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Design, characterization and modelling of high efficient solar powered lighting systems

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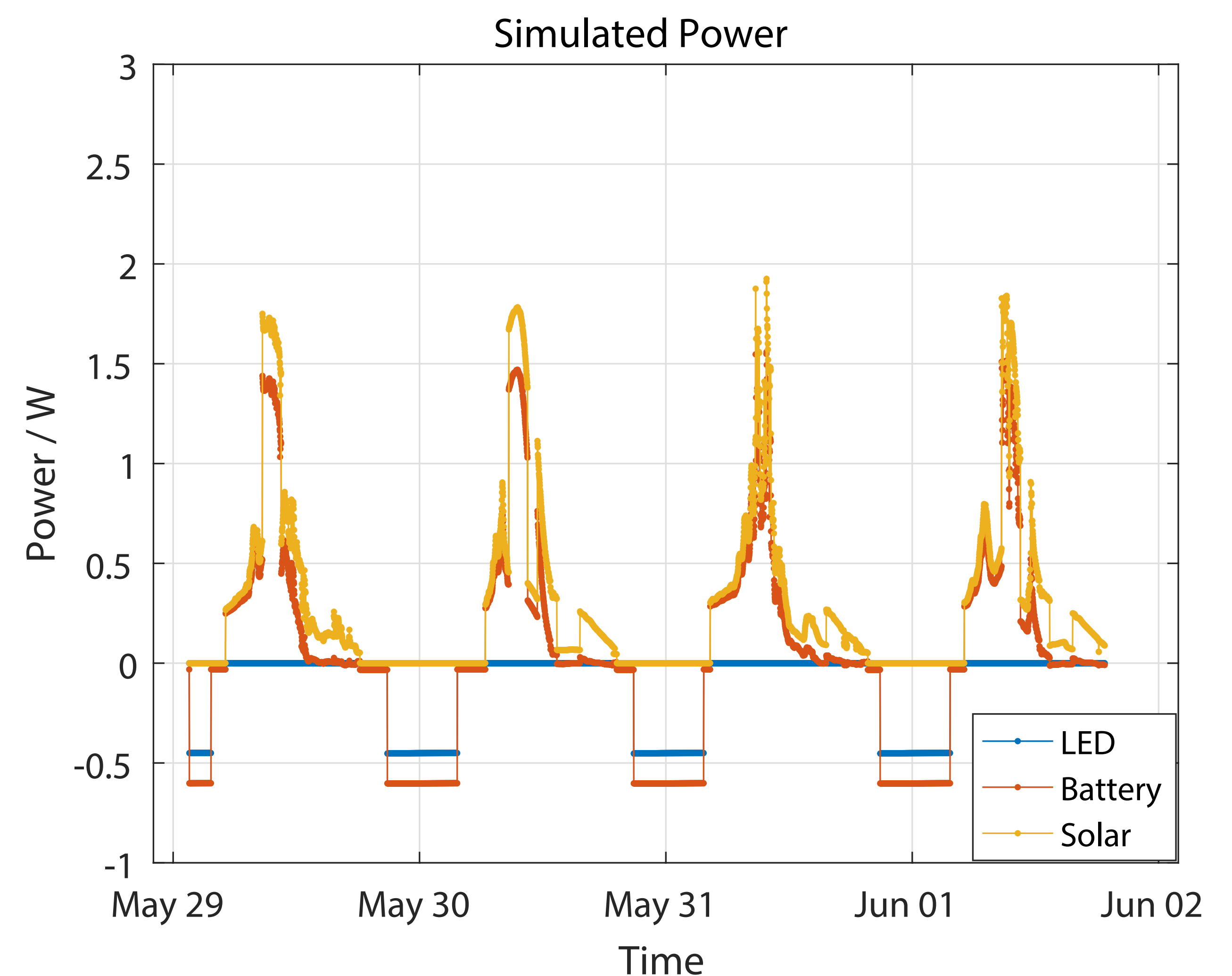
Motivation

Urban solar powered standalone lighting systems have become progressively more popular due to increasing efficiency and decreasing costs of PV-panels. In order to leverage the technology, to its fullest with minimal costs, it is necessary to determine the dimensions of the system components before development. However no tool yet is able to simulate an entire standalone system for component dimensioning. An attempt of such a tool is here validated against a field test.

