JUST TRANSITION DEVELOPMENT PLAN

CURRENT SITUATION AND PROSPECTS FOR AREAS IN ENERGY TRANSITION IN GREECE

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Preface

At the beginning of this project last March, one of my first concerns as Chairman of the Steering Committee of the Just Transition Plan was to ensure a complete, objective and reliable documentation of the current state, with the most up-to-date data, as needed in every project of high demands.

Taking into account the Proposal for a Regulation of the European Parliament and of the Council establishing the Just Transition Fund - and in particular Article 7 on Territorial Just Transition Plans - the need to establish a basis with a scholar-quality study of the current state of energy transition regions, as well as their development prospects became more evident.

This study was commissioned to the South East European Energy Institute (IENE), which has the relevant credentials and human resources. The scientific team of the Institute documented the productive activity, the infrastructure and the energy potential that can be mobilised in the coming years, as well as the international experience and good practices in areas under energy transition. It therefore constitutes a useful basis for all of us who have the responsibility of preparing a Just Development Plan for these regions (Master Plan).

The findings of the study will contribute substantially to the completion of the Master Plan prepared this period and to the new Just Transition Operational Programme 2021-2027, the preparation of which was decided by the Government Committee and materialised with the submission to the European Commission services of the Partnership Agreement 2021-2027 (NSRF) by the Ministry of Development and Investments.

However, the scope of the project exceeds the authority of any Steering Committee, nor does it concern exclusively the energy transition areas. It is a matter of national importance for the country. Therefore, this plan is drafted together with all the stakeholders, notably the local communities, but also those who will choose to invest and live in these areas.

I hope that the findings of the present study will be useful to anyone who wishes to contribute to our common endeavor.

On this occasion, I would like to thank the Chairman and Executive Director of IENE Mr. Kostis Stampolis for the preparation of the study, as well as the Chairman and CEO of PPC Mr. George Stassis for the comprehensive support to the efforts of the Steering Committee.

Kostis Moussouroulis

Executive Summary

For the past seven decades, Greece has relied on lignite, which was the national fuel that contributed greatly to the development of the economy and the electrification of the country. Today, the country is moving towards replacement of lignite as the main fuel for power generation, in compliance with European energy and climate targets, but also for purely economic reasons.

Decarbonisation aims to reduce greenhouse gas emissions and increase the use of "clean" fuels, such as Renewable Energy Sources (RES), which are now finally becoming competitive with fossil fuels.

The challenge of rapid delignification arose from Greece's obligations to harmonize its national energy policy with EU climate policies and, more specifically, its emission reduction targets for 2020 and 2030, the high emission prices through the CO2 Emissions Trading Scheme, EU policies to protect public health and, in particular, the Industrial Emissions Directive, combined with the ongoing reduction in the cost of RES, as well as the cost of energy storage systems. The main consequence of the above is that the older and more polluting lignite plants must close down.

According to the updated National Energy and Climate Plan (NECP), of December 2019, all Public Power Corporation (PPC), lignite thermal power plants (TPP), of total installed capacity of about 4 GW_e, are expected to be withdrawn by the end of 2023 (except for the new Ptolemaida 5 plant, which is under construction and is estimated to be withdrawn in 2028), and all lignite mines to be closed in the areas of Western Macedonia and Megalopolis, Peloponnese.

In real terms, the delignification has already begun, as the electricity load for certain days in May and June 2020 was covered without the operation of any lignite units. In general, a new picture is now formed in the domestic power generation sector, where PPC uses few or no lignite units and these for purposes of district heating.

However, given the very short timeframe set by the Greek government for decarbonisation, the need of thorough studies and decisions on a successful delignification process is imperative, in order to mitigate the effects on the local economy and society.

Undoubtedly, the contribution to the local economy from the operation of the current PPC units, in the regions of Western Macedonia (Ptolemaida, Amyntaio, Florina) and the Peloponnese (Megalopolis) was particularly important and contributed greatly to the primary and secondary employment in TPPs and mines, but, also, offered local added value from the existence of secondary activities related to the operation of these units.

The present study aims in drawing a detailed survey of the current situation, in the areas involved in energy transition and the anticipated decoupling of electricity generation from fossil fuels, lignite and oil. This survey focuses on the existing energy potential and the corresponding infrastructure, the economy of the areas under consideration, the employment pattern and the existing business activities. Another aim of this survey is to be able to identify and explore the possibilities for job creation through the development of new business activities and investments.

However, apart from the goal of fully replenishing the employment and local wealth currently produced by the operation of PPC plants, it should be borne in mind that any investment costs will be much lower

than the potential costs, involved in case that delignification does not proceed. According to a series of analyses, if the current fleet of lignite thermal power plants remains the same, then, over the next 3-5 years the lignite industry will accumulate huge losses estimated at €1.3 billion. This cost is huge for PPC and the national economy, but, at the same time, it means a high burden on the environment and public health from the consumption of large amounts of valuable natural resources (e.g. water) and the emission of harmful pollutants into the atmosphere (sulphur dioxide, nitrogen oxides, micro-particles, heavy metals, large amounts of carbon dioxide, etc.).

The energy transition in the particular areas of Greece, which the present study focuses on, i.e. Western Macedonia, Megalopolis, the Aegean islands and Crete, based on a new economic and development model is a complex process that requires time, commitment of substantial financial resources and proper design. The energy transition will conserve huge amounts of water used in the lignite plants (soon to be withdrawn), which can be utilized in other productive sectors and also avoid harmful gases and particles that affect the health of the population and for tackling climate change, while also drastically reducing the use of oil in power generation with multiple benefits. Also, through the study, the particularity of the Greek electricity generation case and distribution with the interconnected mainland system and the non-interconnected autonomous island networks is addressed, where the electricity demand is covered by oil power generation units, using imported oil and, to a lesser extent, RES installations in a ratio of about 83% - 17%.

The interventions in the above areas include a series of actions and projects, such as installation of additional RES units (mainly photovoltaic, wind and partly biomass), electricity storage projects, restoration of areas where the mines and lignite units of PPC currently operate, provisions for the existing PPC employees, such as transfers to other sectors of the company, retraining, special retirement "packages" of voluntary redundancies, the development of new industrial activities, such as manufacturing of batteries and battery chargers, assembly of electrical vehicle parts and development of hydrogen units, inter alia.

Among others, the present study highlights the high solar and wind potential of Western Macedonia and Megalopolis. More specifically, the solar potential in the region of Western Macedonia ranges from 1,550 kWh / m^2 / year and up to about 1,700 kWh / m^2 / year in the lignite region of Megalopolis, in terms of horizontal incident solar radiation. Furthermore, the beam radiation on the horizontal plane is approximately 1,600 kWh/m^2/year in the region of Western Macedonia and approximately 1,800 kWh/m^2/year in the lignite region of Megalopolis, Peloponnese. Respectively, the wind potential in the region of Western Macedonia is high, with average annual wind speeds ranging from 8.00–9.50 m/s and power density estimated at 750–1,100 W/m^2. Also, the lignite area of Megalopolis presents a relatively high wind potential, with average annual wind speeds of 7.5–9.0 m/s and power density 500–950 W/m^2.

Furthermore, the need to maintain district heating in the aforementioned energy transition areas, through the use of biomass or natural gas, is expected to play a critical role. The new spatial planning is also crucial, taking into account the needs of delignification, which will clarify the permitted activities and land use.

The promotion of research and innovation is a vital and necessary condition for the development and operation of most of the aforementioned projects and actions. The development and support of

research and innovation is an independent post-lignite activity that should be promoted in the affected areas. The role of the University of Western Macedonia is considered particularly important, which with the appropriate support and encouragement and in the context of international collaborations, could develop relevant research activities for innovative products aimed at exports.

At the same time and in cooperation with the Regional Administrations, the necessary planning should be made in order to offer rapid training and by importing new knowledge and skills that the market will need. Among others, two particular areas are seen suitable for development of research activities: (a) Carbon Capture Utilization and Storage (CCUS) technologies and (b) Research on production techniques and processes from new electric uses of lignite, such as production of methanol, synthetic fuels, rare earths, carbon fibre, nanotubes, graphene, etc.

Institutional measures and financial support are required for the implementation of projects and actions. In particular, lignite areas will continue to receive greenhouse gas emission allowance auctions through the Green Fund, and the following three steps are planned: (a) declaration by the European Commission of lignite areas as special tax zones with specific tax incentives in the context of the Just Transition for Western Macedonia and Megalopolis, (b) existence of special tax incentives for heating e.g. in relation to the gas and emission tax and (c) the existence of special support schemes for those who lose their jobs and until they are employed again in other working areas.

In any case, the next steps must be carefully thought out, as the overall impact on the energy transition areas from the closure of lignite production plants and mines, without timely taking the necessary initiatives for the Just Transition of the local economy, can have negative impact, instead of being opportunities for new development. The aim is to create jobs in both emerging and traditional sectors of the economy, while preserving the environmental and ecological stability of these regions for the future generations.

The key conclusions (see Chapter 6) of this study include the proposals for the activities that can be developed in the above areas. In the context of developing an appropriate roadmap for energy transition areas, good practices are available that are expected to facilitate the whole undertaking. For example, the World Bank has a long-standing experience in the field of decarbonisation and delignification, as it has participated in similar adaptation efforts in Russia, Poland, Ukraine and Romania, and has profoundly studied adaptation processes in the US, China, the United Kingdom and the Netherlands.

1. Introduction - Raison d' Etre

The delignification of the Greek energy production mix is an urgent need, in the context of a comprehensive policy of Just Transition to a zero-carbon Economy, by the middle of this century.

The updated National Energy and Climate Plan (NECP), December 2019, which is a detailed roadmap for achieving specific energy and climate goals by 2030, presents priorities and policy measures in a wide range of development and economic activities for the benefit of Greek society and full delignification, which is expected to take place by 2028.

This goal is fully in line with the European Union's ambition to make Europe the first climate-neutral continent, by 2050. Of course, the effort to achieve this goal must be made with the parallel adoption of comprehensive programs to support the Greek lignite areas, for their transition to a post-lignite period, securing existing jobs and utilizing the high know-how of the human resources of these areas.

The reasons that make decarbonisation the most urgent need are both environmental, due to the phenomenon of Climate Change, and economic, due to the increasing trend of emission prices. The transition to the post-lignite era is possible and can be supported through the solid development of Renewable Energy Sources (RES) and the improvement of energy efficiency in buildings, transport and industry.

Also, the current crisis of the coronavirus pandemic is affecting the transition to clean energy. Global CO_2 emissions are expected to decline on an annual basis in 2020, but a move towards sustainable energy requires continued effort and commitment. According to the International Energy Agency (IEA)[1], governments are expected to play important role in shaping the recovery of the energy sector from the COVID-19 crisis, just as they have long been in the leading position, regarding the orientation of energy investments. In particular, designing financial incentive packages is an significant opportunity for governments to link economic recovery efforts to the transition to clean energy. In such an environment, a coordinated political effort will be needed to seize any opportunities and lead to a more modern, cleaner and more sustainable energy sector for all.

The aim of IENE is the elaboration of a comprehensive and detailed study that will describe the current situation in the lignite areas of Greece from economic, social and energy point of view, the new business opportunities that may emerge in the effort to decarbonisation, but also how the energy system in the lignite areas in the coming years will be transformed. The result of this study will be a more complete record of the current and future energy situation of these areas, which is expected to facilitate the competent decision-making centres to take appropriate actions and options.

1.1. Why Energy Transition is Promoted Today

Today, the European Union faces serious challenges, which are directly related to the ever-increasing energy demand, the significant fluctuations in the prices of energy products and the disorders in the security of energy supply. Of course, the environmental footprint from energy use in all areas of

[1] https://webstore.iea.org/global-energy-review-2020

economic activity remains high. In order for European citizens and businesses to have access to safe, affordable and environmentally friendly energy, the European Union has set three key objectives:

(a) Security of energy supply,

(b) Competitiveness and

(c) Sustainability in the energy strategy, designed and implemented in order to meet these challenges.

The European Union, recognizing the contribution of a global climate change agreement, has made a significant contribution to achieving this, during the World Climate Conference, in December 2015, in Paris (COP21). In particular, the governments of 195 countries agreed on the long-term goal of keeping global warming well below 2 °C relative to pre-industrial levels and seeking to limit the rise to 1.5 °C. Governments, also, agreed to strengthen the capacity of societies to cope with the effects of climate change and provide ongoing and enhanced international support for adaptation in developing countries.

The EU ratified the Paris Agreement on Climate Change, in October 2016, which entered into force in November 2016. Given that 2/3 of greenhouse gas emissions are due to energy production and use, it is clear that the implementation of the EU's commitment, under the Paris Agreement on Climate Change, depends significantly on a successful transition to a "clean" energy system.

The importance of the energy transition to clean energy is described and analysed extensively in various studies by international and European bodies. According to the International Renewable Energy Organization (IRENA), a total of $110 trillion is required to be invested internationally, which would boost, among other things, global GDP growth by 2.4%, by 2050, compared to the current projections and would quadruple the jobs in the RES sector. In fact, IRENA estimates that every $1 spent on the energy transition will yield $3 - $8, reducing the costs associated with the negative effects of climate change and the health effects of air pollution.

The International Energy Agency (IEA) points out that the three main pillars of promoting the energy transition to Clean Energy[2] are the following:

1. **Formulation of an ambitious agenda for the achievement of the climate goals and the creation of jobs through the adoption of appropriate policies (policy initiatives)**.

Those in charge of policy planning should create synergies for job creation and action against Climate Change, in order to promote the economic recovery of global economies, especially in the midst of the current crisis of the coronavirus pandemic. The modernization of energy systems can make a significant contribution to job creation and economic growth, while protecting the Climate.

2. **Leading position of the public sector in investments in clean energy through the formulation and adoption of focused policies**.

A recent IEA analysis shows that governments, directly or indirectly, define more than 70% of global energy investment and in the midst of the coronavirus pandemic, their actions are more important than ever.

[2] https://www.iea.org/commentaries/how-clean-energy-transitions-can-help-kick-start-economies2

3. **Making energy efficiency, RES and electricity storage key parameters of economic recovery.**

Programs to support these dynamic energy industries should be given priority in terms of supporting existing workforce, creating new jobs and reducing greenhouse gas emissions.

Special reference should be made to the EU Emissions Trading Scheme (EU ETS), a greenhouse gas emission mechanism, chosen by the European Union, in 2000, and launched, in 2003, by Directive 2003/87/EC.[3] The EU ETS mechanism is based on setting the desired emission reduction over a period of time, in order to meet the set environmental objectives and the issuance of corresponding emission allowances (EUAs), the price of which will be determined freely by the market at appropriate levels, in order to force the relevant activities to reduce their emissions.

Through this mechanism, the aim was to reduce emissions from activities that accounted for about 50% of all emissions in the European Union and, mainly, related to electricity generation and other large industries and, secondly, to aviation.

The initial allocation of emission reduction efforts through this mechanism was based on historical emissions data. However, due to the distribution of free rights to protect companies from unfair competition outside the European Union, the recognition of rights from actions outside the European Union (CERs) and, of course, the financial crisis of 2008-2009, the market price collapsed below €5 / ton of CO_2, a price that was no longer a strong incentive to further reduce emissions. The gradual reduction of the total number of allowances issued each year and the zeroing of free allowances in electricity generation failed to absorb the surplus of supply and increase the price.

To reduce supply and increase the price of allowances and, therefore, the profitability of the EU ETS, as early as 2013, when the market surplus reached 2,200 million allowances (in total verified emissions in the same year of 1,908 million), the European Commission has proposed a price support mechanism, the so-called Market Stability Reserve (MSR). In general, the MSR is required to intervene by withholding or selling rights, so that the so-called total amount of circulating rights in the European Union remains between 833 and 400 million EUAs. The MSR was launched on 27/2/2014, withdrawing from the market 900 million rights in the three years 2014-2016, with the initial intention to be auctioned after 2018 (the so-called back-loading).

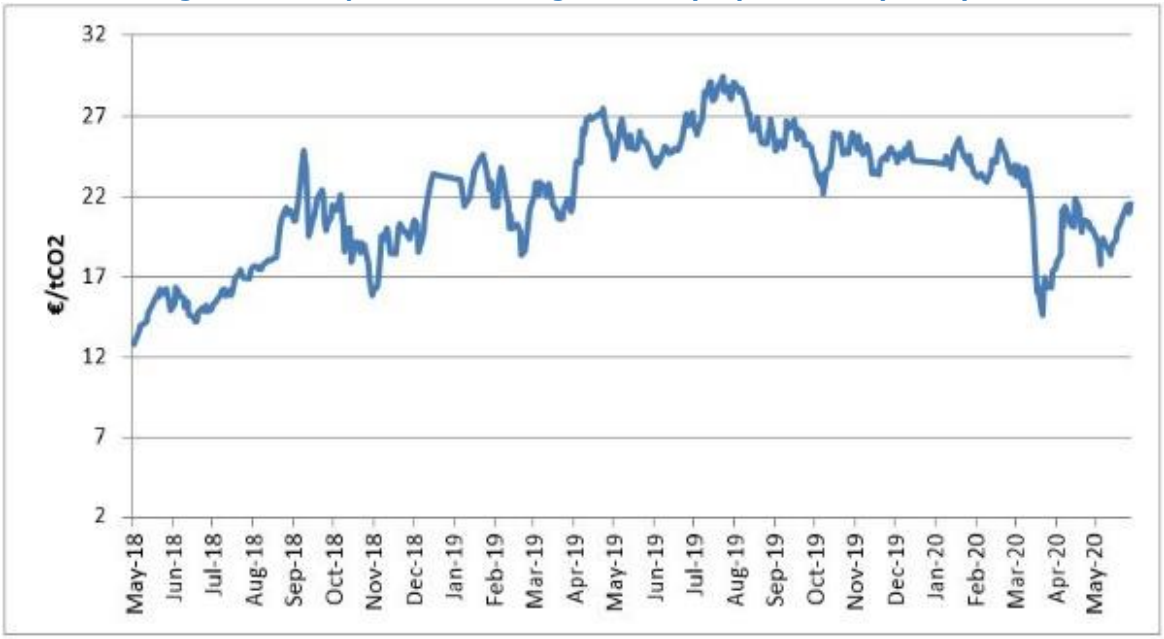
In 2018, the European Commission decided to increase the annual rate of reduction of issued rights, during the decade 2020-2030, from 1.7% to 2.2% and to withhold the 900 million rights of the MSR. It was, also, decided to withhold in the MSR the rights to be auctioned at 24% of the respective annual amount of the total amount of circulating rights, for the five years 2019-2023, which is estimated at a total of € 1.4 million, and by 12%, from 2024 to 2030, and to cancel, annually after 2023, all rights to the MSR in addition to the amount auctioned the previous year.

Of course, many analysts point out that the EU ETS is certainly the most exposed climate policy tool to COVID-19, stressing that system uncertainty and instability may undermine plans for phasing out carbon. They, also, say that the European Commission should consider taking immediate steps to prevent the collapse of the EU coal market and make new proposals to stabilize the price of emissions

[3] https://eur-lex.europa.eu/legal-content/EL/TXT/?uri=CELEX%3A32003L0087

allowances, in order to ensure EU coherence throughout the IV phase of EU ETS, which will run between 2021 and 2030. Phase III of the EU ETS, which entered into force in 2013, will remain in force until 31 December 2020 and includes harmonized allocation methodologies, GHG additions and emission sources.

Diagram 1 - European Emission Rights Rates (May 2018 - May 2020)



Source: European Energy Exchange

Undoubtedly, this drop in European emissions allowances favours electricity producers using fossil fuels (i.e. coal and natural gas), such as PPC – the Greek Public Power Corporation, but also the energy-intensive industries, which buy emissions from the stock market.

According to data from the PPC's Annual Financial Report, for 2019[4], the increase in the company's expenditures for the purchase of CO_2 emission allowances, on an annual basis, reached 50% last year. More specifically, the expenditure that PPC was asked to pay for CO_2 emission allowances increased to €546.5 million, in 2019, compared to €369.6 million, in 2018. This significant increase is due to the increase in the average price of CO_2 emission allowances, which rose at €23.7/ton from €12.5/ton. It is noteworthy that this increase in expenditure is recorded despite the fact that total emissions were significantly reduced, by about 20%, from 29.5 million tons, in 2018, to 23.1 million tons, in 2019.

Indicatively, Table 1 summarizes the emissions of all operating lignite plants of PPC in Greece for 2018, with the largest CO_2 emissions being recorded at the five lignite stations of Agios Dimitrios, owned by PPC in Kozani, when CO_2 levels, in the three years 2016 - 2018, amounted to 9,071,162 kg per year.

[4] https://kentro-typou.dei.gr/media/1348/%CE%B1%CF%80%CE%BF%CF%84%CE%B5%CE%BB%CE%B5%CF% 83% CE% BC% CE% B1% CF% 84% CE% B1-% CE% B5% CF% 84% CE% BF% CF% 85% CF% 83-2019- % CE% BF% CE% BC% CE% B9% CE% BB% CE% BF% CF% 85-% CE% B4% CE% B5% CE% B7.pdf

Table 1 - Emissions (kg) of PPC Lignite Units, 2018

	Ag. Dimitrios	Kardia	Amyntaio	Meliti	Megalopoli A'	Megalopoli B'
Dust	485	1.302	533	8	20	62
SO2	10.299	4.249	5.470	1.381	1.317	594
NOX	7.101	4.978	1.653	892	966	773
CO	3.183	2.747	1.102	43	2.741	563
CO2	9.226.694	5.791.829	2.421.059	1.876.833	2.449.712	1.768.748

Source: PPC

The price of lignite megawatt hour produced, including the cost of pollutants, is € 80- € 90, compared to € 55- € 60 for gas units, while the average system marginal price - based on the latest data of May 2020 - fluctuates around at € 60/MWh, while in the last auction of RAE (April 2020) the prices for both wind and photovoltaic were at the level of € 52 / MWh. The above data highlight the particularly high cost of lignite production compared to other forms of energy in Greece and the need for the country to switch to clean energy.

Legal Dimension of Delignification

(a) European Union

Regarding emissions from industrial activity and large combustion plants, Directive 2010/75 / EU (Industrial Emissions Directive - IED5[5]) sets out the basic principles for the licensing and control of industrial plants, based on an integrated approach and implementation of Best Available Techniques (BAT), replacing the IPPC (Integrated Pollution Prevention and Control) Directive for integrated pollution prevention and control (2008/1/EC, replacing 96/62/EC). The European Commission organizes the exchange of BAT information with Member States and other stakeholders, with a view to drawing up BAT Reference Documents (BREFs), which indicate which are considered BAT at EU level for each industry.

Directive 2010/75 / EU also replaces Directive 2001/80/EC, on the setting of emission limits for SO_2, NOx, dust and CO from Large Combustion Plants (LCP). It also replaces Directives 2000/76/EC (emission limits from waste incineration plants) and 1999/13/EC (emission limit values for activities using organic solvents). Respectively, Directive 2015/2193/ EU provides for the reduction of SO_2, NOx and dust emissions from medium-sized combustion plants (Medium Combustion Plants (MCP).

Based on Table 1, the need to limit the emissions from the operating PPC's lignite plants is identified, which, in order to be compatible with the above EU Directives and the objectives of the NECP, is considered particularly costly. According to 'The Green Tank'[6], the two lignite thermal power stations of Kardia and Amyntaio are among the most polluting in the EU. More specifically, the Amyntaio TPPs emits 8.1 and 4.2 times more than the European emission limits for SO_2 and PM, respectively, while Kardia I, II, III and IV emit on average 15.7, 17.3, 4.1 and 3.5 times above the particle emission limits, respectively. Therefore, the withdrawal of these stations will significantly improve air quality for

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32010L0075
[6] https://thegreentank.gr/wp-content/uploads/2019/09/The-economics-of-Greek-lignite-plants_EN.pdf

the citizens of Greece and neighbouring countries. From an economic point of view, the withdrawal of Kardia and Amyntaio will greatly reduce the fixed costs and, therefore, will improve the overall economic situation of the lignite industry.

Also, all lignite stations must comply with the new BAT limits, by August 2021 at the latest. As the chimneys of Agios Dimitrios units I - II emit on average much more than the limits for all three pollutants (2 times above the limit for NOx, 2.3 times above the limit for SO_2 and 2.6 times above the limit for particles), significant unit upgrades will be required to ensure compliance with the new BAT. Therefore, the closure of these units will help PPC to avoid the cost of installing the relevant anti-pollution technologies that will achieve the required reduction of emissions.

The European Commission's non-support for coal or lignite based power plants is also evident under European Council Decision 2010/787/EU (10 December 2010[7]) on state aid to facilitate the closure of non-competitive coal mines, the provisions of which allowed assistance only for their decommissioning by the end of 2018. One of the objectives of the decision was to ensure a smooth transition and conversion of the sector. In 2019, the above decision was no longer in force, except for the mines that are obliged to repay the state aid they received from 2011. However, there are still many coal or lignite mines in operation in Europe and their closure does not imply abandoning the use of this fuel for electricity generation, as factories may use imported coal or lignite.

The phasing out of mines without the corresponding closure of lignite or coal-fired power plants in the EU increases dependence on imported coal to meet energy demand. Thus, coal from mines with low production costs and good transport connections to ports is in an advantageous position in international trade. Although, the first half of 2019 saw a historic decline in EU thermal coal imports from outside, imports from some Member States remained stable, due to international market trends and changes in the energy model at national level.

After June 30, 2020, when the Transitional National Emission Reduction Plan (TNERP-MESME) expires, every lignite plant in operation in Greece is required to comply with the established limits of EU Directive 2010/75/EU on pollutant emissions. After August 1st 2021, the lignite plant must additionally comply with the new Best Available Techniques for reducing the pollution caused by its operation, as provided in a relevant EU Decision 2017[8].

In the Clean Energy for All Europeans[9] package, published on 30 November 2016, the European Commission proposed a recast of the Internal Electricity Market Regulation (COM (2016) 862) to ban subsidies in new fossil fuel plants emitting more than 550 gCO_2/kWh under capacity mechanisms. In addition, the package is aimed at promoting the transition to clean energy and enabling the European Union to achieve the objectives set out in the Paris Agreement on Climate Change.

[7] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:336:0024:0029:EL:PDF

[8] https://eiDEIb.jrc.ec.europa.eu/sites/default/files/2019-11/JRC_107769_LCPBref_2017.pdf

[9] The package was completed with the publication of the final texts in the Official Journal of the European Union in June 2019, following a tripartite dialogue between the European Commission, the Council and Parliament.

(b) Greece

In Greece, the need for the establishment and operation of a supervisory body at ministerial level, as well as an operational-executive body for the delignification in the Region of Western Macedonia and in the Municipality of Megalopolis in the Peloponnese Region, has long been evident.

According to the Act 52 of the Council of Ministers of 23-12-2019 (FEK 213/A/24-12-2019)[10], a Governmental Committee was established and Just Development Transition to the post-lignite era of the Region of Western Macedonia and the Municipality of Megalopolis of the Peloponnese Region is formed. The Committee consists of: (a) the Minister for the Environment and Energy, as Chairman, (b) the Minister for Finance, (c) the Minister for Development and Investment, (d) the Minister for the Interior, (e) the Minister for Rural Development and Food, (f) the Deputy Minister of Environment and Energy, responsible for Energy and Mineral Raw Materials and (g) the Deputy Minister of Development and Investment, responsible for Public Investment and the NSRF, members.

The task of the Commission is indicatively:

(a) the approval and monitoring of the implementation of the Just Development Transition Plan (JDTP), which addresses all issues arising from the strategic decision of the Government to withdraw, by 2028, all lignite plants of the country. JDTP is a comprehensive multi-dimensional development roadmap for the Region of Western Macedonia and the Municipality of Megalopolis and includes a set of measures, such as indicative investment and tax incentives, new infrastructure, utilization of local natural resources, training of employees, production and support, with the aim of reviving the local economy, securing jobs and creating new ones, through a flexible development transformation, utilizing the existing human resources, after examining the proposals that will be submitted by PPC in the context of its Corporate Social Responsibility and its business activity, as well as by the local administration authorities of the regions concerned,

(b) coordinating the public consultation with the relevant local bodies and local communities, the boards of private institutions and chambers and the provision of directions to them for the planning and implementation of SDAM, (c) coordinating the utilization of available sources of funding, national, European or private.

Also, according to the above mentioned Act 52, a Steering Committee was established as a Working Group, which is responsible for the preparation and implementation of the SDAM, the coordination of the activities required for its preparation and implementation and the submission of the issues to the Commission.

On the 17th of March 2020, the decision of the Government Committee of the SDAM of the Region of Western Macedonia and the Municipality of Megalopolis in the post-lignite era appointed Mr. Konstantinos Mousouroulis, as Coordinator and Chairman of the Steering Committee and this decission was posted on the Diavgeia platform[11].

[10] https://www.e-nomothesia.gr/kubernese/praxe-upourgikou-sumbouliou-tes-23-12-20192.html

[11] https://diavgeia.gov.gr/doc/%CE%A81%CE%A9%CE%954653%CE%A08-% CE% 93% CE% 9A% CE% 93? Inline = true

In addition, the Environmental Law, L.4685/2020 (FEK 92/A/7-5-2020)[12] makes special reference to Article 104, on delignification. In particular, due to the operation of the Target Model for the Electricity Markets, the way of recovering the special fee for exploration and exploitation rights of lignite (Lignite Fee) is modified and the proportional distribution of these funds per Regional Unit in the lignite areas is clearly defined.

1.2. EU targets for 2030, 2050, European Commission New Green Deal

In order to ensure the EU's ability to meet the challenges of both Climate Change and Energy, the Energy Union Framework Strategy was drafted, in February 2015. Creating an Energy Union, focused on an ambitious Climate Policy, aims to ensure safe, sustainable, competitive and economical energy for EU consumers. However, achieving this requires a radical transformation of the energy system of Europe.

In November 2016, the EU introduced a package of measures, also known as the **Clean Energy Package for all Europeans**, seeking to push the European economy into clean energy through the creation of new jobs, business models and economic sectors.

The main objectives of this Package are

(a) the priority in energy efficiency,

(b) the achievement of world leadership in RES energy and

(c) the provision of a fair deal for consumers.

The European Commission also presented a strategic long-term plan, at the end of 2018 for a prosperous, modern, competitive and climate-neutral economy by **2050 - A clean planet for all**[13]. This long-term strategy is not intended to set quantitative targets, but to have a vision and a direction, to draw up a plan that will inspire stakeholders, researchers, entrepreneurs and citizens to develop new and innovative industrial units, businesses and related jobs, in line with the goals of the Paris Agreement.

(a) EU targets for 2030

Every European citizen must have access to safe, sustainable, affordable and competitive energy, and, achieving this, is one of the biggest challenges for the European energy system. However, at a time when the global climate is changing and the Earth's atmosphere is overheating, the EU remains the world's largest importer of energy, importing more than 50% of its energy, the majority of its buildings are far for being energy efficient, while wholesale electricity prices in Europe are 25% higher than in the US.

In order to improve the above situation, the European Union has set **ambitious climate and energy targets by 2030** and more specifically:

- reduction of greenhouse gas emissions, by at least 40% compared to 1990 levels,
- increase the share of RES, to at least 32% of final gross energy consumption and

[12] https://www.e-nomothesia.gr/kat-periballon/nomos-4685-2020-phek-92a-7-5-2020.html
[13] https://ec.europa.eu/commission/presscorner/detail/el/IP_18_6543

- improving energy efficiency, by at least 32.5%.

In addition to the Paris Agreement in 2015, the EU played a key role in the United Nations (UN) Climate Conference, held in Katowice, Poland, in December 2018, where new rules for the implementation of the Paris Agreement were agreed.

(b) European Green Deal and Just Transition Mechanism

The **European Green Deal**[14] sets out how Europe will become the first climate-neutral continent, by 2050 to boost its Economy, Health and Quality of life of its people. The main objective of the Deal is the upward revision of the EU Climate Target, by 2030, in order to provide a reduction of pollutant emissions, by at least 50% to 55%, compared to 1990 levels.

It, also, describes the investments required and the financial instruments available and explains how to ensure that the transition is just and inclusive. The European Green Deal covers, in particular, transport, energy, agriculture, buildings and industries, such as the steel, concrete, textile and chemical industries.

In particular, the European Green Deal provides a roadmap of actions for promoting the efficient use of resources by moving to a clean, circular economy and halting climate change, restoring biodiversity and reducing pollution.

To this end, significant investments are required, both from the EU and from the national public and private sector. The European Green Deal investment plan, the "**Sustainable Europe"** Investment Plan, launched in mid-January 2020, is expected to mobilize public investment and help free up private funds through EU financial instruments, in particular InvestEU, which will lead to in investments amounting to at least € 1 trillion.

As the transition will require the input of all EU Member States, regions and sectors, the scale of the challenge is not the same. Some regions will be particularly affected and will undergo a profound economic and social transformation. The Just Transition Mechanism is expected to provide tailored financial and practical support to assist employees and make the necessary investments in these areas.

More specifically, the investment plan of the European Green Agreement is based on three pillars:

• **Financing**:

Mobilizing sustainable investments of at least €1 trillion over the next decade. The share of spending on Climate and Environment from the EU budget will attract private funding, while the European Investment Bank, EIB, will play a key role.

• **Facilitation**:

Providing incentives for the release and reorientation of public and private investments. The EU will provide tools for investors by putting sustainable financing at the heart of the financial system, while also facilitating sustainable investment by public authorities by encouraging green budgets and green procurement, and designing ways to facilitate approval procedures for the regions of Just Transition.

[14] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_el

• **Practical support**:

The Commission will provide support to public authorities and project implementers in the planning, design and execution of sustainable projects.

The **Just Transition Mechanism** is a key tool to ensure that the transition to a climate-neutral economy takes place in a just manner.

More specifically, the process to date for the approval of the Just Transition Mechanism is analysed below:

- **14 March 2018:** European Parliament resolution on its position on the Multiannual Financial Framework after 2020 [Resolution (2019 / C 162/06)]. Parliament emphasized the importance of **providing comprehensive support, in particular for high-carbon regions,** and called for the **establishment of an integrated Fund to support just transition.**
- **2 May 2018:** Approval of the proposal for the next multiannual financial framework for the period 2021-2027 by the European Commission [Brussels, 2.5.2018 COM (2018) 321 final].

The Commission, on the basis of the Paris Agreement and the United Nations Sustainable Development Goals, proposes more ambitious goals to integrate the climate dimension into all EU programs, with at least 25% of its expenditure EU (€ 320 billion) to focus on climate targets.

Combating climate change and achieving a transition to a climate-neutral society will require alignment of actions, indicatively and not restrictively, in the key areas of energy, environment, mobility, low carbon economy and sustainable development.

- **29 and 30 May 2018**. Adoption of European Commission legislative proposals governing the use of funding under cohesion policy over the same period [Strasbourg, 29.5.2018 COM (2018) 375 final].

One of the policy objectives supported by the Funds (ERDF, ESF+, Cohesion Fund and EMFF) for EU investment in 2021-2027 is "*a greener Europe with lower carbon emissions by promoting a Just Transition to clean forms of energy, green and blue investments, the circular economy, and adaptation to climate change, risk prevention and management* ". According to the Commission proposal, in the ongoing process of adopting the Regulations, a significant share of funding for cohesion is expected to focus on this priority.

- **11 December 2019**: The European Commission announces the European Green Deal, [Brussels, 11.12.2019 COM (2019) 640 final], which provides a roadmap for the key policies and measures required for a new development policy for Europe, with ambitious goals for combating climate change and environmental protection. Achieving the goals presupposes the coverage of additional significant investment needs by mobilizing the public and private sectors.

In order to achieve effectively and fairly the "**Climate Neutrality by 2050**", which is the goal of the Europe Green Deal, the Commission proposes a **Just Transition Mechanism** (JTM) and the establishment of a **Just Transition Fund** (JTF).

In particular, the JTM will consist of three pillars:

1. the JTF that will be implemented in the context of enhanced management,
2. a special scheme under InvestEU,

3. a public sector loan facility from the EIB Group.

Consulting and technical assistance are, also, an integral part of the Mechanism.

The JTM will complement the substantial contribution of the EU budget through all programs directly related to the transition, as well as other funds, such as the ERDF and the ESF+.

- **14 January 2020.** The Commission presents its proposal for the Establishment of the Just Transition Fund (JTF) [Brussels, 14.1.2020 COM (2020) 22 final] and the corresponding amendment to the Common Provisions Regulation of the EU Funds for 2021-2027 (new KKD) [Brussels, 14.1.2020 COM (2020) 23final].

  This is the first piece of legislation that implements the priorities of the European Green Deal, with available resources for the JTF amounting to € 7.5 billion, coming from the Multiannual Financial Framework (PDB) for the period 2021-2027. The proposal for a Regulation provides for the possibility of adding JTF resources from the Union budget by providing additional resources from the Cohesion Strengthening Funds, the ERDF and the ESF+, as well as other resources.

- **27 May 2020.** Following the unprecedented crisis caused by the COVID-19 pandemic, the European Commission, in order to support the Member States in dealing with the economic consequences, announces its intention to feed the EU budget into the European recovery through a Recovery Plan [Brussels, 27.5.2020 COM (2020) 442 final] and resources from:

  (a) the provisional European Recovery Instrument 2021-2024, amounting to € 750 billion.

  (b) the strengthened Multiannual Financial Framework 2021-2027

  According to the Commission, Europe's recovery and future prosperity will depend on the steps taken to move to a climate - neutral, resource - efficient and circular economy. As a result, the total resources of the JTF amount to € 44.1 billion (Amended proposal of the Just Transition Fund Regulation, COM (2020) 460, 28.5.2020).

- **6th of July 2020:** Approval of the JTF by the Committee on Regional Development.

  The Committee on Regional Development further proposes the establishment of a "Green Reward Mechanism", which will allow the allocation of 18% of the Fund's total resources based on the speed with which Member States achieve the reduction of greenhouse gas emissions, divided by their most recent average gross national income. The proposal also provides for 1% of the total JTF resources to be allocated to the islands and 1% to the outermost regions.

  They, also, suggest that the co-financing rate for eligible projects be 85% of their cost, as the JTF provides support for the most vulnerable communities in each region.

  Finally, they agree with the expansion of the JTF coverage, especially in terms of social cohesion and job creation. Activities to be funded by the fund should also include micro-enterprises, sustainable tourism, social infrastructure, universities and public research centres, energy storage technologies, low-emission urban heating, "smart" and sustainable transport, digital innovation, including digital crops and precision agriculture, actions to combat energy poverty, and culture, education and community building.

At the sitting of Parliament under the German Presidency in September 2020, the following will be negotiated:

1. the Commission proposal for JTF resources

2. the connection of the Green Reward Mechanism with the speed of decarbonisation as reflected in the national climate plans

3. The proposal of the MEPs to increase the percentage of co-financing of the resources coming from the MFF 2021-2020, to reach 85%.

4. the criteria for allocating resources [degree of dependence, speed of transition]. The volume of lignite activity in each country could be proposed as a new criterion.

The EU proposal contained the distribution of JTF resources among the 27 Member States, which emerged from the application of five criteria:

1. Greenhouse gas emissions from industrial plants in regions where carbon intensity exceeds the EU-27 average (weight 49%)

2. Coal and lignite mining workers (25% by weight)

3. Industrial workers in the regions referred to in point 1 (weighting factor 25%)

4. Peat production (weighting factor 0.95%)

5. Petroleum shale production (weight 0.05%), followed by two adjustments, one based on Gross Domestic Product (GDP) per capita and one aimed at ensuring a specific minimum aid per Member State

However, the resulting JTF resource allocation directs most of the resources to Member States that either do not comply with the European Climate Neutrality Target for 2050, as set out in the European Green Deal, or are not committed to phasing-out more polluting fuels, such as lignite and coal, by 2030, or both. As a result, for Member States with ambitious commitments to delignification and decarbonisation, there are significantly fewer resources left.

MEPs (6 July 2020) propose an exemption for gas-related activities for regions economically dependent on the production or burning of coal, lignite, bituminous shale or peat. In this way, the Commission can approve regional Just Transition plans including such activities, if they are deemed to be "environmentally sustainable" in accordance with Regulation (EU) 2020/852 of 18 June 2020 establishing a framework for facilitating sustainable investment; and are in accordance with six additional, cumulative criteria.

The JTF resources, according to the Commission proposal, come from:

- directly from the Multiannual Financial Framework (MFF) for the period 2021-2027

- additional resources from the Funds that strengthen the coherence of the ERDF and the ESF +, for the period 2021-2027 as follows: the additional resources will together be at least 1.5 to 3 fold higher than the JTF resources

- from other sources (other resources, e.g. European Recovery Plan) The distribution of resources (amounts in 2018 prices) was done in two periods as follows:

1. January 2020

The initial JTF funds from the Multiannual Financial Framework 2021-2027, according to the Commission proposal, amount to € 7.5 billion, 0.35% of the resources are allocated to technical assistance at the initiative of the Commission to the Regions of the special regime.

With the additional mandatory transfer of funds from the Cohesion Strengthening Funds, ERDF and ESF + and taking into account national co-financing, the financial capacity of JTF in January was estimated at € 30 billion to € 50 billion.

With JTF resources and the contribution from the special "InvestEU" scheme and the public loan facility through the EIB, the initial estimate for investments through the JTM amounted to € 100 billion.

From the distribution of funds (€ 7.5 billion) in the Member States, in Greece resources for JTF amount to € 295 million.

In the NSRF plan 2021-2027 submitted to the EU, based on the Regulations for the period 2021-2027, an amount of € 14 million was allocated to InvestEU, thus setting the amount for the JTF at € 281 million.

This amount, together with the additional ERDF, ESF + resources, amounts to € 757 million (Community contribution, 70%) and with the national participation the total resources of JTF reach an amount of € 1,125 million.

2. May 2020

The JTF budget is amended after the European Recovery Plan as follows:

(a) resources are added from the temporary European Recovery Instrument:

€ 30 billion for budget commitment in the years 2021-2024 (Next Generation EU), as well as € 15,600,000 for administrative expenses.

0.35% of the resources (€ 30 billion) are allocated to technical assistance at the initiative of the Commission to the Regions of the special scheme.

The additional resources of the Recovery Instrument:

- are not complementary to the ERDF and ESF + funds
- are available for fiscal commitment in the context of investments for the employment and growth objectives for the years 2021 to 2024 with a specific commitment rate per year.

(b) In addition, the total resources from the Multiannual Financial Framework (MFF) for the period 2021-2027 for JTF now amount to € 10 billion.

0.35% of the resources (€ 10 billion) are allocated to technical assistance at the initiative of the Commission to the Regions of the special scheme.

To these resources may be added resources from the Cohesion Strengthening Funds, the ERDF and the ESF + and other resources.

The final funds for JTF now amount to € 40 billion. From the new distribution of funds (€ 40 billion) in the Member States, in Greece there are resources for JTF amounting to € 1,726 million, of which € 1,300 million from the temporary European Recovery Instrument.

The total resources for the country with the additional resources ERDF and ESF+, as mentioned above, amount to € 2,446m.

Table 2 - Total Resources of EU Member States and Greece under the Fund and Framework of the Just Transition Mechanism

Just Transition Fund - JTF						
Fund allocation	**Financial instrument**	**Budget Commitment Period**	**Budget (€)**		EU contribution (70%)	
			EU M-S	Greece		
				Initial Fund	**Complimentary funds (EIB+, ERDF)**	Total
1/2020	MFF	2021-2027	**7.500.000.000**	281.000.000	476.000.000	**757.000.000**
5/2020	MFF (recast)	2021-2027	10.000.000.000	426.000.000*	719.940.000	1.145.940.000
	Temporary European instrument recovery	2021-2024	30.000.000.000	1.300.000.000		**1.300.000.000**
		Total MFF	**40.000.000.000**	**1.726.000.000**		**2.445.940.000**

* The amount is the sum of the initial amount of € 281 million and the revised proposed EU budget which is € 145 million.

Source: SDAM Coordinating Committee

The proposal to strengthen the European recovery from the EU budget in addition to increasing JTF resources includes the possibility of supporting investments in areas of Just Transition through any part of the InvestEU policy, thus also strengthening the second pillar of the JTM. The Commission is also submitting proposals for the creation of the new public sector lending facility, which is the third pillar of the Mechanism. The lending facility will receive € 1.5 billion in support from the EU budget and € 10 billion in loans from the European Investment Bank.

In total, all three pillars of the JTM are expected to mobilize investments of up to € 150 billion.

The percentage of resource allocation for Greece amounts to approximately 4.3%. Given this, we estimate that the mobilization of investments by the total Just Transition Mechanism will amount to € 6.45 billion.

Regarding its original proposal, the European Commission made the following three changes:

1. Increased the size of JTF from € 7.5 billion to € 40 billion, at 2018 prices.

2. It set the maximum amount a Member State can receive at € 8 billion, up from € 2 billion in the original proposal.

3. Increased the minimum per capita aid intensity from € 6 to € 32.

Just Transition Mechanism (JTM)

The establishment of the Mechanism aims to address the issues that will arise from the decoupling of Regions and/or sectors from industrial processes of greenhouse gas emissions (use of fossil fuels, including coal, peat and oil shale). Indicatively, it is reported that in 108 European regions there is coal infrastructure, while almost 237,000 people are employed in coal-related activities.

In adapting to the new data, it is certain that some sectors will decline, as the decline in economic output and employment levels will be irreversible for economic activities with high levels of greenhouse gas emissions or for activities based on production and use of fossil fuels, in particular coal, lignite, peat and oil shale. The transformation of existing infrastructure, with alternative technological solutions, may be a bulwark in the effort to maintain economic production and employment.

The JTM consists of three pillars, which will be utilized as follows:

The first pillar, the Just Transition Fund, assisted by the European Regional Development Fund (ERDF) and the European Social Fund (ESF +) and other resources, will be used primarily to provide grants.

The second pillar, the special transition scheme under InvestEU, will seek to attract private investment, covering energy and transport infrastructure projects, including gas and district heating, as well as exemption projects for carbon dioxide emissions

Finally, the partnership with the EIB, **a third pillar,** will leverage public funding to mobilize additional investment in the regions concerned.

Just Transition Fund (JTF)

The establishment of the Fund, as the first of the three pillars of the JTM, is proposed by Regulation COM (2020) 22 14.01.2020. With the proposal to amend the Regulation from 28.5.2020, following the initiatives that the Commission intends to take for the European recovery after the crisis caused by the COVID-19 pandemic, there is a substantial change in the available resources of JTF.

JTF resources. According to the proposal to amend the Fund Regulations, budgetary resources amount to € 40 billion.

Shared management. The JTF will be implemented in close cooperation with national, regional and local authorities and stakeholders. This will ensure the adoption of the transition strategy and provide the tools and structures for an effective management framework.

Geographical Scope. The JTF provides support to all Member States.

Cohesion Policy. The JTF supports the Union's goal of "Investing in employment and growth" and is recommended in the context of cohesion policy, as a key tool to support areas most affected by the negative effects of the transition to climate neutrality and to avoid increasing inequalities at regional level.

It complements the other actions under the next multiannual financial framework 2021-2027 and contributes to the single specific objective "*to enable regions and people to address the social, economic and environmental consequences of the transition to a climate-neutral economy*".

In addition to the other Cohesion Funds (European Regional Development Fund (ERDF), European Social Fund Plus (ESF +) and Cohesion Fund, its management will be governed by the Regulation of common provisions of all EU Funds.

According to the Commission proposal for more flexibility in the planning of JTF resources, there should be the possibility of drawing up an autonomous JTF program or the possibility of programming JTF resources for one or two specific priorities under a program supported by the European Regional Development Fund (ERDF), the European Social Fund + (ESF +) or the Cohesion Fund.

The Government Committee decided that JTF will be an autonomous program under the new NSRF 2021-2027.

Territorial plans for a Just Transition. JTF support will depend on the effective implementation of the transition process in a specific territory.

For this reason, Member States should draw up territorial plans for a Just Transition. The territories to be supported will correspond to an NUTS level 3 administrative division.

The JTF resource planning process, including the identification of the areas in which the intervention will take place and the corresponding actions, will be agreed in a dialogue between the Commission and each Member State.

Intervention areas (territories) should be the ones most negatively affected by the economic and social impact of the transition, in particular with regard to the expected job losses and the transformation of the production processes of industrial plants with the highest greenhouse gas emissions.

For each of these territories, Territorial Just Transition plans will identify social, economic and environmental challenges and provide details on the needs for economic diversification, new skills acquisition and environmental rehabilitation, as appropriate.

The Territorial Just Transition plans will take into account the Commission's analysis for the European Semester 2020 and will include a description of the transition process by 2030, in line with its national energy and climate plans and the EU Climate Neutrality target by 2050.

In addition, adequate justification will be provided for the additional ERDF and ESF+ resources that may be transferred, as well as for any productive investment support to firms other than SMEs, if necessary.

Only investments in line with the transition plans should receive financial support from the JTF.

Territorial plans for a Just Transition will be part of the 2021-2027 Programs and will be approved by the same Commission decision as the Program.

The approval of the Territorial Just Transition Plans will provide support not only from the Just Transition Fund, but also from the special Just Transition scheme under InvestEU (second pillar of the Just Transition Mechanism) and the public sector loan facility implemented in cooperation with the EIB (third pillar), which will support investment in the territories concerned.

Territorial Just Transition plans may be updated and re-approved when necessary, in particular in the case of updating national energy and climate plans.

Eligibility of investments

- **Investments supported by JTF**

The activities supported by the Fund must contribute to the implementation of the Territorial Plans for Just Transition, and they have an eligibility start date of January 1, 2021. They relate to:

(a) productive investments in SMEs, including start-ups, leading to economic diversification and transformation

(b) investments in start-ups, inter alia, through entrepreneurial incubators and consulting services

(c) investing in research and innovation activities and promoting the transfer of advanced technologies

(d) investments in the development of technology and infrastructure for affordable clean energy, in the reduction of greenhouse gas emissions, in energy efficiency and in renewable energy sources

(e) investments in digitization and digital connectivity

(f) investments in land regeneration and decontamination, soil remediation and land use adjustment plans

(g) investments in strengthening the circular economy, including through the prevention and reduction of waste, through the efficient use of resources, reuse, repair and recycling

(h) upgrading skills and acquiring new skills by employees;

(i) job search assistance to jobseekers

(j) active inclusion of job seekers;

(k) technical assistance.

- **Investments under the Special InvestEU and EIB Scheme**

Eligibility for investments under the other two pillars of the JTM (Special InvestEU scheme, EIB) will be wider to support energy-related activities (e.g. energy and transport infrastructure projects, including infrastructure gas and district heating, as well as projects for the exemption of carbon dioxide) within a geographical area and outside the territories under transition.

Particularly:

The special InvestEU scheme will cover energy and transport infrastructure projects, including gas and district heating infrastructure, as well as carbon offset projects.

Under the EIB Public Loan Facility, public authorities will be given the opportunity to implement measures to facilitate the transition to climate neutrality. The projects will range from energy and transport infrastructure to district heating networks and energy efficiency measures, including the renovation of buildings. Additional public and private resources will be freed up through a coherent regulatory framework, in particular sectoral state aid rules, which will create opportunities to facilitate the use of national resources for projects in line with the objectives of Just Transition.

Technical assistance mechanism. Territories receiving support from the Just Transition Fund will benefit from a special technical assistance mechanism. The purpose of this mechanism is to design a

customized package for the full range of support available from the Commission, the EIB and other international organizations in a simple and comprehensive manner.

Platform for a Just Transition.

The Commission has set up a platform for a Just Transition to enable bilateral and multilateral exchanges of lessons learned and best practices in all affected sectors, based on the existing platform for the coal mining regions under way.

1.3. National Objectives: NECP, Long-Term Energy Strategy 2050

(a) Greek National Energy Policy Objectives

A single European energy policy has set specific objectives for each EU Member State. These objectives are set in cooperation with the governments of the Member States, with most countries accepting the key guidelines. In this sense, the central axis of Greece's energy policy is largely determined by Brussels, although there is scope for differentiation if a country is willing and able to develop energy resources, in which it considers to have comparative advantages over other countries (e.g. RES, energy efficiency, hydrocarbon production, etc.).

A well-known implication for Greece in terms of the adoption of the current European energy policy is the issue of Climate Change, which until recently, was not a priority of our country, as the use of lignite was a strategic choice, despite the negative environmental effects, as it is the only domestic fossil fuel.

Today, the objectives of Greece's energy policy, which are compatible with those of the EU, are summarized as follows in Table 3, which is contained in the updated National Energy and Climate Plan (NECP), December 2019, depicting our country's energy transition to clean forms of energy.

Table 3: Summary of National Objectives in the Framework of the Revised NECP, 2030

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

Source: NECP

In this context, the main objectives of national energy planning are to achieve the following:

• an integrated model of sustainable development in all economic sectors,

• combining energy sector development with environmental protection with decisive measures to combat climate change,

• the choice of energy policies with the best cost-benefit ratio for energy transition,

• waste management and utilization with modern technologies of circular economy,

• the transformation of Greece into an energy hub with a strong contribution to the energy security and security of supply of the EU,

• the strategy of diversification of energy imports, along with the modernization and development of energy infrastructure and the lifting of energy isolation of islands,

• an attractive investment environment to support the energy transition, with an emphasis on innovation and new technologies,

• maximizing the use of Community resources and mechanisms and

• extroversion and innovation to achieve growth that will create new jobs.

In the context of the above, the main objective of the NECP is to design, plan and implement the most socially, environmentally and economically effective policy measures, which will contribute to the achievement of the medium and long-term national energy and climate goals, will contribute to the economic development of the country and, at the same time, they will meet the challenge of reducing energy costs and generally protecting final consumers from high prices of energy products and services.

The national energy and climate targets for 2030 are formulated, taking into account specific quantitative commitments undertaken by Greece as an EU Member State (i.e. the targets for the sectors outside the Emissions Trading Scheme and the reduction of national emissions of certain air pollutants, in comparison to 2005), the characteristics and peculiarities of our national energy system, the domestic potential for the development of technologies and applications, the possibilities of adaptation, as well as the socio-economic characteristics of the country. This process results in the adaptation of the national targets to the corresponding central European targets (i.e. the targets for the sectors included in the Emissions Trading Scheme, for RES, for energy efficiency) and which are ultimately proposed under this national plan. .

In addition, in the context of the National Energy Planning, the main quantitative policy objectives set for the period up to 2030 are at the same time "intermediate" objectives for reducing greenhouse gas emissions by 2050, where Greece's goal is to participate in the commitment to a climate-neutral economy at EU level.

