PRELUDE

Prescient building Operation utilizing Real Time data for Energy Dynamic Optimization

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under Grant Agreement N° 958345. Call identifier: LC-EEB-07-2020

ABOUT

The PRELUDE project represents the improvement of the buildings smartness through minimization of energy utilization, maximization of self-consumption and Renewable Energy Sources investment and personalization, reduction of CO_2 footprint and improvement of comfortable and healthy indoor conditions. This will be possible through the combination of innovative, smart, low-cost solutions and proactive optimization service.

For more information you can visit this website: www.prelude-project.eu

This is the third release of the PRELUDE Project newsletter. An updated report of the activities and results achieved in 2023 within Work Packages 4, 6, 7 and 8.

RESULTS UPDATE

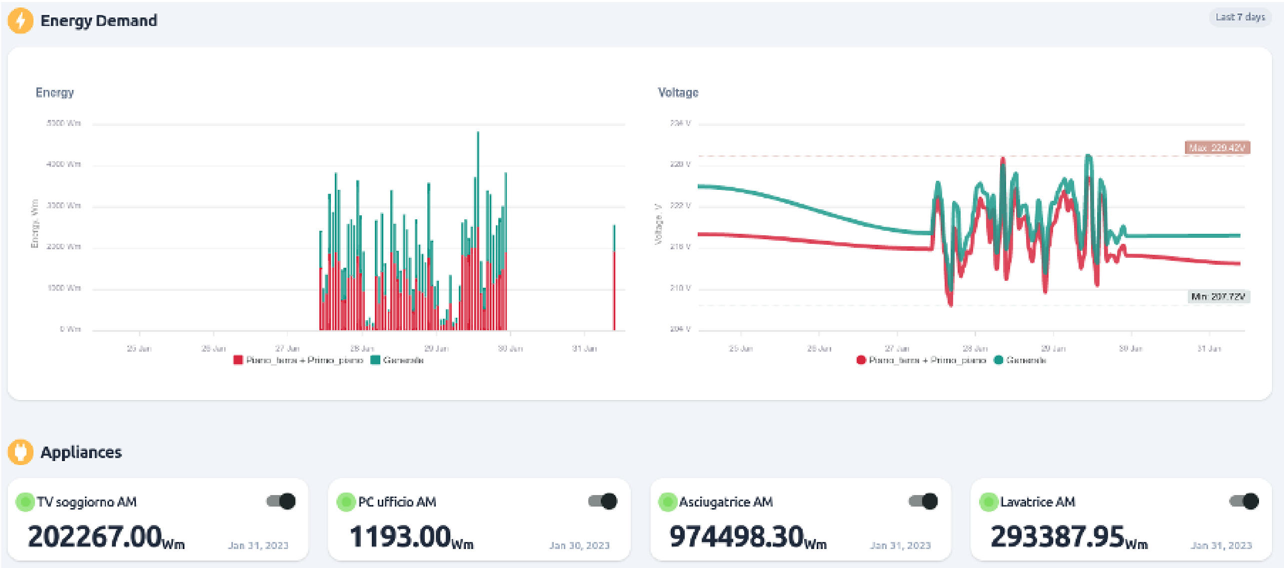
WP4_STAM
Proactive optimization functions

The PRELUDE platform algorithms, developed within WP4, are targeting the facility energy efficiency, the users' comfort and wellbeing enhancement, the predictive maintenance of the main appliances and their results through validation and verification of the implemented optimization strategies.

The synergies between these services help the final user in making the optimal decisions about energy aspects in his/her building in various real-life situations. At first the "RES selector" tool, by using a set of energy data from the past, support the person in the optimal investment of technologies such as: photovoltaic panel, wind turbines and heat pumps. Moreover, thanks to the "Predictive Maintenance" tool, it is possible to monitor and predict the health status of these assets, to detect anomalies in the energy data and prevent possible failures.

In an everyday situation, the user can have information about the forecasting of the energy consumption and production thanks to an ad-hoc algorithm. Moreover, by using this information, the "Comfort Optimizer" tool can provide a weekly optimal energy behaviour in a user-friendly environment. The algorithm suggests the optimal energy activities by considering: the usual energy consumption, the user-wanted indoor comfort and the energy production and/or storage. The user can play with this tool by selecting the different optimizer input and watching the outputs related to the planned cost savings and the indoor comfort conditions.

Finally, the developed "M&V" algorithm can perform multiple simulations on past and present data to quantify and validate the energy savings achieved through the implementation of a specific energy-efficiency interventions, such as the one in the PRELUDE project.



