development of Greece. For instance, its School of Environmental Engineering[15] covers the issues of sustainable energy and climate change, including renewable energy systems management, biofuels, energy efficiency and cogeneration, fuel cells, hydrogen production as well as natural gas and biogas valorization and utilization.

[6] https://www.cperi.certh.gr/
[7] http://www.lignite.gr/en/index.htm
[8] http://www.cres.gr/cres/index_uk.html
[9] http://www.demokritos.gr/
[10] https://www.igme.gr/index.php/en/
[11] https://www.noa.gr/en/
[12] https://www.elidek.gr/en/homepage/
[13] https://e3modelling.com/
[14] https://www.epu.ntua.gr/rdservices/energy
[15] https://www.enveng.tuc.gr/en/research/research-fields/

Also, in Crete, the Institute of Petroleum Research (IPR)[16], which was founded in January 2019, is the newest Institute of the Foundation for Research and Technology (FORTH). It focuses on basic and applied research related to the detection, extraction and enhanced oil recovery as well as oil recovery with simultaneous CO2 storage and exploitation of hydrocarbon deposits. Its main areas of activity include: (a) detection of hydrocarbon deposits (Petroleum Exploration), (b) development and exploitation of hydrocarbon deposits (Drilling and Production engineering) and (c) studying and addressing of the concomitant environmental impacts (Environmental Engineering). The Institute is based in Chania, on the premises of the Technical University of Crete, thus enabling the exploitation of the knowledge, experience and existing infrastructure, in alignment with the excellence and innovation environment at FORTH. It is anticipated that the creation of IPR will act as a catalyst for strengthening oil research in the country, developing synergies with all relevant structures in Universities and Research Institutions, and enhancing cooperation among FORTH Institutes.

The Department of Electrical and Computer Engineering at the Aristotle University of Thessaloniki[17] also focuses on energy research, covering a wide range of areas, such as power systems planning, operation and control, renewable energy sources, power transmission and distribution, power electronics and energy conversion, applications of informatics to power systems, electrical machines, hierarchical and decentralised control of large-scale systems, high voltage technology, electrical breakdown, high voltage laboratory techniques, high voltage applications and lightning protection systems.

In 1996, the Energy Policy and Development Centre (KEPA)[18] was established, within the institutional framework of the National and Kapodistrian University of Athens. The main goal of the academic center is to study issues related to energy geopolitics in SE Europe, the Black Sea and Central Asia. With emphasis on the development of regional energy markets, the construction of transcontinental and regional energy interconnections and finally, on climate change policies, KEPA promotes a stable, scientific and economic cooperation on these issues in the region. In close cooperation with the Black Sea Economic Cooperation Organization (BSEC) countries, and funded mainly by competitive EU programmes, KEPA is an extrovert organization advancing international cooperation of the University with the countries of the region. The entrance of KEPA in the United Nations Academic Impact (UNAI) initiative has increased further the possibilities of the international academic network PROMITHEASnet, that KEPA has created, for the promotion of University of Athens objectives and its influence, internationally.

The Energy and Environmental Policy Laboratory at the University of Piraeus[19] was established in 2016, within the Department of International and European Studies of the School of Economics, Business and International Studies, combining energy research and taught programmes. The same School and Department hosts a Master Program on Energy: Strategy, Law and Economics, which is the leading multi-disciplinary programme in energy in Greece and one of the most business-oriented relevant programmes in Europe. The Energy and Environmental Policy Laboratory, through the multi-disciplinary expertise of its staff, produces high quality, independent research in energy and environmental policy issues.

A prominent, non-governmental, research-oriented body is the Athens-based Institute of Energy for SE Europe (IENE)[20] , 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. IENE has published several studies and research papers in Greece's key energy issues.

[16] https://www.forth.gr/index_main.php?c=86&l=e&s=&p=1&y=&in=

[17] http://ee.auth.gr/en/school/structure/departments/electrical-energy-department/

[18] http://www.kepa.uoa.gr/index.php/en/home/kepa-id-en

[19] http://energypolicy.unipi.gr/

[20] https://www.iene.eu/

[21] https://www.dei.gr/en

[22] https://www.mytilineos.gr/en-us/corporate-social-responsibility/of-mytilineos

Greece's private energy sector is also supporting R&D efforts, as several major companies have an autonomous and separate R&D department in their organizational chart, which in turn supports their business development. Indicatively, Greece's Public Power Corporation (PPC)[21] has Testing, Research & Standards Center, while environmental R&D expenditures of Mytilineos[22] cover investments in the development of pilot plants in the metallurgy sector, where new technologies for the exploitation of bauxite residues are already being tested.

Furthermore, Viohalco's R&D work[23] is focused in developing new, innovative and high value-added products and efficient solutions to optimise industrial and business processes. Products include oil and gas pipelines and electricity transmission cables. At the forefront of technological developments, Viohalco companies promote on-going R&D, develop innovative solutions and maintain strategic partnerships with scientific bodies, international research centres and other pioneering companies around the world.

In addition, Systems Sunlight[24] , which already supports research in new type of batteries, has announced plans to invest more than €100 million in Greece, with a new R&D Centre in Athens, which will complement and reinforce the R&D Centre to be located already operating in Xanthi. The project aims to develop innovative lithium battery technologies for the energy storage sector, focusing on new technologies that will usher in a clean energy future. This ambitious project will require recruiting highly qualified scientific staff, will offer attractive conditions for the return of Greek researchers currently working abroad, foster cooperation with higher education institutions, and offer funding to postgraduate and doctoral researchers.

To conclude, the only way forward for Greece is to expand its presence and activities in the energy sector through the strengthening of its R&D activities in order to provide innovative and environmentally and economically viable solutions. For instance, hydrogen is a future solution, although it is currently at an early stage of development, and taking into account that Greece has a significant track record in scientific investigation and research in the field of hydrogen production from RES, the country could play a vital role in its deployment.