(b) Greece's Long-Term Energy Strategy for 2050

Greece, in the context of its participation in the collective European goal of a successful and sustainable transition to a climate-neutral economy by 2050, prepared in 2019 and in addition to the

aforementioned NECP, the Long-Term Energy Strategy for 2050, which is essentially a Roadmap for Climate and Energy issues.

With the completion of the elaboration and adoption of the NECP, which analyses the energy and climate goals set by the country as well as the policy priorities and measures for their implementation, Greece also explores the optimal mix of structure and evolution of the energy system up to 2050 to achieve specific climate targets in order to set the framework for its long-term energy and climate strategy for 2050. It is clear that the Long-Term Energy Strategy was developed in addition to the NECP, which is the central strategic plan on the basis of which specific energy and climate policy measures are being implemented.

The decade 2030-2040 should be a decade of choosing the then mature for adoption technological solutions, but also of continuing the successful policies and measures that will contribute to achieving the goals of 2050, with even greater intensity and pace of implementation.

The Long-Term Energy Strategy analyses scenarios for the evolution of the energy system and the pattern of consumption in the final sectors, with the ultimate goal of transition to a climate-neutral economy by 2050, without presenting specific specialized measures. These scenarios will be further discussed and elaborated in the future, in order to select the appropriate policy measures and corresponding technologies that will change the operating model of the consumption and production system.

2. Capturing the Existing Situation in the Energy Transition Areas

Short introduction

In the decade 2008-2018, the Greek economy was in the vortex of a serious fiscal crisis, which significantly affected not only the financial capacity of the state, but also the productive capacity of the country in almost all sectors of the economy, with particularly negative effects in the field of construction and manufacturing[15], especially during the first period of the crisis.

In addition, the main economic activity precursors declined significantly, such as public and private investment (gross fixed capital formation), the degree of utilization of factory capacity, while the amount of non-performing business loans increased significantly[16] (from 5.7% in December 2008 to 45.4% in December 2018).

The decline in GDP (from € 250.7 billion in 2007 to € 184.4 billion in 2016, at constant prices) and of employment by 1 million people[17], as well as the reduction in the number of active enterprises (by approximately 200,000 enterprises)[18] changed the productive structure of the Greek economy, acting as a driving force for industries with a greater comparative domestic and export advantage (such as tourism, agricultural processing, energy), which in the first phase recorded smaller losses and then

[15] Cf. production indices in constructions and the b Statistical Bulletin of Economic Situation, Bank of Greece, chronological order, https://www.bankofgreece.gr/ekdoseis-ereyna/ekdoseis/anazhthsh-ekdosewn?types=9e8736f4-8146-4dbd8-4dbd8

[16] https://www.bankofgreece.gr/statistika/ekseliksh-daneiwn-kai-kathysterhsewn

[17] https://www.statistics.gr/el/the-greek-economy

[18] Cf. Small Business Act, Greece, 2019, https://ec.europa.eu/growth/smes/business-friendly-environment/performance-review_en

recovered rapidly (data from the development of Gross Added Value, Statistical Register of Businesses, ELSTAT, 2017).

However, during this period a number of important structural changes took place in the Greek economy, which arose both as a consequence of international economic realignments (international trade, digital transition, development of new energy networks) as well as internal regulatory and economic reforms aimed to the deregulation of product and service markets (implementation of proposed OECD toolbox reforms I and II19[19]).

The energy market has been arguably the main recipient of these restructuring trends in the mix of economic organization (energy market liberalization, financing and development of renewable energy sources, etc.).

According to the annual survey of companies in Europe, Greek companies amount to 821,209 (data 2018) - excluding certain parts of the financial sector, agricultural sector, health - education and professional scientists. Small and medium enterprises constitute 99.8% of the total enterprises, employ 87.9% of the total number of employees and produce 63.5% of the total added value.

Table 4 - Number of Companies and Employees and Value Added in Greece and EU-28, 2018[20]

	N° of Enterprises			N° of employees			Added Value		
	Greece		*EE-28*	Ελλάδα		*EE-28*	Ελλάδα		*EE-28*
	No	**Share**	**Share**	**No**	**Share**	**Share**	**bil €**	**Share**	**Share**
Very small	800,075	97.4%	*93.0%*	1,527,075	62.0%	*29.7%*	9.0	17.6%	***20.8%***
Small	18,958	2.3%	*5.9%*	398,514	16.2%	*20.1%*	11.8	23.1%	***17.6%***
Medium	2,176	0.3%	*0.9%*	239,627	9.7%	*16.8%*	11.7	22.9%	***18.0%***
Total SME	**821,209**	**100.0%**	***99.8%***	**2,165,216**	**87.9%**	***66.6%***	**32.6**	**63.5%**	***56.4%***
Large	331	0.0%	*0.2%*	297,411	12.1%	*33.4%*	18.7	36.5%	***43.6%***
Total	**821,540**	**100.0%**	***100.0%***	**2,462,627**	**100.0%**	***100.0%***	**51.2**	**100.0%**	***100.0%***

Source: NECP

According to official ELSTAT data, in 2017 there were a total of 1.4 million business units operating in the country, including sole proprietorships, NGOs, scientists, farmers, etc. The sectors of wholesale and retail trade, manufacturing, accommodation and catering services, constructions and transport participate with the largest shares in the economic activity recorded in the country.

[19] These interventions were later incorporated into the National Reform Program

[20] «These are estimates for 2018 produced by DIW Econ, based on 2008-2016 figures from the Structural Business Statistics Database (Eurostat). The data cover the 'non-financial business economy', which includes industry, construction, trade, and services (NACE Rev. 2 sections B to J, L, M and N), but not enterprises in agriculture, forestry and fisheries and the largely non-market service sectors such as education and health. The following size-class definitions are applied: micro firms (0-9 persons employed), small firms (10-49 persons employed), medium-sized firms (50-249 persons employed), and large firms (250+ persons employed). The advantage of using Eurostat data is that the statistics are harmonized and comparable across countries. The disadvantage is that for some countries the data may be different from those published by national authorities. »

Table 5 - Number of Businesses, Turnover and Employees by Sector of Economic Activity in Greece, 2017 (Source: ELSTAT)

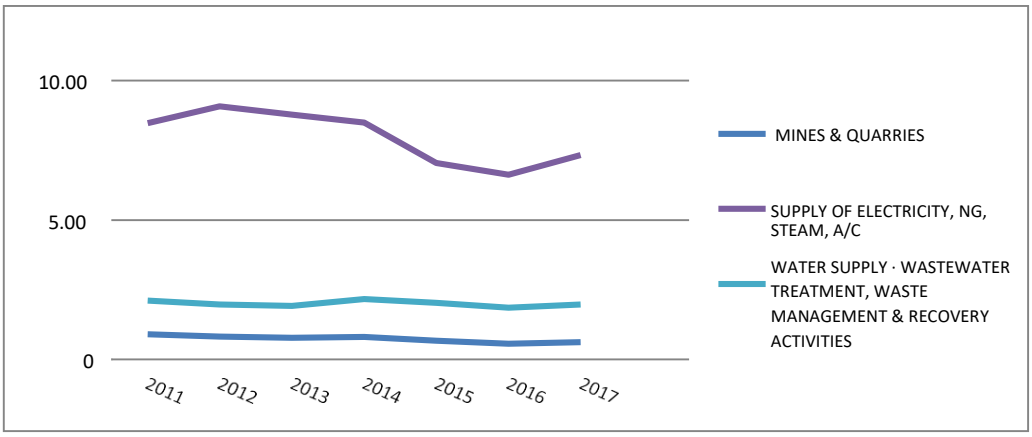
ECONOMIC ACTIVITY		NUMBER OF LEGAL UNITS		TURNOVER (in thousand euros)		TOTAL EMPLOYMENT	
Code NACE Rev.2	Description		% OF THE TOTAL		% OF THE TOTAL		% OF THE TOTAL
A	AGRICULTURE, FORESTRY AND FISHING	528.632		7.668.998		516.082	
B	MINING AND QUARRYING	625	0,07%	700.291	0,2%	5.722	0,2%
C	MANUFACTURING	58.300	6,70%	56.309.298	20,1%	326.335	8,9%
D	ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY	7.326	0,84%	21.641.813	**7,7**%	31.846	0,9%
E	WATER SUPPLY; SEWERAGE, WASTE MANAGEMENT AND REMEDIATION ACTIVITIES	1.970	0,23%	1.756.777	0,6%	17.113	0,5%
F	CONSTRUCTION	62.749	7,2%	10.009.648	3,6%	124.224	3,4%
G	WHOLESALE AND RETAIL TRADE; REPAIR OF MOTOR VEHICLES AND MOTORCYCLES	234.733	27,0%	111.465.618	39,7%	696.823	19,0%
H	TRANSPORTATION AND STORAGE	61.152	7,0%	14.902.837	5,3%	178.495	4,9%
I	ACCOMMODATION AND FOOD SERVICE ACTIVITIES	111.780	12,8%	11.807.010	4,2%	531.718	14,5%
J	INFORMATION AND COMMUNICATION	17.020	2,0%	9.855.714	3,5%	82.696	2,3%
K	FINANCIAL AND INSURANCE ACTIVITIES		0,0%	13.248.989	4,7%	84.093	2,3%
L	REAL ESTATE ACTIVITIES	9.673	1,1%	1.461.351	0,5%	18.116	0,5%
M	PROFESSIONAL, SCIENTIFIC AND TECHNICAL ACTIVITIES	138.195	15,9%	8.563.601	3,1%	233.353	6,4%
N	ADMINISTRATIVE AND SUPPORT SERVICE ACTIVITIES	20.183	2,3%	6.232.240	2,2%	136.509	3,7%
O	PUBLIC ADMINISTRATION AND DEFENCE; COMPULSORY SOCIAL SECURITY	989	0,1%	445.596	0,2%	421.176	11,5%
P	EDUCATION	20.517	2,4%	1.140.472	0,4%	345.915	9,4%
Q	HUMAN HEALTH AND SOCIAL WORK ACTIVITIES	57.629	6,6%	3.914.341	1,4%	261.147	7,1%
R	ARTS, ENTERTAINMENT AND RECREATION	20.857	2,4%	5.848.373	2,1%	64.986	1,8%
S	OTHER SERVICE ACTIVITIES	37.574	4,3%	1.219.651	0,4%	91.617	2,5%
W	UNKNOWN ACTIVITY	8.749	1,0%	24.335	0,0%	10.233	0,3%
		870.021		280.547.954		3.662.117	
Total		**1.415.370**		**288.216.952**		**4.178.199**	

Source: ELSTAT

The energy sector, while not participating with high percentages in the employment figures and number of economic units, nevertheless, realized 7.7% of total turnover (estimated € 21.6 billion). If we include part of the activities included in the categories of mining and water management, but also other indirect participations in the manufacturing sector, it appears that the contribution of the sector may amount to 10.0% of the total economic activity (contribution to value added).

It is also clear that due to the economic scale and volume of investments required, the mining, energy, water management and related sectors include mainly bigger economic units. In 2017, 625 companies in the mining and quarrying sector, 7,326 companies in the energy supply, but also 1,970 companies in the supply of water and waste management services were registered in the NACE 2 categories of ELSTAT.

Diagram 2 - Number of Companies in the Energy Sector of Greece, 2011-2017



Source: ELSTAT

During the last economic crisis (starting from 2008), the total GDP of the country lost (2008-2016) more than 25% of its value, at constant prices, while the energy sector as a whole showed a significant increase in terms of produced value added (from € 12.8 billion in 2011 to € 21.6 billion in 2017, according to the latest available data), with projections showing a new increase over the next few years. In individual sectors the significant decline of the lignite mining sector[21], which amounted to -44.1% in terms of turnover index in industry and -58.3% in terms of industrial production index, is noted.

A similar trend is recorded for sector E, water and waste management, without, however, this change in terms of value being capitalized at the level of employment (in the energy sector there is a decline of up to 25% of staff).

Table 6 - Turnover of Companies in the Energy Sector in Greece, 2011-2017

ECONOMIC ACTIVITY		TURNOVER (mil €)						
NACE Rev .2	**Description**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**
B	MINES & QUARRIES	730,7	636,8	690,2	800,4	704,9	622,5	700,3
C	PROCESSING	61.683,6	61.003,4	57.843,0	58.080,4	54.236,5	51.708,6	56.309,3
D	SUPPLY OF ELECTRICITY, NG, STEAM AND AIR CONDITIONNING	12.858,8	16.930,7	16.375,1	17.024,1	19.777,2	18.457,5	21.641,8
E	WATER SUPPLY · WASTEWATER TREATMENT, WASTE MANAGEMENT & RECOVERY ACTIVITIES	1.464,0	1.437,4	1.591,4	1.418,9	1.519,1	1.585,2	1.756,8

Source: ELSTAT

[21] Cf. Press Release, Industrial Production Index, https://www.statistics.gr/el/statistics/-/publication / DKT21/-

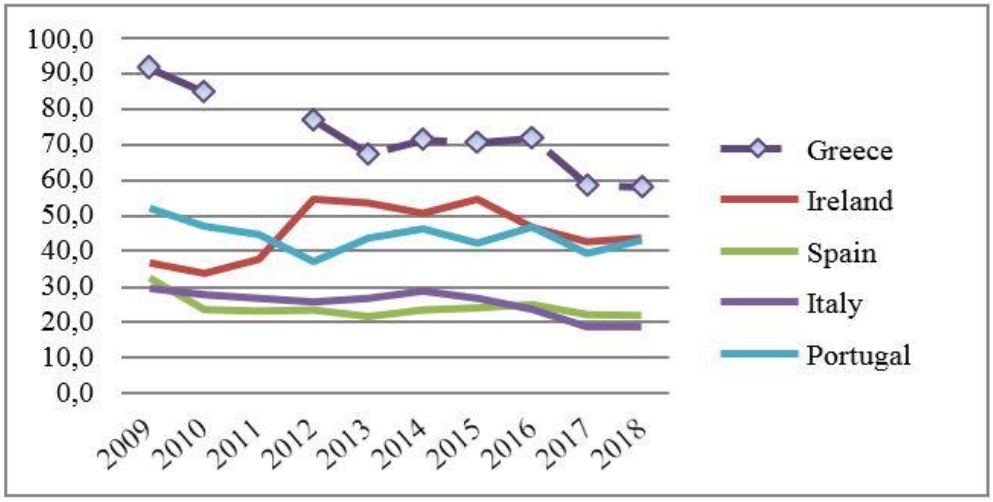
Table 7 - Number of employees in Energy Companies in Greece, 2011-2017

ECONOMIC ACTIVITY		EMPLOYEES (thousand)						
NACE Rev .2	Περιγραφή	2011	2012	2013	2014	2015	2016	2017
B	MINES & QUARRIES	6,5	5,7	6,6	6,8	5,9	5,7	5,7
C	PROCESSING	382,4	342,1	337,9	335,3	309,0	329,1	326,3
D	SUPPLY OF ELECTRICITY, NG, STEAM AND AIR CONDITIONNING	40,8	38,0	36,2	33,8	30,5	32,7	31,8
E	WATER SUPPLY · WASTEWATER TREATMENT, WASTE MANAGEMENT & RECOVERY ACTIVITIES	16,8	15,3	15,9	17,8	16,8	17,0	17,1

Source: ELSTAT

The energy sector in Greece is dominated by the presence of PPC, whose production share rose to 90% in the late 2000s, while today it has fallen to 70.54% in dispatched units, as a result of the general liberalization of the energy market, with more companies entering the market. However, compared to other countries with similar "homogeneous" economic characteristics, it seems that the strong leadership position in the market is maintained by the national energy supplier, both in terms of distribution to businesses and households.

Diagram 3 - Market Share (%) of the Largest Electricity Producer in Selected Countries of Europe, 2009-2018



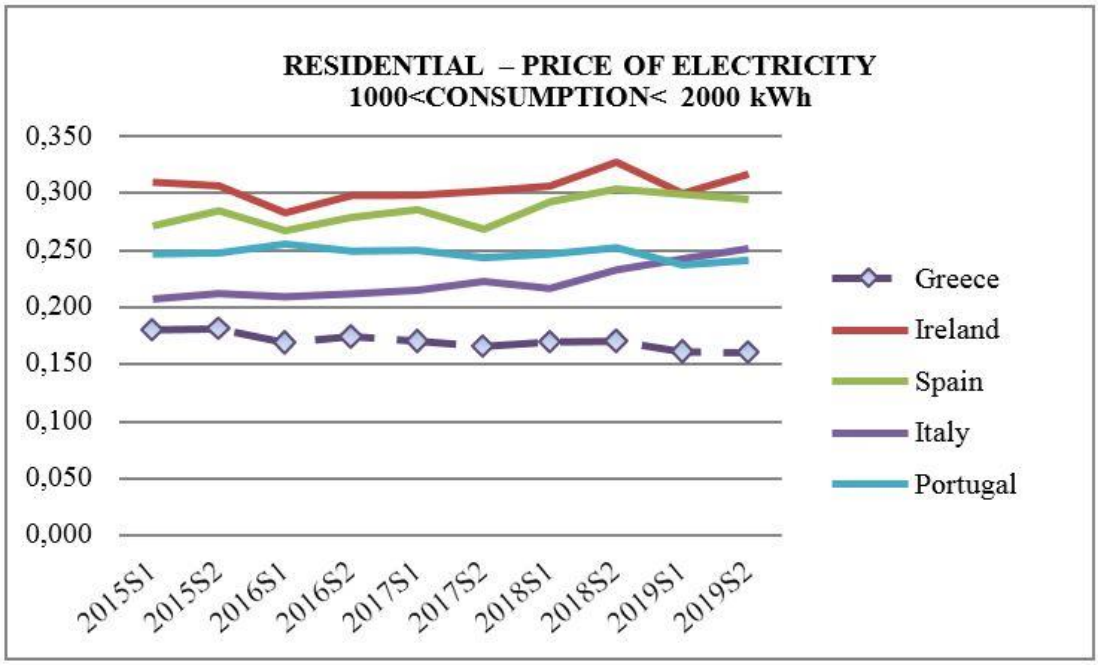
Source: Eurostat

According to the latest published annual report[22], the PPC group made investments, in 2018, worth € 746.7 million, maintaining a high sales share (81.9%), a percentage that corresponded to 6.9 million consumers, individuals and legal entities. An important parameter that determines the level of quality of life, but also the competitiveness of an economy, is the cost of energy for households (household

[22] https://www.dei.gr/el/i-dei/enimerwsi-ependutwn/etisia-deltia/etisios-apologismos-2018

consumers) and businesses. In recent years, the average price per kilowatt hour for Greek households has decreased (despite relative taxation), widening the gap with other EU countries.

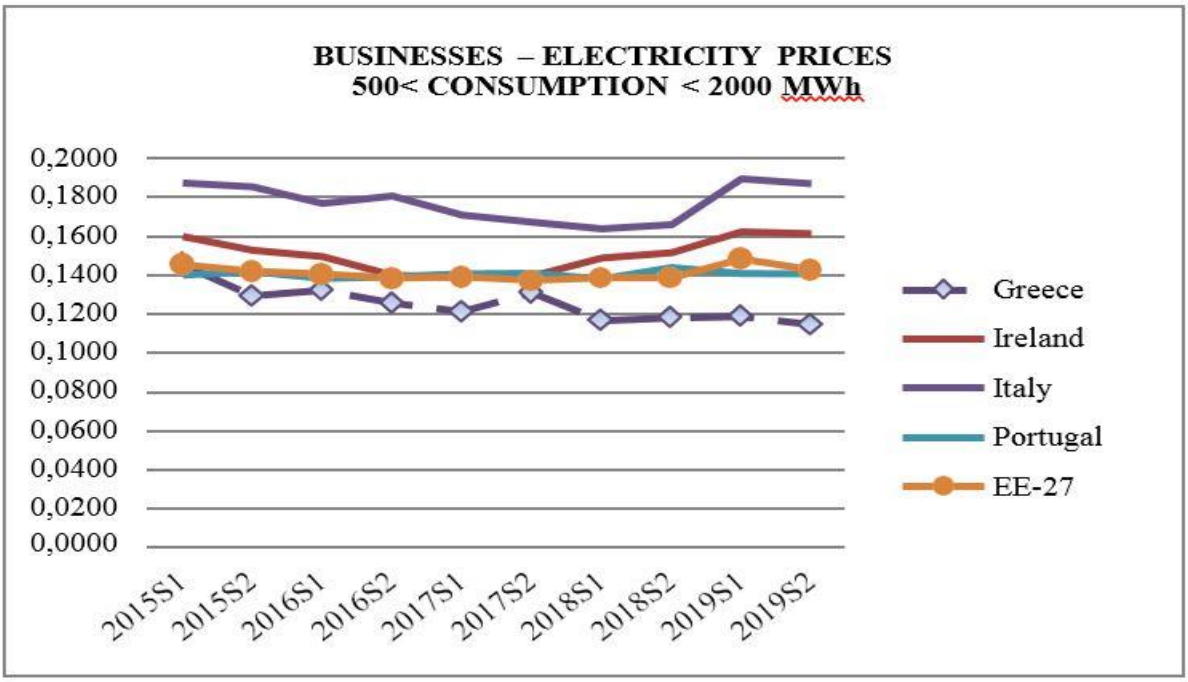
Diagram 4 - Household Electricity Prices in Selected European Countries, 2015-2019



Source: Eurostat

Respectively, the cost of electricity for companies in the intermediate consumption category fell to € 0.1149 / MWh, while, in 2015, it was at the European average (€ 0.1457 / MWh).

Diagram 5 - Electricity Prices in Businesses in Selected Countries of Europe,2015-2019



Source: Eurostat

Although the country is in the top three in the EU, in terms of the amount of environmental taxes it imposes, it nevertheless remains below the average in electricity consumption tax[23]. Table 8 presents the total amount of energy and transport taxes recorded based on all economic activities, but also the consumption of household customers.

Table 8 - Total Amount of Energy and Transport Taxes per Economic Activity and Consumption of Household Customers in Greece

Centralized classification of economic activities NACE Rev.2	Energy Taxes	Transportation Taxes	TOTAL
Agriculture, fisheries & forestry	365,55	111,83	477,38
Mines & quarries	24,56	1,27	25,83
Processing	622,46	34,75	657,21
Electricity, gas, steam supply & related activities	372,07	2,07	374,14
Water supply, wastewater management, waste & related activities	148,69	3,42	152,11
Constructions	44,98	37,70	82,68
Wholesale & retail trade; repair of motor vehicles & motorcycles	256,15	104,68	360,83
Transport & storage	852,24	48,06	900,30
Services (except wholesale & retail, transport & storage)	550,20	156,76	706,96
Total activities	3.236,90	500,54	3.737,44
Households	2.485,08	939,46	3.424,54
Total energy taxes	**5.721,98**	**1.440,00**	**7.161,98**

Source: ELSTAT

The sharp decline of GDP, rising unemployment and the consequent decline in disposable income have led to a significant increase in the overdue debts of households and businesses on energy bills, respectively. From 2008 to 2015, the percentage of overdue debts more than doubled and remained at 35.6% in 2018.

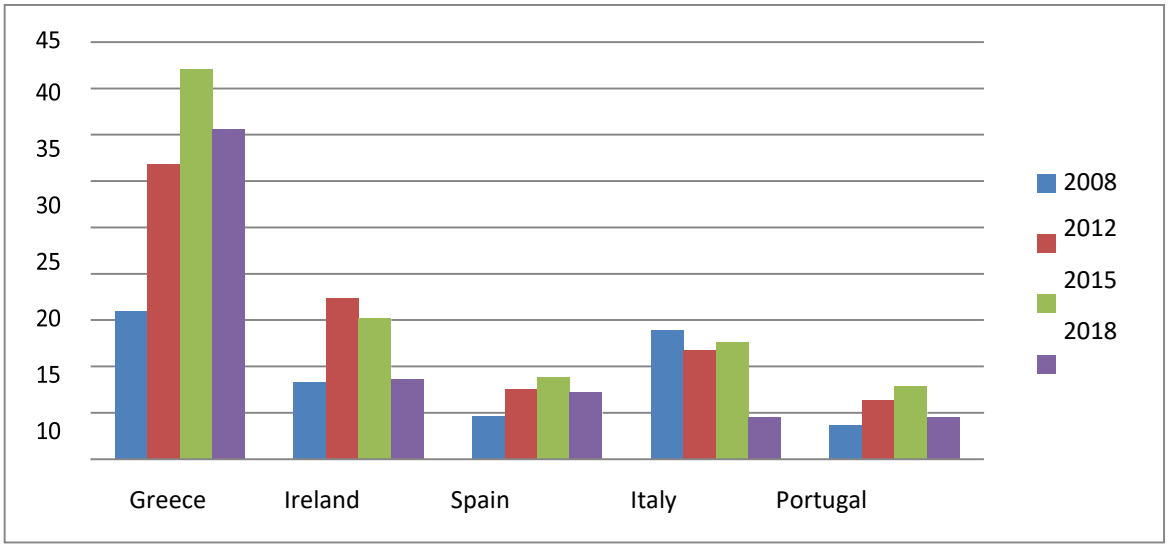
Similar trends appeared in other countries under financial supervision, but, nevertheless, the volume of change was less high. In addition, according to primary data from a field research of IME GSEVEE on the overdue debts of small and medium enterprises[24], it appears that 15% of companies has arrears on electricity and gas bills.

According to PPC data, its overdue receivables from consumers in February 2020 amounted to € 2.8 billion, while 140,000 arrangements had been launched for amounts of € 230 million.

[23] https://ec.europa.eu/eurostat/statistics-explained/index.php/Electricity_price_statistics#Electricity_prices_for_household_consumers

[24] IME GSEVEE, "Semi-annual depiction of economic climate in small businesses" - July 2019, https://imegsevee.gr/%CE%B4%CE%B7%CE%BC%CE%BF%CF%83%CE%B9% CE % B5% CF% 8D% CF% 83% CE% B5% CE% B9% CF% 82 /% CE% B5% CE% BE% CE% B1% CE % BC% CE% B7% CE% BD% CE% B9% CE% B1% CE% AF% CE% B1- % CE% B1% CF% 80% CE% BF% CF% 84% CF% 8D% CF% 80% CF% 89% CF% 83% CE% B7- % CE% BF% CE% B9% CE% BA% CE% BF% CE% BD% CE% BF% CE% BC% CE% B9% CE% BA% CE% BF% CF% 8D- % CE% BA% CE% BB% CE% AF% CE% BC% CE% B1% CF% 84% CE% BF% CF% 82-% CE% B9% CE% BF% CF% 8D% CE% BB% CE% B9% CE% BF% CF% 82-2019

Diagram 6 - Evolution of Overdue Energy Bills in European Countries in Adjustment Schedule, 2008, 2012, 2015, 2018



Source: Eurostat

The financial crisis, the accumulated debts, the new regulatory environment of the energy market and the delignification process create new challenges for the PPC group. According to the annual report, in 2018, the PPC group employed 15,526 employees. In 2020, entering the new phase of restructuring, PPC employs approximately 4,350 employees in stations and mining production.

In the process of restructuring the group, there is the implementation of an extended voluntary exit program on the horizon. In fact, PPC's Business Plan envisages the departure of 4,500 people, by 2024, but, also, the hiring of 800 employees – mainly young qualified scientists and engineers. To these will be added 1,300 departures of staff working through mining contractors.

Therefore, the total number of employees who will be removed from PPC, in Western Macedonia and Megalopolis, and will be available in the labour market is estimated to 5,000, by 2024.

Table 9 - PPC Human Resources Serving in Production Stations and Mines, May 2020 and Number of Subcontractors in the Period 2015-2019

Number of PPC's Subcontractor Companies over the last 5 Years that Work on Production and Transportation of Lignite and Estimates of their Number of Employees						
Year	*2015*	*2016*	*2017*	*2018*	*2019*	*Five-Year Average*
LKDM	*1.900*	*1.265*	*1.682*	*1.591*	*1.365*	*1.560*
Megalopolis	*350*	*244*	*253*	*295*	*364*	*300*

Human Resources Serving in Power Plants and Mines			
Time period	*Regular Staff*	*Temporary Staff (8-month contract)*	*Total Number of Employees on average*
Megalopolis A' TPP	*154*	*0*	*154*
Megalopolis B' TPP	*111*	*0*	*111*
Mines of Megalopolis	*473*	*11*	*484*
Lignitiki Megalopolis	**738**	**11**	**749**
South Field Mine Branch	*734*	*96*	*830*
Main Field Mine Branch	*313*	*49*	*362*
Kardia Field Mine Branch	*355*	*6*	*361*
Amyntaio Field Mine Branch	*202*		*202*
LKDM Support Units	*424*	*106*	*530*
Total of LKDM	**2.028**	**257**	**2285**
Agios Dimitrios TPP	*423*	*46*	*469*
Kardia TPP	*258*	*70*	*328*
A-F TPP	*243*	*46*	*289*
Meliti TPP	*194*	*49*	*243*
Total of TPPs	**1.118**	**211**	**1329**
SUMMARY OF EMPLOYEES BY EMPLOYMENT TYPE & TOTAL	**3.884**	**479**	**4.363**

Source: PPC

Domestically, the energy industry has, until recently, relied on lignite mining, which typically takes place in 2 of the 3 areas under study in the country. The regions of Western Macedonia and Central Peloponnese support a large part of the business activity in energy sector, i.e. in the production of electricity from the major lignite thermal power plants of Ptolemaida, Kardia, Meliti Florina and Amyntaio, as well as Megalopolis in Arcadia, Peloponnese.

In addition, the regions of Crete, the SE and NE Aegean (for the purposes of the study will be referred to as the Aegean Region, NUTS1) participate in the production of energy through the operation of existing oil power plants that use imported oil. Recently, (2019), a financing program for the electricity interconnection between mainland Greece and Crete was signed with the European Investment Bank. The new interconnection is expected to cover up to 40% of the demand for electricity in Crete, but also to create the conditions for the utilization of economies of scale, from the rapid development of renewable energy sources, in Crete and the Aegean islands.

Recent developments, at European level, form a new framework for public and private sector activity in the energy sector, with a view to achieving sustainable development standards and minimizing the effects of the climate crisis. With the ratification of the Green Deal[25]a breakthrough is made in the environmental and energy policy of the EU Member States, as the latter agreed as a strategic priority to achieve environmental neutrality in Europe by 2050. To achieve this, investment planning and a financing mechanism of approximately € 1 trillion, with a combination of public, private and syndicated financial resources are required.

In this context, the Plan for the Just Transition[26] of areas dependent on energy production methods that are more closely linked to the exploitation of fossil fuels and the emission of harmful gaseous pollutants has been developed. The Just Transition Mechanism will provide financial and technical support to areas exposed to immediate transformation, in order to minimize labour market consequences and channel the appropriate investment mix.

In line with European developments, the drafting and ratification of the National Energy and Climate Plan[27] (which has been the result of extensive consultation in recent years) and in order for the country to align its development strategy with the Green Deal, a number of intermediate objectives were set in order to achieve its smooth and efficient transition to a new model of energy and environmental neutrality,

This intermediate goal focuses on the complete decarbonisation of the country forward by 2028, the substitution of energy production and the use of gas and RES, as well as policies that will focus on energy savings, the circular economy, green public procurement, the new spatial planning of RES. All of the above accelerates the need to intervene and promote the appropriate structural and productive reforms to be carried out in regions where mining and energy production have been a key driver of growth.

Below there is a brief overview of the geo-economic, demographic and sectoral characteristics of the areas under study, in order to diagnose specific problems and identify some areas and scenarios of

[25] https://www.consilium.europa.eu/el/policies/green-deal/
[26] Just Transition mechanism, https://ec.europa.eu/commission/presscorner/detail/en/ip_20_930
[27] Law 4893 / 31-11-2019

intervention, on which the new energy policy of the country could be designed and built, with emphasis on the development character of the sector, but also its contribution to shaping a Just Transition path, which will include tackling the violent transformation in the labour market that will occur, alleviating the effects of energy poverty and inequalities in access to cheap energy by companies and households. Each region is distinguished by special and differentiated characteristics in terms of demographic, sectoral and productive structure, which should be analysed in order to formulate appropriately tailored policies.

Table 10 - Gross Added Value in Greece and the Energy Transition Areas, 2008-2017

Gross Added Value (mil €)										
REGIONS	**2008**	**2009**	**2010**	**2011***	**2012***	**2013***	**2014***	**2015***	**2016***	**2017***
Greece	213,82	212,39	199,64	181,91	168,98	160,24	157,91	156,61	154,04	157,53
Aegean islands Crete	20,77	20,12	18,80	16,93	15,56	15,19	15,36	15,47	14,99	15,49
Western Macedonia	4,24	4,51	4,40	4,23	4,18	3,90	4,00	3,83	3,42	3,47
Peloponnese	8,93	8,86	8,33	7,74	7,31	6,96	6,86	6,92	6,88	7,02

Source: ELSTAT

2.1. Geographical - Economic Description of Areas in Transition (Western Macedonia, Megalopolis, North Aegean, South Aegean, Crete)

Geographical and Demographic Structure

(a) Western Macedonia

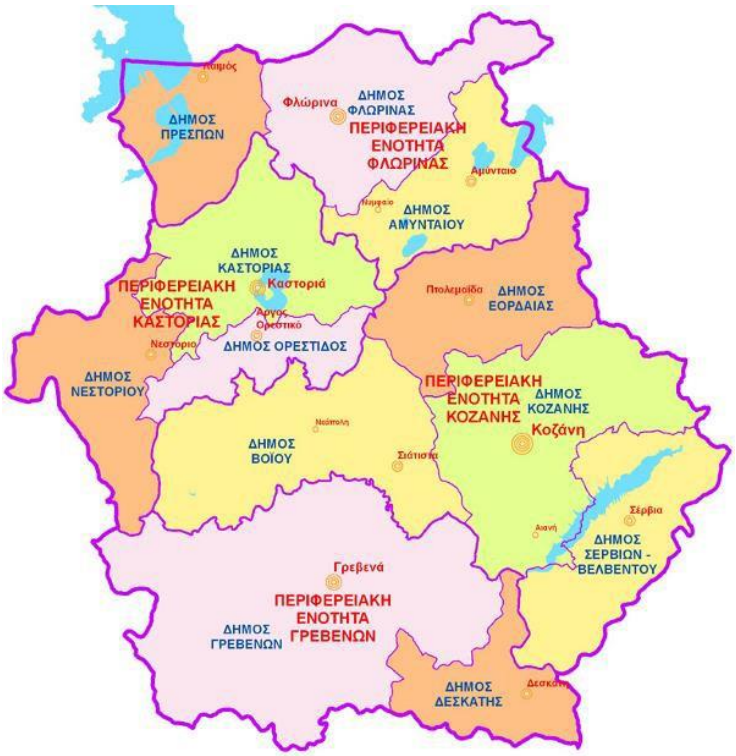
The region of Western Macedonia consists of the distinct regional units of Florina, Kozani, Grevena and Kastoria. The seat of the Region is the city of Kozani.

It is the region of the country, which covers the north-western part of Greece, bordering Albania and North Macedonia, in terms of external borders, while inland it borders west with Epirus, east with Central Macedonia and in the south it borders with Thessaly. In total, Western Macedonia extends to 9.5 sq.km and the population amounts to 268,800 people (ELSTAT, 2019).

The region of Western Macedonia hosts the homonymous university, based in Kozani, which incorporated also the former Technological Educational Institution of Western Macedonia, based in Florina. Today, the University of Western Macedonia[28] has 22 Departments, divided into 7 faculties, located in 5 different cities (Kozani, Florina, Kastoria, Ptolemaida, Grevena).

[28] https://uowm.gr/to-panepistimio/istoria/

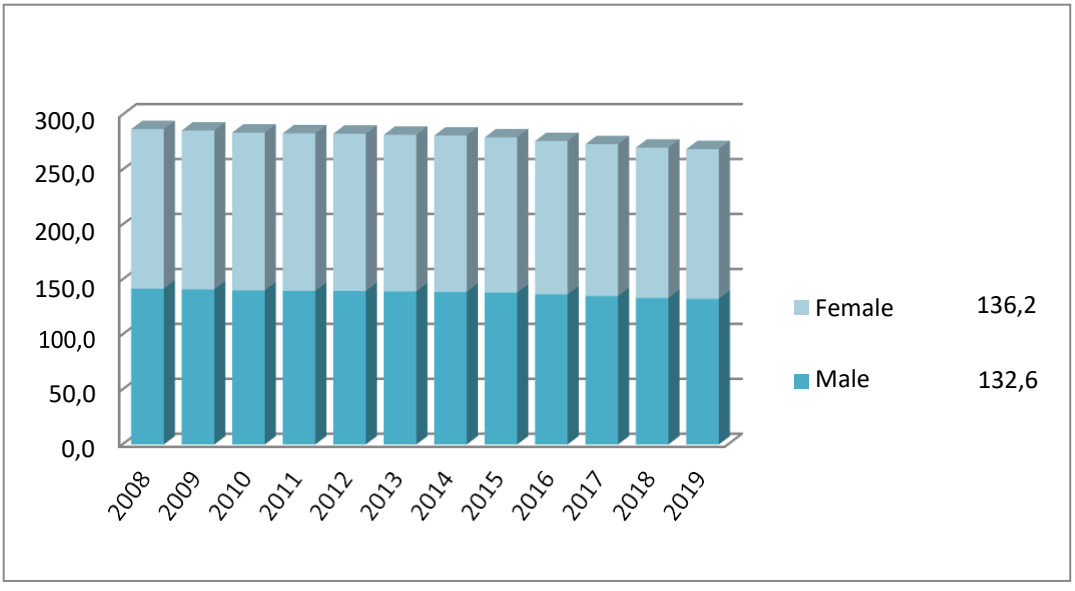
Map 1 - Regional Units of Western Macedonia



Source: Region of West Macedonia

In the last decade, the population of the area has been steadily declining (from 287,000), cumulatively approaching 7%. The male-female ratio in the total population remains stable, recording a slight difference in favour of the female sex. Maintaining the productive structure in the midst of the crisis has undoubtedly sustained this relatively small rate of population contraction, even though it has long been one of the regions with the highest unemployment rates, both in the country and compared to other regions in Europe.

Diagram 7 - Evolution of Population Composition of Western Macedonia, 2008-2019



Source: ELSTAT

Thus, while the absolute number of the workforce decreased by only 4,000, during the period 2008-2019, nevertheless the number of employees decreased significantly (by 17,400 people). Part of this loss is now recorded as unemployed (increased by 13,400 people), while the rest either migrated, became inactive or died.

Table 11 - Employment Status in Western Macedonia, 2008-2019

EMPLOYMENT STATUS	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Workforce	119,4	121,7	118,4	117,7	114,3	112,6	113,9	117,3	118,0	119,2	118,2	115,4
Employed	104,5	106,5	100,2	90,6	80,4	77,1	82,5	81,2	81,1	84,5	86,2	87,1
Unemployed	14,9	15,1	18,2	27,1	33,9	35,5	31,4	36,0	36,9	34,7	31,9	28,3
Inactive	124,2	121,0	122,8	123,4	127,1	128,2	126,5	122,3	119,0	115,7	114,9	116,9

Note: The discrepancies of the above Table in comparison with Tables 48 and 73 are due to the methodological differences of the ELSTAT data collection surveys.

Source: ELSTAT

In contrast to the marginal changes in the total population, during the recent economic crisis, the age structure of the area changed significantly. In essence, this is a tangible version of demographic aging at the local level. The age structure, as described in the table below, shows a significant decrease in population at the so-called "productive ages" (20-44 years), as well as a decline in births within a decade (a decrease of 7,000 in the 0-14 age group). On the contrary, the population is increased in the category 45-64 and 65+.

Table 12 - Age Distribution Status in Western Macedonia, 2008-2019

AGE DISTRIBUTION	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
0-14	43,5	43,1	42,6	42,0	41,5	41,1	40,8	40,0	39,2	38,4	37,1	36,5
15-19	15,3	13,9	15,2	16,0	17,0	17,4	16,3	14,0	14,9	16,0	16,3	17,0
20-24	15,6	16,2	14,4	13,4	12,3	11,5	12,1	14,2	12,9	11,6	11,4	10,7
25-29	18,4	17,9	17,2	16,0	17,0	16,8	15,7	16,0	13,7	14,8	13,5	12,6
30-44	61,8	61,4	60,4	60,0	57,1	55,6	55,5	53,3	53,6	50,5	49,5	48,7
45-64	70,6	71,4	72,1	73,4	74,9	75,6	76,1	77,4	78,1	78,8	79,2	79,6
65+	61,8	61,9	61,9	62,4	63,1	63,9	64,7	64,5	63,7	63,1	63,1	63,7

Source: ELSTAT

Educational Profile

Regarding the educational level of the residents of Western Macedonia, we observe a significant change in the distribution of the population, as in the lower category we have a decline of 50% of the population declaring primary to lower secondary education, and at the same time there is an increase of 16,200 people, who completed postsecondary education, and 9,500 people graduated from a higher education

institution - University. This change may reflect a strong potential production capacity of the existing workforce, which must be exploited in the sectoral restructuring and transition phase of the region.

Table 13 - Educational Level Status of Residents in Western Macedonia, 2008-2019

EDUCATION LEVEL	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Primary-Secondary (0-2)	51,80	47,90	46,30	44,40	45,30	42,80	42,60	41,10	38,80	34,90	32,60	26,00
Post-Secondary (3-4)	30,70	34,80	35,40	36,50	36,90	37,10	35,10	36,90	39,30	40,60	41,40	46,90
University (5-8)	17,60	17,30	18,40	19,10	17,80	20,10	22,30	21,90	21,80	24,50	26,00	27,10

Source: ELSTAT

Health Profile

In terms of capturing the health profile of the population, it is observed that Western Macedonia, after 2014, maintains a consistently small difference in life expectancy compared to the general population of Greece, which is expanding in the last 2 years. Women's life expectancy is 5 years higher in this Region.

Table 14 - Life Expectancy in Western Macedonia, 2008-2018

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GREECE	80,2	80,4	80,6	80,8	80,7	81,4	81,5	81,1	81,5	81,4	81,9
WESTERN MACEDONIA	80,3	80,4	80,9	81,1	80,9	81,3	82,2	81,5	81,8	82,2	83,0
MALE	77,9	78,0	78,7	78,3	78,6	79,1	79,9	79,5	79,6	80,0	80,6
FEMALE	82,8	83,0	83,4	84,2	83,3	83,6	84,7	83,7	84,1	84,6	85,4

Source: Eurostat

Regarding the general picture of the population morbidity, we observe that Western Macedonia has higher rates of death, due to general causes and neoplasms, however the picture is completely different when compared to respiratory diseases. Possible replacement of the latter category of disease by precursor neoplasms may explain the large difference.

Table 15 - Causes of Death (per 100,000 inhabitants) in Western Macedonia, 2011-2017

	2011*	2012*	2013*	2014*	2015*	2016*	2017*
of any reason							
GREECE	994,02	1.047,65	1.013,69	1.039,46	1.115,9	1.097,5	1.150,56
Western Macedonia	1.091,1	1.153,62	1.134,5	1.132,71	1.222,68	1.179,47	1.247,2
from neoplasms							
GREECE	245,36	253,91	262,37	266,88	274,18	278,53	277,05
Western Macedonia	258,11	268,56	291,79	296,87	295,86	280,56	299,83
from respiratory diseases							
GREECE	92,67	102,34	99,17	116,93	136,86	128,03	128,26
Western Macedonia	66,01	80,78	85,19	81,42	120,31	106,72	102,77

Source: Eurostat

(b) Peloponnese

The Peloponnese Region includes the regional units of Arcadia, Argolida, Corinthia, Laconia and Messinia. The prefectures of Achaia and Ilia belong geographically and historically to the Peloponnese, administratively, however, they belong to the Region of Western Greece. The seat of the Region is the city of Tripoli. The city of the region with the largest population is Kalamata, Messinia.

The Region is surrounded to the west by the Ionian Sea and borders to the northeast with the region of Attica, while on the east coast it is surrounded by the Myrtoon Sea. Its territory has a total area of 15,490 sq.km.

The region hosts a higher university institution, the University of Peloponnese, based in Tripoli, founded in 2003 and with L.4610/2019 incorporated the School of Technological Applications that belonged to the Technological Educational Institute of Patras. In the current period, it has 9 schools with 22 departments, distributed in 6 cities of the region (Kalamata, Corinth, Nafplio, Patras, Sparta, Tripoli).

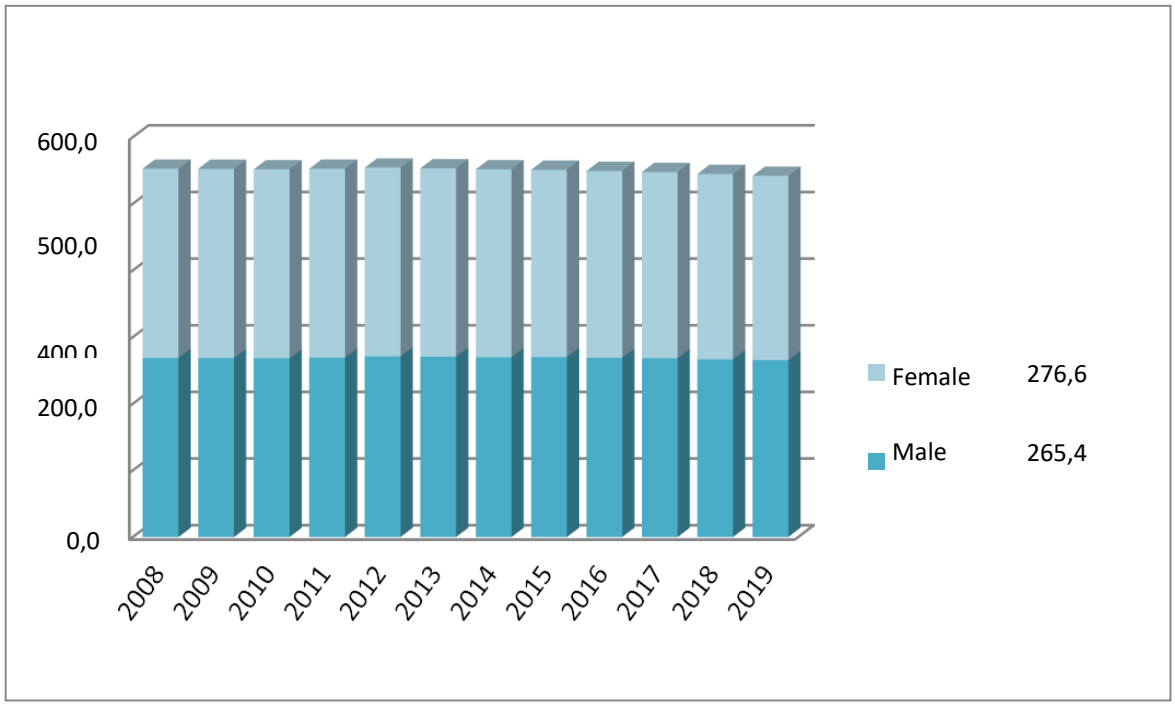
The Peloponnese has some strong competitive advantages such as proximity to the metropolitan center of Attica, large infrastructure and transport networks and integrates a skilled workforce in the tourism and agri-food sectors.

Map 2 - Regional Units of Peloponnese Region (Achaia & Hlia are excluded)

Source: Peloponnese Region

The Peloponnese has a population of 542,000, of which the majority are women (276,000). During the last decade, there has been a significant change in the population structure, while the contraction of the total population was about 5%.

Diagram 8: Evolution of Population Composition of the Peloponnese Region,2008-2019



Source: ELSTAT

The labour force of the region shrank by 6,700 people, while the employed category suffered the largest decrease (by 29,000 people), consisting partly of the population which moved to the category of unemployed and partly of inactive population (10,700 and 11,600 people respectively).

Table 16 - Employment Status in the Peloponnese Region, 2008-2019

EMPLOYMENT STATUS	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Workforce	472,0	471,4	470,3	471,4	473,2	472,6	471,7	471,6	469,8	468,5	466,8	465,3
Employed	240,4	238,7	228,8	214,1	197,2	191,3	188,7	193,2	196,3	205,0	208,2	211,4
Unemployed	18,1	20,5	24,4	34,1	46,9	53,8	57,5	55,4	46,7	41,5	34,9	28,8
Inactive	213,5	212,2	217,1	223,2	229,1	227,6	225,6	222,9	226,9	222,0	223,7	225,1

Source: ELSTAT

The age structure is characterized by a significant shift in the number of inhabitants belonging to the productive age of 20-44 years, in the population category of 45-64 and 65+, an indication that strengthens the argument of demographic aging in the Peloponnese Region.

Table 17 - Age Distribution Status in the Peloponnese Region, 2008-2019

AGE DISTRIBUTION	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
0-14	80,6	81,1	81,4	81,3	81,1	80,6	79,9	79,5	79,5	79,2	78,0	76,7
15-19	24,9	23,5	21,4	25,6	24,8	23,2	21,4	22,4	24,3	22,3	24,0	26,2
20-24	19,3	19,4	20,3	16,0	17,4	18,3	19,2	17,9	14,3	15,2	13,4	11,1
25-29	33,4	32,0	30,9	29,8	31,7	29,6	27,6	27,8	24,8	25,3	24,4	20,4
30-44	120,6	121,5	121,3	121,1	117,7	117,0	116,0	114,3	115,7	113,3	111,2	111,6
45-64	147,3	148,9	150,0	151,3	152,6	153,8	155,1	156,6	158,3	159,7	160,6	161,5
65+	126,5	126,1	126,3	127,5	129,1	130,8	132,4	132,6	132,5	132,6	133,2	134,6

Source: ELSTAT

Educational Profile

Regarding the educational profile of the inhabitants of the Region, there is a significant shift of population groups from the category of primary and secondary education (decrease by 17,000), to the categories of post-secondary and tertiary education. The strengthening of the educational profile highlights the possibilities of utilization and deepening of the cognitive abilities and skills of the population, in view of the transition to a new "Green Environment ".

Table 18 - Educational Level of Residents in the Peloponnese Region, 2008-2019

EDUCATION LEVEL	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Primary-Secondary (0-2)	46,70	47,60	46,20	43,70	41,00	40,60	39,80	37,90	34,90	32,50	33,50	29,50
Post-secondary (3-4)	36,50	37,40	38,40	39,00	41,30	40,30	41,00	41,40	43,70	44,50	42,70	46,70
University (5-8)	16,90	15,00	15,50	17,30	17,70	19,10	19,30	20,80	21,40	23,00	23,80	23,80

Source: ELSTAT

Health Profile

The Peloponnese follows the same trend of development as the country average in terms of life expectancy of its inhabitants (the difference is consistently marginal without ever exceeding 0.6 years). Women record a difference to their life expectancy compared to men in the Peloponnese region of over 5 years.

Table 19 - Life Expectancy in the Peloponnese Region, 2008-2018

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GREECE	80,2	80,4	80,6	80,8	80,7	81,4	81,5	81,1	81,5	81,4	81,9
PELOPONNESE	80,8	80,6	80,9	81,2	80,7	82,0	82,0	81,3	82,3	81,8	82,1
MALE	77,9	77,8	78,4	78,5	78,1	79,6	79,7	79,0	79,8	79,4	79,4
FEMALE	83,9	83,6	83,7	84,3	83,6	84,6	84,5	83,8	84,9	84,4	85,1

Source: Eurostat

Despite the positive deviation from the Greek average in terms of life expectancy, the Peloponnese records worse performance in terms of death rates in all cases under study. Both in the general category and in the percentage of deaths from neoplasms and respiratory diseases, the Peloponnese

shows a significant deviation. In the latter category of respiratory diseases, the deviation is close to 50 points, based on the population. This condition may be related to the aging rate of the population.

Table 20 -Causes of Death(per 100,000 inhabitants) in the Peloponnese Region,2011-2017

	*2011**	*2012**	*2013**	*2014**	*2015**	*2016**	*2017**
Of any cause							
GREECE	994,02	1.047,65	1.013,69	1.039,46	1.115,9	1.097,5	1.150,56
Peloponnese	1.187,32	1.247,14	1.163,77	1.183,82	1.296,4	1.216,85	1.318,07
from neoplasms							
GREECE	245,36	253,91	262,37	266,88	274,18	278,53	277,05
Peloponnese	258,61	259,19	261,52	271,61	279,62	272,54	280,05
from respiratory diseases							
GREECE	92,67	102,34	99,17	116,93	136,86	128,03	128,26
Peloponnese	120,78	139,02	125,5	150,1	177,94	164,63	179,74

Source: Eurostat

(c) South Aegean - Crete

The geographical area of the Aegean and Crete islands is a statistical - not an administrative - region of one of the first four levels of NUTS analysis of the European Union and it belongs to the southernmost borders of the EU (Gavdos island). The Aegean islands and Crete have in total the longest coastline in Europe. The region of the Aegean and Crete islands is divided into three regions: the North Aegean Region, the South Aegean Region and the Region of Crete.

The North and South Aegean Regions border Turkey to the east, while the southern part of Crete borders to the Libyan Sea. In recent years, due to the intense mobility in the field of claiming hydrocarbon mining rights, there has been intense competition for securing maritime zones for exploitation by neighbouring countries (Turkey, Libya).

Map 3 - Regions of North and South Aegean Islands and Crete

South Aegean Region

North Aegean Region

Region of Crete

Sources: Websites of the Above Regions

The North Aegean Region, with Mytilene as its capital, is the least populous (2nd least in the country after the Ionian Islands), with 211,137 inhabitants and includes ten inhabited islands. Its total area, including many uninhabited islands, reaches 3,832 sq.km.

