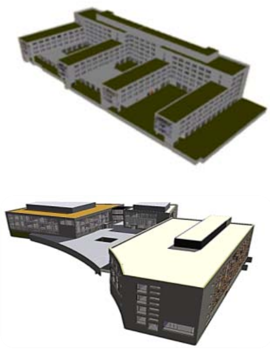
HESMOS Newsletter

Special Issue for the BuildingSmart BIM Week 2013

Welcome to the **HESMOS Newsletter – Special Issue for the BuildingSmart BIM Week 2013**. HESMOS is a so called STREP-Project funded by the EU under the 7th framework Programme. During the runtime of the project several newsletters are published. For further information and downloads, please visit our website. There you can also register if you want to receive the newsletters automatically. **In this issue**, we present a concise summary of the **main objectives and findings** of the project before its final phase.

HESMOS – PROJECT OBJECTIVES

HESMOS stand for **H**olistic **E**nergy Efficiency **S**imulation and Life Cycle **M**anagement Of Public Use Facilitie**S**. The overall objective of the project is to develop an **Integrated Virtual Energy Laboratory** (IVEL) which allows decision makers to design and compare several energy and life cycle cost optimised alternatives as well as to optimize the operation of Public Private Partnership Projects (PPP). To achieve this objective **HESMOS IVEL** enhances existing Computer-Aided Design (CAD) and Facility Management (FM) tools with information from energy simulation and cost calculation as well as up-to-date data from the Building Automation Systems (BAS). To evaluate the functionality of the HESMOS IVEL, an extensive 30-month validation program will be **realized at two PPP projects**.



2 HESMOS Pilots

HESMOS – PARTNERS

TECHNISCHE UNIVERSITÄT DRESDEN

NEMETSCHEK

Granlund

bam

OBERMEYER

AEC3

ANALYSIS OF USER REQUIREMENTS

In the first phase of the HESMOS project the research team, led by Royal BAM Group nv, analysed the processes involved in the design, construction and operation phase of PPP projects.
This analysis showed that there is a strong request for integrated design, simulation and facility management tools to further optimize the processes and support the involved disciplines.

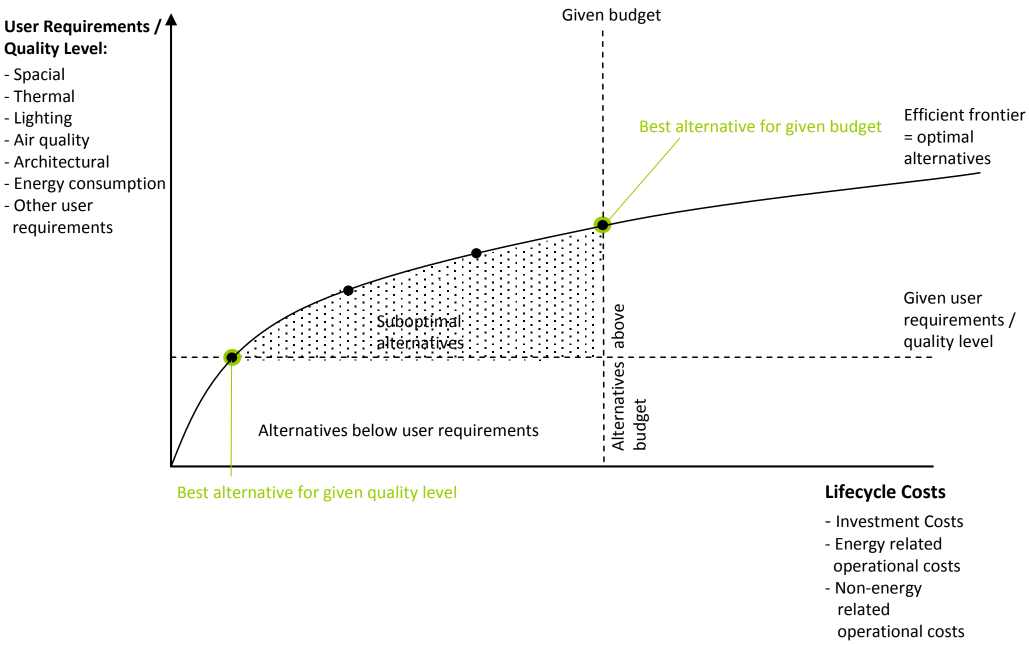


Figure 1: Decision making during the Life Cycle of PPP Projects

The graphic illustrates how decisions are made during the lifecycle of a Public Private Partnership (PPP) project. In an iterative process, the design team constantly strives to increase the quality of the building and to decrease life cycle costs. Alternatives with the highest quality level for a given budget or the lowest cost for a given quality level are considered to be optimal since there is no alternative with a better cost/quality ratio. These alternatives are on the “efficient frontier” of all possible alternatives.

