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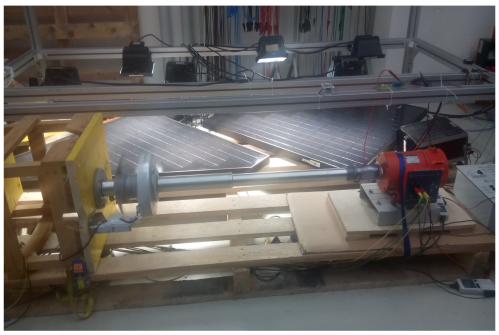
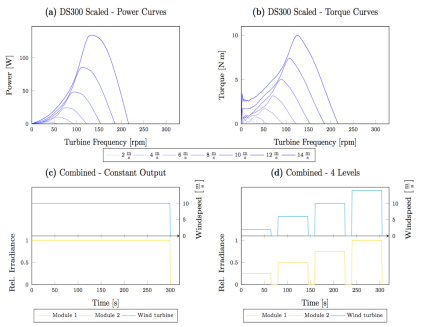
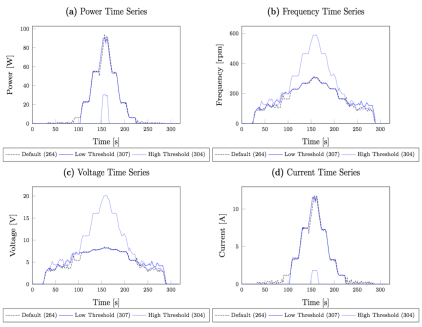
Development of a Test Environment for a Hybrid Solar and Wind Power Generator



Emulation in Progress



Configuration Data



Measurements

Problem: The inconsistent behavior of wind and solar irradiation makes the performance evaluation of wind- and solar-powered devices a time-consuming task. For hybrid power generators combining these two renewable energy sources, this is even more challenging. This project aims to develop a test environment for such devices, making it possible to test and compare different settings and configurations within a short time and with standardized environmental parameters.

Proceeding: To achieve this, an emulation system for both solar irradiation and wind turbine behavior had to be developed, and measurement devices had to be installed.To emulate solar irradiation, a number of spotlights were directed towards the solar modules and dimmed to allow for different irradiance levels. The wind turbine emulation was done with a dc shunt motor,for which the torque was controlled through adjustment of the armature voltage. The required torque was extracted from a data-based model, containing the torque curves in dependence of the rotation frequencies for different wind speeds. For this, a control loop was implemented, that monitored the rotation frequency of the turbine and adjusted the emulation behavior accordingly. The entire emulation was controlled through a custom-made software consisting of two parts. A database responsible of storing the configuration of the emulation and recording emulation data, and a command-line application to execute the emulation. In the database, it was possible to store wind and irradiation scenarios, to define different wind turbine torque profiles and to adjust the emulation to the hardware setup at hand. The command-line application could then execute these scenarios and control the emulation in the process. After development, the test environment was applied to the PowerPyramid, a prototype for a hybrid power generator model. Various scenarios were executed for a number of different configurations. The recorded data was then used to evaluate the performance of the emulation and to make a proof of concept.

Result: It has been shown, that in general the emulation worked well with a high degree of automation, and that meaningful information can be extracted about the tested system. However, for the future use of the developed test environment, improvements would be necessary, especially on the hardware side.