Presentation of other related research projects of CERTH

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SmartWins

Key topics

Related Projects:

- RE-COGNITION
- DRIMPAC
- MiniStor

RE-COGNITION

RENEWABLE, COGENERATION AND STORAGE TECHNOLOGIES INTEGRATION FOR ENERGY AUTONOMOUS BUILDINGS

www.re-cognition-project.eu

This project has received funding from the European Union's Horizon 2020 research & innovation programme under grant agreement n° 815301

RE-COGNITION

Cross-Functional Renewable Energy Sources Integration Platform

Automated Cognitive Energy Management Engine (ACEME)

Harmonizes the power generation with the power-heating-cooling demand of the building.

Building Energy Plant Planning Tool (BE-PLATO)

Allows the building stakeholders to make informed decisions on whether or not to install RES equipment on their building.

iGateway

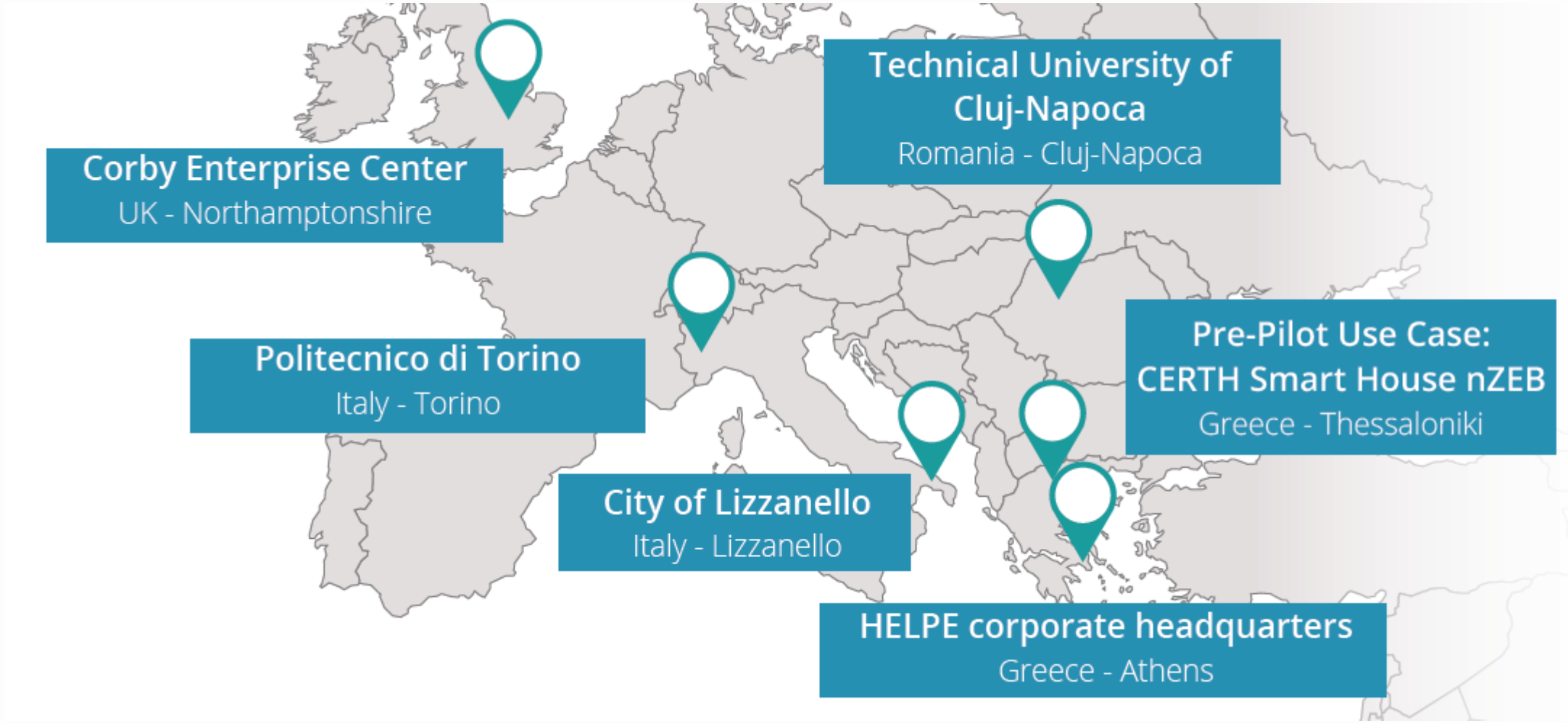
Delivers insightful data for the connected subsystems through their embedded intelligence.

