



Report 2021 Greece

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The total installed wind power capacity in Greece at the end of 2021 reached 4456 MW [3] (an 8% increase compared to the end of 2020).

THE TOTAL NEW capacity installed in Greece in 2021 was 338 MW lower than the all-time record of 2019 (752 MW), but still higher than the 10 year average (284 MW). A total of 128 new wind turbines with an average nameplate capacity of 2.67MW were installed.

Aside from natural gas, wind energy remains the biggest domestic energy source for the Greek Electricity system, providing 18.9% of total demand. During the year, variable RES penetration to the electricity system reached values as high as 92% of total demand (1 hour average), without any negative side effects on the operation and stability of the system.

Table 1. Key National Statistics 2021: Greece

Total (net) installed wind power capacity*	4.45 GW
Total offshore capacity	0.0 GW
New wind power capacity installed	0.34 GW
Decommissioned capacity (in 2021)	0.0 GW
Total electrical energy output from wind	10.5 TWh
Wind-generated electricity as percent of national electricity demand	18.9%
Average national capacity factor**	27.9%
Target (2030 National Plan for Energy and Climate)	7.0 GW
National wind energy R&D budget	

Highlight(s)

- Wind energy is the biggest domestic power source for the Greek electricity system
- Periods with very high wind solar and small hydro penetration (max 92%) received smoothly by the electricity grid throughout the year
- The positive effect from wind energy on reducing extreme prices in the electricity market
- By the end of 2021, 650MW of new wind energy plants were under construction

Market Development

Targets and Policy

The National target for renewable energy for 2030 as set in the National Plan for the Energy and the Climate [1] foresees 66% RES share in electricity production by 2030. To achieve this target, an estimated total wind capacity of 7000 MW is needed by the end of 2030. Such a target would require a mean annual installation rate of 250-300 MW per

year, comparable to the average rate of new installations achieved in the last three years. Strong political will exists within EU countries to accelerate the transition to a 100% carbon free electricity system. However this has not yet been depicted into concrete new targets.

An auction system for guaranteed feed-in prices for medium sized wind farms and PV systems has been in effect in Greece since 2018. The auction system applies to wind farms with installed capacity greater than 3MW competing for eligibility in a "Contract for Difference" payment scheme, where the spot market price paid to the wind energy producer is corrected to reach a predetermined target price. For 2021, one auction round was run, common for PV (>1MW) and wind (3MW – 50MW), for 350MW of combined capacity. PV projects offered very low prices (lowest price 33 €/MWh, average 40€/MWh), resulting in all available capacity being covered by PV projects. For 2022 auctions, minimum technology quotas are to be set to provide a balanced energy mix. Since the beginning of the auction system in 2018, a total of 1400 MW of new wind

farms and 1300 MW of PV systems have been awarded. The auction system is planned to be continued until 2024, with no specific guidance for the successor plan

Progress and Operational Details

During the year, non-dispatchable RES (wind, solar and small hydro) penetration to the electricity system reached high values. Maximum 1-hour averaged wind energy penetration on the main electricity grid was 73.5% (October 25th, 03:00-04:00), while on the same day, maximum day-averaged wind penetration of 52.5% was achieved [2]. Maximum 1-hour averaged penetration for all non-dispatchable RES reached an impressive 92.1% on October 28th. Throughout the year, the central electricity system of Greece operated with non-dispatchable RES penetration exceeding 50% for 851 hours without any problem. The total value of new wind capacity set in operation within the year in Greece is estimated to be 340mio euros. By the end of 2021, 650MW of new wind energy plants were under construction, most of which are expected to be operational within the next 18 months.



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Matters Affecting Growth and Work to Remove Barriers

Licensing: Typical time needed for getting through the licensing procedure for a wind farm in Greece is between 8 to 10 years exceeding by far the target set by the EU (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 already in place. The legislation review was expected to be finished within the first half of 2021 but was later delayed for second quarter of 2022.

Grid restrictions: The weak grid and the operation of several isolated, autonomous grids serving the islands of the Greek archipelago pose additional technical limitations in RES expansion. Significant grid strengthening works are underway, some already completed. A major breakthrough achieved this year was the completion of the first sub-sea interconnection line to Kriti (the biggest island of the Greek Archipelagos) in June 2021. When the second line will be in operation (expected

2023), apart from significant savings in electricity cost, increasing the security and improving the quality of electricity provided to the islands will allow 2000MW additional RES capacity to be added to the system.

Public opposition: As a secondary result of the extremely complicated licensing procedure, limited or no interaction between the local public, developers, and licensing authorities is the 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 awareness campaigns were released by the wind energy industry, while actions are 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

Greece's R&D activities in wind energy are funded mainly through EU

and national programs. Due to the pandemic situation, no new funding schemes for wind energy projects 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 2021 revealed two new projects with a total budget of 1.95mio euros, which were awarded under the Program for Research, Technological Development and Innovation "EREVNO" (co-funded by the Greek state and the European Regional Development Fund).

