ISES Project Periodic Report summary (12/2011-11/2012)

ISES is a European FP7 industry-driven project established under call FP7-ICT-2011-7 in the thematic area "ICT systems for energy efficiency" (ICT-2011-6-2).

The **objective** of the project is to develop ICT building blocks that will integrate, complement and empower existing tools for design and operation management to a **Virtual Energy Lab** (VEL). This will allow evaluating, simulating and optimizing the energy efficiency of products for built facilities and facility components (such as pre-fabricated building elements and building services equipment) in variations of real life scenarios before their realisation, acknowledging the stochastic life-cycle nature of the involved data and processes. The focus of the prototype application domain is on buildings where about 40% of the global energy is used and 30% of CO_2 emissions and solid waste is created.

ISES focuses specifically on the following **RTD issues**:

- *Interoperability* between energy analysis tools, product/component design tools and building and facility design tools (BIM)
- *Configurators and evaluators* for the combination of energy and climate/weather profiles for stochastic life-cycle consideration
- *Intelligent and adaptable access and management methods* for heterogeneous distributed information resources and services on the basis of system and domain ontology schemas and tools
- Multi-model filtering, navigation and evaluation services for the support of energy-aware engineering design.

The **product** of ISES will be the stochastic model-based Virtual Energy Lab platform for new component product development and integrated engineering design. It will allow engineers to handle holistically the analyses regarding the energy efficient design of products and to take informed design decisions. This comprises the following three tasks: (1) Consideration of the stochastic nature of the energy performance and consumption profiles in the facility lifecycle, (2) Balanced design of the involved new building products and components, taking into account their functionality and behaviour for various possible lifecycle demands, and (3) Integration of these products / components in the facility, taking into account various alternatives with regard to location, usage, costs etc. Each of these tasks requires several **iteration cycles** in order to reach an optimal balanced solution.

