Annual Report 2024

Greece

Photo: *Wind turbine 800kW at Central Greece. (Source: ELETAEN.)*

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The total installed wind power capacity in Greece at the end of 2024 reached 5355MW, (2.5% increase compared to end of 2023). Wind energy remains the biggest domestic energy source for the Greek Electricity system.

Wind energy is estimated to cover 23% of total electricity demand. Combined with PV, hydro and smaller shares from biomass and small hydro, the total RES share in electricity mix exceeds 50%, bringing Greece at the top 10 globally, on what regards the RES penetration to electricity production.

Annual electricity demand in 2024 rose by 5.5% after two consecutive years of decline, but the general trend remains negative (reduction of energy demand) in the last decade.

Also notable, in 2024 Greece became a net energy exporter (although marginal 0.5%), while electricity imports covered 10.2% of demand in 2023 (table 1).

Highlights

- National wind target further increased in the new draft of the 2030 NPEC. Wind installed capacity (onshore and offshore) target increased to 10.8 GW (up from 9.5 GW)

Total (net) installed wind power capacity	5.4 GW
Total offshore capacity	0.0 GW
New wind power capacity installed	0.126 GW
Decommissioned capacity (in 2024)	N/A
Total electrical energy output from wind	13 TWh
Wind-generated electricity as percent of national electricity demand	23 %
Average national capacity factor	N/A
Target	10.8 GW
National wind energy R&D budget	N/A

Table 1. *Key Statistics 2024: Greece*

• Greece net exporter of electrical energy with 50% share of renewables.

Market Development

Targets and Policy

The **revised National Plan for the Energy and the Climate** [1] was published in September 2024 adopting a bolder approach to the decarbonization of Greek energy system. The new 2030 target for the total RES share in energy consumption is now set at 45% (up from 37% in the draft NPEC), which translates into a 77% share of RES in electricity production.

Following this increase, the estimated wind capacity needed by the end of 2030 is increased to 10.8 GW (up from 9.5 GW). Offshore wind is estimated to provide 1.9 GW, while the remaining 8.9 GW will be covered by onshore wind. Regarding onshore wind, the mean annual installation rate achieved in the last years is 300-350 MW per year.

The set target is deemed feasible, despite challenges for the local supply chain and financing capacities. Offshore wind is a completely new field for Greece and there is a higher uncertainty regarding reaching the target on time.

Currently, there is no support scheme for large scale onshore wind projects. A fixed Feed in Tariff for small commercial projects (up to 6MW) is set at EUR 89 / MWh. Considering that mean wholesale electricity price for 2024 in Greece was EUR 105 /MWh, wind electricity fed to the grid by small commercial wind farms is 18% cheaper, while the competitive auction prices offered by larger wind projects in previous auctions (EUR 58 /MWh in 2022) are 80% cheaper.

Considering the disruptions caused in electricity production and international trade in Greece and southeastern Europe due to the war in Ukraine, the low prices retained by wind produced electricity verify the value of wind as a provider of resilient and affordable energy.

The **National Plan for the deployment of Offshore Wind** farms and its Strategic Environmental Impact Analysis are currently under consultation and negotiations with licencing authorities. Tenders for field measurements are expected to be launched as soon as the plan is officially ratified. A first batch of 600MW pilot projects at preselected areas (all bottom fixed), are in a more advanced stage with field studies on going. The Support scheme for future offshore wind farms is under negotiations with EU.

Progress and Operational Details

The total installed wind power capacity in Greece at the end of 2024 reached 5355 MW. The new capacity installed in Greece in 2023 was 126 MW, below the 10-year average (337 MW). A total of 39 new wind turbines with an average nameplate capacity of 3.2 MW were installed.

The average name plate capacity decreased compared to the previous year (average for 2023 3.5MW), however for the last three years it remains above 3MW. Typical size of the wind turbines installed are 4 to 5MW, but because there is still activity in the 1MW range, average capacity remains relatively low. Weighted average rotor diameter remained around 120m [2].

