Islands' challenges and R&D activities funded by HEDNO

Nikos Hatziargyriou
Chairman of the Board and CEO of HEDNO
ETIP SNET Vice-Chair

Clean Energy for All Europeans-Clean energy for EU Islands

More than 2200 inhabited islands in the EU. Despite access to renewable sources of energy, they mainlydepend on expensive fossil fuel imports for their energy supply.

As part of the **Clean Energy for All Europeans** package, the EU's Clean Energy for EU Islands initiative provides a long term framework to help islands generate their own sustainable, low-cost energy, resulting in:

- Reduced energy costs and greatly increased production of renewable energy and construction of energy storage facilities and demand response systems
- Better energy security for islands, less reliance on imports
- Improved air quality, lower greenhouse gas emissions, less impact on islands' natural environment
- New jobs and business opportunities, boosting islands' economic self-sufficiency.

The Clean Energy for EU Islands initiative was launched in May 2017 in Malta, when the European Commission and 14 EU countries (Croatia, Cyprus, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Malta, Portugal, Spain, and Sweden) signed a Political Declaration
followed by Clean Energy for EU Islands-Inaugural Forum (Chania, Crete – 22 September 2017)

Greek Non Interconnected (NII) Islands

32 Electrical Systems (ES)

Categorized by Average Peak Demand (last 5 years)

Large (>100 MW):2 ES

Non Interconnected Islands (NII)

32 Electrical Systems (ES)

Categorized by
Average Peak
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Large (>100 MW):2ES

Medium (>5≤ 100 MW): 14 ES

Non Interconnected Islands (NII)

32 Electrical Systems (ES)

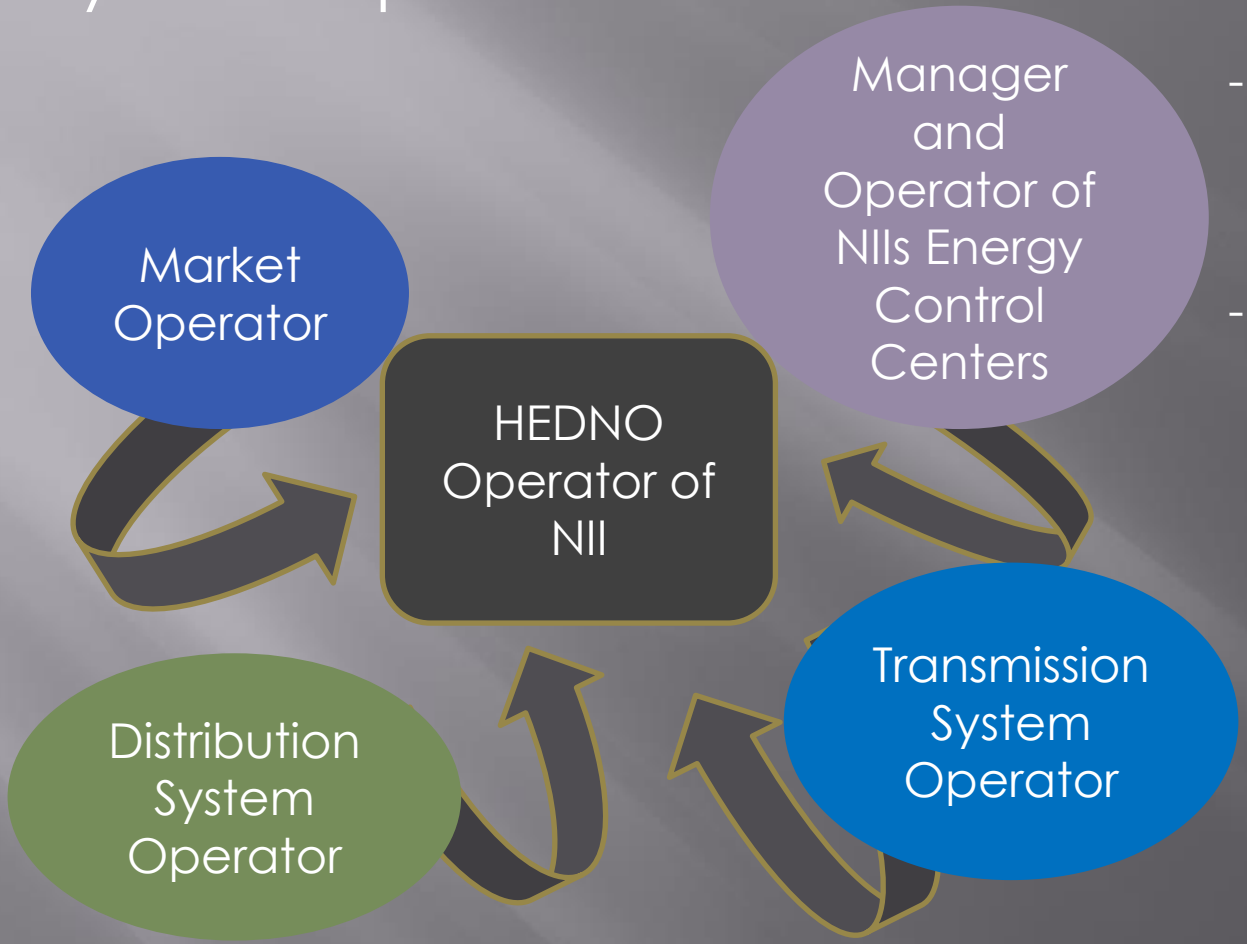
Categorized by Average Peak Demand (last 5 years)
Large (>100 MW):2ES