Energy monitoring, consumption & sensors' status

Energy monitoring, production

WP6_FORSCHUNG BURGENLAND Validation and demonstration in relevant environment

In the Living Laboratory Environment (LLE) ENERGETIKUM, an office building located in Austria that serves as a test site under real operating conditions, all relevant PRELUDE components were implemented and validated. The building was equipped with additional sensors and communication infrastructure to fulfil the requirements for testing in PRELUDE.

During the third year of the project, the long-term test and testing-scenarios for different automation levels and solutions had been successfully completed. All key performance indicators (KPIs) for validating the objectives of the grant agreement were achieved by long-term test in the LLE.

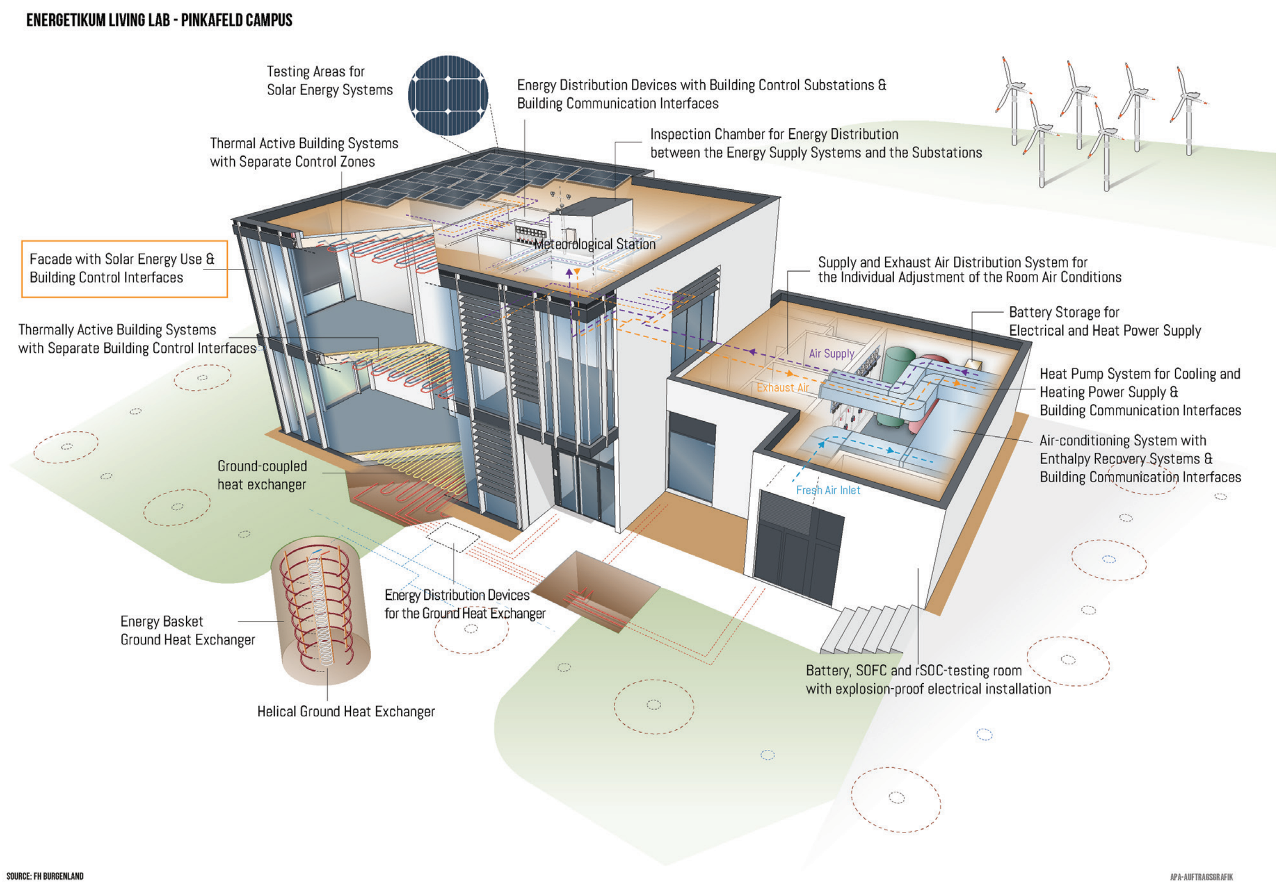
EMTECH's FusiX middleware plays a crucial role in this setup, enabling efficient data transfer and user interaction. PRELUDE offers specialized solutions for buildings with varying levels of automation. For those with minimal automation, it introduces three modules. The first two modules focus on optimising the control of buildings in a free-running state, where no active heating or cooling is needed, thus saving energy. BUL's Climate Correlation module estimates indoor environment quality based on weather forecasts, advising on actions like window opening or shading. POLITO's Dynamic Free Running Module, using the PREDCYE model, forecasts indoor climate and suggests manual control actions. STAM's Comfort-Energy Efficiency Optimiser helps residential users balance comfort and energy consumption using Deep Learning and thermal models.