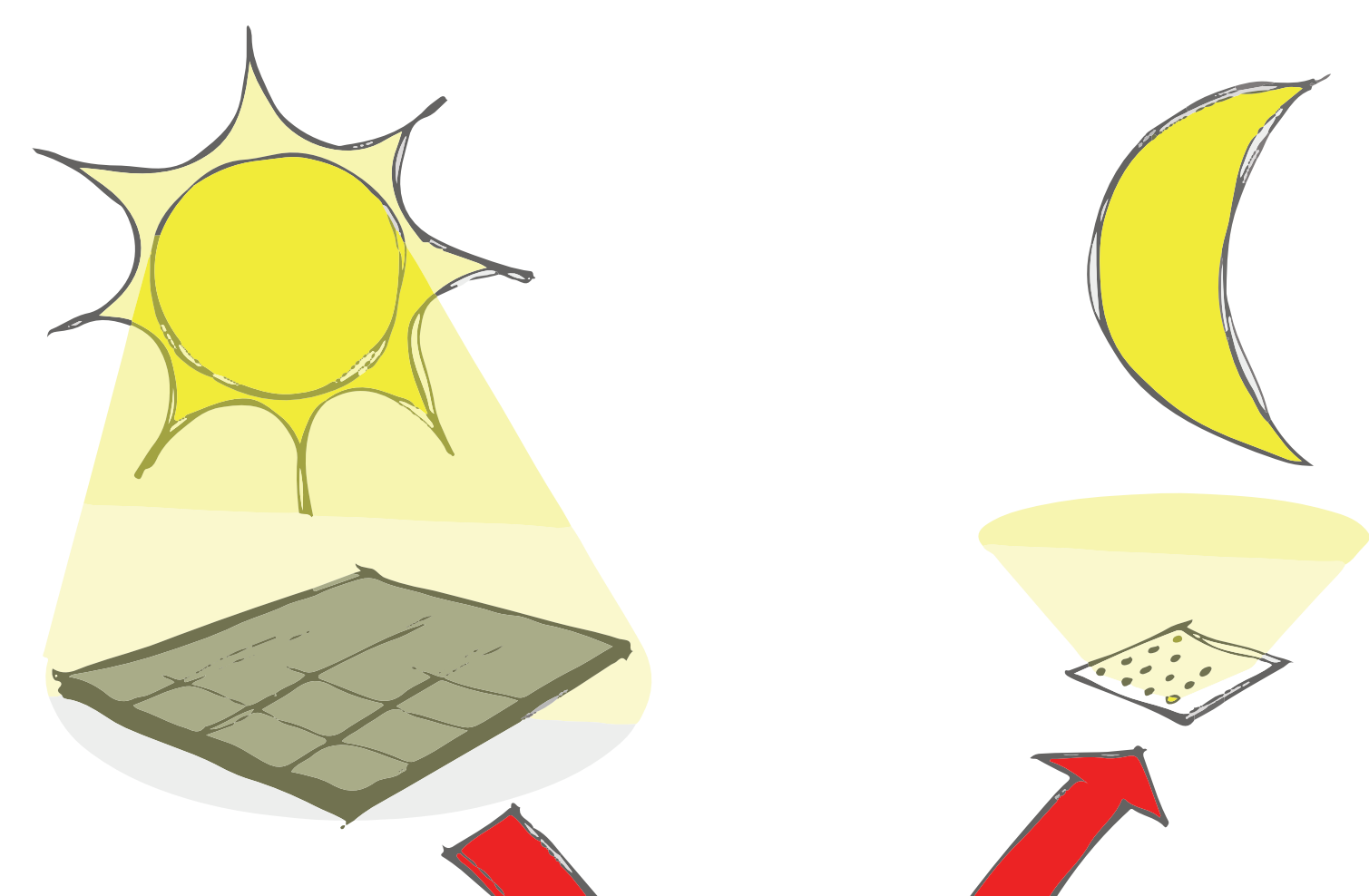
Conclusion

An urban stand alone PV powered lighting simulation tool was created and validated by a field test product with a cumulated energy difference up to 5.3 % for the different components over a four day time period. Next step is an extended characterization of PV-panel and battery.