Medium (>5≤ 100 MW): 14 ES

- Small(≤ 5 MW): 16 ES

- ✓ St.Efstratios
- ✓ Agathonisi
- ✓ Amorgos
- ✓ Anafi
- ✓ Antikythira
- ✓ Arkioi
- ✓ Astypalaia
- ✓ Gavdos
- ✓ Donousa
- ✓ Ereikousa
- ✓ Kythnos
- ✓ Megisti
- ✓ Othonoi
- ✓ Serifos
- ✓ Skyros
- ✓ Symi

HEDNO's role as NII's Electrical System Operator



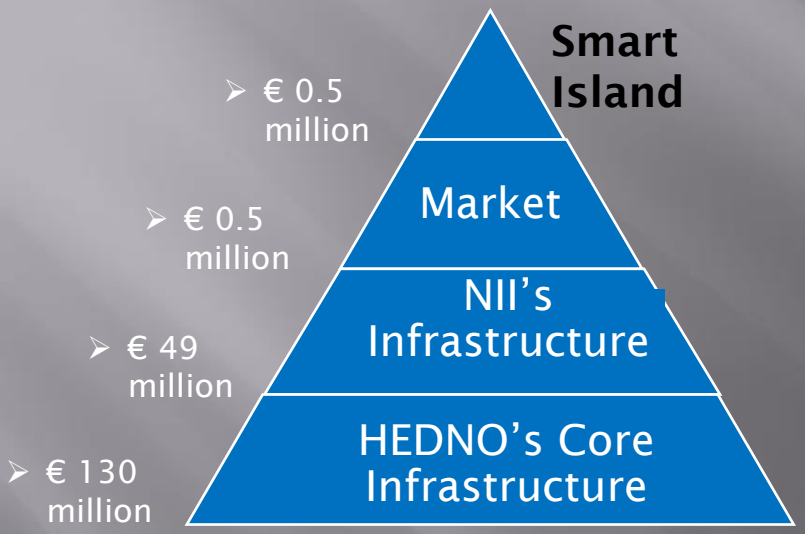
Our MISSION

- Increase RES penetration in each ES of NII
- Reduce the operational cost of NII's ES
- Ensure uninterruptible electricity supply of prosumers

Our GOAL

Develop all the necessary infrastructure for the 32 ES of NII, covering the emerging needs of all Participants in the NII's Market

Strategic Plan for NIIPs



HEDNO's Core Infrastructure

- Further implementation of Smart Metering
- Digitalization and Data Management through smart and integrated systems

NII's Infrastructure

- Metering Infrastructure for producers
- Development of the IT System for NII
- Energy Control Centers (ECC) in Athens, Grete and Rhodes
- Energy Control Centers (ECC) in the rest ES

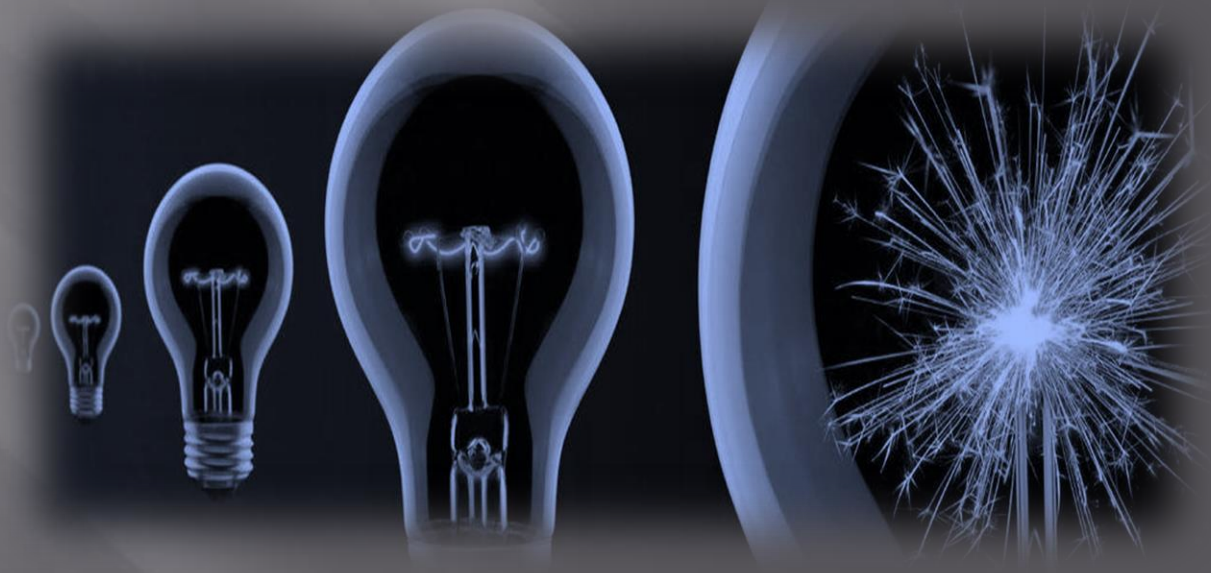
Market

- NII's market Infrastructure

Smart Island

- increase of RES penetration
- reduction of the operational cost
- contribution to environmental protection
- saving of resources
- ensure reliable and uninterrupted supply of electricity

R&I is a key activity in our business



Research, Development and Innovation

HEDNO'S main objective is the continuous modernization through research and development, with emphasis on innovation

"Smart grids" create new opportunities for HEDNO's contribution to the country's productive reconstruction.