Greece's NECP estimates an investment of €800 million on research and innovation activities over 2020-2030, which means that the government's will exists, but more needs to be done if we want to avoid the marginal growth (if not stagnation) observed in this sector over the last years. It should be understood that Greece's (energy) R&D sector is one of the strengths of its economy, which can further contribute towards solving many (energy) problems and ensuring the overall development of the Greek economy. Hence the government, in cooperation with industry and academic, needs to develop a better strategy related to research and be able to channel multiple amount of funds to those foreseen in its. NECP.

Contributor

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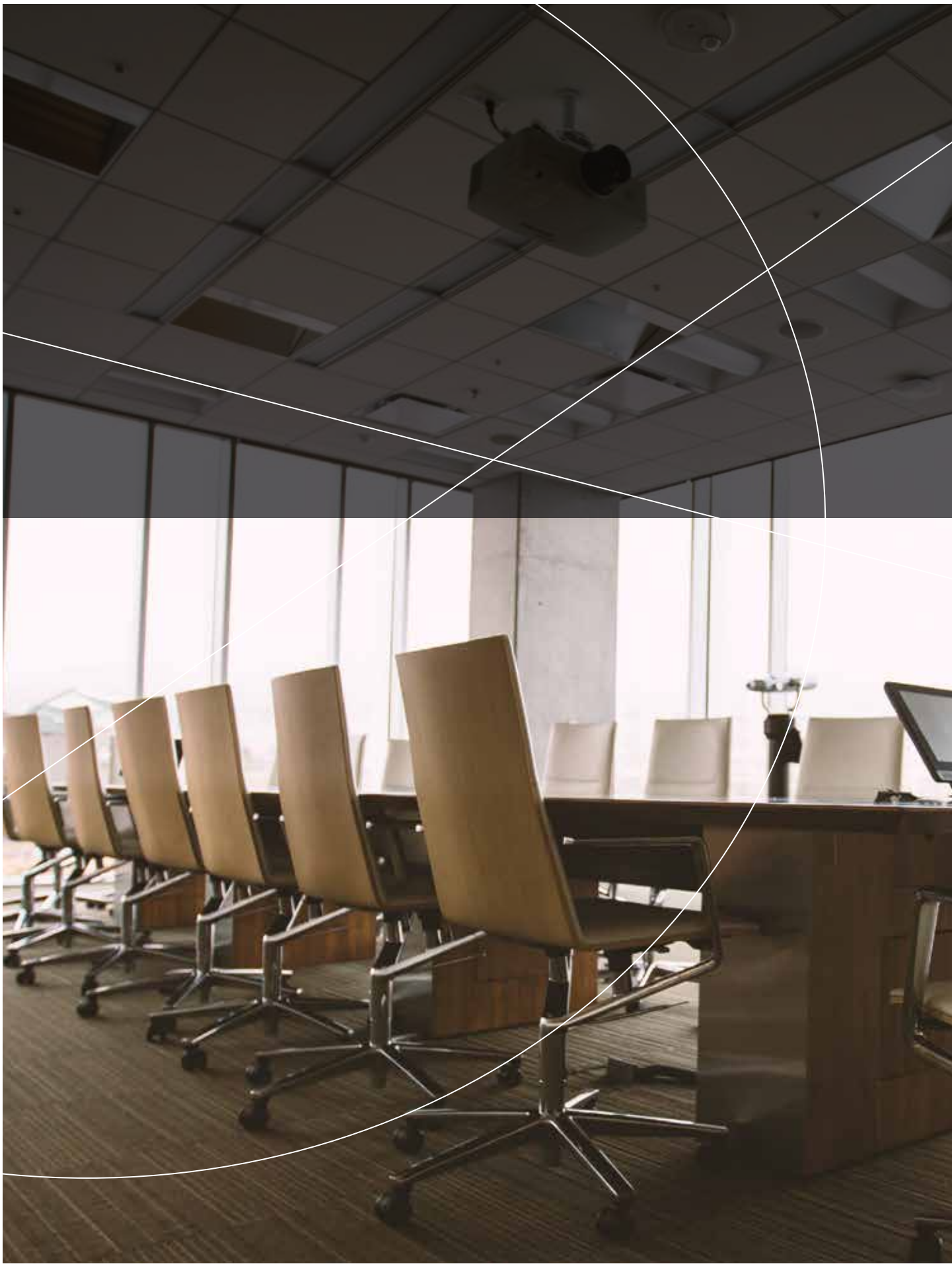
Dimitrios Mezartasoglou is currently Head of Research at IENE. He has full exposure across the energy sector specifically for Greece/SE Europe. Whilst at IENE, Dimitrios has been part of a variety of projects, including "SE Europe Energy Outlook 2016/2017" study and "Greek Energy Directory 2016" publication, while he is Assistant Editor of "Market Fundamentals and Prices", "Monthly Analysis" and several other IENE's newsletters. Dimitrios holds two Master's degrees from the University of Strathclyde on Global Energy Management and from the University of Exeter on Money and Banking.

[23] https://www.viohalco.com/724/en/Technology-and-RandD-/

[24] https://www.systems-sunlight.com/corporate-news/2020/12/12875/



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BUSINESS DIRECTORY

10. Business Directory

Energy Research in Greece

Governement Institutions

A. Government Funded Institutes and Research Centers

ATHENA - RESEARCH AND INNOVATION CENTER IN INFORMATION COMMUNICATION AND KNOWLEDGE TECHNOLOGIES
T: +30 2106875300
F: +30 2106854270
Artemidos 6 & Epidavrou 151 25, Maroussi
www.athena-innovation.gr
info@athena-innovation.gr

CENTER FOR RENEWABLE ENERGY SOURCES AND SAVING (CRES)
T: +30 2106603300
F: +30 2106603301/302
19th km Marathonos Ave 19009, Pikermi Attiki
www.cres.gr
cres@cres.gr

FOUNDATION FOR RESEARCH AND TECHNOLOGY-HELLAS (FORTH)
T: +30 2810391500-2
F: +30 2810391555
100 Nikolaou Plastira str. Vassilika
Vouton Heraklion Crete 700 13
P.O. Box 1385
Heraklion Crete 711 10
www.forth.gr
central@admin.forth.gr

