# Greek Renewable Energy Market Outlook 2022-2023

WATTCROP

SOLAR PV | WIND | ENERGY STORAGE

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“Paving the path towards a brighter, greener future for generations to come.”

Ypatios Moysiadis

# About Wattcrop

Wattcrop was incorporated in 2019 aiming to develop best-in-class renewable energy and energy storage projects mainly in South-East Europe and the UK.

## A sustainable future for all

Currently Wattcrop has partnered with CERO GENERATION, a Macquarie Green Investment Group portfolio company and one of the largest renewable energy developers internationally, aiming to develop organically a significant asset portfolio exceeding 750MW of generation and 600MW of storage assets.

To achieve that we are capitalising on local talent by establishing local teams on the jurisdictions we operate. In addition to greenfield development, we aim to expand our portfolios through licensing acquisition and strategic partnerships.

Our goal is to drive Carbon Zero energy generation, support local communities, protect, and enhance ecosystem biodiversity, envisioning a better more sustainable future for all.

## Who we are

A multi-shareholder company with founding members from across Europe driven by our passion to lead the way towards energy transition. Our competitive advantage is the company's global outlook; derived from the collective experience of our shareholders and coupled with our constant strive for excellence

A sustainable future for all.

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**2019**

Wattcrop is incorporated by international investors with the aim to be a major developer in Greece.

**2020**

We exceed our initial development target of 250MWp in Renewable projects.

**2021**

Cero Generation / Macquaire GIG become a majority partner after successfully concluding the transaction.

**2022**

First projects with draft PPAs submitted to IPTO for grid connection offer.

Company Milestones

## What we do

We have created services that address the development and operational cycle of renewable energy projects. Primarily focusing on Solar PV and Onshore Wind we start from greenfield development all the way to asset management and ancillary services for operational plants.

# Foreword

**In 2022 we are witnessing many disasters from the changes caused by climate change on all continents. The World Bank estimates that total damages exceeded $14.9 billion**

Amidst the tumultuous waves of economic adversity, Greece emerged as a beacon of resilience in the wake of the global financial crisis of 2007-2008, only to be tested once more by the far-reaching impacts of the Covid-19 pandemic. However, against all odds, the Hellenic economy staged a remarkable comeback in 2021, defying expectations and surging back to pre-pandemic levels.

This remarkable turnaround was further propelled by the implementation of the National Recovery and Resilience Plan, signaling a clear commitment to charting a path towards sustained prosperity.

However, amidst this optimism loom a potent threat to Greece's economic narrative: the escalating energy crisis, exacerbated by geopolitical tensions such as the Russia-Ukraine conflict. The relentless surge in energy prices witnessed throughout 2021 has triggered consumer price inflation, amplifying the strain on low-income households.

Furthermore, regulatory changes with the introduction of priorities for grid offer, the reduction of the average licensing period for new Renewable Energy Projects, and the increased capacity of the electricity network to enable integration of more Renewable Energy projects are setting the scene for a continuous dynamic market.

2022 is the first year in history during which energy production from RES and large hydroelectric dams exceeds that produced by fossil fuels and lignite.

We at Wattcrop aim to take a role in the center stage and help realize the Green Energy Transition in harmony with the local communities.

This report represents our interpretation of the market, its opportunities, and challenges. Combining data and information from various sources and by doing our own analysis our goal is to provide a solid market view from our perspective. We try to decode and analyze the market giving a current snapshot of the situation and the future outlook within the Greek Renewable Market.

As true believers of free open information sharing, we hope that this report will help all willing stakeholders to engage in the right discussions and help accelerate the transition to a greener energy economy by focusing on providing solutions to issues we all face within the Greek market environment.

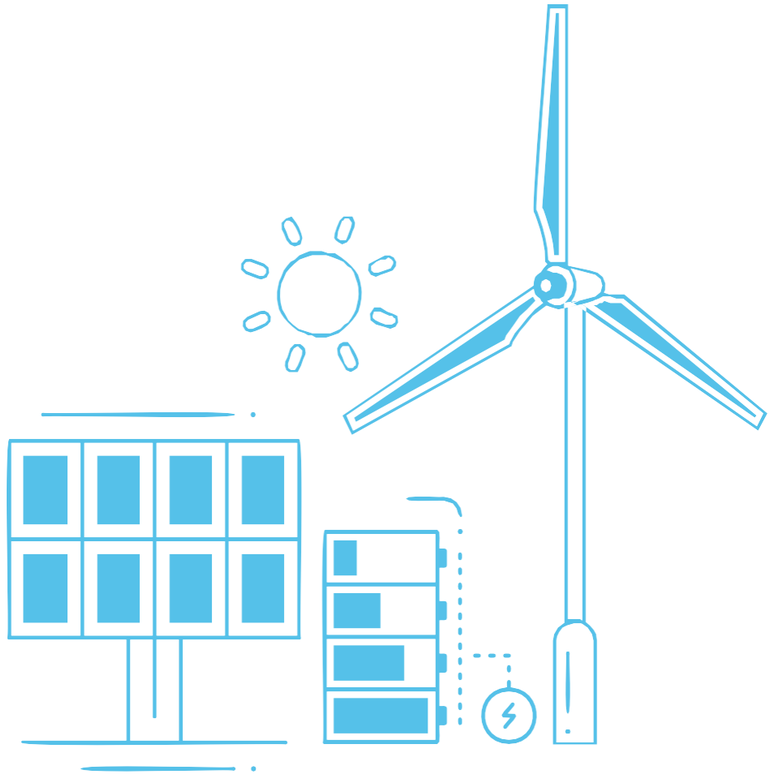
"As the energy landscape in Greece continues to evolve, Wattcrop remains committed to providing insightful analysis through our 'Greek Energy Market Outlook.' Our aim is to empower stakeholders with strategic foresight, enabling informed decision-making in this dynamic sector. With our comprehensive understanding of market trends and regulations, we're dedicated to helping shape a sustainable and thriving energy future for Greece."

Ypatios Moysiadis
Managing Partner

"At Wattcrop, sustainability is the foundation of our work. Our team is dedicated to integrating best practices, supporting local communities, and fostering biodiversity conservation, all while paving the way for a resilient and thriving energy future. Our latest Greek Renewable Energy Market Outlook covers key market trends, regulatory developments, and innovative solutions driving progress in the sector. We aim not only to lead by example but also to inspire other companies to embrace this mindset, fostering a collective commitment to sustainable practices across the industry."

Elena Gkagkani
Head of Strategy
and Development

# We had an excellent year






## Research and Editing Team

**Managing Partner** Ypatios Moysiadis
**Senior Project Coordinator** Elena Gkagkani
**Head of Operations** Christos Kougevetopoulos
**Design Director** Dimitris Bizioglis


Greek Renewable Energy Market Outlook

# Table of Contents

# Executive Summary

## This report endeavors to offer a comprehensive overview of the present state and prospective trajectory of the Greek Renewable Energy Market. Positioned at the threshold of a transformative era, Greece is steadfastly advancing towards a more sustainable energy landscape.

The urgency of addressing the climate crisis has prompted bipartisan recognition within the political establishment of the need for action. Both government and opposition factions are aligned with EU policies and international initiatives, demonstrating robust support for transitioning towards renewable energy sources without subsidies. Additionally, there is a concerted effort to enhance energy efficiency, primarily through the provision of public grants.

Greece grapples with a population decline primarily fueled by migration, an aging population, and a low birth rate among young couples, posing potential long-term challenges. Despite these concerns, there are positive signs: despite the COVID-19 slowdown, unemployment rates are steadily decreasing, and the fiscal outlook is showing signs of stabilization. In 2021 the unemployment rate for the general population was 14.7 as opposed to the previous years when it was higher. In terms of electricity, Greece operates as a net importer, with an annual consumption averaging about 52TWh, a figure not particularly high compared to other nations.

The country holds unique advantages for renewable energy. Its suitability for both wind and solar installations, coupled with plans for new national and international interconnectors, presents a significant opportunity to become a major net exporter of green power within the EU. Considering the green European legislative framework and the EU's ambitious yet attainable objectives outlined in the REPowerEU plan, the Fit-for-55 package, and the EU Green Deal, Greece has initiated political measures aimed at transitioning its energy sector from fossil-fuel dependence to zero-carbon alternatives. Notably, natural gas and renewable energy sources are supplanting lignite in the electricity generation mix.

Furthermore, there is a significant amount of applications for new connections both on larger and smaller projects waiting to be realised. Despite the congestion on the grid and the slow response times of the grid operators there is a dynamic that by 2025 Greece will be exceeding its 2030 targets in installed RES capacity.

Greek Renewable Energy Market Outlook

However, electricity prices in Greece soared to historic highs during the second half of 2021. Similarly, household natural gas prices experienced a parallel surge, tripling over the period from 2021 to 2022. This unprecedented surge in gas and subsequently energy prices has been caused by a combination of factors such as the potential Russian sanctions.

Battery storage was introduced in July 2022 and there was immediate interest from investors that have applied for Storage licenses. Based on current projections on RES installed capacity and on the fact that hourly storage will predominantly be provided by batteries, the energy storage requirements by 2030 is expected to be between 5 – 8 GW.

The looming challenge, much like in other countries, lies with the Grid. Despite the announced upgrade and expansion plans, there's a glaring gap in meeting the demand for new generation connections. To address this shortfall, the private sector is poised to play an active role by providing essential capital for grid upgrades, facilitating the connection of large-scale generation projects. Furthermore, we anticipate increased collaboration among established players in licensing and jointly constructing grid infrastructure.

As anticipated, Greece is gradually transitioning to a fully unsubsidized market, with merchant contracts and corporate Power Purchase Agreements (PPAs) taking on greater significance. Corporate PPAs will hinge on market price expectations, risk management, and adherence to Environmental, Social, and Governance (ESG) standards. Although there's a need for further legal framework clarifications to enable sleeved (virtual) PPAs, the market is still in its early stages, requiring an educational process for both developers and off-takers.

Initially, the PPA market in Greece was nascent, but interest from domestic and international players is growing. Potential candidates for PPAs include municipalities, industrial consumers, commercial enterprises, and companies with high energy costs. The PPA market is expected to evolve rapidly by 2030, driven by regulatory developments, supply and demand dynamics, and investor sentiment favoring bilateral PPAs over renewable energy tenders.

Greece has emerged as a hub for renewable energy, yet success in the industry hinges on a cautious strategy and the cultivation of high-quality projects through collaboration with local communities and respect for environmental harmony.

Greek Renewable Energy Market Outlook

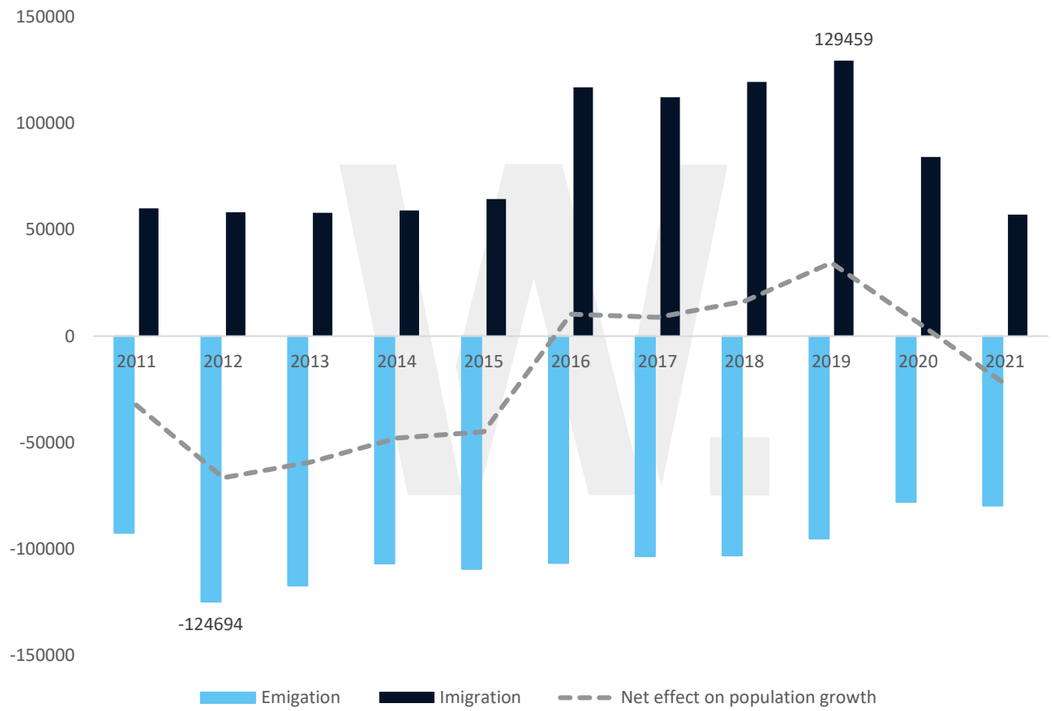
# 1

# Demographics

# Demographics

From 2011 to 2021, Greece has experienced a sharp population decline, dropping from 11.1 million people to 10.57 million in 2021. This is closely associated with the brain drain; According to research, approximately 500.000 people moved abroad, mainly in Europe, during the financial crisis. Coupled with the aging population and low birth rate, the most recent projections show a continuation of this trend, resulting in a population of 9.03 million by 2050 and 6.61 million by 2099.

Migration Flows in Greece 2011-2021



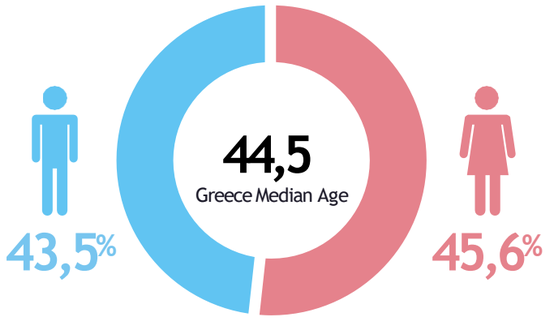

## Migration flows

The most significant emigration flows in Greece are observed in 2012, at the peak of the financial crisis. Between 2011 and 2016, there was a net outflow of people, which then leveled, not due to the decrease of emigration but due to the refugee crisis that affected Europe from 2016 onwards.

Greek Renewable Energy Market Outlook

# Demographics

Adults: 8,658,460




## Annual Salary

**$17.700**

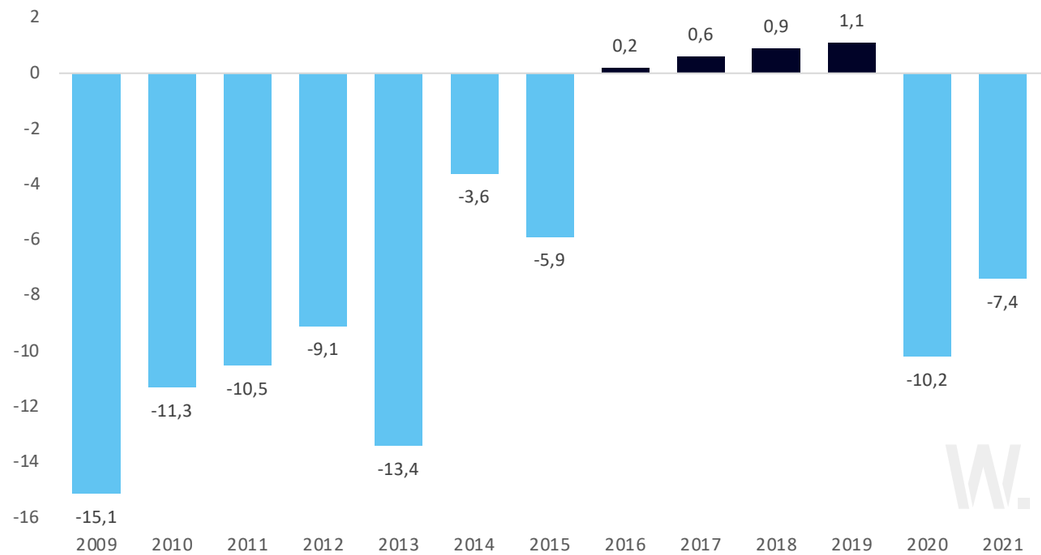
average annual salary, compared to the OECD average of $33.604 a year.

**55%**

would be at risk of falling into poverty if they had to forgo 3 months of their income.

# Government Budget

(% of deficit and surplus) 2009-2021




Cumulative Greek Government (Deficit)
-353.434 Million € in 2021



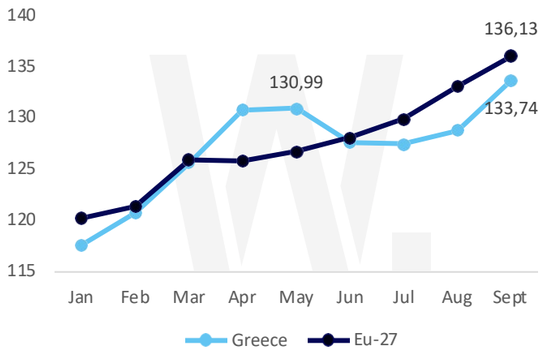
Source: ELSTAT, 2022

# One Million

## households in Greece are energy-poor

The chart on the left shows the significant increase in the harmonised index of consumer prices for housing, water, gas electricity and other fuels in Greek households from January to September 2022.

