



WIND FARM IN EVIA, CENTRAL GREECE (SOURCE: CRES)

GREECE

The previous year, wind energy in Greece continued its dynamic expansion with annual new installations exceeding long-term average. 525 MW of new wind farms were completed and connected to the grid in 2020 corresponding to a 13% increase in installed wind capacity.

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As a result of a decision to speed up the switch to carbon free system, significant installed capacity of lignite plants was shut down,

resulting in a drastic reduction of lignite share in electricity production (12.1% compared to 18% in 2019). Although natural gas remains the main energy source for the Greek electricity grid, RES is steadily increasing its share on track to become the major component by 2030.

TABLE 1. KEY NATIONAL STATISTICS 2020: GREECE

Total (net) installed wind power capacity*	4.11 GW
Total offshore capacity	0.0 GW
New wind power capacity installed	0.52 GW
Decommissioned capacity (in 2019)	0.0 GW
Total electrical energy output from wind	9.32 TWh
Wind-generated electricity as percent of national electricity demand	16.9 %
Average national capacity factor (based on average installed capacity during the year)	27.5 %
Target (2030 National Plan for Energy and Climate)	7.0 GW
National wind energy R&D budget	-

*Installed wind power capacity: Use nameplate power ratings of the installed wind turbines.

***Average national capacity calculation. Only include turbines in operation the whole year: Only include turbines in operation the whole year:

(MWh production/8,760 hrs) / MW installed capacity

MWh total electrical production from wind turbines operating 1 January through 31 December divided by 8,760 hrs divided by the total installed wind capacity (in MW) at the beginning of the year.

You can also use an estimate based on the average installed capacity during the year: (installed 1 Jan + installed 31 Dec)/2. But in that case, state that this is how the estimate is calculated.]

Market development

National targets and policies supporting development

The National targets for renewable energy for **2030** as set out in the National Plan for the Energy and the Climate [1] foresee a 66% RES share in electricity production by 2030, while all lignite power stations are to be taken out of operation by 2028 the latest. To achieve this target, an **estimated total wind capacity of 7,000 MW** is needed by the end of 2030. After a record 727 MW new capacity in 2019 and 525 MW in 2020, more than 4,100 MW are now operational, leaving less than 3,000 MW to be installed till 2030. Such a target would require a mean annual installation rate around 300 MW per year. The high volume of new installations in the last two years, indicate that the 2030 target for wind power in Greece is feasible.

An auction system for guaranteed feed-in price for medium sized wind farms and PV systems is in effect since 2018. The auction system applies to wind farms with installed capacity greater than 3 MW competing for eligibility in a 'Contract for Difference- payment scheme, where spot market price paid to the wind energy producer is corrected to reach a predetermined target price. In two auctions rounds for 2020 (one technology specific and one technology neutral), wind farm projects with total nameplate capacity 624 MW were granted with contracts. The weighted average

