Artificial Intelligence for Cooperative Demand Response Programs in the Residential Sector

Iker Esnaola-Gonzalez | Sustainable Places 2020 | 2020/10/30

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SUSTAINABLE PLACES 2020
October 27-30, 2020
Digital Event

01 The RESPOND H2020 project

02 The central AI System

03 A Real-World Use Case

04 Conclusions

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The RESPOND Project

RESPOND

DEMAND RESPONSE FOR ALL

Co-funded by the Horizon 2020 programme of the European Union

fenie energía

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ALBOA

AURA rådgivning

DANISH BUILDING RESEARCH INSTITUTE
AALBORG UNIVERSITY COPENHAGEN

Fuinneamh Oileáin Árann
Aran Islands Energy

NUI Galway
OÉ Gaillimh

institute MIHAJLO PUPIN

DEVELCO PRODUCTS

energomonitor

DEXMA ENERGY MANAGEMENT

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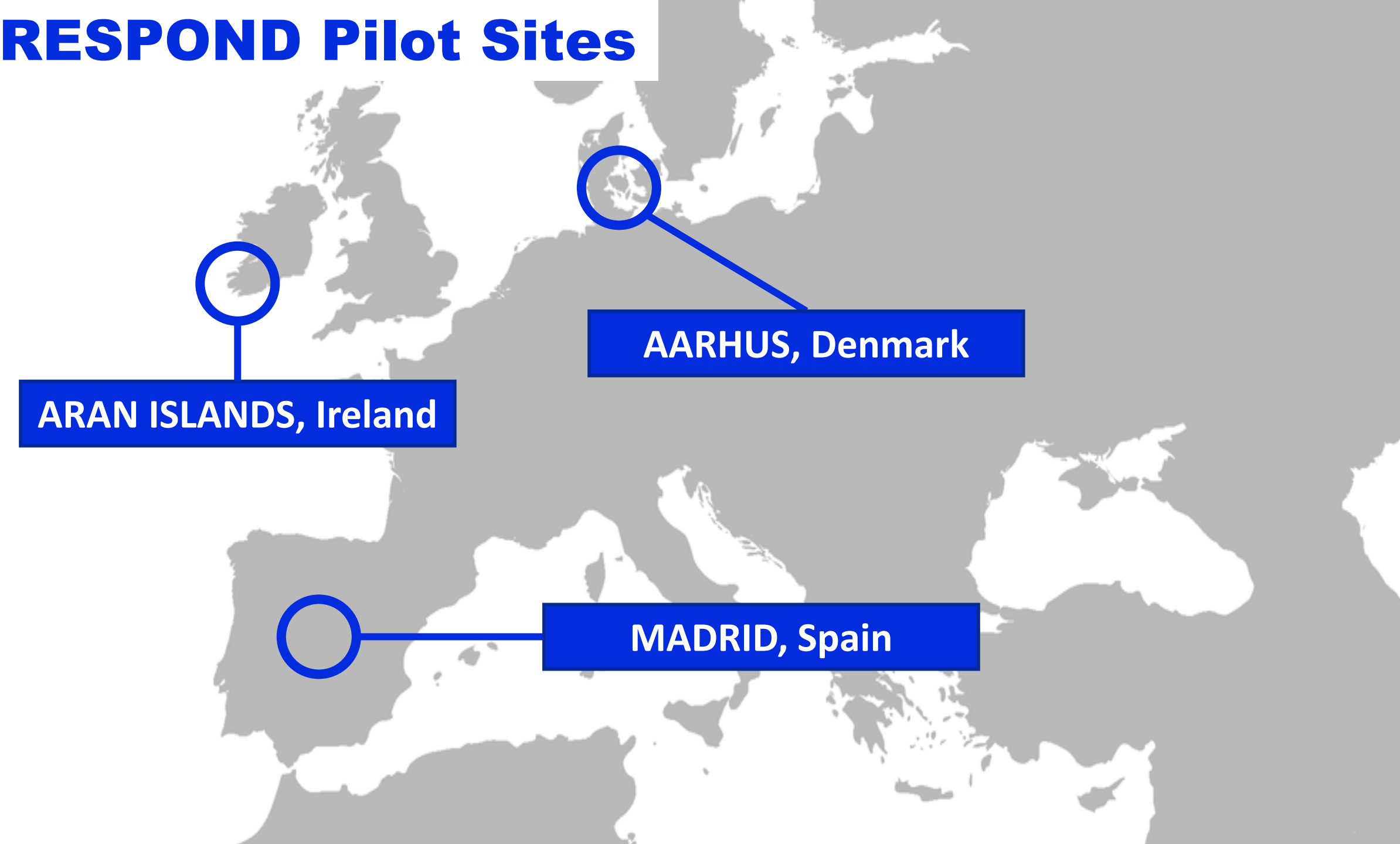
RESPOND Pilot Sites



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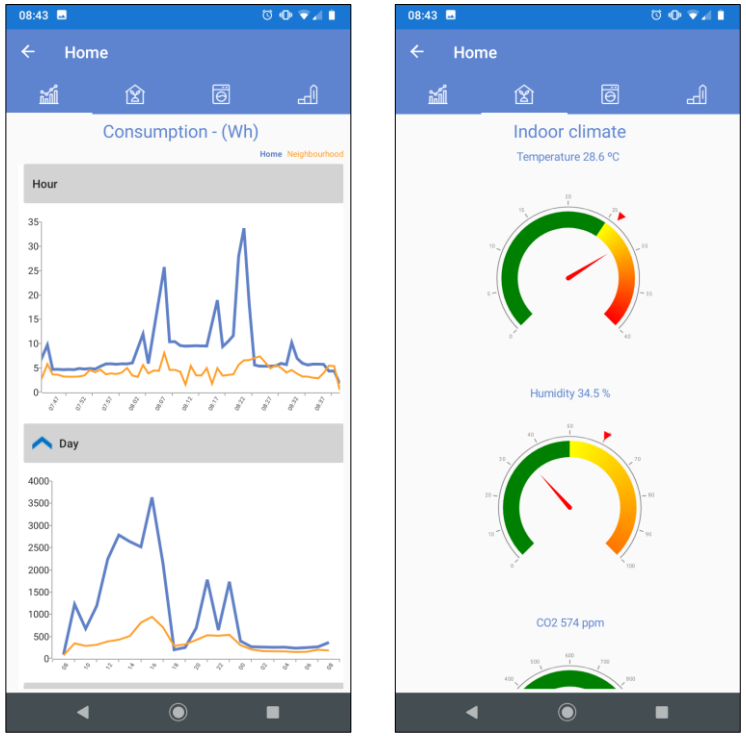
The RESPOND App



