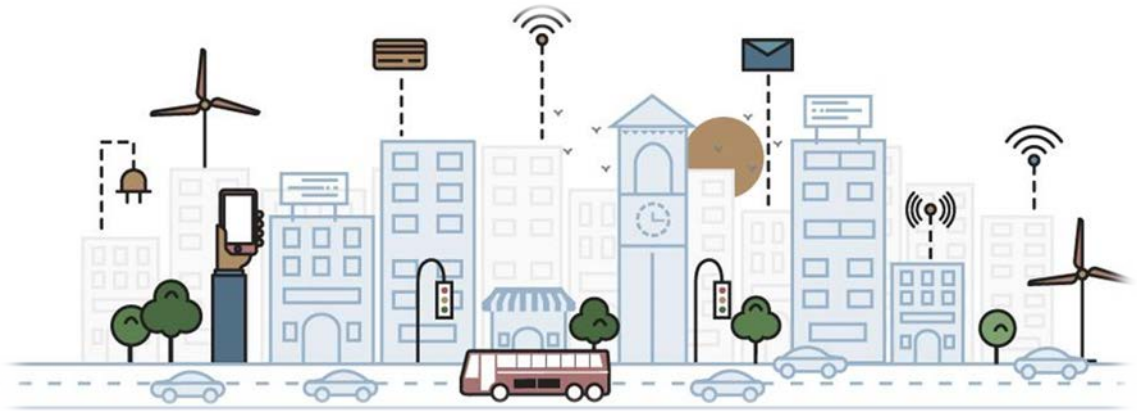


Projects for Smartening the Greek Islands

ETIP SNET
South-Eastern Region Workshop
September 19-20, 2018

Prof. Nikos Hatziargyriou
Chairman

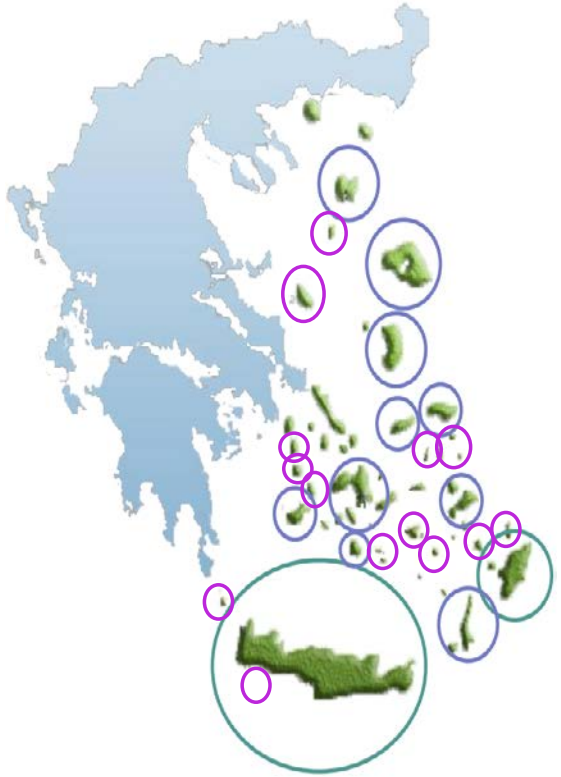
Non-Interconnected Island Systems (NIIS) in Greece

- 60 Islands

  - 11 Electrical Systems (ES) consisting of 39 interconnected islands

  - 21 ES consisting of autonomus islands

- 1 Small Isolated System (Crete)



✓ host 15 % of the Greek population and account for almost 14 % of the total national annual electricity consumption (~42.300 GWh/year)

Generation Mix

Total NIIS installed Power capacity 2328,14 MW

35 Conventional (Thermal) Stations

1845,3 MW

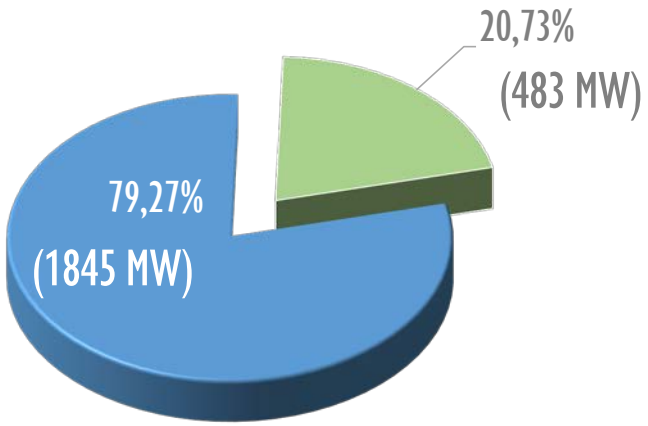
5098 RES Stations (482,84 MW)

