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Integrating BMS and BIM to improve interoperability between simulation and energy management environments

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Current and Future Challenges to Energy Security

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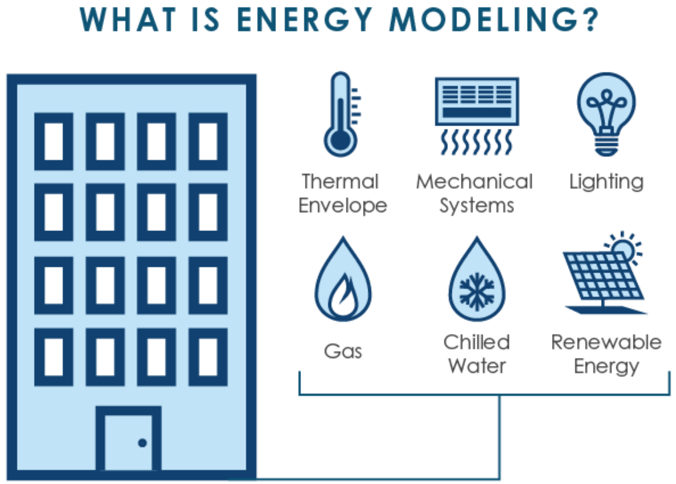
Background : BEM

- Building Energy Modeling (BEM) is the process of utilizing a computer to replicate building energy performances.

- BEM predicts building energy consumption, CO_2 emissions, peak demands, energy cost and renewable energy production.

- There are two ways to create a BEM:
  - Design the building from scratch within the simulation environment;
  - Use an architectural model.

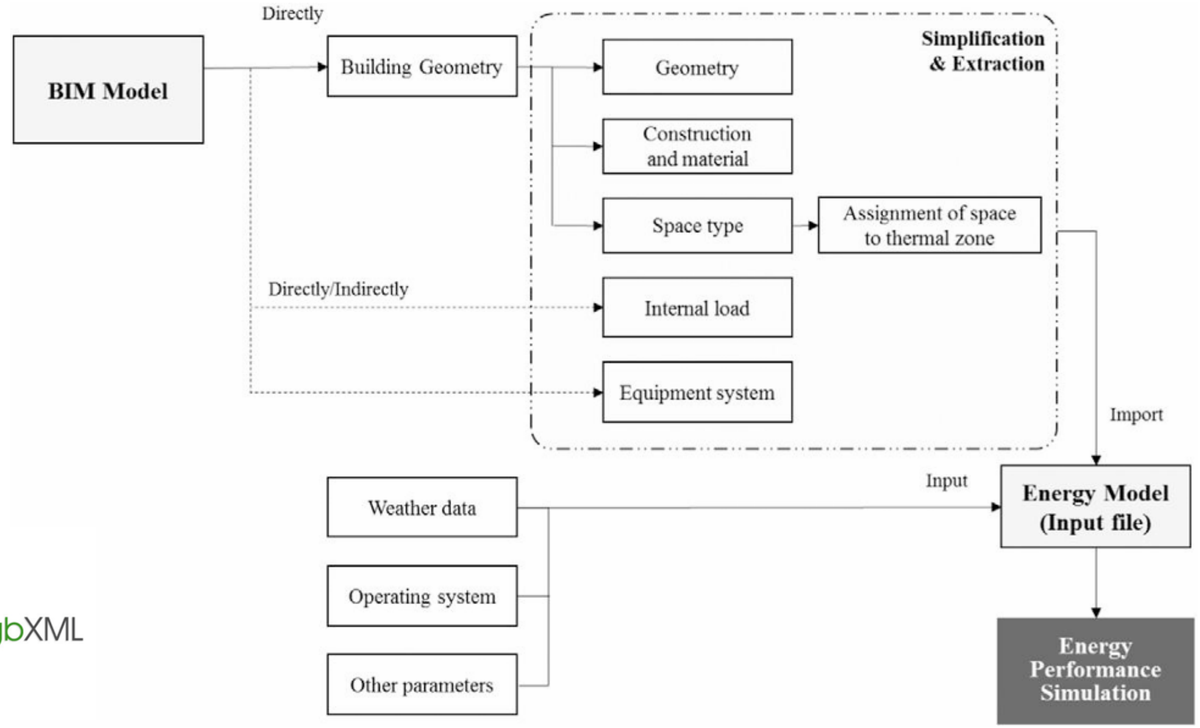


Background : BIM to BEM

- BIM to BEM is a process that uses BIM to create the simulation input model and usually involves four steps:

