



**UNIVERSITY OF PIRAEUS**  
**DEPARTMENT OF INTERNATIONAL**  
**AND EUROPEAN STUDIES**

**MSc in Energy: Strategy, Law & Economics**

**Postgraduate Dissertation**

**Liberalization of the electricity market in Greece and its  
evolution until today.**

**From monopoly, to the Hellenic Energy Exchange**

**Variadaki G. Ioanna**

**Supervisor: Spyridon Roukanas**

**Athens, Greece 2022**

*Το έργο που εκπονήθηκε και παρουσιάζεται στην υποβαλλόμενη διπλωματική εργασία είναι αποκλειστικά ατομικό δικό μου. Όποιες πληροφορίες και υλικό που περιέχονται έχουν αντληθεί από άλλες πηγές, έχουν καταλλήλως αναφερθεί στην παρούσα διπλωματική εργασία. Επιπλέον τελώ εν γνώσει ότι σε περίπτωση διαπίστωσης ότι δεν συντρέχουν όσα βεβαιώνονται από μέρους μου, μου αφαιρείται ανά πάσα στιγμή αμέσως ο τίτλος. / the intellectual work fulfilled and submitted based on the delivered master thesis is exclusive property of mine personally. Appropriate credit has been given in this diploma thesis regarding any information and material included in it that have been derived from other sources. I am also fully aware that any misrepresentation in connection with this declaration may at any time result in immediate revocation of the degree title.*

## Acknowledgements

*This thesis is a dissertation of the MSc in Energy: Strategy, Law & Economics of the Department of International & European Studies of the University of Piraeus, Greece.*

*First of all, I would like to express a special thank you to my supervisor, Prof. Spyridon Roukanas, for his support, his patience, and for always willing to offer me his guidance. Thank you so much for your kindness and encouragement.*

*Further, I would particularly like to thank my family for supporting me during the elaboration of this dissertation. I really feel that I would not have been able to complete it without their support.*

*Finally, from the bottom of my heart, I would like to thank my beloved partner, for always being by my side, full of support, motivation, and inspiration. Thank you so much for shining on...*

## Table of Contents

Abstract	5
Acronyms	6
Introduction	7
1. Progress of the Legal Framework in the European Union	9
1.1 Introduction	9
1.2 The 1st energy package	9
1.2.1 Directive 96/92/EC (12/1996)	9
1.3 The 2nd energy package (7/2003)	10
1.3.1 Directives 2003/54/EC and 2003/55/EC	10
1.4 The 3rd energy package (7/2009)	11
1.4.1 Directive 2009/72/EC	11
1.4.2 Regulation (EU) 347/2013	12
1.4.3 Regulation (EU) 2018/1999 (Governance of the Energy Union)	12
1.5 The 4th energy package (2019):	13
1.5.1 Regulation (EU) 2019/943 & Directive (EU) 2019/944	13
1.6 The 5th energy package (2021)	14
1.7 Conclusions	15
2. The liberalization of the electricity market in Greece	15
2.1 Introduction	15
2.2 Law 2773/1999	16
2.3 Law 3426/2005	17
2.4 Law 4001/2011	17
2.5 Law 4389/2016 – Auctions based on NOME mechanism	18
2.6 Law 4425/2016	19
2.7 National Energy and Climate Plan (NECP)	20
2.8 Conclusions	21
3. Hellenic Energy Exchange & Target – Model	22
3.1 Introduction	22
3.2 Coupling of the European Markets	22
3.3 Law 4512/2018 – The inception of HEnEx. A step closer to the Target Model.	23
3.4 Conclusions	24
4. The Operators and the Supervisory Authorities of the Energy Market	24
4.1 Introduction	24
4.2 RAE (Regulatory Authority for Energy)	24

4.3 IPTO SA (Independent Power Transmission Operator)	25
4.4 RESOGO SA (Renewable Energy Sources Operator and Guarantees of Origin SA / DAPEEP SA)	25
4.5 HEnEx S.A. (Hellenic Energy Exchange S.A.) & EnExClear S.A. (EnEx Clearing House S.A.)	26
4.6 HEDNO SA (Hellenic Electricity Distribution Network Operator)	26
4.7 Conclusions	27
5. The real competition	27
5.1 Introduction	27
5.2 Requirements for entry in the new market	27
5.3 Advantages and disadvantages of liberalization	29
5.4 The evolution of liberalization and market shares	32
5.5 Significant changes of dynamics brought by the liberalization	34
5.5.1 Electricity prices for household and industrial customers	35
5.5.2 Smart Grids	38
5.5.3 Energy Democracy	40
5.5.4 Energy Communities	40
5.5.5 E-Mobility	41
5.5.6 Market Coupling	42
5.5.7 Price Coupling of Regions – PCR	43
5.5.8 De-lignification / Decarbonization	43
5.6 Conclusions	45
6. Conclusions and Suggestions	46
References	49

## Abstract

The liberalization of the electricity market in Greece is a process that has basically been evolving over the last 15 years, timidly and searchingly at first, while imperatively and decisively over time, with continuous corrective moves on previous steps, due to encounters of failures and oppositions. The transition of this market from a monopoly regime to a competitive market is a very important step not only for our country but for the entire Europe, as it has led to positive changes for the well-being of consumers in the domestic market and the development of our energy security.

This paper illustrates the course to the liberalization of the electricity market from the monopoly regime to the current commencement of the official operation of the Hellenic Energy Exchange. The configuration of this market is guided by the directives of the European Union. It will be supported by the corresponding development of the European electricity market and then by the corresponding harmonization of Greek legislation. The harmonization of the Greek legislation with the European directives will put our country in the process of modernization of the energy market in order for our cooperation with the other European energy markets to follow.

Finally, as a result of these changes, the social implications of liberalization, the evolution of technology in the energy sector and the new perspectives that open up in the immediate and indirect future are analyzed in detail.

## Acronyms

ACER = European Union Agency for the Cooperation of Energy Regulators  
CBAM = Carbon Border Adjustment Mechanism  
CEP = Clean Energy Package  
CHP = Combined Heat and Power (for cogeneration units)  
DDPPC = Distribution Department of Public Power Corporation  
DEP = Daily Energy Planning  
EBRD = European Bank for Reconstruction and Development  
EED = Energy Efficiency Directive  
EnExClear = Energy Exchange Clearing House  
ESM = European Stability Mechanism  
HETS = Hellenic Electricity Transmission System Administrator  
ETS = Emissions Trading System  
EU = European Union  
EUPHEMIA = Pan-European Hybrid Electricity Market Integration Algorithm  
FEP = Forward Electricity Products  
FOSETEK = Aggregator of last resort of RES (until 31/12/2022 is RESOGO SA)  
HEDNO = Hellenic Electricity Distribution Network Operator  
HEMO = Hellenic Electricity Market Operator  
HEEx = Hellenic Energy Exchange  
HGTO = Hellenic Gas Transmission Operator  
HTSO = Hellenic Electricity Transmission System Operator  
IPTO = Independent Power Transmission Operator  
NECP = National Energy and Climate Plan  
NEMO = Nominated Electricity Market Operator  
NOME = Nouvelle Organization du Marché de l'Electricité (New Electricity Market Organization)  
PCI = Projects of Common Interest  
PCR = Price Coupling of Regions  
PPC = Public Power Corporation  
RAE = Regulatory Authority for Energy  
RES = Renewable Energy Sources  
RESOGO = Renewable Energy Sources Operator and Guarantees of Origin  
SDAC = Single Day – Ahead Coupling  
SIDC = Single Intraday Coupling  
TPA = Third Party Access

## Introduction

### ***The aim :***

Electricity is regarded today as one of the commodities that determine the people's quality of life. It is the product that has a leading role in everyday life, in health, industry, transport, trade and technology. Its use not only spread rapidly among people but was also developed with the aim of maximising its exploitation. Over time, electricity supply needs are growing at such a rate as to be regarded by most as a commodity of vital importance now, while technology together with sciences are in a race to find new solutions and products to fully meet these needs.

The access to electric energy and the cost that it entails are crucial because they both need to be served simultaneously and in a satisfactory way, so that the citizens of each country can enjoy this good, which to a certain extent is considered necessary. Through the record of the development of the electricity market in Greece and its consequences for both its citizens and the Greek State itself, the purpose of the present paper is to highlight the importance of this change in citizens' everyday life, in the cost they have to bear, but also in the start of new technologies and products.

### ***The methology:***

Starting with the establishment of the Hellenic Public Power Corporation which used to be the sole Provider in a monopoly status, the whole course of the European and consequently the Greek Legal Framework is recorded, until the establishment and function of the Hellenic Energy Stock Market. Greece, following the European Guidelines as a member of the European Union and considering the need for competition and consequent price reduction following, adapts and harmonizes with them. In a race to catch up with the rest European countries, which chose the free competition in this sector years before, it was led to important changes within a few years. Importing and developing domestic technology, Greece managed to develop quickly, organize itself inside the borders, connect with other countries and trade electric energy outside the borders.

### ***The structure :***

The comparison of the European Directives starts with the reference to the three energy packages and the targets they set. Over time, they become more specific, stricter and every



next step provides for the completion of the previous one. Energy packages refer to general common goals, and the European Directives, moving towards these targets determine specific ways of achievement. Then, member-states formulate, during the harmonization process, their internal market with specific processes and regulations. For this reason, these Directives prepare us indirectly for the corresponding changes Greece will carry out. The market is active within the legal framework and in case of distortions, Laws are modified according market and consumer needs.

This is followed by an analysis of the Greek legislation, which, as already mentioned, had to face domestic resistances and distortions. Aiming at the effective resolution of these problems, the legislation concerning the liberalization of the specific market is constantly regulated, amended and developing, it determines public auditing bodies, consolidates energy democracy, opens the way to new services and products, and sets own targets.

***The contribution of the thesis:***

The liberalization in the energy market has become the object of study in previous times by the legal and economic sciences. However, the energy sector has been developing in such a dynamic way during the last years that data constantly change, and new ones are created. New opportunities are opening up and new paths are discovered in the everyday life as we know it and their results have direct effect on people's lives, who learn to live with these changes, manage and utilize them.

# 1. Progress of the Legal Framework in the European Union

## 1.1 Introduction

Energy, being a major good in modern society, could only be at the center of the European Union's attention. The Union's vision of creating a single internal market and cross-border energy networks within the European area is essential in order to make individual markets open and therefore competitive. Since the 1990s, European institutions have been creating the energy legal framework, through new regulations and directives, which in turn are being integrated and guide the Member States in this direction.

The European Union's objectives in the energy sector consist in the formation of the internal energy market, increase in competitiveness, the establishment of the provision safety, the best interconnection of energy networks and environmental protection. These targets are gradually achieved through the issuance of guidelines - legislation ("energy packages"), divided as follows:

## 1.2 The 1st energy package

The first energy package was adopted in 1996 and passed into the legal framework of the Member States by 1998.

- o Establishes common rules for the internal electricity markets
- o Finds the national regulatory authorities and assigns compliance supervision roles for the market rules and the audit of sale invoices
- o Introduces the right of free access for third parties to networks ["Third Party Access" (TPA)]
- o Obliges to accounting and operational separation (unbundling)

### 1.2.1 Directive 96/92/EC (12/1996)

The Directive that officially launched the 1st energy package was published in December 1996. In these first steps towards competition status is the full liberation of the electric energy production, high-voltage power lines are assigned to an independent administrator, and it is

determined that the final consumers with high consumption are now Eligible Customers, i.e., they have the right to choose a Provider. Moreover, an arrangement of key importance for the next day of the market liberalization is the obligation of vertically integrated businesses to carry out accounting separation for every sector of their activities (unbundling). More detailed, it is asked by these businesses to separate the activities of energy production and provision, from activities regarding the transmission and distribution networks. In this way an obstacle is put in place for the existence of parallel interests in both sectors, as, if a company operates alongside the transmission network with energy trading, it may have a motive to impede access of other producers (competitors) to the network infrastructure (The European Parliament and the Council of the European Union, 1996).

