ENSNARE

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What's inside

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Pioneering Digital Innovations in Building Renovation

The ENSNARE project is at the forefront of revolutionising building renovations across Europe, aiming to create sustainable, energy-efficient structures that meet the Net Zero Energy Building (NZEB) standards. By integrating advanced digital tools across various work packages, ENSNARE is addressing the challenges of energy use, carbon emissions, and operational efficiency in renovated buildings. This newsletter provides an in-depth look at the progress, challenges, and expected outcomes of these digital initiatives.

WP1: Development and implementation of the Digital Platform for Envelope Retrofitting (DP4ER)

WP1 focuses on developing and implementing the Digital Platform for Envelope Retrofitting (DP4ER), which provides the involved stakeholders with a clear structure and access to a wide range of technologies for deep renovation of buildings (Figure 1). It supports all stages of the renovation process, from early decision making and data acquisition to the manufacturing, construction works, and the operation and maintenance of the implemented system, including a communication protocol that facilitates the communication and interaction among the involved actors.

Main Achievements:

1. **Information Flows and KPIs:** Defined key parameters and optimised the information flow to reduce time and costs in the decision-making process, ensuring efficient data collection and processing for building redesign and renovation.
2. **Database Implementation (Referential Module):** Established key databases, including Building Characteristics database, a Library of Technologies, and an LCA/LCC database, to support accurate scenario generation when limited building information is available.
3. **Digital Tool Development:** The DP4ER is a toolbox that consists of different modules. Those modules are introduced in various stages of the renovation process but can also span over the phases. These modules can be used separately depending on the specific project's needs, but they also interlink to facilitate the exchange of information.
4. **Communication Protocol:** A communication protocol was established to coordinate stakeholder collaboration, ensuring data consistency and the smooth progression of renovation projects. This protocol helps to maintain transparency and agreement among all parties involved.