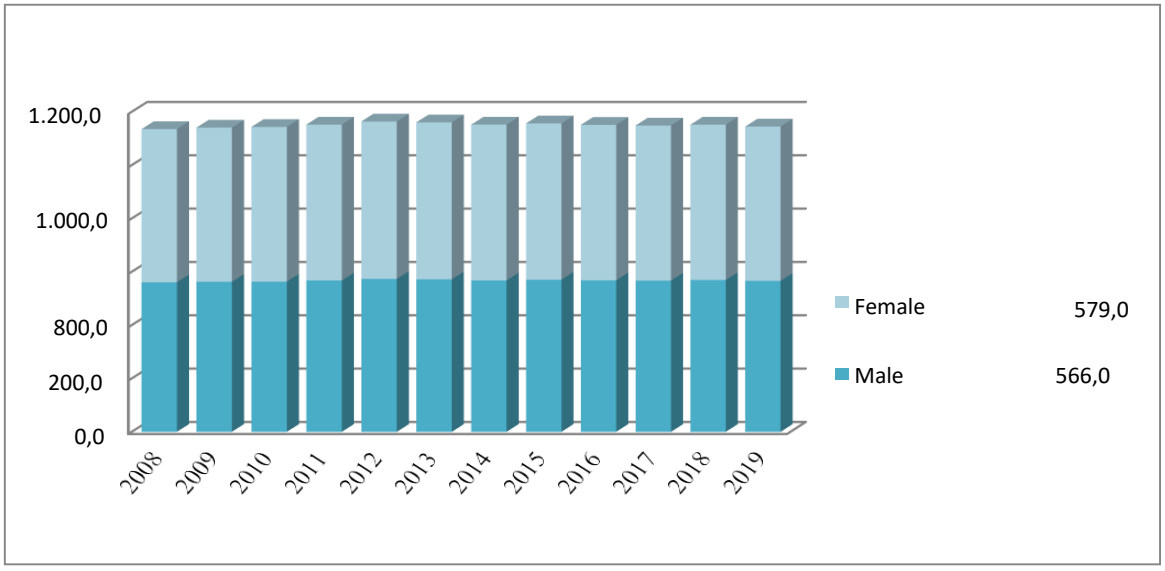
The Region of the South Aegean, with its capital in Ermoupolis, Syros, has a population of 340,870 inhabitants and an area of 5,286 sq.km.

Crete, with its capital Heraklion, is the most densely populated area of the complex with 633,506 inhabitants and covers an area of 8,303 sq.km.

These three regions are the only ones in the country where population growth has been recorded in the last five years.

The North and South Aegean host the University of the Aegean[29], which has 6 faculties and 18 academic departments, distributed in 6 cities of the regions (e.g. Mytilene, Samos, Chios, Rhodes, Syros). The Region of Crete has the University of Crete[30], which consists of 5 Schools and 16 academic departments, hosted in the cities of Heraklion and Rethymnon. Since 2008, there has been a marginal increase in the total population, evenly distributed between men and women (5,100 and 4,700 respectively).

Diagram 9 - Evolution of Population Composition of the Regions of North and South Aegean and the Region of Crete, 2008-2019



Source: ELSTAT

[29] http://www.aegean.gr/%CE%B9%CF%83%CF%84%CE%BF%CF%81%CE%B9%CE%B1
[30] https://www.uoc.gr/university/chronology

Despite the increase in population, the phenomenon of demographic aging of the workforce remains, as in the age group 20-44 years there is a significant decrease in population, which is absorbed by the increase in the age categories 45-64 and 64+.

Table 21 - Age Distribution Status (in thousands) of the North and South Aegean Regions and the Region of Crete, 2008-2019

AGE DISTRIBUTION	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
0-14	80,6	81,1	81,4	81,3	81,1	80,6	79,9	79,5	79,5	79,2	78,0	76,7
15-19	24,9	23,5	21,4	25,6	24,8	23,2	21,4	22,4	24,3	22,3	24,0	26,2
20-24	19,3	19,4	20,3	16,0	17,4	18,3	19,2	17,9	14,3	15,2	13,4	11,1
25-29	33,4	32,0	30,9	29,8	31,7	29,6	27,6	27,8	24,8	25,3	24,4	20,4
30-44	120,6	121,5	121,3	121,1	117,7	117,0	116,0	114,3	115,7	113,3	111,2	111,6
45-64	147,3	148,9	150,0	151,3	152,6	153,8	155,1	156,6	158,3	159,7	160,6	161,5
65+	126,5	126,1	126,3	127,5	129,1	130,8	132,4	132,6	132,5	132,6	133,2	134,6

Source: ELSTAT

Regarding the composition of the workforce, in the period 2008-2019, there is a decrease of 6,700 people in total, which reflects the intensity of demographic aging. A large decrease is recorded in the number of employed (by 29,000 people), which is distributed almost equally in the category of unemployed and inactive potential.

Table 22 - Employment Status of the North and South Aegean Regions and the Region of Crete, 2008-2019

EMPLOYMENT STATUS	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Workforce	472,0	471,4	470,3	471,4	473,2	472,6	471,7	471,6	469,8	468,5	466,8	465,3
Employed	240,4	238,7	228,8	214,1	197,2	191,3	188,7	193,2	196,3	205,0	208,2	211,4
Unemployed	18,1	20,5	24,4	34,1	46,9	53,8	57,5	55,4	46,7	41,5	34,9	28,8
Inactive	213,5	212,2	217,1	223,2	229,1	227,6	225,6	222,9	226,9	222,0	223,7	225,1

Source: ELSTAT

Educational Profile

Similar trends with the other regions are observed regarding the degree of educational mobility in this area. Between 2008-2019, there is a clear shift in the educational profile of the residents of the area, as the percentage of people who received primary to secondary education fell by 16,400 people, while in the categories of post-secondary education there is an increase of 9,000 people and in category of higher education by 7,600 people.

Table 23 - Educational Level of Residents of the North and South Aegean Regions and the Region of Crete, 2008-2019

EDUCATION LEVEL	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Primary-Secondary (0-2)	43,60	44,20	45,40	43,20	41,40	39,70	38,90	36,50	33,50	33,40	32,00	27,20
Post-secondary (3-4)	38,60	38,70	37,60	38,20	39,20	39,10	39,80	41,10	42,70	41,50	43,50	47,60
University (5-8)	17,80	17,10	17,00	18,60	19,40	21,20	21,30	22,40	23,80	25,10	24,50	25,20

Source: ELSTAT

Health Profile

The territory of the Aegean islands and Crete is characterized by significant differences in life expectancy compared to the general population. The gap between the life expectancy of men and women tends to consolidate at 5 years and is stable over time.

Table 24 - Life Expectancy of the North and South Aegean Regions and the Region of Crete, 2008-2018

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GREECE	80,2	80,4	80,6	80,8	80,7	81,4	81,5	81,1	81,5	81,4	81,9
AEGEAN ISLANDS - CRETE	81,1	81,2	81,3	81,5	81,3	82,2	81,9	81,7	82,1	81,9	82,7
MALE	78,5	78,4	78,7	78,8	78,6	79,6	79,3	79,3	79,8	79,3	80,2
FEMALE	84,0	84,2	84,1	84,3	84,1	84,9	84,7	84,3	84,5	84,6	85,2

Source: Eurostat

The wider geographical unit also tends to have a more positive health picture in terms of death rates in the general population. Both in the category of general cause, as well as in the sub-categories of neoplasms and respiratory diseases, the region of South Aegean-Crete has statistically significant differences, noting lower levels of morbidity.

Table 25 - Death Causes (per 100,000 residents) in the Regions of North and South Aegean and the Region of Crete, 2011-2017

	2011*	2012*	2013*	2014*	2015*	2016*	2017*
of any cause							
GREECE	994,02	1.047,65	1.013,69	1.039,46	1.115,9	1.097,5	1.150,56
Aegean islands - Crete	909,12	934,63	889,53	935,17	983,36	954,66	995,87
from neoplasms							
GREECE	245,36	253,91	262,37	266,88	274,18	278,53	277,05
Aegean islands - Crete	208,13	212,25	223,13	220,24	231,85	241,06	236,56
from respiratory diseases							
GREECE	92,67	102,34	99,17	116,93	136,86	128,03	128,26
Aegean islands - Crete	96,16	105,32	96,02	115,1	127,36	116,17	121,13

2.2. Characteristics of Use of Fossil Fuels and Electricity at Local Level in the Energy Transition Areas

2.2.1. About Lignite

Lignite, or carbon, due to its brown-black colour, is a rock of organic origin, the main element of which is carbon, in a content of 50% to 70%, while the rest is water, hydrogen, oxygen and nitrogen.

It comes from the carbonization of mainly plant organisms and, as pointed out by the Department of Geology of the University of Patras[31], lignitogenesis occurs in Greece from the Eocene (56 to 33.9 million years ago) to the Lower Pleistocene (2.6 million to 11,700 years) when the most and most important lignite deposits in the country were formed. The main feature of the deposits is intense tectonism.

The most important lignite deposits were developed in shallow lakes and marshes of closed intercontinental basins, where the conditions for the formation of peat were met, resulting in lignite layers, with relatively large distribution and thickness, such as those of Florina, Ptolemaida, etc., while among the newer lignites (Pleistocene) belongs the peat-shaped, soft lignite found in the area of Megalopolis. Lignite is considered the worst quality carbon fuel, however it has a higher carbon content than peat.

In general, the quality of Greek lignite is low, since its calorific value ranges from 975-1,380 kcal / kg in the areas of Megalopolis, Amyntaio and Drama, from 1,261-1,615 kcal / kg in the area of Ptolemaida and 1,927-2,257 kcal / kg in the areas Florina and Elassona. The caloric content of lignites is from 3 to 7 times lower than that of coal and 5 to 10 times lower than that of oil. An important comparative advantage of the country's lignites is the low content of fuel sulphide.

Lignite is used as fuel in thermal (steam) power plants, as well as in the production of organic fertilizers, in agriculture, etc.

2.2.2. Lignite Mining Technologies

Internationally, there are two main methods of extracting lignite layers:

1. underground mining and

2. surface mining (opencast or open-cut mining)

In surface mining, the overlying lignite layers are excavated and then the lignite is mined and greater reserves of the stocks are achieved, as well as greater safety of the mine workers. The disadvantage of surface mining is the movement of large quantities of barren materials, without commercial value, which are characterized as waste (barren), which cause problems in the Environment.

Analytically, the main conditions that ensure the efficient operation of a mine, for the extraction of lignite, is the correct organization of the required works, with division of the individual mining works but also the cooperation between the fixed machinery and the emergency equipment.

The most common way of dividing mining operations involves the following tasks:

[31] http://www.geology.upatras.gr/index.php/el/56-labs/research-team-of-energy-raw-materials/384-lignite-deposits-research-objective-research-team-of-energy-raw-materials

• Land clearing by removing the surface layer of the soil

• Drilling and blasting of topsoil (barren) soil materials

• Drilling and blasting of the lignite deposit

• Removal-Extraction of supernatants and transport

• Extraction of lignite deposit and transportation

• Dropping of supernatants and finally

• Environmental restoration

Surface extraction can be done in many ways, depending on the number and thickness of the carbonaceous layers that will be extracted as well as their relationship with the topography of the area and the hydrological network.

An indicator that characterizes the exploitation of the lignite field is the barren to lignite layer ratio, where the smaller the ratio the more efficient the exploitation.

2.2.3. Sequence Analysis and Flow of Lignite Mineral Materials

Initially, before and after the extraction of the basic lignite deposit of a mine, the movement of the labour force to the lignite mine is required, all those who are not directly related to these works. Then, with the help of the emergency equipment of the lignite mine, the surface layer of the soil with an average thickness of about 0.2-0.4 meters is removed.

At the same time, after drilling in selected parts of the lignite mine with the help of drilling machines, the supernatants in the case of hard formations are blown up with explosives, in order to start their removal from the high-capacity electric mining machines.

The removal of supernatants can be achieved mainly with the most applied alternative mining, where the continuous operation of the bucket excavator ensures a high productivity index in the mine, while the cooperation with conveyor and depositor is required, due to the continuous flow of materials from mining. Finally, if access to lignite deposits is now possible, lignite mining is usually carried out with the same electric equipment available from the extraction (barren) mining operations.

After the disposal of the supernatants is completed, the restoration of the natural landscape is carried out, mainly by tree planting, for reasons of social responsibility of the company to the adjacent communities.

2.2.4. Lignite reserves in Western Macedonia and Megalopolis

The total certified geological reserves of lignite in the country amount to about 5 billion tons, while according to current technical and economic data suitable for energy exploitation reserves amount to about 3.2 billion tons (or 450 million tons of oil)[32]. The main exploitable lignite deposits are located in the areas of Ptolemaida, Amyntaio and Florina, with an estimated reserve of 1.8 billion tons, in the area of Drama with a reserve of 900 million tons and in the area of Elassona with 169 million tons.

[32] https://www.dei.gr/el/i-dei/i-etairia/tomeis-drastiriotitas/oruxeia

Also, in the Peloponnese, in the area of Megalopolis, there is a lignite deposit with a reserve of about 223 million tons.

According to PPC data, these reserves are estimated to be sufficient for more than 45 years. To date, mined lignite has accounted for about 29% of total reserves.

2.2.5. Lignite mining in Western Macedonia and Megalopolis

For the exploitation of lignites in the two lignite-bearing areas of the country, that of the Ptolemaida-Amyntaio basin (Northern System) and the Megalopolis basin in the Peloponnese (Southern System), where there are scattered mines, surface lignite mining is applied.

The main feature of lignite deposits in the areas of Ptolemaida, Amyntaio and Megalopolis is the frequent alternation of thickness of horizontal lignite layers and intermediate barren materials, which mainly consist of marls, gravel and clay. The exploitation of multilayer lignite deposits is done superficially, with vertical steps (open-pit mining).

For the extraction of the deposit, the barren materials and the lignite layers are divided into steps of 10 to 30 meters, depending on the type of bucket excavator. The deposit is excavated in layers and the barren materials are transported by conveyor belts to the landfills, which are specially selected areas for this purpose, while the lignite is transported to the yards of the steam power plants or to other consumers or to outdoor warehouses of the lignite mines. In this method, the main equipment is a continuous operation system consisting of electric bucket excavators and in parallel with the use of diesel excavators, conveyors and dumps. Electricity and power are important for the operation of bucket excavators and conveyors on a continuous basis, powered by dedicated substations.

In addition to the main equipment in the production process of lignite extraction, other smaller earthmoving machines, loaders, bulldozers, excavators, trucks, etc. are used, which support the operation of the mine and are called auxiliary equipment, with corresponding oil consumption.

The critical disadvantage of mining with diesel excavators is the inability to accurately sort thin layers of lignite and separate them from the intermediate layers of barren materials, resulting in quality degradation of lignite, resulting in low efficiency of TPS and high pollutant emissions. To address, partially, the problem it was decided by the DG Mines of PPC to use a machine, for selective extraction of thin-walled lignite deposits, which aims to increase the degree of extraction of lignite deposits and facilitate the homogenization of lignite. This results in the improvement of its quality, the increase of the produced electricity, through the reduction of the special consumption of lignite due to the increase of the calorific value, the reduction of its cost of electricity generation and the reduction of adverse effects on the Environment, through the reduction of CO_2 and ash produced.

2.2.6. Lignite mines in Western Macedonia and Megalopolis

The first systematic research for the detection and evaluation of lignites in the country began in the wider area of Ptolemaida, in 1938. In 1955, the company, LIPTOL, was established with the object of exploiting lignite and using it for the production of briquettes, nitrogenous fertilizers and for electricity generation. In 1959, 90% of LIPTOL shares went to PPC and in 1975 it merged with PPC.

The Lignite Center of Ptolemaida - Amyntaio (LKPA) currently operates four lignite mines:

1. the South Field Mine,
2. the Kardia Mine,
3. the Main Field Mine and
4. the Amyntaio Mine, including the Mine in Florina.

Map 4 - Ptolemaida Mine

Map 5 - Amyntaio Mine

The Megalopolis lignite deposit was first studied scientifically in 1957. In 1969, PPC began to exploit lignite, as a special case, worldwide, because for the first time so poor in calorific value lignite is mined to produce electricity. The Megalopolis lignite mine started in 1969, with an annual production of 1 million tons and in 2006 reached 13.5 million tons.

Map 6 - Megalopolis Mines

From the beginning of operation of the lignite mines until the end of 2017, PPC has mined in the areas of Western Macedonia and Megalopolis 2,064 million tons of lignite, while the corresponding total excavations amount to 9,558 million cubic meters. The remaining recoverable lignite reserves amount to 1.7 billion tons[33].

Lignite production in LKDM, in 2017, amounted to 27.3 million tonnes, compared to 25.3 million tonnes in 2016 and in LKM to 8.1 million tonnes compared to 6.1 million in 2016.

Total lignite production of PPC mines in 2017 amounted to 35.4 million tons and total excavations to 196.4 million cubic meters. The constantly decreasing production of lignite reached only 35.4 million tons in 2017 versus 48.03 million in 2014 and 62 million in 2009, with corresponding energy production only 16.4 TWh compared to 22.7 TWh in 2014 and 30.5 TWh in 2009.

[33] https://www.sme.gr/portfolio-items/%CE%BB%CE%B9%CE%B3%CE%BD%CE%AF%CF%84%CE%B7%CF%82/

In the mines of PPC, in 2017, 4,302 people were employed as employees of the company and 1,865 people as employees in contractors. Revenues from the sale of lignite to TPPs amounted to € 556.5 million, while the costs for investments of the mines by PPC in the same year amounted to € 75 million. The production of lignite by PPC on an annual basis ranks it in second place in European Union, fifth place in Europe and sixth in the world.

2.2.7. Operation of Lignite Thermal Power Plants

With the help of lignite steam power plants, the chemical energy of lignite is converted into heat, then into kinetic energy and finally into electricity.

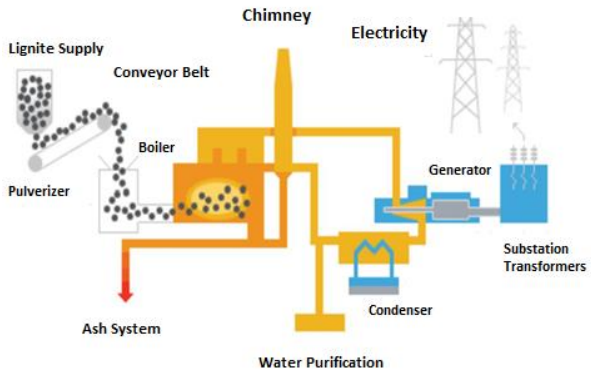
In detail, the procedures followed for this conversion are:

1. The lignite is transported from the extraction point (mine) to the power plant, with the help of conveyors and is either stored in the lignite yard or led directly to the crushers, where it is crushed into pieces with a maximum diameter of 4 cm and then transported to the lignite silos of the units. .

2. The combustion of lignite takes place in the boiler of the unit, where the thermal energy released by the combustion of lignite, evaporates the water resulting in the creation of superheated steam (see schematic illustration).

3. The superheated steam (S / S) is released in a high pressure turbine, where useful work is produced. The steam is, then, brought back to the boiler to be reheated to raise its temperature and then released into a medium and low pressure turbine, where extra work is produced.

Diagram 10 - Schematic Illustration of Operation of Lignite Power Plant for Electricity Generation



Source: PPC

4. The steam enters the refrigerator of the unit, where it is condensed with the help of cooling water. The condensed steam, with the help of pumps, is preheated using heat exchangers and is led through pumps back to the boiler, completing the thermal cycle.

5. The thermal energy extracted from the cooling water is discharged to the cooling tower, where, by the method of sprinkling, a quantity of water is lost in the form of steam and droplets to the outside environment.

6. On the axis of the turbine, which rotates at 3,000 rpm, an electric generator is connected, which converts kinetics into electricity.

7. The exhaust gases, produced by the combustion of lignite, are led to massive devices for retaining the suspended particles, the so-called electrostatic filters (E/F). In these filters, the particles are exposed to a continuous high voltage electric field, converted to ions and finally collected in the filters. Ash, the residue of lignite combustion, is also transported to the landfills.

8. The generated electricity is led to the extra-high voltage substation, then to the transformers and the Transmission Network (EHV and HV), to the Distribution Network (MV) and finally to the points of use (LV).

2.2.8. Lignite Thermal Power Plants in Western Macedonia and Megalopolis - Power Station Features - Supply Chain of Mines and Lignite Stations

In Western Macedonia, initially, 6 lignite steam power plants (TPPs) were installed to generate electricity. Today, only 4 are operating, since the operation of LIPTOL and Ptolemaida power stations had stopped. Each station consists of individual units, which are supplied with lignite from the Lignite Center of Ptolemaida - Amyntaio and are presented in Table 26 (in red the withdrawal units):

Table 26 - Lignite power plants in Western Macedonia

LIGNITE POWER STATION	INITIAL INSTALLED CAPACITY (MW)	WITHDRAWN UNITS (MW)
TPP LIPTOL	1 x 10 + 1 x 33 = 43	1 x 10 + 1 x 33 = 43
TPP PTOLEMAIDA	1 x 70 + 2 x 125 + 1 x 300 = 620	1 x 70 + 2 x 125 + 1 x 300 = 620
TPP KARDIA	2 x 300 + 2 x 325 = 1.250	
TPP AG. DIMITRIOS	2 x 300 + 2 x 310 + 375 = 1.595	
TPP AMYNTAIO	2 x 300 = 600	
TPP MELITI	1 x 330 = 330	
TOTAL	**4.438**	**663**

Source: PPC

In the area of Megalopolis, 2 lignite power plants are installed. Each station consists of individual units, which are supplied with lignite by the Lignite Center of Megalopolis and are presented in Table 27 (in red the units in withdrawal).

Table 27 - Lignite power plants in Megalopolis

LIGNITE POWER STATION	INITIAL INSTALLED CAPACITY (MW)	WITHDRAWN UNITS (MW)
TPP MEGALOPOLI 3	2 x 125 + 1 x 300 = 550	2 x 125 = 250
TPP MEGALOPOLI 4	1 x 300 = 300	
TOTAL	**850**	**250**

Source: PPC

Table 28-Existing Hydroelectric Power Plants Connected to the System in the Lignite Areas

PRODUCER	POWER STATION	PRODUCTION UNIT	INSTALLED CAPACITY (MW)	NET POWER (MW)	REGION
PPC	HPP ILARIONA	Ilarionas I	76,5	76,5	**Kozani**
PPC	HPP ILARIONA	Ilarionas II	76,5	76,5	**Kozani**
PPC	HPP LADONA	Ladonas I	35	35	**Arcadia**
PPC	HPP LADONA	Ladonas II	35	35	**Arcadia**
PPC	HPP POLIFITOU	Polifito I	125	125	**Kozani**
PPC	HPP POLIFITOU	Polifito II	125	125	**Kozani**
PPC	HPP POLIFITOU	Polifito III	125	125	**Kozani**
Total installed capacity of HPP in lignite areas:			**598**	**598**	

Notes: (a) Only the units that are in commercial operation and are connected to the Interconnected System are mentioned, regardless of their registration in the ADI Register, (b) The Small Hydroelectric plants that fall under the provisions of Article 9 of Law 3468/06 are not mentioned, considered as RES Production Stations.

Source: ADMIE

2.2.9. Water Consumption in Lignite Power Plants - Variable Energy Cost

Regarding the water consumption for the production of electricity from lignite steam power plants, PPC has calculated the per TPP water consumption, in m^3 per MWh produced (see Table 28).

Table 29 gives, per lignite thermal (steam) power plant, TPP, for the regions of Western Macedonia and Megalopolis, their installed and net power, the annual production of electricity and the consumption of water at the station, and in total, for 2017[34].

Table 29 calculates the total average index of water consumption, in m^3, per MWh of electricity produced, with lignite fuel. For 2017, the index is 2.78 m^3 / MWh or 2.78 liter / kWh.

Table 29 - Water Consumption by Lignite Power Plants (year 2017)

TPP with lignite	Units	Installed capacity	Net capacity	Annual electricity production	Water consumption per MWh produced	Water consumption
		MW	MW	MWh	m^3/MWh	m^3
Ag. Dimitrios	I	300	274	1.085.736	3,00	3.257.208
Ag. Dimitrios	II	300	274	988.619	3,00	2.965.857
Ag. Dimitrios	III	310	283	1.097.507	3,00	3.292.521
Ag. Dimitrios	IV	310	283	1.099.251	3,00	3.297.753
Ag. Dimitrios	V	375	342	1.932.280	3,00	5.796.840
Kardia	I	300	273	1.044.658	2,50	2.611.645
Kardia	II	300	273	1.111.317	2,50	2.778.293
Kardia	III	300	275	998.061	2,50	2.495.153
Kardia	IV	306	275	1.008.274	2,50	2.520.685
Amyntaio	I	300	273	837.364	2,60	2.177.146
Amyntaio	II	300	273	830.645	2,60	2.159.677
Megalopoli	III	300	255	1.439.209	3,00	4.317.627
Megalopoli	IV	300	256	1.078.947	3,00	3.236.841
Meliti	I	330	289	1.643.970	2,50	4.109.925
TOTAL	**14**	**4331**	**3898**	**16.193.400**		**45.017.170**

Source: LAGIE

[34] Data from the monthly LAG bulletin of LAGIE for 2017, www.lagie.gr

For the production of 1 kWh of electricity from lignite power plants in Greece, in 2017, on average, the burning of 35.4 million tons of lignite is generally required for the production of 16.19 TWh = 2.2 kg / kWh and consumption of 2.78 litres of cooling water, noting that the degree of efficiency of the old units is low with consequences on CO_2 emissions and final production costs so that their competitiveness with other power stations with different fuels becomes problematic. Emphasis is placed on high water consumption at high cost, which is lost and does not return to the basin for utilization.

2.2.10. Variable Cost of Lignite Thermal Power Plants in Greece

The analysis of the determination for the variable costs of the lignite and hydroelectric power generation units of PPC is done according to the Joint Ministerial Decree, JMD, which is issued jointly by the Ministers of Energy and Finance.

The JMD is issued on an annual basis, because the minimum price concerns the offer of auctioned future electricity products (NOME). Thus, for 2019, was issued, on June 26, 2019, the JMD ENM/ DIE / 58239/1169, which determines the ratio of the mixture of lignite and hydroelectric production and determines the mathematical formula for calculating the minimum bid price of the auctioned term electricity products.

The mathematical formula of the methodology for determining the minimum value is the following [35]:

Minimum Price = (a x Variable Lignite Production Costs)+
(b x Variable Hydroelectric Production Costs)

where the sum of the coefficients of gravity a and b is equal to 1.

For 2018, according to the aforementioned JMD, the coefficients of gravity are as follows:

Lignite Production Ratio (Coefficient a)	88.91%
Hydroelectric Production Ratio (Coefficient b)	11.09%

All information is based on IPTO accounts of the previous year, which relate to the hourly hydroelectric and lignite base production and the average daily minimum value of the hourly lignite and hydroelectric production is calculated. Regarding the variable cost of PPC lignite power plants, it consists of the following elements[36]:

(a) Variable Costs of PPC's Mines:

They are calculated based on the financial statements of PPC of the previous year and as variable costs are characterized those that change with the level of mining and lignite production and relate to: (a) staff remuneration, only for overtime pay or other extraordinary remuneration, (b) materials and consumables, (c) electricity purchases, (d) third party maintenance and supplies, and (e) third party fees.

(b) Costs of Purchasing Fuels from Third Parties, based on the unit fuel price in the relevant purchase agreement.

(c) Special Lignite Fee, which burdened the lignite production, as it is expressed in the amount of two (2) € perMWh37[37].

[35] See paragraph 2 of article 139 of law 4389/2016
[36] See paragraph 3 of article 139 of law 4389/2016
[37] See paragraph 7 of article 52 of law 4042/2012

(d) Special Start-up Cost: The number of starts and extensions of PPC lignite units is taken into account.

(e) Variable Operating and Maintenance Costs: taking into account the following variable cost elements of PPC: (a) Consumption of Materials-Spare Parts, (b) Payroll, overtime only, (c) Repairs and Maintenance, (d) Earthworks, (e) Electricity and (f) Ash and Lignite Yards.

(f) Purchase Costs of Carbon Dioxide Emissions: The cost of purchasing CO2 emission allowances is calculated annually on the basis of the corresponding 12-month future contract of the European Energy Exchange, as in December of the previous year. Also, the annual CO_2 emissions of PPC lignite units during the previous year of the year of application of the minimum auction price are taken into account, so that based on the lignite production of electricity, the cost of purchasing CO_2 emission allowances is calculated.

Variable operating costs of PPC's hydroelectric power plants are characterized those that change with the level of production and relate specifically[38]: (a) staff remuneration, only for overtime pay or other extraordinary remuneration, (b) materials and consumables, (c) electricity purchases, (d) third party maintenance and benefits and (e) third party fees.

According to the JMC, data are derived from the published financial statements of PPC of the previous year and the revised cost of purchasing CO_2 emission allowances.

The unit variable cost of the hydropower plants results from:

(a) the total annual production from hydropower plants, for 2018, 5,051,449 MWh and (b) from the total variable cost € 11,043,791.

Regarding the lignite plants, the total annual production was 12,507,368 MWh with a total variable operating and maintenance cost of € 39,769,858.

The Variable Costs of PPC Lignite Production are given, per € / MWh, as[39]:

- Variable mining costs: 18.13
- Costs of buying fuel from third parties: 1.98
- Special Lignite Fee: 2.00
- Special Starting Cost: 2.68
- Variable operating and maintenance costs: 3.18
- Costs of purchasing CO2 emission allowances: 37.13

Total of the variable costs of lignite power plants: 65.10 € / MWh

The Variable Costs of PPC Hydroelectric Stations are given as:

Variable costs of hydroelectric power stations: 2.19 € / MWh

[38] See paragraph 4 of article 139 of law 4389/2016
[39] See paragraph 3 of article 139 of law 4389/2016

The application of the equation for the minimum price gives 58.12 € / MWh, a very high price, mainly due to the high variable cost of lignite production, which is affected by the costs of purchasing CO_2 emission allowances (stock market price).

2.3. District Heating Systems (DHS) in Western Macedonia and the Peloponnese: Current Situation - Problems - Prospects

2.3.1. General Issues Concerning DHS

District Heating is defined as the supply of heating and domestic hot water (DHW), with a special network of insulated pipes that carry hot (or superheated) water, usually produced in thermal power plants, far away from the consumption site, to heat the buildings of a city or of a part of the city by a central heating system and not by individual boilers.

District Heating has been implemented in Greece for the last 30 years and today there are (or are in development) five that are supplied by PPC steam power plants and one, private, which operates with HECHP units and natural gas fuel (Serres District Heating).

The district heating supplied by PPC's TPP, with hot (temperature 90-60 °C) or superheated water (temperature 115-120 °C), provide heating during the winter period and DHW for the whole year to the inhabitants of the interconnected cities with the network. Hot or superheated water is initially transported by the co-generating steam power plants in the supply/return network of D / H, through twin pre-insulated pipes and separate branches, in pumping stations, on the outskirts of cities and then through the distribution network in the interconnected buildings and / or apartments.

The results from the operation of DH systems are, among others:

• Significant reduction of gaseous pollutants in cities and at the same time reduction of the health problems of the population (pulmonary, cardiovascular, cancers, etc.)

• Foreign exchange savings, due to non-consumption of thousands of tons of heating oil. For example, the operation of the DH in the city of Kozani saves 32,000 tons of heating oil every year.

• Increase of work at local level, both during the construction of the project, as well as for the extensions of networks and related systems (pumping stations, substations, etc.) but also during their operation.

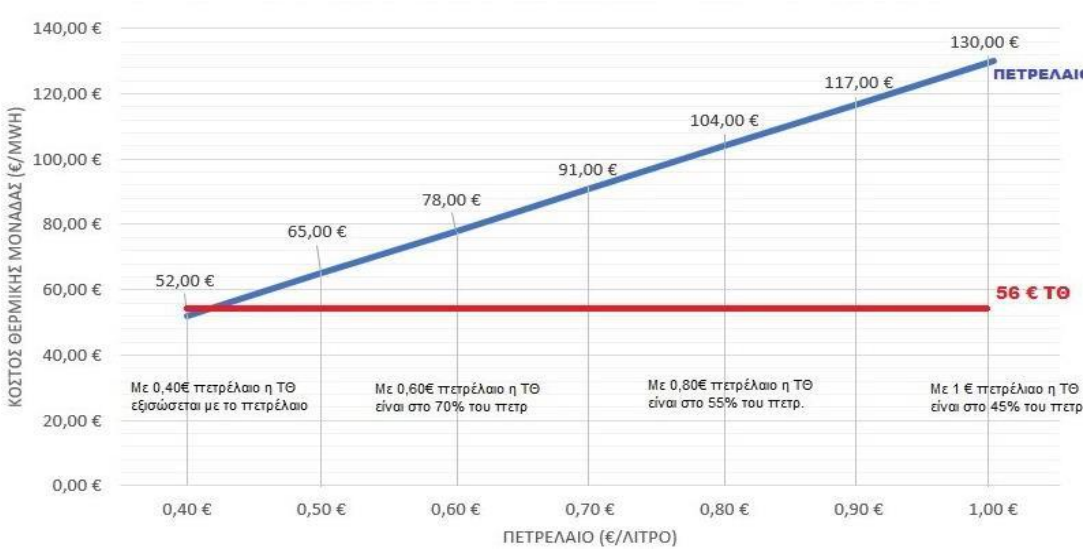
• Possibility of further development of the areas with other activities, in the primary and secondary sector, based on the benefits of D/H, such as heating in greenhouses, dryers, etc.

• The implementation of DH systems is fully in line with the provisions of the Directive 2012/27 / EU on Energy Efficiency and National legislation - L.4342 / 2015.

The price of thermal energy offered by the DH system is clearly lower than the price of heating oil, as shown in Diagram 11. It is worth mentioning that the price of thermal MWh in DH of Ptolemaida in the last decade (2011-2020) remained constant at € 37.74 / MWh (Source: General Hospital of Ptolemaida Bodosakeio).

Diagram 11: Correlation of DH Price (€ / MWh) with the Price of Heating Oil (€/lt)

Source: DETEPA



The DH installations in Greece and the planned network extensions follow the requirements of the European Standard EN13941: 2010, which concerns the method of design and installation of pre-insulated bonded pipe systems for district heating (Design and Installation of pre-insulated bonded pipe systems for district heating).

2.3.2. District Heating in the Region of Western Macedonia

The Region of Western Macedonia is the first region in Greece, where district heating systems were designed and installed for the needs of citizens in three cities (Ptolemaida, Kozani and Amyntaio), for about 30 years. There are three main reasons for this:

1. The "heart" of the Greek energy system is in this area, both with the lignite mines and the electricity generation units, from where the country has been supplied with electricity for more than 60 years, while the produced thermal energy led to cooling towers and finally to the atmosphere.
2. The three cities, which are located near the power stations, are classified in the 4th climate zone, according to T.D. 20701-2 / 2010 of TCG, which means very low air temperatures, during the winter season.
3. All previous years there have been serious environmental problems - mainly air pollution - both from lignite mines and PPC power stations, as well as from the use of oil (or fuel oil) for space heating and DHW, by city dwellers.

2.3.2.1. District Heating in the City of Ptolemaida

The then-called Municipality of Ptolemaida, today the Municipality of Eordea, has installed, since 1991-93, co-financed by the European Program "VALOREN" and put into operation since 1994, the first district heating system in Greece, which operates throughout this period the Municipal District Heating Company of Ptolemaida-DETIP.

According to the company[40], during the first 25 years of operation of district heating in Ptolemaida, investments in infrastructure amounted to € 55 million, which connected more than 3,800 buildings and almost 15,000 apartments, providing heating and hot water for the inhabitants of the area, at prices lower than any other fuel, while the reduction of gaseous pollutant emissions was also significant, in relation to the possible combustion of oil for heating and DHW.

Diagram 12 - Basic Technical Characteristics of DHS

Thermal load, MW_{th}	Water temperature, °C	PPC Power Station / Other
100	115-120	Unit III + IV Kardia Station
24,71		Top / backup boiler room - oil
Total length of pre-insulated pipes, m		22.300

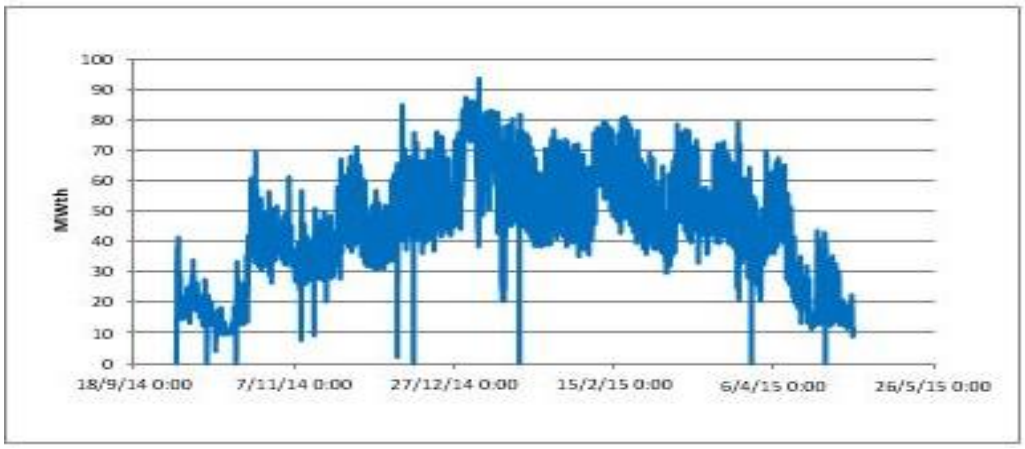
Source: PPC

The thermal energy provided by PPC in the Ptolemaida DH network is in the form of superheated water, temperature 95 °C – 120 °C, depending on the thermal load, and maximum pressure 25 bar (g), provided that the supply water to the HPP , after Pumping Station AK1, has a temperature of 70 °C and a pressure of at least 5 bar (g).

From the company's data, it is known that the trend of buildings / apartments connected to the DH network during the last 25 years is increasing by +140%, as well as the thermal load, in MWth, increase by +220%.

Diagram 13 shows the distribution of thermal energy demand during the heating season (September-May 2014 - 5,000 operating hours) for Ptolemaida District Heating, according to PPC data.

Diagram 13 - Distribution of Total Hourly Thermal Energy Demand of DHS of Ptolemaida, 2014-2015

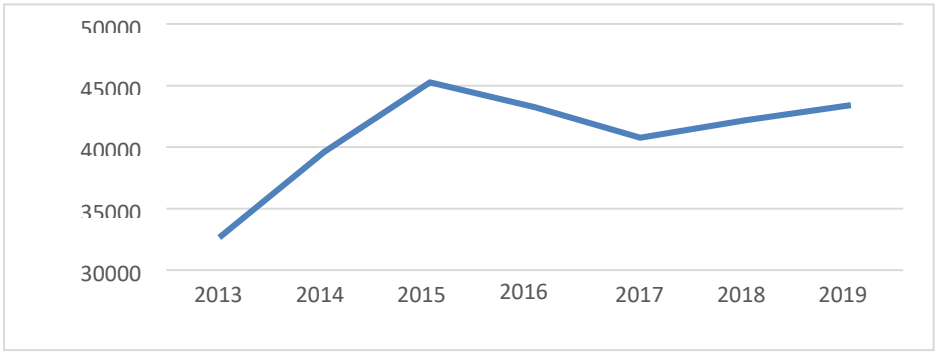


Source: PPC

Diagram 14 presents the annual supply of thermal energy from units III + IV of the Kardia stations to the district heating system of Ptolemaida, for the years 2013 to 2019, from PPC data.

[40] DETIP website: www.tpt.gr

Diagram 14 - Annual Thermal Energy Supply, MWh_{th} from Units III + IV of the Kardia TPP into the DH System of Ptolemaida, 2013-2019



Source: PPC

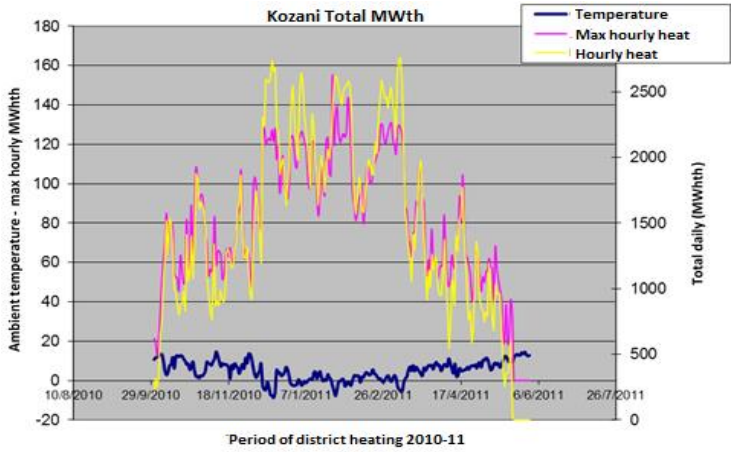
2.3.2.2. District Heating in the City of Kozani

Kozani District Heating has been operating since 1993, heating about 25,000 apartments, in a total of about 4,900 buildings. The investment of € 75 million came from the European program VALOREN, the Public Investment Program and resources of DEYAK, the Municipal Water Supply and Sewerage Company of Kozani, a company that operates the district heating system of the city[41].

Kozani District Heating receives the required thermal load from the steam installations of units III, IV and V of the Agios Dimitrios Power Plant, while it has a state-of-the-art boiler room, transmission and distribution pumping stations, as well as a supply and distribution network of 450 meters in total length. The thermal energy provided by PPC to the Kozani DH network is in the form of hot water, temperature 95-120 °C, depending on the thermal load and maximum pressure 25 bar(g), provided that the water supply to the TPP, after pumping station A3, has a temperature between 65 and 75 °C and a pressure between 8 and 12bar (g).

Diagram 15 shows the distribution of thermal energy demand during the heating season (October-May 2010 - 5000 operating hours) for Kozani District Heating, according to PPC data.

Diagram 15 - Distribution of Thermal Energy Demand in Kozani DHS, 2010

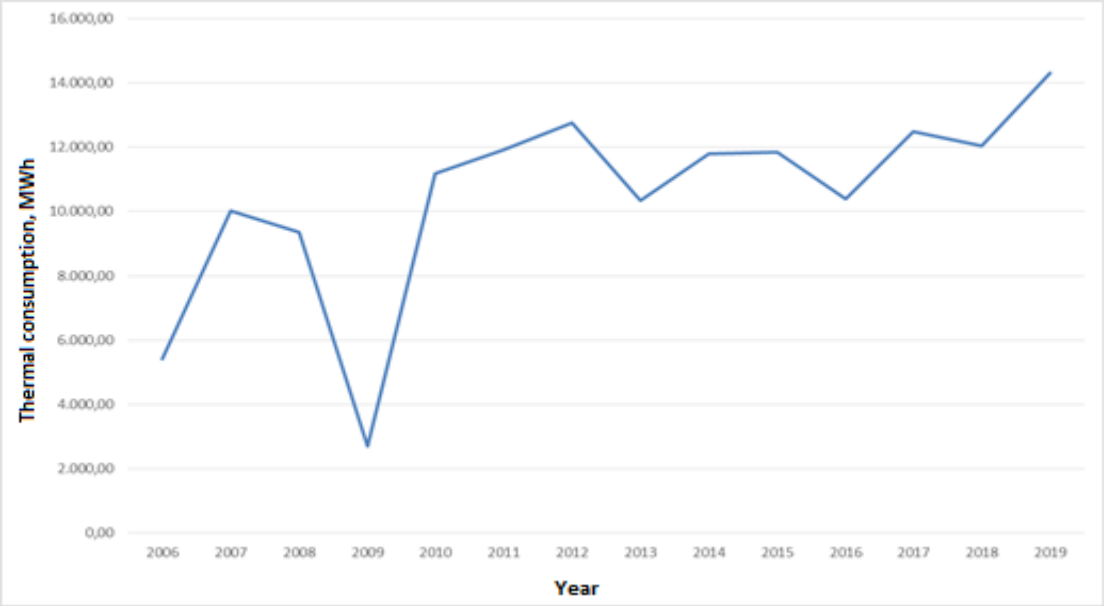


Source: PPC

[41] DEYA Kozani website: www.deyakozanis.gr

Diagram 16 presents the annual supply of thermal energy from the units of the Agios Dimitrios substation to the district heating system of Kozani, for the years 2013 to 2019, from PPC data.

Diagram 16 - Annual Thermal Energy Supply from Units III + IV of the Kardia TPP into the DH System of Kozani, 2000-2019



Source: PPC

The district heating network carries out, throughout the 25 years, expansion and upgrade projects, with the most important being:

- The expansion of the hot water transfer system from the Agios Dimitrios TPP in the city of Kozani with the construction of a second transmission pipeline, doubling the heat transfer capacity from 70 to 140 MW_{th}.

- The supply and installation of a new boiler with a capacity of 27.5 MW_{th}, a state-of-the-art boiler room, thanks to which the total reserve of the system is maintained at levels above 50% of the maximum demand.

- The construction of a new DH distribution network in the settlement of Nea Haravgi, with a capacity of 300 buildings and a total length of distribution pipes of 30 km.

- The construction of a DH distribution network in the extensions of the Kozani city plan. This network can supply at least 1,700 buildings, while its total length reaches 155 km.

- The supply and installation of 2,200 thermal substations that supplied an additional 500,000 m^2.

- The construction of a heat storage boiler, 1,600 m^3, energy capacity 70 MWh.

2.3.2.3. District Heating in the City of Amyntaio

Amyntaio District Heating started its operation in 2005 and is the main activity of the Municipal District Heating Company of Amyntaio Area (DETEPA)[42], established in 1997. The DH investment, a cost of € 18.3 million, came from the Development Law 1892/90, bank lending and co-financing by the NSRF 2014-2020.

The supply of thermal energy to the DH installation is provided by the PPC's lignite thermal power plant at Amyntaio, using the technology of cogeneration of power and heat, CHP.

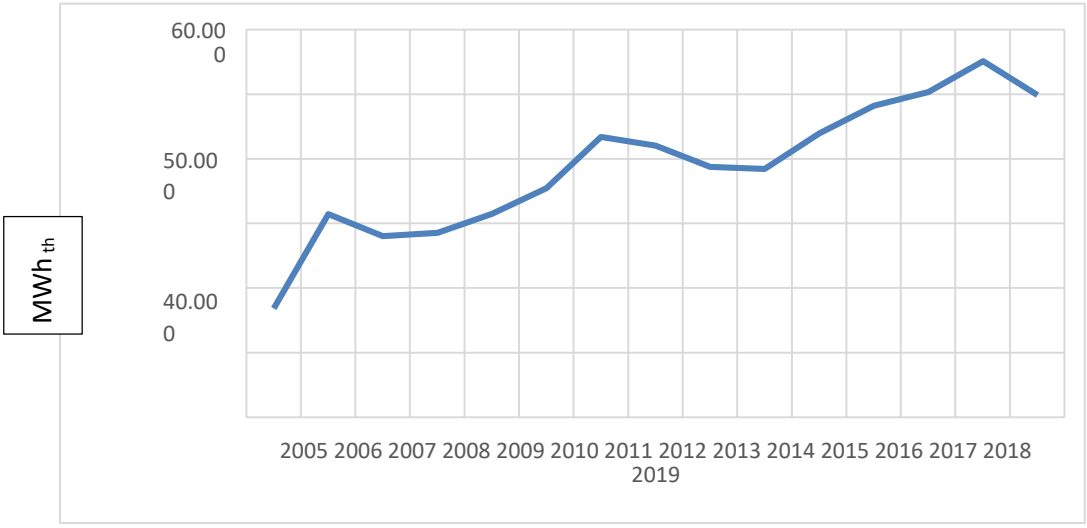
The thermal energy provided by PPC in the DETEPA network is in the form of hot water, temperature 95-120 ^{o}C, depending on the thermal load and maximum pressure 10 bar (g), provided that the supply water to the TPP, after the pumping station of DETEPA, near the HPP, has a temperature between 65 ^{o}C and a pressure of at least 5 bar (g).

The district heating of the wider area of Amyntaio was constructed in three phases: Phase A from the period 2000-2004 and was put into operation in 2005, Phase B: extensions in the period 2008-2009 and Phase C with extensions from 2014-2015, supplying thermal energy the buildings in the settlements of Amyntaio, Levaia and Filota.

The thermal energy of the system is received by the Amyntaio substation through steam extraction of the turbines. The district heating system is connected to both units of the TPP, with 100% backup capability. Today, one extraction from each turbine has been constructed and is operating, with a nominal thermal power of 25 MW_{th}. If the other extraction is connected to the district heating from each turbine, the nominal power of the system can reach 40 MW_{th}.

Diagram 17 presents the annual supply of thermal energy from the units of the Amyntaio TPP to the district heating system of the city of Amyntaio, for the years 2005 to 2019, from PPC data.

Diagram 17 - Annual Thermal Energy Supply from the Units of the Amyntaio TPP into the DHS of the City of Amyntaio, 2005-2019



Source: PPC

[42] DETEPA website: www.detepa.gr

2.3.3. District Heating in the Peloponnese Region

The district heating system of Megalopolis in the Prefecture of Arcadia, in Peloponnese, was designed and installed for covering the needs of the citizens for the following reasons:

• In this area there are lignite mines and power plants of PPC, where the generated thermal energy is led to cooling towers and finally to the atmosphere.

• The city of Megalopolis is classified in the third climatic zone, according to T.D. 20701-2/2010 of TCG, which means low air temperatures, during the winter period.

• In recent years, serious environmental problems have been observed - mainly air pollution - both from the production of electricity from PPC stations, and from the use of oil (or fuel oil or other fuel) for space heating and DHW by residents of the city of Megalopolis.

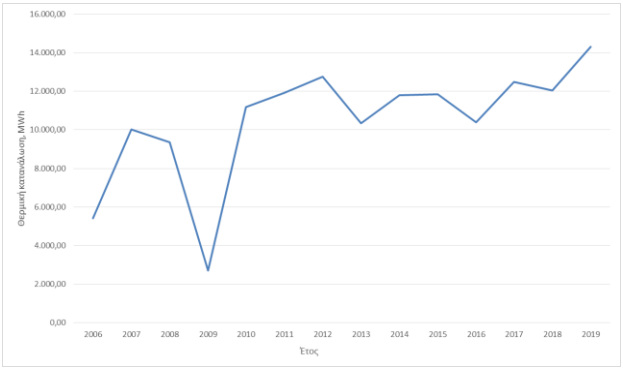
2.3.3.1. District Heating in Megalopolis

Megalopolis District Heating started operating in 2007 and supplies the city of Megalopolis with thermal energy for space heating and domestic hot water, while the DH distribution network covers about 30% of the city i.e. 516 buildings, about one third of the existing buildings, with the heated surface with the use of DH amounting to ~ 90,000 m^2. It is the main activity of "Megalopolis District Heating - Local Government Societe Anonyme"[43] established in 2011, for this purpose. The DH investment in Megalopolis amounted to € 18.3m.

The total nominal installed load is 21.8 MW_{th}. The operation of Megalopolis district heating is based on the acquisition of thermal energy by Unit III of the PPC Megalopolis lignite power plant which is located at a distance of 4.5 km from the city center and gives a thermal power of 20 MWth. The thermal energy is transferred with the help of pumping units through an existing system of pre-insulated transfer pipes to the central distribution pumping station of the installation.

Diagram 18 presents the annual supply of thermal energy from the units of the Megalopolis TPP to the district heating system of the city, for the years 2006 to 2019, according to PPC data.

Diagram 18 - Annual Thermal Energy Supply from the Units of Megalopolis TPP in the DHS of the City of Megalopoli, 2006-2019



Source: PPC

[43] https://www.megalopoli.gov.gr/dimos/dimotikes-epixeiriseis/128-dimotikes-epixeiriseis/649-tilethermansi-megalopolis-anonymi-etaireia-ota

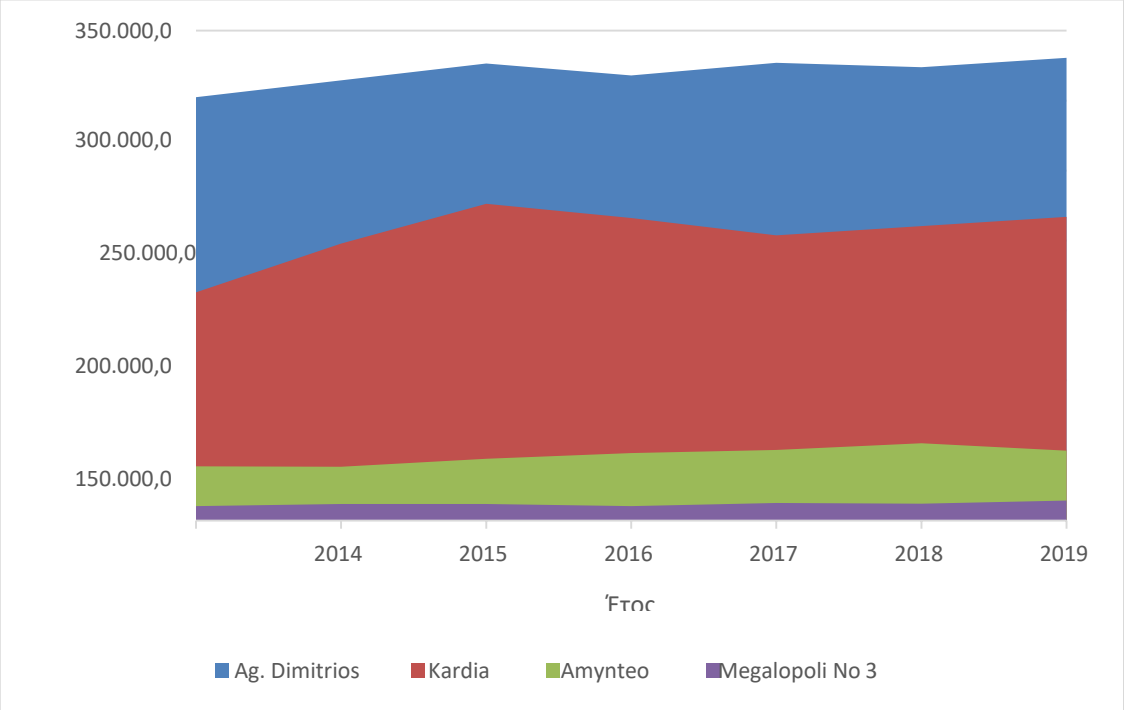
The total district heating system is designed to serve consumption with hot water supply temperatures, which will be seasonal between 50 °C and 85 °C, with a maximum possible operating temperature of 90 °C. Existing building installations allow return temperatures to the secondary seasonally ranging between 40 °C and 65 °C.

The interconnection of the buildings in the district heating distribution network is done indirectly. For this purpose, hot water thermal substations are used, where their power varies, depending on the energy needs of the buildings, from 29 up to 233 kW_{th}.

To cover the peaks of demand and reserve, there is a boiler room with two boilers using diesel / biomass fuel, of a total nominal thermal power of 14 $MW_{th.}$ The peak / backup system is assisted by an existing thermal energy storage tank, with a capacity of 1,617 m^3, while the thermal energy storage capacity is 60 MW_{th}.

Diagram 19 shows the annual heat consumption, in MWh, for all district heating operated by lignite-fired power plants.

