SUSTAINABLE PLACES 2024

24 September 2024

Luxembourg

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY | LIST

R2M SOLUTION

Energy communities

WORKSHOP

Innovative Solutions for Sustainable Energy:
Lessons Learnt from HESTIA, ACCEPT & SENDER

Hestia   SENDER   accept – active communities & energy prosumers for the energy transition

www.sustainableplaces.eu

Hestia

Stéphane POUFFARY

CEO ENERGIES 2050 - HESTIA consortium member

Stéphane POUFFARY is the founder and the Chief Executive Officer of ENERGIES 2050, a network and an association active, for more than 25 years in over 70 countries. Stéphane has been working internationally for over 35 years. He is a specialist in climate change, energy and territorial transition.

Introduction

Exploring innovative solutions from 3 Horizon Europe-funded projects to accelerate the energy transition through energy communities.

HESTIA - Holistic dEmand response Services for European residenTIAl communities

SENDER - Sustainable consumer engagement and demand response

ACCEPT - Active Communities & Energy prosumers for the Energy transition

Objective of our Workshop:
Showcase a selection of technical and societal innovations developed through these projects to foster sustainable and inclusive energy systems.

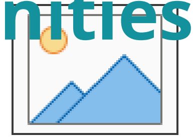
Energy communities, one of the cornerstones of the EU roadmap for the energy transition

RECs question all traditional modes of production and consumption. In essence, it is a real transformational process across the entire energy value chain.

RECs involves various stakeholder: producers with all the associated stakeholders (from grid operators to distributors to technology providers) and consumers of energy so called “prosumer” (individuals or groups who produce and consume in an efficient and appropriate manner some or all of their own renewable energy produced) in addition the needed legal framework and financial mechanisms.

Implementing a decentralized low-carbon, inclusive energy transition, faces several complex challenges. These challenges are technical, political, and related to evolving consumer needs.

ges, but also tremendous opportunities to reconsider our modes of energy

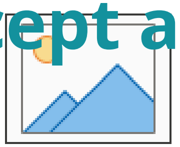


Major Challenges for a Low-Carbon, Inclusive and Decentralized Energy Transition as well as the specific needs for setting-up and operating a RECs are mostly known but having the right solutions, modular and able to respond to different situations/constraints requires a lot of innovation on all the pieces of the puzzle and on the interconnections.

Without being exhaustive, we will mention some challenges:

- Technological Integration & Variability of production & Grid Management & Flexibility…
- Regulatory and Policy Frameworks…
- Financing and Investment and need for new mechanisms/models…
- Consumer Engagement and Behavioral Change (User-friendly tech, modification of its energy demand and acceptance of flexibility or even transparency of its energy data)…
- Equity and Social Inclusion, community-driven projects to ensure equitable access…
- …/…

Innovation trough Hestia, Accept and Sender…. The way forward



Without being exhaustive our today discussion will put the emphasis on some great examples but within these projects we had worked on quite a number of additional Technical Innovations, such as :

- Integration of Variable Renewable Energy
- Managing grid flexibility and stability
- New Economic Models for Decentralized Energy
- Cooperative ownership, peer-to-peer trading, community investments
- Evolving Political Frameworks
- Policy adaptations to enable energy communities and prosumers

and number of Societal Innovations such as:

- Social Acceptance and Prosumers' Role
- Building community support and engagement in energy production.
- Data Sensitivity and Transparency
- Managing privacy and optimizing energy consumption through data insights
- Demand Flexibility and Forecasting
- Aligning energy consumption with renewable energy production for efficiency

Hestia

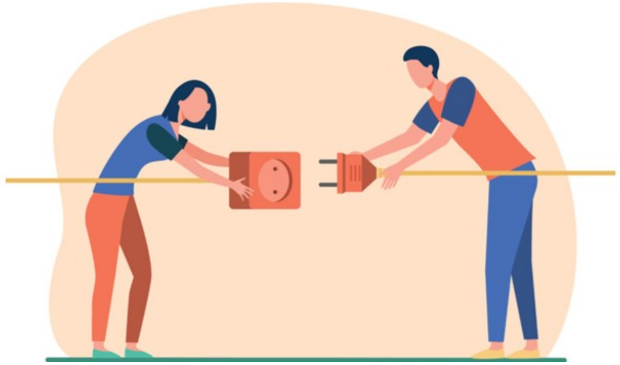
Francesco Belziti

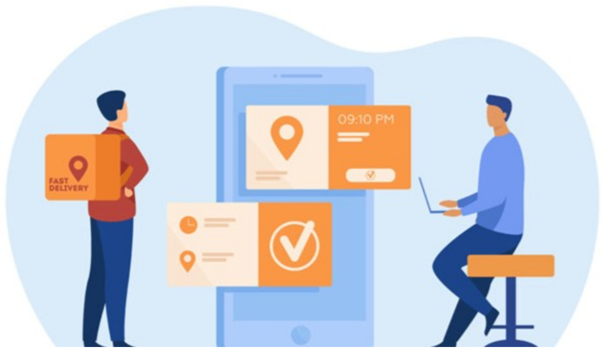
AXPO - Technical validation

Francesco, who has a 15 years experience in Energy and Oil&Gas filed, works as Project Manager and Operations Manager at Axpo Energy Solutions Italia. The company is the Energy Service Company of Axpo Group in Italy

HESTIA project

fective solution for the next-generation DR services which will leverage the consumer engagement,



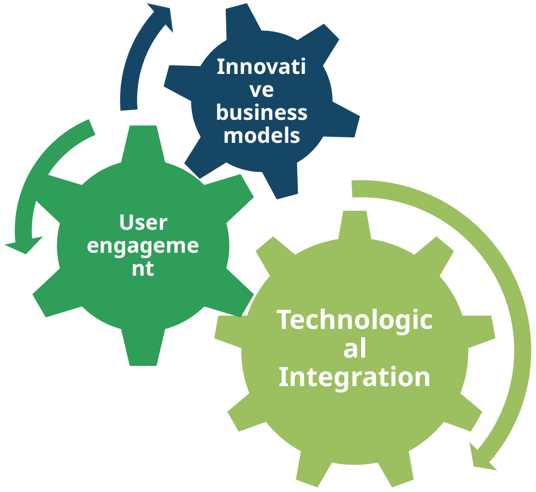


HESTIA objectives

A project has several key objectives aimed at enhancing energy management and usage for residential consumers.

op Cost-Effective Solutions: Create next-generation demand-side response services that encourage residential consumers to engage in energy flexibility sharing and grid b
onmental Impact: Reduce greenhouse gas emissions and promote the use of renewable energy sources.
omic Benefits: Generate energy cost savings for consumers and optimize investment resources for utilities.
ological Advancements: Leverage advanced ICT tools to enable real-time monitoring, predictive analytics, and automated decision-making.

A solution is designed to create a more sustainable, efficient, and resilient energy system by combining technological advancements with active consumer participation.

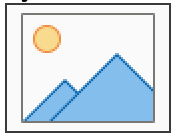


HESTIA solution innovations

ICT) tools to enable real-time monitoring, predictive analytics, and automated decision-making. Thi

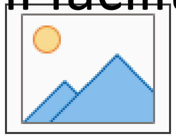
HESTIA solution innovations

ng and grid balancing. By involving users directly, HESTIA fosters a more participatory and responsiv



HESTIA solution innovations

n an incentive for DR actions. This approach will facilitate the deployment of innovative business mo



HESTIA solution innovations

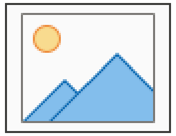
erate cost savings for consumers. By promoting the use of renewable energy sources and optimizin

HESTIA solution innovations

nces to develop cost-effective demand-side response services. This interdisciplinary approach ensu

HESTIA pilots

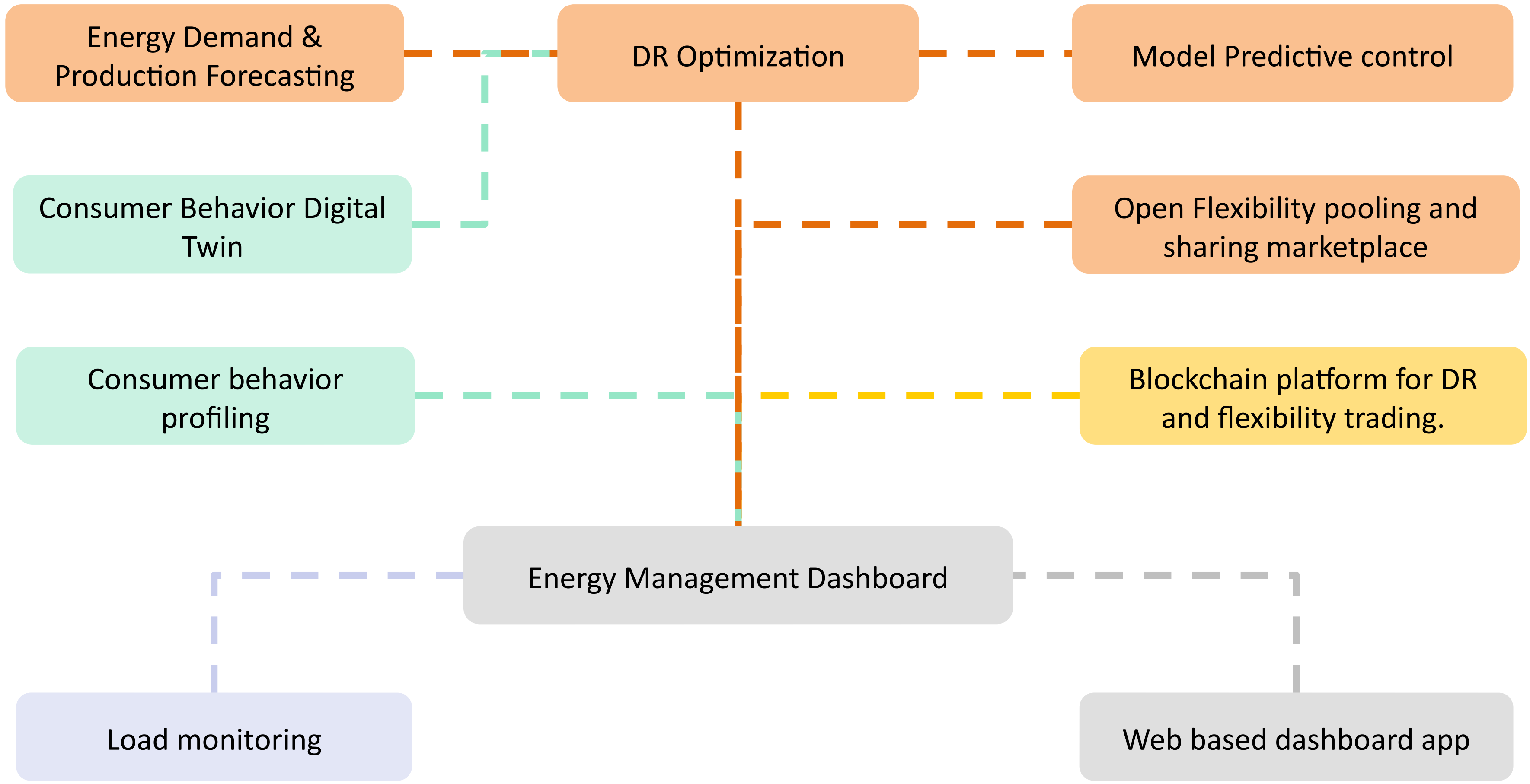
ally the owner of the electricity grid (ring infrastructure) in both the town centre and the surrounding rural area and serves as the DSO in the form of AEC (Municipal Elect



Camille Claudel Eco-District, France: the HESTIA project encourages residents of the same neighborhood to adjust, reduce or shift their energy consumption during peak electricity consumption periods and during periods of decarbonized energy production, typically in the afternoon during peaks in photovoltaic production observed in France.