HELLENIC CENTRE FOR MARINE RESEARCH (HCMR)
T: +30 2291076462
F: +30 2291076323
Street Address 467 km Athens Sounio
ave. 9013, P.O. Box 712 Anavyssos
www.hcmr.gr
webadmin@hcmr.gr

INSTITUTE OF ENVIRONMENTAL AND SUSTAINABLE DEVELOPMENT (IERSD)
T: +30 2108109122
F: +30 2108103236
I. Metaxa & Vas. Pavlou 15236, Penteli
www.meteo.noa.gr

INSTITUTE OF GEOLOGY AND MINERAL EXPLORATION (IGME)
T: +30 2131337000-3
F: +30 2131337440
Sp. Loui 1 C Input (Olympiako Xorio)
Axarne 13677 Athens
www.igme.gr
dirgen@igme.gr

INSTITUTE FOR RESEARCH AND TECHNOLOGY OF THESSALY (I.RE.TE.TH)
T: +30 24210967409
F: +30 2421096750
Dimitriados 95 & Pavlou Mela 383 33, Volos
www.ireteth.certh.gr
admin@ireteth.certh.gr

NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"
T: +30 2106503002
Patr. Gregoriou E' & 27 Neapoleos str.
153 41 Agia Paraskevi
www.demokritos.gr
communications@central.demokritos.gr

Solar & Other Energy Systems Laboratory
www.solar.demokritos.gr

Institute of Nuclear & Radiological Sciences and Technology Energy & Safety (INRASTES)
www.ipretea.demokritos.gr

NATIONAL DOCUMENTATION CENTRE
T: +30 2107273900-3
F: +30 2107246824
48 Vassileos Constantinou Avenue
11635 Athens
www.ekt.gr
ekt@ekt.gr

ENERGY CONSERVATION GROUP (GREC)
T: +30 2108109122
F: +30 2108103236
I. Metaxa & Vas. Pavlou 15236, Penteli
www.energycon.org

B. Independent Institutes and Research Centers

GREEK INSTITUTE FOR COPPER DEVELOPMENT
T: +30 2104898298
Piraeus 252, 177 78 Tavros, Attica
www.copperalliance.eu/gr
info@copperalliance.gr

HELLENIC INSTITUTE OF PASSIVE BUILDING
Anastaseos 112 and Pindou Avenue
156 69 Papagou
T: (+30) 211 408 11 09
www.eipak.org
info@eipak.org

HELLENIC RESEARCH CENTRE FOR METALS S.A. (ELKEME)
T: +30 2262604400
F: +30 2262604358
56th km Athens-Lamia Nat. Road, 320
11 Oinofyta Viotia
www.elkeme.gr
info@elkeme.gr

INSTITUTE OF ENERGY FOR SOUTH-EAST EUROPE (IENE)
T: +30 2103628457, 2103640278, 2103624245
F: +30 2103646144
Alex. Soutsou 3-10671 Athens
www.iene.eu
secretariat@iene.gr

C. Academic Institutions

NATIONAL TECHNICAL UNIVERSITY OF ATHENS (NTUA)
Department of Electrical and Computer Engineering
E3MrLAB (ENERGY - ECONOMY - ENVIRONMENT MODELLING LABORATORY)
Director: Professor Pantelis Capros
T: +30 2107723629
F: +30 2107723630
9, Iroon Politechniou Street 15 773 Athens
www.e3mlab.ntua.gr
kapros@central.ntua.gr

School of Mining and Metallurgical Engineering
LABORATORY OF APPLIED GEOPHYSICS
Director: Professor Sofia Stamataki
T: +30 2107722067-68-71
F: +30 2107722063
9, Iroon Politechniou Street 15 773 Athens
www.metal.ntua.gr
secretary@Tmetal.ntua.gr

LIGHTING LABORATORY
Director: Professor Frangiskos V. Topalis
T: +30 2107723506
F: +30 2107723627
9, Iroon Politechniou Street 15 773 Athens
www.lighting.ece.ntua.gr

HIGH VOLTAGE LABORATORY
Director: Professor Ioannis A. Stathopulos
T: +30 210772 3582
F: +30 210772 3504
9, Iroon Politechniou Street 15 773 Athens
www.highvoltages.ece.ntua.gr
stathop@power.ece.ntua.gr

School of Chemical Engineering
LABORATORY OF THERMAL TURBOMACHINES
Director: Professor Constantinos Mathioudakis
T: +30 2107721638
F: +30 2107721658
9, Iroon Politechniou Street 15 773 Athens
www.ltt.ntua.gr
kmathiou@central.ntua.gr

LABORATORY OF INDUSTRIAL & ENERGY ECONOMICS
Director: Professor Aggelos Tsakanikas
T: +30 2107723283
F: +30 2107723155
9, Iroon Politechniou Street 15 773 Athens
www.liee.ntua.gr
liee.ntua@gmail.com

THERMODYNAMICS AND TRANSPORT PHENOMENA LABORATORY
Director: Professor Konstantinos Magoulas
T: +30 2107721128, 2107721134, 2107721502
F: +30 2107723304
National Technical University
of Athens Dept. of Chemical Engineering 9,
9, Iroon Politechniou Street 15 773 Athens
http://ttpl.chemeng.ntua.gr/staff/the_staff.html
secretariat@chemeng.ntua.gr

UNIT OF ENVIRONMENTAL SCIENCE AND TECHNOLOGY
Director: Professor Maria Loizidou
T: +30 2107723106, 2107722334
National Technical University of Athens
School of Chemical Engineering Unit of
Environmental, Science and Technology
9, Iroon Politechniou Street 15 773 Athens
www.uest.gr
mloiz@chemeng.ntua.gr

School of Mechanical Engineering,
Section of Thermal Engineering
LABORATORY OF THERMAL PROCESSES
Director: Professor Eirini Koronaki
T: + 30 210772-1581
F: + 30 210772-3670
School of Mechanical Engineering
Department of Thermal Engineering National
Technical University of Athens
9 Iroon Polytechniou Str., Zografou 15780
Mechanical Engineer's Building E -2nd floor
www.mech.ntua.gr
koronaki@central.ntua.gr

