

ETN Decentralised Energy Systems webinar – Episode 2

Modelling tools

Agenda

Short introduction

Our speakers



Paul Barberi
Senior Project Manager
Artelys



Sergio Herraiz Jaramillo
Associate Professor
University of Girona

Facilitating Local Multi Vector Energy Systems: Operational Planning

Sergio Herraiz

Control Engineering and Intelligent Systems
University of Girona

Introduction



E-LAND supports the decarbonisation of energy islands and isolated communities.

Technology challenges

- Energy sectors are **de-coupled** from both operational and planning viewpoints
- **Lack of** optimisation **tools** which can optimally co-manage different storage types
- **Seasonal imbalance** in generation and demand

Societal challenges

- **Lack of understanding** the role of the communities
- Impact of **gender** in a community on acceptance and use of technology

Business challenges

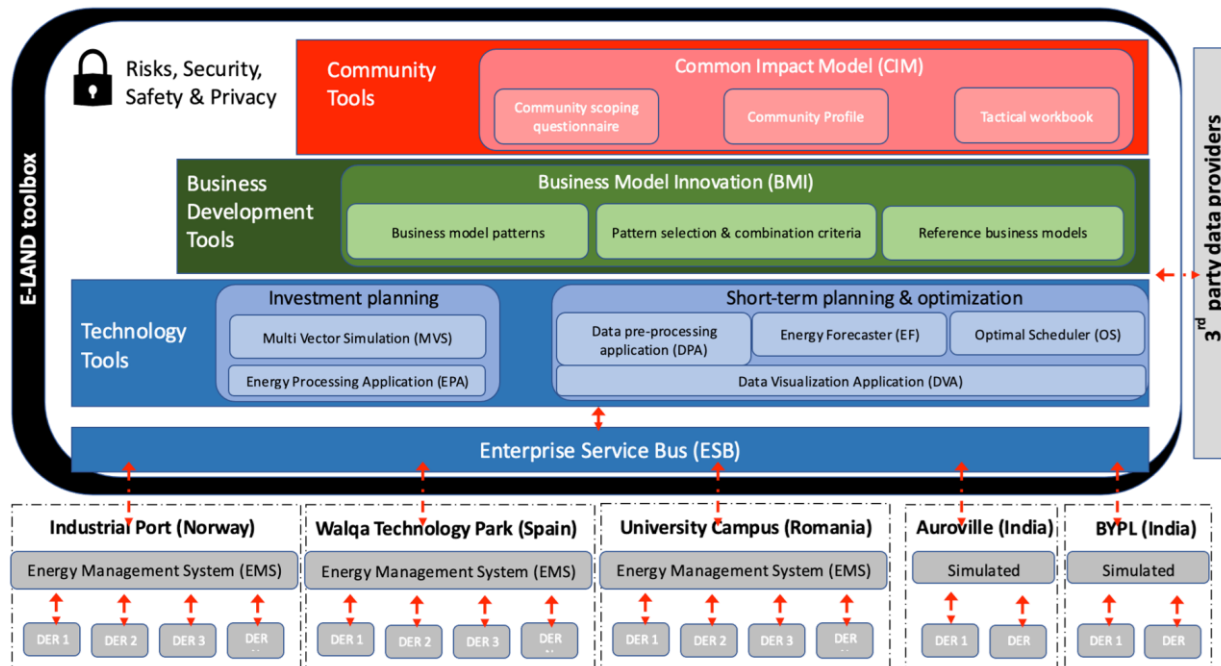
- Energy industry **lacks proper tools** for bringing innovation to the business models
- Energy **communities need viable business models** to run a local energy business.
- New **business models** are required **for** different types of **energy storage**



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957752

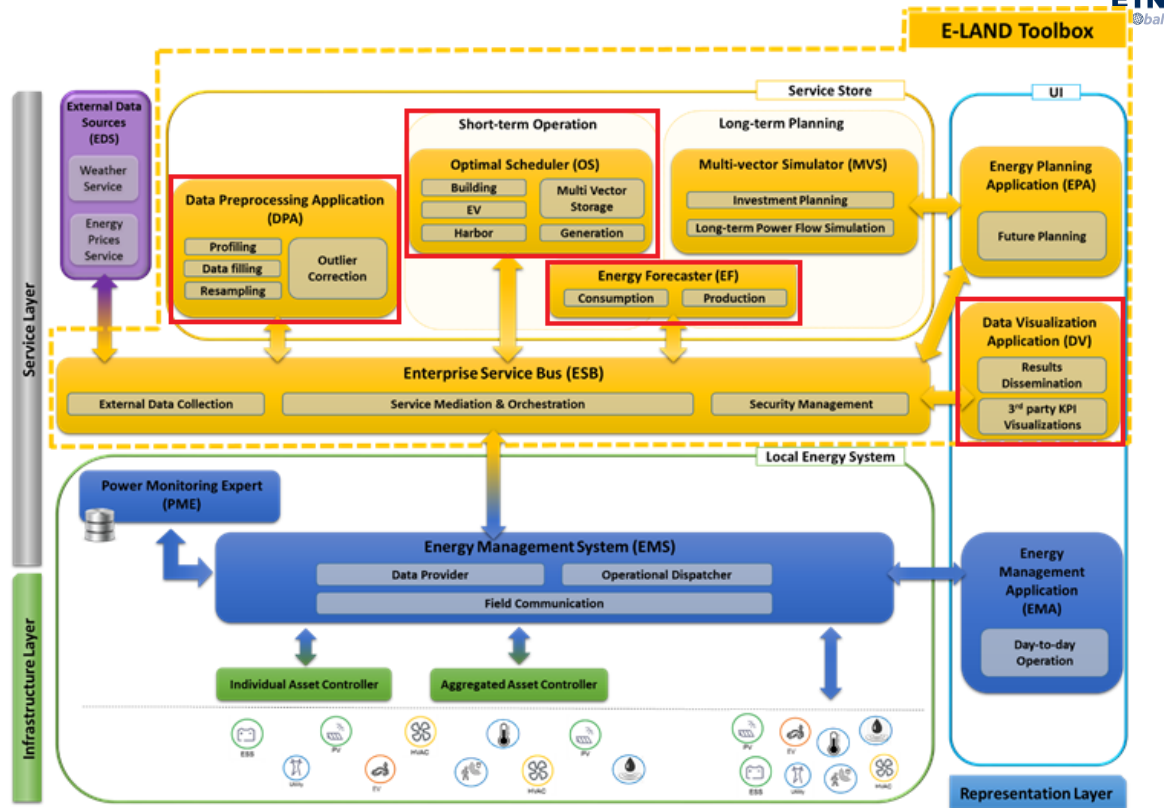
Introduction

E-LAND: Toolbox approach



Introduction

E-LAND Toolbox Technical tools – Focus Area



Introduction

E-LAND toolbox includes a set of technical tools that enable:

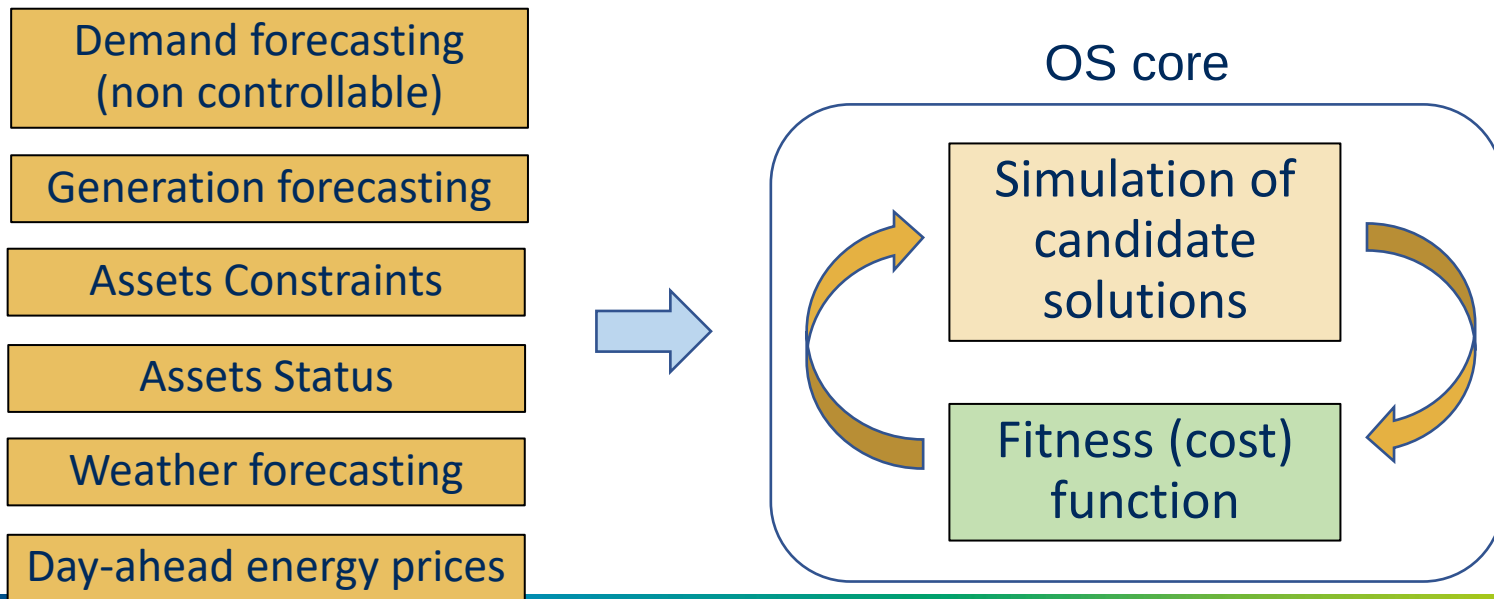
- Calculation of **WHEN** and **HOW** to consume and store energy to **OPTIMISE** the use of local distributed energy resources (generation and storage) in local energy systems
- Leverage the power of **FORECASTING**, for short-term operational planning
- Harness data from the field (e.g. energy measurement, weather data) by improving its **QUALITY**
- **INTEGRATE** with existing or newly deployed energy management solutions via the Enterprise Service (ESB)
- Consider **MULTI-VECTOR** energy scenarios considering electricity, thermal, hydrogen, electro mobility energy vectors

Description

- The multi-vector energy island has a set of **dispatchable assets** that can be controlled in order to optimize a set of objectives
- **Different objectives** may be supported: peak-shave the power supplied by the grid, maximize self-consumption, maximize the percentage of green energy consumption share, etc.
- Such objectives are supported in the PUCs
- Scheduling should satisfy **operational constraints** (balancing energy demand and supply, technical constraints of the assets)
- **Day-ahead / intra-day** scheduling

Optimal Scheduler (OS)

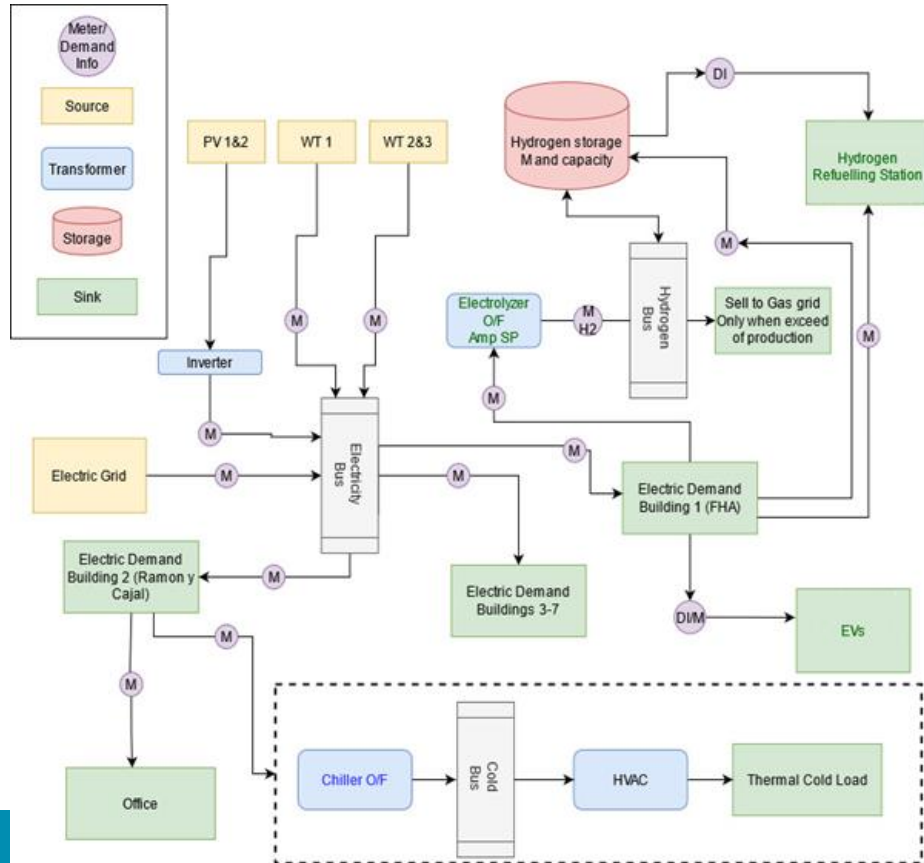
Provides schedule plans for the controllable assets in the LES (HVAC, EESS, EV chargers...) based on the forecasted local energy production and the forecasted energy demand



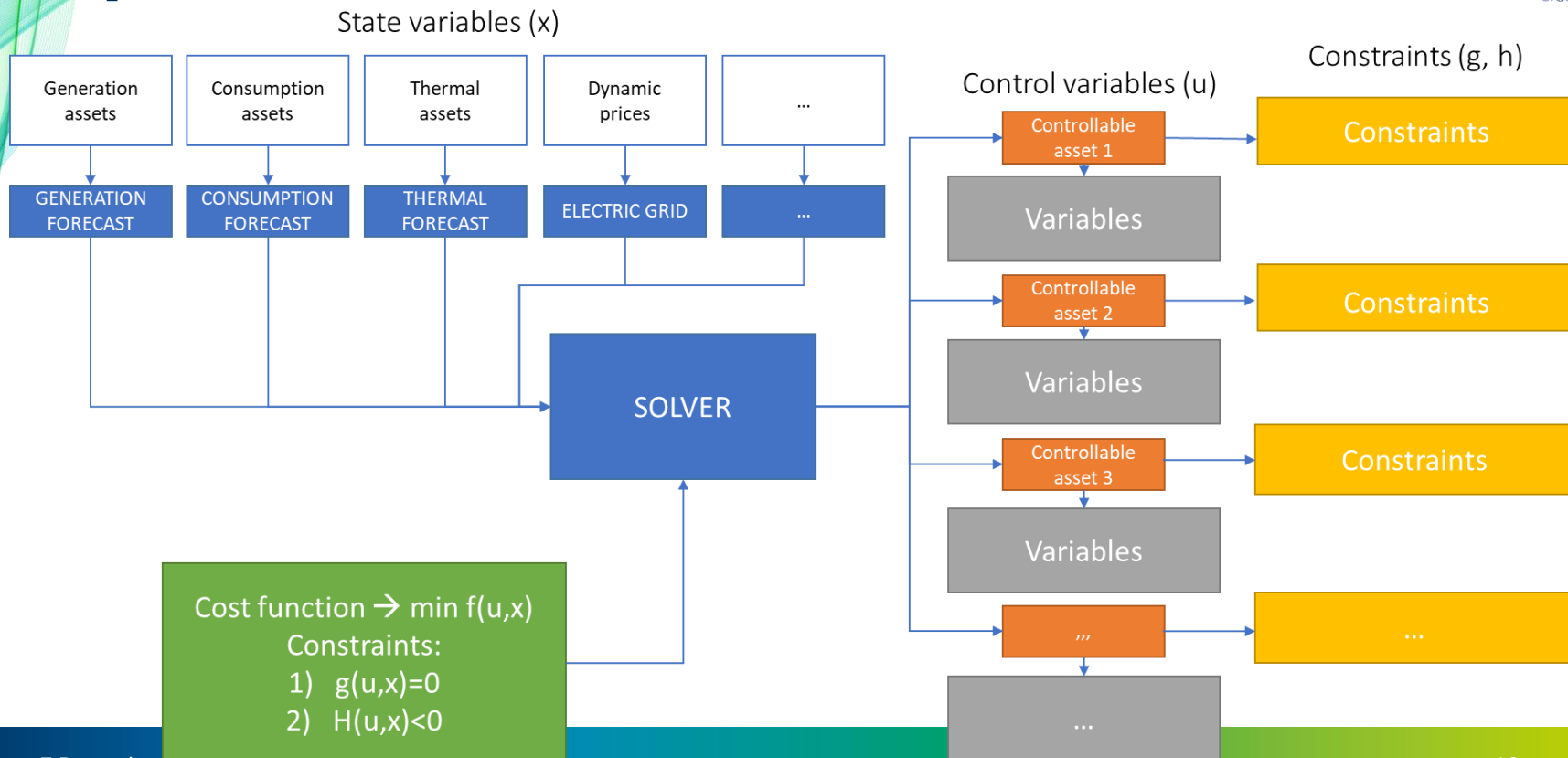
Optimal Scheduler

How does it work?