Voorhout, Netherlands: 46 households involved, with Approx. 8 kWp of photovoltaic system installed. 29 houses are equipped with 5KW/5-10kWh 2nd life EV batteries, a heat vessel of about 200l with a heat pump, a community battery 50kW/50kWh

HESTIA services



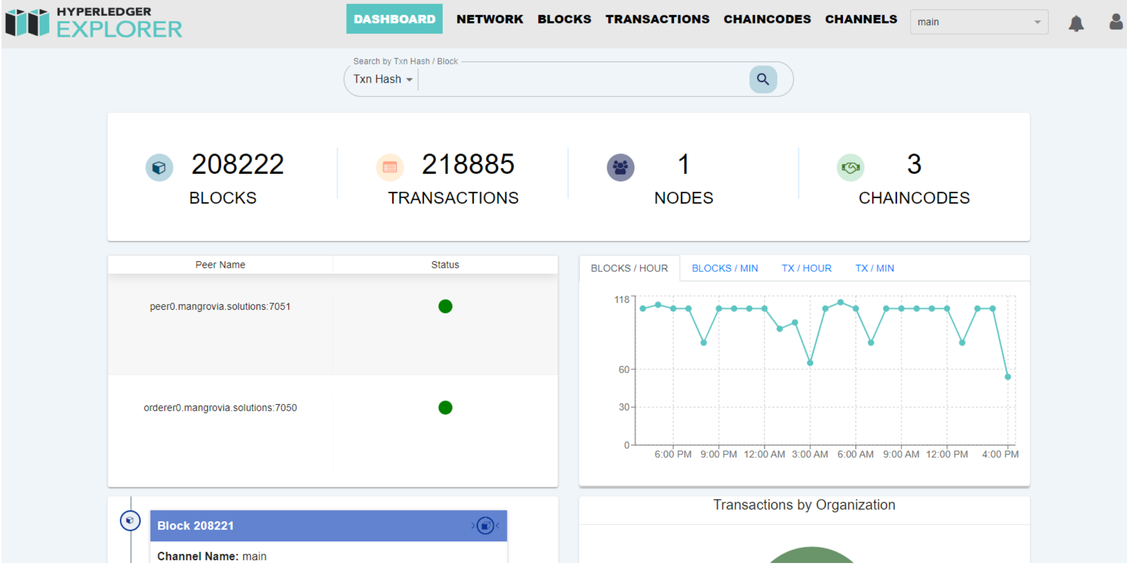
HESTIA Demand and Response

ilable battery capacity to charge at lows and discharge at highs to capitalise on the difference between ther
tructions to occupants to maximize the consumption of household solar production in real time. Behaviour

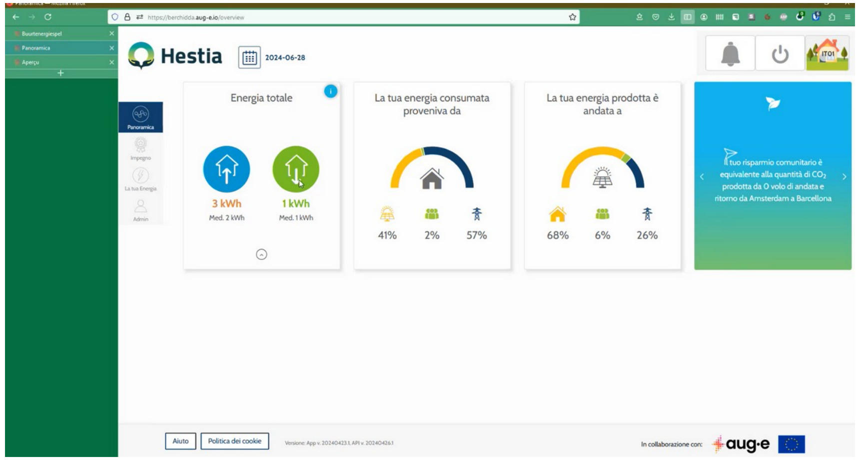
0 PM and 6:00 PM to 8:00 PM on weekdays. This Use Case was the main use case during the project, becau
uction observed in France.

HESTIA remuneration module

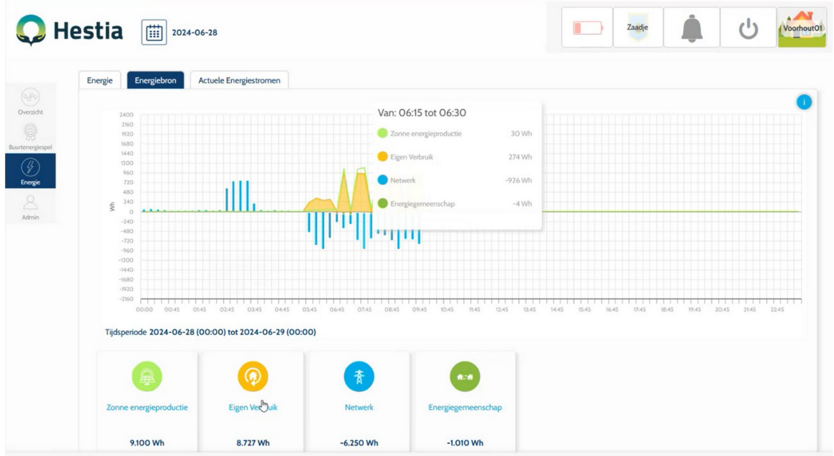
In HESTIA, Smart Contracting feature have been developed in order to calculate rewards for users who adjust their energy usage based on received DR commands, by reading data stored across multiple sources and organized in an ontology, bypassing specific protocol limitations. The blockchain technology simplifies the "production-transfer-payment" process and the “demand-response-remuneration" process, fostering a flexible and remunerative local market model for the Renewable Energy Community.



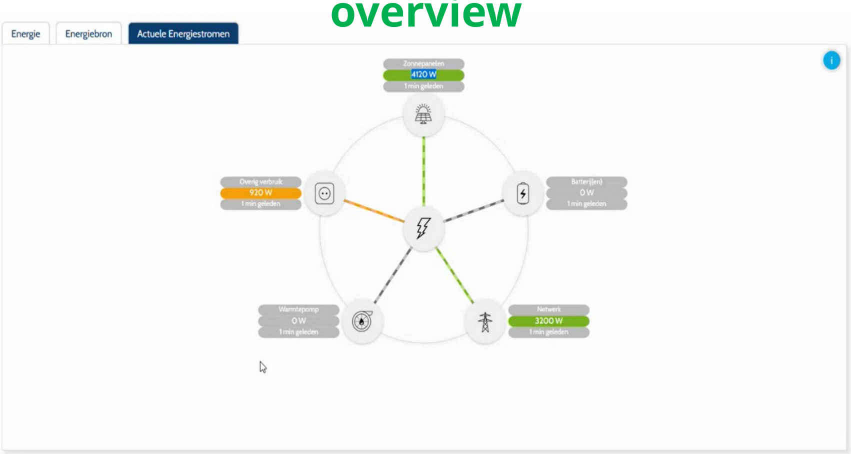
HESTIA platform



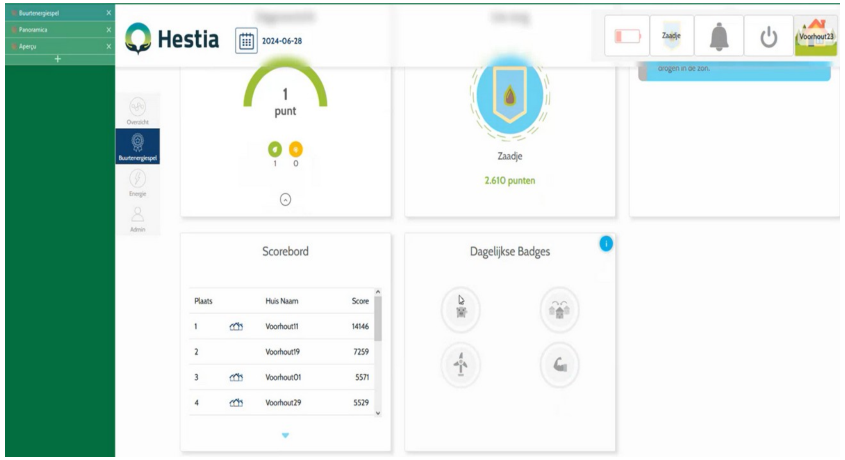
Consumptions and generation overview



Graphic analysis



Energy flow



Gamification

HESTIA results – energy efficiency KPIs

For each pilot, daily average energy efficiency KPIs of the validation period are compared to those of the baseline, which is obtained through a regression methodology. Then, KPIs are evaluated comparing baseline and actual consumptions and other parameters.

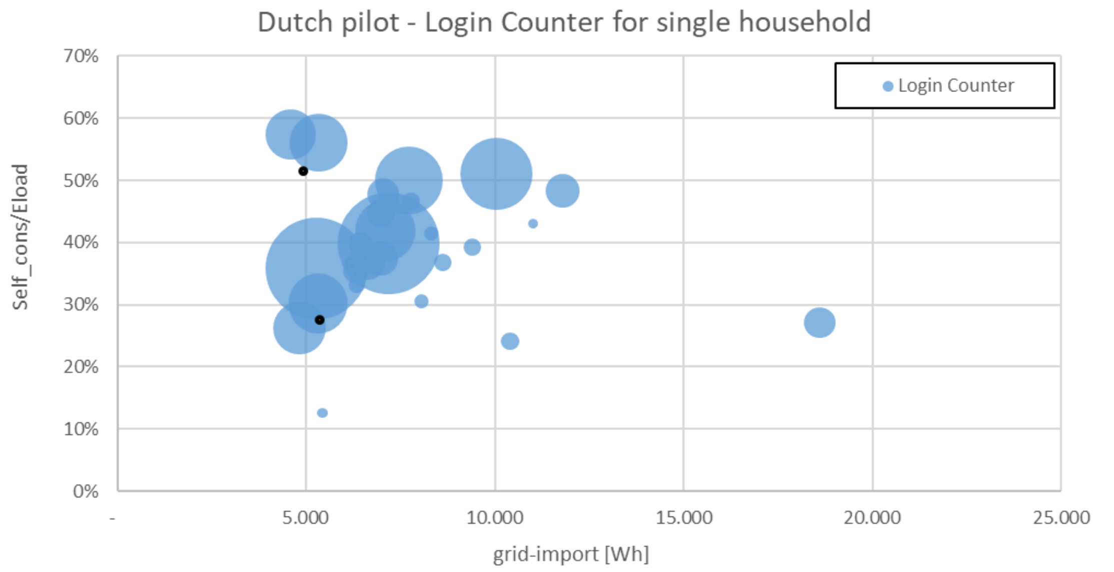
10% mean reduction in consumption from the grid

More than 50% increase in self consumption for the Italian pilot

More than 20% overall consumption reduction for the Dutch pilot

HESTIA results – user engagement

Each sphere represents the total amount of accesses to the platform made by a single user during the validation period. The best performing users are located in the upper-left corner of the graph, meaning they have high self consumption ratio and low energy imported from the grid.



*Households who have not logged in to the platform are represented by a black circle

		grid-import actual [Wh]	Self_cons/Eload %
IT	Login Counter >= 20	3,671	93%
	Login Counter < 20	4,381	90%
	Percentage difference (LC>=20-LC<20)	-16%	3%
NL	Login Counter >= 20	6,911	43%
	Login Counter < 20	8,137	36%
	Percentage difference (LC>=20-LC<20)	-15%	7%

HESTIA conclusions

The HESTIA project explored the possibilities of developing energy communities at three pilot sites in Europe, focusing on analyzing regulations, engaging end users, and developing services and tools for the optimal management of Energy Communities (REC), with the aim of **maximizing their energy, economic, and environmental benefits**.

The developed services enabled the implementation of **demand and response strategies**, identifying operational scenarios for each pilot and providing suggestions to users to improve their performance.

User engagement in the project, both through the platform and periodic dedicated workshops, demonstrated the potential of the solution. Notably, it was observed that more engaged users achieved better results, **with an average increased reduction in grid consumption exceeding 15% and an increase in self-consumed energy exceeding 5%**

Credits for the icons in the presentation: flaticon.com

SENDER

Christian Kunze

Smart Innovation Norway – Coordinator

Christian has 25 years experience in the electricity industry. In his role as Senior Energy Researcher and Consultant he coordinates the SENDER project and is involved in projects in the DE/AT/CH region.

Sustainable consumer engagement and demand response

Sustainable Places 2024

Innovative Solutions for Sustainable Energy

Smart Innovation Norway / Christian Kunze

Luxembourg, 24th of September 2024

This project has received funding from the European Union's **Horizon 2020 Research and Innovation programme** under Grant Agreement No. **957755**.

SENDER Concept & Objectives

As the EU moves towards sustainable energy, co-creation processes are the future for the design of energy service markets, turning customers into a new generation of collaborators and putting them at the heart of the energy sector.

SENDER will develop energy service applications for demand response (DR), home automation, convenience, and security mechanisms.

Consumer data will be collected and processed to identify typical consumption patterns, mirror them by digital twins (DTs) based on artificial intelligence technologies and aggregate the DTs' supply/demand characteristics. Therefore, the project will shift DR from a reactive to a proactive approach.