Based on the results of the analysis, the research team developed the HESMOS TO BE Process. This process describes the development of a PPP project focusing on possible use case scenarios of the HESMOS IVEL during the design and tendering phase, the operational phase and the refurbishment/retrofitting phase.

USE CASE SCENARIO 1 – PLANNING AND TENDERING

Based on the user requirements, which comprise especially, spatial, thermal, lighting, air quality, design, energy consumption and other requirements, an interdisciplinary team of architects, planners, consultants, construction, facility management and life cycle cost specialists develop and optimise complex projects for a contract period of 20-30 years. The planning and tendering phase in the “TO BE Process” involves a number of iterations, whereby simulations and cost calculations are carried out for all iterations in the HESMOS Integrated Virtual Energy Laboratory (IVEL) in order to reach the best cost / quality ratio.

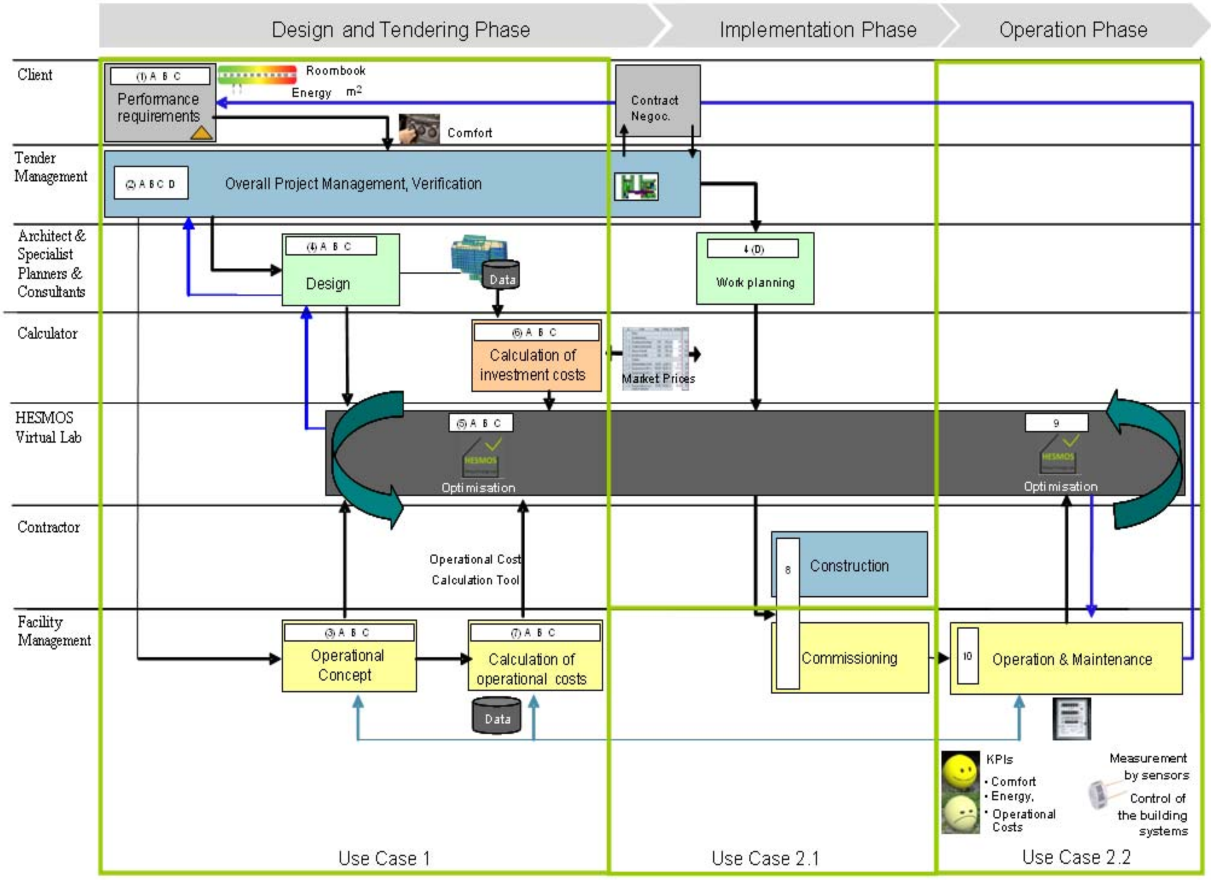


Figure 2: HESMOS TO BE Process - Design and Tendering as well as Commissioning and Operational Phase

USE CASE SCENARIOS 2.1 and 2.2 – COMMISSIONING & OPERATION PHASE

During the commissioning & operation phase the project team analyses and evaluates sensor data from the Building Automation System (BAS) of a current PPP Project. The sensor data will be logged and visualised to detect indoor conditions, to identify possible areas of improvement of Heating, Ventilation and Air-Conditioning (HVAC) systems and to report changes in user behaviour. This information gained from evaluating operation data concerning energy consumption, emissions and Life Cycle Costs is the basis for optimizing the operating strategy of existing PPP projects and for improving the design and operating concept of future projects.

USE CASE SCENARIO 3 – RETROFITTING AND REFURBISHMENT PHASE

The HESMOS IVEL also covers the retrofitting & refurbishment phase. Similar to the design an tendering phase, the HESMOS IVEL can be used to simulate and decide among different alternatives for retrofitting or refurbishment to improve the performance of the building. The HESMOS IVEL can be used to either further optimize the design for given user requirements (i.e. to further decrease energy consumption) or to find the optimal design for increased or changed user requirements (i.e. increased thermal comfort).

