IBPSA Project 1

BIM/GIS and Modelica Framework for building and community energy system design and operation

TASK 3: Application and Dissemination
ST 3.1 District Energy DESTEST

Dirk Saelens (task leader)

Online expert meeting – status presentation – 2021.10.18

General information

- ➔ General objective: development of a DESTEST to
  - develop typical or representative DES cases that can be used for testing different DES simulation environments (intermodel comparison, …)
  - develop a test framework for testing models in a predefined DES environment
  - provide series of common exercises that can also be used for training and teaching purpose so that modellers improve skills and learn from other’s common mistakes / pitfalls.

General information

- ➔ Approach:
  - Two tracks are working in parallel
    - Focus on **building models**: Tohid Jafarinejad (KUL)
    - Focus on **network and energy system models**: Hicham Johra (AAU)
  - Common Exercises
    - Start with description of (very) simple neighborhood of buildings
    - Use this information to design thermal network(s)
    - Gradually increase the complexity
    - Increase size of the network to check scalability

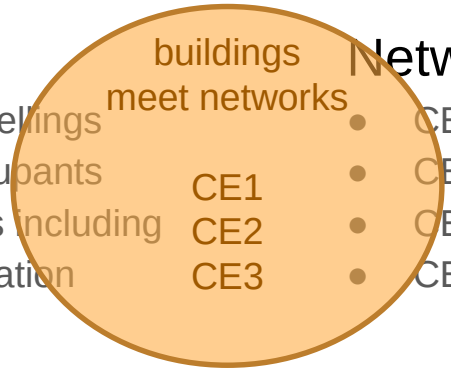
General information

- Communication through WP3 Google Group
  - Meeting invites and minutes are sent here
- Major information is collected in a Google presentation
  - More details: on the Project 1 GitHub page + in the e-mails sent in the Google Group
- Contact people:
  - WP lead: Dirk Saelens <dirk.saelens@kuleuven.be>
  - Buildings lead: Tohid Jafarinejad <tohid.jafarinejad@student.kuleuven.be>
  - Networks lead: Hicham Johra <hj@build.aau.dk>

Overview of common exercises

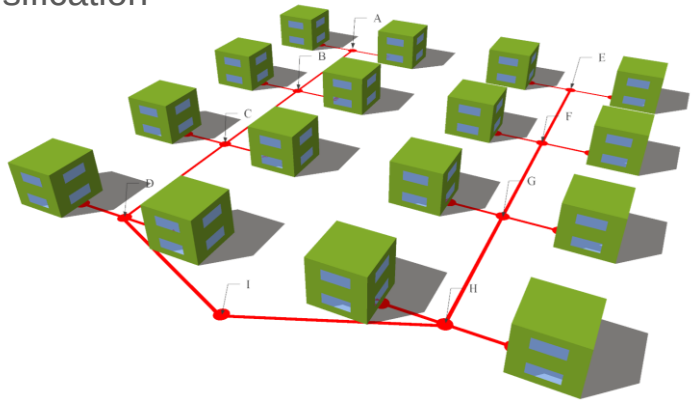
Buildings

- CE1 16 identical residential dwellings
- CE2 inclusion of stochastic occupants
- CE3 different construction types including variations in thermal mass, insulation levels and air tightness
- CE4 office building
- CE5 (new) further diversification



Networks

- CE0 (new) fixed load
- CE1 load = input from Buildings CE1
- CE2 (new) include ground temperature
- CE3 (new) load = input from Buildings CE3 + low temperature network, include ground temperature



