ENSNARE

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What's inside

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Digital toolkit Introduction

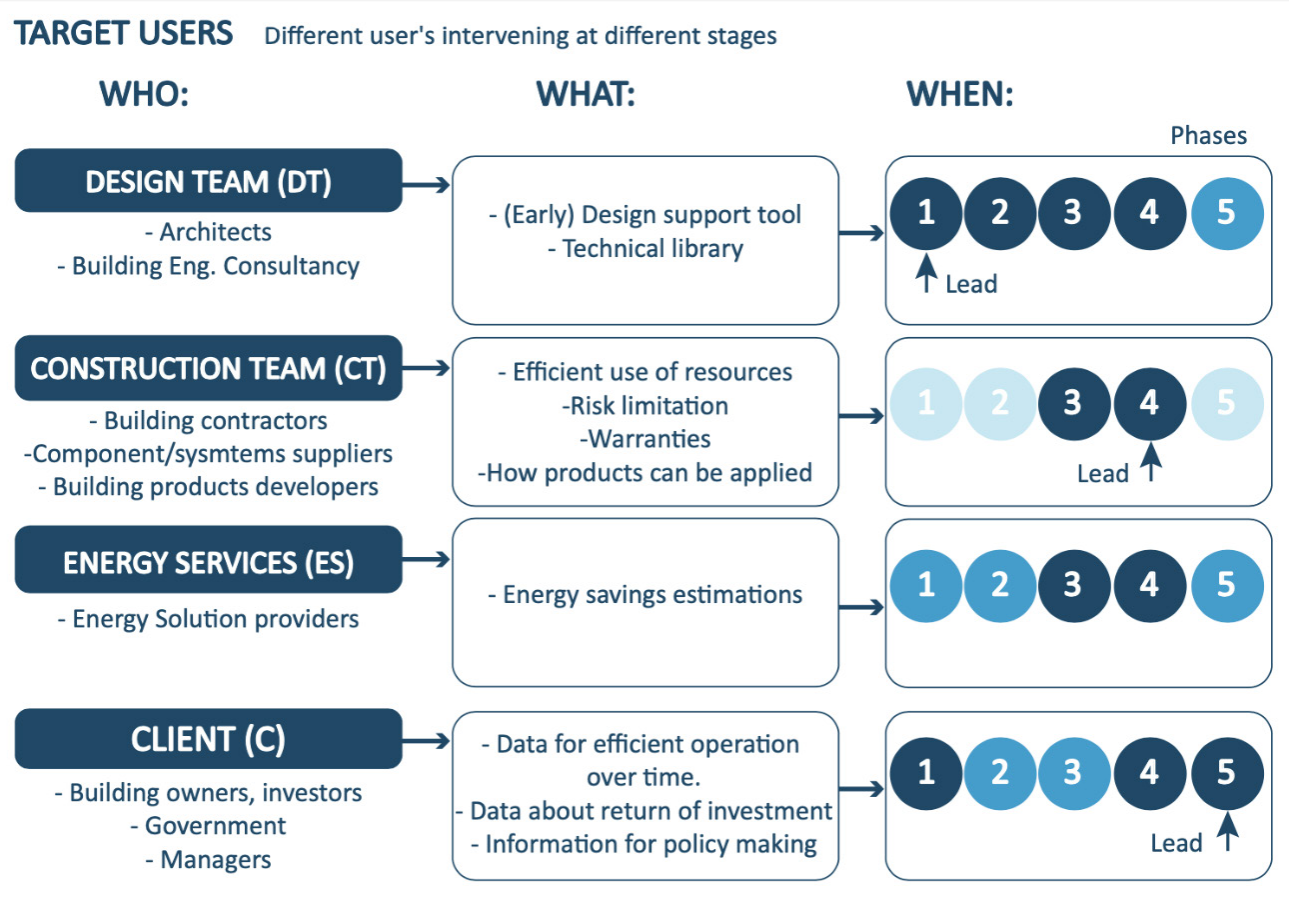
ENSNARE boosts the uptake of solutions for NZEB renovation, underpinned by several digital tools. These tools are connected via a **Digital Platform for Envelope Retrofitting (DP4ER), a digital environment** that covers all phases of the renovation process, and it's further structured in several modules, including an **Early Decision Support Tool (EDST)** that assess the potential of different renovation packages, a **Building Data Gathering Tool** that semi-automatically collects and processes the building information to design and manufacture the pre-fabricated elements and facilitate the subsequent installation, and an **Operational Digital Twin** for real-time performance analysis, optimisation and active control of the system during the operation phase. The **DP4ER** facilitates information sharing among renovation actors to save time and resources and represents the first iteration to develop a digital model of the building. As the process evolves, the model increases in complexity and interaction potentialities throughout the different renovation phases. Complementary modules are present that can be used separately or interlinked.