### 1.3 The 2nd energy package (7/2003)

The 2nd energy package was adopted in 2003 and passed into the states' legal framework in 2004, while some of its directives were implemented in 2007.

- o Introduces regulations with the conditions of access to the network for trans-border electric energy exchanges as well as to the transport networks for natural gas
- o Introduces the right to free choice, and easy change, of the provider

#### 1.3.1 Directives 2003/54/EC and 2003/55/EC

The kick-off for the 2nd energy package was given by Directive 2003/54/EC, which continued the work of the 1st energy package and enhanced its scope, determining the way of production liberation by assigning it to the same independent authority as the transmission and distribution network and also determines that starting from July 2007, all final consumers will be considered as eligible customers. The establishment of an independent authority is now obligatory for all member States, even those which have not created it yet (article 7.5).

Directive 2003/55 correspondingly regards the determination of liberation rules for natural gas, provides for the creation of independent administrators for transmission systems and gives member States the freedom to decide how to handle this liberation, i.e., whether a private entity or the State itself will undertake the utilization of the transmission system. Finally, the notion of universal service is determined, so that all consumers have access to energy, in any case, as a good of key importance. Universal service providers are the

providers who undertake to represent small home and small professional provisions in the network, in every case and for whichever reason their administrators have not chosen a Provider as Eligible Customers (article 3.3). (The European Parliament and the Council of the European Union, 2003)

## 1.4 The 3rd energy package (7/2009)

Despite the fundamental changes brought by the two first energy packages, the single market found obstacles through its adjustment. Markets remained mainly national, with a relatively limited trans-border trade. The 3rd energy package:

- o Enhances the competences, independence and cooperation of regulatory authorities and network administrators
- o Attaches importance in natural gas trade and distribution
- o Legislates in great detail regarding competences, processes and problem and distortion resolution, the whole base for the production, distribution and trade across the borders.

### 1.4.1 Directive 2009/72/EC

In August 2009, in the Official Journal of the European Union Directive 2009/72/EC was published where, as it is mentioned, *“However, at present, there are obstacles to the sale of electricity on equal terms and without discrimination or disadvantages in the Community. In particular, nondiscriminatory network access and an equally effective level of regulatory supervision in each Member State do not yet exist”* (Paragraph 4). There is also the assumption that *“the present rules and measures do not provide the necessary framework for achieving the objective of a well-functioning internal market”* (Paragraph 7). (The European Parliament and the Council of the European Union, 2009)

Therefore, with this stricter Directive:

- o Guidelines frame the development of transborder interconnections which aim at the increase of energy safety.
- o The greatest possible competition increase is supported by the suggestion of faster processes and facilitation of investors’ access to the market
- o Transparency of invoices is requested and

- o the network administration is strictly separated and with an extended reference from production and provision sectors, in order to eliminate the risk of market distortions.

#### 1.4.2 Regulation (EU) 347/2013

Regulation 347/2013 regarding the guidelines for trans-European energy infrastructure, as published in the European Union Official Journal, is about the implementation of short-term procedures for licensing, support and completion of Projects of Common Interest (PCI's) (The European Parliament and the Council of the European Union, 2013). This means that it speeds up the procedures regarding the approval and realization of trans-border infrastructure projects that concern either the integration of European Union countries by Energy Networks or the energy safety of the Union (energy supply) or the development of Renewable Energy Sources (RES), with the ultimate purpose of upgrading the energy policy pursuant to the "Paris Agreement". Specifically referring to the trans-border interconnection lines between member States, it promotes and encourages investment in such projects that help and speed up the Internal Energy Market. Based on Regulation 347/2013 the European Commission is authorized to issue a list - "EU list" - of European Union PCIs every two years (Paragraph 23 & 24).

#### 1.4.3 Regulation (EU) 2018/1999 (Governance of the Energy Union)

The European Commission in 2015, at the request of the Heads of State and Government of the EU, presented a unified strategy that would ensure economic, safe and sustainable flow of energy.

The energy union decides and acts according to five main pillars:

- ✓ Security, solidarity, and trust / cooperation between EU countries - ensuring energy security through alternative and diversified energy sources as well as
- ✓ A fully integrated internal energy market, with infrastructure that allows the free and unimpeded flow of energy
- ✓ Energy efficiency – whose improving will reduce energy imports, reduce carbon dioxide emissions
- ✓ Climate actions, with decoupling of the economy from greenhouse gas emissions

- ✓ Research, innovation and competitiveness - supporting achievements in new "green" energy technologies, prioritizing research and innovation to increase competitiveness and create new jobs. (Ciucci, 2021)

This regulation establishes a governance system for:

- Implementation of measures aimed at achieving the Energy Union's greenhouse gas emissions targets under the Paris Agreement, as well as the Union's energy and climate targets by 2030 and in the long term by 2050
- Developing cooperation between Member States in order to achieve these objectives
- Ensuring the quality of energy and climate reports that will be written by the Union and the Member States (National Energy and Climate Plan)
- Inspires greater investor confidence in stimulating new investments and economic growth. (The European Parliament and the Council of the European Union, 2018)

## 1.5 The 4th energy package (2019):

The original version of the package was proposed by the European Commission in 2016. The European Commission presented a set of proposals called "Clean Energy for All Europeans", which were all adopted by May 2019, thus completing the energy union, a fully integrated internal energy market (European Commission, 2019). This reality strengthens Europe, whose energy is diffused without national borders and, with increased competition and reduces the final cost to its citizens. The final version was published in June 2019 by agreement of three parties, the European Commission, the European Council and the European Parliament.

### 1.5.1 Regulation (EU) 2019/943 & Directive (EU) 2019/944

The "Clean Energy for all Europeans package", or "Clean Energy Package" (CEP) for short, focuses on electricity and upgrades the targets of the European Union as follows: (The European Parliament and the Council of the European Union, 2019)

- o 40% reduction in greenhouse gases compared to 1990
- o 32% share of RES in the European energy mix
- o Introduces new rules to meet the needs of renewable energy sources and attract investment
- o New limit for power plants to be eligible for subsidies as capacity mechanisms.

- o Preparation of emergency plans by the states for cases of electricity crises
- o Increase ACER's responsibilities for regulating cross-border cooperation when there is a risk of energy rupture.

This energy package is designed to focus on the transition from fossil fuels to low-emissions energy and to meet the commitments of the EU-Paris Agreement on Emissions Reduction, while ensuring that energy as a commodity is affordable, safe and sustainable.

## 1.6 The 5th energy package (2021)

Considered as the fifth energy package, the "Fit for 55" package was presented by the Commission in July 2021 and sets even higher goals to be achieved by 2030, compared to its predecessor. In particular, instead of a 32% reduction, the share of RES in the European Union energy mix increases to 40% and for greenhouse gas emissions the reduction from 40% is revised to 55%, compared to 1990. These directives include:

- Reconsideration of the Emissions Trading System (ETS), with the addition of more polluting industries such as shipping and future addition of travelling and real estate, starting in 2026. This fund is distributed to support citizens affected by climate change (EU Social Climate Fund) as well as to support the country's environmental policy (e.g. public constructions, grants, etc.)
- Legalization of the principle "energy efficiency first" [Energy Efficiency Directive (EED)]. This principle concerns the priority given by the energy union to the achievement of the objectives it has set and the efficiency of its reforms in the environment and consequently to its citizens and is achieved by removing the obstacles identified, mid-term and long-term evaluation of the decisions taken as and careful monitoring of these
- Definition of Carbon Border Adjustment Mechanism (CBAM). This proposal takes into consideration that there is production abroad with lower costs due to weaker environmental standards, asks producers to pay for emissions, as paid by European citizens, and respectively compensates the non-polluting production
- Provide incentives to investors for new projects and companies that choose to exploit and invest in Hydrogen renewable energy (Kneebone, 2021)

## 1.7 Conclusions

The liberalization of the internal energy market in parallel with the protection of the environment seek to build a sustainable competitive market, clearly defining the era before and after the liberalization of the energy sector. This transition is an effective measure for European countries, regardless of their socio-economic context. Carbon dioxide emissions are declining with the liberalization of the internal energy market.

The benefits of this policy are not obvious in the short term, but in the long term, as liberalization is a policy that is being implemented progressively. In parallel with the upgrading of the energy market, the above measures aim at climate neutrality in Europe while the Member States are in continuous dialogue to define the next steps to achieve this goal, which must be achieved by 2050.

## 2. The liberalization of the electricity market in Greece

### 2.1 Introduction

The incorporation of the European Directives for the liberalization of the electricity market in the Greek legal framework from the beginning came into conflict with the prevailing monopoly situation in all sectors: production, transmission, distribution and supply. The transition to a competitive market was an important and difficult reform, as for years a monopoly model of market organization had been established. PPC has been a point of reference of the country's electrification with large capital investments in production units, networks, transformation stations and control centers in mainland and island territories (Greek Government, 1950).

In order for new producers or suppliers to enter the market, all companies had to be given equal access to the use of the networks, guarantees of equal competition due to PPC's access to lignite in production, and consequently the same initial wholesale cost so as to enable competitive prices.



## 2.2 Law 2773/1999

Law 2773/1999, known as the Liberalization of the electricity market Law, established at the end of 1999 with the aim of transposing Directive 96/92/EK into Greek legislation and, together with its amendments, marks the first steps of the transition from the monopoly regime to the free competition.

The Regulatory Authority for Energy (RAE) is established, which, under control of the Minister of Development, is responsible to supervise the operation of the market and take all the necessary measures in order to protect the consumers and the compliance of the Laws. For the smooth operation of the market, four main Codes are drafted by ministerial decision: the Management Code of the Electricity Transmission System, the Transaction Code for Electricity, the Management Code of the Distribution Network and the Customer Supply Code.

The market is divided into 4 subcategories:

- i) electricity generation from power plants
- ii) electricity supply, and more specifically its sale to ultimate consumers
- iii) electricity transmission system through high voltage network
- iv) supply through the medium and high voltage network

The generation of electricity was accessible to investors except for the Major Supplier under conditions such as the own consumption of the generated energy, the RES units and cogeneration of electricity and heat.

The supply of electricity is partially liberated, and as non-Eligible Customers, i.e. consumers who are not free to choose their Supplier, remain the households, other small consumption meters, and the consumers of non-interconnected islands. Regarding the pricing, the Supply invoices to Eligible Customers are obtained by agreement of the latter with the Suppliers, while the invoices to Non-Eligible Customers are formed after the approval of the Minister of Development and the Regulatory Authority for Energy (RAE).

The Transmission System and the Distribution Network remain property of PPC, which is obliged for the separation of the production, transmission and distribution activities. Finally, the "Hellenic Electricity Transmission System Operator" SA (HTSO) is established, with the

responsibility to ensure the supply of electricity for the country, giving access of the Network to the holders of production and supply licenses, manages the Transmission System and its interconnections with other networks, ensures its smooth operation and undertakes the settlement of transactions between the participants in the System. At its establishment, 51% of HTSO belongs to the State and 49% to energy generation companies connected to the system, distributed according to their production capacity (Greek Government, 1999). Therefore, due to the lack of other producers up to this point, this percentage concerns PPC.

### 2.3 Law 3426/2005

With Law 3426/2005 on "Acceleration of the process for the liberalization of the electricity market", Directive 2003/54/EK and 2003/55 /EK (inception of the 2nd energy package) were incorporated into Greek legislation. In Greece, there is already the Regulatory Authority for Energy (RAE) as an independent supervisory authority, but with this Directive the Member States are now required to establish corresponding Authorities. This Law clarifies and expands the jurisdiction of RAE, for example it has the power to sue the Major and the System and Network Operator in case of violation of law. It also undertakes the role to ensure compliance with utility obligations in order to protect consumers.

