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ACCELERATING THE EU BUILDING RENOVATION RATE THROUGH THE DEVELOPMENT AND DEMONSTRATION OF PROMISING TECHNOLOGY INNOVATIONS



REHOUSE

JAVIER ANTOLÍN GUTIÉRREZ (CARTIF)

BRIEF SUMMARY

- Project name: Renovation packages for **H**olistic improvement of EU's **b**uildings **E**fficiency, maximizing RES generation and cost-effectiveness.
- Project starting date: 1 October 2022 (M1)
- Project ending date: 30 September 2026 (M48)
- Current date: June 2023 (M9)
- Total budget: 12,561,346.95 € (Grant amount: 10,016,536.45 €)
- 25 partners from 8 countries

Main objective: To develop fully-functional prototypes and demonstrate in operational environment [TRL7] 8 Renovation Packages (RPs) of promising technology innovations designed for a wide range of building renovation actions, including deep renovation, that overcome the main barriers that slow down the current EU renovation ratios.

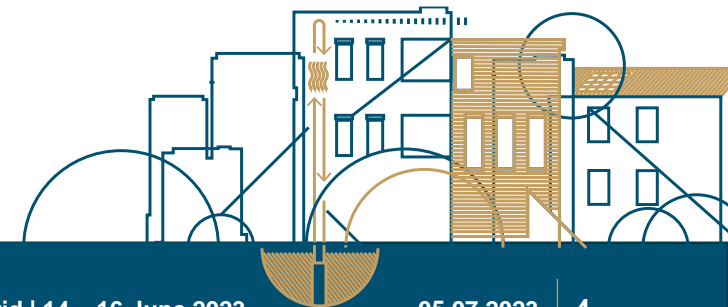
REHOUSE SPECIFIC OBJECTIVES

- Implement a **people-centric social engagement strategy** (Establishment of a social task force).
- Upgrading **8 renovation packages (RPs)** from **TRL4/5** to **TRL6** integrating bio-sourced/reused/recycled materials, multi-functional designs and onsite RES valorisation.
- Application of a **BIM-based workflow and deploy an Integrated Project Delivery (IPD) methodology** during the renovation activities including design, construction and building operation phases.
- Deployment of **4 buildings renovations (5,355 m²)** in **Kimmeria (GR), Budapest (HU), Saint-Dié-des-Vosges (FR) and Margherita di Savoia (IT)**, including detailed design, pilot set-up, demonstration and evaluation **to validate in operational conditions (TRL7) the 8 renovation packages.**

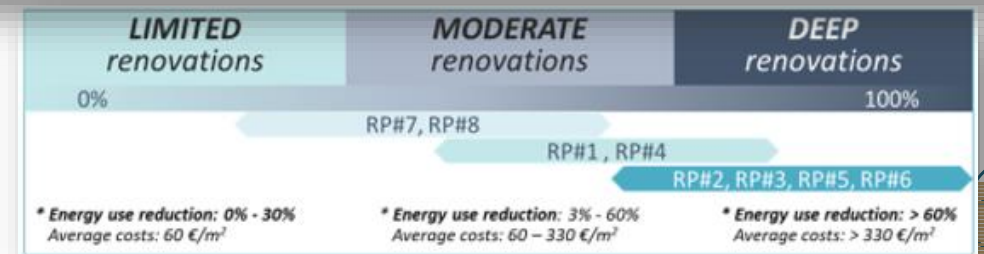
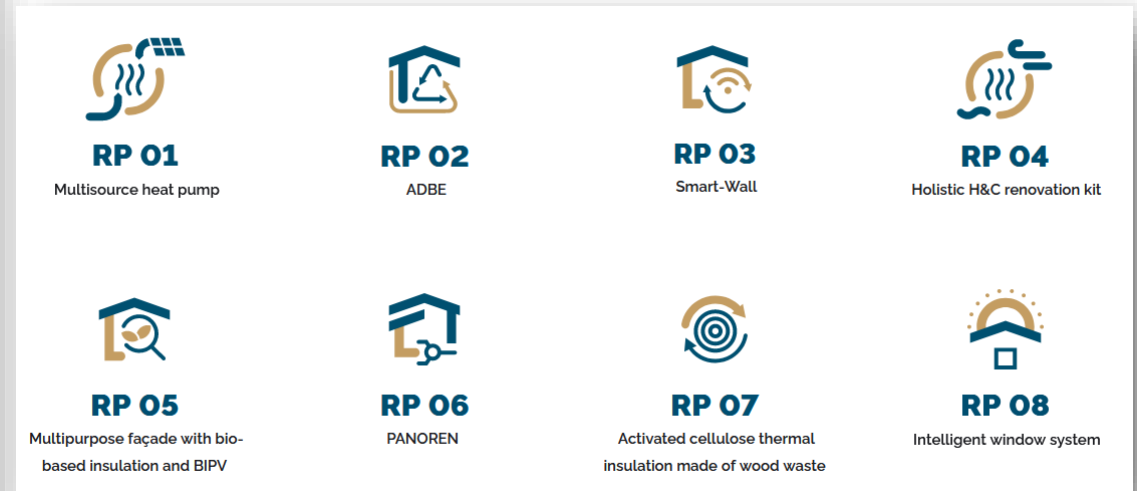


REHOUSE SPECIFIC OBJECTIVES

- Definition and demonstration of several **renovation business cases**, adapted to different contexts and exploring the suitability of **novel business models**. Definition of a clear and robust **pathway to the market** per RP.
- Boost **market uptake, scalability and replicability** of REHOUSE Renovation Packages towards TRL9. **Standardization** of the RP through a set of guidelines.
- Deployment of **dissemination and communication** channels and synergies with other relevant projects and EU level initiatives.



RENOVATION PACKAGES



DEMO-SITES

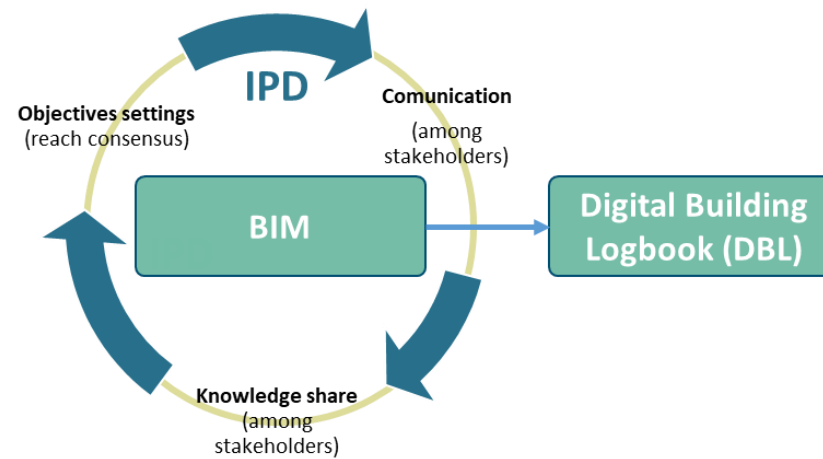
RPs real-scale demonstrations in 4 buildings to reach TRL7:

- Student residence building in Kimmeria (Greece).
- Social housing building in Margherita Di Savoia (Italy).
- Large residential block in Saint-Dié-des-Vosges (France).
- Student residence building in Budapest (Hungary)



