

BIMERR Renovation 4.0 toolkit

BIM-based holistic tools for Energy-driven Renovation of existing Residences

Giorgos Giannakis



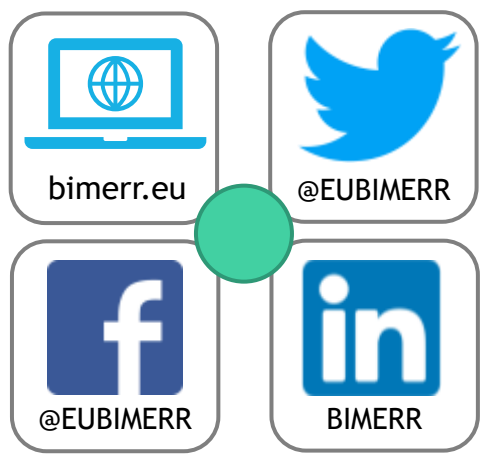
BIMERR - Design and develop an ICT-enabled Renovation 4.0 toolkit comprising tools for AEC stakeholder support throughout the energy efficiency renovation process of existing buildings.

BIMERR is an **EU-funded project** under Horizon 2020, related to the Building Information Modelling (BIM).


16 partners from **9 Member States**

Budget: approx. **7€ million**


Project duration: **45 months** (1/2019 - 09/2022)




BIMERR Pilot sites




Pre-pilot Kripis
KRIPIS home, the first Smart Near-Zero Energy Building in Greece, with IoT, Smart Home solutions



Pre-pilot Athens
Residential building in Athens for smart sensors installation, audits, surveys, and digital model population activities



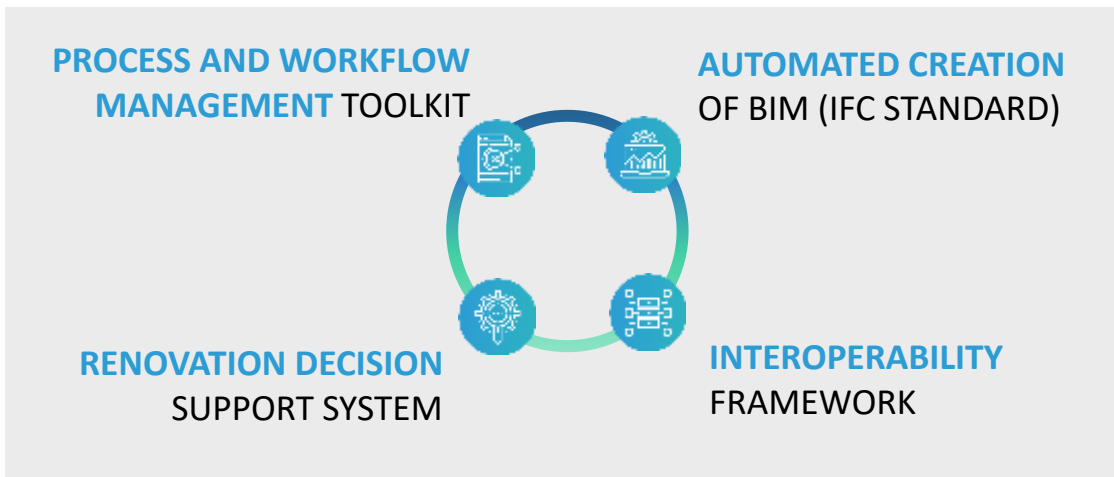
Pilot Bilbao
Residential building in Bilbao, Spain. 5-storey high with 60 apartments that will be renovated using the BIMERR tools



