NTNU

Norwegian University of Science and Technology

Trondheim uses an OPAL-RT simulator for feasibility studies of an offshore wind park

The research project "Wind Energy Conversion using high frequency transformation and DC collection" is funded by the Norwegian Research Council and is a collaboration between the Norwegian University of Science and Technology and Michigan Technological University. The project aims at evaluating the feasibility of an offshore wind park where the turbines are organized in series rather than in parallel converters.

1. Challenge

The project aims at evaluating the feasibility of an offshore wind park where the turbines are organized in series rather than in parallel. This configuration spares the cost of building an offshore platform to support a transformer and/or converter for voltage step up and/or AC to DC conversion. The transformer and AC to DC converter (diode bridge rectifier) are instead moved into the turbine along with an AC-AC converter which controls the generator speed.

To fit the equipment in the nacelle, the transformer is designed for high frequency operation so that its volume is considerably reduced. Part of the project work has been to identify a suitable AC-AC converter and develop the design of the high frequency transformer. A prototype of a 10 kW conversion system including a matrix converter and a high frequency transformer with operating frequency 5 kHz has been built.

The challenge is twofold. Firstly, it is to complete the testing of the prototype within the allotted time of a PhD grant. Secondly, it is to implement the converter control and modulation without prior knowledge of any Hardware Description Languages (HDL). HDL knowledge is usually needed to program the FPGA which processes the fastest parts of

the converter modulation calculations. It is also desirable that prototypes can easily be reused.

2. Solution

A single environment with MATLAB/Simulink
A solution to the challenge is to implement the modulation and control of the matrix converter on the OPAL-RT target real-time simulator using the eFPGAsim solution. This solution offers one single environment; MATLAB Simulink, to build the entire control and modulation models.

Fast simulation on FPGA
In addition to the basic RT-LAB toolbox and required I/O interfaces, eFPGAsim gives access to the RT-XSG toolbox which allows the fastest parts of the modulation to be implemented on the FPGA of the simulator.

Accurate Testing
Furthermore before testing the control and simulation on the prototype, it can be tested on a very accurate eHS model of the matrix converter, build in Simulink as well, to make the transition to the prototype testing easier.

3. Achievement

The benefits are mainly:

- Reduced implementation time
- And the use of one single platform

Also students can later reuse the prototype and modify the control and modulation easily with MATLAB Simulink and some basic RT-LAB/RT-XSG knowledge.