1. Simplification;
2. Extraction of data for simulation;
3. Input file creation;
4. Simulation.

Ifc and gbXML as data models and BIM export standards



Jungsik, C.; Jihye, S.; Minchan, K.; Inhan, K. (2016)

Background : BMS

- Building Management System (BMS) → heating, cooling, ventilation, air conditioning, lighting, etc

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Building Automation Protocols → rules and standards

BMS platforms are quite closed systems that use proprietary protocols

There is a need to use an open protocol to ensure interoperability and integration

To date, open protocols have been developed:

KNX

DALI

LonWorks

ASHRAE BACnet®

Modbus

Background : BEM e BMS

- **Problem**: BEM and BMS are mapped according to customised rules and standards

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Need for integration between energy simulation (BEM) and real energy data (BMS) to optimize energy behaviour

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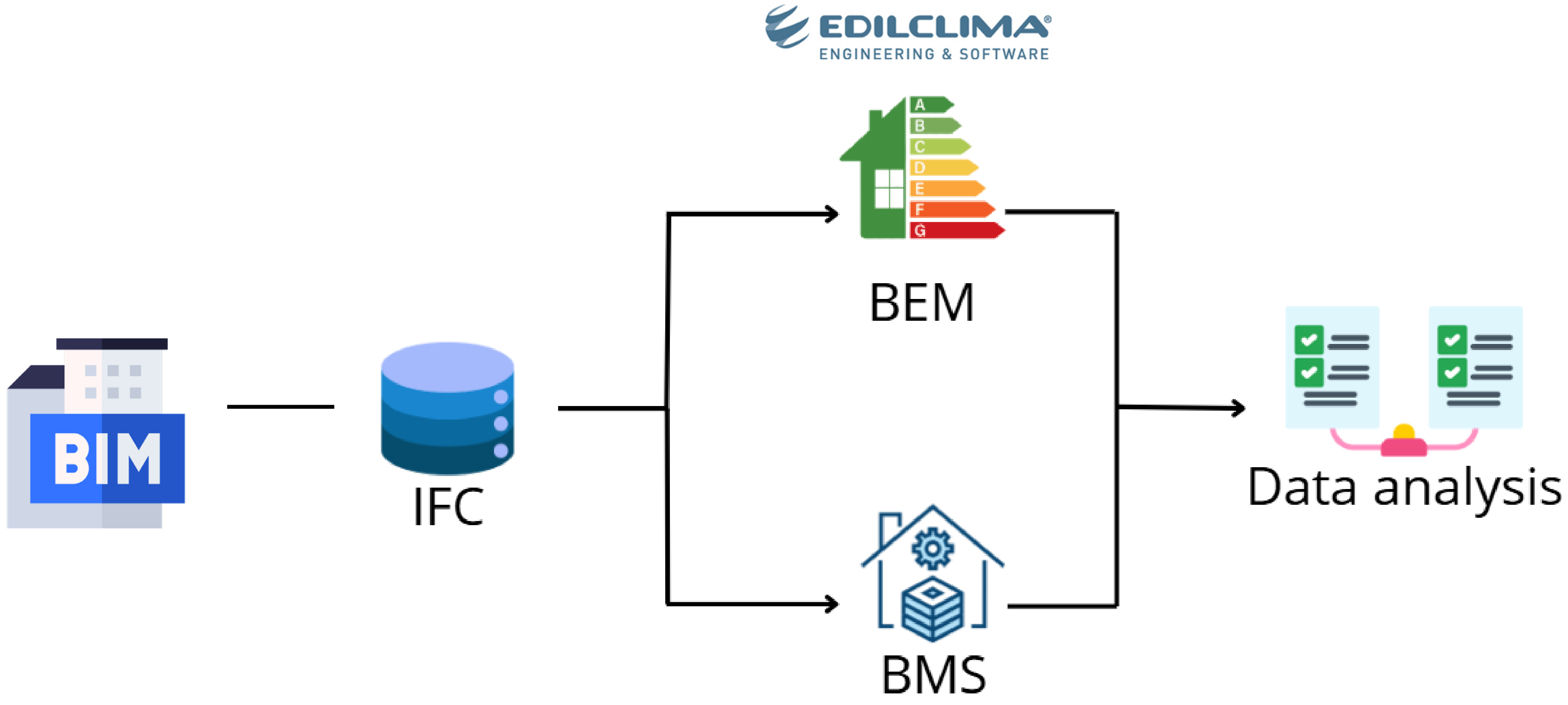
IFC can act as a communication standard between energy simulations and real energy data

Methodology

- The application case study presented below was created with the aim of using an IFC file within a BEM and BMS platform in order to compare energy simulation results with actual values.



