Karlsruhe Institute of Technology

Division III – Mechanical and Electrical Engineering

Institute of Electrical Engineering (ETI)

Solarpark 2.0

Optimization of Power and Yield in Photovoltaic Systems.

Aim: Increase the yield of large photovoltaic systems

Shade, dirt, or aging considerably reduce the yield of large photovoltaic facilities. Karlsruhe Institute of Technology (KIT) and partners from science and industry have now launched the Solar Park 2.0 project to reduce these losses. Innovative circuits, novel power electronics, and AI-supported optimization are expected to increase the yield and service life of facilities and to reduce their operation costs.

Optimization by Multilevel MPP Tracking

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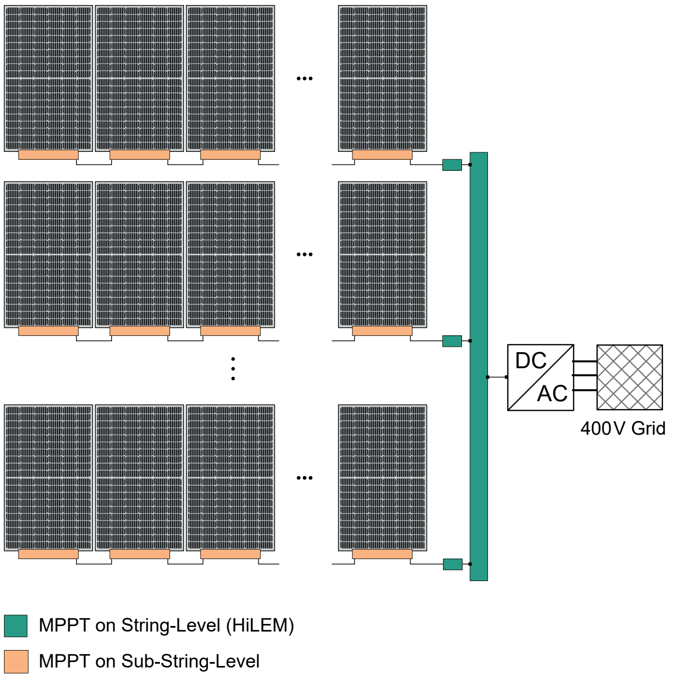
In the past, often only one MPP tracker was used in the central inverter. However, especially in large systems, different influences act on the modules at times. For example, only a part of the park could be shaded by a cloud. Then MPP tracking via a single power optimizer is not optimal, since each solar module/solar cell has an individual MPP. Recently, there has been an increasing demand for string-level MPPT in large-scale ground-mounted PV systems. Currently, normal string inverters are used for this purpose. Therefore, in the Solarpark 2.0 project, multilevel MPP tracking is set up with optimizers in the sub-strings (modules) and the PV-strings.



String MPPT through highly efficient HiLEM circuitry

The HiLEM (High Efficiency Low Effort MPPT) circuit patented by KIT is used for the string-level MPPT in this project. This combines the individual PV strings very efficiently to a common DC output and simultaneously regulates each string in its individual MPP.
The HiLEM circuit replaces the conventional combiner boxes for parallel connection of the module strings and enables efficient MPPT at string level, making the single MPPT in the inverter obsolete.In addition, integration into the inverter is also possible, creating a new topology for string inverters.

Using AI methods to increase the economic efficiency of photovoltaic systems

Another goal is to develop an artificial intelligence (AI)-based performance prediction for photovoltaic systems that can identify shaded, degraded and dirty modules based on operating data. The aim is to determine at which point in solar parks it would be profitable to retrofit them with performance optimizers.

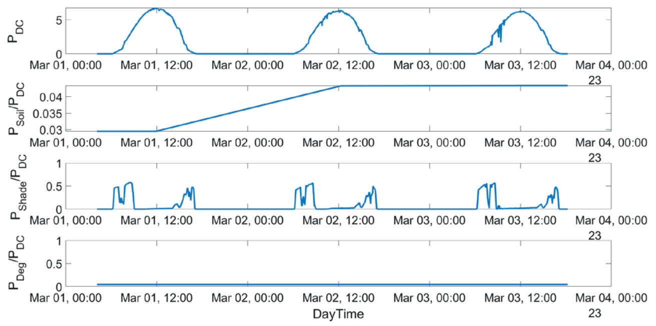


Figure 1 Determination of the proportions that lead to a reduction of the maximum PV power due to soiling and shading.

The necessary data for training the AI will be generated from the existing data of a solar park as well as from new test plants, which will be built for the project. Furthermore, these data will be used to train an AI-based power prediction model, which should make it possible to estimate the yield of a photovoltaic system up to one day in advance.

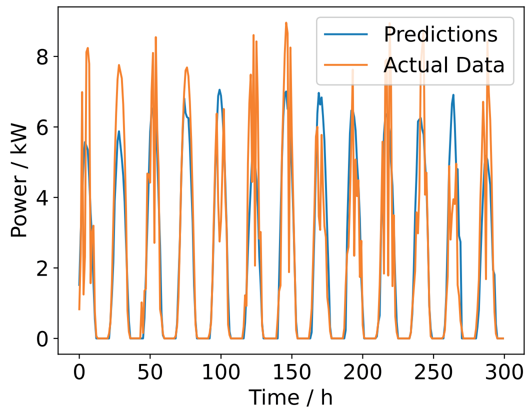


Figure 2 Solar power forecast over one day by use of LSTM networks.

Together with the detection of shading, soiling and degradation, this should also reduce the cost of electricity. Maintenance, cleaning and inspection intervals can thus be intelligently planned. This should reduce downtimes and lower operating costs.

Own testing facility

In order to validate the advantages of the Multilevel MPPT with the HiLEM circuit, a 60 kWp field test system is being built on the premises of KIT Campus North. This will be divided into two identical plants. One part of the plant will be equipped with the new technologies and validated against the other part of the plant with standard technologies as reference.

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