

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 was 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 CO₂ emissions and solid waste are 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 is 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.

The project ran from 01.12.2011 with **duration** of three years. It was extended in July 2013 by two new partners and two new work packages through a merger with a proposed and approved extension called "ISES-enlarged". Thus, the consortium features a mix of **10 partners from 7 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 project's 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 as well as software engineering (Innovation Center Iceland, National Observatory of Athens, Greece, and the Institute of System Programming at the Russian Academy of Sciences)
- Academia (TU Dresden, Germany, with the institutes Construction Informatics and Building Climatology, the University of Ljubljana, Slovenia, and the University of Cyprus), specialised in ontologies, cloud/grid computing, stochastic and energy-aware design.

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

In the **first project period** (01.12.2011-30.11.2012), the focus of the RTD work had been on the gap analysis for energy performance assessment, the specification of user scenarios and requirements to the ISES VEL, the conceptual development of the ISES stochastic approach, the specification of the overall framework for the use of energy profiles and consumption patterns taking into account the stochastic nature of the data, and the principal development of the ISES service-oriented cloud-enabled architecture.

In the **second project period** (01.12.2012-30.11.2013), the focus of the RTD work had been on the development of the resource service framework for product components, the realisation of the cloud environment and implementation of supporting core services and energy aware engineering services and tools of the VEL. This includes BIM management functions like IFC filtering, transformation of space boundaries and ontology queries and enhancements.

In the **current and last project period** (01.12.2013-30.11.2014), the **focus of the RTD work** was especially on:

- Development of the simulation workflow services including a simulation matrix for the specification of varying parameters and BIM targets;
- Adjustment of the cloud to enable the simulation workflow (passive simulation, sensitivity analysis, full building simulation and CFD simulation);
- Improvement of the building information models for the pilot projects *Young Opera* in Dresden, Germany and *Mavrca Kindergarten* in Slovenia;
- Enhancement of the nD Navigator to allow the choice and adaptation of energy resources from the resource service framework, visualization of sensitivity parameters and decision making;
- Extension of the resource service framework to an intelligent building component library;
- Concept for stochastic modelling and filtering of stochastic variants.

The **simulation workflow** (Figure 1) starts by uploading a building information model in the VEL. The user assigns resources like materials to building elements, climate and occupancy provided by the resource service framework. All the assignments are stored in a RDF file based on the ontology schemas. A new feature is the usage of ontology rules to check construction assignments to building elements. This prevents the wrong assignments regarding national regulations or project specific requirements. The ontologies and the RDF instances are main concepts of the overall workflow and are interpreted in the VEL by simulation tools and the nD Navigator.