Prices for housing and consumers' energy needs spiked in April and May, following a downward trend and then plateauing during summer. However, the decline was short-lived, as Greece is now following the same trend as the EU-27 average, with prices rising significantly in September.




According to the data of the Action Plan to Combat Energy Poverty 2021 - 2030, the percentage of affected households in Greece reached 11.2% in 2019.

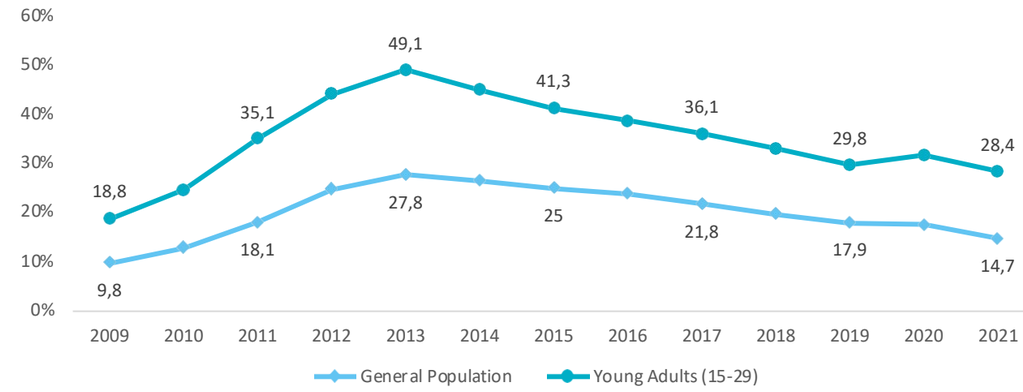
Based on research conducted by STEP-IN, RAE, and NTUA, 80% of Greek households spend more than 10% of their annual income to cover the cost of heating and electricity and meet their energy needs.

The goal of the Plan is to reduce this percentage to 7% by 2025 (about 2 thousand households) and at 3% in the year 2030 (about 143 thousand households).

Greek Renewable Energy Market Outlook

# Average annual unemployment rate

## in Greece 2009-2021



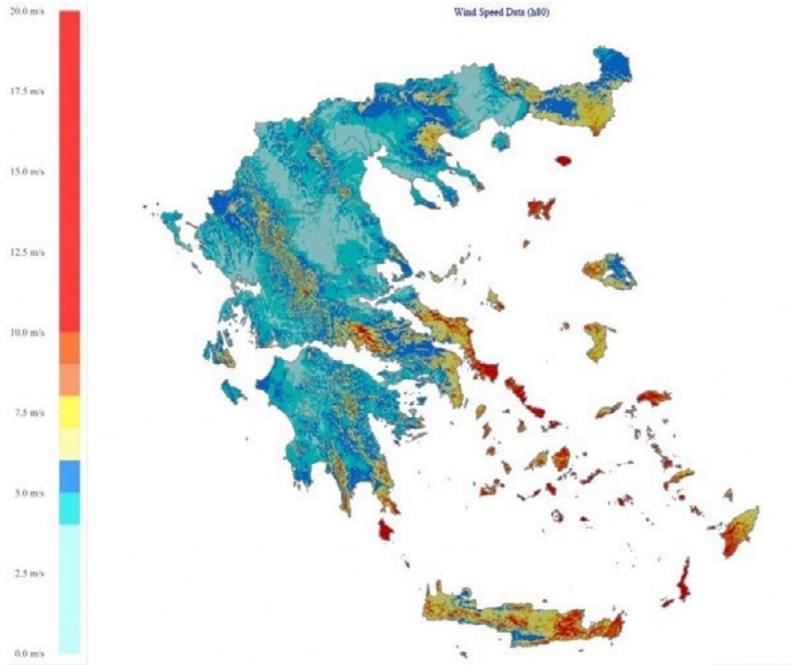

The unemployment rate in Greece rocketed during the financial crisis especially between 2011 and 2015. There has been a gradual decline in recent years, which was slowed due to the Covid pandemic in early 2020. Young adults (neither in employment nor in education or training) were the hardest hit age group, with almost half of the group's population being unemployed in 2013.

Greek Renewable Energy Market Outlook

# 2

# Electricity Generation & Consumption

# The Country's Wind Potential

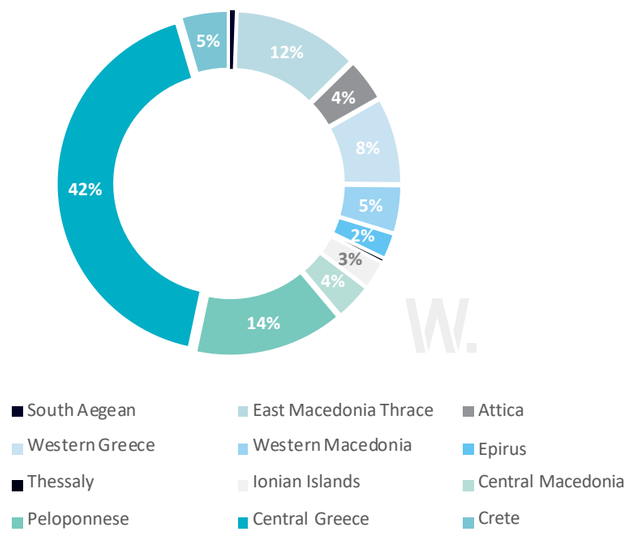



The strong wind potential of the country is mainly concentrated in the Greek islands (Crete, Aegean, Evia, etc) as indicated on the map, while areas in Northern and Western Greece are also suitable for wind project development.

Further exploitation of wind power, in combination with technological improvements in the sector and modernisation of current licensing legislation is expected to play a key role, enabling wind energy to make significant contributions towards sustainable development.

The lengthy licensing process for wind projects coupled with frequent interventions by the local communities, bureaucracy, and lack of a stable legal framework prevents many projects from reaching construction. According to the Hellenic Association of Wind Energy, it is evident that less than 13% of projects with a grid connection offer (or pending receipt of one) concern wind farms, while a whopping 85% corresponds to solar.

## Percentage of wind projects installed by region (2021)




Most of the country's installed wind capacity is currently located in the areas of central Greece and Evia Island (1863MW), Peloponnese (639MW), and Eastern Macedonia and Thrace (535.25MW).

The wind dynamics of the regions in Greece are expected to change once legislation for offshore wind is in place.

The Greek Ministry of Energy along with legislators, professional bodies, and other stakeholders have taken important steps in this direction, but to date, despite the country's significant sea fronts and high wind potential, Greece has lagged behind other EU coastal countries that are already realizing the benefits of major offshore wind projects.

Source: Rae.gr

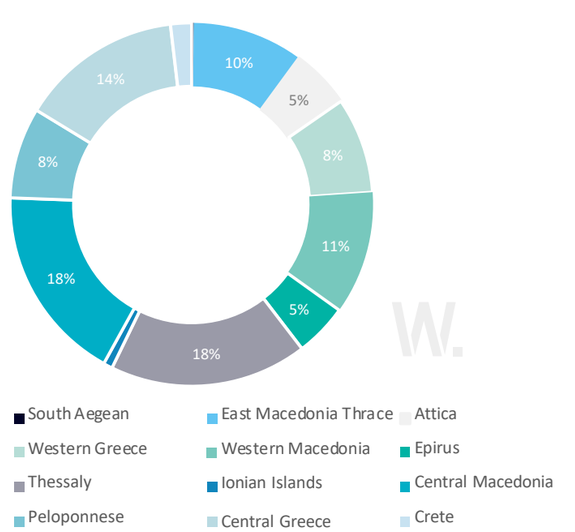


# The Country's Solar Potential


The prevailing conditions in Greece favour the development of solar PV mainly due to the high horizontal irradiation, which ranges between 1400-1800 kWh/m2 per year, depending on the latitude and topography of each region. This is evident on the solar resource map, where Peloponnese, Crete and Dodecanese islands benefit from the highest insolation, however, the whole country offers lucrative conditions for solar PV development, boasting one of the highest irradiation levels in Europe.

The steady, year-round sunlight that peaks during the summer months, conveniently coincides with the significant incoming tourism activity during the same period offering a significant seasonal correlation between energy demand and PV power generation.

## Percentage of solar projects installed by region




PV installations are nearly evenly dispersed across mainland Greece, with the largest concentration of projects in Central Macedonia and Thessaly.

At the end of 2019, the total installed solar capacity in Greece was 2,288 MW and only 7.6% of this amount was provided by large-scale PVs (above 5 MW).

The majority of the solar production comes from small PV installations (P<100kW), holding a 35.5% of the total solar capacity.

This trend will change, as there is a shift toward utility-scale projects, due to technology advancements, large foreign investors entering the Greek market, and congestion of Medium Voltage lines.

Source: Rae.gr

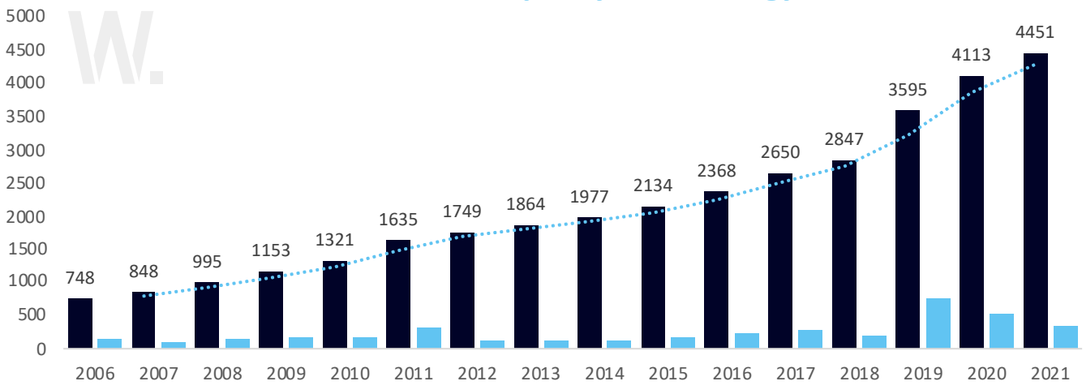
# Annual Wind & Solar Installed Capacity Growth

The Greek solar industry has experienced unprecedented growth over the last decade, with the total installed capacity of solar PV projects rising more than six-fold from 2011 to 2021.

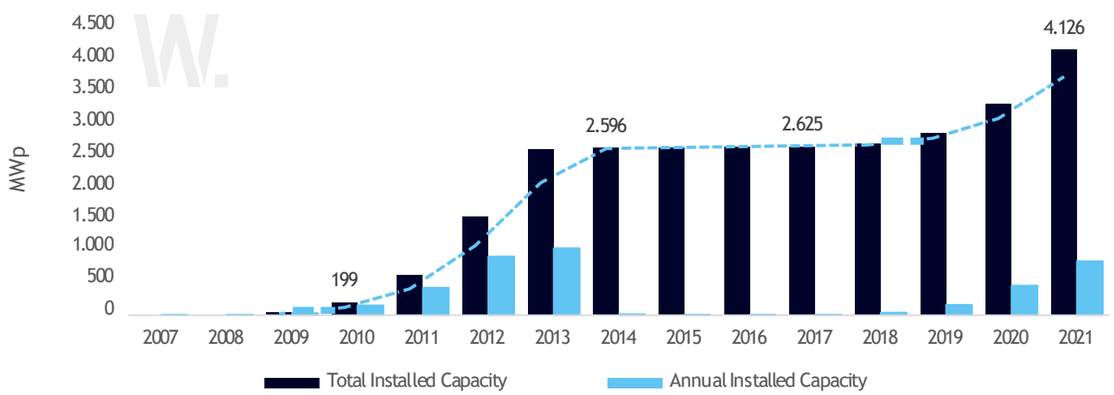
The upward trend is set to continue over the next few years, as a large number of utility-scale projects are currently under construction or at a Ready to Build stage.

The growth of installed capacity for wind projects is linear, with the total installed capacity almost tripling between 2011 and 2021. The capacity added each year ranges from 100MW to 500MW, except for 2019 when the new capacity added reached a record high of approximately 750MW.

## Total Installed Capacity Wind Energy



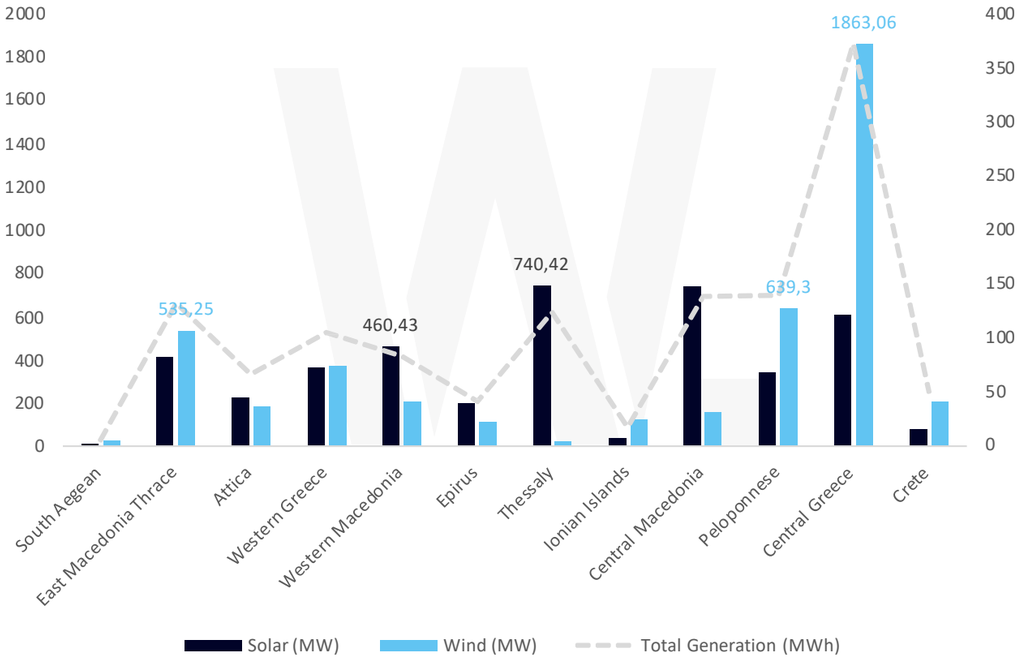

## Total installed Capacity - Solar energy



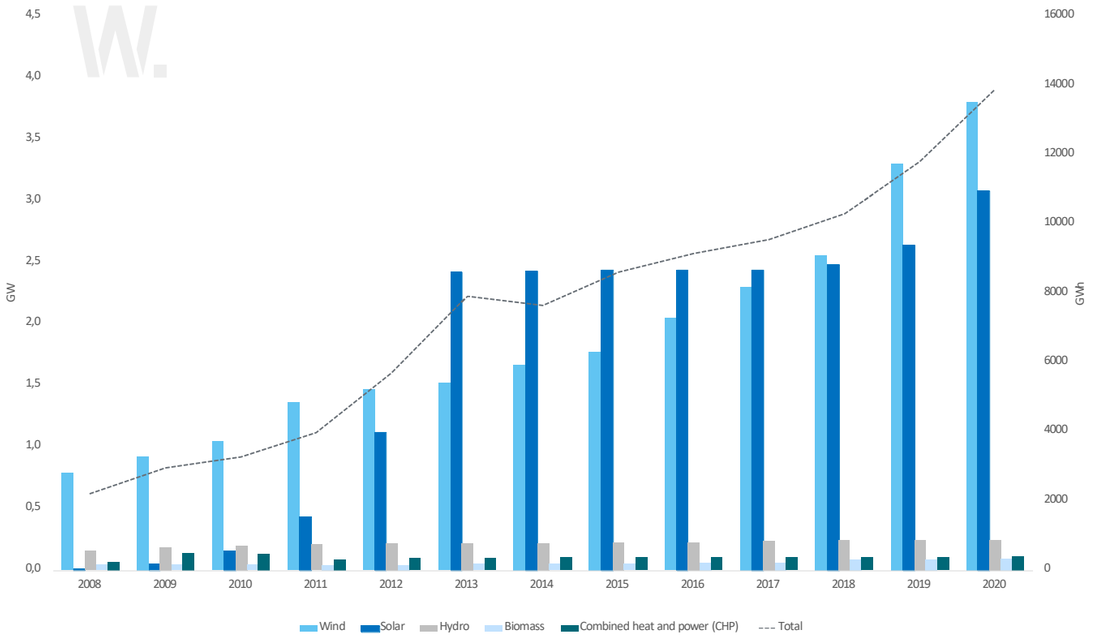

Source: IEA

Greek Renewable Energy Market Outlook

# Solar & Wind total installed capacity (GW) and total generation (GWh) by Region




# Share of total installed capacity (GW) and electricity generation (GWh) by technology in the Greek interconnected system (2008-20)



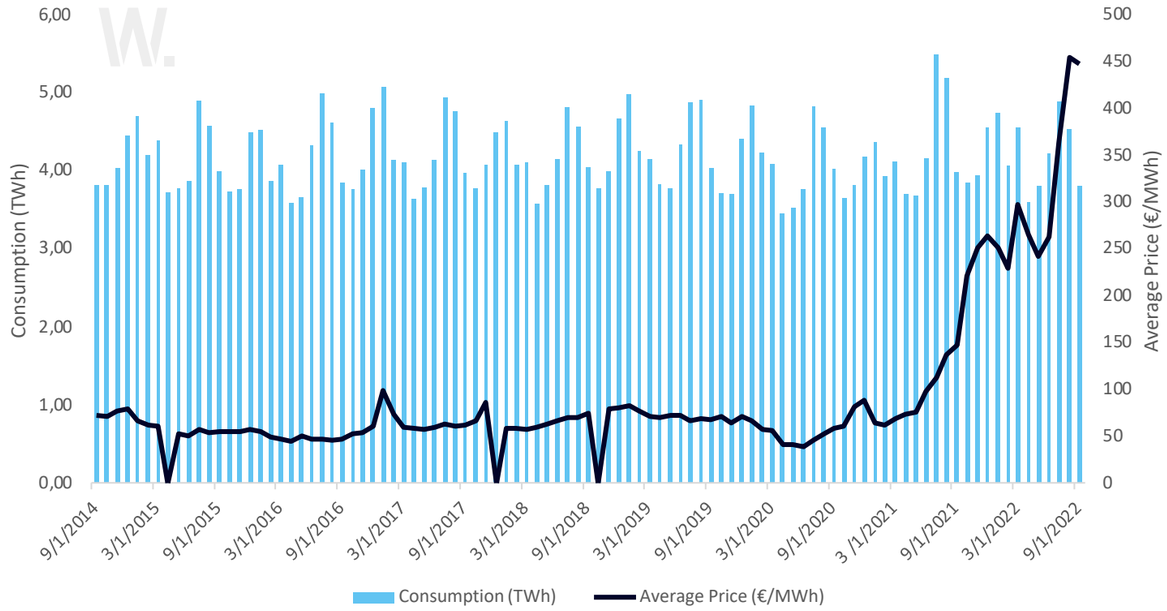

RES penetration to the Greek market follows an upward trajectory with new projects plateauing during the period between 2013 and 2018.

