ETN Decentralised Energy Systems webinar – Episode 2

Modelling tools

Agenda

Short introduction

Our speakers

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Facilitating Local Multi Vector Energy Systems: Operational Planning

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Introduction

https://elandh2020.eu/

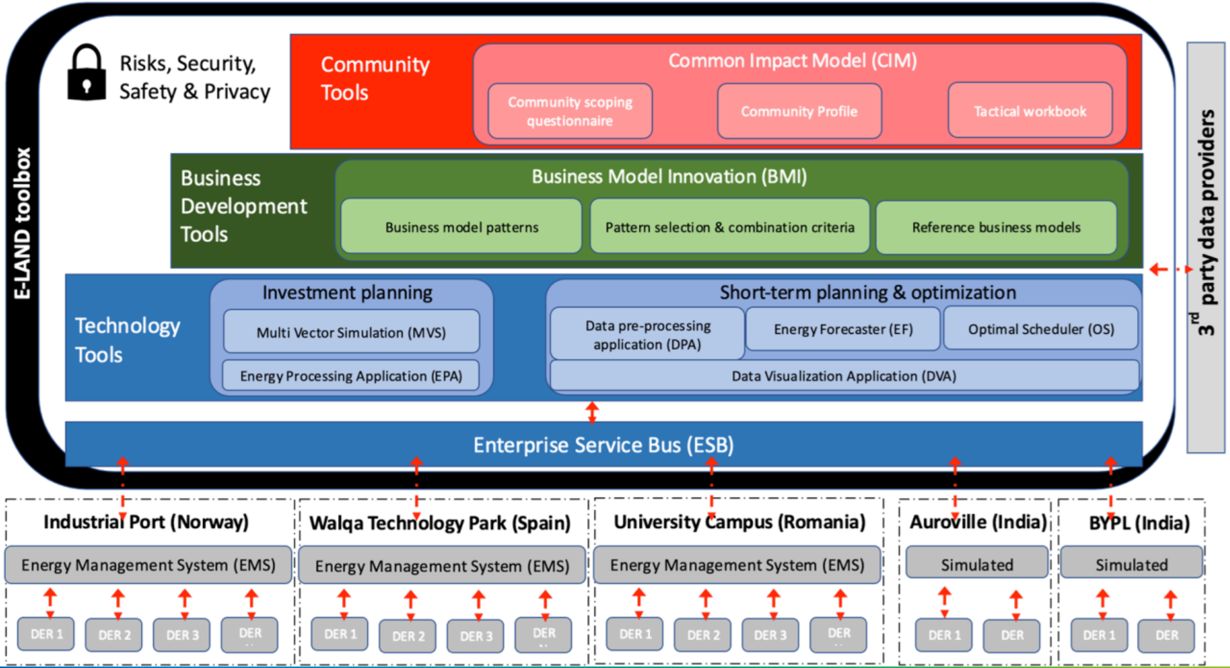
E-LAND supports the decarbonisation of energy islands and isolated communities.

Technology challenges	Societal challenges	Business 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	• **Lack of understanding** the role of the communities • Impact of **gender** in a community on acceptance and use of technology	• 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