Visual Analytics Dashboard

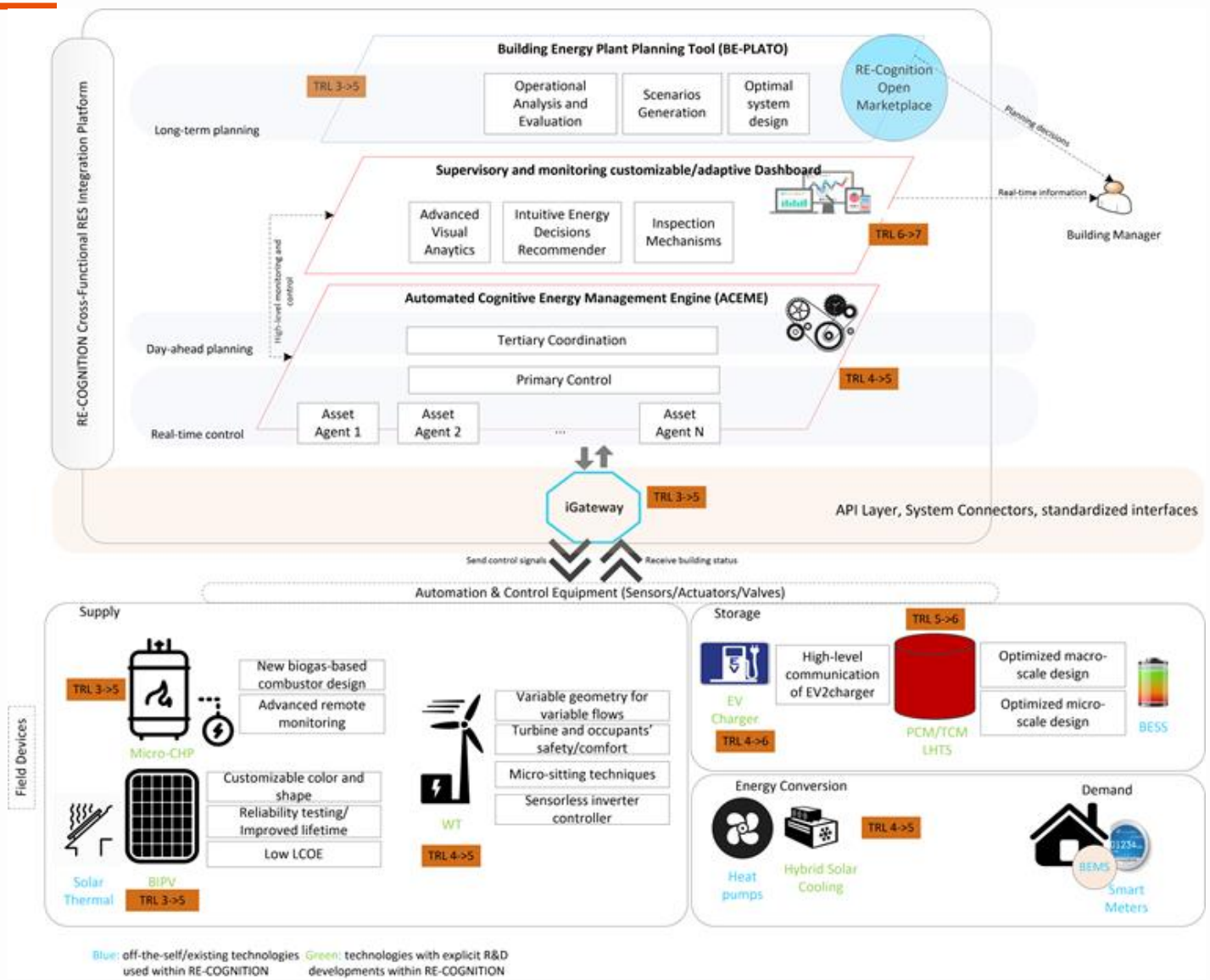
Provides a holistic overview of the RE-COGNITION framework operation, through access to the monitored data of the developed technologies and pilot buildings.

RE-COGNITION - RENEWABLE ENERGY SOURCES AND STORAGE TECHNOLOGIES

RE-COGNITION - PROJECT PILOT SITES



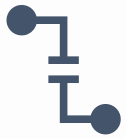
RE-COGNITION - High – Level Overview of System Architecture



RE-COGNITION - High – Level Overview of System Architecture (Optimization)

Mixed-Integer Linear Problem (MILP), taking all assets and loads into consideration

Objectives:
- ✓ **Minimization of the building's total energy-related cost**
- ✓ **Minimization of the building's energy demand cost**
- ✓ **Minimization of the building's energy dependence (maximization of self-sufficiency)**



Three optimization variable groups

- ✓ **Electrical & Thermal produced/consumed energy variables**
- ✓ **Auxiliary binary variables modelling the mutually exclusive operation of bi-directional energy flow assets or constraining the operation of one-directional assets**
- ✓ **The number of the variables depend on the optimization horizon (day-ahead or intra-day) and the selected data resolution (15/30/60 minutes)**

Integration of assets' physical constraints into the optimization process

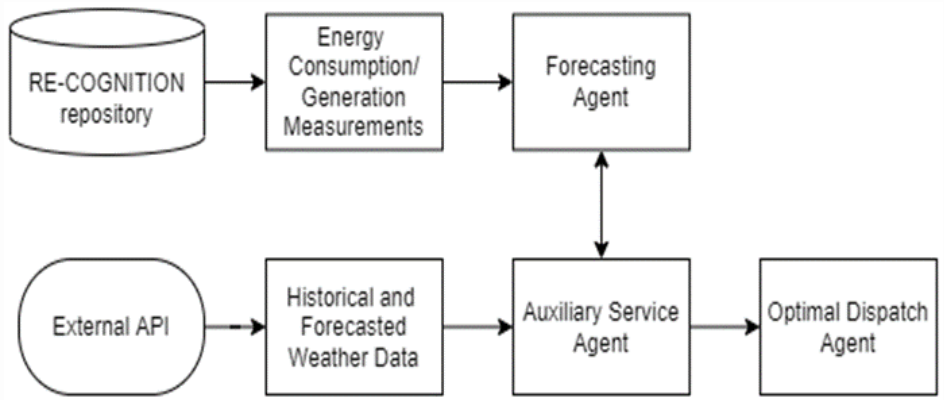
- ✓ **Limitations regarding the output power/safe operation of the assets**
- ✓ **Building's electrical and thermal power balance**

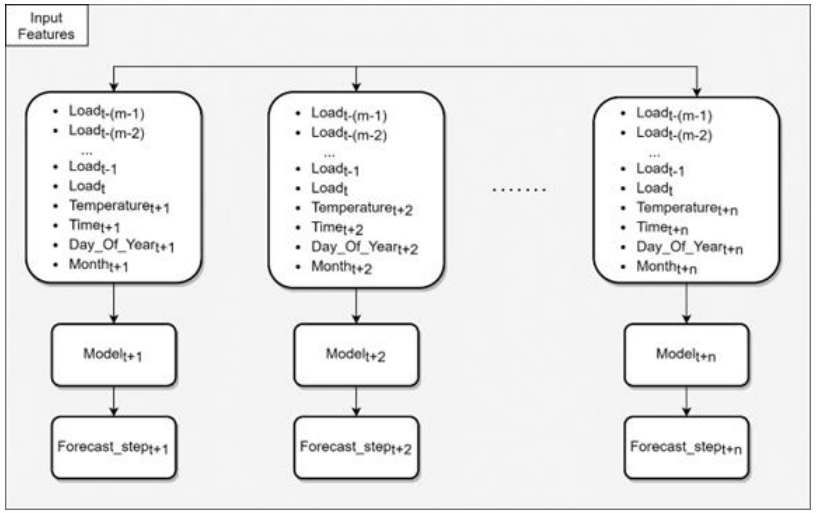
Integration of electrical and thermal energy costs

Through the Visual Analytics Dashboard, building administrators can define:
- ✓ **The electrical and thermal energy supply cost**
- ✓ **The operation cost for the energy assets during their parametrization**