Engaging users to participate in energy saving activities

- Android and iOS
- Multilingual
- Visualization, Notifications and Control actions

Source: http://project-respond.eu/personal-energy-performance-assistant-version-1-15-released/

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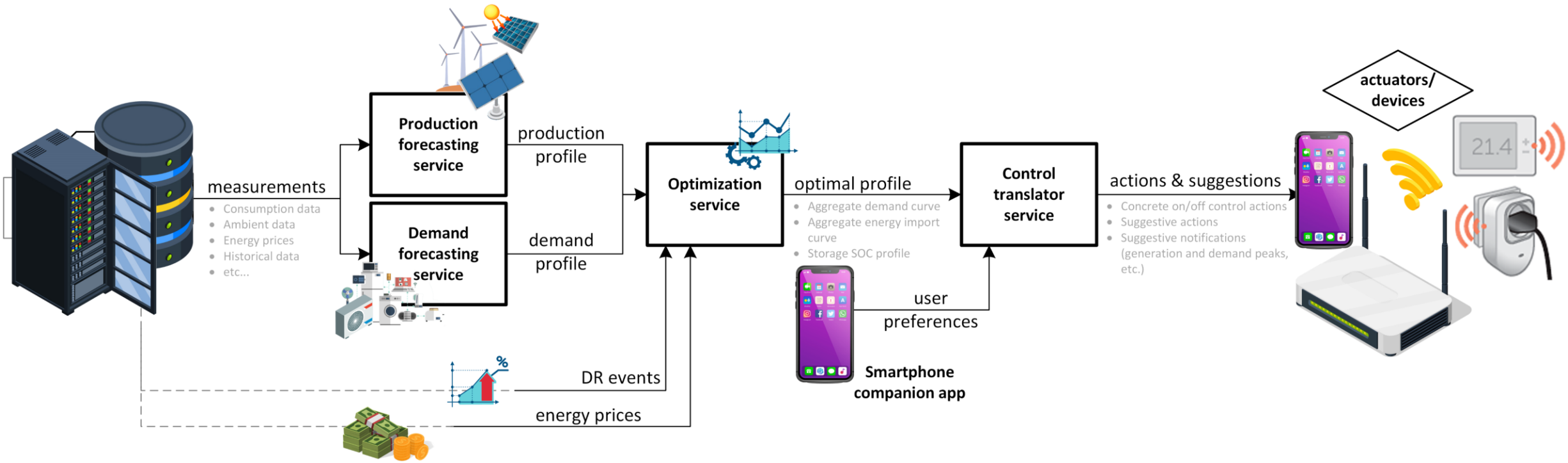
The RESPOND AI system



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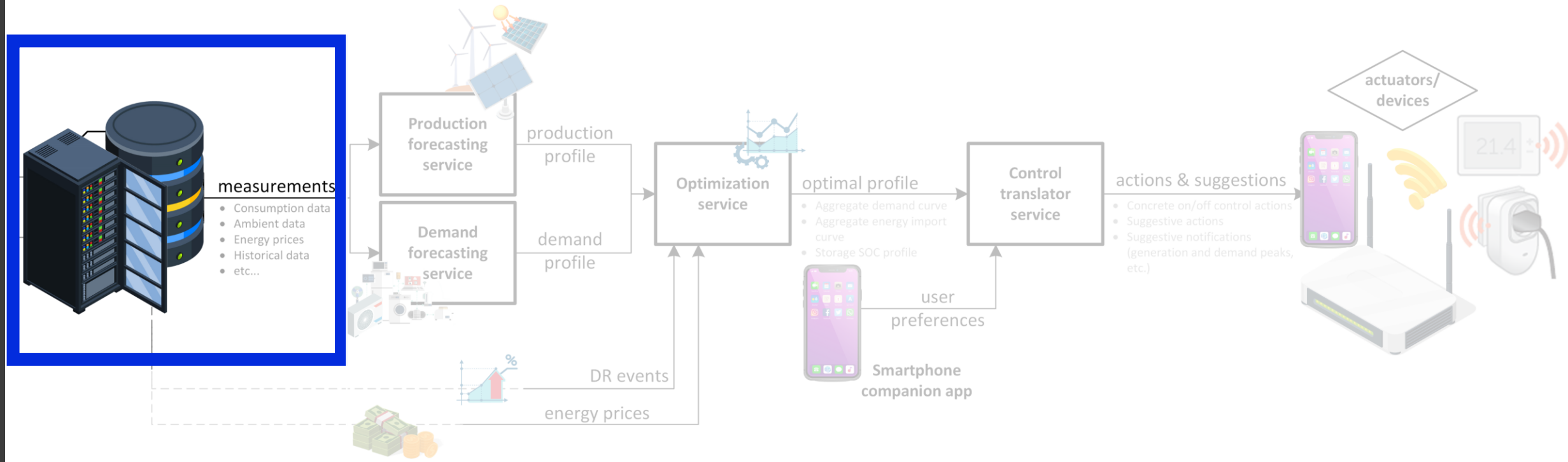
Measurement Block



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Measurement Block

Energomonitor Smart Plug

Develco Air Quality Sensor

Energy Gateway

InfluxDB DB

- Two Smart Home solutions: Develco and Energomonitor
- Energy Gateway based on OpenMUC
- Three data repositories:
  - Time Series (InfluxDB)
  - Triplestore (Virtuoso)
  - Relational (MySQL)

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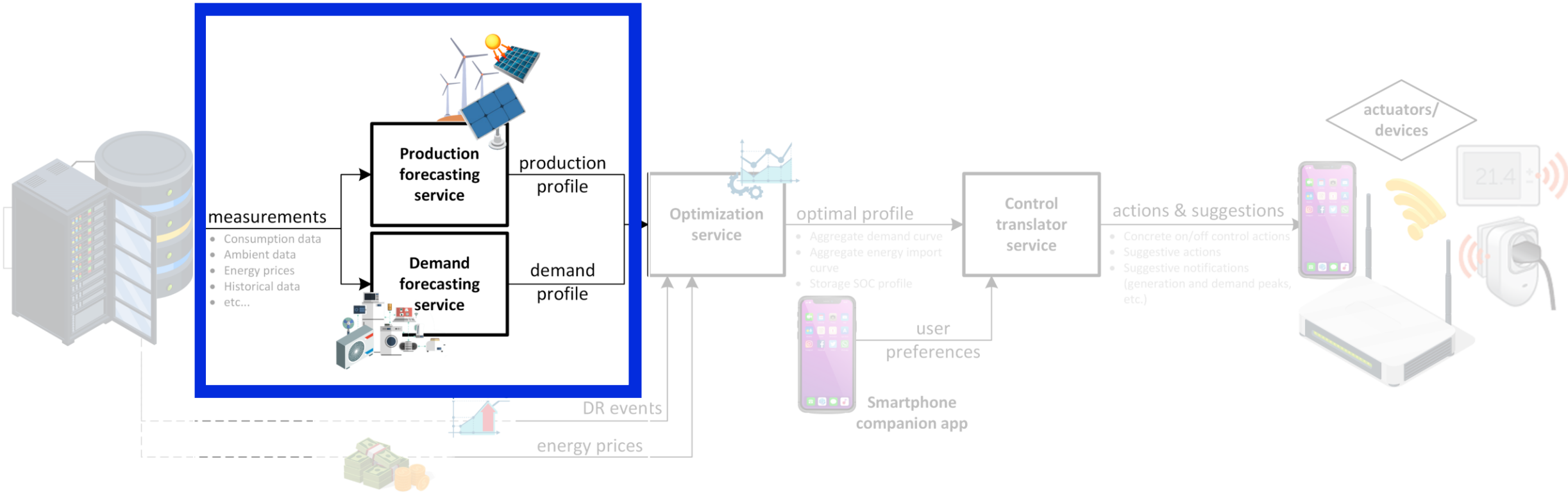
Forecasting Block



