ANSI/ASHRAE standard 140-2011 testing of KIT's CityGML Energy ADE implementation

Joachim Benner
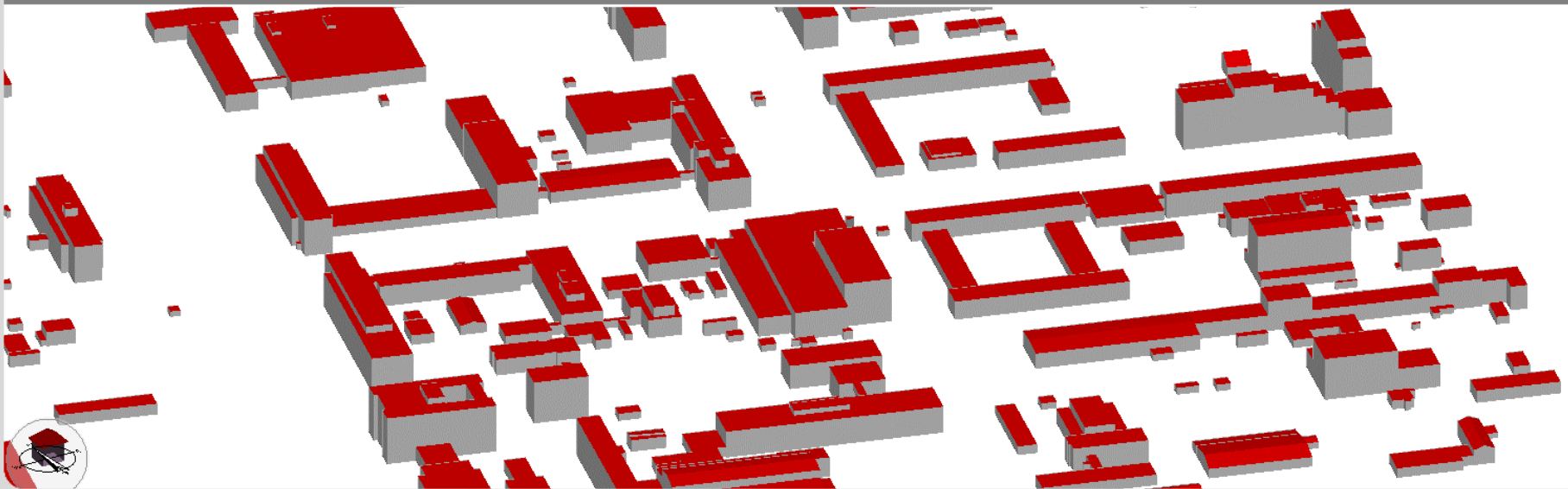
EnergyPlus Testing with Building Thermal Envelope and Fabric Load Tests from ANSI/ASHRAE Standard 140-2011

EnergyPlus Version 8.2.0

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Prepared for:

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Office of Building Technologies
Washington, D.C.

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Test Suite: ANSI/ASHRAE Standard 140-2011

- Based on the IEA *Building Energy Simulation Test* (*BESTTEST*) *and Diagnostic method.*

- Comparative testing approach, where a program is compared to itself and to other programs.

- Tested is the "ability to model thermal processes associated with the building envelope".

- The approach consists of a number of carefully specified test case buildings
  - Detailed geometrical, physical and usage parameters,
  - Detailed weather data (Denver CO)
  - Expected results for annual heating and cooling demand (min and max values).

- At the moment, only a few of these test-cases have been implemented
  - Test cases 140-600 – 140-650
  - Test cases 140-900 – 140-960