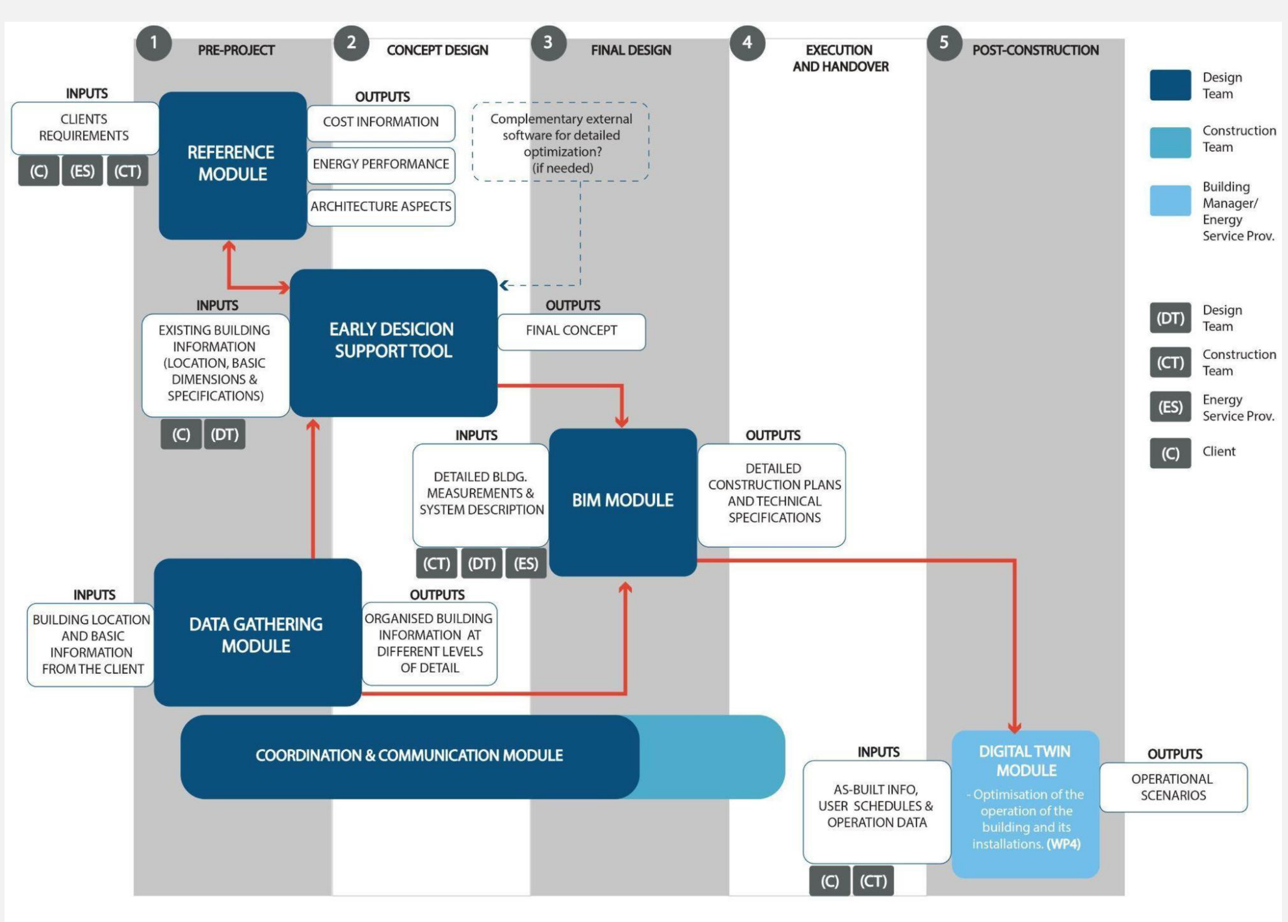

Figure 1: DP4ER Workflow diagram

WP2: Enhanced Precision in Built Environment Measurement

WP2 Addresses the challenges of accurately locating and identifying connectors in building renovations involving prefabricated modules. Traditional measurement methods, such as total stations or laser scanners, are time-consuming and require skilled technicians. To overcome these limitations, WP2 has developed a refined AprilTag detection pipeline integrated with machine learning to improve measurement accuracy and accessibility.

Main achievements:

1. **Precision Enhancement:** AprilTags are robust visual fiducial markers that enable precise detection and localisation. By embedding these tags into building elements, ENSNARE achieves high accuracy in spatial measurements, crucial for effective planning and renovation. In addition, machine learning models are trained to interpret data from AprilTags, further refining the measurement process. This integration ensures precise identification of building components and their dimensions.
2. **Real-Time Measurement:** ENSNARE system processes measurement data in real-time, facilitating immediate feedback and adjustments. This capability is essential for reducing manual errors and optimising measurement workflows. The system automates calibration procedures, ensuring consistent measurement accuracy throughout different stages of the project.
3. **Scalability & Versatility:** We have achieved a scalable and adaptable solution designed for various building types and project sizes. Whether for large-scale renovations or small construction tasks, the technology provides flexible and reliable measurement solutions. ENSNARE has developed interfaces to integrate the measurement system with other digital tools and platforms, enhancing its applicability across different project stages.
4. **Improved Efficiency:** By reducing the need for manual measurements and interventions, our technology streamlines the workflow, leading to faster project execution and reduced labour costs. The automated and precise measurement capabilities minimise errors, leading to higher-quality outcomes and better project results.

The proposed pipeline was tested in simulation, indoor and outdoor environments respectively.

