



# The electrical systems of the Greek Non Interconnected Islands

4<sup>th</sup> International Hybrid Power Systems Workshop  
Heraklion, Crete, 22-23 of May 2019

**Eirini Stavropoulou**  
Director of the Islands Network Operation Department, HEDNO

# About us



2

- **HEDNO** (Hellenic Electricity Distribution Network Operator S.A.) is the organizationally and functionally independent Company in Greece, which distributes electricity to **7,5 million customers** across the country.
- **HEDNO** established in May 2012 as a 100% subsidiary of PPC S.A.
- **HEDNO** is among the **10 largest Electricity Distribution Corporations in EU** (based on the number of consumers and the total length of its network)
- Our Turnover is **885 million €** (2018)
- Our Total Assets are **802 billion €** (2018)
- Our average Annual Investment is **125 million €** (2017-2018)
- **HEDNO** employs approximately **7.000 individuals**:
  - 51% Technical ,
  - 25% Administrative
  - 11% Scientific-Technical
  - 9% Supporting
  - 4%Scientific-Administrative
- **Average Electricity Consumption : 43.000 GWh/year**
- **Total Network Length : 239.000 km (nearly 6 times earth's perimeter)**
- **Amount of Substations: HV/MV-235 & MV/LV-163.200**



# Our mission



3



## OUR MISSION is to ensure:

- the proper **Operation, Maintenance and Development of the Distribution Network** all over the country
- the proper **Operation and Management of the Non-Interconnected Islands' (NII's) Electrical Systems**
- the **access** of the **Producers and the Suppliers** to the NII's Electrical Systems
- the proper **Operation of the Non-Interconnected Islands' (NII's) Market** in terms of transparency and impartiality

# Our Vision and Strategy



Our **VISION** is to become the top Network Operator in South Europe achieving the optimal combination of **QUALITY** and **LOW-COST SERVICES**, having as our first concern the **ENVIRONMENTAL PROTECTION**.

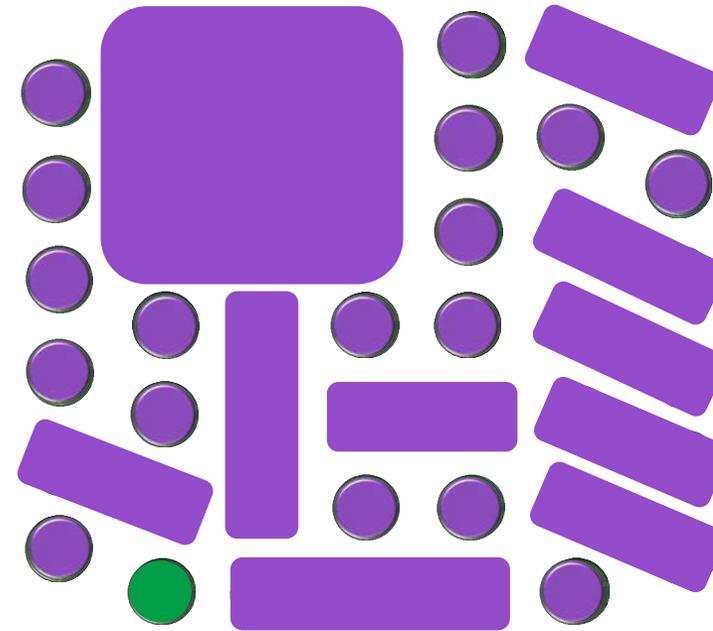
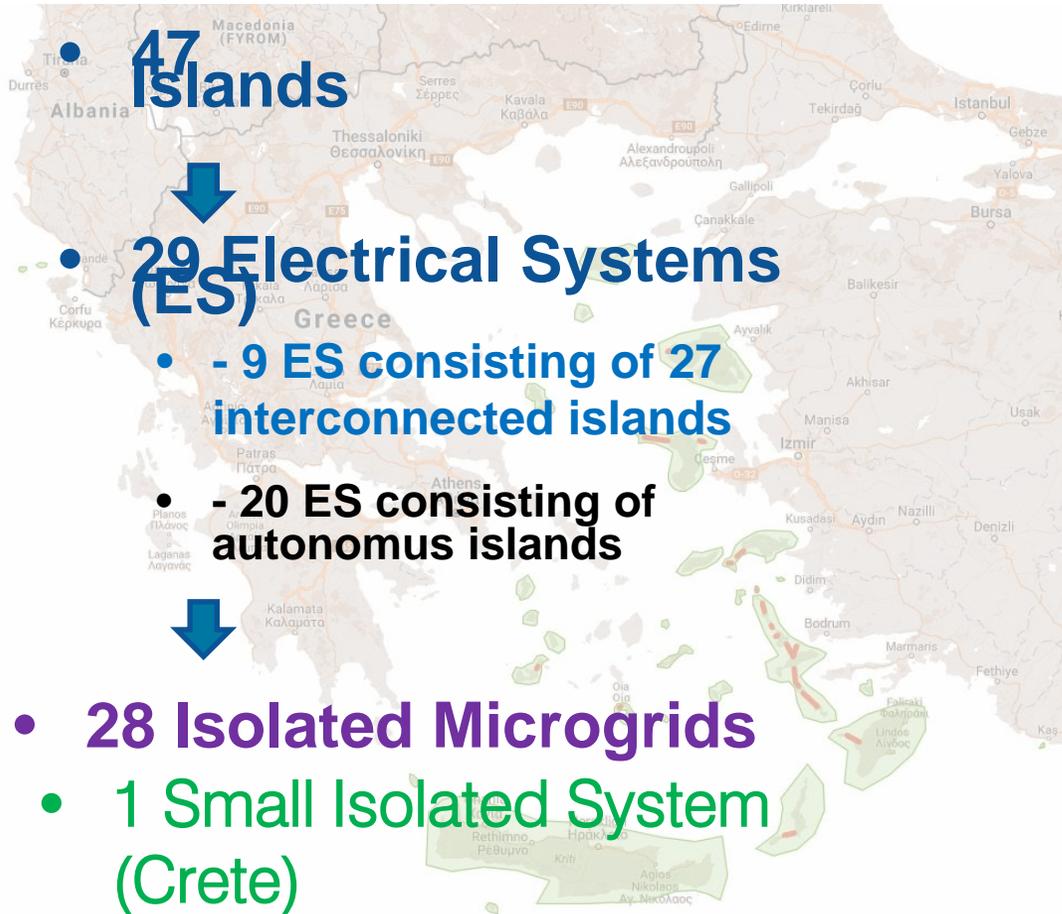
Our **INVESTMENT PLAN** is of a total average annual budget of €250 million (2019-2023) and concerns to projects for reinforcing and modernizing the Distribution Network including the implementation of 13 fundamental strategic projects.



Our **STRATEGY** refers to the integration of new technologies (“Smart Grids”, Remote Metering, Remote Services, Automations etc)

Our **GOAL** is to modernize the Distribution Network and transform it into a “**Smart System**” that will continually optimize the management of the connected consumers and producers, covering their emerging needs by an optimal techno-economical way.