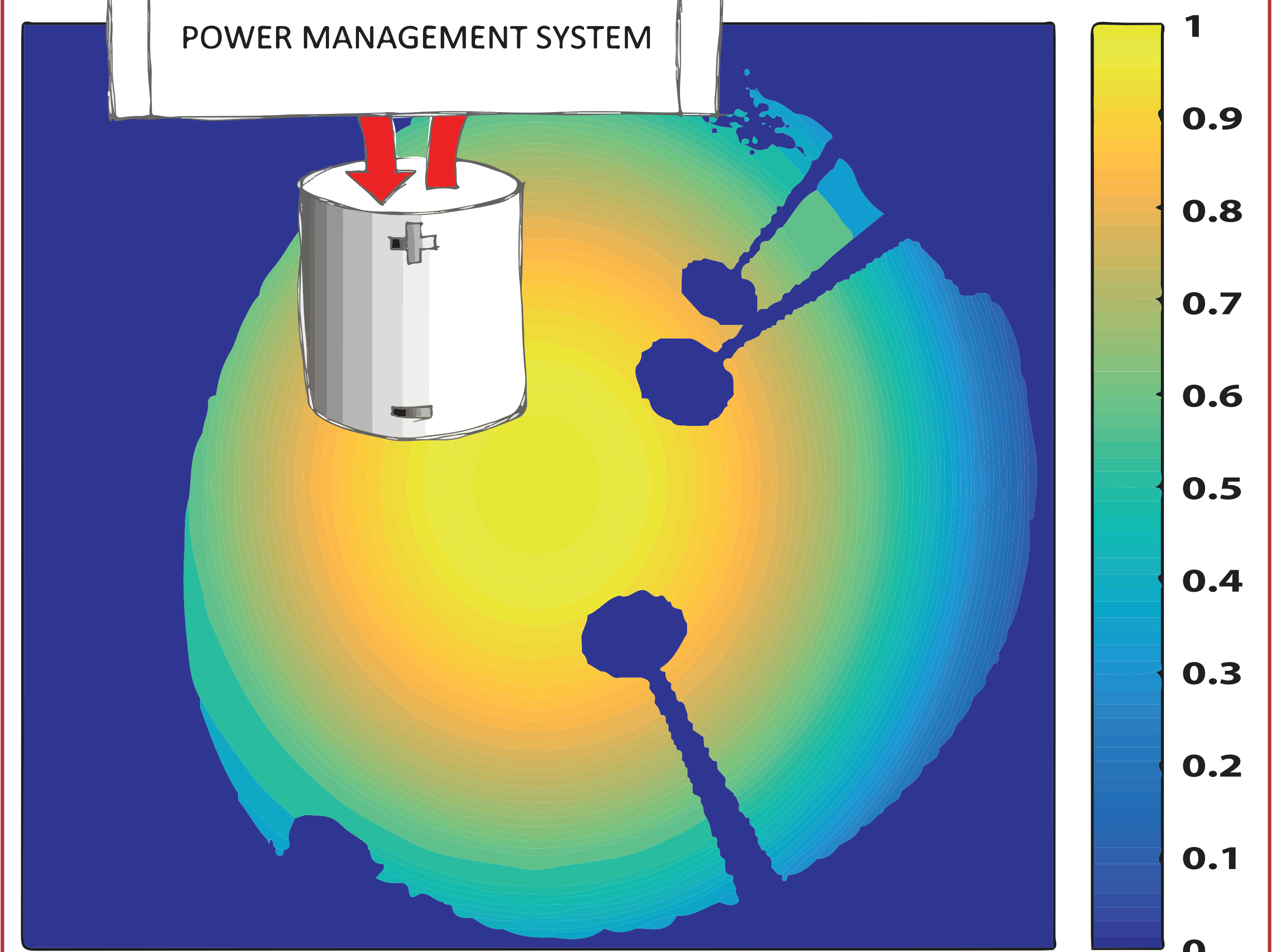
Simulation



Power calculated by the simulation tool. Weather data from weather station at DTU Risø 1 min resolution