HEDNO participates in various research projects through European and national partnerships, and with a particular focus on fields such as the optimal integration of RES into the Network, the production and load forecasting, the Network development and upgrading, the remote metering of electricity consumption etc.

Active member of:

EDSO for smart grids

eurelectric

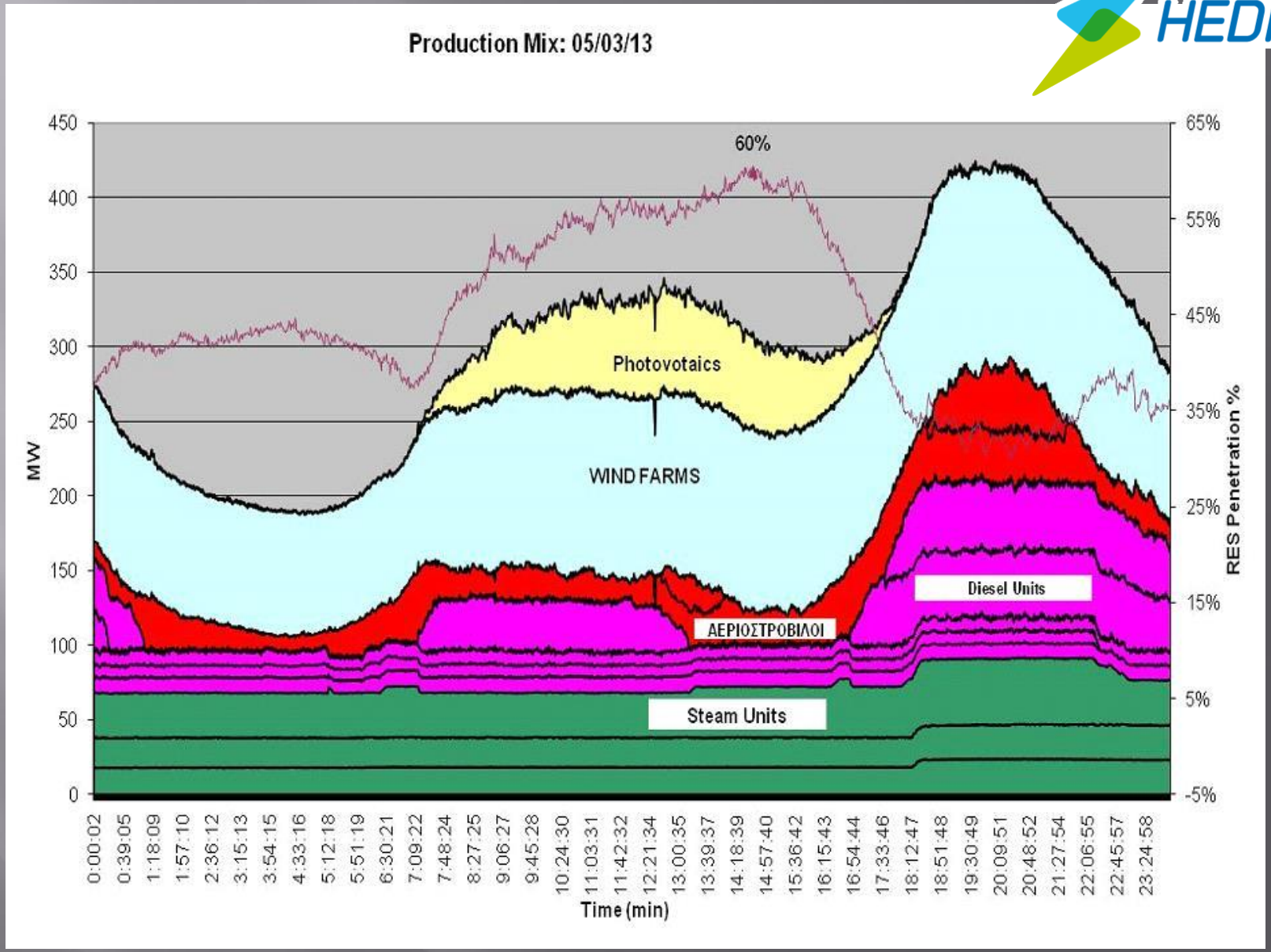
SMARTGRIDS

cigré INTERNATIONAL COUNCIL ON LARGE ELECTRIC SYSTEMS

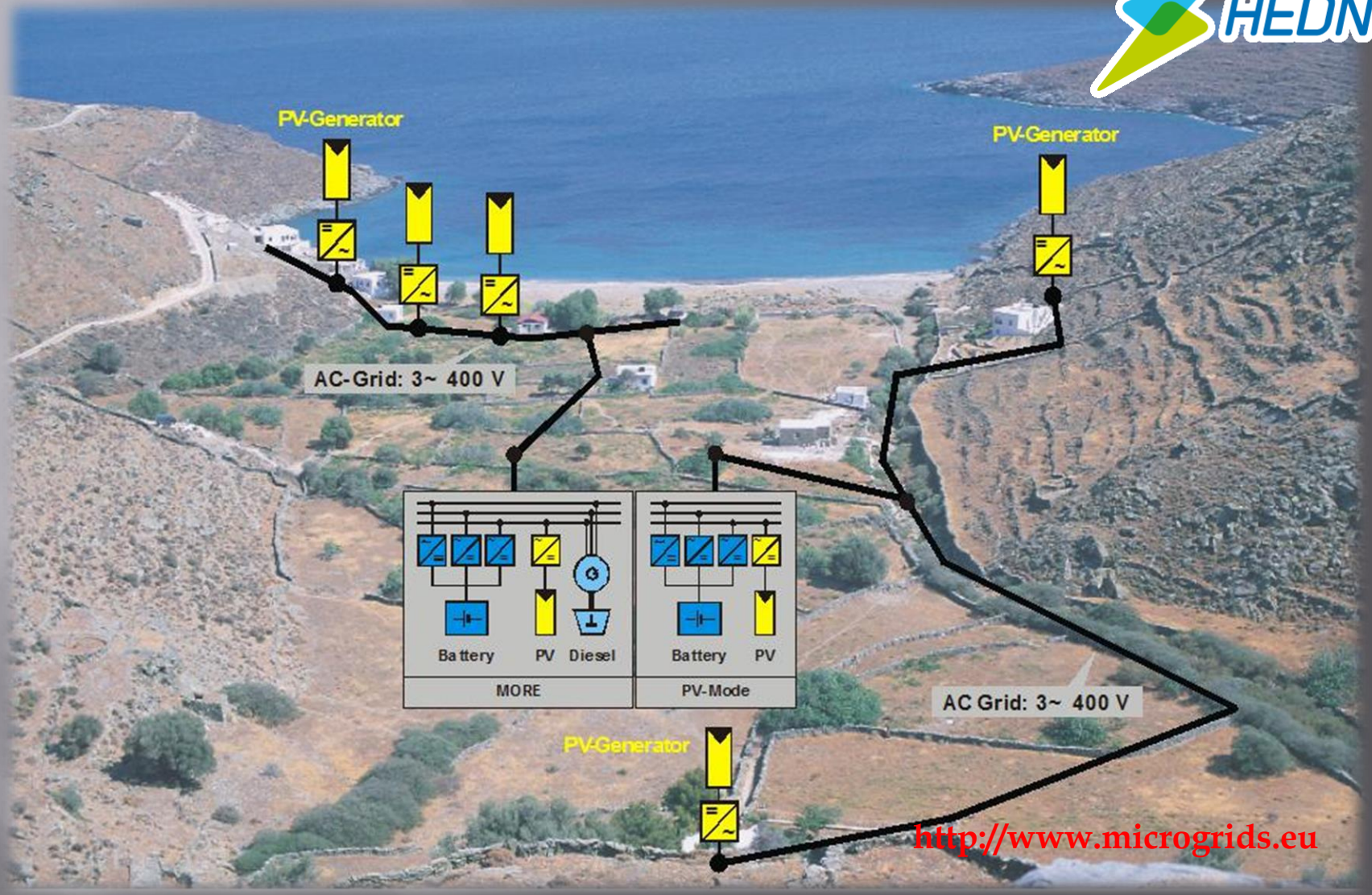
CIRED

Research and Innovation in the Greek Islands/Success stories

- Kythnos (1982) Operation of the first Wind Park in Europe (5x20kW)
- Kythnos(1983) Operation of the first hybrid station comprising a 100 kW PV system with Battery storage
- Kythnos (2000) Operation of a fully automated power system with 500kW battery storage and a 500kW Wind Turbine
- Kythnos (2001) Operation of the first Microgrid electrifying 12 houses with intelligent autonomous Load Control
- Crete (2003) Development of advanced control software system for isolated systems with high RES penetration
- Ikaria hybrid power station: Consisting of 1.05 MW small hydro, 3MW pumped storage and 2.7MW wind farm (*Almost completed*)
- TILOS: Small Hybrid station (Wind Turbine, PV and battery storage) (on-going)
- Several RD&D projects