Following the increase in installed capacity, wind penetration to the electricity system continues to rise in 2024 in parallel with other non-dispatchable RES. Maximum 1-hour averaged wind energy penetration on the main electricity grid was 90.4% (8.4.2024, 03:00-04:00).
Wind penetration was above 30% for 2575 hours (2117h in 2023), while total non-dispatchable RES penetration was higher than 60% for 2618 h (1717 h in 2023). Also notable, total RES penetration exceeded total demand for 306

hours (120 h in 2023), making Greece a net exporter of RES electricity [2].

Matters Affecting Growth and Work to Remove Barriers

Licensing: Although a major review of the licensing framework was ratified in the last years, aiming to reduce the licensing time a wind farm in Greece from the current 8 to 10 years to as close as possible to the target set by EU which is 2 years, secondary regulations are still under review.

Better coordination between licensing authorities and the drafting of local / thematical special plans is needed. The issues of lifetime extension and repowering are becoming more critical as older wind farms approach their design life limit but are still not well covered.

Grid restrictions. Significant grid reinforcing works are in progress on major energy corridors and RES concentration areas. In parallel significant progress is made for the interconnection with the mainland of all major islands of the Greek archipelagos, which currently operate as isolated, diesel-powered grids. The first interconnection line for Crete (400MVA) is fully operational since 2021, while the second line (1000 MVA) is under construction and expected to be fully operational by 2026.

The first phase of the central Aegean loop connecting part of Cyclades islands is operational, while the second phase is advancing expected to be fully operational by 2026. The interconnection of the major south-eastern Aegean Islands is to start construction works late in 2025 and be completed by 2028 .
The north-eastern Aegean loop to follow, is expected to be operational by 2030. These interconnections are also strategically connected to the offshore wind farm development, having included in their planning additional capacity to accommodate for planned offshore wind farms in the Aegean Sea.

Increase in RES Curtailment. Another significant trend emerging in recent years is the increase in RES curtailments. RES curtailments rose to 4% of total RES production in 2024, up from 1.2% in 2023.

Lack of storage capacity. Although the rapid increase of solar capacity in the last years and its inherently correlated production profile is creating surplus energy flows, it is the severe lack of energy storage capacity that exacerbates the problem. Currently, while 15 GW of non-dispatchable RES are operating in the Greek system, only 700MW of hydro pumped storage are available.

An additional 900MW of battery storage is expected to be operational by the end of 2026, while another 4500 MW (3500 batteries and 1000 hydro) should be expected till 2030. It is crucial to see the storage capacity increasing faster in the next years to cope with the expected increase in RES capacity to avoid unnecessary energy losses.

Public opposition: Interaction between the local public and developers and licensing authorities remains limited. Industry shareholders are active in campaigns aiming to respond to fake news on wind farms and promote environmental, societal and economic positive impacts of wind energy.

RD&D Activities

National RD&D Priorities and Budget
R&D activities in wind energy in Greece are funded mainly through EU and national programs. A major funding tool for applied research in Greece is the Program for Research, Technological Development and Innovation “EREVNO” (co-funded by the Greek state and the European Regional Development Fund).

The new period of the EREVNO program was launched in 2024 with an estimated total funding of EUR 300 million for all research areas for the period 2023-2030. Results from the first call are pending.

Test Facilities and Demonstration Projects

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 800-900kW wind turbine and 100-200 kW PV array.

A 2.5 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 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. Construction works are finished, and test runs were successfully executed in 2024. Full operation is expected in Q2 2025, due to delays in negotiations and approvals of the operational scheme and pricing (total budget EUR 8.5 million, co-funded by the by the Greek state and the European Regional Development Fund [3].

Collaborative Research

A non–exhaustive review of collaborative R&D projects with Greek participation in wind energy that were active in 2024 is given in the following:

MARINE WIND: Coordination and support action aiming to identify bottlenecks and potential opportunities to strengthen floating offshore wind’s technology FOWT role in delivering innovative solutions to system integration, considering how best to integrate such a system by exploring the market, policy and regulations issues, social, financial and techno-economic optimal solutions, and provision for storage and flexibility recommendations [4].