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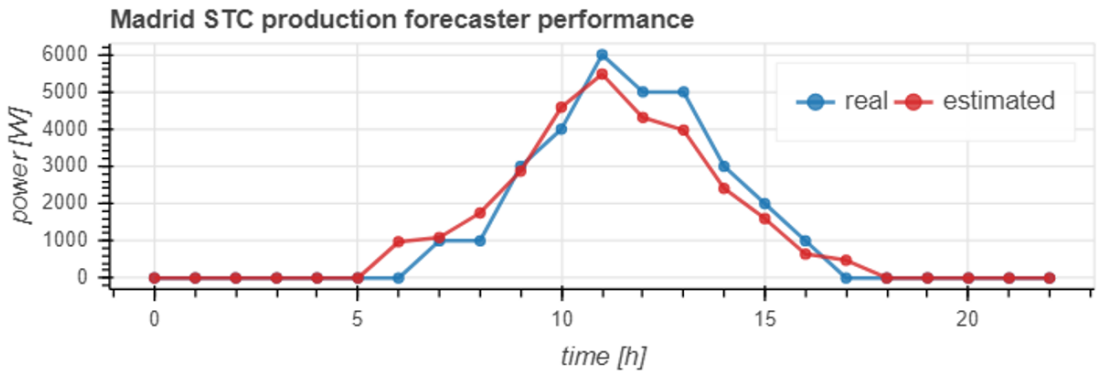
Forecasting Block

Production Forecasting



- Estimation for next 24 hours
- Data-driven models for Aarhus (PV) and Madrid (STC) pilots – random forests and neural networks
- Physical models for PV production on Aran Islands pilot due to lack of historical data

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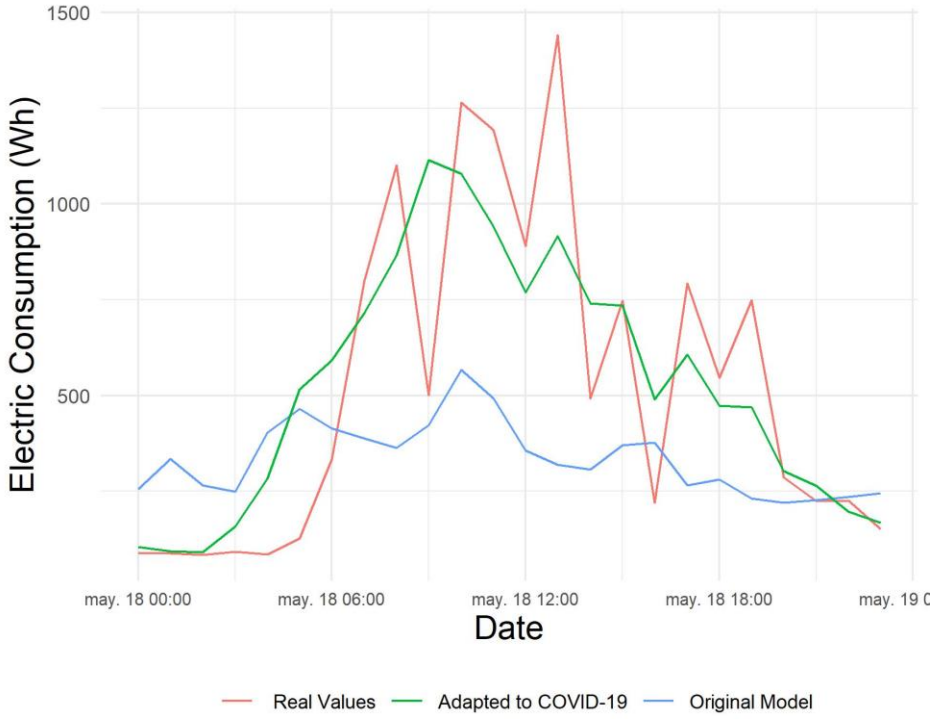
Forecasting Block

Demand Forecasting



- Estimation for next 24 hours
- kNN algorithm
- Variant based on patterns instead of features
- Dealing with Concept Drift (COVID-19)

Source: https://www.researchgate.net/publication/342834502_Short-term_Forecasting_Methodology_for_Energy_Demand_in_Residential_Buildings_and_the_Impact_of_the_COVID-19_Pandemic_on_Forecasts