Finally, in the field of supply, full liberalization is envisaged. Specifically, all consumers - and households, from 01.07.2007 are considered " Eligible Customers" - i.e. have the right to choose a provider (Greek Government, 2005).

### 2.4 Law 4001/2011

Greece was one of the first EU countries to incorporate Directive 2009/72/EK (3rd energy package) into its legislation. Specifically, this Law sets a clear framework in which the market of electricity and gas is organized and controlled, based on specific instructions.

RAE is assigned new responsibilities. Among them, it is worth mentioning the security of energy supply, the issuance of licenses to new participants and the issuance of decisions regarding the development of infrastructure and transmission system.

This law introduces the important concept of "Vulnerable Customers" and presents appropriate measures to address energy poverty. Energy poverty in this law is defined as *"The situation of consumers, in which they are in a difficult position due to their low income, as evidenced by their tax notice, combined with their professional status, their family status and special health conditions, to cover the expenses for their reasonable needs in electricity or gas, as these expenses constitute a significant percentage of their disposable income "* (Article 2).

The obligations of the Suppliers towards the consumers are analyzed, while original provisions are presented, such as the information of the consumers for the energy mixture of fuels of the country and the corresponding emissions of carbon dioxide caused (article 48). Concepts such as "intelligent measurement systems" are introduced which are designed to replace the existing ones.

Finally, the following bodies with the respective responsibilities are established:

- o HTSO SA is divided into i) "Independent Power Transmission Operator - IPTO" for the maintenance and development of the transmission network and ii) "Hellenic Electricity Market Operator – HEMO SA" responsible for the wholesale operation, the injection of quantities of electricity in the Network and the settlements between the Participants, while
- o for the activity of distribution and the networks of non-interconnected islands, "the Hellenic Electricity Distribution Network Operator – HEDNO SA" is established (Greek Government, 2011).

## 2.5 Law 4389/2016 – Auctions based on NOME mechanism

With the implementation of the memorandum, the Greek energy market will take the first important steps towards the "Target - Model". Law 4389/2016 was a preliminary stage of the rapidly approaching stock market. The design of the auction system was based on the French model NOME ("Nouvelle Organization du Marché de l'Electricité") which concerned nuclear energy auctions. In Greece, the auctions concern production from lignite and hydroelectric power plants of PPC so that its market share to fall below 50% by 2020 according to the Memorandum of Understanding of the "European Stability Mechanism" ("ESM") in 2015.

HEMO is appointed responsible for conducting the auctions, while the quantities to be auctioned are determined by RAE and the starting price is set by a joint ministerial decision. Those who have a supply license have the right to participate, except for the industrial consumers with a license and PPC SA itself. The auctions are held quarterly and concern quantities for physical delivery during the 12 months following the auction (Greek Government, 2016).

## 2.6 Law 4425/2016

Aiming at the existence of a single energy market, the reorganization of the domestic wholesale market is the only way. The changes that are coming are more frequent and more fundamental, with the aim not only of the full harmonization of the Greek market with the European directives, but also the development of faster reflexes in the monitoring of new technologies and in synchronization with the other Member States.

In this law, the existing wholesale energy market is transformed into a Wholesale Market of Forward Electricity Products (FEP), in which purchase and sale contracts with a physical delivery obligation are included. The new Market consists of 3 markets with different characteristics:

- i) The Day Ahead Market which concerns transactions of electricity with physical delivery the next day. The operation of the Day Ahead Market, along with the single coupling of the European electricity markets, is a responsibility of the Energy Exchange Group, and of the HETS Administrator
- ii) the Intraday Market in which the transaction orders of the Participants are on the date of fulfilment of the physical delivery, after the expiry of the deadline for placing transaction orders at the day ahead market. This is likely to happen, given the results of the Day Ahead Market with the already committed amount of electricity. The operation of the Intraday Market, even within the single framework for the coupling of European markets, is carried out by the Energy Exchange Group in collaboration with the HETS Administrator and the competent bodies.
- iii) The Balancing Market includes the balancing capacity market, the balancing energy market and the imbalance settlement process. The Participants are obliged to submit bids in both the Balancing Capacity Market and the Balancing

Energy Market based on the respective Balancing Market Regulation, according to which, the management of this Market is the sole responsibility of the HETS Administrator. (IPTO, 2021)

According to the new requirements of the Markets, their supervision is assigned to RAE, HEMO is appointed manager of the Wholesale Market of Forward Products and undertakes the settlement of transactions and the redefinition of the duties of the HETS Administrator (Greek Government, 2016).

## 2.7 National Energy and Climate Plan (NECP)

Based on the European Union's energy and climate targets in the 4th Energy Package, targeting 2030, each Member State had to formulate its national ten-year plan (2021 - 2030), by the end of 2019, and then submit a progress report every two years. The draft of each country was studied by the commission which gave as feedback proposals, methodology and annexes, so that based on all that material the final plan of each state will be submitted.

The National Energy and Climate Plan was published in Gov. Gazette 4893/2019 and concerns the presentation and analysis of the Greek government's goals on energy and climate with an initial time horizon the year 2030. In addition to NECP, follows the Long-Term Strategy for 2050 which is also the guide for actions related to energy and climate, so that our country is in line with the European goal of transition to a climate-neutral economy (Ministry of Environment and Energy, 2020).

Indicatively, the goals that have been set by Greece for 2030 are:

- reduction of greenhouse gas emissions over 56%, compared to 2005
- participation of RES in the energy mix at least by 35% (European target at 32%), while it is reported that the actions that are already studied increase the percentage to more than 60%
- improvement of energy efficiency with a focus on the buildings and transport sector, where the goal is that energy consumption will ultimately be lower than in 2017

- cessation of lignite power plants (de-lignification) - this specific goal is desirably achieved by 2023 - with parallel planning of measures to support lignite areas due to cessation of this activity.

## 2.8 Conclusions

In 1999, with the Liberalization of the electricity market Law, the transition of Greece from the monopoly to the competition regime begins. The Energy Regulatory Authority is established, and a senior market supervisor is appointed, while the structure of the latter is formed by division into sectors

- Production and supply sectors are open for the entry of new investors,
- Transport and distribution sectors, where the main holder remains the state but everyone is offered access and exploitation and for the management of the transmission system HTSO is established. “Elective Customers”, ie consumers with the right to choose a supplier are defined the High and Medium Voltage benefits, while the right to the Low Voltage will be given only in 2007. In 2011 the concept of “Vulnerable customers” is set and the formation of special tariffs for this group begins. Consumers are given information about the operation of the market such as the monthly fuel mixture and the emissions of producers. HTSO is divided into IPTO and HEMO (LAGIE) with separate responsibilities for infrastructure and market clearance respectively, while managing the Low Voltage Network and non-interconnected islands. A harbinger of the stock market was the launch of the NOME model in which the first distortions were addressed, and private suppliers were offered access to cheaper energy in order to stimulate healthier competition. With law 4425/2016 the steps of harmonization with the European legislation become more imperative. Futures products are imported, and transactions become more flexible with separate clearing. The establishment of the Hellenic Energy Exchange is a fact.

## 3. Hellenic Energy Exchange & Target – Model

### 3.1 Introduction

One of the key objectives of the European Union is to create a single internal energy market in the fields of production, transmission, distribution, and supply. Achieving such a single network will bring advantages at various levels such as increasing cross-border competition, which will reveal new investment opportunities, increase the union's security of supply and reduce the wholesale prices that are passed on to consumers.

### 3.2 Coupling of the European Markets

With the issuance of EU guidelines, Member States at different speeds, in recent years, are shaping their market to integrate these Directives into their legislation, each finding either different or identical problems in their implementation. Then, two countries with a common energy market structure can, through Market Coupling, transfer the energy generated in an EU country and deliver it to consumers in a different Member State. The essence of this new model of operation ("Target Model") but also its difference with the pre-existing cross-border energy trade is that through cross-border trade, supply and demand will be balanced, energy fluctuations will be addressed immediately, and a country's energy deficit will be covered by the energy surplus of another, directly and with agreements that come at the time of demand (Next, 2020).

The Target Model that the European Union wants to be achieved through all its members, is the structure of the energy market with the demarcation and smooth operation of the four (4) sub-markets, which were analyzed in a previous chapter: a) the Day-ahead Market, b) the Intra-Day market c) the Forward Market and d) the Balancing Market. Essentially on a common platform, supply on the one hand and demand on the other, are both matched, selected and served at all times, so that free competition and the achievement of adequacy work to the benefit of the ultimate consumer.

### 3.3 Law 4512/2018 – The inception of HEnEx. A step closer to the Target Model.

In order to achieve and successfully operate a Single European Electricity Market, the harmonization of this legal and regulatory framework of the European states in accordance with the "Target Model", is necessary. The "Target Model" is based on the EU's third energy package and was developed with the agreement of the European Commission, ACER, Transmission System Operators, Regulators, and stakeholders to develop a single EU market model.

Article 96 of Law 4512/2018 provides for the establishment of the "Hellenic Energy Exchange SA" (HEnEx) following Law 4425/16 aiming at the coupling of the Greek wholesale market with the respective energy markets of Europe in order to create a single European wholesale energy market ("Internal Electricity Market").

HEnEx SA was founded on 6/18/2018, its Operating Regulations were approved by RAE and was appointed by the Regulator as the Nominated Electricity Market Operator (NEMO) specifically for the Day Ahead Market and the Intraday Electricity Market. Its subsidiary, EnEx Clearing House S.A (EnExClear - November 2018), is respectively responsible for the liquidation and settlement of transactions in these markets as well as for the settlement of the positions of the Balancing Market. These two companies constitute the Energy Exchange Group.

Its shareholder composition until today is as follows:

- Renewable Energy Sources Operator & Guarantees of Origin (RESOGO SA/ DAPEEP SA) (22%)
- IPTO (20%)
- Hellenic Gas Transmission Operator (HGTO – DESFA) (7%)
- Athens Stock Exchange (21%)
- European Bank for Reconstruction and Development (EBRD) (20%)
- Cyprus Stock Exchange (CSE) (10%) (from 18/12/18) (Athens Stock Exchange, 2020)

The harmonization of the Greek wholesale energy market with the Target Model was completed on November 1st, 2020 and Greece is currently in the Day Ahead Market pairing



with Italy (12/2020) and Bulgaria (5/2021) and Single Intraday Coupling with the markets of Italy and Slovenia (12/2021).

### 3.4 Conclusions

In order for the Greek market to be harmonized with the European directives, to be synchronized with the other European energy markets and to participate in the target model, Greece establishes the HEnEx, with the law 4512/2018. The HEnEx aims to strengthen not only competition and energy trade but also our country's participation in the Europe's overall vision for a common trade base without individual borders.

## 4. The Operators and the Supervisory Authorities of the Energy Market

### 4.1 Introduction

The Union's goal of the operation of a single internal market based on a secure and coherent network could not be achieved without effectively separating transmission and distribution activities from electricity generation and supply activities. This separation can only be achieved by the successful elimination of the conflict of interest created during the vertical integration of procurement and network activities. The European Directives therefore set strict rules to ensure the independence of each of the activities.

### 4.2 RAE (Regulatory Authority for Energy)

The Regulatory Authority for Energy (RAE) was established by Law 2773/1999, in the context of harmonization of Greek legislation with the European Directives 2003/54/EK and 2003/55/EK on energy. Its main responsibility since then is to supervise and guide the functioning of the domestic energy market.

In addition to monitoring the proper functioning of the energy market in all its forms – electricity / gas / RES / oil – in terms of transparency, compliance with Regulations, pricing of Participants and maximizing fair competition, the Regulatory Authority undertakes the protection of consumers from any distortions, the issuance, modification and revocation of licenses of participants through control procedures, ensuring the energy supply of the country and cooperates with the Regulatory Authorities of other States in order to monitor and regulate the access of Participants to cross-border activities (RAE, 2021)

### 4.3 IPTO SA (Independent Power Transmission Operator)

Based on the functional separation of activities in order to comply with the European regulations, PPC gives its subsidiary "Independent Power Transmission Operator (IPTO) SA", as the main operator of the Transmission Network. The new independent body is joined by the respective responsibilities and the staff of HTSO related to the operation, control, development and maintenance of the Transmission System, the clearing of discrepancies arising from intermediate transactions and the settlement of issues arising from the ongoing procedures (IPTO, 2021).