For more automated buildings, the Data-driven Predictive Control (DPC) module, developed by FB and UASB, has shown impressive results in the LLE. It uses a grey-box model for building thermal dynamics and of the Heating, Ventilation and Air Conditioning (HVAC) systems to optimise energy costs and provide comfort in the LLE. LIBRA's Measurement and Verification (M&V) Framework validates its energy savings.

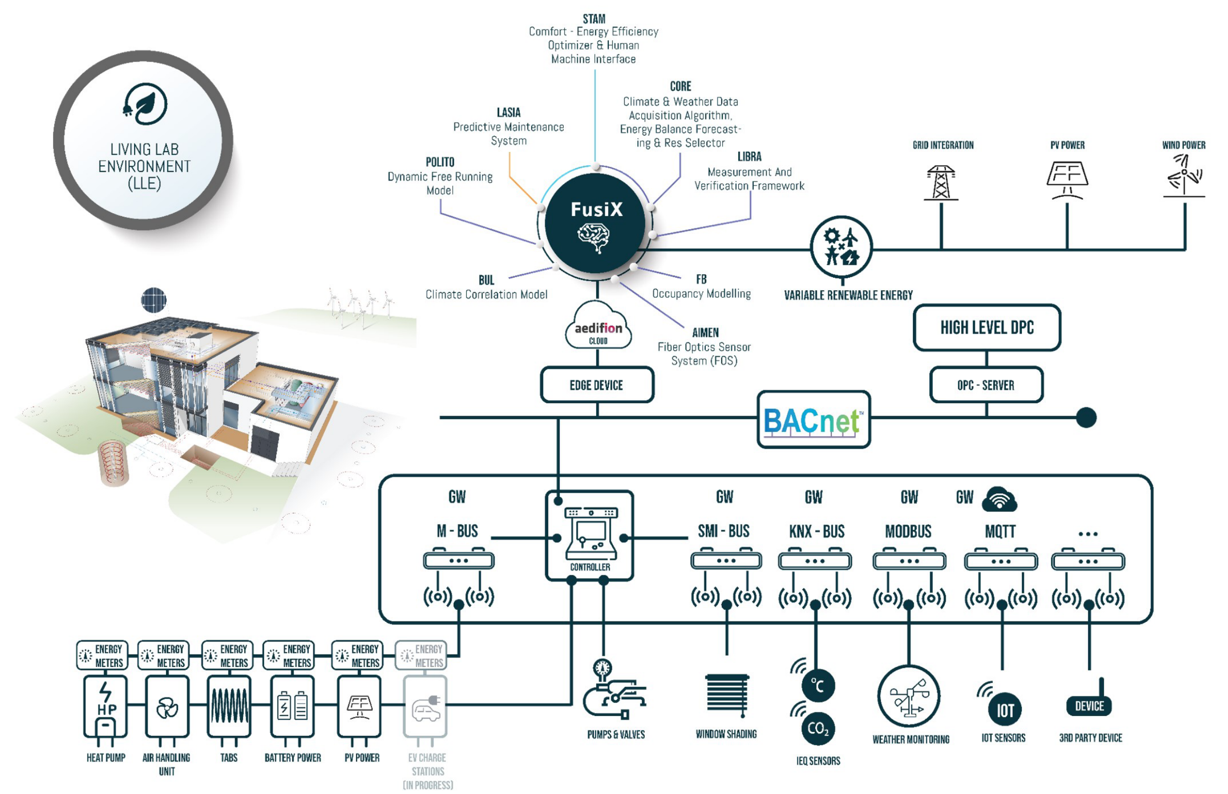
Additional modules like AIMEN's Fiber Optic Sensor system for detailed temperature and humidity measurements, CORE's Weather Forecast and Energy Balance Forecasting modules, and FB and UASB's Occupancy module support these optimisations.

LASIA's Predictive Maintenance system and CORE's Renewable Energy Source (RES) Selector extend the project's scope, focusing on long-term building maintenance and energy investment decisions.

Successfully implemented, improved and validated in the LLE, the PRELUDE solutions demonstrated its potential in a real office building. This paved the way for expanding the PRELUDE solutions to further demonstration buildings in Athens (Greece), Krakow (Poland), Geneva (Switzerland), Turin (Italy), Egernsund and Ry (Denmark).