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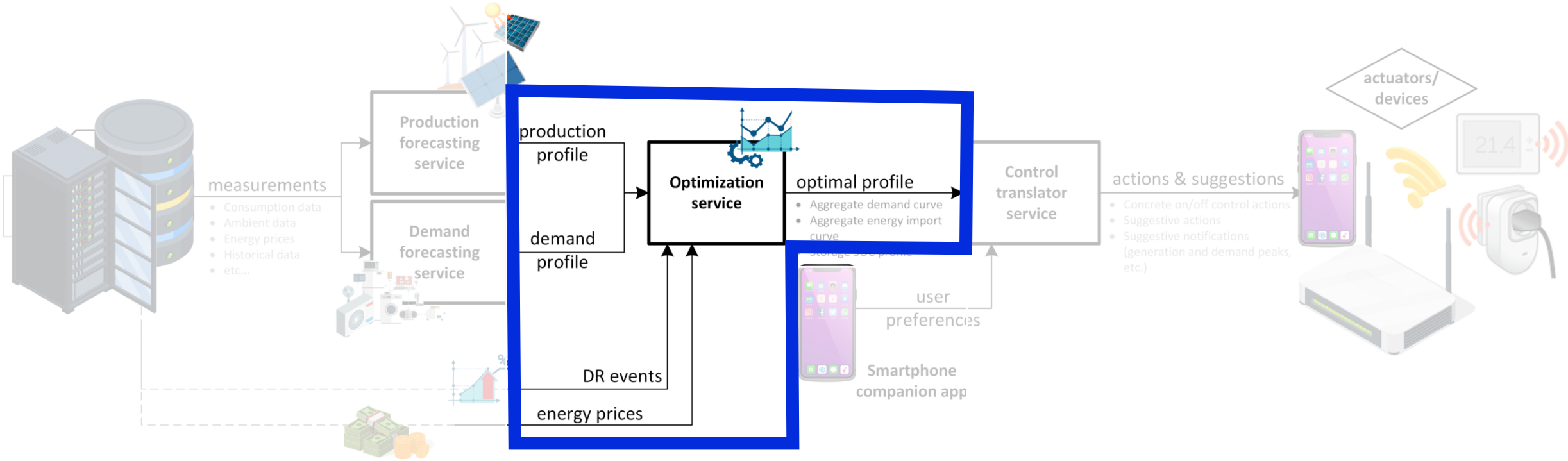
Optimization Block



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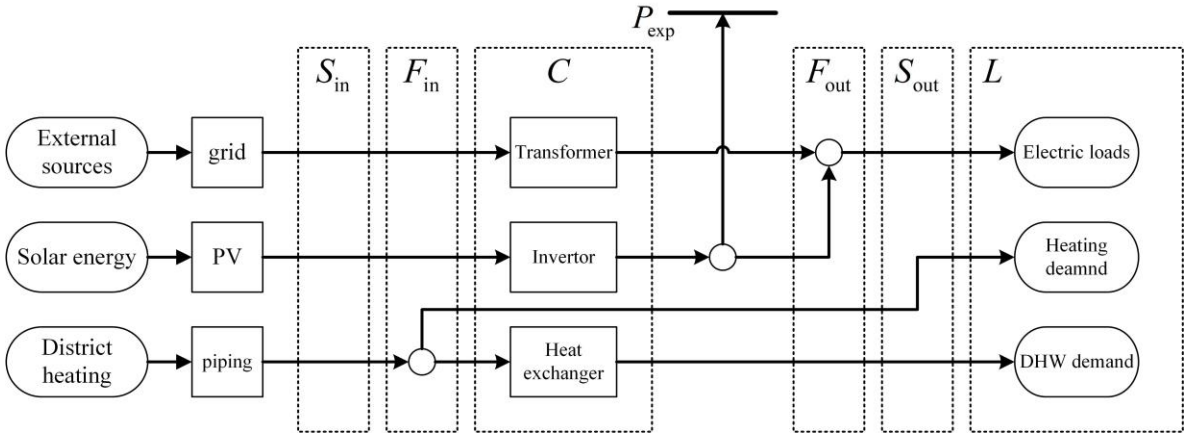
Optimization Block



- Based on the Energy Hub optimization model
- Utilizes the information from production and demand estimates
- Considering energy prices and DR constraints
- Adapted to the configuration of each pilot site

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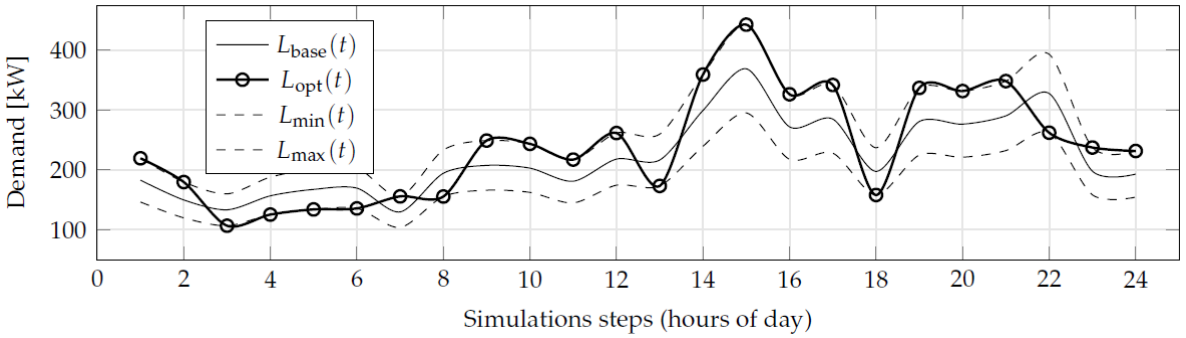
Optimization Block



- Users are supposed to display flexibility proportional to their demand
- The optimizer utilizes the demand flexibility in order to shift loads
- Total daily consumed energy remains the same between predicted and optimized profiles

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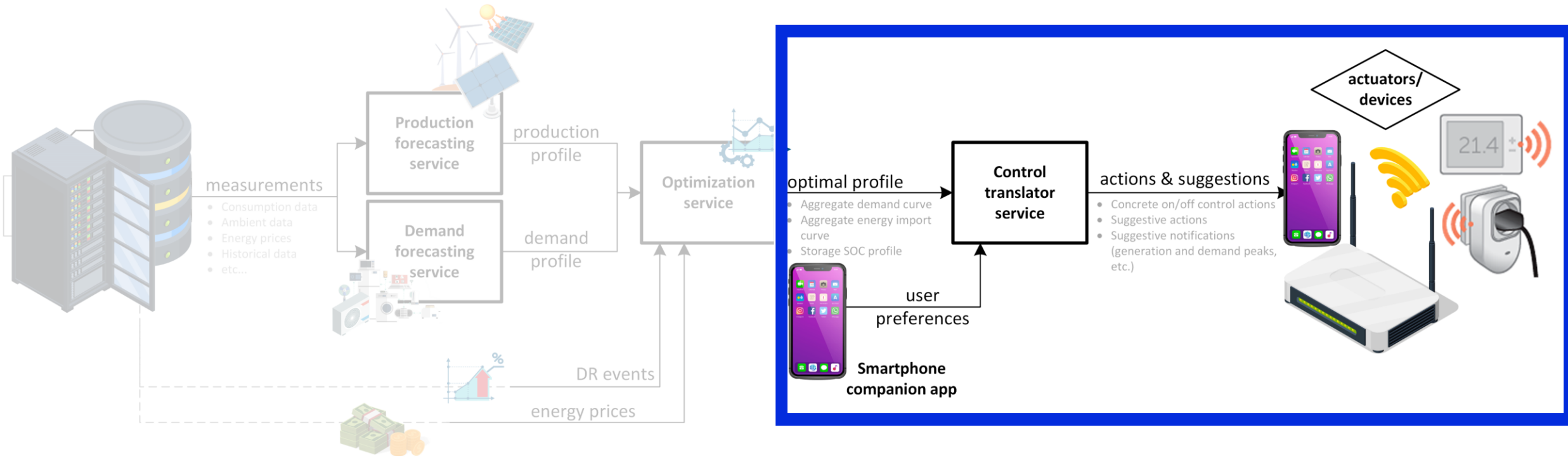
Control Block