South
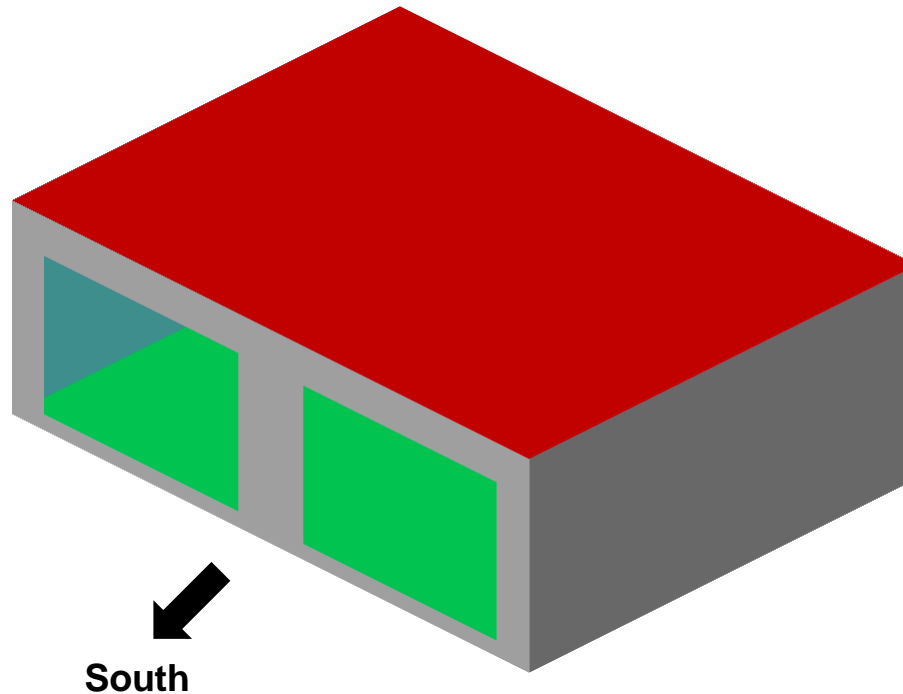
Base model 140-600

Ground area: 48 m²
Height: 2,7 m
Volume: 129,6 m³
Front side: 21,6 m²
Windows: 2 * 6 m²

Detailed physical and optical properties
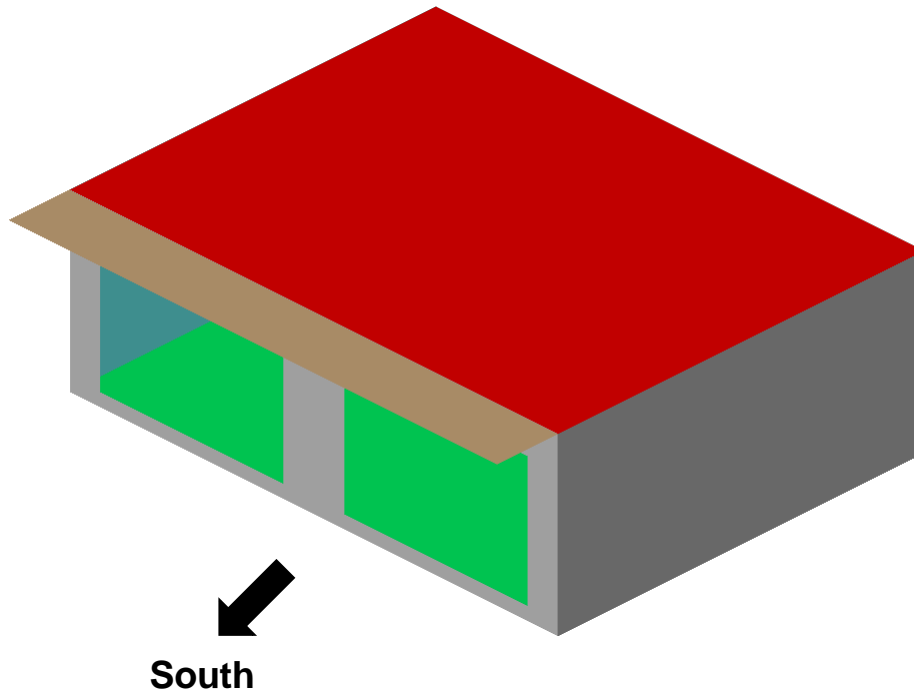
Simple usage parameters
    Constant ventilation (0,5 1/h)
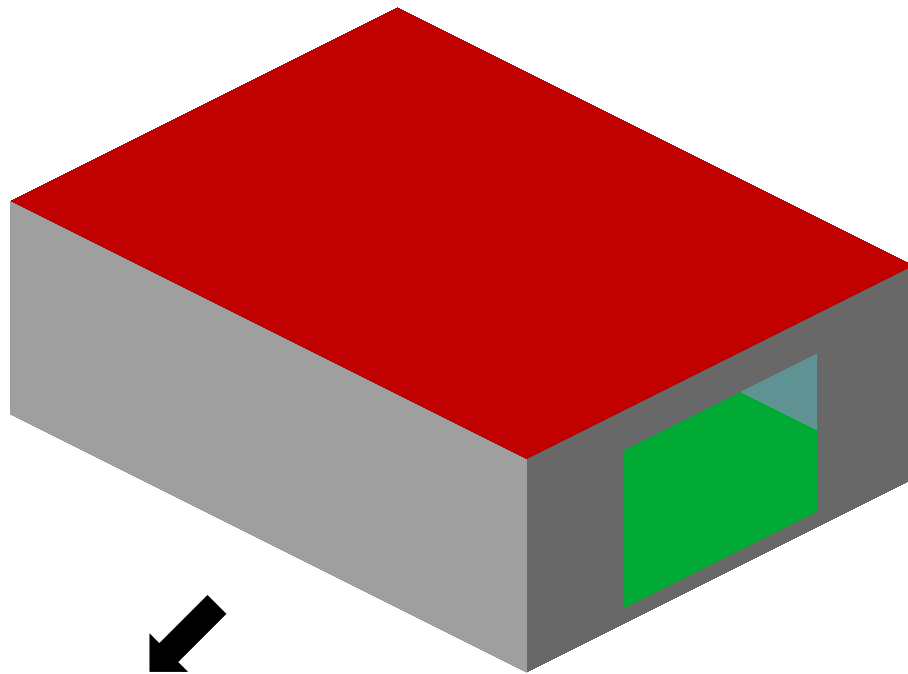   Constant internal loads (200 W)