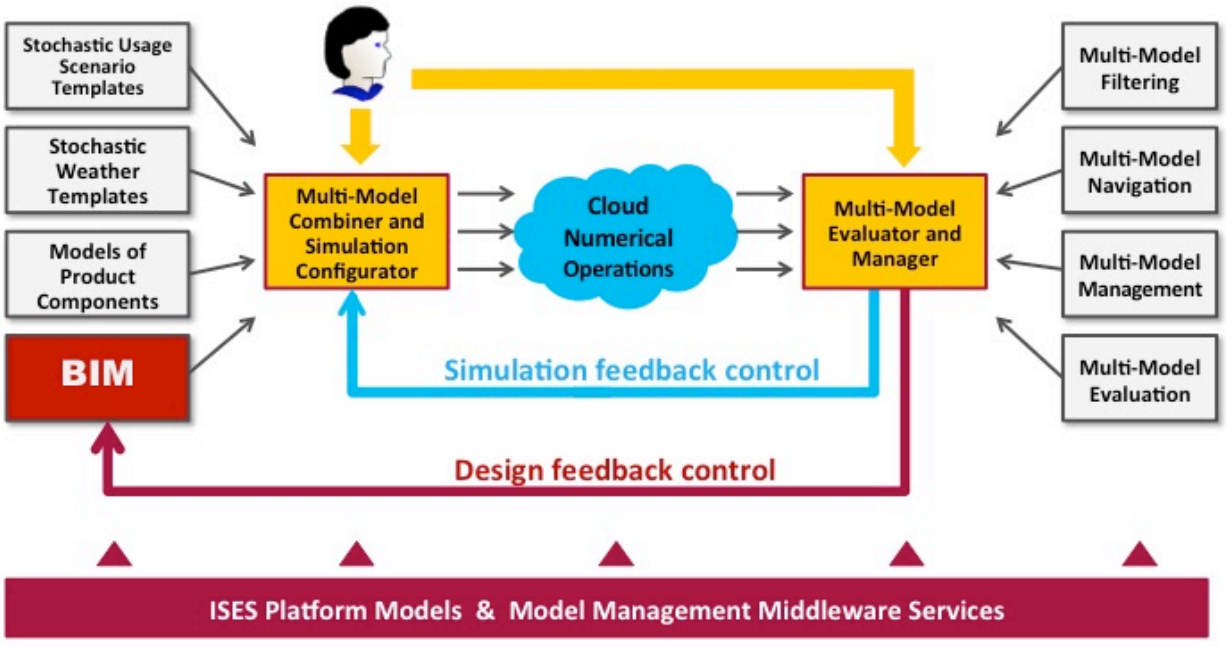

Figure 1: Functional structure of the ISES Virtual Energy Lab

The project runs from 01.12.2011 with **duration** of three years. The Consortium features a mix of **8 partners from 5 European countries** covering the key areas of research and development relevant to the project goals and spanning over all relevant climatic regions targeted in the use case scenarios.
They represent:

- End-users (TRIMO Engineering, Slovenia, and Leonhardt, Andrä & Partner, Germany)
- BIM-based software developers (SOFiSTiK Hellas, Greece and Granlund Oy, Finland)
- Research institutes with departments specifically engaged in energy and stochastic aspects of design (NOA, Greece and NMI, Iceland)
- Academia (TU Dresden, Germany, with the institutes Construction Informatics and Building Climatology, and the University Ljubljana, Slovenia), specialised in ontologies, cloud/grid computing and energy-aware design.

Coordinator of the project is the Institute of Construction Informatics of the TU Dresden.

In the **first year of the project** (01.12.2011-30.11.2012), the **focus of the RTD work** has been especially on the following issues:

- Analysis of the state-of-the-art and gap analysis for energy performance assessment
- Specification of user scenarios and requirements to the ISES VEL
- Conceptual development of the ISES stochastic approach and specification of the overall framework for the use of energy profiles and consumption patterns taking into account the stochastic nature of the data
- Conceptual development of the ISES service-oriented grid/cloud architecture.

ISES defines three major **usage scenarios**: (1) Conceptual manufacturer product / component development, (2) Design of new buildings, and (3) Refurbishment / retrofitting of existing facilities. These scenarios span over a complete lifecycle, involving a broad spectrum of actors, energy-related aspects, required information resources and models and ICT tools.

The **studied information resources** comprised weather and climate data, user behaviour, user comfort, occupancy profiles, building models, systems, elements and materials, as well as libraries for digital specification of product components. Examined ICT tools and methods included an overview of building energy tools available on the market, as well as specific considerations with regard to simulation tools, CFD analysis tools and stochastic analysis methods and tools to be used in ISES. Fig. 2 shows a general view of the **two principal life cycles addressed** in ISES, i.e. (1) component product development, and (2) the building's life cycle, highlighting the targeted main usage scenarios and presenting in concise form the information and computational targets and needs for successful performance of these scenarios. Preliminary analyses showed that for all scenarios principally the same information resources and computational tools are needed, although in detail there are various minor differences have to be considered.

