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ASSESSING THE ENERGY TRANSITION OF THE GREEK ISLANDS

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ASSESSING THE ENERGY TRANSITION OF THE GREEK ISLANDS

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Abbreviations	
BESS	Battery Energy Storage System
CO_2	Carbon Dioxide
ESF+	European Social Fund Plus
ESI Fund	European Structural & Investment Fund
ETS	Emissions Trading System
EV	Electric Vehicles
FiT	Feed-in Tariff
GHG	Greenhouse Gasses
H2	Hydrogen
HC	Hydrocarbon
PPC	Hellenic Public Power Corporation
ICE	Internal Combustion Engine
JTF	Just Transition Fund
JTM	Just Transition Mechanism
$NaNiCl_2$	Sodium Nickel Chloride
NECP	National Energy and Climate Plan
NII	Non-Interconnected Island
NIMBY	Not In My Back Yard
NSRF	National Strategic Reference Framework
PV	Photovoltaic
PSO	Public Service Obligation
RES	Renewable Energy Sources
SECAP	Sustainable Energy and Climate Action Plan
SLO	Social License to Operate
Telco	Telecommunicaitons

Preamble

In its efforts toward a net-zero economy, the EU has realized the untapped energy potential offered by islands, as well as the high levels of carbon emissions resulting from the use of Fossil Fuel powered generators in cut off/remote islands. Greece, being one of the predominant nations in island count and subsequent resident population, stands in the position of realizing this potential, whilst significantly lowering energy costs and GHG emissions in those regions.

Greece has successfully sent out proposals, launched and completed numerous projects with respect to island interconnections (between islands and the mainland), renewable energy infrastructure, smartification of the energy grid and services, as well as electromobility.

This publication investigates the regulatory framework and support schemes and the related barriers for the social relief and energy transition efforts in the Greek islands.

Such an example are PSOs (Public Service Obligations), primarily intended to cover the high energy costs of NII, in addition to other support mechanisms for RES. Moreover, HAEE's team illustrates the unique situation regarding the national energy grid and its autonomous energy systems located in the Aegean. Specifically, HAEE's team analyses the 28 NNIs and the ambitious national plan to interconnect as many as possible to the mainland grid.

Finally, HAEE's team explores the plethora of active projects and proposals for the reformation of island energy systems to be primarily dependent on RES, as well as the various EU and Greek Government-backed funding schemes, which are enabling the realization of these initiatives, in the hopes of a new era for Greek energy until 2030.

Exploring the Current Landscape

Navigating Energy Policies and Regulatory Framework

Greece as a nation is defined by the many islands that are spread across the Ionian and Aegean Seas. The 227 inhabited islands can be split into two major groups, with respect to the state of their energy system. One group includes islands that are interconnected to the mainland grid and the other group includes the islands that are autonomous energy systems, that are not interconnected to the mainland grid. Since Greek islands play a prominent role in the Greek economy and are significant part of the overall energy system of Greece, there are various regulatory/ legislative frameworks, policies, and supporting mechanisms designed for the islands, or at least include special provisions aimed at islands.

For example, Renewable Energy Sources (RES) projects located on non-interconnected islands that can be supported through a Feed-in Tariff (FiT) mechanism regardless of their size (in terms of capacity), whereas RES projects on interconnected islands have a ceiling of 400kW, according to Law 4414/2016 and the update from Law 4546/2018 [1].

Moreover, there is also a subsidy for RES plants on NIIs employing two or more RES technologies. In terms of both installed capacity and electricity production, Greece supports both solar PV and onshore wind power, especially on islands that possess high potential for both types of RES, hence the focus on hybrid plants (plants that use two or more RES technologies) for Non-Interconnected Islands (NIIs). Another special subsidy scheme for the uptake of e-mobility also runs specifically for the island of Astypalea, with even higher subsidies [2].

1 PUBLIC Island Secretariat II Study on barriers and recommendations GREECE_20221214 clean.pdf (europa.eu)
2 e-Astypalea Services
3 Regulatory Framework for the Pricing of Public Service Obligations (PSO)| PPC (dei.gr)
4 Τιμές και Χρεώσεις - Rae Website

Interconnecting Greek Islands' Power Grids

Finally, the most important regulatory instrument that also concerns the Greek islands is related to energy cost alleviation. Since the energy costs of the NIIs are particularly high, a special levy that is charged to all electricity consumers is designed to cover such costs. This levy is called Public Service Obligation (PSO). PSOs, according to Law 4067/2012, are intended to cover primarily the high energy costs of NIIs, but also aid families with four or more children, and households with low income [3].