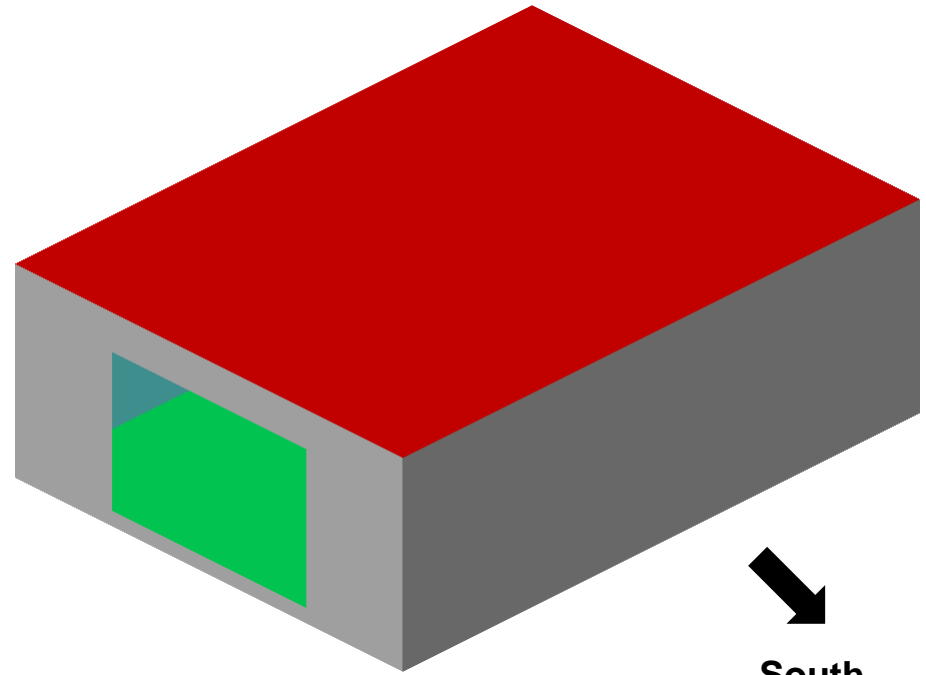Simple HVAC system
    <20° heating
    >27° cooling