### 4.4 RESOGO SA (Renewable Energy Sources Operator and Guarantees of Origin SA / DAPEEP SA)

Law 2307/2018 divides HEMO, defining as separate the RES and CHP sector. The Market Operator, as referred to in this Law, through secession of a branch and transfer of activities to the Hellenic Energy Exchange (HEEnEx SA) is renamed to "RES Operator and Guarantees of Origin SA" (RESOGO SA/ DAPEEP SA). RESOGO is from the middle of 2018 the contractor in the responsibilities held until then by the Electricity Market Operator (HEMO SA) in the field of RES and CHP.

The responsibilities of the new body, which are equal to those of HEMO, are detailed in the following instructions:

- ✓ Manages the RES and CHP units in the Interconnected system and the guarantee of origin of the energy they generate
- ✓ Is the auctioneer of the CO2 Emissions Allowances in Greece

- ✓ Represents the stations, which are unable to assign or undertake their representation, in the pre-day electricity market, as the Aggregator of Last Resort (FOSETEK) of RES (DAPEEP, 2021)
- ✓ It is the largest shareholder of HEnEx SA (DAPEEP, 2021)

#### 4.5 HEnEx S.A. (Hellenic Energy Exchange S.A.) & EnExClear S.A. (EnEx Clearing House S.A.)

EnExGroup consists of Hellenic Energy Exchange S.A. (HEnEx S.A.) and EnEx Clearing House S.A. (EnExClear S.A.). The purpose of establishing the Hellenic Energy Exchange was the coupling of the Greek energy market with other European markets and the strengthening of competition, with immediate benefits of reducing energy costs for the ultimate consumer of any size, ensuring energy supply, and diversification of energy sources in the energy mix.

Specifically, after the withholding of the aforementioned responsibilities, (HEMO) LAGIE, as a new RESOGO, grants all other responsibilities to HEnEx SA, in addition to organizing and conducting auctions for the sale of forward electricity products with natural delivery.

The Purpose of EnExClear is the Clearing of Transactions in the Next Day and Intraday Markets, the clearing of all energy financial market transactions (market of derivatives) of the Hellenic Energy Exchange SA. as well as any other related activity in accordance with the provisions of Regulation (EU) 2015/1222 and Law 4425/2016. EnExClear was founded on 18.6.2018 and has a sole shareholder, the Hellenic Energy Exchange SA. (HEnEx Group, 2021)

#### 4.6 HEDNO SA (Hellenic Electricity Distribution Network Operator)

The Hellenic Electricity Distribution Network Operator is a Societe Anonyme, a subsidiary and 100% owned by PPC SA. With Law 4001/2011, which was analyzed in a previous section, based on the operational separation of activities of PPC SA, HEDNO has taken over as Administrator of the Hellenic Distribution Network but also as Administrator of the markets in the Non-Interconnected Islands. According to its Operating License, HEDNO must protect the environment, ensure energy efficiency and access of Users and Suppliers to the Hellenic Electricity Distribution Network. The operator of the Greek distribution

network is a natural monopoly and for this reason its operation is regulated and controlled by the independent Regulatory Authority for Energy (RAE). (HEDNO, 2021)

## 4.7 Conclusions

The presence and proper operation of each of the above entities are essential elements in the liberalized electricity market. Each of the above bodies, cooperates with the others, has clear responsibilities and all of them operate under the supervision of the Energy Regulatory Authority.

## 5. The real competition

### 5.1 Introduction

The liberalization of the electricity market refers to the gradual transformation of the former monopoly regime into the provision of competing goods and energy services. Specifically, the abolition of monopoly has led to the development of mixed ownership and management schemes and increased the number of private companies. An inevitable consequence of these changes is the emergence of conflicting interests that have also contributed to increased competition. Few are the examples both of the pure monopolies and of perfect competition. Even the utilities sector (eg telecommunications, water supply, etc.) which were previously referred to as the most characteristic pure monopoly markets, have now been transformed and gradually liberalized.

### 5.2 Requirements for entry in the new market

It is clear that the entrance of new members in the market, depends on the barriers they will meet, during their entry (barriers to entry), and on the predictable reactions of the already existing companies. The bigger the barriers, the more difficult the transformation from a

monopoly to a competitive environment is. Such barriers could be the following: (Porter, 1986, cited in Georgopoulos, 2015)

- ✓ *Economies of scale*: It is difficult for new companies to reduce their variable cost per unit, efficiently and quickly enough in order to operate immediately. Instead, they are usually forced to enter the market gradually.
- ✓ *Experience*: Besides of the economies of scale, the existing companies have already organized their knowledge, supplies and cooperation, difficulties that for a start-up will cost even more
- ✓ *Product differentiation*: At the time of the emergence of new competitors, the existing companies, have already a well-established reputation, well-known products and consequently customer loyalty.
- ✓ *Funds*: Entering a new market often requires high capital needs for fixed assets such as personnel and equipment, research for investment and development, advertising, etc.
- ✓ *Adjustment costs*: An important factor for the acceptance of the new competitor by the consumers is the cost that probably exists for the latter if he chooses an alternative supplier, and how this compares with the benefits he will gain.
- ✓ *Market access*: For start-ups there are often restrictions on access to distribution and supply circuits, which are controlled by the already established companies.
- ✓ *Government policy*: The state through various regulations can support, impede or even prevent new companies from entering the market (Porter, 1986)

The provision of monopoly privileges to the existing companies, puts them in an advantageous position, from which they create an inhospitable environment either for the development or the restriction of competition, to their advantage. This position of power that appears in the market makes it necessary to formulate and adopt a policy, aimed at consolidating healthy competition which will smooth the unequal distribution of benefits among market participants.

The beginning of the formation of markets in the European Union with the aim of achieving liberalization, has come a long way and has passed through various barriers. When these changes started in Greece, they encountered delays, resulting that our country reached the target model operation last among the member states. Every change, especially of this

magnitude, is expected to provoke reactions in various parts of it and through such fermentations to reach its most complete form possible.

This liberalization brings the positive results which were initially the lever of this change, while at the same time some negative features of the new reality are emerging.

### 5.3 Advantages and disadvantages of liberalization

Firstly, as a basis for the following analysis is the fact that the product produced, electricity, is common to all consumers and not characterized by quality. However, what is differentiated and shaped by each provider is the quality of the services offered with which the product is accompanied.

Today, all consumers are classified as eligible customers and have the freedom to choose their supplier. Responding to this audience and trying to claim market share, power generation and supply companies shape their prices and services in order to meet the expectations and needs of consumers as much as possible. Pricing policies of the providers, that come as a result of competition, squeeze the charges downwards, and in many cases down to cost limits. The high profit margins are small and if such opportunities appear temporarily, in the long run this profit will disappear in the daily life of the market. Another consequence of competition, at the level of services, is the continuous increase of their quality and transparency. As long as the consumer is the final recipient and judge, the efficiency of the operation of each producer and supplier will be constantly increasing.

The unimpeded entry of new participants into a regulated free market offers benefits not only to the ultimate consumer but also to the market itself. New opportunities are offered to those who are interested in investing in this new market in many areas. The construction of new production units with gas as raw material, happened in a short time. Within just a few years, apart from the PPC units, also gas units of private suppliers started operating, units that operated with the more modern technology, higher efficiency and lower costs. New trading companies negotiating cross-border energy trade agreements, either by importing energy at lower than domestic production prices or by exporting quantities when the domestic market fluctuates at low prices, make their presence visible by showing new profit opportunities and foreshadowing the single market through continuous interaction.

Renewable energy installations, which are multiplying at an exponential rate, are claiming an ever-increasing percentage of participation in the daily power supply. Finally, the continuous evolution of all these facilities and activities in order to maximize efficiency and the most environmentally friendly operation requires growing know-how, specialization, new jobs and new methods of business activity.

For a successfully competitive market, a key component is a sufficient number of participants, so that any strategic agreement between them is not possible. Any distortion in the energy market, in countries that have abolished the monopoly in this area, can be addressed or eliminated under the supervision of the appropriate and independent regulators. At the same time, in the European single energy market, where competition is expanding and consolidating across borders, the fermentations are continuous and rapid, so the development of such strategies for the sake of speculation or any other complication that ultimately affects consumers, is difficult.

On the other hand, a liberalization process such as that of the energy market, although it follows the guidelines of common decisions of the European Union, does not evolve smoothly as it proceeds in many stages almost in parallel with the other Member States. This means that the competitive market, in its formation, corrects itself and learns through distortions that occur along the way, such as opportunistic speculation, possible exploitation of a dominant position of the dominant supplier or activity at the expense of the ultimate consumer. The development of competition in the real economy does not guarantee equality between companies operating in the industry or between consumers. To achieve this, regulators and independent managers need to be unaffected by their own interests and constantly on the lookout for energy security and credibility in the energy market.

Investigating the problems that arise in the domestic energy market due to the liberalization, firstly we find that in our country there are 35 supply companies (IPTO, 2021), of which the top ten in market share, including PPC SA, are in conflict and cause different fermentations to each other. In a country the size of Greece, it is consequent that the number of suppliers starts decreasing through horizontal acquisitions, ie acquisition of suppliers in the same sector (power supply) in order to reduce competition, increase the bargaining power of the final supplier in market, as well as increasing its market share. These fermentations between companies are expected, but two issues need to be addressed. Firstly, the continuation of the existence of adequate participants in order to maintain the transparency between them

and also the maintenance of trust in the market on the part of the consumers so that they do not feel insecure with a good as important to them as electricity.

With so many participants in the energy market and the different choices of suppliers, one would expect that consumers would be allocated faster to different providers enjoying similar benefits. The reality, however, is different as the largest market share to date remains with PPC and also the rate of withdrawal from the beginning of the liberalization was low. The reasons why this happened are mainly related to the dominant Supplier. The oldest existing energy company had already a highly developed marketing network, which urgently supported the company, the knowledge of exclusive, until the release, operation of the networks by PPC, created insecurity and had to be demolished for ultimate consumers, as well as certain groups of consumers enjoying special tariffs from PPC have been late or until today have not been able to find a more attractive offer from a private supplier. Such groups are the managers of agricultural meters, public facilities and public spaces, while another typical example of different treatment are the consumers on islands, on the non-interconnected islands, which are supplied with power exclusively by the oil factory that operates on the same or on a neighboring island. Particularly, in this case, the private companies themselves were delayed in operating on these islands – they did only in 2017 - due to increased wholesale costs compared to the competitive tariffs they had to provide in order to claim market share.

Finally, the net profit of these companies is compressed due to existing competition, which results in a relatively small margin for new investments and innovations in favor of the ultimate consumer. More specifically, the company that will want to stand out by implementing any innovation needed, has to invest the required funds. The dynamics of the emerging market, which gives competitors rapid reflexes, has a result that these competitors adopt the innovation or modify it partially, but without having invested the corresponding or equal amounts of their own funds. The margins between the companies are so small that with this view, the first company is discouraged to proceed with innovative moves in order to differentiate and grow, since it is predicted that its investment will not be able to bear the desired fruits.



