

**European Union's vision of Clean Energy for
all European islands.**

**RAE' s approach on the interconnections of
the isolated Greek islands.**

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Agenda – Thematic Areas

1. Introduction, RES Targets and legal framework over interconnections
2. European Vision on Clean Energy for the Islands. Targets, Roadmap
3. RAE's Actions and Responsibilities
4. Interconnection Projects under Development
5. Initiatives approved in the Greek islands

Introduction, RES Targets and legal framework over interconnections

- Adoption of EU Directive 2009/28/EC regarding the European Union Member States RES targets (20-20-20) and RES treatment (connection issues, dispatch, financing)
- This trend based on recent Commission announcements will be extended to 2030: 27% RES penetration at Community Level
- Roadmap to 2050 under discussion: 80% CO₂ emission reductions
- In Greece based on the above EC Directive the target set for 2020 is 18% of RES penetration in the energy mix
- Nevertheless, the Greek State has set even more ambitious targets (Law 3851/2010) up to 2020:
 - 20% in total in the Gross Energy Consumption of which
 - ✓ 40% RES Penetration in the Gross Electricity Consumption
 - ✓ 20% RES Penetration in the heating sector
 - ✓ 10% in the transport sector
- Currently a specific Task Force has been established by the Ministry of Energy working on the specific national RES targets on the road to 2030

Introduction, RES Targets and legal framework over interconnections

- New Legislative Framework in Greece (Law 4414/09.08.2016) regarding RES operation & remuneration approved and published on 25.02.2017 in the EU[C(2016) 7272 final], SA 44666] and the Tendering Schemes (SA 48143) based on the “**EC Guidelines over the State Aid in the sectors of energy and environment (2014 – 2020)**”

Principles

- ✓ The existing FIT scheme is being replaced by a market oriented sliding FiP scheme with the exception of small RES plants (W/F with P_{inst} up to 3MW and rest RES with up to 0.5MW). Special Treatment of Energy Communities (L. 4513/2018).
- ✓ The new Law sets the Reference Prices to each RES Technology
- ✓ The premium will be offered by means of tenders organized by RAE from 01.01.2017
- ✓ RES producers are obliged to submit production forecasts and are entitled to a management bonus / penalty depending on their forecasts' accuracy
- ✓ RES producers supported under sFiP have to assume balancing responsibilities (intraday market must be in place).
- ✓ RES producers can be represented in the market mechanisms by aggregators. To that end, the Last Resort Aggregator is to be appointed.
- ✓ A pilot PV tender for 40MWs was organized in December 2016.
- ✓ Tendering Scheme in place for PV and W/F (2018-2020) with an auctioned capacity of 2600MW. First auction held successfully on 02.07.2018.

Introduction, RES Targets and legal framework over interconnections

- Interconnections are considered an essential element towards the realization of the internal EU market in the context of Directive 2009/72/EC.
- European Commission target of achieving interconnection of at least 10% of the installed electricity production capacity for all Member States by 2020
- Regulation No 347/2013 sets out the legal framework for the development and operation of Projects with Paneuropean Significance (PCIs)
- Next step: the 2020 interconnection target is increased to 15% by 2030 based on three pillars/drivers:
 - a) Minimizing electricity markets price differentials (2€/MWh threshold)
 - b) Ensuring that electricity demand is covered in all extreme scenarios (interconnectors' capacity at least 30% of the maximum peak demand)
 - c) Enabling export potential of excess renewable production (interconnectors' capacity at least 30% of the renewable installed capacity)

European Vision on Clean Energy for the Islands. Targets, Roadmap

2.700 ISLANDS IN THE EU, POPULATION NEARLY 15 MILLION

Today

Dependence on fossil fuel

High costs for electricity production

Compensation of these high cost: over 3 billion EURO annually

Looking ahead

Bring down energy production costs

Eliminate subsidies for fossil fuels

Focus on energy efficiency and renewables, with best use of available technologies

European Vision on Clean Energy for the Islands. Targets, Roadmap

Clean Energy Package 4 All Europeans

Goal: EU becoming a low carbon economy via transformation of its energy system. Principles /Pillars:

- ✓ putting energy efficiency first
- ✓ achieving global leadership in renewable energies
- ✓ providing a fair deal for consumers

Role of EU Islands in Clean Energy Package

- ✓ As platforms for pilot initiatives on clean energy transition
- ✓ Showcasing island success stories at international level

European Vision on Clean Energy for the Islands. Targets, Roadmap

Clean Energy for EU islands Malta Political Declaration, 18 May 2017

Commission and 14 MS launched “Clean Energy for EU Islands” initiative to:

- ✓ accelerate the clean energy transition on EU's 2700 islands
- ✓ help islands reduce dependency and costs of energy imports by using RES
- ✓ embrace modern and innovative energy systems
- ✓ improve air quality and lower greenhouse gas emissions