South shading with 1 m horizontal overhang
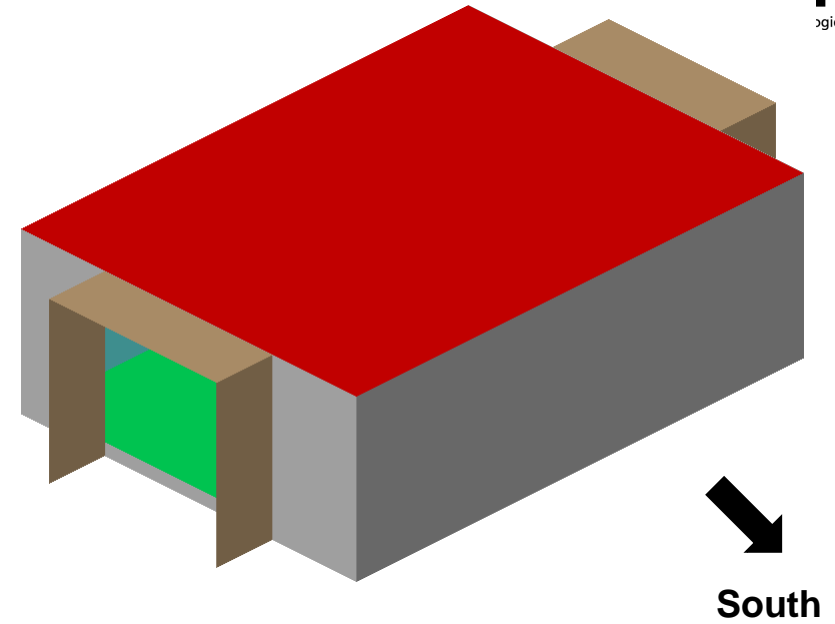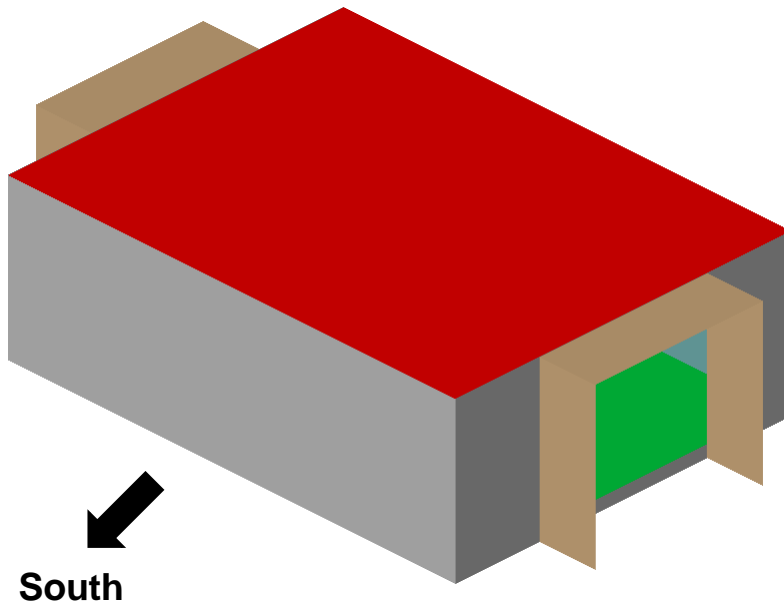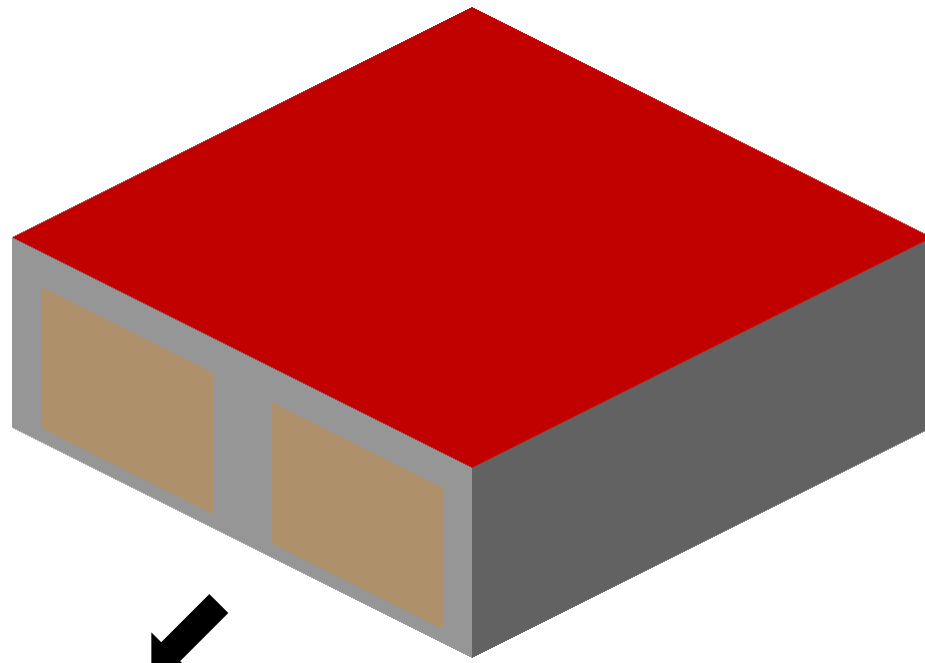
South