Taking as an example
the Spanish pilot site,
Walqa Technologic
Park



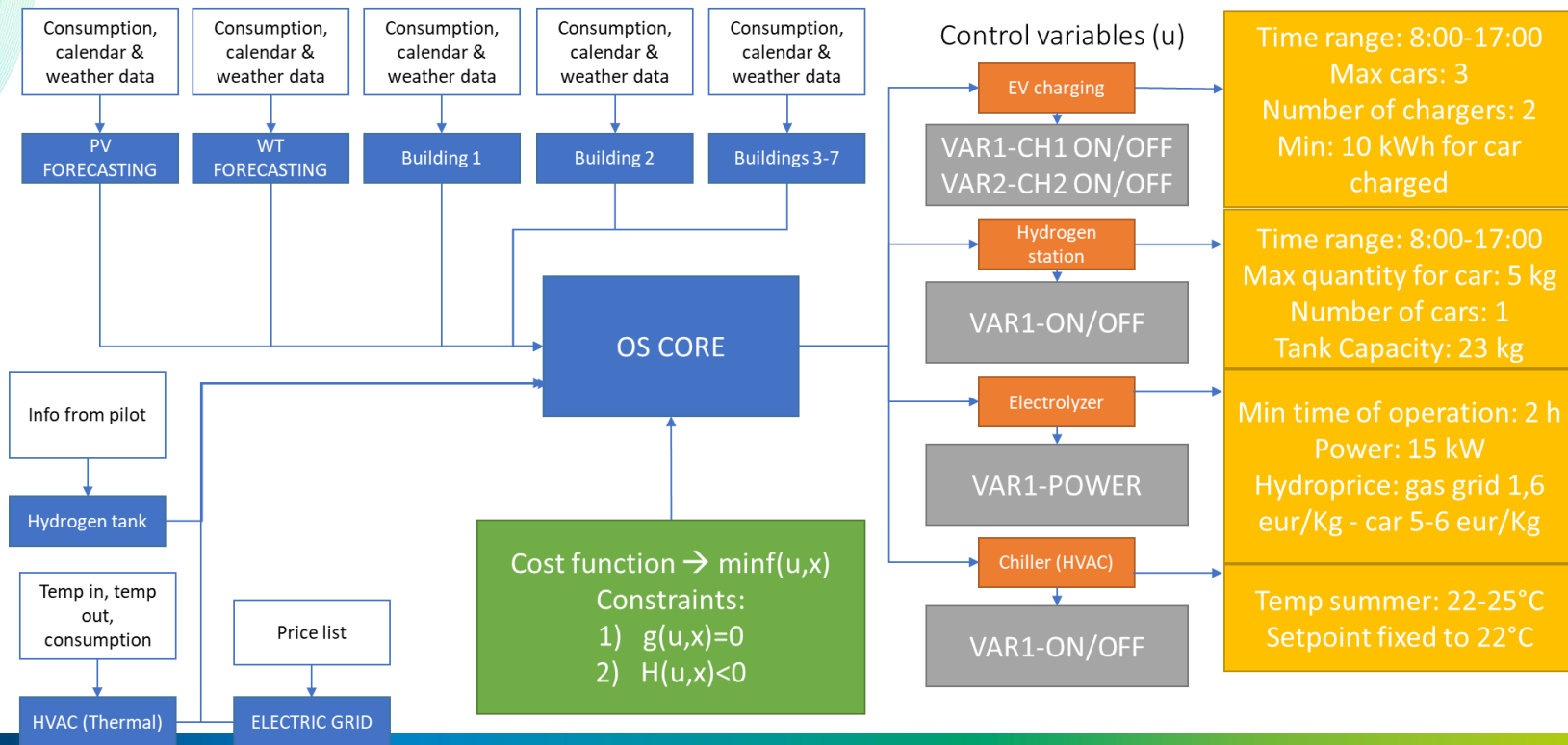
Optimal Scheduler



Optimal Scheduler

State variables (x)

Constraints (g, h)



ENERGY FORECASTER

```
wind_prod (kWh) = [13, 16, 11, 7, 33, 29, 19, 5, 10, 19, 21,  
22, 28, 27, 28, 27, 33, 29, 35, 36, 35, 41, 29, 20]
```

ELECTRICITY PRICE PROVIDER

elec_buy (€/kWh) = [0.133, 0.126, 0.128, 0.141, 0.147, 0.148, 0.155, 0.156, 0.158, 0.152, 0.147, 0.148, 0.144, 0.141, 0.139, 0.136, 0.134, 0.137, 0.143, 0.152, 0.157, 0.164, 0.159, 0.156]

PILOT INFORMATION

tank status (kg) = 15

WEATHER SERVICE PROVIDER

```
temp (K) = [298.15, 298.15, 298.15, 298.15,
298.15, 298.15, 298.15, 298.15, 298.15,
298.15, 298.15, 298.15, 298.15, 298.15,
298.15, 298.15, 298.15, 298.15, 298.15]
```

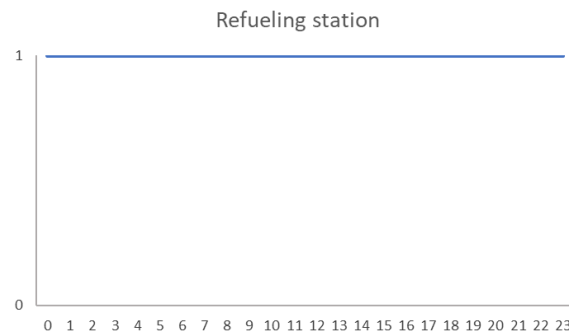
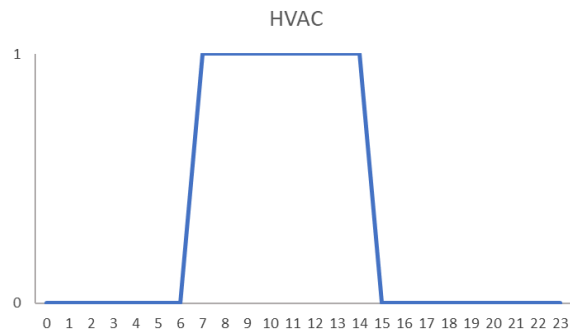
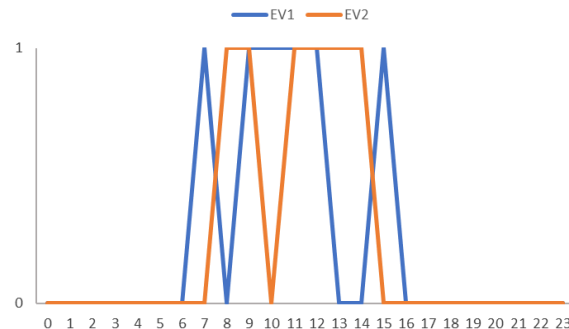
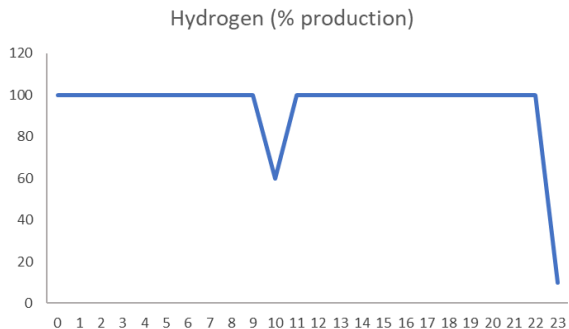
STATIC INFORMATION

```
elec_sell (€/kWh) = [0.054, 0.054, 0.054,
0.054, 0.054, 0.054, 0.054, 0.054, 0.054,
0.054, 0.054, 0.054, 0.054, 0.054, 0.054,
0.054, 0.054, 0.054, 0.054, 0.054, 0.054,
0.054, 0.054, 0.054]
```