VALLETTA 18 May 2017

POLITICAL DECLARATION on CLEAN ENERGY FOR EU ISLANDS

Inhabited EU islands are often well placed to employ innovative solutions and attract energy investments that integrate local renewable production, storage facilities and demand response in order to achieve interoperable, economic, environmentally friendly and sustainable energy systems, to implement the key priorities of the Clean Energy for all Europeans package;

Recognising that with their strong sense of community and their territorial potential, EU islands can be the architects of their own energy transition. We underline that several of them are already global frontrunners with innovative approaches for integrating variable renewable energy into energy systems and for reducing the emissions from transport, in particular with alternative fuels for transport both on the islands and for the connections to them;

Underlining that EU islands are very diverse and, inter alia, their location, geographic and climatic potential, size and population, provide specific opportunities and challenges that require tailor-made solutions;

Acknowledging that most EU islands face high energy costs and challenges regarding energy security of supply due to their geographic insularity, small economies of scale, and in many cases, reliance on imported fossil fuels and limited or lack of connection to the EU single energy market;

Noting that many EU islands still rely heavily on diesel fuel and oil to generate electricity, with significant negative impacts on emissions, the competitiveness of businesses, and the economy driven by the frequent use of administrative measures and financial aid to mitigate cost reflective high electricity prices for local consumers;

Taking into account that tourism is a key sector for many EU islands' economies, resulting in seasonal energy demand which puts a strain on natural resources and infrastructures;

Acknowledging that alternative fuels, indigenous renewable energy including marine energy, energy efficiency measures implemented with innovative solutions, and connection, where relevant, with the EU's electricity and gas networks are important drivers for sustainable and resilient economic growth and the development of local skills and jobs for the communities on EU islands;

Recognising that many islands and their marine waters are unique ecosystems that require special attention during infrastructure planning and development;

Highlighting, in the context of the 2015 Paris Climate agreement, the vulnerability of islands to climate change and the important role that a clean energy transition along with increased climate resilience plays to mitigate this risk;

Having regard, among other initiatives, to the European Parliament's resolution on the special situation of islands (2015/3014(RSP)) stressing the European islands' potential to contribute to strengthening sustainable development in the Union.

European Vision on Clean Energy for the Islands. Targets, Roadmap

Clean Energy for EU islands' Inaugural Forum Chania, 22 September 2017

- overwhelming endorsement by political representatives, policy makers and other stakeholders
- over 200 participants and close to 40 speakers taking the floor
- interventions strongly supportive of EU action and facilitation of decarbonisation of islands in its legal, financial and technical dimensions

European Vision on Clean Energy for the Islands. Targets, Roadmap

Objectives

- Islands as innovation leaders for integrating local renewable production, storage facilities and demand response;
- Islands to demonstrate how decarbonisation creates resilient energy systems via reduced reliance on fossil fuel imports, the protection of the local environment, and autonomy over its energy supply
- Islands to show how an energy transition can be a driver for economic development, by creating local jobs,
- Provide new business opportunities and supporting self sufficiency of the island communities.

