Next Generation Modelling and Forecasting of Variable Renewable Generation for Large-scale Integration in Energy Systems and Markets

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 864337

1. The Smart4RES project consortium

- A multi-disciplinary consortium

6 countries
12 partners

End-users
Industry
Research
Universities
Meteorologists

Funds: H2020 programme
Budget: 4 Mio€
Duration: 3.5 years

11/2019-4/2023

Denmark: DTU

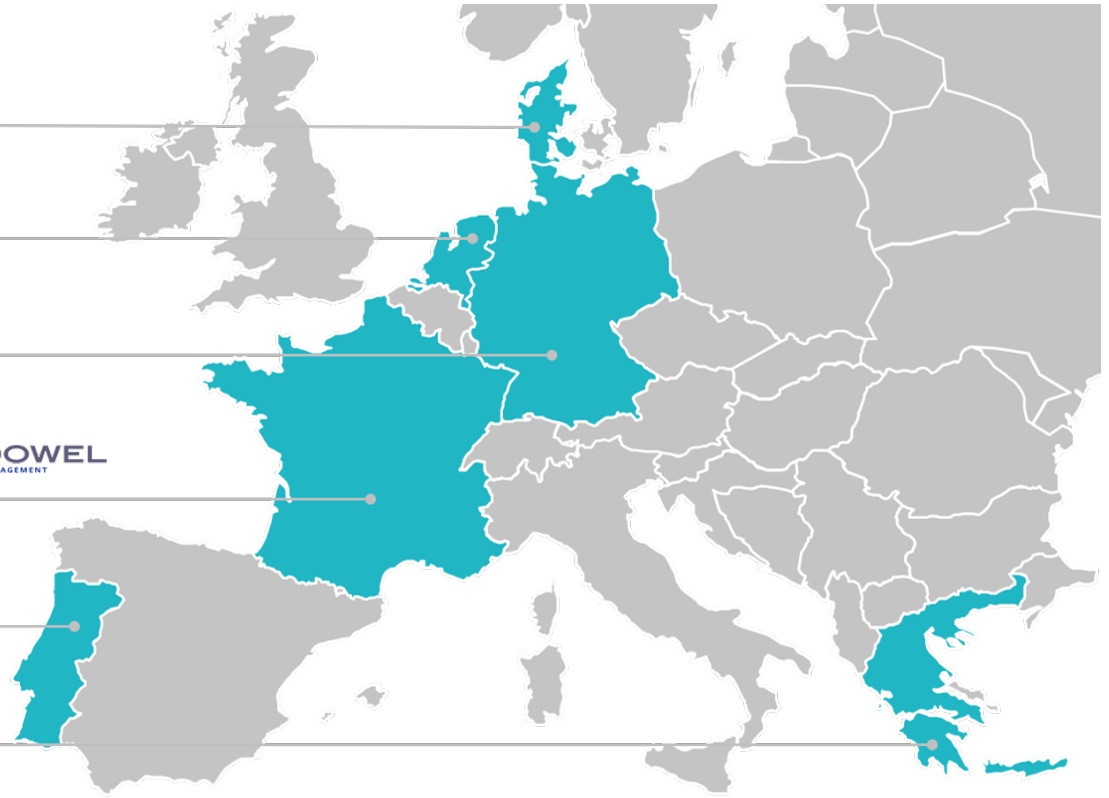
Netherlands: WHIFFLE, DNV·GL

Germany: DLR, energy & meteo systems

France: ARMINES, MINES ParisTech, METEO FRANCE, DOWEL MANAGEMENT

Portugal: INESCTEC, NEW ENERGY WORLD

Greece: HEDNO, ICCS



2. The Greek Non Interconnected Island Power System (NIIPS)

HEDNO roles in the NIIPS

- Market Operator
- DSO & TSO
- Local Generation Management

Challenges

- Seasonality
- Fossil-fuel (22% of demand by RES)
- Non-controllable RES

Objectives

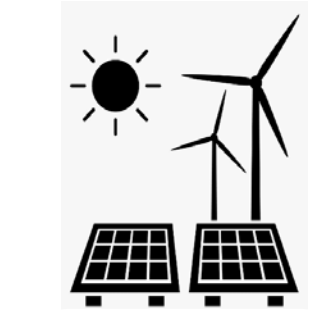
- Increase RES penetration
- Optimize cost
- While maintaining security of the PS