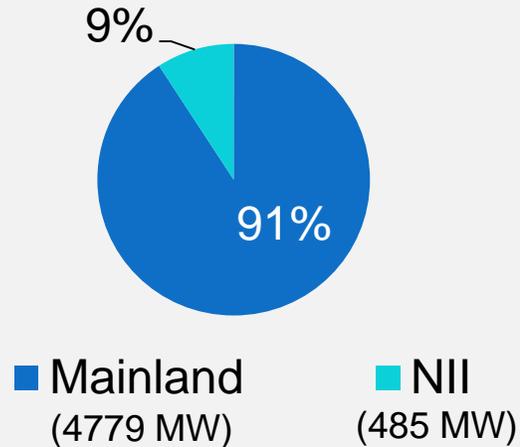
# The structure of the Power Systems of the Greek Non Interconnected Islands



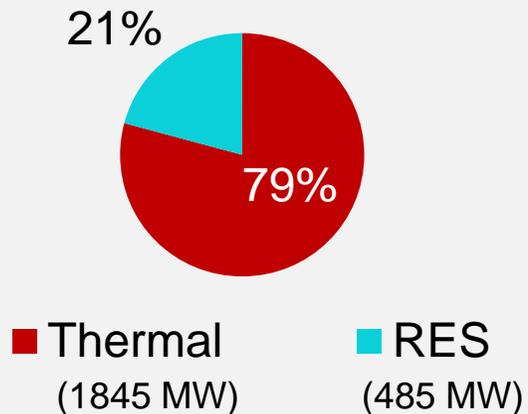
# Installed RES in NII



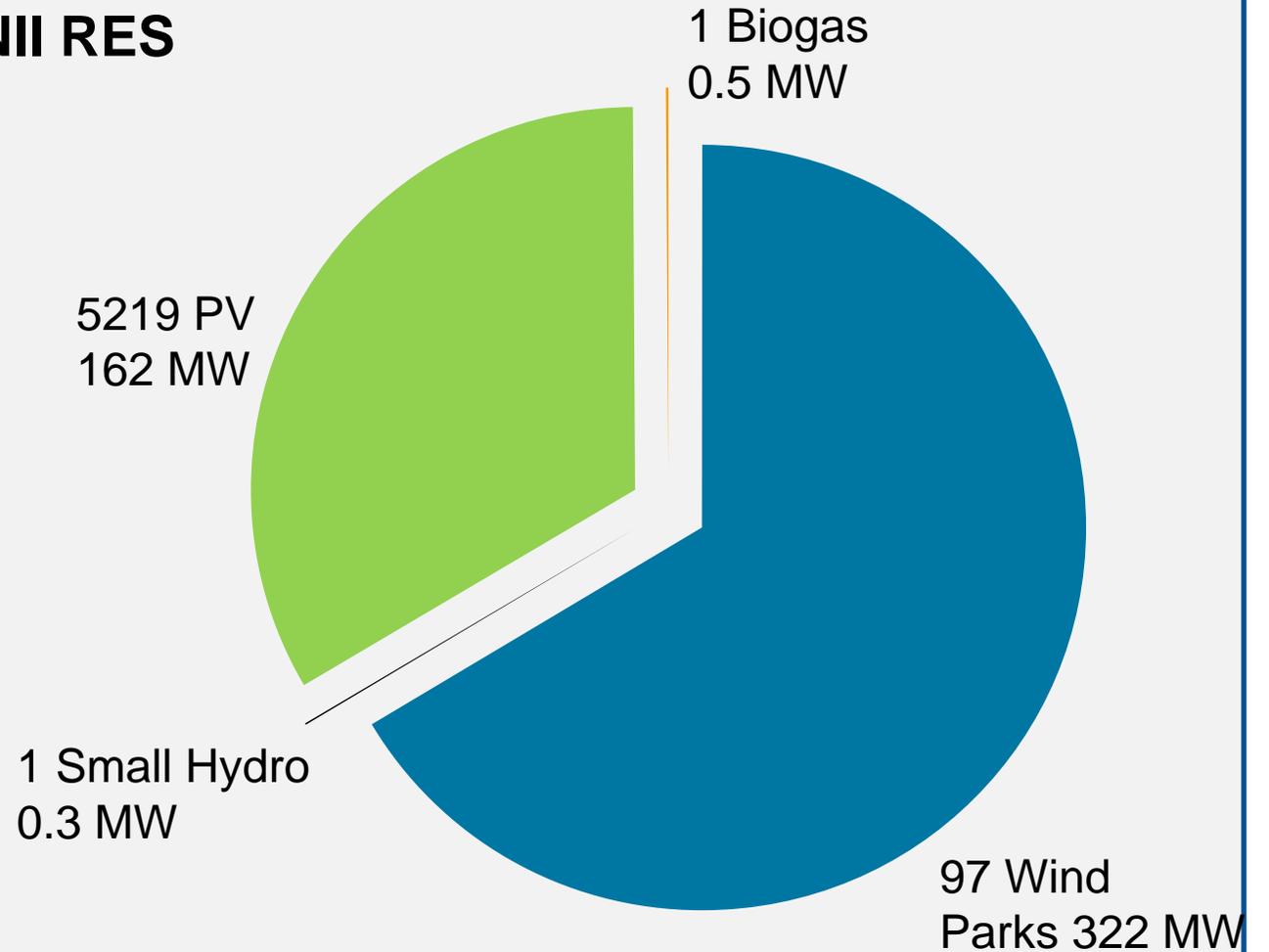
## RES - Greece



## Power Mix - NII



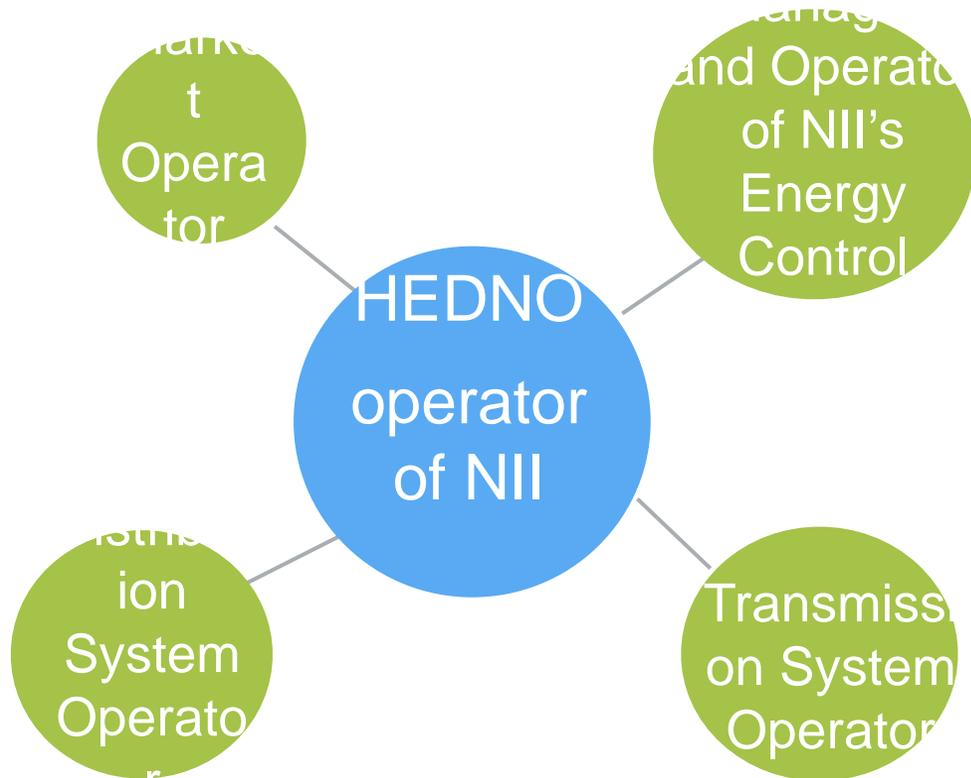
## NII RES



# HEDNO's role as NII Electrical System Operator



7



## Our **MISSION:**

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

## Our **GOAL:**

Development of all the necessary infrastructure for the 29 ES of NII, covering the emerging needs of all Stakeholders and Participants in the NII's