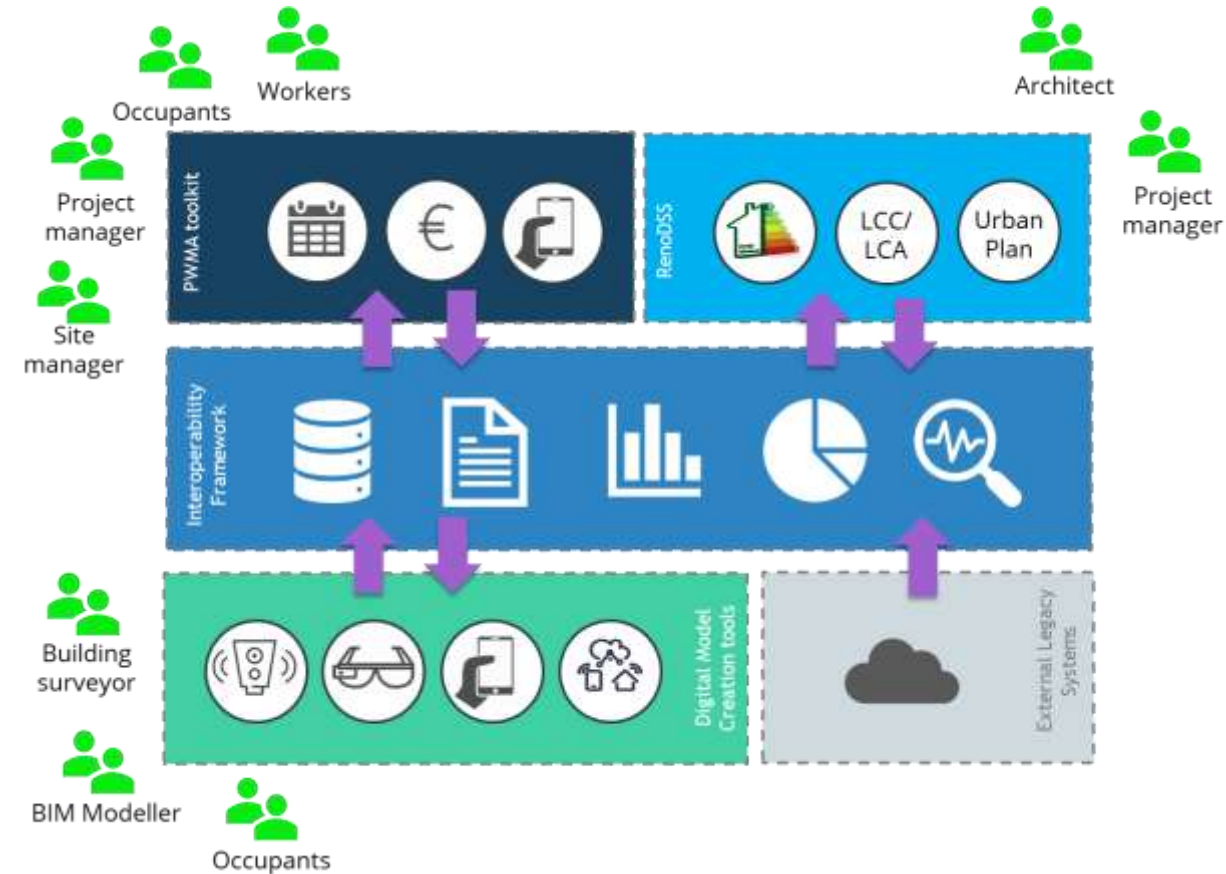
Pilot Warsaw
Residential building in Warsaw, Poland. L-shape, 4-storey building will be renovated using the BIMERR tools