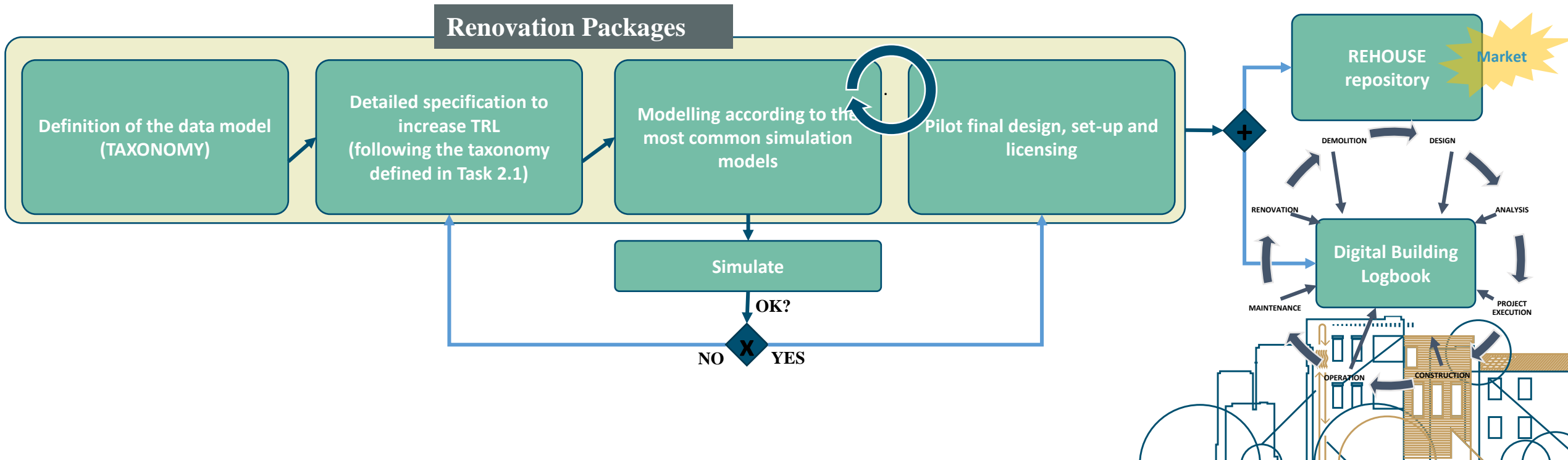
BIM-BASED WORKFLOW & IPD METHODOLOGY

- Promote the implementation of coherent work flow based in BIM (Building Information Modelling), and deploying a digital register of the building (DBL, Digital Building Logbook), to adapt, simplify and deploy a methodology of Integrated Projects (IPD, Integrated Project Delivery) during the activities of a renovation project, including the design, construction (rehabilitation) and building operation (performance) phases.

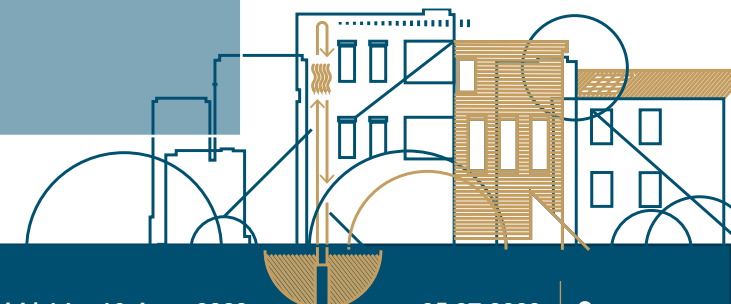
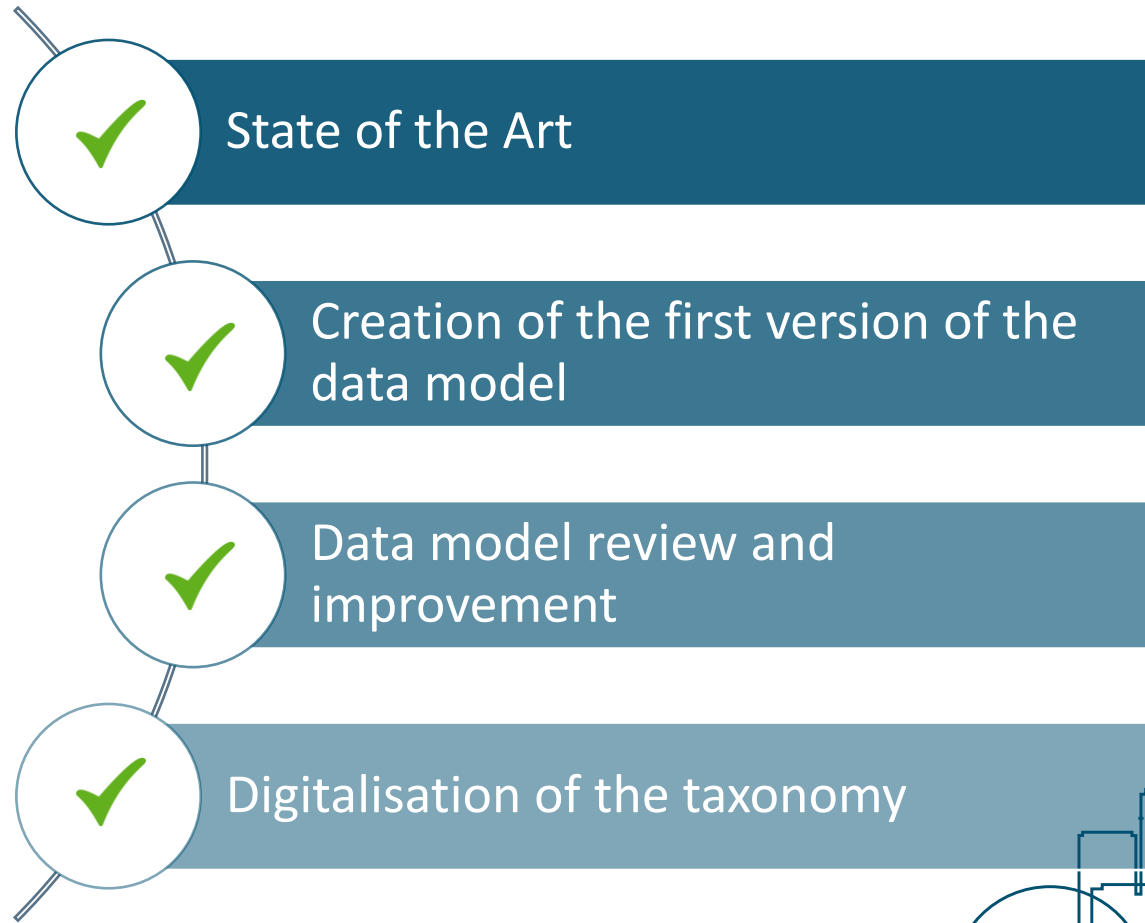
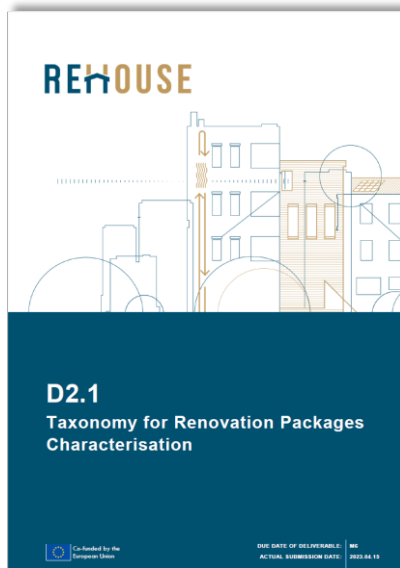