Indicatively, the daytime rates of PSO are the following for domestic electricity consumers [4]:

- 6.90€/MWh—consumption up to 1600 kWh/4 months.
- 50€/MWh—consumption 1601 to 2000 kWh/4 months.
- 85€/MWh—consumption above 2001 kWh/4 months.

The islands of Greece possess a unique feature concerning their electricity grid. Specifically, most of the Greek islands' energy systems are autonomous and are not connected to the transmission system or the distribution network of the mainland. The operation of the electric systems of the NIIs, which includes the (i) management of electricity production facilities and infrastructure and (ii) the operation of both the market and distribution systems of these islands, falls under the responsibility of HEDNO S.A. [5]

As of 2023, the electricity market of the NIIs consists of twenty-eight (28) autonomous systems. There are cases where such an autonomous electricity system corresponds to more than one island, forming an island complex.

NII Electricity System		Peak Annual Demand (MW)	Average Energy Production (MWh)
Small	Antikythera	0.12	24.47
	Arki	0.16	35.04
	Gavdos	0.19	47.60
	Agathonisi	0.23	61.32
	Othonoi	0.25	54.02
	Agios Efstratios	0.3	84.55
	Ereikousa	0.49	69.55
	Donousa	0.52	84.32
	Anafi	0.63	116.12
	Megisti	1.31	381.50
	Astypalaia	2.36	546.81
	Amorgos	3.23	947.77
	Serifos	3.58	755.37
	Symi	3.93	1129.83
	Kythnos	4.05	942.36
	Skyros	4.18	1245.81
	Patmos	5.18	1509.81
	Sifnos	6.64	1678.03
	Ikaria	6.74	2168.62
Medium	Karpathos	10.94	3300.08
	Milos	13.59	4536.06
	Lemnos	14.1	4771.28
	Samos	28.6	10337.09
	Chios	44.9	15384.80
	Thira	58.5	20844.01
	Lesbos	63.25	22561.66
	Kos - Kalymnos	97.5	31243.51
Large	Rhodes	218	65449.94

Table 1. The NII systems and their respective peak annual demand (for 2022) and average energy production from thermal units and RES (as of July 2023), source: HEDNO S.A

The various insular autonomous systems can be broadly grouped based on the size of their respective peak annual demand into three groups, as follows:

- Nineteen (19) "small" stand-alone systems with a peak demand of up to 10 MW.
- Eight (8) "medium-sized" stand-alone systems with peak demand from 10 MW to 100 MW.
- One (1) "large" autonomous system with a peak demand of more than 100 MW.

The great variety that exists between the islands in terms of size, population and tourist activity directly results in a great variance in quantities such as the installed power, the annual electricity production and demand, etc. For instance, as of July 2023, the smallest electricity production belongs to Antikythera with an average of 24.47 MWh while the largest production comes from the Rhodes system with an average of 65,449.94 MWh. A brief overview of the various autonomous systems is presented in Table 1.

There is an official plan (as part of the Ten-year Network Development Plan 2021-2030 of IPTO) regarding the future of the NIIs' energy systems that entails their planned interconnection with the mainland grid. The process of interconnection encompasses the direct connection of an island's autonomous electricity system to the national electricity grid that serves the mainland Greece, via underwater electric cables[6].