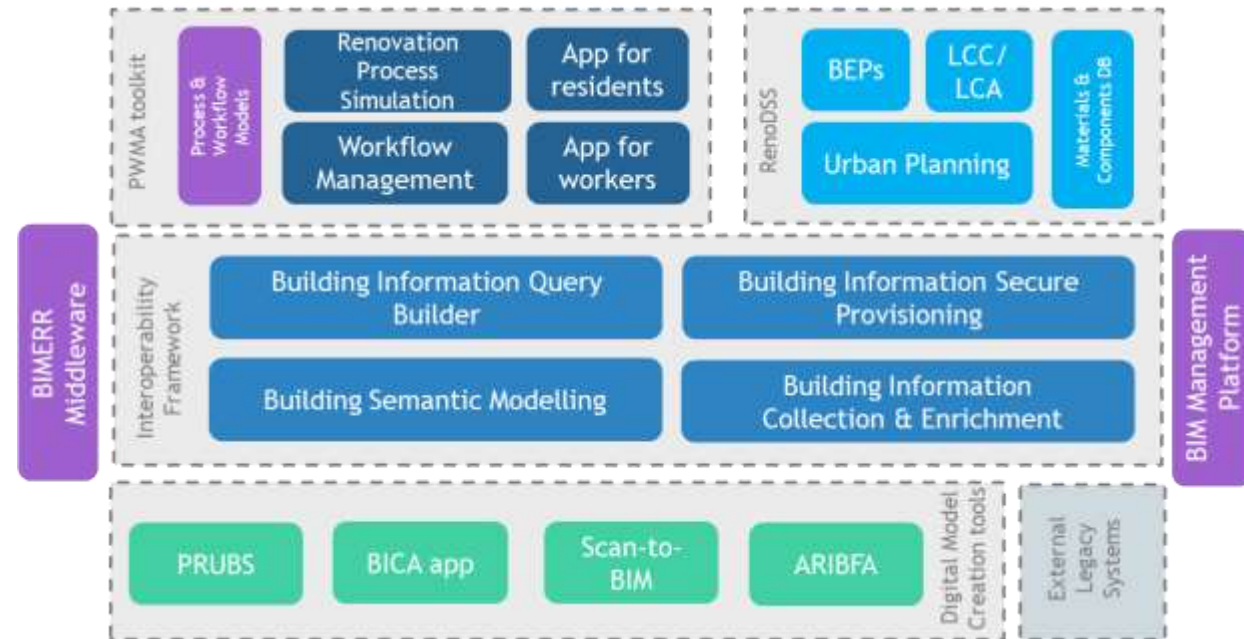
BIMERR Objectives



BIMERR concept



BIMERR solution



Architect

Project Manager

Students & Researchers

Building Surveyor

BIM Modeller

Workers

Project Manager

Site Manager

Occupant

The collage displays various BIMERR components:

- Architectural Tools:** A hierarchical tree diagram, a software interface with multiple panels, a mobile app showing a list of items, and a 3D model of a building with different sections highlighted.
- Mobile Applications:** A control panel with various icons, a 'bimerr_demo' app interface, and a 'Reset Password' app screen.
- Central BIMERR Framework:** A central hub with 'BIMERR Middleware' on the left and 'BIM Management Platform' on the right. It includes:
 - PWMA toolkit:** Renovation Process Simulation, App for residents, Workflow Management, App for workers.
 - RenodSS:** BEPs, LCC/LCA, Urban Planning, Materials & Components DB.
 - Interoperability Framework:** Building Information Query Builder, Building Information Secure Provisioning, Building Semantic Modelling, Building Information Collection & Enrichment.
 - External Legacy Systems:** PRUBS, BICA app, Scan-to-BIM, ARIBFA, Digital Model Creation toolset.
- Other Interfaces:** A detailed data table, a 3D model of a building, a mobile app showing a 3D model, a 3D rendering of an interior room, and a detailed material property card for a wall.

IFC Label: 18008
Type: IcWall
Global ID: 0hZAr06lz5hWRv0DdeF74
Name: Basic Wall: My interior wall 80...
PROPERTY SETS
Area: 25.5198517439947
Volume: 2.09262784300757
CONSTRAINTS
Level: Level: Ground Floor
MATERIAL SETS
Size: 5
Material 1: PART inside
Material 2: MY Gypsuam Wall Board
Material 3: Rock Wool
EXIT **ADD ANNOTATION** **PIN**

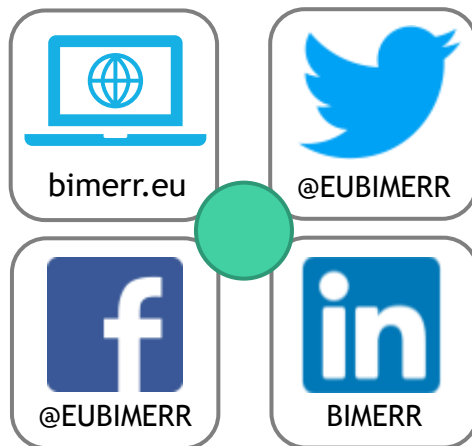
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BIMERR Consortium