Case study

The experimentation is in collaboration with SMACT Competence Center, one of the 8 Industry 4.0 Competence Centers established in Italy

The case study focuses on a real building located on Via Niccolò Tommaseo, near the Padua Fairgrounds, where Schneider installed multiple devices for smart building control and management.

Case study

The building covers an area of 3000 sqm and is developed over 4 levels.

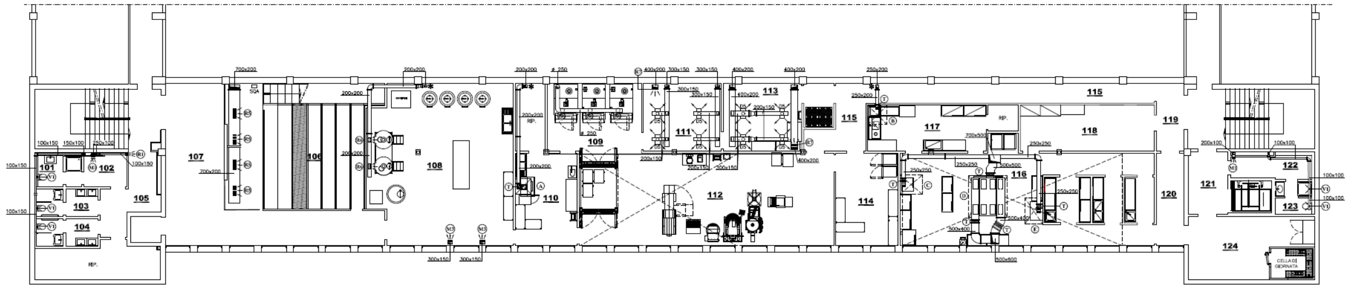
The building primarily serves two types of use: **production** on the lower levels and **administrative spaces** on the top floor.

The structure is equipped with six AHUs and VRF systems.

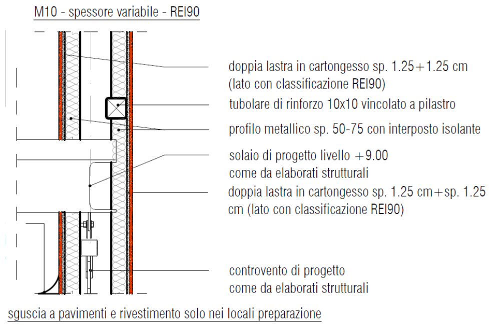
Case study: BIM

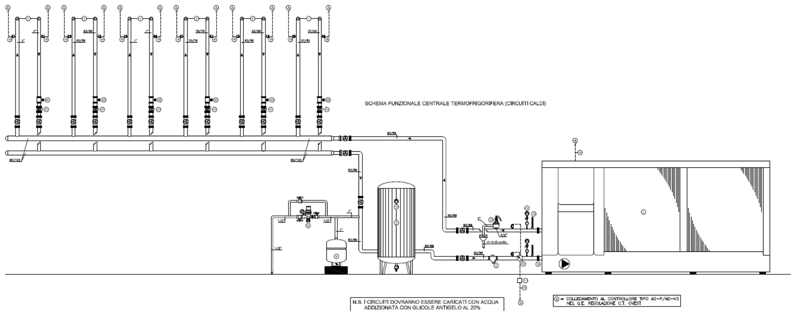
Information analysis:

Design drawings for:
- Definition of geometries
- Material characterization
- System schematization



On-site inspection to verify discrepancies in the current state.





Case study: BIM

Information analysis:

Design drawings for:

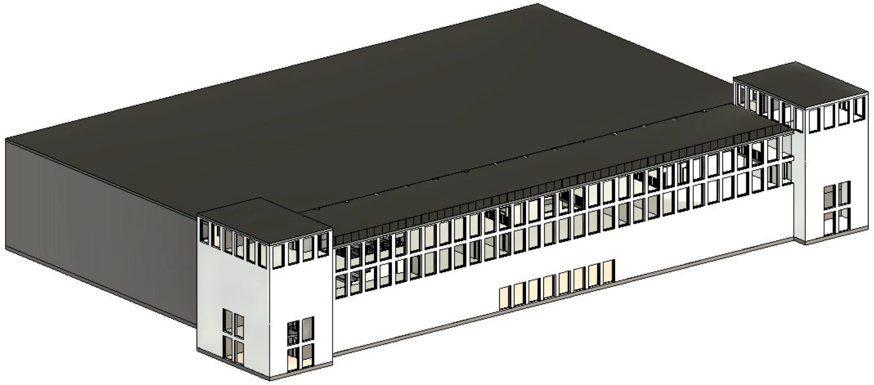
- Definition of geometries
- Material characterization
- System schematization

On-site inspection to verify discrepancies in the current state.