97 Wind Parks (322,83 MW)

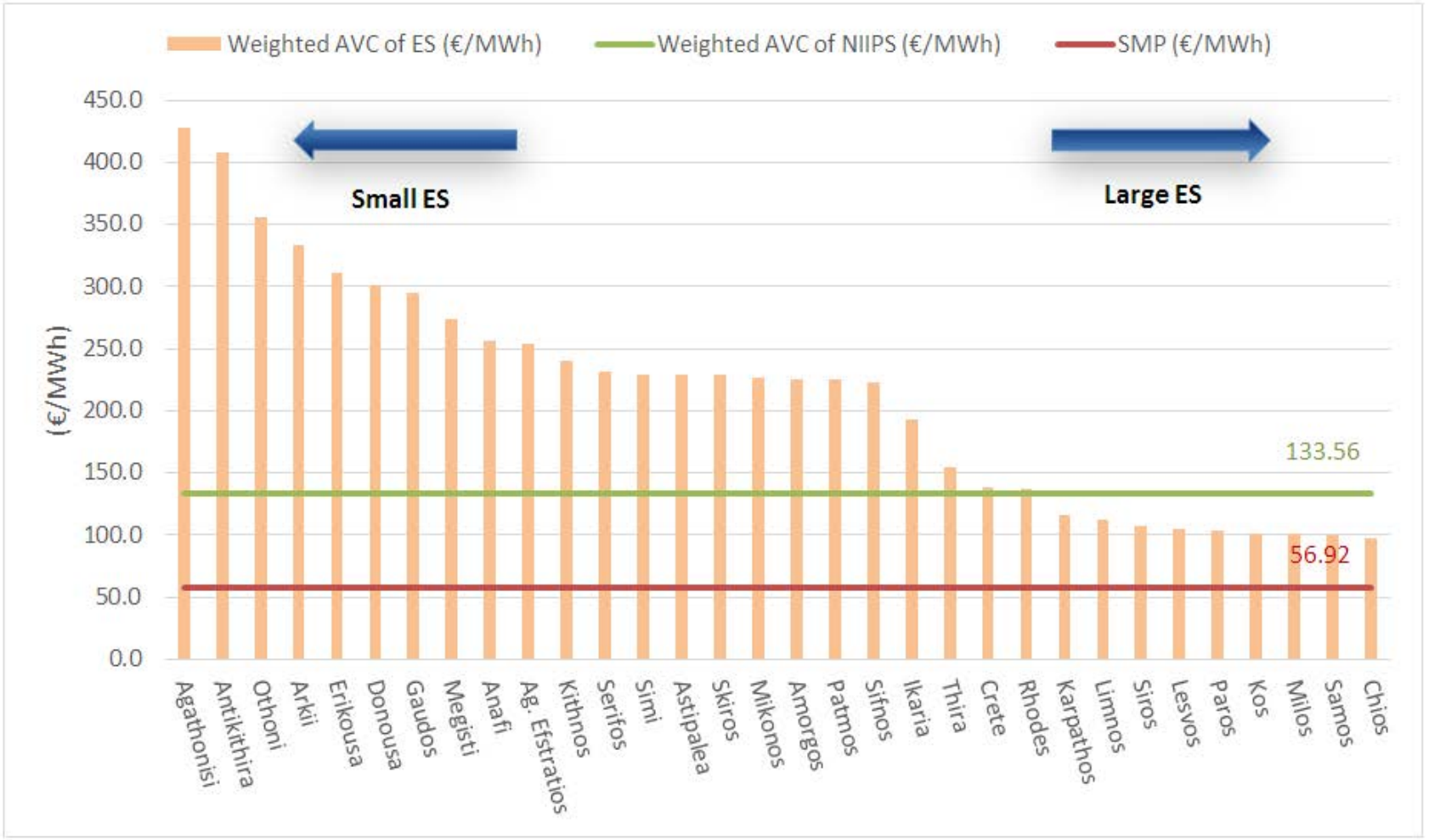
1758 PV Stations (135,98 MW)