Hydro, biomass, and CHP are relatively steady throughout the period under consideration.

The wind has been relatively steady since 2013 with projects picking up during 2018-2020. Solar is also steadily growing, with more projects coming online during 2019 and 2020 after a relatively static period from 2013 to 2018.

Greek Renewable Energy Market Outlook

# Weighted Average Price of Electricity in Greece 2014-2022




The first signs of a potential energy crisis in Europe emerged in 2021, with gas prices rising exponentially. The TTF day-ahead went up by a whopping 585% within a year, from December 2020 to December 2021.

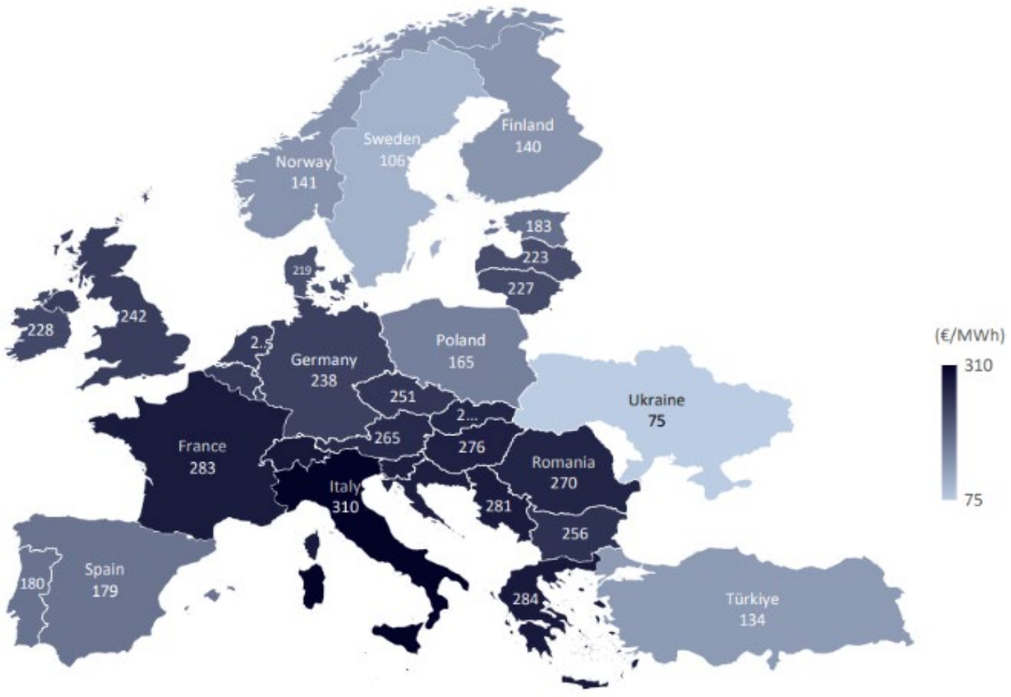
In Greece, prices reached an all-time high in August 2022, with an average price of 455.49€/MWh. This unprecedented surge in gas and subsequently energy prices has been caused by a combination of factors, as laid out below:


1. TTF Day-Ahead means the arithmetic average of the bid and offer prices of the TTF Price Assessment Day-Ahead or Weekend, as published in the ICIS European Spot Gas Markets report, in Euro/MWh; Source: Lawinsider

Source: European Union Institute for Security Studies (EUISS)

# Average Year-To-Date Spot Prices in Europe (Up to November 2022)

Average wholesale electricity prices in the Greek market were one of the highest in the region in 2022 (data up to November) with the average price for the period being 284€/MWh.



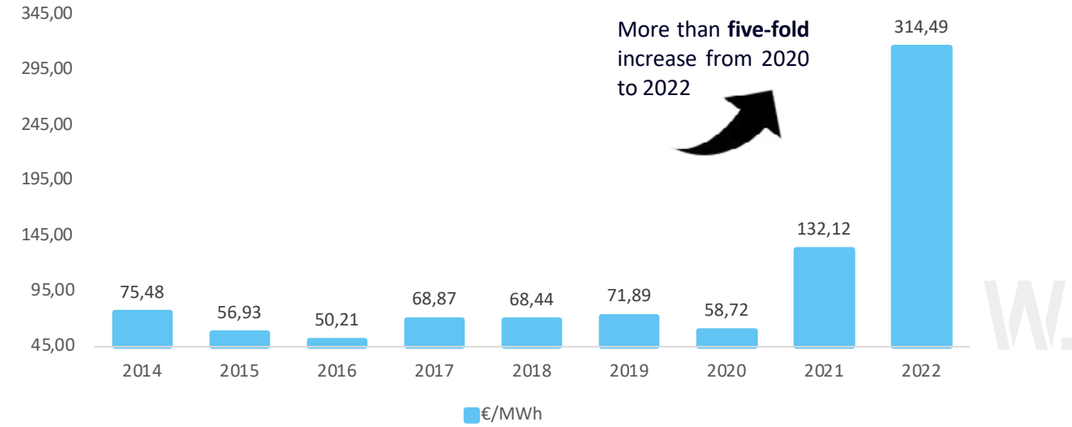

Only regions with data are displayed.

The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Wattcrop Hellas IKE concerning the legal status of any country, territory, city or area or concerning the delimitation of its frontiers or boundaries.

Source: ENTSOe, GME

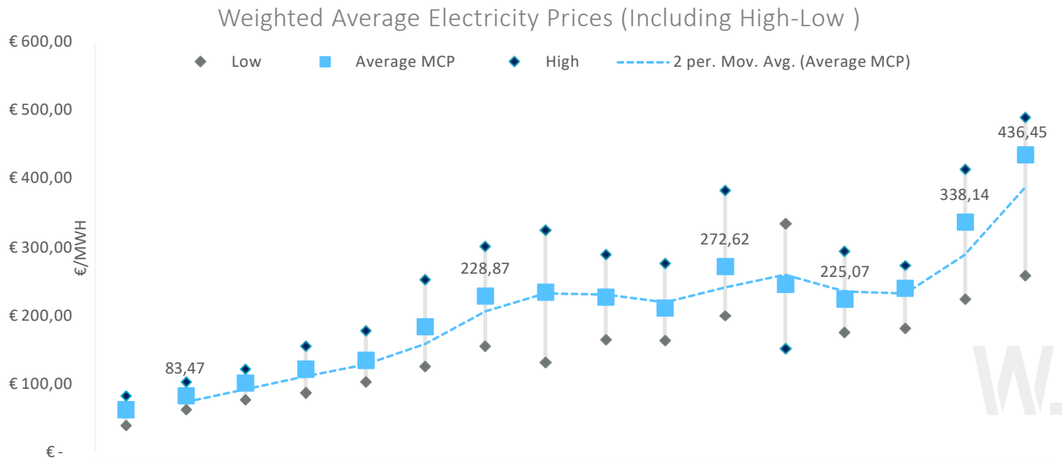


# Weighted Average Price of Electricity Market in the Interconnected System 2014-202



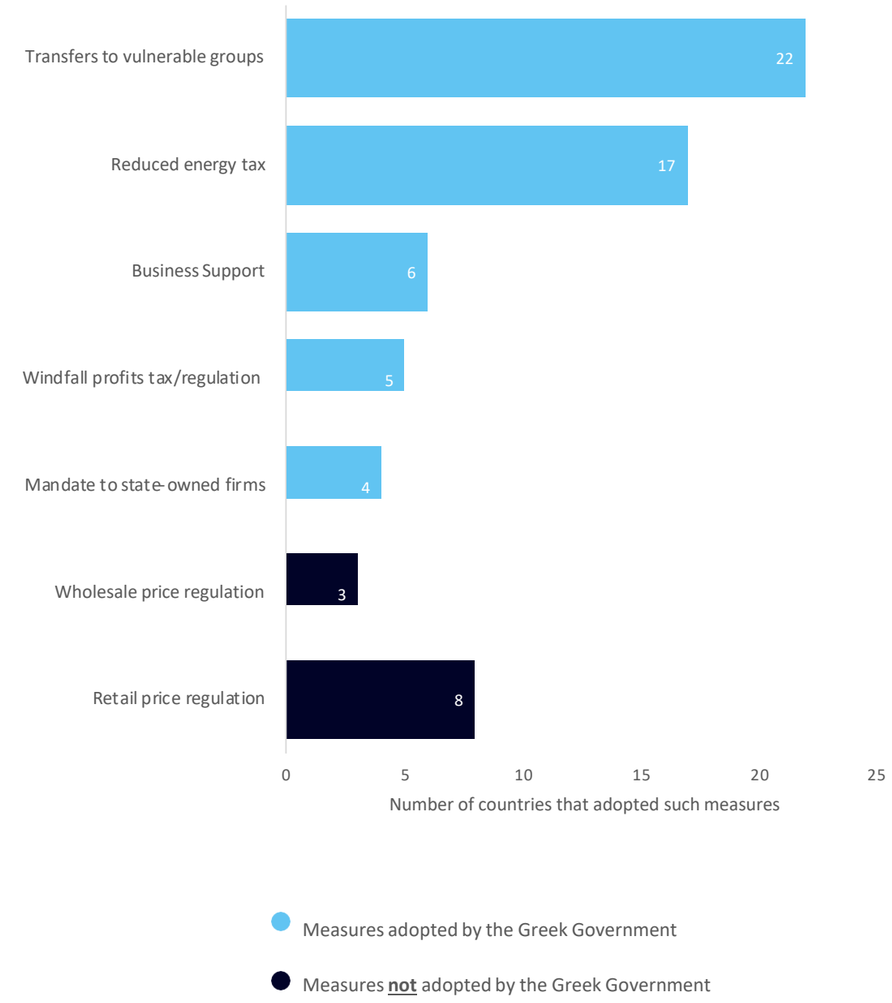

*Data up to October 2022

# Weighted Average Electricity Prices




| | May-21 | Jun-21 | Jul-21 | Aug-21 | Sep-21 | Oct-21 | Nov-21 | Dec-21 | Jan-22 | Feb-22 | Mar-22 | Apr-22 | May-22 | Jun-22 | Jul-22 | Aug-22 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Low | € 40,1 | € 63,1 | € 78,0 | € 88,0 | € 103, | € 126, | 155,98 | 132,48 | 165,93 | 164,34 | 199,60 | 334,37 | 176,20 | 180,86 | € 224, | 259,58 |
| Average MCP | € 63,1 | € 83,4 | € 101, | € 121, | € 134, | € 183, | 228,87 | 235,38 | 227,30 | 211,71 | 272,62 | 246,60 | 225,07 | 240,49 | 338,14 | 436,45 |
| High | € 83,1 | € 103, | € 122, | € 155, | € 178, | € 253, | 301,02 | 325,54 | 289,67 | 276,71 | 384,46 | 153,28 | 294,37 | 273,91 | 414,48 | 490,75 |

# Government measures to support households and businesses amid the energy crisis in Europe



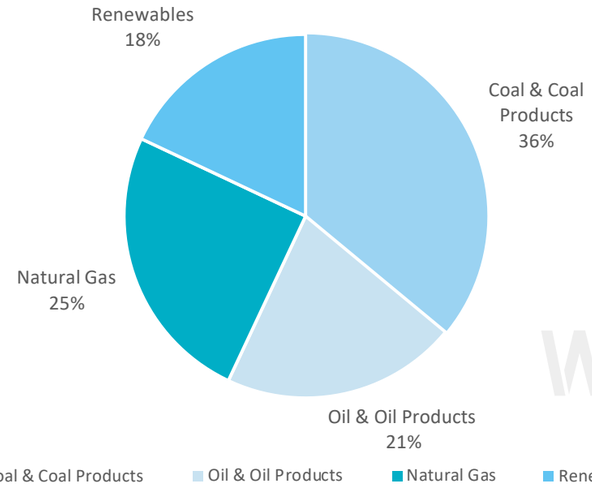

Note: The data include all EU countries, the United Kingdom and Norway

Source: www.bruegel.org

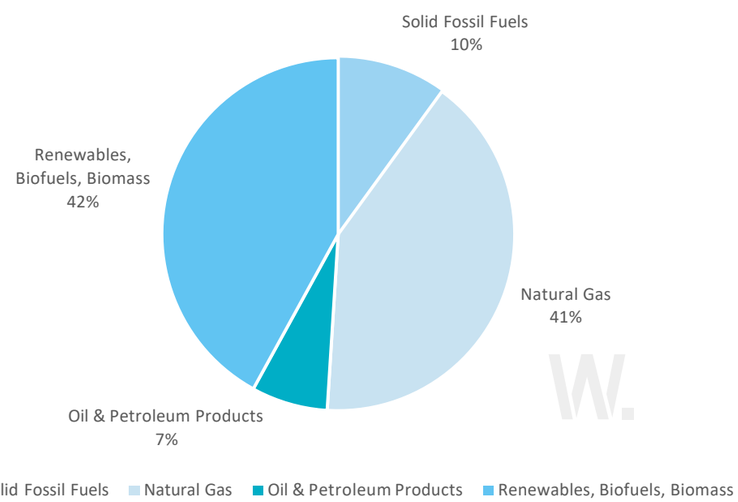
Greek Renewable Energy Market Outlook

# Greek Energy and Electricity Mix 2021

## Greek Energy Mix (2021)




## Greek Electricity Mix (2021)



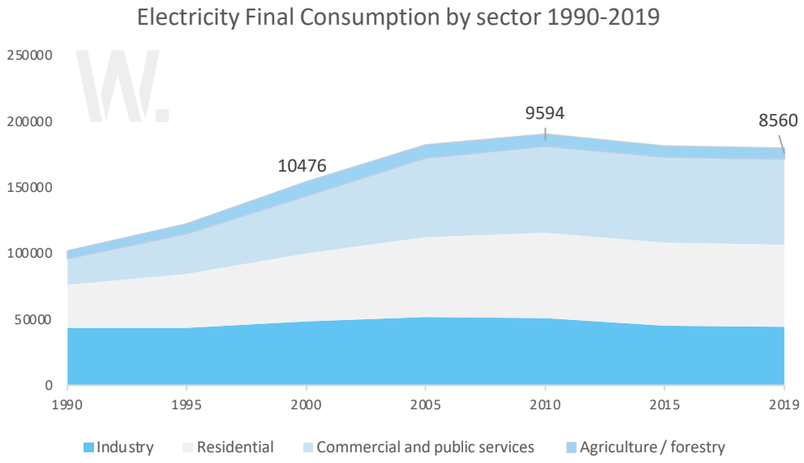

Source: DG ENER and Eurostat

Greek Renewable Energy Market Outlook

# 3

## Factors for potential electricity demand increase

# Energy Consumption Profile

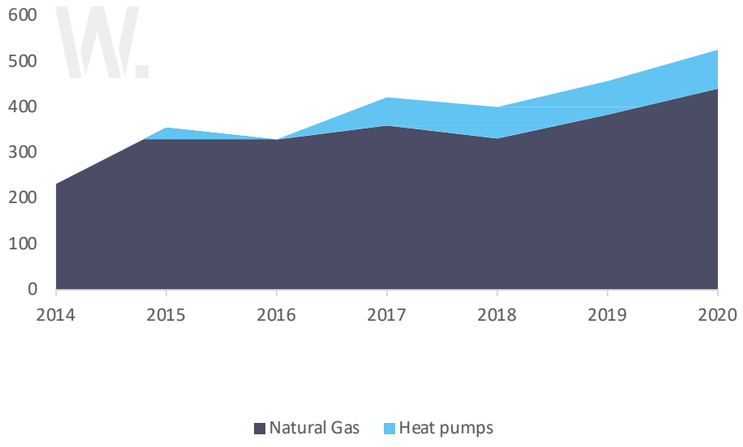



### Electricity Consumption

62,559 TJ in 2019 residential consumption
64,493 TJ in 2019 Commercial and public services consumption

### Low penetration of EVs & Hybrids

Residential and Commercial consumption is driven mainly by more densely populated urban areas.