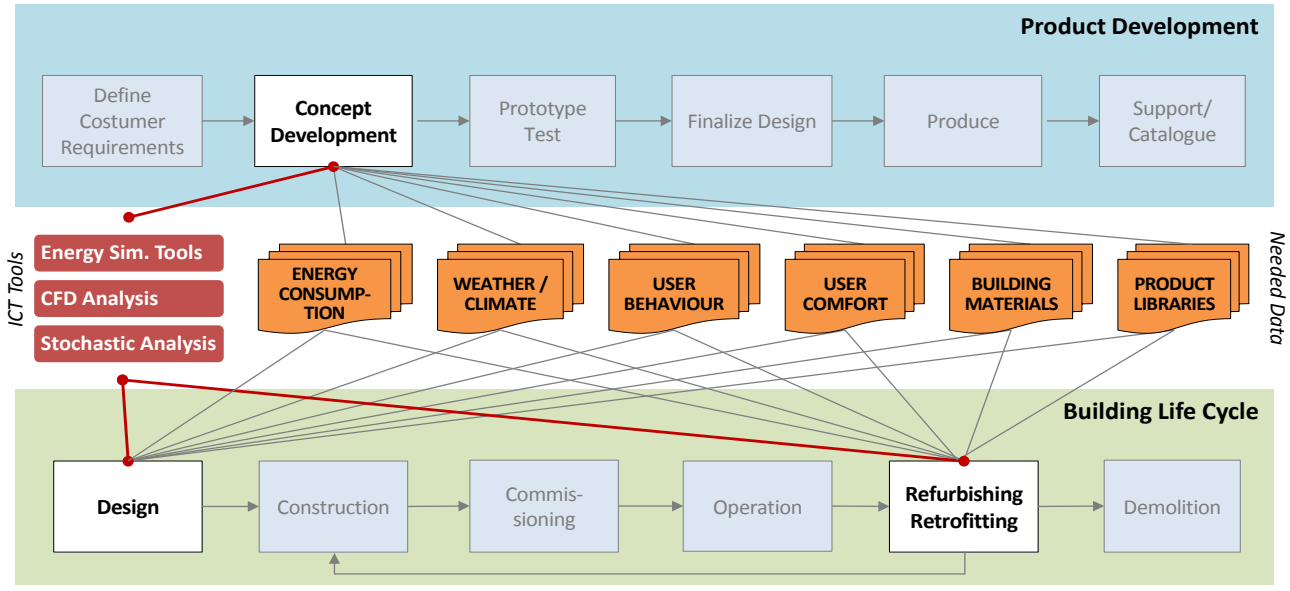

Figure 2: Focused lifecycle phases and related information resources and tools in the targeted VEL

Specifically with regard to user behaviour and comfort as well as the weather/climate data, the stochasticity of the data will be taken into account. As basis, user profiles from practical experience will be taken and additionally subjected to stochastic distribution. Fig. 3 below shows some examples of initial (deterministic) occupancy profiles that will be further investigated with regard to their stochastic nature and respective influence on energy performance.