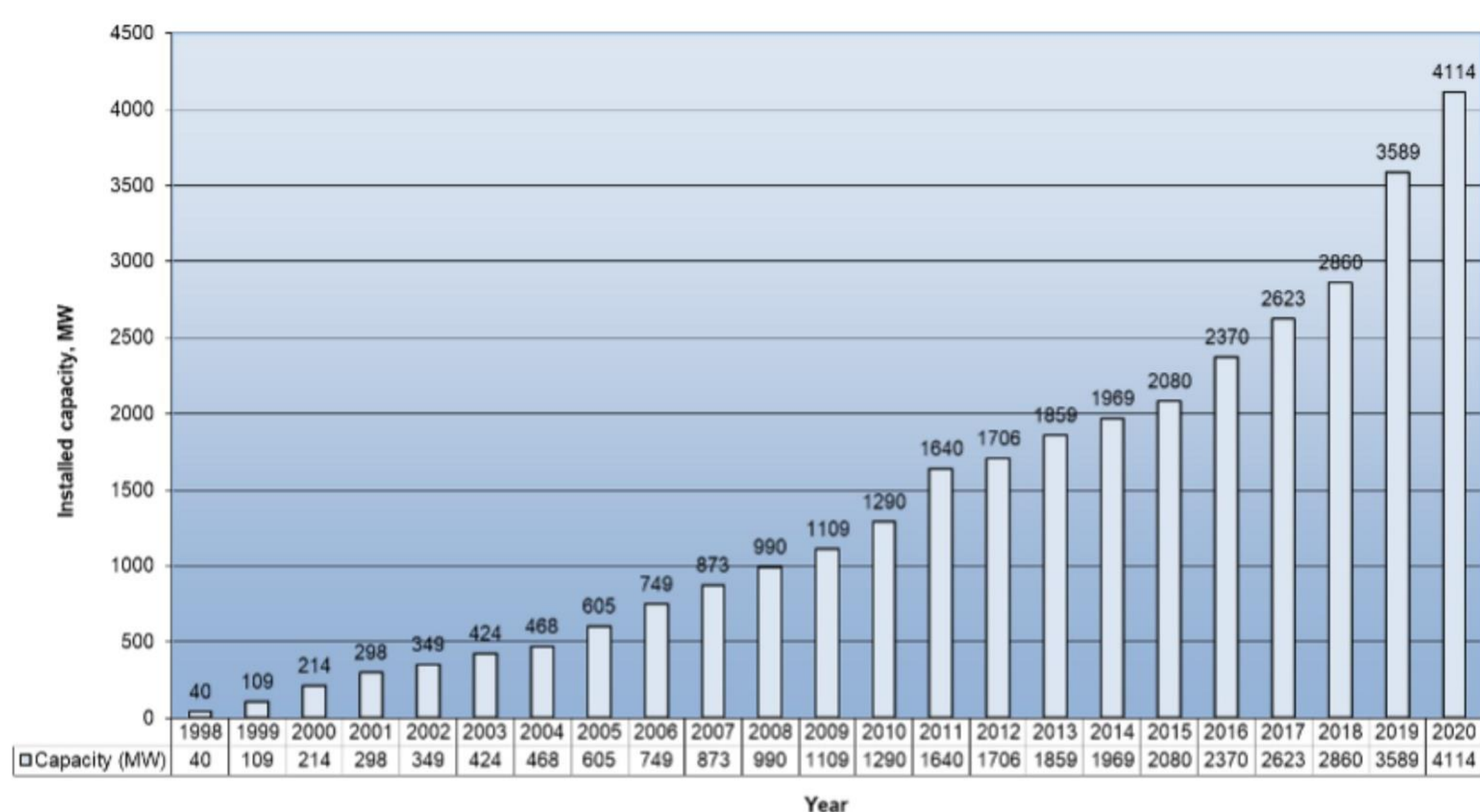
price offered by the wind energy farms for 2020 was 55.67 EUREUR/MWh, slightly lower than Dec 2019 values. During the spring months of 2020, following the economy slow-down due to the pandemic, electricity demand fell, resulting in record-low wholesale prices around 40 EUR/MWh. Demand increased in the summer and winter months, resulting in a year-averaged wholesale price of 58 EUR/MWh. On-shore wind energy in Greece remained competitive as an electricity sources even at pandemic conditions.

The auction system is planned to be continued until 2024, with no specific guidance for the successor plan.

Progress and operational details

The **total installed capacity of wind power** in Greece at the end of **2020** reached **4114 MW**, (13% increase compared to 2019). The total new capacity installed in Greece in 2020 was 525 MW, less than 2019 (725 MW), but significantly higher than the long-term average (245 MW) [2], [3]. Wind covered 16.9% of the total electrical energy demand. The retaining of a high volume of installed capacity in the previous two years, reveals a considerable dynamism of the market.

Very limited activity on repowering and hybrid systems was seen in the previous year. However, as the legislative framework for licensing and market integration of hybrid systems are gradually taking shape. More activity is expected in the near future.



