AC-Yield

An investigation into cooling of modules in floating PV systems and light penetration in land-based solar parks.

Public Summary

In recent years the number of large-scale solar parks strongly increased. This not only increases the solar energy produced, but also the impact on the landscape, ecology and biodiversity. TNO has developed a yield model for solar energy installations, BIGEYE, which simulates light falling on the PV modules for different system designs, which in term is used to simulate the energy produced. This model is adapted to simulate the light falling únder the modules, which is a key ingredient to sustain soil quality, ecology and biodiversity. Although this is a powerful tool, the model had not been validated.

In this project, Groenleven and TNO worked together to extend, improve, validate and calibrate the model. For this purpose TNO measured the light falling under PV modules in a commercial solar park of Groenleven. Groenleven facilitated the measurement. These measurements were used to calibrate and validate the simulation software. Investigations show that a number of phenomena are important to include in the light penetration simulations that were not included before. We have shown that specular reflections from surrounding modules and diffuse rear side reflections play an important role. Furthermore we experimented with a variable albedo on the ground. This is a useful addition for currently ongoing and future projects that involve nature inclusive solar parks and agrivoltaic solar farms. With this tool we can quantitively show the effects of design choices for both energy output and under-module soil irradiation. We have shown that both the energy yield calculations and the ground irradiance simulations show the best performance for the semi-transparent bifacial module. This means that for a given minimum irradiance or minimum kWh per unit area demand, with a bifacial module you can achieve the soil quality with a higher coverage of solar panels. Alternatively, you can achieve the energy performance demand with fewer modules per area due to the bifacial gain and have a higher soil irradiance.

A second goal of the project was to quantify the so-called cooling effect of floating PV systems. Previous studies have shown that PV modules are cooler when they are deployed above water, but accurate modelling was not yet available. A new thermal module for the existing model was developed that not only takes into account irradiance and ambient temperature, but also water temperature. This model was calibrated and validated using data that we collected at a commercial floating solar of Groenleven near Oosterwolde, which includes a reference system on land for direct comparison of the PV module temperatures. We found that the influence of ambient temperature and water temperature are strongly intercorrelated and therefore adding water temperature to the model does not increase the accuracy. We did not find significant edge effects, such that the modules near the edges of the system were cooler than the modules near the centre of the system. We did find that cooling due to wind is slightly higher for floating systems, which results in an annual simulated yield increase of 0.8%.

TNO has incorporated the new acquired knowledge into the BIGEYE model. With the newly acquired properties of the model, new types of projects can be initiated in the PV sector, i.e. projects that include soil irradiation simulations or floating PV systems.

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