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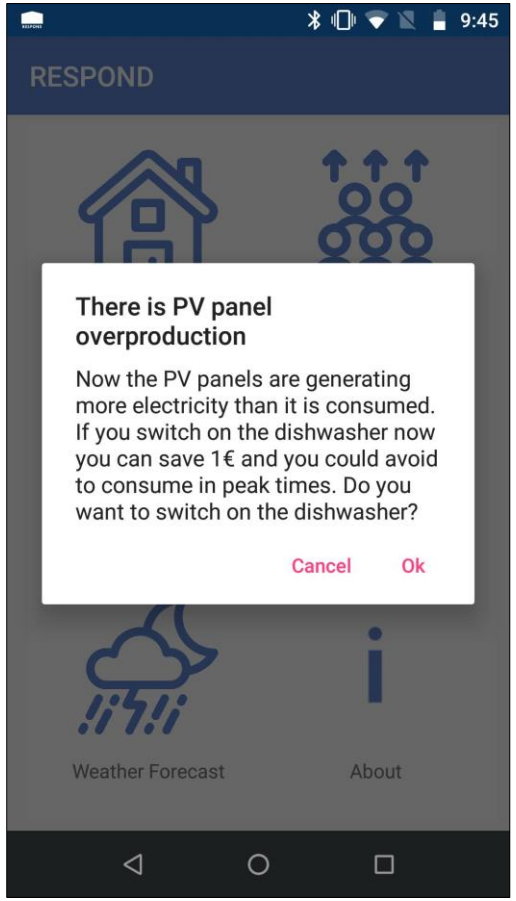
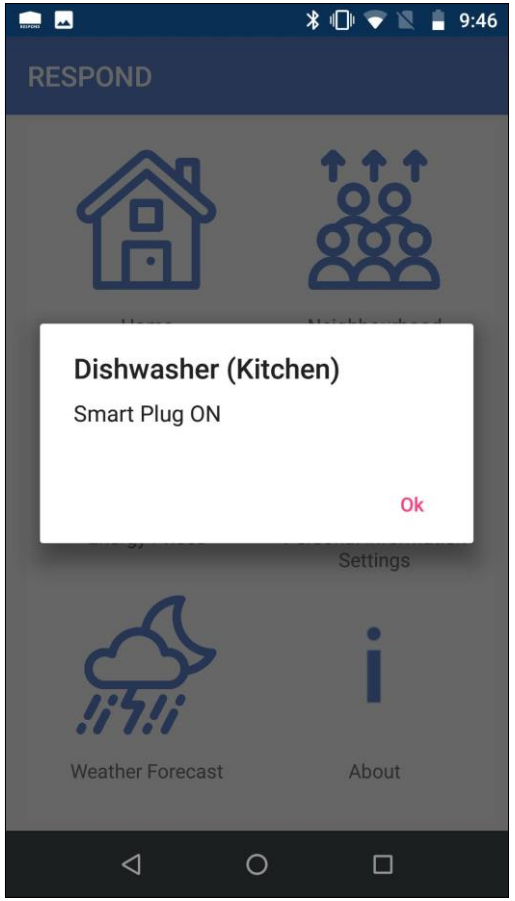
Control Block





- Translates optimal curve into specific control actions
- Considers both manual and automatic control actions
- Remote control actions enabled by the RESPOND App

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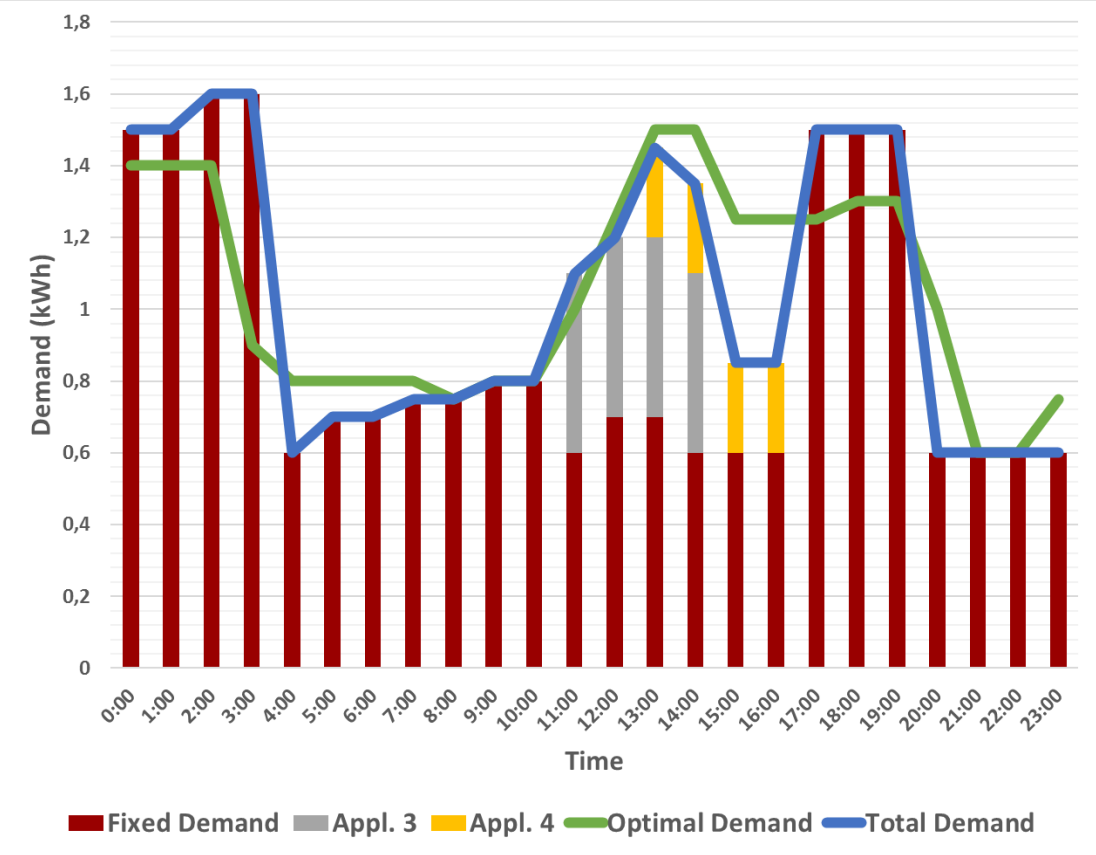
Control Block