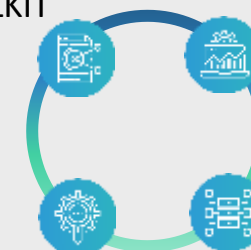
BIMERR Objectives

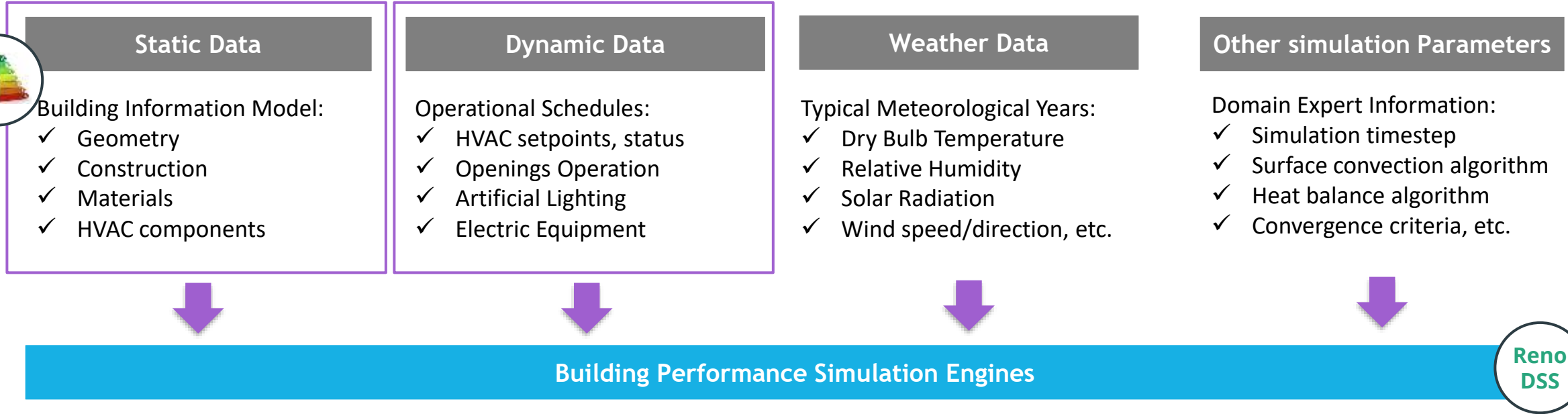
PROCESS AND WORKFLOW MANAGEMENT TOOLKIT

AUTOMATED CREATION OF BIM (IFC STANDARD)

RENOVATION DECISION SUPPORT SYSTEM

INTEROPERABILITY FRAMEWORK





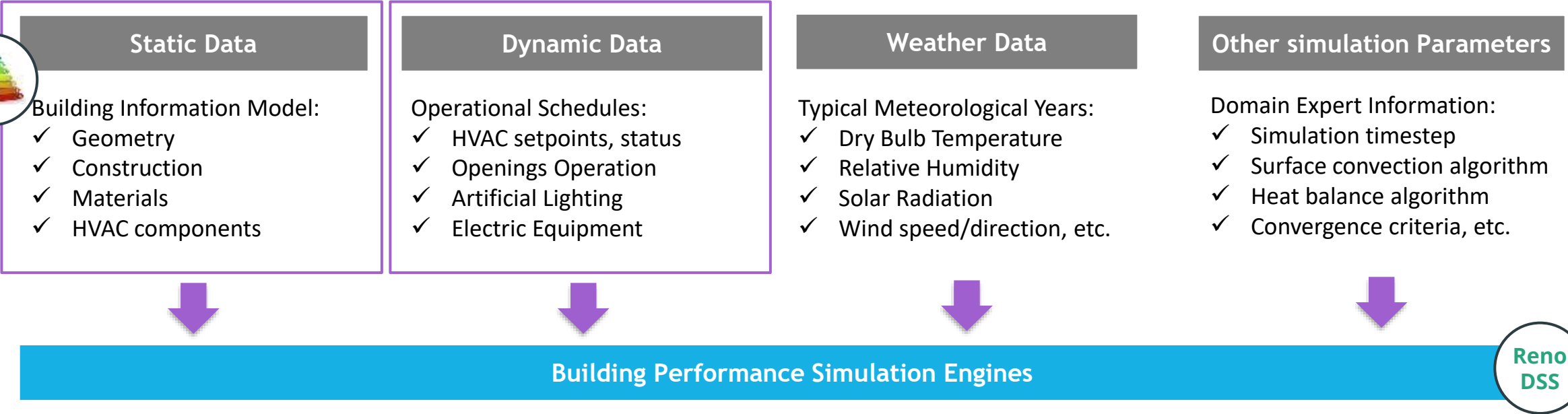
- ✓ Static data collection is very time-consuming process, often requiring more time than is available within project deadlines
- ✓ Static data transformation non-standardized process; results can significantly vary from one modeller to another

- ✓ oversimplified and modelled as either deterministic or predefined rule-based schedules

EPW

JSON

Reno DSS



Static Data

- Building Information Model:
- ✓ Geometry
 - ✓ Construction
 - ✓ Materials
 - ✓ HVAC components

Dynamic Data

- Operational Schedules:
- ✓ HVAC setpoints, status
 - ✓ Openings Operation
 - ✓ Artificial Lighting
 - ✓ Electric Equipment

Weather Data

- Typical Meteorological Years:
- ✓ Dry Bulb Temperature
 - ✓ Relative Humidity
 - ✓ Solar Radiation
 - ✓ Wind speed/direction, etc.