BIM ENHANCEMENT SPECIFICATION

With completion of the *BIM Enhancement Specification* the HESMOS consortium reached a new milestone. It enables the development of the underlying energy-enhanced BIM (**eeBIM**) platform and the related link and transformation services. But it is a lot more than a technical guideline that defines how to implement the HESMOS use case scenarios. We also specified a conceptual framework that shows how to deal with a diversity of data required in the overall life-cycle processes and how to interoperate with the well-established openBIM schema from buildingSMART (IFC; ISO16739) and additional models based on a multi-model architecture. As our *BIM Enhancement Specification* provides an open and extensible framework we elaborated the general development process that has been adopted from the Information Delivery Manual (IDM) methodology.

Figure 3 below shows the main eeBIM component models and the involved model transformations embedded in the building life cycle. At the top, the major relevant tasks in the building life cycle are shown, i.e. the Architectural Space Program developed in the early design phase where fundamental energy related decision are taken, the BIM-based Architectural and HVAC design, where decisions on material and component level are taken, and the Monitoring and Control via Building Automation System (BAS) in the Operation and Maintenance phase. At the bottom, the main related analysis tasks are shown, i.e. Energy Simulation – to forecast or check energy performance, and Life Cycle Costs Calculation – to include energy costs in the total life cycle costs and check eventual redesign, retrofitting or refurbishment decisions against the related investment and operational costs, thereby enabling informed decision-making. In the center, the eeBIM framework enabling the inter-operability and integration of all other components into a consistent platform is shown.