Crete Power Production – 60% hourly RES penetration

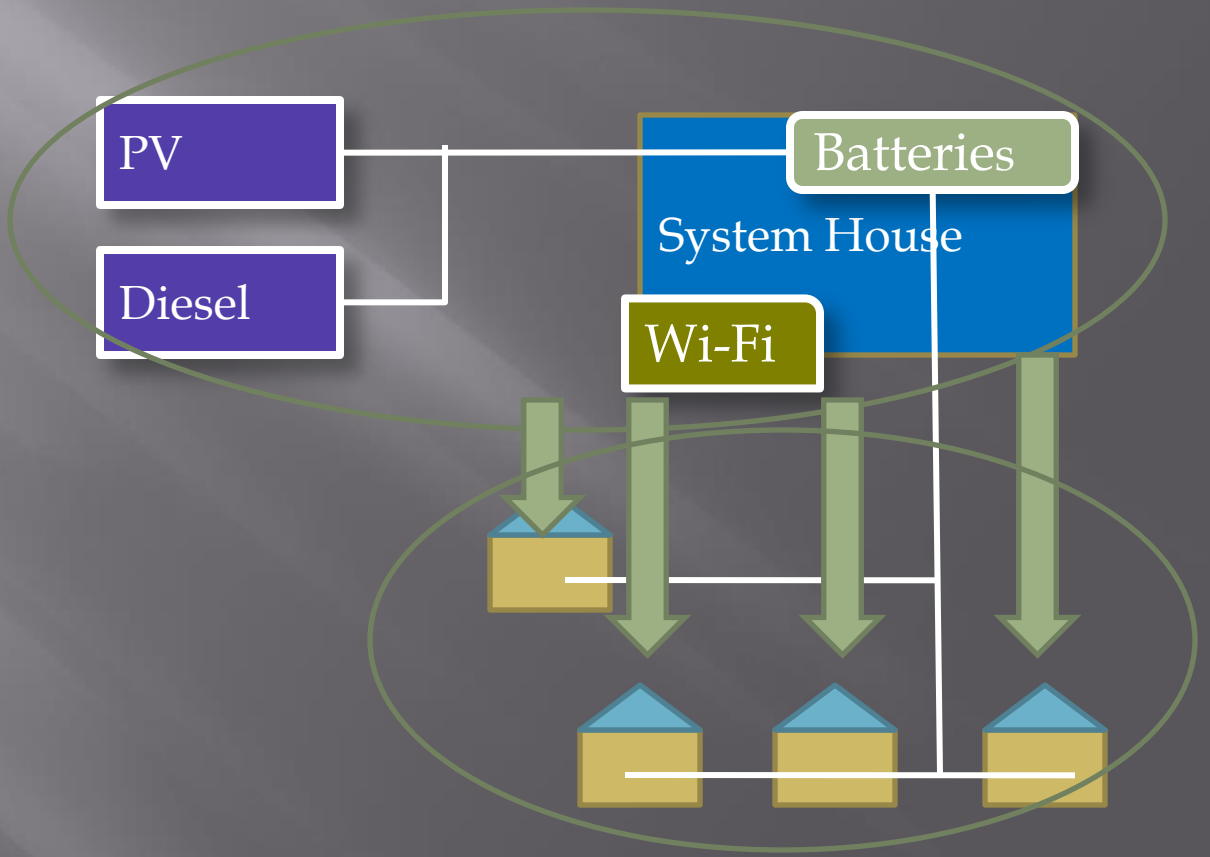


Kythnos Microgrid of 12 houses comprising PVs and Batteries (52 kWh), 9 kVA Diesel (only back-up), flexible loads (1-2 kW irrigation pumps), Intelligent Load Controllers

Decentralized MAS Based Control for Energy Efficiency (Kythnos)

Agents embedded in Intelligent Load Controllers identify the status of the environment (available energy)

Agents negotiate on how the share the available energy without central coordination



R&D activities funded by HEDNO

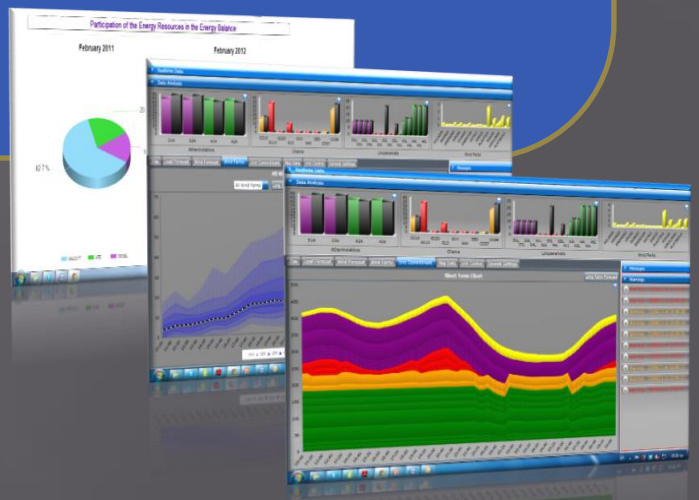
R&D activities funded by HEDNO

ENERGY MANAGEMENT

The objective of the e-Care software is to optimize the overall performance of island systems by increasing the share of RES energy maintaining security.

Modular Architecture

- **Load and RES forecast**
- **RDAS and ED according to the NII Code**
- **Online Security Monitoring**
- **Web based environment**

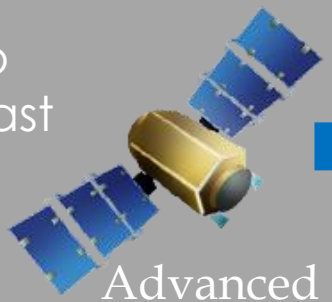


R&D activities funded by HEDNO

Load and RES Forecasting

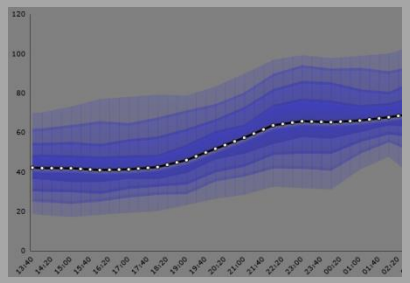
SCADA

Meteo Forecast



Advanced All Technologies

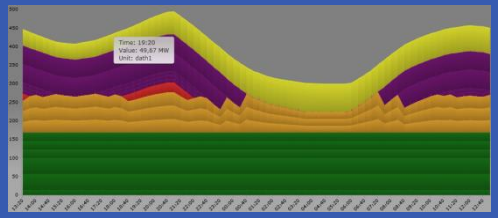
Advanced Modules



Rolling Day Ahead Scheduling/Economic Dispatch

Scheduling based on power optimization libraries (CPLEX)
Integration of Market Rules