Other simulation Parameters

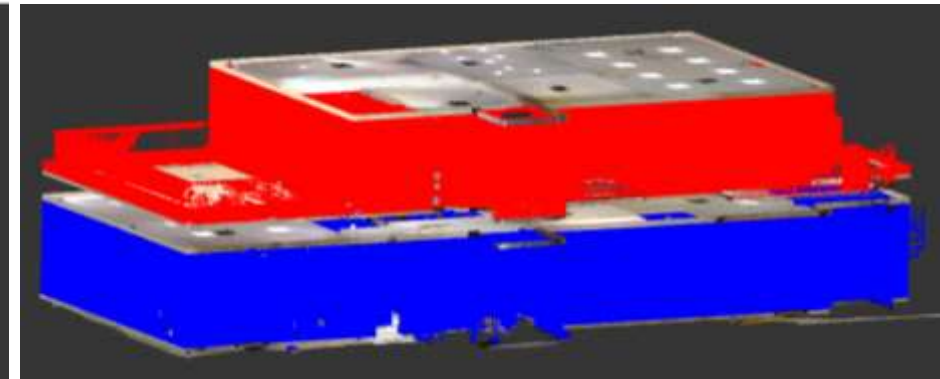
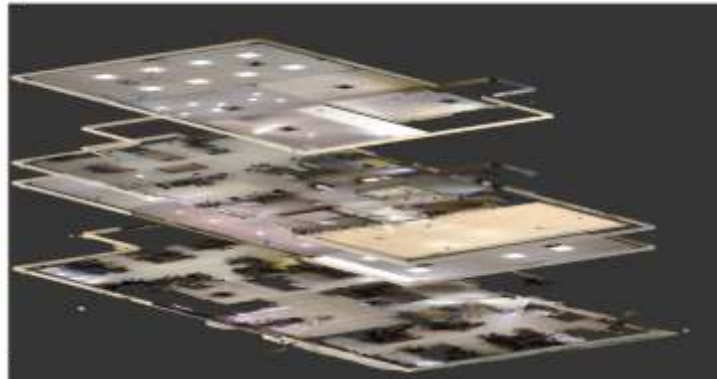
- Domain Expert Information:
- ✓ Simulation timestep
 - ✓ Surface convection algorithm
 - ✓ Heat balance algorithm
 - ✓ Convergence criteria, etc.

Building Performance Simulation Engines



✓ Automated IFC to Input Data Files of Simulation Engines – streamline & expedite the static data acquisition

✓ obXML – methods and models to reduce the gap between simulated and measured BEP by representing OB in a standardized XML schema

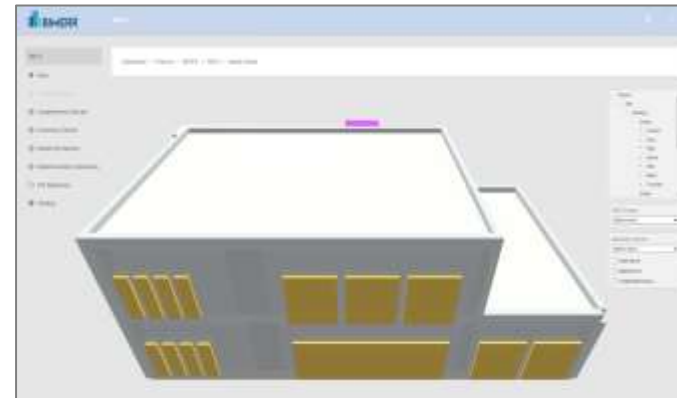


Scan-to-BIM: A toolset for the automated creation of BIM

- ✓ Input – the laser scanning and photography
- ✓ Output – a Building Information Model of the building, that includes structural components (walls, floors, openings) and MEP components (e.g., HVAC, sockets, and switches)
- ✓ Scan-to-BIM Structural sub-component – to create the structural BIM model from the point cloud data
- ✓ Scan-to-BIM MEP sub-component – to enhance the previous BIM model with MEP components
- ✓ Scan-to-BIM Editor – to modify the generated BIM model by adding information about materials and properties
- ✓ Sub-components are integrated in an umbrella component with Graphical User Interface (GUI): the Scan-to-BIM Interface