OVERALL SCHEME FOR DIGITAL ASPECTS

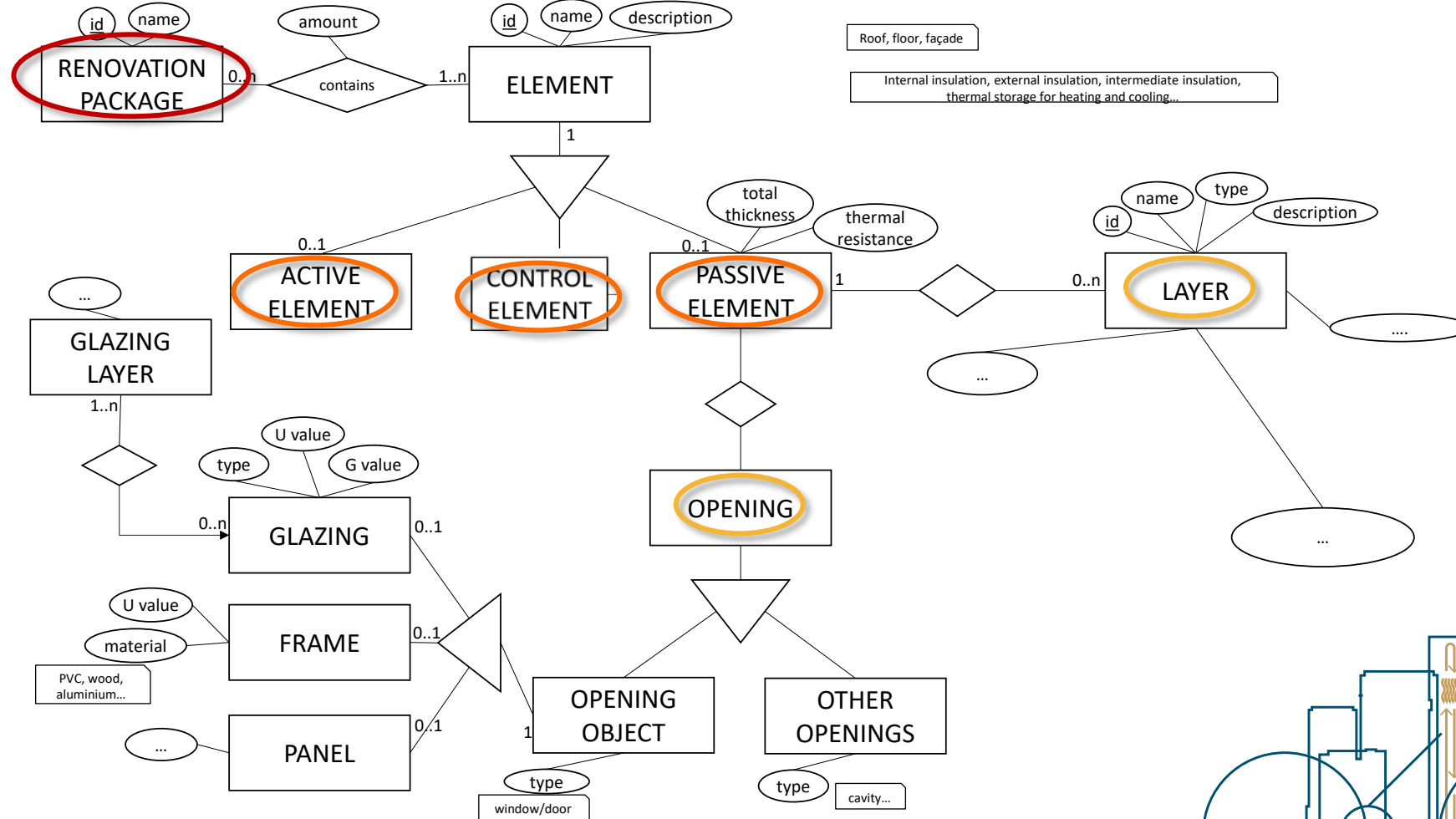
- Digital aspects to support in the definition, design, implementation, installation and operation of the 8 RPs.