- Schedules the use of appliances for achieving optimal profile
- Considering user preferences
- Heuristics Optimization as there are too many possible solutions to analyze

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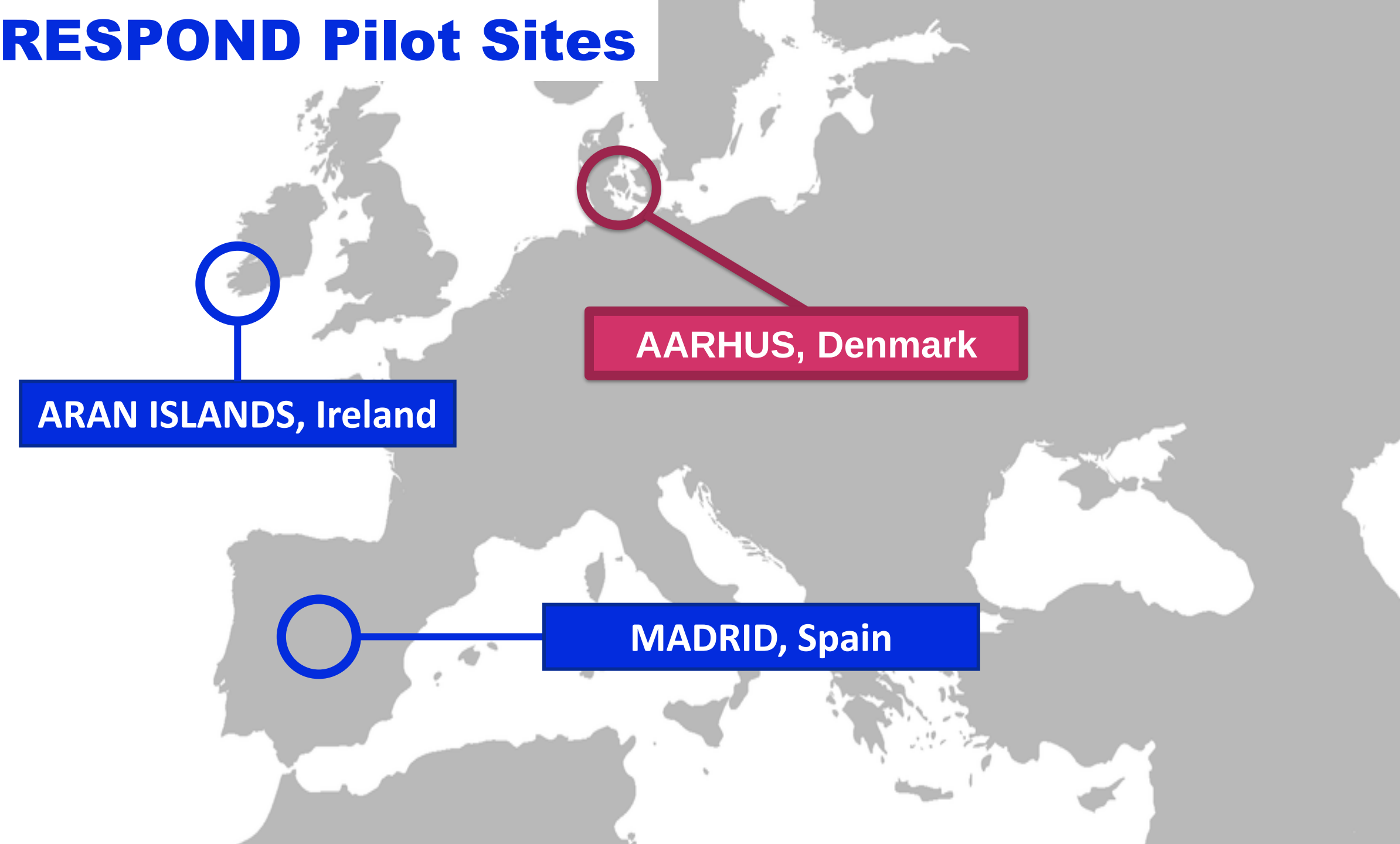
RESPOND Pilot Sites



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A use case in Aarhus

- 20 Social houses
- PV Panels for RES
- Electric and Thermal Consumption

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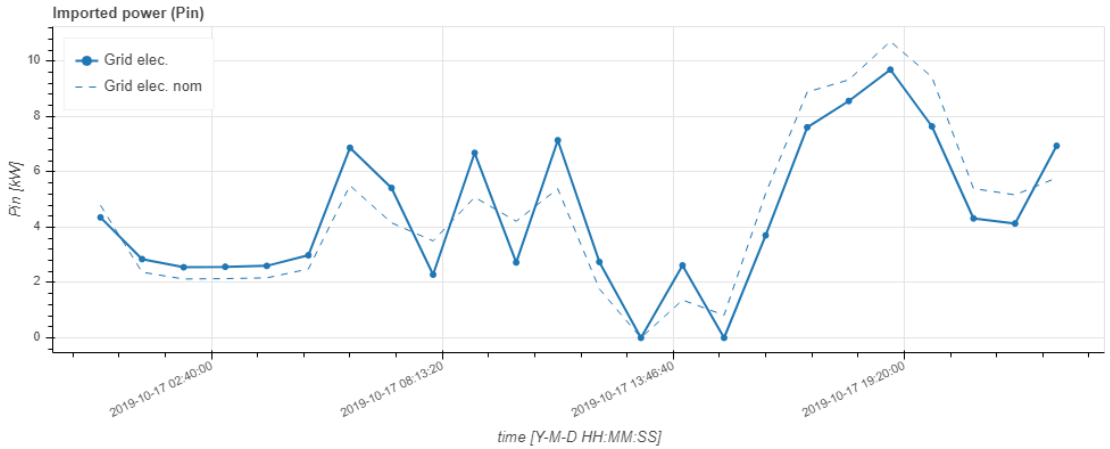
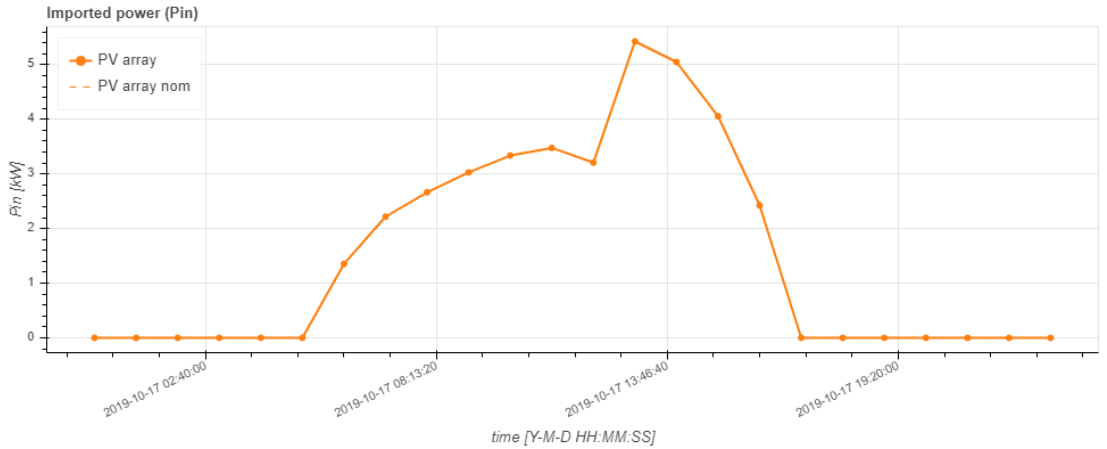
A use case in Aarhus