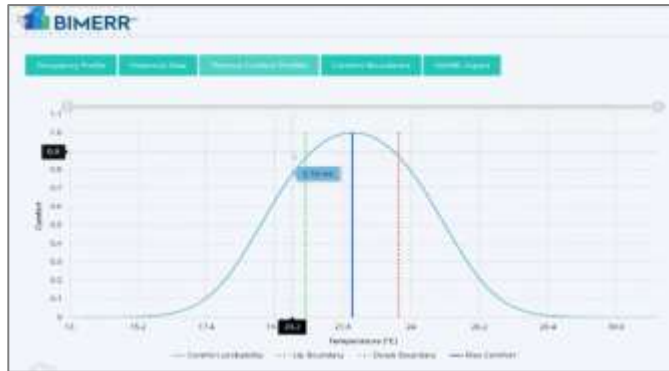
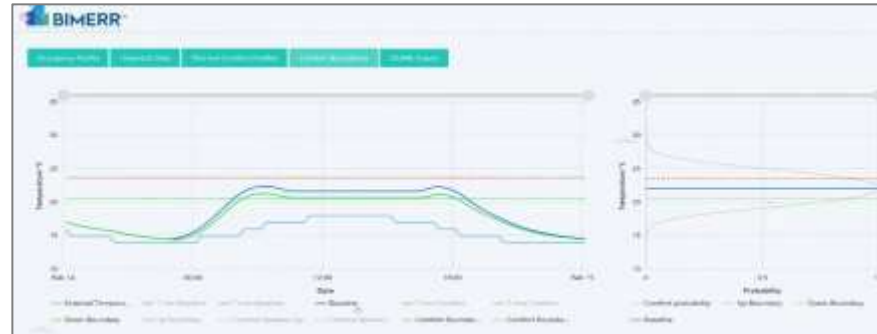
Scan-to-BIM: the first version of the BIM model in IFC format is ready to be processed by ARIBFA and BIM platform





BIM Platform: A toolset that optimises and checks the completeness & correctness of the BIM model

- ✓ Input – BIM model in IFC format
- ✓ Output – a complete, correct and optimised IFC model that meets the building performance simulation static data requirements
- ✓ 3D Model viewer
- ✓ Completeness checker of the BIM model
- ✓ Correctness checker of the BIM model
- ✓ BIM model geometry generator - OBJ