6 The map of interconnections to be completed by 2030 | IPTO (admie.gr)

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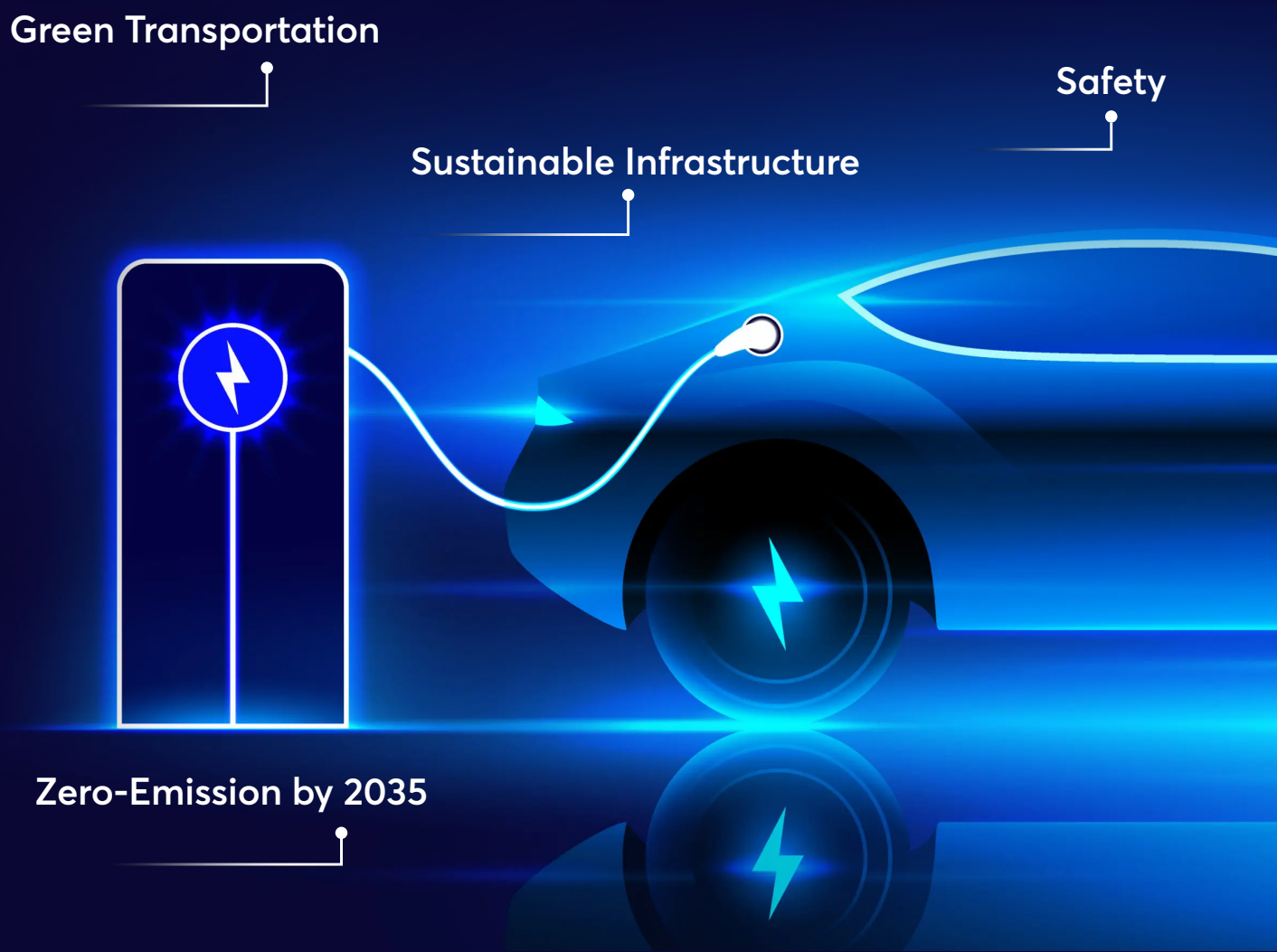

Experts' views

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A Blueprint for Sustainable Energy Transition in the Greek Islands

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BOSTON CONSULTING GROUP

Transitioning to Net Zero needs to happen roughly 3x Faster than in previous transitions. According to a recent Boston Consulting Group publication on the topic, we have the technological levers to make this feasible, but we do not have the policies, proven business cases, and capabilities in place to massively accelerate the pace of action.

The Greek islands, known for their beauty and cultural history, now find themselves at the forefront of a broader narrative: the global shift toward sustainable energy. With geographical challenges and fragmented energy infrastructures, they present a unique yet complex microcosm for global energy transition.

The abundant sun and wind resources offer an opportunity to create a global standard. Storage facilities and smart microgrids could be game changers, offering a decentralized energy architecture that can withstand the islands' geographical challenges, at least for the ones that will not be interconnected with the mainland grid in the upcoming years. Finally, a shift toward electric vehicles would not only reduce carbon footprint but – in combination with smart charging infrastructure – could also help balance the energy demand, benefiting the renewable energy sector.