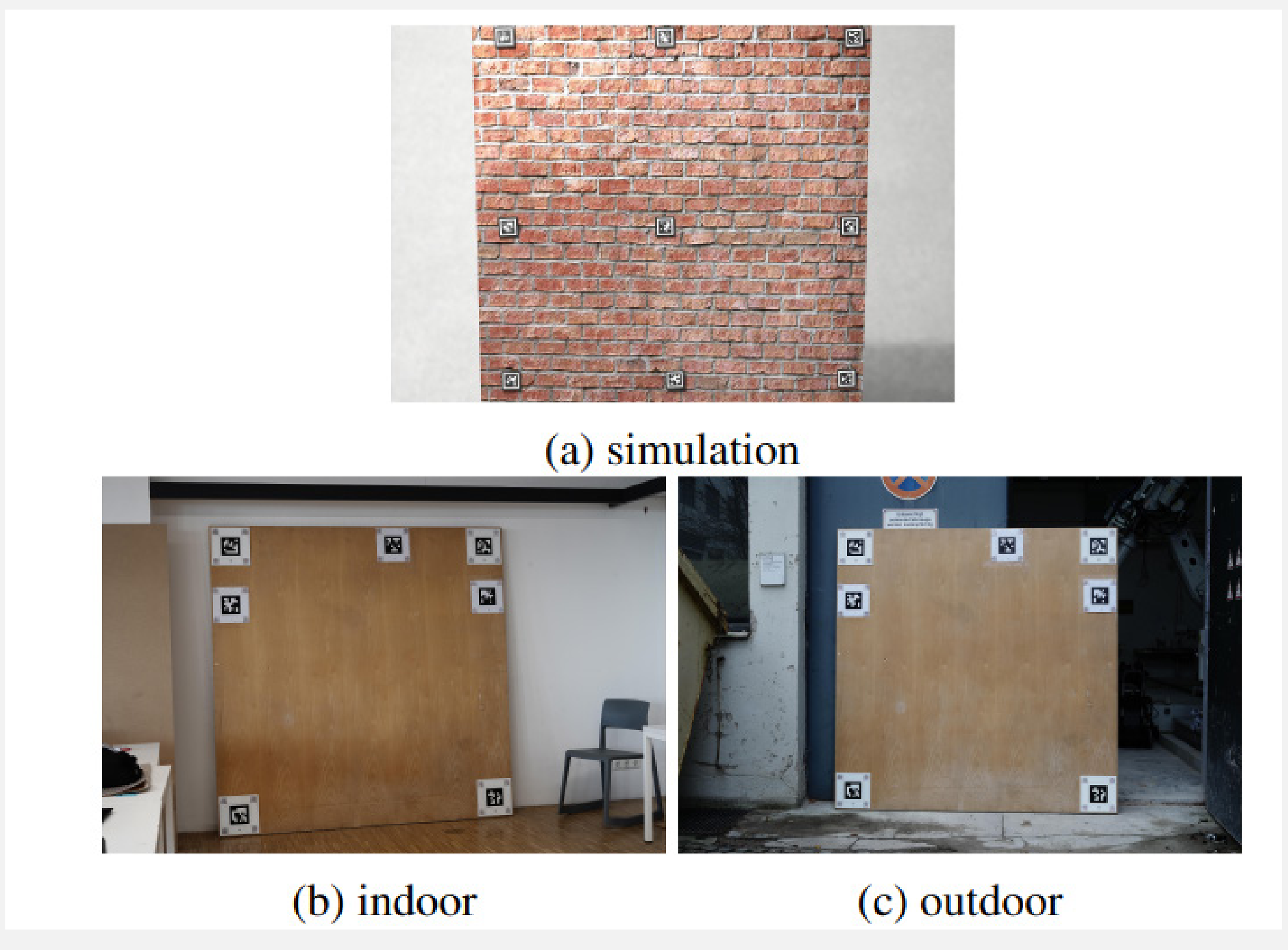

Figure 2: Example pictures of real-world and simulation experiments

WP3: An Early Decision Support Tool for Energy-Focused Renovation

WP3 introduces an innovative Early Decision Support Tool (EDST), designed to assist users in making informed decisions during the early stages of energy-focused renovation projects, when there is greater potential to impact the design. This tool addresses the challenge of limited initial data by providing actionable insights and estimates.