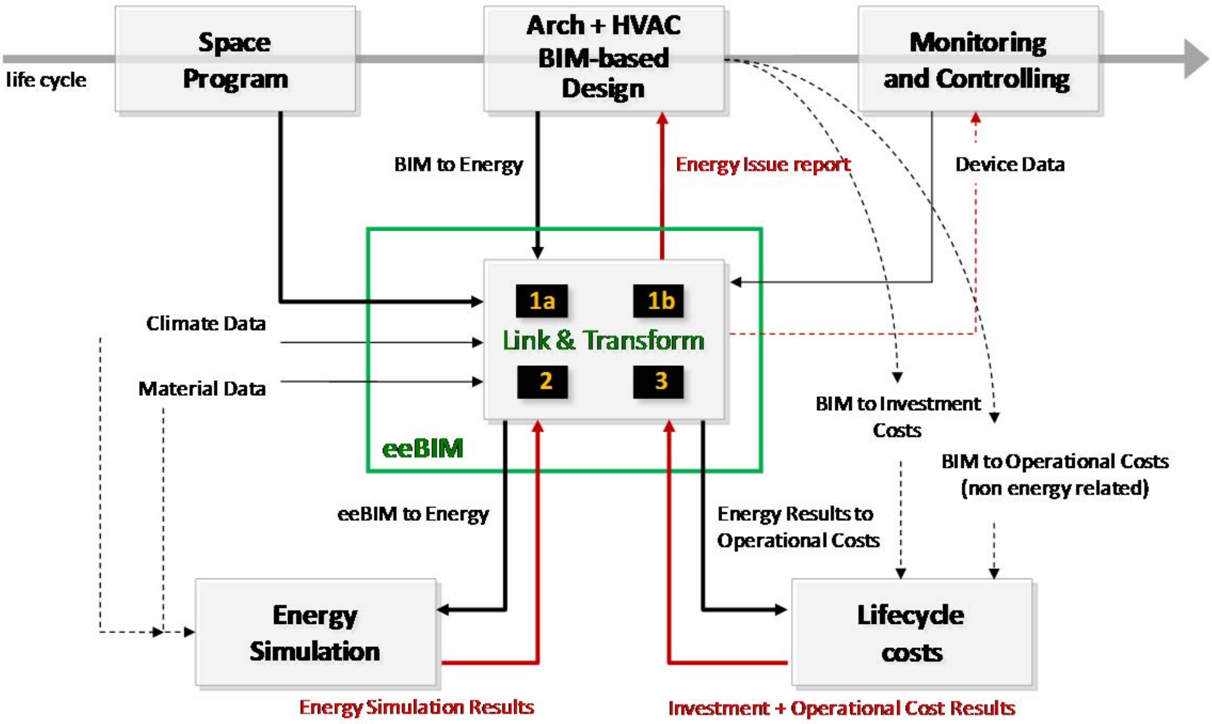


Figure 3: Generalised view of the suggested eeBIM framework

CONCEPT OF THE IVEL

Many advanced ICT applications for the design of energy efficient buildings already exist. However, while it is generally understood that decisions on energy efficient building design and operation have to be taken in all life cycle phases, current applications are mostly developed for the use by energy experts in detailed design, where most building parameters affecting energy performance are already determined and optimisation capabilities are limited. There is little energy-related ICT support both for early design, where vital strategic decisions have to be met, and for the later operational phase, where improvement decisions have to be taken. As a result, ICT integration is poor and the provided decision support is on limited level. With projects, however, where public-private contracts of 25-30 years of building operation are usual, there are excellent chances to develop a more efficient, holistic approach for the realisation of innovative services and tools for energy efficient and low carbon buildings, enabling better consideration of a large number of life cycle issues. A central enabling aspect in that regard is the achievement of a consistent integrated platform that can handle energy-related tasks while being at the same time aligned with design, facilities management, cost estimation and other life-cycle activities. Such a platform can be realized by an **Integrated Virtual Energy Laboratory (IVEL)** providing a set of value-add and supporting ICT components and a coherent approach how such components can be further extended, adapted or, if necessary, replaced by others.

OVERALL SOFTWARE ARCHITECTURE

Using the IDM methodology (ISO 29481) and the defined “TO-BE” process mentioned above, the software architecture of the IVEL platform together with the related information exchange and interoperability requirements and the software components with their major features, APIs and GUIs were conceptually developed.

Figure 4 shows a generalised view of the architecture of the IVEL with its principal modules, services and applications. The shown modules, framed in the dashed boxes, are briefly examined in the following sections. The specification of their components on technical level is provided in the public HESMOS Deliverable D2.1. This marked the starting point of the actual software development in the project.

The IVEL core is essentially a service registry that controls user registration, data manipulation, calls to sensors and the workflow of energy analysis, CAD and facility management tools. It is responsible for various data manipulation tasks such as model mapping, model conversion, multi-model linking, filtering and model versioning, and can thus be generally seen as a data warehouse enhanced with explicit business logic to allow the adaptation and (semi-) automatic execution of user workflows. It comprises three sub-modules, namely *Platform Management*, *Model Management* and *Simulation Management*, thereby enabling separation of concepts, high level of modularity and parallel RTD work.