While the small islands are not representative of Greece's energy profile, making it difficult to scale-up solutions, they can serve as testing grounds for new technologies and energy concepts. As a member of the EU's "Clean Energy in EU islands" initiative, Greece already hosts numerous projects. To name a couple, the first Hybrid Power Station combining PV, wind and batteries is in operation in Tilos, while the e-astypalea initiative signals the transition of Greek islands to e-mobility.

Successful transition requires not only technological ingenuity, but also effective policies and collaborations:

- Regulatory Incentives: The crafting of forward-thinking government policies can act as a catalyst for green investments and boost adoption. Energy efficiency initiatives on EU and country level can have even higher impact in contained, decentralized grids like the ones on the islands.
- Public-Private Synergies: Collaboration between governmental bodies and the private sector can unlock unprecedented levels of investment and thus speed-up the deployment of green technology. Positive business cases – required by such partnerships – will ensure that the solutions will be long-term and forward looking.
- Innovation in Technology: Deploying cutting-edge solutions can help assimilate renewable energy options into current infrastructures and build the required know-how across players in the energy ecosystem.

Of course, no transformation is without its obstacles:

- Aging Infrastructure: The existing facilities on the islands are often not built to accommodate new, green technologies, mostly due to the variability of load and supply profiles. Increased demand during the touristic period creates additional obstacles.
- Regulatory Labyrinth: The bureaucratic red tape can be a headwind against swift energy transition. Policymakers should consider simplifying processes for lighthouse projects on the Greek islands, that could serve as global paradigms of successful sustainable solutions.

Public opinion, incl. local municipalities and communities, plays an indispensable role in the success of any transition. As such, an open dialogue and community education about the benefits of sustainable energy, including waste and pollution reduction, are imperative for acceptance and can speed-up the implementation of these ambitious initiatives. Finally, avenues for community involvement are paramount to ensuring that the transition is not only technologically feasible but also socially equitable.

A transition to sustainable energy on the Greek Islands is more than a lofty ideal. Building on the promise of renewable technologies, it is incumbent upon policymakers, industry stakeholders, and local communities to create an ecosystem that not only propels the Greek Islands toward a sustainable future but also elevates them into a global example of what a green future can look like.

Energy Transition.

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The opportunity to decarbonize the Greek islands

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The Greek territory includes about 6,000 islands and islets in the Aegean and the Ionian seas, gifted with extraordinary ecosystems and cultural heritage, which makes the country unique within the European continent. Yet, the islands' remote status implies energy dependency on fossil fuels, high transportation costs and limited economic diversification. The decarbonization of these islands is an ambitious but indispensable venture both on environmental and economic grounds.

The 32 thermal plants on the non-interconnected islands (NIIs) produce 10% of Greece's electricity and contribute significantly to emissions. The National Energy and Climate plan aims to decommission these plants by 2029, by connecting certain islands to the mainland and introducing RES units.
For the islands to remain non-interconnected - and the interconnections planned after 2025 – the transition will be based on the installation of hybrid power stations.

To address these challenges, several initiatives are in progress. Notably, the Greek Government promotes the "GR-eco islands" initiative, established by the National Climate Law. GR-eco Islands vision is to support a holistic sustainable transformation of the development paradigm of the Greek islands, as a key driver of economic growth, social well-being, and territorial cohesion. This will upgrade the living conditions for permanent and seasonal residents and create a competitive tourism advantage, in response to the demands of the ever-increasing trend of environmentally conscious tourists.

It is expected that any island could become a GR-eco as long as it develops a balanced performance across a series of complementary pillars driven by energy transition as instrumental to support a development transformation alongside with climate neutrality. The other pillars include sustainable resource management, environmental protection, entrepreneurship & innovation, digital transformation and human resource empowerment. Some islands are already moving forward with the initiative, in line also with the directions of the National Energy and Climate plan. Indicative examples in energy transition include Chalki that has set targets for 100% energy autonomy, Tilos that has already reached 100%, while Aghios Efstratios surpassed 85%. For energy efficiency, Kasos, Simi, Chalki target >40% annual energy savings in buildings and 20%-40% in hydraulic/ pumping networks. In electromobility, Chalki aims for 100% electrified public vehicle fleet and Astypalaia targets 100% electrified public transport by 2026.