Advanced Modules



Simple Messages to the operator

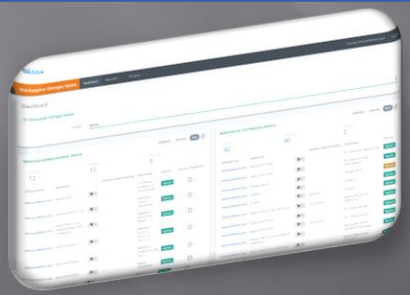
R&D activities funded by HEDNO

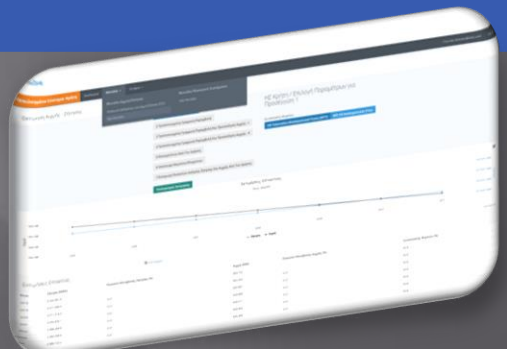
PLANNING AHEAD

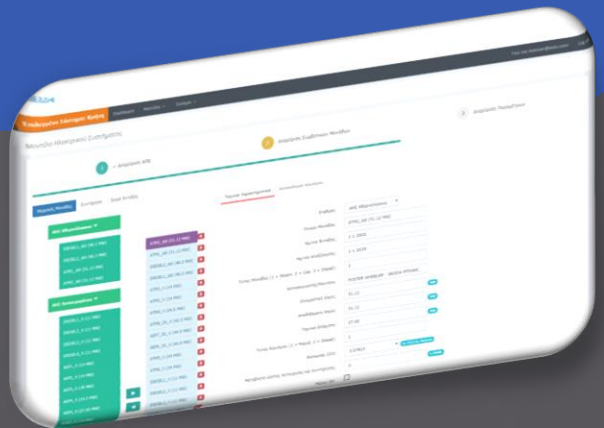
Cover yearly demand and peak by Thermal Unit and RES

- Maximize RES Penetration
- Minimize Fuel Cost
- Respect Market operation and associated constraints

Identify type and size of ICE/Thermal Units (Data Base for all island systems)
Identify RES Capacity limits including new technologies : Hybrid (Storage with RES) and CSP
Compare interconnections (between islands or with the mainland system) with new Thermal Units
Analysis of technical constraints on island operation (reserves, RES penetration limits, etc)
Hourly simulation for several years ahead(1 to 10)
Online environment to create and store scenarios







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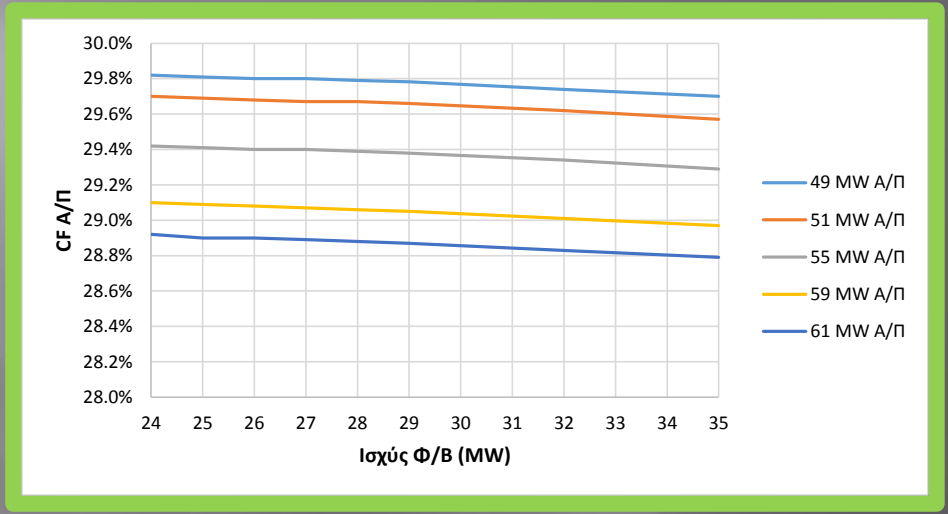
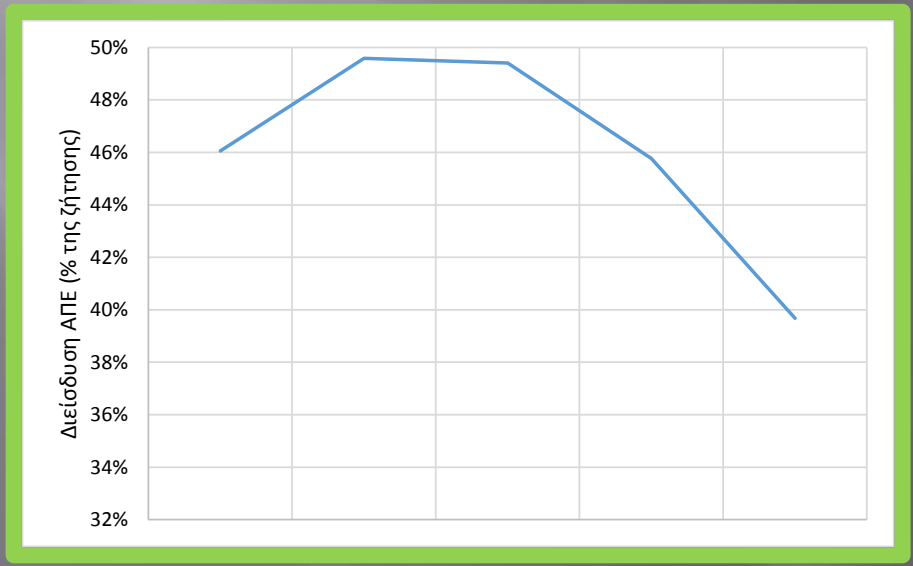
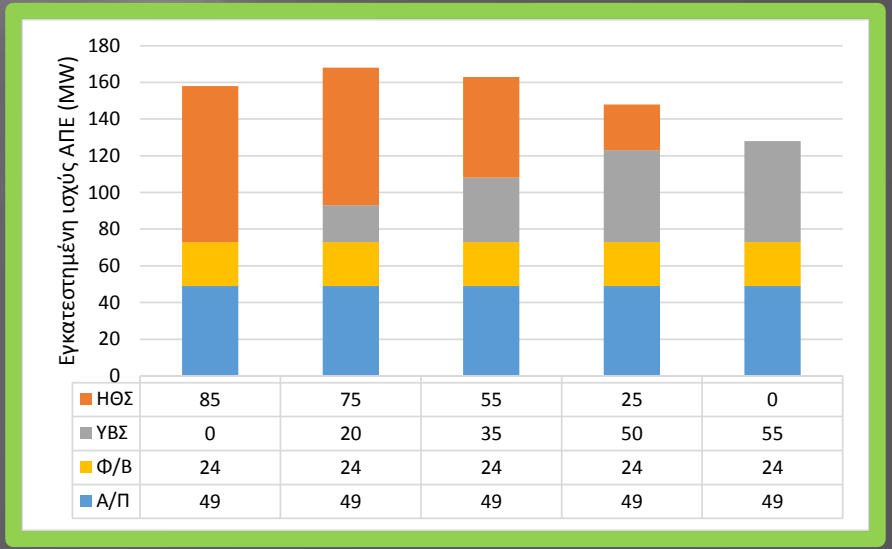
RES Hosting Capacity: Island of Rhodes