28 Electrical Systems

Rhodes is the largest isolated system

33 Thermal Units

Total capacity: ~**1.570 MW**



1.778 RES

- **445MW installed**
- **86 Wind Parks**
- **1.688 PV**
- **1 Biogas**
- **1 Hydro**
- **2 Hybrid RES**

15 Suppliers (Load representatives)

Total supplied energy~4.300 GWh *(2020)*

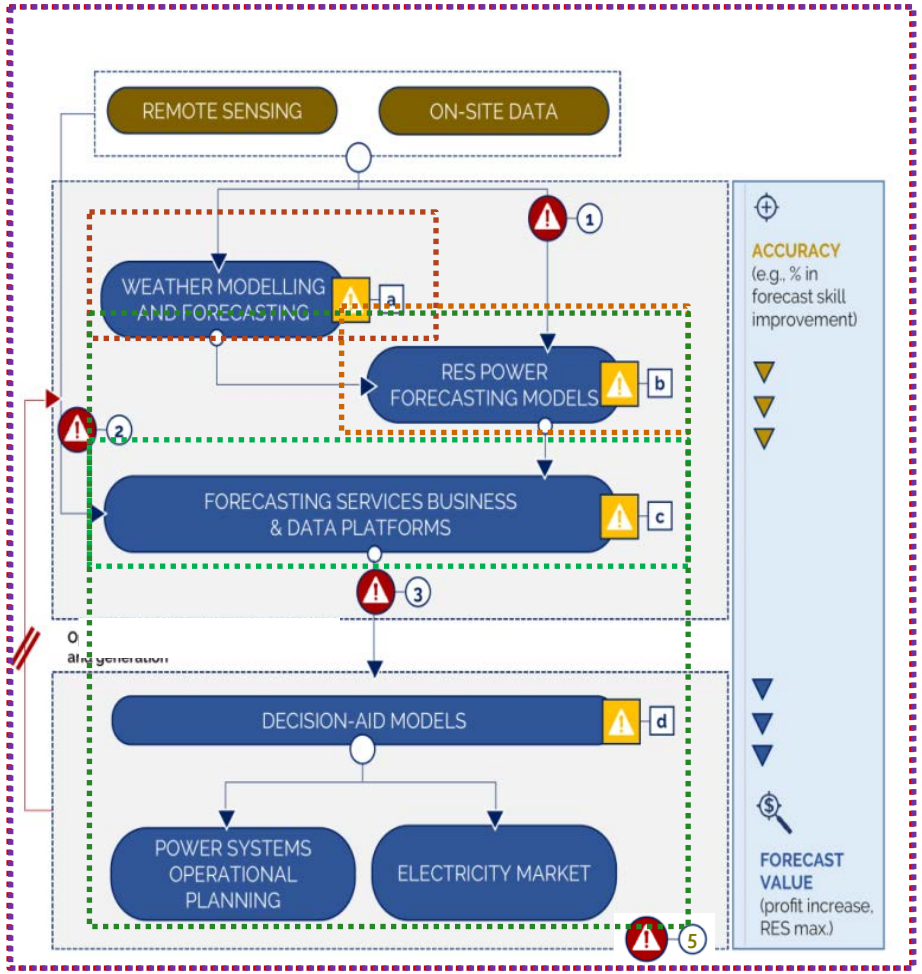
Small PV

- **2.906 net-billing**
- **497 net metering**

Total power: ~**28,5 MW**

3. The Smart4RES Project

- Objectives: prepare the next generation of solutions for RES forecasting and applications



1. Requirements for forecasting technologies to enable 100% RES penetration
2. RES-dedicated weather forecasting with 10-15% improvement using various sources of data and very high resolution approaches.
3. New generation of RES production forecasting tools enabling 15% improvement in performance.
4. Streamline the process of getting optimal value through new forecasting products, data market places, and novel business models
5. New data-driven optimisation and decision aid tools for power system management and market participation
6. Validation of new models in living labs and assessment of forecasting value vs remedies.