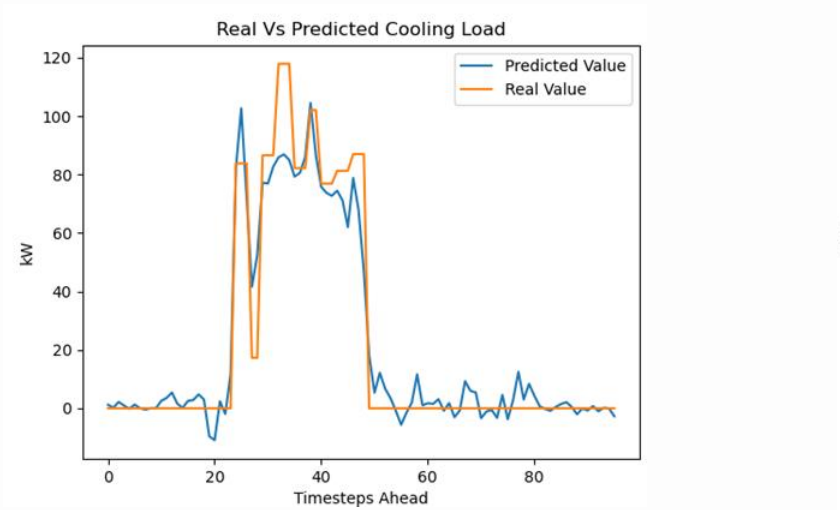
RE-COGNITION - Forecasting approach in the ACEME

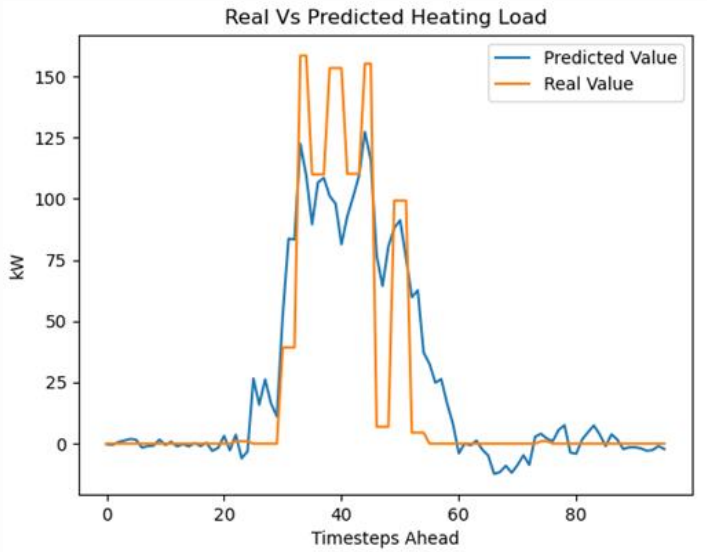
- ❖Historical energy & weather data per asset are transferred from the RE-COGNITION Repository to the Forecasting Agent for processing followed by their unique timestamps. Weather forecasts are retrieved from external weather API.
- ❖Direct forecasting strategy was chosen. Utilizing a total of 24, 48, or 96 models, the day ahead forecasting is achieved
- ❖More than 10 methods/algorithms were evaluated towards selecting the optimal solution

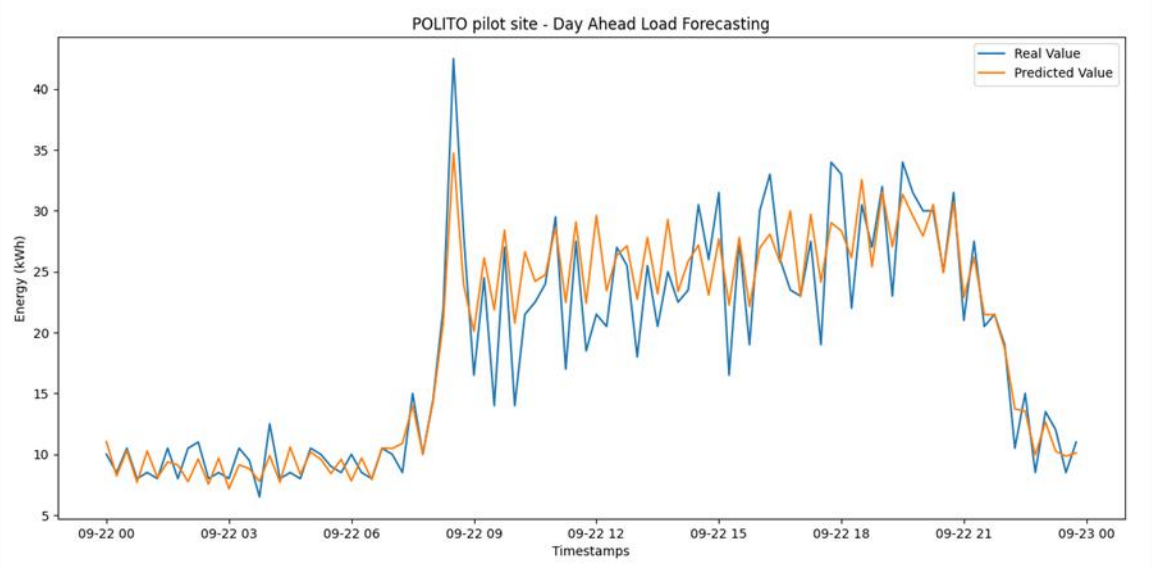




RE-COGNITION - Forecasting approach in the ACEME







RE-COGNITION – ML Papers

Aristeidis Mystakidis, Evangelia Ntozi, Paraskevas Koukaras, Nikolaos Katsaos, Dimosthenis Ioannidis, Christos Tjortjis, Dimitrios Tzovaras, “Energy load forecasting: A multi-energy performance comparison approach”, Energy Efficiency by Springer, 2023 (Under review)

- Possible identification of the best performing ML & DL models across all ETs as well as the
- Multi-energy behavior recognition of the multi-step ahead strategies

Heating					
Voting Ensemble with CatBoost & LightGBM	R^2	MAE	MSE	RMSE	Training time
	0.882	5.442	399.33	19.983	484.8 s
Cooling					
Voting Ensemble with CatBoost & LightGBM	R^2	MAE	MSE	RMSE	Training time
	0.858	8.052	527.44	22.966	409.95 s
Electricity					
Voting Ensemble with CatBoost & LightGBM	R^2	MAE	MSE	RMSE	Training time
	0.879	2.440	13.592	3.688	76.68 s

DRIMPAC

Unified DR interoperability framework enabling market participation of active energy consumers

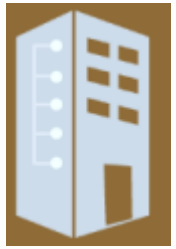
https://www.drimpac-h2020.eu/

This Project Has Received Funding From The European Union's Horizon 2020 Research And Innovation Programme Under Grant Agreement No. 768559.