Diagram 19 - Annual Thermal Consumption, in $MWh_{th,}$ of All DHS Operating with Lignite Power Plants, 2013-2019



Source: PPC

2.3.4. Future Coverage of Thermal Needs in Western Macedonia and Megalopolis

2.3.4.1 Existing District Heating in Western Macedonia

The overall proposal for the next day in the existing district heating in Western Macedonia, after the closure of the lignite plants, is based on the following basic principles:

- Utilization of existing infrastructure to the maximum extent possible

• Compatibility of the implementation schedule with the withdrawal plan of the existing lignite plants

• Optimization of the mixture of fuels and means of production for the production of thermal energy in order to keep tariffs low

• Development of synergies between the bodies that are active in the area and in the field of district heating

• Formulation of the proposal and the necessary business schemes using all the financial tools

• Support the development perspective of the area with the integration and gas infrastructure planning

For this reason, the three existing district heating systems (Kozani, Ptolemaida and Amyntaio) are integrated under one entity, a network of district heating interconnections of the three cities is developed, which is connected to the main thermal energy production points and two main thermal energy production points are formed (Kardia TPP, Ptolemaida 5) and the necessary reserves are secured.

More specifically:

Kardia station: Electric boilers will be installed, with a capacity of 80 to 100 MW_{th}, the installation and operation of which, no later than 2021, is the only feasible (temporally) transitional solution for this period, and then they will be a reserve for the system. New thermal power plants will be built using natural gas fuel, with a total capacity of 160 MW_{th}, with a combination of HECHP Units and natural gas boilers (the exact composition will be investigated later, taking into account the fact that the overall solution should lead to an efficient heating system).

Ptolemaida 5: The necessary conversions of 140 MW_{th} thermal energy production and the interconnection with the network of district heating pipes will be implemented.

Amyntaio DH: The thermal energy production unit will be a mixed biomass combustion with a small amount of lignite, with a total capacity of 30 MW_{th} that will meet the thermal needs of Amyntaio, Filota and Levaia, as well as future thermal needs of the area and is expected to operate in October 2020.

The project includes two boilers, with a capacity of 15 MW_{th} each, with the prospect of a third of the same thermal capacity. The boilers will perform mixed biomass combustion with a small amount of lignite, if required. At the same time, the project includes the creation of infrastructure for the installation of fuel supply grilles to boilers, covered biomass storage areas and auxiliary spaces. The control system of biomass boilers will be connected to the existing SCADA system of the central district heating pumping station of DETEPA.

The total available thermal power will initially rise to 400-420 MW_{th}. The system backup will amount to approximately 120-140 MW_{th}. In the proposed project of a common district heating system, a network of thermal energy transmission pipelines will be developed, which will connect all consumption points (cities) and production points (Kardia substation, Ptolemaida 5, Amyntaio boiler).

2.3.4.2. Florina

The project of District Heating of Florina, initially included in the O.P. "Environment and Sustainable Development" of the NSRF 2007-2013, and then in the O.P. "Transport Infrastructure, Environment and Sustainable Development" of the NSRF 2014-2020, as a Phasing project, would recover the waste

heat of the power generation process at the steam power plant (TPP) Meliti of PPC, in order to provide heat for urban use (space heating and hot water supply) in the city of Florina and to achieve positive environmental, social, national and economic results. According to the withdrawal schedule of the lignite units, the Meliti steam power plant (TPP) will be withdrawn in 2023.

It is noted that the plan to withdraw lignite plants has taken into account the need to ensure the smooth operation of district heating to meet the thermal needs of energy municipalities, as well as alternatives for cities that have not developed a district heating network, such as, among others, the development of a gas network in these areas.

Taking into account the above, it is proposed to cover the thermal needs of the city of Florina with the development of a medium and low pressure gas network, with a construction schedule until the end of 2023, while at the same time the connections for the city's consumers will be implemented.

2.3.4.3. Existing District Heating in Megalopolis

According to the schedule for the withdrawal of lignite plants, the steam power plant (HPP) of Megalopolis of PPC and consequently the operation of district heating will cease to operate in 2022.

For this reason, it is preferred to cover the future thermal needs with the development of a medium and low pressure gas network throughout the city of Megalopolis until 30/9/2022, both to meet the needs of existing buildings covered by District Heating, and the buildings of new consumers who will be asked to connect to the gas network.

An action or actions will be implemented with funding from the NSRF 2014-2020 and / or other resources for the replacement of existing heating systems with natural gas systems, from which the transition to natural gas systems will be subsidized to the maximum acceptable percentage. The funding will cover all costs required for the installation of the new system, including the required studies. Any amount not covered by the amount of the grant will be covered by other sources (e.g. national resources), so as not to incur any additional burden on final consumers

With regard to the supply of heat from the district heating network in the transitional period until the operation of the gas network and the supply of consumers with natural gas, there will be no burden on the existing consumers of the district heating network with the cost of supply - installation with all the necessary components (gas boiler) for its safe operation in order to supply heat to the district heating network.

2.4. Environmental Impacts from the Operation of Lignite Mines - Lignite Thermal Power Plants (LTPP) - District Heating Units

2.4.1. Environmental Impact on the Environment from the Use of Lignite Mines and Lignite Steam Power Plants (LTPPs)

(a) Lignite Mines

Lignite mining is considered to have an impact on the Environment, both in terms of size and diversity. Some of these effects include erosion, sink-holes, loss of biodiversity and contamination of groundwater by chemicals from the extraction process in general and open-pit mining in particular.

Impacts of mining and processing facilities on the Environment include land degradation, noise, dust, toxic gases, water pollution, etc. (Dudka and Adriano, 1997)[44].

Ptolemaida Mine

Megalopolis Mine

The extraction, movement and transport of lignite are the main reasons for the dust, however, it can be produced in almost all processing phases, from the starting point (crusher) to the end (drying of the ore concentration).

Water pollution is another aspect of mining that seriously affects the Environment. Polluted water from mining processes has vital effects on rivers, agriculture, drinking water and ecosystems, due to the abundance of heavy metals, suspended solids and the reduced pH level. Declining water levels in mines due to drainage can threaten aquifers with devastating consequences for humans and agriculture (Ritcy, 1989)[45]. Land degradation mining contributes greatly to soil erosion - a phenomenon that can be seen more in surface mining activities. Mining waste, i.e. part of the materials resulting from exploration and extraction, contains chemical, inorganic and organic additives and many have high concentrations of heavy metals and toxic materials, such as lead, copper, zinc, aluminium, mercury, marcasite and pyrite (FeS_2), harmful to the environment (Daskalakis and Helz, 1999)[46]. It should be noted that compared to underground mining, open pit mining has a more negative impact on the Environment (Zhong, 1998)[47].

(b) Lignite Steam Power Plants

Steam power plants are used as base stations and are the most economical power plants, they use lignite as fuel and their advantage is that they can operate continuously for a long time, without maintenance.

However, the combustion of lignite from steam power plants to generate electricity causes serious environmental problems, as it releases nitrogen oxides, sulphur oxides, SOx, suspended particles,

[44] Dudka S, Adriano DC (1997) Environmental impacts of metal ore mining and processing: a review. Journal of Environmental Quality 26: 590–602

[45] Ritcy GM (1989) Tailings management: problems and solutions in the mining industry. Environ Intern 26: 389–394

[46] Daskalakis, Helz GR (1999) Solubility of CdS (Greenockite) in sulfuric waters at 25 ° C. Environ Sci Technol26: 2462–2468

[47] Zhong Z (1998) Overview of national mineral policy in China: opportunities and challenges for the mineral industries. Resource Policy 23: 79–90

while sulphur is also contained in the fly ash coming out of the TPP's chimney because of the lignite combustion.

The use, therefore, of any type of coal, as an energy source and the selection of sites for lignite mines and power plants has been the subject of intense controversy for years, both globally and in Greece. As a result of the use of lignite for electricity generation, there have been many conflicts in societies mainly due to environmental concerns, involving mining and energy companies, state and local authorities, environmental organizations, local communities, etc. (Badera et al, 2014)[48]

Many studies[49] highlight the serious effects on human health, but also on fauna and flora, from the burning of lignite, such as:

* Sulphur dioxide (SO2), which contributes to acid rain and respiratory diseases,

* Nitrogen oxides (NOx), which contribute to smog and respiratory diseases,

* Particles, which contribute to smog and respiratory and lung diseases,

* Carbon dioxide (CO_2), which is the main greenhouse gas directly linked to Climate Change,

* Mercury and other heavy metals, which have been linked to both neurological and developmental damage in humans and animals,

* Suspended ash, a residue created by the combustion of lignite which affects the respiratory system of humans.

2.4.2. Annual Emissions of Greenhouse Gas Pollutants from the Operation of Lignite Mines and PPC's Lignite Power Stations

(a) Lignite Mines

The total certified geological reserves of lignite in our country amount to about 5 billion tons, according to PPC[50] and according to current technical and economic data, the reserves that are suitable for energy exploitation amount to about 3.2 billion tons and are equivalent to 450 million tons of oil.

There are exploitable lignite deposits in the areas of Ptolemaida, Amyntaio and Florina, with an estimated reserve of 1.8 billion tons, in the area of Drama with a reserve of 900 million tons, in the area of Elassona with 169 million tons and in the area of Megalopolis with a reserve of about 223 million. To date, mined lignite has accounted for about 29% of total reserves.

Apart from lignite, Greece has a large peat deposit in the area of Philippi, in Eastern Macedonia, where the exploitable reserves are estimated at 4 billion cubic meters and are equivalent to approximately 125 million tons of oil. In general, the quality of Greek lignites is low.

The calorific value ranges from 975-1,380 kcal / kg in the areas of Megalopolis, Amyntaio and Drama, from 1,261-1,615 kcal / kg in the area of Ptolemaida and 1,927-2,257 kcal / kg in the areas of Florina

[48] Badera J., Kocoń P. 2014. Local community opinions regarding the socio-environmental aspects of lignite surface mining: experiences from central Poland. Energy Policy, 66: 507–516
[49] https://www.eia.gov/energyexplained/coal/coal-and-the-environment.php
[50] https://www.dei.gr/el/oruxeia/apothemata-kai-poiotita

and Elassona. An important comparative advantage of the country's lignites is the low sulphur content of the fuel.

PPC follows "Environmental Terms of Mining Operation", according to JMD, which have been issued for all its mines. Indicatively, the JMD 171001/3243/22.08.2007 concerns the mines of Amyntaio and Lakkia, where the required safety limits for soils (§2.3), air pollution (§2.7), noise (§2.8) and vibrations (§2.9), are specified, while for the safety limits for mine wastewater (Law Decision 555 / 26.3.90), liquid waste (art. 42 L.4042 / 2012) and water (JMD Y2/2600/2001) other legislation follows.

Also, every year, PPC issues the "Annual Environmental Quality Report - AEQR" for its mines, which concerns the monitoring of the environmental impact of the mining activity that develops, the impact on the adjacent cities and is prepared in accordance with the obligations arising from the Article 10 of Chapter 2 of the respective JMC of the mine.

From the data of the EEPPs of the mines studied, it is clear that in all the mines all the limits are within the safety limits set by the JMC and the Laws.

(b) Annual CO_2 Emissions from PPC HPPs in Western Macedonia and Megalopolis

Table 30 presents the emissions of gaseous pollutants, in kg, from six lignite power plants, for the three years 2016-2018 according to data from the DG Strategy and Transformation of PPC[51]

Table 30 - Emissions of GHG from Lignite Power Plants of PPC, 2016-2018

2016	AG. DIMITRIOS	KARDIA	AMYNTAIO	MELITI	MEGALOPOLI A'	MEGALOPOLI B'
DUST	653	973	564	9	42	95
SO2	5.971	3.078	9.917	849	886	893
NOx	8.700	5.206	2.309	669	758	1.482
CO	2.955	2.685	1.330	61	1.894	796
CO2	9.050.119	5.589.447	2.652.482	1.557.925	1.898.669	1.899.220
2017						
DUST	573	2.056	541	10	56	86
SO2	12.824	3.344	8.541	1.803	1.199	1.159
NOx	8.237	5.518	2.136	1.246	1.033	1.376
CO	2.608	2.814	1.366	87	2.538	844
CO2	8.936.672	6.397.011	2.751.115	2.273.794	2.624.012	2.046.778
2018						
DUST	485	1.302	533	8	20	62
SO2	10.299	4.249	5.470	1.381	1.317	594
NOx	7.101	4.978	1.653	892	966	773
CO	3.183	2.747	1.102	43	2.741	563
CO2	9.226.694	5.791.829	2.421.059	1.876.833	2.449.712	1.768.748

Source: PPC

From the Table 30, it can be seen that regarding of the pollutants it seems that the Meliti substation emits the least pollutants, which is explained by the fact that it is of newer technology than all the others. In contrast to the Agios Dimitrios and Kardia substations, which have high emissions in all sub-sectors.

[51] Source: DEI - DG Strategy and Transformation

Finally, according to a study by the Heinrich Boll Stiftung[52] "*In 2010, in 9 of the 15 stations measuring the concentrations of suspended particulate matter PM10, in the Prefectures of Kozani and Florina, a percentage of exceedances was observed in relation to the European limits of more than 20%*".

(c) Annual CO_2 Emissions from PPC

Table 31 shows in detail the data from the CO_2 emissions recorded by PPC for all its functions, noting that the emissions related to the operation of the units for the district heating of these areas where such systems operate, for the period 2018 have been removed. -2019[53]

Table 31 - PPC Annual CO_2 Emissions, 2018 and 2019

Data on CO_2 emissions	2018	2019
Emissions CO_2 (mil. tn/MWh)	29,5	23,1
Price (€/tn CO_2)	12,5	23,7

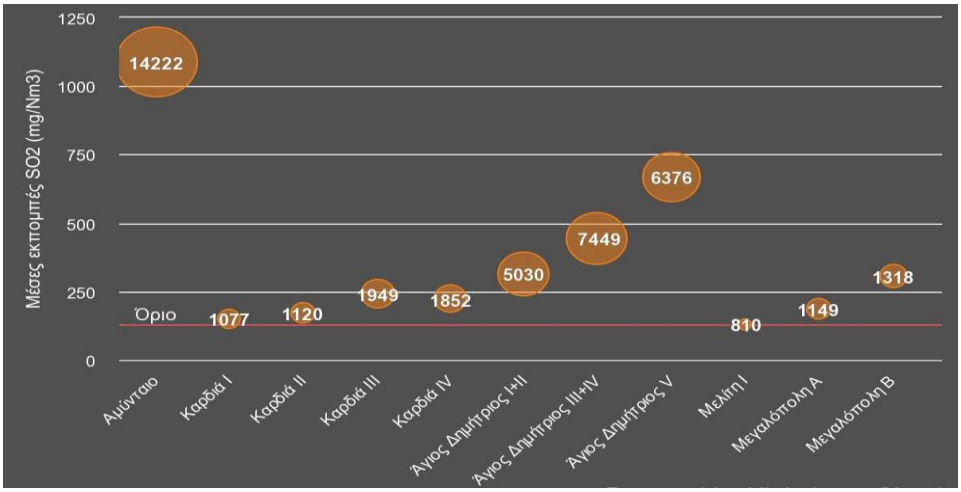
Source: PPC

PPC, in the annual report of its financial figures for 2019, states that for this year the total annual CO2 emissions were 21.7% less than in 2018, while the international price per ton of CO2 increased by 89.6%. It should be noted that according to PPC data in 2019 there was a decrease in lignite production by 30.1% or 4,489 GWh and at the same time an increase in domestic electricity demand by 3.1%.

In addition to CO_2 emissions during the combustion of lignite for the production of electricity from all PPC units, other gaseous pollutants are emitted, with the most important being SO_2 and PM10 microparticles.

Diagram 20 shows the SO_2 emissions in the lignite units of PPC, from data processed by the Energy Ministry for the period 2012-2016, where it seems that almost all units exceed the limit with special reference to the lignite units of Amyntaio, where the emissions are excessive multiples of the limit.

Diagram 20 - Average SO_2 Emissions from PPC Lignite Units, 2012-2016



Source: Greek Min. of Energy and Environment

[52] https://gr.boell.org/el/o-lignitis-sto-elliniko-energeiako-systima
[53] https://www.dei.gr/el/anakoinwseis/oikonomika-apotelesmata/anakoinwseis-oikonomikwn-apotelesmatwn-2019/oikonomika-apotelesmata-etous-2019-tis-dei-ae

2.4.3. Environmental Rehabilitation Actions in PPC Lignite Centres

The long-term exploitation of domestic lignite, while undoubtedly had invaluable positive effects on the national economy, ensuring for sixty years the country's fastest electrification, with cheap electricity for households, businesses and industry, had a number of effects on wider environment, such as:

* Commitment of large areas of land for long periods of time,

* Alteration of soil morphology,

* Disruption of flora and fauna,

* Movements of settlements, as well as transport network,

* Release of greenhouse gaseous pollutants into the Environment, but also dust from the transport of barren materials and ash.

For the General Directorate of Mines (DG Mines) of PPC[54], the treatment of environmental problems are issues of primary importance and for this reason a clear strategy was created, where PPC allocated huge funds for environmental protection and restoration measures, as well as for joint projects of benefit and social return in local communities.

For the environmental restoration of the areas affected by the operation of the mines, actions and policies were developed, with the main goal of creating a new terrain that resembles the original natural landscape. The areas, in which the exploitation of lignite and the deposition of barren materials are completed, are immediately restored. In order to minimize the impact or nuisance caused by the development of lignite deposits from the two lignite centres of PPC (Western Macedonia and Megalopolis), in addition to compliance with national and European legislation, PPC undertakes actions and initiatives, aimed at benefit of local communities.

Typical rehabilitation projects for both lignite centres, according to PPC data, are the following:

The Lignite Center of Western Macedonia (LKDM), where extensive rehabilitation programs have been implemented for a number of years, for the soils which have been disrupted by the operation of the mines. To date, about 40,000 acres have been restored from the LKDM, with the creation of plantations with forest species in about 20,000 acres, of special beauty and variety of fauna, with the configuration of areas for agricultural cultivation in about 14,000 acres, granted to local farmers for exploitation, while, finally, the remaining 6,000 acres have been allocated for other uses, such as a pilot hydroponic cultivation greenhouse with coverage of its thermal loads by the district heating system, in collaboration with EL.GO. DIMITRA (former ETHIAGE) and the TEI of Florina, an artificial wetland, which is evolving into an important ecosystem, in collaboration with university bodies, used as an environmental education park, a forestry park, in the external deposit of the mine "main field". Finally, an exhibition center was created, which is visited every year by over 5,000 people from Greece and abroad, an open-air theatre, for the construction of which old materials collected from the mines were used, amusement park, track for motocross races. Finally, Landfills, Landfills and Industrial

[54] https://www.dei.gr/el/i-dei/perivallon/perivallontiki-stratigiki

Waste Disposal areas were created. The Lignite Center of Western Macedonia implements a certified Environmental Management System (ISO 14001: 2004).

The Lignite Center of Megalopolis (LKM), which carries out very important actions to reduce the nuisance caused by the development of local lignite deposits. To date, the LKM has proceeded with the restoration of 7,038 acres, where in over 4,300 acres plantations with forest species have been created, 2,300 acres have been formed on agricultural land and leased to farmers in the area, while another 1,700 acres have become special purpose areas. Finally, 2,000 acres are intended for the construction of a Photovoltaic Park.

In addition to the conventional restoration of the soils, in the Lignite Center of Megalopolis have been applied "alternative" restoration techniques, such as: amusement park with playground, playground, stadiums, where events are held in collaboration with the Municipality of Megalopolis, artificial aquifers artificial lakes, some of which have been enriched with fish, motocross track, where, on an annual basis, pan-Hellenic championship races are held, while world and pan-European championship races are hosted, since the track has been characterized as a model by international sports personalities, meeting and training of air model men of the surrounding areas. Finally, a kennel for small birds and animals has been created, which when they grow up, are released into the wild by students from schools in the area, who visit it.

For the coming years, both for the rehabilitation of the mining areas and the dismantling of the lignite power plants and the rehabilitation of the areas in both regions of the country, there are proposals for interventions through funding from the new NSRF. The total cost, according to estimates, was over € 1 billion, an amount equal to about 30% of the total required funds, amounting to € 3.5 billion, to which Greece is entitled by InvestEU[55], in order to start the projects for the post-lignite period.

2.4.4. Annual Emissions of Greenhouse Gas Pollutants from the Operation of District Heating Systems in the Two Lignite Areas

The use of district heating systems in cities to meet their thermal needs, located near power stations, significantly reduces emissions of gases - mainly due to the shutdown of boilers, with oil and / or other fuels - and, consequently, environmental pollution is reduced. In these areas, there is a reduction of CO_2 emissions, but also of other pollutants, such as SO_2, CO, NO_X, HC and suspended particles. A typical example of reducing emissions are data from DETIP, the company that operates district heating in the city of Ptolemaida. According to these data, for a period of five years (2010-2015), the reduction of CO_2 emissions from the use of district heating, instead of heating oil, in apartment buildings exceeds 250,000 tons, as shown in Table 32.

[55] https://europa.eu/investeu/home_el

Table 32 - Pollutant Emissions in Case of Boiler Operation Instead of District Heating System in Ptolemaida, 2010-2015

Year	Sold TE by DHS	Oil substitution toe	CO_2	SO_2	CO	NO_x	HC	Particles
	MWh/έτος	tons	Tons/year					
2010-11	154.204	15.043	47.264	10,53	8,60	35,86	2,87	4,30
2011-12	158.094	15.422	48.456	10,80	8,82	36,77	2,95	4,41
2012-13	150.768	14.707	46.211	10,30	8,41	35,06	2,81	4,21
2013-14	157.029	15.318	48.129	10,72	8,76	36,52	2,93	4,38
2014-15	183.583	17.908	56.268	12,54	10,24	42,69	3,42	5,12

Source: PPC

According to the current European and National legislation, during the 3rd phase of implementation of the EU-ETS (period 2013-2020), PPC is not entitled to free allocation of CO_2 emissions allowances of its liable production plants, with the exception of emissions corresponding to supply thermal energy for heating.[56]

Based on the verified emissions each year, PPC announces the total CO_2 emission allowances (in millions of tonnes) for this 12-month period, as well as the emission allowances corresponding to thermal energy supply for district heating assigned free of charge[57].

Table 33 presents the verified emissions of PPC and the allowances for the emissions corresponding to the supply of thermal energy for district heating for the years 2014-2016.

Table 33 - Verified Emissions of PPC and Rights from DH, 2014-2016

Year	Verified Emissions, (million tons)	Rights from emissions corresponding to the provision of Thermal Energy for DH, (thousand tons)
2014	39,20	150,60
2015	34,30	87,20
2016	31,74	62,77

Source: PPC

In conclusion, the use of coal for the production of electricity and heat has been shown to have an impact on the environment, both in its extraction and in its combustion. These effects have serious effects on human health but also on fauna and flora, especially in areas close to mines and lignite power plants. These findings are also verified for the lignite areas of the country, i.e. Western Macedonia and Megalopolis, as the PPC data show and were recorded in the previous sections.

Conversely, district heating systems significantly improve the environmental impact of coal mining and use in the areas where they operate.

56 https://www.dei.gr/Documents2/FY2015/%CE%95%CE%9A%CE%98%CE%95%CE%A3%CE%972015%CE%A44.pdf

57 https://www.dei.gr/Documents2/OIKONOMIKA%20ΑΠΟΤΕΛΕΣΜΑΤΑ%202017/FY2017/OIKONOMIKH%20ΕΚΘΕΣΕΣΗ%202017%20GR%20ΤΕΛΙΚΟ.pdf

For this reason, the rights from CO2 emissions that correspond to the supply of thermal energy from district heating systems are excluded (free of charge) from the distribution of rights that PPC is obliged to pay, on an annual basis, with a fluctuating price of € per ton of CO_2.

2.5. Energy Infrastructure, Electrical Interconnections and Pipelines / Natural Gas Networks

This chapter refers to the electrical and natural gas infrastructure of the lignite areas of Western Macedonia and Megalopolis. Electrical infrastructure includes existing transmission lines (TL), medium to high voltage (MV) step-down substations, MV step-up substations for power supply to the high voltage network (150 kV), MV hoisting substations for absorption power generated by RES units and high voltage centres (HVC). Gas infrastructure includes the gas transmission network.

(a) Substations 150 kV / MV

In the lignite areas of Western Macedonia and Arcadia, until the end of 2016, according to data obtained from ADMIE,[58] a total of 26 substations of 150 kV / MV were connected to the electricity transmission system.

•15 150 kV / MV step-down substations that serve the needs of the customers of the Distribution Network, of which 5 in Arcadia and 10 in Western Macedonia.

- The 15 substations include 7 substations, to which are also connected to step-up substations of 7 conventional production stations, as well as 5 substations connected to the 150 kV side of the substations.

• 12 150 kV / MV step-down substation of PPC SA, of which:

- 4 are used to power mining loads. The Ptolemaida I substation also serves the needs of the mines, which is included in the aforementioned 15 that also serve distribution needs.
- A Substation (Polyphyto Pumping Station) serves pumping needs for the power plants of PPC SA. in Western Macedonia.
- The above substations include the 7 step-down substations 150 kV / MV that serve auxiliary loads of thermal power plants of PPC SA and are connected to substations and substations near the respective production stations.

• 10 substations for the absorption of the power produced by RES units, of which only 2 are in Western Macedonia and 8 in Arcadia.

• MV Step-Up station / 150 kV in Production Stations of PPC:

- 7 Thermal Power Stations.
- 3 Hydroelectric Stations.

• 1 step-down substation 150 kV / MV that serves the facilities of customers.

[58] These data are not presented independently in a version of IPTO but are processed data from the Ten-Year Transmission System Development Program 2019-2028.

Table 34 presents the "150 kV / MV substations in the Lignite Areas of Western Macedonia and Arcadia" Source ADMIE[59] and is given in Annex G (in Greek).

Transformers

In the lignite region of Western Macedonia, in 15 substations HV / MV are located transformers with a total capacity of 3,596.5 MVA. Of these, the total power of the simple two-winding transformers is 2,135.61 MVA, of which 4.11 MVA is the power of auxiliary voltage transformers in connection units of distributed units (i.e. thermal and hydroelectric), while the rest of the power relates to step-up current transformers of thermal generation units to connect them to the electricity transmission network.

Also, in the 15 substations of the lignite region of Western Macedonia are 1,111 MVA of total power of transformers 150kV / MV two windings with voltage regulation under load, 420 MVA of which serve voltage degradation function for the needs of lignite mines, 240 MVA serve power dissipation for customer service in medium and low voltage, 80 MVA serve step-up voltage needs of R / RES stations (RES- PV), 170 MVA serve to increase the voltage of hydroelectric power stations (Hilarionas), 80 MVA serve the needs of voltage reduction (step-down) for the service of pumping loads (Polyphyto Pumping Station), while the rest of the power concerns the increase of voltage of auxiliary systems (Polyphyto TPP). In addition, in the substations of Kardia substation and Ptolemaida substation I there are a total of 12 transformers of three windings 150 / 20kV 100/50 + 50 MVA, with a total power of 350 MVA, which serve the voltage raising needs of auxiliary systems.

In the lignite area of Megalopolis Arcadia (Prefecture of Arcadia), in 14 substations MV / MV are transformers installed with a total capacity of 1,808 MVA. Of these, the total power of the simple transformers of two windings is 946 MVA, of which 20 MVA is the power of step-up voltage transformers of auxiliary systems in the substation Megalopolis I, and the rest, 926 MVA, serve to increase the voltage of thermal units to connect them to the electricity transmission network.

Also, 150kV / MV transformers are located in the 14 substations of the lignite area of Arcadia. two windings with voltage regulation under load, total power 662 MVA, 80 MVA of which they serve voltage degradation function for the needs of lignite mines (Megalopolis III, Horemi), 160 MVA serve power outage to serve consumers at average and low current, 160 MVA serve the needs of voltage increase of RES stations (W/P and PV) for their connection with the electricity transmission system, while 32 MVA serve the needs of voltage increase of the auxiliary systems of the heating station of Megalopolis I. In addition, in the substations Megalopolis I and Megalopoli II are located a total of 5 transformers of three windings 150 / 20kV 100/50 + 50 MVA with a total power of 200 MVA (5 X 40/50 MVA), which serve the voltage needs of the auxiliary systems of the power units.

Reactive Power Compensation Devices

The needs for reactive power compensation are covered by the installation of stator capacitors and coils. More specifically, for the local support of the voltages in the 150 kV / MV substations, capacitors are used that are installed mainly in the MV balances of the Substations, with their total power reaching

[59] These data are not presented independently in a version of IPTO but are processed data from the Ten-Year Transmission System Development Program2019-2028.

192.1 MVAr in the lignite region of Western Macedonia and 150.68 MVAr in the lignite region of Arcadia respectively.

In the lignite region of Western Macedonia, out of the total capacitors of 192.1 MVAr, 160.1 MVAr concern reactive power compensation power in a power storage substation for the needs of the consumers of the MV network (of these, 125 MVAr concern the power compensation of electric needs of the lignite mines of South Field, Ptolemaida and Amyntaio), while the capacitors with a power of 32 MVAr, serve the compensation of reactive power in a substation for voltage rise and connection of RES stations.

In the lignite region of Arcadia, out of the total capacity of 150.68 MVAr capacitors, 47.49 MVAr concern reactive power compensation power in a power storage substation for the needs of the consumers of the MV network (23.7 MVAr concern the power compensation of the electric power supply of Choremio mine), while the 103.19 MVAr concern reactive power compensation power in substations connecting RES stations.

Finally, coils have been installed in the tertiary winding (side 30 kV) of the AM / S of the KYT to deal with problems of occurrence of high voltages during low load hours.

Table 35 - Substations in the Lignite Region of Western Macedonia and Existing Equipment, including Transformers and their Rated Power is given in Annex G (in Greek)

Table 36 - Substations in the Lignite Region of Arcadia and Existing Equipment, including Transformers and their Rated Power is given in Annex G (in Greek)

(b) Extra High Voltage Centres (EHVCs)

The EHVCs are the connection points of the 400 kV and 150 kV Systems and serve the needs of power storage to the 150 kV System. In the lignite areas of Western Macedonia and Megalopolis there are only 2 EHVCs, the Kardia EHVC in Kozani and the Megalopolis EHVC in Arcadia. In addition, there are 3 EHVCs (not included in the above 2), the EHVCs of Agios Dimitrios, Amyntaio, Meliti of Achlada, located near the homonymous production stations, which serve in parallel or exclusively step-up voltage needs from the production units to the 400 kV System. Specifically, the Meliti Achlada TPP, in addition to raising the voltage of the adjacent thermal power plant, also serves to shut off the power of the 400 kV Meliti- Bitola electrical interconnection.

(c) Transmission Lines (TL)

In the electricity transmission system in the lignite regions of Western Macedonia and Arcadia there are high (66 kV and 150 kV) and extra high (400 kV) voltage lines of various types and types. The existing TLs connect the existing production infrastructure with the voltage downtime substations that serve the demand needs of the consumers of the distribution network. The existing TLs in the lignite regions of Western Macedonia and Arcadia are presented in the following tables.

Table 37 - Interconnected Transmission System Lines in Western Macedonia is given in Annex G (in Greek).

In Western Macedonia, the transport system focuses on EHVC of Kardia and Ag. Dimitrios, where the power of the lignite units in the area of Kozani Ptolemaida is added to the System. The EHVC of Kardia

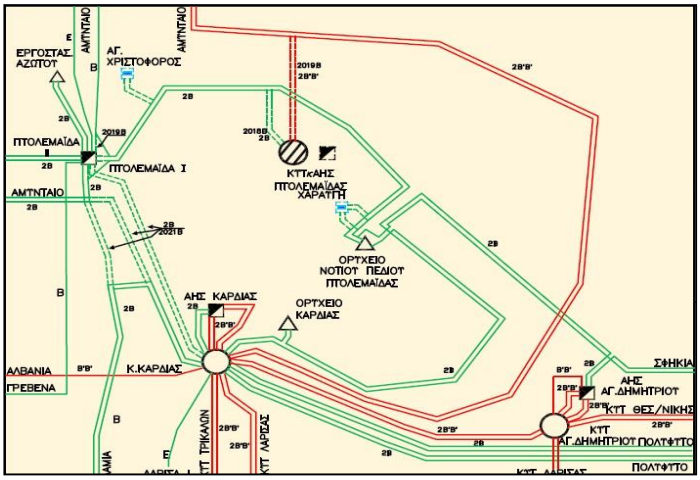
connects the network of Western Macedonia to the south with the EHVC of Trikala and the EHVC of Larissa with overhead transmission lines of 400kV double circuit, while the EHVC of Ag. Dimitrios and Amyntaio connect the transport system of the area with the area of Thessaloniki, through the EHVCs of Thessaloniki and Lagada respectively. To the east, the system of the area is connected to the area of Edessa and Veria through the branches of the network of Amyntaio - Agra and Ag. Dimitrios - Sfikia respectively. In the west, the Kardia EHVC is connected through Kastoria and Grevena through the Ptolemaida I substation. The wind farms in the area are connected to the system at the Florina I and Polymylos Kozani Substations, while to the south the Hilarionas and Polyphyto hydroelectric stations are connected.

The transmission system extends to the north to the Meliti substation, where there is one of the two connection points of the Greek electricity transmission system with that of North Macedonia through the line Meliti - Bitola. To the west, Kardia EHVC is connected to the Albanian system via the line Kardia - Zemblak.

Map 7 - Electricity Transmission System Infrastructure in Western Macedonia

Source: ADMIE

Map 8 - Electricity Transmission System Infrastructure in the Lignite Region of Kardia - Ag. Dimitrios - Ptolemaida – Kozani

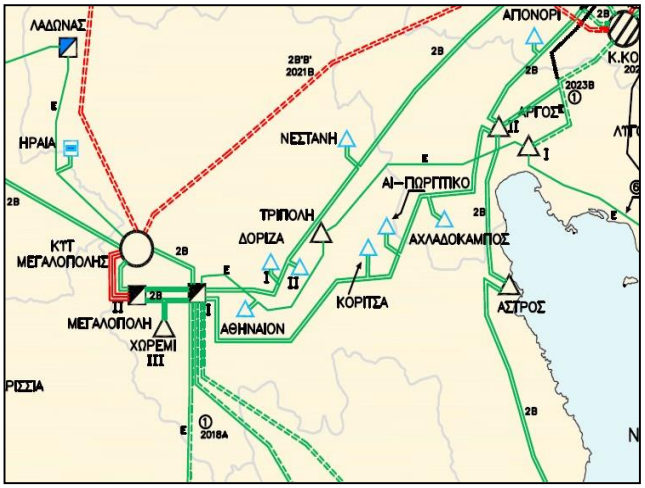


Source: ADMIE

Table 38 - Transmission Lines of Interconnected System in Arcadia is given to annex G (in Greek).

The part of the transmission system of the lignite area of Megalopolis Arcadia extends east of the lignite mine of Megalopolis, connecting the RES stations located in the central and eastern area of the prefecture along the axis of Megalopolis - Corinth. The branch of the system in the northwest of the prefecture connects the hydroelectric park of Ladonas and photovoltaic units in Irea with the southern part in the EHVC of Megalopolis. The transmission network, through EHVC Megalopolis, is connected to the part of the network south in Sparta and Kalamata, west with Pyrgos and northeast with Argos and Corinth.

Map 9 - Electricity Transmission System Infrastructure in the Lignite Area of Megalopolis Arcadia



Source: ADMIE

(d) International Electrical Interconnections of the Lignite Areas of Western Macedonia

Two of the country's cross-border electricity connections are located in the region of Western Macedonia. Specifically, one of the two interconnections of Greece is with North Macedonia, i.e. the 400 kV single-circuit transmission line with twin conductor, between the Meliti substation in Florina and Bitola in North Macedonia. In addition, in the wider region of Western Macedonia is located one of the two electrical connections of the country with Albania and specifically a 400 kV single circuit line with twin conductor, between EHVC Kardia and Zemlak (Albania).

Map 10 - Diagram of Interconnected Electricity Systems in the Balkans

Source: ADMIE

Table 39 - ESMIE Interconnecting lines in the Lignite Region of Western Macedonia (31/12/2019)

Name of Transmission Line TL	Line Length (km)	Voltage (kV)	Thermal limit TL
KARDIA – ZEMBLAK (Albania)	75(GR) + 69 (AL)	400	1100-1400 MVA
KYT MELITI – BITOLA (N. Macedonia)	18(GR) + 18 (NMK)	400	1100-1400MVA

Source: ADMIE

(e) Gas Pipelines / Networks

Special mention should be made of the Trans-Adriatic Pipeline (TAP), which will transport natural gas from the Caspian region to Europe, passing, inter alia, through the wider region of Western Macedonia. In particular, the TAP will be interconnected with the Anatolia gas pipeline (TANAP) at the Greek-Turkish border and will pass through Northern Greece, Albania and the Adriatic Sea before reaching the coasts of Southern Italy, where it will be connected to the Italian natural gas network.

On May 20, 2020, the import of natural gas began in the last section of TAP in Greece, from Serres to Ieropigi, Kastoria and the Greek-Albanian border, as part of the pilot operation of the project. The introduction of natural gas at 550 km of the Greek section of the pipeline began in November 2019 and is an important milestone on the road to the completion of the project. During the testing process, it is checked that the infrastructure is safe and ready for operation, according to national and international standards. At the end of May, RAE issued a 50-year Independent Natural Gas System (ASFA) Management License to TAP AG for the section of the pipeline passing through Greece, taking another step towards the start of commercial operation of the pipeline forecast for the last quarter of 2020.

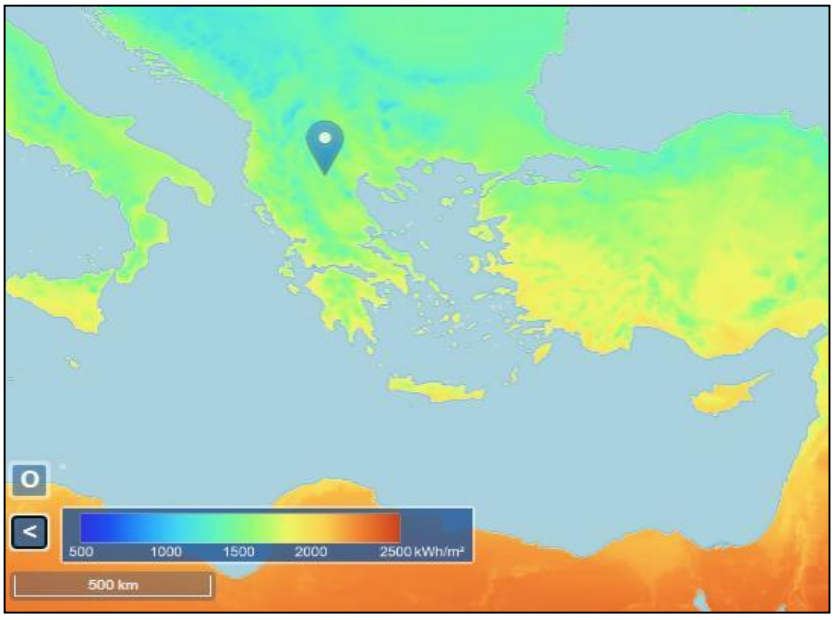
In the region of Western Macedonia, in addition to the construction of metering stations that will be created at points where the TAP pipeline passes, the creation of a new extension pipeline of the National Natural Gas System (NSGF) is being considered. The project is under study as there are plans for the construction in the region of Western Macedonia of a new power plant with fuel natural gas. In such a case, the gas from the TAP pipeline will not be enough to cover the needs and for this reason the construction of a small extension of the NSRF is being studied, which will start from Nea Mesimvria. Relevant information is extensively reported in Chapter 4 of this study.

2.6. Energy Potential of RES in the Energy Transition Areas

2.6.1. Solar Energy Potential

With estimates based on the database of the Joint Research Center (JRC) of the European Union, Sarah, and the PV-GIS software and sample from the years 2005-2016, the solar potential of the lignite areas of Greece is quite high and is around 1,550 kWh / m^2 / year in the region of Western Macedonia up to approximately 1,700 kWh / m^2 / year in the lignite region of Megalopolis Arcadia in terms of total incident radiation in the horizontal plane. In addition, the beam radiation in the horizontal plane is approximately 1,600 kWh / m^2 / year in the region of Western Macedonia and about 1,800 kWh / m2 / year in the lignite region of Megalopolis Arcadia.

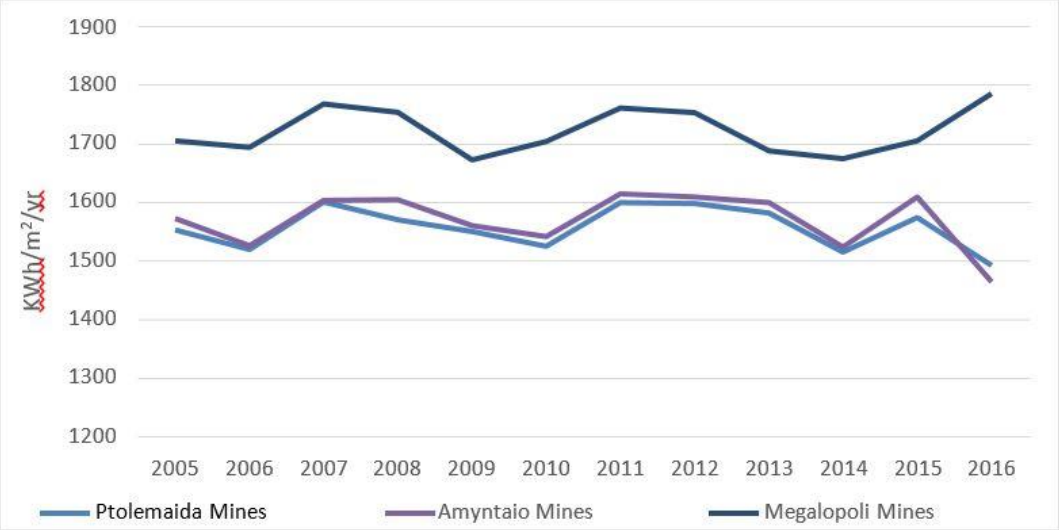
Map 11 - Solar Potential of Greece - Average Annual Fluctuating Solar Radiation at the Horizontal Level



Source: JRC Photovoltaic Geographical Information System

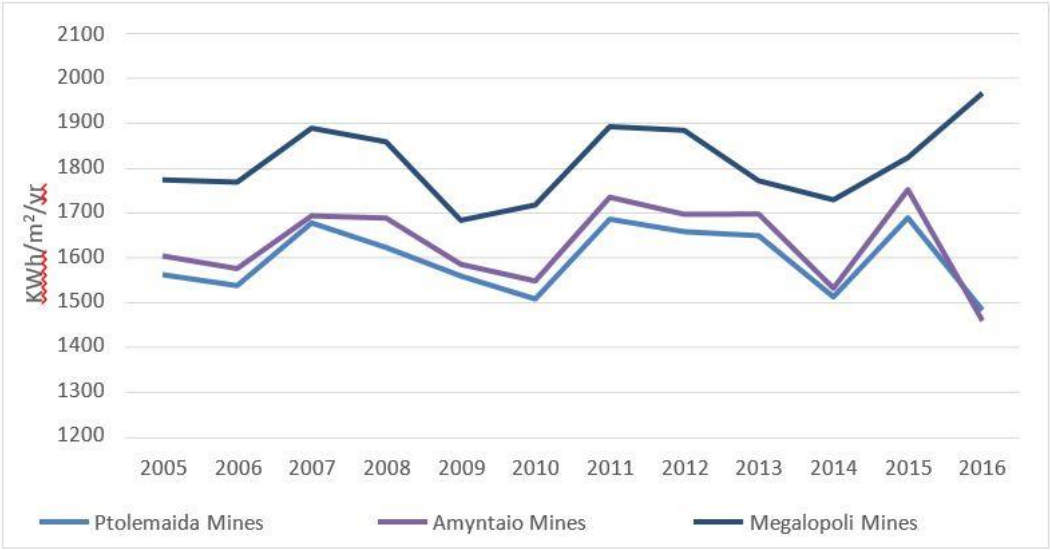
In addition, the average value of the ratio of diffuse radiation to total (global) solar radiation in the horizontal plane, as reported in the JRC database, ranged for the specific reference years (2005-2016) to 42.4% and 41.7% for the lignite mines of Ptolemaida and Amyntaio respectively, while the area of the lignite mine of Megalopolis with lower cloud cover had a ratio of diffuse to total radiation of 38.8%.

Diagram 21 - Average Total Incident Radiation at the Horizontal Level in the Lignite Mines of Ptolemaida, Amyntaio and Megalopolis (KWh / m² / year) [60]



Source: Sarah PV-GIS, JRC

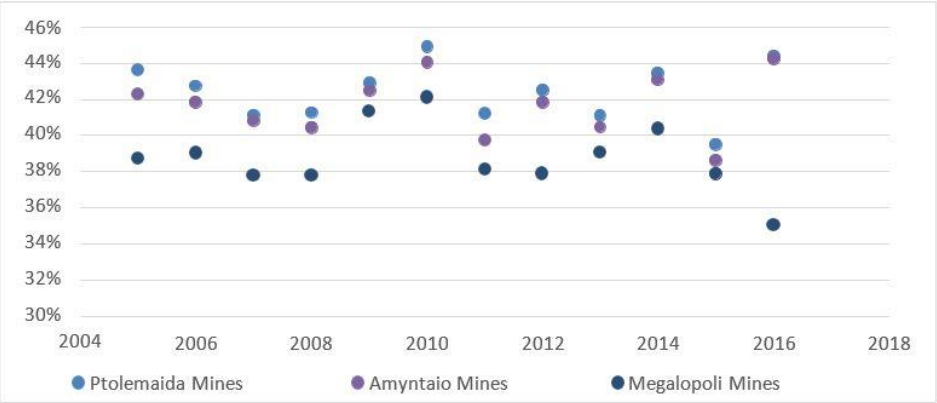
Diagram 22: Average Incident Beam Radiation at the Horizontal Level in the Lignite Mines of Ptolemaida, Amyntaio and Megalopolis (KWh / m² / Year)



Source: Sarah PV-GIS, JRC

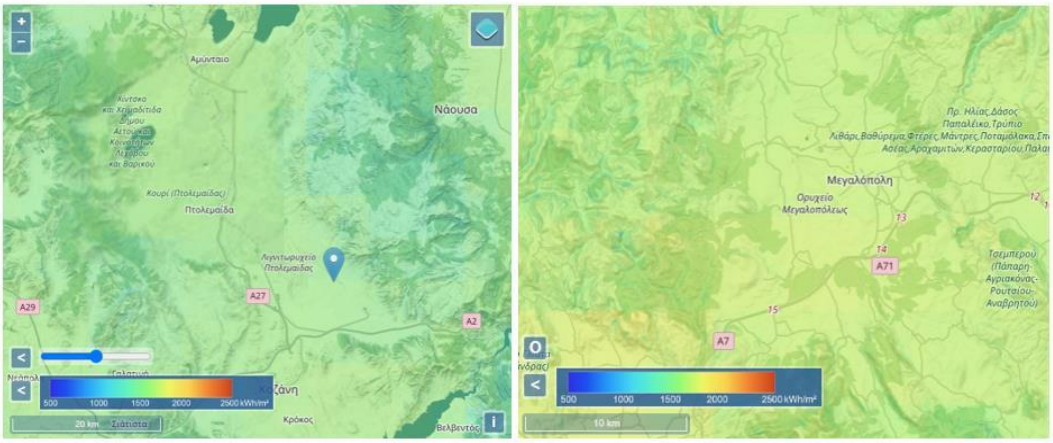
[60] The data are taken from the Sarah PV-GIS database for the years 2005-2016 from five (5) different points of each lignite mine so that there is a sufficient spatial sample for the printing of the solar potential

Diagram 23: Mean Ratio of Diffuse Radiation Towards Total (Global) Solar Radiation at the Horizontal Level in Ptolemaida, Amyntaio and Megalopolis Lignite Mines



Source: Sarah PV-GIS, JRC

Map 12: Solar Potential of Lignite Areas (a)Ptolemaida-Amyntaio (b)Megalopolis - Average Annual Fluctuating Solar Radiation at the Horizontal Level



Source: JRC Photovoltaic Geographical Information System

2.6.2. Wind Energy Potential

The wind potential of the lignite areas of Western Macedonia and Arcadia Peloponnese is quite high, due to the many mountain ranges within walking distance of the open lignite mines. Specifically, in the area of Kozani, southwest of the lignite mine of Ptolemaida, are the mountains Siniatsiko (Askio), Velia and south the peak Drisinikos with quite high wind potential, with average annual wind speeds ranging from 8.00–9.50 m / s and, i.e. the amount of wind energy passing through the surface swept by the impellers of wind turbines, to be estimated at 750–1,100 W / m2.[61]

In the lignite area of Amyntaio, Florina, high wind potentials are found at the top of Liliakos, north of the lignite mine of Amyntaio, while in the western hills in the area of Aetos and Nymfaio they present high potentials for wind production, with average annual wind speeds of 6.5 – 8.5m / s and power

[61] Estimates made using the Global Wind Atlas: https://globalwindatlas.info/

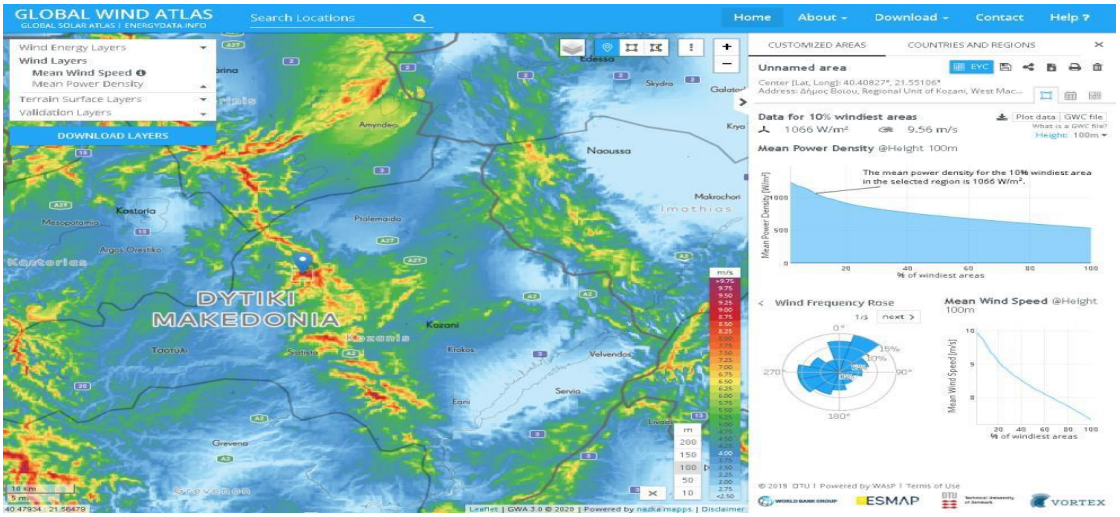
density 700–1,100 W/m^2. Further, at the west border of the prefecture of Florina with the prefecture of Kastoria, Mount Kronos and north the mountains Viglaka Varnounta show high wind speeds, however they are located in a densely forested area with low accessibility.

In the lignite area of Megalopolis Arcadia, and west and south of the lignite mine area, mountain hills near the villages of Vastas, Tourkolekas and Hirades present relatively high wind potentials with average annual wind speeds of 7.5–9.0 m/s and power density 500–950 W/m^2. Farther from the lignite mine of Megalopolis, in the east of the prefecture of Arcadia, various peaks in the northern and eastern slopes of Parnon in the area of the municipality of Evrotas, North and South Kynouria offer very high wind potential.

The Table 40 shows some places in the lignite areas of Western Macedonia and Megalopolis Arcadia and their respective wind potentials at average annual wind speeds and average annual power densities.

Table 40- Indicative Positions with High Wind Capacity in the Lignite Areas of Western Macedonia and Megalopolis and their Respective Capacity at Average Annual Wind Speed (m / s) and Power Density (W / m^2) is given in Annex H in Greek.

Map 13 - Wind energy potential in the Lignite Regions of Kozani-Ptolemaida, Florina (in the Diagram the peak of the Siniatsiko mountain with average wind speed of 9.56 m/s at mast height of 100 m)



Source: Global Wind Area

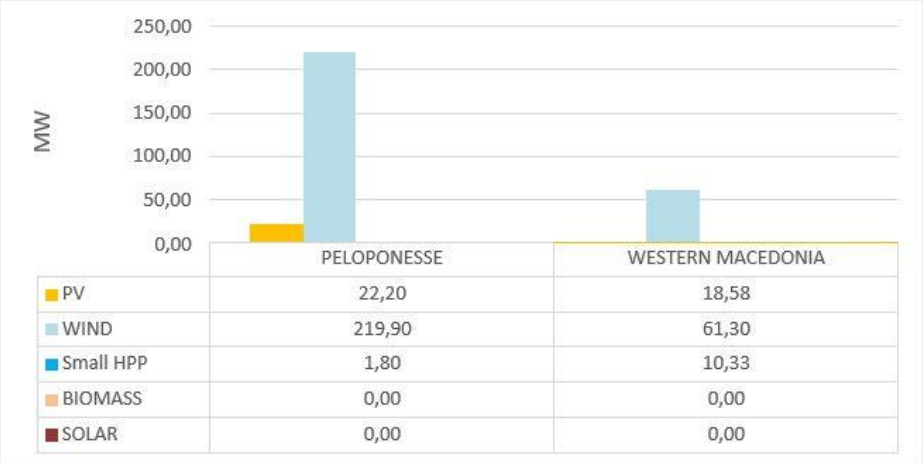
2.6.3. Existing RES Infrastructure

In the lignite areas of Kozani, Ptolemaida, Florina and Arcadia, RES have low penetration and are under development, given the saturation of networks due to the until recently high utilization of existing thermal units, mainly lignite. In June 2020, the lignite area of Megalopolis and the wider area of the prefecture of Arcadia[62] had about 244 MW, 23 RES projects with operating license, of which the largest share of power consists of wind farms, 11 in number and a total capacity of about 220MW.

[62] Regional units: Arcadia, Laconia & Arcadia, Arcadia & Argolida, Argolida & Arcadia, Laconia & Arcadia

Respectively, the lignite region of Western Macedonia and the wider region of the prefectures of Kozani and Florina[63], i.e. the epicentre of the lignite heat production of the country, presents significantly lower RES penetration with only 16 projects with operating license, total capacity 90 MW. Here, due to the available RES potential and the geomorphology of the area, we see a more balanced distribution of RES projects by technology, with 61.3 MW wind, 18.6 MW photovoltaic and 10.3 MW small hydroelectric.