### Air Source Heat Pumps penetration

Increased market penetration since 2014. 35.38% increase between 2015 and 2020

### Heat Pumps VS Natural Gas

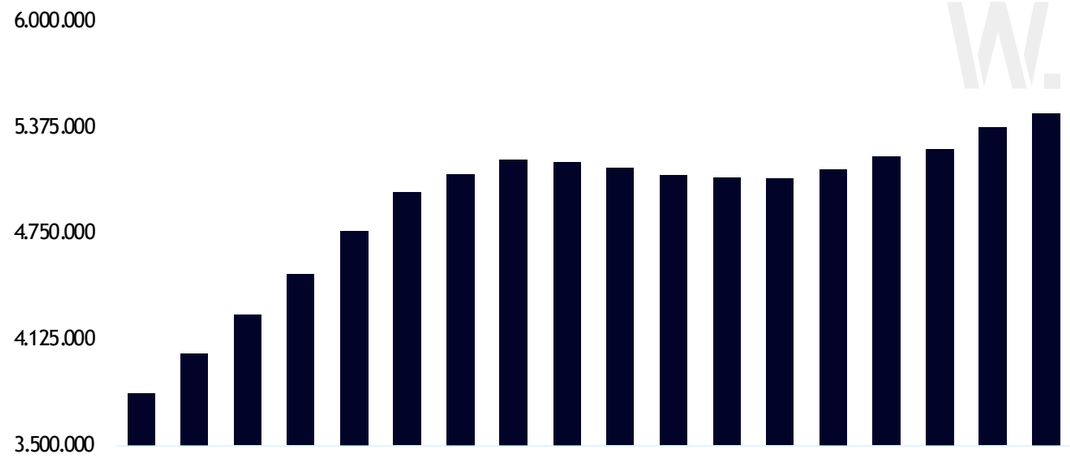
Both show upwards trends but the share of heat pumps is increasing more rapidly compared to natural gas. Increase of 22.55% in natural gas between 2015 and 2020

Source: IEA



# Passenger Vehicles & Electromobility Outlook

## Number of Private Passenger Vehicles in Greece 2003-2020




### 4th oldest fleet in Europe

over 56% of the vehicles are 10-20 years old and 25% of them are older than 20 years

### Low penetration of EVs & Hybrids

Battery electric vehicles (BEVs) and plug- in hybrid vehicles (PHEVs) did not exceed 0.33% of the overall market in August 2019.

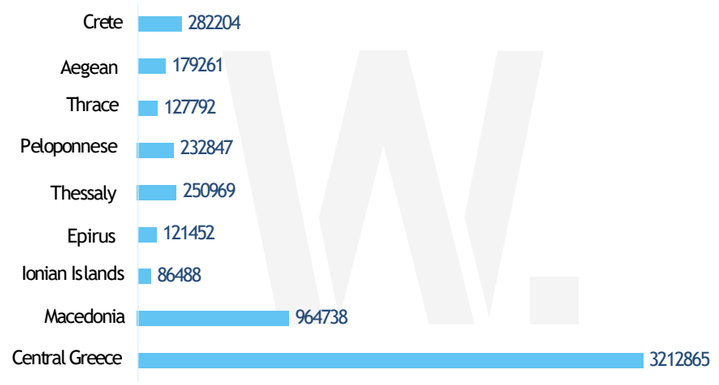
### EVs to represent 24-30%

of new vehicle registrations by 2030 according to the national energy and climate plan.

### EVs regional penetration

expected mainly in Macedonia and Central Greece reflecting the trend of urbanization being observed in the country

## Passenger vehicles per region in 2020




Source: Hellenic Statistical Authority

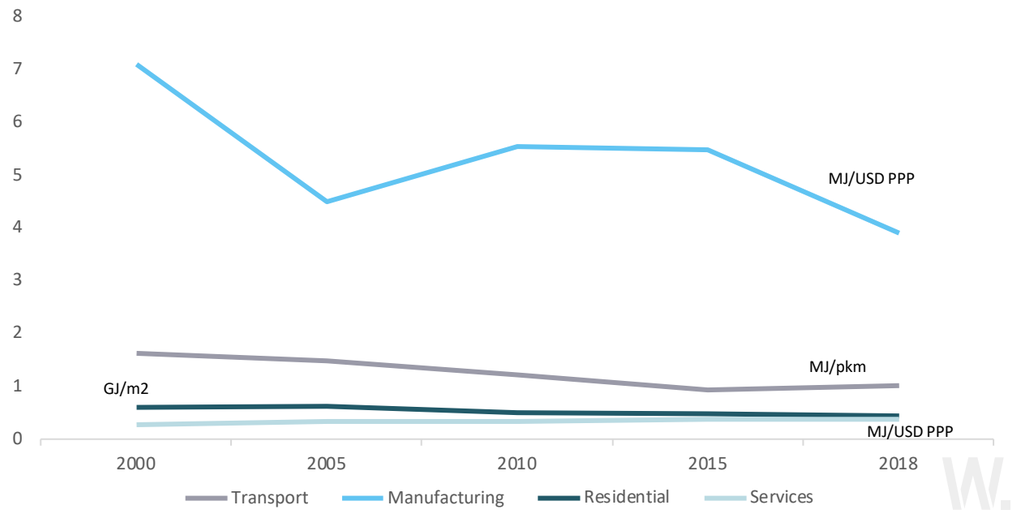
# Electricity Demand Trends

Electricity demand based on the available data will be on an upward trend given further electrification needs. The main drivers for that will be the increased requirements of EV chargers predominantly in cities and urban environments, along with the ongoing decarbonization initiative and reduction of fossil fuel energy sources.

As presented the rollout of Air Source Heat Pumps and the use of electricity for heating purposes in commercial and residential sectors will further increase the electricity consumption in specific regions with bigger cities and increased population.

This can change the grid requirements and projections of electricity consumption in the coming decades.

## Energy efficiency indicators per sector - Energy Intensity




The general trend across all sectors apart from services is that operations are becoming more energy efficient. This is driven partly because of general public expectations (modern and energy-efficient buildings and commercial/office space) but also as a result of the introduction of various Government Schemes over the past decades that subsidize improvements to existing buildings, EV charging, and eclectic car uptake, domestic solar and storage installation, and general overall green initiatives.

The government initiatives are predominantly focused on minimizing the use of fossil fuels along with an increasing trend of increased energy requirements in bigger cities and urban landscape, will have an impact not only on higher electricity demand but also on where the demand is required.

Grid expansion along with an energy storage strategy will have to align with where the main energy requirements are geographically to increase both capacity and efficiency. We believe that due to the above factors, ESEK targets will need to be revised to reflect different demands.

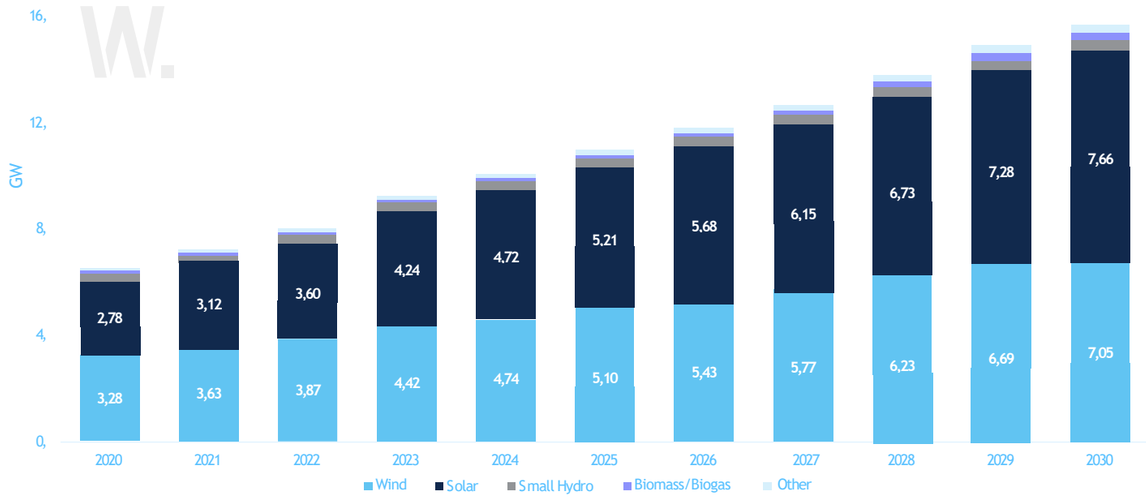
Source: IEA



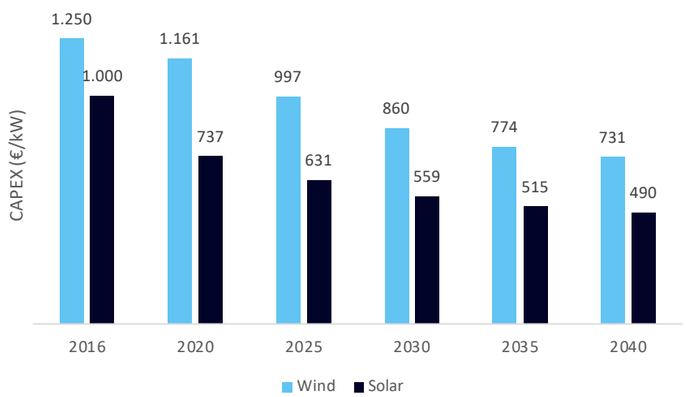
# Renewable Energy Penetration 2020-2030

The scenario, presented by in ESEK, although optimistic when drafted, seems rather pessimistic nowadays, especially if we consider the RES investments so far. Considering the grid upgrades IPTO has planned for the next decade, and the forthcoming enhancement in PV modules technology, the RES penetration seems to move forward faster than previously planned. Finally, if we take into account the framework planned for Battery Energy Storage Systems, which will help RES Integration, new targets might have to be set by the state.

The gradual interconnection of Crete, Cyclades, North Aegean, and Dodecanese with the mainland and the electrification of transport and heating/cooling will increase the electricity demand up to 61 TWh by 2030.




## CAPEX Projections for the development of solar & wind projects in Greece 2016-2040




Development costs per kW installed are expected to drop significantly for both solar and wind projects within the next decade according to estimations presented in Greece's National Energy & Climate Plan. The cost re- reduction in solar PV is sharper than the one observed in wind farms, which is still however significant compared to the current spending required. Major efficiency improvements are also expected for both technologies.

Greek Renewable Energy Market Outlook

# 4

## National Energy & Climate Plan

# Key Drivers for Renewables

## Enhancing Energy Efficiency

Final energy consumption not to exceed 16.5 Mtoe, and primary energy 21 Mtoe in 2030.
To achieve an improvement in energy efficiency by 38%

## Reducing GHG emissions and environmental objectives

Total GHG emissions to be reduced by at least 40% compared to 1990.

To shut down lignite power plants by 2028

## Increasing the RES share in energy consumption

- RES share in gross final electricity consumption to reach at least 60%
- RES share in covering heating and cooling needs to exceed 40%
- RES share in the transport sector to exceed 14% (19% attained).

## 1 Simplification of the licensing process

To cut down on project implementation times, to accelerate investment in this sector and eventually to strengthen investor confidence and thus attract new investment.

## 2 Combination of RES and storage

This combination opens up new prospects for participation in additional energy markets, such as the balancing market and the long-term capacity compensation scheme.

## 3 Licensing & Framework for Offshore wind & Floating Solar

Through a special regulatory (licensing and support scheme) and physical planning framework

## 4 Promotion of electromobility

Through an efficient package of measures and policies to facilitate the increase in the number of electric vehicles, while simultaneously building the necessary infrastructure and network

Source: EC.Europa

Greek Renewable Energy Market Outlook

**44 billion**
Prospective investments deriving from Greece's energy and climate plan by 2030

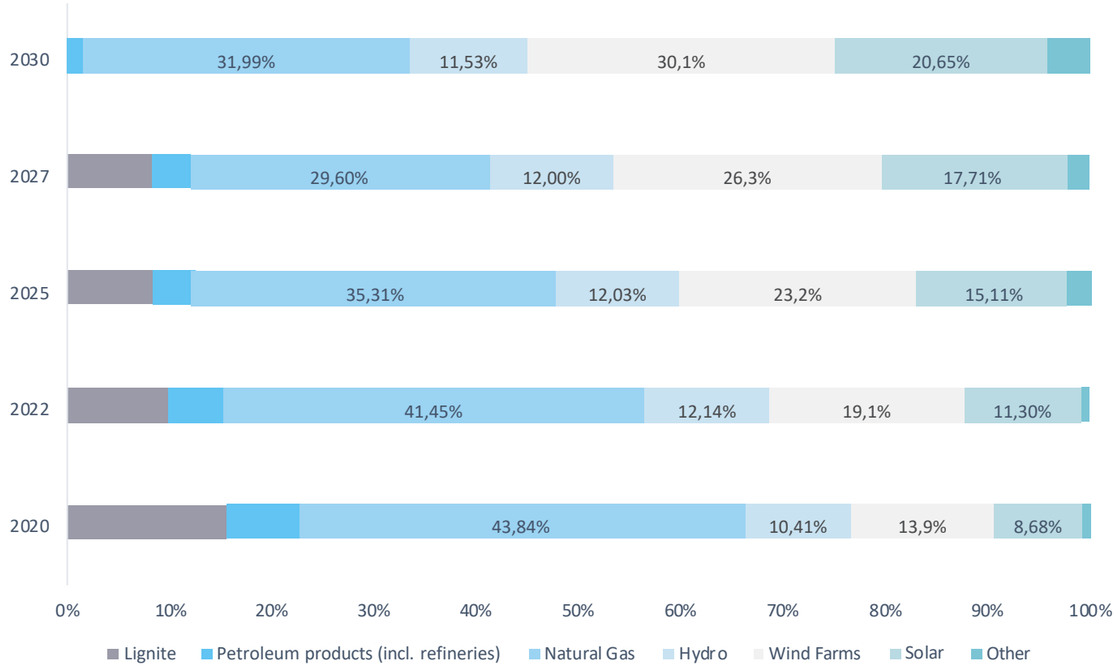
**2025**
Target date for closure of Greece's lignite-fuelled power plans

**66.5%**
Amount of net electricity generation to derive from RES by 2030

**10GW**
Est. installed RES capacity (April 2020)

Greek wind and solar installed capacity is forecasted to grow from 6.6 GW to 14.7 GW in just ten years

**Share of solar and wind in net electricity generation (GWh) 2020-2030**



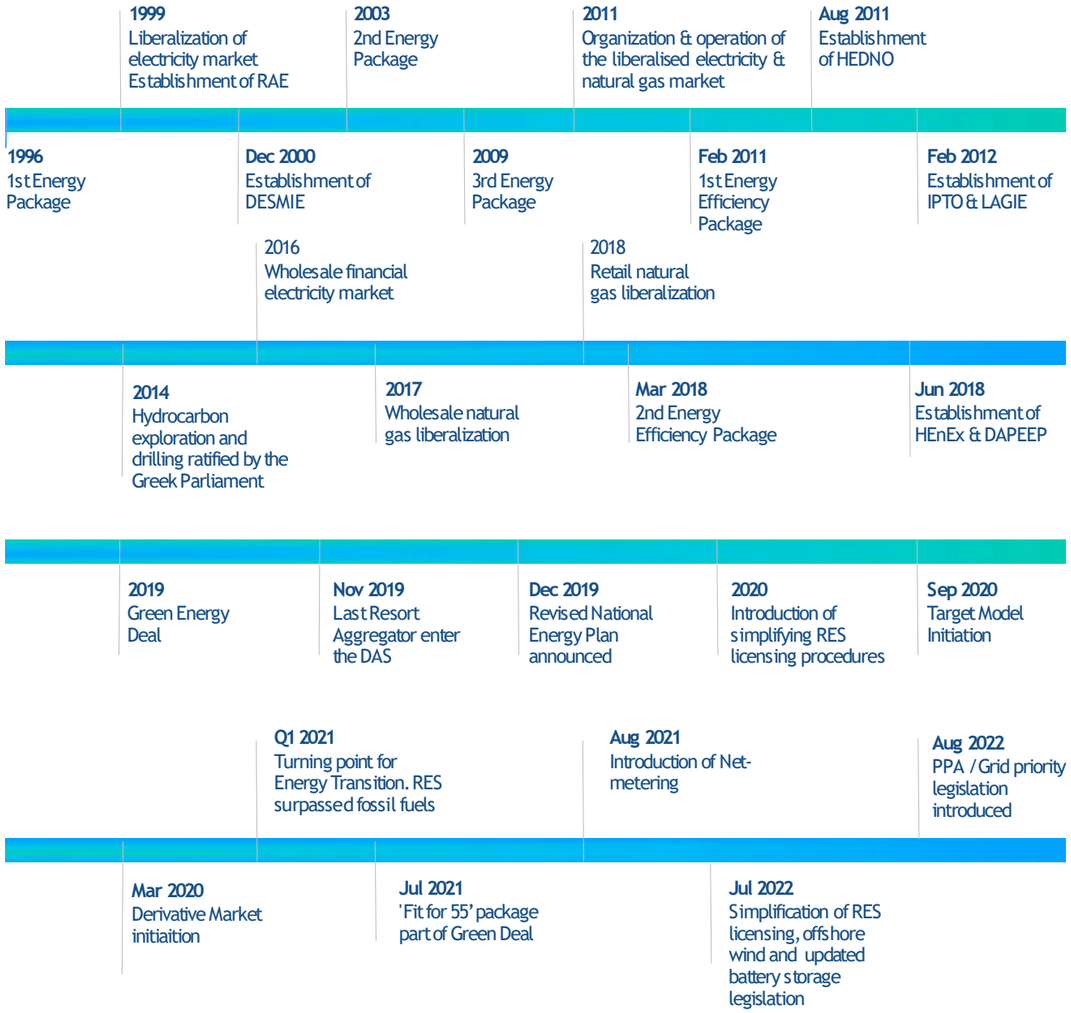

Scenario of RES growth (ESEK)