Statistical Data and Involved Partners

From 2020
To 2024

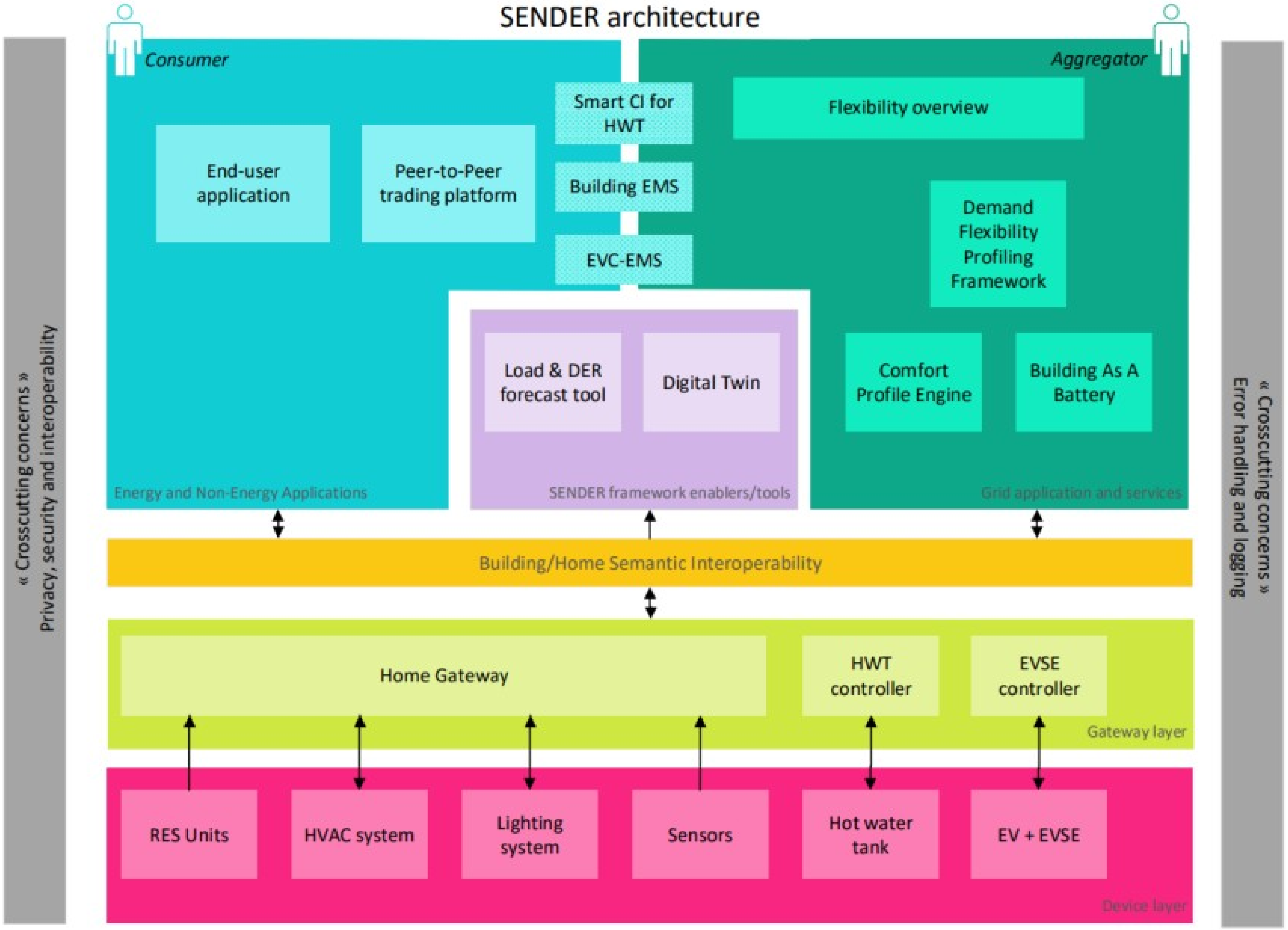
Project total cost	EU contribution	Website
6,759 M€	5,837 M€	www.sender-h2020.eu

Technologies and services deployed

Technologies for consumers	✓ Demand response ✓ Smart appliance ✓ Smart home
Grid technologies	✓ Micro-grid management and control tools ✓ Digital twins
Large-scale storage technologies	
Distributed storage technologies	✓ EVs ✓ Thermal Storage
Generation technologies	✓ PV
Market	✓ Electricity market ✓ Ancillary services

Project partners' countries

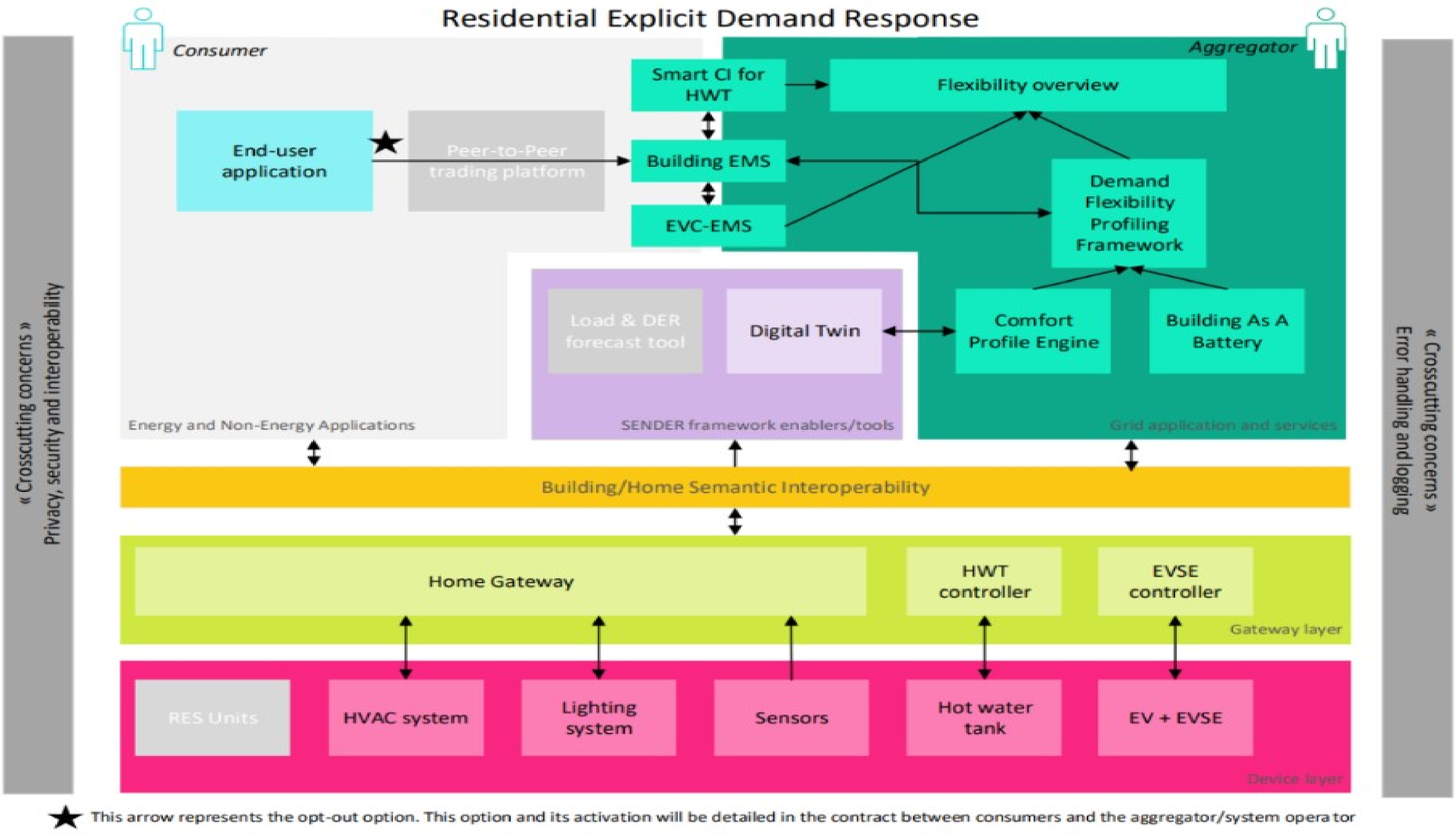
SENDER System Architecture



Reference architectures used:

- SHBIRA
- SGAM
- interconnect

SENDER UC 1: Residential Explicit Demand Response

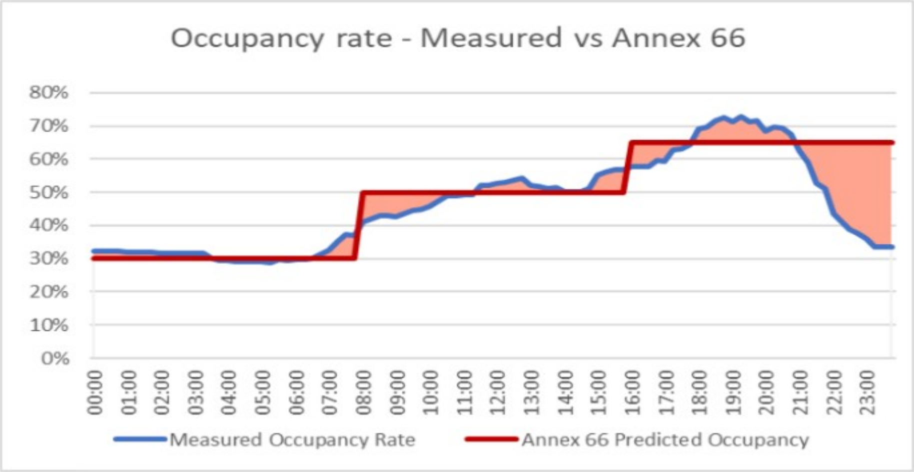


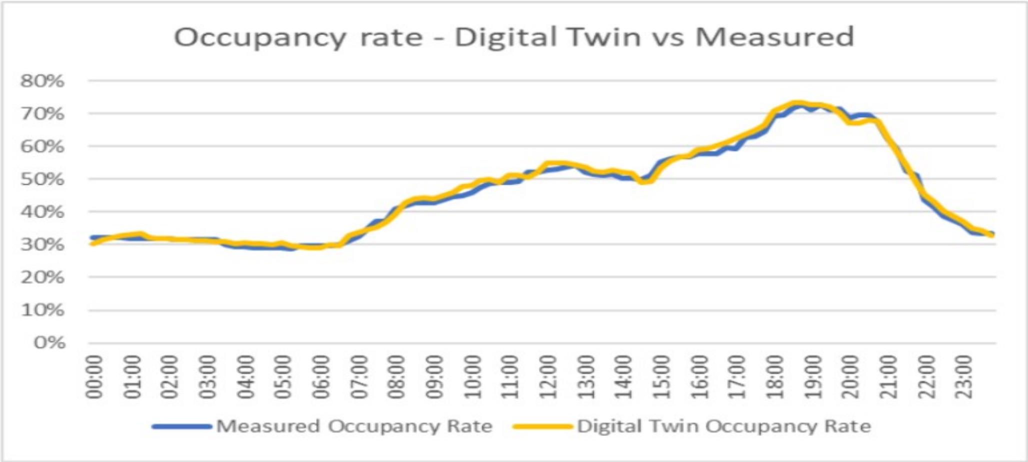
CONSUMER DIGITAL TWIN (PARA)

The Digital Twin (DT) applied in the SENDER project simulates consumer behaviour.

The DT was developed including an AI component, with a clear path of development beginning from the current Annex 66 statistical approach and from there towards a Deep Learning approach to satisfy the requirements of the SENDER solution, which was implemented using Artificial Neural Networks (ANN). The ANN technology applied is transferred from the Aeronautics sector, where a similar application was developed to model the behaviour and response of passengers in commercial long-haul flights.

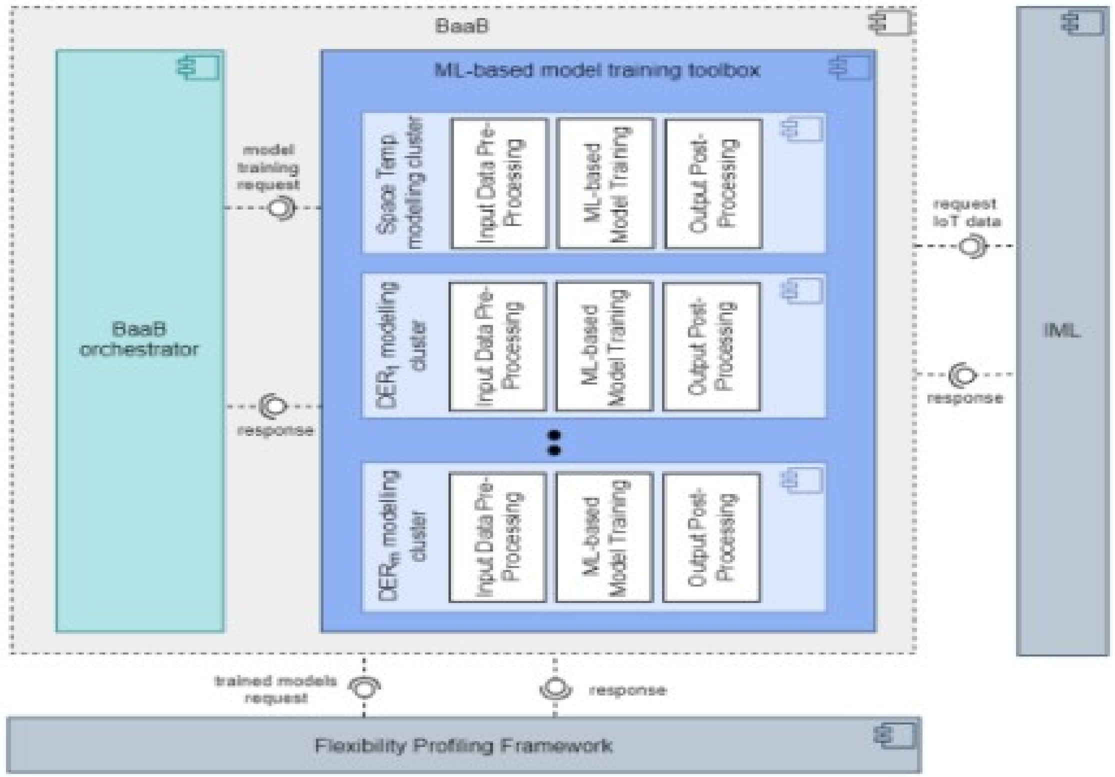
The Sender DT prototype was successful, achieving a performance that closely predicted the occupancy rate percentage with up to 2% deviation.