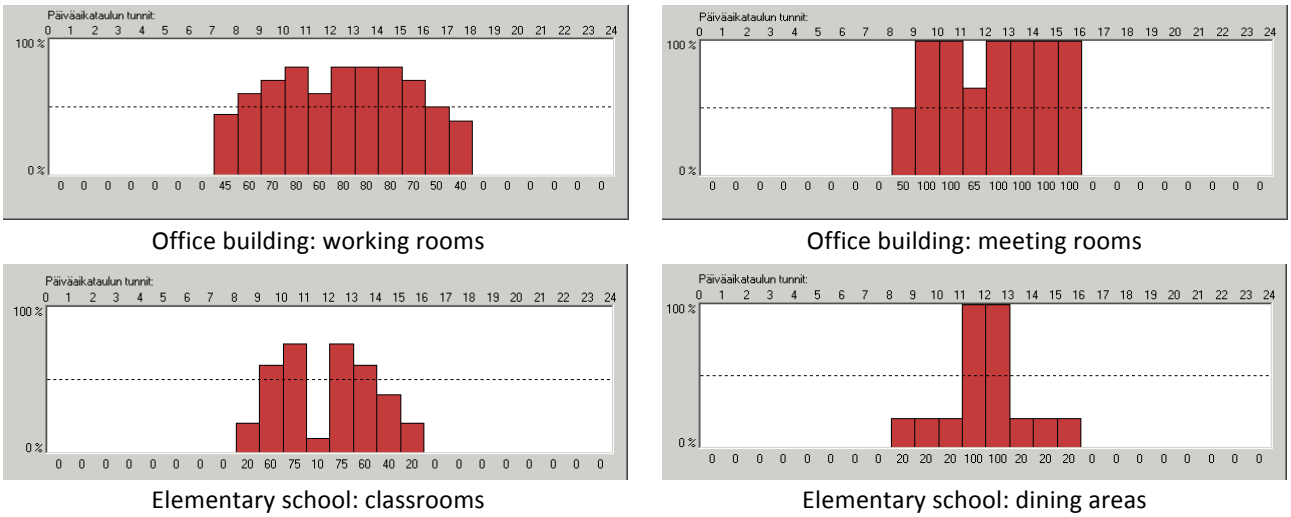

Figure 3: Occupancy profiles for selected building types and areas

The ISES **stochastic approach** is focused on determining the probabilistic distribution of an outcome that relies on multiple probable scenarios. It produces not only one answer, but rather a range of answers over which the results vary as a function of probability of occurrence and also a most expected result. Targeted is the overall treatment of the stochastic nature of the involved lifecycle processes and data, with emphasis on the *methodology* for the stochastic consideration of energy performance and not on specific methods for which data may even not yet be fully available.

The stochastic simulation is divided into the three **phases**: (1) Pre-processing, (2) Simulation, and (3) Post-processing. Identification of the applicable stochastic variables, their ranges and scope, appropriate probability distribution function and identification of the appropriate sampling methods are conducted during the pre-processing phase. Stochastic issues are considered primarily with regard to climate/weather data and the user behaviour and occupancy profiles. Once the model evaluations have been performed, during the post-simulation step all results from multiple simulations done on the VEL Cloud will be collected and an uncertainty analysis will be performed. However, to minimize the number of stochastic variables, before the uncertainty analysis a sensitivity analysis will be carried out.

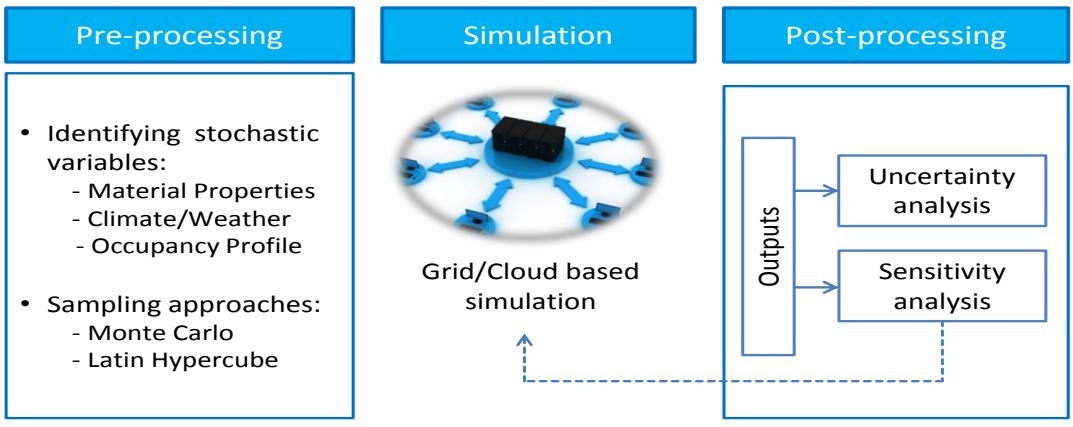

Figure 4 : Principal stochastic approach

To enable holistic treatment of all relevant issues to the ISES VEL, a flexible **software architecture** has been set up following the service-oriented paradigm (Fig. 5). The information framework of the envisaged VEL platform will be based on an integrating platform ontology binding together the model of the facility represented as a standard BIM / IFC model and the multi-model environment of related external information resources such as stochastic occupancy profiles, detailed material data and manufacturer product components provided in digital catalogues. The platform comprises several types of services and applications, bound together by a common *Core Module* that acts as the middleware providing the required data and functional interoperability. All other components of the targeted VEL prototype are consistent with the identified use cases and can easily be extended or re-configured in accordance to specific preferences and building types. These are:

- *Design Module*, comprising a BIM-based CAD system, a product catalogue module for the selection and testing of new products and supporting tools capable to produce and export IFC model data.
- *Requirement Management Module*, comprising a FM system and related energy and costing tools.
- *Common Access Module*, providing a general-purpose interface to the VEL via a web application and enabling light-weight easy-to-do studies of building performance with regard to energy and life cycle costs.
- *Cloud Service Module*, providing energy related analysis and simulation services and tools, a simulation model configurator for simultaneous alternative simulations of stochastic values, reporting tools for the generation of various kinds of aggregated reports for decision makers and access to all distributed information resources (product data catalogues, climate databases, BIM data etc.).