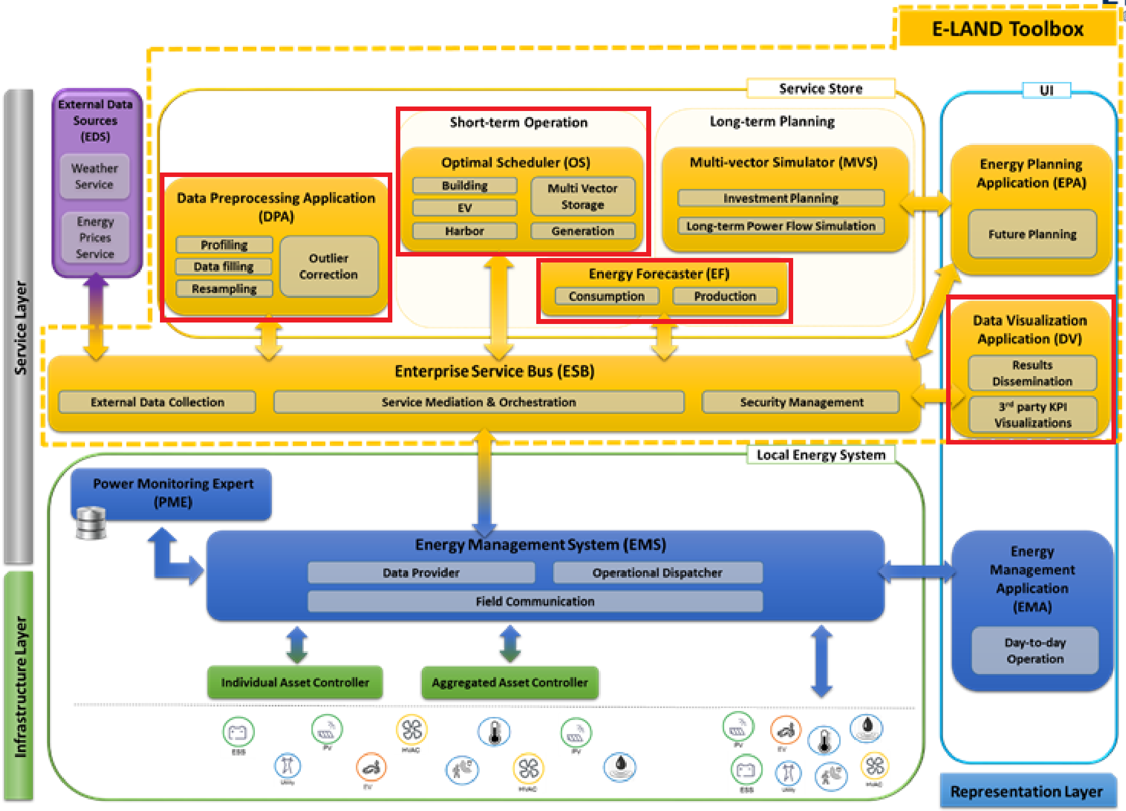
Introduction

E-LAND: Toolbox approach



Introduction

E-LAND Toolbox Technical tools – Focus Area



Introduction

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

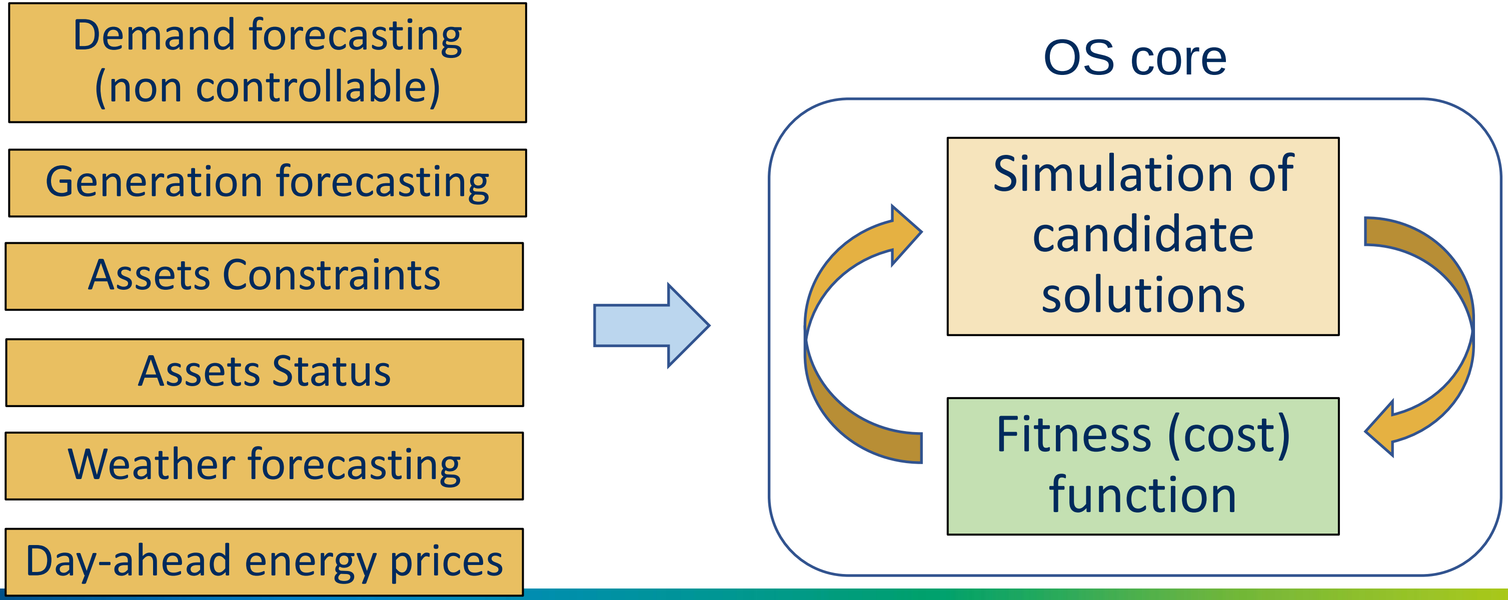
- Calculation of **WHEN** and **HOW** to consume and store energy to **OPTIMISE** the use of local distributed energy resources (generation and storage) in local energy systems
- Leverage the power of **FORECASTING,** for short-term operational planning
- Harness data from the field (e.g. energy measurement, 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)

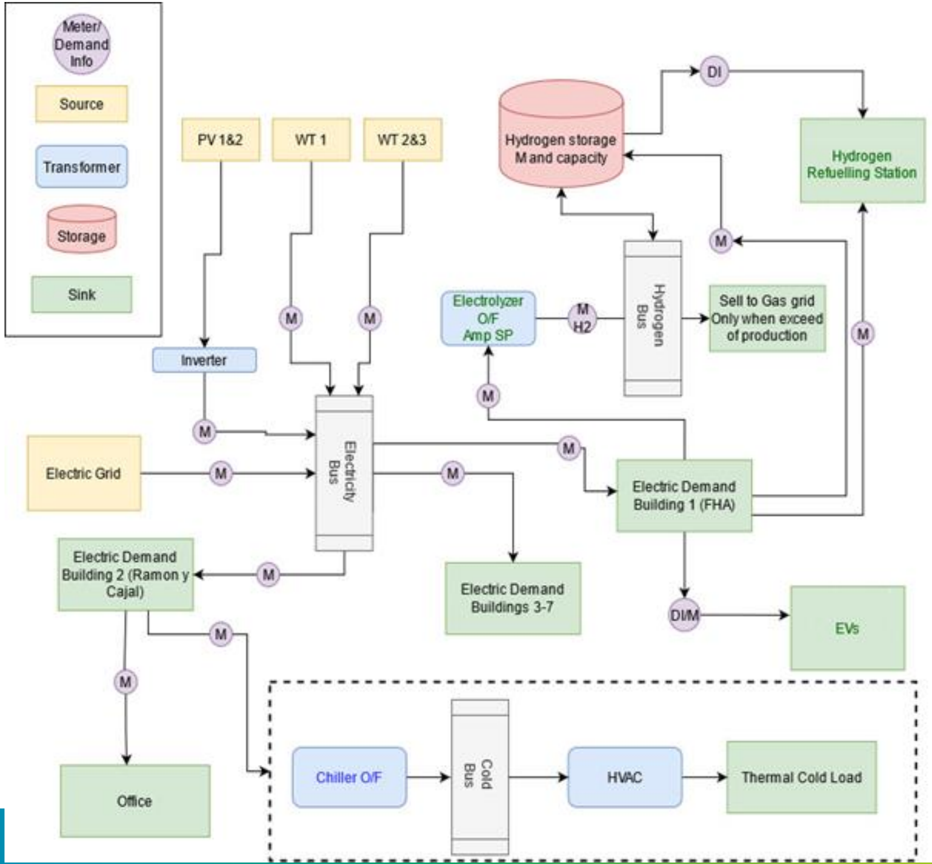
Provides schedule plans for the controllable assets in the LES (HVAC, EESS, EV chargers…) based on the forecasted local energy production and the forecasted energy demand