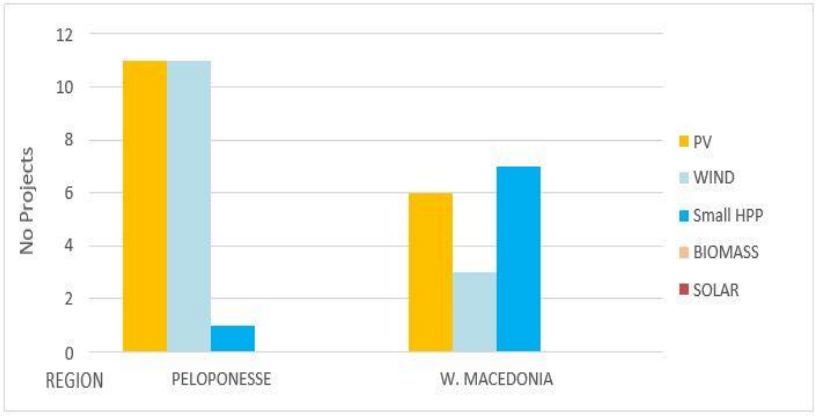
Diagram 24 - Power (MW) of Projects with Operating Permits, by Region and RES Category (June 2020)



	PELOPONESSE	WESTERN MACEDONIA
PV	22,20	18,58
WIND	219,90	61,30
Small HPP	1,80	10,33
BIOMASS	0,00	0,00
SOLAR	0,00	0,00

Source: RAE

Diagram 25 - Number of Projects licensed per Lignite Area, Region and RES Category (June 2020)



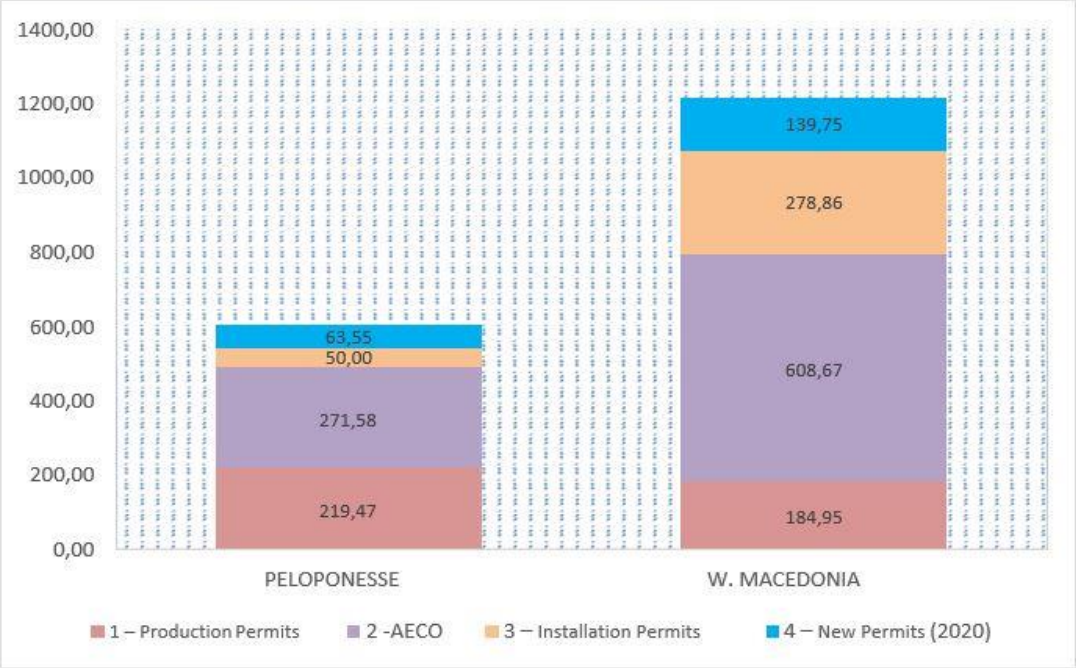
Source: RAE

[63] Peripheral units: Florina, Florina & Kastoria, Pella & Florina, Florina & Kozani, Florina & Pella, Kozani, Kozani & Imathia, Kozani & Grevena, Grevena & Kozani, Kozani & Kastoria, Grevena & Kozani & Larissa, Kastoria & Kozani, Kozani & Larissa

2.6.4. RES Projects Under Licensing in the Energy Transition Areas

Respectively, the RES projects that are in one of the stages of the licensing process (June 2020) are 600 MW and 1,210 MW in the lignite areas of the region of Peloponnese and Western Macedonia.

Diagram 26 - Capacity (MW) of RES Projects Under Permit Procedure by Lignite Area, Region and Permit Stage (June 2020)

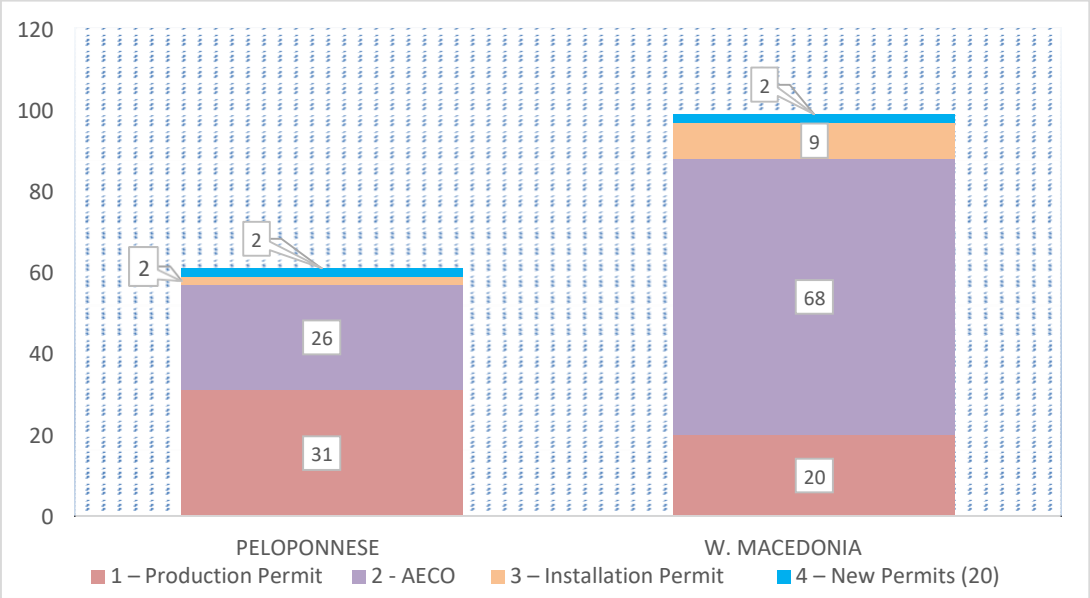


Source: RAE

The largest share of these projects is in the third stage of the licensing process, i.e. they have issued a Decision of Approval of Environmental Conditions (AECO) and are in the process of issuing an installation permit. The capacity of RES projects at the licensing stage amounts to 609 MW and 272 MW in the lignite areas of the regions of Western Macedonia and Peloponnese respectively, which refer to 26 and 68 RES projects respectively. In the second stage of the licensing process, i.e. in the process of issuing AECO, having received a production license, there are 31 projects in the lignite area of the Peloponnese region and 20 projects in the lignite area of the region of Western Macedonia, with a total capacity of 219.5 MW and 185 MW respectively.

In addition, the projects, which are in the fourth stage of the licensing process, having already started construction work after obtaining an installation permit and therefore are expected to issue an operating license after the completion of the works are 9 in the Region of Western Macedonia and 2 in the Peloponnese region, with a total capacity of 279 MW and 50 MW respectively. It is worth mentioning that 2 new production licenses have been granted in 2020 to RES projects in the lignite region of Western Macedonia and 2 in the lignite region of the Peloponnese region, with a total capacity of 139.75 MW and 63.55 MW respectively.

Diagram 27 - Number of RES Projects Under Permit Procedure per Lignite Area, Region and Permit phase

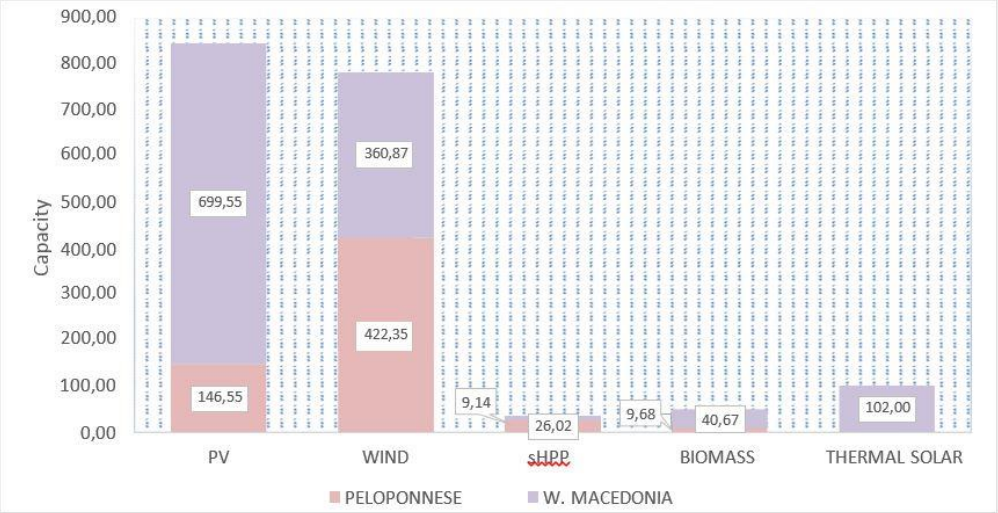


Source: RAE

Of the RES projects that have received at least a production license and are in an advanced stage of licensing, the main volume concerns photovoltaic and wind farms. Specifically, 28 photovoltaic parks in the lignite area of Arcadia and 37 in the lignite area of Western Macedonia, total power 146.55 MW and 699.55 MW respectively, are in a mature licensing stage. Also, 26 wind farms in the lignite area of the Peloponnese region and 9 in the lignite area of Western Macedonia, with a total capacity of 422.35 MW and 360.87 MW respectively, have exceeded the first stage of the licensing process.

The small hydroelectric projects (SHPP), which are in a mature licensing stage, are 5 in the lignite region of Arcadia and 8 in the lignite region of Western Macedonia, with a total capacity of 26.02 MW and 9.14 MW respectively. Two (2) mature biomass projects are located in the lignite region of the Peloponnese and 6 in the lignite regions of Western Macedonia, with a total capacity of 9.68 MW and 40.67 MW respectively. Finally, 38 projects of solar thermal units, which are located entirely in the lignite fields of Western Macedonia, total 102 MW, are in a mature licensing stage, with 36 of them, with a total capacity of 94.9 MW, located in the area of the Amyntaio lignite mine, in the prefecture of Florina, having already secured AECO.

Diagram 28 - Capacity (MW) of RES Projects Under Permit Procedure by Lignite Area, Region and RES Technology (June 2020)



Source: RAE

Table 41 - Capacity (MW) of RES Projects Under Licensing Procedure by Region, Licensing Stage and RES Technology (June 2020)

Region	Permit Stages	PV	WIND	sHPP	BIOMASS	THERMAL SOLAR	TOTAL
PELOPONNESE	1 – Production Permit	12	13	4	2	0	31
	2 - AECO	13	12	1	0	0	26
	3 – Installation Permit	2	0	0	0	0	2
	4 – New Permits (2020)	1	1	0	0	0	2
	TOTAL	**28**	**26**	**5**	**2**	**0**	**61**
WESTERN MACEDONIA	1 – Production Permit	11	1	6	1	1	20
	2 - AECO	21	5	1	3	38	68
	3 – Installation Permit	5	3	0	1	0	9
	4 – New Permits (2020)	0	0	1	1	0	2
	TOTAL	**37**	**9**	**8**	**6**	**39**	**99**

Source: RAE

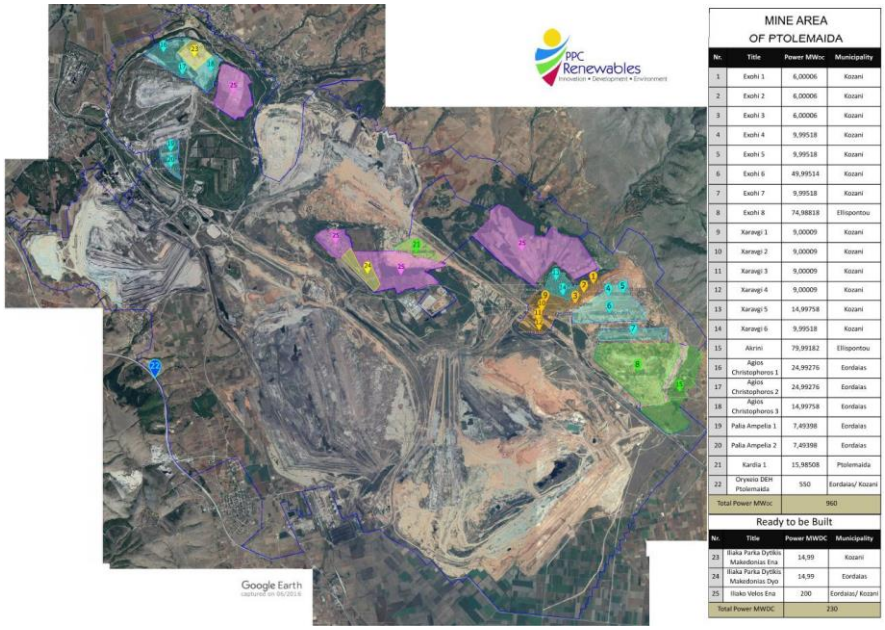
Table 42 - Number of RES Projects Under Licensing Procedure by Region, Licensing Stage and RES Technology (June 2020)

Region	Permit Stages	PV	WIND	sHPP	BIOMASS	THERMAL SOLAR	TOTAL
PELOPONNESE	1 – Production Permit	12	13	4	2	0	31
	2 - AECO	13	12	1	0	0	26
	3 – Installation Permit	2	0	0	0	0	2
	4 – New Permits (2020)	1	1	0	0	0	2
	TOTAL	**28**	**26**	**5**	**2**	**0**	**61**
WESTERN MACEDONIA	1 – Production Permit	11	1	6	1	1	20
	2 - AECO	21	5	1	3	38	68
	3 – Installation Permit	5	3	0	1	0	9
	4 – New Permits (2020)	0	0	1	1	0	2
	TOTAL	**37**	**9**	**8**	**6**	**39**	**99**

Source: RAE

The most important RES project under construction in the lignite area of Western Macedonia is the photovoltaic park SOLAR ARROW ONE, of PPC Renewables (PPCRen), capacity 200 MWp, at the Lignite Center of Western Macedonia in the municipalities of Eordea and Kozani in the prefecture of Kozani. PPCRen, after securing successive extensions of the installation permit for this project, finally announced its construction in an international tender in March 2020, while the submission of bids was extended until June 11. Other important projects under development are the Solar Parks Western Macedonia I & II at the Ptolemaida lignite mine, with a total capacity of 30 MWp (2 x 14.99 MWp) at the Paliambela and Xiropotamos sites, also of PPCRen, which have been announced in a tender, the results of which are expected in June 2020, with work starting in the summer.

Map 14 - Photovoltaic Parks Under Development at the Ptolemaida Lignite Mine by PPC Renewables (With Purple the Emblematic Project SOLAR ARROW ONE)



MINE AREA OF PTOLEMAIDA

Nr.	Title	Power MWoc	Municipality
1	Exohi 1	6,00006	Kozani
2	Exohi 2	6,00006	Kozani
3	Exohi 3	6,00006	Kozani
4	Exohi 4	9,99518	Kozani
5	Exohi 5	9,99518	Kozani
6	Exohi 6	49,99514	Kozani
7	Exohi 7	9,99518	Kozani
8	Exohi 8	74,98818	Ellispontou
9	Karavgi 1	9,00009	Kozani
10	Karavgi 2	9,00009	Kozani
11	Karavgi 3	9,00009	Kozani
12	Karavgi 4	9,00009	Kozani
13	Karavgi 5	14,99758	Kozani
14	Karavgi 6	9,99518	Kozani
15	Akrini	79,99182	Ellispontou
16	Agios Christophoros 1	24,99276	Eordaias
17	Agios Christophoros 2	24,99276	Eordaias
18	Agios Christophoros 3	14,99758	Eordaias
19	Paka Ampelia 1	7,49398	Eordaias
20	Paka Ampelia 2	7,49398	Eordaias
21	Kardia 1	15,98508	Ptolemaida
22	Oryxeio DEH Ptolemaida	550	Eordaias/ Kozani
Total Power MWoc		960	

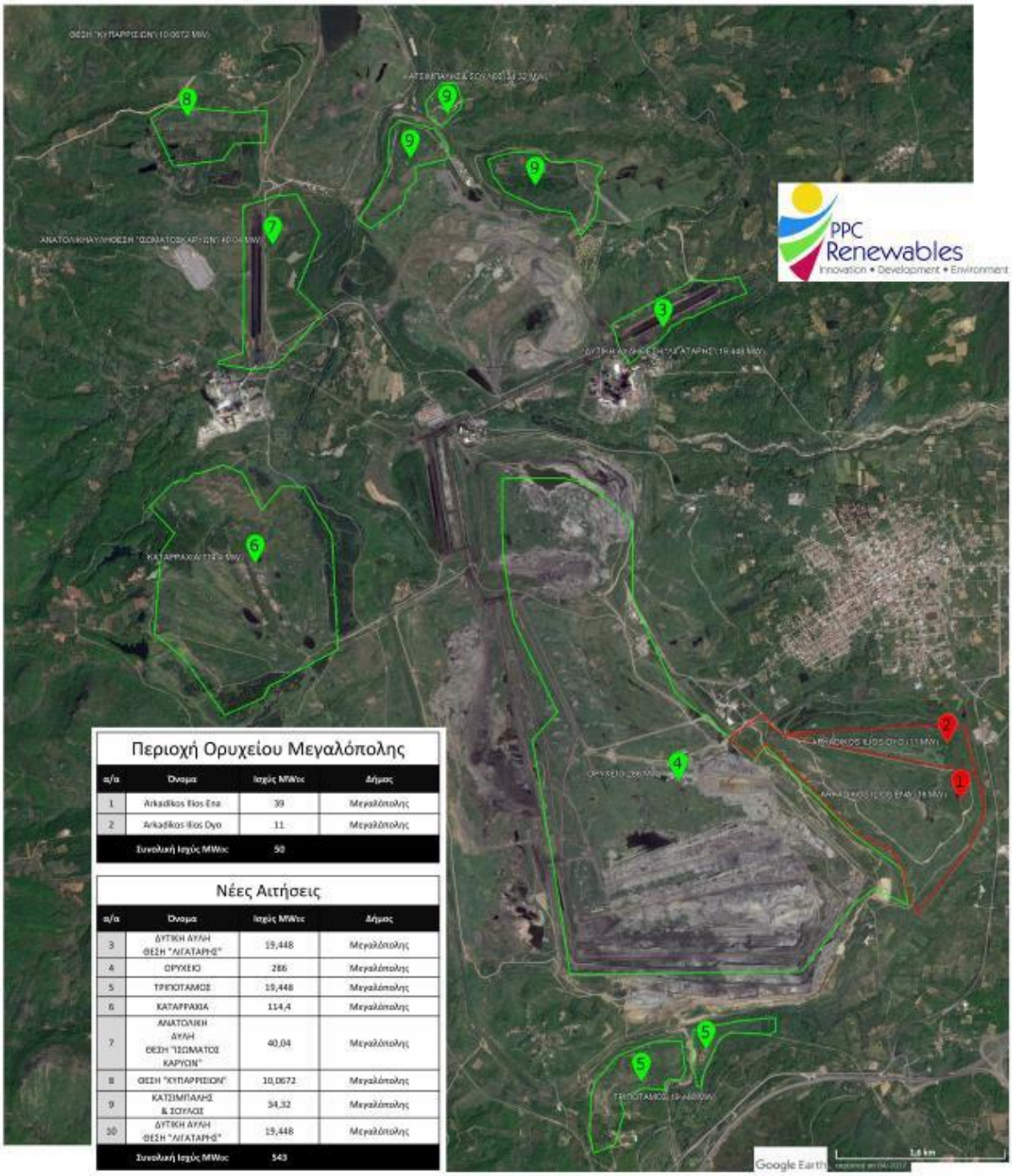
Ready to be Built

Nr.	Title	Power MWOC	Municipality
23	Iliaka Parka Dytikis Makedonias Ena	14,99	Kozani
24	Iliaka Parka Dytikis Makedonias Dyo	14,99	Eordaias
25	Iliako Velos Ena	200	Eordaias/ Kozani
Total Power MWOC		230	

Source: PPC

At the same time, PPC Renewables has announced a tender for the two projects Arkadikos Helios I & II, power 39 MW and 11 MW respectively in Megales Lakkes, which have already secured an installation permit and are the first part of the large photovoltaic project of PPC in Megalopolis, with a total capacity of 500 MW. This project will not claim fixed tariffs by participating in RAE tenders, but will operate according to the rules of the target model, through bilateral power supply contracts (PPAs).

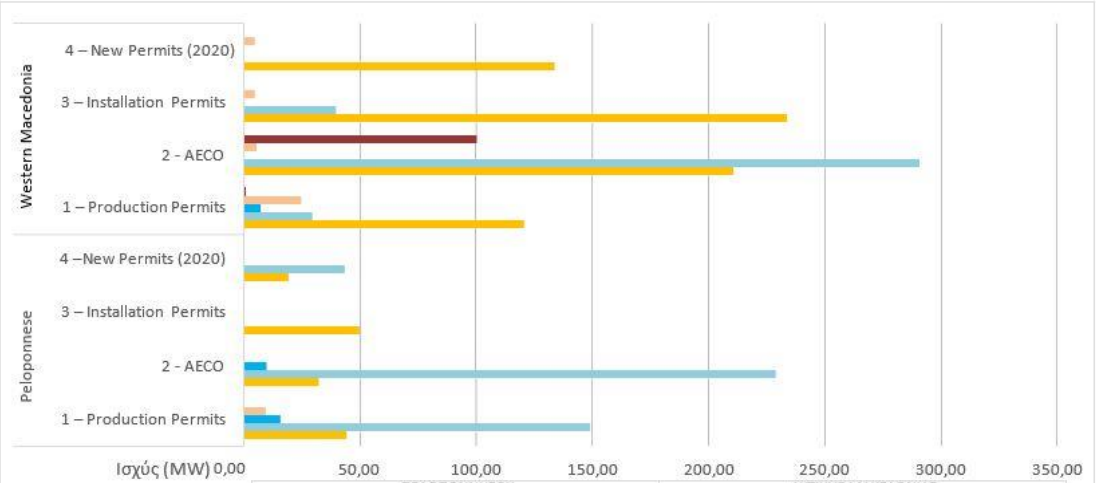
Map 15 - Photovoltaic Parks Under Development at the Megalopolis Lignite Mine by PPC Renewables (With Red Projects Arcadian Sun I & II)



Source: PPC

In detail, the validity of the RES projects under development in the lignite areas of Peloponnese and Western Macedonia per licensing stage and technology are presented in Diagram 29.

Diagram 29 - Capacity (MW) of RES Projects Under Permit Procedure by Region and RES Technology (June 2020)



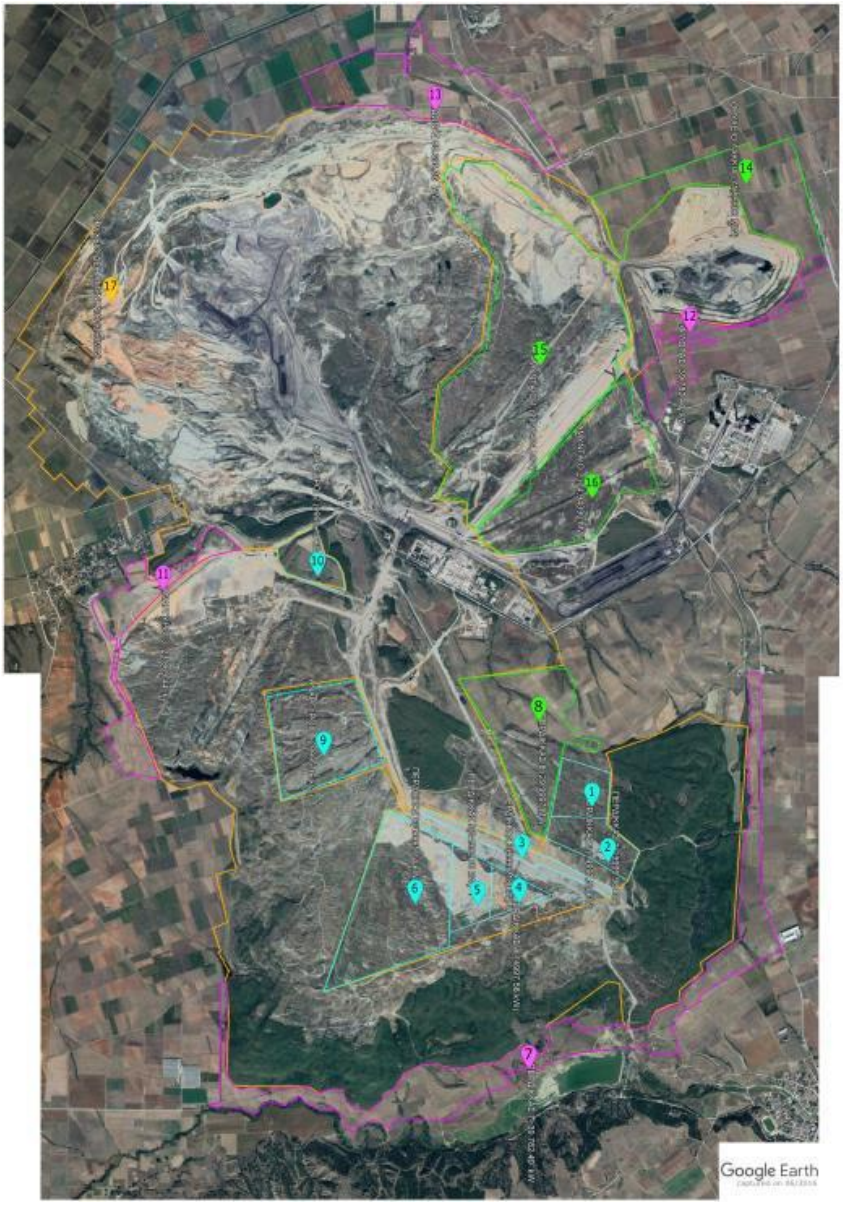
	ΠΕΛΟΠΟΝΝΗΣΟΥ				ΔΥΤΙΚΗΣ ΜΑΚΕΔΟΝΙΑΣ			
	1 – Production Permits	2 - AECO	3 – Installation Permits	4 – New Permits (2020)	1 – Production Permits	2 - AECO	3 – Installation Permits	4 – New Permits (2020)
SOLAR THERMAL	0,00	0,00	0,00	0,00	1,50	100,50	0,00	0,00
BIOMASS	9,68	0,00	0,00	0,00	25,00	5,67	5,00	5,00
sHPP	16,02	10,00	0,00	0,00	7,61	0,75	0,00	0,78
WIND	149,25	229,10	0,00	44,00	30,00	290,95	39,92	0,00
PV	44,52	32,48	50,00	19,55	120,84	210,80	233,94	133,97

Source: PAE

2.6.5. The Future of RES Projects in the Lignite Areas of Arcadia, Florina, Ptolemaida and Kozani

A significant number of applications for the development of RES projects in the lignite areas of Western Macedonia and the Peloponnese have been submitted to the Energy Regulatory Authority, RAE, a total of 257, which mostly concern photovoltaic parks, most of which have been requested by PPC Renewables and are located in the lignite mines of Ptolemaida but also in the lignite mines of Amyntaio in Florina and Megalopolis in Arcadia. Except of 7 older applications, concerning large and small hydroelectric power plants, the pending applications under consideration date from 2018 until today (June 2020).

Map 16 - Photovoltaic Parks Under Development at the Amyntaio Lignite Mine by PPC Renewables (The 8 Projects at Perdikkas Position and the 3 Projects at Anargyroi Position with Blue and Purple)



PPC Renewables

MINE AREA OF AMYNTAIO			
Nr.	Title	Power MWoc	Municipality
1	Perdikkas 1	14,99758	Eordaias
2	Perdikkas 2	19,99998	Eordaias
3	Perdikkas 3	9,99518	Eordaias
4	Perdikkas 4	14,99758	Eordaias
5	Perdikkas 5	24,99276	Eordaias
6	Perdikkas 6	49,99514	Eordaias
7	Perdikkas 7	39,7824	Eordaias/ Amyntaio
8	Perdikkas 8	29,9997	Eordaias/ Amyntaio
9	Anargyroi 1	29,99516	Amyntaio
10	Anargyroi 2	9,99518	Amyntaio
11	Anargyroi 3	23,86944	Amyntaio
12	Filotas	18,60656	Amyntaio
13	Rodonas	55,69536	Eordaias/ Amyntaio
14	Oryheio Lakkia	71,955	Filotas
15	Amyntaio 1	99,98424	Filotas/ Amyntaio
16	Amyntaio 2	74,9439	Filotas
17	Oryheio DEH Amyntaio	350	Eordaias/ Amyntaio
Total Power MWoc		940	

Source: PPC

It is worth noting that the saturation of the Peloponnese Network has suspended the development of RES projects in the lignite area of Megalopolis Arcadia. Specifically, with regard to photovoltaics, applications have been submitted for 212 projects in the Lignite area of Western Macedonia, with a total capacity of 6.15 GWp.

The high demand is directly related to the vacuum in the electrical space that is expected to create the withdrawal of lignite plants in Western Macedonia in 2023. Most applications have been submitted by PPC Renewables and relate to projects located in the areas of lignite mines, which are expected to utilize the connection infrastructure of the withdrawing thermal units. Among these are the

applications of PPC for photovoltaic parks in the open lignite mines of Ptolemaida, Amyntaio and Megalopolis, with a capacity of 550 MWp, 350 MWp and 286 MWp respectively, which, however, presuppose the restoration of the lignite mines. Among the rest, the photovoltaic projects at Perdikkas, Eordaia Amyntaio, with a total capacity of 204.76 MW, the PV parks Amyntaio I & II, with a capacity of 100 MWp and 75 MWp respectively, as well as the 8 PV parks at Exochi in Kozani at the Ptolemaida lignite mine stand out, with a total capacity of 173 MWp.

Table 43 - Applications for Photovoltaic Park Projects by Region (June 2020)

REGION	REGIONAL UNITY	No OF PROJECTS	TOTAL POWER (MW)	POWER/PROJECT (MW)
WESTERN MACEDONIA	KOZANI	143	4384.79	30.66
	KOZANI & FLORINA	3	490.00	163.33
	KOZANI & HMATHIA	3	139.00	46.33
	GREVENA & KOZANI	1	19.90	19.90
	KOZANI & FLORINA	16	295.29	18.46
	FLORINA	46	820.52	17.84
	FLORINA & KASTOPIA	0	0.00	0.00
	TOTAL	**212**	**6149.50**	**29.01**
PELOPONNESE	ARKADIA	0	0	0
	LAKONIA & ARKADIA	0	0	0
	TOTAL	**0**	**0**	**0**
	TOTAL	**212**	**6149.50**	**29.01**

Source: RAE

The applications for obtaining a production license in the category of wind farms follow with 31 and 44 proposed projects with a total capacity of 379 MW and 50 MW in the lignite areas of Western Macedonia and the Peloponnese respectively. Specifically, applications have been submitted by 20 companies and investment schemes for a total of 33 projects. Of these, due to their total power, the applications for projects of Siemens Gamesa Renewable Energy A.E. in the key position of Amyntaio, Florina, with a capacity of 45 MW and of VENTAVEL ENERGY SA at the locations Anemodarmeni & Megalexandros which concerns three parks with a total capacity of 100 MW stand out.

Table 44 - Applications for Wind Park Projects by Region (June 2020)

REGION	REGIONAL UNITY	No OF PROJECTS	TOTAL POWER (MW)	POWER/PROJECT (MW)
WESTERN MACEDONIA	KOZANI	20	187.89	9.39
	KOZANI & FLORINA	0	0.00	-
	KOZANI & HMATHIA	0	0.00	-
	GREVENA & KOZANI	1	27.30	27.3
	KOZANI & FLORINA	1	2.99	2.99
	FLORINA	0	0.00	-
	FLORINA & KASTOPIA	7	124.18	17.74
	TOTAL	2	36.60	18.30
	ARKADIA	31	378.96	15.14
PELOPONNESE	LAKONIA & ARKADIA	1	20.00	20.00
	TOTAL	1	30.00	30.00
	TOTAL	2	50.00	25.00
	KOZANI	**33**	**807.92**	**13.00**

Source: RAE

Another 4 large hydroelectric projects are under consideration, of which 3 in the Prefecture of Kozani in Western Macedonia and 1 in the Prefecture of Arcadia in the Peloponnese. 2 of the 3 projects in Kozani concern the Hilarion stream, capacity 110 MW and 104.5 respectively and 1 the Acheloos stream, capacity 100 MW. The large hydroelectric / pumping storage project for which a licensing application has been submitted in the prefecture of Arcadia is on the river Ladonas at Skala - Agios Nikolaos (175 MW), which is promoted by the PPC – TERNA sa consortium. All the above projects of large hydroelectric plants are considered as "frozen" projects. whose licensing is not expected in the near future.

Also, 4 small hydroelectric projects (MYE) have applied for a production license on the river Aliakmonas, in the area of the municipality of Voio, prefecture of Kozani, with a total capacity of 2.23 MW and 1 in the municipality of Florina at the site of the Triantaphyllia torrent dam, capacity 1 MW.

2.7. A Survey of Energy Projects / Actions Under Development

(a) Energy Projects

In the context of delignification, several energy projects are expected to be implemented in the lignite areas of Greece, mainly RES and natural gas projects. In particular, in mid-February 2020, Hellenic Petroleum (ELPE) announced the acquisition of a strong portfolio of photovoltaic works of the German company Juwi in the Kozani region, with a total capacity of 204 MW. This is the largest RES project in Greece, 20 times larger than the existing ones, while it is among the 4 largest photovoltaic parks in

Europe, estimating that it will produce 300 GWh of energy per year. The total investment will amount to € 130 million, while the work period is expected to last 16 months and the project will be fully operational in the 4th quarter of 2021.

Recently, RAE granted a license to generate electricity in 7 photovoltaic parks, with a total capacity of 149.8 MW, which are located in the Peripheral Unit of Kozani and are developed by the company "Juwi Hellas Renewable Energy Sources", a 100% subsidiary of the aforementioned German company Juwi.

Also, PPC is expected to soon install photovoltaics with a total capacity of 2 GW in Western Macedonia. In this context, the tender of PPC Renewables for the first mega-photovoltaic to be built in Ptolemaida and which when completed will be among the largest in Europe is of great importance. According to the latest information, the project, with a capacity of 200 MW, is expected to employ at least 300 workers during its construction, while when completed it will produce 390,000 MWh, capable of meeting the electricity needs of approximately 290,000 Residents.

In essence, this first mega-project will concern three different "packages", two small ones, with a total capacity of 30 MW, which have already been announced and a large one, of 200 MW, for which the start of the tender by PPC Renewables took place in mid-April 2020 with the publication of the relevant notice. According to the latest information, the first park, capacity 15 MW, with its own substation and solar trackers will be awarded to METKA of Mytilineos, with a total cost of about € 11.5 million. The second park, also 15 MW capacity and with its own substation, but with fixed support bases, will be awarded to TERNA with a total cost of just under € 10m.

At the same time, PPC Renewables is launching the procedures to tender the large photovoltaic project of Megalopolis, with a total capacity of 500 MW, starting from two projects with a capacity of 39 MW and 11 MW respectively. This project will not claim fixed tariffs by participating in RAE tenders, but will operate according to the rules of the target model, through bilateral power supply contracts (PPAs).

During this period, the parameters of such a contract are being studied with the parent PPC (which is also the largest electricity supplier) and at the same time discussions are taking place with banks to finance the project, given that this is the first time in our country. The information indicates that the interest of the banks is remaining as high.

In general, the company has total licenses for projects in the whole range of RES technologies (i.e. wind, small hydroelectric, photovoltaic, while launching the licensing for the development of geothermal fields) with a total capacity of 6 GW, of which 2 GW in the mines of Kozani , for the development of which it has signed a memorandum of cooperation (MoU) with the German RWE.

Also, PPC will proceed with the restoration of the areas where the mines and lignite plants currently operate. The plans include artificial lakes, utilization of lignite residues for fertilizer production, biomass crops, etc.

Characteristic is the case of PPC, which is proceeding with the plan for the development of aromatic plants in the external deposit of the Amyntaio Field Mine Branch, thus implementing an idea that had been launched by the previous administration, within the framework of the company's plans for delignification. PPC hopes that in about a year the development of the crop will be completed. After all, this is the estimate of the company for the time the contractor of the announced tender will need

for the supply, planting and irrigation of plants, soil cultivation with the application of a cultivator, the destruction of wild vegetation manually and by mechanical means, as well as its chemical control.

The plants that have been selected for cultivation are oregano, lavender, sage and rosemary. The quantities that will be planted will be quite large, as the PPC plan envisages up to 20,000 plants of oregano, 5,000 lavender, 4,000 rosemary and 12,000 sage. PPC's plan, of course, is not just the landscaping of areas that have suffered from mining in the surrounding areas, but the business development of aromatic plants, as an industry that has flourished in recent years.

In addition, PPC is planning new power plants, most likely from waste incineration or biomass. Proposals of FODSA (Solid Waste Management Bodies) of the area for the creation of a waste-to-energy unit are being examined.

Recently, TERNA tendered in the tender of PPC Renewables for the project "Design, civil engineering works, supply, transport, installation and commissioning of a 14.99 MW photovoltaic station at Xiropotamos in the Municipality of Eordea in Kozani and a Substation". Both the photovoltaic station and the substation will be constructed in areas expropriated by PPC. The project budget is close to € 15 million.

Also, in October 2019, a proposal was presented to the European Commission for a large photovoltaic park in Western Macedonia, over 1 GW, with a total budget of over € 1 billion, the electricity from which will be used for hydrogen production. The hydrogen produced will be used firstly as district heating fuel, secondly as exported fuel via TAP to the West but also to the East and thirdly as fuel for transport, especially for large vehicles, trucks, garbage trucks, buses, etc.

The latest list of projects of common interest (PCI) of the European Organization of Electricity System Operators (ENTSO-E)[64] includes for the first time the installation of lithium ion batteries in the region of Western Macedonia, in Ptolemaida, a project of a Greek company Eunice, capacity 250MW and a budget of approximately € 320 million. The business plan of the project is expected to be prepared in 2021, as an effort is currently being made to advance the licensing pillar.

According to the 10-year investment plan of DESFA for the period 2020-2029, which includes projects with a total budget of € 300 million, there are projects in the foreground, such as the development of the gas transmission network in new areas and specifically the planned extensions for Western Macedonia.

More specifically, these are three new metering and regulating stations, which will be created in Perdika Eordaia (€ 3 million), Poria in Kastoria (€ 2 million) and in Aspros in Edessa, Naoussa and Giannitsa (€ 3 million). . From these three measuring / regulating stations it will then be possible to build the medium and low pressure network, which will transport the natural gas to the cities of the region.

According to DESFA sources, the specific projects in Western Macedonia are expected to be completed by the end of 2022, in line with the delignification program. The same sources of DESFA note that for the region of Western Macedonia, in addition to the construction of metering stations that will be

[64] https://tyndp.entsoe.eu/news/2020/02/148-pan-european-electricity-transmission-projects-and-25-storage-projects-in-the-tynd-p2020/

created at points where the TAP pipeline passes, the creation of a new extension pipeline of the National Natural Gas System (NSF) is being considered. The project is under study as there are plans for the construction in the region of Western Macedonia of a new power plant with natural gas fuel[65]

In such a case, the gas from the TAP pipeline will not be enough to cover the needs and for this reason the construction of a small extension of the NSRF is being studied, which will start from Nea Mesimvria. The investment decision for the project depends exclusively on whether or not a new gas-fired power plant will be created.

Regarding the new exit of Megalopolis, the Metering and Regulation station will be included in the List of Small Projects, so that the Administrator can proceed with the start of the works. According to the preliminary program, the project can be ready for operation within 28 months from the start date. However, it has been agreed that through the temporary installation of a portable Metering Station approximately 2 km from the construction site of the permanent station, the project will be operational within six months.

Also, according to the draft law for the electrification, which is estimated to be presented next June, in the current lignite areas of Western Macedonia and Megalopolis are expected to be developed units for the construction of chargers, transformers, batteries and general equipment related to the logistic support of electric mobility. The investor, Greek or foreign, who will choose the lignite fields to create installations related to electromobility will be rewarded with lower tax rates and a reduction in non-wage costs.

In summary, the delignification plan includes the following:

• First in the line of investments are the mega-photovoltaics of PPC (in about 30% of the lignite land), power 2 GW and amounting to € 1-1.5 billion, nearby, with which there were thoughts to develop hydrogen units, but also innovative technologies.
• In one of the current PPC units, the initial scenarios spoke of setting up a waste power plant.
•Much of the area will be forested.
• Another section will be agricultural with traditional and alternative crops.
• One industrial department (industrial sector), while another will host a research and innovation center and the University of Western Macedonia.

(b) Immediate Action Measures

At a conference on "Just Development Transition of Western Macedonia", organized by the Region of Western Macedonia, in early February 2020[66], the Minister of Environment and Energy, Mr. Kostis Hatzidakis, presented a series of immediate action measures for Western Macedonia. Among other things, Mr. Hatzidakis pointed out that PPC will proceed with the necessary speed in the restoration of the mines, an activity that will help in the immediate absorption of jobs, paving the way for the utilization of the lands in new ways.

[65] http://www.ypeka.gr/el-gr/

[66] https://www.khatzidakis.gr/index.php/enimerosi/omilies

Also, the necessary changes in the regulatory framework are promoted so that the district heating is not interrupted, while the Public Enterprise of Gas Distribution Networks (DEDA) is expected to adapt its investment program for the development of natural gas networks to the new data created by delignification. As a result, the company's new business plan gives priority to the areas of Florina, Kozani and Amyntaio.

At the same time, the spatial planning is adapted to serve the development perspective of the area. In particular, the Regional Spatial Framework of Western Macedonia has already been updated by the services of ENM, taking into account the needs of delignification and will be officially approved in the coming months. This plan is a valuable tool for development as it clarifies what activity can be done where, providing uses even for the industry, the University, etc.

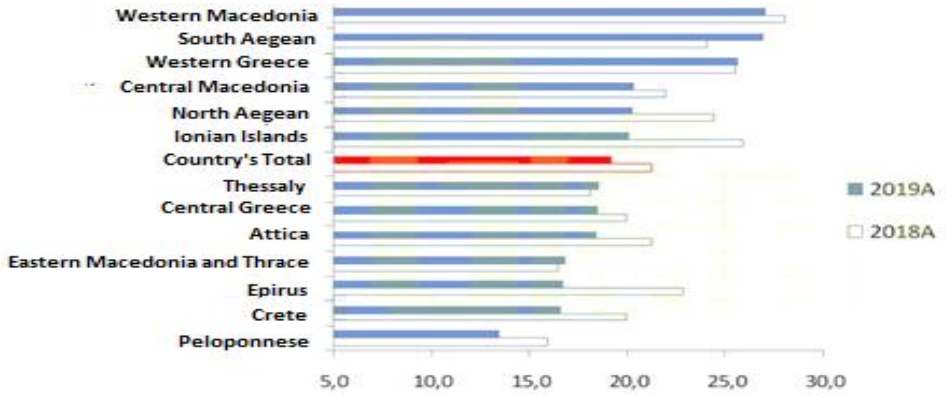
Mr. Hatzidakis stated that there will be no change in relation to the PPC (POT) discount tariff for lignite areas, because it is a significant aid for the residents of the Region of Western Macedonia and the Municipality of Megalopolis. Also, the resource of € 130 million is expected to be returned by PPC to the lignite areas.

It is expected that the lignite areas will continue to receive funding from the greenhouse gas emissions auctions through the Green Fund, estimating that these areas will receive around € 60 million from the Green Fund, which concerns its funds of 2018 and 2019.

The role of the University of Western Macedonia is expected to be crucial, giving a different growth impetus to the region through its cooperation with local companies, creating new jobs. Besides, the Region of Western Macedonia had the highest unemployment rate in Greece in 2018 and 2019, which is over 27% (see Diagram 30).

Also, 59.2% of households in the Region of Western Macedonia consume for heating more than 10% of their total annual income (see Table 45), which is the largest percentage of all Greek Regions, with a very significant difference from the rest.

Diagram 30 - Unemployment Data by Region in Greece[67]



Source: B2Green

[67] https://www.b2green.gr/el/post/79924/exoikonomo-orthi-katanomi-kondylion-stis-perifereies-technooikonomiki-meleti?fbclid=IwAR02Yjc-KK1Jjt9JBNAisk2CIFZt3ATvNovYdCm09QwuyQqIFfBxGN_HaFs

Table 45 - Percentage of Households by Region in Greece, with Annual Energy Expenses for Heating Higher than 10% of their Annual Income

REGION	PERCENTAGE OF HOUSEHOLDS %
WESTERN MACEDONIA	59.2
CENTRAL GREECE	43.1
NORTH AEGEAN	42.1
THESSALY	41.8
EASTERN MACEDONIA & THRACE	40.2
CENTRAL MACEDONIA	38.8
PELOPONNESE	33.5
CRETE	32.7
SOUTH AEGEAN	31.2
EPIRUS	30.7
WESTERN GREECE	28.3
IONIAN ISLANDS	27.3
ATTICA	18.1

Source: B2Green

The need for the European Commission to declare lignite areas as special tax zones with special tax incentives in the context of the Just Transition for Western Macedonia and Megalopolis is considered a necessary action. In this context, special tax incentives should be given for heating, e.g. in relation to the gas tax, but also a special tax treatment for those who lose their jobs and wait until they are re-hired.

A key development is the immediate elaboration of the new lignite development program with funding from the NSRF, the Just Transition Fund, the European Investment Bank, tools such as the InvestEU (the so-called Juncker Package), national and private resources. This financial support amounts, according to European Commission estimates, to an amount between € 3.7 billion and € 4.4 billion.

In mid-March 2020, the Government Committee on delignification unanimously approved the preparation of a single Operational Program for Just Development, to which resources will be transferred from the new NSRF (2021-2027), which will correspond to at least twice the national share of the new European Just Transition Fund.

Also, the preparation of a Transitional Program for the period 2020-2021 based on the possibilities of the current NSRF, but also the resources of the "Lignite Stamp" of PPC and the Green Fund was discussed. The Transitional Program will include priority actions, such as:

• Penetration of natural gas in energy municipalities, with co-financing (from Community funds and the Public Investment Program, PIP) of Medium Pressure networks. By registering in the PIP, the procedures for the assignment and implementation of projects will be activated. Especially for Florina and for the Municipality of Megalopolis, it was decided that the transition to natural gas will be smooth, in a way that benefits the consumers and without burdening the municipal authorities.

• Social cohesion enhancement programs with OAED as beneficiary, to support employment and entrepreneurship.

• Photovoltaic Station Development Program by PPC, private investors and the local community.

• Preparation of basic infrastructure.

According to the latest information, the delignification master plan for Western Macedonia and Megalopolis is expected to be an independent operational program of the new NSRF for the period 2021-2027, with exclusively its own resources. The priority axes of the Special Transitional Program for Just Development (2020-2021) for the lignite areas of the country are seven and can be summarized as follows:

• Promoting the employment of the unemployed and the self-employed and the adaptability of workers and enterprises

• Addressing social impacts and strengthening social cohesion

• Preparing for economic and productive diversification, including the primary sector

• Enhancing entrepreneurship and attracting investments

• Restructuring of energy identity and rationalization of the utilization and use of environmental resources

• Promoting urban revitalization and Sustainable Urban Mobility

• Scientific and Technical Support, Maturation of Actions

It is worth noting that the consortium of consulting companies Boston Consulting Group and Grant Thornton undertook, after a relevant tender of the Superfund, the elaboration of the master plan of delignification with the obligation within three months from the signing of the contract, i.e. somewhere in early autumn to have submitted to the Steering Committee a draft of the master plan, while the final plan must have been submitted within 6 months from the signing of the contract, i.e. by the end of 2020.

Also, the creation of the "Delignification Observatory" in Western Macedonia last February can be characterized as particularly important. More specifically, 15 companies that have been operating for many years in the largest energy center of the country, employing about 3,200 employees, created the "Greece 2028 - Delignification Observatory", with the ultimate goal of active participation as directly interested in the national effort for planning and implementation of the delignification plan and the energy transition of the region.

Regarding investment proposals and development actions in the lignite areas, ENM recently decided to establish a Technical Committee for the Just Development Transition Plan with an advisory, technical and supportive role to the Steering Committee.

The task of the Technical Committee is the support of the Steering Committee especially in relation to the investment proposals and the development plans and the following actions are included:

1. Elaboration of criteria and methodology of pre-screening proposals and plans in the transition Regions / areas

2. Preparation of a manual for the preliminary evaluation of proposals and projects

3. Preliminary evaluation of proposals and projects submitted to the Steering Committee by various bodies

4. Preliminary analysis of the impact on the economy, employment, energy and environment of the above proposals and development plans

5. Evaluation of proposals for the use of Technical Assistance tools of the European institutions of the European Union and International Organizations, with the aim of developing mature and sustainable investment projects in the regions / areas in transition.

On May 27, 2020, it was announced by the ENM that the Green Fund approved the first program for the financing of green projects in the lignite cities of Kozani, Florina, Amyntaio, Ptolemaida and Megalopolis, totalling € 31.4 million, for the publication of the relevant announcement within the coming June, which will contain the deadlines for submission of proposals by the beneficiaries. Within the summer, the second program for delignification is expected to follow.

The first program, which emerged after the cooperation of the Green Fund with the Coordinating Committee for Just Development, is structured in seven sub-programs with specific measures and axes as follows:

1. **Circular Municipal Wastewater Management Program in the Regional Units of Kozani and Florina:** The upgrade of the existing municipal / domestic wastewater treatment plants will be supported, in order to treat the sewage sludge, in order to turn it into an environmentally friendly and renewable combustible material and/or secondary material (soil conditioner). Integrated networks for the collection, treatment and reuse of household waste (e.g. used oils) will also be developed.

2. **Megalopolis Business Park:** The Green Fund will invite the Peloponnese Region to submit a request for funding to update the Feasibility and Sustainability Study of the Megalopolis Business Park, prepared in 2014.

3. **Energy Communities Program:** The Program will support the development of RES energy projects by energy communities through the use of specialized financial tools, enabling residents of lignite areas to have an additional income.

4. **Circular Economy Action Plans:** Innovative methods for reusing materials through the development of a local green entrepreneurship will be promoted. For this purpose, € 1.4 million have been budgeted for each of the Municipalities of Megalopolis, Eordaia, Amyntaio and Florina and € 1.65 million for the Municipality of Kozani.

5. **Small and Medium Enterprises Support and Aid Program:** Granting assistance from the Green Fund to small and medium-sized enterprises from Western Macedonia affected by delignification. The purpose of this action is to make the operation of these companies more environmentally friendly.

6. Development of a specialized Innovation Zone in Western Macedonia for Clean Energy and Environmental Technologies: Creation of an Innovation Zone in the current energy axis of Kozani, Ptolemaida, Amyntaio and Florina, according to the standards of the international Innovation Zones. The University of Western Macedonia in partnership with the National Center for Research and

Innovation (CERTH) will prepare a feasibility study, organization and institutionalization of the Zone, at the invitation of the Green Fund.

7. Sustainable Energy and Climate Action Plans: The Program benefits the lignite municipalities. Indicative examples of actions covered are: installation of RES systems for electricity generation and heating / cooling of buildings, promotion of units and energy storage systems, interventions to improve energy efficiency in buildings and businesses, sustainable urban mobility actions. For these actions, € 1.35 million have been budgeted for each of the Municipalities of Amyntaio, Megalopolis, Eordaia and Florina and € 1.6 million for the Municipality of Kozani.

3. Economic Activity - New Business Opportunities

3.1. Economic Activity at Local Level and Social Implications

3.1.1. Economic Structure

(a) Western Macedonia

During the period of late Greek economic history, the region of Western Macedonia supported its development and productive structure in the field of energy and especially lignite mining and the operation of lignite plants. Overall, the economic activities and professions that emerged were intertwined with the energy model developed by the country, in conjunction with certain specific areas of interest, such as fur industry and the standardization of agricultural products. The economic crisis in the country has had a serious impact on the region's economy, especially on small businesses and employment. In addition, a percentage of the population emigrated in order to secure work abroad, but also in other parts of the country.

It is obvious that after the initial "symmetrical shock" that the Greek economy as a whole received in all regions and sizes, the impact was stronger in the region of Western Macedonia, which joined the phasing out regime in the direction of shaping conditions for a low-carbon economy, adaptable to climate change.

Contribution to GDP

Western Macedonia participates steadily in the country's GDP with a percentage ranging from 2.0% - 2.5% of total national income. Most (over 60%) is produced in the regional unit of Kozani. Of particular interest is the fact that the region's GDP did not follow the same downward trend as the national GDP (lost € 1.1 billion), which is why in the period of the great decline it increased its contribution. This finding may be justified by the dependence of economic activity in the area on the power generation sector, which is necessary to operate even in recessionary conditions.

Table 46 - Contribution (billion €) of the Region of Western Macedonia to the GDP of Greece, 2008-2018

REGION/YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GREECE	242,0	237,5	226,0	207,0	191,2	180,7	178,7	177,3	176,5	180,2	184,7
Western Macedonia	4,8	5,0	5,0	4,8	4,7	4,4	4,5	4,3	3,9	4,0	4,0
Grevena	0,4	0,4	0,4	0,4	0,3	0,3	0,3	0,3	0,3	0,3	-
Kozani	2,8	3,0	3,0	2,8	2,8	2,6	2,7	2,6	2,2	2,3	-
Kastoria	0,7	0,7	0,6	0,6	0,6	0,6	0,5	0,5	0,5	0,5	-
Florina	0,9	1,0	1,0	1,0	1,0	0,9	1,0	0,9	0,8	0,9	-
Contribution to National GDP	***1,98%***	***2,12%***	***2,20%***	***2,33 %***	***2,47 %***	***2,43 %***	***2,54%***	***2,45%***	***2,22%***	***2,20 %***	-

Source: ELSTAT

Gross Fixed Capital Formation

Following the general disinvestment trend experienced by the country during the economic crisis, the Region of Western Macedonia lost 63.8% of the value of total investments in the last decade. However, it should be noted that the contribution to the country's total investment is more than double the contribution to the national income, an indication related to the need to maintain and renew the energy production capacity.