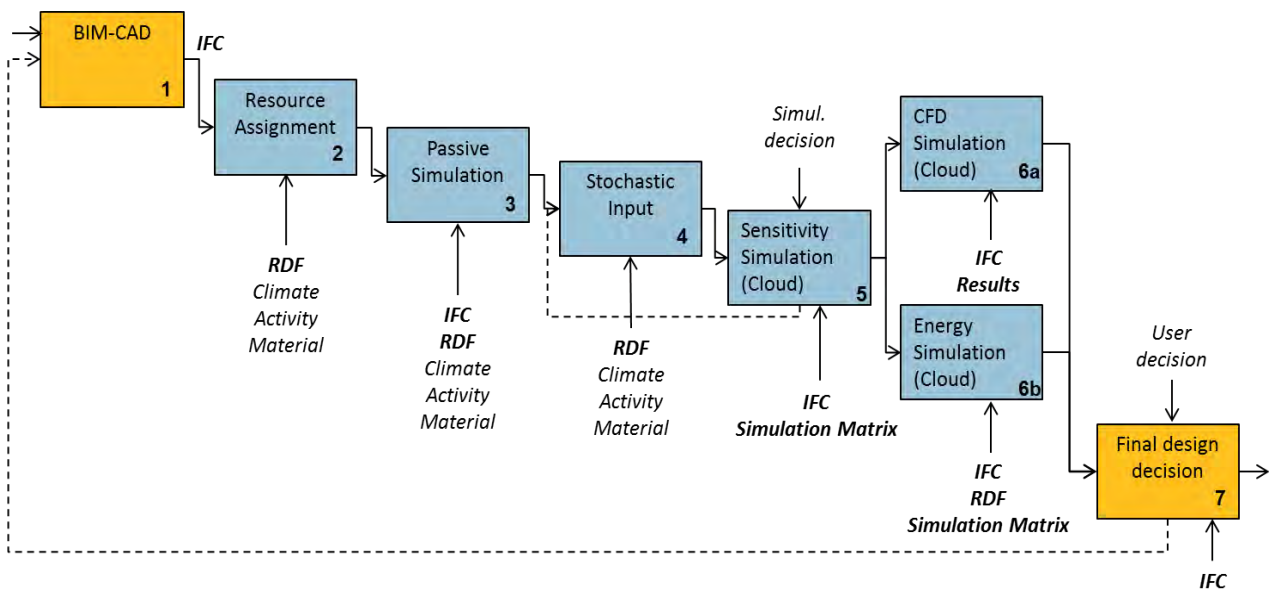


Figure 1: Simulation workflow

With this information a passive simulation without heating and cooling is started to analyse the initial building behaviour based on the assigned energy resources. The results are zones of interests where the energy planner should focus on the improvement of insulations or room usages in a sensitivity analysis. This leads to hundreds of variants with several combinations of different materials to targets like rooms and storeys.

The combinations are stored in the newly developed simulation matrix which includes variables with URLs to the resource service framework and modifications like stochastic input parameters related to the BIM elements which will be applied to multiple zone simulations in the cloud. The output is the behaviour of the combinations per zone. All the result sets will be compared in the **multi-eKPI analysis**. With that tool the user can filter and easily select variants which fulfil the requirements. Visualized are the results as scatter diagram, hyper radial visualization, parallel coordinate plot or radar chart. An overview of the developed different visualizations is provided in Figure 2.

