PROJECT:
ICT Platform for Holistic Energy Efficiency Simulation and Lifecycle Management Of Public Use Facilities

HESMOS Virtual Energy Lab

DELIVERABLE TITLE:
Recording evidence on benefits and costs

Deliverable Number:
D 9.2.1 (non-public)

WORK PLAN:
The **objective** of Work Package 9 is to validate the operation of the facilities, comparing current practice and anticipated new capabilities enabled by HESMOS developments using the defined energy-related Key Performance Indicators as well as expert rules and procedures. Important aspects that are usually underestimated will be taken into account such as user behaviour, effects of thermal masses and the control of technical systems in general.

This deliverable covers task T9.2.1 (initial specification) of the work performed in WP9 and comprises:

- Review of the energy-related Key Performance Indicators
- Cost-benefit analysis of HESMOS IVEL implementation
  - Presentation of components of HESMOS IVEL
  - Description of functionalities provided by HESMOS components
  - Qualitative evaluation of the benefits provided by HESMOS functionalities
  - Summary of costs for implementation of HESMOS IVEL
- Recording evidence on pilot projects
  - Profiles of pilot projects with key factors
  - Definition of quantifiable and non-quantifiable benefits during operation phase.

EXECUTIVE SUMMARY:
The deliverable report is structured into four parts. The first part provides **profiles of energy-related Key Performance Indicators (eKPIs)** defined in D9.1 as well as an overview of the indicators of European Norms and sustainability certification systems which are covered by HESMOS Integrated Virtual Energy Laboratory (IVEL).

In the second part the **methodology of the cost-benefit analysis** is described. This analysis includes the HESMOS IVEL components, the functionalities, with their respective benefits, as well as an overview of investment costs for implementing the HESMOS IVEL.

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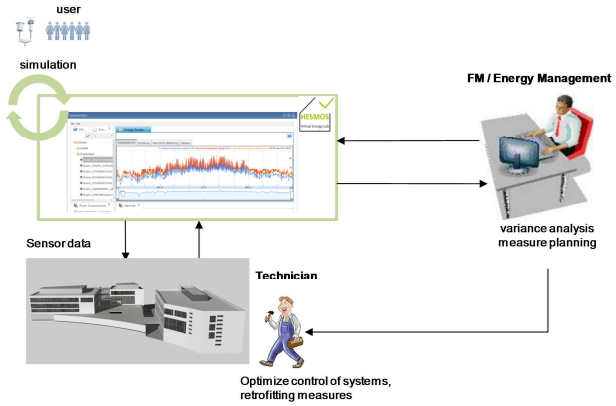
Functionalities	Benefits
Use Case 1: Design and Tendering Phase An **energy-enhanced Building Information Model (eeBIM),** which comprises a 3D geometry model as well as the respective information such as user requirements, material data, climate data, user profiles, etc., is the basis for thermal and energy simulations. For **requirements management** of thermal conditions the HESMOS IVEL provides the tender management with a graphical user interface to compare simulation results with thermal user requirements. **Life cycle optimisation** of the building envelope as well as HVAC equipment is the result of energy simulations and feasibility analysis with in the HESMOS IVEL. For interpretation and decision-making, effects of changes of parameters such as • component area (e.g. window area) • material of opaque components (thermal mass) • material of transparent components • shading device (F_c value) on the defined energy-related Key Performance Indicators (eKPIs), can be shown by comparison graphics, value tables, as well as highlighted elements in the 3D model. To evaluate the feasibility of different alternatives via HESMOS IVEL, simulated energy demand and respective energy-related operational costs can be compared to the investment costs.	**Process time** √ Faster decision-making √ More effective communication √ Information easily managed, accessed and shared √ Automated requirements management √ Fast iterations with performance prognoses **Process quality** √ Transparency in communication √ Automated comparison of thermal simulation results with client requirements √ Required data provided for thermal and energy simulations **Building quality** √ Optimisation of the building regarding eKPIs **Building costs** √ Optimization of investment costs and energy-related operational costs
Use Case 2: Commissioning & Operation Phase Actual measured sensor data is provided via intelligent access services for **requirements management**, **target performance comparisons,** as well as continuous **reporting**. FM can continuously monitor the building via a web based application, to check whether client requirements are met, as well as, enabling the comparison of simulation results with actual measured operational building data in order to allow for immediate reaction on deviations.  Figure 1: Optimisation of processes with HESMOS IVEL For these analyses, user behaviour and system performance are taken into account. User behaviour can be tracked by comparing actual room temperatures, presence of people or CO_2 concentration level with user requirements. For optimisation of system performance a performance metric has been developed within HESMOS for Air Handling Units (AHU).	**Process time** √ Fast and intuitive access to relevant up to date data √ Automated comparison which avoids time-consuming process of manually checking each room for requirements management √ Remote access to sensor data saves time and travel costs for energy management **Process quality** √ Avoidance of incorrect results because of inconsistent data √ Continuous monitoring of client requirements to minimise complaints of tenants √ Automated graphical interpretation √ Immediate reactions on energy variances are possible **Building quality** √ Optimized building control √ Energy savings and CO_2 reduction **Building costs** √ Reduction of energy-related operational costs

Use Case 3: Retrofitting & Refurbishment Phase

Continuous monitoring during the operational phase and graphical interpretation via HESMOS IVEL platform, allows the FM team to identify potential retrofitting (replacement of HVAC components) and refurbishment (improvement of the building envelope) measures.
The **as-built simulation model** is calibrated with actual measured energy use data of the baseline period, measured weather data and other operating data that it closely represents the current operation of the building. The calibrated model is then used to predict energy use after a retrofit of building equipment or refurbishment of building envelope **(ECM - Energy Conservation Measure)**.
Energy saving potential can be derived by comparison of the simulation calibrated with metered data and a simulation after the retrofit or refurbishment or by comparing the calibrated simulation results with metered data in the reporting period.
To evaluate the feasibility of retrofitting and refurbishment measures, investment costs can be estimated and compared to the monetized energy savings identified by calibrated simulation.

Process time

√ As-built simulation model saves time for data collection

Process quality

√ Continuous calibration of the simulation model allows to better understand building behaviour

√ Feasibility analyses with a reliable forecast of energy-savings help convincing the client

Building quality

√ Well-planned retrofitting & refurbishment measures reduce energy consumption and CO_2

Building costs

√ Optimized ratio of investment costs and their respective energy-related operational costs

In the third part the **pilot projects of BAM** were introduced.

Operational data from the pilot projects:

a. User profiles
b. User requirements
c. Measurement points Building Automation Systems (BAS)

Additionally, an outlook on how **evidence on benefits and costs** will be continuously recorded, is provided.

Quantifiable benefits during operation phase:

a. Processes time
b. Building quality
c. Building (energy-related operational) costs

Non-quantifiable benefits during operation phase:

d. Process quality

Finally, the fourth chapter summarizes the conclusions of this deliverable.

School

Finance Centre

TAGS:
Energy-related Key Performance Indicators (eKPIs), cost-benefit analysis, components, functionalities, benefits and costs of HESMOS IVEL, process time, process quality, building quality, building costs, BAM pilot projects

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