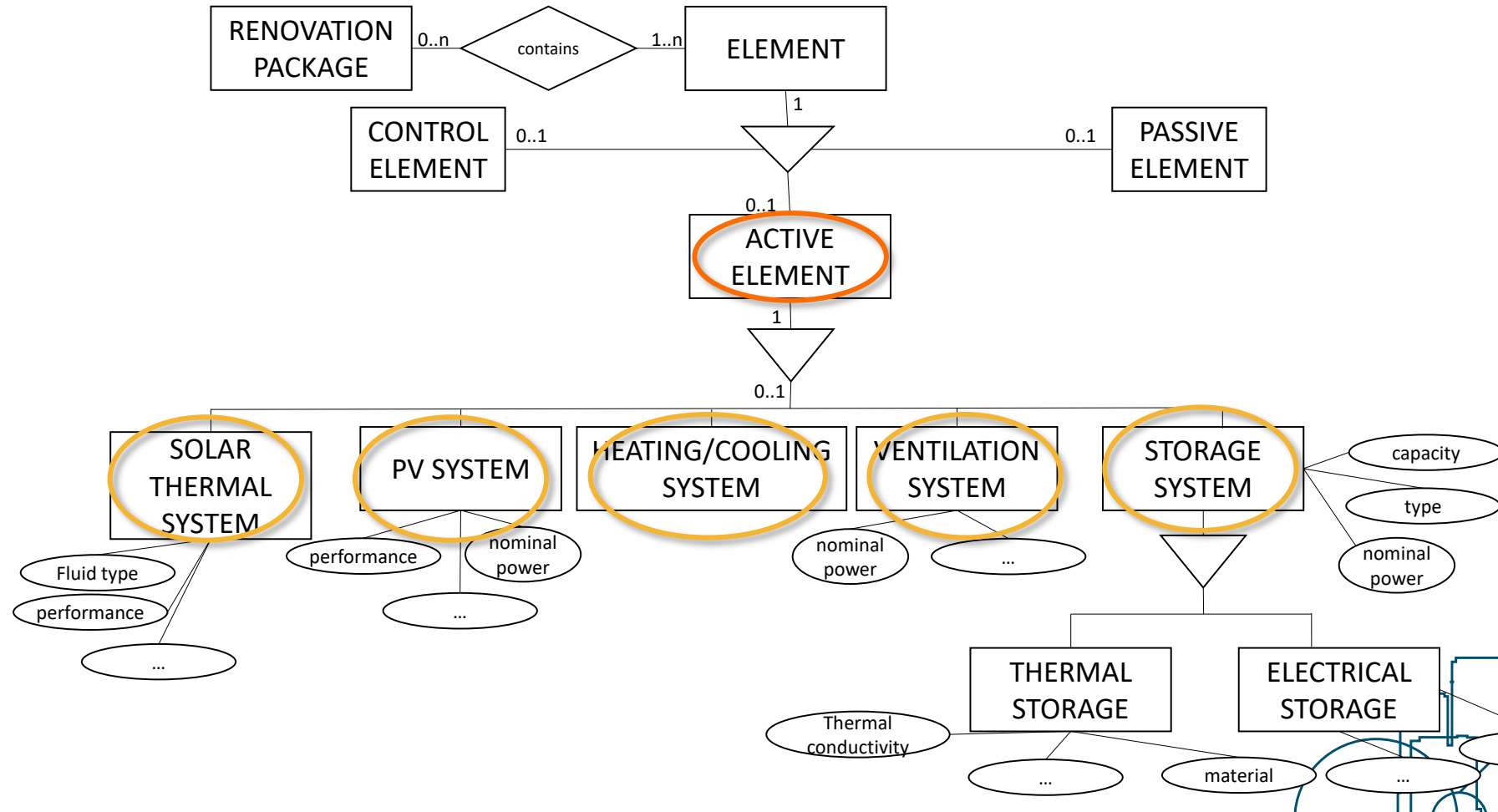
DATA MODEL FOR RENOVATION PACKAGES



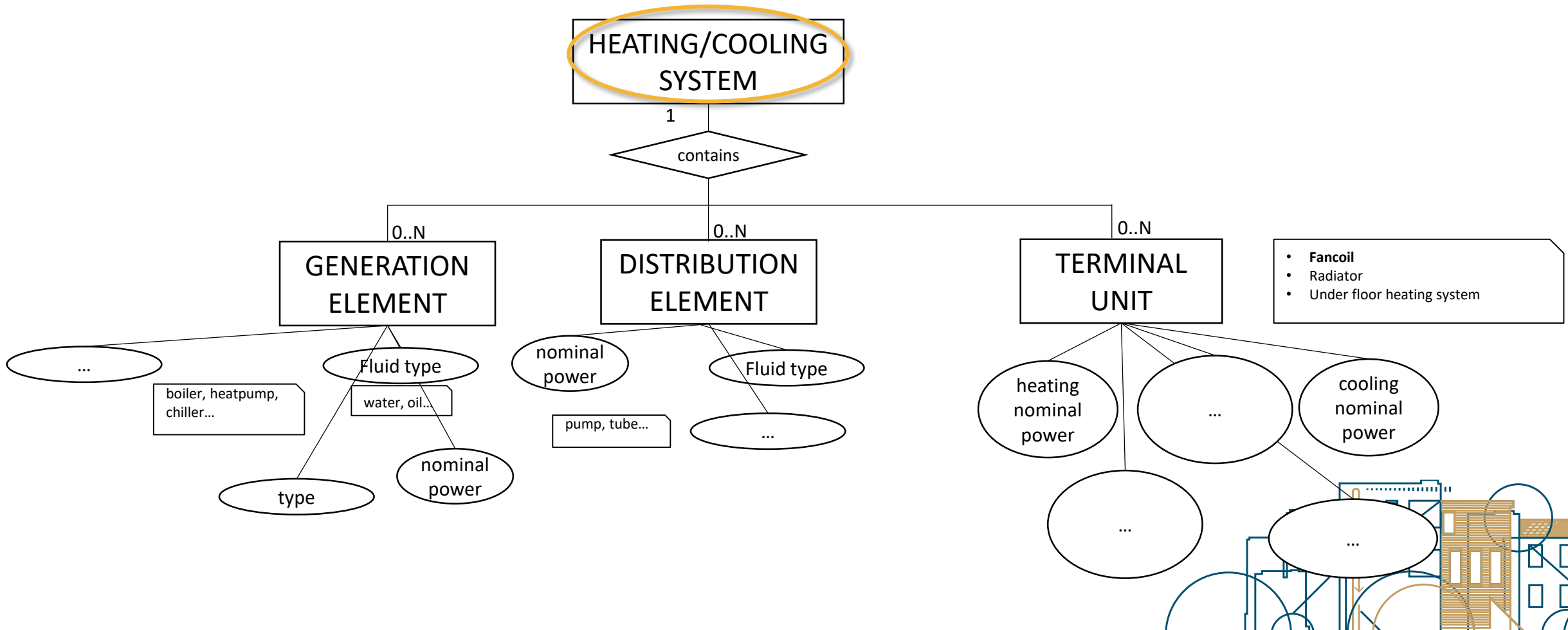
DATA MODEL FOR RENOVATION PACKAGES



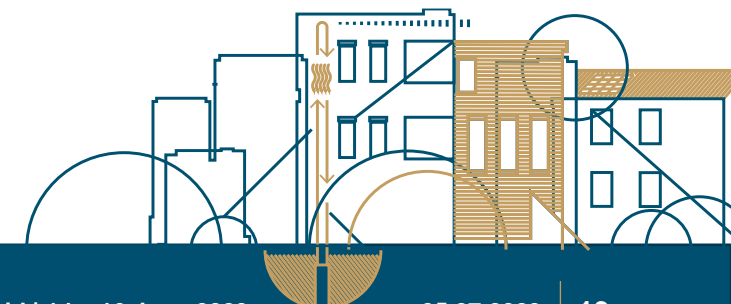
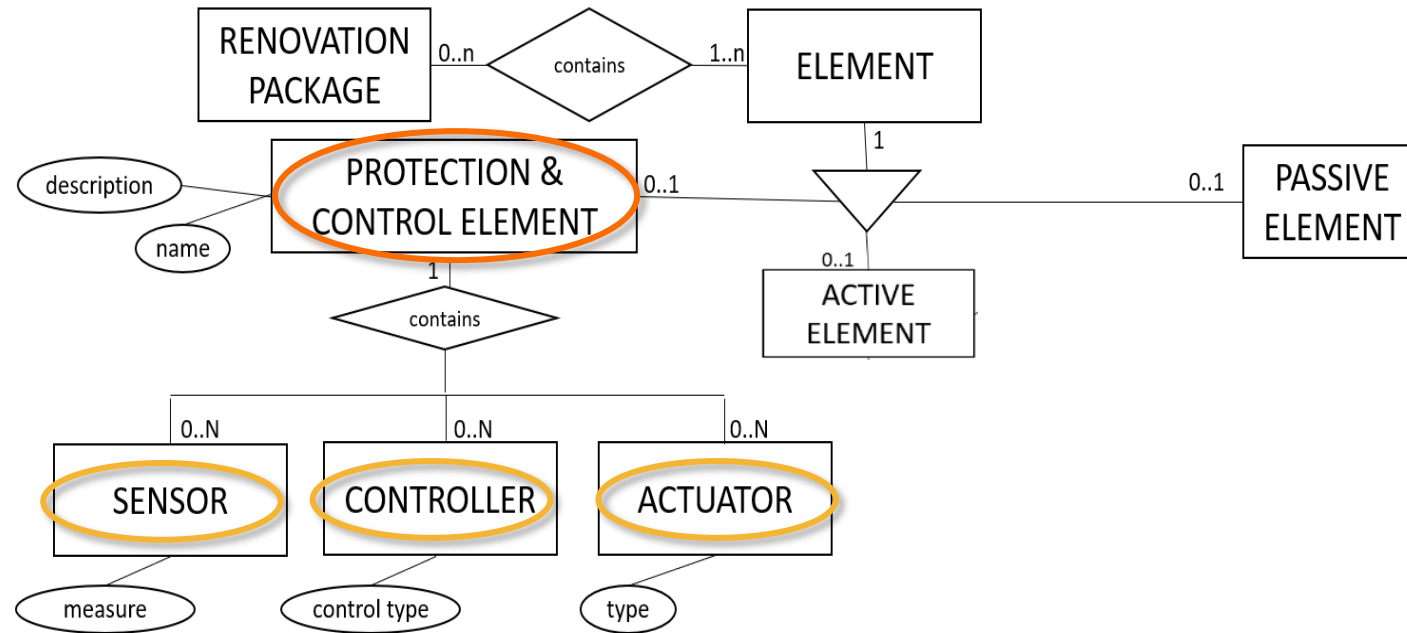
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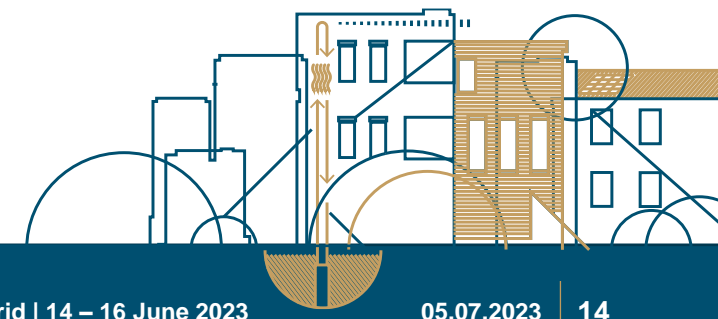
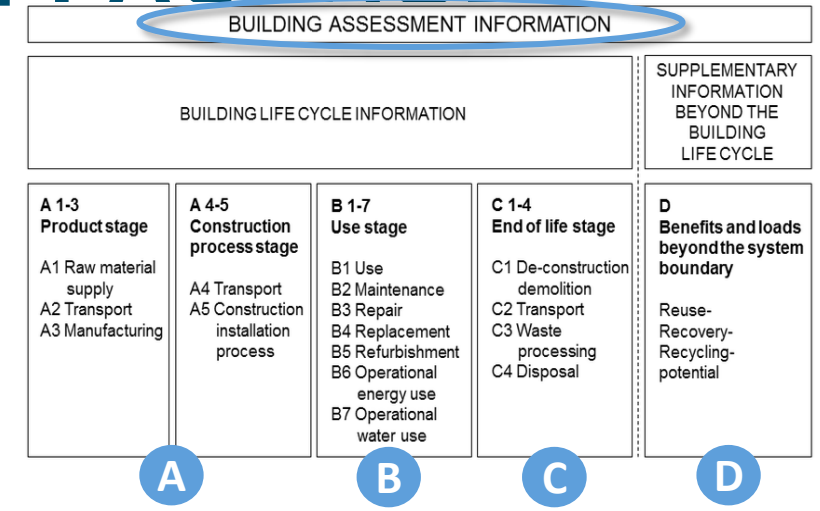
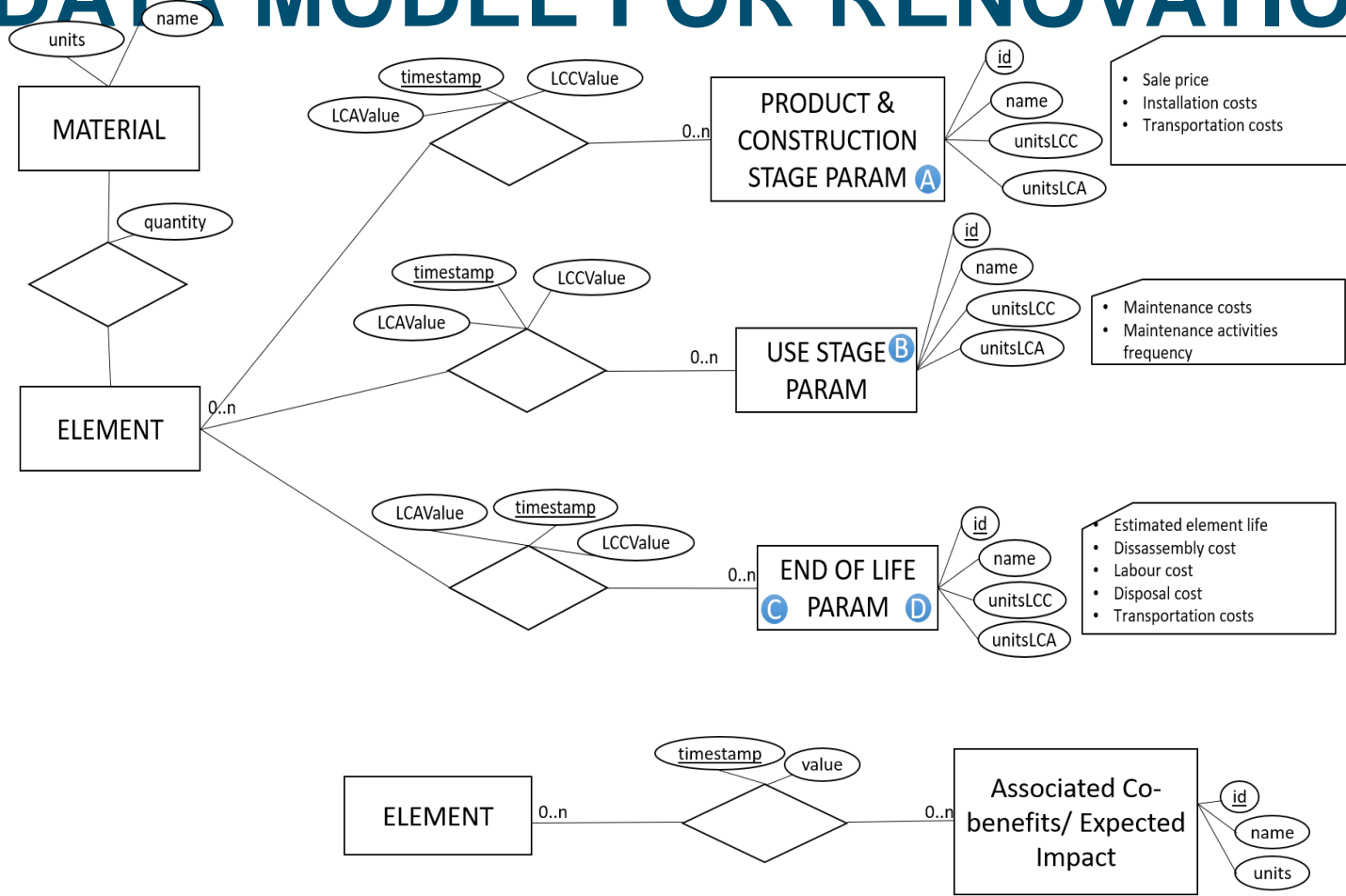
DATA MODEL FOR RENOVATION PACKAGES



