<u>IBPSA Project 1</u>: BIM/GIS and Modelica framework for building and community energy system design and operation: Ongoing developments, lessons learned and challenges

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Motivation

- Smart Energy Systems several use cases benefit from using models:
 - Optimal design,
 - optimal control,
 - diagnosis & fault detection

- Ergo 1: We need models throughout the building delivery stages and continuing into the operational phase
- Ergo 2: This lead to new requirements for building and urban simulation tool



Image adapt

Motivation

Fostering joint developments

• Tools, frameworks, tool-chains, tools, frameworks, tool-chains, tools, frameworks, tool-chains, tools, frameworks, tool-chains



The vision of IBPSA Project 1

[...] is to create open-source software that builds the basis of next generation computing tools for buildings and districts



Why Modelica and the Functional Mock-up Interface



- Previous studies have reported that the <u>time spending for</u>
 <u>model development</u> is significantly high (up to <u>80%</u>) [1-5]
- 70% of project costs are consumed by model creation and calibration [6-8]
- There is an urgent need for **<u>automated model creation</u>** for optimization [10-12]





Declarative language

Allow acausal modelling



 $\mathbf{0}=F(t,x,\dot{x},y)$





Scalability?

Co-Simulation

Monolithic simulation: the entire system is modelled and simulated in a single tool



<u>Co-Simulation</u>: established tools for the respective subsystems are coupled



In your opinion, is there a widely accepted standard for [...]





94%

IBPSA Project 1 ...ongoing developments

The IBPSA Project 1 [2017 - 2022]

WP 1:

Modelica library for design and operation [LBNL Berkeley – Michael Wetter] Model Predictive Control [KU Leuven – Lieve Helsen]

WP 2

City District Information Modeling [TU Graz – Gerald Schweiger] BIM [RWTH Aachen – Christoph van Treeck]

WP 3

DESTEST [KU Leuven – Dirk Saelens]

Application [Aalborg University – Alessandro Maccarini]



Ongoing developments

WP 1: Modelica library & MPC

- Robust, validated and well documented library of Modelica models that serve as the <u>core of Modelica libraries</u>
- The IBPSA library also becomes part of the redesign of EnergyPlus called <u>"Spawn of EnergyPlus"</u>
- Development of an **open source library** for MPC
- Development of the **BOPTEST framework**: Test cases & Benchmark



Ongoing developments

WP 2.1: Data Modeling & BIM

- Exchange requirements and **country-specific data mapping approaches**
- Participation in development of the <u>CityGML</u> schema and <u>EnergyADE</u> for specific simulation tools
- Transform building information models to building performance simulation
- Advanced space boundary algorithms for model topology analysis and model generation

Ongoing developments

WP 3.1: Appliocation & DESTEST

- Validated models of urban energy systems by defining specific district energy cases
- Comparison and benchmarking of different tools and libraries
- Demonstrate capabilities enabled by the use of <u>Modelica for building and district energy</u> systems

Conclusion

- We want to develop and demonstrate the next-generation computational tools to analyze and optimize buildings and districts.
- The developments are based on open standards for data modeling (IFC and CityGML), for modeling of physical and control systems (Modelica) and for exchange of simulators (FMI).
- Collaborative development



https://ibpsa.github.io/project1/