## 5.4 The evolution of liberalization and market shares

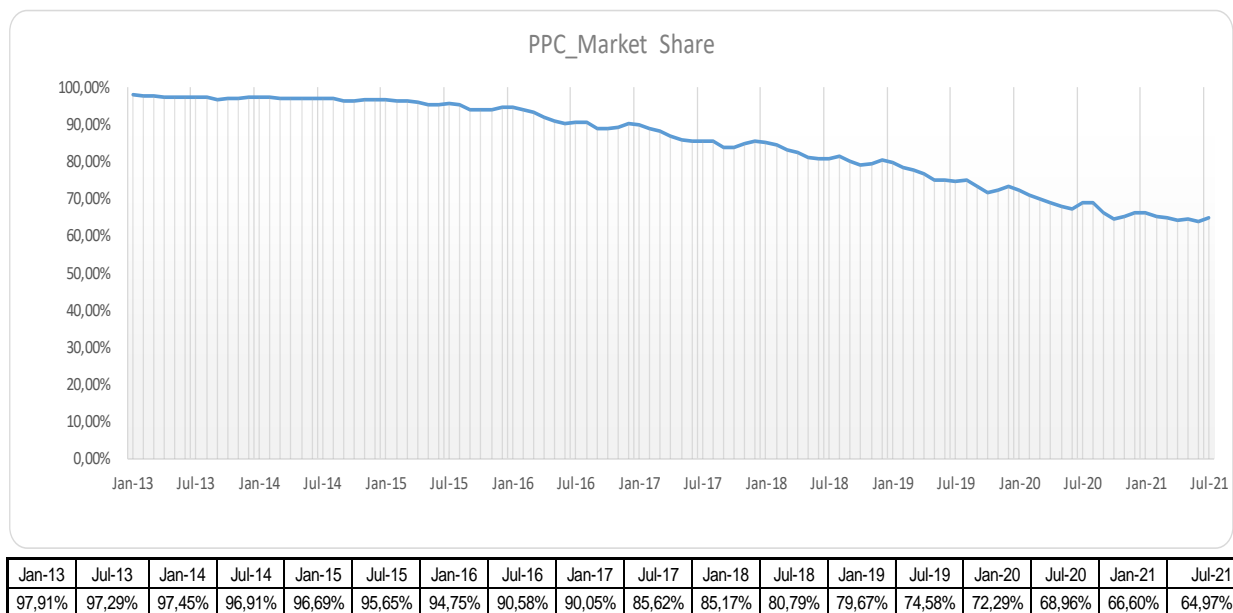
The first steps were taken by private investors in the production sector, when in 2004 HERON I started operating (Heron, 2021), while at the end of 2005 the first unit of ELPEDISON ENERGY SA starts in Thessaloniki and in 2006 participates in the System Marginal Price\* together with the PPC units (Elpedison, 2011). Then, in 2007 the units of "Aluminum of Greece" (Mytilineos Group) start (MYTILINEOS SA, 2021) and until 2010 new production factories operate, reducing the share of PPC in the production sector.

In terms of ultimate consumer pricing, individuals find no room against PPC, which is still shaping prices, but the entry of new companies, the maturation of competition and interconnection with neighboring countries later helped to claim a clientele. During the liberalization, it is a fact that Greece could not keep up with most of the other European countries. The fully vertical and experienced PPC in combination with the fact of its dominant position resulted, despite the intense investment interest, in the creation of obstacles and the delay in claiming market shares in provision. The creation of independent regulators, the clear distinction between competitive and non-competitive activities and the imposition of equal access and treatment to all participants did not exist from the beginning of the liberalization and the Greek market had not only to follow the European Union, but also deal internally with distortions and self-regulation.

*\*According to the Daily Energy Planning (DEP) process, all participating producers offer their production until the demand of the next day is covered by the cheapest offers. The result of this auction determines the System Marginal Price, which is the price that is requested by the unit that participated last into the system, before the demand is fully covered to be covered. At the System Marginal Price, all the producers finally sell their production of electricity and respectively it is the price that all production is paid by all suppliers. Imports and renewables are an exception because their available power is injected into the system with priority due to the guaranteed price regime.*

The NOME auctions, which forced PPC to give part of its lignite production at very low prices, caused damage to the company. As we can see in Figure 1, during the auctions PPC showed a decrease in market share, which continued after the end of the auctions since the increase it made beforehand in all its tariff categories, gave additional motivation to the competition to claim an additional clientele (Λιάγγου, 2019). The changes and reorganizations in market shares and the restructuring of the market at a very fast pace are especially distinct the last three years, during the preparation and operation of the target model and the Energy Exchange Group.

Figure 1. PPC SA: The evolution of market share in consumer supply 2013-2021



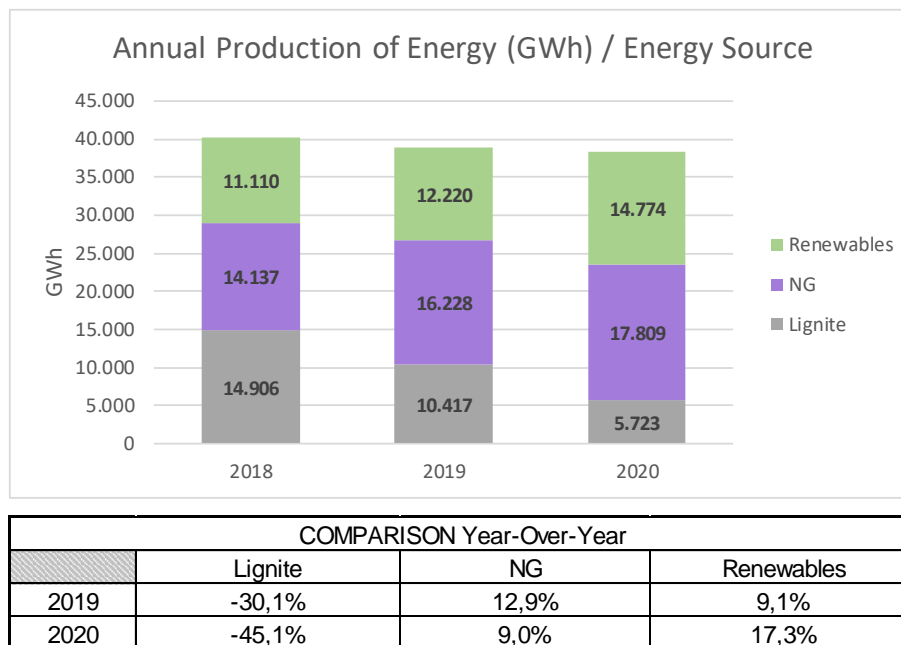
Source: (Independent Power Transmission Operator (IPTO), 2021)

Characteristic among the new market data is the great reduction of pollutant and costly lignite production. This means that in the part of production the share of PPC is declining, since until today it exclusively owned all the lignite production. In replacement of lignite, the adequacy of power in the country is estimated to be ensured by the growing RES units but also by the units of electricity production with gas, both of PPC and of independent producers.

At the same time, in 2019, five private companies announced their intention to proceed with the construction of new gas units, which according to the data of that time was enough for

the country (Capital, 2019). However, the biggest gainer of the market is Renewable Energy Sources, which are steadily increasing their share of the total electricity generation mix. According to IPTO monthly energy reports, taking into consideration that domestic demand has not changed substantially despite the pandemic, as shown in Figure 2, the strengthening of the share of RES and the profitability of gas units as an investment, confirms that the already domestic power generation system has begun the process of transition to complete detoxification from the polluting lignite (delignification) (Independent Power Transmission Operator (IPTO), 2021)

Figure 2: Fuel mixture of the domestic market 2018-2020.



Source: (Independent Power Transmission Operator (IPTO), 2021)

## 5.5 Significant changes of dynamics brought by the liberalization

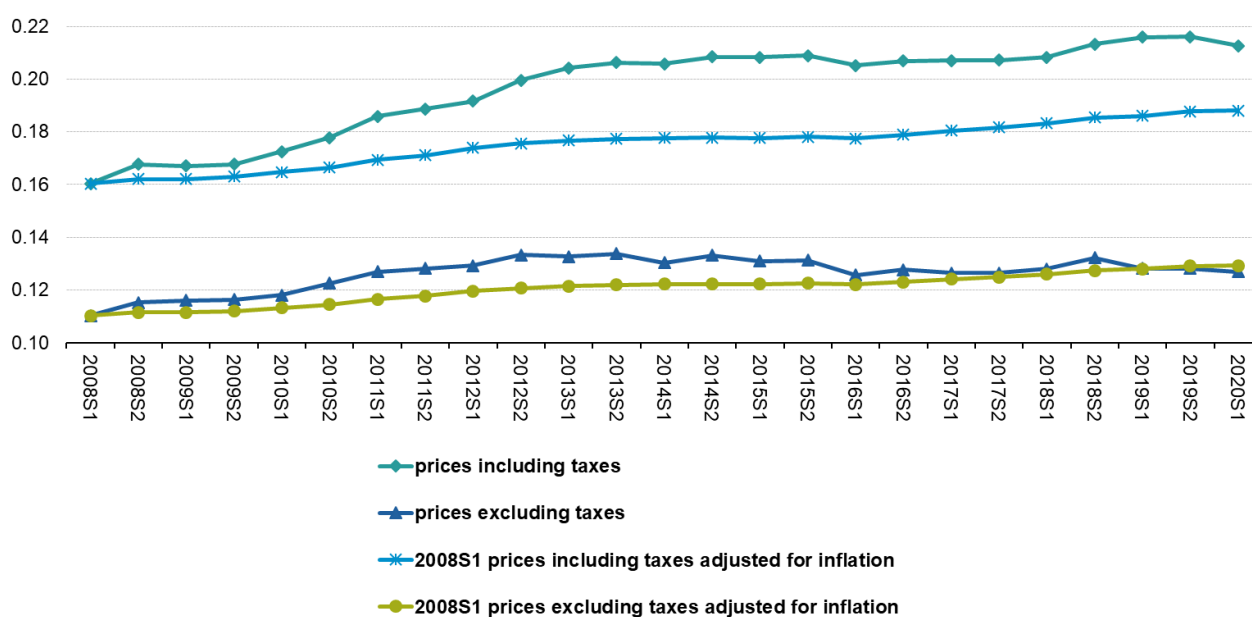
All the major changes that have been made in the energy sector are aimed at increasing competitiveness - by removing barriers to entry, reducing costs - by maximizing efficiency and environment protection - through alternative technologies, with these objectives at the same time interacting with each other. These are the goals that are repeated and emphasized in every new study, report and investment that studies market progress.

### 5.5.1 Electricity prices for household and industrial customers

Despite the importance given to these goals, checking in particular the price trends during the liberalization, we note that the figures do not reflect the cost reduction to which liberalization aimed.

In household meters, as shown in Figures 3 to 6, from 2008 until the first half of 2020, electricity prices are constantly increasing, whilst specifically in Greece, the cost in the first half of 2020 compared to the first half of 2019 shows increment, in contrast to the European average which shows a decrease over the same period.

Figure 3: Development of electricity prices for household consumers, EU-27, 2008-2020 (EUR per kWh).



