PHD THESIS

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Process, Energy and Automation Engineering

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Dynamics and control of integrated energy systems

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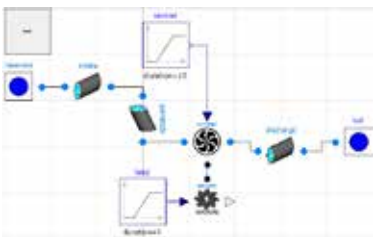
Background and objectives

A transition towards more renewable energy sources is currently happening in Europe and all over the world. This leads to an increase in the use of flexible hydropower plants to compensate the highly changing production from intermittent energy sources such as wind and solar energy. In the study of dynamics and control of integrated energy systems, the research focus will be within hydropower systems, but in such a way that the developed methods and tools are relevant for other energy systems, too.

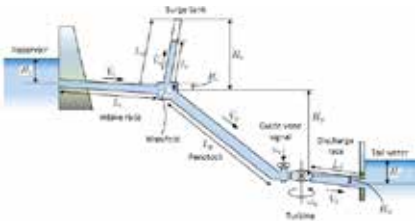
The study aims at developing a set of models relevant for hydropower production from precipitation, via transport through the catchment to dams or rivers (hydrology) , as well as flow in rivers and/or pressure shafts to the turbine, including turbine, various pressure shock damping devices, and possibly including generator. The models will be encoded in a Modelica library (using OpenModelica as an open-source Modelica-based modelling and simulation environment), and should be able to interact with other libraries "downstream" from the generator, e.g., including transmission, and consumption.



Screen dump of the library components combined in the hydro power system

Different methods for efficient analysis of the models, such as decomposition into different time scales, decoupling into subsystems and others are the aims of study. The developed methods should be implemented as tools in Python (powerful open source programming language), which can be interfaced to Open Modelica via a Python API under development.

Other methods for energy analysis and synthesis of control systems exist, e.g., the Power flow method, which attempts to integrate modelling and control of the system. These methods are designed for the overall power system network, consisting of an interconnection of the various components.



Schematic of a hydro power system