Case study: BIM

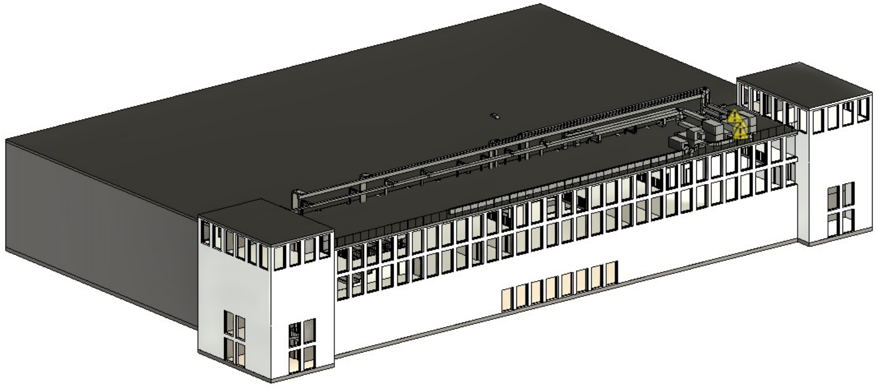
- The creation of the **information model** is the first step to define a digital twin

<u>Architectural model:</u>
Envelope, materials, spaces and zones



Architectural model

<u>Mechanical model:</u>
HVAC system



Mechanical model

Case study: IFC

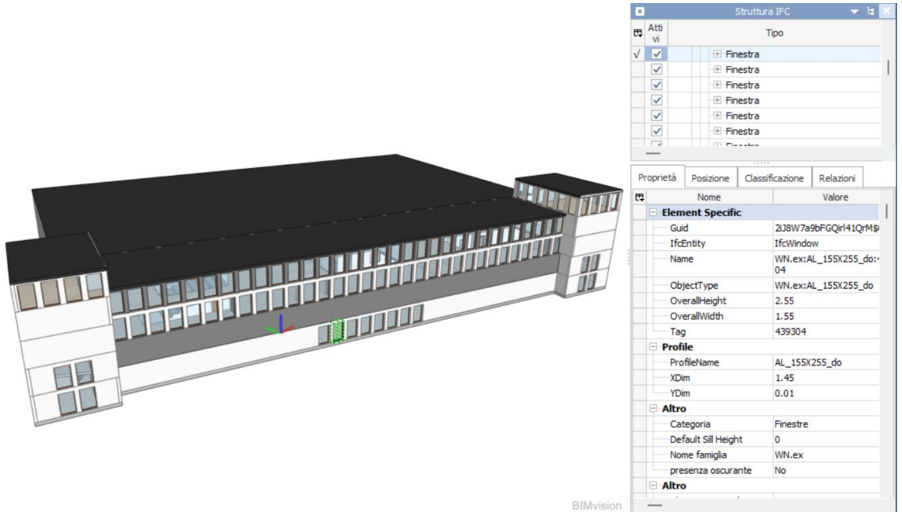
- The creation of the **IFC** is necessary to integrate BEM and BMS