European Vision on Clean Energy for the Islands. Targets, Roadmap

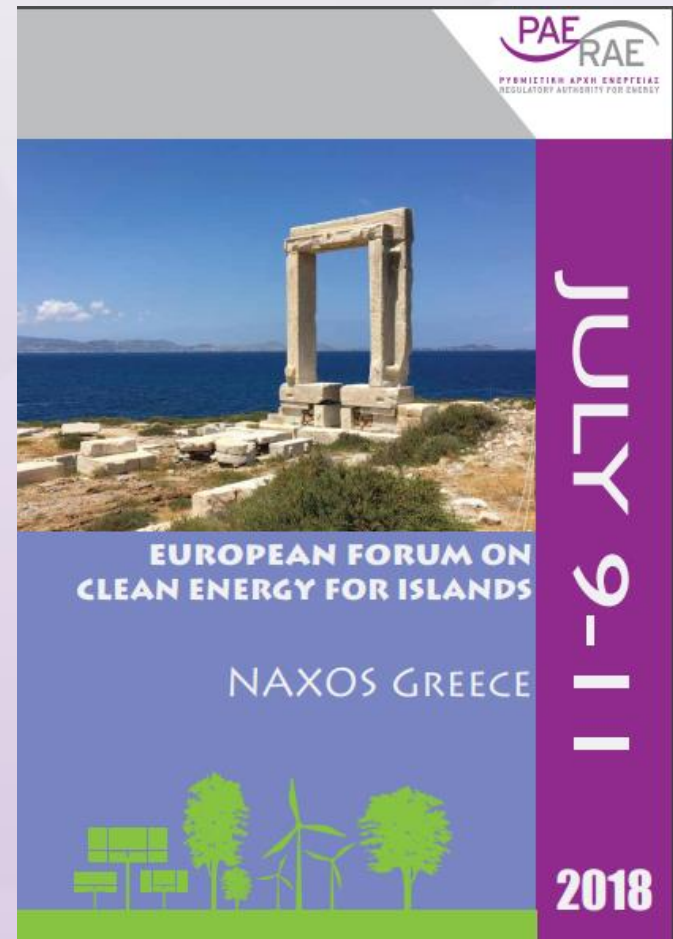
Support

- **Secretariat** soon to be established for the Initiative to help
 - ✓ launching decarbonisation plans on islands,
 - ✓ Capacity-building for islands' stakeholders on the design,
 - ✓ development and financing of integrated decarbonization plans;
 - ✓ host a stakeholders' exchange platform towards awareness raising and communication, as well as
 - ✓ organize yearly forums
- **Island Facility** to be set up to support comprehensive energy transition in preparatory and implementation phase under Horizon 2020

European Vision on Clean Energy for the Islands. Targets, Roadmap

"European Forum on Clean Energy for Islands" organized by RAE in collaboration with the French Regulator (CRE) Naxos, 9-11 July 2018

- ✓ More than 140 delegates attended the forum (high ranking governmental, regional and Commission's officials, Regulators' experts, TSOs and DSOs, Technical Universities)
- ✓ Primary goal: capturing the challenges and proposed policies relevant to the energy transition towards a future with clean energy for the European islands



European Vision on Clean Energy for the Islands. Targets, Roadmap

Main Outcomes:

- I. The gradual withdrawal from conventional and polluting fuels and their replacement with renewable energy sources is inevitable for the energy systems
- II. To that end, The choice between the available technical solutions should be made on a case-by-case basis, taking into account the particularities of each island electrical system and the cost-benefit analysis of each solution.
- III. The transition to clean energy must be achieved with due regard and respect for the environment of the islands, their fragile ecosystems, their cultural heritage and their natural beauty.
- IV. Consent of the local community is ensured through the collaboration of local and central governments and the necessary consultations. The local community must be actively involved both in the planning and the development of RES plants, via the establishment of energy communities and other similar unions.
- V. There is room and need for cooperation between European regulatory authorities to formulate and implement a specialized regulatory framework for the operation of energy systems of the islands. RAE and CRE have already agreed to take initiative and work together to achieve such a collaboration agreement for elaborating on a common policy between all interested NRAs

Current Situation of Greek islands

- Most islands today in Greece (mainly in the Aegean Sea) are electrified autonomously by both local thermal power plants, which operate with fuel oil, heavy (mazut) or light (diesel), and RES plants (especially wind farms and PV).
- The electricity market of non-interconnected islands consists of twenty nine (29) autonomous systems. Some of them consist of several islands (islands' clusters), where in charge of the operation and management of the relevant Markets and networks is the HEDNO S.A.
- The size (peak demand) in MW of the 29 autonomous systems varies:
 - Nineteen (19) "small" autonomous systems have peak demand up to 10 MW.
 - Eleven (8) "average size" autonomous systems have peak demand from 10 MW to 100 MW.
 - Two (2) "large" autonomous systems have peak demand exceeding 100 MW, i.e. Crete (with peak demand over 600 MW) and Rhodes (demand peak ~ 200 MW).

RAE's actions and responsibilities

- RAE promotes the idea of interconnection of the Non Interconnected islands to the bulk Continental grid, as the permanent and sustainable solution of islands electrification.
 - Several studies have been conducted in the last years, either by RAE or by TSO with the support of NTUA.
- Law 4414/2016 embodies provisions of EC Derogations Decision 2014/536, with respect to advanced investigation and monitoring of islands interconnections
 - Restrictions on further conventional production long term expansion, priority to investigate technical feasibility and economic viability of the interconnections' solutions
 - RAE is in charge of close monitoring of approved Interconnection projects' progress and has the right to take over the necessary actions for their on time realization.
- By virtue of RAE's decision 469/2015, a Working Committee, comprised of RAE's, DSO and TSOs' (for electricity and gas) experts, was set up to examine, from a technoeconomical standpoint, the options for the permanent electrification of the Non-Interconnected Islands in the future.
- Interconnection projects are approved by RAE through the Ten-Year Network Development Plan (TYNDP) submitted by the Greek TSO.
 - RAE may distinguish projects of TYNDP as of "national major importance". Special monitoring and development restrictions (binding time schedules) apply in these cases
 - With RAE's decision 280/2016, the TYNDP 2017-2026 was approved including interconnection of Cyclades and Crete. Following that, by means of RAE's Decision 256/2018 special directions were given to the TSO in order to accelerate the approved Islands' interconnections and to evaluate and adopt the Working Committee proposal on the interconnection of Dodecanese.

