Technology Collaboration Programme
by IEA

IEA Technology Collaboration Programme

International Energy Agency

Technology Collaboration Programme on

Energy Storage (ES TCP)

Storage for renewables and flexibility through standardized use of building mass

Questionnaire: SIMULATION

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Contact:

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Software development at the Institute for Building Climatology

The Institute for Building Climatology (IBK) at the Technical University of Dresden has been researching the theoretical principles of combined heat, moisture, air, pollutant and salt transport in porous building materials for more than 30 years. The area of building energy efficiency was added in 2007 and the IBK has also been active in the area of renewable energies for around 10 years. A particular focus is now on the integration and optimization of the entire system, from renewable energy sources to domestic heating networks to the energy performance of buildings, where thermal activation of construction components in the building plays an important role.

An important goal of IBK's research work is to disseminate new findings to other research institutes and practitioners. That's why IBK continually integrates these findings into its user-friendly software and calculation tools. The software programs are intended to support other research institutes in their work, to teach students the basics of building physics and to support the work of civil engineers, architects and other people working in this area.

Personal Information *(optional)*	
Name:	Grunewald, John
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Contact	☒ I am available for follow-up questions

Company / Institution	
Name:	TU Dresden
Country:	Germany
Type:	☒ University / Education ☐ Research Institution ☐ Company using simulation software ☐ Company developing simulation software

Simulation tools

DELPHIN is a comprehensive numerical simulation tool for the combined heat, air, moisture, and matter (e.g. salt) transport in porous building materials.

NANDRAD is a computation kernel for building energy performance simulation (a multi-zone model), specialized on large massive buildings with many zones and detailed construction models (walls, floors, ceilings, ...).

MASTERSIM is a simulation master for coupled simulation of models encapsulated in Functional Mockup Units (FMU), and a program library with FMU import and simulation functionality.

POSTPROC 2 is a program for scientific analysis and visualization of simulation results and measurement data. It specializes in the handling of large time-dependent/dynamic data sets (e.g. from DELPHIN).

All software tools are available under https://www.bauklimatik-dresden.de/index.php.

DELPHIN

Detailed Simulation Tool / Model		
Name:	DELPHIN (numerical solver + GUI)	
Homepage:	https://www.bauklimatik-dresden.de/index.php	
Relationship to you:	☒ I / my company are developing this software ☐ I / my company are using this software on a daily basis ☐ I / my company are using this software sporadically ☐ Other:	
License:	☐ Not publicly available; developed in-house, e.g., in research projects ☒ Commercial license (GUI) ☒ Free software (solver) ☐ Open source ☐ Other:	
Type:	☒ Stand-alone software ☐ Library / Plugin for: ☐ Other:	
Co-Simulation Interfaces:	☐ None ☒ FMI / FMU ☐ Custom (e.g., call to DLL) ☐ Other:	
Consideration of TABS:	☒ Components ☒ Ceiling ☒ Wall ☒ Other: Soils (ground heat exchangers and bore hole fields)	☒ Concrete ☒ Brick ☒ Wood ☒ Other materials: ca. 540 Materials in DB
Method to consider TABS[1]:	☐ Ordinary differential equations (ODE) ☒ Partial differential equations (PDE) ☐ Finite Element Method ☒ Other: Semi-discretization, finite volume method, CVODE for time integration	
Scope:	☒ Component ☒ Room (2D) ☐ Building ☐ City (quarter) ☐ Other:	
Main application:	*Transient hygrothermal transport processes in porous media, air flow, pollutants and salts included*	
USP: *(unique selling point)*	*Most complete and powerful tool worldwide in the area of main application*	
Alternatives:	*WUFI from Fraunhofer Institute of Building Physics*	

[1] How are thermally activated building components represented in the simulation? If, for example, the entire slab is considered as one block (1D model), this would correspond to an ODE. If piping space can be considered, it could be either PDE or FEM

Speed: *(approximate time for simulating one day)*	☒ Seconds ☐ Minutes ☐ Hours ☒ Other: Depends very much on system size, boundary conditions, etc.
Publications on method:	*See https://www.bauklimatik-dresden.de/delphin/index.php*
Publications on applications:	*See https://www.bauklimatik-dresden.de/delphin/index.php*
Additional Information:	*See https://www.bauklimatik-dresden.de/delphin/index.php*

Open Challenges for Detailed Simulation Models
3D Graphical user interface, simulation speed in 3D cases

NANDRAD

Detailed Simulation Tool / Model		
Name:	NANDRAD (numerical solver)	
Homepage:	https://www.bauklimatik-dresden.de/index.php	
Relationship to you:	☒ I / my company are developing this software ☐ I / my company are using this software on a daily basis ☐ I / my company are using this software sporadically ☐ Other:	
License:	☐ Not publicly available; developed in-house, e.g., in research projects ☐ Commercial license ☒ Free software ☐ Open source ☐ Other:	
Type:	☒ Stand-alone software ☐ Library / Plugin for: ☐ Other:	
Co-Simulation Interfaces:	☐ None ☒ FMI / FMU ☐ Custom (e.g., call to DLL) ☐ Other:	
Consideration of TABS:	☒ Components ☒ Ceiling ☒ Wall ☒ Other: through GUI SIM-VICUS	☒ Concrete ☒ Brick ☒ Wood ☒ Other materials: through GUI SIM-VICUS

Method to consider TABS[2]:	☐ Ordinary differential equations (ODE) ☒ Partial differential equations (PDE) ☐ Finite Element Method ☒ Other: Semi-discretization, finite volume method, CVODE for time integration
Scope:	☒ Component ☒ Room ☒ Building ☒ City (quarter) ☐ Other:
Main application:	*Transient building energy performance simulation including thermo-hydraulic networks inside and outside buildings*
USP: *(unique selling point)*	*Powerful numerical solver for multi-zone building energy, construction components are automatically discretized, standard solver under GUI SIM-VICUS www.sim-vicus.de*
Alternatives:	*IDA ICE from EQUA Solutions, TRNSYS from Transsolar, EnergyPlus from DOE*
Speed: *(approximate time for simulating one day)*	☒ Seconds ☐ Minutes ☐ Hours ☒ Other: Depends very much on system size, boundary conditions ect.
Publications on method:	*See https://www.bauklimatik-dresden.de/nandrad/index.php?aLa=en*
Publications on applications:	*See https://www.bauklimatik-dresden.de/nandrad/index.php?aLa=en*
Additional Information:	*See https://www.bauklimatik-dresden.de/nandrad/index.php?aLa=en*

Open Challenges for Detailed Simulation Models
Simplified moisture model for construction components, Pollutants in air flows still missing, No own detailed HVAC models (must be coupled though FMI)

Thank you for completing the questionnaire! Kindly send back the filled-out form to daniel.muschick@best-research.eu.

[2] How are thermally activated building components represented in the simulation? If, for example, the entire slab is considered as one block (1D model), this would correspond to an ODE. If piping space can be considered, it could be either PDE or FEM