Modelica Library for Building and Low-Voltage Electrical AC and DC Grid Modeling

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This paper presents a Modelica library for electrical grid systems for low-voltage distribution grids and in-building grids. The library is based on previous work, in which a library was presented to simulate fully balanced three-phase AC low-voltage distribution grids [1].

This library is extended to simulate three-phase unbalanced AC low-voltage distribution grids as part of the IDEAS library [2]. A second extension is the ability to simulate DC grids. The Modelica implementation also allows to simulate multiple types of grid (i.e. single-phase AC, three-phase AC and DC grids) on different scales (in-building or low-voltage distribution grids) in one simulation. For AC grid analyses, a quasi-stationary model is implemented, assuming a fixed frequency (e.g. 50 Hz). This allows to represent the waveforms by its amplitude and phase shift. Therefore, dynamic transient are not included.

Electrical grids may connect many different energy systems (loads and generation units), different grids and/or buildings within districts. The library allows to assess the grid impact of these systems on different grid types. Control or optimization strategies can use grid variables, such as voltages and power exchanges.

The electrical grid models are validated using a comparative validation method. The three-phase grid models from this Modelica library are compared with the power flow analysis tool in [3]. A simple case study is developed with a small three-phase unbalanced residential distribution grid, consisting of one feeder connected to the feeding transformer. The feeder consists of 20 residential loads connected to respectively one of the 20 nodes in this feeder. The comparative validation of this Modelica library shows that the difference in nodal voltages depends on the loads, the grid topology and end criterion. Also the mutual impedance of cables in three-phase systems is neglected. Nevertheless, the average voltage differences between both models are limited, for this case study in the order of 10^{-2} V for a voltage of 230 V.

References

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