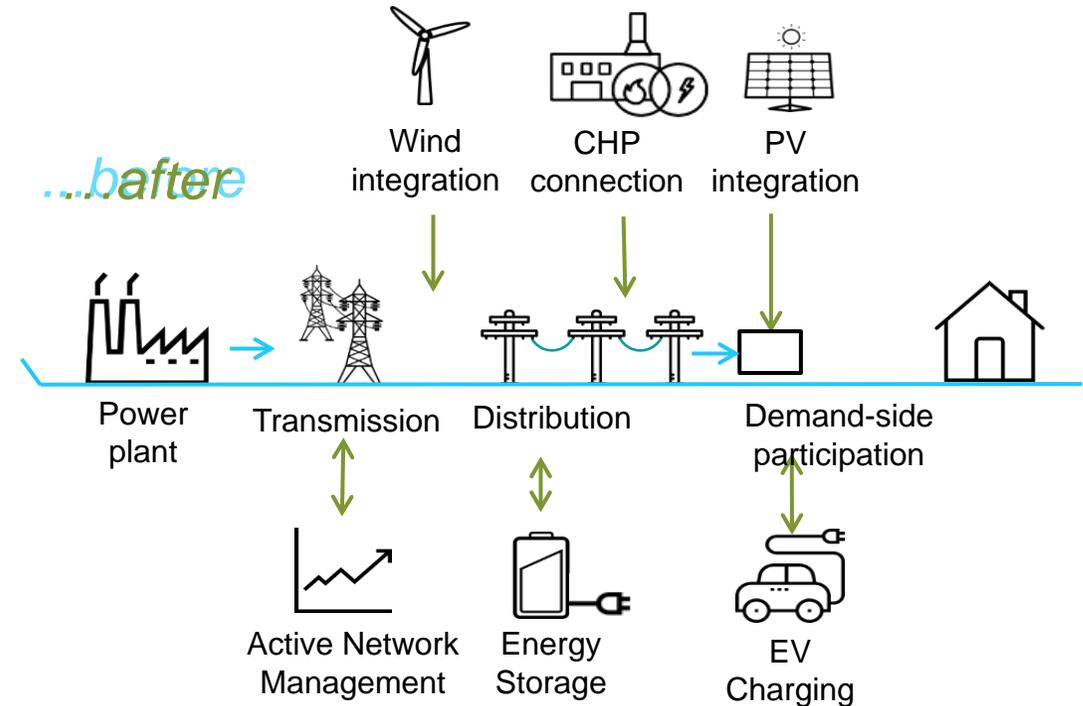
Market

# HEDNO's major goals in the NIIs



8

Adaptation to the upcoming challenges of HEDNO's role as NII's Electrical System Operator (ESO)



# HEDNO's major goals in the NIIs



9

Adapting an **economic** and an **environmental** approach of operation and management of NIIPS, in a manner that guarantees the **secure operation** of the systems



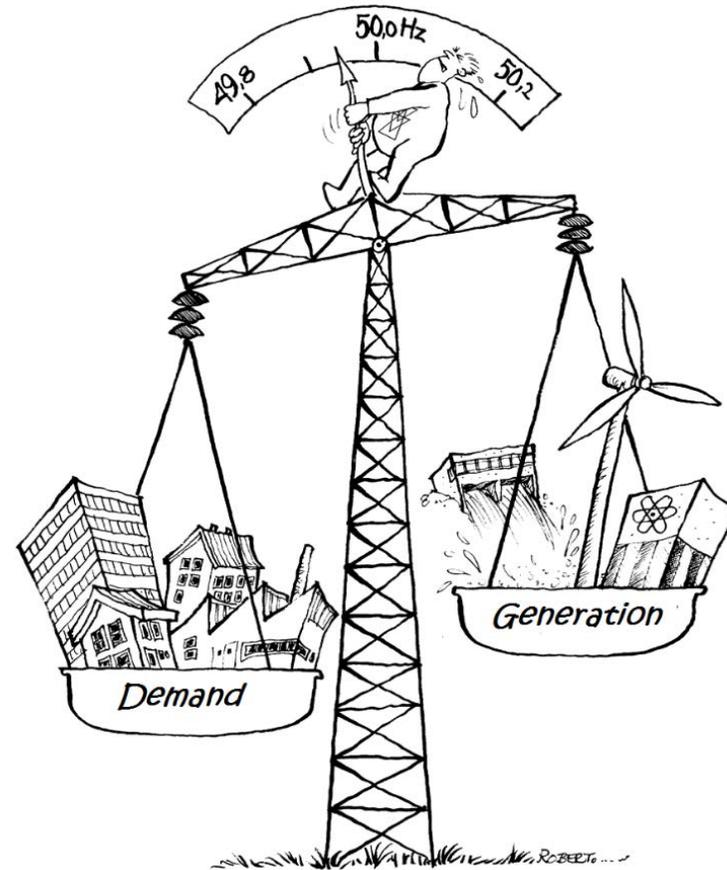
- Compliance with Domestic and EU Guidelines and Regulations
- Reduction of CO<sub>2</sub> emissions of thermal power stations in the NIIPS.
- Minimization of operational cost of thermal units.
- Increase of RES penetration.

# HEDNO's major challenges in the NIIs



10

1. Islands of different size, population and distance from the Mainland, without easy access at any time especially by the sea.
2. Isolated ES, without energy exchange ability, with direct bearing on ensuring the availability of energy supply.
3. Due to lack of interconnections with electrical systems of high inertia, the NII's ES face problems of voltage and frequency stability.

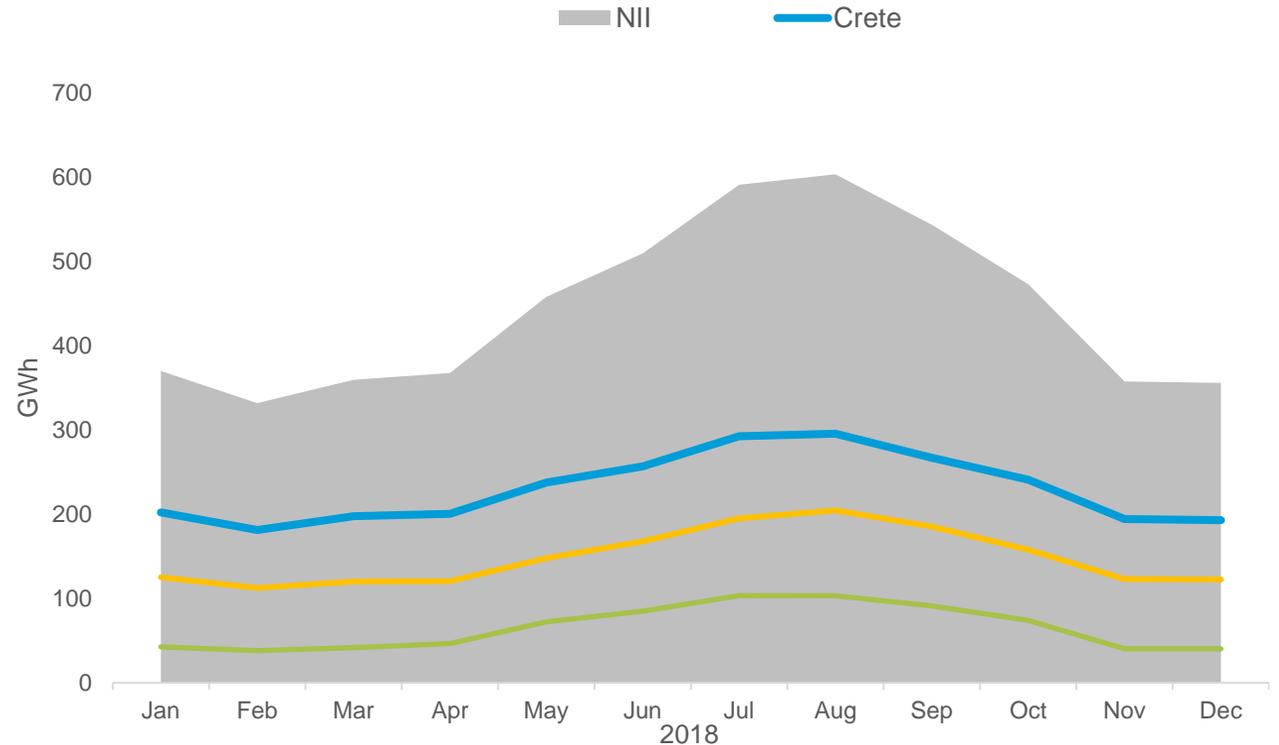


# HEDNO's major challenges in the NIIs



11

4. High fluctuations of demand both on a daily and monthly basis. Common characteristic in all the NIIs is the seasonal peak demand due to touristic period. Due to that there is a need to operate each ES with an excessive thermal capacity installed throughout the year and in some cases to add emergency power capacity in order to meet peak demand.