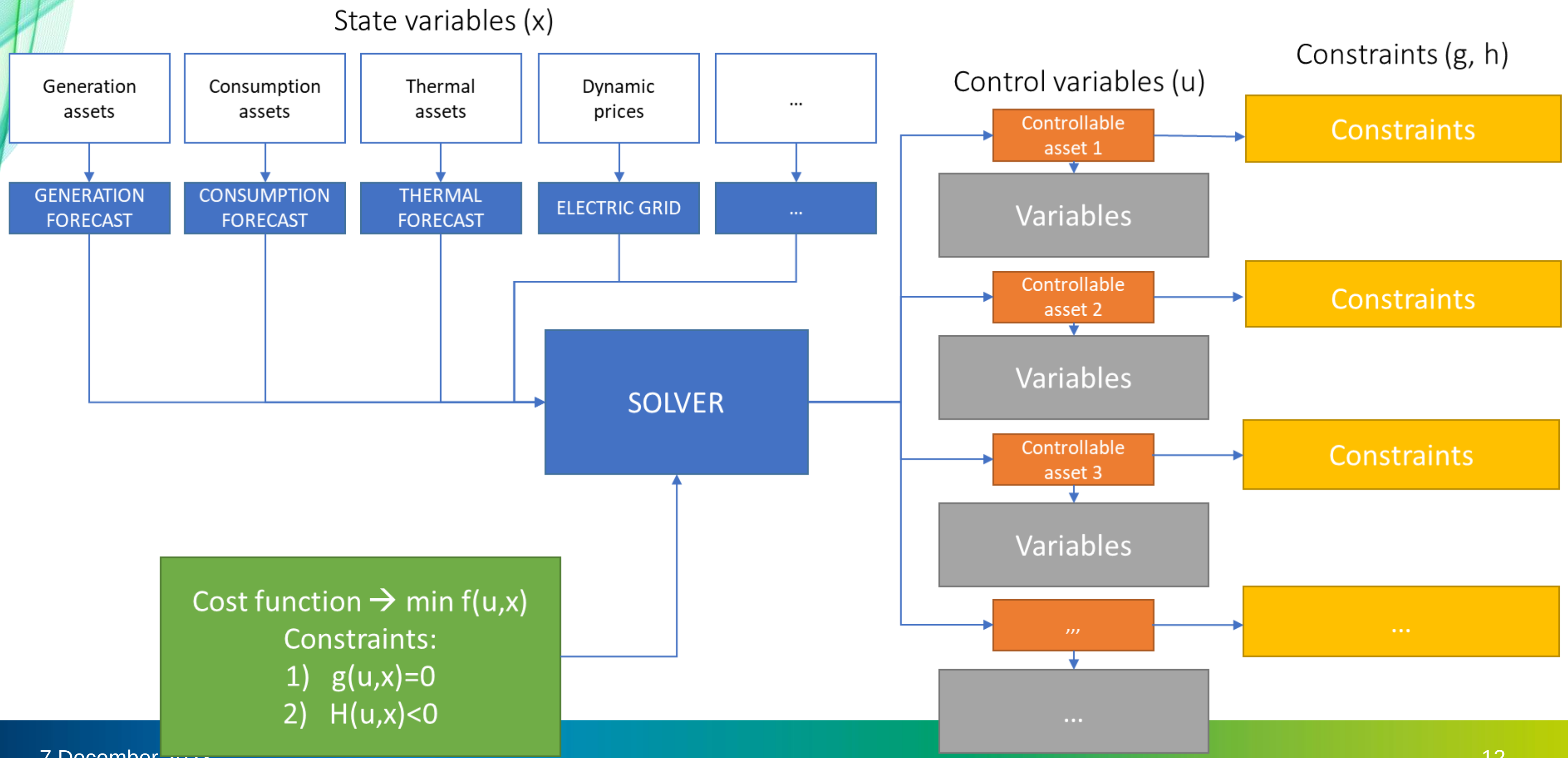
Optimal Scheduler

How does it work?

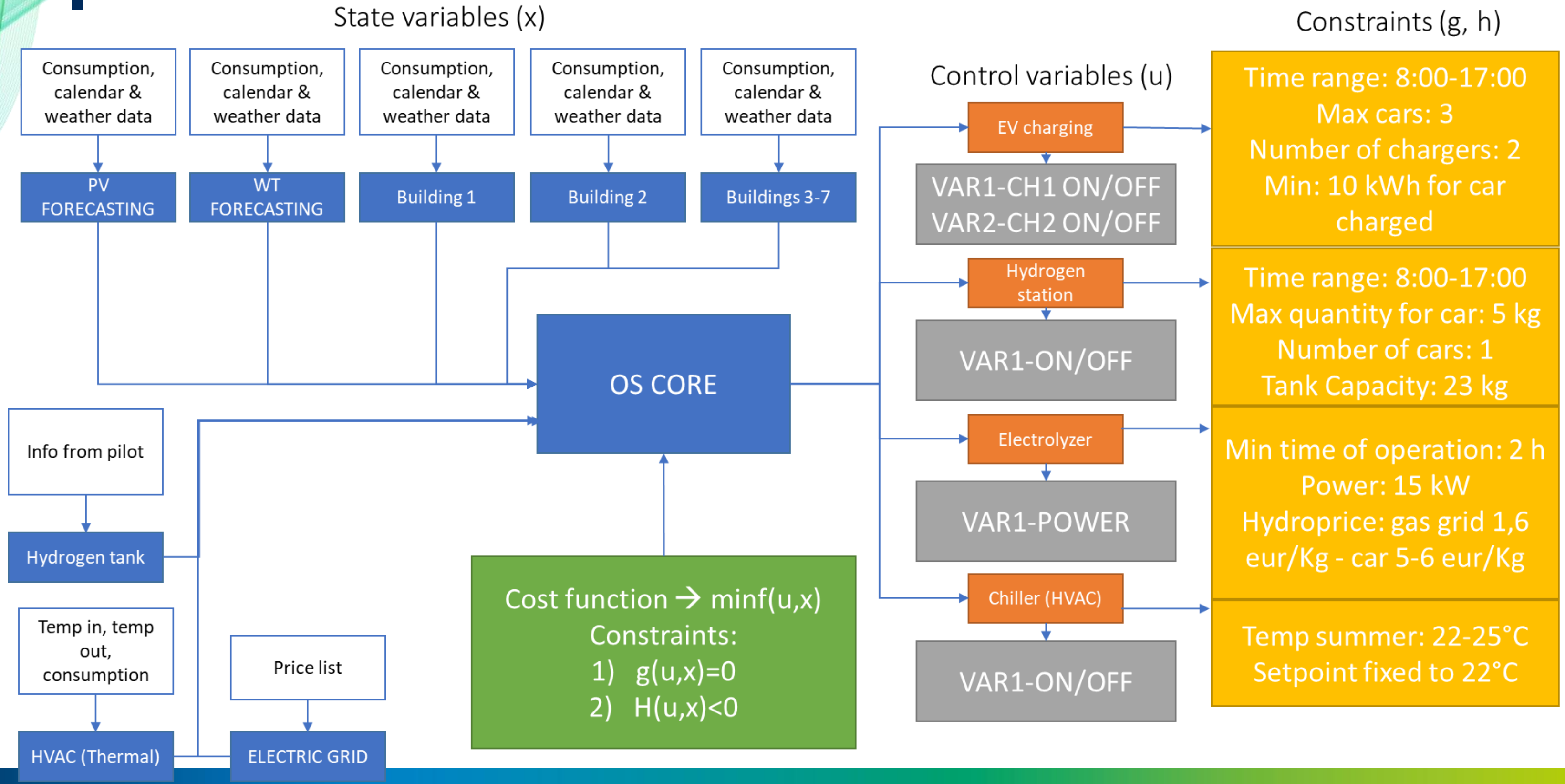
Taking as an example the Spanish pilot site, Walqa Technologic Park



Optimal Scheduler



Optimal Scheduler



Optimal Scheduler

Example: 1) Inputs (simulation – static data)

ENERGY FORECASTER

building_dem (kWh) = [214, 216, 221, 217, 252, 251, 231, 216, 221, 222, 220, 218, 209, 197, 188, 185, 184, 188, 221, 227, 222, 216, 217, 212]
solar_prod (kWh) = [0, 0, 0, 0, 0, 0, 3, 12, 27, 38, 44, 48, 49, 48, 45, 36, 22, 7, 0, 0, 0, 0, 0, 0]

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]