UNIVERSITY OF PIRAEUS
Department of International and European Studies MASTER PROGRAMME IN ENERGY STRATEGY, LAW & ECONOMICS
Director: Professor Nikolaos E. Farantouris
T: +30 2104142731, F: +30 2104142779
80,Karaoli & Dimitriou St. 185 34 Piraeus
www.des.unipi.gr
nfarant@unipi.gr

UNIVERSITY OF WEST ATTICA
SOFT ENERGY APPLICATIONS & ENVIRONMENTAL PROTECTION LABORATORY
Director: Professor John Kaldellis
T: + 30 2105381237, 2105381467
F: + 30 2105381467
Soft Energy Applications & Environmental Protection Laboratory University of West Attica
P.O.Box 41046, 12201, Aegaleo
www.sealab.gr
jkald@teipir.gr

OPTIMISATION OF PRODUCTION SYSTEMS LABORATORY
Mechanical Engineers Department
Director: Professor Emilia Kondili
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F: +30 2105381430
Capus 2, P. Ralli St. and Thivon 250 122 44, Athens
www.ikaros.teipir.gr
ops@teipir.

Electrical and Computer Engineering Department
ENERGY APPLICATIONS AND ENERGY SAVING SYSTEMS LABORATORY
Director: Professor Antonios X. Moronis
T: +30 2105385307, F: +30 2105385306
Department of Energy Technology Engineering 17 Agiou Spyridona 12210 Egaleo
www.uniwa.gr
energytechnology@teiath.gr

ARISTOTLE UNIVERSITY OF THESSALONIKI
Department of Electrical and Computer Engineering POWER SYSTEMS LABORATORY
Director: Professor Grigoris Papagiannis
T: +30 2310 99.6392, F: +30 2310 99.6023
Egnatia Str., University Campus, Dept. of Electrical & Computer Engineering, 54124, Thessaloniki
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LABORATORY OF APPLIED THERMODYNAMICS
Director: Professor Zisis Samaras
T: +30 2310 996072
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Aristotle University of Thessaloniki,
PO Box 458 - GR 541 24 Thessaloniki
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info@meng.auth.gr

LABORATORY OF FLUID MECHANICS & TURBOMACHINERY
Director: Associate Professor Kyriakos Yakinthos
T: +30 2310996072
F: +30 23109960 12
Egnatia Str., University Campus, Dept. of Electrical & Computer Engineering, 54124, Thessaloniki
www.meng.auth.gr
info@meng.auth.gr

LABORATORY OF HEAT TRANSFER AND ENVIRONMENTAL ENGINEERING
Director: Professor Nicolas Moussiopoulos
T: +30 23109960 11
F: +30 23109960 12
Egnatia Str., University Campus, 8th floor, Building D, School of Engineering, University campus, 54124, Thessaloniki
www.aix.meng.auth.gr
infolhtee@aix.meng.auth.gr

DEMOCRITUS UNIVERSITY OF THRACE
Electrical and Computer Engineering Department POWER SYSTEMS LABORATORY
Director: Professor Mixail Danikas
T: +30 2541079527
F: +30 2541079526
Power Systems Laboratory Electrical and Computer Engineering Department Democritus., University of Thrace University Campus, 67100 Xanthi
www.she.ee.duth.gr
asafig@ee.duth.gr

School of Engineering Department of Production Engineering & Management Faculty of Materials MECHANICAL DESIGN LABORATORY
Director: Associate Professor Pantelis Botsaris
T: +30 2541079878, +30 2541079325
F: +30 2541079878
12 Vas. Sofias str., Office 107 Central University Campus, 67100, Xanthi
www.medilab.pme.duth.gr
panmpots@pme.duth.gr

Environmental Engineering Department NONrCONVENTIONAL ENERGY SOURCES LABORATORY
Director: Assistant Professor Costas Elmasides
T: +30 25410 79876, +30 6974447972
Vas. Sofias 12, 67100, Xanthi
www.env.duth.gr
secr@env.duth.gr

UNIVERSITY OF PATRAS
RENEWABLE ENERGY LABORATORY
Director: Professor Emeritus Panayotis Yianoulis
T: +30 261099744
Physics Department Building B, 2nd floor University of Patra's University Campus, 26504, Rio
www.physics.upatras.gr
gle+her@physics.upatras.gr

CENTER FOR RESEARCH AND APPLICATIONS OF NONLINEAR SYSTEMS (CRANS)
Director: Professor Tassos Bountis
T: +30 2610997381
F: +30 2610997381
Department of Mathematics,
University of Patras 26500 Patra
www.math.upatras.gr/crans/index.html
bountis@math.upatras.gr

Electrical and Computer Engineering Department • LABORATORY OF ELECTROMECHANICAL ENERGY CONVER
Director: Professor Emmanuel C. Tatakis
T: +30 2610996412, F: +30 2610997362
Electromechanical Energy Conversion Laboratory University of Patras Electrical and Computer Engineering Department University Campus of Patras, 26504 Rio
www.lemec.ece.upatras.gr

NATIONAL AND KAPODISTRIAN UNIVERSITY OF ATHENS • THE ENERGY AND CLIMATE CHANGE POLICY CENTRE (KEPA)
Director: Professor Dimitrios Mavrakis
T: +30 2107275732, +30 2107275809
F: +30 2107275828
KEPA building, University Campus, 157 84 Athens
www.kepa.uoa.gr
epgsec@kepa.uoa.gr

Department of Environmental Physics METEOROLOGY, BUILDINGS ENVIRONMENT RESEARCH GROUP
Director: Professor Matheos Santamouris
T: +30 210-727 6830, F: +30 2107276791
University of Athens, Department of Physics, Department of Environmental Physics and Meteorology University Campus Zografou Ktirio PHY-V, 15784 Athens
www.env.phys.uoa.gr
emoutziki@phys.uoa.gr

UNIVERSITY OF THESSALY
Department of Mechanical Engineering LABORATORY OF ALTERNATIVE ENERGY CONVERSION SYSTEMS
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Panagiotis Tsiakaras Head of Laboratory of Alternative Energy Conversion Systems University of Thessaly Department of Mechanical and Industrial Engineering 38334, Pedion Areos, Volos
www.mie.uth.gr
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
T: +30 2821037808
Energy Management in the Built Environment Research Unit Faculty of Environmental Engineering, Technical University of Crete Technical University Campus, Kounoupidiana, 73100 Chania
www.ember.tuc.gr
dkolokotsa@enveng.tuc.gr