Digital Platform for Envelope Retrofitting

The Digital Platform for Envelope Retrofitting (**DP4ER**) facilitates the exchange of information between the renovation actors to save time and costs. It consists of different modules for different phases and users. It supports all stages of the renovation process, from early decision making and data acquisition to the manufacturing, construction works, operation and maintenance of the implemented system. The DP4ER uses a digital toolbox which is closely linked to a digital model of the building, consisting of a collection of tools, referred to as modules. As the process evolves, increases in complexity and interaction potentialities throughout the different renovation phases. The following modules are present:

- **Reference Module** provides energy and cost calculations from simplified building archetypes. It provides basic information about regulations, standards, constraints, and technical catalog of energy renovation solutions. It is the backbone allowing the users to interact with the Early decision support tool.

- **Building Data Gathering Module** collects and processes the needed information of the existing building to design the prefabricated elements and devices.
- **Early Decision Support Tool Module** proposes and assesses potential renovation solutions in the initial exploration phase by comparing design alternatives. The BIM Module creates a model for the construction and technical specifications.
- **Coordination and Communication Module** establishes a digital communication protocol when the decision-making process is presented and approved by all parties.
- **Digital Twin Module** creates a digital twin of the building, allowing for performance analysis, optimisation, and active control of systems during operation.



The figure presents the different involved stakeholders, highlights their involvement throughout the renovation process as well as the main outcomes and information that they would seek from the Digital Platform, based on their tasks and roles.

Building data gathering tool

The **Building Data Gathering tool** improves the available online information along the different stages according to the level of details required and enables Computer-Aided Manufacturing (CAM). It leverages 2 elements:

- An **online semi-automated building modeling** to determine the shape and content of the building by using open data sources to generate a 3D model with geometry, shape and building elements reducing the needed time.
- An **online automated layout definition** which enables the layout definition of the prefabricated modules to be attached to the existing building.

Early Decision Support tool

The **EDST** makes use of public information and minimal inputs from the user to propose renovation solution kits and evaluate their potential in an early decision stage. The EDST performs a pre-feasibility analysis of different retrofit options, providing the various actors involved in a retrofit project with an overview of the **energetic, economic and environmental impacts** of their choices, enabling a conscious decision-making process. Four calculation modules are present:

- The **generation of renovation scenarios** automatically generates a set of renovation kits to suit the specific building and climate targets.
- The **energy simulation** performs an assessment of energy performance and thermal comfort of each renovation kit through a dynamic simulation model.
- The **life cycle calculation** carries out an environmental and economic assessment for each renovation kit.
- The **multi-criteria analysis** involves a decision-making model to rank the identified solution sets in accordance with the user needs.

The resulting summary report is subdivided into 3 sections with i) the input data; ii) the Key Performance Indicators obtained; iii) the Opportunity Measures (OM) identified.

Operational Digital Twin

The **operational Digital Twin** allows for monitoring, performance analysis, optimisation and active control of the system during operation. Its utilization begins after the renovation execution and handover. The digital twin combines physics-enabled simulations and data from real and virtual sensors to create a dynamic virtual building representation. The data acquisition architecture is organized through layers, in which each layer represents a specific set of technologies and that defines the communication across layers. The technologies to be used are also identified.

- **Data Source Layer** includes physical elements that either provide the system with information or that must be controlled by the system. They are divided into 5 categories: Heat pumps, Solar collectors, PVT systems, Heat exchangers and Ambient sensors.
- **Data Persistence Layer** corresponds to the databases that store the needed information for the correct operation. A relational data model for storing static information is placed in a relational database and placed in a time-series database.
- **Data Exchange Layer** provides access to the Data Persistence Layer. Data producers must design and build data exchange interfaces to allow inserting, updating and deleting information from the time-series databases.

The resulting digital asset after acquiring data and creating a calibrated digital twin optimizes the building performance using machine learning to fill data gaps, check for anomalies and predict future performance. This allows for continuous monitoring and evaluation against design targets, establishing user behaviour patterns with respect to energy consumption and performance.

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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