Test Facilities and Demonstration Projects

In the following, some representative test facilities and demonstration projects in development or operation in Greece for the year 2021 are presented:

- **GREEN ISLAND – Agios Efstratios:** The project deals with converting a small isolated island grid into a RES powered system. The main power sources on the island will be an 800-900kW wind turbine and 100-200 kW PV array. A 2.5

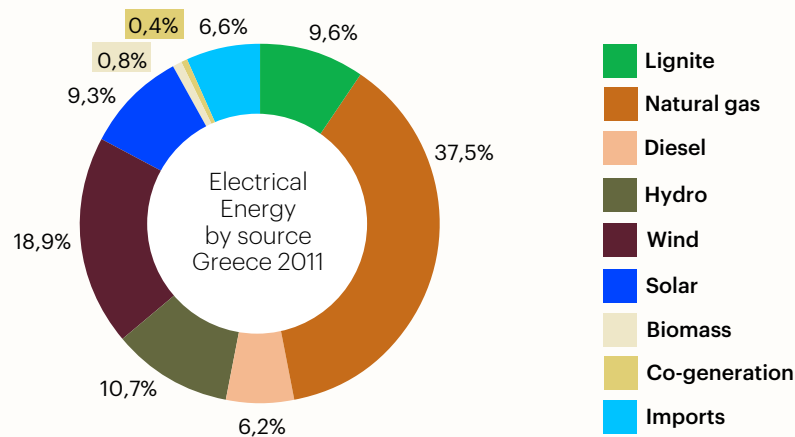


Figure 3. Greece : Energy sources in the electricity mix for 2021 (data from grid and market operators compiled by CRES)

MWh Li-Ion battery bank 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 backup 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 were delayed due to a pandemic situation and are now expected to start in the second half of 2022. (total budget 8.5mio Euros, co-funded the by the Greek state and the European Regional Development Fund, <http://aistratis.agenso.gr/>)

Impact of Wind Energy

Wind energy remains the biggest domestic energy source for the Greek Electricity system, providing 18.9% of total demand, exceeded only by imported natural gas. A breakdown by an energy source of the Greek electricity system is presented in the figure above.

The electricity market in Greece exhibited severe fluctuations during 2021, following similar global trends. In early spring, low demand due to covid19 restrictions resulted in very low wholesale prices, ranging from 40 to 50€/MWh. As restrictions were removed in summer, economies around the world accelerated at a pace faster than expected. By the end of the year, the supply and demand balance in the energy sector was fully reversed. Following this trend, wholesale prices for electricity in Greece reached 244€/MWh in December (monthly averaged price).

In this demanding set-up, **wind energy and other RES had a significant effect on reducing the extremes in**

the electricity market, as highlighted by a study published by the Hellenic Wind Energy Association [4]. According to this study, if RES were not present to reduce the dependence of the electricity system on imported fuel, yearly averaged wholesale electricity prices **would be up to 40% higher**. Apart from clipping the extremes in the electricity market, RES directly subsidized electricity bills. Due to the high wholesale prices prevailing in the electricity market during the second half of the year, the special fund created to support RES tariffs gave a positive surplus (**market price higher than guaranteed RES prices**). This surplus was used to subsidize the electricity bills for retail consumers. For October 2021, **the amount returned to the consumers through this procedure is estimated at 114mio euros**, providing considerable relief to the burden created by the high energy bills.

Wind energy produced 10500 GWh of electricity in 2021, offsetting the equivalent of 6 359 000 tons of CO₂ emissions.



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Next Term

Global energy supply chain disruptions have been seen in recent months, as a direct result of logistical problems caused by the demand fluctuations due to covid and the war in Ukraine. These disruptions are seen as severe but transitional situations, which are expected to be resolved in the course of time. However, the unprecedented effects they had on the economics and the security of the global energy system underline the extreme risks associated with the dependence on fossil fuels, which, apart from being a threat to the environment and the climate, are in short supply, and concentrated on restricted areas of the globe. The importance of renewable energy sources as an abundant, available to all mankind, and the environmental friendly power source is further stressed. In the short term, the Plan “REPowerEU: Joint European Action for more affordable, secure and sustainable energy” aims to make Europe independent from imported fossil fuels well before 2030 by diversifying gas and oil providers, speed-

ing up the roll-out of renewable sources, and replace gas in heating and power generation. A strong push forward on the RES is expected in the near future.

References

- [1] National Plan for the Energy and the Climate (NPEC – <http://www.opengov.gr/minenv/?p=10155>)
- [2] <https://windeurope.org/about-wind/statistics/>
- [3] <http://eletaen.gr/>
- [4] Chaviaropoulos (2021) “Penetration of RES and prices at the Greek electrical energy market in 2021” (downloaded from www.eletaen.gr, 3/5/2022., in Greek)