hydrogen_price (€/kg) = 1.6

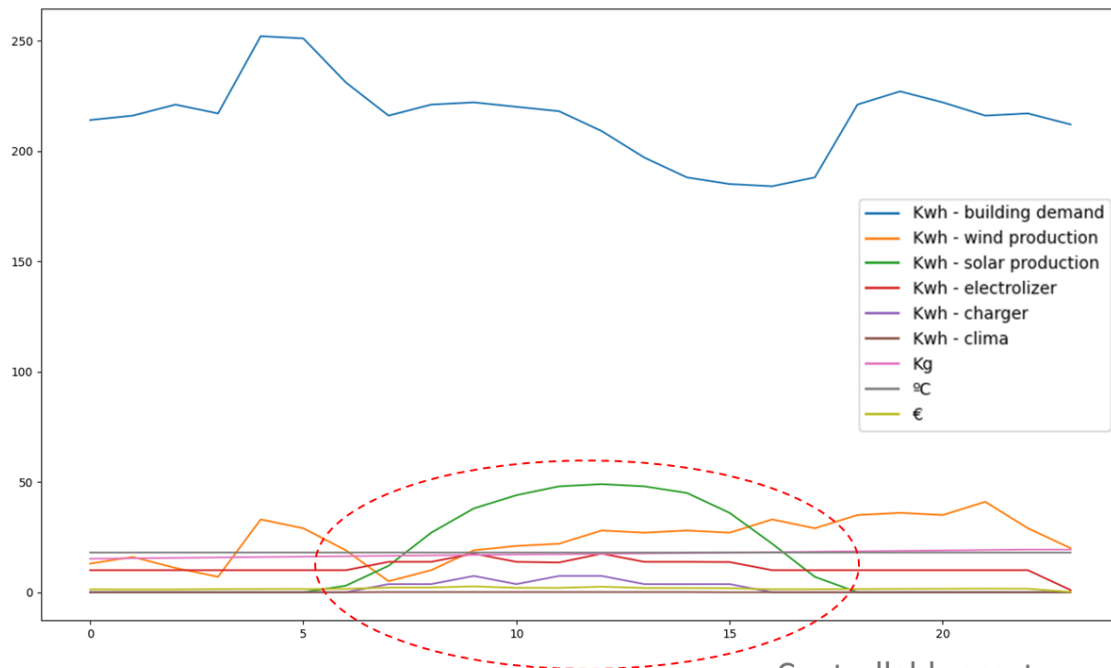
Optimal Scheduler

Example: 2) Outputs – controllable assets



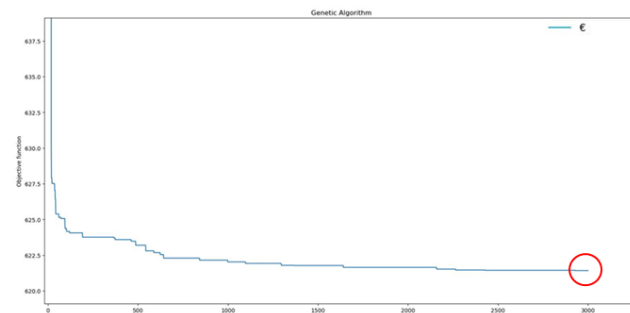
Optimal Scheduler

Example: 3) Simulation of the proposed scheduling



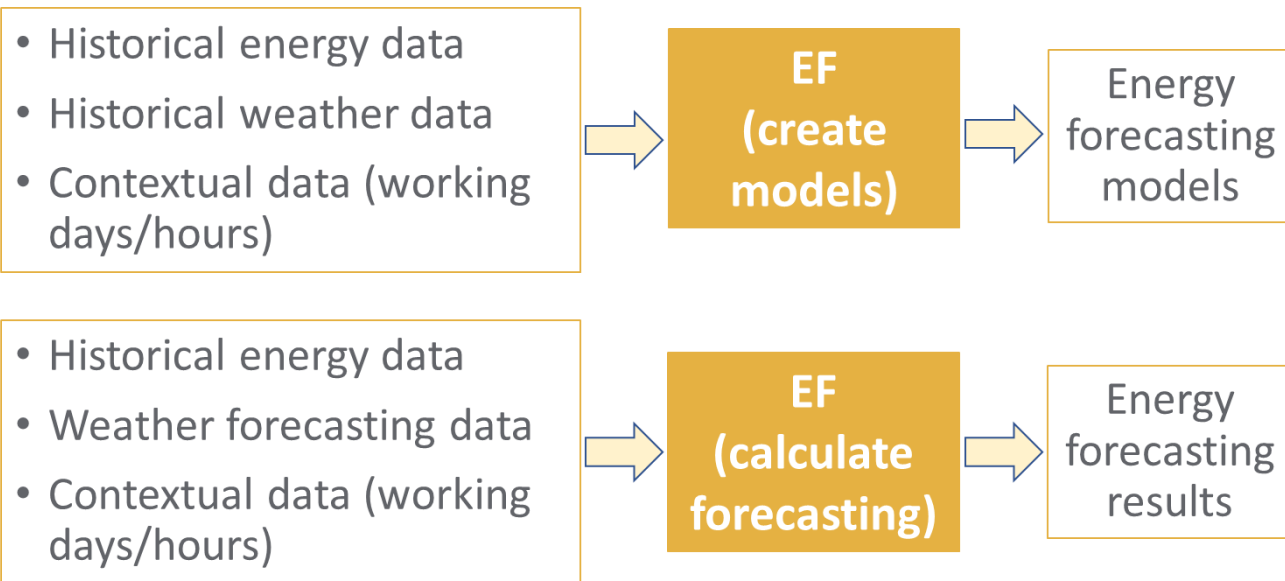
Controllable assets overlap PV generation

Minimization of the cost function



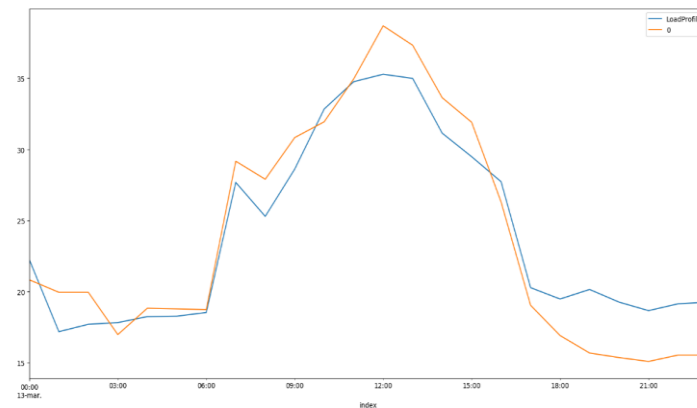
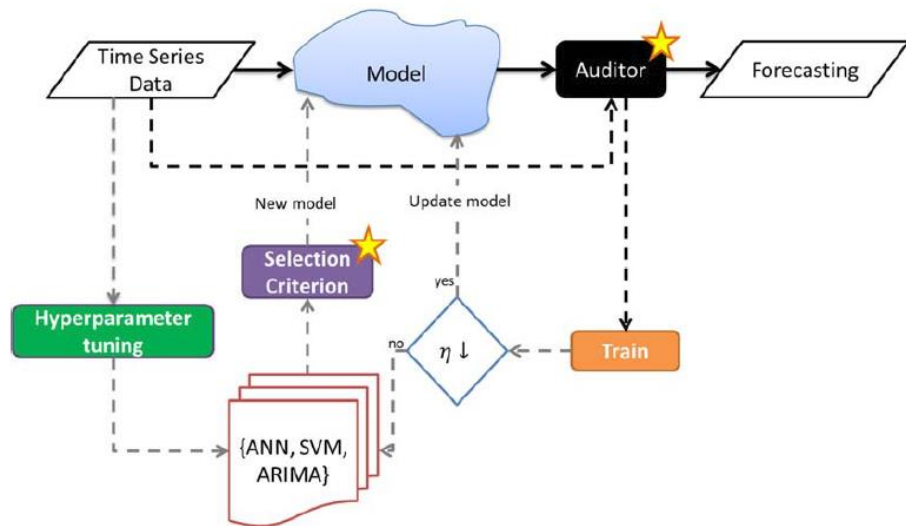
Energy Forecaster

Allows the creation of short-term energy demand and production forecasting models and provides energy demand and production forecasting.