Table 47 - Total Investments (€ billion) in the Region of Western Macedonia, 2008-2017

REGION/YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CHANGE
GREECE	57,63	49,39	39,70	31,61	24,14	21,96	20,62	20,49	21,28	23,24	***-59,7%***
Western Macedonia	2,25	2,67	1,60	1,80	1,07	1,07	0,93	0,98	0,93	0,81	***-63,8%***
% investments	*3,9%*	*5,4%*	*4,0%*	*5,7%*	*4,4%*	*4,9%*	*4,5%*	*4,8%*	*4,4%*	*3,5%*	

Source: ELSTAT

Contribution to Employment

The contribution of the region to the total employment of Greece, as recorded by ELSTAT, remains low over time (on average at 2.2% of total employment), but it is indicative that from 2008 to 2013 19,000 jobs were lost, which were not filled except only slightly (less than 8%). This means that during the crisis there were factors that were not only related to the business cycle, but also had structural features (such as migration, demographic aging, productivity change).

Table 48 - Contribution of the Region of Western Macedonia to the Total Employment of Greece, 2008-2017

(in thousands)	2008	2009	2010	2011*	2012*	2013*	2014*	2015*	2016*	2017*	Diff 2008-2017
GREECE	4856,4	4829,0	4705,5	4381,8	4105,2	3997,7	4034,8	4064,0	4083,0	4146,0	-14,6%
Western Macedonia	108,4	110,3	104,6	98,6	91,8	89,0	90,8	90,5	90,2	90,6	-16,4%
Contribution to employment	***2,23%***	***2,28%***	***2,22%***	***2,25%***	***2,24%***	***2,23%***	***2,25%***	***2,23%***	***2,21%***	***2,19%***	

Source: ELSTAT

Competitiveness Indices

According to the European Regional Competitiveness Index[68] which assesses the performance of the regions on the basis of 11 sub-indices, and 4 more general, the region of Western Macedonia lags significantly behind both the European average and the Greek average. The areas in which they perform best are health, business complexity and level of education.

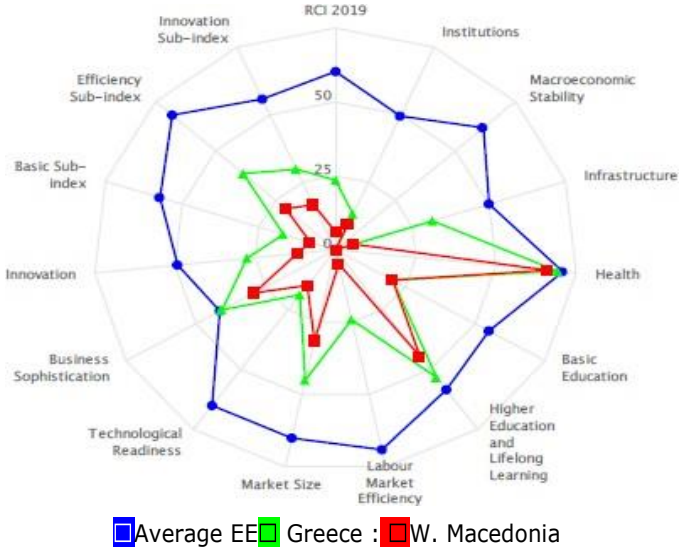
Table 49 - Competitiveness Indices of the Region of Western Macedonia, 2019

INDICATORS	INSTITUTIONS	MACROECONOMIC STABILITY	INFRASTRUCTURE	HEALTH	BASIC EDUCATION	HIGHER EDUCATION	LABOR MARKET EFFECTIVENESS	MARKET SIZE	TECHNOLOGICAL READINESS	BUSINESS COMPLEXITY	INNOVATION	MAIN	EFFECTIVENESS	INNOVATION	RCI 2019
Greece	13.27	0	31.63	69.29	20.48	53.3	24.17	45.07	18.79	40.63	27.66	16.98	38.51	29.82	**23.53**
Western Macedonia	9.32	0	6.1	66.17	20.48	44.55	4.89	31.43	14.91	29.14	11.85	8.2	20.74	16.68	**6.05**

Source: European Commission

Lower performance is seen in the areas of technological readiness, macroeconomic innovation[69]and efficiency of the labour market. This negative assessment is linked to the fact that the structural reforms during the period of implementation of the economic adjustment programs did not have a significant impact on the regional economy.

Diagram 31 - Comparison of Competitiveness Indices of the Region of Western Macedonia with Greek and European Average, 2019



Source: European Commission

[68] https://ec.europa.eu/regional_policy/en/information/maps/regional_competitiveness/#2

[69] The index probably does not take into account current fiscal trends, and is affected by the overall picture of the national economy

Financial Status of Households

Regarding the economic situation and the domestic demand conditions of the households in the region of Western Macedonia, we observe that the disposable income exceeds the final consumption expenditure, however it constitutes a very small part of the total value of the national disposable income. In 2017, the disposable income (i.e. income after taxes-deductions) was € 2.6 billion. The per capita income recorded in 2017 was € 14,700, lower by € 2,100 than the national average.

Table 50 - Consumer Expenditure and Income of the Residents of the Region of Western Macedonia, 2008-2017

	2008*	2009*	2010*	2011*	2012*	2013*	2014*	2015*	2016*	2017*
Disposable income (bill. €)										
GREECE	156,8	159,8	146,5	132,8	120,3	109,7	110,1	106,5	104,3	105,9
Western Macedonia	3,7	3,9	3,7	3,4	3,1	2,8	2,8	2,7	2,6	2,6
Final consumer expenditure (bill. €)										
GREECE	159,1	157,4	152,0	139,9	128,9	122,9	120,5	118,1	117,2	118,8
Western Macedonia	3,1	2,9	3,0	2,6	2,7	2,3	2,8	2,5	2,6	2,6
Per capita income (bill. €)										
GREECE	21,8	21,4	20,3	18,6	17,3	16,5	16,4	16,4	16,4	16,8
Western Macedonia	16,7	17,6	17,4	16,9	16,7	15,7	16,3	15,8	14,4	14,7

Source: ELSTAT

Over time, Western Macedonia held the negative record of the highest unemployment rates in Greece, but also in Europe as a whole. It is indicative that in 2008, before the outbreak of the economic crisis, the region recorded unemployment rates at 12.3%, while at the peak of the crisis, the percentage exceeded 31%. Women are significantly more affected by the intensity of unemployment (up to 40.6% in 2016), while youth unemployment is one of the highest in the OECD countries (above the average of Greece).

Table 51 - Unemployment Indices of the Residents of the Region of Western Macedonia, 2008-2019

% Unemployment	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***	***2015***	***2016***	***2017***	***2018***	***2019***
GREECE	7,7	9,5	12,7	17,8	24,3	27,3	26,4	24,9	23,5	21,4	19,3	17,3
W. Macedonia	12,3	12,5	15,5	23,2	29,6	31,5	27,4	30,9	31,2	29,6	27,0	24,6
Male	7,7	9,5	12,5	18,8	24,7	26,7	22,1	23,8	24,1	23,1	22,2	17,7
Female	18,8	16,5	19,5	28,9	36,2	37,9	34,7	40,2	40,6	37,9	33,2	33,4
Youth (15-24)	36,6	34,8	35,3	52,7	72,3	70,4	49,6	49,4	48,8	55,0	62,0	53,5
Workforce (thous)	119,4	121,7	118,4	117,7	114,3	112,6	113,9	117,3	118,0	119,2	118,2	115,4

Sources: Eurostat, ELSTAT

The analysis of the poverty and social inclusion indices shows that the region of Western Macedonia is most affected by the national average on exposure to the risk of poverty[70] for households, as according to 2018 data, 24.8% (versus 18.5%) of them face the poverty spectrum. 18.7% of the population is employed in low-intensity work (precarious work, part-time) and 16.5% lack basic conditions for material reproduction.

Table 52 - Poverty-Social Conditions of the Residents of the Region of Western Macedonia, 2018

YEAR, 2018	% POPULATION in condition:		
	POVERTY	*LOW WORKLOAD*	*MATERIAL DEPRIVATION*
GREECE	18,5	14,6	16,7
W. MACEDONIA	24,8	18,7	16,5

Source: Eurostat

Energy consumption

From the available data of ELSTAT on energy consumption, it appears that the region of Western Macedonia consumes 3.0% -3.5% of total oil consumption, with Kozani receiving a share of more than 50%, due to industrial infrastructure and the largest numerical population. The reduction in consumption between 2008-2018 is close to 1/3 of consumption.

Table 53 - Evolution of Petroleum Consumption in the Region of Western Macedonia, 2008-2018

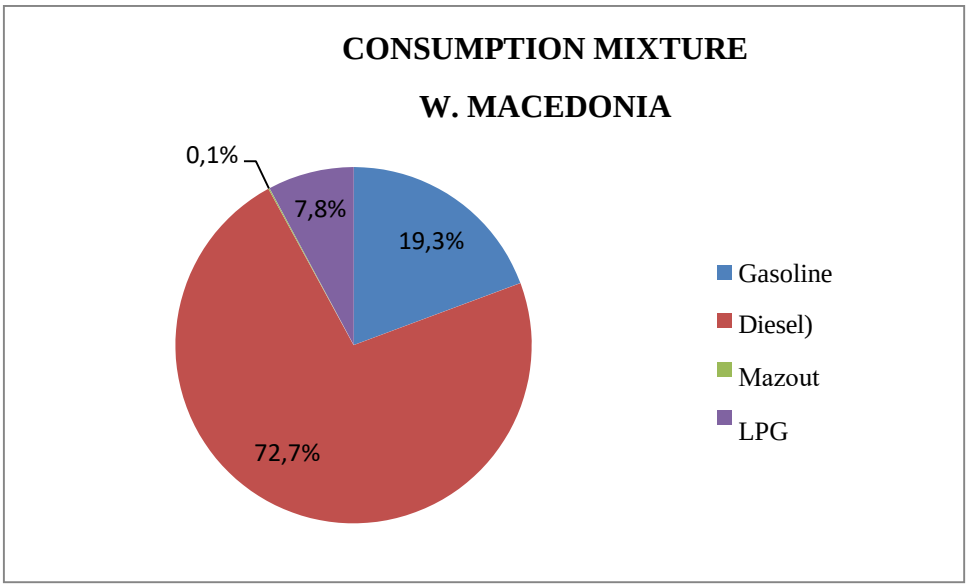
	2008	**2009**	**2010**	**2011**	**2012***	**2013***	**2014***	**2015***	**2016***	**2017***	**2018***	**Diff. 2008 - 2018**
Total Greece	10.649	10.570	9.396	8.652	7.788	6.557	6.655	7.046	7.273	7.186	7.017	**-34,1%**
W. Macedonia	337,3	331,5	311,6	293,6	258,0	234,1	240,6	253,3	216,8	214,1	224,1	**-33,6%**
% total of the country	**3,2%**	**3,1%**	**3,3%**	**3,4%**	**3,3%**	**3,6%**	**3,6%**	**3,6%**	**3,0%**	**3,0%**	**3,2%**	
Grevena	32,9	29,2	29,5	23,7	25,3	21,9	22,6	25,5	23,9	23,2	22,7	
Kastoria	62,4	58,9	55,5	50,0	42,9	38,2	39,2	41,5	38,8	35,9	36,4	
Kozani	178,9	180,5	161,9	171,2	148,4	130,4	125,1	135,2	119,6	114,3	123,3	
Florina	63,0	63,0	64,7	48,8	41,3	43,6	53,7	51,1	34,4	40,7	41,7	

Source: ELSTAT

Regarding the consumption mixture, most of it concerns oil consumption (72.7%), followed by gasoline with 19.3% and LPG with 7.8%.

[70] In the most basic version, the risk of poverty is calculated as the percentage of households living on less than 60% of median income.

Diagram 32 - Consumption Mixture in the Region of Western Macedonia, 2018



Source: ELSTAT

Energy Poverty

The term energy poverty refers to the financial inability of a household to access basic energy services, such as heating, lighting, kitchen use, transportation. An important parameter for the evaluation of this possibility is the disposable income, the energy prices but also the total needs for consumption (due to cold, need for movement and access to markets / services). The table below shows that the population of Western Macedonia is more exposed to energy poverty, as there are three cumulative factors: lower disposable income than the national average, higher annual consumption and higher risk of poverty.

Table 54 - Needs for Heating (in thousand days) for the Residents of the Region of Western Macedonia, 2008-2018

AREA	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Greece	1,51	1,52	1,41	1,81	1,66	1,45	1,41	1,58	1,46	1,66	1,38
W. Macedonia	2,35	2,31	2,33	2,62	2,53	2,22	2,27	2,37	2,23	2,33	2,06

Source: Eurostat

(b) Peloponnese

The economy of the Peloponnese region supports its development mainly in the utilization of its energy infrastructure, as in the region there are 2 industrial production units (PPC Megalopolis in Arcadia and Corinth Refineries in the prefecture of Corinth).

At the same time, it maintains the level of agricultural production and develops tourism, while in the last decade a large part of transport infrastructure has been completed, which has reduced the access time to the metropolitan center.

The economic crisis has hit the Peloponnese economy hard, going through a phase of transition from the previous energy model to a new one with an emphasis on grid interconnections, energy communities and RES development. In addition, hydrocarbon exploration in the Ionian and Crete

plots, which are connected to the Peloponnese Region, creates conditions for a smooth transition to a new efficient industrial and energy model.

Contribution to GDP

The Peloponnese participates steadily in the country's GDP with a percentage ranging from 4.1% - 4.5% of total national income. Production is distributed relatively evenly across the different regional units. Most (20%) is produced in the peripheral unit of Corinth (close to the metropolitan center) and Messinia (tourism and agri-food complex). The total value of the region's GDP has declined significantly over the last decade (by € 2 billion annually).

Table 55-Contribution(€ billion)of the Peloponnese Region to the GDP of Greece,2008-2018

REGION/YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GREECE	242,0	237,5	226,0	207,0	191,2	180,7	178,7	177,3	176,5	180,2	184,7
Peloponnese	10,1	9,9	9,4	8,8	8,3	7,8	7,8	7,8	7,9	8,0	8,2
Argolida	2,0	1,9	1,8	1,6	1,5	1,4	1,4	1,4	1,4	1,5	
Arkadia	1,6	1,7	1,6	1,5	1,4	1,4	1,4	1,4	1,3	1,4	
Korinthia	2,6	2,5	2,3	2,2	2,1	2,0	1,9	1,9	2,0	2,0	
Lakonia	1,4	1,4	1,3	1,3	1,2	1,1	1,1	1,1	1,1	1,1	
Messinia	2,5	2,5	2,4	2,2	2,1	1,9	2,0	2,0	2,0	2,0	
Contribution to national GDP	***4,17%***	***4,17%***	***4,17%***	***4,25%***	***4,33%***	***4,34%***	***4,35%***	***4,42%***	***4,46%***	***4,46%***	***4,46%***

Source: ELSTAT

Gross Fixed Capital Formation

The contribution of the Peloponnese region exceeds the average contribution to the national income. However, the general trend of de-investment observed throughout the country is repeated in the case of the Peloponnese, which records a loss of 57.4% of the value of total investments in the last decade. Total investments in 2017 amounted to € 1.26 billion from € 2.96 billion in 2008.

Table 56 - Total Investments (€ billion) in the Peloponnese Region, 2008-2017

REGION/YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CHANGE
GREECE	57,63	49,39	39,70	31,61	24,14	21,96	20,62	20,49	21,28	23,24	***-59,7%***
Peloponnese	2,96	2,22	2,43	1,97	1,30	1,26	1,09	1,26	1,16	1,26	***-57,4%***
% investments	*5,1%*	*4,5%*	*6,1%*	*6,2%*	*5,4%*	*5,8%*	*5,3%*	*6,1%*	*5,5%*	*5,4%*	

Source: ELSTAT

Contribution to Employment

The contribution of the Peloponnese region to the total employment recorded by the Greek economy follows the trend of contribution to the national income, ranging between 5.0% -5.3%, marking a small increase during the crisis. From 2008 to 2017, 26,000 jobs were lost (down 10.6%), better than the national average.

Table 57- Contribution of the Peloponnese Region to the Total Employment of Greece, 2008-2017

(in thousand)	2008	2009	2010	2011*	2012*	2013*	2014*	2015*	2016*	2017*	Diff. 2008-2017
GREECE	4856,4	4829,0	4705,5	4381,8	4105,2	3997,7	4034,8	4064,0	4083,0	4146,0	-14,6%
Peloponnese	244,3	245,5	238,4	227,7	215,3	215,4	215,3	214,9	216,1	218,4	-10,6%
Contribution to employment	***5,03%***	***5,08%***	***5,07%***	***5,20%***	***5,25%***	***5,39%***	***5,34%***	***5,29%***	***5,29%***	***5,27%***	

Source: ELSTAT

Competitiveness Indices

According to the European Regional Competitiveness Index of the European Commission, which evaluates the performance of the regions on the basis of specific measurable thematic indicators, the Peloponnese region lags significantly below the European average, but follows an almost linear course with the performance of the Greek economy in total. The areas that perform best are health, business complexity, market size and level of higher education.

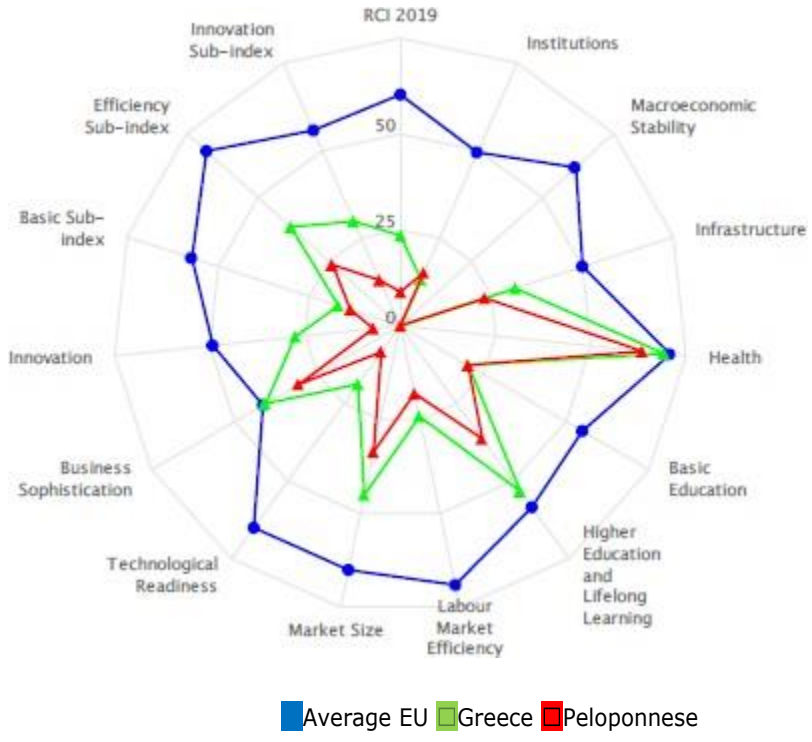
Table 58 - Competitiveness Indices of the Peloponnese Region, 2019

INDICATORS	INSTITUTIONS	MACROECONOMIC STABILITY	INFRASTRUCTURE	HEALTH	BASIC EDUCATION	HIGHER EDUCATION	LABOR MARKET EFFECTIVENESS	MARKET SIZE	TECHNOLOGICAL READINESS	BUSINESS COMPLEXITY	INNOVATION	MAIN	EFFECTIVENESS	INNOVATION	RCI 2019
Greece	13.27	0	31.63	69.29	20.48	53.3	24.17	45.07	18.79	40.63	27.66	16.98	38.51	29.82	**23.53**
Peloponnese	15.16	0	23.27	63.7	20.48	36.47	18.06	33.61	8.41	30.45	7.08	13.74	23.76	12.96	8.84

Source: European Commission

On the contrary, the indices related to innovation, technological readiness, macroeconomic environment and institutions show worse performance.

Diagram 33 - Comparison of Competitiveness Indices of the Peloponnese Region with Greek and European Average, 2019



Source: European Commission

Financial Status of Households

Regarding the economic situation and domestic demand conditions of households in the Peloponnese region, we observe that disposable income is lower than final consumption expenditure, indication of exposure to loan liabilities, and is less than 5% of the total value of national disposable income. In 2017, disposable income (i.e. income after tax-deductions) was € 5.2 billion. The per capita income recorded in 2017 was € 13,900, lower by € 2,900 than the national average.

Table 59 - Consumer Expenditure and Income of the Residents of the Peloponnese Region, 2008-2017

	2008*	2009*	2010*	2011*	2012*	2013*	2014*	2015*	2016*	2017*
Disposable Income (bill. €)										
GREECE	156,8	159,8	146,5	132,8	120,3	109,7	110,1	106,5	104,3	105,9
Peloponnese	7,3	7,7	7,3	6,4	6,0	5,4	5,3	5,2	5,1	5,2
Final consumer expenditure (bill. €)										
GREECE	159,1	157,4	152,0	139,9	128,9	122,9	120,5	118,1	117,2	118,8
Peloponnese	7,7	9,2	7,3	8,2	6,8	5,8	4,7	5,3	5,4	5,3
Per capita income (bill. €)										
GREECE	21,8	21,4	20,3	18,6	17,3	16,5	16,4	16,4	16,4	16,8
Peloponnese	17,2	16,9	16,0	14,9	14,1	13,4	13,3	13,4	13,6	13,9

Source: ELSTAT

Over time, the Peloponnese has a lower unemployment rate than the overall national rate. In 2008, the unemployment rate was 7.1% and the highest price was recorded in 2014, at 23.4%. Unemployment de-escalated significantly by 2019, approaching 12.2%. Women are significantly more affected by the intensity of unemployment, maintaining a difference of 7% -8% from men (reaching up to 28.3% in 2014), while youth unemployment is 53.5%.

Table 60 - Unemployment Indices of the Residents of the Peloponnese Region, 2008-2019

% Unemployment	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
GREECE	7,7	9,5	12,7	17,8	24,3	27,3	26,4	24,9	23,5	21,4	19,3	17,3
Peloponnese	7,1	8,0	9,7	13,9	19,1	22,1	23,4	22,6	19,3	16,7	14,6	12,2
Male	4,0	4,4	6,3	11,3	15,1	18,2	19,5	18,3	15,6	13,2	11,1	9,4
Female	11,2	12,8	14,0	17,1	24,4	26,9	28,3	27,8	24,0	21,2	19,1	15,8
Youth (15-24)	36,6	34,8	35,3	52,7	72,3	70,4	49,6	49,4	48,8	55,0	62,0	53,5
Workforce (thous)	258,5	259,2	253,2	248,2	244,1	245,0	246,2	248,6	243,0	246,5	243,1	240,2

Sources: Eurostat, ELSTAT

The analysis of the indices of poverty and social inclusion shows that the Peloponnese region is moving symmetrically with the national average on the exposure to the risk of poverty for households. According to data from ELSTAT, in 2018, 19% (compared to 18.5%) of them face the spectrum of poverty. 12.9% of the population is employed in low-intensity work (precarious work, part-time) and 17.2% lack basic conditions for material reproduction.

Table 61 - Poverty-Social Conditions of the Residents of the Peloponnese Region, 2018

Year, 2018	% POPULATION in condition:		
	POVERTY	*LOW WORKLOAD*	*MATERIAL DEPRIVATION*
GREECE	18,5	14,6	16,7
Peloponnese	19	12,9	17,2

Source: Eurostat

Energy consumption

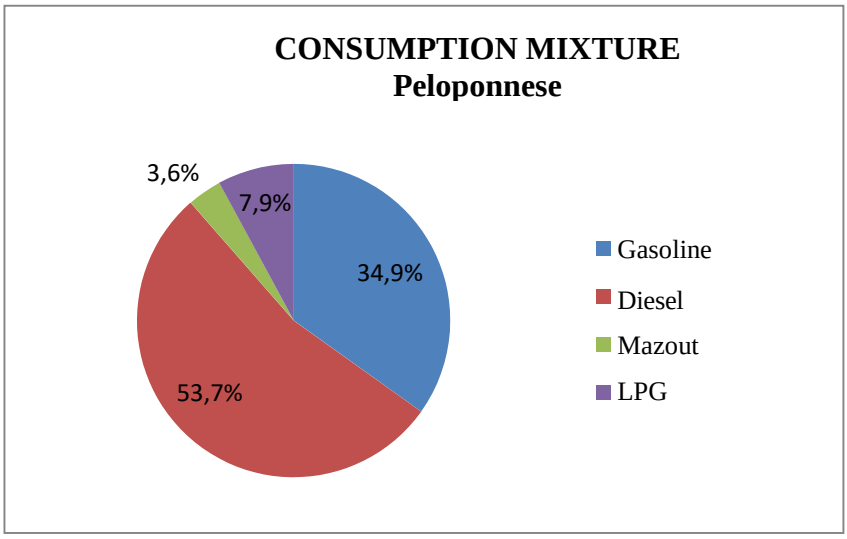
From the available data of ELSTAT on energy consumption, it appears that the Peloponnese region consumes 5.8% - 6.2% of total oil consumption, with Corinthia and Messinia receiving the highest share, a finding related to the productive capacity of the regions. The reduction of oil consumption between 2008-2018 exceeds 1/3 of the consumption of 2008.

Table 62 - Evolution of Petroleum Consumption in the Peloponnese Region, 2008-2018

	2008	2009	2010	2011	2012*	2013*	2014 *	2015*	2016*	2017*	2018 *	Diff. 2008 - 2018
Total Greece	10.649	10.570	9.396	8.652	7.788	6.557	6.655	7.046	7.273	7.186	7.017	**-34,1%**
Peloponnese	637,5	650,6	542,8	529,2	463,2	400,8	401,3	423,7	431,8	417,9	406,4	-36,3%
% total of the country	6,0%	6,2%	5,8%	6,1%	5,9%	6,1%	6,0%	6,0%	5,9%	5,8%	5,8%	
Argolida	115,9	116,7	94,2	98,9	90,5	74,9	77,3	80,9	81,2	78,3	78,2	
Arkadia	121,8	120,2	108,7	91,4	75,1	64,5	62,4	68,0	65,9	64,1	59,2	
Korinthia	179,0	187,7	144,6	145,3	125,6	110,5	113,7	121,4	124,0	122,4	115,8	
Lakonia	73,2	82,7	62,1	73,2	69,1	59,7	59,0	61,3	63,5	60,5	59,6	
Messinia	147,5	143,3	133,2	120,4	102,9	91,2	88,8	92,1	97,2	92,7	93,6	

Regarding the consumption mixture, most of it concerns oil consumption (53.7%), followed by gasoline with 34.9% and LPG with 7.9%. The use of fuel oil accounts for only 3.6% of total consumption.

Diagram 34 - Consumption Mixture in the Peloponnese Region, 2018



Source: ELSTAT

Energy Poverty

The table below shows that the population of the Peloponnese is less exposed to energy poverty compared to the region of Western Macedonia, as it records higher disposable income and heating needs are below the national average, due to the climatic conditions of the region.

Table 63 - Needs for Heating (in thousand days) for the Residents of the Peloponnese Region, 2008-2018

REGION	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Greece	1,51	1,52	1,41	1,81	1,66	1,45	1,41	1,58	1,46	1,66	1,38
Peloponnese	1,24	1,26	1,11	1,55	1,42	1,18	1,21	1,36	1,21	1,45	1,17

Source: Eurostat

(c) Aegean Islands - Crete

The economy of the Aegean archipelago and Crete is characterized by a high degree of dependence on the tourist product and at the second level has sufficient opportunities to meet the agri-food needs of local communities. Investments in infrastructure sectors to cover the growing tourist traffic, maritime transport and interconnection with mainland Greece are important projects for the development of these regions.

Although these regions have managed to overcome the recession trap by gradually restoring the economic figures of production and employment, significant social and structural challenges remain in the epicentre of regional policy such as refugee flow management, energy autonomy and climate change.

Contribution to GDP

The geographical unit of the Aegean-Crete participates with a high share in the GDP of the country (approaching 10%), as the total income amounts to € 18.3 billion (current prices 2018). The production is evenly distributed in the two imaginary geographical subdivisions - Crete records € 9.4 billion and the islands of the Aegean € 8.9 billion. Their economy relies heavily on tourism and agricultural production. The decline in GDP during the crisis was symmetrical in terms of the trend recorded throughout the country.

Table 64 - Contribution (€ billion) of the Aegean Islands and Crete to the GDP of Greece, 2008-2018

REGION/YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
GREECE	242,0	237,5	226,0	207,0	191,2	180,7	178,7	177,3	176,5	180,2	184,7
Aegean islands, Crete	23,5	22,5	21,3	19,3	17,6	17,1	17,4	17,5	17,2	17,7	18,3
N. Aegean	3,5	3,4	3,2	2,9	2,7	2,6	2,6	2,5	2,5	2,5	2,5
S. Aegean	8,2	7,6	7,2	6,6	6,1	6,0	6,0	6,1	6,0	6,1	6,4
Crete	11,8	11,5	10,9	9,7	8,8	8,6	8,8	8,9	8,7	9,1	9,4
Contribution to national GDP	***9,71%***	***9,47%***	***9,41%***	***9,30%***	***9,21%***	***9,48%***	***9,73%***	***9,88%***	***9,73%***	***9,83%***	***9,92%***

Source: ELSTAT

Gross Fixed Capital Formation

The contribution of the geographical unit of the Aegean-Crete exceeds the average contribution to the national income by 2 percentage points (11.5%, prices 2017). However, the disinvestment trend observed in the region exceeds the negative performance of the country as a whole, as a loss of 60.5% of the value of total investments has been recorded since 2008. Total investments in 2017 amounted to € 2.67 billion (from € 6.76 billion in 2008).

Table 65 - Total Investments (€ billion) in the Aegean Islands and Crete, 2008-2017

REGION/YEAR	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	CHANGE
GREECE	57,63	49,39	39,70	31,61	24,14	21,96	20,62	20,49	21,28	23,24	***-59,7%***
Aegean islands, Crete	6,76	4,91	4,15	3,28	2,58	2,30	2,35	2,56	2,38	2,67	***-60,5%***
% investments	11,7%	10,0%	10,4%	10,4%	10,7%	10,5%	11,4%	12,5%	11,2%	11,5%	

Source: ELSTAT

Contribution to Employment

The contribution of the geographical unit of the Aegean-Crete to the total employment remains high, exceeding 10.5% of the total domestic employment and tends to acquire structurally positive dynamics, as during the crisis it grows steadily. From 2008 to 2017, 46,900 positions of employment were lost (decrease of 9.2%), better than the national average.

Table 66 - Contribution of the Aegean Islands and Crete to the Total Employment of Greece, 2008-2017

(in thousand)	2008	2009	2010	2011*	2012*	2013*	2014*	2015*	2016*	2017*	Diff. 2008-2017
GREECE	4856,4	4829,0	4705,5	4381,8	4105,2	3997,7	4034,8	4064,0	4083,0	4146,0	-14,6%
Aegean islands, Crete	511,4	507,8	497,5	473,4	455,1	443,5	446,1	457,6	461,5	464,5	-9,2%
Contribution in employment	***10,53 %***	***10,51%***	***10,57%***	***10,80 %***	***11,09 %***	***11,09 %***	***11,06%***	***11,26%***	***11,30 %***	***11,20%***	

Source: ELSTAT

Competitiveness Indices

According to the European Regional Competitiveness Index of the European Commission, which evaluates the performance of the regions, the regions of the North and South Aegean and Crete are distinguished for different structural weaknesses.

Crete lags far behind the European and national average in the field of infrastructure, but achieves better results in terms of market size, education, innovation, business complexity and health. The North Aegean region performs well in health and infrastructure, but lags far behind in the areas of labour market, innovation and market size, due to its geographical location and lack of regional interconnection. The South Aegean region has a low degree of business complexity and innovation, but is more effective in adapting the labour market.

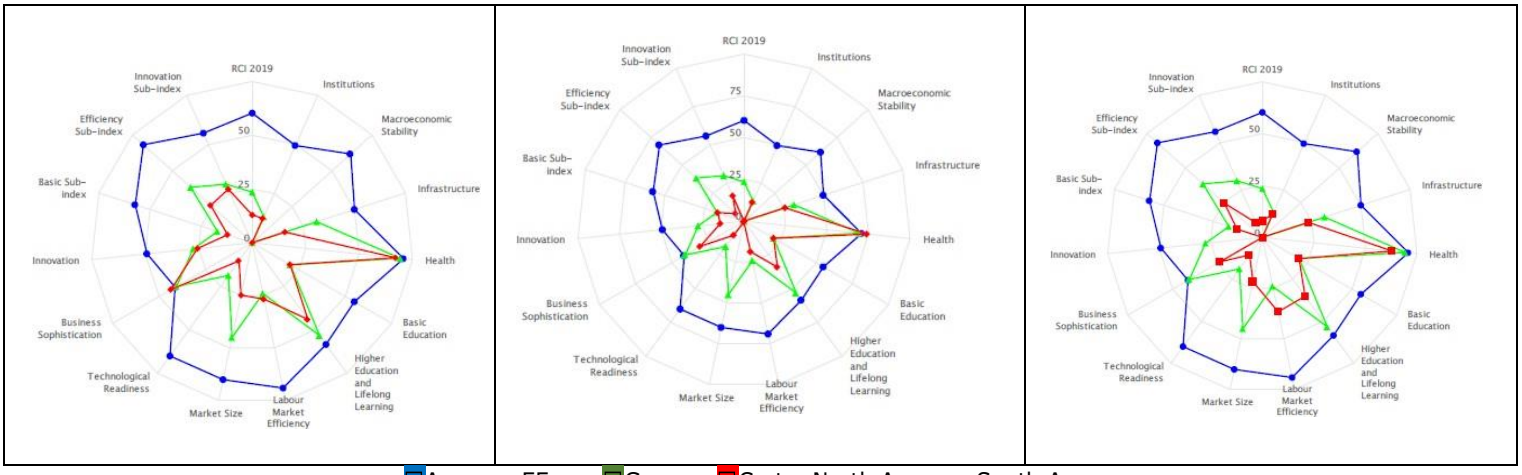
Table 67 - Competitiveness Indices of the Aegean Islands and Crete, 2019

INDICATORS	INSTITUTIONS	MACROECONOMIC STABILITY	INFRASTRUCTURE	HEALTH	BASIC EDUCATION	HIGHER EDUCATION	LABOR MARKET EFFECTIVENESS	MARKET SIZE	TECHNOLOGICAL READINESS	BUSINESS COMPLEXITY	INNOVATION	MAIN	EFFECTIVENESS	INNOVATION	RCI 2019
Greece	13.27	0	31.63	69.29	20.48	53.3	24.17	45.07	18.79	40.63	27.66	16.98	38.51	29.82	**23.53**
N. Aegean	12.35	0	25.76	74.36	20.48	34.07	18.73	0.46	10.39	30.36	14.28	16.57	6.75	16.6	0
S. Aegean	12.35	0	23.36	62.98	20.48	35.08	36.7	21.81	10.39	23.78	0	12.76	24.72	7.73	7.93
Crete	12.35	0	16.08	67.27	20.48	44.08	26.82	24.95	10.39	43.53	25.66	12.02	25.96	27.28	12.93

Source: European Commission

Diagram 35 - Comparison of Competitiveness Indices of the Aegean Islands and Crete with Greek and European Average, 2019

Crete **North Aegean** **South Aegean**



Average EE Greece: Crete, North Aegean, South Aegean

Source: European Commission

Financial Status of Households

Regarding the economic situation of households in the geographical unit of the Aegean-Crete, we observe that the disposable income in total exceeds 10% of the total national disposable income (€ 11.7 billion in 2017), while consumer spending periodically fluctuates at marginally lower or higher levels. (in 2017 it was € 11.9 billion). The size of the declining adjustment of disposable income and consumer expenditure since 2008 exceeds 30%. The per capita income recorded in 2017 was € 15,000, down by € 1,800 from the national average.

Table 68 - Consumer Expenditure and Income of the Residents of the Aegean Islands and Crete, 2008-2017

	2008*	2009*	2010*	2011*	2012*	2013*	2014*	2015*	2016*	2017*
Disposable income (thous. €)										
GREECE	156,8	159,8	146,5	132,8	120,3	109,7	110,1	106,5	104,3	105,9
AEGEAN ISLANDS - CRETE	14,4	14,7	14,3	12,7	11,5	10,7	12,0	11,9	11,8	11,7
Final consumer expenditure (thous. €)										
GREECE	159,1	157,4	152,0	139,9	128,9	122,9	120,5	118,1	117,2	118,8
AEGEAN ISLANDS - CRETE	14,8	13,7	14,1	12,2	11,0	12,4	12,6	11,9	11,0	11,9
Per capita income (thous €)										
GREECE	21,8	21,4	20,3	18,6	17,3	16,5	16,4	16,4	16,4	16,8
AEGEAN ISLANDS - CRETE	20,5	19,5	18,4	16,6	15,1	14,7	14,9	15,0	14,7	15,0

Source: ELSTAT

Over time, the geographical unit of the Aegean-Crete presents a lower unemployment rate than the overall national rate. In 2008, the unemployment rate was 6.7%, while the highest number was recorded in 2014, at 19.9%. Unemployment de-escalated significantly until 2019, when it reached 10.0%. The unemployment rate for women is twice as high as for men, while youth unemployment is significantly lower than the national average (32.8%).

Table 69 - Unemployment Indices of the Residents of the Aegean Islands and Crete, 2008-2019

% Unemployment	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
GREECE	7,7	9,5	12,7	17,8	24,3	27,3	26,4	24,9	23,5	21,4	19,3	17,3
AEGEAN ISLANDS - CRETE	6,7	9,5	12,2	15,3	20,0	23,3	22,5	20,4	20,3	18,0	15,9	13,1
Male	4,1	6,6	8,9	12,9	16,2	19,6	19,9	17,3	16,1	14,9	12,4	10,0
Female	10,8	13,7	16,7	18,6	25,0	28,1	25,9	24,5	25,8	22,0	20,4	17,0
Youth(15-24)	15,0	22,5	29,6	39,3	43,6	42,9	38,9	38,4	37,6	36,1	32,0	32,8
Workforce (thous)	512,3	527,3	529,0	527,8	527,5	526,1	514,2	510,7	524,5	526,8	534,9	531,1

Sources: Eurostat, ELSTAT

The analysis of the indices of poverty and social deprivation shows that the wider geographical region records a higher risk of poverty, 19.6% versus 18.5% and material deprivation 18.3% versus 16.7%. However, in the field of labour intensity (precarious work, part-time work) it is characterized by better performance (11.7% vs. 14.6%). The above shows, in combination with the high contribution to national income, that inequalities within regions may be more intense.

Table 70 - Poverty-Social Conditions of the Residents of the Aegean Islands and Crete, 2018

YEAR, 2018	% POPULATION in condition:		
	POVERTY	*LOW WORKLOAD*	*MATERIAL DEPRIVATION*
GREECE	18,5	14,6	16,7
AEGEAN ISLANDS CRETE	19,6	11,8	18,3

Source: Eurostat

Energy consumption

From the available data of ELSTAT on the annual energy consumption, it appears that the geographical unit of the Aegean-Crete consumes 9% -10% of the total consumption of petroleum products, with Crete participating with the highest share and the North Aegean with the lowest. The total reduction of oil consumption between 2008-2018 amounts to 29.4% of consumption in 2008.

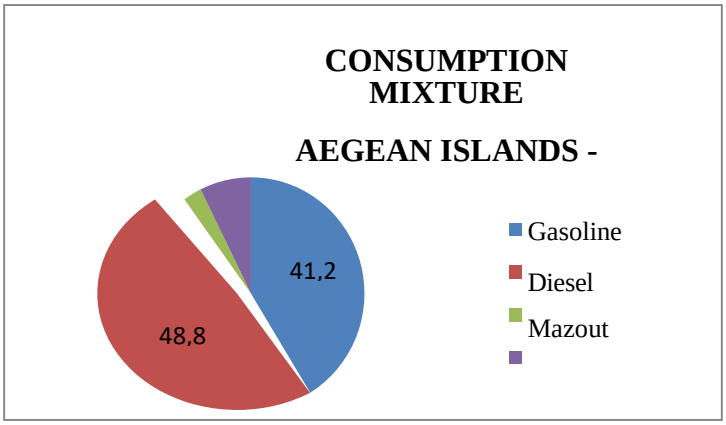
Table 71 - Petroleum Consumption of the Aegean Islands and Crete, 2008-2018

	2008	2009	2010	2011	2012*	2013*	2014*	2015*	2016*	2017*	2018**	Diff. 2008-2018
Total Greece	10.649	10.570	9.396	8.652	7.788	6.557	6.655	7.046	7.273	7.186	7.017	**-34,1%**
Aegean islands - Crete	**996,6**	**944,0**	**950,0**	**804,5**	**716,6**	**643,5**	**647,6**	**703,6**	**698,9**	**708,7**	**703,7**	**-29,4%**
% Total of the country	**9,4%**	**8,9%**	**10,1%**	**9,3%**	**9,2%**	**9,8%**	**9,7%**	**10,0%**	**9,6%**	**9,9%**	**10,0%**	
North Aegean	125,7	124,3	141,7	116,3	107,9	90,6	88,9	99,9	98,1	96,0	89,5	
South Aegean	304,3	291,2	338,5	247,3	215,1	199,1	201,1	217,5	214,9	222,1	228,4	
Crete	566,6	528,5	469,7	441,0	393,6	353,7	357,6	386,2	386,0	390,6	385,8	

Source: ELSTAT

Regarding the consumption mixture, most of it concerns oil consumption (48.8%), followed by gasoline with 41.2% and LPG with 7.3%. The use of fuel oil concerns only 2.7% of the total consumption of petroleum products.

Diagram 36 - Consumption Mixture of the Aegean Islands and Crete, 2018



Source: ELSTAT

Energy Poverty

The table below shows that the population of the Aegean-Crete geographical unit is the least exposed to energy poverty in the country, as it records very low heating needs, as a result of climatic conditions, while at the same time presents a high level of disposable income.

Table 72 - Heating Needs (in thousand days) of the Residents of the Aegean Islands and Crete, 2008-2018

REGION	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Greece	1,51	1,52	1,41	1,81	1,66	1,45	1,41	1,58	1,46	1,66	1,38
Aegean islands - Crete	0,81	0,77	0,61	1,04	0,97	0,74	0,67	0,89	0,79	0,94	0,69

Source: Eurostat

3.1.2. Sectoral Structure

(a) Western Macedonia

According to the latest business structure survey (ELSTAT, 2017), in the region of Western Macedonia a total of 38,781 units operate and employ 75,514 employees. Of these, approximately 19,100 companies operate (and / or practice similar professions) in the primary sector. Essentially, the region's agriculture, forestry and fisheries sector accounts for 3.4% and 3.8% respectively of the total national contribution to the sector in terms of turnover and employment, which is the highest share of business activity.

The contribution of the mining and quarrying sector (with 2.4% and 2.8% respectively), water treatment (3.09% and 2.75%), as well as construction (2.06% and 3.53%) is also particularly important. Manufacturing, services and trade follow with rates not exceeding 2%. From the scientific professions, the health and education sectors maintain high contributions.

It is understandable that in the transition phase to the post-lignite era there are potential advantages in the region related to bio-waste treatment of farms, the utilization of human resources (professions and employees) in Renewable Energy Sources, while there is room for further development of transport and tourism. The detailed snapshot of the sectoral structure in the region of Western Macedonia is described in a relevant table in the Annexes of the present study.

Employment Distribution

The agricultural economy, as well as the wider sector of processing, energy, mining and water treatment, contribute to 1/3 of the total employment in the region of Western Macedonia. The trade, transport and catering sector[71] contributes with 25%, while the services of the public sector (administration, defence, health, education) cover 21.8%. The construction sector, which participates with 7.0%, has suffered the largest contraction (37.2%) in the last decade. Financial services also lost a significant share of employment (-23.9%), but also the two sub-sectors with the largest economic contribution (agricultural sector and the mining-industry-energy-water treatment sector). On the

[71] The classification at regional level is carried out by mergers of branches, according to the special bulletin issued by ELSTAT and concerns the business register.

contrary, the number of technical and scientific professions increased significantly, possibly due to the outflow of skilled employment from sectors that lost more than 20% of their jobs (see Table 73, in addition to Table 74, which explains the statistical classification).

From the above, it can be concluded that the activities of some key sectors in the region of Western Macedonia communicate with each other in addition to business, and as a means of substituting jobs for employees.

Table 73 - Employment by Sector (in thousands of employees) of the Residents of the Region of Western Macedonia, 2008-2017

NACE2 / YRS	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Δ 2008 - 2017	% TOTAL EMPLOYMENT
A	18,86	21,07	18,35	15,81	14,30	14,55	15,76	15,59	15,06	15,36	**-18,6%**	**17,0%**
B_E	19,86	20,47	19,59	18,56	16,70	15,95	15,53	15,60	15,59	15,51	**-21,9%**	**17,1%**
ΣΤ	10,03	8,99	7,49	5,44	5,19	5,86	6,44	5,96	6,16	6,30	**-37,2%**	**7,0%**
Z_H_Θ	26,00	27,29	26,70	26,39	23,97	21,93	22,54	22,67	22,88	23,19	**-10,8%**	**25,6%**
I	0,41	0,40	0,41	0,40	0,39	0,39	0,38	0,37	0,39	0,41	**-0,8%**	**0,5%**
K	1,20	1,07	1,05	1,05	1,04	1,01	0,95	0,89	0,91	0,92	**-23,9%**	**1,0%**
Λ	0,12	0,12	0,14	0,11	0,10	0,10	0,11	0,11	0,11	0,10	**-14,4%**	**0,1%**
M_N	3,51	4,18	4,36	4,44	4,66	4,43	4,51	4,57	4,59	4,62	**31,8%**	**5,1%**
Ξ_Ο_Π	23,71	21,94	21,53	21,48	20,30	20,08	20,06	20,21	20,18	19,76	**-16,6%**	**21,8%**
P_Σ_T_Y	4,76	4,75	4,99	4,92	5,13	4,73	4,52	4,54	4,35	4,45	**-6,4%**	**4,9%**
TOTAL	**108,45**	**110,27**	**104,59**	**98,59**	**91,77**	**89,04**	**90,80**	**90,51**	**90,22**	**90,62**	**-16,4%**	**100,0%**

Source: ELSTAT

Table 74 - Explanatory Table of Statistical Classification

A	Γεωργία, δασοκομία και αλιεία
B_E	Mining, quarrying, industry, electricity, gas, steam, air conditioning and water, wastewater treatment, waste management and remediation activities
ΣΤ	Construction
Z_H_Θ	Wholesale and retail trade, repair of motor vehicles and motorcycles, transport and storage, accommodation and catering activities
I	Information and Communication
K	Financial and insurance activities
Λ	Real estate management
M_N	Professional, scientific and technical activities, administrative and supportive activities
Ξ_Ο_Π	Public administration and defense, compulsory social security, education, related activities human health and social welfare
P_Σ_T_Y	Arts, entertainment, recreation, other service activities, household activities as employers, non-differentiated household activities related to the production of goods and services for own use, activities of heterodox organizations

Source: ELSTAT

Production Structure (Contribution to Gross Added Value)

In terms of Gross Added Value (GVA), the region of Western Macedonia records a decline of € 778 million from 2008 to 2018. The most significant decrease is manifested in the construction sector - a change that affects the overall productive structure of the regional economy, while the sectors trade-transport-tourism recover after a decline of 7% in the period 2008-2012.

Manufacturing, as well as the mining, energy and water sectors, are steadily increasing their participation in the total GVA of the region. Significant increase in participation, but at the same time, a decrease in its total current value is recorded by the real estate management sector, an indication that the area has not reached land use saturation or is not fully developed in terms of housing or infrastructure and facilities.

Table 75 - Gross Added Value (million €) and Production Structure by Sector of the Region of Western Macedonia, 2008, 2012 and 2017

Gross added value per sector (mill €)				PRODUCTIVE STRUCTURE		
WESTERN MACEDONIA	**2008**	**2012**	**2017**	**2008**	**2012**	**2017**
A	251	227	316	4,5%	5,0%	5,4%
B_E	1.373	1.830	1.429	6,5%	7,6%	8,7%
of which processing	212,43	195,62	206,16	3,9%	4,3%	4,8%
ΣΤ	277	161	89	5,8%	5,3%	3,4%
Z_H_Θ	710	430	387	41,3%	34,4%	38,6%
I	60	42	38	1,8%	1,6%	1,6%
K	98	78	71	2,3%	2,7%	2,6%
Λ	347	410	326	9,9%	16,1%	13,0%
M_N	123	147	68	3,7%	3,0%	4,1%
Ξ_Ο_Π	862	711	644	20,7%	20,2%	18,4%
P_Σ_T_Y	143	139	96	3,4%	4,2%	4,2%
TOTAL	**4.243**	**4.175**	**3.465**			

Source: ELSTAT

Participation of the Sectors in the Investments

In 2017, the sector with the highest absolute value of investments (€ 419 million) in the region of Western Macedonia was the public sector (and related activities), which demonstrates the dependence of the region on public investment. Then the sub-sector that includes the sectors of processing, mining, energy, water follows with investments of € 189 million, which, however, records a decrease of 64% compared to the absolute figures of 2008. The largest decrease in investments is recorded by the real estate management sector at a rate exceeding 80%. From the above emerges an indirect long-term potential complementarity between public sector investment and industry-mining-energy sector.

Table 76 - Gross Fixed Capital Investments (million €) by Geographical Zone, Region and Sector of the Region of Western Macedonia, 2008, 2012 and 2017

NACE2/ YRS	2008	2012	2017	CHANGE
A	128	49	62	-52%
B_E	533	358	189	**-64%**
ΣΤ	23	5	8	**-62%**
Z_H_Θ	55	25	32	**-42%**
I	11	13	5	**-58%**
K	6	3	12	**94%**
Λ	577	271	70	**-88%**
M_N	32	20	8	**-76%**
Ξ_Ο_Π	865	293	419	**-51%**
P_Σ_T_Y	19	34	10	**-47%**
TOTAL	2.248	1.071	814	**-64%**

Source: ELSTAT

(b) Peloponnese

According to the latest business structure survey (ELSTAT, 2017), in the Peloponnese region there are a total of 112,884 units with 191,734 employees. Of these, more than half (66,738) are active in the primary sector, employing 66,789 people. The possibilities of developing economies of scale and expanding the livestock sector are shown by the fact that the ratio of companies-employees in the industry is 1: 1.

The participation of the mining, energy, water treatment and processing sectors is quite important in the national economy, as they cumulatively constitute over 9% of the total turnover and 14% of the total employment of the sector in the country. The trade and the tourism-catering services participate with shares that exceed 3%. Of the scientific professions, the health and education sectors maintain high contributions, as does the arts sector.

It is clear that during the transition phase to the new period with a lower carbon footprint there is the possibility to develop and help evolve comparative advantages in the tourism sector and the agri-food complex in general, in the utilization of water resources, while the modernization of farms would be linked to the organized utilization of the produced biomass for energy production.

Employment Distribution

The agricultural economy, as well as the wider trade-transport-tourism sector each participate with more than ¼ (i.e. 56%) of the total contribution to employment recorded in the Peloponnese region.

The energy-mining-water-processing sector contributes 7.1% to employment, while the construction sector contributes 5.6%. In addition, the public sector contributes 17.5% of jobs in the region.

The largest contraction in the employment rate was almost symmetrical in the agricultural sector (21.7%), in the sub-sector mining-energy-processing-water (28.7%), in construction (29.7%) and in financial services, apparently as a result of the reduction in credit expansion and reduction of regional banking networks (22.8%).

In contrast, the sectors that have improved their contribution to employment over the last decade are the scientific-professional-administrative activities, as well as services related to society, culture, the so-called creative industry and related services (arts, other services, social welfare). The tourism-catering sector showed a marginal improvement.

From the above, it appears that there are two opposite trends in business activities recorded in the major sectors of the Peloponnese region. On the one hand, traditional manufacturing activities affected by the economic crisis are declining and / or restructuring, while maintaining high contributions to employment, while on the other hand, the possibilities of sectors of the regional economy that are expected to increase their footprint in the coming years as they operate in addition (agri-tourism, cultural routes, modern catering and luxury tourism).

Table 77 - Employment by Sector (in thousands of employees) of the Residents of the Peloponnese Region, 2008-2017

NACE2 / YRS	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Δ 2008-2017	% TOTAL EMPLOYMENT
A	76,36	76,75	69,41	66,51	62,49	63,69	62,38	61,59	60,36	59,80	**-21,7%**	**27,4%**
B_E	21,88	20,56	19,30	17,80	16,91	16,25	15,73	15,65	15,53	15,60	**-28,7%**	**7,1%**
ΣΤ	17,39	18,08	17,46	15,64	13,08	12,37	12,65	12,30	12,30	12,23	**-29,7%**	**5,6%**
Z_H_Θ	62,70	63,31	63,49	60,40	58,96	56,79	58,64	58,75	61,06	62,93	**0,4%**	**28,8%**
I	2,00	1,80	1,84	1,78	1,77	1,83	1,80	1,74	1,81	1,87	**-6,3%**	**0,9%**
K	3,56	3,22	3,26	3,06	3,14	3,03	2,78	2,69	2,74	2,75	**-22,8%**	**1,3%**
Λ	0,40	0,41	0,47	0,39	0,36	0,35	0,38	0,38	0,39	0,36	**-11,6%**	**0,2%**
M_N	9,62	9,18	10,60	10,22	9,01	9,58	9,87	10,12	10,17	10,26	**6,7%**	**4,7%**
Ξ_Ο_Π	39,21	39,67	38,68	37,84	35,63	37,62	37,09	37,37	37,75	38,18	**-2,6%**	**17,5%**
P_Σ_T_Y	11,21	12,47	13,90	14,05	14,00	13,93	14,02	14,30	13,95	14,38	**28,3%**	**6,6%**
TOTAL	**244,32**	**245,45**	**238,42**	**227,70**	**215,35**	**215,44**	**215,34**	**214,90**	**216,05**	**218,36**	**-10,6%**	**100,0%**

Source: ELSTAT

Production Structure (Contribution to Gross Added Value)

In terms of Gross Added Value (GVA), the Peloponnese region records a significant decrease in value of € 1.9 billion at current prices from 2008 to 2017. These losses are attributed to the sharp decline in business activity in the transport-trade-tourism sectors (€ 730 million), reduction of the contribution of the public sector (€ 570 million) and construction (€ 263 million).