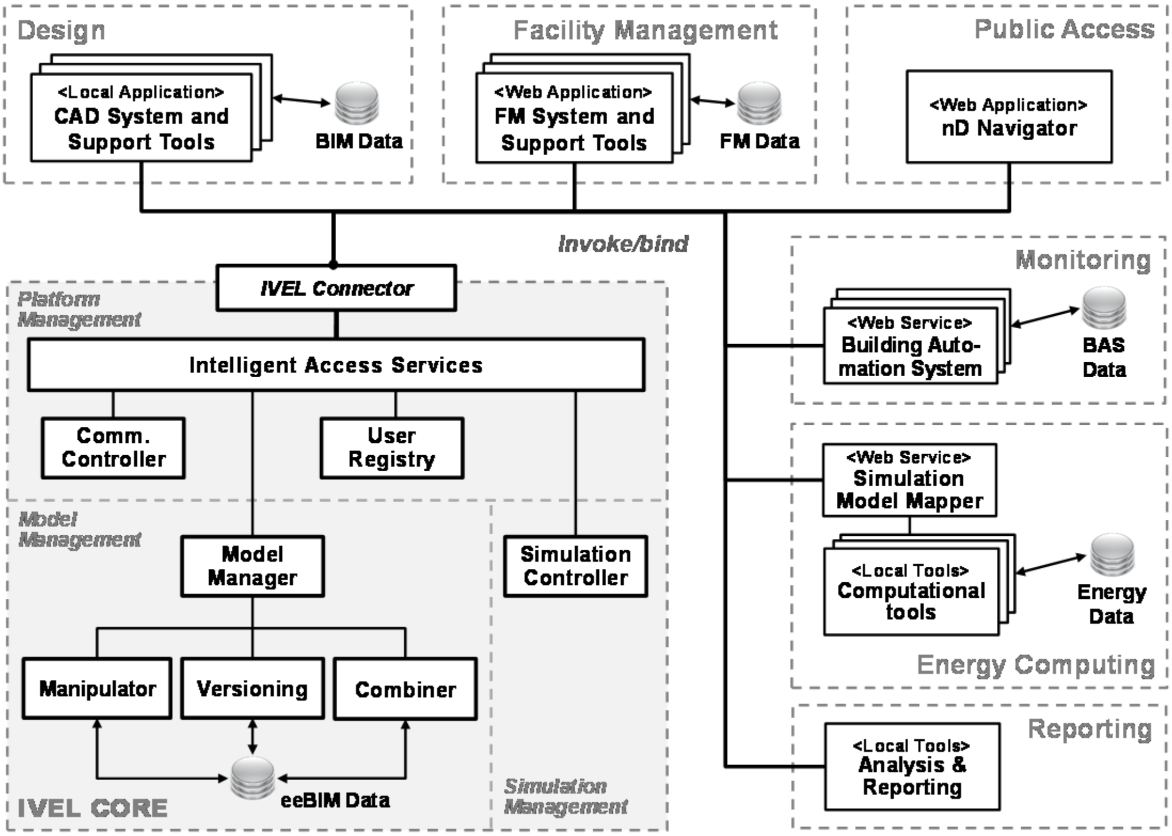


Figure 4: Software Architecture of the IVEL

The end user applications provide the productive environment and the GUIs for the users to the IVEL, where they can configure simulation parameters and control the overall simulation process and its results. The different users will have different access rights depending on their roles and each user can use her/his specific expertise to detail the workflow and refine the process. With regard to the identified user scenarios, we distinguish:

- Architectural design and Investment costs calculation
- Building performance, facility management and client requirements
- Varying simulation configurations and light-weight visualization for non-professionals

ENERGY SOLVERS OF IBK IN HESMOS

The **Institute of Building Climatology (IBK)** at the Technische Universität Dresden (Faculty of Architecture) traditionally investigates the theoretical basis of combined heat, air, moisture and salt transport in building materials. IBK's software programs support other research institute's work, assist students in learning the fundamentals of building physics, and enhance the working capabilities of civil engineers, architects, and other working disciplines in the field.