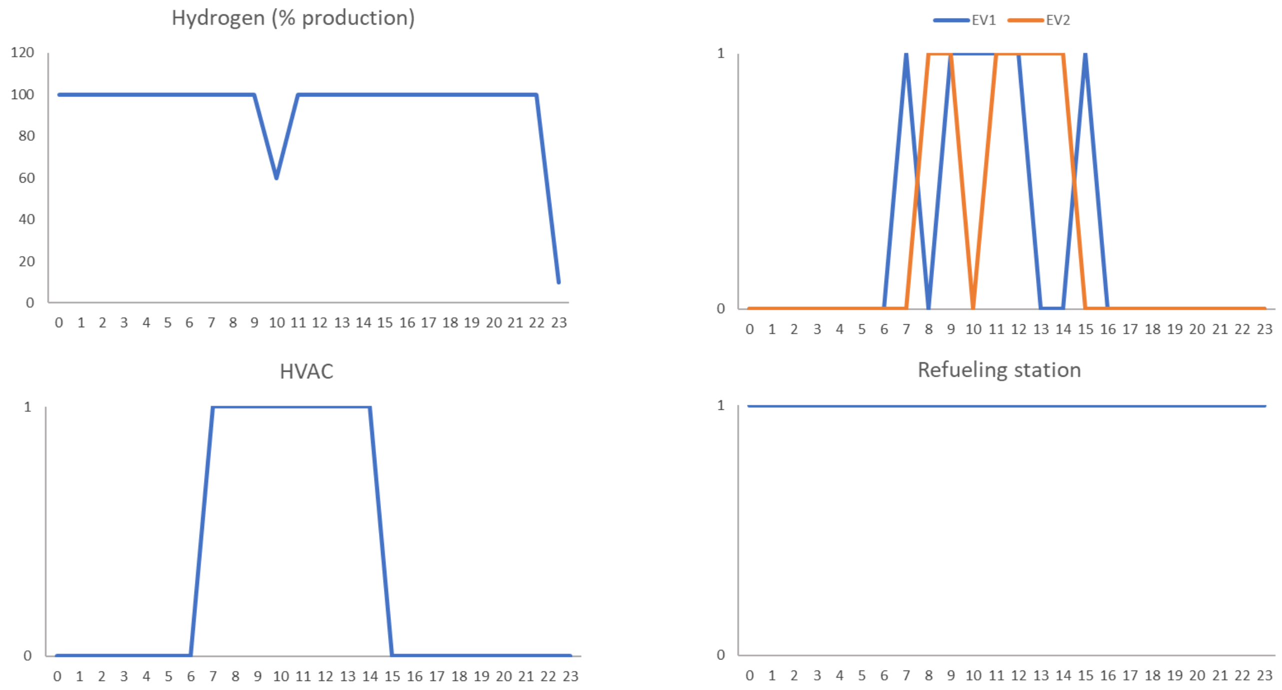
STATIC INFORMATION

elec_sell (€/kWh) = [0.054, 0.054]