Benefits of the Islands' Interconnections

- Consumer relief, over time, from the charges imposed by means of Public Services Obligations (PSO, ~ €600-800 million/ year, oil prices dependent)
- Improvement of the environment in islands by setting the polluting thermal plants to reserve status or by decommissioning them in view of the strict EU environmental/emission restrictions
- Exploitation of high RES (mainly wind) potential of the islands in the way towards the achievement of the binding national RES targets
=> **sustainable future**
- Independence from the oil imports and the fluctuations in its price
- Electricity Market Integration
- Ensuring energy efficiency and improved security of supply of the islands' electricity systems

Approved Interconnection Projects in TYNDP

Interconnection of Cyclades (Syros, Mykonos, Paros, Naxos) (~420mil. €)

Stage A, approved, operational

- Syros to Attica and to Tinos (AC 200 MVA)
- Syros to Paros (AC 140 MVA)
- Syros to Mykonos (AC 140 MVA)

Stage B, expected by 2019

- Paros to Naxos (AC 140 MVA)
- Naxos to Mykonos (AC 140 MVA)
- Upgrading Andros - Evia & Andros - Tinos

Stage C, expected by 2020

- Second cable Syros to Attica (AC 200 MVA)

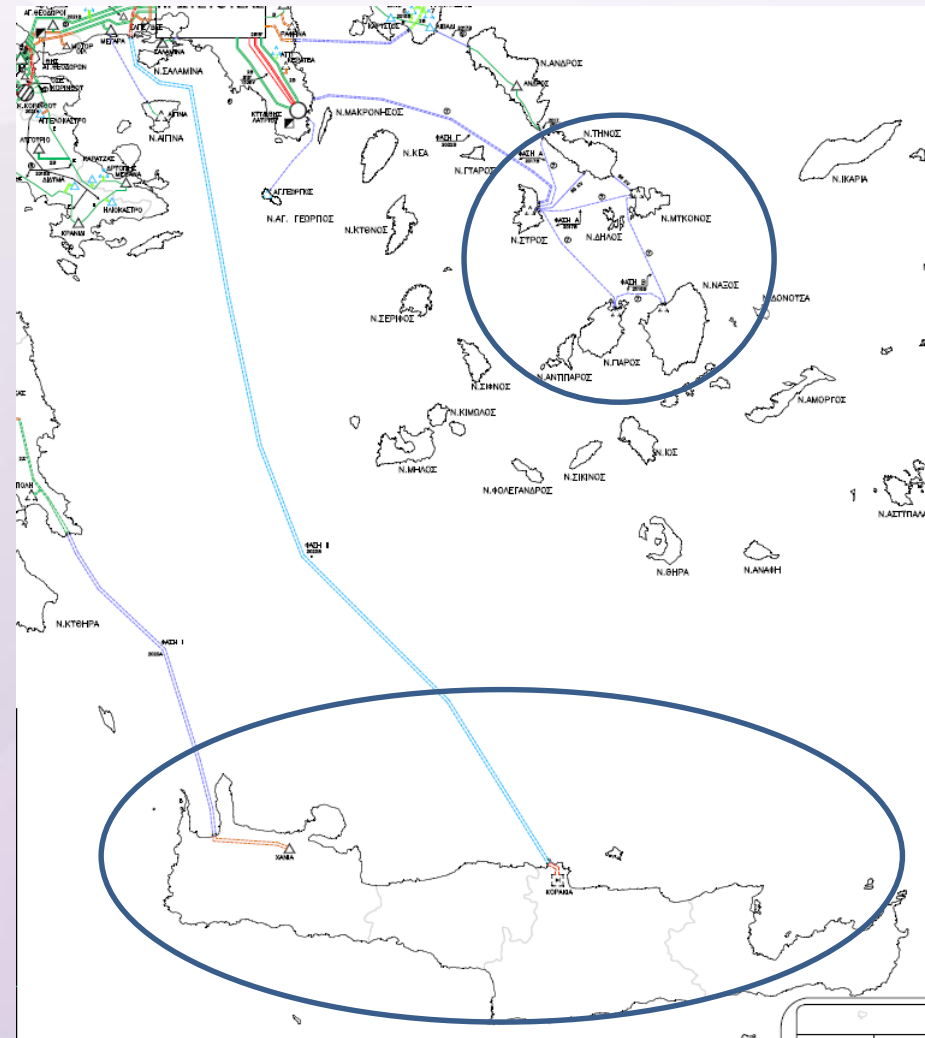
Interconnection Of Crete

Stage A:, planned by 2020 (~320mil. €)

- Crete - Peloponnese, AC 150kV, 2×200MVA

Stage B:, planned by 2022 (~770mil. €)