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buildings meet networks

CE1
CE2
CE3

Networks

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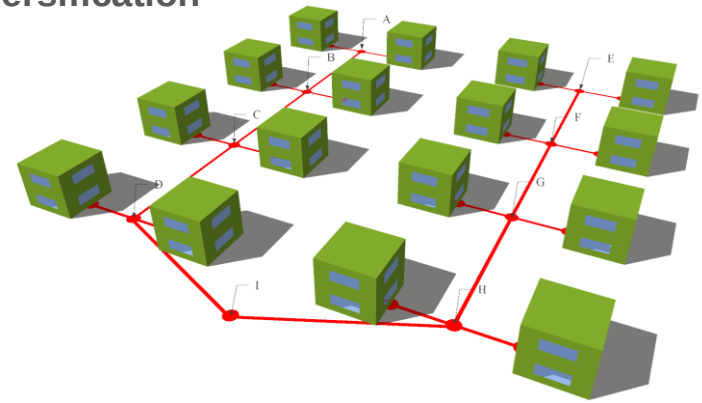
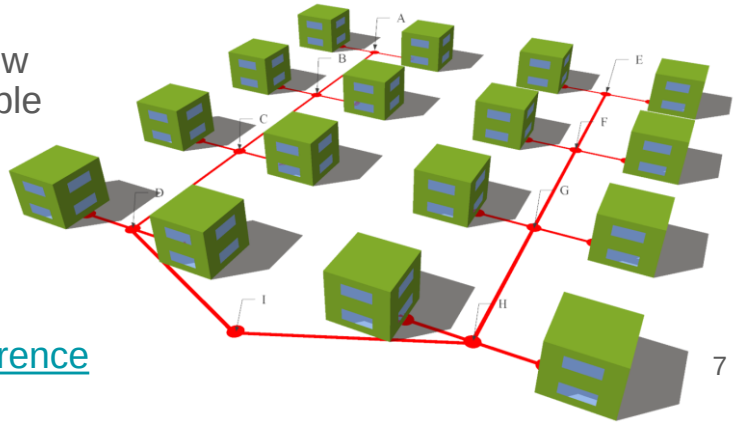


Buildings

- ➔ Buildings 1st common exercise (CE)
  - 16 identical single-family dwellings
  - Single-family dwelling of 1980
    - Thermal performance based on TABULA project for Belgium
    - Two-zone model (day zone and night zone)
    - Only heat demand for space heating
    - Standard occupant (ISO 13790)
  - Description can be found here
    - README-file that explains the followed workflow and the provided documents as much as possible
    - questions and remarks are collected here
  - Final documentation is available
    - In text format
    - In CityGML format
  - Described in a paper presented at the BS2019 conference



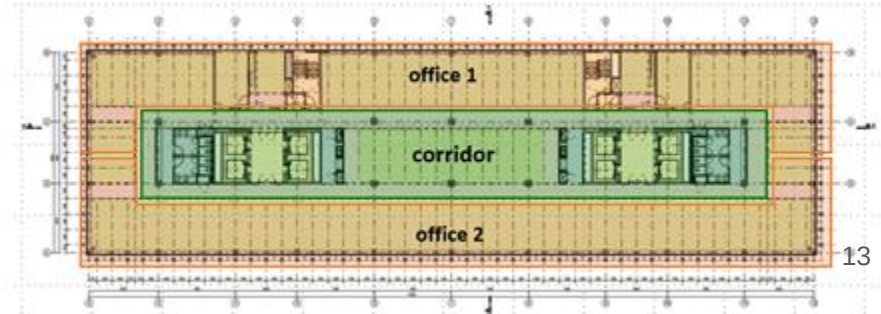
Buildings

➔ 1st common exercise - results

Modelling environment	Modeler	Affiliation of participant
Modelica IDEAS	Ina De Jaeger	KU Leuven / VITO / EnergyVille
Modelica Buildings	Alessandro Maccarini	Aalborg University
Modelica AixLib	Michael Mans	RWTH Aachen
Modelica BuildingSystems	Haris Shamsi	UCD Dublin
IDA ICE	Øystein Rønneseth, Igor Sartori	Sintef Norway
DIMOSIM	Enora Garreau	CSTB
Trnsys	Lien De Backer	UGent
New: Modelica IDEAS	Yasuyuki Shiraishi	University of Kitakyushu
New: BSim	Hicham Johra	Aalborg University