hydrogen_price (€/kg) = 1.6

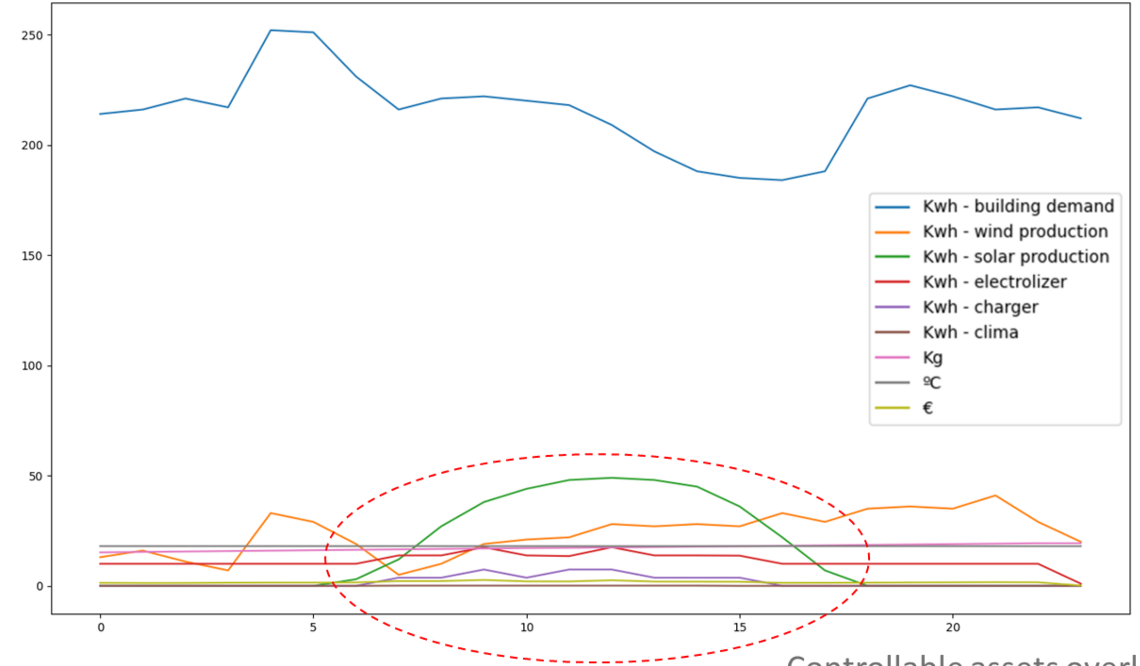
Optimal Scheduler

Example: 2) Outputs – controllable assets

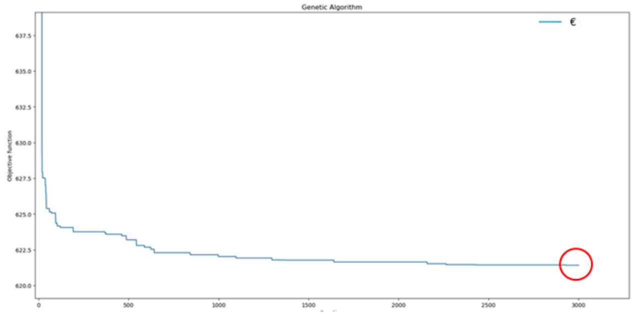


Optimal Scheduler

Example: 3) Simulation of the proposed scheduling



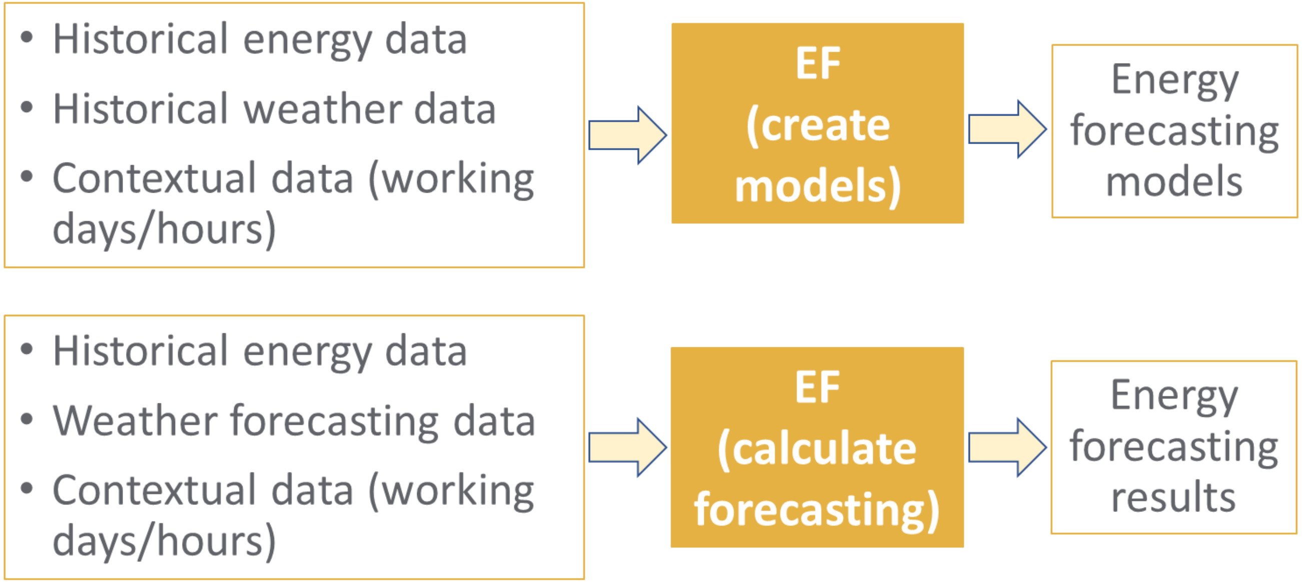
Minimization of the cost function



Controllable assets overlap PV generation

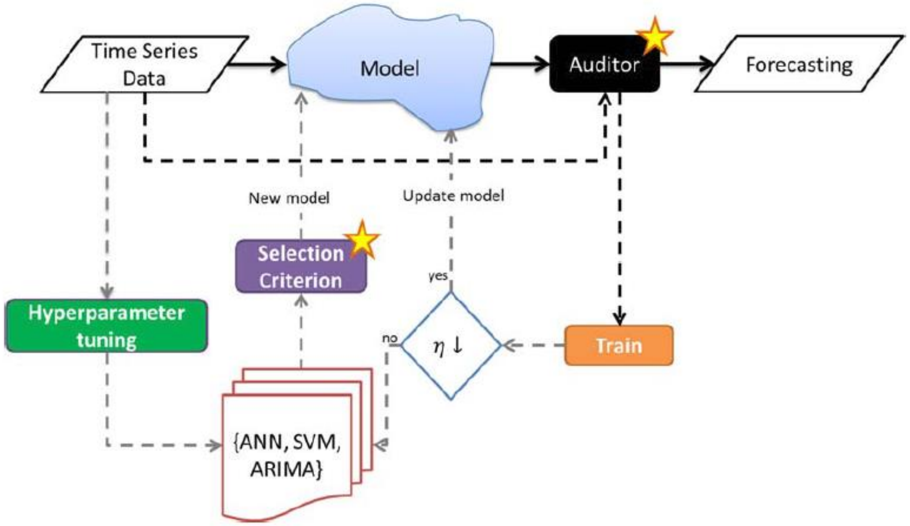
Energy Forecaster

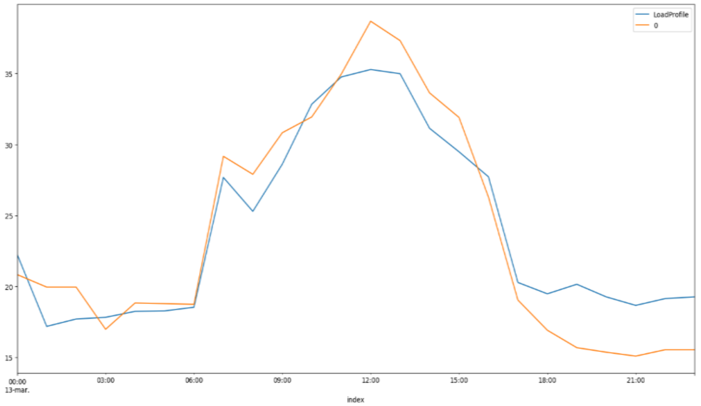
Allows the creation of short-term energy demand and production forecasting models and provides energy demand and production forecasting.



Energy Forecaster

Consumption forecasting



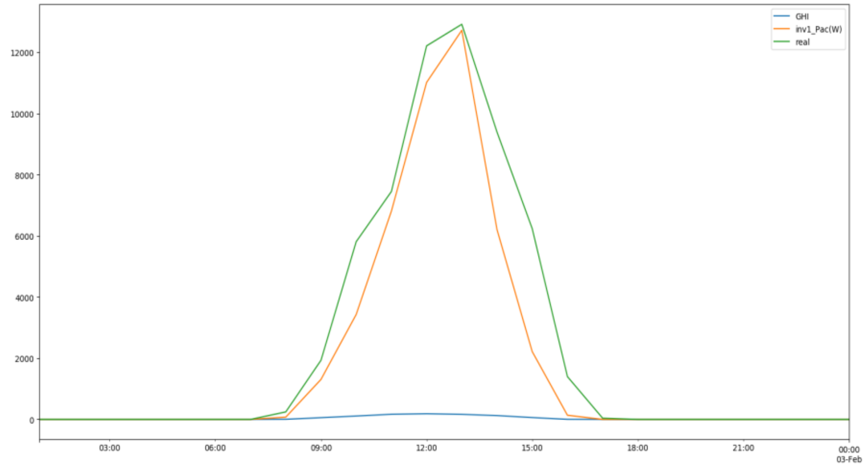


Electrical consumption

Energy Forecaster

Generation forecasting

Physical expressions + Adjustment of parameters based on historical data



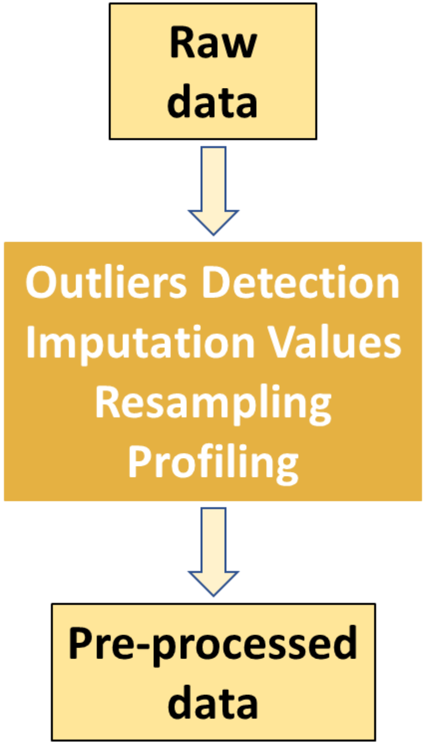
PV generation

Data Pre-processing Application

Historical data may contain errors

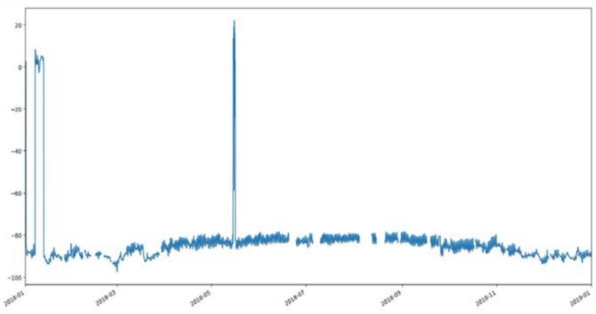
Historical data may need resampling

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

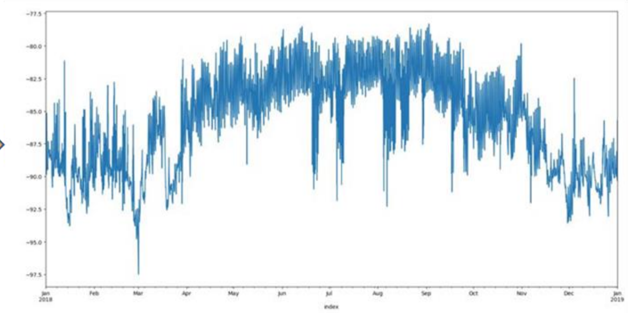


Data Pre-processing Application

Data filling / Outlier detection

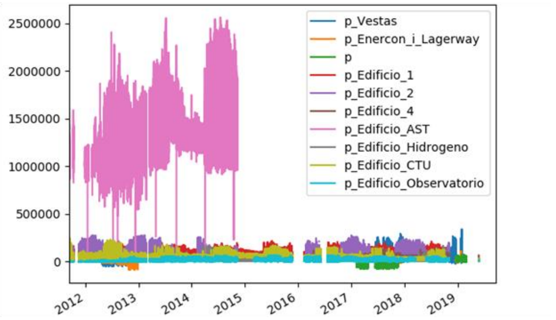


Raw data

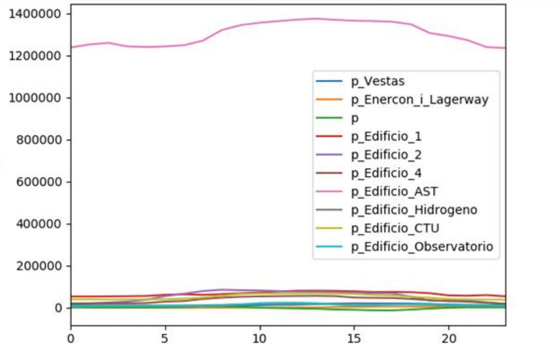


Energy profiling

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

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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**.