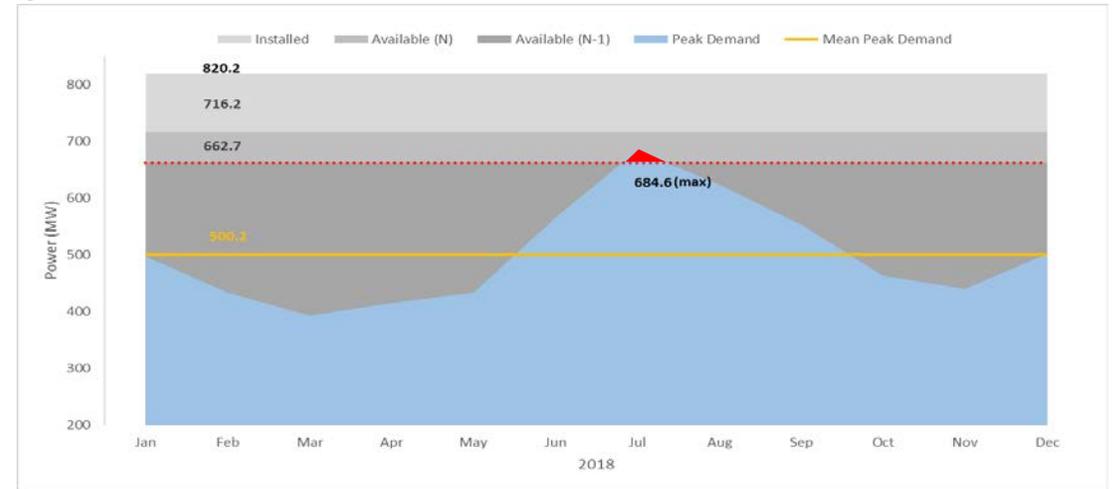
Monthly Load 2018 of NIIPS

# HEDNO's major challenges in the NIIs

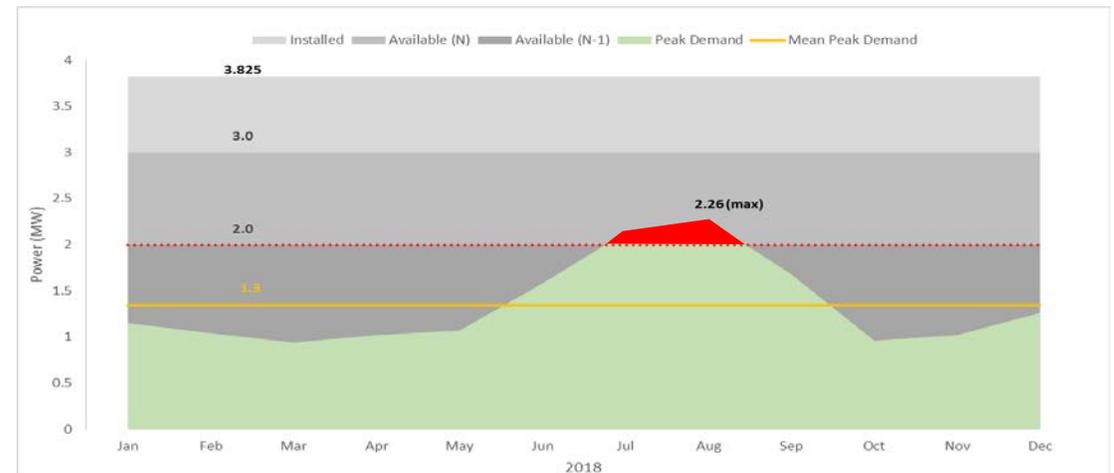


5. Large variations of Peak Demand among ES, between 100 kW to 650 MW which results to individual cases of capacity assurance mechanisms.

### Large ES: Crete



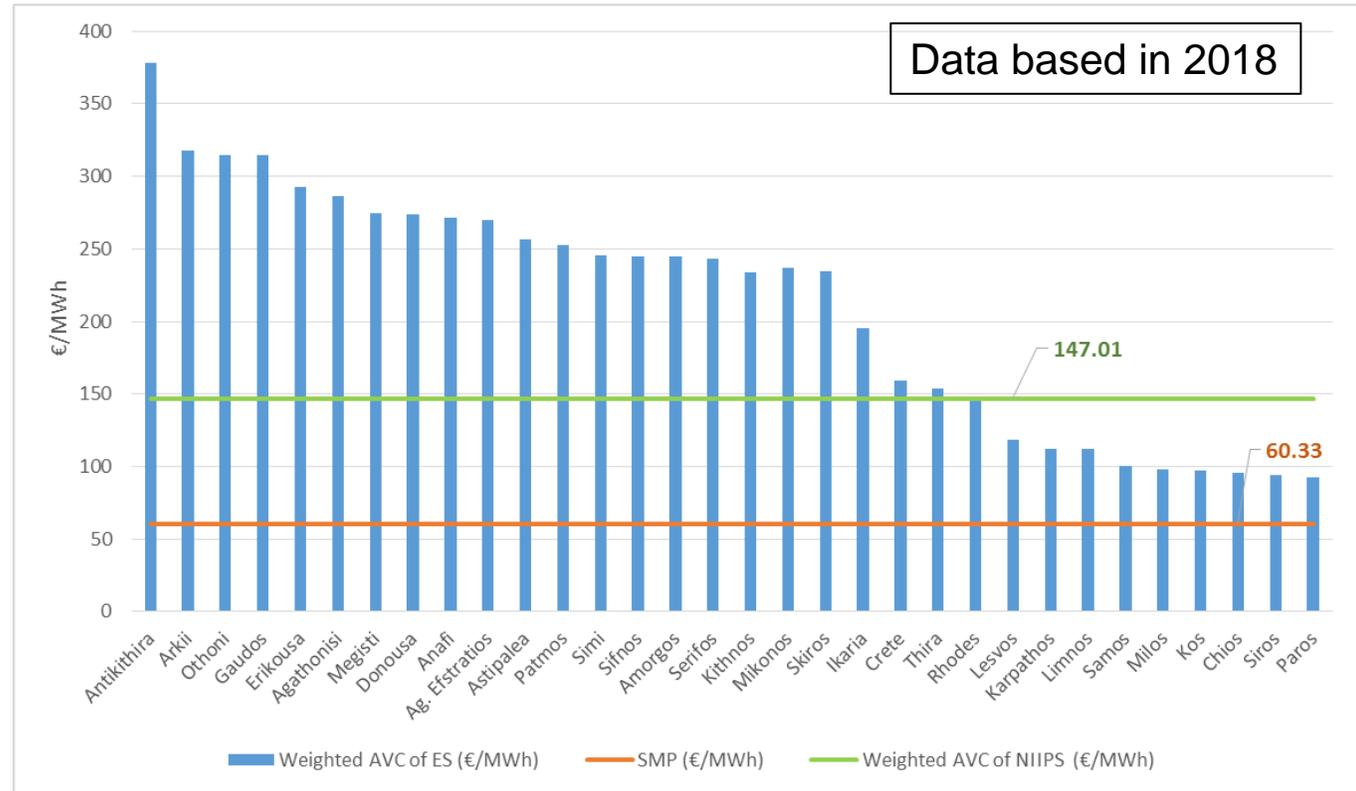
### Small ES: Astypalea



# HEDNO's major challenges in the NIIs



6. NII's Average Variable Cost (AVC) is substantially higher (up to 6 times) than the average System Margin Price (SMP) of the mainland Grid.