Source: (eurostat, 2021)<sup>1</sup>

Despite the difficulty of accurately comparing electricity and gas prices with those of other countries, there are clear indications of higher energy costs also for the Greek industry than in other EU countries, mainly in electricity (Bank of Greece, 2018). The most important reasons for this increment that need to be addressed are the following (Bank of Greece, 2020) :

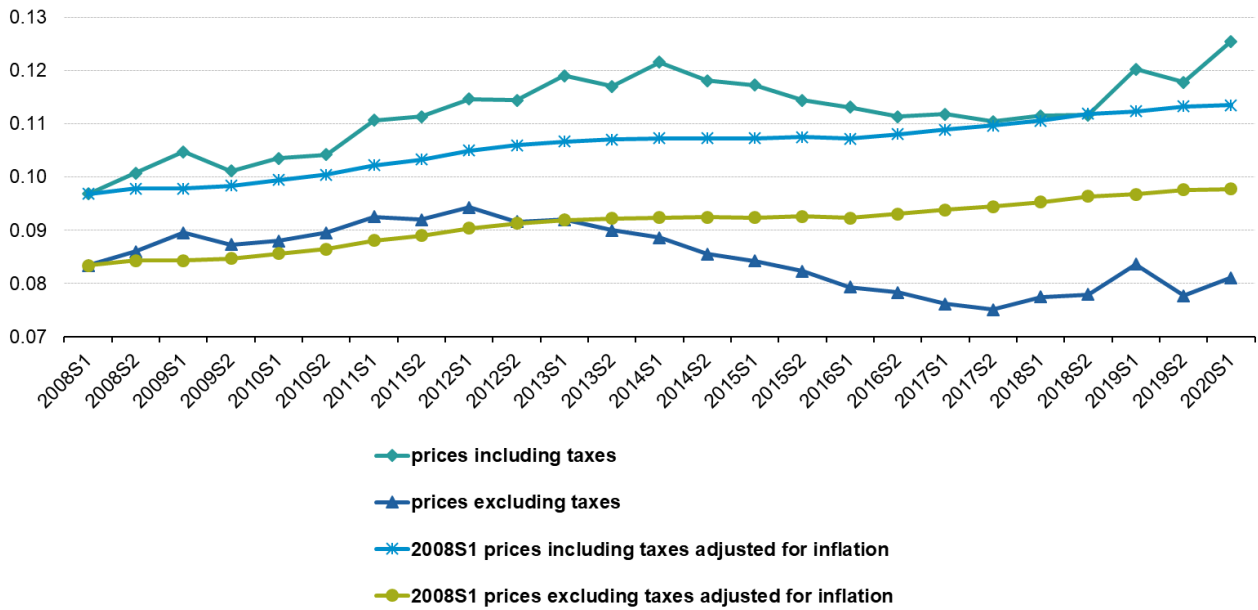
- Incomplete market liberalization: delay in transition to a competitive electricity market, such as the implementation of the EU target launched on November 1st, 2020 and the interconnection with neighboring countries for market coupling (eg Italy, Bulgaria).
- Long delays in the operation of the Greek Energy Exchange Group, which started operating in March 2020.
- Inability to sign bilateral energy contracts without the participation of the Daily Energy Planning (DEP)
- Many and high additional charges and taxes that increase the competitive price of energy
- Lack of measures that are compatible with the EU regulatory framework to support the Greek industry in the field of energy and environmental issues.

Figure 4: Change in electricity prices for household consumers compared with previous year, same semester, first half 2020



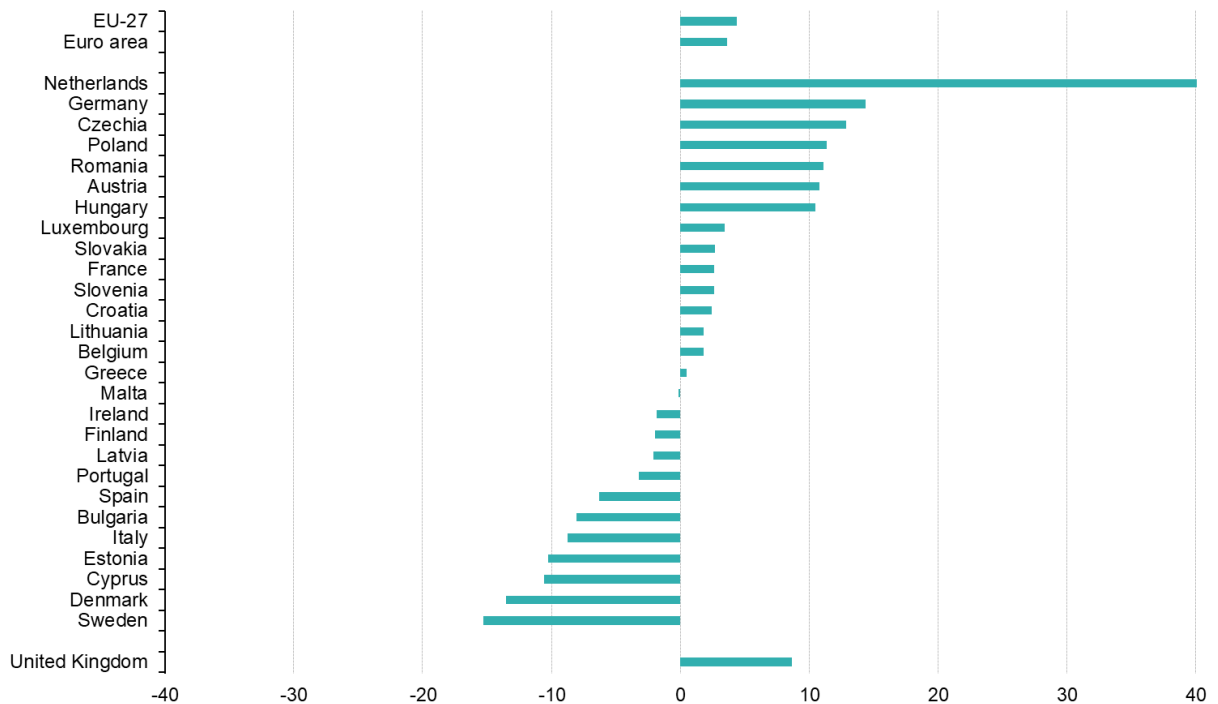
Source: (eurostat, 2021)<sup>2</sup>

Figure 5 : Development of electricity prices for non-household consumers, EU-27, 2008-2020 (EUR per kWh)



(eurostat, 2021)<sup>3</sup>

Figure 6: Change in electricity prices for non-household consumers compared with previous year, same semester, first half 2020.

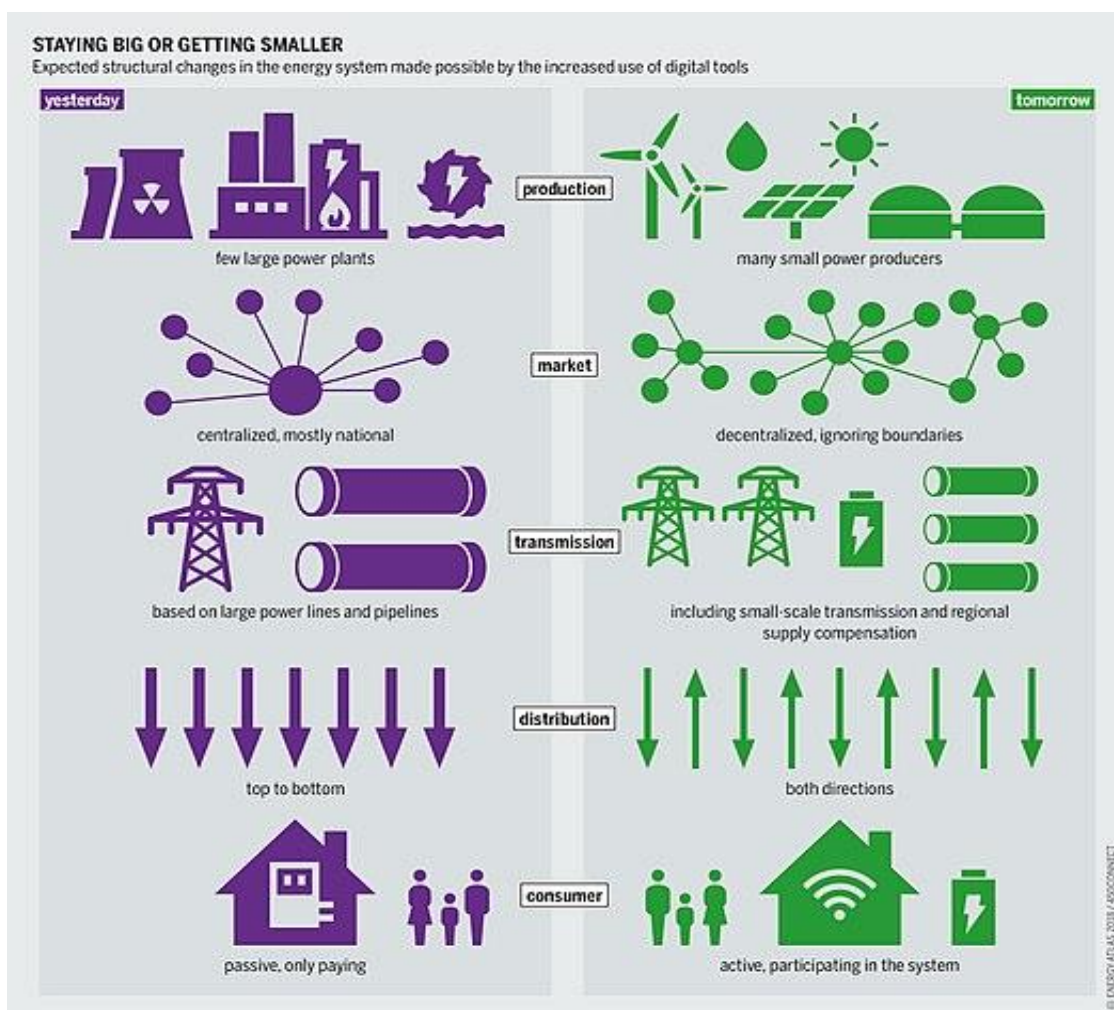


Source: (eurostat, 2021)<sup>4</sup>

## 5.5.2 Smart Grids

The current electrical grid, which is characterized as conventional, starts from central power stations, is connected to medium voltage substations through high voltage transmission systems and ends through low voltage infrastructure to the ultimate consumers. The distribution and transmission of electricity is done mainly in a monopolistic way by public bodies, which control the operation of the network. The flow of electricity is one-direction, covering long distances with losses along the way. Its production is polluting due to the burning of fossil fuels and CO<sub>2</sub> emissions and its transportation requires costly network maintenance, which is of low reliability, with constant voltage fluctuations and sold power problems.

Figure 7 : Characteristics of a traditional system (left) versus the smart grid (right).



Source: (Wikipedia, 2021)

A smart grid is an electrical grid that uses advanced, mainly digital, technology to transfer and monitor electricity from all sources in order to meet the changing needs of users. In Figure 7 we can see all the features that differentiate a smart grid from a conventional one. Smart grids coordinate the needs and capabilities of producers, network operators, consumers, and other market entities, so that all parts of the system operate optimally, minimizing costs and environmental impact, and maximizing adaptability, stability and reliability.

The evolution of smart grids requires technological development that will work together in real time. Such technologies are the following:

- ✓ Scattered production / distributed production for energy autonomy of areas or even buildings. Scattered production is defined as small-scale energy generation either through a small -local- power generation plant or through RES, which is produced at a short distance from the point of demand. Scattered production can be adjusted to consumer needs, or through incentives, consumer demand can be adjusted to RES production. The great advantages of dispersed production are the flexibility of production in changing market conditions, the reduced cost of networks construction and the reduction of energy losses, either due to distance or due to insufficient storage (Τσαούσογλου, 2015)
- ✓ Smart meters / sensors for transmission of electricity measurements and energy management in real-time. With the help of telemetry, the energy profile of each consumer, depending on the hours of day up to seasonal consumption, can be formed. Then, this data can be used by providers to create dynamic tariffs for each consumer, up to the best planning of daily generation and demand. As a result, there may also be better planning for electricity derivatives trading, such as contracts for future energy supply.
- ✓ Energy storage systems, such efficient so as to offer stability in the network in case of voltage fluctuations of any fault.
- ✓ High level systems of data collection and analysis. Due to the increased complexity of the network but also due to the need for monitoring many millions of meters in real time, the architecture and good operation of the network are considered prerequisites.
- ✓ Internet data security to protect the privacy and personal data of the ultimate consumer. The protection of such technologies against unauthorized access and malicious use of the information they contain, is necessary.



Pillars for the successful implementation of all the above technologies are mainly the independent Distribution Network operators and secondly the Transmission Network operators. However, this project, except for the multidimensional advantages that it will bring to the managers themselves - elimination of losses, cost reduction, reliability, etc., will also immediately provide incredible opportunities in the production and supply of energy, since there will be the space and the knowledge for the design of many more products, perfectly in line with the real needs of consumers. The flexibility of these products will contribute even more pressure to competition increment.