3242 PV_{roofs} (23,73 MW)

1 Small HydroElectric Station (0,3 MW)

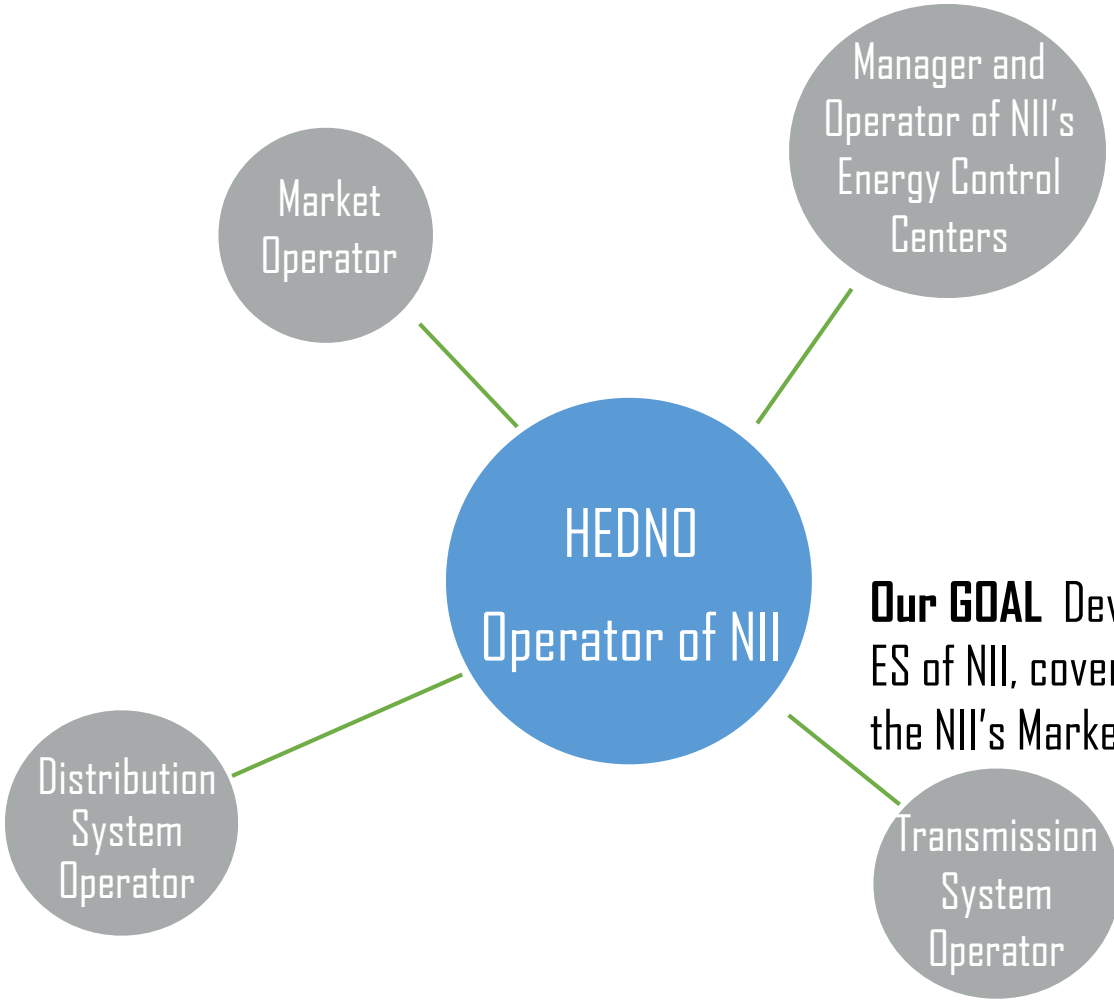


Production Cost



AVC Average Cost,
SMP System Marginal Price

HEDNO's role as NII's 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 the necessary infrastructure for the 32 ES of NII, covering the emerging needs of all participants in the NII's Market

HEDNO's major challenges in the NIIs

01 Islands of different size, population and distance from the Mainland, without easy access at any time especially by the sea.