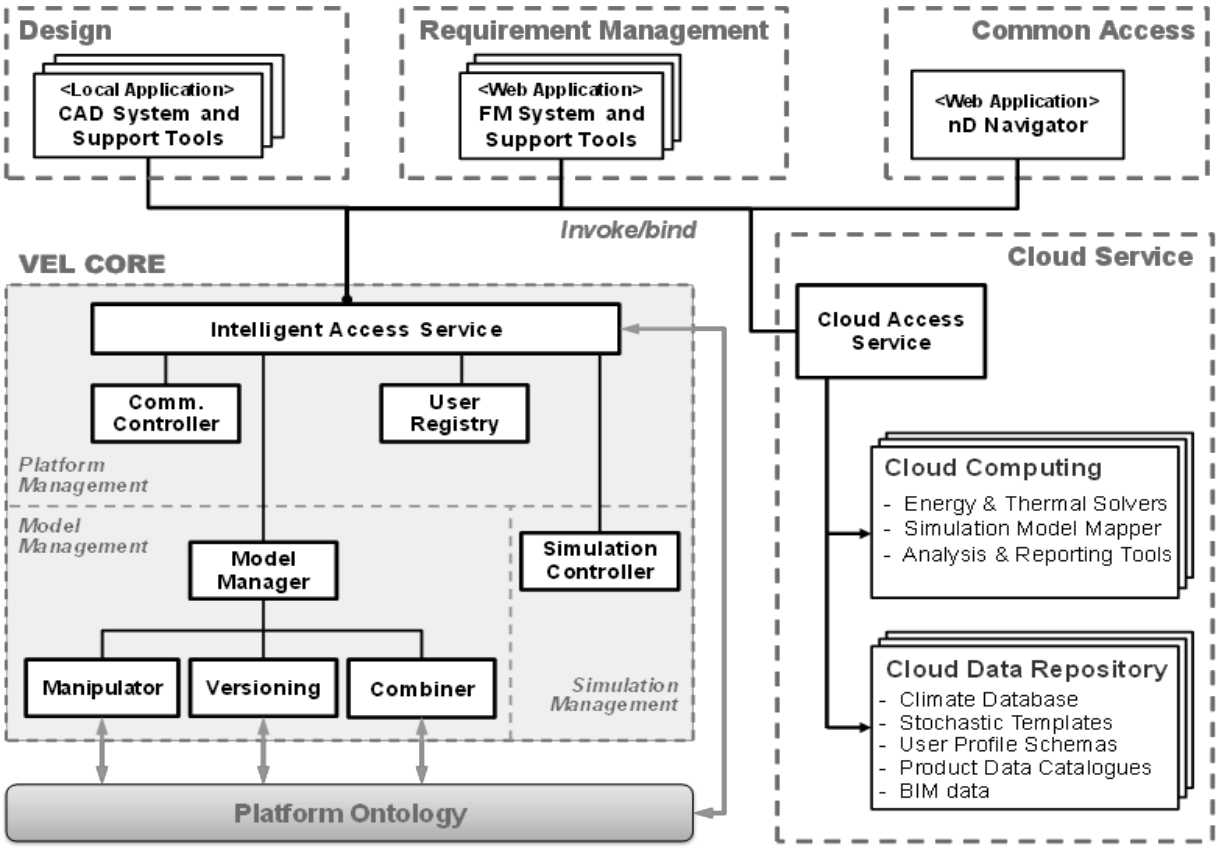

Figure 5: Software architecture of the ISES Virtual Energy Laboratory

More results, summaries of all deliverables and a download section containing all public material issued so far can be found on the project's **Web Site**: http://ises.eu-project.info.