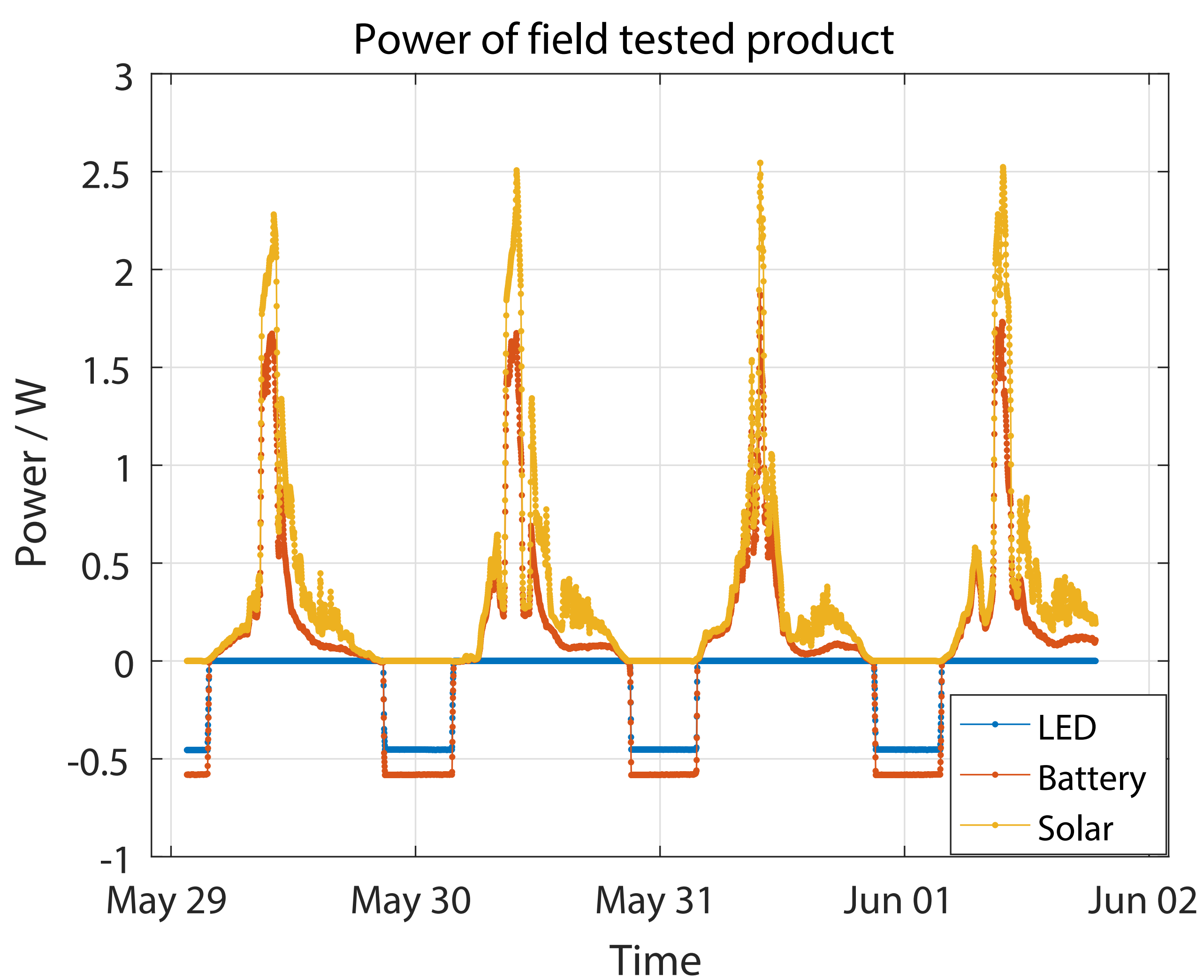


The simulation tool is written in MATLAB and uses the specialized laboratory's characterisation data along with weather data; direct irradiance, diffuse irradiance and temperature to simulate the field test product.



With a fraction of open sky at 70 % a level of 81 % of the Diffuse light contributes to the total irradiation.