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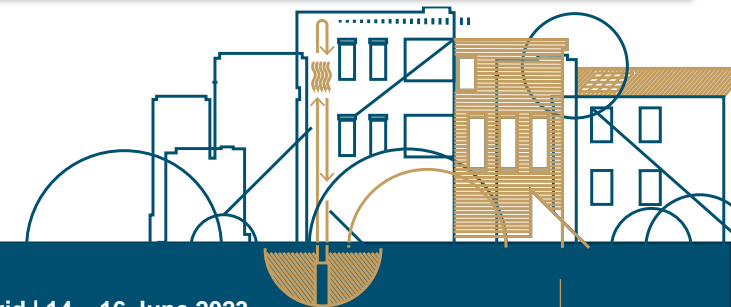
DATA MODEL FOR RENOVATION PACKAGES



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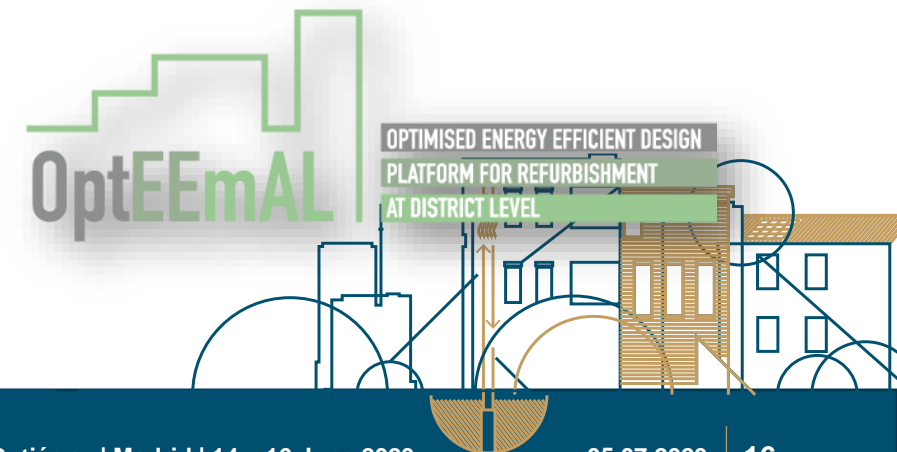
```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE ACTIVE_ELEMENT [
  <!ELEMENT ACTIVE_ELEMENT (DATA_RECORD*)>
  <!ELEMENT DATA_RECORD (description?,ELEMENT_idELEMENT?)+>
  <!ELEMENT description (#PCDATA)>
  <!ELEMENT ELEMENT_idELEMENT (#PCDATA)>
]>
<ACTIVE_ELEMENT>
  <DATA_RECORD>
    <description>active element _element2</description>
    <ELEMENT_idELEMENT>2</ELEMENT_idELEMENT>
  </DATA_RECORD>
</ACTIVE_ELEMENT>
```

```
<?xml version="1.0" encoding="UTF-8"?>
<!DOCTYPE PASSIVE_ELEMENT [
  <!ELEMENT PASSIVE_ELEMENT (DATA_RECORD*)>
  <!ELEMENT DATA_RECORD (totalThickness?,thermalResistance?,ELEMENT_idELEMENT?)+>
  <!ELEMENT totalThickness (#PCDATA)>
  <!ELEMENT thermalResistance (#PCDATA)>
  <!ELEMENT ELEMENT_idELEMENT (#PCDATA)>
]>
<PASSIVE_ELEMENT>
  <DATA_RECORD>
    <totalThickness>1</totalThickness>
    <thermalResistance>2</thermalResistance>
    <ELEMENT_idELEMENT>1</ELEMENT_idELEMENT>
  </DATA_RECORD>
</PASSIVE_ELEMENT>
```



DESIGN SUPPORTING TOOLS

- Digital models of the RPs.
- Modelling and simulation tools.
- Guidelines on how to integrate digital models of the RPs into the relevant simulation tools (formats and software developments needed).
- Digital products repository for the RPs Digital models.