Federated model

IFC model

The process included the definition of the correct MDV for data export

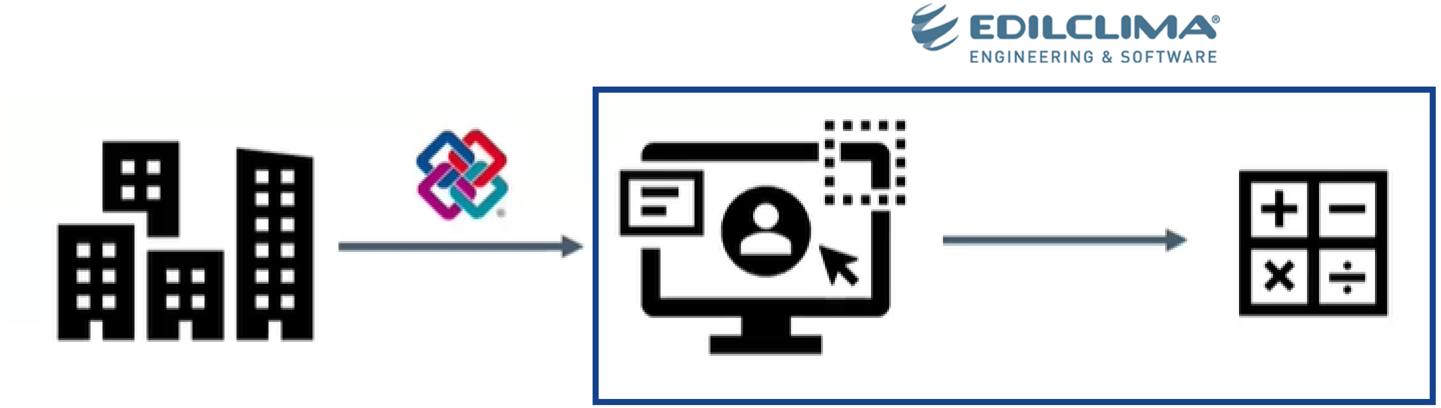
IFC 2x3 VS IFC 4



Case study: Edilclima

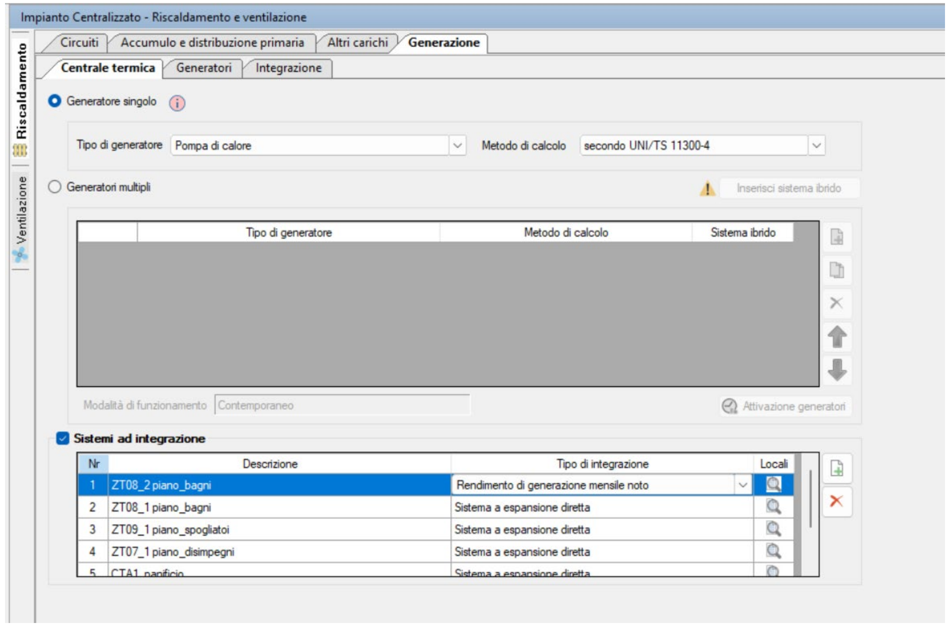
- Edilclima EC700 is the calculation engine for the energy performance of buildings, including both the monthly method according to UNI/TS 11300 and the hourly dynamic method according to UNI EN ISO 52016-1.