RENEWABLE AND SUSTAINABLE ENERGY SYSTEMS LABORATORY
Director: Professor Theocharis Tsoutsos
T: +30 2821037825
University Campus, Kounoupidiana 73100 Chania
www.resel.tuc.gr
theocharis.tsoutsos@enveng.tuc.gr

School of Mineral Resources Engineering
Division of Minerals Exploitation SOLID FUELS BENEFICATION AND TECHNOLOGY LABORATORY
Director: Professor Despina Vamvouka
T: +30 2821037603
Technical University of Crete, School of Mineral Resources Engineering, 731 00 Chania, Crete
www.mred.tuc.gr
vamvuka@mred.tuc.gr

School of Electronic and Computer Engineering (ECE) ELECTRIC CIRCUITS AND RENEWABLE ENERGY LABORATORY (ECRESL)
Director: Professor Kostas Kalaitzakis
T: +30 2821037213
School of Electronic and Computer Engineering, Technical University of Crete Akrotiri Campus 73100 Chania, Crete
www.elci.tuc.gr
vicky@ece.tuc.gr

School of Mineral Resources Engineering of the Technical HYDROCARBONS CHEMISTRY & TECHNOLOGY
Director: Nikos Pasadakis
T: +30 28210 37669
M1.207, Building ΜΗΧΟΠ (M1), 2nd Floor
73100 Chania, Crete
www.hydrocarbons.tuc.gr
pasadaki@mred.tuc.gr

TECHNOLOGICAL EDUCATIONAL INSTITUTE OF CRETE • WIND ENERGY LABORATORY AND SYNTHESIS ENERGY SYSTEMS
Director: Professor Dimitrios Christakis
T: +30 2810379200
Stauromenos, 71004, Heraklion Crete
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www.lofmat.wordpress.com
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Environment Division
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Energy Division
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T: +30 210 6969501
F: +30 210 6969849-850
www.ypeka.gr

REGULATORY AUTHORITY FOR ENERGY (RAE)
132 Pireus Ave., 11854, Athens Greece
T: +30 2103727400
F: +30 2103255460
info@rae.gr
www.rae.gr

RENEWABLE ENERGY SOURCES OPERATOR S.A. (DAPEP)
Kastoros 72 str., 18545 Peiraeus
T: +30 211 8800700
F: +30 211 8806766
info@dapeep.gr
www.dapeep.gr

INDEPENDENT POWER TRANSMISSION OPERATOR (IPTO)
89 Dyrrachiou str, Athens, 10443
T: +30 210 5192101
F: +30 210 5192324
info@admie.gr
www.admie.gr

HELLENIC ELECTRICITY DISTRIBUTION NETWORK OPERATOR S.A.(HEDNO)
Perraivou 20 & Kallirrois 5, Athens Greece
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F: +30 210 9281698
infodeddie@deddie.gr
www.deddie.gr

HELLENIC GAS TRANSMISSION SYSTEM OPERATOR S.A. (DESFA)
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F: +30 210 6749504
desfa@desfa.gr
www.desfa.gr

PUBLIC POWER CORPORATION (PPC)
30 Chakokondyli Str. 10432, Athens
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info@dei.com.gr
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DEPA COMMERCIAL SA
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T: +30 210 2701000
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www.depa.gr

DEPA INFRASTRUCTURE (HRADF) SA
1 Kolokotroni & Stadiou Str, 105 62, Athens
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F: +30 210 3274448-9
info@hraf.gr
www.hradf.com

HELLENIC PETROLEUM GROUP
8A Chimarras str., 151 25, Maroussi
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F: +30 210 6302510, +30 210 6302511
www.helpe.gr

Energy Industry Associations

ENERGY ASSOCIATION FOR NATURAL GAS
T: +30 210 28 31 118
info@esfa.com.gr
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FEDERATION OF RECYCLING AND ENERGY RECOVERY - INDUSTRIES AND ENTERPRISES
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T: +30 210 5580963
info@sepan.gr
www.sepan.gr

GREEK ASSOCIATION OF RES ELECTRICITY PRODUCERS (HELLASRES)
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info@hellasres.gr
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GREEK SOLAR INDUSTRY ASSOCIATION
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info@ebhe.gr
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HELLENIC ASSOCIATION OF ELECTRICITY TRADING & SUPPLY COMPANIES (ESEPIE)
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www.esepie.gr

HELLENIC BIOMASS ASSOCIATION (HELLABIOM)
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info@hellabiom.gr
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HELLENIC ASSOCIATION FOR THE COGENERATION, HEAT & POWER (HACCHP)
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HELLENIC ASSOCIATION OF INDEPENDENT POWER PRODUCERS (HAIPP)
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T: +30 210 8184629
info@haipp.gr
www.haipp.gr

HELLENIC ASSOCIATION OF PHOTOVOLTAIC COMPANIES (HELAPCO)
11 Fidiou & E. Benaki Str., 106 78 Athens
T: +30 210 9577470
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www.helapco.gr

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info@spef.gr
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seepe@seepe.gr
www.seepe.gr

HELLENIC ASSOCIATION OF MICRO HYDROPOWER PROJECTS (ESMYE)
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T: +30210 8081755
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info@psem.gr
www.psem.gr

PANHELLENICASSOCIATION OF PETROLSTATION OPERATORS AND TRADERS (POPEK)
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popek@popek.gr
www.popek.gr

Energy Companies*

* **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 2021.

