

BuildSysPro: a Modelica library for modelling buildings and energy systems

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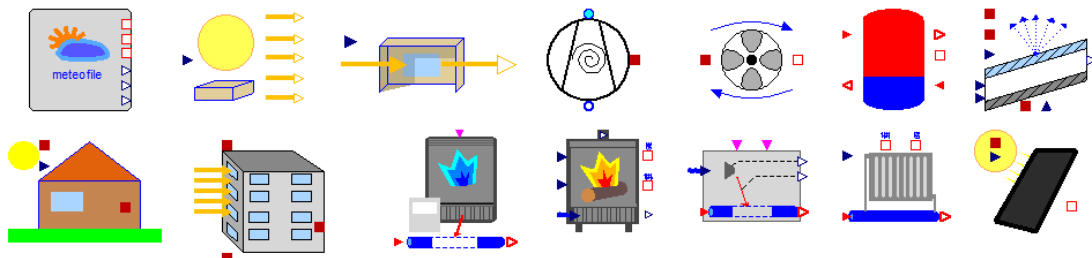
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This paper presents the BuildSysPro Modelica library developed by the department of Energy in Buildings and Territories (EnerBaT) of EDF R&D.

Since the building sector is one of the main energy consumers nowadays, energy policies drive existent and new buildings towards better performances. These evolutions raise quantity of questions regarding their ability to ensure the occupants' health and comfort while decreasing energy consumption and increasing energy efficiency. These questions rely strongly on multi-domain representations including thermal, electrical, hydraulic or chemical processes. Modelica being an object-oriented, equation based language, is therefore well suited to represent this kind of coupled problems and complex systems.

The EnerBaT department of EDF R&D developed its own Modelica library, BuildSysPro, in order to perform multi-scale and multi-domain modelling. The choice of a new library was dictated by research needs, very specific for an energy producer and retailer, since they cover many domains. This library is designed to be used in several contexts including building physics research, global performance evaluation, technology development and impact assessment. It is also a basis for urban and building stock simulation. BuildSysPro is intended for a relatively large audience ranging from R&D scientists to building services engineers.



BuildSysPro contains classes to describe the whole building and its energy systems. These include boundary conditions models, envelope components, HVAC systems and other energy conversion devices (DHW, thermal and photovoltaic panels...) and their control systems. BuildSysPro provides a comprehensive set of elementary 0D/1D components which can be used for both static and dynamic applications. It is principally based on two branches of physics: pure thermal and thermo-fluid dynamics modelling. These classes are compliant with the *Thermal.HeatTransfer* and *Media* packages of the Modelica standard library to ensure a good level of interoperability with other Modelica libraries. BuildSysPro in its current version contains around 380 models and 130 functions. The BuildSysPro library has already been successfully used in published studies including:

- Technology performances and impact assessment,
- Sensitivity analysis regarding experimental validation,
- Urban simulation.

This paper presents the structure and some key elements of the library such as building envelope components, boundary conditions and HVAC systems. A focus is then made on validation through numerical comparisons with the IEA BESTEST procedure. Finally the use of BuildSysPro is described on a basic use case aiming at analysing the matching between heat demand and supply in a residential building. For more complex applications and validations, other papers are referred to and can be consulted.

Keywords: Modelica library; Building; Dynamic simulation; Numerical validations, Energy systems