GREECE : TOTAL INSTALLED WIND ENERGY CAPACITY PER YEAR

Matters affecting growth and work to remove barriers

Although the natural resources and the industry potential seem more than adequate to support the national targets for the transition to a carbon-free 100% renewable energy system, considerable challenges remain and need to be addressed if the targets are to

be met. Some of these challenges are discussed in the following:

- **Licensing bottlenecks and unnecessary delays.** The typical time needed for getting through the licensing procedure for a wind farm in Greece is 8 to 10 years, exceeding by far the target set by EU



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for such procedures (2 years maximum). A drastic revision of all licensing procedures is currently in progress by the Greek government. The first part of the legislation review was completed, and a new procedure simplifying the production license is in place. The legislation review is expected to be completed within the first half of 2021.

- **Grid restrictions.** Weak grids and the operation of numerous isolated grids serving the islands of the Greek archipelago pose additional limitations for the RES expansion. Significant works are under way, especially for the interconnection of isolated islands to mainland. Round 3 of Cyclades islands interconnection was completed within 2020, increasing local grid stability. The first of the two interconnection lines to connect Crete to the mainland advanced significantly, with electrification of the line expected in 2021. When the second line is also in operation (2023), all high-cost diesel-powered stations on Crete will be shut down, saving 400 million EUR in electricity bills in Greece. According to the Greek TSO 10-year plan, all major Greek islands are to be interconnected to the mainland by

2030. Apart from significant electricity cost savings, increasing the security and improving the quality of electricity provided to the islands, the planned interconnections will allow an additional 2,000 MW RES capacity to be added in the grid.

- **Offshore wind:** In Greece, activity for offshore wind farms remains limited. The sea floor in Greek seas is generally very steep, usually reaching depths of more than 40 m at distances less than 1 km from the shore, making not practical the use of the well proven concept of bottom fixed offshore wind turbines. Still, the technically feasible offshore wind capacity with bottom fixed wind turbines could be in the range of 1 to 3 GW as some preliminary studies revealed. Floating wind technology, gradually advancing from demonstration, is changing the scene in offshore wind in Greece. Increased interest from established companies in the field is noted, attracted by the excellent wind potential in the Greek seas. In response to this, the Greek state is increasingly expressing its commitment to offshore wind development. Although, the offshore wind provision in the National Energy and Climate plan



WIND FARM IN WEST MACEDONIA, GREECE (SOURCE: CRES)

issued in 2019 is modest (200 MW), work to define a more ambitious framework is in progress. Combined with a possible review of the national Climate and Action plan in 2021, a modernized framework for offshore wind in Greece is also expected in the next year. Additionally, the recently approved law for the simplification of the licensing procedure for RES, also includes explicit guidance for offshore wind farms.

- **Public opposition.** As a secondary result of the extremely complicated licensing procedure, limited or no interaction between the local public and developers and licensing authorities is the general rule for most wind energy developments in Greece. This, combined with the increased construction activity in the last two years resulted in considerable local opposition to wind development in some areas. Public information campaigns were run by the wind energy industry, while actions have been taken by the state to review the mapping of areas available for wind energy development and clear the license registry from dormant projects.

R,D&D activities

National R,D&D priorities and budget

R&D activities in wind energy in Greece are funded mainly through EU and national programmes. Due to the pandemic situation, no new funding's schemes relative to wind energy were launched in Greece. Delays were also experienced in contract signing and fund flow for projects approved in the previous year. A non-exhaustive review of R&D proposals oriented mainly in wind energy that were granted funding in 2020, revealed no new projects awarded to Greek partners.

Test facilities and demonstration projects

In the following, some characteristic test facilities and demonstrations projects in development or operation in Greece for the year 2020 are presented:

- **FloatMAst Blue:** Developed by Greek SMEs in collaboration with R&D institutions, a floating Tension Leg Platform (TLP) is proposed to provide a competitive, reliable, and robust system for measuring wind potential and win turbine power curves in offshore wind farms, as well as a wide range of met-ocean parameters. The platform features a Lidar system and a 40 m mast, which combined with the negligible displacements obtained by the TLP_ principle of operation, provide high accuracy wind speed and regime measurements. The prototype platform successfully completed a year-round operation at the Aegean Sea, undergoing an extensive monitoring programme (budget 2.9 million EUR, co-funded by EU under H2020-SME instrument and private funds, <http://www.floatmast.com>)