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info@elinbio.gr
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PAVLOS N. PETTAS S.A.
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www.staffcolour-energy.gr

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vertoil@otenet.gr

Biomass

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F: +30 2510 250323
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F: +30 2310 752396
info@nhouse.gr
www.nhouse.gr, www.pellet-stove.gr
www.eco-flame.gr

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www.nphilippopoulos.gr

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marinesales@aegeanoil.gr
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info@avinoil.gr
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www.bp.com

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info@elin.gr
www.elin.gr

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eteka@eteka.com.gr
www.eteka.com.gr

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F: +30 210 4283823
info@wwbunkering.com
www.helexon.gr

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F: +30 210 680 1870
marine@agiphellas.gr
www.jkassimatis.gr

JETOIL BUNKERING
27 Evrota & Kifisou Str., 145 64 Kifisia
T: +30 210 8763140
F: +30 210 8763139
bunkering@jetoil.gr
www.jetoil.gr

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T: +30 210 808 2205
F: +30 210 808 9315
marfuel@otenet.gr

ORION MARITIME SERVICES
39, D. Gounari Str., 185 31 Piraeus
T: +30 210 4174942 / 2104174175
F: +30 210 4117853
orionms@otenet.gr
www.orion-ms.com

SEKA S.A.
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T: +30 210 429 3160
F: +30 210 429 3345
sekasales@seka.gr
www.seka.gr

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sales@sekavin.gr
www.sekavin.gr

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T: +30 210 4596911, 912
CSC-Hellas@ceg.gr
www.shell.gr

SHIPOIL
99, Kolokotroni Str., 185 35 Piraeus
T: +30 210 422 1373
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shipoil@shipoil.com
www.shipoil.com

Electrical Equipment

ALSTOM GRID HELLAS S.A.
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T: +30 210 6079 703
www.alstom.com

ABB
13o klm. National Road Athens-Lamia,
144 52 Metamorfosi
T: +30 210 2891500, +30 210 2891900
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abb@gr.abb.com
www.new.abb.com/gr

FULGOR GREEK ELECTICV CABLES S.A.
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T: +30 210 6787 416, 900
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info@cablel.vionet.gr
www.cablel.com

GEYER HELLAS S.A.
Drosia, 341 00 Chalkida
T: +30 22210 98711 F: +30 22210 98712
www.geyer.gr

HAGER HELLAS A.E.B.E.
7 Matsa Str., 145 64 Kifisia
T: +30 210 6203800 F: +30 210 6203801
info@hager.gr www.hager.gr

SCHWABE HELLAS S.A
77 Koropiou-Varis Ave., 194 00 Koropi
T: +30 210 6623890-1 F: +30 210 6624861
info@schwabe.gr, internationalsales@schwabe.gr
www.schwabe.gr

SIEMENS S.A
6-8 Agisilaou Str., 151 23 Marousi
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greece.web.gr@siemens.com
www.new.siemens.com/gr

SPACE HELLAS S.A.
302 Mesogeion Ave., 155 62 Cholargos
T: +30 210 6504100 F: +30 210 6516712
info@space.gr www.space.gr

FEILO SYLVANIA GREECE A.E.E.E.
153 Menelaou str., 173 42 Agios Dimitrios
T: +30 210 9966561 F: +30 210 9969029
info@feilosylvania.com
www.sylvania-lighting.com

NEXANS HELLAS A.B.E.
15 Mesogeion Ave. 115 26 Athens
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info.hellas@nexans.com
www.nexans.gr

HELLENIC CABLES S.A.
33 Amarousiou-Halandriou Str.,
151 25 Marousi
T: +30 210 6787416, +30 210 6787900
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info@cablel.vionet.gr
www.cablel.com

HELLINIKI LEGRAND S.A.
184A Kifisias Ave., 152 31 Chalandri
T: +30 210 6797500 F: +30 210 6797 560
www.legrand.gr

Ericsson Hellas S.A
40.2 km Attica Ave., 190 02 Peania
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F: +30 210 6695300
www.ericsson.com/gr

ACEPOWER ELECTRONICS LTD
39 Othonos 17343, Ag. Dimitrios
T: +30 210 9966555 F: +30 210 9969444
info@acepower.gr www.acepower.gr

ALPHA LAVAL AEBE
20th km Lavrion Ave., 19400
Thesis Karella Koropi-Attica
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ELESIS ELECTRICAL SOLUTIONS S.A.
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Landis & Gyr SA
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www.landisgyr.eu

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MAS SA
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www.maseurope.com

Electricity Suppliers

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info@vienersa.gr
www.viener.eu

ELINOIL S.A.
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info@elin.gr, www.elin.gr

ELPEDISON Energy S.A.
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info@elpedison.gr
www.elpedison.gr

ELTA Energeia S.A.
1 Apellou Str., 101 88 Athens
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info@eltaenergeia.gr
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ENEL Green Power Hellas S.A.
4 Gravias Str., 151 25 Marousi
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www.enelgreenpower.com

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www.interbeton.gr

KEN S.A.
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PetroGaz S.A.
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PROTERGIA S.A.
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VOLTON S.A.
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WE ENERGY
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Electricity Traders

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ENSCO S.A.
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Energy Consulting Companies

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sales@biossol.gr
www.biossol.gr

BOSCH
37 Erxeias Str., 19400 Koropi
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www.bosch.gr

CALDA ENERGY
100 Tatoiou Str., 144 52 Koropi
T: +30 210 2843176 F: +30 210 2843164
calda@calda.gr www.calda.gr

CALORIA
57 Ifaistou Str., 194 00 Koropi
T: +30 210 6628068-72
info@caloria.gr
www.caloria.gr

CALPAK SA
9 Sygrou Ave., 117 43 Athens
T: +30 210 9247250
F: +30 210 9231616
export@calpak.gr
www.calpak.gr

GHP HELLAS
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info@ghp.gr
www.ghp.gr

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ENEFSYS
5 Xanthou Str., 167 77 Elliniko
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17 Vassileos Alexandrou, 143 42
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T: +30 210 23 145 74
F: +30 210 27 19 421
lotsis@otenet.gr
www.lotsis.gr

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info@eurogas.com
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GAS PIPE
4 Nikomidias Str., 133 44 Ano Liosia
T: +30 210 2470870
info@gaspipe.gr www.gaspipe.gr

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99A Achilleos Str., 175 63 Palaio Faliro
T: +30 210 9881616 F: +30 210 9881211
info@gazpro.gr
www.gazpro.gr