2000
CREATION
Arnaud Renaud

15% per year
of sustained
GROWTH

+100 EXPERTS
Engineers
Doctors

30% of activity
dedicated to R&D

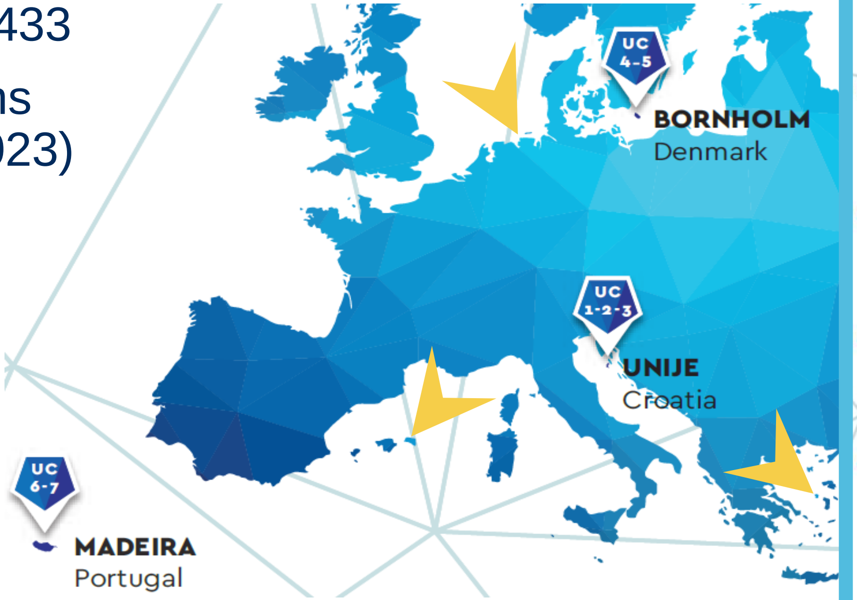
SOFTWARE
Custom software,
off-the-shelf software suite,
digital solvers

SERVICES & CONSULTING
Optimization, Data
Science and Business

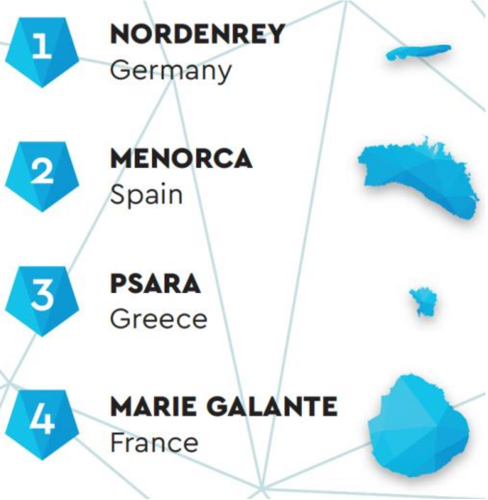
INSULAE overview

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

Lighthouse Islands



Follower Islands



INSULAE technical overview

IPT

Investment Planning Tool

↕

Follower Islands

1. **UNIJE** Croatia
2. **BORNHOLM** Denmark
3. **MADEIRA** Portugal

- UC-1 Hybrid RES & storage
- UC-2 Smart control of water & energy
- UC-3 Energy communities through 5G & IoT
- UC-4 Transition to DC grids
- UC-5 Local bio-based economies
- UC-6 Electric Transport for grid services
- UC-7 Stabilization of microgrids through storage

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.

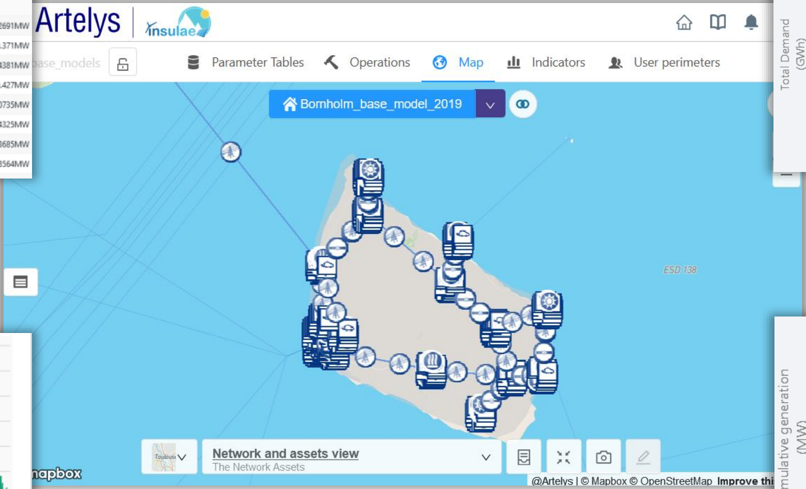
- The IPT is divided in two modules:
  - The Island Modelling Assistant (IMA):
    - This module is mainly used to represent the current state of the island energy system.
  - The Scenarisation Module:
    - This module is used to represent possible future scenarios of the island energy system, and to investigate the potential benefits of different actions that could be implemented by policy-makers.

IPT - Island Modelling Assistant

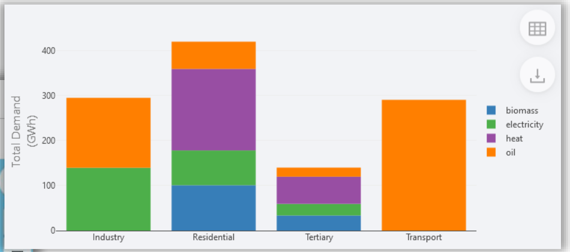
Solar fleet

Name	Asset zone	Longitude	Latitude	Sc	Production	U	D	U	D	CAPEX	Fixed Operati...	Capacity
Solar - Gudhjem	BH	14.9748	55.22046		BH_GUD, electr...	E	E	E	E	80,150.5967€/MW,	13,350€/MW/Year	0.2691MW
Solar - Svaneke	BH	15.14569	55.14488		BH_SVA, electri...	E	E	E	E	80,150.5967€/MW,	13,350€/MW/Year	0.371MW
Solar - Poulsker	BH	15.01607	55.03167		BH_POU, electr...	E	E	E	E	80,150.5967€/MW,	13,350€/MW/Year	0.4381MW
Solar - Oesterlars	BH	14.95431	55.17393		BH_OES, electri...	E	E	E	E	80,150.5967€/MW,	13,350€/MW/Year	0.427MW
Solar - Snorreb...	BH	14.75114	55.11814		BH_SNO, electr...	E	E	E	E	80,150.5967€/MW,	13,350€/MW/Year	0.60735MW
Solar - Bodilsker	BH	15.07615	55.0717		BH_BOD, electr...	E	E	E	E	80,150.5967€/MW,	13,350€/MW/Year	7.84325MW
Solar - Olsker	BH	14.80155	55.24942		BH_OLS, electri...	E	E	E	E	80,150.5967€/MW,	13,350€/MW/Year	0.53685MW
Solar - Nexoe	BH	15.13369	55.07419		BH_NEX, electr...	E	E	E	E	80,150.5967€/MW,	13,350€/MW/Year	0.8564MW