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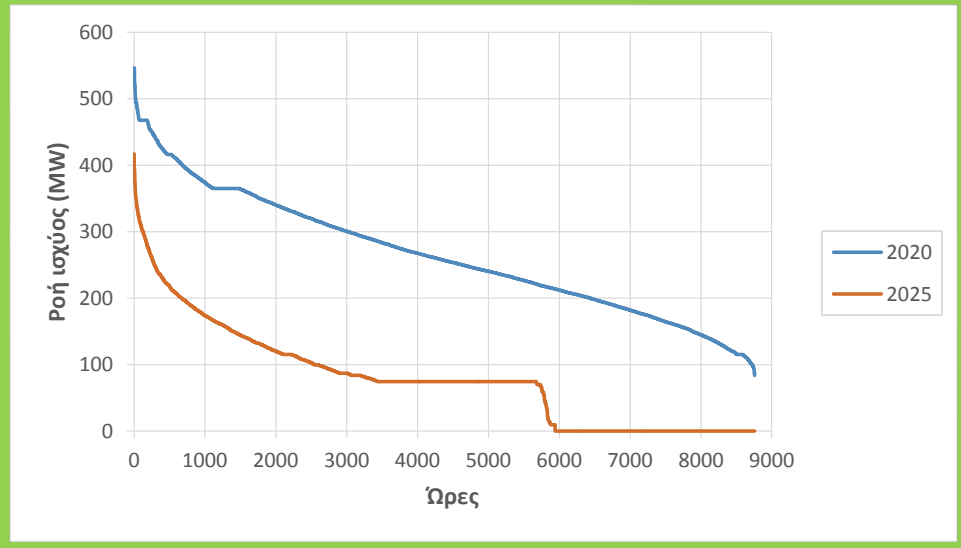
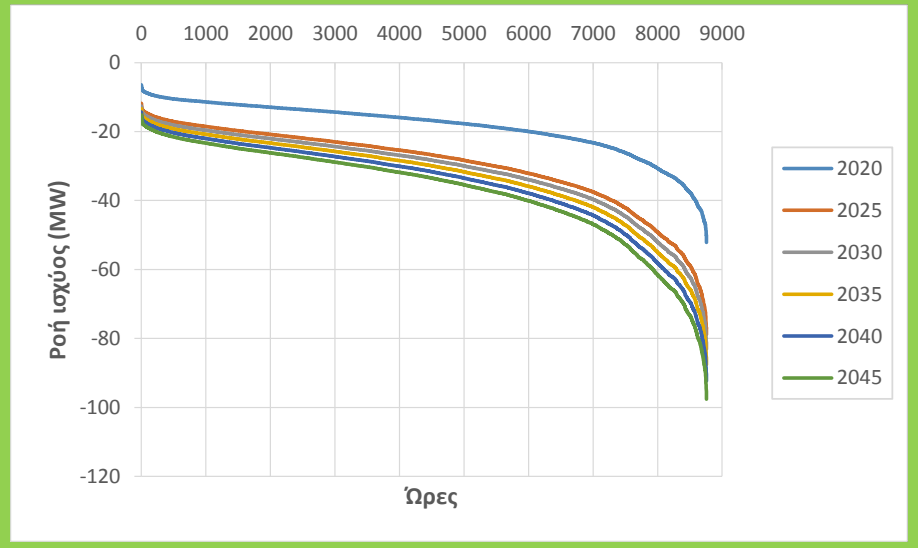
Impact of a new interconnection