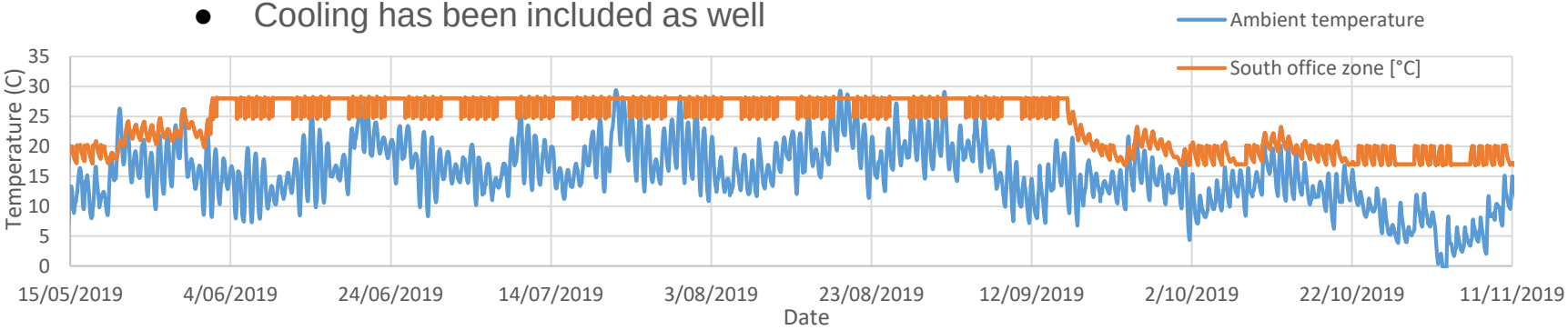
Current activities

- ➔ Buildings - 4th common exercise - resources
  - ◆ Improved description of the office building can be found here (google docs)
    - First models and results were made by:
      - Buildings (Alessandro)
      - IDEAS (Arash)
      - DIMOSIM (Enora)
    - Model description was updated (→ updated results)
      - IDEAS (Arash)



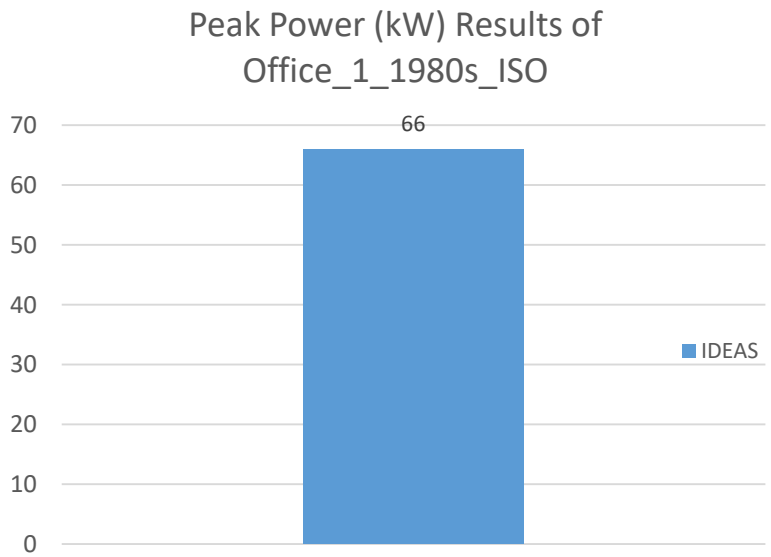
Buildings

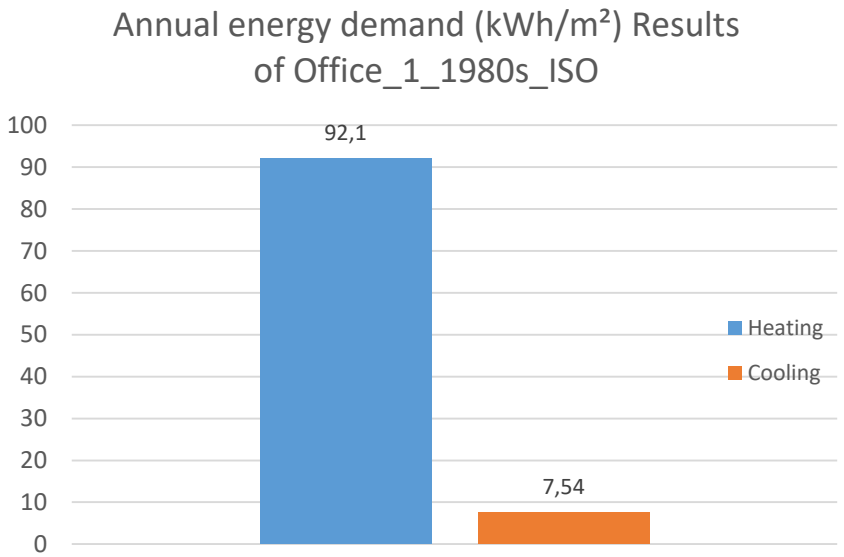
- Buildings - 4th common exercise
  - One-story Office
    - 2 office zones and one corridor
    - Given the high window to wall ratio, glazing description has been updated as it plays an important role
    - Internal heat gains have been revised to be more realistic
    - Ventilation is added to the description
    - Shading is integral to avoid overheating
    - Cooling has been included as well