Energetikum living lab, Pinkafeld campus



WP7_1AI
Demonstrations in operational environment

In 2023, WP7 has developed numerous advances, among which the development of deliverables D7.1 to D7.6 stands out, in which the progress and first results of the actions carried out in the pilots were shown. In Deliverable 7.2, we identified the potential of the Geneva case study for PRELUDE technologies implementation.

Several technologies were implemented or tested on the case study with some results already available for some of them. For example, the VRE used the installed PV system data and battery characteristics to evaluate the potential for system optimization.

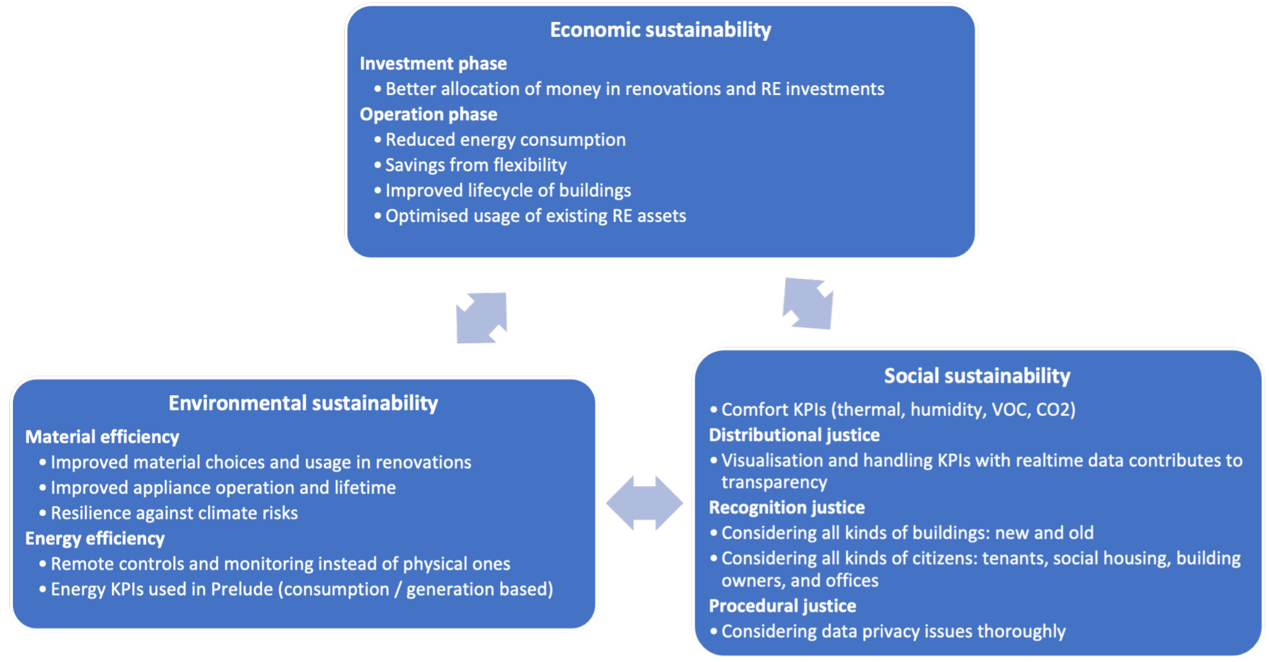
A Renewable Energy Source Selector was also tested with available building data, indicating that wind turbines could be implemented on site to produce electricity with an interesting production rate. The overall heating system is performing well, and the combination of the gas heater with a Heat Pump working essentially on PV-produced electricity is a solid solution for reducing energy consumption in this building.Deliverable 7.3 of the PRELUDE project focuses on implementing and testing connected technologies and smart solutions in a residential building located in Turin.

The building, constructed in the 1960s-1970s. Key components of the PRELUDE solutions are being tested such as the dynamic free-running model or comfort and energy efficiency optimiserwhich will be evaluated by the measurement and verification framework to know the performance of these solutions.In Athens and Krakow we find the pilots with the lowest level of technology, where the main aim is to improve the climatic conditions. Of particular interest is the case of Krakow where fibre optic sensors have been installed which will allow accurate measurement of conditions inside the building.

PRELUDE solution is demonstrated and tested in two single-family houses, which are nearly zero energy buildings (NZEB) equipped with modern heating, ventilation, and house control technologies. The Danish demonstration focuses on two challenges relevant to NZEB buildings. The first challenge is that actual energy use by NZEB buildings is higher than expected. Elevated temperatures during the heating season counteract energy efficiency solutions. Occupants often increase room temperature for comfort, which is affordable. A test of reducing room temperature is ongoing, with preliminary results showing acceptance at 22 °C.