The next steps of the initiative are pipelined through an envelope of approx. 150 m€ from NSRF 2021 – 2027 Programmes ("Environment & Climate Change", "Just Development Transition") earmarked for the GR-eco Initiative, while Regional Programmes and other financial sources may also contribute therein. The GR-eco development programming requires a strong governance mechanism that can safeguard an efficient and effective use of the available funds, exploring synergies and local consultation within geographies with multiple challenges and administrative layers.

The energy transition of the Greek islands will be substantially supported through the Islands' Decarbonisation Fund (IDF), a financial instrument that can support the decarbonization of the islands through e.g. generation and use of electricity from renewable sources, energy storage, charging infrastructure and electrical interconnections. This novel national instrument is expected to collect funds from the auctions of the unused CO2 allowances that can lead to a financial envelop of €1.8 billion and €2 billion, which could be increased if leverage from private resources is also accounted for.

The available financing sources as well as the favorable policy context provide a momentum to pursue the decarbonization of Greek Islands. It is a multiparameter endeavor that is positioned high in the agenda of various stakeholders. As all these parameters and initiatives are interrelated, a coordinated effort is required in order to reach the ambitious and feasible targets.

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IPTO: Green interconnections for the energy transition of the Greek Islands

Over the last years, the Greek Electricity Transmission System is on a dynamic growth trajectory, owing to the large-scale island interconnection projects implemented by the Independent Power Transmission Operator (IPTO).

This new generation of green infrastructure is gradually lifting the "energy isolation" of the Aegean Islands, expanding the boundaries of the Transmission System beyond the mainland and securing stable power supply to each corner of the country.

Island interconnections are a major pillar of IPTO's investment program, reaching 5 billion euros until 2030 , and a catalyst for the country's energy transition as they significantly expand available electrical space , and a catalyst for the country's energy transition as they significantly expand available electrical space, paving the way for the penetration of up to 29 GW of RES plants in the domestic energy mix by the end of the decade.

They are also pivotal for the improvement of the islands' environmental footprint. With the completion of the island interconnections, air pollution associated with power generation from fossil fuels in the Aegean will be reduced to zero, ridding the atmosphere of around 1.8 million tons of CO2 emissions every year, thus making a decisive contribution to the fight against climate change.

Clean and secure electricity supply for all islands

By 2030, almost all Aegean islands will have been interconnected with the continental Electricity Transmission System. In the northwestern Aegean, the electric interconnection of Skiathos was completed in the summer of 2022, enhancing energy security for all northern Sporades.

With the northern Cyclades having already joined the "family" of interconnected islands since 2020, the Operator is now connecting Santorini, Folegandros, Milos and Serifos to the High Voltage System. This important investment, co-financed with 165 million euros from the Recovery and Resilience Fund, is the last phase of a wider project for the interconnection of more than 20 Cycladic islands to the mainland.

Through a new series of flagship and technically demanding projects, by 2029, IPTO will also interconnect the Dodecanese and the northeastern Aegean to the continental grid, concluding its significant investment programme regarding the development of state-of-the-art energy infrastructure for the Greek islands.

The Operator caters for the energy shielding of the Ionian Sea as well. In the summer of 2023, IPTO completed the upgrade of the cable connection between Kyllini and Zakynthos while it plans new projects worth 100 million euros for the modernization of the electricity transmission infrastructure in the Ionian Islands and Western Greece.

Crete evolves into a strong link for the Greek Transmission System

After the successful completion and commissioning of the "record-breaking" interconnection between Crete and the Peloponnese, with the longest alternating current power cable in the world, the island's energy isolation became a thing of the past.
Now, the construction of the Crete-Attica interconnection is in full swing. It is the largest energy transmission project currently implemented in the country by IPTO's subsidiary Ariadne Interconnection; a huge investment amounting to 1 billion euros, co-financed by the European Union, through the NSRF Operational Program "Transport Infrastructure, Environment & Sustainable Development".
Ariadne Interconnection has laid all 1,350 km of submarine power cables as well as optical fiber cables and continues intensively with the installation of the underground cable sections and the construction of the Converter Stations at the two terminals of the interconnection, in Heraklion, Crete and Aspropyrgos, Attica.
Upon its operation, the second interconnection will put a definitive end to the Crete's dependence on fossil fuels, practically eliminating CO2 emissions for its energy coverage, it will upgrade the island's position on the domestic and regional energy map and will greatly expand the "green margin" for RES development in the area.


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