Energy Forecaster

Consumption forecasting

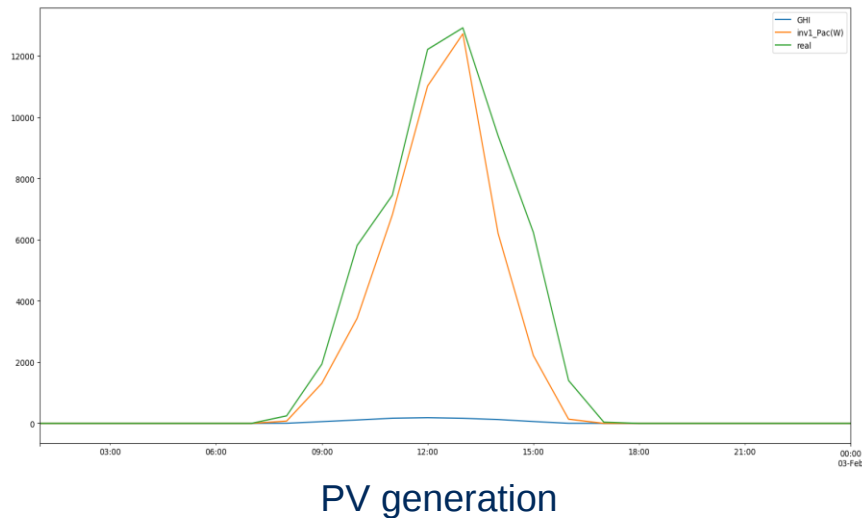


Electrical consumption

Energy Forecaster

Generation forecasting

Physical expressions + Adjustment of parameters based on historical data

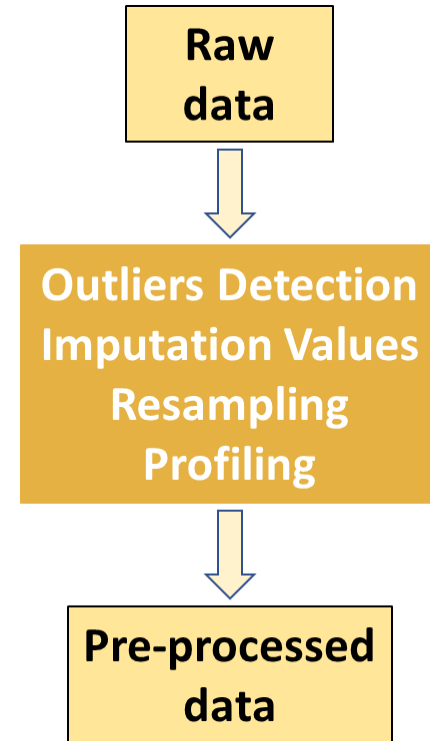


Data Pre-processing Application

Historical data may contain errors

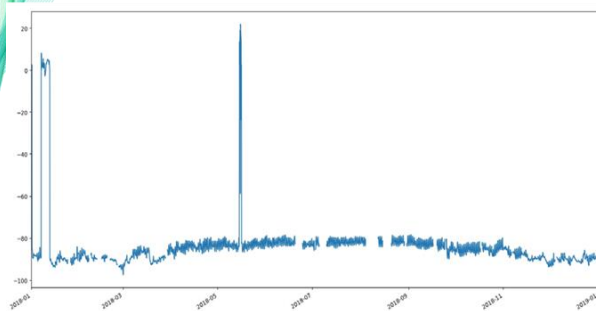
Historical data may need resampling

Tool that prepares gathered data, improving its **QUALITY**, so it can be used by other analytical tools such as EF and OS

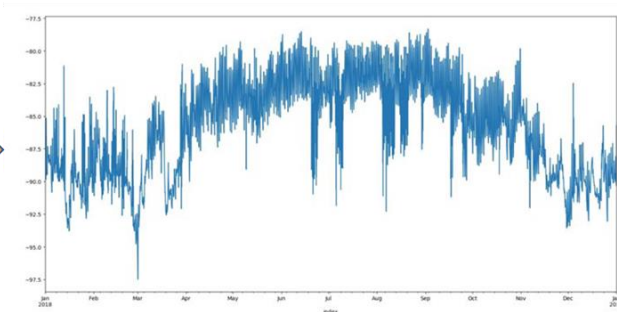


Data Pre-processing Application

Data filling / Outlier detection

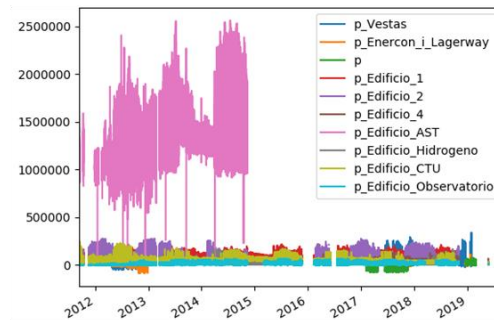


Raw
data

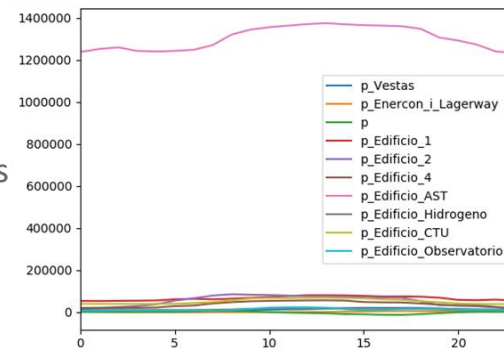


Energy profiling

Raw
data



Daily
profiles



Summary

- OS provides a 24-hour optimal scheduling plan to operate the controllable assets in a local energy system.
- Development of modular tools (Software as a Service).
- Multi-vector local energy systems approach.
- Publication: “Multi-vector energy management system including scheduling electrolyser, electric vehicle charging station and other assets in a real scenario”, <https://doi.org/10.1016/j.jclepro.2022.134996>

- Moving forward:



reschool

RESCHOOL improves the way energy communities operate by enhancing the technology and behaviour of their users. This will help to make these communities more efficient and effective in their use of energy.

<https://www.reschool-project.eu>



Co-funded by the European Union (grant agreement N°101096490). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union. Neither the European Union nor the granting authority can be held responsible for them.



Thank you for your attention

Sergio Herraiz
sergio.herraiz@udg.edu

Q&A

Feel free to ask any questions!

Decorative wavy lines in shades of blue and green on the left side of the slide.

The INSULAE Investment Planning Tool: A Powerful Software to Help Island Decision-Makers Design their Energy Strategies

Paul Barberi
Senior Project Manager, Artelys



Agenda

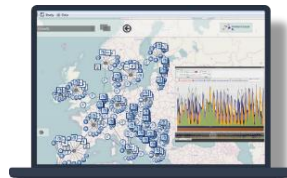
- Overview of INSULAE project
- IPT presentation
 - Introduction to the software
 - Energy system modelling
 - Demonstration
- Commercialisation roadmap of the IPT

Artelys

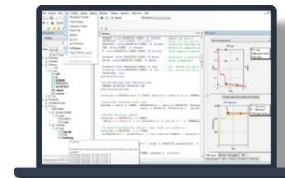
Artelys is an **independent** company, founded in 2000, specialized in **decision support**, modeling and **optimization**.