# Interconnection of ES-NIIs to the Mainland



14

## A: Cyclades (3 ES of NIIPS) - *Completed between March & May 2018*

- ▣ ES Mykonos
  - Mykonos
  - Dilos
  - Rinia
- ▣ ES Syros
  - Syros
- ▣ ES Paros
  - Paros
  - Naxos
  - Antiparos
  - Koufonisi
  - Schinousa
  - Iraklia
  - Sikinos
  - Folegandros
  - Ios

## B: ES of Crete – *In progress*

- ▣ Main connection with Attica
  - DC underwater
  - 2x350 MW
  - 400 km
  - By 2023
- ▣ Reduced Cost Connection with Peloponnese
  - AC underwater
  - 200 MVA
  - 150 km
  - By 2020

# Interconnection of ES-NIIs to the Mainland



15

## **C: Interconnections of ES-NIIPS – *Under approval***

- C1: Interconnections via HV Underwater Cables
  - ▣ ES–Thira (Islands: Thira, Thirasia) with ES-Paros and ES-Milos
  - ▣ ES–Sifnos: (Islands: Sifnos) with ES-Syros
  - ▣ ES–Milos: (Islands: Milos, Kimolos) with ES-Thira, ES-Sifnos and possibly ES-Serifos
  - ▣ ES–Serifos: (Islands: Serifos) with ES-Syros
- C2: Interconnections via MV Underwater Cables
  - ▣ ES–Serifos: (Islands: Serifos) with ES-Sifnos
  - ▣ ES–Anafi: (Islands: Anafi) with ES-Thira
  - ▣ ES–Astypalea: (Islands: Astypalea) with ES-Thira

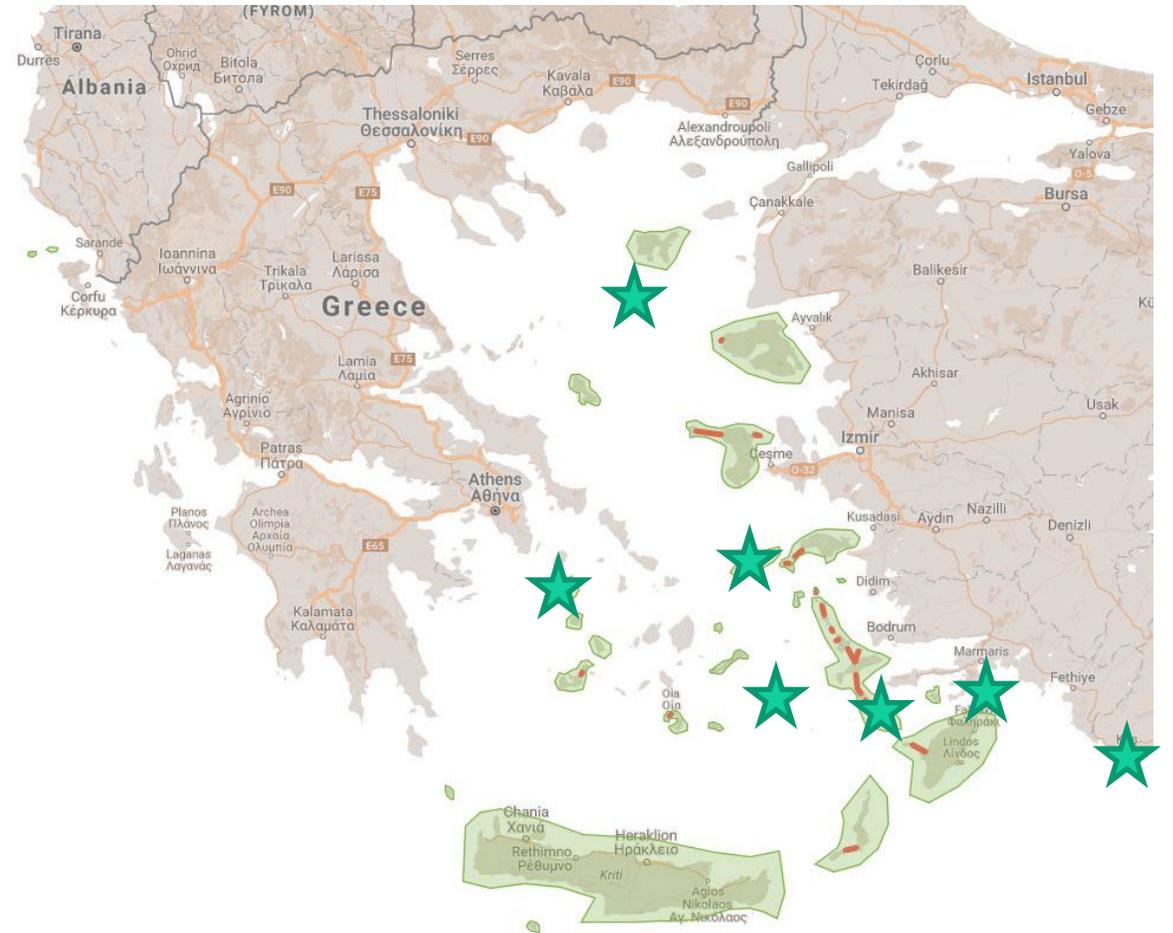
# Innovative Projects in Islands



16

- ✓ Kythnos
- ✓ Icaria
- ✓ Tilos
- ✓ Agios Efstratios
- ✓ Symi
- ✓ Megisti
- ✓ Astypalea

 Islands with Innovative Projects



# Innovative Projects in Kythnos (1)

17

- **Kythnos** is an island in the Western Cyclades with a population of 1.632 people and its **5-year Average Peak Demand** is **3,1 MW**.
- The island has been a **pilot site** for many innovative projects which have taken place on the island **during the last three**



- 1982 - Operation of the **first Wind Park in Europe** (5x20kW)
- 1983 - Installation of a **100 kW PV system with Battery storage** (400kWh)
- 1989 - **Replacement of the wind turbines** (5x33kW)
- 1992 - **Inverters in the PV system**

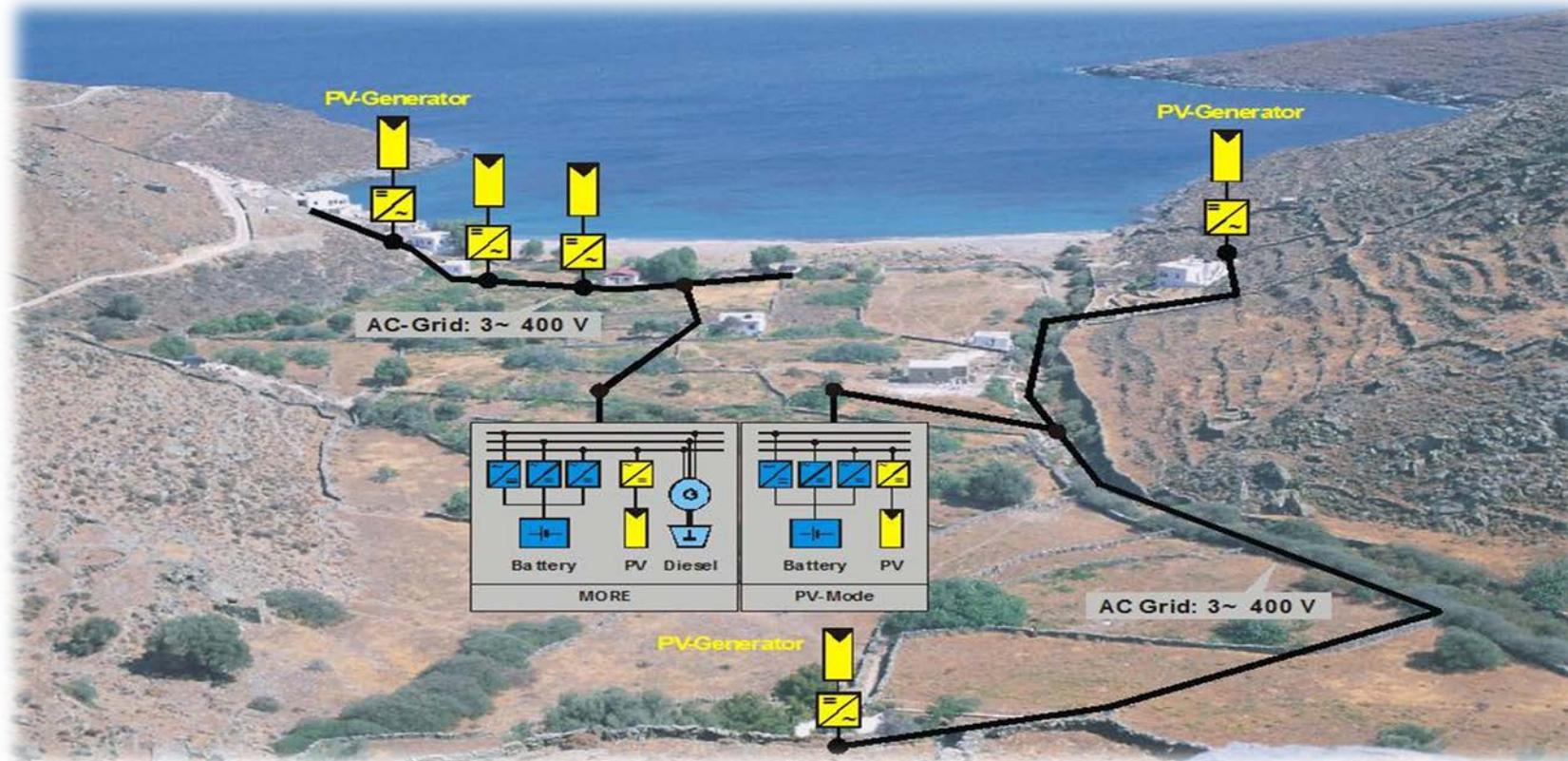
- 1998 - Installation of the **new Vestas 500kW wind turbine**
- 2000 - Operation of a **fully automated power system with 500kW battery storage and a 500kW Wind Turbine**
- 2001 - Operation of a **Microgrid electrifying 12 houses with intelligent autonomous Load Control**



