SOLAR HEATING & COOLING PROGRAMME
INTERNATIONAL ENERGY AGENCY

IEA-SHC TASK59: FACT SHEET

Multidisciplinary planning process:

Enhancing the use of the European standard EN 16883:2017

SIMULATION TOOLS FOR HISTORIC BUILDINGS

This is part of a series of fact sheets meant to facilitate and enhance the use of the European standard EN 16883:2017 Conservation of cultural heritage – Guidelines for improving the energy performance of historic buildings.

This particular fact sheet provides information about building simulation tools to assess energy and hygrothermal performance. Each tool is described briefly. For more detailed information, the reader is referred to the references

Contributors:

Fabrizio Leonforte
Politecnico di Milano (Italy)

Harold E. Huerto
Politecnico di Milano (Italy)

Niccolò Aste
Politecnico di Milano (Italy)

Claudio Del Pero
Politecnico di Milano (Italy)

IEA-SHC Task 59 Renovating Historic Buildings Towards Zero Energy
Subtask B Multidisciplinary planning process
Subtask Leader Tor Broström, Uppsala University, Sweden
Email task59@eurac.edu
Website task59.iea-shc.org

Renovating Historic Buildings Towards Zero Energy

BES tool	Applications	Main limitations	Ref.
EnergyPlus	EnergyPlus is a widespread and accepted tool in the building energy analysis community around the world. This programme models heating, cooling, lighting, ventilation and other energy flows as well as moisture in buildings. EnergyPlus performs sub-hourly calculations and integrates the dynamic performance of technical systems into the whole building energy balance calculations.	The main limitation of EnergyPlus is the lack of a graphical user interface. A complete, simple but flexible user interface is needed to allow faster and more convenient user input. The simulation of thermal bridges and the integration with CFD software are not allowed.	[1]
Design Builder	DesignBuilder is the most comprehensive interface for EnergyPlus. Its current version includes a simplified CAD interface, templates and compact air system configurations for EnergyPlus. An important feature of DesignBuilder is the help window that provides tips and wizards guiding the user through the creation of the thermal model.	A range of common HVAC systems is available in the Design Builder user interface, but do not include detailed information about the components and their topology. The inability to import EnergyPlus input files limits the utility of the program.	[2,3]
Trnsys	TRNSYS is a transient system simulation software with a modular structure that allows to simulate a variety of energy systems with various levels of complexity. It was designed and tailored to simulate complex energy systems by decomposing the problem in simpler and smaller components (called “types”). Models are constructed in such a way that users can modify existing components or write their own, extending the capabilities of the environment.	The major limitation of TRNSYS is to not being able to connect with AutoCad Software tool for importation and exportation of files. Finally, no type related to specific features of historical building exists.	[1,4,5]
WUFI Plus	WUFI plus is a software tool that connects dynamic energy simulation and hygrothermal calculation. It is the most used tool for evaluating moisture conditions in building envelopes. WUFI Plus performs 3-dimensional hygrothermal calculations on building component cross-sections, taking into account built-in moisture, driving rain, solar radiation, long-wave radiation, capillary transport, and summer condensation.	The radiation model in WUFI plus contains only the so called “geosurf factor method” which distributes the incoming radiation on every surface according to factors not editable by the users.	[6,7]
IES VE	IES VE provides an environment for the geometric representation which is evaluated with ApacheSim engine, a CIBSE qualified model tested using the ASHRAE 140. The dynamic tool ApacheSim can be dynamically linked to the Macro FLO dynamic tool for natural ventilation and HVAC Apache dynamic tool to study air leaks and natural lighting. It is possible to include LCA and LCC parameters.	IES VE is a commercial program, so its code is not accessible and the user cannot add any additional simulation modules to enhance either application-oriented or general-purpose modelling capabilities. Analysis of thermal bridges is not considered.	[5–8]
IDA ICE	IDA Indoor Climate and Energy (IDA ICE) is based on a general simulation platform for modular systems: IDA simulation environment. Physical systems from several domains are in IDA described using symbolic equations, stated in either or both of the simulation languages Neutral Model Format (NMF) or Modelica. IDA ICE offers separated but integrated user interfaces to different user categories: simplified, standard or advanced for developers.	Although the program is flexible and easy to use, it can have a long run time, depending on the complexity of the model structure.	[1,5,9,10]

HAM-base	HAMBASE is a Matlab-based tool for the simulation of heat and vapour flows in buildings. It is particularly appreciated in simulation of historical buildings since it allows to develop models of the different phenomena with the desired level of accuracy. Detailed evaluation of thermal bridges is allowed. It also allows to overcome some problems related to the simulation of thick walls.	Basic knowledge of Matlab are required to use this tool. At this moment HAMLab is a research tool. Therefore, it lacks facilities for design oriented users, such as user-friendly interfaces and user guides.	[11]

REFERENCES

[1] Crawley DB, Hand JW, Kummert M, Griffith BT. Contrasting the capabilities of building energy performance simulation programs. Build Environ 2008;43:661–73. doi:10.1016/j.buildenv.2006.10.027.

[2] Maile T, Fischer M, Bazjanac V. Building Energy Performance Simulation Tools-a Life-Cycle and Interoperable Perspective. 2007.

[3] Design Builder Software. Official web site n.d. http://www.designbuilderitalia.it/ (accessed June 12, 2019).

[4] TRNSYS. Official website n.d. http://www.trnsys.com/ (accessed June 12, 2019).

[5] Castaldo VL, Pisello AL. Uses of dynamic simulation to predict thermal-energy performance of buildings and districts: a review. Wiley Interdiscip Rev Energy Environ 2018;7:1–34. doi:10.1002/wene.269.

[6] Pallin S, Ph D, Shrestha S, Ph D, Adams M. State-of-the-Art for Hygrothermal Simulation Tools 2017.

[7] Schmidt S, Lindauer M, Hoppe M. Comparing TRNSYS and WUFI ® plus simulation models-illustrated on models validated on measurements at Schack-Gallery Munich. Proc. 5th IBPC, Kyoto, Japan, May 28-31, 2012.

[8] IES. Official website n.d. https://www.iesve.com/ (accessed June 12, 2019).

[9] EQUA. IDA ICE - Simulation Software, Official website n.d. https://www.equa.se/en/ida-ice (accessed June 12, 2019).

[10] Schwab M. Review of Building Energy Simulation Tools that Include Moisture Storage in Building Materials and HVAC Systems. Dep Mech Eng Univ Saskatchewan 2004:1–13.

[11] Wit MH de. HAMBase: Heat, Air and Moisture Model for Building and Systems Evaluation, Bouwstenen 100. vol. 100. 2006.

Project structure

The project consists of four work packages called "Subtasks"

Subtask B > Multidisciplinary planning process

led by Uppsala University, Sweden

Investigate how existing guidelines for improving the energy performance of historic buildings can be enhanced and complemented in order to better meet the needs of the end user by providing an integrated design platform

Organizational details

Full project title
Deep Renovation of Historic Buildings Towards Lowest Possible Energy Demand and CO_2 Emission (NZEB)

Project sponsor
International Energy Agency's
> Solar Heating & Cooling Programme (SHC) Task 59
> Energy in Buildings and Communities (ECB) Annex 76

Duration
September 2017 – February 2021

Operating Agent
Alexandra Troi
Institute for Renewable Energy
EURAC Research
Via Volta 13/A
I-39100 Bolzano / Bozen
Italy

Connect with us

http://task59.iea-shc.org
http://annex76.iea-ebc.org
task59@eurac.edu
www.facebook.com/HistoricNZEB
www.twitter.com/HistoricNZEB