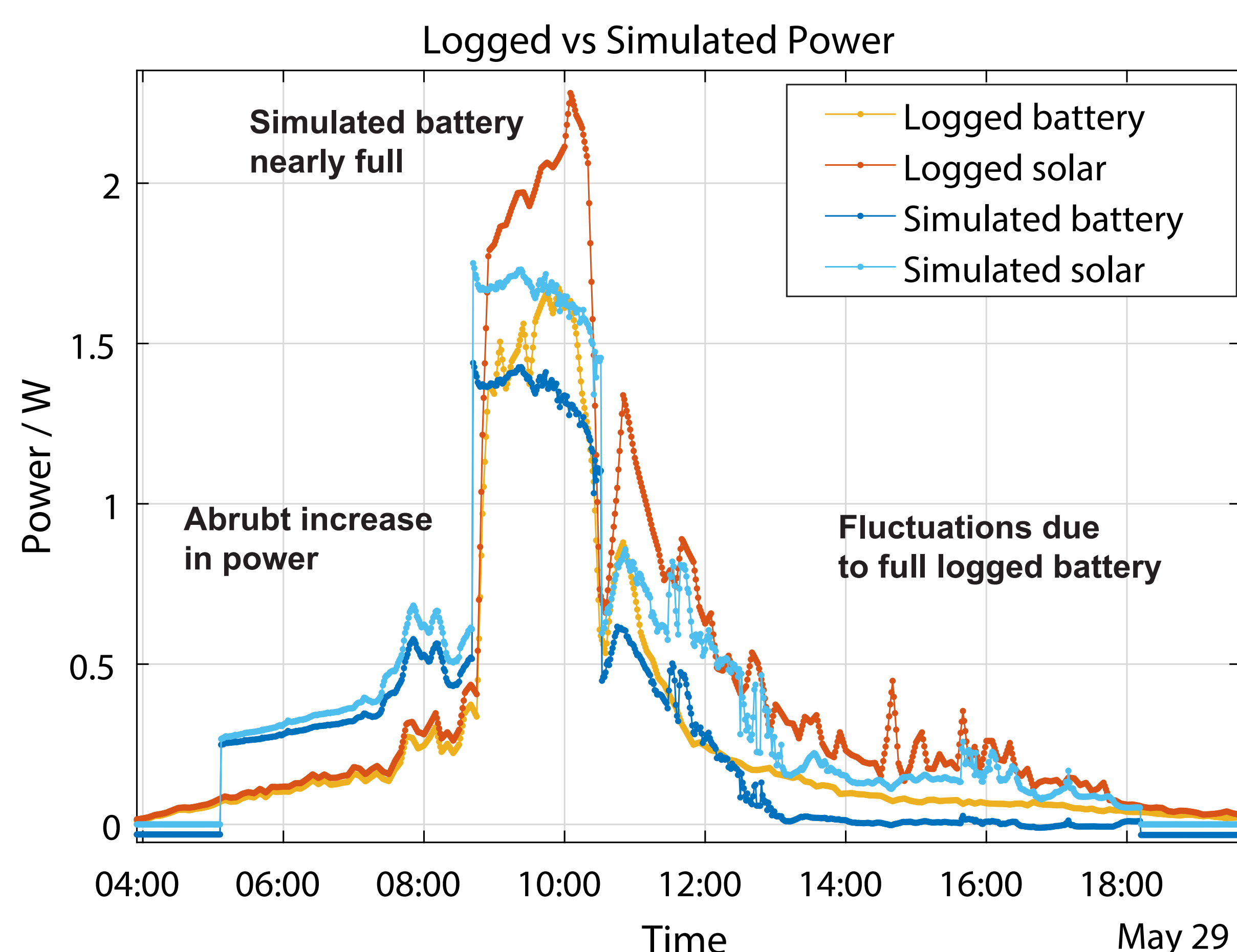
Fieldtest



Power measurement from the field test. Device from the living lab at DTU Risø

A living lab and a specialized laboratory is installed. One to feed the simulation tool with characterisation data of the different component. The other to monitor the field test product.

Validation



1. The cumulated energy flow over the four days for the PV, battery and LED is respectively 29.4 Wh, 3.1 Wh, and 12.0 Wh. Simulated differences 2.9 %, 4.5 % and 5.3 %.

2. Better panel characterisation, Abrupt increase in power, and higher power during early hours of day

3. Better battery characterisation, Simulated battery is charged faster than logged battery

Simulated model lacks current fluctuations for nearly charged battery.