# Innovative Projects in Kythnos (2)

18

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

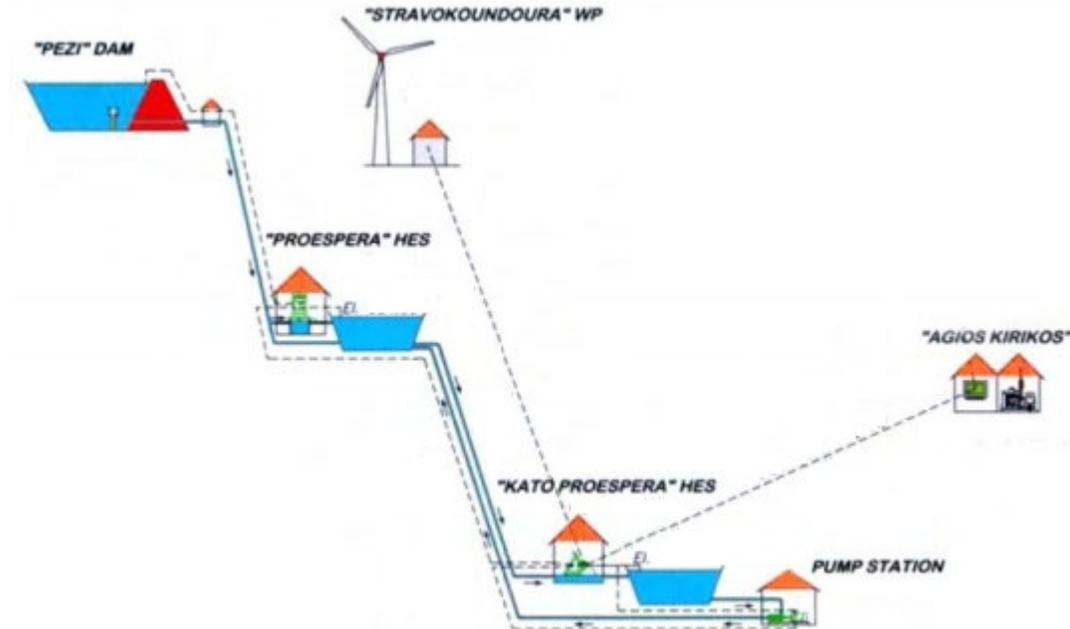


# Ikaria's Hybrid Station



19

- The project combines **Hydro Electric** power and **Wind** power and its **guaranteed power is 2,55 MW**, when the **5-year Average Peak Demand** of Ikaria is **7,3 MW**.
- The whole project consists of **two hydro power plants** (1 MW & 3 MW) with two reservoirs that exploit water that comes from a dam and a **wind park** (2,7 MW)
- ~~This provides energy to the water~~ **It provides energy to the water** plant will cover **30% of the energy needs** of the island.
- The project is **already partially operated** with the wind park and the small hydro power plant at Pezi.



# TILOS Project



20

- **TILOS** project is a **Horizon 2020 EU funded project** located in the island of Tilos.
- **Tilos** is an island of the Dodecanese complex. It is **interconnected with Kos** and it is one of the 9 islands of the **ES of Kos-Kalymnos**, The **5-year Average Peak Demand** of the **Kos-Kalymnos ES** is **94,8 MW**.
- The **main objective of TILOS** project, is the development and operation of a **prototype battery system** based on  $\text{NaNiCl}_2$  batteries (2,4MWh) with Wind turbines (800 kW) and PVs (160 kW), provided with an **optimum, real-environment smart grid control system** and coping with the challenge of supporting multiple tasks including:
  - Micro grid energy management
  - Maximization of RES penetration
  - Grid stability
  - Export of guaranteed energy
  - Ancillary services to the main grid of Kos



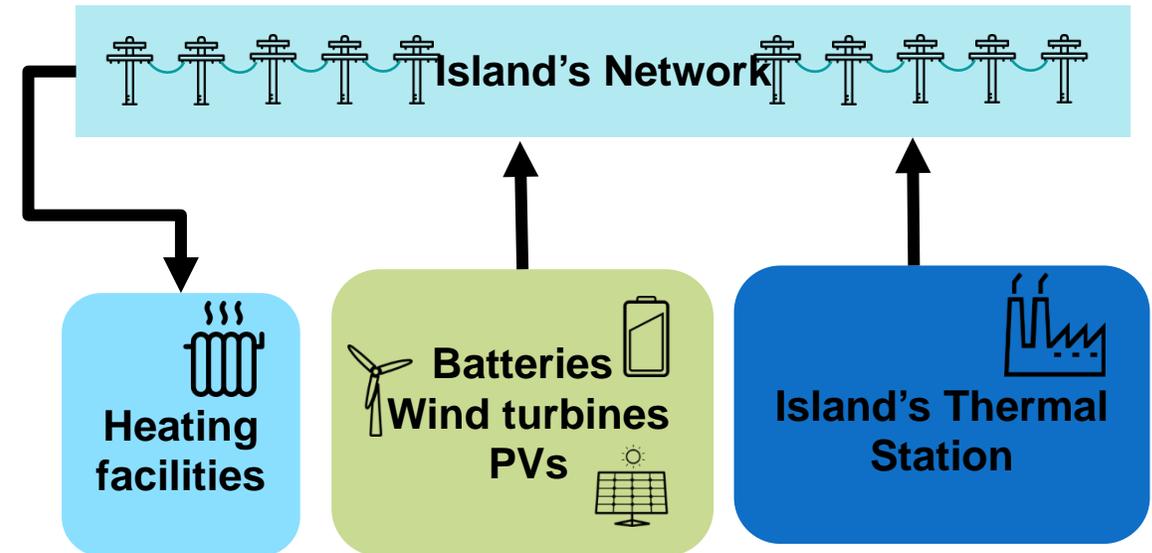
- The TILOS project won **two European Sustainable Energy Week (EUSEW) Awards** in Brussels in 2017. The first ever **Energy Islands award** and the **Citizen's Award**.

# Agios Efstratios – “Green Island” project



21

- **Agios Efstratios** is a small island in the North – East part of the Aegean Sea, with only 270 inhabitants (2011) and its **5-year Average Peak Demand 0,32 MW**.
- The project of Agios Efstratios includes **two subprojects**, the development of a **Hybrid power plant** and the development of a **District Heating system** (teleheating).
- The **Hybrid power plant** consists of **Wind turbines** (900 kW), **PVs** (150 kW) & **Batteries** (2,5 MWh), which is combined with a **District Heating system** (teleheating).
- The target of the project is to accomplish **85% energy of the island to come from RES**.
- The project is **funded by the EU**, it is run by the CRES and it is still **under study**.



- Law 4495/2018 authorizes the Ministry of Energy, RAE and HEDNO to take all necessary actions for the implementation of the project.

# “Smart Island” pilot projects (1)



22



- During the last 10 years, significant efforts have been made to further enhance RES integration in the Non Interconnected islands.
- Law 4495/2017 & Law 4546/2018 authorize the Ministry of Energy, RAE and HEDNO to take all necessary actions for the implementation of “Smart Island” pilot projects in 3 Greek islands.
- Each pilot project will consist of new RES units in combination with storage units controlled by a smart management system.
- The target of the “Smart Island” pilot projects is to **increase RES penetration**, while **ensuring the supply of demand** and **the secure operation of the power systems in a cost efficient way**.
- The “Smart Island” pilot projects will be implemented by investors who will have to participate in **tenders** held by the Regulatory Authority for Energy.