Greek Renewable Energy Market Outlook

# 5

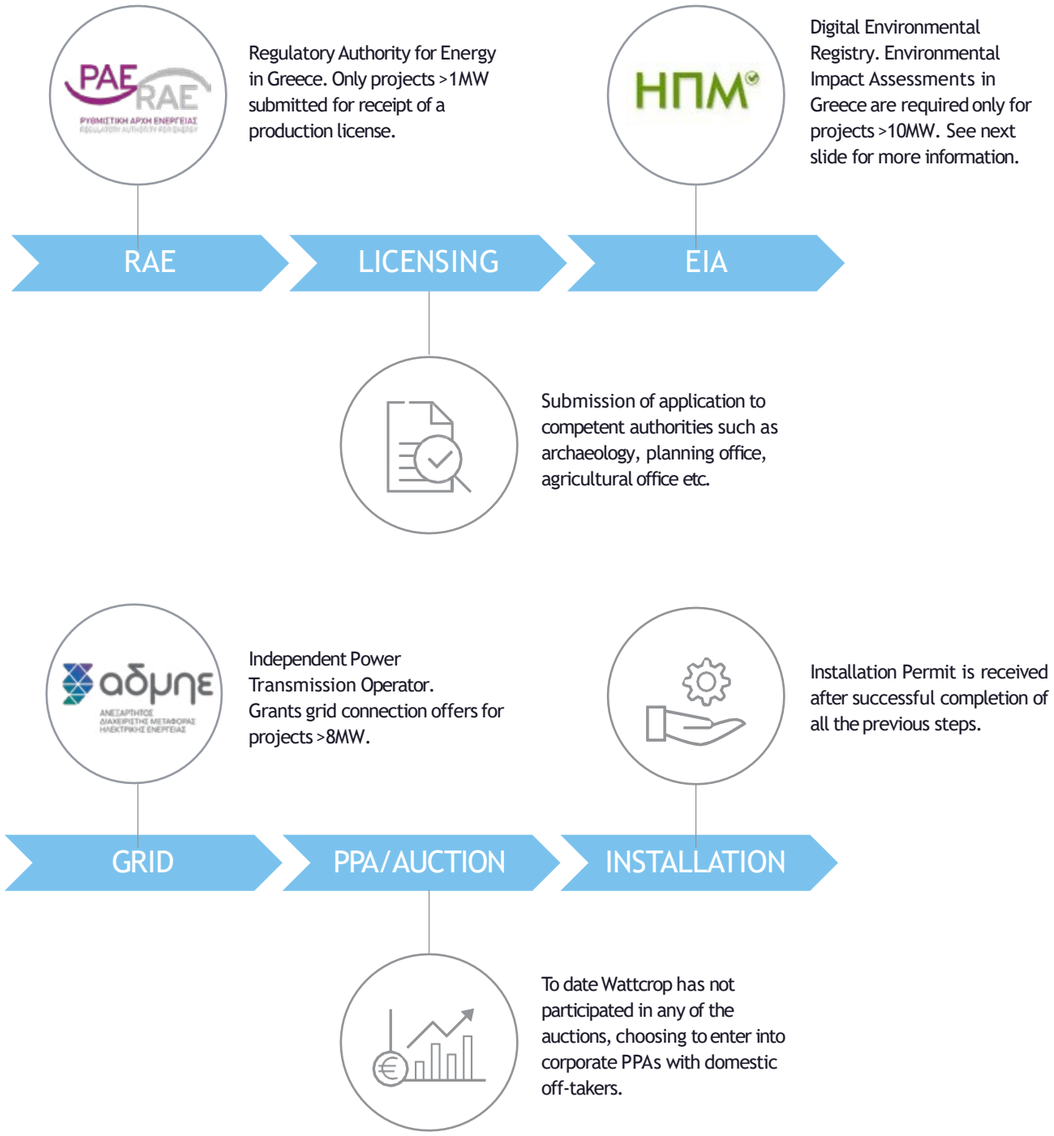
# The Greek Energy Market

# Timeline of the liberalisation process in the Greek energy market






# The licensing process in Greece for Renewable Energy Projects



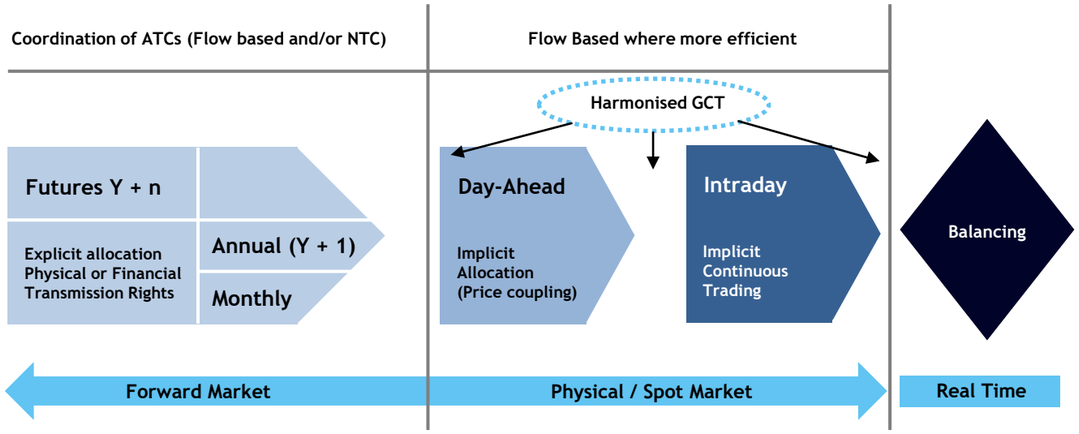
# European Target Model & Electricity Markets in SEE

Greece, among seven other countries in the Southeast Europe region, has liberalized wholesale electricity markets, operating established internal spot electricity markets.

The European Target Model includes both the explicit allocation of transmission capacities in the form of annual and monthly transmission rights (derivatives market) as well as the implicit allocation in the day-ahead and Intraday markets (spot market).

The adoption of the Target Model is expected to promote competition, increase transparency, enhance system operation through the efficient use of interconnections, and allow for the increased possibility of transactions (including exports) of electricity from RES.

The implementation of the target model replaces the day -ahead scheduling and replace it with the day ahead market, intraday market, and balancing market as per the schematic below




ATC - Available Transmission Capacity | NTC - Net Transfer Capacity | GTC - Gate Closure Time

Greek Renewable Energy Market Outlook

# Aggregators - FoSE

In Greece, the complete implementation of the target model transfers the responsibility of balancing from the IPTO to RES producers, meaning that asset owners will be fully responsible for the deviations between the declared and injected energy to the Day-Ahead Scheduling.

Therefore, due to the highly complicated process and high costs involved in forecasting, the commercial management of green units will be undertaken by the Market Aggregators (FoSE)

FoSE reduce the discrepancy between forecast and actual production and consequently, the variability of the production of RES stations. This volatility and uncertainty will be further reduced in the future when energy storage systems are proposed and implemented in the renewable energy mix.

RES projects over 400kW participate in the electrical energy market as a stand-alone project or through an aggregator (FoSE)

## Main Market Aggregators - FoSE participating in the target model

| | |
|---|---|
| Eunice Aggregation | HELPE Renewables |
| Elpedison | Solaris Power SEE |
| DEI A.E. | Forena Energy |
| Sympower Greece | AR Energy |
| Optimus Energy | Volton |
| Mytilineos | NGR Trading |
| Sentrade | Solar Energy |
| Inaccess | Motor Oil R.E. |
| Watt and Volt | Kiefer |
| Prevision Clean Energy | Vootis |
| Verd | Arinomario |
| NC Energy | Renoptipower |



Source: Enexgroup

# 6

# Power Purchase Agreements & RES Tenders

Greek Renewable Energy Market Outlook

# Evolution of the Greek PPA Market

Until recently, the PPA market in Greece was at its infancy, even though large domestic and international players are showing growing interest. Municipalities, small and large industrial consumers, large commercial enterprises, and companies with high energy costs could be potential candidates for PPAs. As pointed out by the Greek Minister of Energy & Environment in May 2021, the government's goal is for Green PPAs to cover 20% of demand in energy-intensive industries. The lack of a regulatory framework for PPAs, coupled with the heavy reliance on subsidies, did not create fruitful conditions for the corporate PPA market to flourish. Up to the first half of 2022, the only PPAs signed in Greece were from vertically integrated energy groups, between their subsidiaries. PPA contracts have many advantages for both sides: renewable energy producers or developers and large consumers (off-takers):

1. they enhance the predictability of revenue for the seller and energy costs for the buyer by reducing their exposure to energy market price fluctuations;
2. they ensure affordable prices, as they exploit the strong cost reduction in RES, and
3. implement the companies' environmental commitments for climate-neutral activities, with reflection on the general public and investors.

## PPAs Enhance:


# The Market is Maturing

The situation is now rapidly changing, as PPAs in Greece start to gain momentum. In June, the Greek energy exchange (HENEX) launched a pre-feasibility study for a non-mandatory auction platform, which suggests that HENEX is investigating the possibility of implementing Corporate PPAs. In July Cero Generation announced what is quoted as «the first private PPA-backed utility-scale solar project» for a 100MW solar project under construction in Northern Greece. In August, The Ministry of Environment and Energy issued a decree concerning the criteria for grid connection priority. Projects with a draft PPA in place, where the off-taker is a domestic industrial consumer, will be prioritized over those aiming to secure tariffs through auctions.

Source: Enexgroup

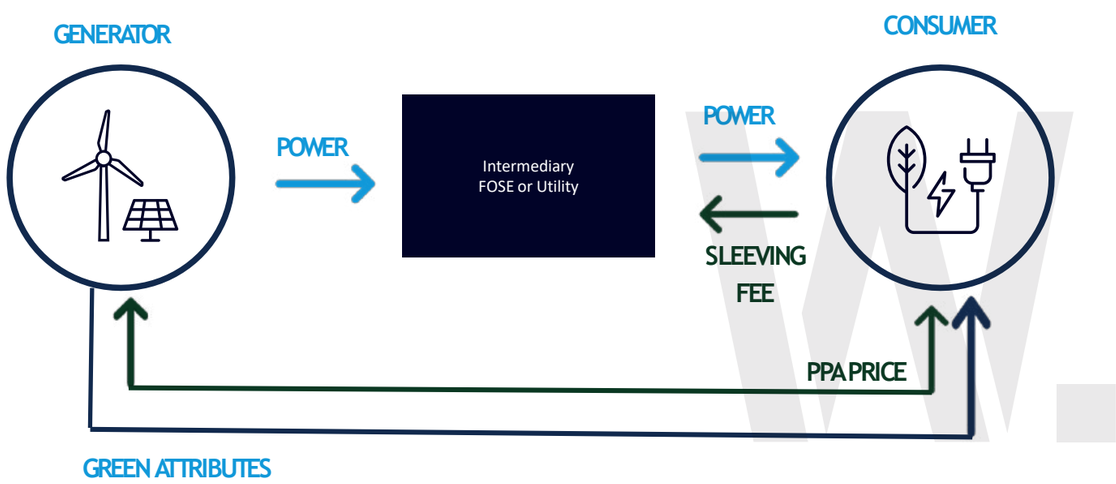
Greek Renewable Energy Market Outlook

# PPA models in the Greek Market

The dominant model of PPAs in Greece will be the sleeved PPA (as is already the case in Europe), ie a "tripartite scheme" consisting of the producer, an intermediary (supplier or FOSE), and the final consumer.

According to this model, an "intermediary" of the RES producer and the consumer either an energy supplier or a FOSE (Cumulative Representation Body), enters the agreement, to guarantee uninterrupted supply when there is a shortage from the producer/generator. The FOSE meets demand either by purchasing energy from the wholesale market or other assets of its portfolio. For this service (availability service) the supplier receives a fee from the final consumer.

**SLEEVED PPA**



# Market forces enhance PPA deployment

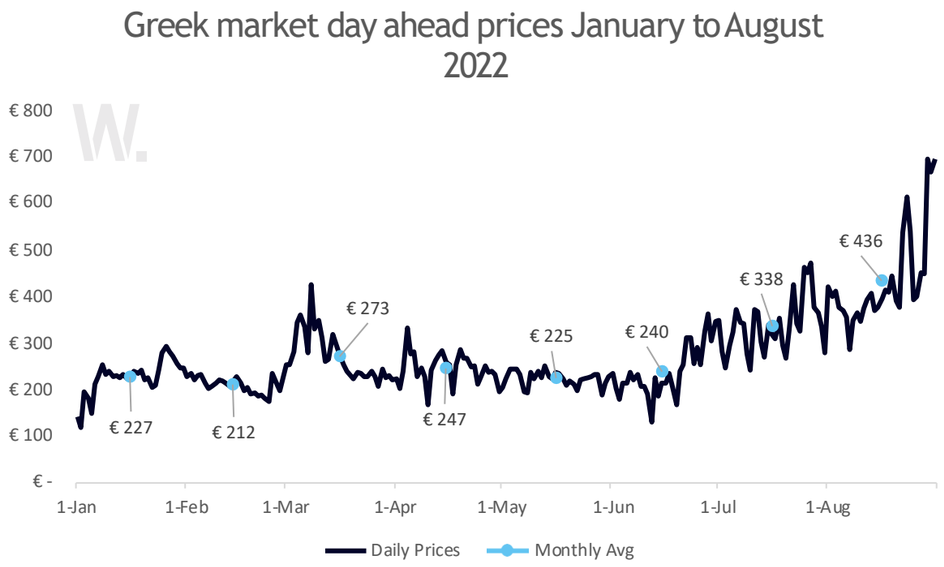
## Supply

In terms of supply, developers and investors are investigating the possibility of PPAs as the market's next growth engine; the main driver is that renewable auctions become increasingly more competitive, observing a downward pricing trend, especially for solar projects. Moreover, as seen in other markets, the 2030 NECP targets for Greece cannot be met solely through subsidised projects. As a result, merchant projects with PPAs will be crucial in realising the nation's potential for renewable energy. Another aspect of the changes in the revenue models adopted by suppliers is the change in the risk profile that the financiers and lenders are willing to accept. Both suppliers and lenders are willing to engage in discussions and leverage the high energy prices by allocating part of their production in the merchant market. Therefore, new models allow 70% - 80% of the annual yield to be secured under a PPA (until now we see that there is a requirement for a minimum 10-year tenor) and the remaining to be openly traded in the day ahead markets. However, there is a catch: the asset can borrow and is underwritten only against the secure PPA revenue value. The potential merchant revenue is disregarded in the financial structuring but can bring a significant upside to knowledgeable asset owners.

## Demand

Due to the sharp increase in power prices, medium and large industrial consumers face great challenges, and the idea of long-term PPAs starts to gain traction on the demand side; it also indicates the market's growing interest, given that ESG criteria are increasingly becoming a part of organizations' "day-to-day operations".

The following graph shows the evolution of energy prices in Greece from January 2022 to August 2022, where the impact of the disruptions due to gas shortage is evident, with the current peak in August at 697€. It goes without saying the major issue amongst industrial consumers is the cost of energy. Therefore, PPAs with bankable producers that uphold ESG and HSE criteria are very high on everyone's agenda.




Source: IENE

Greek Renewable Energy Market Outlook

# Key takeaways from the recent grid priority framework

Although the Ministerial Decree that surfaced in August 2022 does not provide the much-anticipated framework for PPAs in Greece but rather lays out the criteria for grid connection priority, it presents useful indications of how the market will evolve:

- The framework covers up to 1500MW of projects with draft PPAs until October 2022. It is uncertain whether this is the first in a series of incentives for PPA-backed projects or if the total capacity of 1.5 GW will be covered by the deadline. It sets the stage for utility-scale projects, either wind or solar, to negotiate and close bilateral supply contracts with major industrial consumers, helping the market mature rapidly. This in turn will create a snowball effect, generating more interest from developers and industry alike.
- Eligible PPAs only involve large domestic and commercial consumers, leaving households and foreign potential offtakers out of the picture - for the time being. The rationale behind this is that consumption from industrial consumers is significant and fluctuations In fixed costs, such as electricity, are devastating for their budget. At the same time, PPA negotiations with large companies can be more straightforward than structuring a product for households or navigating cross-border energy interconnections and trade rules. Nevertheless, there are cases of corporate PPAs with foreign entities, such as the collaboration between CERO Generation and AXPO, as well as products for households, like Heron ENA, a small-scale long-term PPA for residential customers.
- The minimum duration of eligible PPAs is set to 8 years, which is on the shorter side, but still renders a project bankable. This is in line with the trend observed in Europe, where in 2021 the length of publicly disclosed PPA deals was on average just over 11 years. Just 3 years earlier, in 2018 the average tenor was 14 years, dropping from 16.5 years in 2016, according to ICIS, the Independent Commodity Intelligence Services.