INTEMA.building - Concept and Main Components

INTEgrated Energy **MA**nagement (**INTEMA**) is an **energy systems modeling and simulation platform**. It is based on **open-source non-proprietary tools** (AixLib) and Building Systems libraries.

It is composed by the following main components:

Power System Simulations – Based on the acausal, object-oriented, equation based **Modelica language** to conveniently model complex physical systems.

Power Optimization – Ability to construct optimization problems varying from simple Optimal Power Flow (OPF) to complex Model Predictive Control (MPC) schemes using **Python** optimization tools **pyomo** along with the **neos-server** that provides the required solvers.

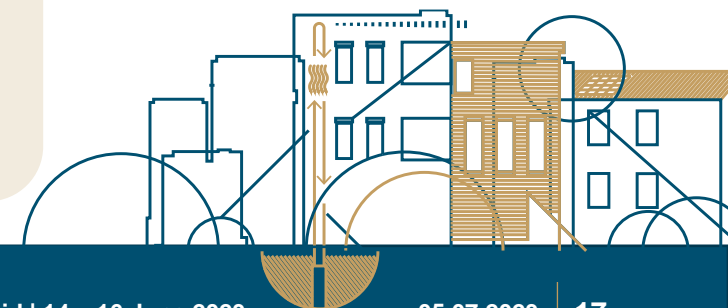
Power Forecasting – Utilizing open-source Machine Learning (ML) frameworks in **Python**, i.e. **scikit-learn and Keras**.

Accurately forecast key operational parameters, enabling energy system's automated actions and suggestions to the user.

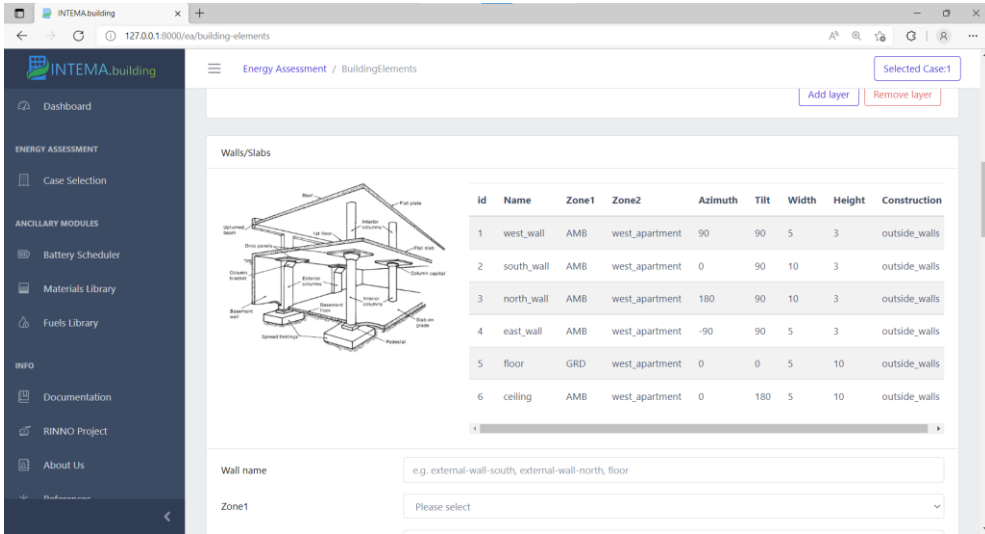
INTEMA can lead to primary energy savings of 10-15%, increase total controllable loads (>30%) and has a PBT of around 3-4 years.

Main features:

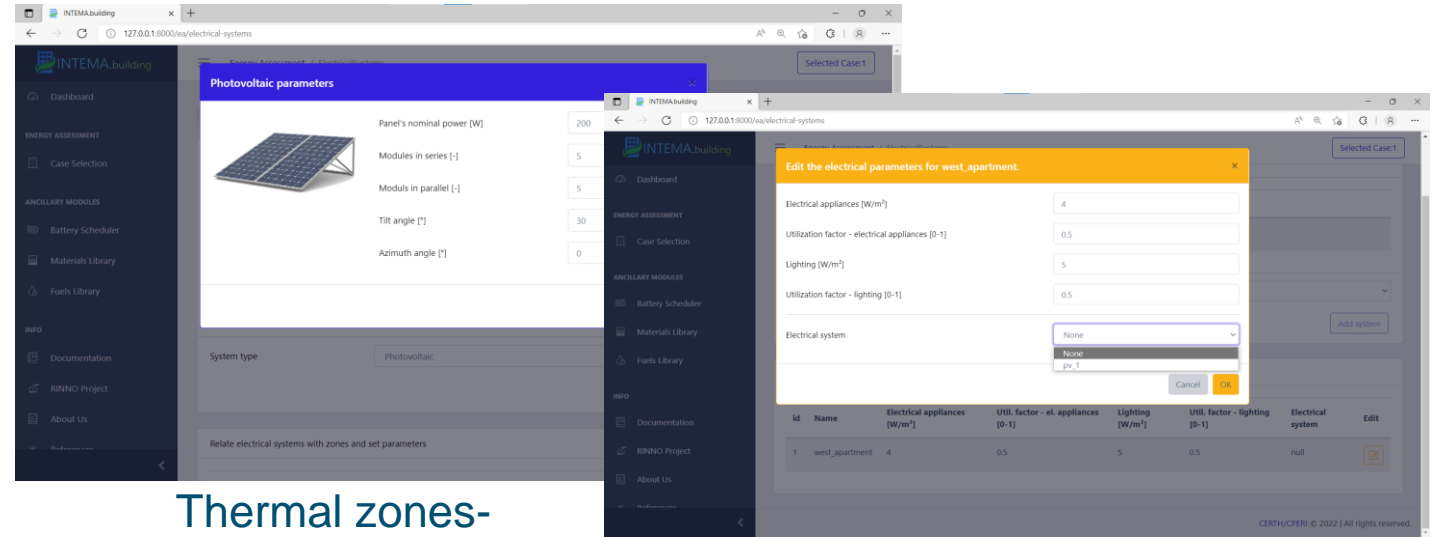
- ✓ Software tools for buildings & districts
- ✓ Software modules for multiple (passive and active) energy systems
- ✓ Add-ons for data gathering and processing
- ✓ INTEMA.building is accessed online – no need to install packages