- Crete - Attica DC link, 2×500MW



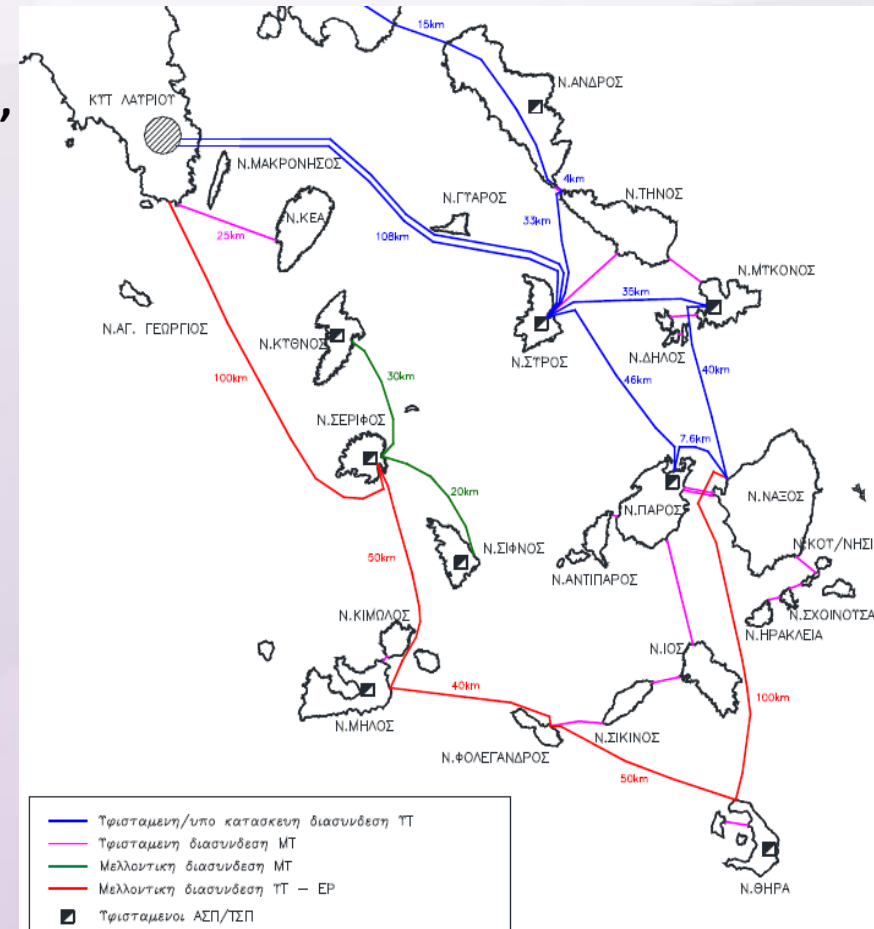
Interconnection Projects in TYNDP under approval

- **Interconnection of the rest of Cyclades (Santorini, Milos, Folegandros, Serifos, Kithnos, Sifnos)**

Stage D, planned by 2024 (~370mil. €)

- Naxos (or Paros) to Santorini (AC 200 MVA)
- Santorini to Folegandros (AC 200 MVA)
- Folegandros to Milos (AC 200 MVA)
- Milos to Serifos (AC 200 MVA)
- Serifos to Lavrion, Attica (AC 200MVA)

- ✓ The interconnection is based on the Working Committee's Proposal for the extension of the Cyclades Interconnection.
- ✓ Submission in the context of TYNDP 2019-2028
Currently under Approval by RAE



Working Committee Proposal

Analysis Approach

Two scenarios are taken into consideration:

1. Autonomous development of the NII by means of

- (a) Oil use in thermal plants in the context of existing EU Regulations & Directives over emissions (MCPD, Dir. 2015/2193 and IED, Dir. 2010/75) or
- (b) LNG use with simultaneous transformation of thermal power plants (oil to gas fueled) and/or construction of new units

Significant elements under analysis: the storage and regasification applicable methods and the supply of the necessary LNG quantities

2. Interconnection to the mainland grid

Analysis of alternatives (AC-DC technologies and voltage levels, topology of the interconnections connection points, capacities) with possible operation of local thermal units for limited periods (cold reserve). Specialized Studies on:

- (a) Load Flows and Voltage/frequency Levels
- (b) Operation (Steady state and transient phenomena)

3. Comparison of the two solutions by means of the NPV. The NPV is calculated for the year 2025 (starting date) and the evaluation period is 25 years (2025 - 2050)

- The RES penetration is considered to remain stable at the existing levels.