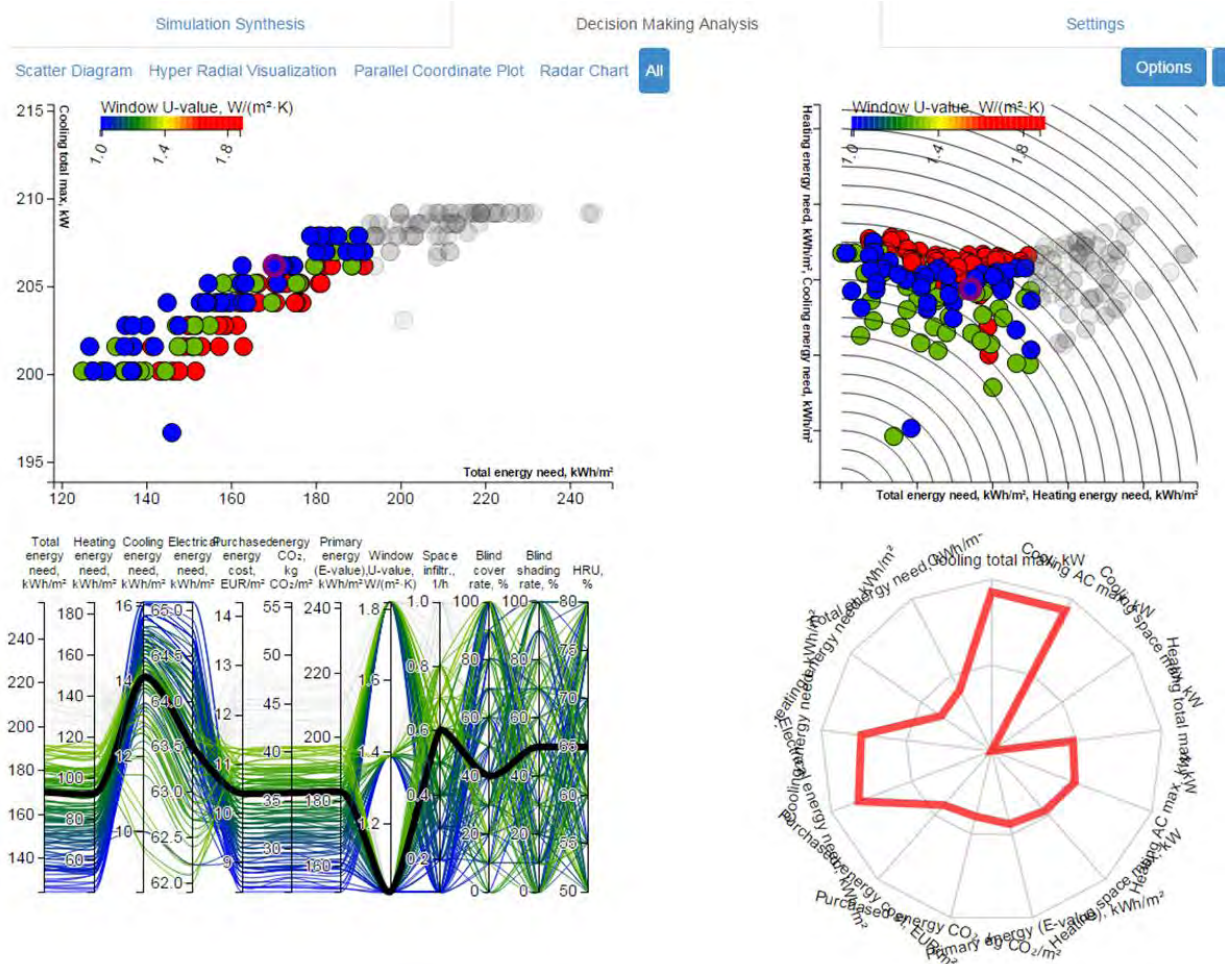


Figure 2: Visualizations of the multi-eKPI analysis (left top: scatter diagram, right top: hyper radial visualization, left bottom: parallel coordinate plot, right bottom: radar chart)

This tool is embedded in the **nD Navigator** of the VEL. With the nD Navigator (Figure 3) the user can manage BIM and simulation projects equally. The BIM projects are visualized in 3D and can be explored through selection and filtering mechanisms. All the selected BIM elements are highlighted and coloured, e.g. if it is a zone of interest or a building element with insulation problems. Resource assignments are possible through Drag & Drop and the current state of assignments is presented through the ontology view. In the nD Navigator the simulation steps are highlighted and checked if they can be executed and continued regarding model requirements.

After selecting the appropriate simulation variants in the multi-eKPI analysis tool the variants are used for full building simulations (with heating and cooling). All variant parameters are mapped to the whole building simulation model to verify how it behaves in multi-zone simulations. These building simulations are executed in the cloud by uploading a modified simulation matrix and the use of the passive simulation. The results are visualized in bar charts so that the variants can be compared.