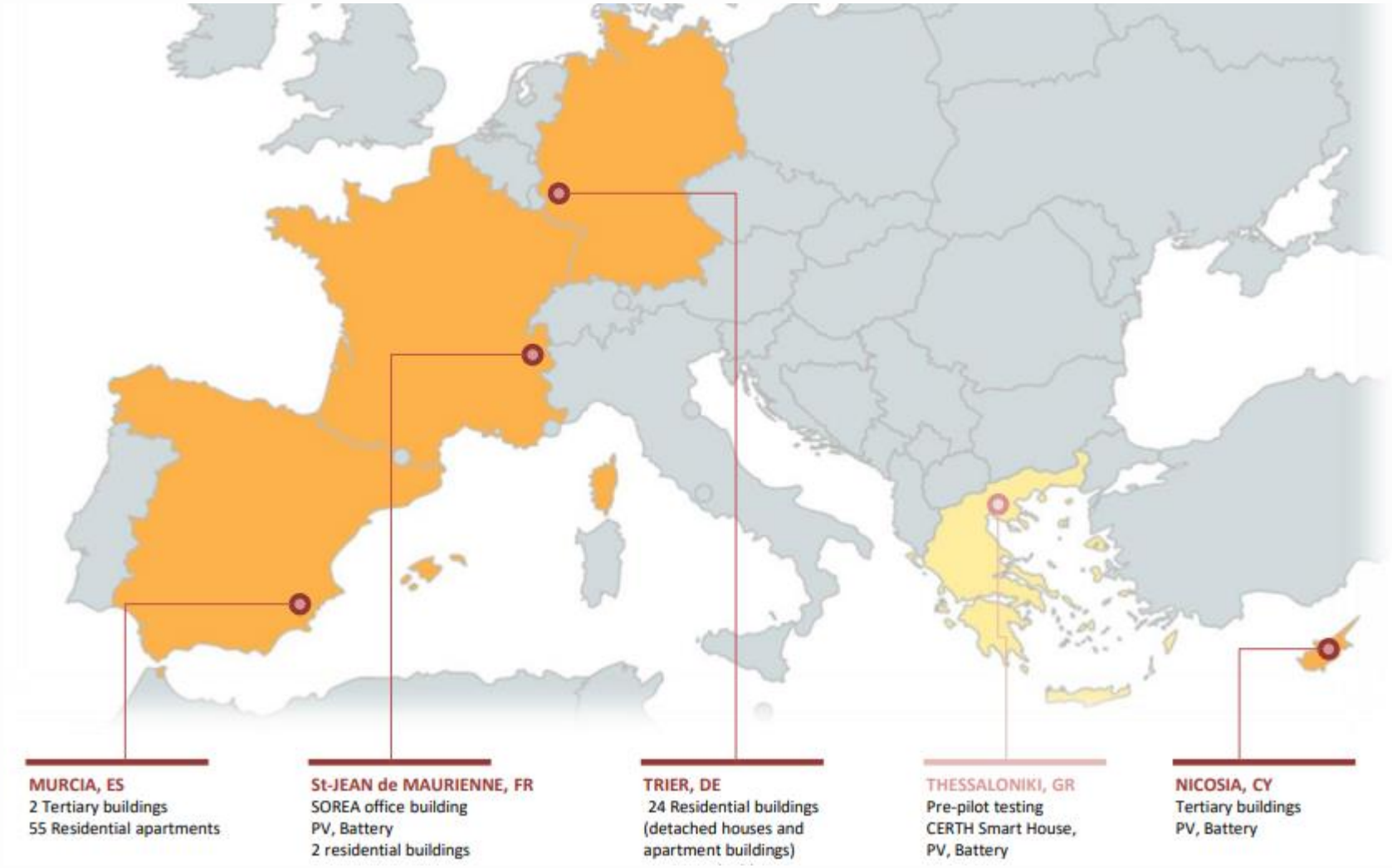
DRIMPAC

FLEXIBILITY RESOURCES

- RESIDENTIAL BUILDINGS - introducing demand response functionality to the “smarthome” environment.
- TERTIARY BUILDINGS - achieving interoperability with all main building control & automation standards & protocols in the domain.
- DISTRICT LEVEL ENERGY RESOURCES - facilitating proper and standards-compliant DER integration for district-level DR services.



DRIMPAC - PROJECT PILOTS



DRIMPAC

OBJECTIVES - ACHIEVEMENTS

- Develop and deliver the DRIMPAC solution as an interoperability TECHNOLOGICAL ENABLER for small prosumer Demand Response
- Define innovative service offerings and BUSINESS MODELS for energy retailers
- DEMONSTRATE AND VALIDATE via piloting and market testing on real users
- Creation of the ICT backbone for the connectivity of DSO/AGR/ platform/asset (DL-DER)
- Completion of energy management system, smart boxes and local IoT monitoring/control system
- Testing of different innovative DR business models at the pilot sites

TARGET GROUPS

- “USER GROUP” potential participants in the project pilot demonstration and validation activities aiming for 1000 active participants
- “STAKEHOLDER ECOSYSTEM” market and industry stakeholders to enhance the exploitation potential of project outputs

DRIMPAC

High-level use cases

DRIMPAC developed the ICT infrastructure to enable services and devices interoperability among energy market stakeholders and small to medium size prosumers for:

- Implicit Demand Response services based on day-ahead dynamic tariffs (load shifting)
- Explicit Demand Response services (load shedding or generation curtailment)