SOFTWARE
Custom software,
off-the-shelf software suite,
digital solvers

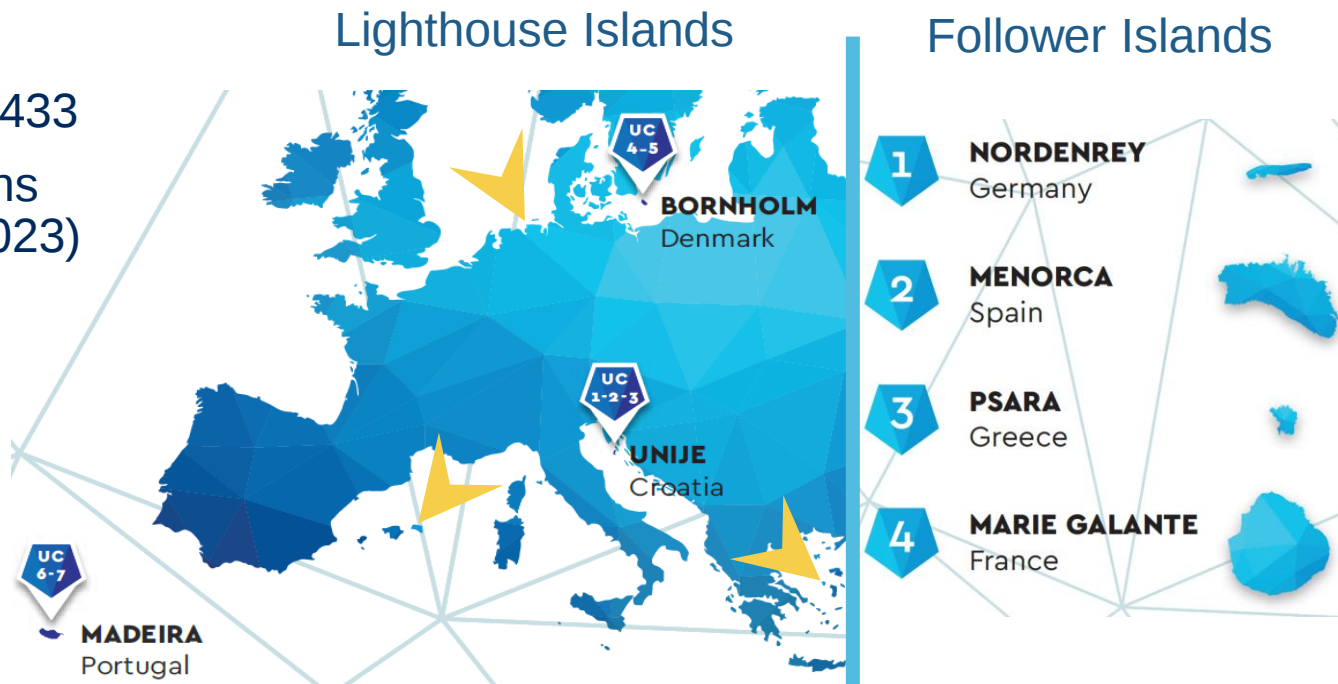


SERVICES & CONSULTING
Optimization, Data
Science and Business



INSULAE overview

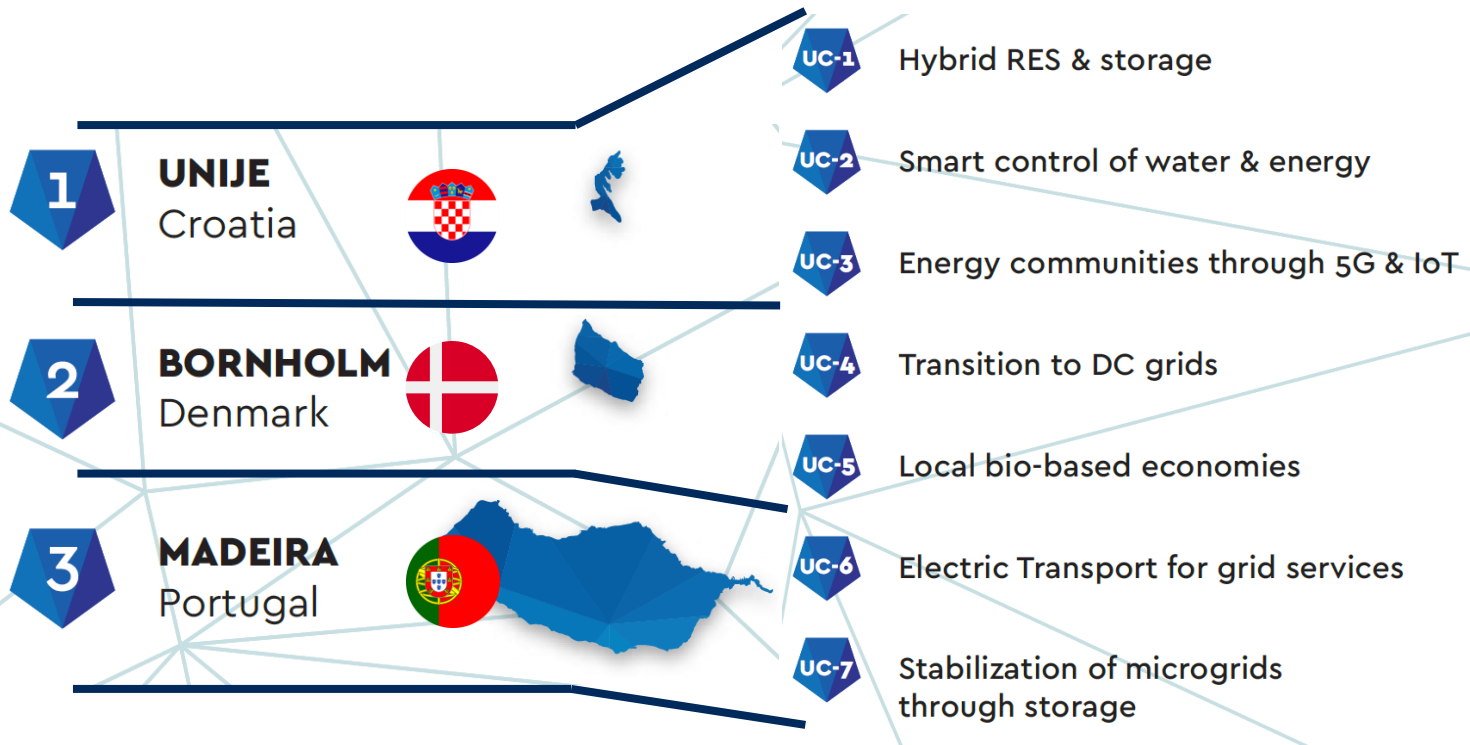
- Horizon 2020, grant number 824433
- Duration 56 months (Apr 2019- Nov 2023)
- 26 Partners
- 10 Countries
- € 12 Million total Budget



INSULAE technical overview



Investment
Planning
Tool
↕
Follower
Islands



What is the Investment Planning Tool exactly?

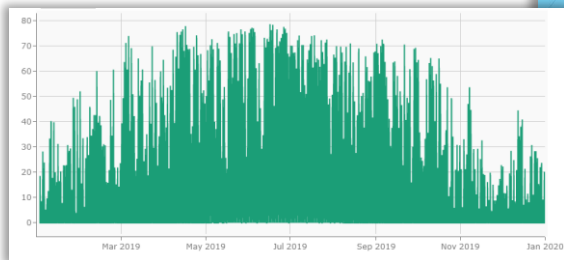
- The **Investment Planning Tool (IPT)** is a web based software developed by Artelys within the INSULAE project in order to **assist island decision-makers to design energy strategies**, and to monitor their impacts on insular energy systems.
- The IPT is divided in two modules:
 - **The Island Modelling Assistant (IMA):**
 - This module is mainly used to represent the **current state of the island energy system**.
 - **The Scenarisation Module:**
 - This module is used to represent **possible future scenarios of the island energy system**, and to investigate the potential benefits of different actions that could be implemented by policy-makers.

IPT - Island Modelling Assistant

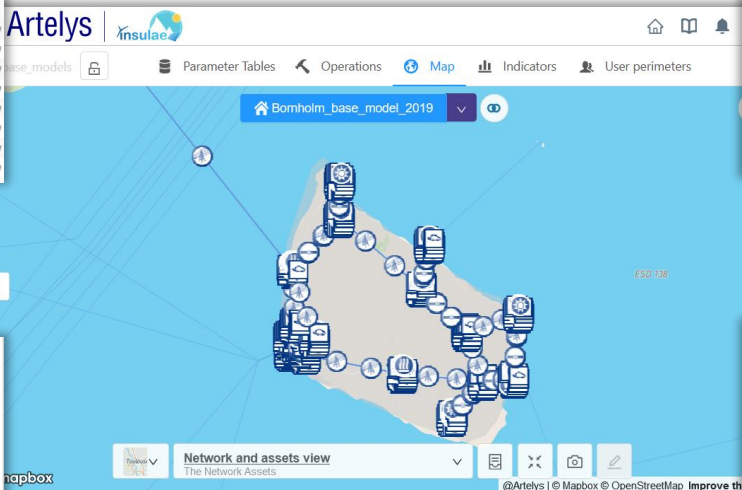
Solar fleet

	Name	Asset zone	Longitude	Latitude	St	Production	UUD	CAPEX	Fixed Operati...	Capacity
☐	Solar - Gudfjerm	BH	14.9748	55.22046	BH_GUD_electr...	E E E E	80	150.59676/MW	13.3504/MW/Year	0.2691MW
☐	Solar - Svaneke	BH	15.14569	55.14488	BH_SVA_electr...	E E E E	80	150.59676/MW	13.3504/MW/Year	0.3718MW
☐	Solar - Poulsker	BH	15.01607	55.03167	BH_POU_electr...	E E E E	80	150.59676/MW	13.3504/MW/Year	0.4381MW
☐	Solar - Osterlars	BH	14.95431	55.17393	BH_OES_electr...	E E E E	80	150.59676/MW	13.3504/MW/Year	0.4278MW
☐	Solar - Snorreby...	BH	14.75114	55.11814	BH_SNO_electr...	E E E E	80	150.59676/MW	13.3504/MW/Year	0.607336MW
☐	Solar - Bodsker	BH	15.07615	55.07717	BH_BOD_electr...	E E E E	80	150.59676/MW	13.3504/MW/Year	7.843259MW
☐	Solar - Olsker	BH	14.80155	55.24942	BH_OLS_electr...	E E E E	80	150.59676/MW	13.3504/MW/Year	0.536859MW
☐	Solar - Næsoe	BH	15.13389	55.07419	BH_NDX_electr...	E E E E	80	150.59676/MW	13.3504/MW/Year	0.8564MW