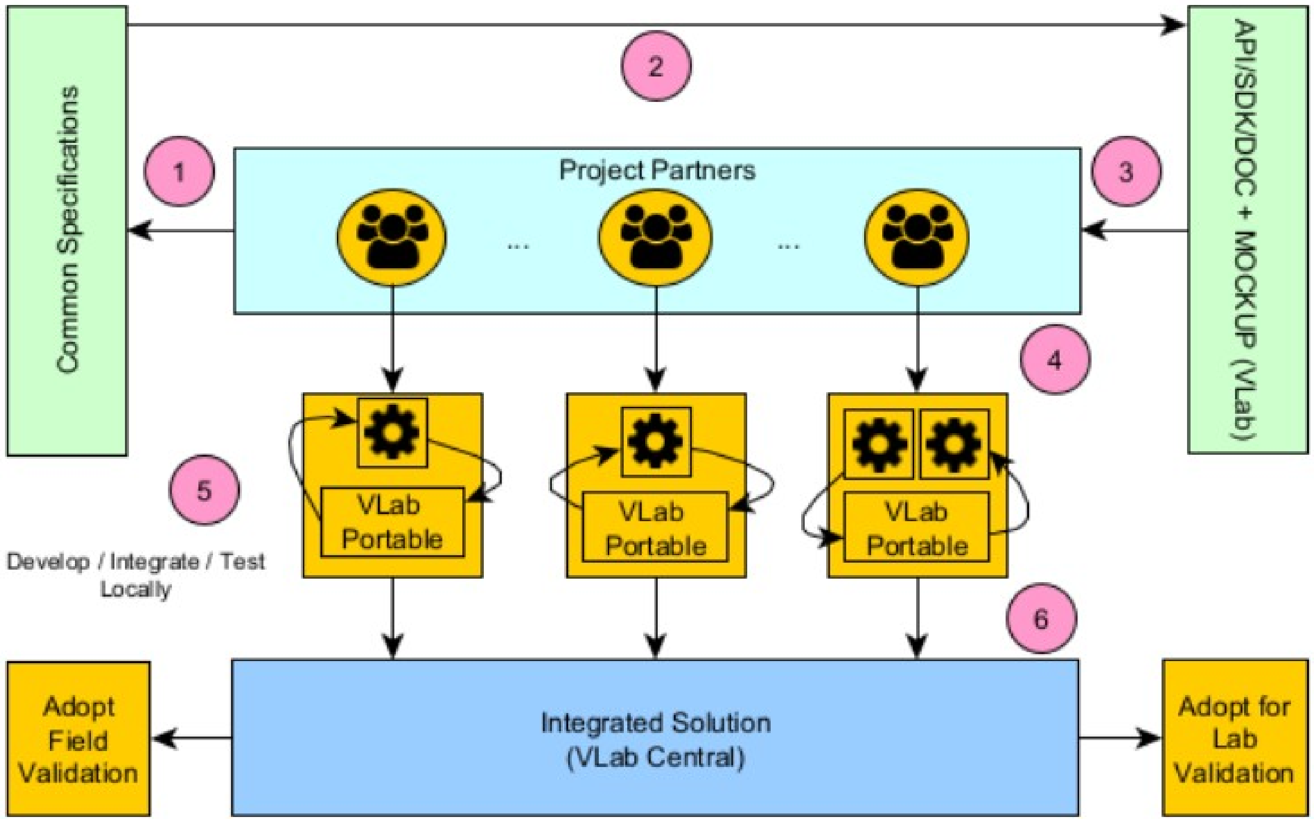
BUILDING AS A BATTERY & FLEXIBILITY PROFILING / MANAGEMENT TOOL (HPT)

The Building as a Battery (BaaB) module aims to discover and exploit the thermal storage capabilities of building spaces and transform them to thermal batteries by storing and preserving energy consumed by thermal appliances in the context of the demand flexibility framework. The implementation is incorporated into the Demand Flexibility Profiling Framework for supporting flexibility extraction from thermal appliances.

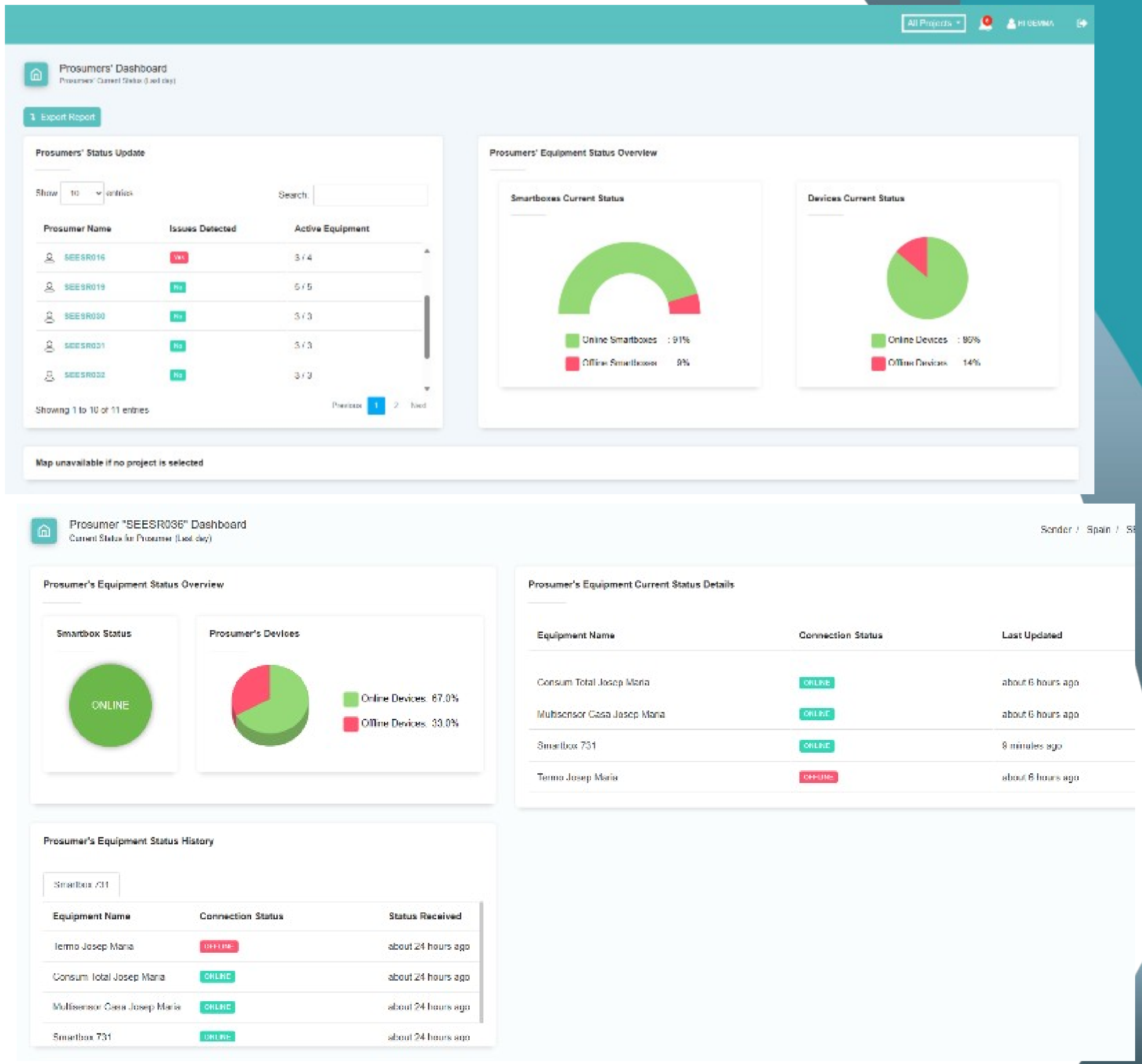


VIRTUAL LAB AND GLOBAL INTEGRATED PLATFORM (AIT)

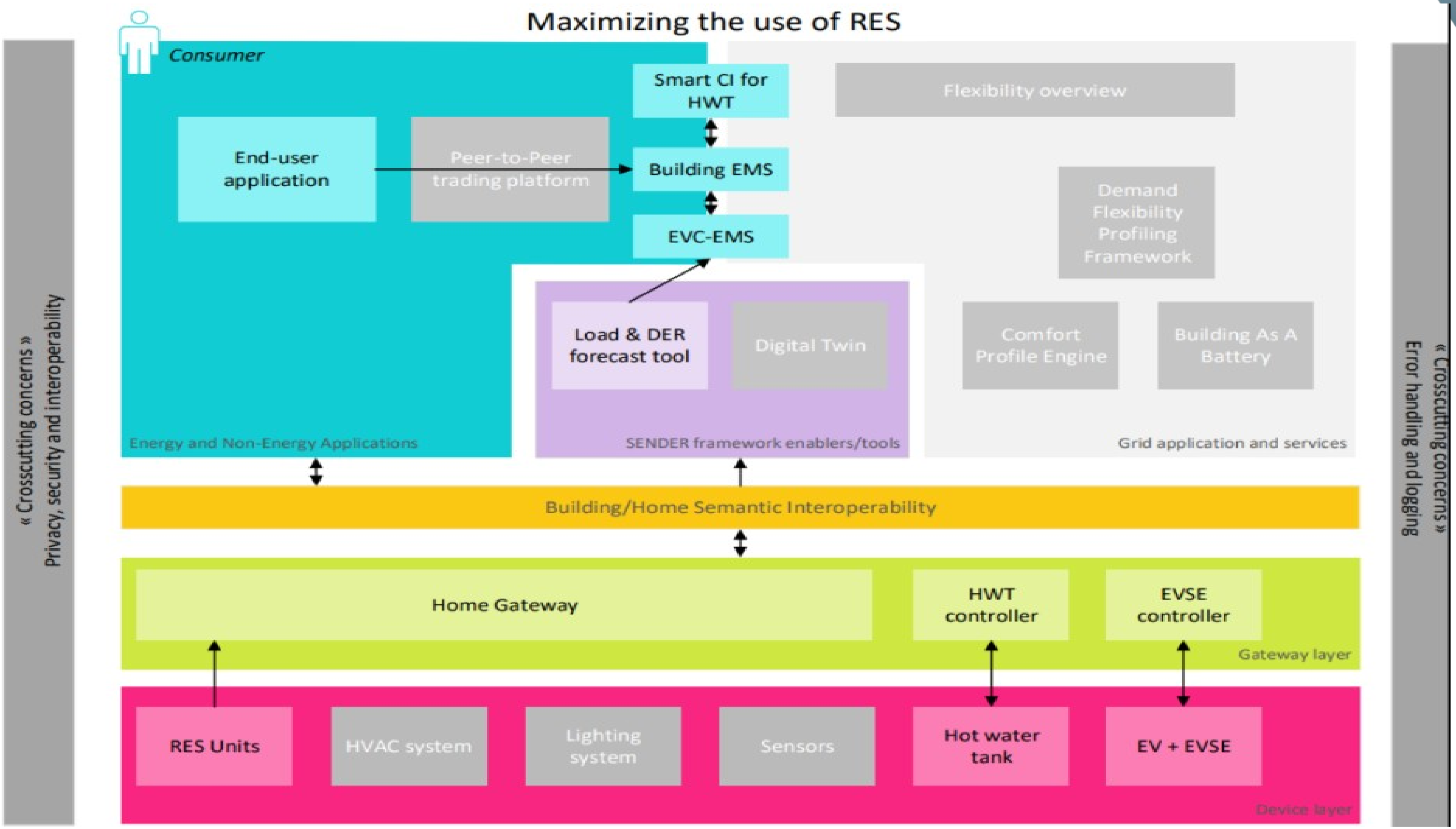
- Support in achieving semantic interoperability by helping to foster a common understanding of the problem and the solution
- Providing a bigger picture view
- Bridging between the high-level requirements and their implementation
- Provisioning of the virtual mock-up environments for easy integration testing and support in development with dependencies from other partners
- The ecosystem of actors, sample actions, interfaces, APIs and client SDKs, and documentation that can reduce the development and integration time and efforts