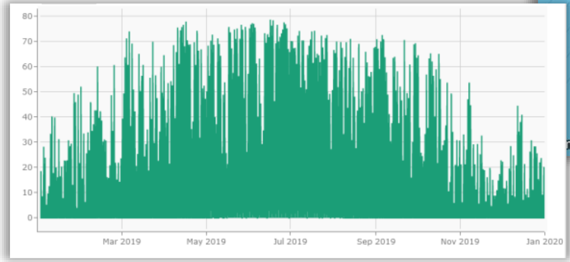
Use the parameter table view to adapt your model, or import structured csv files



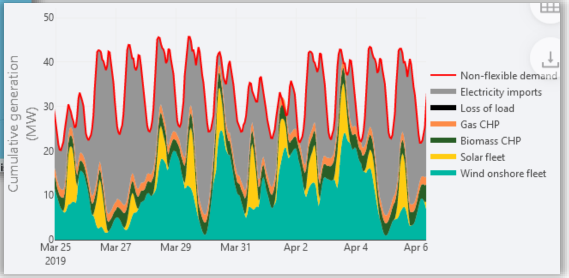
Map view of the IPT



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



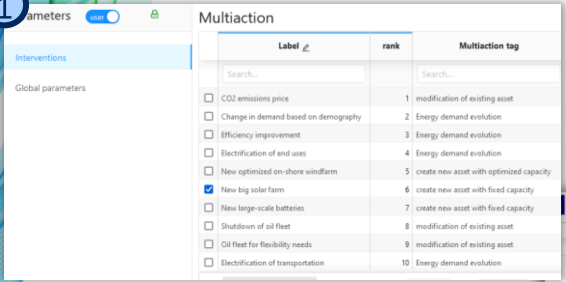
The IPT handles hourly data to take into account the variability of renewables



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

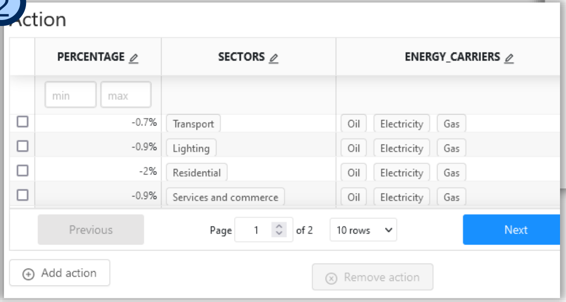
IPT - Island Modelling Assistant

1



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

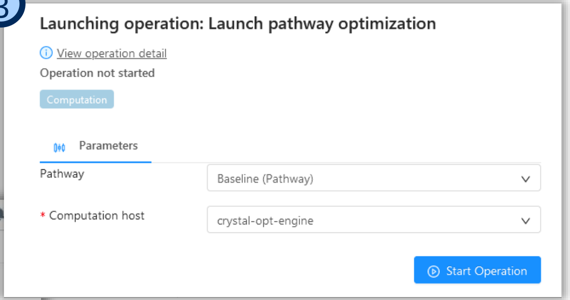
2



Configure each intervention with the appropriate parameters

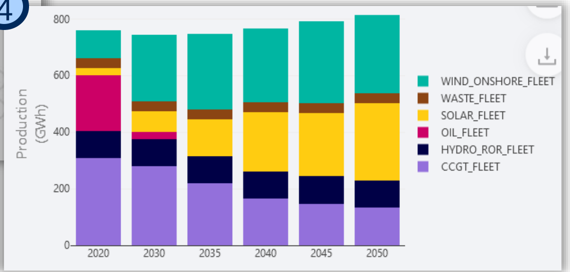
Pathway diagram view of the IPT

3



Apply your interventions and optimise investments in new capacities

4



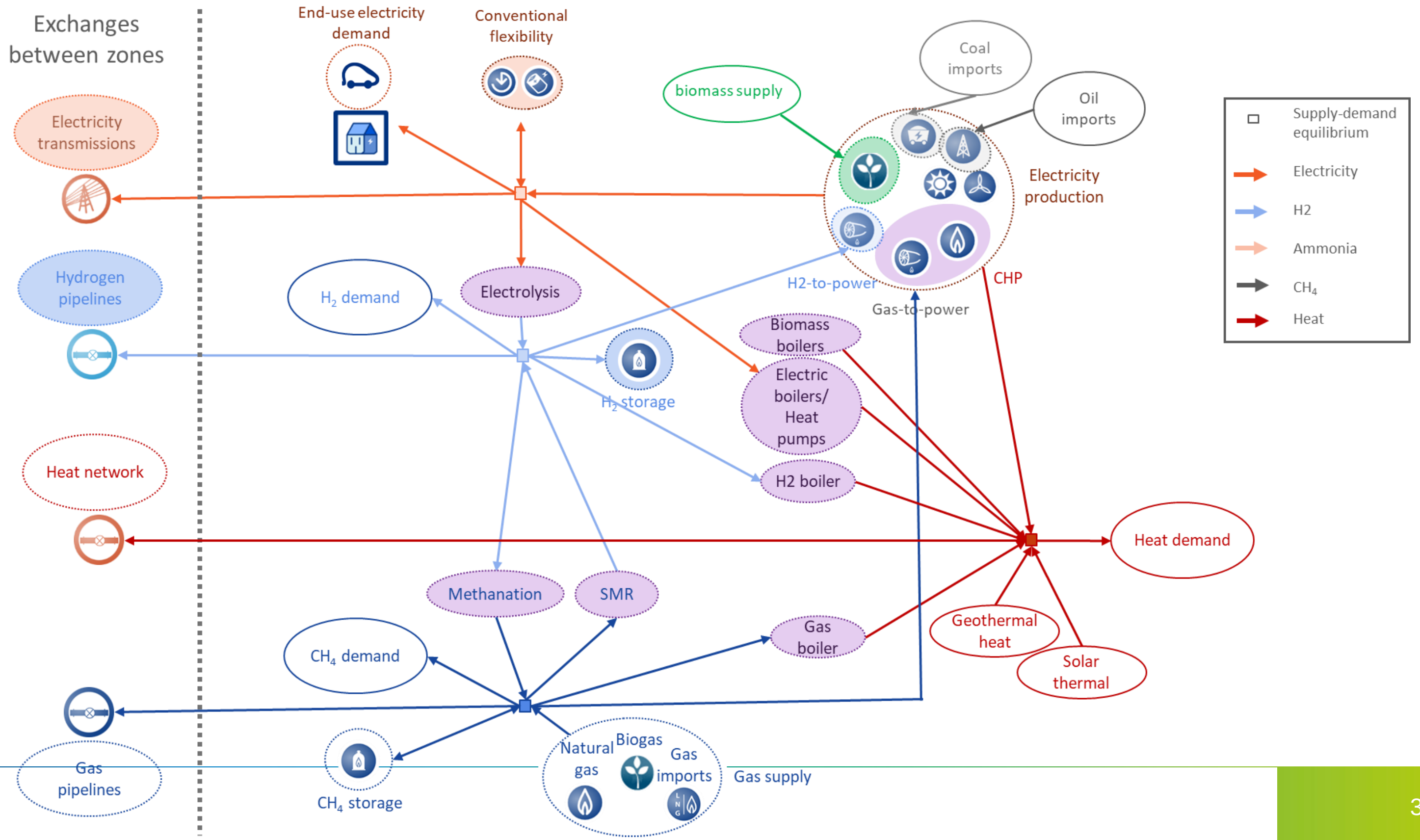
Use dedicated KPIs to analyse pathways of evolution of your island's energy system