DRIMPAC

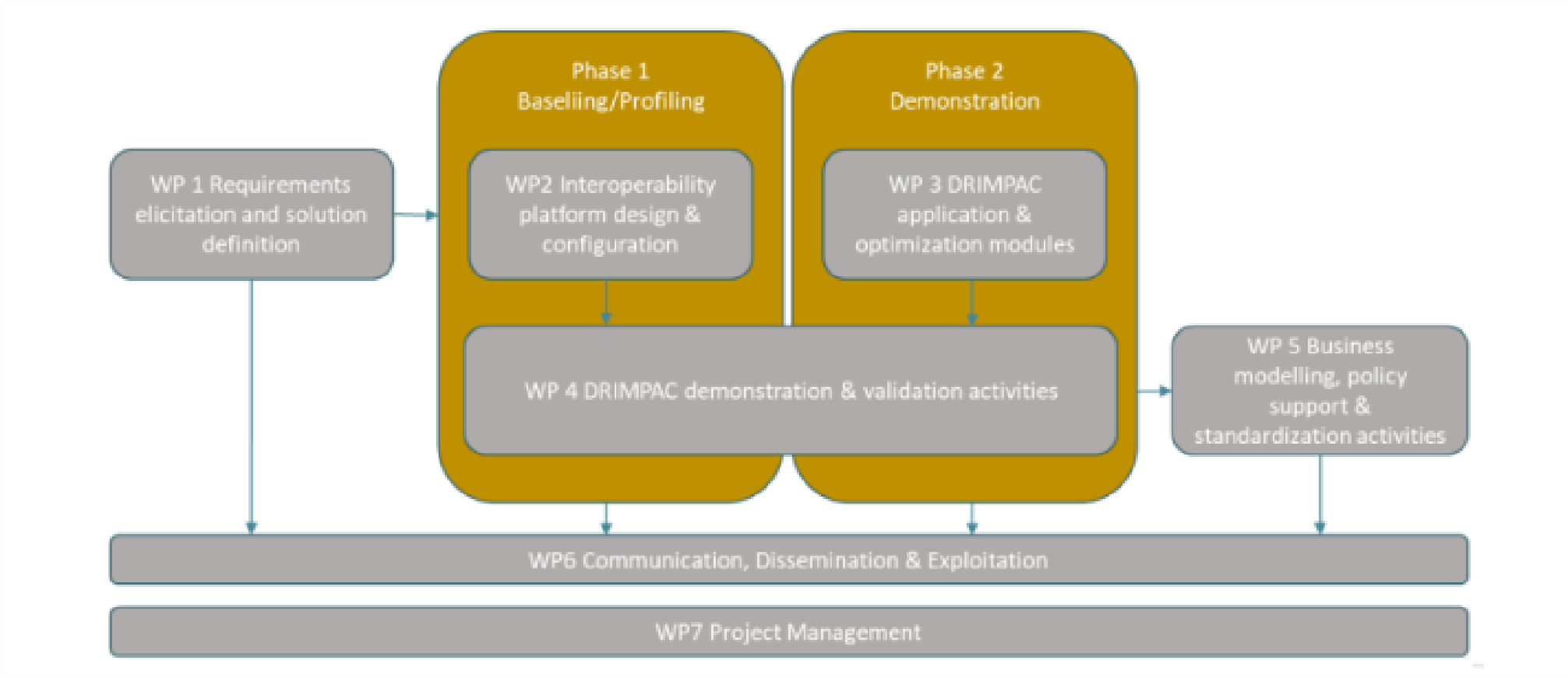
Challenges

- Create grid-to-market communication system

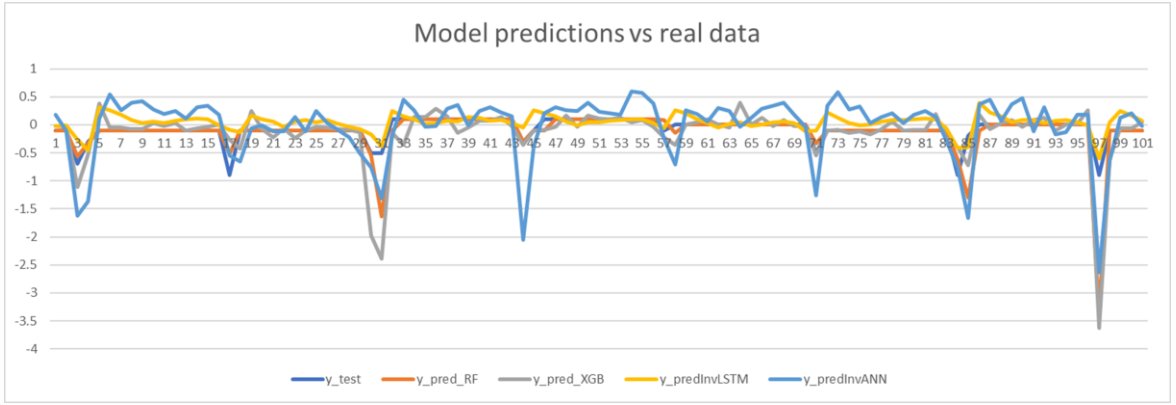
- Develop interoperable smart Building EMS

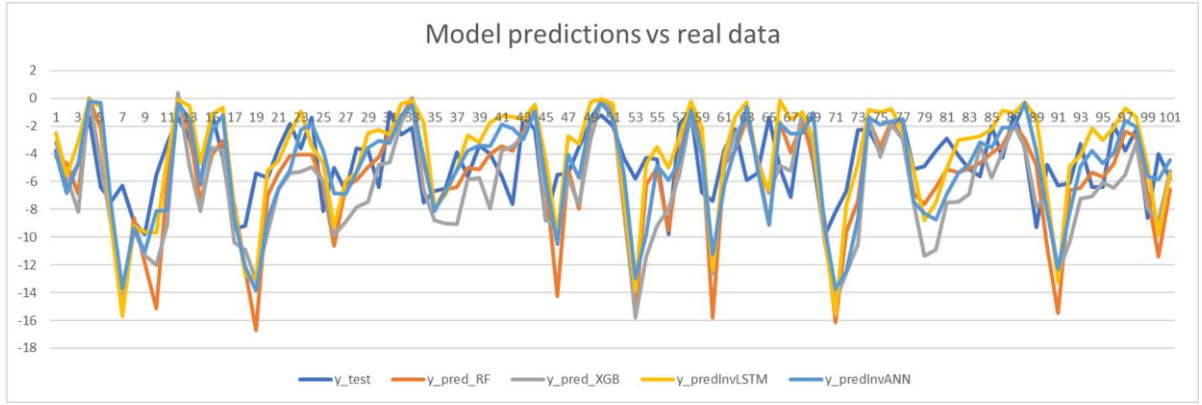
- Increase the overall energy demand flexibility of buildings