Electric Demand Forecast



PV Panel Production Forecast

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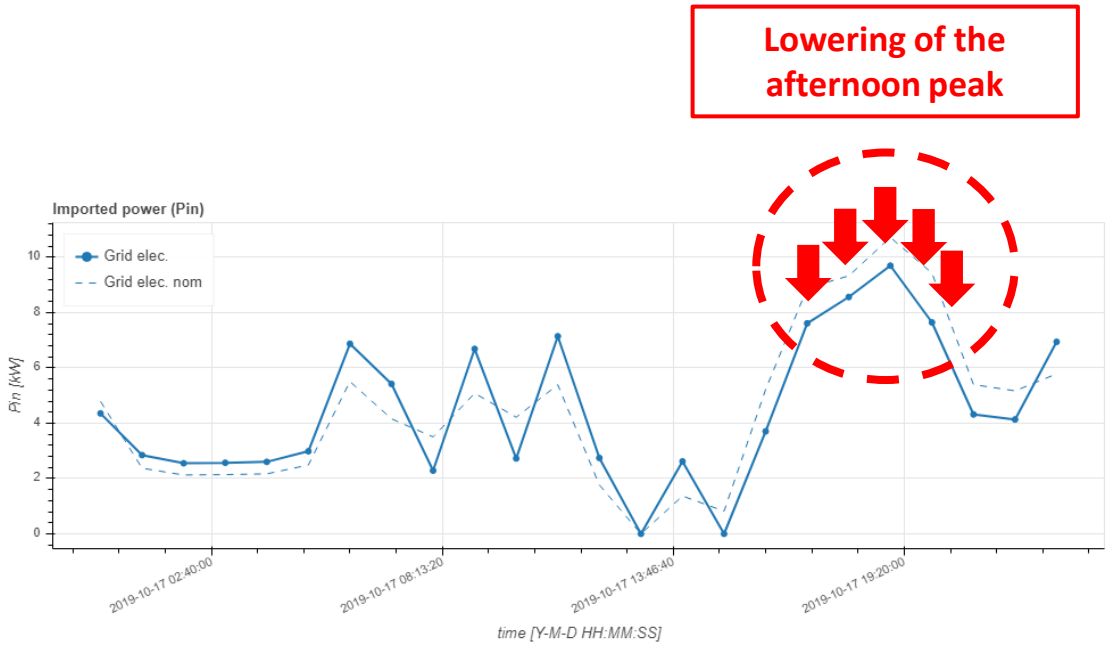
A use case in Aarhus



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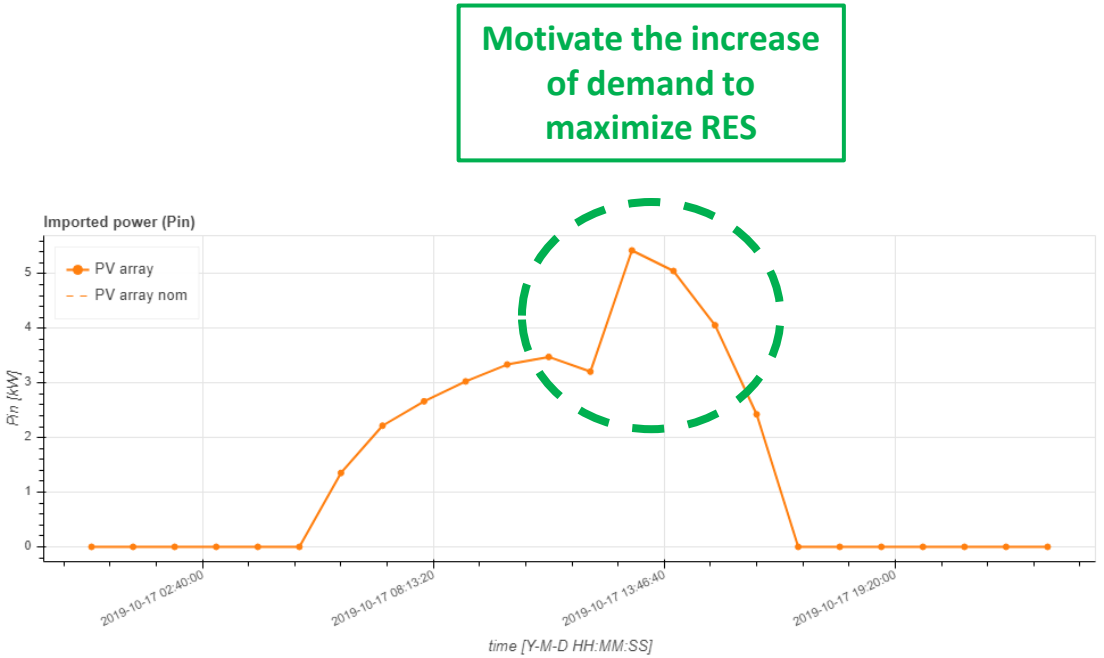