The second challenge is the use of historical, live, and forecasted data. Historical data identifies building performance, while live data enables control and monitoring. Combining this with weather and price forecasts allows smart control, bringing energy and economic savings and load shifting.

WP8_TAU
Holistic Sustainability Strategy



Summary of the Prelude's sustainability aspects in three pillarss

Task 1: Business model landscape/ TAU

The deliverable D8.1. summarises this task's work. This has included analysis on macro and micro-level.

On the macro-level, the regulatory landscape and development of relevant infrastructure were analysed in case countries. On the micro-level, energy community creation, economic evaluations, potential value streams,

	NECPs	Energy communities	Explicit Demand response	Smart meters	Electricity prices
Italy	***	***	**	***	***
Greece	**	**	*	*	*
Poland	*	*	*	*	*
Switzerland	n/a	**	**	*	*
Denmark	***	**	***	***	***
Finland	**	**	***	***	***

Summary of the regulatory comparison in case countries (deliverable 8.1)

and HEMS service provider business models were studied. Also, the BUC workshop efforts done within the WP9 studies have been extended with studies within the demo pilots.

Task 2: Life cycle analysis / Brunel

Aim of this task is to conduct a life cycle analysis on the environmental and economic impacts of the retrofits and other changes done in the demo sites. This gives a better understanding of what is the scale and scope of different renovation andenergy efficiency efforts in the building sector. So far, studies have been conducted for Geneva, Krakow, Ry and Athens buildings, and others are also nearly done. Collecting data is a major part of the work, as the cases are very different and there are also differences in local practices on what and how it is collected and stored.

Task 3: Transferability / Eurocore

Transferability refers to the ability to do similar services in other countries and contexts. In this task, this is being done through stakeholder analysis and interviews. Here is a list of barriers and drivers related to transferability.

Categories	Barriers	Drivers
Economic	Access to capital	Increased capital allocation to energy issues, especially in the private sector
	Hidden costs	Dissemination of industry-wide knowledge about energy-efficient technologies and methods
	Lack of financial resources	Innovative funding models for retrofitting challenging properties
	Split incentives	Aligning incentives between landlords and tenants, possibly through policy interventions
Behavioral/ Social	Inertia	Early capacity building and encouraging individuals to step beyond their comfort zone
	Fear and resistance	Building confidence through success stories, education, and transparent information sharing
	Lack of knowledge	Disseminating knowledge about energy-efficient technologies and their benefits
Organizational	Lack of support	Establishing support networks within organizations, fostering a culture of energy consciousness
	Lack of technical knowledge	Providing training, workshops, and resources to enhance technical understanding
	Conflicts of interest	Creating transparency, clear guidelines, and codes of conduct
	Limited accurate information	Enhancing accessibility to reliable information through centralized databases or platforms
Regulatory	Policy barriers	Legal energy efficiency targets, consistent government policies, expanded funding
	Need for individual design	Implementing standardized approaches
	Lack of mandate and values	Advocating for policies mandating energy efficiency and promoting value-driven decision-making
	Poor equipment performance risk	Quality assurance standards, certifications, and regular maintenance protocols for equipment

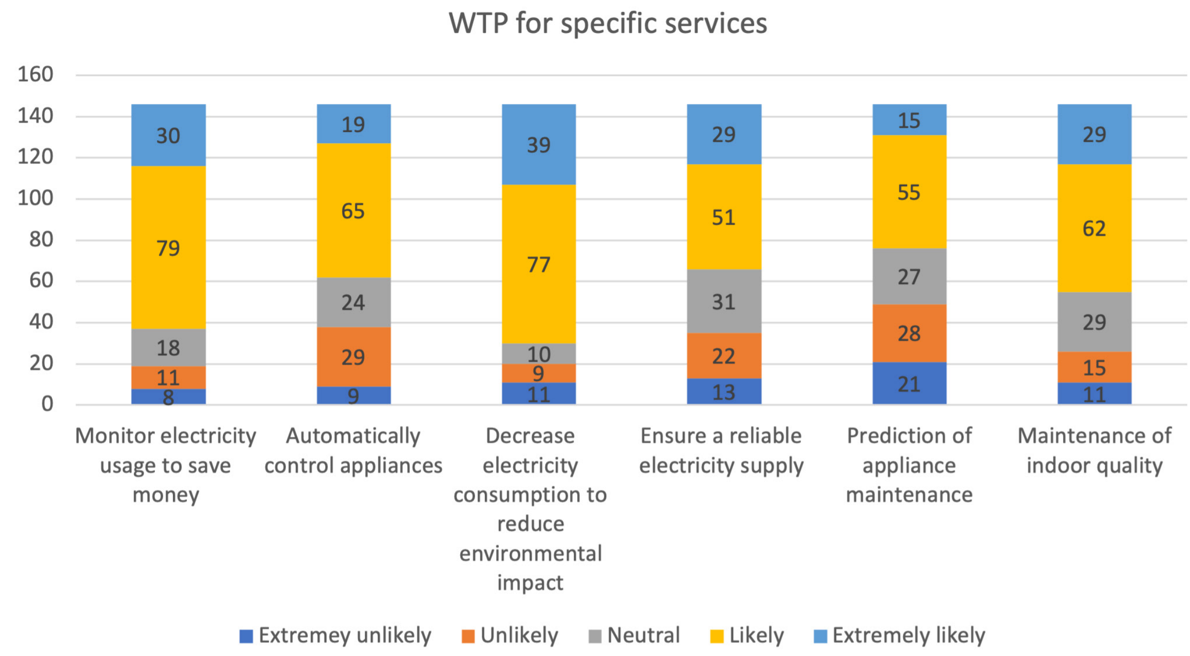
Task 4: Consumer to prosumer transformation (ended M30)