Working Committee Proposal

Analysis Approach

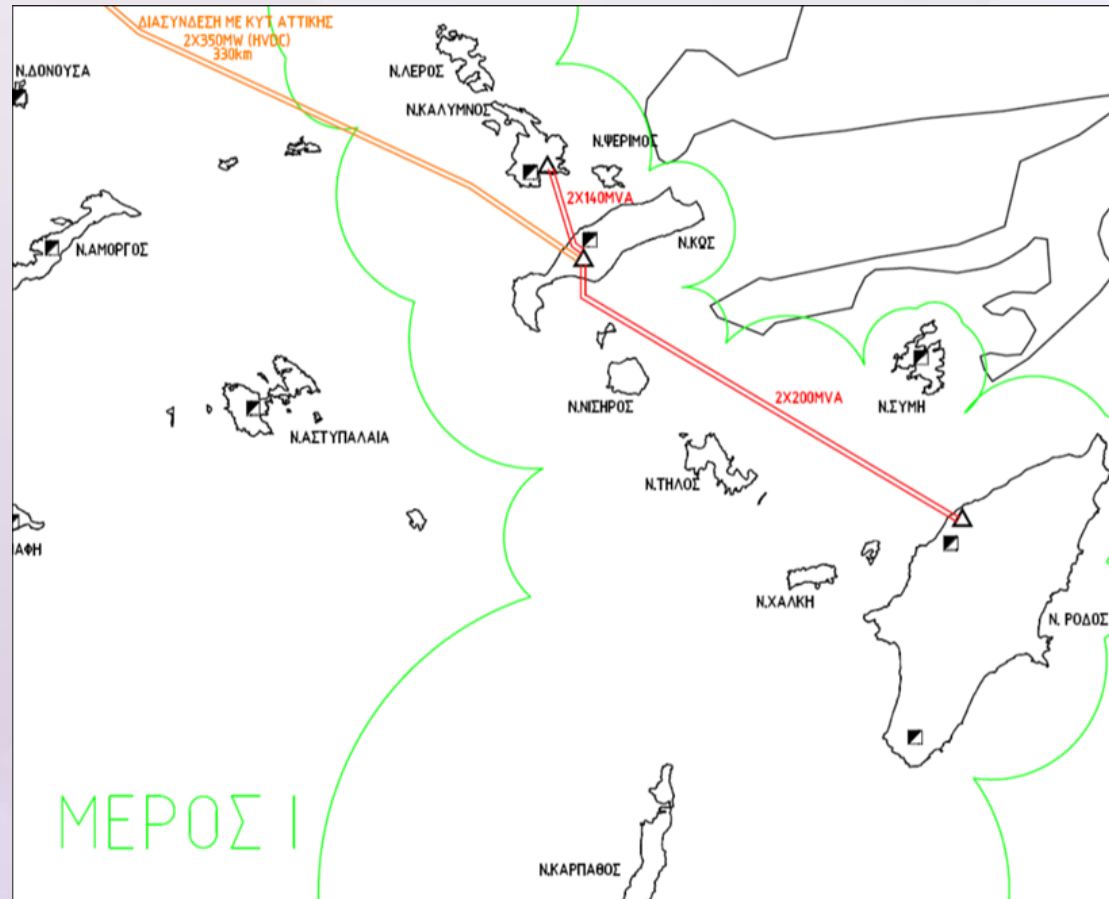
Inputs / Parameters for the Calculations:

- Annual Energy Consumption Increase Rate of the island
- Construction Costs of oil fired thermal Plants (€/MW) and transformation costs (oil to gas)
- Operational Costs of Thermal Plants and typical efficiencies
- LNG regasification units' costs
- Costs of Primary Energy Sources and energy components (Oil, NG, CO₂, RES)
- Interconnectors' Costs (construction and operational costs)
- Energy Costs of the Interconnected System
 - (a) SMP
 - (b) Gas Fired CCGT Marginal Cost
 - (c) Total Energy Cost of the Interconnected System
- NPV Sensitivity Analysis arising out of basic parameters costs' fluctuations in the range of $\pm 10\text{-}20\%$.