Buildings

- Buildings - 4th common exercise
  - Some preliminary results





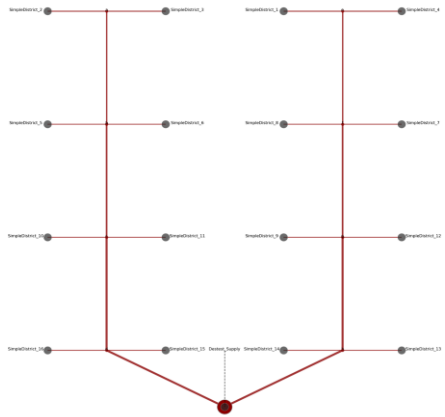
Buildings

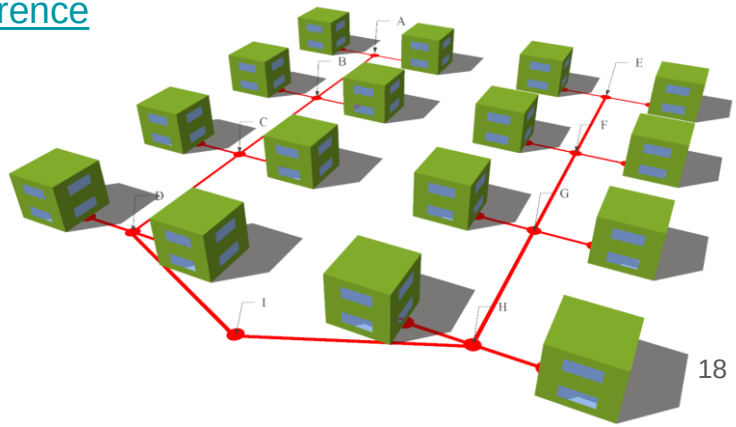
➔ Buildings - 5th common exercise → towards DOPTEST models

- Composition of “realistic” neighborhood
- Single-family dwellings with varying thermal performances
  - Different thermal mass classes are introduced
  - Different dwelling sizes are to be considered
  - Single zone model
  - Only heat demand for space heating + estimate for DHW
  - Stochastic occupants (16 different profiles)
- Offices with varying thermal performances
  - Heating and cooling load
  - Different occupants
- How to scale up?

Networks

- ➔ Network – 1st common exercise (CE)
  - 16 identical single-family dwellings of 1980s
  - Connected by a district heating network
  - Load of Buildings CE1 serves as input
  - First description can be found here
  - Documentation is available
    - In text format
  - Described in a paper presented at the BS2019 conference





Networks

➔ Network – 1st common exercise - results

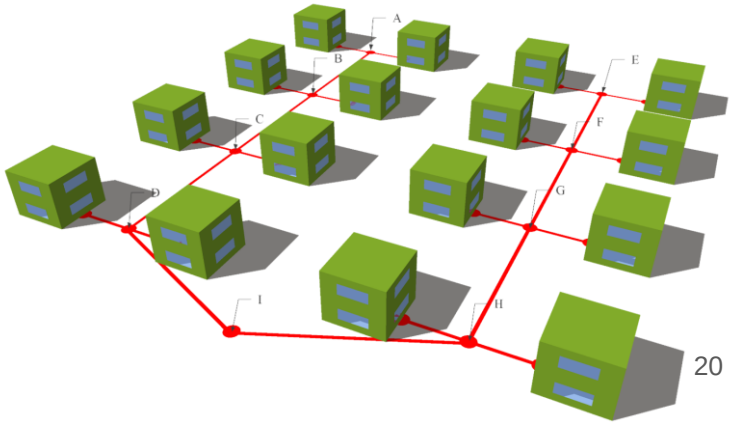
Modelling environment	Modeler	Affiliation of participant
Modelica IDEAS	Bram van der Heijde; Annelies Vandermeulen	KU Leuven
Modelica Buildings	Alessandro Maccarini	Aalborg University
Modelica AixLib	Michael Mans	RWTH Aachen
DIMOSIM	Enora Garreau	CSTB

Current activities

➔ Network – 1st common exercise (CE)

Reporting

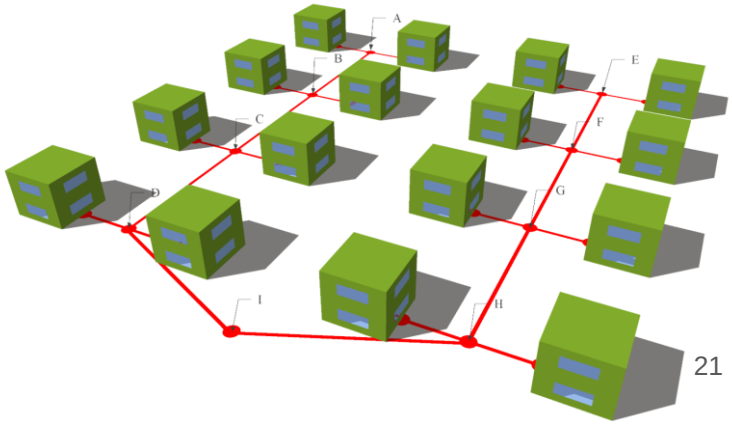
- Editing of the network CEs documents to make them more coherent with each other in terms of structure, improve text
- Adding introduction and aims for common exercises
- Improving case descriptions to enable participation of different modelling tools (f.i. important to explicitly state all dimensions of building elements)