Energy system modelling

Current situation of an island's energy system

- Detailed representation of the different energy vectors (electricity, heat, gas, oil products, biomass, H_2, 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

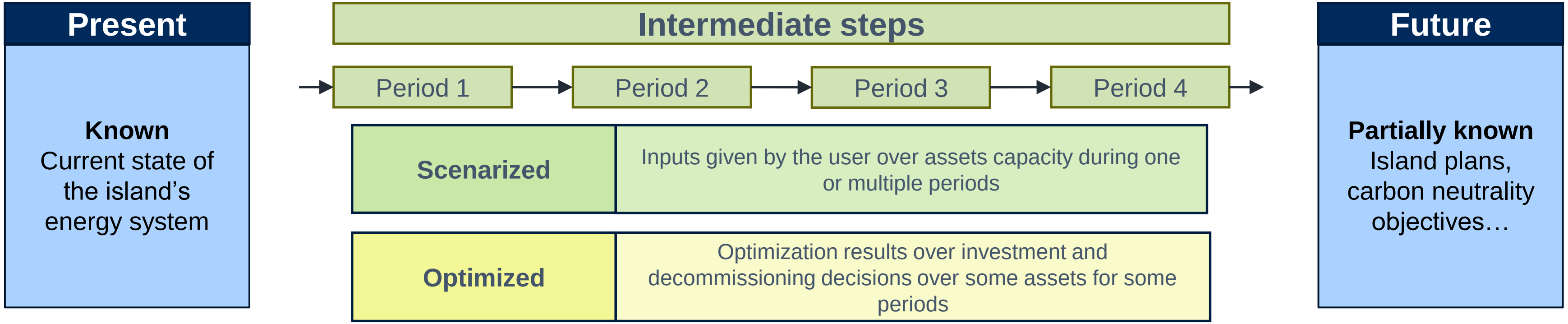
Evolution of the energy system

- 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)

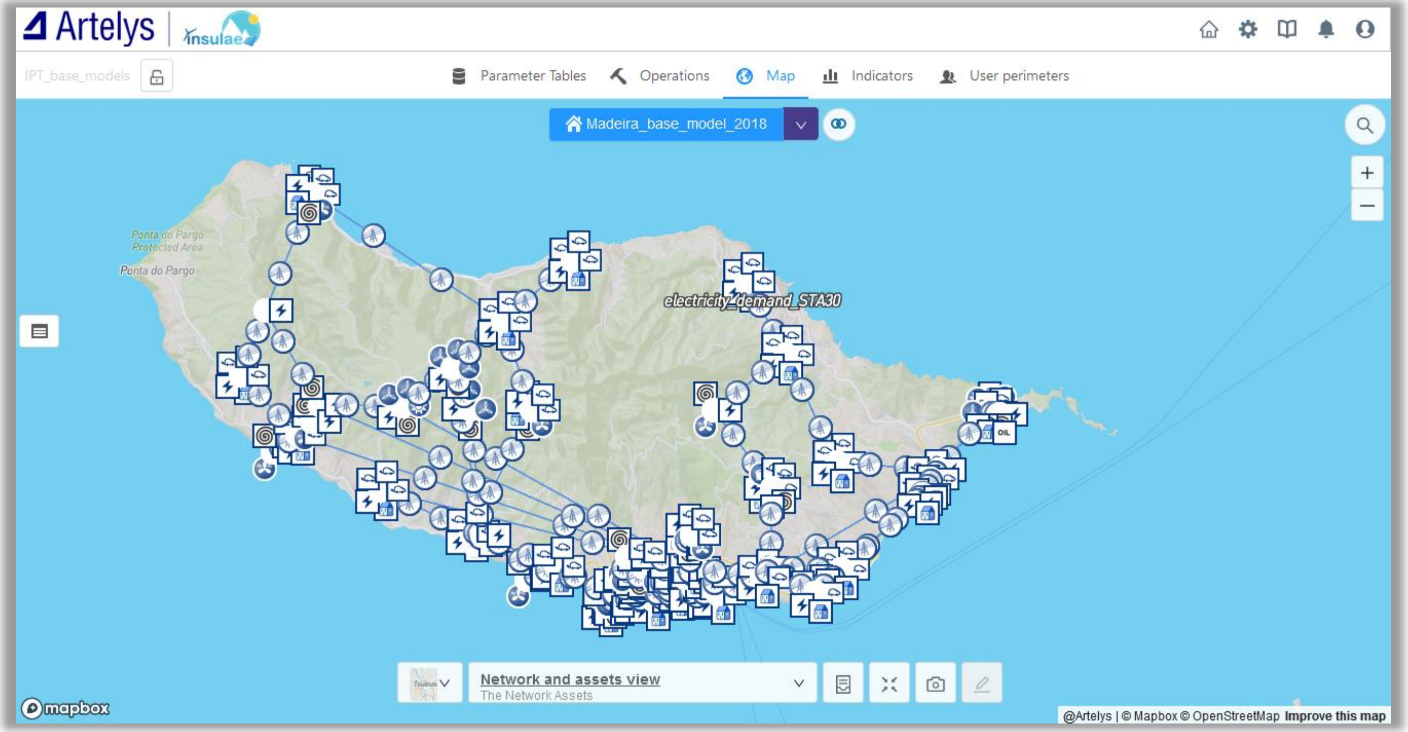
Energy system modelling

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..)

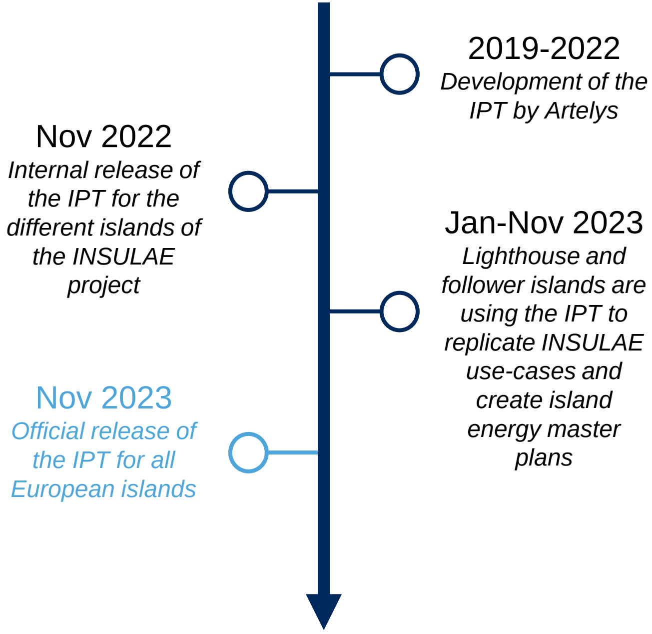


Demonstration of the IPT



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



Thank you for your attention !

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Q&A

Feel free to ask any questions!