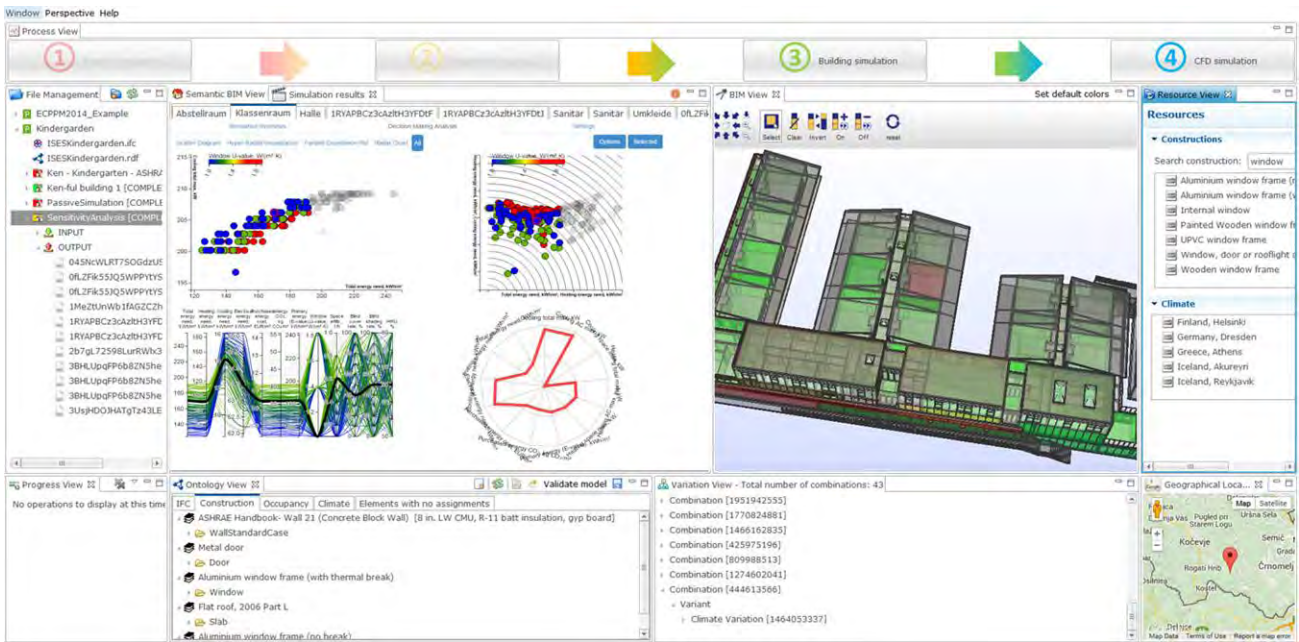


Figure 3: nD Navigator shows a zone of interest (coloured red in the 3D BIM View) in the Kindergarten and the results after varying parameters in the sensitivity analysis

The user has also the possibility to start a CFD simulation of some selected zones in the building to additionally check the thermal comfort. Figure 4 shows results of the performed analyses for the Young Opera pilot project in Dresden. The CFD simulation is not strictly integrated in the simulation workflow but can be started on demand, if a more detailed view on specific and characteristic and/or critical zones of the building needs to be examined.

The overall workflow on the ISES platform is very flexible, allowing different configurations of the integrated analysis and simulation services depending on the specific project context.

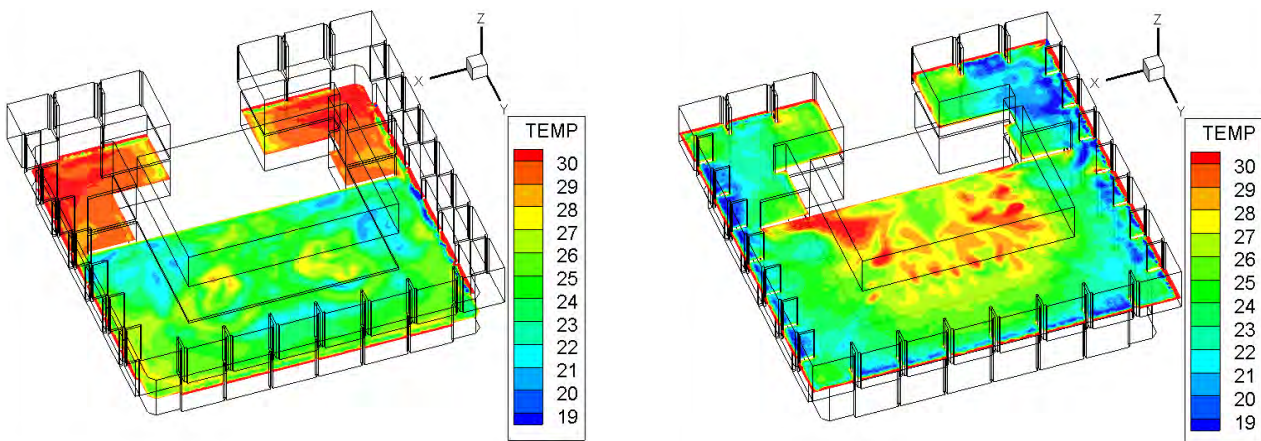


Figure 4: CFD analysis results of the Young Opera

More results and a download section containing all issued public materials and specifications are available at the project's **Web Site**: <http://ises.eu-project.info>.