In terms of the productive structure, there is a steady increase in the participation of the agricultural sector in the total GVA of the region, while the mining-energy-water sector increases its participation by 4%. Manufacturing stabilizes its contribution at 15%.

Table 78 - Gross Added Value (million €) and Production Structure by Sector of the Peloponnese Region, 2008, 2012 and 2017

Gross added value / sector (mil. €)				PRODUCTIVE STRUCTURE		
Peloponnese	**2008**	**2012**	**2017**	**2008**	**2012**	**2017**
A	664	603	669	7,4%	8,3%	9,5%
B_E	1.683	1.452	1.616	18,9%	19,9%	23,0%
of which processing	1290,21	970,16	1051,02	14,5%	13,3%	15,0%
ΣΤ	490	352	217	5,5%	4,8%	3,1%
Z_H_Θ	2.093	1.352	1.364	23,4%	18,5%	19,4%
I	180	115	106	2,0%	1,6%	1,5%
K	210	170	157	2,3%	2,3%	2,2%
Λ	1.179	1.429	1.147	13,2%	19,5%	16,3%
M_N	286	199	167	3,2%	2,7%	2,4%
Ξ_Ο_Π	1.791	1.298	1.214	20,1%	17,8%	17,3%
P_Σ_T_Y	351	340	367	3,9%	4,7%	5,2%
TOTAL	**8.926**	**7.309**	**7.024**			

Source: ELSTAT

Participation of the Sectors in the Investments

In 2017, the sector with the highest absolute value of investments (€ 581 million) in the Peloponnese region was the public sector (over 40% of total investments in the region). The following is the sub-sector that includes the sectors of processing, mining, energy, water with investments of € 226 million, which, however, records a small decrease of 13% compared to the absolute figures of 2008. The largest decrease in investments is recorded by the real estate management sector more than 90% (total investment reduction of € 1.5 billion). A significant decrease in investments is also recorded in the agricultural sector with a loss of € 100 million compared to 2008.

Table 79 - Gross Fixed Capital Investments (million €) by Geographical Zone, Region and Sector of the Peloponnese Region, 2008, 2012 and 2017

NACE2/ YRS	2008	2012	2017	CHANGE
A	231	111	132	-43%
B_E	261	163	226	**-13%**
ΣΤ	16	13	19	**17%**
Z_H_Θ	195	31	109	**-44%**
I	34	35	11	**-67%**
K	13	7	26	**101%**
Λ	1.658	636	97	**-94%**
M_N	74	27	19	**-75%**
Ξ_Ο_Π	428	196	581	**36%**
P_Σ_T_Y	46	84	38	**-17%**
TOTAL	**2.956**	**1.303**	**1.259**	**-57%**

Source: ELSTAT

(c) Aegean Islands - Crete

According to the latest business structure survey (ELSTAT, 2017), in the geographical unit of Crete and the Aegean islands there are 218,948 economic units (corporate, sole proprietors, professionals), which employ a total of about 480,000 employees. The sectoral structure of the region is characterized by increased economies of scale and significant competitive advantages, which are not limited to the energy sector.

The primary sector has 101,708 units and employs 82,281 people, an indication of the fragmentation of agricultural production, but also the existence of multiple activities per natural person. The region records 9.7% of turnover in the primary sector.

In contrast to the other areas under study, the manufacturing, trade and tourism-catering sectors participate with high shares in the regional economy, but also in the domestic sizes of the sector (with a turnover of € 1.9 billion, € 8.8 billion and € 4.1 billion respectively). It is followed by the transport and construction sector, whose total contribution exceeds € 1.6 billion in turnover.

Heterogeneous findings are observed in the mining-energy-water management sub-sectors, as while they account for 10% of business activity, they nevertheless participate with significantly lower percentages in turnover and employment. The water management sector maintains the highest contribution of this geographical unit to the industry.

For the region of Crete and the Aegean islands, the interconnection and correlation of economic activities with tourism, the agri-food sector, the efficient organization of transport and the ensuring of energy adequacy and appropriate infrastructure is a critical parameter.

The balanced promotion of Renewable Energy Sources in all forms (wind farms, hydroelectric, geothermal, and photovoltaic) and the exploitation of water resources create conditions for a sustainable development model. The detailed instantaneous mapping of the sectoral structure in the geographical unit of Crete-Aegean is described in a relevant table in the Annexes of the present study.

Employment Distribution

The sectors of trade, transport and tourism-catering hold the largest share of the contribution to the employment of the wider geographical unit of Aegean-Crete islands. The rural economy accounts for 12.5% of employment, while the public sector holds 18.8%. The sub-sector of extraction-processing-energy and water management contributes to 6.6% of the total employment in the geographical unit. Construction contributes 6.4% in employment, but in the last decade it has lost 35.7% of jobs. Respectively, high percentages of employment reductions have been recorded by the financial services with 27.5%, the sub-sector of mining-energy-processing-water management with 23.7% and the management of real estate with 10.9%. On the contrary, the sector of professional-scientific activities, other services and the sector of culture and art (creative industry) recorded a positive sign.

Table 80 - Employment by Sector (in thousands of employees) of the Residents of the Aegean and Crete Islands, 2008-2017

NACE2/ YEARS	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	Δ 2008-2017	%TOTAL EMPLOYMENT
A	63,59	68,79	72,71	70,80	67,58	63,97	60,35	58,76	58,21	57,87	***-9,0%***	***12,5 %***
B_E	40,08	38,07	36,28	33,69	32,47	31,18	31,23	31,32	30,64	30,73	***-23,3 %***	***6,6%***
ΣΤ	46,45	48,88	44,01	36,06	31,94	30,30	30,30	28,95	29,47	29,86	***-35,7 %***	***6,4%***
Z_H_Θ	201,27	192,29	184,85	176,70	173,11	171,24	177,56	190,81	194,52	195,90	***-2,7%***	***42,2 %***
I	4,62	4,49	4,56	4,41	4,37	4,49	4,34	4,24	4,41	4,52	***-2,2%***	***1,0%***
K	7,67	7,35	7,11	7,01	6,49	6,23	5,68	5,47	5,56	5,56	***-27,5 %***	***1,2%***
Λ	0,70	0,71	0,82	0,68	0,63	0,61	0,66	0,67	0,68	0,62	***-10,9 %***	***0,1%***
M_N	28,79	30,49	30,02	27,09	27,09	27,39	28,01	28,85	29,11	29,58	***2,7%***	***6,4%***
Ξ_Ο_Π	97,51	93,67	94,33	94,85	87,89	86,02	85,31	85,68	86,62	87,43	***-10,3 %***	***18,8 %***
P_Σ_T_Y	20,73	23,00	22,85	22,11	23,52	22,04	22,66	22,87	22,30	22,45	***8,3%***	***4,8%***
TOTAL	511,42	507,75	497,54	473,39	455,09	443,48	446,09	457,63	461,52	464,53	***-9,2%***	***100,0 %***

Source: ELSTAT

Production Structure (Contribution to Gross Added Value)

In terms of Gross Added Value (GVA), the geographical unit of the Aegean and Crete Islands records a significant decrease of € 5.3 billion in current prices from 2008 to 2017. These losses are attributed to the sharp decline in business activity in the transport-trade-tourism sectors (€ 1.6 billion), the reduction of the contribution of the public sector (€ 1.2 billion) and that of construction (€ 700 million). Manufacturing recorded losses of € 70 million, quickly reversing the losses of the first years of the crisis.

In terms of the productive structure, there is a stabilization of the wider trade-transport-tourism sub-sector, a steadily increasing participation of the mining-energy-water sector (14.9% in 2017), an increase in the real estate management contribution, despite the correction of the initial prices maintained during the financial crisis.

In addition, there is an increase in the share of the agricultural sector in the total GVA of the region (4.2% from 3.2% in 2008), while manufacturing stabilizes its contribution at levels higher than 10%.

Table 81 - Gross Added Value (€ million) and Production Structure by Sector of the Aegean and Crete Islands, 2008, 2012 and 2017

Gross added value / sector (mil. €)				PRODUCTIVE STRUCTURE		
AEGEAN ISLANDS, CRETE	**2008**	**2012**	**2017**	**2008**	**2012**	**2017**
A	940	777	843	3,2%	3,7%	4,2%
B_E	1.346	1.177	1.351	12,7%	12,8%	14,9%
of which processing	808,55	674,02	736,05	9,6%	9,1%	10,8%
ΣΤ	1.206	820	523	5,0%	3,4%	2,3%
Z_H_Θ	8.587	5.355	5.975	26,6%	22,3%	24,3%
I	378	256	242	3,8%	3,3%	3,5%
K	479	416	404	4,4%	5,0%	4,1%
Λ	2.056	2.498	2.015	13,2%	19,1%	17,1%
M_N	769	462	630	6,4%	5,1%	5,2%
Ξ_O_Π	4.309	3.136	2.856	20,6%	21,3%	20,3%
P_Σ_T_Y	699	659	648	4,1%	4,1%	4,1%
TOTAL	**20.768**	**15.557**	**15.488**			

Source: ELSTAT

Participation of the Sectors in the Investments

In 2017, the sector with the highest absolute value of investments (€ 1.3 billion) in the geographical unit was the public sector (almost equal to 50% of total investments in the region). With a large difference follows the subsector that includes the trade-transport-tourism sectors with € 492 million, while in the agricultural sector the expenditure of € 202 million is quite high. In 2017, the manufacturing, mining, energy, water sectors record investments of € 189 million, which constitutes a small decrease of 8% compared to the absolute figures of 2008. The largest decrease in investments is recorded by the real estate management sector with a percentage exceeding 90% (total reduction of investments € 2.75 billion). The trade-transport and tourism sector lags behind investments of approximately € 500 million compared to 2008, with a significant recovery trend after 2012. A significant decrease in investments is also recorded in the agricultural sector with a loss of € 225 million compared to 2008.

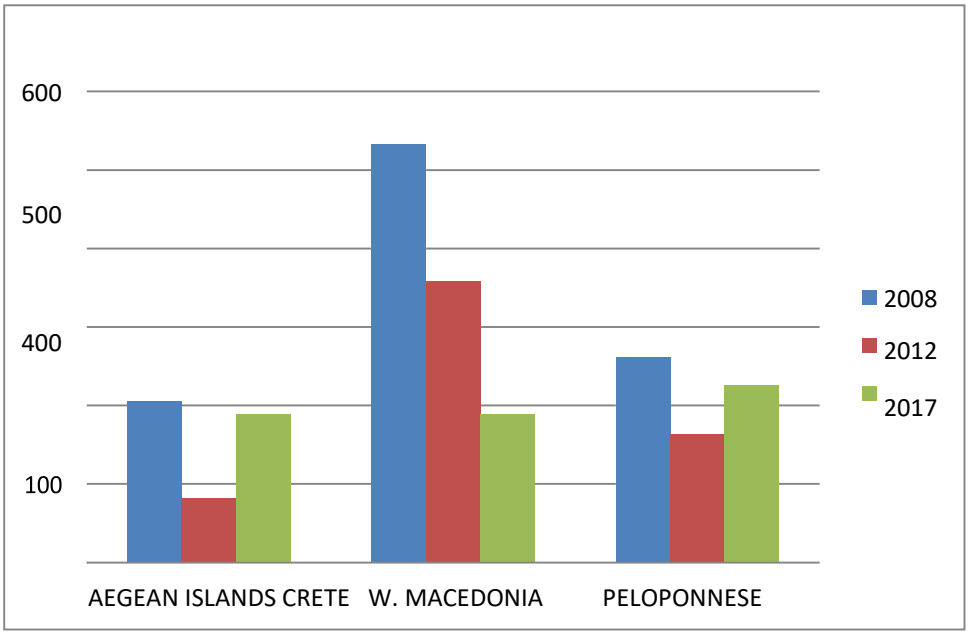
Table 82 - Gross Fixed Capital Investments (million €) by Geographical Zone, Region and Sector of the Aegean and Crete Islands, 2008, 2012 and 2017

NACE2/ YRS	2008	2012	2017	CHANGE
A	427	176	202	-53%
B_E	205	81	189	-8%
ΣΤ	143	23	62	-56%
Z_H_Θ	1.085	215	492	-55%
I	69	78	38	-45%
K	29	16	66	125 %
Λ	2.929	1.105	167	-94%
M_N	198	62	71	-64%
Ξ_Ο_Π	1.582	664	1.315	-17%
Ρ_Σ_Τ_Υ	92	163	68	-27%
TOTAL	6.760	2.583	2.670	-61%

Source: ELSTAT

Overall, the diagram below concludes that in the area of investment, the regions of Peloponnese and Crete-Aegean (geographical unit) show a relative resilience, as there are signs of recovery in absolute terms from 2012 onwards. However, the region of Western Macedonia shows signs of stagnation and further contraction of investment activity.

Diagram 37 - Investment Development in the Regions Under Examination, 2008, 2012 and 2017 - Gross Capital Formation in million €



Source: ELSTAT

3.2. Opportunities for the Development of New Business Activities

One of the challenges of the transition to the post-lignite era is the creation of new business activities that will offer employment opportunities to a part of the workforce currently working in lignite. For the transition to the post-lignite era, it is recommended rapid training of this staff (in collaboration

with the local universities), as well as the installation and operation-maintenance of wind and photovoltaic applications as well as other applications (e.g. techniques for improving energy efficiency of buildings) with staff utilization to be a critical parameter in the transition of PPC to the post-lignite era.

As expected with the ambitious goals for 2030 and beyond, experienced staff will be needed for the new activities, since the investment interest is moving from the thermal power plants of the fossil fuels to the RES (installation, operation-maintenance). The development potential of RES is expanding in the wider region and beyond Greece by companies that will be created for the needs of the market and will rely on competent, well-trained and experienced staff to be competitive. The creation of a special purpose organization (e.g. New Technologies Training Center) in the regional level, with the active participation of PPC, it could promote the relevant plans and support measures for the successful transition to the post-lignite era.

The creation of business technology parks in areas where some of the lignite power plants are currently operating is also proposed, with incentives from the state, to attract and install industrial units (non-disturbing industry, etc.). The creation of the above parks is considered crucial, since, if the above activity can be developed, it will offer the possibility of absorbing a part of the working staff of the lignite production areas.

3.3. World Bank study

In the last three years, significant progress has been made at European policy level regarding Greece's energy transition to clean energy. As a result of this effort, Western Macedonia was one of the first 4 pilot regions to join the ambitious initiative of the European Commission "Coal Regions in Transition Platform", which started in 2017.

In essence, this platform functions as a tool of public dialogue, trying to bring together all the parties involved in the transition to lignite areas, i.e. local bodies, competent government agencies of the respective countries, companies, unions, non-profit organizations and academics. Since 2019, a special secretariat has been set up to manage the relevant activities of the platform, covering, among other things, events, support material and technical assistance in lignite areas, including the Czech Republic, Germany, Poland, Slovakia and Spain. and specific countries of SE Europe, i.e. Greece, Romania and Slovenia. In October 2019, a group of 41 mayors from 10 coal regions in 9 European countries signed a joint statement calling on the EU to provide more structural and financial assistance to coal regions[72]. Greece is also the first country in the European Union to implement the relevant provision of the Pollution Directive, channelling part of the public revenue from the auction of carbon dioxide rights to the Just Transition of the three lignite peripheral units of the country. In addition, Greece is one of the very few countries in the EU that has included the shift of the economy of its lignite areas in the National Plan for Energy and Climate with a horizon of 2030.

As part of the program for the smooth transition to the post-lignite age, the European Commission has commissioned a study by the World Bank on lignite substitution and economic activity in Western

[72] https://www.wwf.eu/?uNewsID=354315

Macedonia and Silesia, Poland[73]. The main scenario considered by the World Bank for Western Macedonia is the utilization of the infrastructure of PPC lignite plants that will begin to be gradually withdrawn from the first half of 2020 for the installation of energy storage systems.

The European Union has selected the World Bank as its advisor on technical support for delignification, and by August 2020 the final draft, which will outline the roadmap and the steps that should be taken in the axes of entrepreneurship, environment, education and human resources, so that the Greek lignite areas move to economies of low dependence on this fuel.

The intention of the World Bank is the energy transition of Western Macedonia in the post-lignite era to be accompanied by the simultaneous development of RES projects and energy storage in their entirety to compensate for the withdrawal of the main economic activity that has dominated the region for years. In particular, the World Bank proposals are aimed at revising the land use regulatory framework, where, in addition to the crops, the natural environment and the recreation areas provided for in the existing framework, new uses must be made possible.

Such may be areas for the installation of photovoltaics, areas for commercial development and research centres, areas for industrial development, green hydrogen production, pumped storage areas and areas for reuse of existing thermal power plants (biomass, fluids).

The selected land use will be dictated by the examination of a series of criteria based on an evaluation system developed by the World Bank. The criteria under consideration are social, economic, topographic, hydrological, geological, environmental as well as economic value added in order to correctly classify the areas to select for the most appropriate future land use.

Therefore, in the context of the World Bank's strategy for the decarbonisation model, it is appropriate for the delignification plan to aim at creating energy production and storage infrastructure using existing technologies and at the same time envisaging the use of future technologies, thus making Western Macedonia a hub of clean energy.

Of course, in addition to the World Bank, the European Commission will assign relevant studies to other bodies, in order to have a more comprehensive assessment of the whole situation. Based on the studies and public consultations that will be carried out, a master plan will be formulated, which will not only concern energy issues, but the development of the Greek lignite areas as a whole, including industry, agriculture and agri-tourism.

The World Bank proposes four areas of activity for the transformation of the local economy of Western Macedonia and Megalopolis in the Peloponnese:

1. Energy: Production of electricity from photovoltaics and biomass, natural gas and hydrogen. It proposes to consider converting existing lignite power plants into gas and solar power plants (which will create jobs in the short term) and more innovative renewables in the long term.

2. Incubators for Innovative Enterprises: Creating structures that will bring together investors, public institutions and small and medium-sized enterprises, in order to boost the production of services for

[73] https://www.kathimerini.gr/1041042/article/oikonomia/ellhnikh-oikonomia/mpataria-twn-valkaniwn-h-dytikh-makedonia

growing economic activities. Energy, agriculture and information technology are the most promising areas of action for such incubators, according to the World Bank.

3. Digitization: Acceleration of the digital transformation of urban and rural areas in order to support business, education and services.

4. Agriculture: It is already an activity with participation in the employment of the region and can be further expanded, in areas such as (a) development of value chains for traditional products (apples, peaches, legumes, potatoes, saffron, mutton and goat, dairy products, barley) and new (aromatic and medicinal plants, permanent crops), (b) agri-tourism, (c) e-commerce of food products and (d) hydroponics.

4. The NECP and the Evolution of the Energy System in the Energy Transition Regions

4.1. Prospects of Energy Development of the Energy Transition Areas

The prospects for energy development in energy-transition areas should be considered in respect of three key factors:

1. The particular climatic data of the area,
2. Its special geophysical characteristics and
3. The peculiarities of the region in relation to other energy resources.

These prospects, for the mainland, include both the utilization of RES potential, e.g. wind, solar, geothermal or biomass, but also the use of natural gas, which to a large extent is estimated to be able to replace lignite power generation (for base loads).

It is worth mentioning that for the region of Western Macedonia the TAP (Trans Adriatic Pipeline) will play an important role, as crosses Greece for about 500 km and passes through Western Macedonia, before entering in Albania, as shown in the Map 17.

Map 17 - The TAP Pipeline

Source: TAP

The initial volumes of natural gas from TAP pipeline is estimated at 10 billion cubic meters, while its maximum capacity, according to the manufacturers, can reach 20 billion cubic meters annually, with the initial projected quantity in Greece amounting to 1.0 billion cubic meters per year, while in the second phase, after 2025, to 2.0 billion cubic meters per year. Therefore, the conversion and replacement of some lignite-fired power plants in the area to gas-fired power stations can be considered in depth.

In the framework of the Just Transition Plan in Western Macedonia, the transformation of the Ptolemaida 5 NPP into a unit using alternative fuels, such as biomass[74], can be gradually integrated. There is extensive experience in European countries (Great Britain, Denmark), where biomass is used as the main fuel for the operation of base thermal power plants. In the fuel mixture of the unit, lignite can also remain under the condition of capture and storage of carbon dioxide through CCUS technology (Carbon Capture Utilization and Storage). With CCUS technology, carbon sequestration takes place at the point where it is produced, as it prevents the entry of emissions into the atmosphere by compressing, transporting and storing carbon dioxide underground or through its use as an input for new, high-value, products. At the global level, in fact, the need to use CCUS technologies is becoming increasingly apparent, with the McKinsey Quarterly Report (April 30, 2020)[75] stressing that it is impossible to reduce global warming by 1.5 degrees (critical to avoiding dangerous and irreversible consequences), without carbon replacement being accompanied by CO2 removal, where there are continuous emissions. In fact, the technology of capture, use and storage of CO2 through CCUS is included in the green technologies proposed by the Treaty of Paris. It is now internationally recognized and accepted that coal that is avoided is declining carbon (see Annex E ').

According to a recent study by IEA[76], there are currently two large-scale CCUS projects operating internationally, with a combined capacity of 2.4 million tonnes of CO2 (MtCO2) per year. The Petra Nova coal-fired power plant in Texas, which has been operating successfully since 2017, is the largest commercial example of carbon capture and storage worldwide, and the Boundary Dam CCUS project in Saskatchewan, Canada, opened in 2014, offering both the appropriate and necessary experience for future relevant cost reductions.

Regarding the area of Megalopolis, it should be noted that from the end of April 2015, the generator of the turbine 2 of the homonymous new natural gas unit of PPC was synchronized with the network. It is worth mentioning that since the end of last May the specific unit of PPC entered the system at full capacity, i.e. with 811 MW of its nominal capacity, after the relevant approval of ADMIE at the persistent request of PPC, while, until then, the unit was operating at only 500 MW of installed capacity. The aforementioned solution of CCUS technology could be applied for the lignite units 3 and 4 of Megalopolis, with a net power of 255 MW each.

Regarding the power generation facilities in the island area, it is estimated that in several of the large islands (e.g. Rhodes, Kos, Crete) part of the power generation from oil and diesel will be replaced by

[74] https://www.e-mc2.gr/el/news/ptolemaida-5-mehri-septembrio-toy-2020-i-apofasi-gia-metalignitiko-kaysimo

[75] https://www.mckinsey.com/business-functions/sustainability/our-insights/climate-math-what-a-1-point-5-degree-pathway-would-take#

[76] https://www.iea.org/reports/ccus-in-power

LNG, in a short time, while the RES installation processes will be accelerated as well as, in several cases, the interconnection of the islands with the mainland energy system of the country.

Most of the Aegean islands have high RES potential, which exceeds their electricity needs. This means that the interconnection with the National Electricity Transmission System (ESMIE) enables the full utilization of the potential of RES, with a basic limitation of the effects that their construction has on the local environment. In particular, the application of "smart" energy management methods can eliminate any impact, so that the interface provides a complete flexibility of choice, in order to achieve the best technical and economic solution, depending on the characteristics of each island.

Today, power generation in the Non-Interconnected Islands (NIIs) is based on 29 autonomous systems, some of which consist of several islands (island clusters). Now, there is an urgent need to withdraw the power generation systems in the NIIs using oil and diesel, with the main priority being the promotion of RES.

In 2019, IENE prepared a study titled "Energy Transition of the island of Kastellorizo"[77], which proposes the installation of photovoltaic and wind units, in combination with a system of batteries, in order to fully meet the needs of the island for electricity. More specifically, in the proposed electrical system of Kastellorizo, the RES power generation units will consist of wind turbines of 750 kW (3x A / G EWT 250kW), photovoltaic, 2,300 kW, a spare conventional diesel unit 1,000 kW (2X500 kW / 600 K electricity storage system with lithium batteries 2 X 2,000 kWh / 2 X 1,000 kW. Also, the DSM demand response technique is proposed in the electric water desalination loads and the participation of consumers in the photovoltaic power generation, with the integrated RES and storage system achieving 93.3% penetration in the island's electricity generation.

Internationally, it is noteworthy that indicative islands, such as Samso (Denmark), Aroe (Denmark) and Gotland (Sweden), which have achieved 100% RES penetration, are interconnected and converted into "smart" autonomous energy islands, with the aim of local transport (electromobility) and "smart city" applications.

At the same time, in all areas under energy transition there should be a program for large-scale implementation of energy efficiency improvement systems, especially in buildings, public and private, with the aim of creating "almost zero energy" buildings, according to the existing Community directives and national legislation on the subject.

The primary goal of this program will be the energy upgrade of all private and public buildings (e.g. hospitals, health centres, schools, universities, libraries, sports centres, nursing homes, working-class homes, etc.). Also important in these upgrades are the applications of High Efficiency Cogeneration of Heat / Cool and Power (HECHP), district heating systems and, possibly, district cooling.

It is therefore proposed to create a specialized methodology, which can be applied in each region in energy transition and which will be based on a series of alternative energy solutions and proposals,

[77] IENE (2019), "The Energy Transition of the island of Kastellorizo", Study M45

where their main axis will be the introduction of cutting-edge technologies, applied with success in other developed countries.

A necessary condition for the application of this methodology is the deep knowledge and the detailed recording of the energy potential of each region. The participation in the creation and implementation of local bodies, such as universities and technological institutes, the Technical and Economic Chamber and other organizations, is expected to play an important role in the successful implementation of the methodology.

4.2. Development of Conventional Electricity and Electricity Generation from RES

The evolution of the key figures of the Greek energy system for 2030 is presented in Table 83, making a parallel comparison between the results of the initial NECP, as published in January 2019, and the final NECP, which incorporates the latest political commitments. The new differentiated goals lead to a new forecast of the evolution of the energy system, with different results in terms of the structure and the participation of fuels and technologies. The results, based on the revised targets of the final NECP for 2030, are characterized by higher shares of RES penetration in gross and final energy consumption, greater improvement of energy efficiency, which translates into lower forecasts of final energy consumption and cessation of participation of the lignite units in electricity generation.

Regarding the participation of RES in the energy system, the revised NECP predicts a much higher share of RES in the energy system both overall and in individual sectors. This significantly higher RES participation is a result of the new policy measures and the commitment to gradually reduce lignite power plants until their final withdrawal by 2028. This decision creates space for additional installation of RES plants, while strengthening the role of natural gas power plants that will provide the required flexibility in the system.

The additional production from natural gas and RES units compared to lignite plants also has an impact on the total greenhouse gas emissions, for which there is a significant reduction of 17%. In addition, there is reduced self-consumption in electricity generation, as RES plants, which basically replace lignite plants, have significantly lower self-consumption.

The revised NECP presents a further improvement of energy efficiency and ultimately a reduction of final energy consumption by approximately 3.6%-4.7% in relation to the goal set during the preparation of the initial NECP, depending on the methodological approach used. It is pointed out that the forecast of the evolution of the energy system from the second energy model, used in addition to the first in the original NECP, estimates an even greater contribution of the planned policy measures to improve energy efficiency and a reduction in final consumption of over 6.5%. In this direction, special emphasis will be given to measures for the energy upgrade and renovation of the building stock in the scenario of achieving goals. Specifically, the total number of renovations of buildings or building units by 2030 is expected to reach 600,000 instead of the 400,000 that were considered in the original NECP.

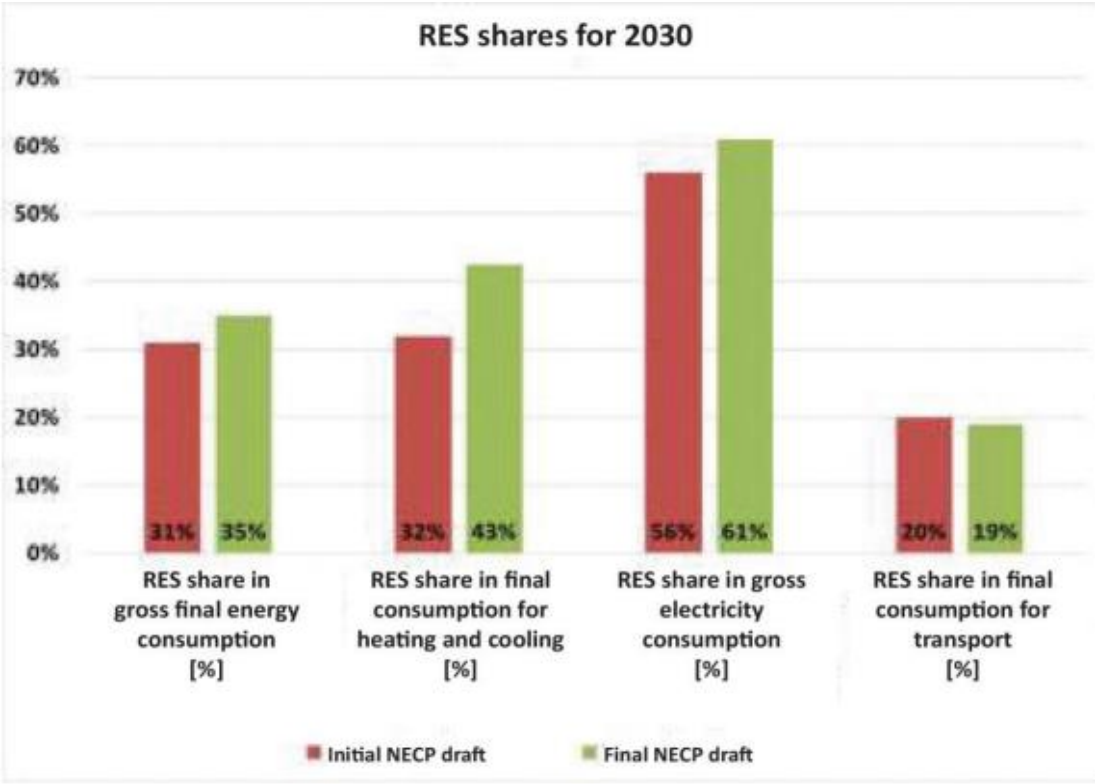
Table 83 - Comparison of the Basic Results of the Energy System of Greece for 2030, Between the Initial and the Final NECP

	Initial NECP	Final NECP
Core indicators		
Total GHG emissions (MtCO2eq)	71	60.6
RES share in gross final energy consumption [%]	31%	35%
RES share in final consumption for heating and cooling [%]	32%	43%
RES share in gross electricity consumption [%]	56%	61%
RES share in final consumption for transport [%]	20%	19%
Energy productivity [EUR million '10/ktoe]	9.98	11.03
Energy consumption		
Gross domestic consumption	23.02	22.19
Primary energy consumption [Mtoe]	22.26	20.55
Final energy consumption [Mtoe]	18.04	17.38
Final energy consumption (without ambient heat) [Mtoe]	*17.32*	*16.51*
Power generation		
Installed capacity [GW]		
Lignite	2.70	0.00
Natural Gas	5.40	6.91
Wind farms	6.60	7.05
Photovoltaics	6.80	7.66
Total installed RES capacity for power generation	17.70	19.03
Gross power generation [TWh]	57.37	57.93
Net power generation [TWh]	55.56	57.22
Lignite	9.03	0.00
Petroleum products	1.54	0.83
Natural Gas	10.26	18.30
Bioenergy	1.74	1.58
Hydro	6.27	6.60
Wind farms	15.51	17.21
Photovoltaics	10.34	11.82
Solar thermal	0.26	0.26
Geothermal	0.63	0.63
Net power generation from fossil fuels [TWh]	20.80	19.13
Net electricity imports [TWh]	4.16	4.58
Total electricity supply [TWh]	59.72	61.80
Final electricity consumption [TWh]	54.32	56.4
Buildings		
Total number of residential buildings renovated by 2030	400,000	600,000

Source: NECP

Regarding the shares of RES for 2030, there is a significant increase in the percentage prices in the revised NECP compared to the original NECP (see Diagram 38). In particular, the introduction of the target for 35% share of RES in final consumption leads to an increase of shares by 33% in the field of heating and cooling and by 9% in the field of gross electricity consumption, where a share of at least 61% is expected.

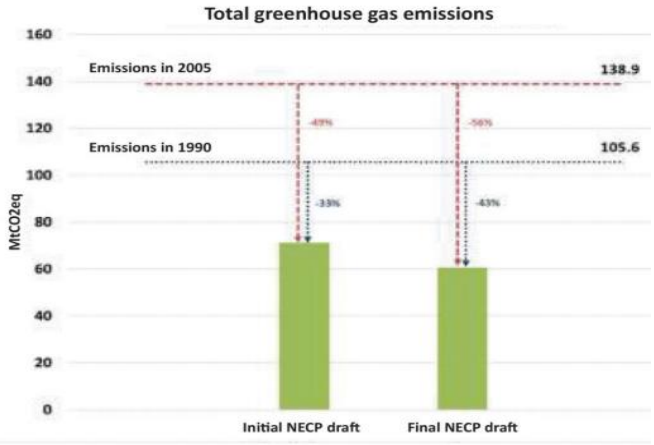
Diagram 38 - Comparison of RES Shares for 2030, of the Initial and the Final NECP



Source: NECP

There is a significant difference in the results of the two approaches regarding the projected total greenhouse gas emissions for 2030 (see Diagram 39). Specifically, the total levels of greenhouse gas emissions, according to the revised NECP are projected at 60.6 $MtCO_{2eq}$ compared to 71 $MtCO_{2eq}$ provided by the original NECP. In fact, the decrease compared to 1990 and 2005 is almost 43% (42.6%) and 56%, respectively. This difference reflects the diversification of the energy mix, with a significant strengthening of the role of RES and natural gas units and the reduction of oil and the withdrawal of lignite plants.

Diagram 39 - Comparison of Total Greenhouse Gas Emissions for 2030, of the Initial and Final NECP with Reference to the Emissions of the Years 1990 and 2005

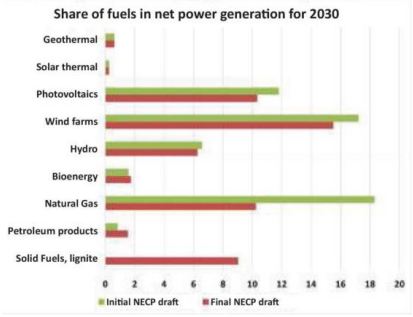


Source: NECP

Also, the fuel mixture differs significantly between the two NECPs, as shown in Diagram 40. The biggest difference is the total withdrawal of the lignite units instead of their reduction, as envisaged in the original plan. Consumption of lignite for electricity generation will stop permanently by 2028, while the use of RES and mainly wind and photovoltaic is significantly expanding. The penetration of natural gas in the energy mix is significantly enhanced, as new units are expected to replace part of the lignite production but also to provide the system with the flexibility required by increasing the participation of uncontrolled RES.

There is a drastic decrease in the participation of oil plants, due to their ever-increasing operating costs, which makes them no longer competitive with RES technologies, but mainly due to the acceleration of the interconnection of almost all NIIs with the mainland system during the period under review in relation to the original NECP and the extended use of RES hybrid systems on the few islands that are not expected to be interconnected.

Diagram 40 - Comparison of Fuel Participation in Net Electricity Generation for 2030, of the Initial and Final NECP



Source: NECP

4.3. Evolution and Characteristics of Energy Consumption and Use of Fossil Fuels

Table 84 and Diagram 41 show the differentiation in the share of each sector or each fuel respectively in the final energy consumption, as calculated in the initial and revised NECP for 2030. A significant difference is recorded in the final consumption in the household sector, as the reduction of the final consumption is improved by 9.3% compared to the forecast of consumption reduction in the initial NECP, as well as in the industry where the improvement in energy efficiency simulated in the final NECP is increased by 6% compared to the initial NECP. For the other sectors, tertiary and transport, the initial with the final NECP do not show substantial differences in the percentage change of final consumption and in absolute terms an increase in final consumption is estimated in 2030 compared to 2020.

Table 84 - Change in Final Energy Consumption by Sector for the Years 2020-2030

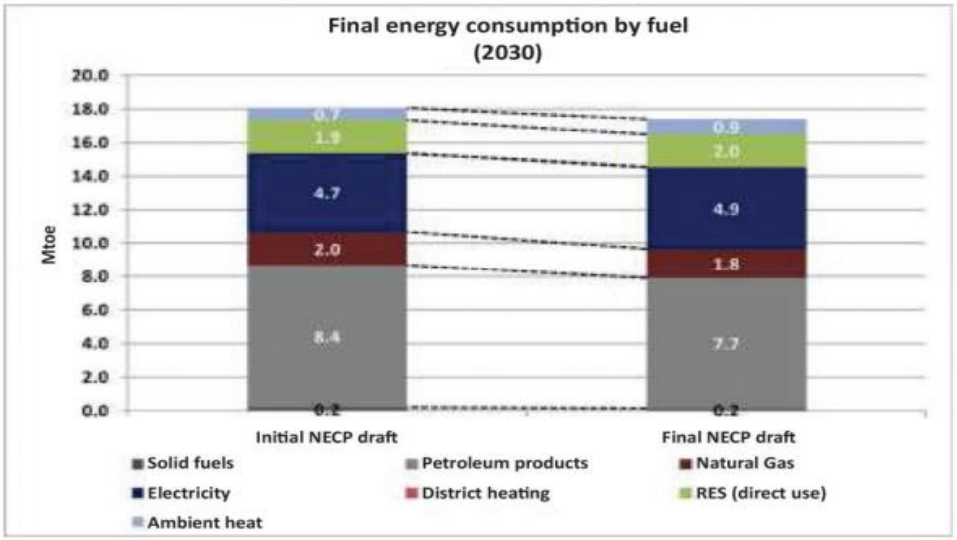
Sectors	Initial NECP – Change FEC* 2020-30 %	Final NECP – Change FEC 2020-30 %	Difference Initial – Final NECP %	Weighted difference initial – Final NECP %
Industry	1.7	-4.4	6.0	1.1
Residential	-0.4	-9.7	9.3	2.3
Tertiary	0.6	1.2	-0.6	-0.1
Transportation	1.3	1.0	0.3	0.1
TOTAL	**1.2**	**-2.5**	**3.7**	**3.7**

**FEC: Final Energy Consumption*

Source: NECP

With regard to final consumption fuels, there is a large change in oil, gas and solid fuels, whose consumption is reduced by about 8% (700 ktoe), 13% (260 ktoe) and 34% (80 ktoe), respectively. There is a small increase in electricity consumption, the direct use of RES and ambient heat, through heat pumps.

Diagram 41 - Final Consumption per Fuel for 2030 in the Initial and Final NECP



Source: NECP

4.4. Energy Transition Schedule

Table 85 shows the withdrawal schedule of the lignite units currently in operation, which will be completed by the end of 2023. The plan for the withdrawal of the lignite units has taken into account the smooth operation of district heating systems to meet the thermal needs in energy areas. In this context, all alternatives will be considered, as well as the development of a gas network in these areas.

Table 85 - Lignite Unit Withdrawal Schedule

TPP from lignite	Nominal Power (MW)	Withdrawn Year
Kardia	275	2019
Kardia	275	2019
Kardia	280	2021
Kardia	280	2021
Ag. Dimitrios	274	2022
Ag. Dimitrios	274	2022
Ag. Dimitrios	283	2022
Ag. Dimitrios	283	2022
Ag. Dimitrios	342	2023
Amyntaio	273	2020
Amyntaio	273	2020
Florina/Meliti	289	2023
Megalopoli	255	2022
Megalopoli	256	2023

Source: NECP

4.5. Evolution of Energy Infrastructure

Among the various projects that are expected to be developed in the energy-transition lignite areas, a typical example is the development of a gas network in Megalopolis, which will meet the needs of all buildings in the city, i.e. both current users of district heating (approximately 50% of households) as well as new consumer buildings, which will be able to connect to the gas network.

Today's district heating users will not incur the cost of connecting their building to the gas network, as they had paid when they connected to district heating. New consumers, in order to connect their buildings to the gas network, will have an equal amount of burden that their fellow citizens had when they connected to the district heating network.

The aim of the design is the uninterrupted coverage of the needs of the consumers of district heating for the transitional period and the fastest possible coverage of the needs of all citizens with natural gas, in a fair and economically beneficial way for the consumers.

It is noted that PPC will continue to cover the needs of district heating in Megalopolis during the heating season 2020-2021, despite the expiration of the relevant contract at the end of this year. Demonstrating Corporate Social Responsibility, PPC will install a boiler that will operate with LPG combustion and with the possibility of burning gas, while it will cover the cost of installation and operation of the boiler for the aforementioned period. The transition from district heating to natural gas is estimated to be completed within 2022 and will be supported by ESPA resources.

With regard to the mines, the shutdown of each of them cannot be purely connected, nor can it be synchronized with the withdrawal of each lignite plant. The elaboration of studies by PPC is in progress for the precise determination of the time of cessation of the exploitation of each mine, in combination with the coverage of the needs of Ptolemaida 5 that will remain in operation until 2028.

All the measures for the penetration of RES in the production of electricity, in heating and in transport contribute to the achievement of the specific goal of delignification. In addition, as natural gas, although a fossil fuel, has lower greenhouse gas emissions than conventional fuels, the substitution of oil and lignite for natural gas is an intermediate policy step towards a reduction in greenhouse gas emissions. A key priority is also the promotion of natural gas in certain final consumption sectors to replace the use of petroleum products.

Additional reductions in greenhouse gas emissions are also expected from the interconnection of the autonomous island systems with the mainland system, where the operation of the local, especially polluting, power generation units will gradually cease.

As analysed in Chapter 2 of the present study, according to the 10-year investment plan of DESFA for the period 2020-2029, which includes projects with a total budget of € 300 million, there are projects in the foreground, such as the development projects of the gas transmission network in new areas and specifically the expansions planned for Western Macedonia.

More specifically, these are three new metering and regulating stations, which will be created in Perdika Eordaia (€3 million), Poria in Kastoria (€2 million) and in Aspros in Edessa, Naoussa and Giannitsa (€3 million). From these three measuring / regulating stations it will then be possible to build the medium and low pressure network, which will transport the natural gas to the cities of the region.

According to DESFA sources, the specific projects in Western Macedonia are expected to be completed by the end of 2022, in line with the delignification program. The same sources of DESFA note that for the region of Western Macedonia, in addition to the construction of metering stations that will be created at points where the TAP pipeline passes, the creation of a new extension pipeline of the National Natural Gas System (NSF) is being considered. The project is under study as there are plans for the construction in the region of Western Macedonia of a new power plant with natural gas fuel.

In such a case, the gas from the TAP pipeline will not be enough to cover the needs and for this reason the construction of a small extension of the NSRF is being studied, which will start from Nea Mesimvria. The investment decision for the project depends solely on whether or not a new gas-fired power plant will be built. In general, three connection points with the NSRF are foreseen in areas of Western Macedonia.

Also, the Energy Regulatory Authority (RAE) recently disbursed the entire Peloponnese Region (Tripoli, Corinth, Argos, Nafplio, Sparta and Kalamata) and the cities of Veria and Giannitsa from the 5-year development program of the natural gas network) for the period 2020-2024. DEDA, for its part, studies the legal parameters in order to select the best moves to challenge the decision of RAE and is expected to submit an application for revision of the decision while developing its argument. It is recalled that RAE after the initial submission of the new 5 year by DEDA, asked the company for an exact schedule for each city. For as many cities as the new schedule exceeded 18 months of excess in relation to the first 5-year program, it was decided to disengage, according to what is provided by law.

As for the reasons why the 18-month period was exceeded and therefore the specific cities were excluded, the DEDA administration claims that the initial schedule was unrealistic, as it had not ensured that there would be objective conditions for the promotion of the projects. It is characteristic that the necessary precursor projects of DESFA have not been done yet, such as the exit stations to be able to supply Tripoli, Corinth and Argos or the loading station in Revythousa to supply with LNG Kalamata and Sparta. In addition, the projects of the Peloponnese were not possible to be included in the NSRF of the Region. There were technical issues for both cities of Macedonia (Veria and Giannitsa) too, where the permits for the installation of CNG decompression stations have not yet been issued.

However, DEDA submitted to RAE a few days later an updated Development Plan for the period 2020-2024 which provides for the creation of gas distribution networks in the cities of Veria and Giannitsa with a plan for faster implementation of the projects so that there is no question of delay, while it is expected the projects in the Peloponnese also proceed.

Regarding the electricity infrastructure projects, the extension of the 400 kV System of ADMIE to Megalopolis is probably the most important ongoing project of the Administrator in mainland Greece, with the projects of the Western Corridor (Megalopolis - Patras - Western Sterea) to be in progress and to be completed within 2020, in order to continue with the completion within 2021 of the section of the Eastern Corridor (Megalopolis - Corinth - Attica) from the high voltage center of Megalopolis to the high voltage center of Corinth and until 2024 the rest .

The reason why ADMIE cannot yet announce the delivery of the 400 kV line that will connect Megalopolis with Patras (and from there with Etoloakarnania), which according to the planning should

have been electrified by February, is that the placement of 2-3 pillars is pending due to the reaction of the monks of the Holy Monastery in Kalavrita, which has taken the form of legal actions.

The extension of the 400 kV System to Megalopolis (with the subsequent creation of a 400 kV loop Patras - Megalopolis - Corinth) drastically increases the capacity to transfer to and from the Peloponnese, enables the development of RES and thermal power plants, significantly improves the margin of stability trends for the Southern System and secures the Peloponnese in any combination of production and load conditions.

In addition, it strongly connects the production center of Megalopolis with the areas of high load (Attica and Patras area) and contributes to achieving balanced development of production and transmission systems in the Southern System. It should be emphasized that the development of the 400 kV System to the Peloponnese helps to reduce the total losses of ESMIE.

Regarding the Western Corridor, the interconnection of the high voltage center of Megalopolis, which was fully operational in 2014, with the 400 kV circuits on the Antirrio side, is carried out with a new 400 kV double circuit transmission line, consisting of aerial, underground and submarine sections, as well as the corresponding compensation inductors. The works of the Western Corridor are in progress and will be completed within 2020.

Regarding the Eastern Corridor, its main junction is the high voltage center of Corinth, which is planned to be connected to the 400 kV System with the high voltage center of Koumoundourou through a new double transmission line 2B'B '/ 400 kV and, after construction with the new high voltage center of Megalopolis through a new double transmission line 2B'B '/ 400 kV. The works of the Eastern Corridor are in progress and are expected to be completed by 2024 (the section from the high voltage center of Megalopolis to the high voltage center of Corinth will be completed within 2021).

5. International Experience from European Union Regions in Energy Transition

5.1. The Importance of Coal in the Energy System of the European Union from its Establishment to "Energy Transition"

The historical period of the Industrial Revolution (1760-1860) in England and later in Europe is inextricably linked to the use of coal, as a basic fuel in the emerging metal industry, in the tertiary sector (e.g. textiles, etc.), but also in household sector (e.g. for space heating or DHW).

The catastrophic consequences of both World War I and World War II, as well as the subsequent East-West confrontation, made Franco-German reconciliation a top priority, initially for the countries of Western Europe. The Treaty of Paris, in 1951[78], with the decision of six European states - France, Germany, Italy, Belgium, the Netherlands, Luxembourg - to jointly manage the "Coal and Steel" industries, was the first step towards European integration. This shows the historicity but also the importance of coal as one of the main fuels of the European economy over the past decades.

[78] The Treaty establishing the European Coal and Steel Community, ECSC Treaty, is available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:xy0022

In 2018, there were 207 coal-fired power plants in the EU in 103 regions, with a total capacity of almost 150 GW or 15% of the total power generation capacity. This percentage was 16.4% for 2017.

There were also 128 coal mines in 12 Member States in 41 regions, with a combined annual production of around 500 million tonnes (55% of gross consumption in the EU). In total, carbon infrastructure exists in 108 European regions[79]. The vast majority of coal plants in Europe were put into operation after the end of World War II and the coming decades of rebuilding Europe. The average operation of the factories is 35 years, with a yield of <35%.

According to Eurostat data, 10 Member States base their energy production on coal, from low rates (3.3% - Spain) to very high rates (77.4% - Poland). But 6 EU M-S still rely on coal to cover at least 25% of their energy demand, namely Bulgaria (48.5%), Germany (34.1%), Greece (60.9%), Poland (77.4%), Slovenia (26.6%) and the Czech Republic (55.5%).

The policy of the aforementioned 6 Member States for their energy transition is analyzed in the following sections of the chapter.

5.2. The Importance of Coal in the European Energy System's Current Energy Transition System

In the energy sector, the essence of the transition to a lower polluting economy is concentrated in the triptych of "3Ds", which reflects three basic concepts: Decarbonisation, Decentralization and Digitalization [80].

The climate change crisis is now at its gates and it is characteristic that the European Commission has estimated that, for 2017, the economic losses related to Climate Change have exceeded, worldwide, € 270 billion.

This shows that the transformation of the European energy system, while reducing coal use to reduce greenhouse gas emissions and increasing the share of RES, is now an imperative rather than an option.

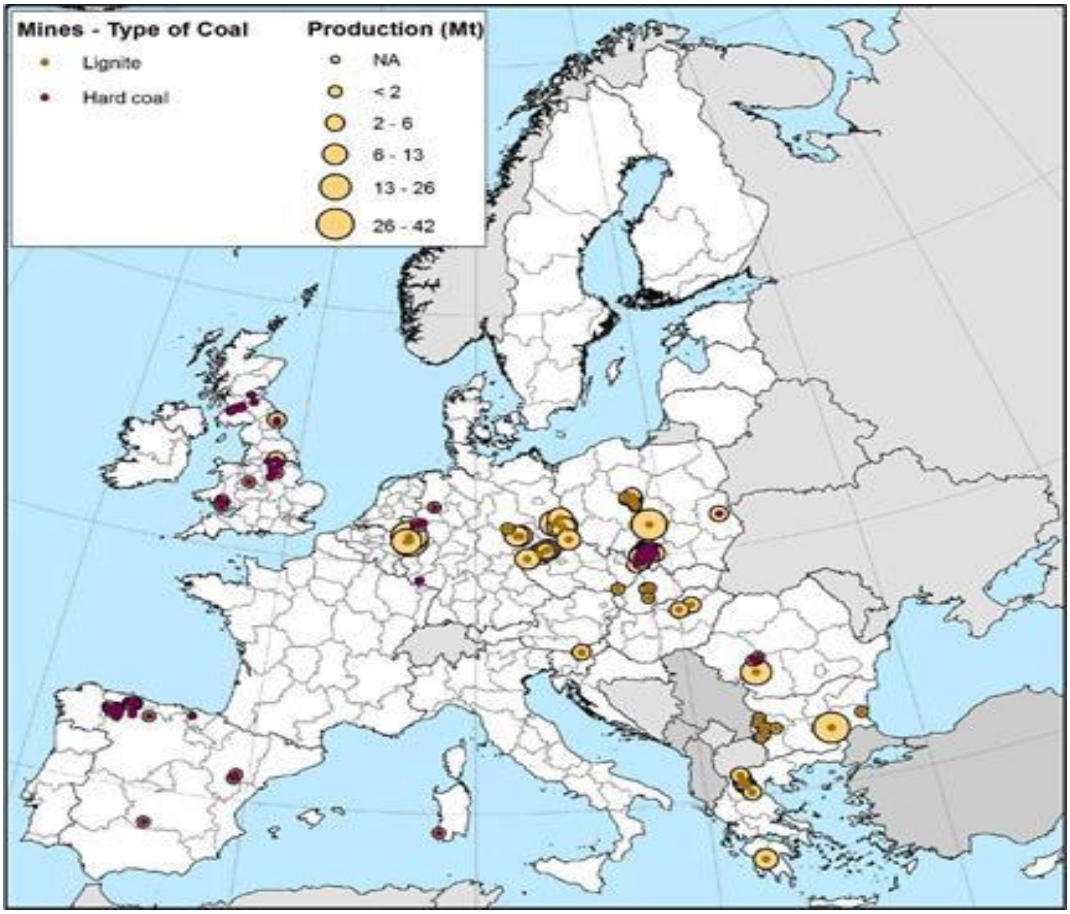
Therefore, in the EU today, the operation of coal mines and coal-fired power stations is discouraged, as strict emission requirements have been set after 2020, severely restricting the eligibility of coal as a fuel, especially for electricity and heat generation. For these reasons, the regions of the European Union, where coal is used, are led to an "Energy Transition", with the phasing out of coal mining and the use of carbon fuels for the production of electricity and thermal energy and any other use.

Based on the European policy of "Energy Transition" for the phasing out of coal-fired power plants, it appears that the first wave of withdrawal of coal-fired power plants will take place during the period 2020-2025.

According to the JRC study, from 2014 to 2018, 32 mines were closed in Germany, Poland, the Czech Republic, Hungary, Romania, Slovakia, Slovenia, the United Kingdom and Italy. It is estimated that 26 mines are expected to close in Spain soon.

[79] JRC Science for Policy Report: EU coal regions: opportunities and challenges ahead, 2018 http://ec.europa.eu/jrc
[80] Article by N. Karakatsani, member of RAE plenary session 5.11.19 https://m.naftemporiki.gr/story

Map 18 - Location of Coal Mines in Operation in the EU and Coal Produced Categories



Source: European Commission

Reducing coal-related activities will not only affect energy production, but will also affect other sectors of the economy, especially the European coking coal sector - a critical raw material for the European economy covering 37% of its needs. The coal mines that produce this type of coal will continue to operate, serving this sector, as long as the coke prices are sufficient to sustain the mining activities. Coal mining equipment companies will also be affected.