# “Smart Island” pilot projects (2)



23

- In order to promote the implementation of the “Smart Island” pilot projects, according to the Law, **HEDNO was set responsible to issue its suggestion to RAE and the ministry**, which has been already done, regarding the following subjects:
  1. The power systems where the pilot projects are going to be implemented
  2. The configuration of the RES and storage units
  3. The implementation time
  4. The minimum RES penetration margin to be achieved
  5. Remuneration issues
  6. Special authorization procedures
- It is expected that the relevant ministerial decisions will be issued in order to launch the tendering procedure, conducted by RAE, after public consultation.
- The desired starting year of the full operation to the first “Smart Island” pilot project is 2021.

# “Smart Island” pilot projects (3)



24

## The selected islands are:

Symi



Astypalea



Megisti/Kastelorizo



- Based on the following criteria
  1. Size
  2. Installed RES
  3. Operational Cost
  4. RES penetration
  5. Future Interconnection scenarios

# Other NII Projects in Progress



25

- Tender for the implementation of central ECC (Athens) and local ECC (Rhodes).
- Implementation of SCADA-EMS in 27 ES
- Study for the potential integration of the above SCADA into local ECCs
- Smart metering in Production Units
- Public Electric Vehicle Charging Infrastructure

# Energy Control Centers (ECC)



26

## Central ECC (Athens)



### MMS

- Load/RES forecasting
- RDAS



**Corporate Infrastructure:**  
(IMS, Data Warehouse, Helpdesk)

## Local ECCs

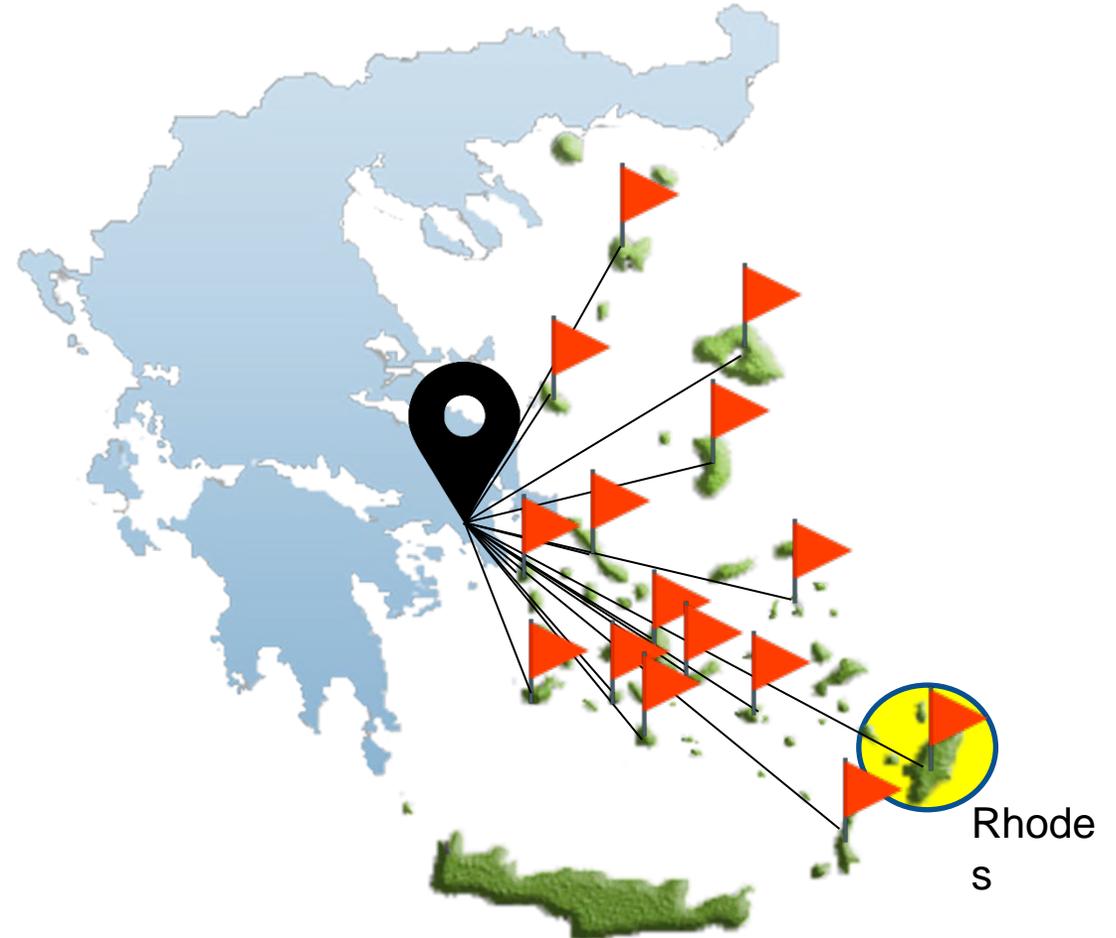


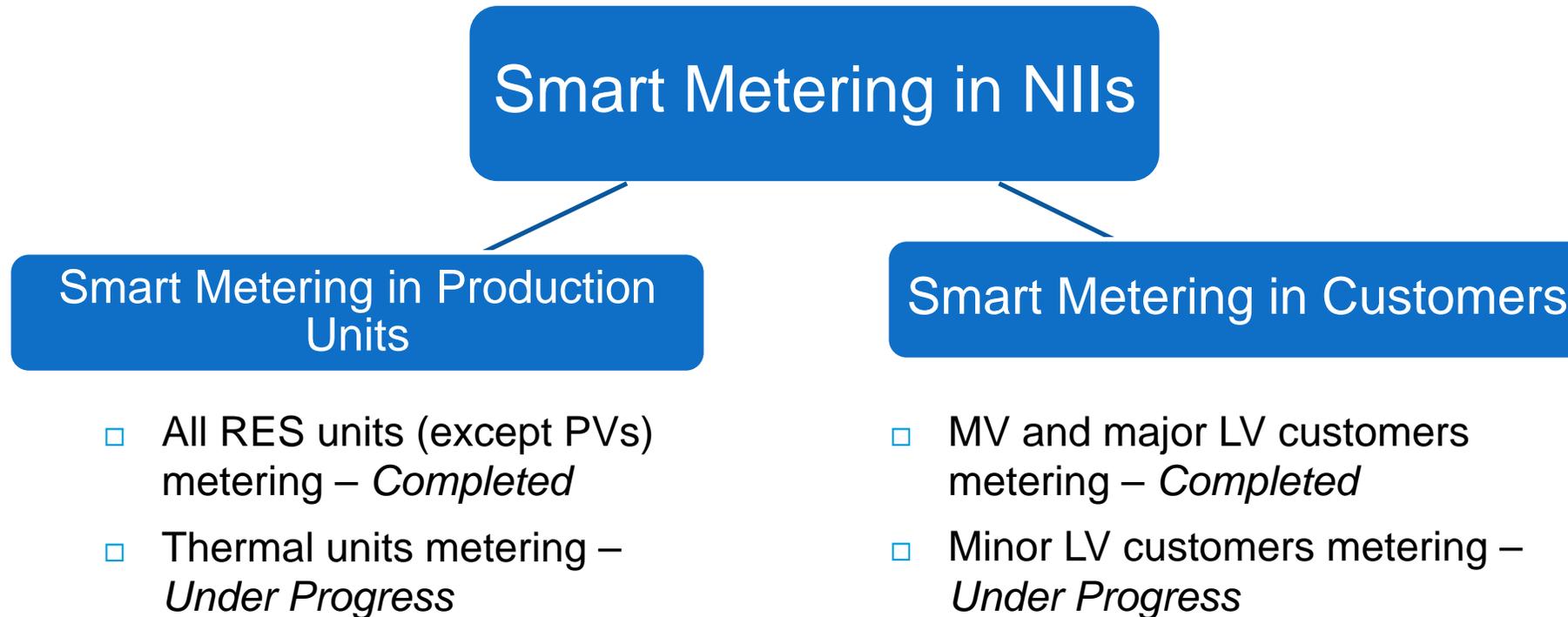
### MMS

**(Backup)**



**EMS (Real-time dispatch)**

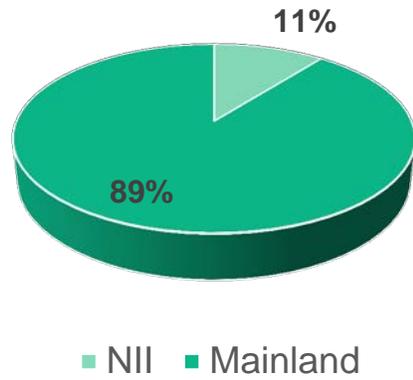




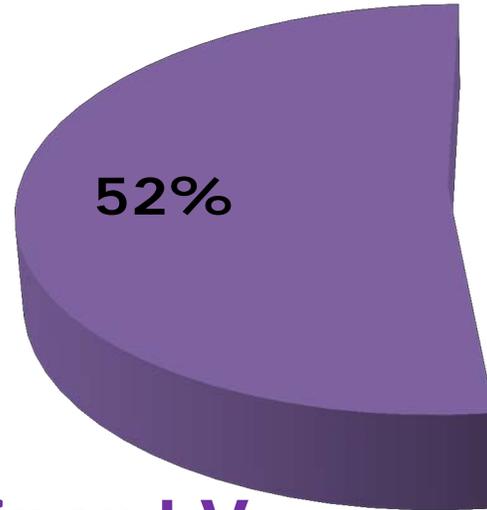
# Smart Metering - GREECE



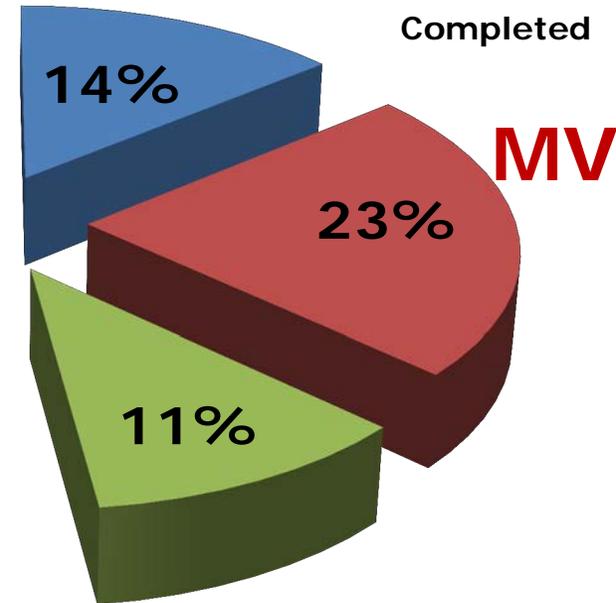
Connection Points



**Minor LV**  
To be completed



**HV**  
Completed



Completed  
**Major LV**

# Public Electric Vehicle Charging Infrastructure



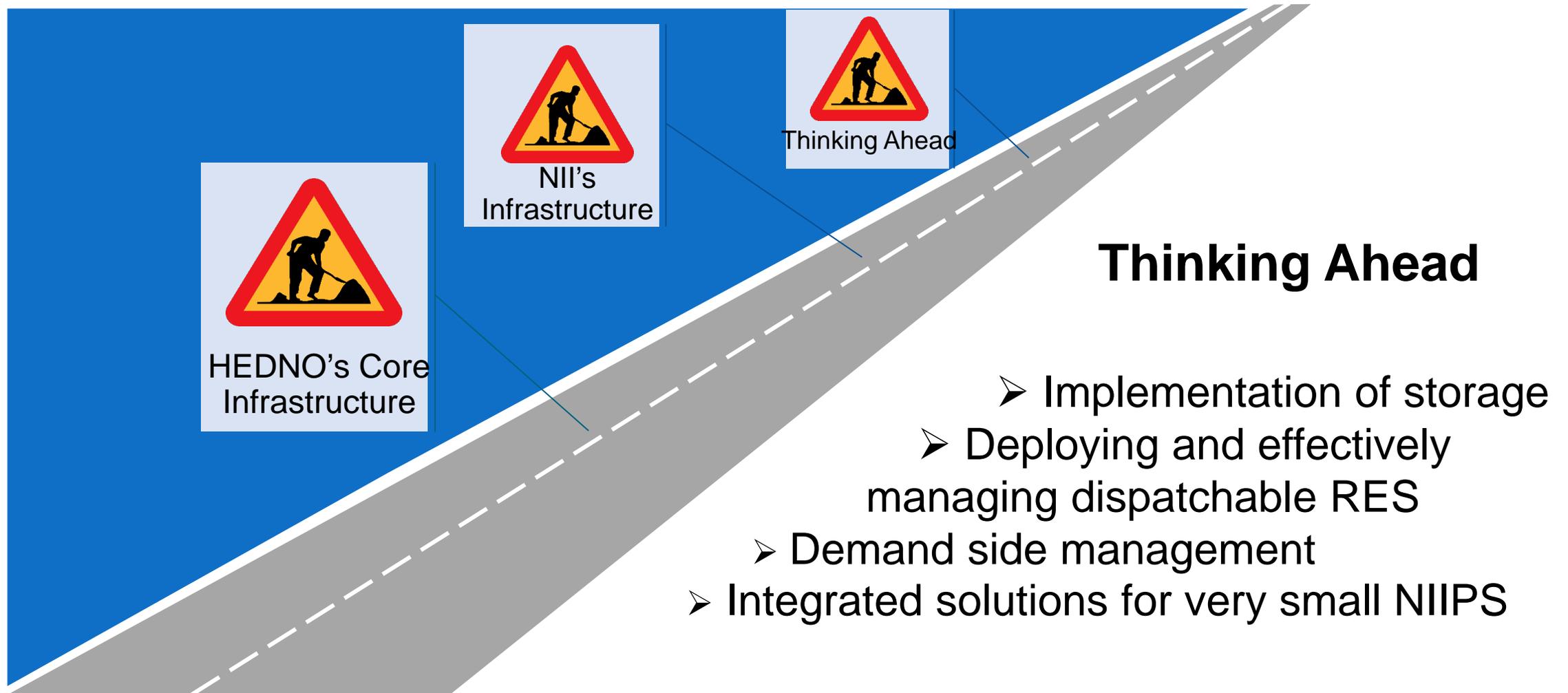