03 High potential for RES due to very good wind regimes and solar irradiation levels

02 Isolated ES, without energy exchange ability, with direct bearing on ensuring the availability of energy supply

04 Due to lack of interconnections with electrical systems of high inertia, the NII's ES potential problems of voltage and frequency stability

Strategy for Non Interconnected Islands

Now

- High reliance on fossil fuels
- High operational cost & CO_2 emissions
- Limitation of RES Penetration

1. Advanced EMS
2. Generation Planning
3. Electric vehicles
4. Smart Islands - Pilot Hybrid stations with Smart Management systems

The future

- Increase of RES penetration
- Minimization of operational cost & CO_2 emissions
- Storage Solutions
- Development of active customers & energy communities

1. Advanced Energy Management Systems (e-CARE)

The objective of the e-Care software is to optimize the overall performance of isolated and weakly interconnected systems by increasing the share of RES energy

Modular Architecture

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

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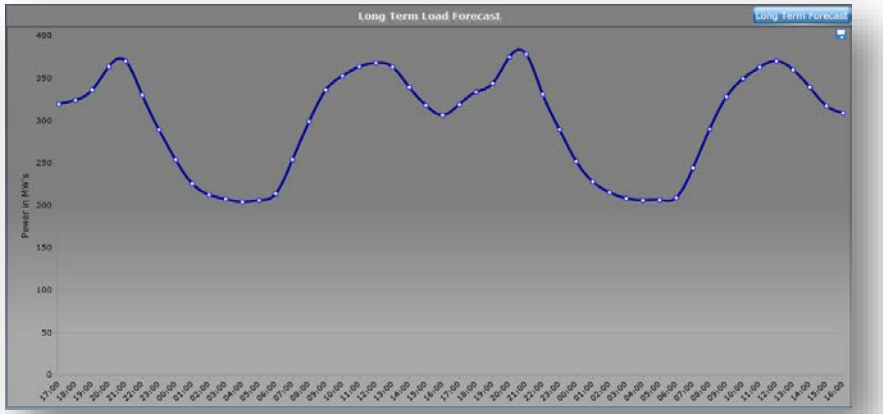
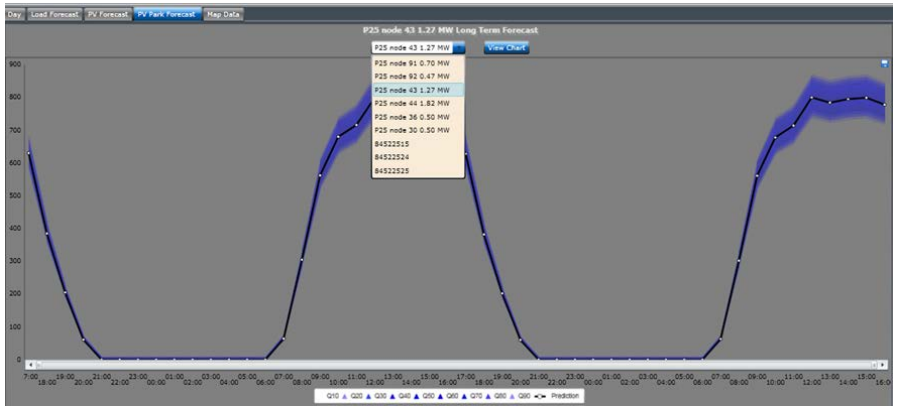
Forecasting Results-Man Machine Interface (MMI)