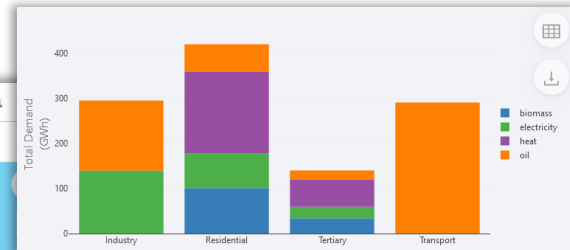
Use the parameter table view to adapt your model, or import structured csv files



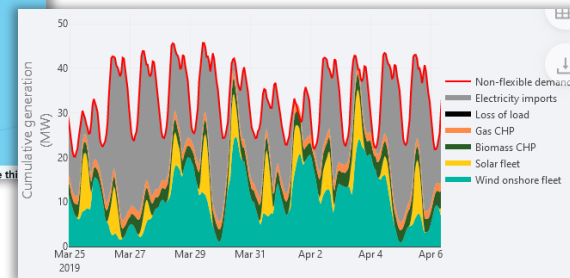
The IPT handles hourly data to take into account the variability of renewables



Map view of the IPT



Various KPIs are available to analyse your island's energy system



Use hourly KPIs for advanced insights on power demand/supply balance

IPT - Island Modelling Assistant

1 Parameters

Multiaction

Label	rank	Multiaction tag
Search...	Search...	
☐ CO2 emissions price	1	modification of existing asset
☐ Change in demand based on demography	2	Energy demand evolution
☐ Efficiency improvement	3	Energy demand evolution
☐ Electrification of end uses	4	Energy demand evolution
☐ New optimized on-shore windfarm	5	create new asset with optimized capacity
☒ New big solar farm	6	create new asset with fixed capacity
☐ New large-scale batteries	7	create new asset with fixed capacity
☐ Shutdown of oil fleet	8	modification of existing asset
☐ Oil fleet for flexibility needs	9	modification of existing asset
☐ Electrification of transportation	10	Energy demand evolution

Use the intervention library to build the pathway of evolution of your island

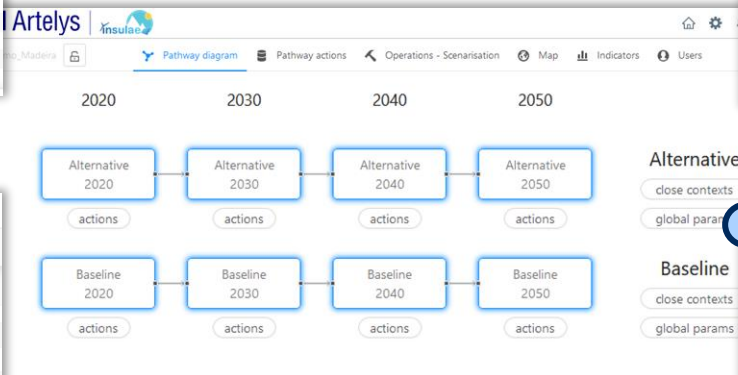
2 Action

PERCENTAGE	SECTORS	ENERGY CARRIERS
min max		
☐ -0.7%	Transport	Oil Electricity Gas
☐ -0.9%	Lighting	Oil Electricity Gas
☐ -2%	Residential	Oil Electricity Gas
☐ -0.9%	Services and commerce	Oil Electricity Gas

Previous Page 1 of 2 10 rows Next

Add action Remove action

Configure each intervention with the appropriate parameters



Pathway diagram view of the IPT

3 Launching operation: Launch pathway optimization

[View operation detail](#)

Operation not started

Computation

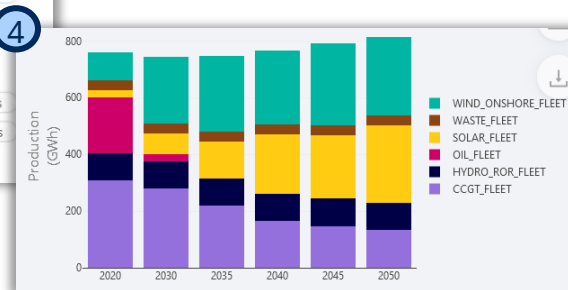
Parameters

Pathway Baseline (Pathway)

Computation host crystal-opt-engine

Start Operation

Apply your interventions and optimise investments in new capacities



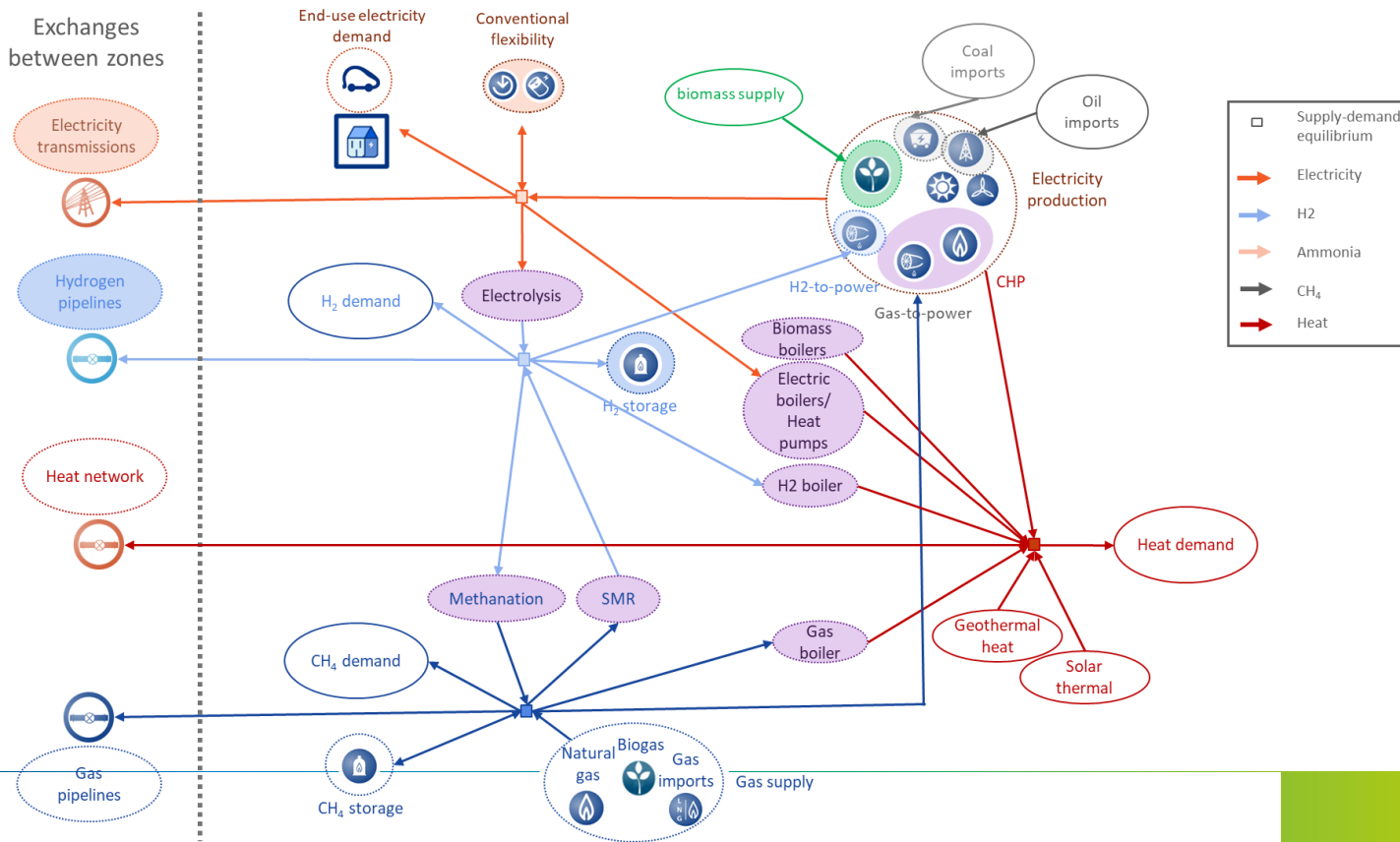
Use dedicated KPIs to analyse pathways of evolution of your island's energy system