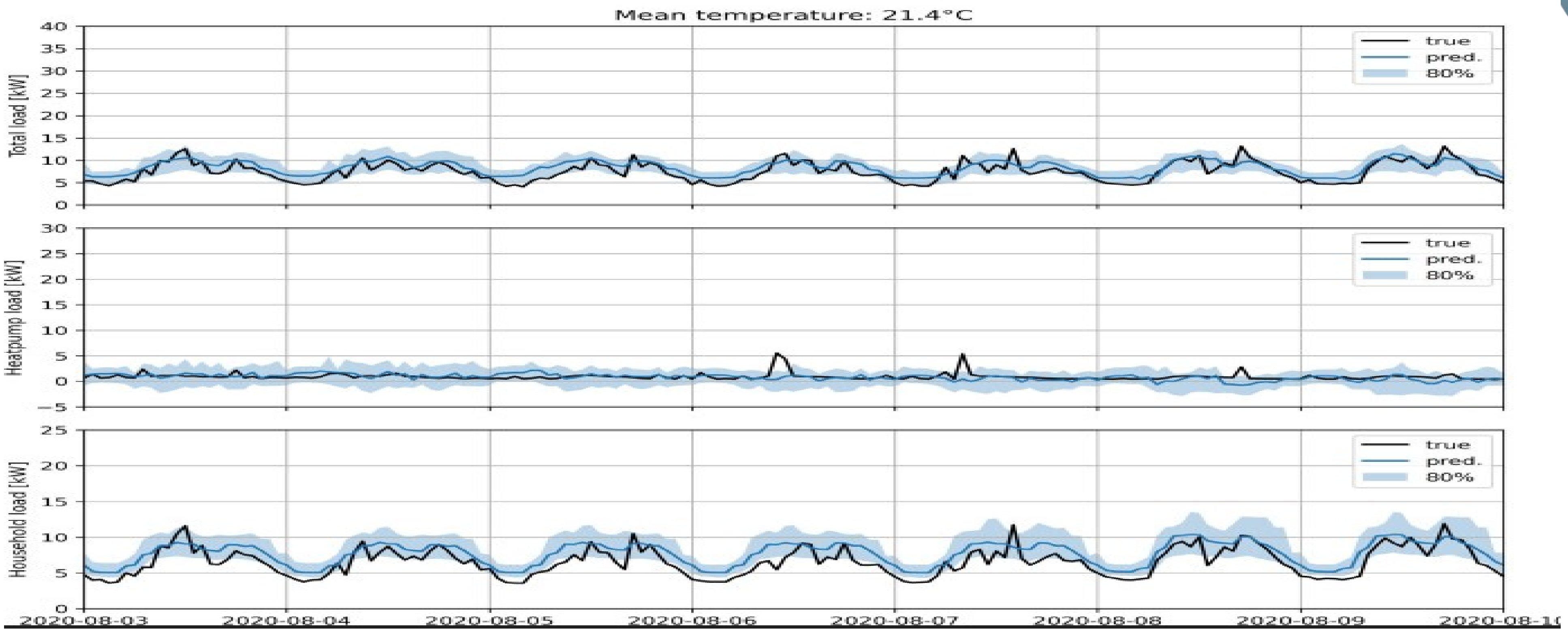
SENDER FRONT-END APPLICATION (QUE)



SENDER UC 2: Maximizing the use of RES

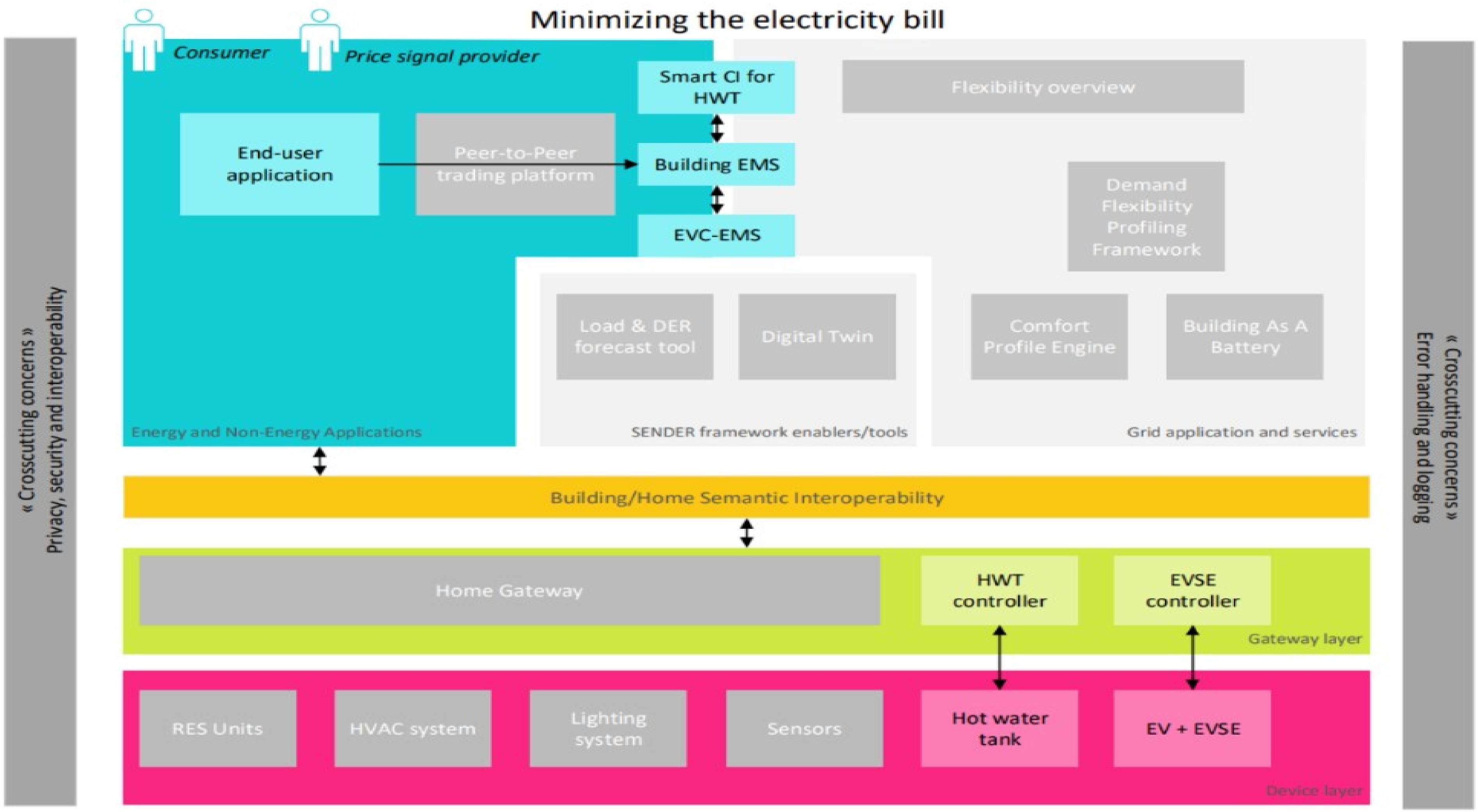


Supply and Demand Forecasting Algorithm Tool (CRS4)



The proposed method produces probabilistic day-ahead hourly forecasts of total energy demand that outperform benchmarks and forecasts of electricity consumption components that are not only more accurate than benchmarks but also close to the accuracy achievable with models trained directly on individual load component data. (Source)

SENDER UC 3: Minimizing the electricity bill



Smart Water Heating System (NXT)

The smart water heater is programmed so that it uses electricity at times when electricity is cheap and switches off when electricity is expensive.

The tank itself downloads the price curve, and everything is automatic in the tank. The smart water heater works like a recharged battery when electricity is the cheapest.

The smart water heater allows control from mobile devices via an app where one can set-up its own management and will also find graphs of the family's water consumption pattern and how the boiler reacts to this. (Source)

Smart water heaters are integrated into the SENDER solution at the Austrian and Finnish demonstration sit

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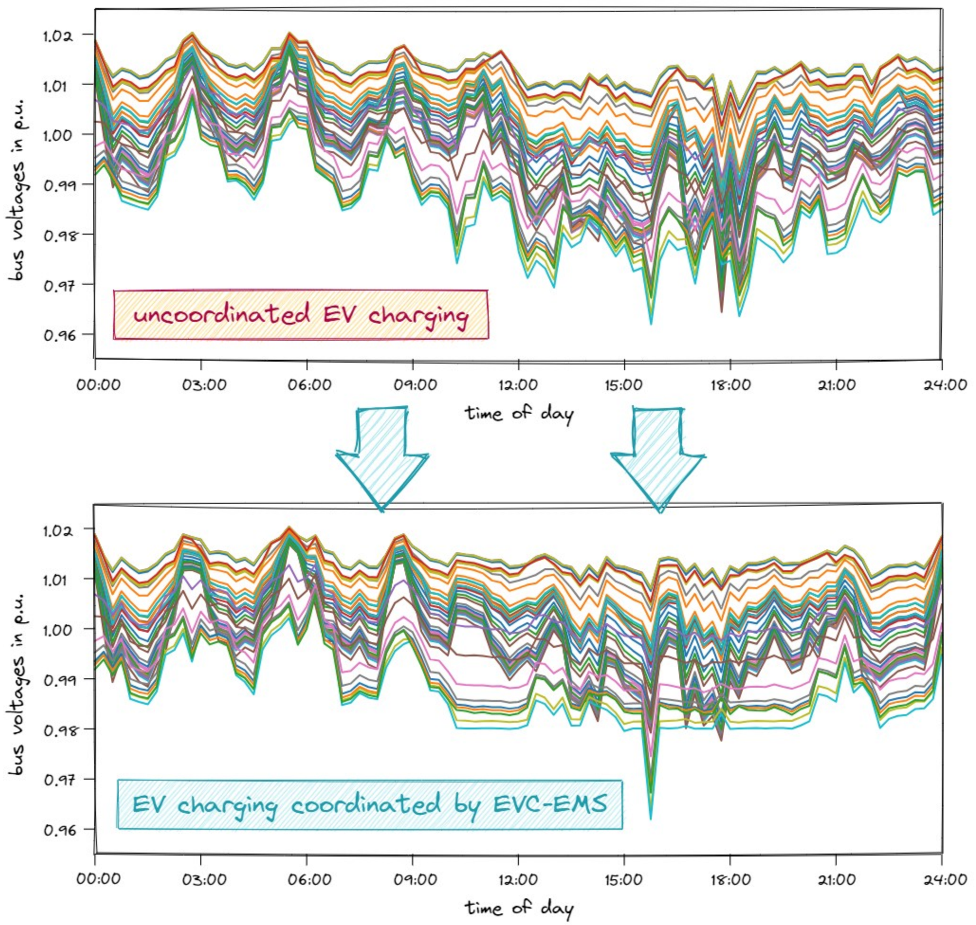
08 - 09	32,243.5	21,408.3	32,243.5	102.01
09 - 10	35,012.5	25,310.2	35,012.5	84.93
10 - 11	37,733.9	28,858.9	37,733.9	65.00
11 - 12	38,890.1	30,991.0	38,890.1	55.77
12 - 13	39,359.7	31,767.0	39,359.7	47.13
13 - 14	38,467.7	32,352.0	38,467.7	44.58
14 - 15	37,999.1	32,171.4	37,999.1	55.00