1500 MW total capacity

Domestic off-takers only

Minimum tenor 8 years

Source: European Commission

# PPA Pricing and the role of Greek Banks

There is no doubt that transactions involving renewable energy projects now make up a sizable share of project financings in Greece. As renewable energy projects in the country steadily move away from government subsidies toward the open market, which is volatile in terms of price, third-party funding sources, such as banks, would be unlikely to offer project financing without long-term security. In the future absence of a government subsidy, a long-term PPA provides that assurance. As banks will play an integral role in the growing PPA market, it is encouraging that they are incentivizing large clients to enter private PPAs by providing relatively low interest rates, not as favorable however as for subsidized projects. Banks consider the optimal tenor/duration for a PPA in Greece to range between 8-12 years. This provides assurance and security in terms of risk for the lender while allowing the project owner room for maneuvering if the market conditions change radically within the next decade.

Greek Banks are receptive to financing projects with long-term PPAs

Acceptable tenor between 8-12 years

Offtaker bankability is the limiting factor in Greek PPAs

# PPA Pricing and Risk Management

Signing a corporate PPA can help both buyers and sellers eliminate financial risks related to energy. However, PPAs are complex contracts with different parameters depending on the risk appetite of both sides. The structure and specific clauses of each contract, ultimately dictate how risk is allocated between the parties in terms of volume, project performance, balancing, credit, price fluctuations, tenor etc. The following table provided by RE-Source, The European platform for corporate energy sourcing, summarises the different PPA risks by category.

Source: IENE

Greek Renewable Energy Market Outlook

# PPA Outlook: The road to 2030

There is no doubt that the PPA market in Greece will evolve rapidly in the years leading to 2030. Except for the latest regulatory developments, supply and demand forces, and the receptiveness of banks to the new route to market for renewables, market sentiment, and investors' appetite also start pointing toward the direction of bilateral PPAs instead of renewable energy tenders. According to an announcement by the Energy Regulatory Authority (RAE), there were not enough applications during the latest RES tender to reach the desired competition level of 80% for the 1 GW which was originally planned as auctioned capacity. Investor interest in participating in tenders has declined significantly in the last cycle, while their interest in other types of support structures, such as corporate PPAs, has increased significantly. The auction scheme is earmarked for a finite capacity of 3.8GW additional projects, which means that investors will need to assess different solutions for the 7.5GW of projects remaining to reach the goals of Greece's revised National Energy and Climate Plan.

# Buyers' or Sellers' market?

According to Aurora Energy Research, PPA demand in 2030 is forecast to be 16% less than PPA supply.

To help large and smaller producers seamlessly participate in the PPA market, the Regulatory Authority for Energy and the Hellenic Energy Exchange started exploring options for the initiation of a centrally organised PPA platform. In the report produced by Afry on behalf of RAE, three different options are presented, each with different characteristics and levels of complexity suitable for the Greek market.

Source: European Commission

# Risks associated with corporate renewable PPAs

| Risk | Summary |
|---|---|
| Development | The renewable power plant is not consented/permitted or constructed on a timely basis or at all |
| Performance Operational | The renewable power plant does not perform as expected (for example it fails to achieve a minimum agreed level of operational availability) |
| Volume | The renewable power plant does not produce the volume expected from modeling of long-term (i.e. 20-30 years) meteorological data as a result of different than expected resource levels (wind speed /solar irradiation etc.) |
| Shape/Profile | Even if the overall volume of output is produced as expected, the hourly production from a renewable power plant will differ from a 24-hour baseload delivery of electricity (quoted for standard products). Differences in hourly prices lead to a production value that is greater or less in aggregate than the equivalent standard baseload product |
| Cannibalisation | The spot price of electricity has a negative correlation with the supply of renewable electricity, and this is expected to increase as more renewable electricity penetrates the market. For example, when the wind is blowing, more electricity from wind farms enters the grid at very low marginal cost and the abundance of cheap power pushes prices down. When the wind is not blowing and the wind farms are not producing power, spot prices are likely to rise again. The same negative correlation applies to solar photovoltaics |
| Basis | The reference price of electricity for payments in the PPA contract can differ from electricity prices that the corporate buyer is exposed to under its local (physical) electricity supply arrangements (more relevant for financial PPAs or physical PPAs in markets with zonal pricing) |
| Balancing | The hourly deviations between scheduled production and real production due to errors in weather/ electricity production forecast |
| Credit-Settlement | The buyer may pay late or fail to make a payment at all for the electricity delivered |
| Credit Replacement | The buyer may default (or the subsidy may be canceled or altered) and a replacement arrangement has to be made |
| Liquidity | Electricity cannot be traded quickly enough to avoid a change in price, determined by the bid-ask spread |
| Price | Losses can occur from adverse movements in the market price of electricity. For instance, if a corporate buyer locks in a price based on projections of future prices and the spot price falls below the agreed PPA price for long periods |
| Merchant Risk | The combination of revenue (or cost) risks for a seller (or buyer) arising from an unknown volume and unknown price of electricity to be produced |
| Tenor/Length of contract | The buyer (or seller) can be locked into costs which can be above or below market price. The risk in-increases with length of the contract |
| Legal | Credit support, Force Majeure, Change of Control, Termination, and Conditions Precedent amongst other key clauses that need to be negotiated |
| Changes in law | Changes in law may affect the balance of benefit or risk between the parties, e.g. tax changes |
| Regulatory | Regulatory changes can affect the economics of a project. For example, retroactive changes to Feed-in Tariffs systems seen in Spain, Romania and the Czech Republic in the early 2010s. |
| Forse Majeure | Events can occur which are out of the control of any of the parties involved which can delay the completion of a project or impact its generation e.g. flood, fire, or storm damage |

Source: RE-Source European platform for corporate renewable energy sourcing

Greek Renewable Energy Market Outlook

# PPAs Structure & Characteristics

It is extremely important for PPA off takers to recognise the development quality of the projects. The projects should abide with ESG standards, environmental best practices, and local community engagement

| Types of PPA | | Volume delivery obligation & delivery profile | Volume risk | Production profile risk | Merchant risk |
|---|---|---|---|---|---|
| Fixed Volume | Baseload | ■ Predefined volumes according to a predefined hourly profile<br>■ Delivery profile obligations for every hour<br>■ Pre-agreed fixed or floor price | ✓ | ✓ | ✗ |
| | Fixed Volume for defined period | ■ Annual/quarterly/monthly pre-defined volumes<br>■ Delivery profile obligation within the predefined timeframe but no matter when<br>■ Pre-agreed fixed or floor price | ✓ | ✗ | ✗ |
| Variable Volume | As-Produced ("As-Produced") | ■ Pre-agreed % of production at a pre-agreed fixed or floor price<br>■ No volume delivery obligation or delivery profile obligation | ✗ | ✗ | ✗ |
| | Route-to-Market | ■ Pre-agreed % of production at market spot price<br>■ No volume delivery obligation or delivery profile obligation<br>■ No fixed or floor price | ✗ | ✗ | ✓ |

*merchant exposure depends on the percentage of production covered by the PPA

Tenor 10-15 years Corporate PPAs

Willingness to participate in time-shifting risk management

Power off-takers looking for prices inclusive of aggregating and balancing costs

Contract structure assumptions influence the majority of the PPAs final price

Source: Acquila Capital

Greek Renewable Energy Market Outlook

# Renewable Energy Auctions in Greece

The Regulatory Authority for Energy in Greece (RAE) completed the first pilot competitive process in 2016. It then proceeded to the implementation of a permanent competitive process for the period 2018-2020, during which the 2.6GW target initially set was exceeded while there was a drastic reduction of prices which benefits consumers and the national economy.

RAE has taken the necessary steps to digitize and modernise both the submission process for a production certificate and the participation in the renewable energy auctions.

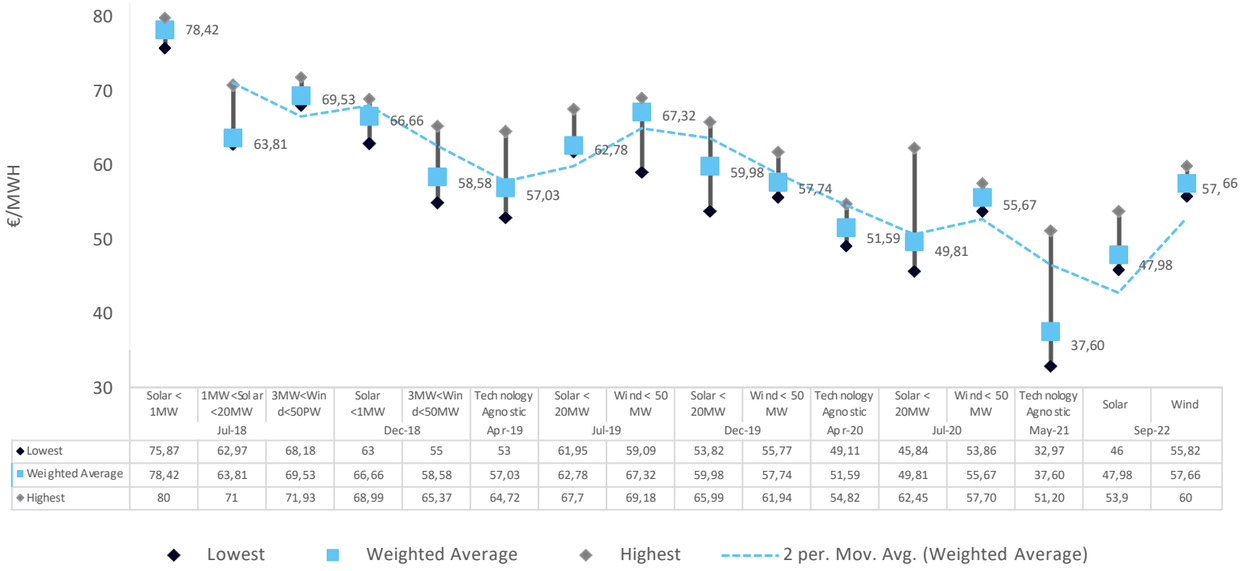
The team at Wattcrop has analyzed the results of the auctions conducted in the period 2018-2022, which are summarised in the diagram below. The price fluctuation stems from the fact that some of the auctions were technology agnostic whereas others targeted solar and wind projects separately with a cap on the total installed capacity. There is a downward trend in pricing, which is expected to intensify through 2022.

The latest RES tender for solar and wind projects took place on Monday 5th of September 2022. 34 projects with a total capacity of approximately 944.5 MW participated. The total capacity awarded in the tender was 538 MW, of which 166.25 MW was awarded to wind farms and 372.16 MW to solar projects. 21 projects were selected with a total capacity of 538 MW.

After a year and a half, the renewable energy tender was particularly important since the prices at which the wind and PV projects were locked in would also affect the prices of bilateral contracts (PPAs). Indeed, the results of the tender confirmed that the prices offered were directly linked to the market prices of the PPAs.

In particular, the lowest price agreed for photovoltaic projects was around EUR 46 per MWh, while for wind projects the lowest price was EUR 55,82 per MWh. For solar, the starting price was 54 euros per MWh, while for wind 63 euros.

## Weighted Average Auction Prices Jul 2018 - Sep 2022 (Including High-Low by category)




| | Solar < 1MW | 1MW<Solar <20MW | 3MW<Wind<50PW | Solar <1MW | 3MW<Wind<50MW | Technology Agnostic | Solar < 20MW | Wind < 50 MW | Solar < 20MW | Wind < 50 MW | Technology Agnostic | Solar < 20MW | Wind < 50 MW | Technology Agnostic | Solar | Wind |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Jul-18 | | | Dec-18 | | Apr-19 | Jul-19 | | Dec-19 | | Apr-20 | Jul-20 | | May-21 | Sep-22 | |
| Lowest | 75,87 | 62,97 | 68,18 | 63 | 55 | 53 | 61,95 | 59,09 | 53,82 | 55,77 | 49,11 | 45,84 | 53,86 | 32,97 | 46 | 55,82 |
| Weighted Average | 78,42 | 63,81 | 69,53 | 66,66 | 58,58 | 57,03 | 62,78 | 67,32 | 59,98 | 57,74 | 51,59 | 49,81 | 55,67 | 37,60 | 47,98 | 57,66 |
| Highest | 80 | 71 | 71,93 | 68,99 | 65,37 | 64,72 | 67,7 | 69,18 | 65,99 | 61,94 | 54,82 | 62,45 | 57,70 | 51,20 | 53,9 | 60 |

Greek Renewable Energy Market Outlook

7

# The Greek Electricity Grid

# Key organisations in the Greek Renewable Energy Market

ADMIE (IPTO) undertakes the role of Transmission System Operator for the Hellenic Electricity Transmission System and as such performs the duties of System operation maintenance and development, to ensure the electricity supply of Greek mainland and islands, in a safe, efficient and reliable manner.

DEDDIE (HEDNO) is responsible for the development, operation and maintenance of the Hellenic Electricity Distribution Network to ensure its reliable, efficient and safe operation. DEDDIE assures transparent and impartial access for Users (Consumers, Providers) and Suppliers in order to carry out their business operations.

The Renewable Energy Sources Operator and Guarantees of Origin (DAPEEP) manages RES and High Efficiency Electricity and Heat Cogeneration (SITHYA) of the National Interconnected System, as well as the Power Supplies provided by them. DAPEEP is the auctioneer of the rights in Greece, while at the same time operates as a Cumulative Representation Body (FOSE) of RES producers.

The Regulatory Authority for Energy (RAE) is an independent regulatory authority that was introduce with Law 2773/1999 to align with EU regulations for electricity and natural gas. RAE's main responsibility is to monitor the Greek energy market and make appropriate recommendations to the Greek Government on measures for the liberalization of the electricity and natural gas markets.

EnEx Group consists of Hellenic Energy Exchange S.A. (HEnEx S.A.) and EnEx Clearing House Single Member S.A. (EnExClear). HEnEx S.A. has been designated by the Greek Regulator (Regulatory Authority for Energy-RAE) as Nominated Electricity Market Operator (NEMO) for the operation of the Day-Ahead and Intraday Electricity Markets. EnExClear, is responsible for the clearing and settlement of transactions concluded in the Day-Ahead and Intraday Markets, for the transactions \Natural Gas Trading Platform as well as the clearing and settlement of positions in the Balancing Market.

Ministry of the Environment and Energy is a Greek government department responsible for the environmental and energy policy. It is tasked with environmental preservation and policymaking on the energy sector; environment; spatial planning and building control; waste management; and forestry.

Greek Renewable Energy Market Outlook

# The Greek Interconnection System (International Level)

Currently, the Greek and European Transmission Systems work in parallel, mainly through Ultra High Voltage (400kV) interconnections with neighbouring countries and one High Voltage DC (400kV) line; These include Albania, Bulgaria, North Macedonia, Turkey and Italy (through a HVDC 400kV submarine connection). International interconnections are vital for the System, since they enhance its stability and contribute to price harmonisation.

According to the IPTO's (ADMIE) preliminary Ten-Year Development Plan for the period 2023-2032 which was announced in March 2022, there are significant interconnections with neighbouring Systems on the pipeline.

1. Second interconnection with Bulgaria with a 400kV overhead line to be completed in Q2-Q3 of 2023.
2. Second interconnection with Italy is under discussion. The current estimates foresee a reinforcement need of 500MW-1000MW.
3. Interconnection between Greece, Cyprus and Israel is moving forward as part of the Euroasia interconnector and completion is expected by 2023.
4. Second interconnection with Turkey is under discussion with preliminary design being undertaken.

Other Interconnection plans on a preliminary stage include a new 400kV interconnection line with Albania and an upgrade of the existing 400kV line with North Macedonia and an interconnection line with Egypt. These plans are still under consideration and discussion between the Operators.