Demand Forecast

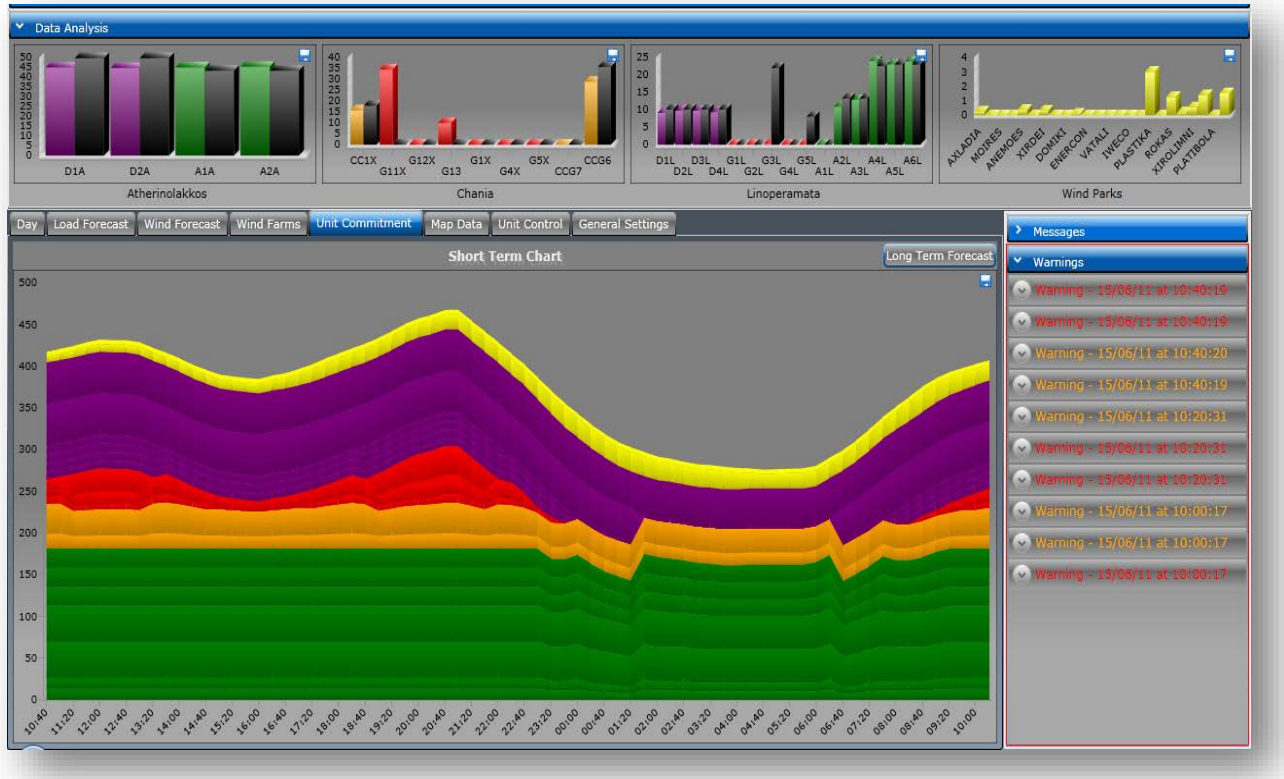


Wind Power Forecast

PV Forecast



Unit Commitment, Economic Dispatch, Security - MMI



e-CARE – Exploitable Result

- Ensure security of supply
- Increase RES penetration
- Decrease Heavy and Light Diesel Fuel Consumption

Next Steps

- Optimal integration of EVs
- Incorporate load management (desalination units) and Demand Response

2. Advanced Generation Planning for NIIs

Cover yearly demand and peak with Thermal Unit and RES

- Maximize RES Penetration
- Minimize Fuel Cost

Identify type and size of Thermal Units

Identify RES Capacity limit including new technologies : Hybrid (Storage with RES) and CSP (Concentrated Solar Power)

Examine scenarios with interconnections (between islands or with the mainland system) instead of new Thermal Units

Consider Market Operation and associated constraints

Consider special characteristics of each NII (e.g. summer peaking systems)

Analysis of the impact of the various technical constraints in the island operation (reserve policy, RES penetration limits, etc)

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Generation Planning Tool

Methods to estimate yearly demand and peaks for the next 7 years

Hourly system simulation for several years (1 to 7)

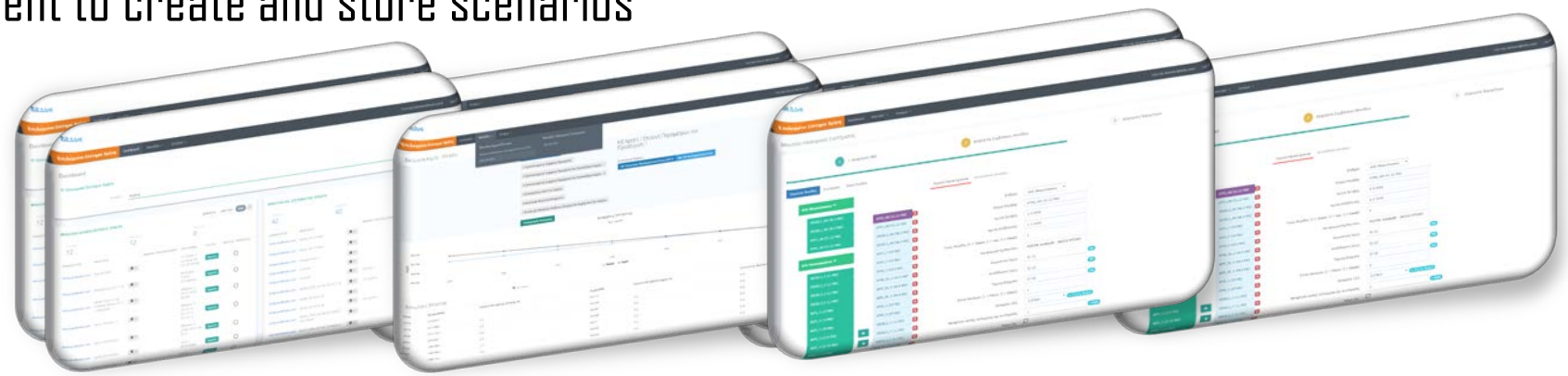
Includes all RES technologies described in the code of NII