29

- The Tender for the purchase of 100 (with an option of -30% ÷ +50%) EV Charging Stations in the islands is in progress.
- At least one Charging station is expected to be installed in every island (interconnected and non interconnected) which has an average peak demand higher than 1 MW. Especially for the islands of Crete and Rhodes, 35 and 10 Stations respectively are foreseen.
- HEDNO will be the Charging Points Owner and Operator (CPO). Additionally, HEDNO will be responsible of metering and data management.
- The E-Mobility Service Providers of the charging services, as well as the Energy Suppliers, will be external companies/bodies.

# Thinking Ahead



30





## Implementation of storage

The implementation of Storage in NIIPS is critical, taking into account the mentioned HEDNO's challenges.

HEDNO's approach is that Storage could be provided by 3<sup>rd</sup> parties, hence it is necessary to adapt the Regulatory Framework accordingly.

# Thinking Ahead - Storage



32

- Benefits
  - Significantly improves system safety (primary reserve operation).
  - Increases RES penetration (drastically decreases wind curtails).
  - Improves thermal units operation (dispatching, loading, start-up).
  - Reduces generation cost.
  - Provides flexibility and fast reserve response.
  - Reduces the need for Network investments.
- Actions to be made
  - Appropriate adjustments to the regulatory framework.
  - Conduction of economic-technical studies for the viability of such investments in specific islands.
  - Pilot projects and evaluation of operation results.
  - Development and enhancement of a new NIIPS-management philosophy, combining central storage, hybrid power stations and high RES penetration.

## Conclusion

Energy Storage is a well-established technology. The implementation of energy storage by the utilities is reasonably investigated, since it can provide improved flexibility, cost reduction, increased security and enhanced management.



*HELLENIC ELECTRICITY DISTRIBUTION NETWORK OPERATOR S.A.*

***Thank you for your attention.***

---