This task was summarized in deliverable D8.4. A review on the existing literature reagrdin consumers' adoption of distributed energy resources show a variety of of barriers and drivers that can be addressed by companies.

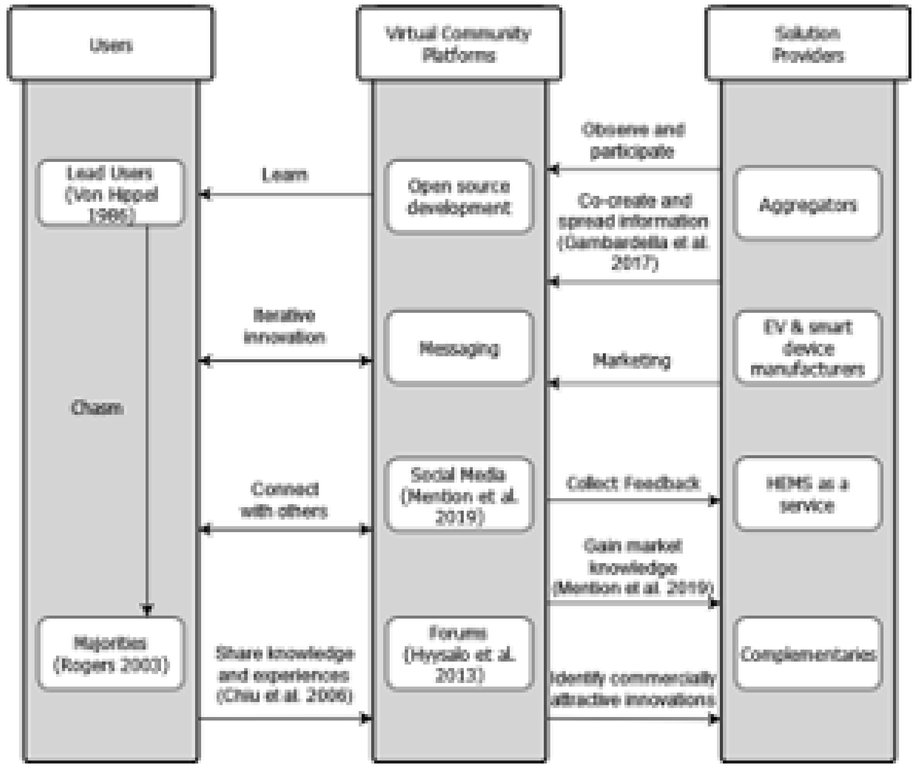
Barriers	Drivers
Systemic • Lack of organizational and institutional support • Uncertainty around regulations and subsidies • Hard to find objective experts	Environmental • Benefitting the grid with flexibility • Carbon, pollution, waste saving
Behavioural • Uncertainty and mistrust that the system will perform as desired • Lack of knowledge • Aesthetic and impact on residence • Perceived increase in maintenance • Presence of different opinion within a household • Satisfied with existing system • Not willing to change routines	Economic • Saving money • Transparency on appliances' energy usage
Technical • Technological complexity • Technical flaws and lack of warranties make the system obsolete • Poor compatibility with existing infrastructure • Stage of technology readiness	Convenience • Controllability of devices
Economic • Investment cost, long pay-off time • Lack of subsidies and not sufficient rate of return	Social benefits • Symbolic value and peer effect • Networking and shared interest in new technology

Summary and classification of the barriers and drivers.