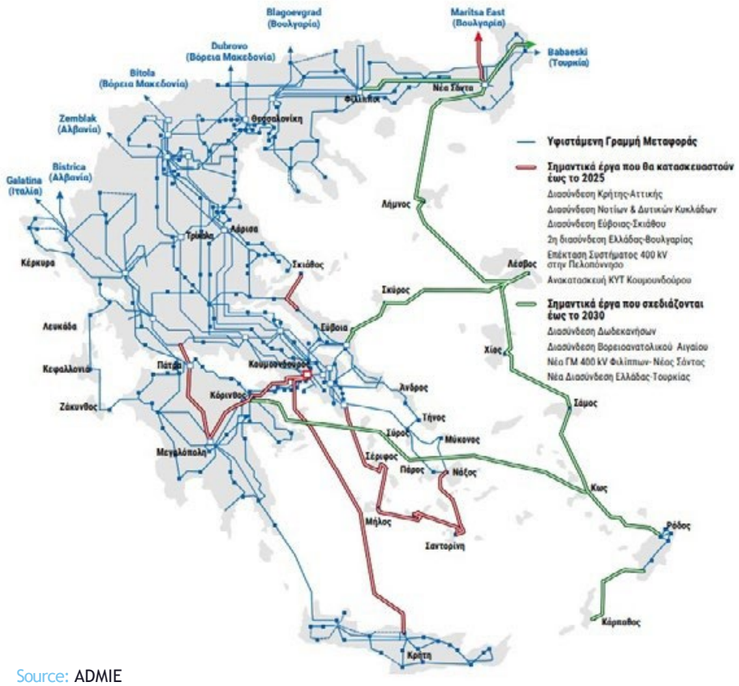
# ADMIE National Interconnections Plan up to 2032

As laid out in its Ten-year Network Development Plan 2023-2032, ADMIE plans to add new electrical interconnections to the existing Transmission System, with a major share of the expenditure allocated to the interconnection of the Greek islands with the mainland. This will facilitate and speed up the development of renewable energy plants, ending the islands' current fossil fuel dependence and upgrading the system substations.

The investment plan is already set in motion with Phase I set to be completed in 2025 which involves projects amounting EUR 1.6 bn. ADMIE has already managed to fully install an interconnection with Crete, currently the world's longest AC cable and the interconnection between Evia and Skiathos. The total investment amount for the Ten-Year plan is expected to approach EUR 4.0 bn.

## List of National Interconnections (With expected dates of completion)

- Crete-Attica Interconnection (2025)
- Expansion of 400 kV System to the Peloponnese (2025)
- New 400kV line Filippoi - Nea Santa (2025)
- Interconnection of the Dodecanese (2030)
- Interconnection of NE Aegean (2030)

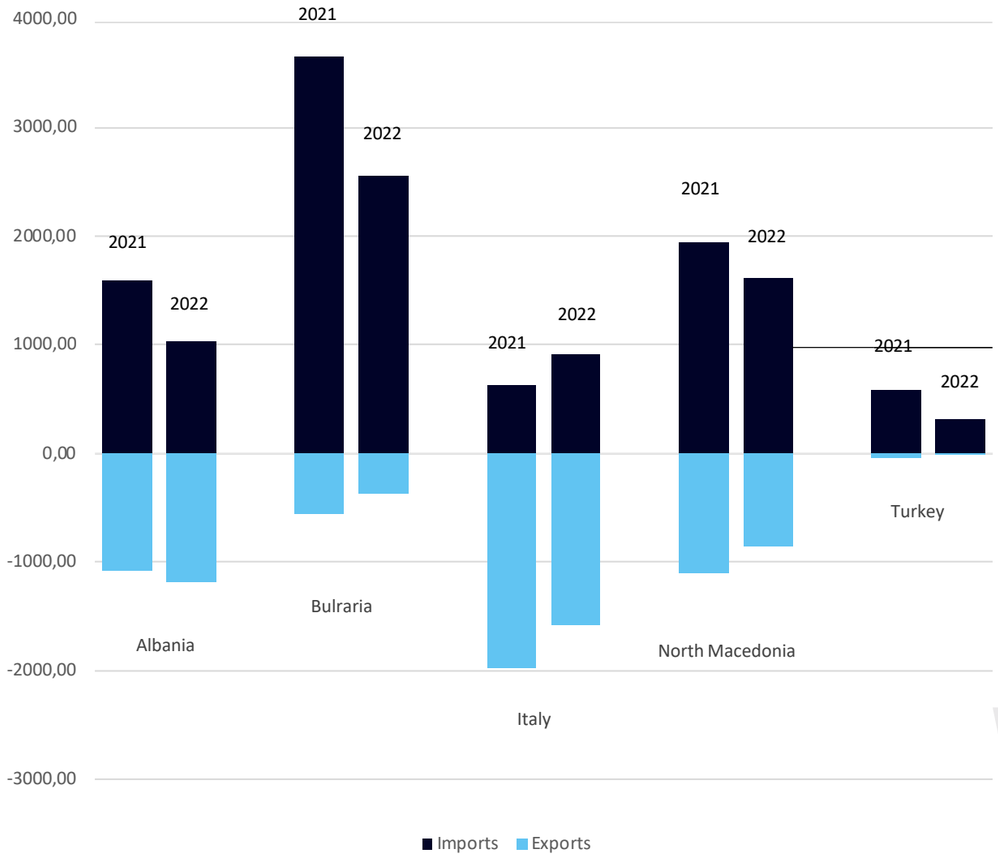



Source: ADMIE

Existing Lines
Completion date up to 2024
Completion date up to 2030



# Balance of International Interconnections 2021-2022




Greece became a net exporter during July 2022 as Balkan countries faced severe electricity production disruptions. Greece exported 351 GWh to Italy, 253 GWh to Albania, and 184 GWh to North Macedonia in July.

Overall as per the above graph Greece is a net importer of energy mainly from Bulgaria and North Macedonia, whereas we are a next exporter of electricity to Italy.

Greek Renewable Energy Market Outlook

# 8

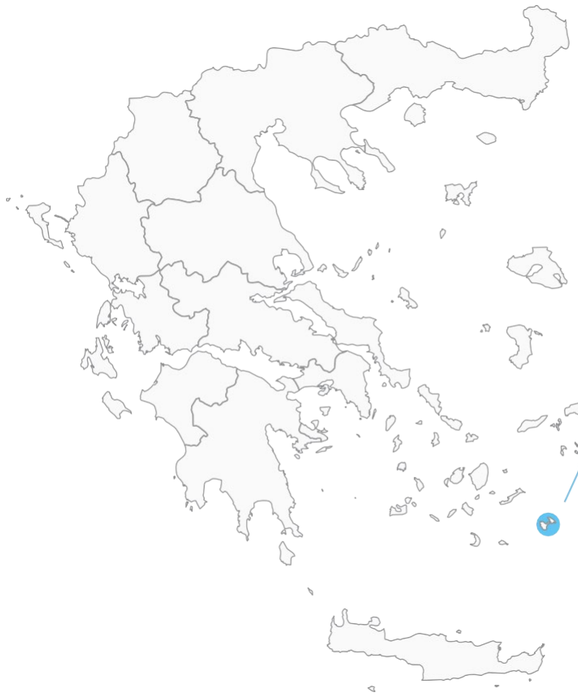
# Greek market developments and Innovations

# Sustainable Greek Islands

An initiative aiming to transform small Greek islands (with a population of up to 5.000) to green and sustainable innovation hubs. The implementation of new technologies will be directed –among others- to fields such as waste management, energy generation and green transportation.

For non-interconnected islands in Greece, fossil fuel dependence involves high transportation and heating costs.

The example set by Tilos' smart, island microgrid system, based on renewable energy and batteries, could serve as model for the expansion of renewable energy and storage-based systems to other non-interconnected islands, providing a viable alternative from polluting and expensive oil-based solutions.



### Astypalaia

Astypalaia is set to become energy sufficient, generating its power from renewable energy, coupled with storage solutions. Electrification of transport is another priority, with relevant infrastructure projects already initiated.

### Tilos

The first Mediterranean island to become entirely self-sufficient in energy featuring a clean power mini-grid which combines wind, solar and storage.

### Chalki

The first GR-eco Greek island, Chalki will benefit from the installation of solar pv, electric vehicles and charging infrastructure, among other innovations in energy and transport.

**40**

**Greek Islands**

are expected to benefit from the GR-ECO islands initiative

| | | | | | | |
|---|---|---|---|---|---|---|
| Symi | Kasos | Nisyros | Foynoi | Irakleia | Koufonisi | Serifos |
| Agathonisi | Pserimos | Tilos | Thymaina | Antiparos | Folegandros | Sifnos |
| Megisti | Gyali | Megalonisi | Amorgos | Sxoinoysa | Thirasia | Kea |
| Arkioi | Leipsoi | Oinoysses | Anafi | Ios | Kythnos | |
| Marathi | Telendos | Psara | Donoysa | Sikinos | Kimwlos | |

Greek Renewable Energy Market Outlook

# Offshore wind – Key Drivers & Challenges to 2030

## Main drivers of change

- The ambitious goals set by the NECP*
- The country's geography and wind potential
- The immediate necessity for new capacity due to the decommissioning of the lignite-fired power plants.
- The limitations of on-shore wind farms (availability of land, opposition by the local communities, need for grid reinforcements, environmental concerns, wayleaves and earthworks required, turbine size compared to offshore etc).

## Main challenges

- **Technical Challenges** such as the steep sea-bed drop-off around mainland Greece and around most of the Greek islands.
- **Foreign affairs policy issues**, mainly due to territorial disputes in the Aegean Sea.
- **Legislative Challenges** which stem from the lack of a clear national regulatory framework, which adequately addresses spatial planning, licensing, grid interconnection and economic support issues.

## The bright side

- In 2022, the Greek government introduced the regulatory framework for offshore wind development. This sets the foundations for the rapid development of the sector within the next decade.
- Next steps: The market now anticipates the National Offshore Wind Farm Development Programme which will map out designated maritime zones for the development of offshore wind farms.

# Battery Storage

Battery storage was introduced in July 2022 and there was immediate interest from investors that have applied for Storage licenses .The current status for stand alone and collocated asset significantly overpasses the target of 1.5GW of energy storage that is in the current ESEK. The target is expected to be revised in the new ESEK in line with market expectations and requirements to enable further penetration of RES projects.

In accordance with the European Market Monitor on Energy Storage (EMMES) the forecast installed capacity for batteries is 3650MW. Based on the energy storage target for 2030 and beyond, the current projections and further penetration of RES will increase requirements for hourly, daily weekly and seasonal storage. On average 20% of electricity production for RES will require seasonal storage, 20% daily/weekly storage, and 60% hourly storage.

Source: : European Association for Storage of Energy (EASE)

Batteries |Stand-Alone AC

24.84 GW of applications

18.17 GW Storage Licenses

Batteries |Co-location

BEES with RES

1.67 GW of applications and storage licenses

## Battery Storage Outlook

- Based on current projections on RES installed capacity and on the fact that hourly storage will predominantly be provided by batteries, the energy storage requirements by 2030 is expected to be between 5 – 8 GW.
- The above aligns with the expectation of increasing the energy capacity in the revised ESEK to 5 to 8 GW by 2030.
- The spatial plan which is expected to be revised will set out any restrictions on land that cannot be used for battery storage development (i.e. high productivity agricultural land) but this may clash with the areas that will require battery storage to balance the grid.

## Energy Storage Auctions

- The current auction scheme aims to support and 900MW of storage projects selected through two separate bidding processes. The first one is expected in Q1 2023 for 450MW stand alone BESS and the second one for the remaining 450MW in Q2 2023.
- The target date for completion of the first 900MW of stand alone battery storage is end of 2025 which is inline with approved EU Recovery and Resilience Facility Greek scheme (budget of €341 million to support construction and operation of storage facilities). The scheme will offer support in the form of investment grant or annual support for the first 10 years of operation of the projects.

## Energy Storage Framework

- The IPTO will make the necessary changes to the Transmition System Code to enable battery storage projects to connect to the grid. This will introduce minimum technical and operational standards as well as static and dynamic curtailment limits.
- The IPTO will undertake the necessary technical studies to define the aforementioned static and dynamic limits.

## Residential Storage Systems

The government aims to introduce a financial support scheme for residential PV systems coupled with storage.

Greek Renewable Energy Market Outlook

# Hydrogen

## Greece could play a decisive role in the European Hydrogen Strategy

Hydrogen came to the spotlight as discussions about Europe's energy security intensified in light of the Russian invasion in Ukraine. Hydrogen is set to play a key role in the energy transition, working alongside renewable energy projects. Hydrogen will mainly replace natural gas, which is currently imported, and secondarily petroleum products in refineries, transport, and industrial sectors.

The current projections for the Greek market up to 2030 estimate a total capacity of 750MW of hydrogen projects, which translates into 3,500GWh of green hydrogen, produced through electrolysis. To operate, this will require 3GW of renewable energy assets (80% solar and 20% wind). Members of the "National Strategy for the Promotion of Technologies - Applications of Hydrogen and Renewable Gases" Committee calculated some of the effects of the programme on an annual basis:

**750 $ktCO_2$**

Reduction of Co2 emissions

**3-4 billion**

Total Investments in the hydrogen supply chain (€)

**90-110 million**

Domestic added value (€)

**500 ktoe**

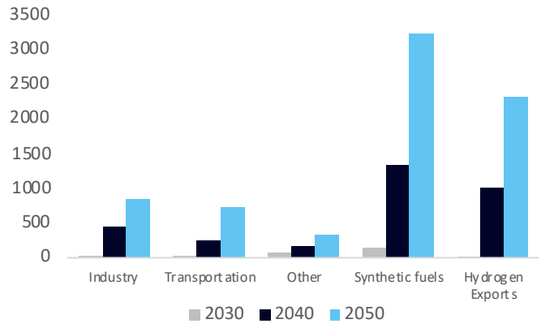
Reduction of gas and oil imports

**3000-4000**

Jobs in the hydrogen supply chain

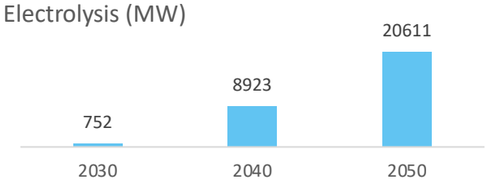
Source: ot.g

### Hydrogen Uses

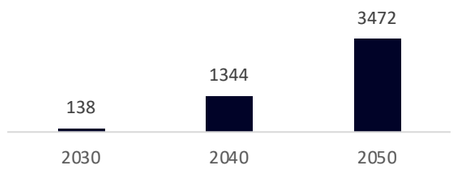



### Domestic Production Units

Electrolysis (MW)




Synthetic Fuels (ktoe/annum)



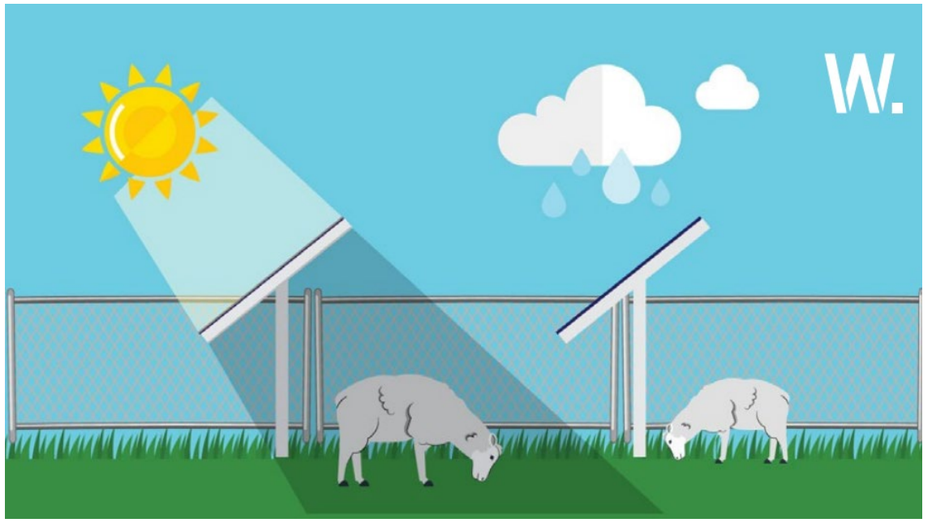
# Technologies with no precise legislation in Greece

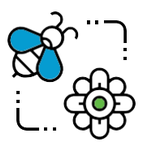
## Agri-PV

### Can agriculture and solar PV work hand in hand for a more sustainable future?

The rapid deployment of renewable energy sources is a necessity not only to help tackle the effects of climate change, but also to enhance Europe's energy security. Agrivoltaics or agri-pv is an innovative solution to help with the deployment of more solar projects, without restricting the land use solely for electricity generation. Agrivoltaics allow the coexistence of solar and crops or animals for grazing, with multiple benefits for both.

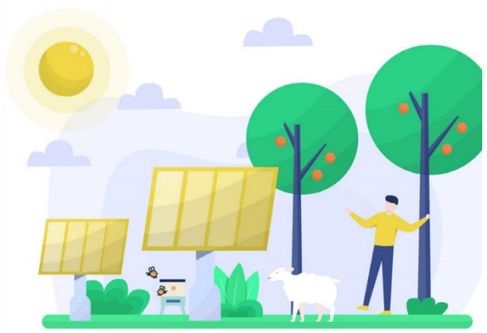
Even though the technology is already widely accepted in more mature markets, there is no provision in the Greek legislation for agri-PV projects yet. Given the latest developments in the market and the government's eagerness to embrace and accelerate renewable energy project development, we expect a framework for agri-PV to emerge soon.



Wattcrop has produced a detailed, free to download Agri-PV guide (in Greek).