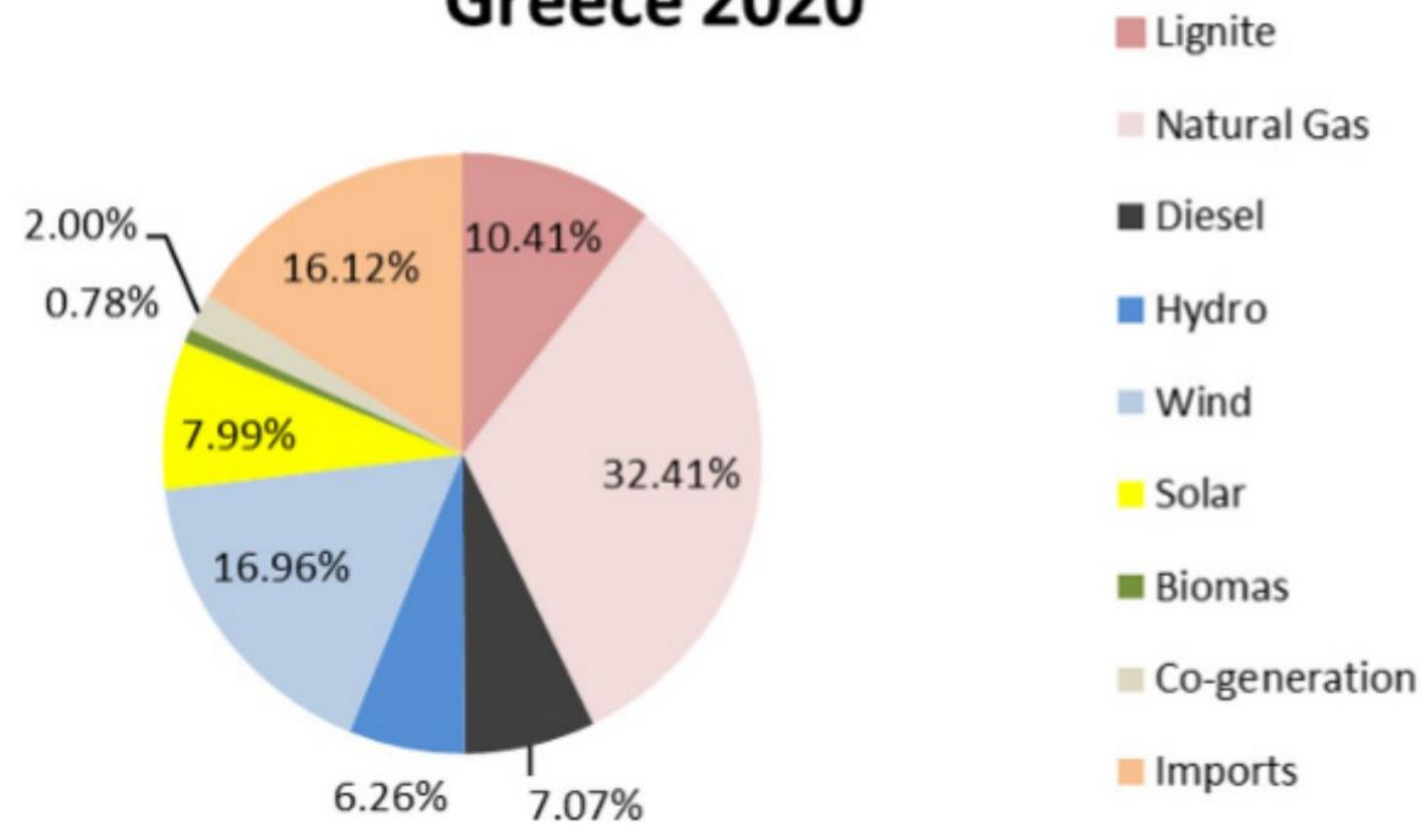
- **GREEN ISLAND—Agios Efstratios:** The project deals with the conversion of a small, isolated island grid into a RES powered system. Main power sources on the island will be an 800-900 kW wind turbine and 100-200 kW PV array. A 2.5 MWh Li-Ion battery pack of is also foreseen for short term energy storage, while thermal storage for district heating will provide load balancing to limit power shredding and medium-term storage. Diesel generators, currently covering the total electricity demand on the island will be limited to back up operation only. The target value for mean annual RES penetration of 85%, making the project a small scale test bench for the electricity networks of the future where RES will be the major contributor. Tenders for the main part of the project (wind and PV generators, battery storage, district heating and central control system) were successfully assigned, construction works expected to start in second half of 2021. (total budget 8.5 million EUR, co-funded by the by the Greek state and the European Regional Development Fund, <http://aistratis.agenso.gr/>)