A cross-country survey was conducted on the willingness to pay for a home energy management system. The answers showed that customers were interested in being able to better monitoring their electricity usage and decreasing their environmental impact. Benefits from other PRELUDE-related services like predictive maintenance and indoor air quality maintenance were slightly less attractive. Resulsts also indicate, that learning to use HEMS needs to be easy, and that the perceived usefulness of HEMS is based on the quick accomplishment of tasks.

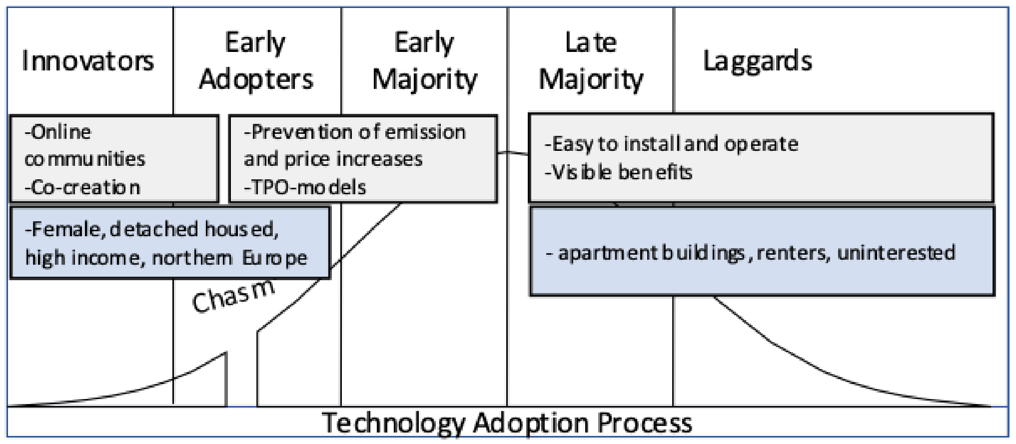


The deliverable also included a survey on user-innovators and benefits they can bring during the commercialisation of HEMS innovations. The Figure in the next page shows the different feedback mechanisms that virtual platforms like forums, open-source development and social media can play in the process.



Framework of user and solution providers' interaction in virtual communities

The Figure below shows the different drives and innovation adopter characteristics within the technology adoption lifeccycle (Moore, 2002)



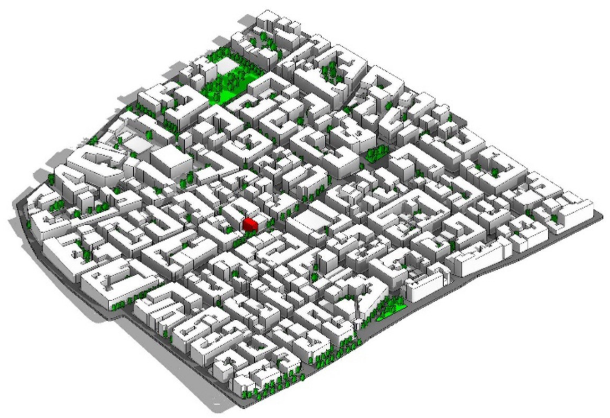
Moore, G. A. (2002). Crossing the chasm: Marketing and selling high-tech products to mainstream customers. HarperCollins cop.

Task 5: Climate resilience modelling / POLITO

This task takes two approaches to make the Prelude solution future proof. First, it studies the future climate change impacts building retrofitting choices in the future. This is done through simulation scenarios, based on extensive history and future weather databases from Copernicus and Eurocordex.

Second, it will study how urban conditions affect energy use and indoor comfort in buildings. The demo site in Athens is used as an example. Many elements need to be considered when simulating the urban environment: building characteristics, urban air and surface temperatures, solar obstructions and urban canyon wind speeds. Bioclimatic designs can take these special circumstances, fostered by climate change, into account in building renovations and smart solutions.

They use a tool to adjust temperature and wind speed, creating a unique weather file for the urban area. They simulate the building with typical and urban weather files, also considering nearby structures. For the future, they use climate change scenarios for 2050, adapting them to the urban setting. The focus is on understanding the impact of these factors on energy consumption and indoor comfort.



Location of the Athens demo is in a densely populated area with specific impacts of climate change to buildings and indoor comfort

Task 6: Building renovation roadmap

In this task, Core and Estia are developing the building renovation estimation tool EPIQR into a customer-friendly application, with appropriate user interface, database on the renovation choices, and backend programming. The tool includes different categories, such as heating, cooling lighting and renewable energy sources. The task includes testing the application with project partners, and eventually, final launch of the product.

Task 7: Regulation compliance and data security monitoring / EUROC

Eurocore is leading the work to research and analyse the regulatory compliance of the PRELUDE service. This work has included gathering information about the technical standards (database available at https://eurocore.be/prelude/), cyber security measures, and data management provisions, as well as seminars and other ways to help partners with the GDPR consents.