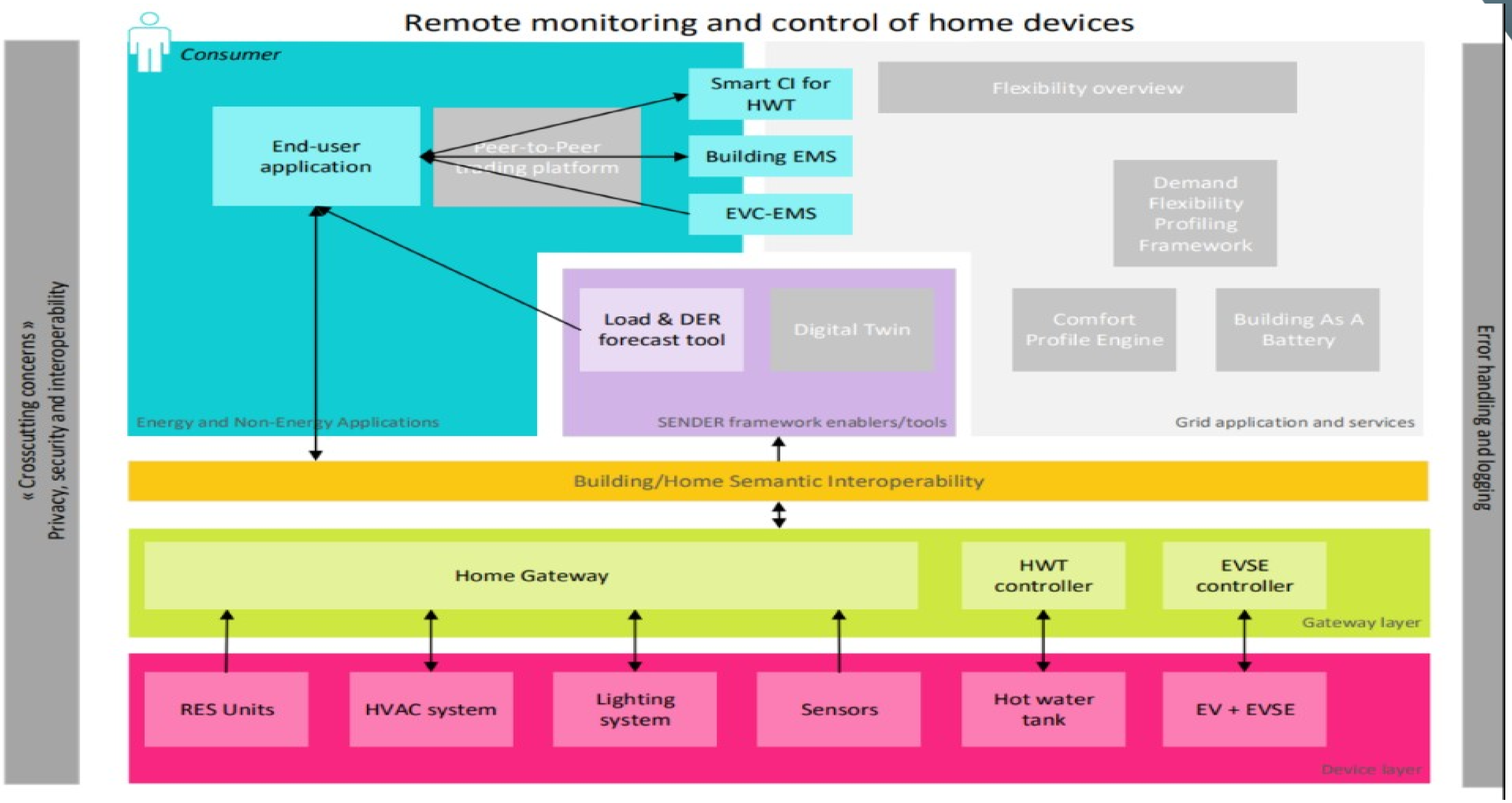
SMART CHARGING EV ENERGY MANAGEMENT SYSTEM (TRIALOG)

Functional Testing of EVC-EMS

- ✓ EVC-EMS successfully utilized for a DR scheme for voltage control in LV distribution network
- ✓ deployed and connected to external system in the same way as in a real-world setup
- ✓ successfully integrated into a Fast DR program (based on OpenADR) , demonstrating the solution’s applicability for next generation DR schemes



SENDER UC 4: Remote monitoring and control of home devices



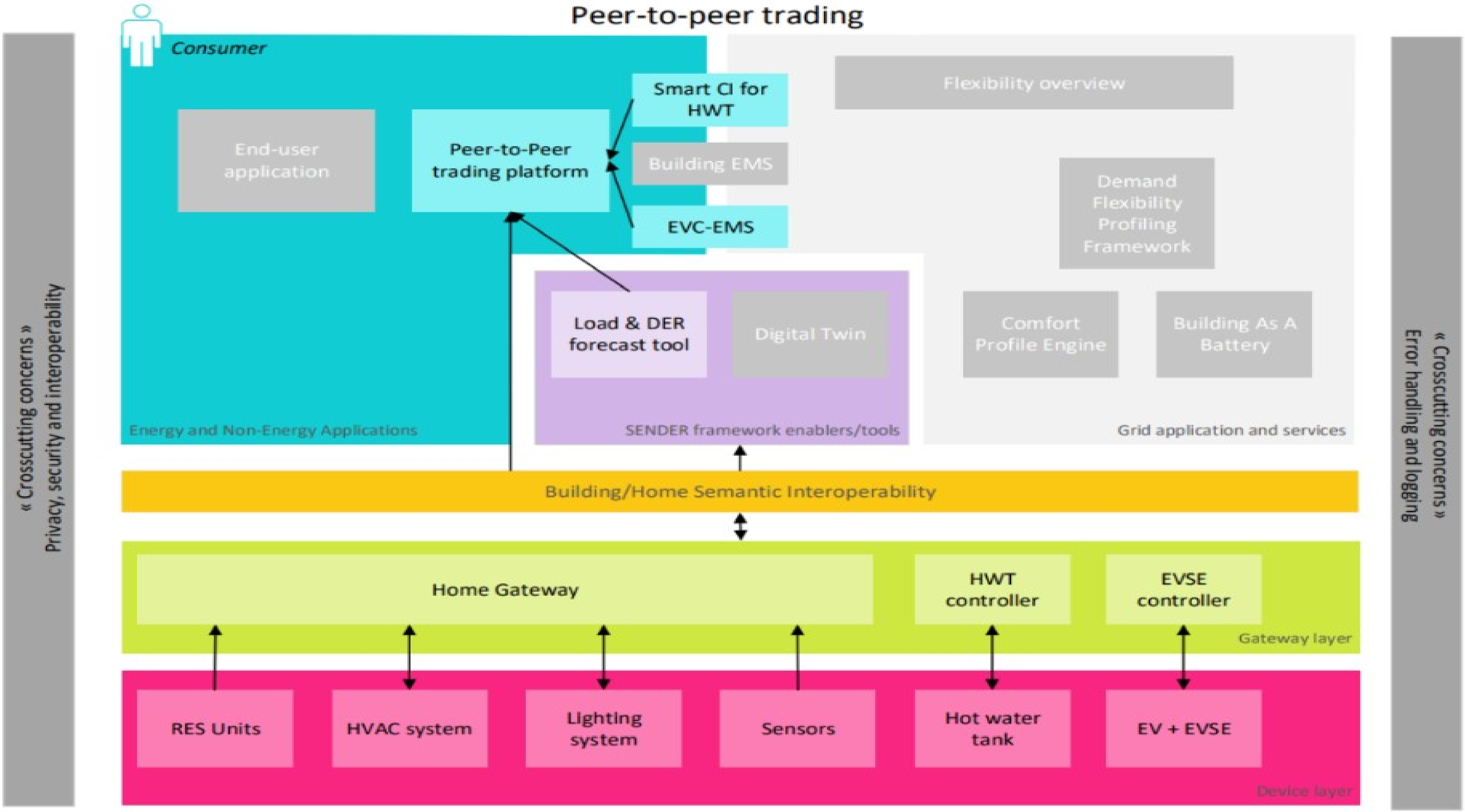
SENDER SMART BOX (HPT)

The SENDER Smart Box is a custom-made device that acts as a building gateway responsible for supporting communication and data transfer from the IoT equipment to the main services of the SENDER system.

The Smart Box mainly aims to establish network connectivity with various off-the-shelf IoT devices over widely used wireless communication protocols, such as Z-Wave, WiFi and BLE. It also supports data collection from the IoTs to the data repository, administrates and heals the local mesh network created by the IoT equipment and finally provides the proper UIs and applications for IoT commissioning and configuration.

A Smart Box is installed in each of the residential pilot sites of the SENDER project.

SENDER UC 5: Peer-to-peer trading



PEER-TO-PEER TRADING SYSTEM (NTNU)

P2P trades 8 hours ahead

Price:

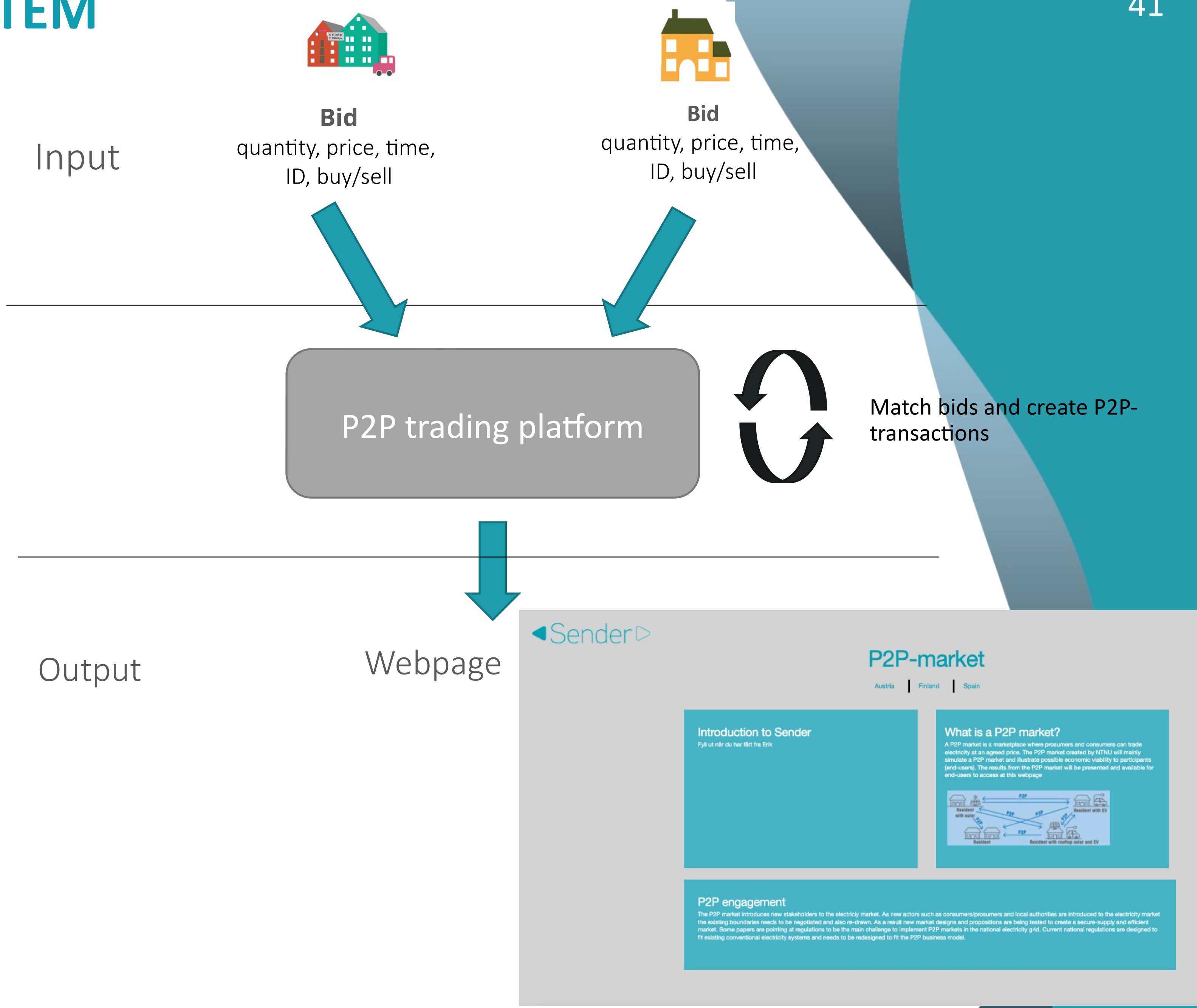
- ✓ Based on day-ahead price in SENDER sites

Quantity, ID:

- ✓ Foreceasting DERs and loads

Quantity, ID:

- ✓ Model uploaded to Github and publicly available
- ✓ User guide developed and tested with students, upload to Github



SENDER Challenges & Lessons Learnt

COVID Impact

- ✓ Challenge: No on-site interaction with project partners
- ✓ Lessons Learnt: Prepare for set-up of remote cooperation; use tools that mirror personal brainstorming interaction (e.g., Miro boards)

Tech Component Supply Shortages

- ✓ Challenge: Limited availability and high prices, e.g., for Raspberry devices
- ✓ Lessons Learnt: Access local tech retailers; swap already procured components between demo-sites

SENDER Challenges & Lessons Learnt

Project Implementation Delay

- ✓ Challenge: Decreasing motivation of demo site users
- ✓ Lessons Learnt: Apply project retention techniques; maintain continuous communication with activated demo-site users

On-site self audit process

- ✓ Challenge: Partly limited self-audit information or no replies
- ✓ Lessons Learnt: Simplification of self-audit questionnaires; set-up of a support procedure; standardization of implementation process

Aggregator involvement

- ✓ Challenge: Limited interest of aggregators to integrate SENDER sites
- ✓ Lessons Learnt: Use the developed aggregator interface to run simulations

active communities & energy prosumers for the energy transition

Antonis Papanikolaou

Hypertech - *Coordinator*

Antonis is a Programme Manager at Hypertech SA overseeing a portfolio of more than 20 projects in the domains of smart energy & buildings. He also serves as the coordinator of the ACCEPT project that focuses on stimulating the active participation of citizens in the energy transition through energy communities.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 957781.