INTEMA.building - Main Features

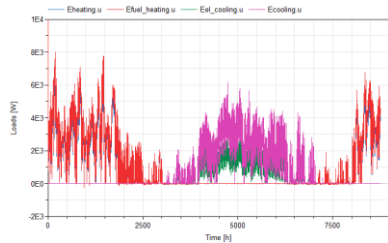


Main Menu of INTEMA.building platform

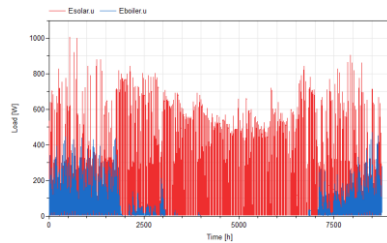


Thermal zones-
INTEMA.building

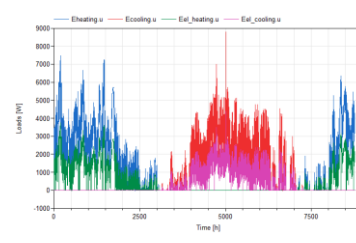
Main Impacts and Outcomes



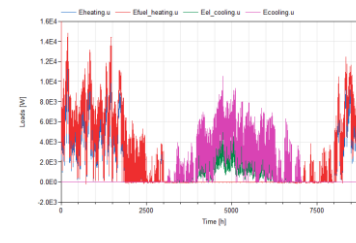
Natural gas boiler and heat pump



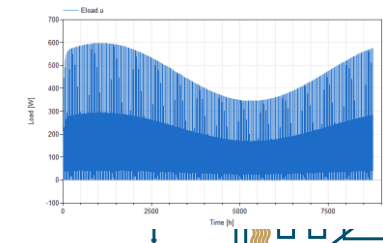
DHW with solar thermal collectors



Reversible heat pump



Oil boiler and heat pump



DHW with electrical heater

VERIFY - Concept and Main Components

Life Cycle Assessment & Life Cycle Costing analysis on building and district level

- ❖ VERIFY advantages: web server installation, variety of computations, open-source programming libraries.
- ❖ Communication with remote sensors is achieved through MQTT messaging transport protocol.

- ⊙ **Analysis can be performed under three input data scales**
 1. Estimated data information through APIs from external tools (synthetic data, no need for time-series data)
 2. Extended historical data (partial need for time-series data)
 3. Sensor real time data (automated time-series data import)
- ⊙ **Performance results include environmental (LCA) and economic (LCC) indicators for:**
 - New constructed building
 - Renovated building - in order to compare existing and planned(after renovation) status

Scenario set up is based on three user options

1. Desired country to perform the use case VERIFY scenario
2. RES-production, consumption, storage and pricing information
3. Building specifications [construction info] and related technologies [heating/cooling/ventilation/insulation/glazing]

Main features:

- ✓ Software tools for buildings & districts
- ✓ Software modules for LCA & LCC
- ✓ Add-ons for IoT sensor connection
- ✓ Add-ons for data gathering and processing
- ✓ VERIFY is accessed online – no need to install packages

VERIFY - Main Features

VERIFY - Main Menu

Project Setup | Data Retrieval | LCA & LCC Analysis | Real Time LCA-LCC | Map | Overview

	Id	Date Created	Location	Electrical Plan	Thermal Plan	Investment Plan	Actions
New Plan							
New Location							
Construct Full Project							
Show Plans							
Show Locations							
	13	2022-04-06	Greece	Moschato - 1	Moschato - 1	empty	No access
	9	2022-03-29	Greece	Athens 2b extended	thermal 2b extended	Empty Investment Thes/niki	
	8	2022-02-25	Greece	Empty Electrical Thes/niki	Empty Thermal Thes/niki	Empty Investment Thes/niki	
	7	2022-02-23	Greece	Comparative Demo Electrical	Comparative Thermal plan	Demo comparative investment	
	6	2022-02-22	Greece	Empty Electrical	Empty Thermal	First Investment Plan	No access

Main Menu of VERIFY platform



VERIFY – LCA indicative performance indicators

VERIFY - Data Upload and Utilization

Component	Installation	Sensor	Edit	Delete	Data	Data Range
Aircondition basic var	New	Smart Plug AC1	Edit	Destroy	Upload measurements CSV	2022-02-02 10:17:44 UTC - 2022-02-07 10:25:54 UTC
		Smart Plug AC2	Edit	Destroy	Upload measurements CSV	2022-02-02 10:18:20 UTC - 2022-02-07 10:25:31 UTC
		Smart Plug AC3	Edit	Destroy	Upload measurements CSV	2022-02-02 10:19:37 UTC - 2022-02-07 10:23:52 UTC
Pv rooftop var	New	No sensor data. Please click Add Sensor	-	-	-	-
Temperature indoor	Both	Thermometer indoor	Edit	Destroy	Upload measurements CSV	2022-02-02 10:24:52 UTC - 2022-02-07 10:17:40 UTC
Total electrical consumption var	New	DinRail	Edit	Destroy	Upload measurements CSV	2022-02-02 10:17:51 UTC - 2022-02-07 10:24:13 UTC

VERIFY data upload and utilization



VERIFY – LCC indicative performance indicators

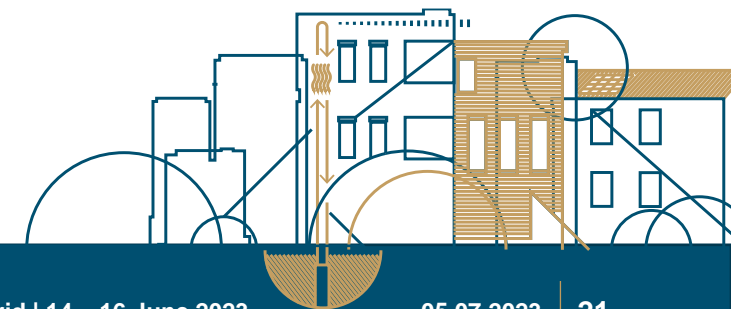
OPTEEMAL

- BIM-based tool.
- This tool provides as an output the optimal configuration of a district under certain boundaries and targets from a defined catalogue of Energy Conservation Measures.
- Adapt this tool to play the role of replication tool in REHOUSE.
- Digital tool integrated with RPs digital models to analyse the replicability potential of each RP.



<https://www.opteemal-project.eu/>

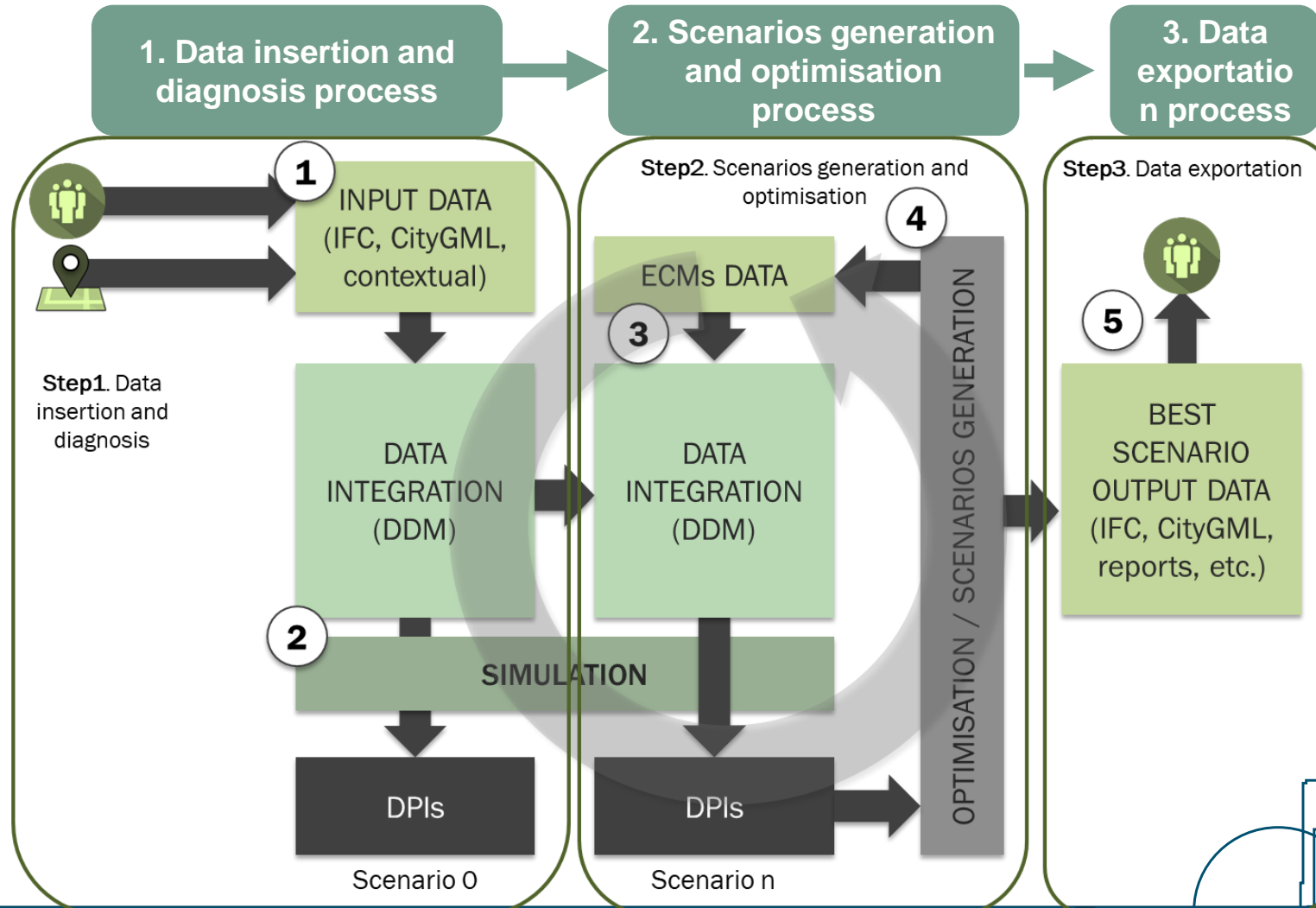
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 680676.