Impact of Interconnections

Identification of RES capacity limits

Database with data for all 29 Electrical Systems

Online environment to create and store scenarios



Generation Planning Tool – Exploitable Result

All RES technologies in the NIIs Code

- Wind Farms
- PV (with or without tracker)
- Biomass (controllable or not)
- Hybrid Stations
- CSP
- Small Wind Turbines

Simulation of Market Operation

Detailed Reporting (including hourly results)

Free access to the planning software for two months provided upon request: Contact Aris Dimeas: adimeas@power.ece.ntua.gr

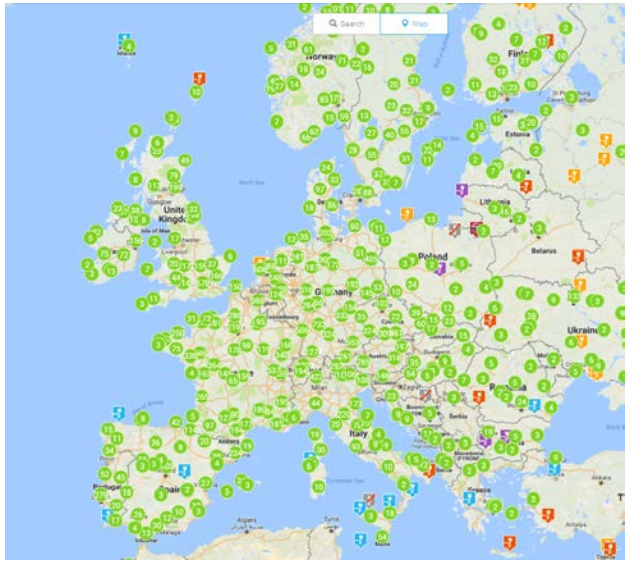
3. EV Management

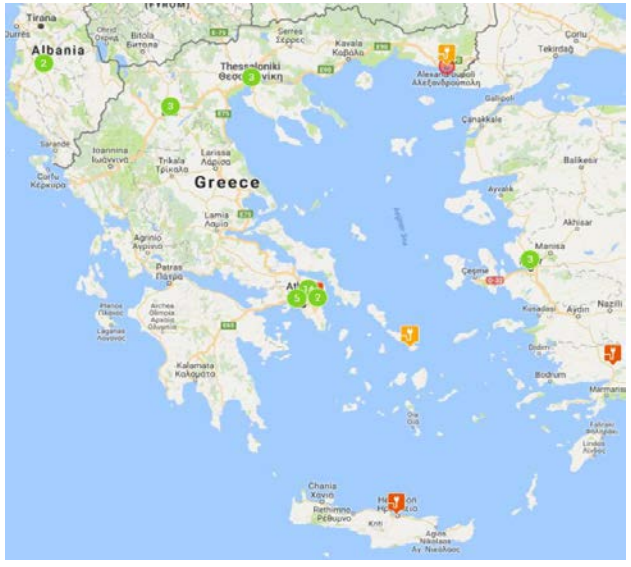
- EU Directive 2014/94
  - *Each Member State shall have a sufficient public network of EVSEs (Electric Vehicle supply Equipment)*
  - *1 charging Station per 10 EVs (Electric Vehicles)*

HEDNO's e-mobility plan

- Development of a critical mass of public charging infrastructures that will promote e-mobility concept in Greece (chicken-egg problem) and encourage private sector to invest on public charging infrastructure
- Two development phases:
  - *Infrastructures in all Greek Islands (2018-2019)*