European Commission
Horizon 2020
European Union funding
for Research & Innovation

active communities & energy prosumers for the energy transition

Workshop

Innovative solutions for sustainable energy: lessons learnt from H2020 -ACCEPT

Sustainable Places

Luxemburg, 24/09/2024

EMPOWERMENT OF ENERGY COMMUNITIES

DIGITAL TOOLBOX & INNOVATIVE DIGITAL SERVICES

DEMONSTRATION & VALIDATION AT FOUR PILOT SITES

accept

active **c**ommunities & **e**nergy **p**rosumers for the energy **t**ransition

start date	duration	end date
2021 january	48	2024 dec

16	9	4
partners	countries	living labs

OBJECTIVES

Technical & Technological

- Delivering an integrated tool-chain for the transition of energy communities to fullplayers of the energy & flexibility markets
- Developing a Consumer Digital Twin model to streamline the information exchange between building-level tools and market actors
- Creating a secure and interoperable digital toolbox compatible with the majority of residential building systems used across the EU

Citizen Engagement & Co-creation

- Designing compound (energy & non-energy) service offerings and business models to enable the participation of the residential sector in demand response markets/services
- Identifying incentives and drivers of citizens and energy communities and delivering a citizen engagement methodology to stimulate citizen participation in the energy transition and community flourishing
- Validation of the expected impact of the ACCEPT solution in real-life conditions (citizens, communities) in four European countries and maximize replication potential

ACCEPT UCs and business scenarios

BS 1 – EC as flexible aggregator for ancillary service provision – *ES, NL*

BS2 – EC as ESCO offering energy management services – *ES, GR, NL, CH*

BS3 – EC as ESCO facilitating P2P flexibility trading – *GR*

BS4 – EC as Retailer – *ES, GR, NL, CH*

BS5 – EC optimized operation via P2P flexibility trading – *ES*

BS6 – Heating as a service provider – *CH*

BS7 – Prosumer engagement in Implicit Demand Response – *ES, NL*

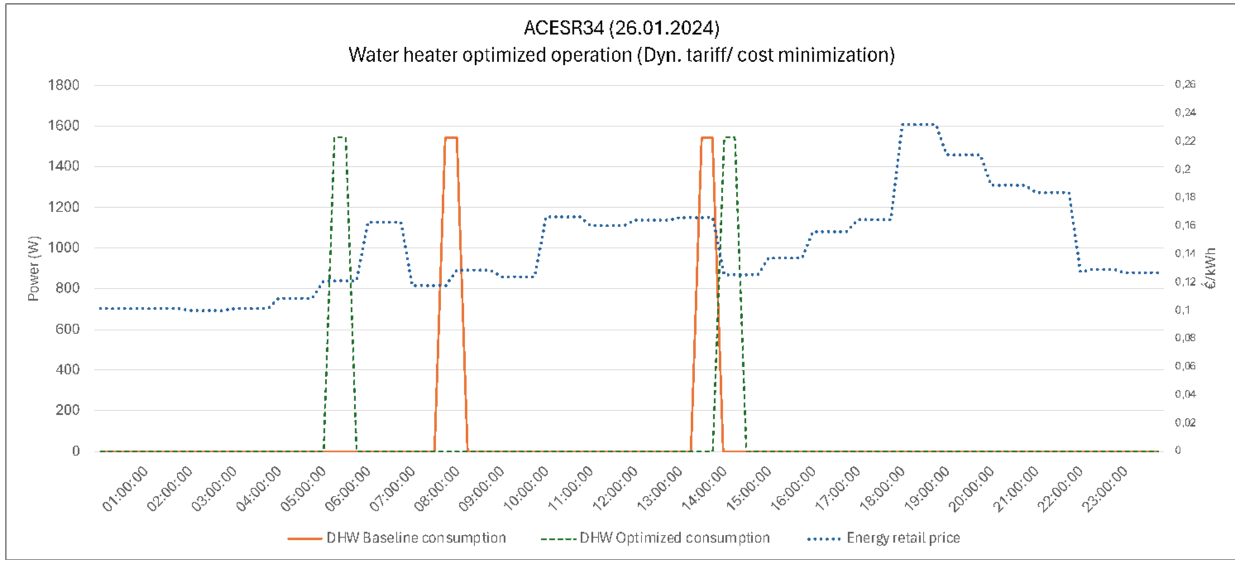
- Metering & Sensor Energy Data
- Virtual energy storage optimisation
- Consumer demand-side flexibility forecasting
- Demand elasticity profiling-forecasting aggregation
- Day-ahead smart charging flexibility quantification
- Community-level P2P flexibility

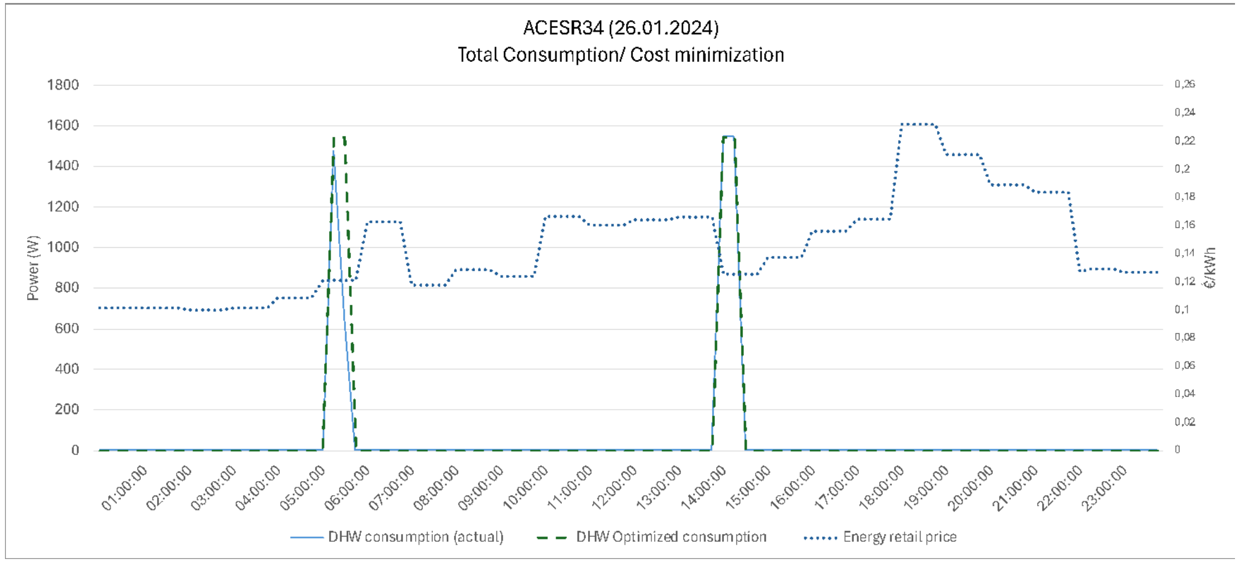
- Increase self-consumption at local level
- Optimal scheduling and operation of heating generation
- Retailer day-ahead optimal pricing configuration
- Participation in Implicit Demand Response schemes
- Participation in Explicit Demand Response schemes

ACCEPT Key Innovations

- Delivery of **ACCEPT Digital Toolbox** designed to
  - enable the ***delivery of energy & non-energy services*** to community members and
  - optimize the ***aggregated flexibility*** potential at district-level
- Delivery of Energy & Non-energy services which achieved prosumer **acceptability and benefits** from Energy Community schemes
- Creation of value propositions for a set of **intra-community service offerings beyond ACCEPT**
- Creation of **business models on different roles** that energy communities can assume **in the energy markets**

ACCEPT Results – Consumer demand-side flexibility forecasting





Daily figures

Total electricity cost (baseline): 1.90€

Load electricity cost (baseline): 0.22€

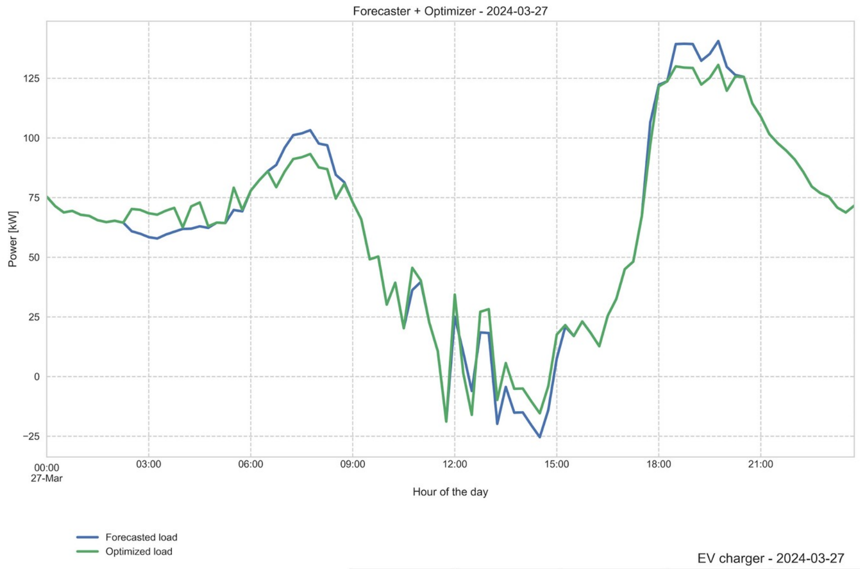
Total electricity cost (ACCEPT): 1.84€

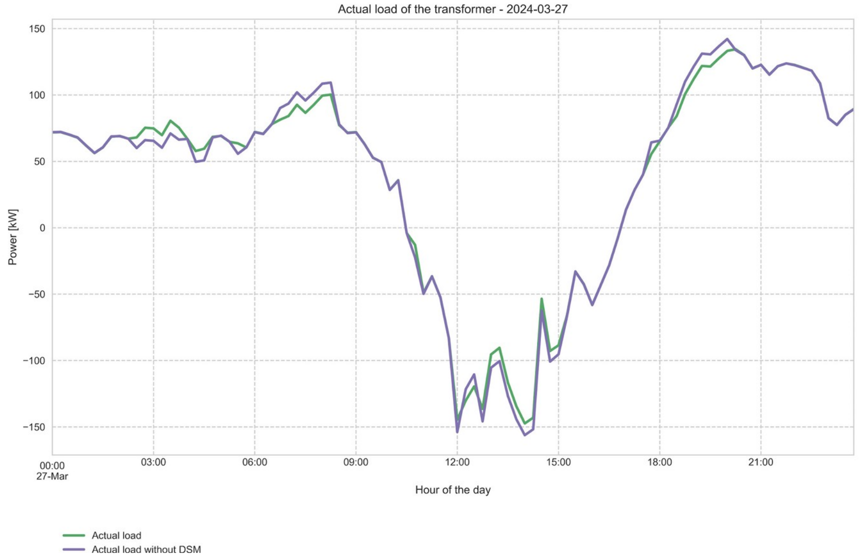
Load electricity cost (ACCEPT): 0.16€

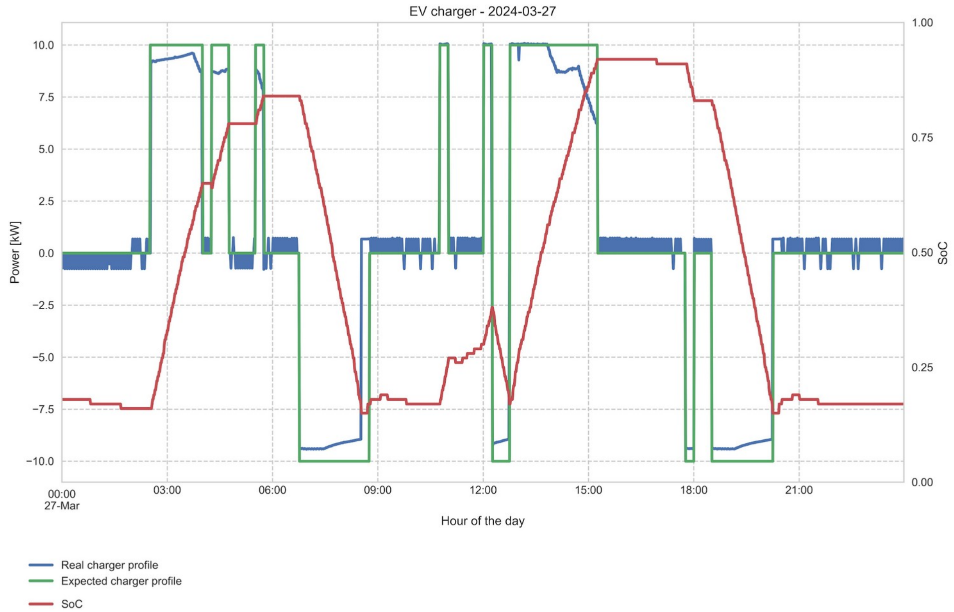
Total cost savings: 0.06€ (3%)