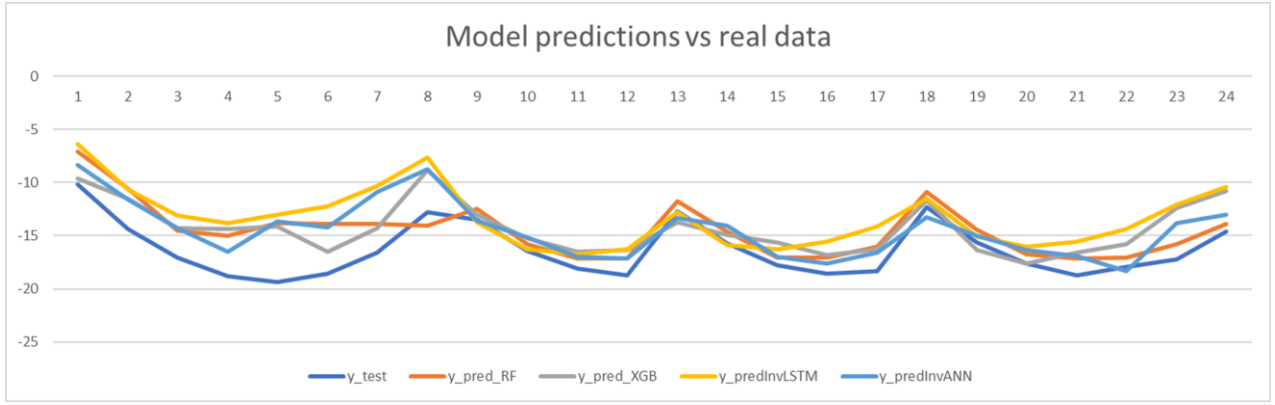
DRIMPAC


Phase 1
Baselling/Profiling
Phase 2
Demonstration
WP 1 Requirements elicitation and solution definition
WP2 Interoperability platform design & configuration
WP 3 DRIMPAC application & optimization modules
WP 4 DRIMPAC demonstration & validation activities
WP 5 Business modelling, policy support & standardization activities
WP6 Communication, Dissemination & Exploitation
WP7 Project Management

DRIMPAC - Forecasting approach (generation)







DRIMPAC

ML Papers

- Aristeidis Mystakidis, Evangelia Ntozi, Konstantinos Afentoulis, Paraskevas Koukaras, Paschalis A. Gkaidatzis, Dimosthenis Ioannidis, Christos Tjortjis, Dimitrios Tzovaras, “Energy generation forecasting: Elevating performance with machine and deep learning”, Computing by Springer, 2022
- Aristeidis Mystakidis, Evangelia Ntozi, Konstantinos Afentoulis, Paraskevas Koukaras, Georgios Giannopoulos, Napoleon Bezas, Paschalis A. Gkaidatzis, Dimosthenis Ioannidis, Christos Tjortjis, Dimitrios Tzovaras "One Step Ahead Energy Load Forecasting: A Multi-model approach utilizing Machine and Deep Learning", UPEC, 2022

MiniStor

Minimal Size Thermal and Electrical Energy Storage System for In-Site Residential Installation