Duration curve of thermal production in Crete

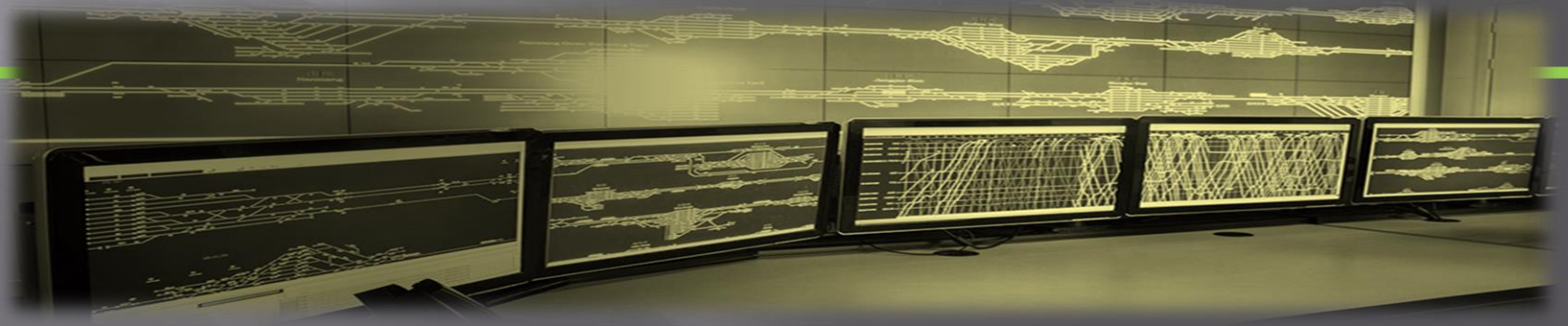


Duration curve in the interconnection between Andros and mainland

R&D activities funded by HEDNO

Smart Island-The GOAL

- Hybrid station with RES and small size of storage
- Increase the RES penetration beyond 60% - 70%
- Sustainable solution
  - Does not increase the total cost in the island
  - Should be attractive investment
- Ensure the power supply in the island
- Minimize impact on thermal production
- New experiences for the Island Operator in order to replicate the solution in other islands
- HEDNO responsible for technical terms, tendering process launched by Regulatory authority for energy within the next months.

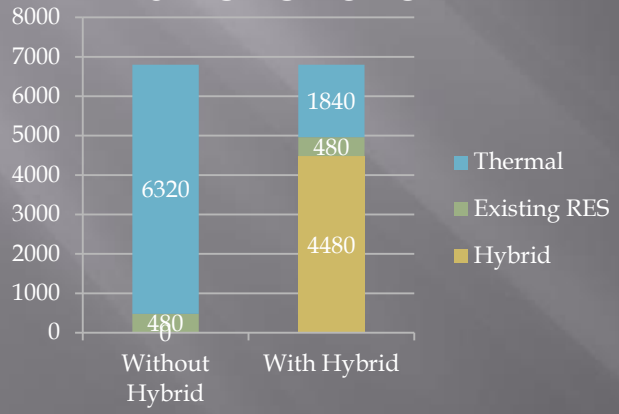


R&D activities funded by HEDNO

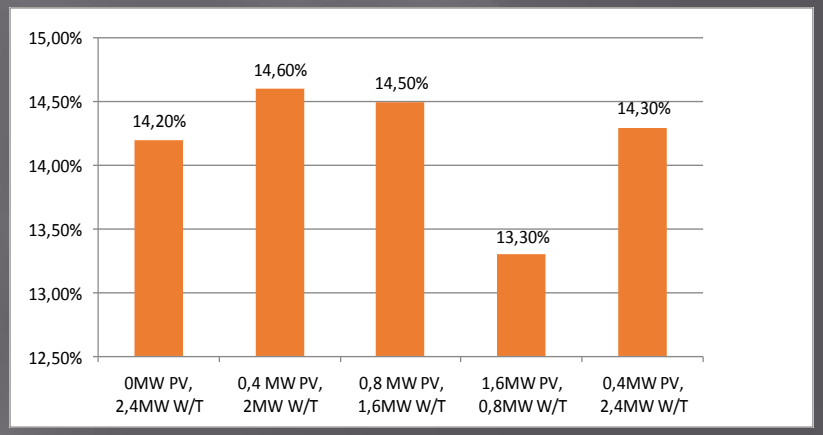
Simulation -Case of Astypalaia

- Typical NII system, summer peak
- 5 thermal units with total capacity 4,3 MW
- Peak Load: 2,3MW
- Yearly Demand: 6,600MWh
- 4 PV plants (0.32MW) and 7 roof top PVs (0,035 MW)
- Hybrid: 0,4MW PV,2MW Wind, Storage 2MW/ 8MWh

RES Penetration



IRR of the investment



Thank you very much.