HELIOSTAT LTD
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T: +30 210 6851159, 210 6844194
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mail@heliostat.gr
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KATSAFANAS
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www.katsafanas.gr

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klimatair@klimatair.gr

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www.moderngas.gr

METRON SA
45 Dimitriou Rigou Str., 190 18 Magoula
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NOVART
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www.novart.gr

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www.profitgas.com

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Natural Gas Suppliers

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www.alhellas.com

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www.elval.com

DEPA COMMERCIAL S.A. (DEPA)
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www.ahi-carrier.gr

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www.rehau.com

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F: +30 210 5144297
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www.general-service.gr

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www.lennik.gr

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www.stibetherm.com

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info@heatingexperts.gr
www.heatingexperts.gr

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therma@thermantiki.gr
www.thermantiki.gr

THERMATTIKI
22 Ag. Dimitriou Str., Ag. Dimitrios
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info@thermattiki.gr
www.thermattiki.gr

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F: +30 210 5222278
www.vassiliadisn.gr

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151 25 Marousi
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F: +30 210 8174299
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T: +30 210 6302000
F: +30 210 6302510-511
www.helpe.gr

MOTOROIL
12A Irodou Attikou Str., 151 24 Maroussi
T: +30 210 8094000
F: +30 210 8094444
info@moh.gr
www.moh.gr

Oil Trading

AEGEAN OIL S.A.
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T: +30 210 4586000
F: +30 210 4586245
marinesales@aegeanoil.gr
www.aegeanoil.com

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12A Hrodou Attikou Str., 151 24 Marousi
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F: +30 210 8093.555
info@avinoil.gr
www.avinoil.gr

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T: +30 210 6887 777
F: +30 210 6887 697
www.bp.com

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12A Irodou Attikou Str., 151 24 Marousi
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CSC-Hellas@ceg.gr
www.coralenergy.gr

CORAL GAS
26-28 Georgiou Averof Str.,
142 32 Perissos
T: +30 210 9491000
F: +30 210 9404751
Hellas-LPG-Customerservice@ceg.gr
www.coralgas.gr

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www.cyclon.gr

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T: +30 211 18 18 050
L.Chatzina@eko.gr
www.eko.gr

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Pigon 33, 14564 Kifisia
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F: +30 210 6241509
www.elin.gr

ETEKA
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T: +30 210 4002658
F: +30 210 4002607
eteka@eteka.com.gr
www.eteka.com.gr

HELLENIC PETROLEUM S.A.
8A Chimaras Str., 151 25 Marousi
T: +30 210 6302000
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www.helpe.gr

JETOIL
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T: +30 210 8763140
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bunkering@jetoil.gr
www.jetoil.gr

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T: +30 210 5538000
F: +30 210 5577524
www.melcopetroleum.gr

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5 Kapodistriou Str., 166 72 Vari
T: +30 210 8976000
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revoil@revoil.gr
www.revoil.gr

SHELL HELLAS
3 Irodotou Str., 185 38 Piraeus
T: +30 210 4596911, 912
CSC-Hellas@ceg.gr
www.shell.gr

Photovoltaic Equipment and Installation

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413 35 Larisa
T: +30 6994 814555
www.axonhomes.gr

AC/DC
Gefyra, P.O. Box 61, 570 11 Thessaloniki
T: +30 2310 715809
F: +30 2310 715809
www.acdc.com.gr

ALPHA THERM
Neochorouda P.O. Box 152,
570 08 Thessaloniki
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F: +30 2310 780440
info@alphatherm.com.gr
www.alphatherm.com.gr

ARVIS SOLAR Ltd.
4 Marni Str., 104 33 Athens
T: +30 210 8232703
F: +30 210 8232045
info@arvisolar.gr
www.arvisolar.gr

BAYER HELLAS
18-20 Sorou Str., 151 25 Maroussi
T: +30 210 6187500
info.gr@bayer.com, www.bayer.gr

CALPAK SA
9 Sygrou Ave., 117 43 Athens
T: +30 210 9247250
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export@calpak.gr, www.calpak.gr
CIVIL DESIGN
28 Trapezountos Str., 162 31, Vyronas
T: +30 210 7644918
F: +30 212 2222670
info@civildesign.gr
www.civildesign.gr

CLIMA CENTER
6 Tenedou Str., 654 04 Kavala
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info@clima-center.gr
www.clima-center.gr

CLIMASYSTEM ENERGY
5 Ag. Panteleimonos Str., 551 33
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T: +30 2310 446000
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www.climasystem.gr

ENGIE (COFELY HELLAS SA)
2 Thermopylon Str., 152 35 Vrilissia
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infogr@engie.com
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COSMOSOLAR LTD.
12 Areopoleos Str., 145 64 Kifisia
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DIANA SOLAR HEATERS INDUSTRY
Ag. Nikolaos, 341 00 Chalkida
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www.diana-solar.gr

DIAS FINANCIAL & ENERGY
23 Konst. Karamanli Str., 551 32 Kalamaria
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www.e-dias.gr

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ECONOMY GREEN ENERGY
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www.papaemmanouel.gr

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SIELINE S.A.
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AKTOR FACILITY MANAGEMENT
Authorized Service Partner of SMA Solar
Technology AG
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www.sma-hellas.com

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F: +30 210 2841650
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SOLE
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136 71 Acharne
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www.sole.gr

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SUN PROJECT
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www.sunproject.gr

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UTECO
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F: +30 211 1206999
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www.uteco.gr

VENMAN
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F: +30 2310 781666
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www.venman.gr

VIOPOL S.A.
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F: +30 22620 31763
info@viopol.gr
www.viopol.com

Solid Fuels (Imports-Trade)

AGET HERCULES
19,3 km. Markopoulou Ave., 190 02 Peania
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www.lafarge.gr

CORAL ENERGY SA
12A Irodou Attikou Str., 151 24 Marousi
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CSC-Hellas@ceg.gr
www.coralenergy.gr

ELINOIL S.A.
33 Pigon Str., 145 64 Kifisia
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F: +30 210 6241509
info@elin.gr
www.elin.gr