Working Committee Proposal

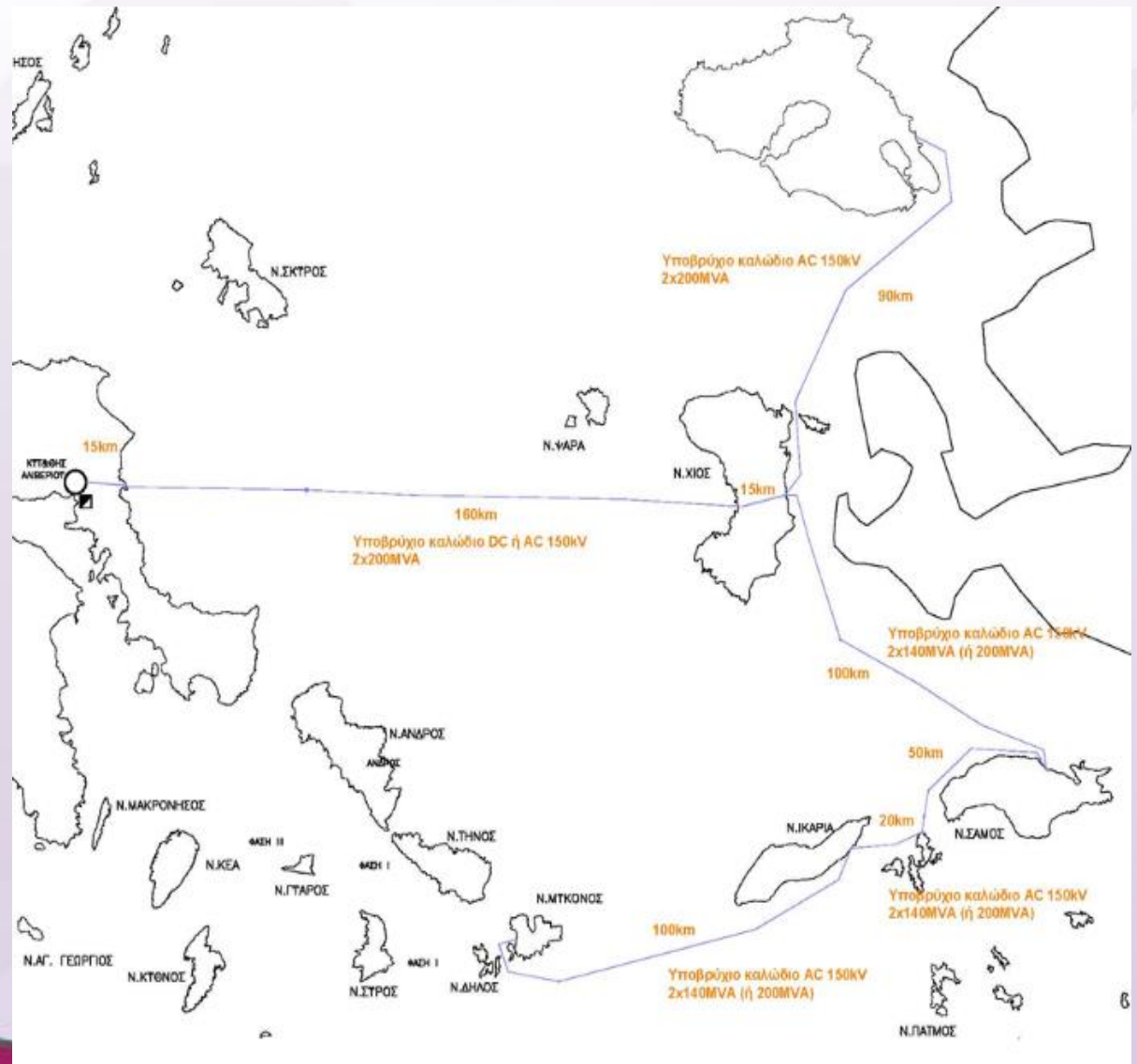
- **Next Case Interconnection of Dodecanese islands**

- Interconnection of the islands in the SE of the Aegean Sea.
- Committee's Proposal for the interconnection of the Dodecanese islands by means of:
a) radial submarine connection to Crete, or b) directly to Attica.
- The best techno - economic solution proved to be the interconnection of Kos Island to Attica by means of submarine DC cables (2x350 - 450MW) and of the rest of the Dodecanese islands to Kos by means of AC 150kV cables.
- In this context, the system of Karpathos – Kasos islands will operate and be developed autonomously.



Working Committee next studies

Next Case:
Interconnection of
North - East Aegean
islands
(preliminary design)

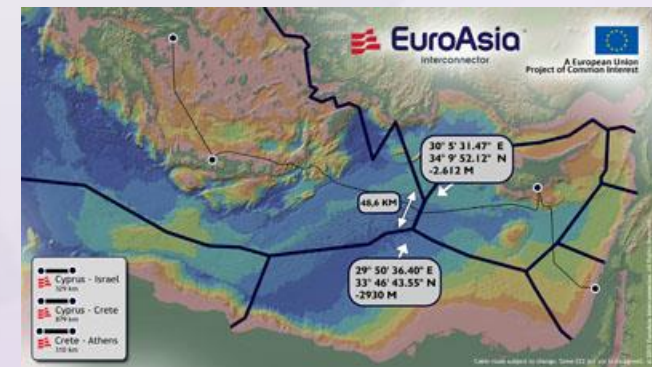


Third Parties Interconnection Projects

➤ Interconnection of Crete

✓ Project of Common Interest «Euroasia Interconnector»

- Comprised of the interconnection of Greece - (through Crete) Cyprus - Israel with initial transfer capacity of 1000MW
- Included in the ENTSO-E TYNDP of 2016
- Approved Commencement of works in 2019 and electrification by 2021 (Attica – Crete)
- Investment Request in the context of Regulation 347/2013 was submitted to RAE and CERA and the CBCA Decision was issued for the Greece - Cyprus part in October 2017
- RAE (Decisions 280/2016 & 256/2018) asked for the collaboration between Euroasia Interconnection and TSO regarding Crete Interconnection and a MoU in this respect was signed prior to the CBCA Decision.
- By virtue of RAE's Decisions No. 816 & 838/2018, the Project was assigned on the basis of the CBCA Decision and the commonly agreed MoU to a SPV under the control of ADMIE S.A., where Euroasia Interconnector Ltd. can actively participate.