The software can be used in various applications. For instance, it can be used during the planning phase to estimate the condensation risk of a building construction under various climate conditions, or to investigate the impact of thermal bridges. It can also be used to determine the reason of damage to constructions or materials, or to develop new materials for potential application areas and limits and to help to optimize materials for special application cases.

NANDRAD

NANDRAD is a solver kernel for multi-zone building energy performance simulation. It is designed to perform transient solutions to energy balances in thermal zones and discretized construction elements. Transient means a non-static value for a parameter in temporally processes.

The development and improvement of optimized numerical algorithms has reduced the efforts of large simulations of buildings. Before the simulation starts a new algorithm inspects the dependencies of different values and combines assembled values to bands. This procedure is one effect the simulation time has been abbreviated.

Especially for architects and specialized energy planners the NANDRAD solver offers high quality results of building properties, e.g. indoor or operative temperature in early design phases. With these possibilities a participant of building construction has the opportunity to run alternatively designs, partitioning and locations.

The NANDRAD solver supports the simulation of buildings with complex geometry, modeling of idealized HVAC system. The level of detail the NANDRAD-solver simulates support results for building elements (e.g. walls), room spaces until a multi-zone building. With the pre-processing in the HESMOS project it is possible to visualize the complex and large output files of the simulation.

The connections between different spaces allow simulations with dependencies of thermal and radiation influences of several zones. If an adjacent zone has a different air-temperature it has a direct influence to the next zone. With the simulation it is now possible to comprehend the thermal fluxes through the constructions between several zones.

THERAKLES

The IBK desktop application to calculate thermal conditions in single zones is called THERAKLES. The simulation tool has been developed to simulate detailed thermal transport processes. A simulation operation includes the outdoor climate influences, e.g. direct and diffuse radiation or air-temperature and thermal loads of devices as well as thermal person loads. Among thermal loads the HVAC-systems and adjacent zones also affect the characteristic of a simulated zone.

The main goal of THERAKLES is supporting the training of architects and building engineers and therefore an intuitional handling simulation tool was implemented. Another advantage is the fast calculation of a yearly period of a single zone. THERAKLES needs significantly less time and efforts than established energy simulation tools, e.g. EnergyPlus.

A special feature of THERAKLES is the detailed transient and local decoupled calculation of thermal fluxes of surrounded building element. This level of detail correspond the grad of building element simulation software DELPHIN. In comparison to THERAKLES the IBK simulation tool DELPHIN also simulates the moisture and salt transport in building elements.

The thermal room model in THERAKLES enables the measurement of effects of indoor climate in compound of materials with different thermal storage characteristics. This ability is necessary to determine the summer heat protection.

In addition to the already mentioned advantages the simulation tool THERAKLES includes a variable selection of user schedules, different outdoor climate sets and strategies to control shading radiation protection and shading of windows. It is also possible to adjust the air exchange or HVAC-system for the zone. Therefore THERAKLES offers individually daily, monthly or yearly schedules that can be changed easily by the user.

DELPHIN

DELPHIN is an application for numerical simulation of coupled heat and moisture transport in building construction elements (walls, roofs and floors). The focus is on constructional details, such as window-wall connections, heat bridges or connections of floors/ceilings to external walls.

In early design or refurbishing phases DELPHIN supports an architect or building engineer to examine critical construction details. DELPHIN is used to calculate thermal bridges with evaluation of hygroscopic problem areas. This means a detailed examination of construction layers and the possibility of condensation between them.

DELPHIN is also used to develop and investigate new materials or the optimization of established systems. These are just some possibilities to use DELPHIN. It is also possible to examine the salt transport or salt damages in building elements.

The special features of the IBK simulation tool DELPHIN are the state-of-the-art models for physical processes or the very fast solver. Other benefits are the editable input data, e.g. climate or materials, the low cost purchase for students or academic institutions.

EXPECT IN THE NEXT NEWSLETTER

- HESMOS Tools for the Building Operation Phase (Granlund Oy, Finland)
- Use of energy-related key performance indicators for decision-making in design and operation
- Validation of the HESMOS Platform by the end users
  (Royal BAM Group, Obermeyer Planen + Beraten)

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