Get your copy here:
https://wattcrop.com/resources

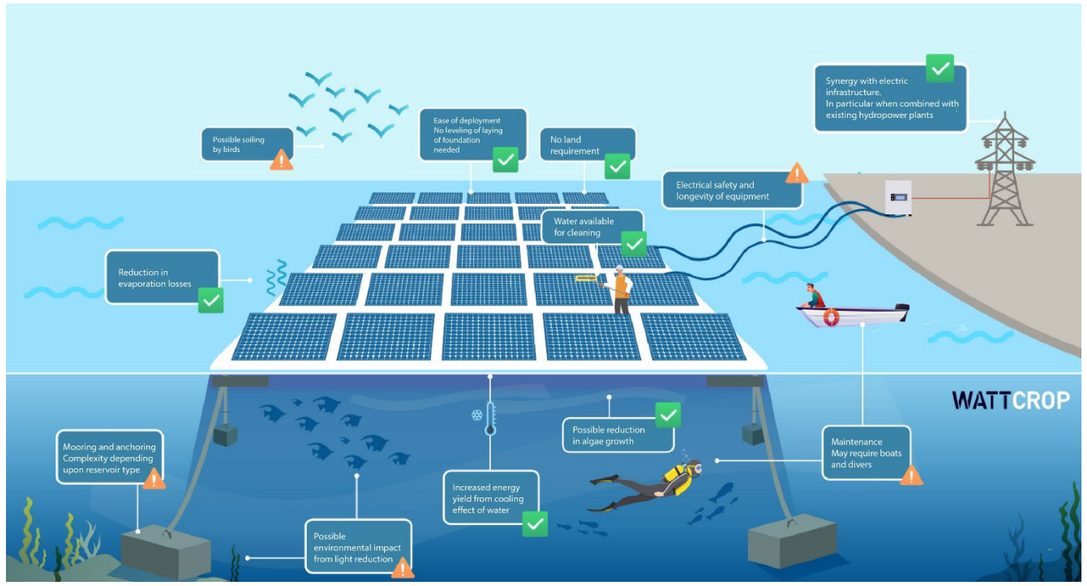


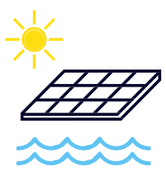


# Floating Solar

### Can solar PV deployment be maximized without compromising high value agricultural land?

Floating solar installations are PV panels installed on floaters on water bodies, without the requirements for land. Floating solar has seen rapid growth since 2016 and projections for installations worldwide show total installed capacity of circa 4000MW by 2026. This is reflective of the numerous advantages of floating solar installations both financially and environ- mentally. The vast amount of floating solar installations is currently in Asia with the EU and USA following. In Greece law 4951/2022 introduces the development framework for 10 pilot sea floating solar projects with installed capacity between 0.5 - 1 MW. There is lack of legal framework for floating solar schemes in lakes and reservoirs which is a major drawback due to the complexity of developing floating solar parks in the sea.



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Greek Renewable Energy Market Outlook

# 9

# Legislation

# Three renewable energy laws introduced that change the legal landscape

## Law 4951/2022 (OJ 129/A/04.07.2022) "Simplification of RES licensing process"

The RES licensing process is simplified with the introduction of Law 4951/2022. The specific law also covers the licensing process for electrical energy storage systems; introduces a framework for the development of pilot offshore floating solar projects; and specific amendments for energy and environmental protection

## Ministerial decree 484014/7123 (OJ 433/B /12.08.2022) on Grid priorities and PPAs"

This law introduces a framework which sets out specific categories of RES, S.I.TH.Y.A. and storage projects that are set to be prioritised to receive Grid Offers.

## Law 4946/2022 (OJ 150/A/30.07.2022) on the Simplification of the environmental legislation and offshore wind

This law introduces procedures for the simplification of the environmental licensing process; introduction of a framework for the development of offshore wind projects; measures for the energy crisis and environmental protection

Source: Ministry of Energy - YPEN

# Further Simplification of RES licensing

## The energy ministry plans passed the long awaited bill which became Law 4951/2022 RES licensing simplifications concerning new projects.

The main changes to the licensing process include:

- Reduction of the average licensing period for new Renewable Energy Projects from give years to 14 months.
- Digitalisation and simplification of the licensing process using a single platform for all applications.
- Increased capacity of the electricity network to enable integration of more Renewable Energy projects

The main changes for storage projects include:

- National target for the development of electricity storage projects with an installed capacity of at least 3.5 GW by 2030; Market expectations is that the target will be revised (to at least double the energy capacity) in the updated National Energy and Climate Plan as the current target is pessimistic for the size of the market.
- Planning has first storage tenders in Greece. Two tenders will be held, which will probably share 50 % of the total capacity (up to 900 MW). The first tender is expected to take place in Q2 2023, while the second is set for Q3 2023. Participants will be able to claim both a CAPEX subsidy and a 10-year tariff.

Source: Energypress



# Offshore Wind – legal framework

## Introduction of law 4946/2022 sets the legal framework for offshore wind projects

The introduction of the specific law aims to kick-start the development of offshore wind projects, which will contribute towards the reduction energy dependency, decarbonization and dependency on fossil fuel. The aspiration is to construct 2 GW of offshore wind projects by 2030.

The key items introduced are:

- A national plan will be established imminently which will set out the areas of organized development of off-shore wind projects. The national plan will also set the conditions for development of off-shore wind projects.
- Specific exploration licenses will be issued to complete surveys, measurements and preliminary design in the areas of organized development.
- Following the exploration licensing process, a competitive tendering process will determine who will be licensed to develop and operate off-shore projects in the specific development areas.
- The competitive tendering process main criteria will be lowest offer in Euro per MWh.
- Further areas of organized development for off-shore wind will be introduced, following the issue of exploration licenses for the previously determined areas.

Source: ec.europa

# Grid Priority Framework & PPAs

## In late summer 2022 the Greek Government issued a ministerial decree for the introduction of priorities for grid offer.

The decree established specific categories and projects in specific areas that would be prioritized. Among other priorities, the decree covers up to 1500MW of projects with draft PPAs unit October 2022.

It is still uncertain whether this is the first in a series of incentives for PPA-backed projects but the general expectation is that other such initiatives will follow.

- Eligible PPAs only involve large domestic and commercial consumers, leaving households and foreign poten- tial offtakers out of the picture – for the time being.
- The minimum duration of eligible PPAs is set to 8 years, which is on the shorter side, but still renders a project bankable.



Source: Energypress

Greek Renewable Energy Market Outlook

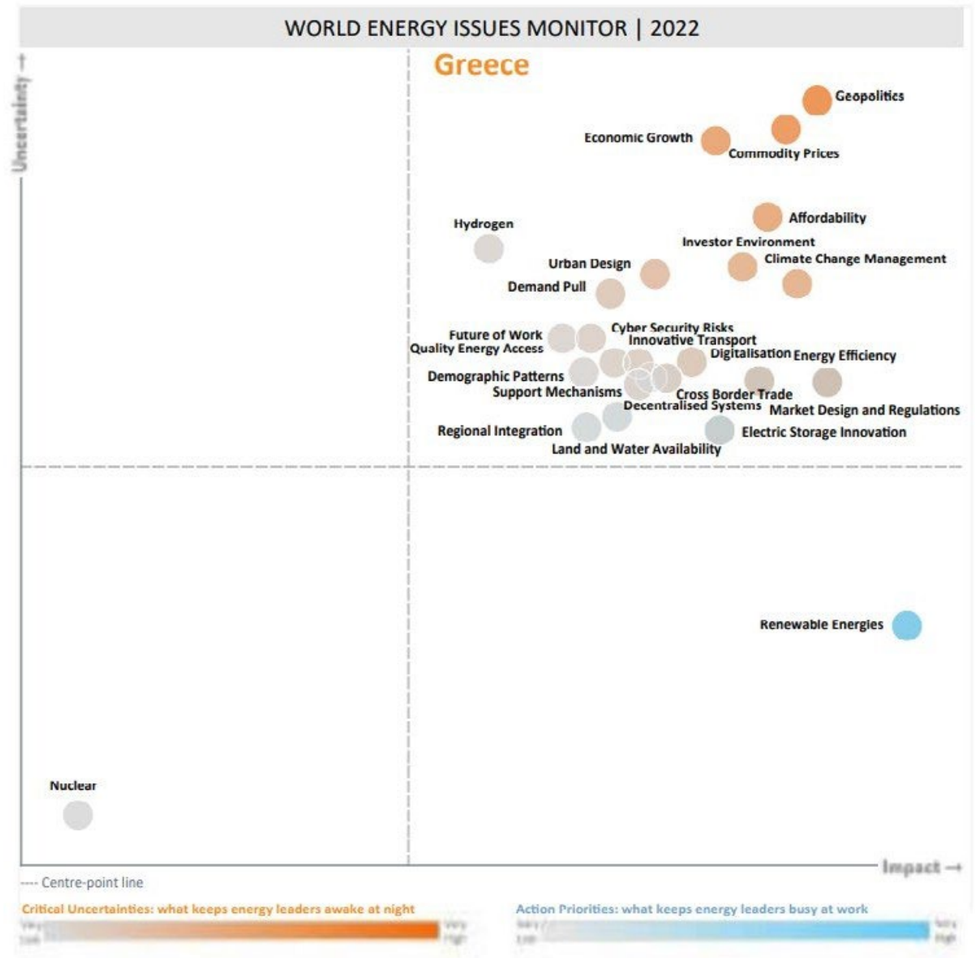
# 10

## Investing in the Greek electricity market

# Critical uncertainties and action priorities in the Greek energy market - 2022

The Issues Map provides a visual snapshot of the critical uncertainties and action priorities that policymakers, CEOs and leading experts strive to address, shape and manage energy transitions. The highest critical uncertainty for Greece on both the 2021 and 2022 versions of the matrix is Geopolitics, closely followed by commodity prices in 2022.

Economic growth and affordability are major uncertainty for 2022. While their impact –also high on the matrix- has been visible in both Greek households and businesses during last year. Renewable energies on the other hand maintain their high impact as an action priority, while uncertainty is reported as "low".




Source: World Energy Issues Monitor, 2022 World Energy Council



# Key barriers in the Greek retail energy market

## Importance of key Europe-wide barriers in Greece

| | | | | Key barriers specific to Greece |
|---|---|---|---|---|
| Advantage of vertically integrated market players | Wide-reaching price regulation | Low margin of regulated offer | Small market or customer value | Discriminating strategic behaviour of incumbent and obstruction by other players |
| Strategic behaviour of the incumbent or other market players | Uncertainty around current regulatory environment or its development | Uncertainty around regulatory future for digitalisation and new technology | Low liquidity on wholesale market | Highly complex to country-specific systems & processes |
| Capacity and ancillary services markets against new/small players | Low customer awareness or interest | Customers do not trust new suppliers or technology | Poor or no access to operations-critical data | Discrimination against new and small market players in capacity and ancillary services markets |
| Missing market value and novel products | Insufficient price signals for end-users | Lack of data for innovative product development | Lack of data hub | Suppliers tasked with collecting tariffs unrelated to energy |

## Legend

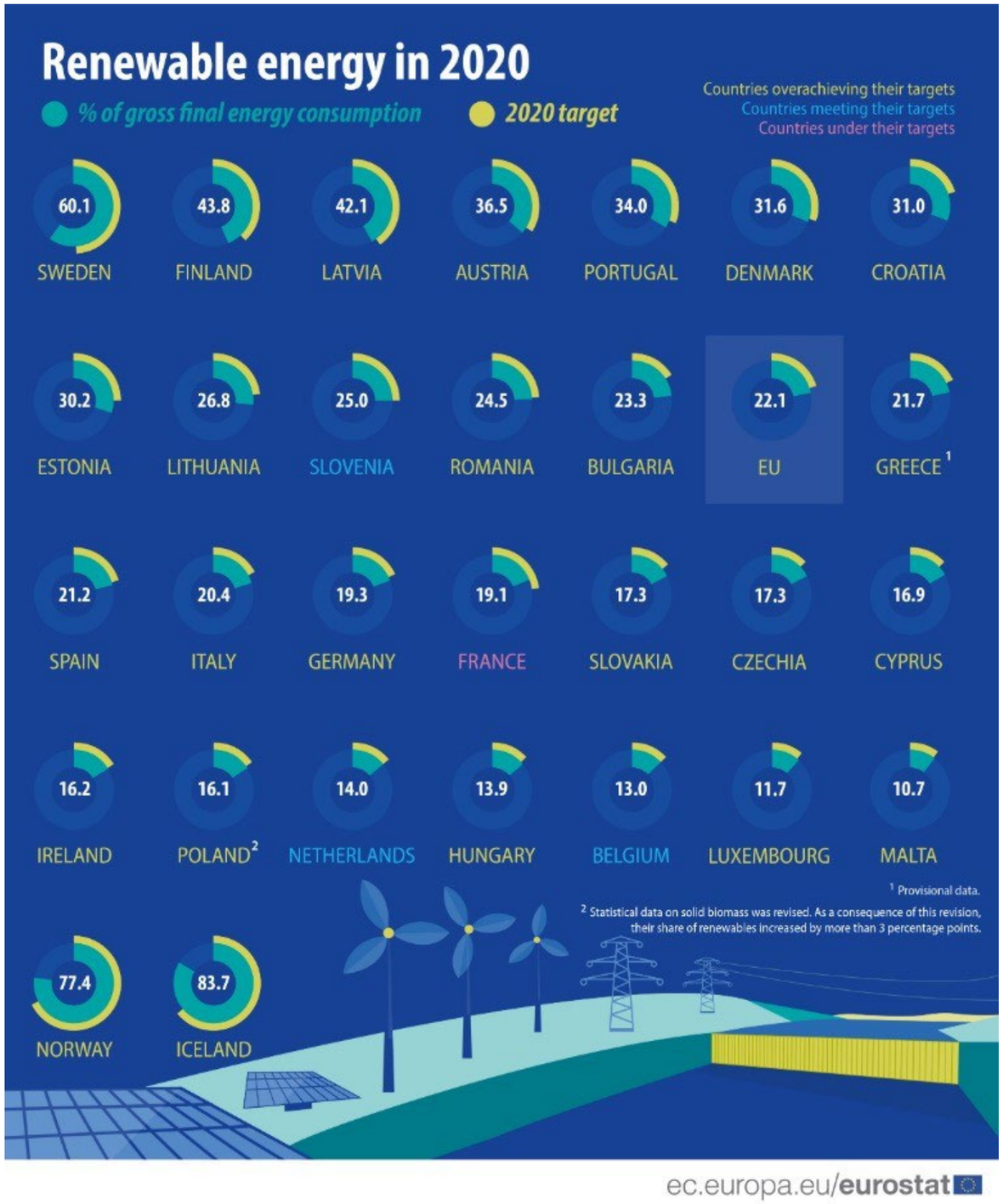
Has not been raised, indicated or identified as a barrier in this country

Has been raised, indicated or identified as an issue in this country

- May include issues that still are present in the country or are experienced by suppliers even though regulation to address the issue has been enacted by the regulator and effects still awaited reporting a lag between the regulatory framework structure and its awaited effects.
- May include issues where suppliers suffer the effects despite the country being relatively advanced on this topic compared with other EU countries, pilot projects being in place or institutions working to overcome the problem.

Has been identified as an issue in this country and is supported by facts or substantial respondent evidence in light of limited initiatives deployed by institutions to control or overcome the issue.

Source: European Commission, Directorate-General for Energy




Source: ec.europa.eu/eurostat/statistics

Greek Renewable Energy Market Outlook

# Greece jumps from 21st to 16th position on EY's Renewable Energy Country Attractiveness Index

The Renewable Energy Country Attractiveness Index (RECAI) ranks the world's top 40 markets on the attractiveness of their renewable energy investment and deployment opportunities.

## October 2022

| Rank | Previous Rank | Movement Previous Index | Country Region | RECAI score | Technology-specific scores: On-shore wind | Off-shore wind | Solar PV | Solar SCP | Bio-mass | Geo-thermal | Hydro |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 16 | ^ | Canada | 53.5 | 54.9 | 35.6 | 46.2 | 19.0 | 33.3 | 23.0 | 45.8 |
| 16 | 21 | ^ | Greece | 53.2 | 51.2 | 30.9 | 48.2 | 35.4 | 44.2 | 25.1 | 41.3 |
| 17 | 14 | v | Chile | 53.2 | 51.5 | 20.6 | 48.1 | 54.7 | 41.9 | 45.8 | 44.9 |

## October 2021

| Rank | Previous Rank | Movement Previous Index | Country Region | RECAI score | Technology-specific scores: On-shore wind | Off-shore wind | Solar PV | Solar SCP | Bio-mass | Geo-thermal | Hydro |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 23 | 21 | v | Portugal | 56.9 | 42.1 | 22.5 | 46.5 | 36.5 | 37.7 | 22.9 | 35.9 |
| 24 | 26 | ^ | Greece | 56.7 | 46.6 | 28.3 | 45.5 | 40.8 | 39.3 | 24.4 | 36.5 |
| 25 | 23 | v | Argentina | 56.7 | 49.4 | 23.5 | 48.3 | 31.9 | 36.0 | 15.4 | 26.7 |

Greece ranks 2nd in the world(!) in the Renewable Energy Country Attractiveness Index after normalising the ranking with the country's GDP.

Source: EY

# Sources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There is no question that what we have doing up until now is killing the planet and ourselves. So it’s not about changing perspective or practise to deliver something for the future generations. We have to take action and we have to take action now for us! It’s not a matter of choice its a necessity!

Ypatios Moysiadis


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