    100-150 stations, Mode 3
  - *Infrastructure across Mainland based on multi-criteria allocation study(2019-2020), 1000-1500 Mode 3 and Mode 4*

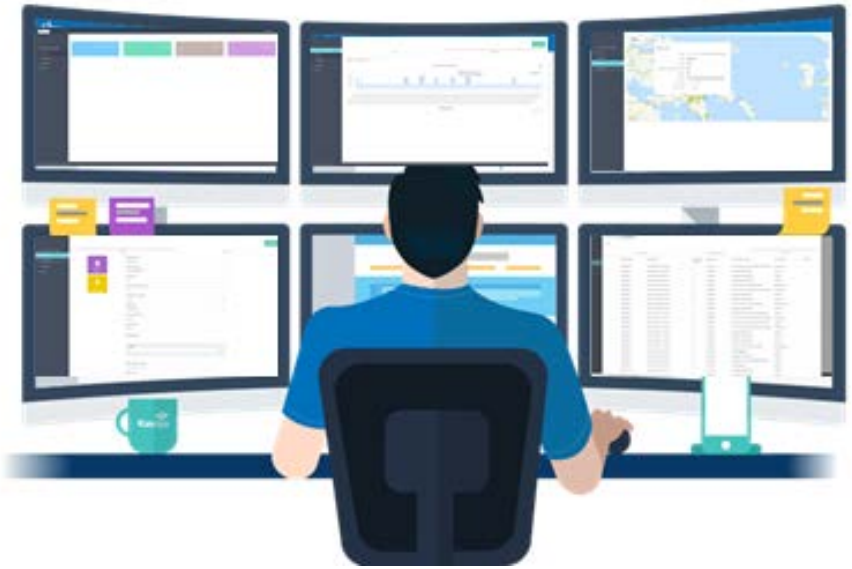




EVSE Management System

Objective :

The development of an interoperable platform that enables the monitoring, operation and management of the public charging infrastructures. The platform is technology and vendor agnostic



Consortium:

Project coordinator: HEDNO

Partners: NTUA

Services offered by EVSE Management System

Services offered to EMSPs

Asset Management

- Connect & configure chargers
- Visual representation of EVSE on Map
- Technical error detection (operation & alarm management)
- Remote control (start/stop charging & reset)
- Monitor network performance (usability & load profile)
- Smart charging

User Management

- Manager Customer (CRM)
- Price Plan administration
- Charging sessions reporting End-points for mobile App development