OPTEEemAL



Steps followed in the OptEEemAL platform



OPTEEMAL



1 BIM approach

1. COLLABORATION among stakeholders

- 2. CONTINUOUS UPDATE (parameterisable elements)
- 3. CHANGE REDUCTION
- 4. COST REDUCTION

2 IPD approach

1. COMMUNICATION among stakeholders

- 2. KNOWLEDGE SHARE among stakeholders
- 3. OBJECTIVES SETTING (reach consensus)

3 ECMs catalogue

1. DISTRICT AND BUILDING LEVEL measures

- 2. PASSIVE, ACTIVE AND CONTROL measures to tackle all possible types of intervention
-

4 MCDA deployment

1. SIMULATION using external tools

2. EVALUATION BASED ON DPis

ENE ECO ENV

- COM SOC URB
3. OPTIMISATION based on calculation results
-

5 Use of ontologies

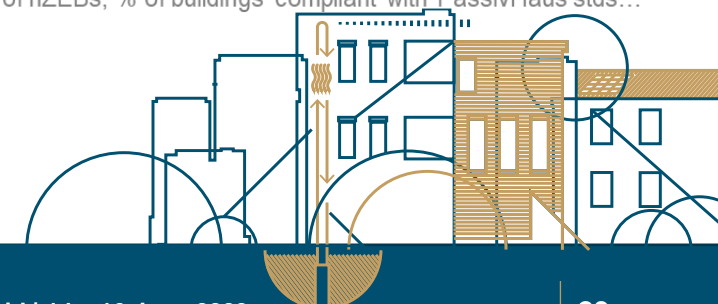
1. COMMON DATA MODEL (DDM)

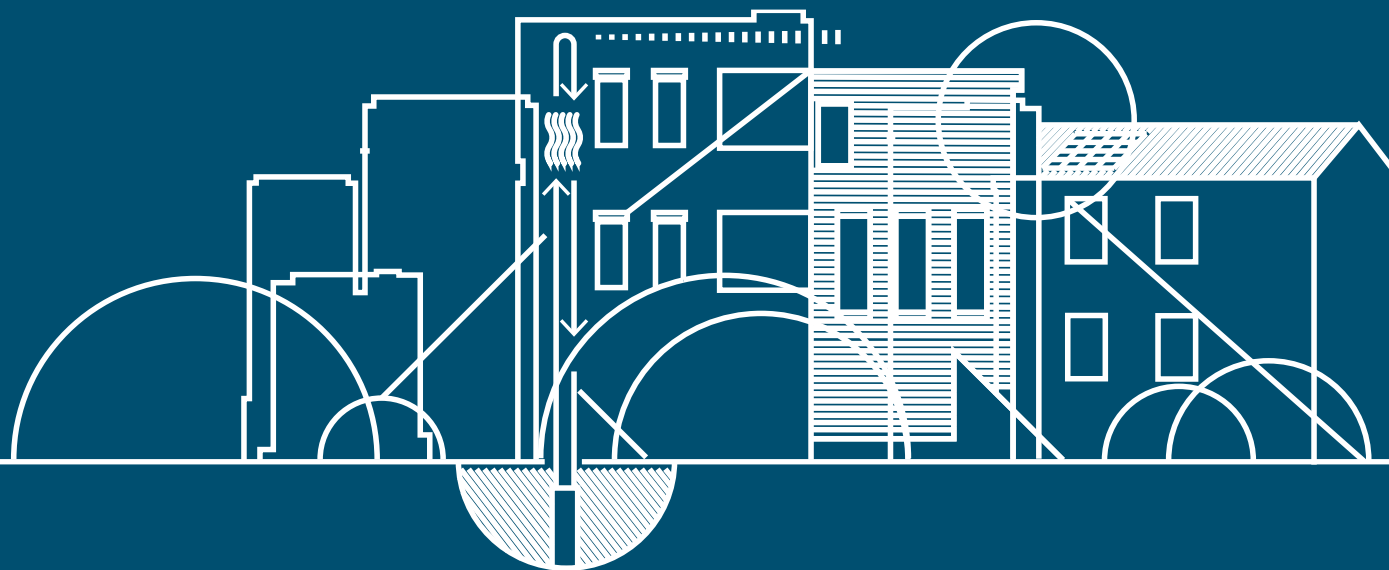
2. TRANSFORMATION OF INPUT DATA to comply with the established data model

3. TRANSFORMATION OF OUTPUT DATA to comply with users' requirements
-

1. District Performance Indicators calculated (42):

- 1. ENERGY (total of 19)
Energy demand, energy consumption, renewable use...
- 2. COMFORT (total of 6)
Local thermal comfort, percentage outside range...
- 3. ENVIRONMENTAL (total of 6)
Global warming potential, embodied energy, energy payback time
- 4. ECONOMIC (total of 5)
Investments, ROI, LCC, operational energy cost...
- 5. SOCIAL (total of 1)
Energy poverty
- 6. URBAN (total of 4)
% of nZEBs, % of buildings compliant with PassivHaus stds...





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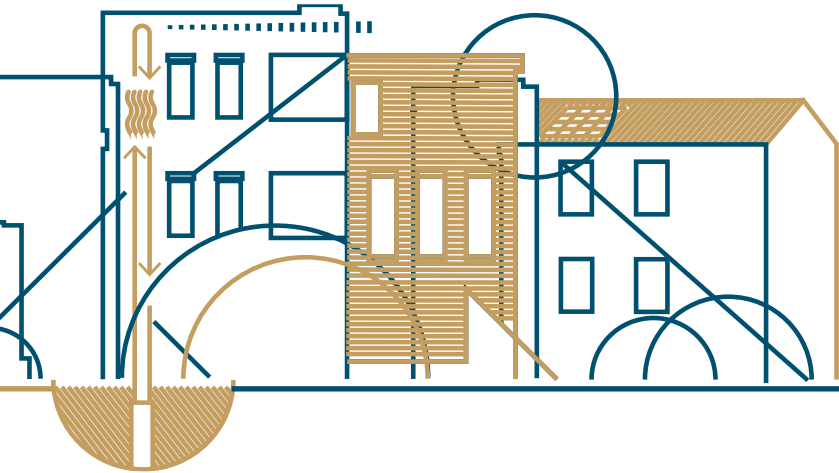
REHOUSE



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PLACES 2023**

THANK YOU FOR YOUR ATTENTION.



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