End date 30 April 2023

4. HEDNO motivation in the Smart4RES project

Utilize, novel data-driven optimization and decision-aid tools to enable the large-scale penetration of RES in the NIIPS by

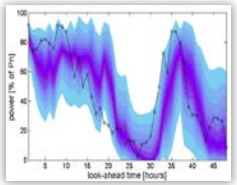
- Mitigating security concerns (which are different) in small isolated systems
- Minimising cost and ensuring security against RES under uncertainty

Methodology

- Evaluation of the impact of battery storage system multiple services in small isolated systems (Frequency containment reserves (**FCR**), virtual inertia (**VI**), fault ride through (**FRT**), voltage support (**VS**), frequency restoration reserves (**FRR**), etc.)
- Introduction of forecast modules and battery storage ancillary services in an advanced economic dispatch module.
- Development of probabilistic dynamic security module for island systems

Q.1: What is the essence of your project's solution with regards to a scenario with high penetration of RES?

- **Stochastic Frequency Constrained Economic Dispatch** tool for non-interconnected islands (**NII**) considering high RES penetration using
  - Probabilistic forecast (*Stochastic*)
  - Dynamic frequency stability (*Security Constrained*)
  - Storage (*Economic Dispatch*)



Probabilistic forecast

Battery Storage, RES control

RES, Demand forecast

Tools developed

Control Actions for Generators, storage, RES

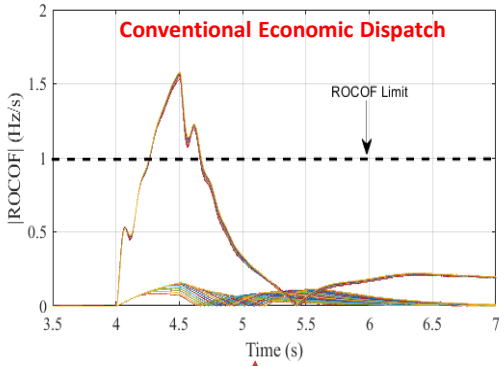
FCR, aFRR, **Virtual Inertia**

ADDITIONAL SERVICES
FRT, VS, Grid forming

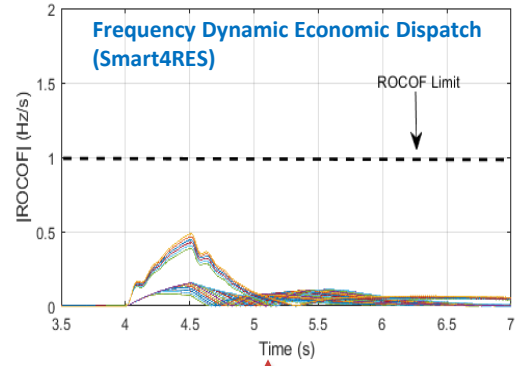
NWP, satellite images, etc.

Real Time measurements

Island SCADA system



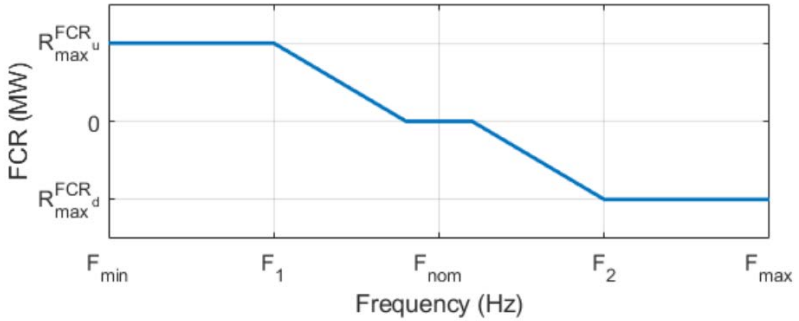
VS



METHOD	LOAD SHEDDING (MWh)
Deterministic	3.24
Stochastic	0.5

For similar RES penetration and production cost, a 84.6% Load shedding decrease is achieved (tests on-going)

Q.2 While the DSOs cannot control the wind or the sun, they may be able to control the use of curtailment. What were the most effective ways to avoid curtailment?