### 5.5.3 Energy Democracy

The importance of electricity market liberalization is remarkably reflected in putting the ultimate consumer at the center of developments. The strengthening of the role of the consumer is progressing rapidly through very important changes in the legislation, enabling him to invest in electricity, to adjust his energy profile, to reduce his energy costs and to cooperate with the state or with other ultimate consumers in achieving maximum efficiency and benefit.

The energy sector in which consumers can most easily infiltrate is Renewable Energy Sources, which are growing rapidly in number with the help of micro-investors. A typical example is the installation of photovoltaic panels in residential or commercial spaces (roof, terrace, etc.) which are accompanied by contracts for the absorption of their production by the Network for up to 25 years, returning to their owners the corresponding remuneration. Followingly, there is a list of some of the consumer incentive policies for the reception and development of RES.

### 5.5.4 Energy Communities

One step towards the "opening" of the electricity market to all, whether they invest or not, is the Energy Communities (L. 4513/2018). The definition refers to cooperatives between either natural or legal persons, or local authorities that utilize RES systems in order to enhance energy self-sufficiency and security, reduce energy costs, fight energy poverty,

improve energy efficiency, e-mobility, storage, self-consumption, selling, energy services etc., either locally or regionally.

Net Metering: It concerns all RES technologies. The energy produced, for example by photovoltaics, is offset by the energy consumed, with the maximum benefit being attributed to the hours of synchronization (generation and consumption occur simultaneously). The facility is very close to consumption.

Virtual Net Metering: It works in the same way but here the installation is far from consumption (the relevant Ministerial Decision to be issued)

Energy sharing: A RES unit (eg a PV park) is installed in the area of a Community and the energy produced by this unit is distributed and offsets the consumption of the members of the Community (the relevant Ministerial Decision to be issued).

#### 5.5.5 E-Mobility

The path to the consolidation of e-mobility reminds to a point this of the liberalization of the electricity market. More specifically, the first slow steps of the emerging technology, evolved, at an exponential rate, in a new market, over time. Its territory is prepared to host new investments, studies, jobs, products and services. The beginning of e-mobility in Greece took place 30 years ago, in 1991, when both the European Association for Electromobility and the International Automobile Federation started a branch of their activity in our country. Currently, for the spread of e-mobility, a large number of events and activities with electric cars have played a decisive role over time, as well as the incitement of the state to this change through occasional additions and amendments to the legislative framework, grants and incentives to those interested.

Nowadays, that the knowledge about electric vehicles is much greater in the general public and the options are more for the prospective users, the interest not only for the vehicles but also for new investments in them, such as photovoltaic installations of which part of the production goes into charging a vehicle or fleet of commercial vehicles, installations with chargers for such vehicles, and services or power packages used for charging, is obvious. Energy suppliers, private entrepreneurs but also just owners of electric vehicles turn their interest to opportunities for activation, investment and electromobility solutions.

A study conducted in March 2021 showed that:

- Electrical vehicles consume much less raw materials (metals) than vehicles that use fossil fuels
- Less raw materials will be needed for batteries over time
- By 2035 more than a fifth of lithium and nickel, and 65% of the cobalt needed to make a new battery could come from recycling. Europe will have to import less raw materials. (Transport & Environment, 2021)

### 5.5.6 Market Coupling

Before the presentation of Market Coupling, in order to understand its importance, it is necessary to clarify that for cross-border energy trade, the interested buyer should first claim part of the capacity of the cables that will be used, in the corresponding price, and then buy the amount of energy that will be transferred. Market Coupling allows for so-called silent auctions, in which market participants do not buy individual cross-border capacity, but simply bid for electricity on the Energy Exchange Group. The countries' stock exchanges then take into account the available capacity in conjunction with the price calculation process, in order to minimize price differences between markets.

Market Coupling optimizes cross-border energy exchanges between coupled countries. Thanks to the synchronized calculation of prices and energy flows, the available cross-border exchange of quantities is used more efficiently, while at the same time the price difference between two or more markets is reduced. This project is vital to achieving the EU's overall goal of a harmonized European electricity market (EnEx Group, 2021).

The Market Coupling consists of 2 markets with different characteristics, similar of the Greek market that were analyzed in a previous chapter:

- i. Single Day-Ahead Coupling – SDAC detects the ability of cross-border grid capacity in the most efficient way, connecting wholesale electricity markets from different regions, always through a common algorithm. A Single Day-Ahead Market is expected to increase the efficiency of total transactions by promoting competition across Europe
- ii. Single Intraday Coupling – SIDC where buyers and sellers of power (market participants) are able to work together across Europe to exchange electricity on the same

day when energy is required, up to one hour before consumption. This ability gives market participants the flexibility to deal immediately with unpredictable changes in consumption and downtime. At the same time, the need for reserves and overpricing is reduced, while time is given for the recovery of the operation of the domestic system and consequently energy security is ensured.

#### 5.5.7 Price Coupling of Regions – PCR

Price Coupling of Regions (PCR) is a creation of the European Energy Exchange Groups to develop a single solution for price linkage used for electricity prices calculation across Europe, taking into account the capacities of the networks involved and the flows on a daily basis (EnEx Group, 2021).

The launch of this innovation took place in June 2009, when the participants - Austria, Belgium, the Czech Republic, Croatia, Denmark, Estonia, Finland, France, Germany, Hungary, Italy, Ireland, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden and the United Kingdom - signed the PCR Cooperation Agreement and the PCR Co-Ownership Agreement in 2012, but as a project it is open to other European stock exchanges wishing to participate (OPCOM, 2021).

PCR is based on 3 basic principles:

- I. The common algorithm (EUPHEMIA) among the participating Stock Exchanges - for the calculation of flows and prices with transparency
- II. Reliable and powerful operation and
- III. Right to energy transactions outside of a coupling project

#### 5.5.8 De-lignification / Decarbonization

The term de-lignification refers to the cessation of the use of lignite as a raw material for energy production. The reduction in the use of this material has been gradually decreasing in recent years for specific reasons. The main ones are that although it is considered a cheap source of energy in terms of raw material costs, the final report shows that the costs skyrocket due to extremely low efficiency, continuous maintenance of older factories, and

the cost of gaseous pollutants (CO<sub>2</sub> emissions) like formed by the EU and which burdens the unit manager, PPC. The above reasons make the final cost of lignite production and the corresponding factories unprofitable. The continuous support and increase of RES, the competition between the other producers and the possibility of imports, leaves little room for the lignite today, mainly due to the large load fluctuations during the day, which need lignite as a safety force (base load).

In September 2019, from the podium of the UN Summit on Climate Change, the Greek Prime Minister announced the closure of all lignite units by 2028. The beginning of this transformation, which concerns all Member States, is the decision of the European Parliament of March 2019 to achieve zero CO<sub>2</sub> emissions and zero fossil fuel use by 2050 with a view to a climate-neutral Union. Due to this goal, gas as a raw material will be abolished with the aim of decarbonization, by 2050, after de-lignification, as a less polluting and more flexible fuel. In place of the fuels that will recede in the face of green energy, the ever-increasing RES are taken into account, as well as the development of hydrogen power plants, renewable and flexible raw material which will cover the risk of fluctuations as a supply of power, when RES do not produce enough.

De-lignification in Greece is an ambitious project which will attract the attention of the public in the near future and will bring great changes in the lives of entire regions of our country, which support the income of their families in the operation of lignite units. The inhabitants of the lignite areas are either directly or indirectly connected with the lignite factories, working for the most part either in the units, or in the mines, or in positions that depend on the operation of the units, such as transport trucks, maintenance parts etc. In other words, the occupations of these inhabitants are identical to those of industrial areas in Europe and elsewhere. The termination of an employment sector that affects a large part of entire regional communities - mainly Florina, Kozani and Arcadia - is expected to bring great disruption to the lives of the inhabitants of these areas and any consequence a vertical focused increase in unemployment can bring.

This predictable problem that cannot be avoided, because the period of time until 2028 is very short, however it can be addressed or mitigated. The Just Transition Development Plan is the strategic and multidimensional plan that focuses on lignite areas in order to achieve the revival of the local economy and the creation or even the insurance of new jobs around five main pillars: i) Green energy, ii) "Smart" agriculture, iii) Sustainable tourism, iv) Industry

and finally v) Digital economy and education. At the same time, based on our country's decarbonization plan, among the other member states, the European Union recently approved the additional inclusion of non-interconnected islands in the Just Transition Development Plan, aiming to phase out diesel and fuel oil production power plants and their replacement with interconnection projects with the Greek mainland and the RES.

## 5.6 Conclusions

The entry of new companies into the energy market depends on what the entry conditions are, on the difficulties that are expected to arise and on whether they are manageable. As in any country, so in Greece, the liberalization encountered difficulties and delays. The advantages of abolishing the monopoly are the reduction of costs to the ultimate consumer, the increment of the quality of the provided services and the new investments. Disadvantages of this free market are the existence of opportunistic risk, the exploitation of an existing dominant position and the loss of equal treatment between the competitors. At the same time, a condition for the smooth operation of the market is the number of participants, so that there are no collaborations to the detriment of others and the consistent supervision of regulatory and independent authorities. The decrease in PPC's share appears essentially from 2014 but the main loss of market share occurs with the NOME auctions and the continuous changes of tariffs. In addition to rearranging the clientele among the production and supply companies, the liberalization of the market brings our country closer to innovations, products and services that would be delayed or would not be provided in a monopoly environment. Such innovations are emission-reduction technologies, smart grids, and the coupling of markets between states. At the same time, the development of RES, helped to reduce energy prices, to develop electromobility and decarbonization projects.

## 6. Conclusions and Suggestions

The electricity market today is dynamic and multidimensional. It is continuously being shaped by the slightest change of dynamics between, not only its participants, but also between every - European - country. The liberalization of this market, as done in similar cases, faces distortions but also self-regulates. Due to the many dimensions, it presents and the many applications it affects, it requires its continuous monitoring by the interested parties who participate and wish to stay in it. The environment is highly competitive and changing, while the requirements in many areas do not need much specialization.

In our country, the changes seemed much bigger compared to other countries because they mainly started and evolved much later. The Greek legal framework was based on and largely followed the European one until the desired harmonization of the former with the latter. The implementation of the European Union Directives had a greater impact on Greece due to the fact that they demanded more radical changes than in other countries, which already had an existing and well-functioning competitive environment. Greece has responded well to this pace of change, despite the consequences and difficulties posed by the implementation of a multi-level new regulatory framework. Cooperation between the Member States in a single European energy market, with a view to the Union 's energy self - sufficiency and the supervised freedom of movement within it, is a significant step forward, compared to where it was a few years ago.

The domestic energy market, in all its sectors, is called upon to meet current and future challenges related to its liberalization but also to its integration with the European energy market. The successful implementation of the liberalization in the energy sector and its contribution to the development of the Greek economy in the coming years is determined by three key elements:

- The investments needed by the energy market, as is today, with the ultimate goal of achieving the National Energy and Climate Plan. The cost / benefit assessment of each investment changes over time, according to the policy measures implemented and the needs that are being reshaped in the market, therefore it is necessary to pay attention to the incentives given to the interested investors and create a suitable place for these investments. Such investments may find place in new technologies such as the upgrading of existing production units to reduce emissions, new advanced production units for

delignification and decarbonization, telemetry and energy saving systems, and upgrade networks.

- The continuous improvement of competition and the smoothing of large fluctuations in the energy market. Improving competition results in reducing energy costs for all participants by broadening consumer choices, promoting quality services and new services, and prices that reflect costs from production to energy supply. Eliminating fluctuating market conditions supports the development of new investments and helps consolidate consumer confidence
- Exploitation and utilization of the natural resources and the geographical position of the country that can lead to the development of the national economy and upgrade of the geopolitical importance of the country as a member state of the European Union

The above are elements that need continuous planning, cooperation and compliance of the participants, proper supervision and finding resources.