Main achievements:

1. **Automated Scenario Generation:** The EDST generates various renovation scenarios suiting the building characteristics and climate. Each scenario is evaluated for its impact on energy performance, cost, and comfort, presenting users with multiple alternatives.
2. **Dynamic Energy Simulation:** The tool performs fast simulations of existing and proposed renovation scenarios, assessing energy performance and comfort levels for different design choices. Users receive instant feedback on simulation results, enabling quick adjustments and optimization of renovation strategies.
3. **Integrated Life Cycle Assessment:** The EDST includes a life cycle assessment to evaluate the economic and environmental impacts of renovation options, supporting sustainable and financially viable decision-making. This assessment helps users select renovation options that align with both sustainability goals and budget constraints.
4. **Multicriteria Analysis:** Data on comfort, economic and environmental performance of each renovation scenario is post-processed through a multicriteria analysis method that ranks the scenarios according to the needs and preferences of the user.

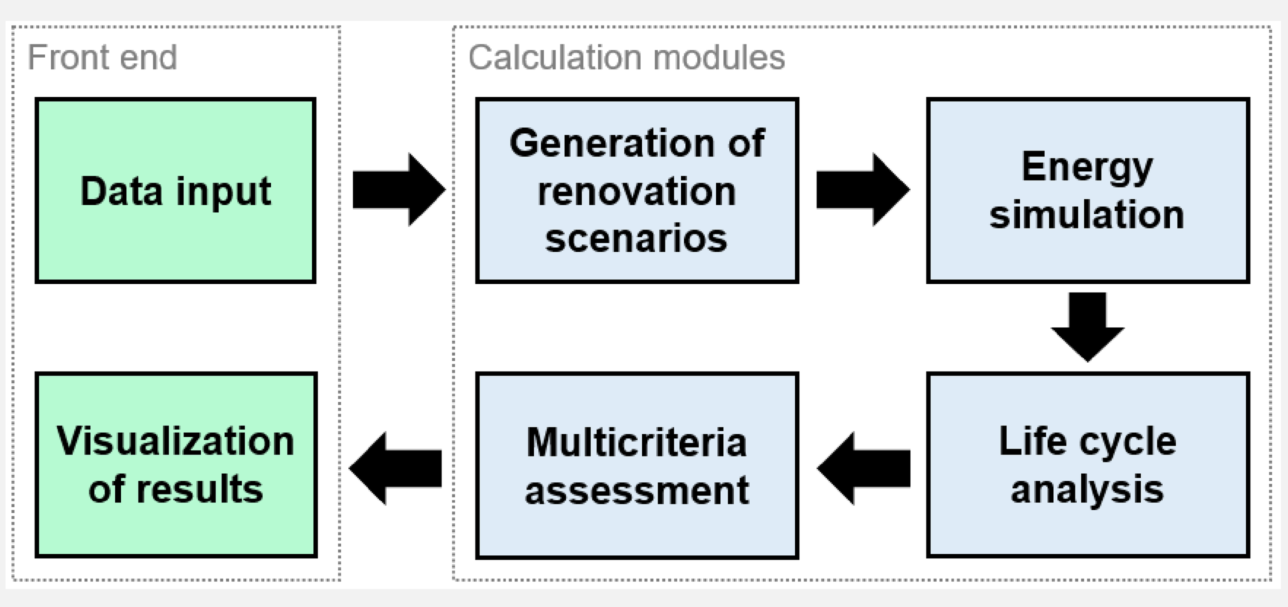

Figure 3: Conceptual workflow of the early decision support tool

ENSNARE plans to validate the EDST through real-world applications and expand its database to include more renovation solutions. Future updates will focus on integrating the tool with Building Information Modeling (BIM) systems to enhance its functionality.

WP4: Digital Twin Technology for Building Renovation

WP4 is dedicated to advancing Digital Twin technology to support building renovation and management. Digital Twins provide a virtual representation of physical buildings, enabling near real-time monitoring and optimization to enhance post-renovation performance.