PV Panel Production Forecast

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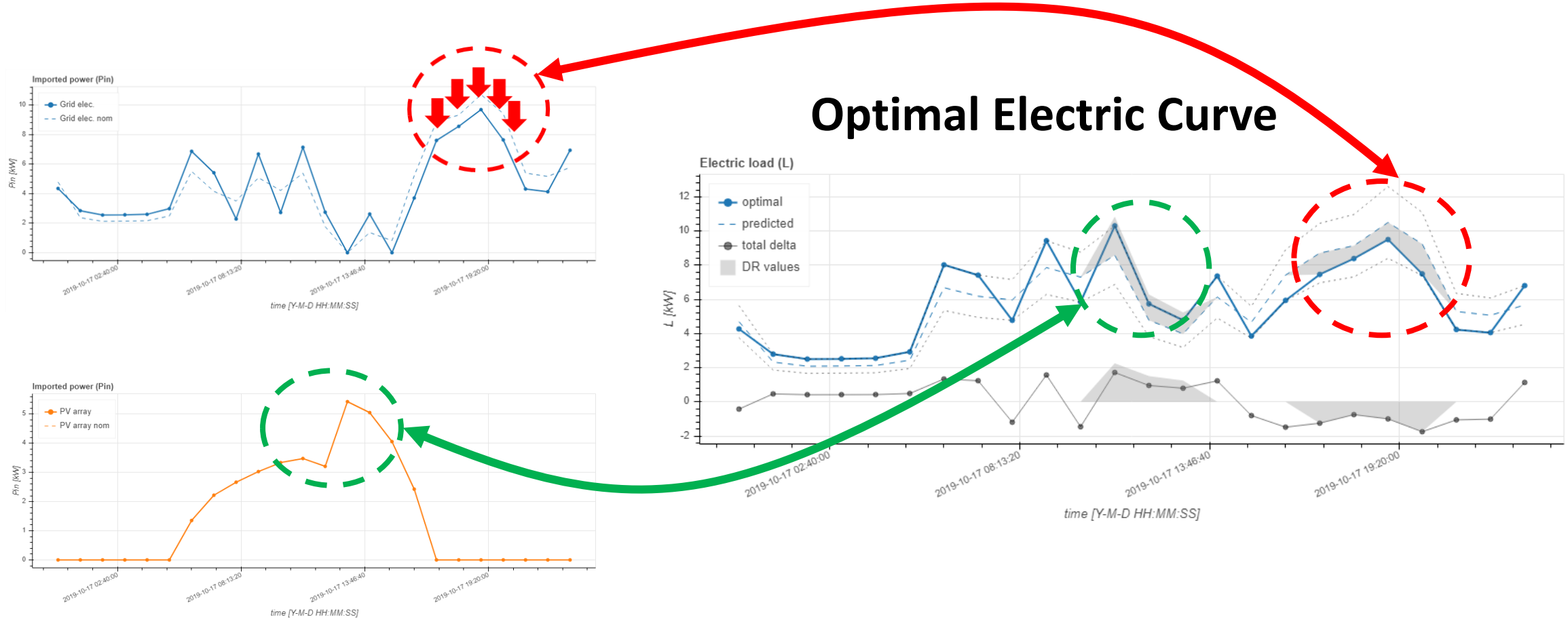
A use case in Aarhus



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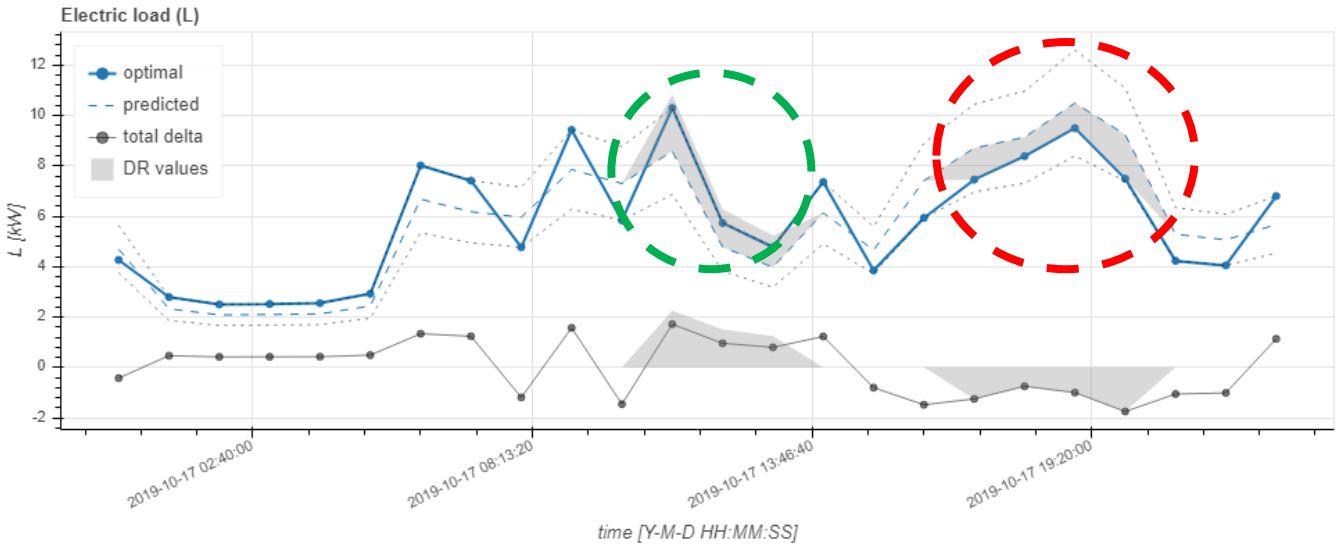
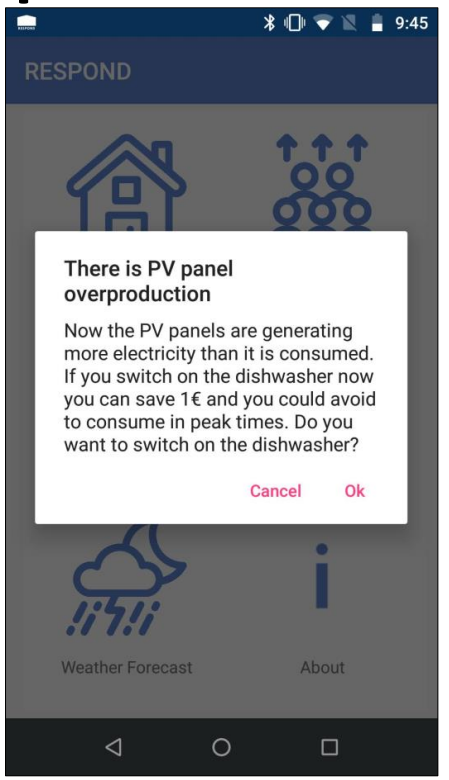
A use case in Aarhus



Action to achieve the Optimal Curve



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Conclusions

- Demand Response as a solution for energy efficiency in houses
- Artificial Intelligence for a complex multi-objective problem
- Seamless interaction of Measure-Forecast-Optimize-Control blocks

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Artificial Intelligence for Cooperative Demand Response Programs in the Residential Sector

Thank you for your attention !

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