Given the European Union's progress towards a less polluting, more efficient and liberalized energy market, from production to consumption, here are some indicative priorities and actions that our country needs in order to play an active role in this energy community while providing the best possible conditions for its citizens.

- State capital budget and its proper planning, with incentives for new investments in entrepreneurship in lignite areas, whose residents will face the loss of income and activity due to the transition from lignite plants to hydrogen and RES plants.
- Consolidation of a competitive electricity market with continuous supervision, along with the development of time-consuming processes and rapid reflexes of response of the authorities and intervention of the authorities and the Administrators
- Continuous development of transmission and distribution infrastructure in the electricity networks, domestic and cross-border, as required by the ever-increasing demand
- Development and implementation of energy storage projects to a satisfactory degree to increase energy security and normalize the country's energy self-sufficiency
- Development of network interconnections with neighboring countries and refinement of the energy trading platform in order our country plays an active role in the wider European energy community - Hellenic Energy Exchange Group
- Introduction of regulatory mechanisms and financial incentives in the charges of the networks, in order to reduce on the one hand the costs for the electricity providers and on the other hand to motivate the consumers for better energy management



- Technological upgrade and digitization of energy networks, which is the basis for maximizing not only the operation but also the flexibility of the energy system.
- Providing incentives for the development of RES power plants, as well as normalization of liquidity and provision of compensation for their production
- Addressing energy poverty and protecting consumers from it, by expanding and proper maintenance of networks by the Administrator but also ensuring the provision of social residential tariffs through continuous control to all consumers
- Reconstruction or energy upgrade of the country's facilities and buildings, which are said to be energy-consuming compared to their operation. In this action, the state itself can be an example, by upgrading public buildings energetically and showing the way to the citizens who are less familiar with the advantages of such a change.
- Incentives for the use of RES systems in partial or complete coverage of thermal / refrigeration needs
- Development and funding of research to support innovative energy saving technologies and smart grid systems.

## References

- Bank of Greece. 2018. ECONOMIC BULLETIN No 48. [Press release]. [Accessed 15 October 2021]. Available from: <https://www.bankofgreece.gr/Publications/econbull201812.pdf>
- Bank of Greece. 2020. ECONOMIC BULLETIN No 52. [Press release]. [Accessed 15 October 2021]. Available from: <https://www.bankofgreece.gr/Publications/econbull202012.pdf>
- Ciucci, M. 2021. Energy policy: general principles. [Online]. [Accessed 10 2021]. Available from: <https://www.europarl.europa.eu/factsheets/en/sheet/68/energy-policy-general-principles>
- DAPEEP. 2021. [Online]. [Accessed 3 2021]. Available from: <https://www.dapeep.gr/>
- Elpedison. 2011. Timeline. [Online]. [Accessed 10 2021]. Available from: <https://www.elpedison.gr/en/the-group/timeline/>
- European Commission. 2019. Clean energy for all Europeans. [Press release]. [Accessed October 2021]. Available from: <https://op.europa.eu/en/publication-detail/-/publication/b4e46873-7528-11e9-9f05-01aa75ed71a1/language-en>
- Eurostat. 2021<sup>1</sup>. Statistics Explained. [Online]. [Accessed 10 2021]. Available from: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Development\\_of\\_electricity\\_prices\\_for\\_household\\_consumers,\\_EU-27,\\_2008-2020\\_\(EUR\\_per\\_kWh\)\\_v01.png&oldid=523951](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Development_of_electricity_prices_for_household_consumers,_EU-27,_2008-2020_(EUR_per_kWh)_v01.png&oldid=523951)
- Eurostat. 2021<sup>2</sup>. Statistics Explained. [Online]. [Accessed 10 2021]. Available from: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Change\\_in\\_electricity\\_prices\\_for\\_household\\_consumers\\_compared\\_with\\_previous\\_year,\\_same\\_semester,\\_first\\_half\\_2020\\_v1.png&oldid=523965](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Change_in_electricity_prices_for_household_consumers_compared_with_previous_year,_same_semester,_first_half_2020_v1.png&oldid=523965)
- Eurostat. 2021<sup>3</sup>. Statistics Explained. [Online]. [Accessed 10 2021]. Available from: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Development\\_of\\_electricity\\_prices\\_for\\_non-household\\_consumers,\\_EU-27,\\_2008-2020\\_\(EUR\\_per\\_kWh\)\\_v11.png](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Development_of_electricity_prices_for_non-household_consumers,_EU-27,_2008-2020_(EUR_per_kWh)_v11.png)
- Eurostat. 2021<sup>4</sup>. Statistics Explained. [Online]. [Accessed 10 2021]. Available from: [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Change\\_in\\_electricity\\_prices\\_for\\_non-household\\_consumers\\_compared\\_with\\_previous\\_year,\\_same\\_semester,\\_first\\_half\\_2020.png&oldid=505001](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Change_in_electricity_prices_for_non-household_consumers_compared_with_previous_year,_same_semester,_first_half_2020.png&oldid=505001)
- Georgopoulos, A. 2015. Απελευθέρωση των αγορών, ιδιωτικοποίηση επιχειρήσεων και αναδιοργάνωση. Business Administration, University of Patras
- Greek Government Law 1468/1950 - Government Gazette 169/7-8-1950 on the establishment of Public Power Company [Online]. [Accessed March 2021]. Available from: <https://www.e-nomothesia.gr/energeia/n-1468-1950.html>

Greek Government Law 2773/1999 - Government Gazette 286/A/22-12-1999 on Απελευθέρωση της αγοράς ηλεκτρικής ενέργειας Ρύθμιση θεμάτων ενεργειακής πολιτικής και λοιπές διατάξεις. [Online]. [Accessed March 2021]. Available from: <https://www.e-nomothesia.gr/energeia/n-2773-1999.html>

Greek Government Law 3426/2005 - Government Gazette 309/A/22-12-2005 on Επιτάχυνση της διαδικασίας για την απελευθέρωση της αγοράς ηλεκτρικής ενέργειας. [Online]. [Accessed March 2021]. Available from: <https://www.e-nomothesia.gr/energeia/n-3426-2005.html>

Greek Government Law 4001/2011 - Government Gazette 179/A/22-8-2011 on Λειτουργία Ενεργειακών Αγορών Ηλεκτρισμού και Φυσικού Αερίου. [Online]. [Accessed April 2021]. Available from: <https://www.e-nomothesia.gr/energeia/n-4001-2011.html>

Greek Government Law 4389/2016 - Government Gazette Α' 94/27.5.2016 on Επείγουσες διατάξεις για την εφαρμογή της συμφωνίας δημοσιονομικών στόχων και διαρθρωτικών μεταρρυθμίσεων και άλλες διατάξεις. [Online]. [Accessed April 2021]. Available from: <https://www.e-nomothesia.gr/kat-oikonomia/nomos-4389-2016-phek-94a-27-5-2016.html>

Greek Government Law 4425/2016 - Government Gazette 185/30.09.2016 on Επείγουσες ρυθμίσεις των Υπουργείων Οικονομικών, Περιβάλλοντος και Ενέργειας, Υποδομών, Μεταφορών και Δικτύων και Εργασίας, Κοινωνικής Ασφάλισης και Κοινωνικής Αλληλεγγύης για την εφαρμογή της συμφωνίας δημοσιονομικών στόχων και διαρθρωτικών μεταρρυθμίσεων και άλλες διατάξεις. [Online]. [Accessed April 2021]. Available from: <https://www.e-nomothesia.gr/energeia/nomos-4425-2016.html>

DEDNO. 2021. Company Profile. [Online]. [Accessed 3 2021]. Available from: <https://www.enexgroup.gr/web/guest/enexgroup>

HEEnEx Group. 2021. [Online]. [Accessed 3 2021]. Available from: <https://www.enexgroup.gr/web/guest/enexgroup>

Heron. 2021. Our History. [Online]. [Accessed 10 2021]. Available from: <https://www.heron.gr/en/omilos/history/>

Independent Power Transmission Operator (IPTO). 2021. Monthly Energy Reports. [Online]. [Accessed 10 2021]. Available from: <https://www.admie.gr/agora/enimerotika-deltia/miniaia-deltia-energeias>

Independent Power Transmission Operator (IPTO). 2021. About Us. [Online]. [Accessed 3 2021]. Available from: <https://www.admie.gr/en/company/about-us>

Kneebone, J. 2021. Fit for 55: EU rolls out largest ever legislative package in pursuit of climate goals. [Online]. [Accessed October 2021]. Available from: <https://fsr.eui.eu/fit-for-55-eu-rolls-out-largest-ever-legislative-package-in-pursuit-of-climate-goals/>

Mytilineos SA. 2021. History Timeline. [Online]. [Accessed 10 2021]. Available from: <https://www.alhellas.com/en-us/history/history-timeline>

OPCOM. 2021. PCR - Price Coupling of Regions. [Online]. [Accessed 11 2021]. Available from: [https://www.opcom.ro/tranzactii\\_produce/tranzactii\\_produce.php?id=250&lang=en](https://www.opcom.ro/tranzactii_produce/tranzactii_produce.php?id=250&lang=en)

RAE. 2021. About RAE. [Online]. [Accessed 3 2021]. Available from: <https://www.rae.gr/σχετικά-με-τη-ραε/?lang=en>

The European Parliament and the Council of the European Union Directive 96/92/EC of 19 December 1996 on common rules for the internal market in electricity. [Online]. [Accessed March 2021]. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:31996L0092&from=EN>

The European Parliament and the Council of the European Union Directive 2003/54/EC of 26 June 2003 concerning common rules for the internal market in electricity and repealing Directive 96/92/EC. [Online]. [Accessed March 2021]. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32003L0054>

The European Parliament and the Council of the European Union Directive 2009/72/EC of 13 July 2009 concerning common rules for the internal market in electricity. [Online]. [Accessed March 2021]. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32009L0072&from=EN>

The European Parliament and the Council of the European Union Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure. [Online]. [Accessed April 2021]. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32013R0347&from=en>

The European Parliament and the Council of the European Union Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action. [Online]. [Accessed April 2021]. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32018R1999&from=EN>

The European Parliament and the Council of the European Union Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity. [Online]. [Accessed April 2021]. Available from: <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019R0943&from=en>

Transport & Environment. 2021. From dirty oil to clean batteries. [Online]. Brussels: European Federation for Transport and Environment AISBL [Accessed 12 2021]. Available from: [https://www.transportenvironment.org/wp-content/uploads/2021/07/2021\\_02\\_Battery\\_raw\\_materials\\_report\\_final.pdf](https://www.transportenvironment.org/wp-content/uploads/2021/07/2021_02_Battery_raw_materials_report_final.pdf)

Wikipedia. 2021. Smart grid. [Online]. [Accessed 3 2021]. Available from: [https://en.wikipedia.org/wiki/Smart\\_grid](https://en.wikipedia.org/wiki/Smart_grid)

Λιάγγου, Χ. 2019. Προς αναστολή των δημοπρασιών ΝΟΜΕ η ΔΕΗ. [Online]. [Accessed 11 2021]. Available from: <https://www.kathimerini.gr/economy/local/1040533/pros-anastoli-ton-dimoprasion-nome-i-dei/>

Τσαούσογλου, Γ. 2015. Διεσπαρμένη Παραγωγή στα Έξυπνα Δίκτυα Διανομής Ενέργειας. Patras: University of Patras.

Φλουδόπουλος, Χ. 2019. Κούρσα για 5 νέες επενδύσεις στις μονάδες φυσικού αερίου. [Online]. [Accessed 12 2021]. Available from:

<https://www.capital.gr/epixeiriseis/3366363/koursa-gia-5-nees-ependuseis-stis-monades-fusikou-aeriu>