Main Achievements:

1. **Operational Digital Twins:** Digital Twin technology has the potential to reduce global operational building emissions by 30%. Despite this, its integration into retrofitting practices is limited at 13% (C.C. Ohueri et al, 2024). Deep renovations significantly reduce energy demand and improve overall energy performance, but further reductions in energy use are possible. ENSNARE focuses on Operational Digital Twins to enhance energy and carbon management in post-renovation buildings.
2. **Core elements:**
   a. **Creation of Operational Digital Twins:** Leveraging building physics to create precise digital replicas of physical buildings. Leveraged by sustainable design experts around the globe, the Virtual Environment (VE) is used as the core software with a building physics engine to create digital twins.
   b. **Optimization of Building Performance:** Focus is on optimising building performance to reduce carbon emissions and energy consumption. Recommendations are provided to improve operational efficiency.
   c. **Testing Active Control in Building Operations:** Innovative near real-time control strategies are tested and implemented to advance smart building energy management.
   d. **User-Friendly Visualisation:** The operational data and recommendations are presented in a clear and intuitive manner, ensuring that insights are effectively utilised for real-world applications.
3. **Advanced strategies:**
   a. **Model Predictive Control (MPC):** MPC optimises the scheduling of building energy systems using forecasts of performance, comfort levels, and weather conditions.
   b. **Demand Side Management (DSM):** DSM techniques including load shifting, are developed to manage energy demand and minimise carbon intensity, especially relevant for buildings transitioning to net-zero energy.
   c. **Fault Detection and Diagnosis (FDD):** Data algorithms are employed to predict and diagnose system faults, ensuring smooth operations, particularly in photovoltaic systems.
4. **Pilot Implementations:**
   a. **Tartu:** Focused on optimising space heating schedules and setpoints, with the algorithm working in coordination with the building management system (BMS).
   b. **Sofia & Sassa Scalo:** Aims to adjust heating setpoints and schedules using LORA technologies to minimise energy use within the heating distribution systems.

Each pilot involves the installation of IoT sensors, equipment to monitor and test active control, some BSM systems, and other necessary equipment to gather data, which is processed by the operational digital twin to suggest optimal operational scenarios.

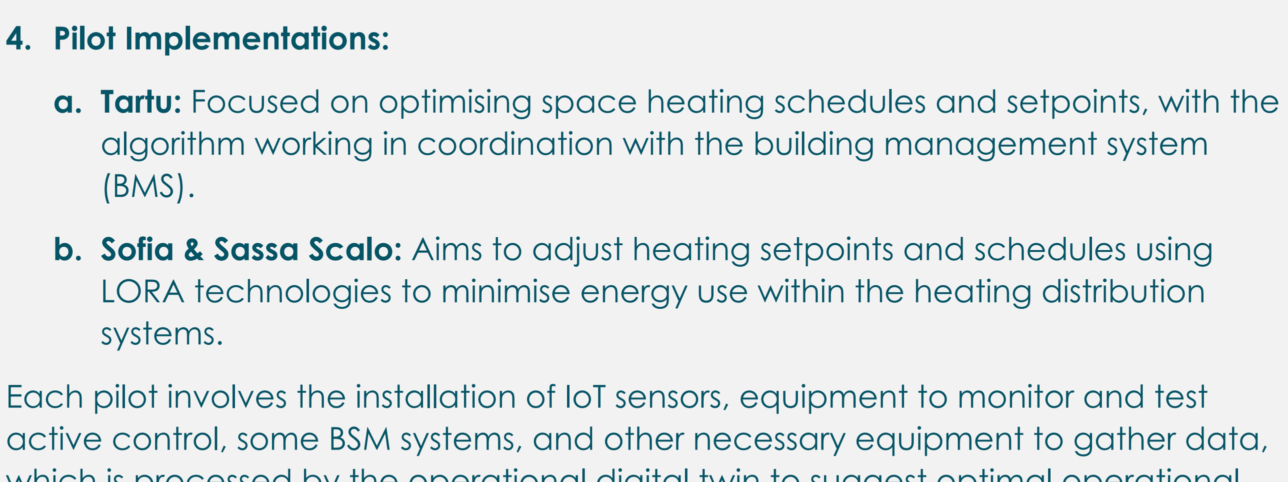

Figure 4: Digital Twin representation and real building of Tartu Pilot

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Who are we?

The consortium

ENSNARE is an Horizon 2020 EU funded project carried out by 19 partners from 12 European countries: 11 SMEs, 5 research institutes, 2 corporations and 1 public body.

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