https://ministor.eu/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 869821

MiniStor

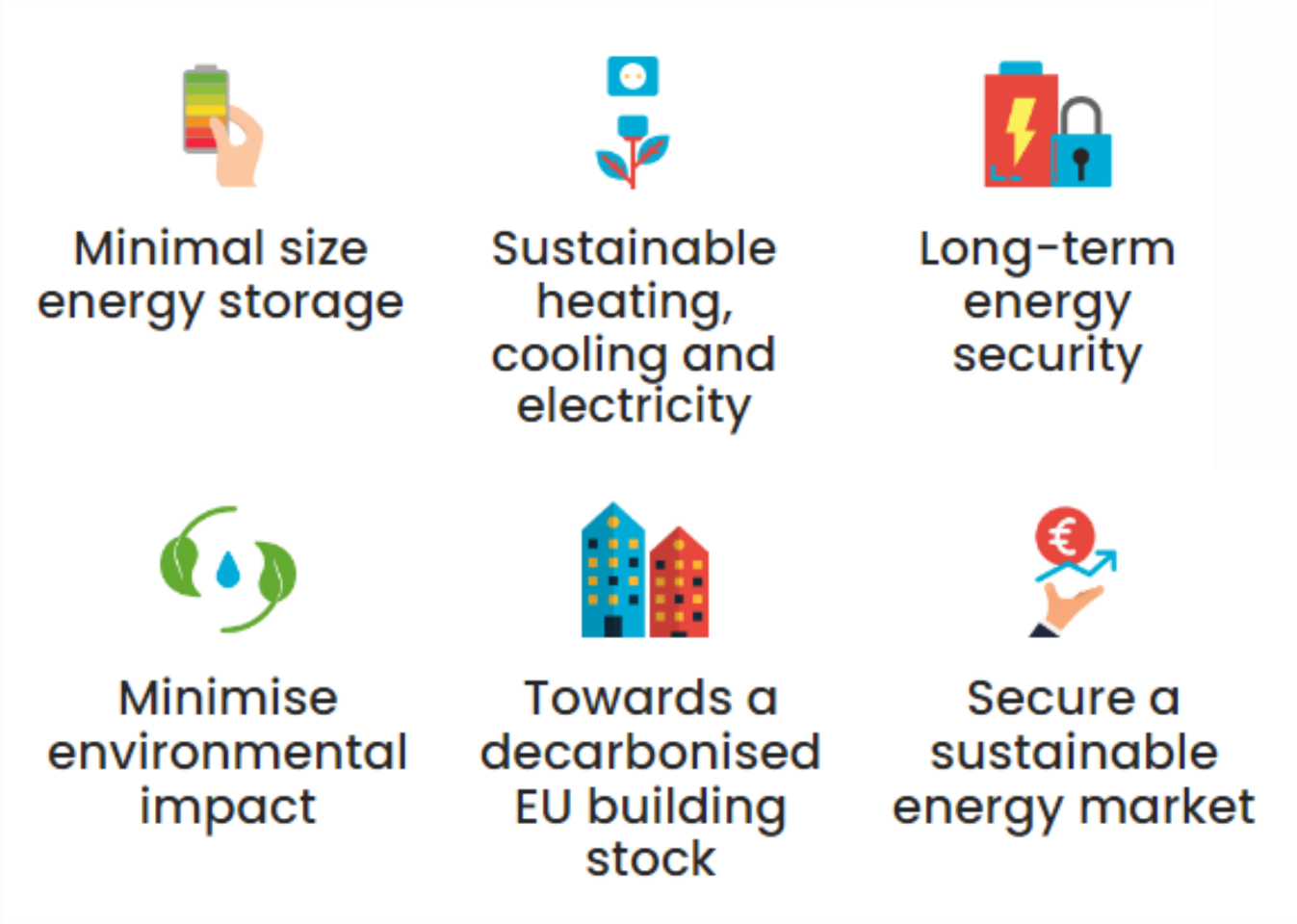
Mission

MiniStor aims at designing and producing a novel compact integrated thermal storage system for achieving sustainable heating, cooling and electricity storage

SYSTEM

MiniStor´ system optimizes the use and management of thermal energy by allowing it to be stored, levelling demand peaks and increasing the use of renewables affected by intermittency such as solar-based heating.

MiniStor - Objectives

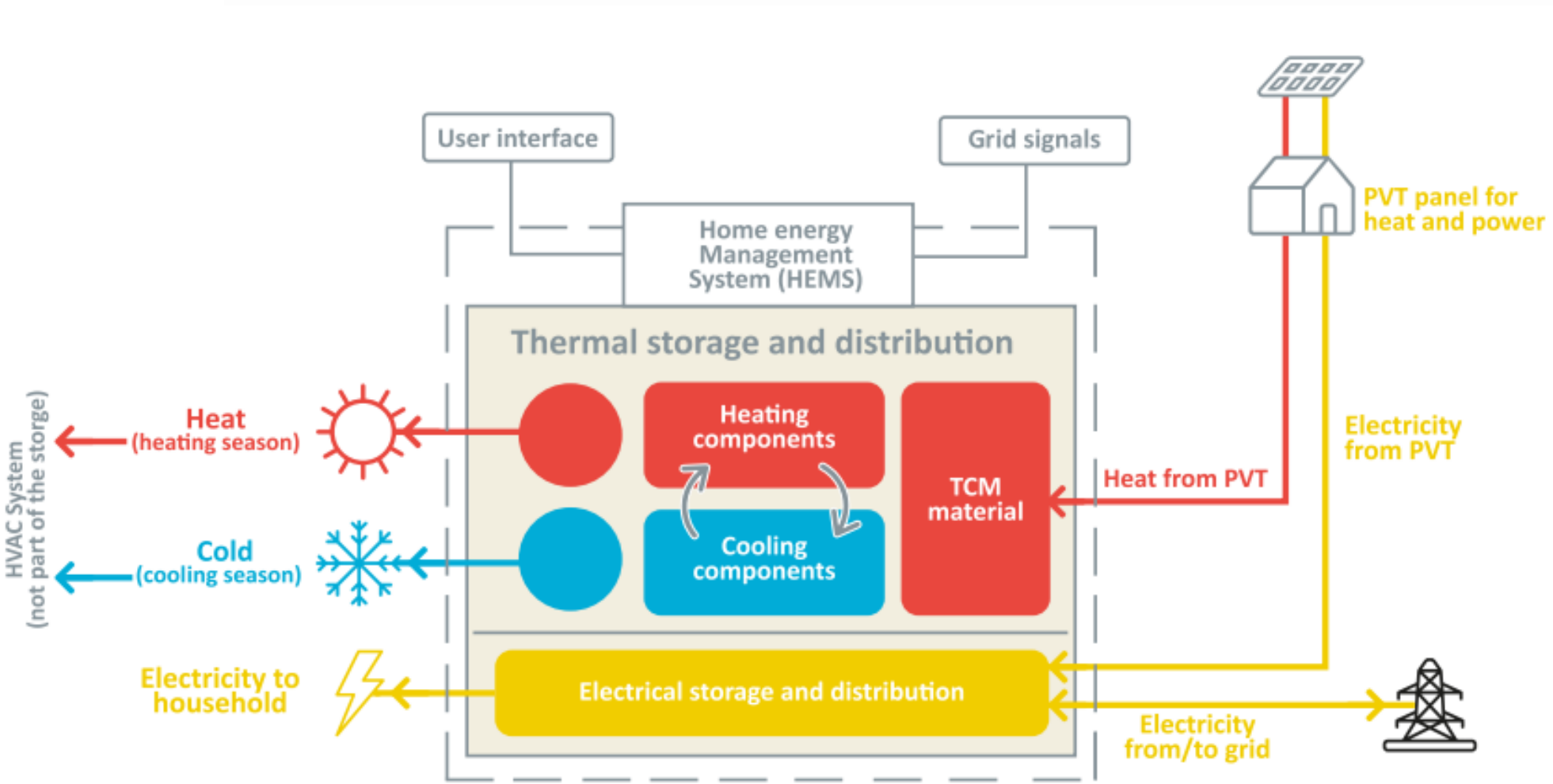


MiniStor

Demonstration Sites

- North-West Europe (Ireland)
  - Cork (Cork City Council)
- Western Europe (Spain)
  - Santiago de Compostela (University of Santiago de Compostela)
- Southern Europe (Greece)
  - Xanthi (Kimmeria)
  - Thessaloniki (CERTH)
- Central Europe (Hungary)
  - Sopron (Woodspring)