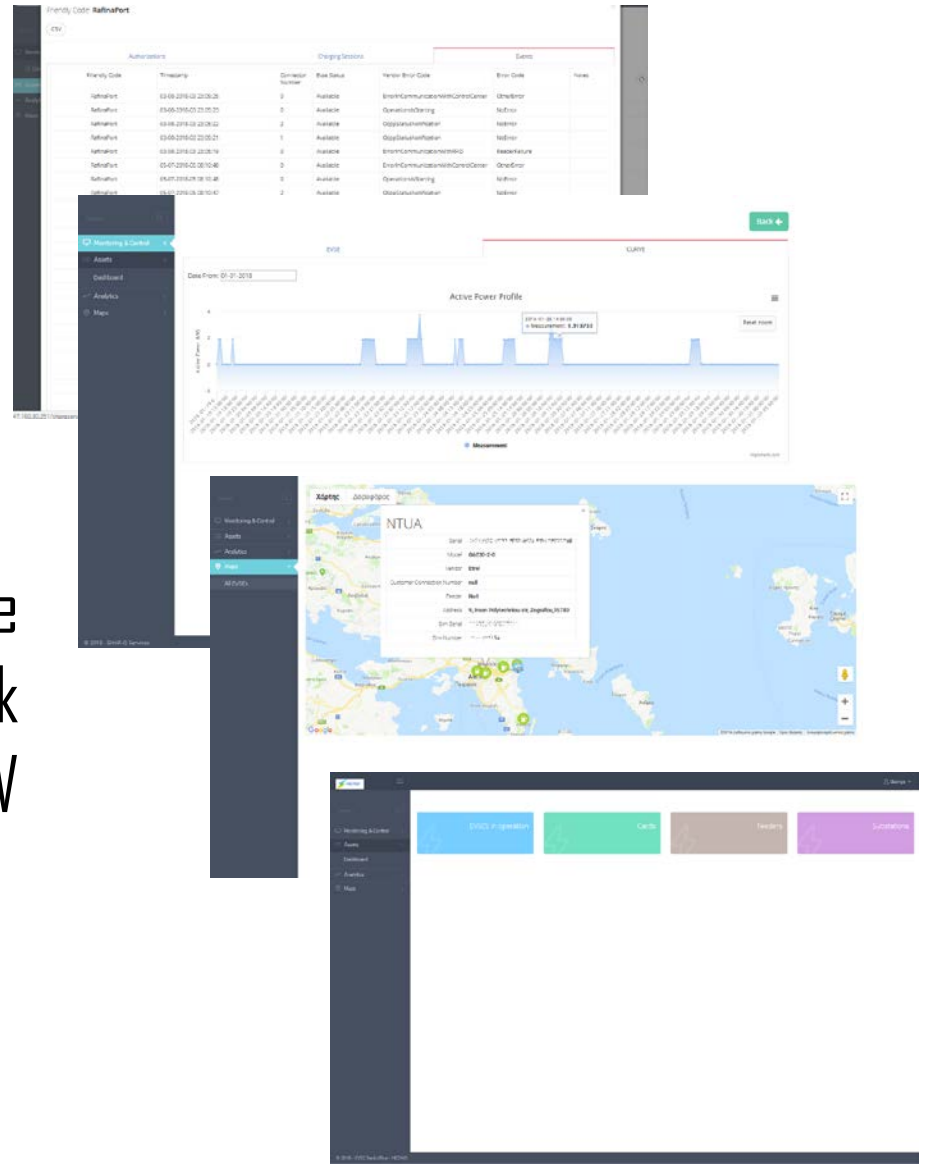
Services offered to EV users

- RFID Authorisation
- Visual representation of EVSE on Map (status and specs)
- Reporting of the charging sessions
- Smart charging

EVSE-MS - Expoitable Result

✓Enables e-mobility service providers (EMSPs) to assess emerging e-mobility services and business models during the infant development phase

✓Network operators gain a better insight concerning the network capacity adequacy and the potential network operational issues provoked by the integration of the new EV charging demand into distribution grids



EVSE-MS - Next Steps

- **Smart charging concepts:**
  - ✓The development and implementation of different smart charging concepts that unlocks new business opportunities to different energy related stakeholders (E-mobility service providers, market and network operators, aggregators, etc.).
- **Technology agnostic platform:**
  - ✓Platform has been tested with AC charging stations. Integration of DC charging stations is pending.
- **Vendor agnostic platform:**
  - ✓During the first development phase, the platform has been evaluated based on charging stations from a limited number of vendors. At the second stage, more vendors should be considered
- **Platform scalability:**
  - ✓The platform scalability should be evaluated according to specific testing mechanisms
- **Platform security:**
  - ✓ Specific testing routines should be executed in order to ensure data is exchanged and stored considering the highest possible security.

4. Smart Islands Pilot Projects

- **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.

Participants: Ministry of Energy, RAE, HEDNO, NTUA (technical studies, consultation), private investors

Smart Islands Pilot Projects

Objectives

- Increase RES penetration above 70%
- Demonstration in 3 islands

Challenges

- Operation only with battery and RES
- Coordination with Thermal Generation

General

- Estimated budget: 4-10M€ per island
- Preparation of public tender

Smart Islands Pilot Projects

Symi

Astypalea

Megisti/Kastelorizo

Selected islands based on

- Size
- Already Installed RES
- Operational Cost
- RES penetration
- Future Interconnection scenarios

Study Results

- RES Penetration > 60%
- IRR from 8.6% to 11.4%

Lessons Learned

- Collaboration between the industrial user and the research team throughout the research projects was of paramount importance for the successful software/tool development (both planning and EMS). Without the practical suggestions of industrial engineers results would be poor.

- The application of innovative solutions in islands, like their operation with very high RES penetration provides valuable lessons on the way large interconnected systems will operate in the future. Islands are ideal test beds for experimentation of new technologies.

- Lack of common EU standards (e.g. for the communication between charging stations and their management platform) creates interoperability issues among the different charging station's technologies and their integration under a common management platform.

Connecting people –business –infrastructure
Providing Energy for every aspect of our life

THANK YOU

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