WSN design/installation

Sensors

- Temperature
- Humidity
- Luminance
- Occupancy
- CO2

Metering

- Plug
- Circuit Board
- Clamp
- Electricity/Gas/District Heating

Weather

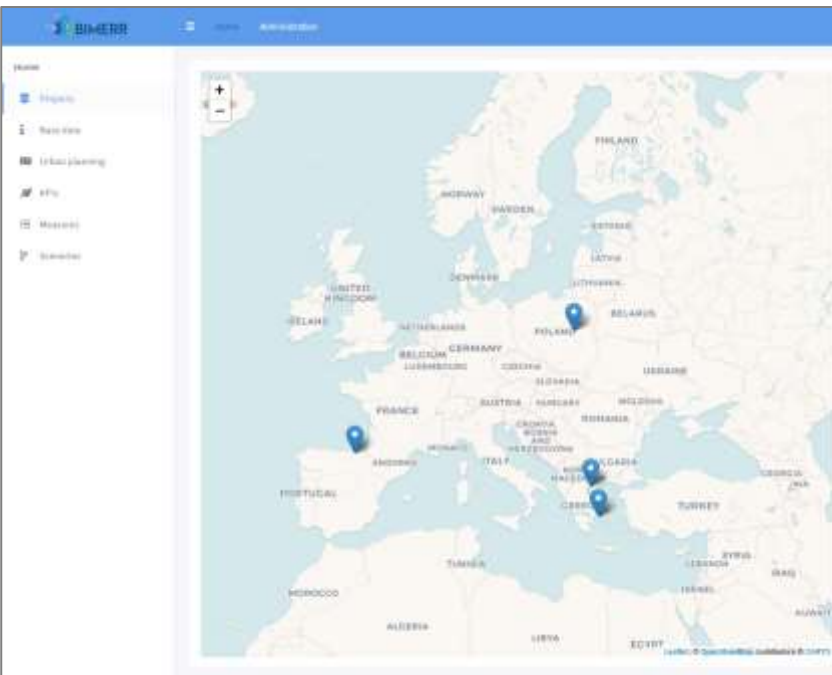
- Temperature
- Humidity
- Cloud cover



PRUBS: Profiling Residents Usage of Building Systems

- ✓ Input – IoT data acquired by a Wireless Sensors Network
- ✓ Output – Occupant behaviour models in obXML format that meet the dynamic data requirements of building performance simulation engines
- ✓ Comfort/Discomfort event generator – extract information about occupant’s comfort/ discomfort sensation driven only by the collected sensing and monitoring data
- ✓ Occupant behaviour modelling – ML based algorithms that estimate the occupants comfort boundaries and actions or controllable elements based on the comfort/discomfort events
- ✓ obXML data model generator – populates the obXML data model with Occupant behaviour Models data





Scenario solutions

RES C	RES T	RES E	EN1 C	EN1 E	EN2 C	EN2 E
44.300	0	42.800	32.2	32.3	40.7	0.0140
57434	0	7.781	65.2	32.8	40.7	0.0140
68240	0	7.781	65.2	32.8	40.7	0.0140

Total scenarios: 3 - Calculated scenarios: 3

Renovation measure

Renovation measure	Element type	Quantity	Life time	Life Cycle Cost	Sustainability
External facade insulation	Facade	220.18 m ²	30	381,844.41	30.12

Economic

ECS - Life cycle cost during period of analysis (monetary unit)

574,334

Payback period (years)

0 - 5

Construction cost (monetary unit)

7,781

Energy

EN1 - Total primary energy consumption (kWh/yr) (year)

65.2

EN11 - Heating energy demand (kWh/m²/year)

33.8

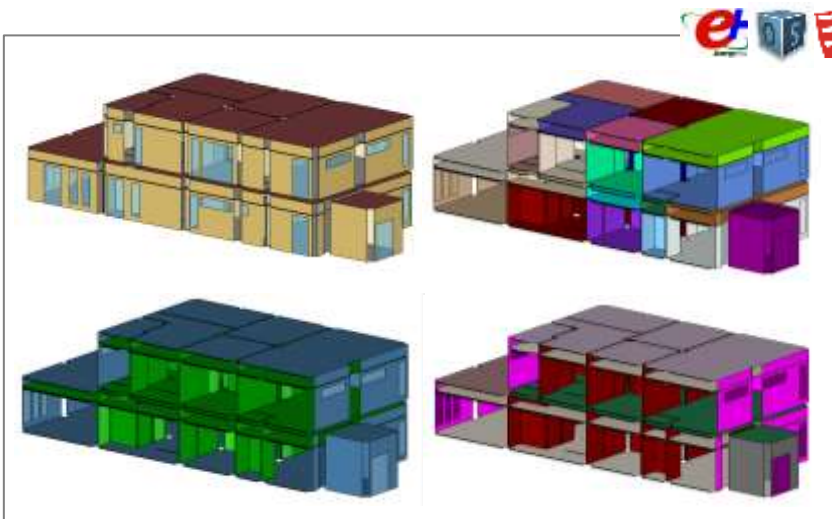
EN12 - Cooling energy demand (kWh/m²/year)

40.7



Scenario Details

Scenario	Scenario ID	Scenario Name	Scenario Description
Scenario 1	1	Scenario 1	Scenario 1
Scenario 2	2	Scenario 2	Scenario 2
Scenario 3	3	Scenario 3	Scenario 3



RenoDSS: A web-based system that can be collaboratively used by multiple users

- ✓ Input – the open industry standard IFC for a given building configuration
- ✓ Output – Energy, sustainability and economic KPIs of a given building configuration
- ✓ Automated generation of renovation scenarios which meet the target KPIs
- ✓ Renovation scenario KPIs sorting, filtering, and comparison
- ✓ Detailed information on single renovation measures on the web
- ✓ PDF reports with detailed information on selected renovation scenarios
- ✓ Download IFC file for each renovation scenario





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