MiniStor - integrated storage system concept



MiniStor

IMPACT

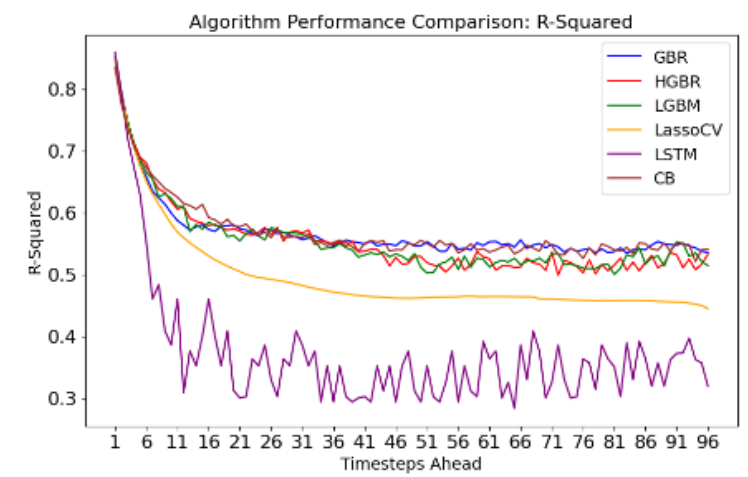
- Minimal-size energy storage solution
- Long-term energy security
- Minimize environmental impact
- Towards a decarbonized EU building stock
- Support Europe's Energy Policy for a sustainable energy market

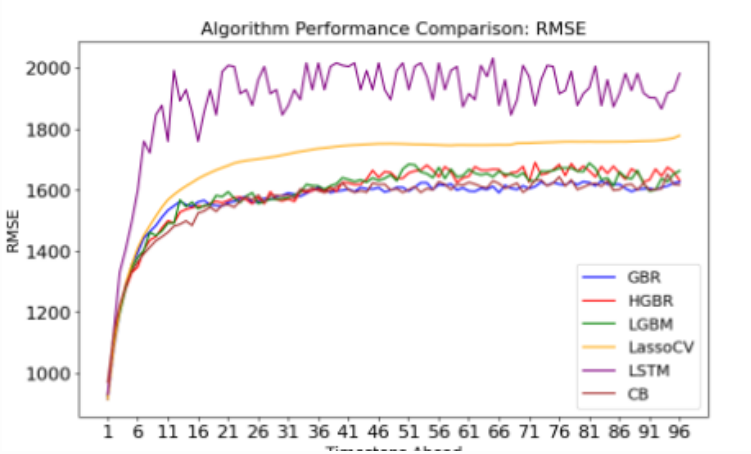
MiniStor

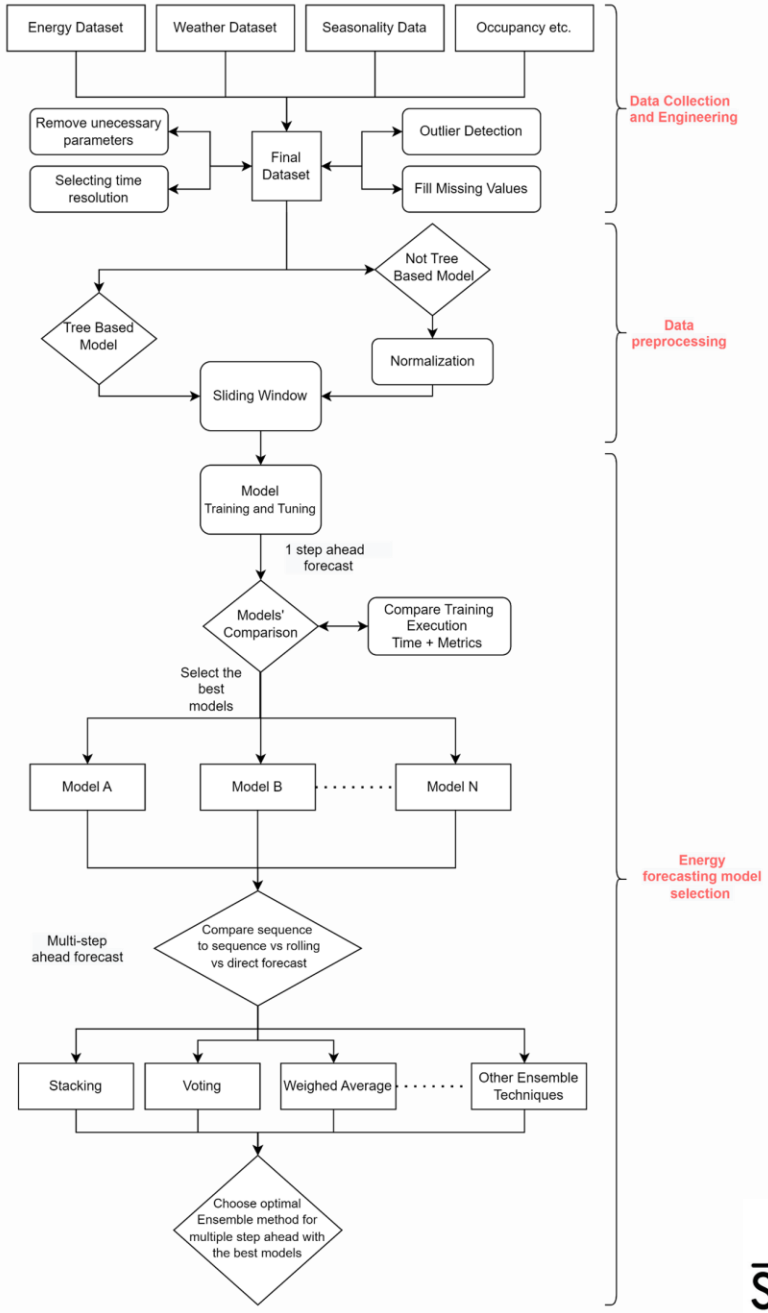
Key Points

- Innovative and minimal-size storage solution for existing and new residential buildings
- Thermal storage for both heating and cooling throughout the year
- Electrical energy storage and management to increase profitabity
- Consumer at the heart of MiniStor: Efficiency and user-comfort
- Reduction of the building’s net energy consumption by at least 44%
- Return-on-investment period of 6.7 years

MiniStor – Forecasting Approach







MiniStor - ML Papers

Aristeidis Mystakidis, Nikolaos Tsalikidis, Paraskevas Koukaras, Chrysovalantis Kontoulis, Paschalis A.
Gkaidatzis, Dimosthenis Ioannidis, Christos Tjortjis, Dimitrios Tzovar as. "Power Load Forecasting: A Time-series Multi-step ahead and Multi-model analysis"

- Wide range of models as potential solutions for multi-step forecasting
- The optimal technique proposes different algorithms per forecasting horizon

Project Partners

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Contecht

INNOTROPE

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