MAVIL SA
1 km. Serron-Neou Skopou, 621 00 Serres
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F: +30 2321 055243
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www.mavil-sa.gr

TITAN GROUP
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info@titan.gr
www.titan.gr

VIASFALT
9 km. Liosion-Elefsinas Str.,
193 00 Aspropyrgos
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Solid Fuels (Production)

BITOULINE S.A.
16 km. Old National Road Chalkidas-Thivon
P.O. Box 19, Vathy Avlida, 32 200 Thiva
T: +30 22620 71792-94
F: +30 22620 71727
sales@bituline.gr
www.bitouline.gr

BITOUMINA S.A.
14th km Old National Road
Thessalonikis-Verias (Aghialos),
P.O. Box: 220, 570 08
Ionia Thessaloniki
T: +30 2310 722396-7
info@bitoumina.gr
www.bitoumina.gr

ESHA S.A.
Aspropyrgos Coast, 19300 Aspropyrgos
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F: +30 210 5572974
info@esha.gr
www.esha.gr

LIGNITORYXIO SERVION
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Str., 505 00 Servia Kozanis
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F: +30 24640 21185
www.larco.gr

METE S.A.
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F: +30 23850 24763
headoffice@mete.gr
www.mete.gr

PUBLIC POWER COPRORATION (PPC)
30 Chalkokondyli Str., 104 32 Athens
T: +30 210 5230301
info@dei.com.gr
www.dei.gr

Thermal Power Generation

ALOUMINIUM OF GREECE S.A.
8 Artemidos Str., 151 25 Marousi
T: +30 210 3693000
F: +30 210 3693108
info@alhellas.gr
www.alhellas.gr

ELPEDISON Energy S.A.
18-20 Amarousiou-Chalandriou Str.
151 25 Marousi
T: +30 210 3441000, 3441112
F: +30 210 3441199
info@elpedison.gr
www.elpedison.gr

KORINTHOS POWER S.A.
12A Irodou Attikou Str., 151 24 Maroussi
T: +30 210 8094000
F: +30 210 8094444
info@moh.gr
www.moh.gr

MOTOROIL
12A Irodou Attikou Str., 151 24 Maroussi
T: +30 210 8094000
F: +30 210 8094444
info@moh.gr
www.moh.gr

PROTERGIA S.A.
11 Marinou Antypa Str., 141 21 Irakleio
T: +30 210 3448500, 18311
F: +30 210 3448555
www.protergia.gr

PUBLIC POWER COPRORATION (PPC)
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T: +30 210 5230301
info@dei.com.gr
www.dei.gr

HERON S.A.
124 Kifisias Ave., 115 26 Athens
T: 18228
F: +30 213 00 75 499
CustomerCare@heron.gr
www.heron.gr

Thermal Insulation

EURODOMI
314 Konstantinoupoleos Str.
564 29 Stavroupoli Thessalonikis
T: +30 2310 685720
F: +30 2310 685720
info@eurodomi.gr
www.eurodomi.gr

FRAGOULAKIS
7 Gonata & 2 Thespion Str., 121 33 Peristeri
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F: +30 210 5778824
sales@fragoulakis.gr
www.fragoulakis.gr

GIANNATOU MONOSI
12 Agias Sofias Str., Ilion
T: +30 210 2620200, +30 210 2610082
F: +30 210 2615477
info@giannatou-monosi.gr
www.giannatou-monosi.gr

GOUMAS
63 Aristotelous Str., 136 72 Acharne
T: +30 210 2440600, 210 2467702
info@monoseisgoumas.gr
www.monoseisgoumas.gr

MATHIOS HIGH PERFORMANCE MATERIAL
5 Epidavrou Str., 18233 Rentis
T: +30 210 4913502
mathios@mathios.gr
www.mathios.com

METAXIOTIS
Apothikes Neochoroudas, P.O. Box 1535
570 08 Ionia Thessaloniki
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MONODOMIKI
97-99 Galatsiou Ave., 111 46 Galatsi
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F: +30 210 2137903
info@monodomiki.gr
www.monodomiki.gr

MONODYNAMIKI
8 Kissavou Str., 121 37 Peristeri
T: +30 210 5759798, +30 6937106600
www.monodynamiki.gr

MONOSIS AVRAMIDIS
13 Konstantinou Karamanli Ave.
546 38 Thessaloniki
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info@monosis-avramidis.gr
www.monosis-avramidis.gr

STEGANOMONOTIKI
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T: +30 210 7621427
ffrontzos@yahoo.gr
www.steganomonotiki.gr

Wind Energy

ABB SA
13o klm N.R. Athinon-Lamias, 144 52 Metamorfosi
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abb@gr.abb.com
www.new.abb.com

ABO WIND HELLAS SA
3 Evritanias Str., 15231 Chalandri
T: +49 611 267 65-857
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panagiotis.sarris@abo-wind.com
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ANIPSOTIKI -ERECTION
Thesi Voro, 196 00 Mandra Attikis
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38-40 Kapodistriou Ave., 151 23 Athens
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CUBICO Sustainable Investments Greece
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ENVITEC S.A. - TECHNICAL & ENVIROMENTAL PROJECTS
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PARISSIS Group
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PPC Renewables S.A.
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ΕΤΑΙΡΙΚΗ ΚΟΙΝΩΝΙΚΗ ΕΥΘΥΝΗ

15 χρόνια τώρα, είμαστε δίπλα σας με όλη μας την ενέργεια

Πριν 15 χρόνια ξεκινήσαμε να είμαστε δίπλα σας με όλη μας την ενέργεια. Με συνεχείς επενδύσεις, με την εισαγωγή φυσικού αερίου στη χώρα μας, με παραγωγή ενέργειας στις δύο υπερσύγχρονες μονάδες μας, με προμήθεια ρεύματος και φυσικού αερίου σε εκατοντάδες χιλιάδες πελάτες, με προηγμένες υπηρεσίες ενεργειακής απόδοσης που προσθέτουν αξία στην ελληνική κοινωνία και οικονομία. Συνεχίζουμε δυναμικά το έργο μας, για να είμαστε δίπλα σας, με όλη μας την ενέργεια, κάθε στιγμή.

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