Connect with us!

Are you interested to stay updated about PRELUDE project developments?

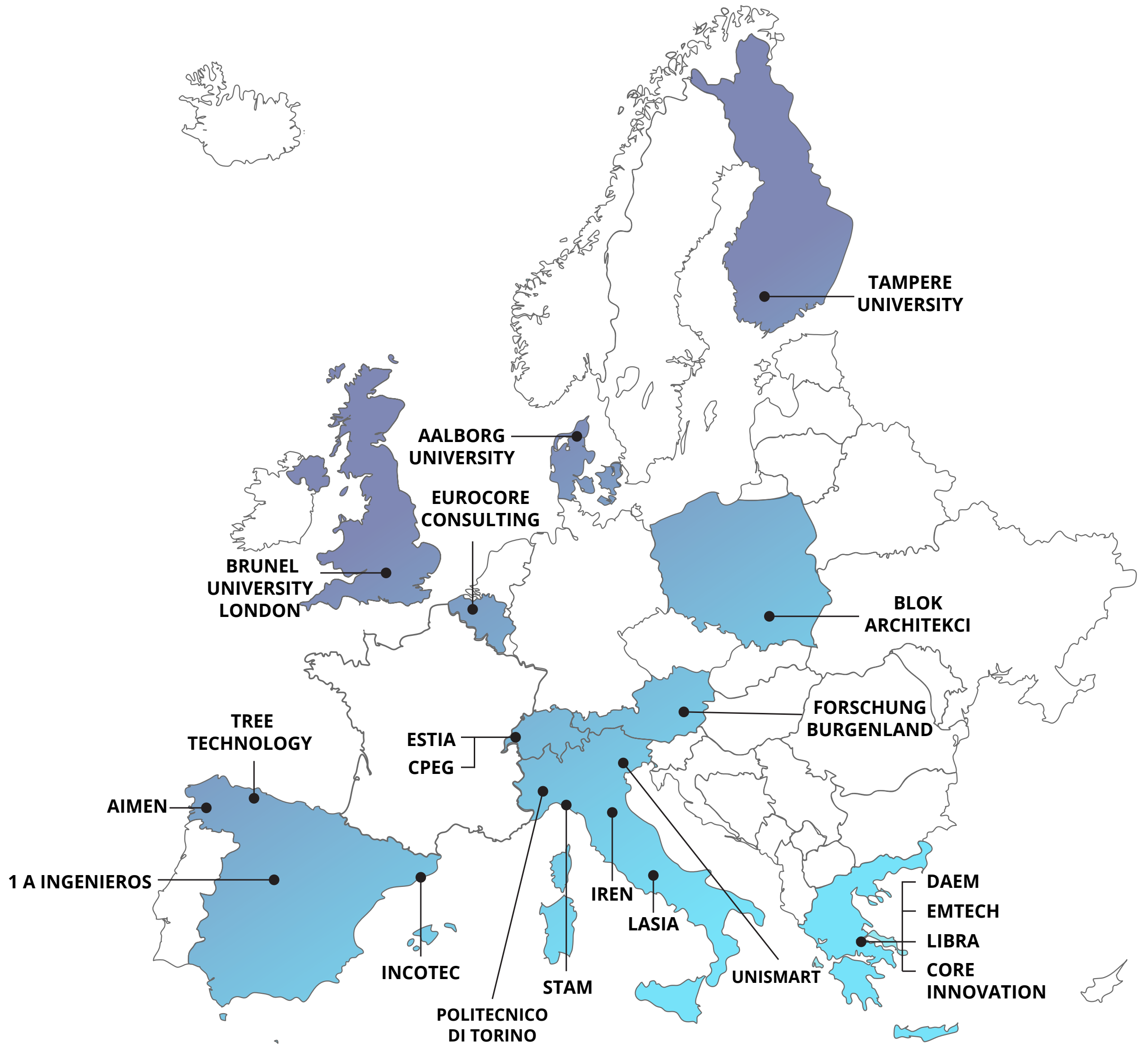
Are you a professional in the field of building or energy service providers interested in collaborating with PRELUDE partners?

Contact us to share your feedbacks and ideas on this page.

Project Coordinator:
Michal Zbigniew Pomianowski
Aalborg University
mzp@build.aau.dk

Dissemination and Exploitation Manager:
Stefano Giulitti
UniSMART Fondazione Università degli Studi di Padova
stefano.giulitti@unismart.it

Partners



https://prelude-project.eu/

https://twitter.com/PreludeEu

https://www.linkedin.com/company/prelude-project/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement N° 958345. Call identifier: LC-EEB-07-2020