5.3. European Experience from Regions in Energy Transition

Table 86 presents the official EU data on energy production for 2007 and 2017, as well as the percentage of each fuel in total production for 2017, while in a red circle is the percentage of carbon in the total energy production of each of its Member States. [81]

[81] https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Coal_production_and_consumption_statistics#Consumption_and_production_of_brown_coal

Table 86 - Energy Production in the EU, 2007 and 2017

(million tonnes of oil equivalent)

	Total production of primary energy		Share of total production, 2017 (%)					
	2007	2017	Nuclear energy	Solid fossil fuels	Natural gas	Crude oil	Renewable energy	Other
EU-28	862.9	758.2	27.8	16.4	13.6	8.8	29.9	3.5
Belgium	14.2	14.9	74.0	0.0	0.0	0.0	21.6	4.4
Bulgaria	9.9	11.7	33.8	48.6	0.6	0.2	16.6	0.3
Czechia	34.0	27.3	25.7	55.5	0.7	0.4	16.3	1.5
Denmark	27.2	15.9	0.0	0.0	27.4	43.6	26.5	2.4
Germany	136.4	115.8	17.0	34.1	5.2	1.9	36.8	5.0
Estonia	4.4	5.8	0.0	0.0	0.0	0.0	27.0	73.0
Ireland	1.4	4.9	0.0	0.0	58.6	0.0	23.5	17.9
Greece	10.2	7.5	0.0	60.9	0.1	1.9	37.1	0.0
Spain	30.1	34.2	44.2	3.3	0.1	0.4	51.3	0.8
France	133.5	132.2	78.6	0.0	0.0	0.6	19.6	1.2
Croatia	4.9	4.2	0.0	0.0	29.2	16.7	52.1	1.9
Italy	31.1	36.7	0.0	0.0	12.4	11.3	72.4	4.0
Cyprus	0.1	0.1	0.0	0.0	0.0	0.0	97.5	2.5
Latvia	1.8	2.6	0.0	0.0	0.0	0.0	99.7	0.3
Lithuania	3.8	1.8	0.0	0.0	0.0	3.2	94.4	2.3
Luxembourg	0.1	0.2	0.0	0.0	0.0	0.0	80.8	19.2
Hungary	10.8	11.1	36.6	11.5	12.7	6.4	28.6	4.2
Malta	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0
Netherlands	60.2	41.7	1.9	0.0	79.5	2.3	13.4	2.8
Austria	10.6	12.3	0.0	0.0	8.5	5.7	79.6	6.2
Poland	71.7	64.0	0.0	77.4	5.5	1.6	14.2	1.4
Portugal	4.6	5.2	0.0	0.0	0.0	0.0	97.1	2.9
Romania	27.8	25.5	11.4	17.5	33.5	13.8	22.9	0.9
Slovenia	3.4	3.5	42.3	26.6	0.2	0.0	29.4	1.5
Slovakia	5.8	6.4	62.6	7.0	1.8	0.1	25.4	3.1
Finland	16.0	18.1	29.8	0.0	0.0	0.0	64.5	5.6
Sweden	32.9	36.6	44.7	0.0	0.0	0.0	53.0	2.3

Source: Eurostat

The following sections present the current situation in the 5 EU Member States, which are implementing policies for the phasing out of coal mines and power stations. Data on mines and coal-fired power plants for the 5 Member States were published in the JRC study.

5.3.1. Bulgaria: Energy Transition Policies

From Table 86 it appears that the total primary production in 2017 was 11.7 Mtoe[82] increased by 15.4%, compared to 2007. The share of fossil fuels (coal) in the total production of primary energy for 2017 was 48.6%, with nuclear energy following at 33.8%.

Geological reserves in Bulgaria are estimated at 3 billion tonnes, of which 88.7% is lignite, 10.9% coal and the remaining 0.4% other coal. There are 12 mines in the country with an annual production of 34.4 Mt (2017)[83]. The largest mine in the country is Maritsa East Mines, with a share of 94.8% of the country's total annual production. 96% of lignites are used as fuel for HPPs, 3.2% as briquettes for heating fuel and 0.8% for other uses.

The 7 coal-fired power stations have a total capacity of 4,377 MW. The main types of fuel are lignite and coal, while the station yields range from 29% -34% and their operating years from 37-51 years. The sector employs a total of 14,500 people.

[82] tons of oil equivalent, 1 toe = 41,868 MJ

[83] https://tracer-h2020.eu/southeast-bulgaria-bulgaria-bg34

In Bulgaria, national energy policy plans, such as the Energy Strategy 2020 and the RES Action Plan, set cleaner electricity generation from existing coal-fired power plants as a priority. However, especially the Bulgarian NECP, published in January 2019, emphasizes that "*coal will be the raw material for electricity production in the country for the next 60 years*."

The World Economic Forum in 2019 praised Bulgaria for significant progress in the Energy Transition Index.

5.3.2. Germany: Energy Transition Policies

From Table 86 it appears that the total primary production in 2017 was 115.8 Mtoe, reduced by 15.1%, compared to 2007. The share of fossil fuels (coal) in the total production of primary energy for 2017 was 34.1%, second after RES, 36.8%.

Germany is the largest user of coal in the EU, mainly for the production of electricity, having a long history in the extraction and use of coal (coal and lignite), in both then West and East Germany[84]

It should be noted that coal was the main fuel that led West Germany to what was called the "economic miracle" in the 1950s, while East Germany was, until 1990 (the year of the reunification of the two Germanys), the world's biggest producer of lignite.

Regarding coal, in 1950 it provided 70% of the primary energy consumption of West Germany, a percentage that decreased to 19% in 1990 and to 12% in 2016, where it was mined in closed mines and at great depth.

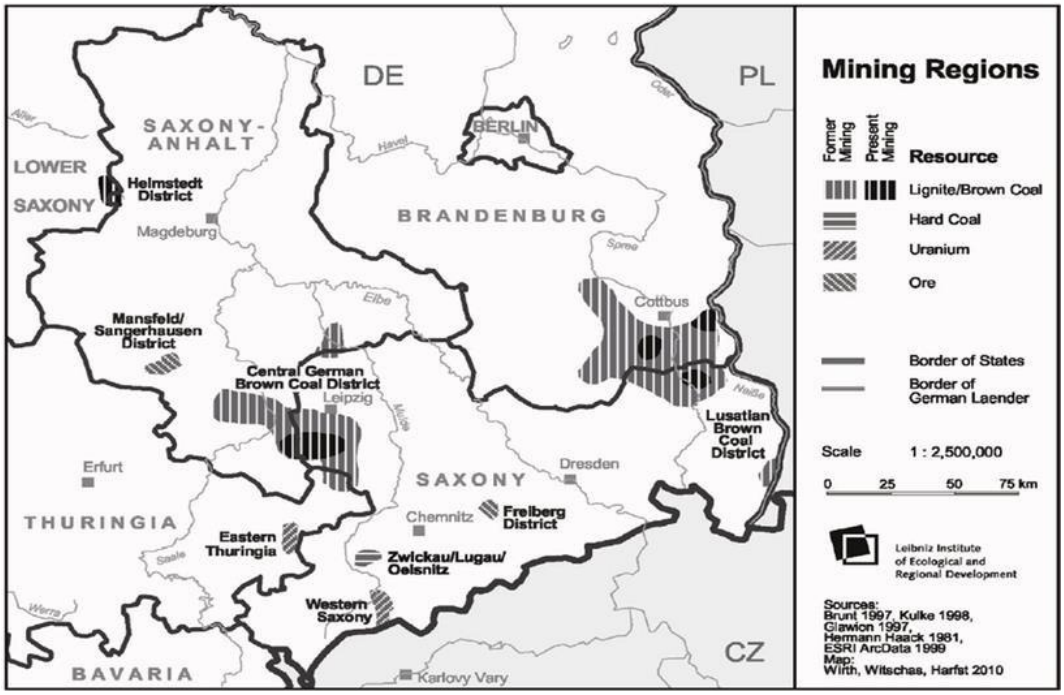
The vast majority of coal reserves are located in the Ruhr area, between Dortmund and Dusseldorf, where the country's metal industry developed, creating Germany's most densely populated area to date.

It should be noted that in the 1950s the mining sector employed 600,000 people, while in 2016 only 6,000 and this is due, among other things, to the import of coal and natural gas at low prices. Unemployment in the Ruhr region has always been higher than the national average, with fluctuations (in 2010 it was 5% higher than the average).

Lignite in West Germany accounted for 15% of primary energy consumption in 1950 and reached 18.1% in 1990. In East Germany, lignite in 1960 accounted for 88% of primary energy consumption which fell to 75% in 1970. The energy crises of 1973 and 1979 increased its share again as well as that of nuclear energy.

84 https://www.diw.de/de/diw_01.c.606862.de/publikationen/sonstige_aufsaetze/2018_0000/an_historical_case_study_on_previous_coal_transitions_in_ger___he_future_of_coal_a_project_funded_by_the_kr_foundation.html

Map 19 - Coal Mining Areas in Germany



Source: Leibnitz Institute of Ecological and Regional Development[85]

The vast majority of coal reserves are located in the Lusatian area, where there were open lignite mines, employing 139,000 people in 1989, in sparsely populated areas, while in 2016 it employed 8,000 people.

Today, there are 12 mines operating in the now unified country, with an annual production of 184 Mt and 53 coal-fired power plants, with a total capacity of 45,420 MW. The types of fuel are mainly lignite, but also coal, while the yields of power plants range from 29% -42% and the years of operation from 4-38 years. The sector employs a total of 35,700 people.

In 2018, the mining company Mibrag compensated the residents of a village near Aachen for leaving their homes, while the energy company RWE cuts down the Habach forest, aiming at coal mining with the residents of the surrounding areas reacting strongly. The closure of the lignite plant in Cottbus has left hundreds of workers unemployed, protesting loudly because they lost their jobs.

The conclusion of the first report published by the country's Coal Committee points to Germany's failure to meet its emission reduction targets and to comply with the relevant European Directives.

It should be noted that Germany is the country with the most carbon emissions - compared to the rest of the European Union - with a total installed capacity of coal units amounting to 46 GW in 2017, representing 37% of total electricity generation. It is no coincidence that in 2019 Berlin revised its emission reduction targets and from 40% in 2020 adjusted its targets to 55% by 2030.

The German government is studying the results of different scenarios for the phasing out of stations and mines, using the Regional Macroeconomic Model (RMM). The model shows that lignite areas show significant employment potential in various other fields, including RES and building renovation. Other

[85] Leibnitz Institute of Ecological and Regional Development: Sources Brunt, 1997, Kulke, 1998, Glawion 1997, ESRI ArcData, 1999

economic opportunities may come from tourism or other uses of former lignite mining areas, e.g. opportunities arising from innovative businesses, but also from local universities.

An important example is the Saxony-Anhalt region, where a new land use plan is being reconsidered, in areas that previously functioned as open pit mines, where, in addition to tourism development, RES systems for electricity generation will be developed (large P / B stations or geothermal). Federal financial support for all of the above for these areas amounts to approximately € 40 billion for cohesion policies for the next 20 years.

5.3.3. Poland: Energy Transition Policies

From Table 86 it appears that the total primary production in 2017 was 64.0 Mtoe, reduced by 10.7%, compared to 2007. The percentage of participation of fossil fuels (coal) in the total production of primary energy for 2017 was 77.4%, with RES as the second fuel (14.2%).

Poland is the second largest producer of coal in Europe after Germany (EIA, 2016)[86] and the country is completely dependent on coal for all its energy uses. The use of coal produces 81% of electricity, wind energy 7% and biomass 6%, while for the required thermal energy coal produces 86%, natural gas 7% and biofuels 5%.

In 2015, CO2 emissions from coal combustion amounted to 282 million tonnes, half for electricity generation, ¼ for thermal energy production and the rest from coal use in industry and transport.

In Poland, there are 35 mines with an annual output of 135 Mt and 37 coal-fired power plants with a total capacity of 25,400 MW. The main types of coal are lignite and coal, while the yields of power plants range from 23% -36% and their years of operation from 37-49 years. The sector employs a total of 112,500 people.

Map 20 - Coal Mining Areas in Poland

Source: Modern Power Systems

[86] EIA (2016) 'Poland - Analysis' Washington DC: Energy Information Administration. https://www.eia.gov/beta/international/analysis.cfm?iso=POL

The role of coal in the country's economic policy is important. The coal sector contributions from the country's public finances for the period 2007-2015 amounted to € 15.9 billion, half of which came from the state budget and the rest from the funds of state insurance organizations. The rising cost of producing electricity from coal, combined with low coal prices, is having a negative effect on the Polish coal mining industry, which was, in part, unprofitable. In 2016, state-owned utilities invested € 570 million to save Europe's largest coal mining company, Kompania Weglowa, from bankruptcy. Nevertheless, the Polish government is going to invest in the start of two mines in Upper Silesia, one with coking coal and the other with coal for thermal processes (thermal coal). Their operation is estimated for the beginning of 2030. There are also thoughts for new anthracite and coke deposits. Regarding the coal-fired power stations, 4 new coal-fired power stations - 1x1075-2x900-1x910 MW - with a total capacity of 3.8 GW have been introduced in the country's energy system, in the 19 GW that are already operating. Additional power stations ~ 1 GW are starting to be built in the country, according to the Ministry of Energy, which estimates they will be ready in 2024.

Of course, carbon pollution and the problem of energy poverty have long been at the center of public consultation on the "Energy Transition", with the solution of energy upgrading of buildings playing an important role, as studies show that the implementation of a complete building upgrade plan will create 100,000 new jobs. This issue, however, requires retraining of miners, subsidizing them, creating interest in construction companies to hire them, but also public acceptance of the plan, both by local governments, NGOs, trade unions, etc.

5.3.4. Slovenia: Energy Transition Policies

From Table 86 it can be seen that the total primary production in 2017 was 3.5 Mtoe, slightly increased compared to 2007 (3.4 million tons). In 2016, 71% of domestic electricity production came from low CO2 sources (the EU average is 58%).

Slovenia's electricity system is highly integrated with neighbouring electricity systems (almost 84% are interconnected) and the flows through its territory are double the energy consumption. Gas consumption is lower than the EU average and consumes more oil than the EU average.

The National Energy and Climate Plan for the RES sector and energy efficiency targets by 2030 was submitted in 2019. Although in the field of building renovation, where Slovenia wants to reduce energy consumption by 60% by 2025 compared to 2015, a lot is being done, the European Commission had serious reservations about its plan for the country's Energy Transition.[87]

Despite the fact that the price of electricity in Slovenia has risen, with the addition of various types of tariffs to the energy prices used to support investments in RES and HECHP, these accumulated resources offer an opportunity to provide a part of the funding required for the implementation of the energy transition. Article 129 of the Law on Environmental Protection provides that the proceeds from the sale of allowances[88] are used to support investments in Energy and Transport, with low carbon content and environmentally sustainable policies. For 2019, taking into account the projected supply

[87] EC / SWD (2019) 271 final / 18.6.2019

[88] as defined in EU Commission Regulation no. 1031/2010

of 3.2 million tons of CO2, the fund has raised approximately € 62 million, which will be allocated to support activities, including grants and loans to companies, public bodies / municipalities, NGOs and civil society for investments in low CO2 energy, sustainable mobility, as well as for financing activities such as awareness and education.

Typical "good examples" are the municipalities of Velenje City and Šoštanj, which aspire to start their energy transformation by acquiring a share of these funds, gradually investing in a sustainable low-carbon energy technology and focusing on zero-emissions public transfers.

Also, the Termoelektrarna Šoštanj (TE λιγ) Lignite Power Plant has developed projects aimed at achieving a gradual Energy Transition and include the use of natural gas through the installation of a CHP plant, the capture and use of CO2 (CCU), the production of hydrogen and the use of for local city buses, while studying alternative fuels, such as SRF (solid recovered fuel) which has a higher calorific value than lignite and is produced from non-hazardous waste, according to the Guidelines of the European Committee for Standardization (CEN) TC 343.

Slovenia has already invested in smart grid projects for cities and local communities, such as SINCRO.GRID, a smart investment project of European importance in the field of smart grid development, involving a virtual cross-border control center that facilitates production electricity from RES in Slovenia and Croatia with their safe and efficient integration into the Network or GOFLEX concerning the integration of a network for RES or FutureFlow, concerning the cooperation of networks with the TSO.

The World Economic Forum in 2019 put Slovenia in the highest position in South-eastern Europe in the Energy Transition Index.

5.3.5. Czech Republic: Energy Transition Policies

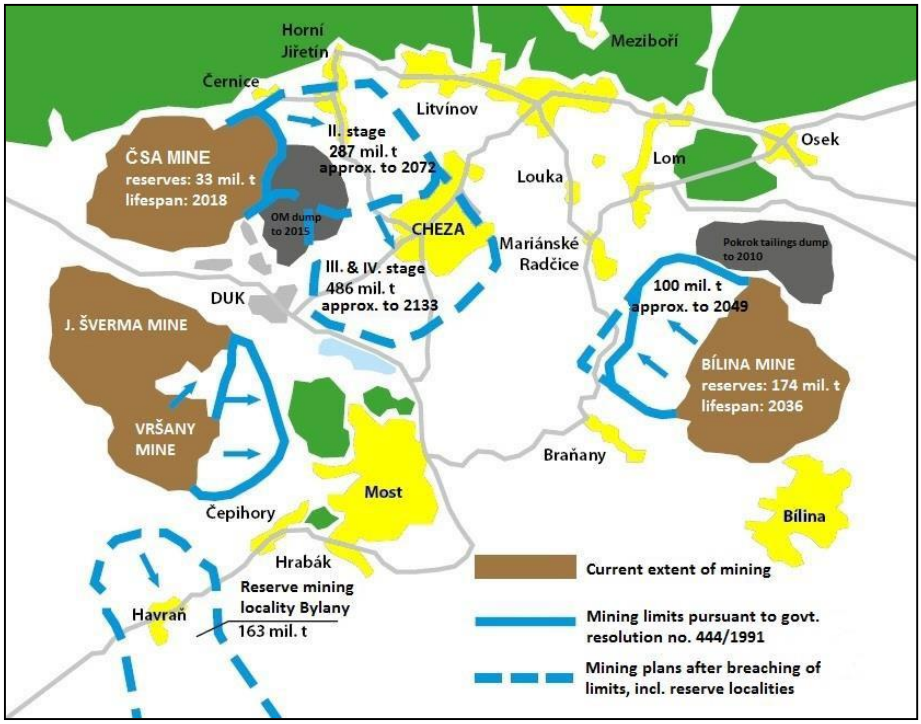
From Table 86 it appears that the total primary production in 2017 was 27.3 Mtoe, reduced by 19.7%, compared to 2007. The share of fossil fuels (coal) in total production for 2017 was 55.5%, with RES as the second fuel (16.3%).

In the Czech Republic there are 9 mines[89]with an annual production of 46 Mt and 13 coal-fired power plants with a total capacity of 6,717 MW. The main types of fuel are lignite and coal, with power plant yields ranging from 29% -36% and operating years from 33-56 years. The sector employs a total of 21,600 people.

The country's national energy policy, designed in 2015, aims to transform the structure of electricity generation, removing coal in favour of nuclear energy, natural gas and RES by 2040. However, moving away from coal for heating production is not easy. The national energy policy of 2015 identified as the main challenge the increase of energy efficiency and the transformation of heat production to combined heat and power (CHP) with the replacement of coal with natural gas, at least in the domestic sector.

[89] https://en.wikipedia.org/wiki/Brown_coal_mining_limits_in_North_Bohemia

Map 21 - Coal Mining Areas in the Czech Republic



Source: Modern Power Systems

The Czech government's measures, which have been implemented to facilitate the transition from coal to other energy sources, have been a gradual process since 1990, with two distinct types of state support. The first type was the environmental rehabilitation of abandoned mines, as well as the provision of benefits to miners who became unemployed in the 1990s. The second type was financial support, from regional programs, in many areas, e.g. infrastructure, environment, entrepreneurship. , unemployment, research and development, etc. or to support efficient coal combustion technologies and the penetration of RES to assist areas affected by the closure of mines or coal-fired power plants.

Although coal represents a strategic resource and an important source of energy for the country, from the point of view of employment it is purely a regional issue, given that mining workers represent only 1% of the country's total workforce. Their total number between 1993 and 2015 decreased by about 86,800 people. From this point of view, it seems that a successful transformation of the economy has taken place, but it has had an impact on the social isolation of coal-producing regions, creating economically problematic areas with above-average unemployment, low living standards, and low levels of economic return.

These are the main issues that the Czech Government is trying to resolve with the financial and technological assistance of European Union programs.

5.4. World Bank Study Overview and Evaluation / utilization of its Proposals

As mentioned in Chapter 3 of this study, the World Bank has been tasked by the European Union with monitoring and technical support for the transition of Western Macedonia to the post-lignite period and is currently working on a roadmap for the transition.

The World Bank has many years of experience in the field of delignification, as it has participated in similar adaptation efforts in Russia, Poland, Ukraine and Romania, and has studied in-depth adaptation processes in the USA, China, the United Kingdom and the Netherlands. More specifically, there are examples of such cases around the world (Nanticoke - North America, Ironbridge - United Kingdom, Alhomens Kraft and Vassa Bio-gasification plant - Finland, Muswellbrook - Australia, etc.), which have been successfully managed by the World Bank and prove the realism and viability of the whole project in the lignite areas of Western Macedonia and Megalopolis.

Among its proposals, the World Bank mentions the creation of a Geographic Information System (GIS) tool, which will display and categorize areas so that it is easy to evaluate each area and what use can be utilized implemented (RES, industry, agricultural production, etc.). At the same time, it proposes the categorization of the mines and the creation of a map with the ideal use. The World Bank also proposes social protection and support measures for workers who will lose their jobs and are not under the umbrella of PPC.

At the same time, it is proposed to revise the regulatory framework for land use, where, in addition to the crops, the natural environment and the recreational areas provided for in the existing framework, new uses should be possible.

6. Key Conclusions

The forthcoming termination of lignite production in the regions of Western Macedonia and Megalopolis and the drastic reduction of oil use for power generation in the island electricity systems presents great challenges, but also opportunities for the development of new activities, which could bring great social, economic and environmental benefits to the regions and areas involved. A summary of the anticipated benefits follows.

6.1. West Macedonia

- The existing extensive energy and building infrastructure, the large land areas of former lignite mines, the strategic location of the areas and the utilization of human resources and the region's vast experience in operating energy systems should be taken advantage of in drawing up plans for the region's post-lignite development.
- The withdrawal of lignite exploitation in the area will release large quantities of water in the catchment area for other applications, while the energy-intensive pumping station at Lake Polyphyto will cease to operate and water could then be supplied for hydroelectric exploitation at the Polyphyto and Sfikia HPPs.
- The main northern road artery, the Egnatia Odos, passes through this area, which quickly leads to the port of Thessaloniki and the international railway network, as well as to the port of Igoumenitsa in the west of the country, thus favouring the development of industrial activities and exports.
- Tax and other incentives are proposed which can attract investment and establish industries focusing on the production of new products that meet environmental objectives, such as the construction of photovoltaic panels with new and efficient technologies, manufacturing of batteries and electric chargers, electric vehicles, etc.

- As the EU needs to strengthen its technological and productive base with new technologies and the manufacturing of innovative products, in line with international competition, these regions can provide land and personnel for the development of future products, with competitive terms and a clean economy.
- The abandoned, formerly lignite mines, can be used for the installation of large photovoltaic plants and wind farms utilizing the existing power infrastructure.
- The creation of a research center for the production of hydrogen by electrolysis, with the use of electricity from photovoltaics, promoting related applications, transport / storage, with prospects for development into a large production unit.
- Installation of large storage units with lithium batteries, of sufficient power, for the successful management of the electrical system of the country and the wider region, thus helping to avoid 'blackouts'. There are good prospects for the installation of large storage units in combination with the large penetration of RES.
- Creation of a center for the development of a circular economy at regional level, but also covering the needs of the wider area.
- Provision of natural gas in the area through the TAP network and creation of local gas networks.
- Construction and operation of a CCUS pilot unit in one of the existing lignite units of PPC in the Region of Western Macedonia or in connection with the Ptolemaida 5 unit now under construction.
- Initiatives can be developed by the University of Western Macedonia for the development of educational and research activities for innovative ideas in energy and in general in efficient applications that meet environmental objectives.
- Initiatives from the Region, in collaboration with the University, for fast training in new and efficient technologies, with new knowledge and skills.

6.2. Megalopolis

- Installation of large photovoltaic units in areas of the former lignite mines.
- This area is suitable for the development of agricultural applications with greenhouses for the production of competitive agricultural products for export.
- The University of Peloponnese could assist in the effort to develop the potential of the region with innovative ideas and in collaboration with the Region, with fast training of human resources and new knowledge and skills.

6.3. Island Systems

- Drastic reduction of oil use in the islands, with high RES penetration between 70% to 90% in the first phase and use of lithium battery storage systems, introducing techniques and ideas of microgrids, regardless of the evolution of the islands' electrical interconnections with the national system.
- Introduction of digital technology in the electricity networks of the islands and application of innovative technologies and techniques for the most efficient management of RES, so that all energy and water needs are covered by RES, which include transportation, heating / cooling, desalination, waste treatment plants, etc.

- Initiatives and interventions on the islands, which will aim to drastically reduce greenhouse gas emissions and reduce the SGIs burden to all consumers and the economy, as well as the strengthening of energy security by discontinuing the transport and use of oil with the largest possible use of RES in the long run.
- The relevant technologies are available, while there is potential in the market, with special knowledge and skills for a successful energy transition, maximizing the social, economic and environmental benefits in the long run. Therefore, decisions are needed here and now, with a new institutional and regulatory framework and with the support of all market players, as it has happened in other EU countries, in the US and elsewhere.

In general and as mentioned in the present study, PPC's Business Plan envisages redundancies for 4,500 people by 2024, but also the hiring of 800 new employees. To this number, one should add 1,300 redundancies of staff employed through mining contractors. Therefore, the total number of employees who will cease working at PPC's installations in Western Macedonia and Megalopolis and will become available in the labour market is estimated at 5,000 by 2024. Therefore, appropriate actions and initiatives must be taken now in order to organise the new employment opportunities and necessary training as soon as possible.

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ANNEXES

Annex A: Existing RES Licenses in the Lignite Areas of Western Macedonia and Megalopolis Arcadia (Source: RAE)

Pls refer to www.rae.gr

Annex B: Number of Legal Units, Turnover and Employees per Single Sector Economic Activity and Region in the Region of Western Macedonia, 2017

(Source: ELSTAT)

Annex C: Number of Legal Units, Turnover and Employees per Single Sector Economic Activity and Region in the Peloponnese Region, 2017

(Source: ELSTAT)

Annex D: Number of Legal Units, Turnover and Employees per Single Sector Economic Activity and Region in the Aegean Islands and Crete, 2017

(Source: ELSTAT)

Annex E: The Proposed CCUS Technology Solution

(Sources: OASIS Carbon Management Group, Deloitte Hellas, University of Western Macedonia)

Annex F: Monogrammed Drawings of 150 kV / MV Substations

(Source: ADMIE-IPTO)

Annex G: Table 34 -150 kV / MV substations in the Lignite Areas of Western Macedonia and Arcadia" (in Greek)

(Source ADMIE-IPTO)

Annex H: Meteorological data in W.. macedonia & Megalopoli

Annex G: Electrical Interconnections in W. Macedonia & Peloponnese

Table 34 -150 kV / MV substations in the Lignite Areas of Western Macedonia and Arcadia" (in Greek)

No	ΥΠΟΣΤΑΘΜΟΙ 150 kV/ΜΤ	ΝΟΜΟΣ	ΤΑΣΗ ΖΥΓΟΥ Ι (kV)	ΤΑΣΗ ΖΥΓΟΥ ΙΙ (kV)	ΤΑΣΗ ΖΥΓΟΥ ΙΙΙ (kV)	ΛΕΙΤΟΥΡΓΙΑ
ΔΥΤΙΚΗ ΜΑΚΕΔΟΝΙΑ						
1	ΟΡΥΧΕΙΟ ΝΟΤΙΟΥ ΠΕΔΙΟΥ ΠΤΟΛΕΜΑΙΔΑΣ	ΚΟΖΑΝΗΣ	150	15	20	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ (ΦΟΡΤΙΑ ΟΡΥΧΕΙΩΝ)
2	ΚΑΡΔΙΑ ΑΗΣ	ΚΟΖΑΝΗΣ	400	150	-	ΑΝΥΨΩΣΗ ΤΑΣΗΣ & ΣΥΝΔΕΣΗ ΜΕ ΚΥΤ ΚΑΡΔΙΑΣ / ΔΙΚΤΥΟ ΜΕΤΑΦΟΡΑΣ
3	ΟΡΥΧΕΙΟ ΚΑΡΔΙΑΣ	ΚΟΖΑΝΗΣ	150	15	-	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ (ΦΟΡΤΙΑ ΟΡΥΧΕΙΩΝ)
4	ΚΟΖΑΝΗ	ΚΟΖΑΝΗΣ	150	20	-	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ
5	ΟΡΥΧΕΙΟ ΑΜΥΝΤΑΙΟΥ	ΦΛΩΡΙΝΑΣ	150	20	-	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ (ΦΟΡΤΙΑ ΟΡΥΧΕΙΩΝ)
6	ΦΛΩΡΙΝΑ Ι	ΦΛΩΡΙΝΑΣ	150	20	-	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ
7	ΦΛΩΡΙΝΑ ΙΙ	ΦΛΩΡΙΝΑΣ	150	20	-	ΣΥΝΔΕΣΗ Α/Π
8	ΠΤΟΛΕΜΑΪΔΑ Ι ΑΗΣ	ΚΟΖΑΝΗΣ	150	15	6	ΑΝΥΨΩΣΗ ΤΑΣΗΣ & ΣΥΝΔΕΣΗ ΜΕ ΔΙΚΤΥΟ ΜΕΤΑΦΟΡΑΣ
9	ΠΤΟΛΕΜΑΪΔΑ ΙΙ (ΕΟΡΔΑΙΑ)	ΚΟΖΑΝΗΣ	150	20	-	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ
10	ΑΝΤΛΙΟΣΤΑΣΙΟ ΠΟΛΥΦΥΤΟΥ	ΚΟΖΑΝΗΣ	150	20	-	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ (ΑΝΑΓΚΕΣ ΑΝΤΛΙΣΗΣ)
11	ΠΟΛΥΦΥΤΟ ΥΗΣ	ΚΟΖΑΝΗΣ	150	20	-	ΑΝΥΨΩΣΗ ΤΑΣΗΣ & ΣΥΝΔΕΣΗ ΜΕ ΚΥΤ ΚΑΡΔΙΑΣ / ΔΙΚΤΥΟ ΜΕΤΑΦΟΡΑΣ
12	ΙΛΑΡΙΩΝΑΣ ΥΗΣ	ΚΟΖΑΝΗΣ	150	20	-	ΑΝΥΨΩΣΗ ΤΑΣΗΣ & ΣΥΝΔΕΣΗ ΜΕ ΤΟ ΔΙΚΤΥΟ ΜΕΤΑΦΟΡΑΣ
13	ΣΕΡΒΙΑ	ΚΟΖΑΝΗΣ	150	20	-	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ & ΣΥΝΔΕΣΗ Α/Π
14	ΕΛΛΗΝΙΚΉ ΕΤΑΙΡΙΑ ΕΞΟΡΥΞΗΣ ΜΕΤΑΛΛΕΥΜΑΤΩΝ (ΜΑΒΕ)	ΚΟΖΑΝΗΣ	150	20	-	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ
15	ΠΟΛΥΜΥΛΟΣ	ΚΟΖΑΝΗΣ	150	20	-	ΣΥΝΔΕΣΗ Α/Π
ΑΡΚΑΔΙΑ						
1	ΑΣΤΡΟΣ	ΑΡΚΑΔΙΑΣ	150	20	-	ΥΠΟΒΙΒΑΣΜΟΣ ΤΑΣΗΣ & ΣΥΝΔΕΣΗ Φ/Β
2	ΛΑΔΩΝΑΣ ΥΗΣ	ΑΡΚΑΔΙΑΣ	150	20	-	ΑΝΥΨΩΣΗ ΤΑΣΗΣ & ΣΥΝΔΕΣΗ ΜΕ ΤΟ ΔΙΚΤΥΟ ΜΕΤΑΦΟΡΑΣ
3	ΜΕΓΑΛΟΠΟΛΗ Ι ΑΗΣ	ΑΡΚΑΔΙΑΣ	150	20	-	ΑΝΥΨΩΣΗ ΤΑΣΗΣ & ΣΥΝΔΕΣΗ ΜΕ ΚΥΤ ΜΕΓΑΛΟΠΟΛΗΣ / ΔΙΚΤΥΟ ΜΕΤΑΦΟΡΑΣ

Source: ADMIE-IPTO

Table 35- Substations in the Lignite Region of Western Macedonia and Existing Equipment, including Transformers and their Rated Power (Greek)

No	Υποσταθμοί 150 kV/ΜΤ, 66 kV/ΜΤ	ΑΠΟΖΕΥΚΤΕΣ	ΑΥΤΟΜΑΤΟΙ ΔΙΑΚΟΠΤΕΣ	ΑΥΤΟΜΑΤΟΙ ΔΙΑΚΟΠΤΕΣ ΣΤΑΥΡΩΤΗΣ ΔΙΑΤΑΞΕΩΣ	ΜΕΤΑΣΧΗΜΑΤΙΣΤΕΣ 150 KV/Μ.Τ.	ΜΕΤΑΣΧΗΜΑΤΙΣ ΤΕΣ 150 KV/Μ.Τ. ΜΕ ΡΥΘΜΙΣΗ ΤΑΣΕΩΣ ΥΠΟ ΦΟΡΤΙΟ	ΜΕΤΑΣΧΗΜΑΤΙΣΤ ΕΣ 150/20 KV 100/50+50 MVA ΜΕ ΡΥΘΜΙΣΗ ΤΑΣΕΩΣ ΥΠΟ ΦΟΡΤΙΟ	ΠΥΚΝΩΤΕΣ	ΠΥΚΝΩΤΕΣ ΒΑΘΜΙΔΩΝ ΜΕ ΑΥΤΟΜΑΤΟ ΣΥΣΤΗΜΑ ΕΛΕΓΧΟΥ	ΒΟΗΘΗΤΙΚΗ ΠΗΓΗ ΤΑΣΗΣ	ΣΥΝΔΕΣΕΙΣ ΜΕ ΜΟΝΑΔΕΣ ΠΑΡΑΓΩΓΗΣ
1	ΟΡΥΧΕΙΟ ΑΜΥΝΤΑΙΟΥ	18	8	-	-	3 x 40/50 MVA	-	5 x 2,44 MVAr 5 x 2,54 MVAr 5 x 2,79 MVAr	-	-	-
2	ΦΛΩΡΙΝΑ Ι	10	4	2	-	2 x 20/25 MVA	-	-	3 x 3,9 MVAr	-	-
3	ΦΛΩΡΙΝΑ ΙΙ	3	1	1	-	1 x 40/50 MVA	-	3 x 3,9 MVAr	-	-	-
4	ΑΝΤΙΛΙΟΣΤΑΣΙΟ ΠΟΛΥΦΥΤΟΥ	14	7	-	-	2 x 40/50 MVA	-	-	-	-	-
5	ΙΛΑΡΙΩΝΑΣ ΥΗΣ	16	6	7	3 x 1250 kVA 1 x 160 kVA 1 x 200 kVA 1 x 4500 kVA	2 x 85 MVA 1 x 20/25 MVA		-	-	0,4 kV	1 x 4,54 MVA 1 x 76,5 MW
6	ΚΑΡΔΙΑ ΑΗΣ	8	-	-	4 x 360 MVA	-	3 x 30/40 MVA 5 x 40/50 MVA	-	-	6,3 kV	2 X 300 MW 2 X 325μ MW
7	ΚΟΖΑΝΗ	8	4	2	-	2 x 40/50 MVA			3 x 3,9 MVAr (20kV)		
8	ΟΡΥΧΕΙΟ ΝΟΤΙΟΥ ΠΕΔΙΟΥ ΠΤΟΛΕΜΑΙΔΑΣ	29	9	12	-	6 x 40/50 MVA	-	5 x 3,44 MVAr (15kV) 5 x 2,91 MVAr (15kV) 5 x 2,95 MVAr (15kV) 5 x 3,17 MVAr	-	-	-

								(20kV) 4 x 2,93 MVAr (20kV) 4 x 3,07 MVAr (20kV)			
9	ΟΡΥΧΕΙΟ ΚΑΡΔΙΑΣ	6	4	2	-	2 x 40/50 MVA	-	-	-	-	-
10	ΠΟΛΥΦΥΤΟ ΥΗΣ	34	10	5	3 x 136 MVA	1 x 5/6,25 MVA	-	-	-	20 kV (DIESEL 450 kVA)	3 x 125 MW
11	ΠΤΟΛΕΜΑΙΔΑ Ι ΑΗΣ	88	25	5	2 x 42 MVA 3 x 60/75 MVA 1 x 90 MVA 1 x 30/37 MVA 1 x 375 MVA	2 x 40/50 MVA 2 x 10 MVA 3 x 12/15 MVA 1 x 20/25 MVA	4 x 15/20 MVA	-	-	6 kV	1 x 70 MW 2 x 125 MW 1 x 300 MW
12	ΠΤΟΛΕΜΑΙΔΑ ΙΙ (ΕΟΡΔΑΙΑ)	15	8	-	-	2 x 20/25 MVA	-	-	3 x 3,9 MVAr (20kV)		
13	ΣΕΡΒΙΑ	5	2	-	-	1 x 20/25 MVA	-	-	1 x 8,6 MVAr (20kV)	-	Α/Π
14	ΕΛΛΗΝΙΚΉ ΕΤΑΙΡΙΑ ΕΞΟΡΥΞΗΣ ΜΕΤΑΛΛΕΥΜΑΤΩΝ (ΜΑΒΕ)	2	1	-	-	1 x 20/25 MVA	-	-	-	-	-
15	ΠΟΛΥΜΥΛΟΣ	5	3	1	-	1 x 40/50 MVA	-	3 x 3,9 MVAr (20kV)	-	-	Α/Π

Source: ADMIE-IPTO

Table 36 - Substations in the Lignite Region of Arcadia and Existing Equipment, including Transformers and their Rated Power (in Greek)

No	Υποσταθμοί 150 kV/ΜΤ, 66 kV/ΜΤ	ΠΟΖΕΥ-ΚΤΕΣ	ΑΥΤΟΜΑΤΟΙ ΔΙΑΚΟΠΤΕΣ	ΑΥΤΟΜΑΤΟΙ ΔΙΑΚΟΠΤΕΣ ΣΤΑΥΡΩΤΗΣ ΔΙΑΤΑΞΕΩΣ	ΜΕΤΑΣΧΗΜΑΤΙΣΤΕΣ 150 KV/Μ.Τ.	ΜΕΤΑΣΧΗΜΑΤΙΣ ΤΕΣ 150 KV/Μ.Τ. ΜΕ ΡΥΘΜΙΣΗ ΤΑΣΕΩΣ ΥΠΟ ΦΟΡΤΙΟ	ΜΕΤΑΣΧΗΜΑΤΙΣΤ ΕΣ 150/20 KV 100/50+50 MVA ΜΕ ΡΥΘΜΙΣΗ ΤΑΣΕΩΣ ΥΠΟ ΦΟΡΤΙΟ	ΠΥΚΝΩΤΕΣ	ΠΥΚΝΩΤΕΣ ΒΑΘΜΙΔΩΝ ΜΕ ΑΥΤΟΜΑΤΟ ΣΥΣΤΗΜΑ ΕΛΕΓΧΟΥ	ΒΟΗΘΗΤΙΚΗ ΠΗΓΗ ΤΑΣΗΣ	ΣΥΝΔΕΣΕΙΣ ΜΕ ΜΟΝΑΔΕΣ ΠΑΡΑΓΩΓΗΣ
1	ΑΣΤΡΟΣ	16	9	-	-	2 x 20/25 MVA	-	3 x 4,03 MVAr (20kV)	-	-	Φ/Β
2	ΛΑΔΩΝΑΣ ΥΗΣ	13	6	-	2 x 28/35 MVA	1 x 20/25 MVA	-	-	-	6 kV	2 x 35 MW
3	ΜΕΓΑΛΟΠΟΛΗ Ι ΑΗΣ	65	23	6	1 x 360 MVA 1 x 150 MVA 1 x 20/25 MVA	2 x 16/20 MVA 2 x 30/37 MVA	2 x 40/50 MVA	1 x 25 MVAr (150kV)	-	6,3 kV	1 x 125 MW 1 x 300 MW
4	ΜΕΓΑΛΟΠΟΛΗ ΙΙ ΑΗΣ	28	11	-	1 x 360 MVA	-	3 x 40/50 MVA	-	-	6,3 kV	1 x 300 MW
5	ΜΕΓΑΛΟΠΟΛΗ ΙΙΙ (ΧΩΡΕΜΙ)	10	5	-	-	2 x 40/50 MVA	-	5 x 2,31 MVAr (20kV) 5 x 2,43 MVAr (20kV)	-	-	-
6	ΤΡΙΠΟΛΗ	12	7	-	-	2 x 20/25 MVA 1 x 40/50 MVA	-	-	3 x 4,03 MVAr (20kV) 3 x 3,9 MVAr (20kV)	-	-
7	ΔΟΡΙΖΑ Ι	2	2	2	-	2 x 40/50 MVA	-	3 x 3,9 MVAr (20kV)	-	-	Α/Π
8	ΔΟΡΙΖΑ ΙΙ	3	1	1	-	1 x 50/63 MVA	-	3 x 3,9 MVAr (20kV)	-	-	Α/Π
9	ΑΘΗΝΑΙΟΝ	5	3	1	-	1 x 40/50 MVA	-	3 x 3,9 MVAr (20kV)	-	-	Α/Π
10	ΗΡΑΙΑ	5	3	1	-	1 x 20/25 MVA	-	2 x 4 MVAr (20kV)	-	-	Φ/Β
11	ΚΟΥΝΟΥΠΙΑ	5	3	1	-	1 x 40/50 MVA	-	1 x 12 MVAr (20kV)	-	-	Α/Π
12	ΝΕΣΤΑΝΗ	5	3	1	-	1 x 40/50 MVA	-	3 x 4 MVAr (20kV)	-	-	Α/Π
13	ΚΟΡΙΤΣΑ	5	3	1	-	1 x 40/50 MVA	-	-	3 x 4 MVAr (20kV)	-	Α/Π
14	ΑΪΓΙΩΡΓΙΤΙΚΟ	1	1	3	-	1 x 40/50 MVA	-	-	3 x 4 MVAr (20kV)	-	Α/Π

Source: ADMIE-IPTO

Table 37 - Interconnected Transmission System Lines in Western Macedonia (in Greek).

ΓΜ	ΥΠΟΔΟΜΗ Α	ΥΠΟΔΟΜΗ Β	ΠΕΡΙΓΡΑΦΗ
1	Υ/Σ ΟΡΥΧΕΙΟ ΑΜΥΝΤΑΙΟΥ	ΚΥΤ ΑΜΥΝΤΑΙΟΥ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
2	Υ/Σ ΦΛΩΡΙΝΑ Ι	ΚΥΤ ΑΜΥΝΤΑΙΟΥ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
3	Υ/Σ ΦΛΩΡΙΝΑ Ι	Υ/Σ ΦΛΩΡΙΝΑ ΙΙ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
4	Υ/Σ ΦΛΩΡΙΝΑ ΙΙ	Υ/Σ ΚΑΣΤΟΡΙΑ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
5	Υ/Σ ΑΝΤΛΙΟΣΤΑΣΙΟ ΠΟΛΥΦΥΤΟΥ	Υ/Σ ΠΟΛΥΦΥΤΟ ΥΗΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
6	Υ/Σ ΑΝΤΛΙΟΣΤΑΣΙΟ ΠΟΛΥΦΥΤΟΥ	ΚΥΤ ΚΑΡΔΙΑΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
7	Υ/Σ ΙΛΑΡΙΩΝΑΣ ΥΗΣ	Υ/Σ ΛΑΜΙΑ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
8	Υ/Σ ΙΛΑΡΙΩΝΑΣ ΥΗΣ	Υ/Σ ΚΟΖΑΝΗ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
9	Υ/Σ ΚΑΡΔΙΑ ΑΗΣ	ΚΥΤ ΚΑΡΔΙΑΣ	2Χ ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 400 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
10	ΚΥΤ ΚΑΡΔΙΑΣ	Υ/Σ ΚΑΡΔΙΑ ΑΗΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
11	Υ/Σ ΚΟΖΑΝΗ	ΥΗΣ ΙΛΑΡΙΩΝΑ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
12	Υ/Σ ΚΟΖΑΝΗ	ΚΥΤ ΚΑΡΔΙΑΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
13	Υ/Σ ΟΡΥΧΕΙΟ ΝΟΤ. ΠΕΔ. ΠΤΟΛΕΜΑΙΔΑΣ	ΚΥΤ ΚΑΡΔΙΑΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
14	Υ/Σ ΟΡΥΧΕΙΟ ΝΟΤ. ΠΕΔ. ΠΤΟΛΕΜΑΙΔΑΣ	ΚΥΤ ΑΜΥΝΤΑΙΟΥ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
15	Υ/Σ ΟΡΥΧΕΙΟ ΝΟΤ. ΠΕΔ. ΠΤΟΛΕΜΑΙΔΑΣ	ΚΥΤ ΠΤΟΛΕΜΑΙΔΑΣ*	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
16	Υ/Σ ΟΡΥΧΕΙΟ ΝΟΤ. ΠΕΔ. ΠΤΟΛΕΜΑΙΔΑΣ	ΠΟΛΥΜΥΛΟΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
17	Υ/Σ ΟΡΥΧΕΙΟ ΚΑΡΔΙΑΣ	ΚΥΤ ΚΑΡΔΙΑΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 400 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
18	Υ/Σ ΟΡΥΧΕΙΟ ΚΑΡΔΙΑΣ	ΑΗΣ ΑΓ. ΔΗΜΗΤΡΙΟΥ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 400 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
19	Υ/Σ ΠΟΛΥΦΥΤΟ ΥΗΣ	ΣΦΗΚΙΑ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
20	Υ/Σ ΠΟΛΥΦΥΤΟ ΥΗΣ	ΚΥΤ ΚΑΡΔΙΑΣ	2Χ ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ

21	ΠΤΟΛΕΜΑΙΔΑ Ι ΑΗΣ	ΚΥΤ ΑΜΥΝΤΑΙΟΥ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
22	ΠΤΟΛΕΜΑΙΔΑ Ι ΑΗΣ	ΕΡΓ. ΑΖΩΤΟΥ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
23	ΠΤΟΛΕΜΑΙΔΑ Ι ΑΗΣ	Υ/Σ ΓΡΕΒΕΝΑ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
24	ΠΤΟΛΕΜΑΙΔΑ ΙΙ (ΕΟΡΔΑΙΑ)	ΠΤΟΛΕΜΑΙΔΑ Ι ΑΗΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
25	ΠΤΟΛΕΜΑΙΔΑ ΙΙ (ΕΟΡΔΑΙΑ)	Υ/Σ ΚΑΣΤΟΡΙΑ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
26	Υ/Σ ΣΕΡΒΙΑ	ΚΥΤ ΚΑΡΔΙΑΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
27	Υ/Σ ΣΕΡΒΙΑ	ΛΑΡΙΣΑ Ι	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
28	ΠΟΛΥΜΥΛΟΣ	ΣΦΗΚΙΑ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
29	ΠΟΛΥΜΥΛΟΣ	ΚΥΤ ΑΜΥΝΤΑΙΟΥ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
30	Υ/Σ ΕΛ. ΕΤ. ΕΞ. Μ. (πρ. ΜΑΒΕ)	ΚΥΤ ΚΑΡΔΙΑΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
31	Υ/Σ ΕΛ. ΕΤ. ΕΞ. Μ. (πρ. ΜΑΒΕ)	Υ/Σ ΛΑΡΙΣΑ Ι (ΣΕΡΒΙΑ)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ

Table 38 - Transmission Lines of Interconnected System in Arcadia (in Greek)

ΓΜ	ΥΠΟΔΟΜΗ Α	ΥΠΟΔΟΜΗ Β	ΠΕΡΙΓΡΑΦΗ
1	Υ/Σ ΑΣΤΡΟΣ	Υ/Σ ΜΟΛΑΟΙ (ΖΑΡΑΚΑΣ)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
2	Υ/Σ ΑΣΤΡΟΣ	Υ/Σ ΚΟΥΝΟΥΠΙΑ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
3	Υ/Σ ΑΣΤΡΟΣ	Υ/Σ ΑΡΓΟΣ ΙΙ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
4	ΛΑΔΩΝΑΣ ΥΗΣ	Υ/Σ ΠΥΡΓΟΣ Ι	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
5	ΛΑΔΩΝΑΣ ΥΗΣ	Υ/Σ ΗΡΑΙΑ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
6	ΜΕΓΑΛΟΠΟΛΗ Ι ΑΗΣ	ΜΕΓΑΛΟΠΟΛΗ ΙΙ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
7	ΜΕΓΑΛΟΠΟΛΗ Ι ΑΗΣ	ΜΕΓΑΛΟΠΟΛΗ ΙΙ (2)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
8	ΜΕΓΑΛΟΠΟΛΗ Ι ΑΗΣ	ΜΕΓΑΛΟΠΟΛΗ (ΧΩΡΕΜΙ)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
9	ΜΕΓΑΛΟΠΟΛΗ Ι ΑΗΣ	Υ/Σ ΚΑΛΑΜΑΤΑ Ι*	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
10	ΜΕΓΑΛΟΠΟΛΗ Ι ΑΗΣ	Υ/Σ ΣΚΑΛΑ* (ΣΠΑΡΤΗ ΙΙ, ΣΠΑΡΤΗ Ι)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΔΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
11	ΜΕΓΑΛΟΠΟΛΗ Ι ΑΗΣ	Υ/Σ ΝΕΣΤΑΝΗ (ΔΟΡΙΖΑ Ι - ΙΙ)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
12	ΜΕΓΑΛΟΠΟΛΗ Ι ΑΗΣ	Υ/Σ ΚΟΡΙΝΘΟΣ (ΔΟΡΙΖΑ Ι)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
13	ΜΕΓΑΛΟΠΟΛΗ ΙΙ ΑΗΣ	ΚΥΤ ΜΕΓΑΛΟΠΟΛΗΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 400 kV ΤΡΙΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
14	ΜΕΓΑΛΟΠΟΛΗ ΙΙ ΑΗΣ	ΜΕΓΑΛΟΠΟΛΗ Ι (ΧΩΡΕΜΙ)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
15	Υ/Σ ΤΡΙΠΟΛΗΣ	Υ/Σ ΑΡΓΟΣ Ι	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
16	Υ/Σ ΤΡΙΠΟΛΗΣ	Υ/Σ ΑΘΗΝΑΙΟΝ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
17	ΔΟΡΙΖΑ Ι	ΚΟΡΙΝΘΟΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ

ΓΜ	ΥΠΟΔΟΜΗ Α	ΥΠΟΔΟΜΗ Β	ΠΕΡΙΓΡΑΦΗ
			ΚΥΚΛΩΜΑΤΟΣ
18	ΔΟΡΙΖΑ ΙΙ	Υ/Σ ΝΕΣΤΑΝΗ (ΔΟΡΙΖΑ ΙΙ)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
19	Υ/Σ ΑΘΗΝΑΙΟΝ	ΚΥΤ ΜΕΓΑΛΟΠΟΛΗΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
20	Υ/Σ ΗΡΑΙΑ	Υ/Σ ΛΑΔΩΝΑΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
21	Υ/Σ ΗΡΑΙΑ	ΚΥΤ ΜΕΓΑΛΟΠΟΛΗΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
22	ΚΟΥΝΟΥΠΙΑ	ΜΟΛΑΟΙ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
23	Υ/Σ ΝΕΣΤΑΝΗ	Υ/Σ ΚΟΡΙΝΘΟΣ	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
25	ΚΟΡΙΤΣΑ	ΑΡΓΟΣ ΙΙ (ΑΧΛΑΔΟΚΑΜΠΟΣ)	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
26	ΚΟΡΙΤΣΑ	ΜΕΓΑΛΟΠΟΛΗ Ι	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ
27	ΑΪΓΙΩΡΓΙΤΙΚΟ	ΜΕΓΑΛΟΠΟΛΗ Ι	ΕΝΑΕΡΙΑ ΓΡΑΜΜΗ ΜΕΤΑΦΟΡΑΣ 150 kV ΑΠΛΟΥ ΚΥΚΛΩΜΑΤΟΣ

Annex H: Meteorological data in W. Macedonia and Megalopoli

Table 40- Indicative Positions with High Wind Capacity in the Lignite Areas of Western Macedonia and Megalopolis and their Corresponding Capacity at Average Annual Wind Speed (m / s) and Power Density (W / m²) (in Greek)

Θέση - Περιοχή	Υψόμετρο (m)	Μέση ετήσια ταχύτητα ανέμου (m/s)	Μέση ετήσια πυκνότητα ισχύος (W/m2)	Περιφερειακή Ενότητα
Όρος Βέλια Σιάτιστας	1450 - 1700	4.75 - 8.65	640 - 925	Κοζάνης
Όρος Ντρισινίκος Σιάτιστας	1300 - 1860	8.00 - 9.35	752 - 1116	Κοζάνης
Όρος Σινιάτσικο (Άσκιο Όρος)	1500 - 2000	7.99 - 9.52	695 - 1050	Κοζάνης
Βλάστη Μιλοχώρι	1450 - 1550	8.34 - 8.97	833 - 896	Κοζάνης
Μεταξάς Σερβιών	1000 - 1200	6.00 - 6.11	296 - 310	Κοζάνης
Αετόπετρα	1100 -1250	6.75 - 6.96	437 - 487	Κοζάνης
Κλισούρα Φλώρινας	1400 - 1500	7.81 - 7.83	727 - 731	Φλώρινας - Κοζάνης
Όρος Κρόνος	1350 - 1600	8.7 - 8.78	1025 - 1053	Φλώρινας
Βεγόρα Αμυνταίου	600 - 700	6.45 - 6.95	495 - 498	Φλώρινας
Όρος Λιλιάκος	800 - 1150	7.89 - 8.54	710 - 844	Φλώρινας
Πισοδέρι Φλώρινας	1750 - 2000	9.32 - 9.64	1097 - 1204	Φλώρινας
Αετός - Νυμφαίο	1000 - 1300	8.58 - 8.60	1051 - 1123	Φλώρινας
Βάστας Μεγαλόπολης	1050 - 1350	7.5 - 9.08	494 - 891	Αρκαδίας - Μεσσηνίας
Τουρκολέκας - Χιράδες	1000 - 1250	8.58 - 8.71	902 - 956	Αρκαδίας
Μαρμαριά - Ανεμοδούρι Αναβρυτό	800 -1200	8.4 - 9.4	880 - 1262	Αρκαδίας
Χρυσοβίτσι Αρκαδίας	1450	7.92 - 8.09	577 - 610	Αρκαδίας