Initiatives approved in the Greek islands

RAE's proposal of HPS pricing

NTUA Study's conclusions

Expected reduction and convergence of investment cost of storage technologies (batteries)

Avoiding a further burden on NII systems electricity cost and consequently on PSOs

Planned interconnections of islands, according to approved TYNDPs

RAE's review of HPS pricing

Remuneration scheme / RAE's Opinion 7/2018

- **Single maximum remuneration price** based on LCOE, at **200 € / MWh**, revised every three years
- Allocation of the above maximum price **in capacity remuneration (k€/MW-year)** and in **energy remuneration (€/MWh)**
 - **Energy remuneration** capped by **120%*Average Variable Cost (AVC)** of NII's conventional units
 - **Capacity remuneration** capped by **Average Fixed Cost (AFC)** of NII's conventional units
- **Energy remuneration price applies to dispatchable energy up to the volume of 3500 MWh / MW** guaranteed power of the HPS (maximum CF of the station of about 40%)
- Dispatchable energy beyond this volume is remunerated on reference prices of RES technologies (energy per technology allocation, based on monthly actual production)
- **Non dispatchable RES energy** (directly injected to the grid) is remunerated **on reference price of RES** technologies (energy per technology allocation, based on monthly actual production)

RAE's review of HPS pricing

Duration of the remuneration scheme / RAE's Opinion 07/2018

- Max. PPA duration for HPS, **23 years for pump-storage and 21 years for battery-storage**
 - Divided in two sub-periods. **1st period (initial)** : 13 years for **pump-storage** and 11 years for batteries. **2nd period (extension)** : 10 years.
- **Price guarantee**
 - (Case A) For the 1st period , under the condition that, at the signing of the contract, no interconnection of the NII has been included (binding timeline) in the TYNDP.
 - (Case B) For 7 (pump)/5 (batteries) years, under the condition that, at the signing of the contract, interconnection of the NII has been included (binding timeline) in the TYNDP.
- The contract is terminated automatically and replaced by another one for the remaining period (up to 21-23 years) in the context of the interconnected system regime:
 - If the NII would be interconnected during the 10-year extension of the contract for case A
 - With the interconnection of the NII for case B
- By renewing the contract for the second 10-year period, the guaranteed prices will be those valid at the time of the renewal of the contract.

RAE's review of HPS pricing

Other considerations / initiatives

- ✓ No production license for a HPS in a NII, in case of NII's interconnection included in TYNDP (binding timeschedule).
- ✓ No PPA for a HPS in a NII, in case of a contract for the construction of the interconnection of the NII has been already awarded
- ✓ Pending licensing requests are evaluated under the new scheme
- ✓ Projects already licensed will be remunerated under the new scheme
- ☐ **Approval of DEDDIE's proposal for the pilot development of EV charging stations on Greek islands under specific terms and conditions (first stage of development)**

Thank you for your Attention!



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Appendix 1: Typical Costs used in the Working Committee Proposals

Parameters		
Internal Combustion Engines Efficiency	40%	
OCGT Efficiency	35%	
CO ₂ Emissions / MWh (NG fueled)	450	kg CO ₂ /MWh
NG Price	30,5	€/MWh
CO ₂ Price	25	€/tn
O&M Costs	3	€/MWh
Diesel	1006	€/klit
Mazut	558,5	€/tn
Amortization Period	25	Έτη
Interest Rate	8%	
Transformation Costs (Diesel to NG)	30%	
OCGT Purchase Costs	650.000	€/MW
Internal Combustion Engine Costs	800.000	€/MW
LNG Storage Costs	2.500	€/m ³ _{LNG}

Appendix 1: Typical Costs used in the Working Committee Proposals

AC DC Converter VSC (MW)	Per Unit Costs (MEuro)		
	Min	Max	Average
500*	98.1*	114.3*	106.2*
700*	113.1*	130.5*	121.8*
800	120.0	138.0	129.0
900*	128.1*	146.7*	137.4*
1000	136.8	156.0	146.4
1200	150.0	170.4	160.2

Element	Per Unit Costs (k €)
Substation GIS 150 kV/MV	10.500
Submarine Cable 150 kV 140 MVA	890 /km
Submarine Cable 150 kV 200 MVA	915 /km