- **PARALOS²:** Supported under the national Program for Research, Technological Development and Innovation 'EREVNO', the project was launched in November 2020 and aims to the optimization of a 50-kW wind turbine in Greece for operation in coastal areas as well as to installation in areas with the limited access of large vehicles from land (islands, seaside resorts, etc.). This wind turbine will be a radical redesign of an existing using advanced aero-elastic studies tools. Changes and redesigns will also be made for the foundation so that it can be erected on both rocky and sandy soils taking into account high seismic loadings, necessary for applications in Greece and eastern Mediterranean. An extensive testing and measurement program is also included. (total budget 990 k euros, co-funded by the Greek state and the European Regional Development Fund).



FLOATMAST | PLATFORM DEPLOYED IN THE AEGEAN SEA (SOURCE : CRES)

Electrical Energy by source Greece 2020



GREECE : ENERGY SOURCES IN THE ELECTRICITY MIX FOR 2020 (DATA FROM GRID AND MARKET OPERATORS COMPILED BY CRES)



Impact of wind energy

Wind energy is becoming a major component in the electricity production system in Greece. For 2020, wind energy provided 16.5% of electricity, becoming **the second-biggest energy source** following natural gas (32.4%) and surpassing lignite (10.4%) and imports (16.1%). Also 8 June 2020, was the first day after 70 years of lignite domination on the electricity production system, that not a single lignite-powered kWh was produced in Greece. A few months later, on 14 September, wind energy and photovoltaics combined covered 51% of total daily demand.

Wind energy produced 7235 GWh of electricity in 2019 offsetting the equivalent of 4 382 000 tons of CO₂ emissions.

Wind energy and photovoltaics are expected to be the two major pillars in the future energy mix for Greece. The current policy foresees more than 80% of total electricity demand to be covered by those two sources in 2050.

Economic benefits and industry development

Wind energy supports more than 5.100 direct full time work positions in Greece, mainly in wind farm construction and maintenance. The manufacturing sector is not developed, but some Greek companies have achieved strong positions in balance of plant equipment (electrical switch gear, cabling including offshore) both in the domestic and international markets.

As an additional benefit to the local communities, an estimated 18 million EUR are distributed annually to the



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communities hosting wind farms, through a 3% levy on sales of electrical energy produced by the wind farms.

Next term

The EU Recovery Plan, aiming to push the EU economies through the pandemic back to a rapid economic recovery afterwards, may offset the delays and even accelerate the move to transition to a 100% carbon free electricity system by 2050. The EU recovery plan is the largest stimulus package ever to be launched by the EU. Greece expects to receive a total budget of 32 billion EUR through this fund. Energy related projects sum-up 6 billion Euros, among the projects already shortlisted for funding under the Recovery fund by the Greek State. Extensive grid improvements (island interconnections, local transmission grid strengthening, international interconnections) would

provide a valuable stimulus for further development of RES and wind energy are included. Combined with increased and steady investor interest, work already on track for the review and upgrade of the licensing and operational framework for RES, hybrid plants and energy storage facilities on a mass scale, the opening of the offshore wind sector, including floating, the scene for the domination of the energy system by RES is gradually being set.

References

- [1] National Plan for the Energy and the Climate (NPEC – ΕΣΕΚ, <http://www.opengov.gr/minenv/?p=10155>)
- [2] <https://windeurope.org/about-wind/statistics/>
- [3] <http://eletaen.gr/> 