ACCEPT Results - Day-ahead smart charging flexibility quantification

Optimized control of V2G charger at Tesserete, Switzerland







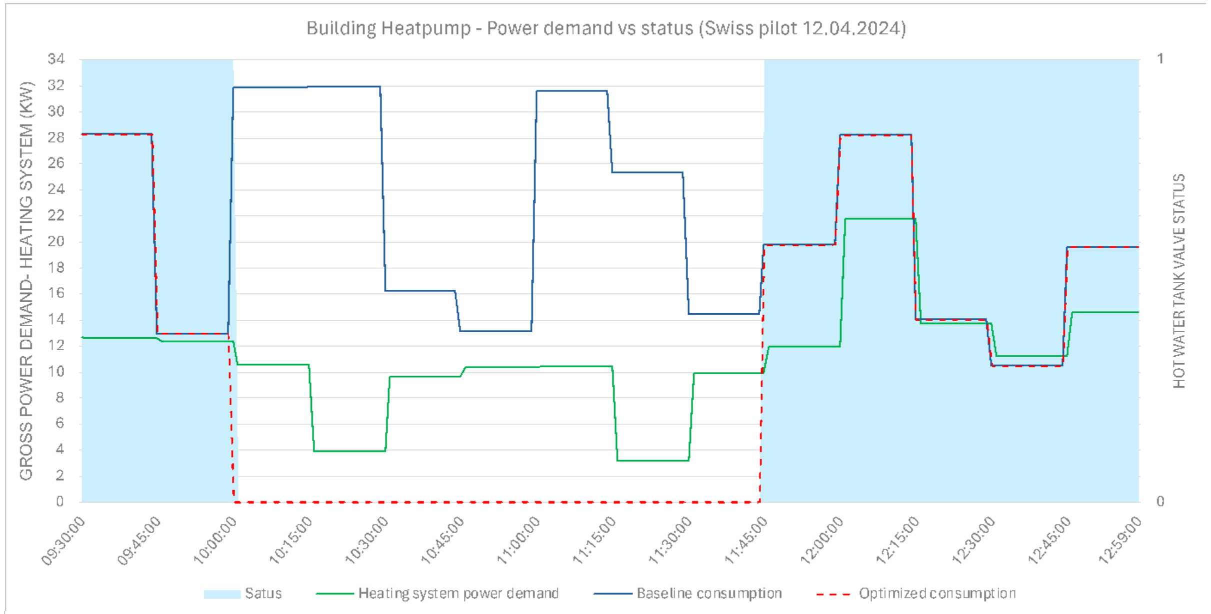
Peak without DSM: 143 kW

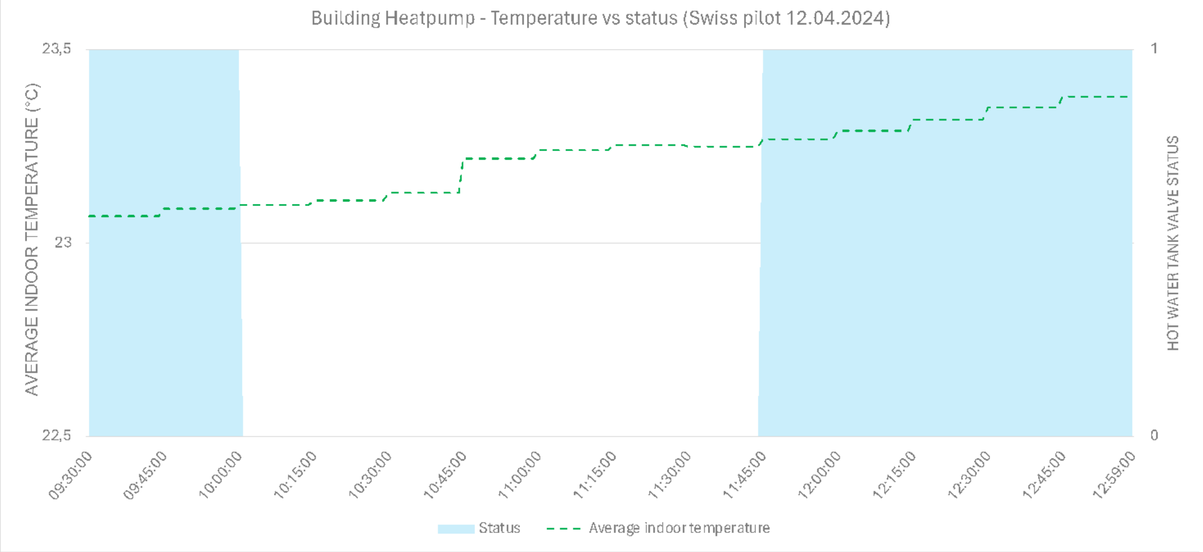
Measured peak: 135 kW

Peak load reduction: 6%

ACCEPT Results - Participation in Explicit Demand Response schemes

Control automation on heat-pump system at a Retirement Home, Switzerland



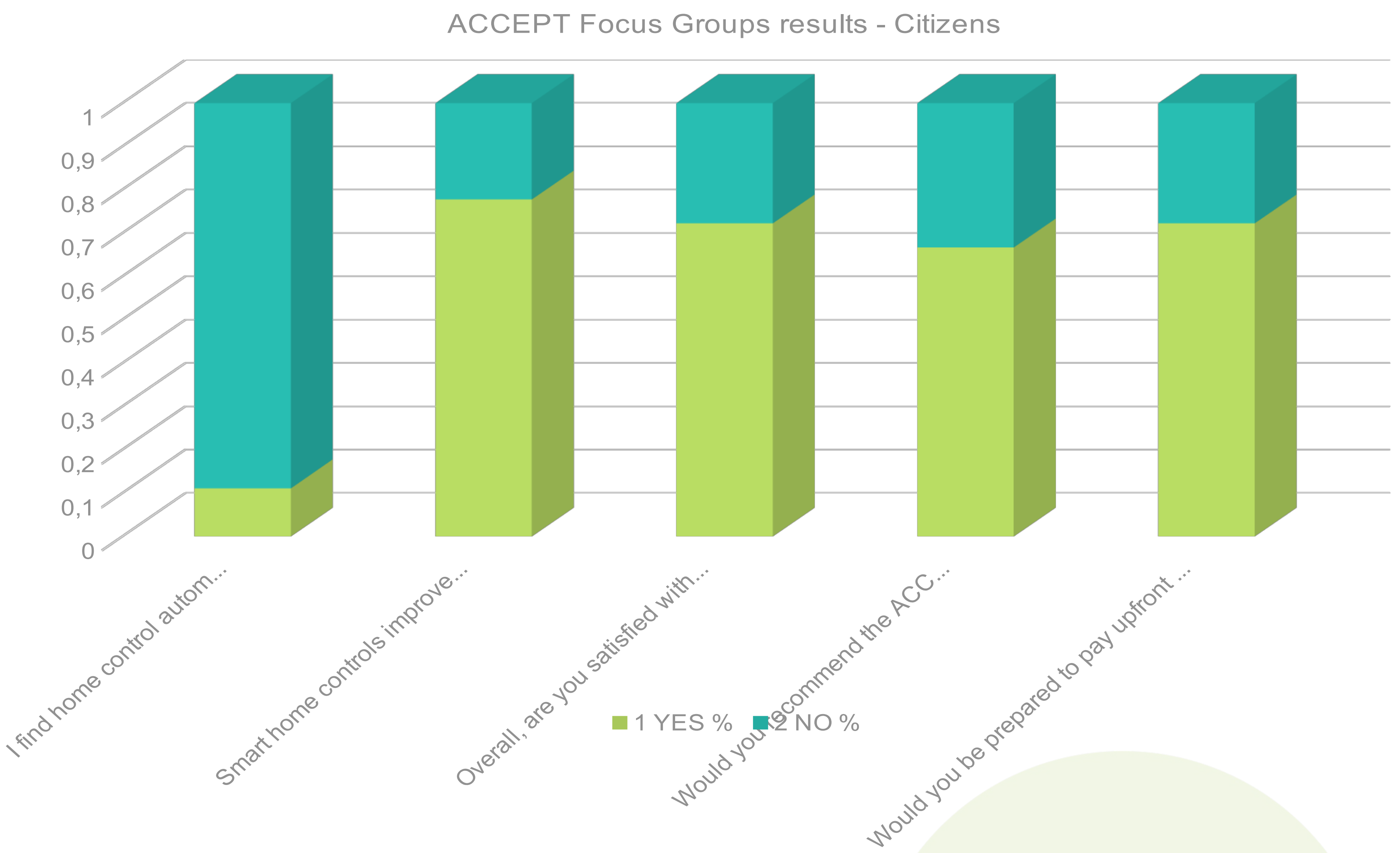


Flexibility Potential : 41 kWh

Achieved flexibility: 14.55 kWh

Disruption of Indoor temperature: No noticeable change

ACCEPT Results – Focus Groups on Citizens using the ACCEPT Solution



ACCEPT Lessons learnt

Issue Identification	Action taken	Lesson Learnt
Delays in the pilot deployment: • *difficult access to the pilot site* • *lack of experienced project team to install IoT systems* • *difficult coordination of multiple parties involved*	*Re-definition of deployment process and collaboration between pilots towards a highly flexible technical solution.*	*(1) **Be flexible in planning & implementation.*** *(2) **Share the wisdom!** - Support from more experienced pilot partners is valuable*
Pre-existing timers hindering the deployment of planned equipment	*Development of a scheduler in the consumer app that replaced the timers on site -based on the co-creation activities of ACCEPT.*	***Listen to user needs and address them!** - True consumer needs are not always obvious. An agile development process is necessary for tools of true added value.*
Users concerns on health regulation compliance during testing - Concerns of Legionella due to regular intervention with the water heaters	*An agreement was reached to limit number of interventions to address concerns.*	***Don't be a stranger! Keep in touch!*** *Real life concerns of users involved are not always foreseen thus post deployment communication should be maintained.*

ACCEPT Lessons learnt

Issue Identification	Action taken	Lesson Learnt
User motivations varied throughout the pilot sites, hindering the user engagement and often producing no clear benefits for the users.	*Demonstration activities were adapted to each pilot specificities to better address their individual drivers.*	***No one strategy fits all.*** *Diverse EU regulations and site specificities lead to diverse participation drivers for the users.*
Concerns of one user easily became concerns of the entire community.	*Keep everyone in the loop, address concerns openly, support open discussion. Find a project champion that is trusted by community members.*	***Communication is critical & having a local project champion helps!***

PROJECT CONSORTIUM

HYPERTECH energy labs

circe

SMART INNOVATION NORWAY

viesgo

Energie Samen Rivierenland

witside

UCC University College Cork, Ireland Coláiste na hOllscoile Corcaigh

RINA

lasolar

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CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS

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How to overcome barriers?: Inspiring examples of HESTIA, ACCEPT and SENDER

Hestia

Round Table

Moderator: Stéphane Pouffary, ENERGIES 2050, HES

Q&A
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Matteo Cavalletti
Technological provider

MIDAC BATTERIES · Hestia

Pablo Barrachina
Pilot leader (Spain)

MIW ENERGÍA · accept – active communities & energy prosumers for the energy transition

Christian Kunze
Coordinator

SMART INNOVATION NORWAY · SENDER

A conclusion to move forward

The HESTIA, ACCEPT, and SENDER projects contribute to demonstrate the **enormous potential of renewable energy communities** to accelerate the global transition to a sustainable, low-carbon future.

Their innovations are paving the way to **multiply the number of Energy Communities**, particularly those based on renewable energy. By empowering citizens as prosumers and fostering decentralized energy systems, these projects are crucial for addressing **climate change** and supporting the **implementation of the Paris Agreement**.

Energy communities offer a key solution for reducing reliance on **fossil fuels**, directly contributing to the goal of **reducing global energy demand** and expanding **renewable energy deployment**. Their scalability is essential not only for developed countries but also for **developing nations**, where inclusive and affordable energy solutions are critical for a **just transition** that leaves no one behind.

As we move forward, these innovations will be instrumental in achieving global climate targets, ensuring energy security, and delivering a fair and equitable transition away from fossil fuels towards a future powered by clean, renewable energy.