BIM2Modelica – An open source toolchain for generating and simulating thermal multi-zone building models by using structured data from BIM models

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This contribution describes an open source toolchain which can transfer BIM models of 3D building constructions from CAAD programs into executable thermal multi-zone buildings models based on Modelica building energy simulation libraries. For this purpose, different open source libraries and tools were integrated into a Python-based software architecture of the toolchain: the IfcOpenShell/OCC libraries as the foundation for the import, analysis, and preparation of the BIM models; CoTeTo as the tool for the template-based code generation of the Modelica building models; the BuildingSystems library as the base for the thermal multi-zone building models; and JModelica as the simulation tool to perform the simulation analyses.

While the first part of the paper describes the general approach and the software architecture of the toolchain, the second part illustrates its application with an example of a real building.

Toolchain

The BIM2Modelica toolchain from the IFC file up to the generated Modelica model includes three serial working Python modules: A module for the BIM data import and analysis, a building data model for storing the analyzed and prepared information for building energy simulation and the CoTeTo tool for generating thermal multi-zone building models based on the BuildingSystems library (http://www.modelica-buildingsystems.de).
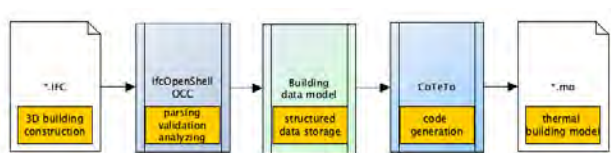

Figure 1. BIM2Modelica software architecture.

Simulation experiment with JModelica

After the multi-zone building model code was generated with CoTeTo, a simulation experiment could be performed with a Modelica tool. Because the objective of the development of the toolchain was a pure open source solution, JModelica was used for this purpose.
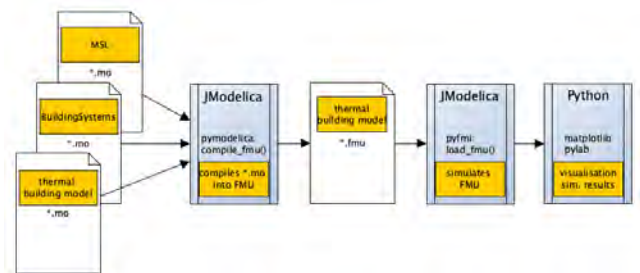

Figure 2. Simulation of building models with JModelica.

Case study

The approach of the toolchain was evaluated with a small residential living unit, the Rooftop building.

Figure 3. BIM model of the Rooftop building.

The generated Modelica model of the Rooftop building was simulated with JModelica for a period of four hot summer days for the location Berlin. In Figure 10, the outside air temperature and the free-floating air temperatures of the four thermal zones are illustrated.
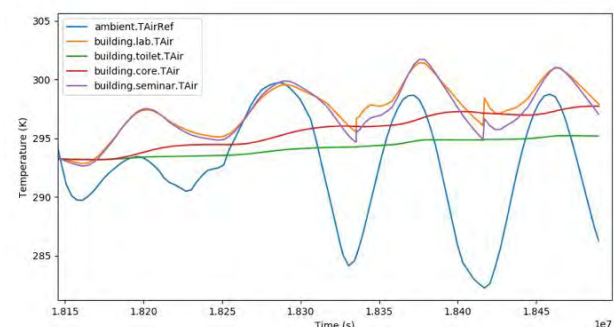

Figure 4. Simulated indoor climate of the Rooftop building during four warm summer days (location Berlin).