Model 140-610

South

South

Model 140-620

South

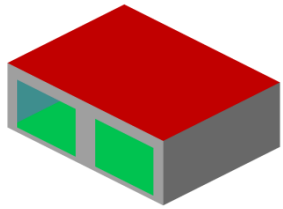**South**

Model 140-630
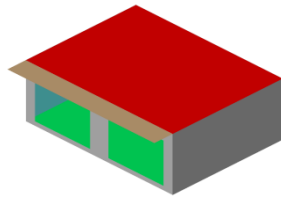
South

Heated zone
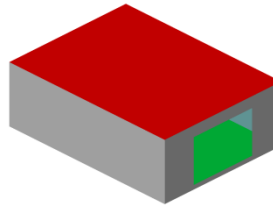
Unheated zone
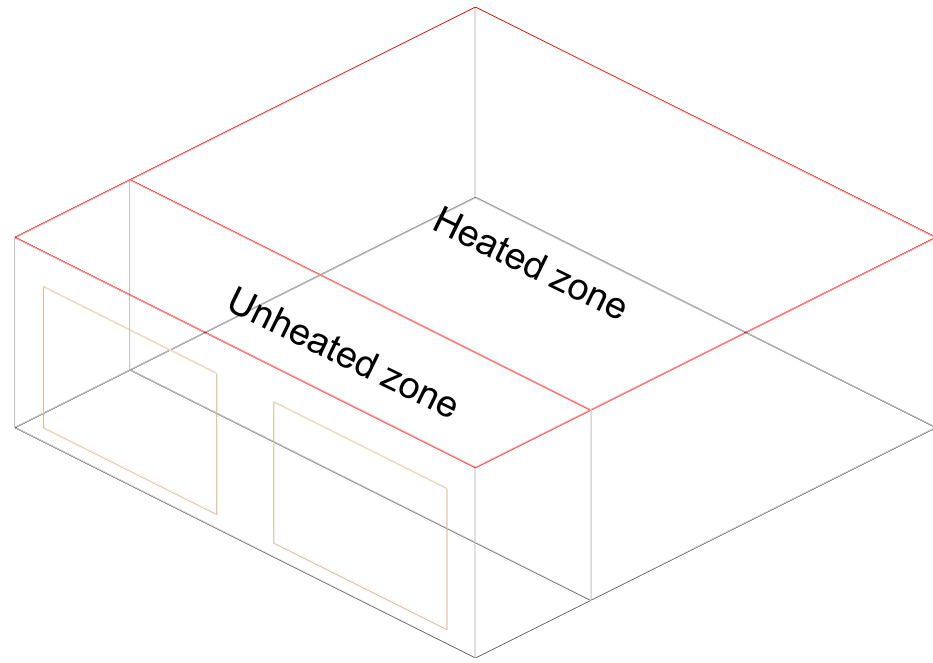
Model 140-960
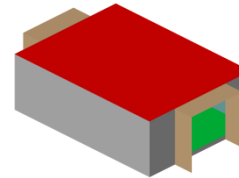
Implemented tests