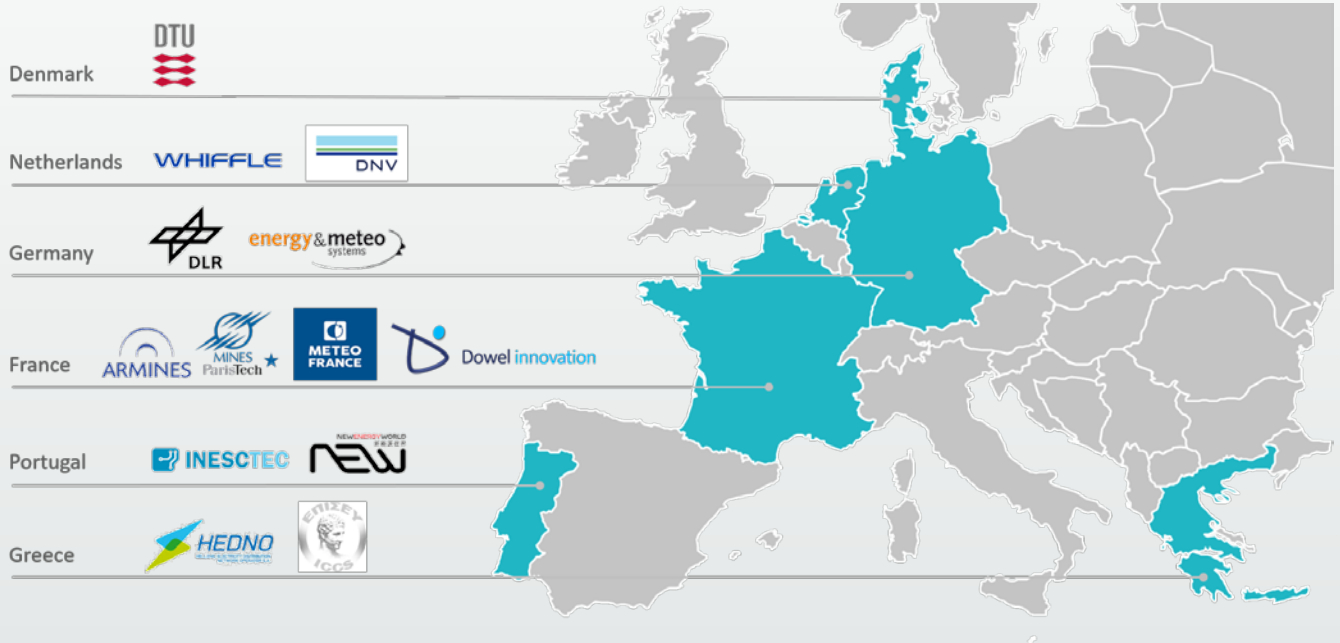
- Avoid thumb rules, use of analytical methods
- Advanced probabilistic forecasts
- Use of storage (e.g. batteries) for ancillary services (e.g. FCR) increasing RES integration
- Use of power electronics and control capabilities (e.g. virtual inertia)
- Data driven decision – aid tools

Q.3 What are the main coordination points with TSO and/or other system stakeholders when it comes to renewables integration in the context of your pilot?

- In Greek NII HEDNO is the TSO and DSO! However,…
- Energy and power products, as well as ancillary services, coming from the Distribution Network (assets located in the DN) destined for (Transmission) System-wide objectives (e.g. FCR, aFRR, Virtual Inertia) – potentially contradictory objectives
- Owners of assets (e.g. batteries, RES) and how they are incentivised/obliged to offer their services (e.g. compensation vs grid code compliance)
- Forecast providers and improvement of forecast, type of forecast (point vs probabilistic), scope of forecast (per installation vs system-wide)
- Regulatory authority, regulatory context

Smart4RES

THANK YOU !



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WP6: Living Lab concept

Island SCADA system

HEDNO

- Real-time data from islands will be used for the testing of the developed tools in realistic enviroment

Real Time Interface

Real Time Data Server

Update values

Real-Time Digital simulator

Forecast Tool

Economic Dispatch, Dynamic Security

actions

Hardware in the Loop interface

Hardware equipment (e.g. protection relays, power converters)

Island Digital Twin

Tools under study

National technical University of Athens