- The software reads the IFC standard for importing the input model

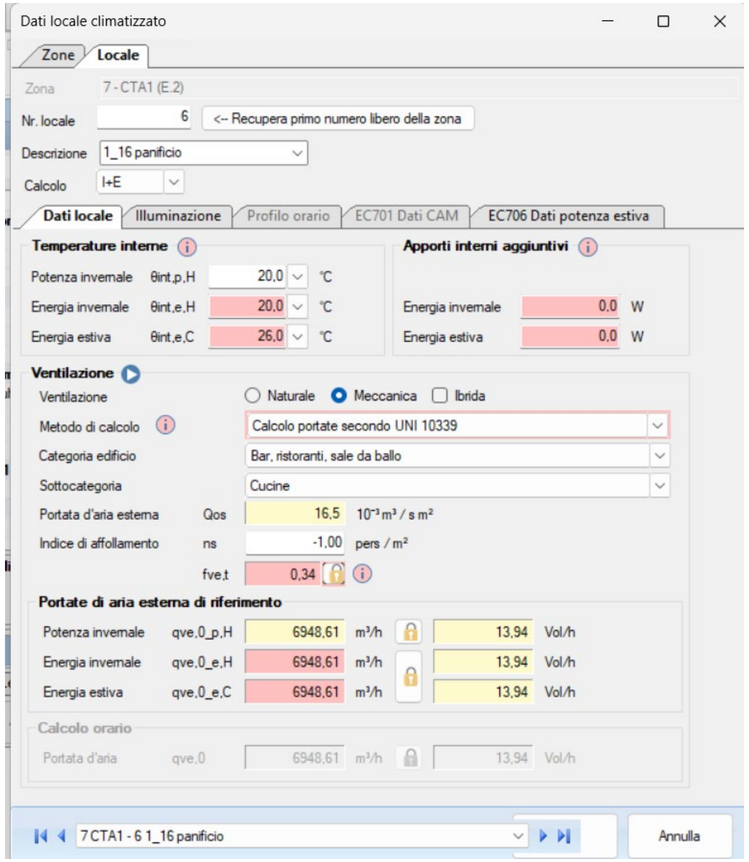


Case study: Edilclima

- Information useful for the simulation must be added manually in the analysis software:
  - climate data;
  - envelope data;
  - Temperature and usage profiles of rooms;
  - HVAC and lighting systems.



HVAC system



Space properties

Case study: BMS

- The connection to the BMS allowed the acquisition of an energy data history

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Real data were processed to create trends for comparison with predictive data