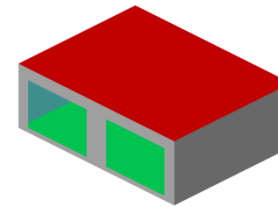

Case 600
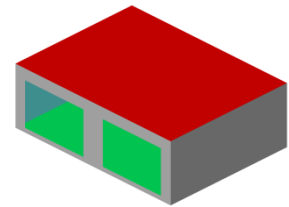Low mass

Case 610
Low mass

Case 620
Low mass

Case 630
Low mass

Case 640
Low mass
Thermostat
setback

Case 640
Low mass
Night
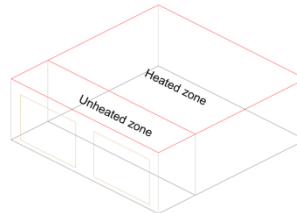ventilation

Case 900
High mass

Case 910
High mass

Case 920
High mass

Case 930
High mass

Case 940
High mass
Thermostat
setback

Case 940
High mass
Night
ventilation

Case 960
High mass

Questions to be answered

- Is the CityGML Energy ADE 1.0 able to completely represent the different BESTEST models?

- Do the implementations of the Energy ADE fulfil the BESTTESTs?
    - Implementation with EnergyPLus
   - Implementation with ETU-Gebäudesimulation (not yet finished)

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Results 1: Gaps in Energy ADE functionality

- Missing representation of specific simulation system parameters
- Missing representation of soil temperatures (e.g.as monthly averages)
- Explicit specification of heat transfer coefficients (outside air ←→ solid material, solid material ←→ inside air) is not possible
- Modelling of multi-pane windows is not possible
- No schedules for heating / cooling availability

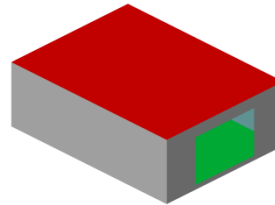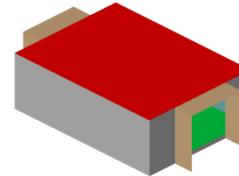27.9.2018 Dr. Joachim Benner Institut für Automation und Angewandte Informatik

Results 2: BESTEST conformity
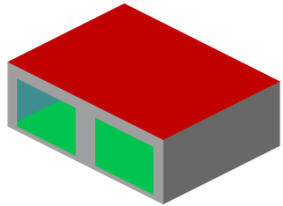
Case 600
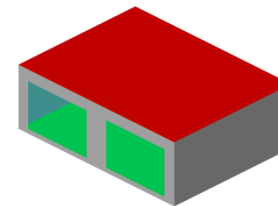Low mass
Heating
Cooling
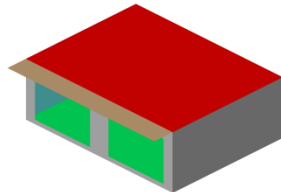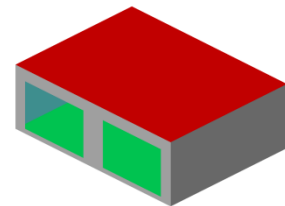
Case 610
Low mass
Heating
Cooling

Case 620
Low mass
Heating
Cooling

Case 630
Low mass
Heating
Cooling

Case 640
Low mass
Thermostat
setback
Heating
Cooling

Case 640
Low mass
Night
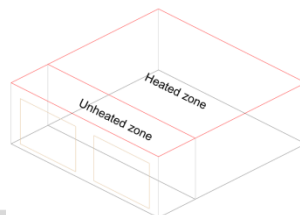ventilation
Heating
Cooling

Case 900
High mass
Heating
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Case 910
High mass
Heating
Cooling

Case 920
High mass
Heating
Cooling

Case 930
High mass
Heating
Cooling

Case 940
High mass
Thermostat
setback
Heating
Cooling

Case 940
High mass
Night
ventilation
Heating
Cooling

Case 960
High mass
Heating
Cooling

Summary

- With some limitations, the BESTEST models can be represented as CityGML Energy ADE models
    - To overcome the limitations, KIT defined a new (internal) version Energy ADE 2.0
    - The models (in version 1.0 and 2.0) can be published a deliverable of ibpsa project 1
- The EnergyPlus (version 8.8) implementation of the Energy ADE fulfills most of the tests, except of the models containing shading devices.