Energy system modelling

Current situation of an island's energy system

- Detailed representation of the different energy vectors (electricity, heat, gas, oil products, biomass, H₂, etc.)
 - Advanced representation of energy demand, with a breakdown by sector, sub-sector, end-use
 - The user can decide for which energy an explicit representation of the supply is necessary (typically only electricity and heat, and not for oil products used for transport)
- Representation of the energy flows within the island, and import/export with the mainland
- Hourly optimisation of the demand/supply balance in order to minimise the total generation costs

Energy system modelling



Energy system modelling

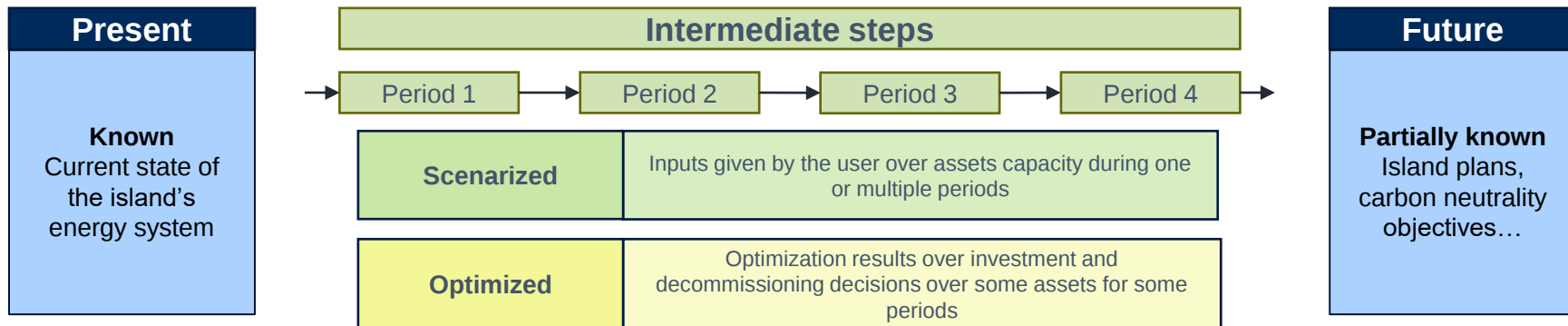
Evolution of the energy system

- The IPT includes a library of “interventions” to create contrasted pathways of evolution:
 - Demand evolution (efficiency measures, switch from ICE cars to electric vehicles, switch from one energy source to another for a specific end-use, etc.)
 - New power lines
 - Investments in new generation plants
- The IPT can also optimise investments in new capacities over a pathway, represented by different steps
 - Typical parameters for new investments : CAPEX/FOC, lifetime, maximum potential
 - Joint optimisation of operation and investment costs over the pathway
 - Possibility to add policy targets (carbon budget, minimum renewable energy target for electricity generation)

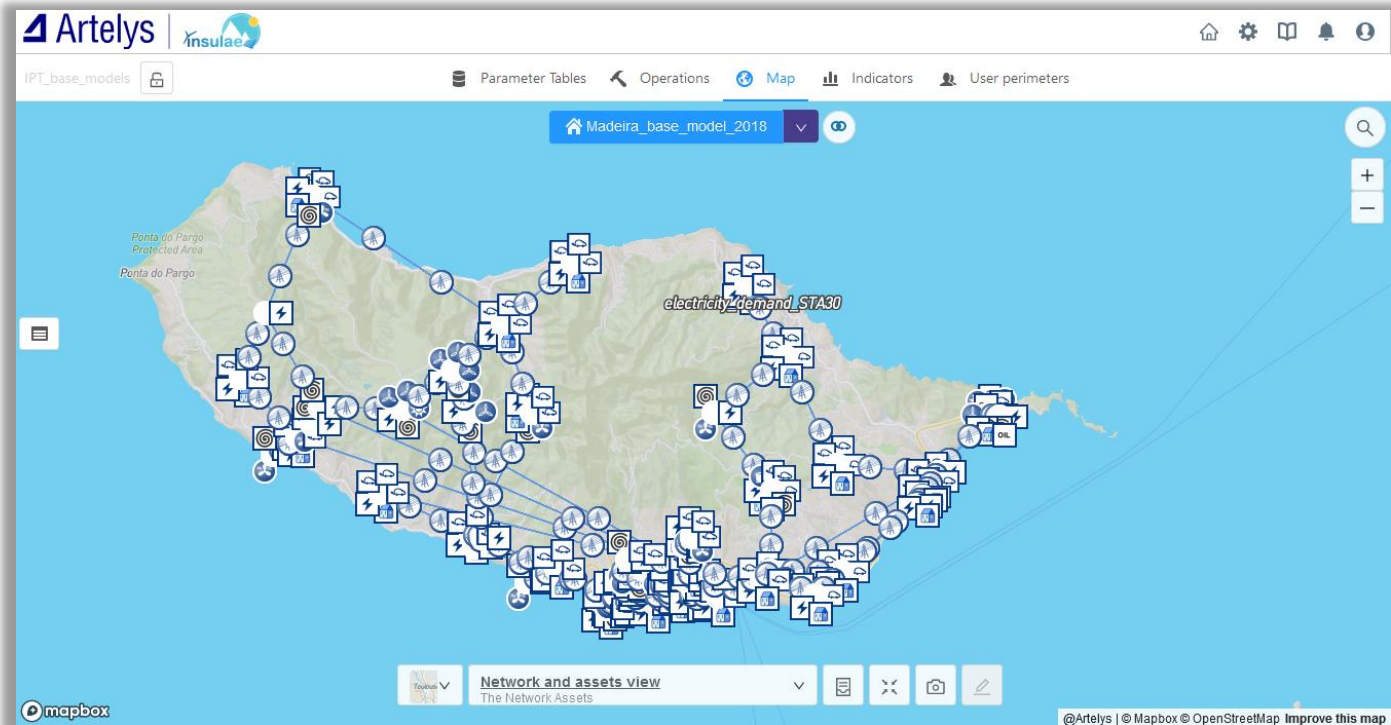
Energy system modelling

Pathway modelling

- A pathway study gives the optimal steps in terms of investment and operating cost to move from one known system to another by modelling the intermediate steps between the two
 - The starting system is the current island's energy system
 - The target system contains a scenarized part (e.g. electricity consumption forecasts, diesel generators phase-out, interconnection with the mainland...) and an optimized part (investments in renewable capacity, investments in batteries...)
 - The intermediate and final steps contain a mix of results (installed capacities at each step, decommissioned technologies...) and inputs (historical nuclear, interconnection capacities, carbon targets..)



Demonstration of the IPT



Commercialisation roadmap

✓ Targeted users:

- ✓ Decision makers involved in the decarbonization of EU islands (municipalities, utilities, energy authorities, consulting support teams, etc.)

✓ IPT Web-based license package :

- ✓ Access to an IPT server, with dedicated calculation services for energy system optimization (include hosting and administration costs)
- ✓ Support and maintenance :
 - ✓ Online training to learn how to use the IPT
 - ✓ Support from Artelys to create the island energy model
- ✓ One island example dataset to get started with the tool
- ✓ User community

✓ Pricing:

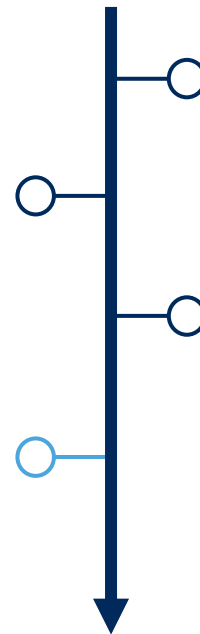
- ✓ Annual subscription to the IPT license package
- ✓ Free trial period
- ✓ Price on demand

Nov 2022
Internal release of
the IPT for the
different islands of
the INSULAE
project

Nov 2023
Official release of
the IPT for all
European islands

2019-2022
Development of the
IPT by Artelys

Jan-Nov 2023
Lighthouse and
follower islands are
using the IPT to
replicate INSULAE
use-cases and
create island
energy master
plans



Thank you for your attention !

Paul Barberi

paul.barberi@artelys.com

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