RE-EMPOWERED: The goal of RE-EMPOWERED is to develop a set of solutions for efficient, decarbonized and RES-intensive multi-energy local energy systems. The solutions of the toolset will be tailored to the specific needs of four pilot cases in the EU and India but will aim at a wide target

group for replication and exploitation in both the developed and developing world. Within this framework, a locally manufactured small wind turbine (4.3m diameter, 3kW@ 10 m/s) was installed on a small Aegean Island (Kythnos) [5]

Research Infrastructure Services for Renewable Energy (RISEnergy) project is dedicated to fostering a long-term, coordinated research effort among leading private companies and research institutions to advance energy technologies within the EU [6].

The Southern European Community for Offshore Wind Energy (SHORE-WINNER) project aims to set up and develop a Community of Practice (CoP) based on the cooperation among five Centres of Vocational Excellence (CoVEs) committed to the development of skills, upskilling and reskilling of the workforce, sharing of resources, and achievement of major European goals and priorities. The CoVEs will be created in southern European countries (Portugal, Spain, Italy, Greece and Cyprus) with a promising offshore energy sector [7].

Impact of Wind Energy

Environmental Impact

Wind energy produced 13 TWh of electricity in 2024 covering 23% of annual electricity demand in Greece, while offsetting the equivalent of 2.4 million tons of CO2 emissions. The volume of avoided CO2 emissions is equal to the emissions of 90% of private cars circulating in Greece.

Wind energy, being the largest domestic energy source, greatly contributes to the reduction of natural gas imports. Also, like all other RES, wind energy is to a great extent immune to fossil fuel price volatility and feeds electrical energy to the grid at stable competitive prices.

Economic Benefits and Industry Development

On the local level, 3% of electricity sales by wind farms under support schemes and EUR2/MWh for wind farms selling directly to the market returns to the local communities as an extra funding to the local administration bodies and direct subsidies to the electricity bills of consumers on the communities hosting wind farms. A total of EUR 29 million were distributed in 2024 to local communities through this mechanism

Photo. *Wind farm (8 x 3.45MW) at Pindos ridge.* *(Source: PPC Renewables.)*

(corresponding to the energy produced by wind farms in 2023).

The total value of new wind capacity set in operation within the year in Greece is estimated to be EUR 190 million. By the end of 2024, 1100 MW of new wind energy plants were under construction, all of which are expected to be operational within the next 24 months [2]. On the employment field, wind energy is estimated to support the equivalent of 6700 full time jobs.

The launch of the offshore wind farm development Greece is perceived as an opportunity for development with significant local impact since the domestic maritime and shipbuilding industry capacities and know-how are currently underused. It's worth noting that, although offshore wind development in Greece is in early planning stage, three companies based in Greece have already substantial activities in the global offshore wind supply chain.

The extensive work currently in progress in the Aegean Sea for the interconnection of islands to the mainland grid, will provide the much-needed grid capacity for the connection of additional on- and offshore wind farms in the Aegean Sea, an area which possesses the best wind potential in Greece. The combined investment related to the major interconnection projects currently in progress or expected to start within the next year is estimated at EUR 2.5 billion.

Next Term

The position of wind energy as one of the major pillars of the energy system of Greece and its importance in the rapid transition to a decarbonized, resilient and secure energy system in Greece is clearly highlighted in the NCEP. For wind energy to fulfill these expectations, the following challenges must be addressed, as outlined by all members of wind industry in Greece:

- Implementation of the revised licensing framework to allow for fast deployment
- Deployment of storage capacity
- Application of load demand management procedures
- Offshore wind development
- Local supply chain strengthening and improvement
- End of life issues
- Societal acceptance

References

[1] National Plan for the Energy and the Climate (NCEP – EZEK; *ypen.gou.gr/energeia/esek/*)

[2] *eletaen.gr/*

[3] *aistratis.agenso.gr/*

[4] *marinewindproject.eu/*

[5] *reempowered-h2020.com/*

[6] *risenergy-project.eu/*

[7] *shorewinner.eu/*