Networks

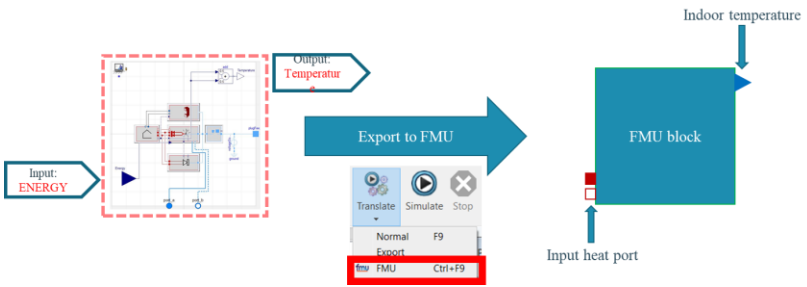
- ➔ Network – 2nd common exercise (CE)
  - 16 identical single-family dwellings of 1980s
  - Connected by a district heating network
  - Adding influence of ground modelling with weather file but still same high-temperature network and pre-calculated building heating load profiles

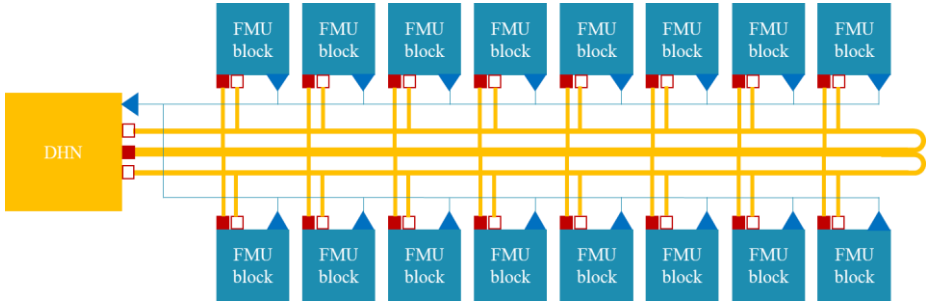
- ➔ Network – 3rd common exercise (CE)
  - 16 load varying (both in terms of time and amplitude) single-family dwellings
  - Connected by a district heating network
  - low-temperature network without insulation and with ground model



Buildings meet networks

- ➔ Buildings and Network CE:
  - CE_1: Going back to high-temperature DH network with ground modelling and adding real building models
  - CE_2: Variation to low-temperature DH network with low-energy houses
  - CE_3: Up-scaling test?





Comparison of simulation results

- Development of a Python-based tool for automatic key performance indicator calculation of your simulation results compared to the “average”
- Will be included in the DESTEST repository
- Good feedback from discussions at BS2021, but no time to implement new changes or to develop the web-based version (to be started asap).

Johra, H., Filonenko, K., De Jaeger, I., Maccarini, A., Saelens, D. (2021). Evaluating different metrics for inter-model comparison of building energy simulations. Presented at BS2021.

Breakout session agenda

Session 1 (Day 1)			**50 min**
WP3.1 DESTEST update	Current status	Dirk	5 min
	Update on CE buildings with focus on office building	Arash	20 min
	Update on CE thermal neworks	Hicham	20 min
	next steps + commitments	Dirk / Hicham	10 min

Publications

- Saelens, D., De Jaeger, I., Bünning, F., Mans, M., Vandermeulen, A., van der Heijde, B., Garreau, E., Maccarini, A., Rønneseth, Ø., Sartori, I., Helsen, L. (2019). Towards a DESTEST: a District Energy Simulation Test Developed in IBPSA Project 1. In: BS'2019, (1-8). Presented at BS2019, Rome, 02 Sep 2019-04 Sep 2019.
- I. De Jaeger, G. Reynders, D. Saelens. Quantifying Uncertainty Propagation For The District Energy Demand Using Realistic Variations On Input Data. Proceedings of Building Simulation 2019: 16th Conference of IBPSA, Vol. 16, September, 2019.
- Johra, H., Filonenko, K., De Jaeger, I., Maccarini, A., Saelens, D. (2021). Evaluating different metrics for inter-model comparison of building energy simulations. Presented at BS2021.
- Jafarinejad, Tohid; De Jaeger, Ina; Erfani, Arash; Saelens, Dirk, Evaluating data-driven building stock heat demand forecasting models for energy optimization, Presented at BS2021.