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Data e ora;Quadro Cucina;Imp. Fotovoltaico;Centrale Termica;Vaso cottura;Birrificio;Luce zone5-6 +9; Luce ascensore;Riserva;FM Smart Cooking; Fm zona 4 +6;Q. Aula gradoni;Fm Zona 8 +6; Ill.
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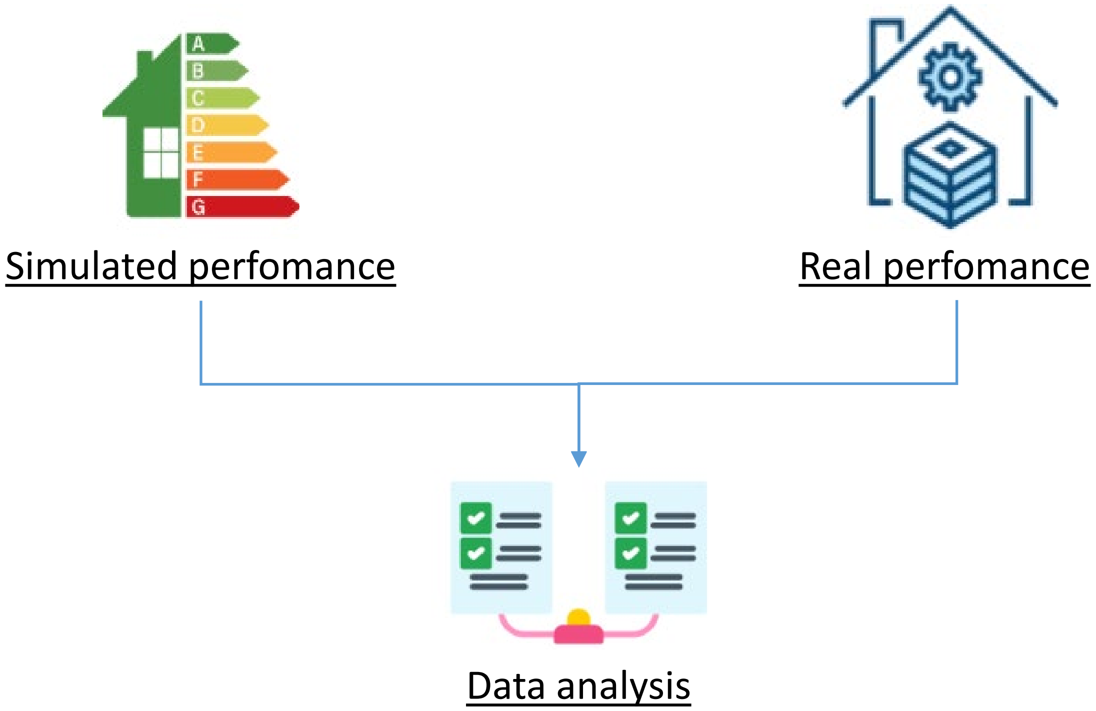
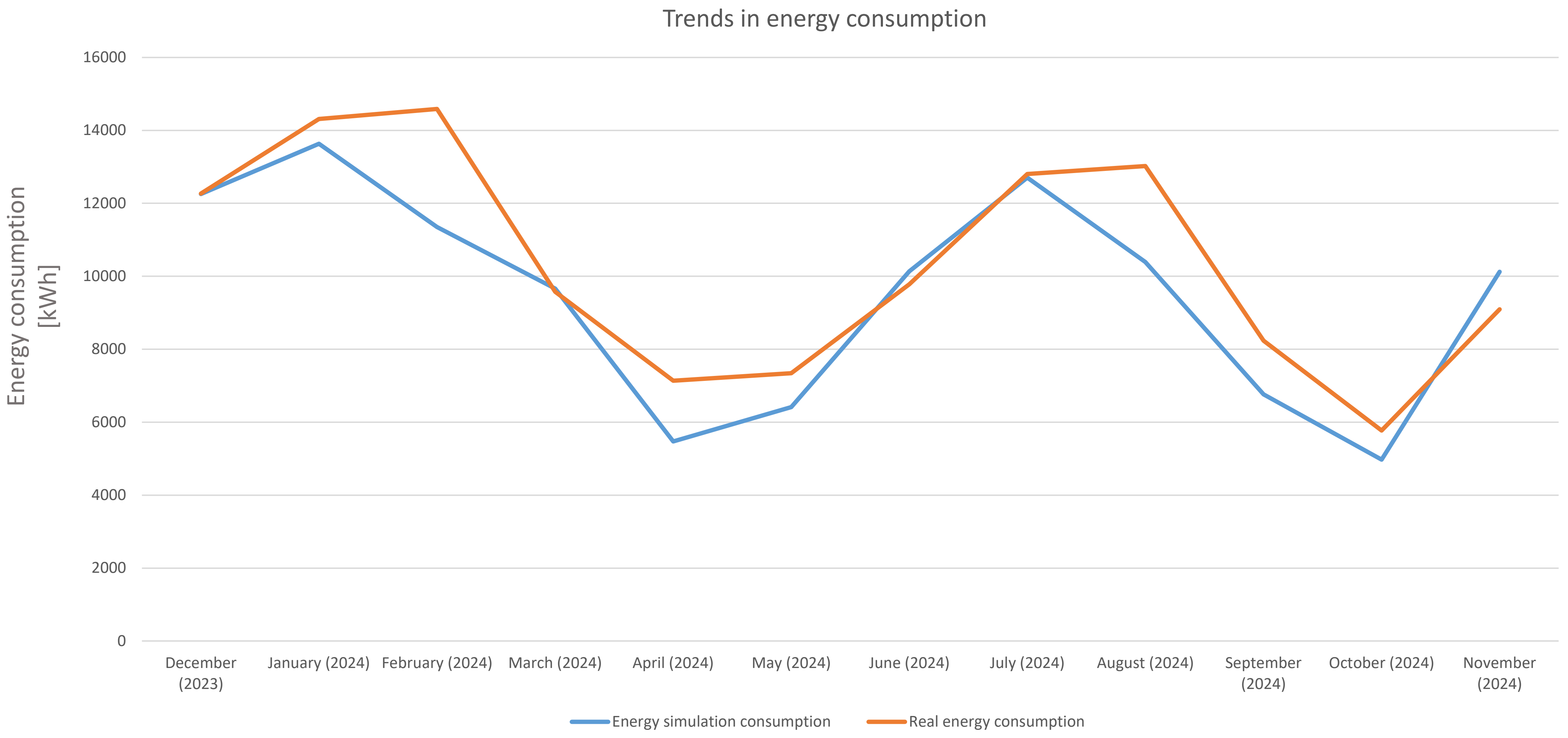
Results

- The import of the IFC file into the simulation environment is not error-free:
  - Manual intervention by the user

- **Comparison** between building energy perfomance:

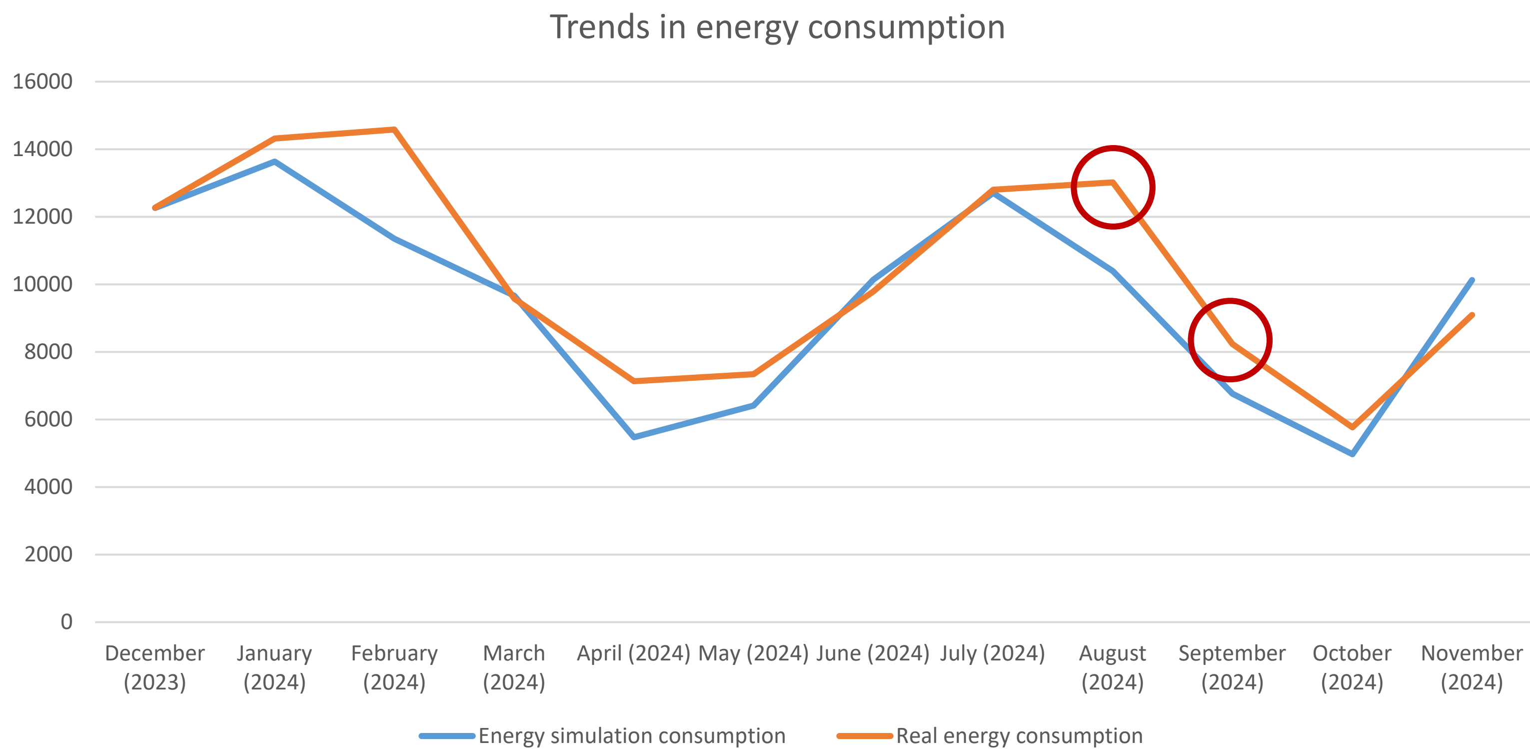


Results



Trends in energy consumption
Energy consumption [kWh]
16000
14000
12000
10000
8000
6000
4000
2000
0
December (2023)
January (2024)
February (2024)
March (2024)
April (2024)
May (2024)
June (2024)
July (2024)
August (2024)
September (2024)
October (2024)
November (2024)
Energy simulation consumption
Real energy consumption

Discussion



Month	Average simulation temperature	Real average temperature
December (2023)	4,8	2,4
January (2024)	3	4
February (2024)	3,6	4
March (2024)	8,6	10
April (2024)	12,8	14
May (2024)	18,9	19
June (2024)	22,3	24
July (2024)	23,7	28
August (2024)	23,7	27
September (2024)	18,6	23
October (2024)	13,9	16
November (2024)	8,3	11

Future work

- BMS independent platform for real-time data reading of sensors
    - Reduce operating costs and improve performance;
    - Identify malfunctions and inefficiencies;
    - Plan corrective maintenance actions.

- Predictive energy simulation based on a digital twin
    - Prediction of system thermal loads based on user profiles and weather data
    - Optimization of energy behaviour

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Thank you for your attention!

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