Master's Thesis Engineering Technology

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Analysis and simulation of a floating PV plant and the construction of a floating PV demonstrator

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Context

The efficient integration of solar panels into the environment is one of the focus points of imec's energy division, based in Energyville Genk. This Master's thesis supports imec in their research on **floating photovoltaics (FPV)**. FPV is a novel integration method that uses the free space on water bodies to generate electricity. It shows multiple **benefits** over ground-mounted PV (GPV). However, the claim that FPV systems perform better due to **improved module cooling** is still controversial.

This Master's thesis consists of **three main parts**:

- Module cooling is investigated based on measured data from an FPV system in Meer, Antwerp called Clicfloats Project 600.
- The accuracy of commercially available software, such as PVSyst, is analysed for use in FPV simulation.
- An interactive demonstrator is designed and built for promotional purposes.

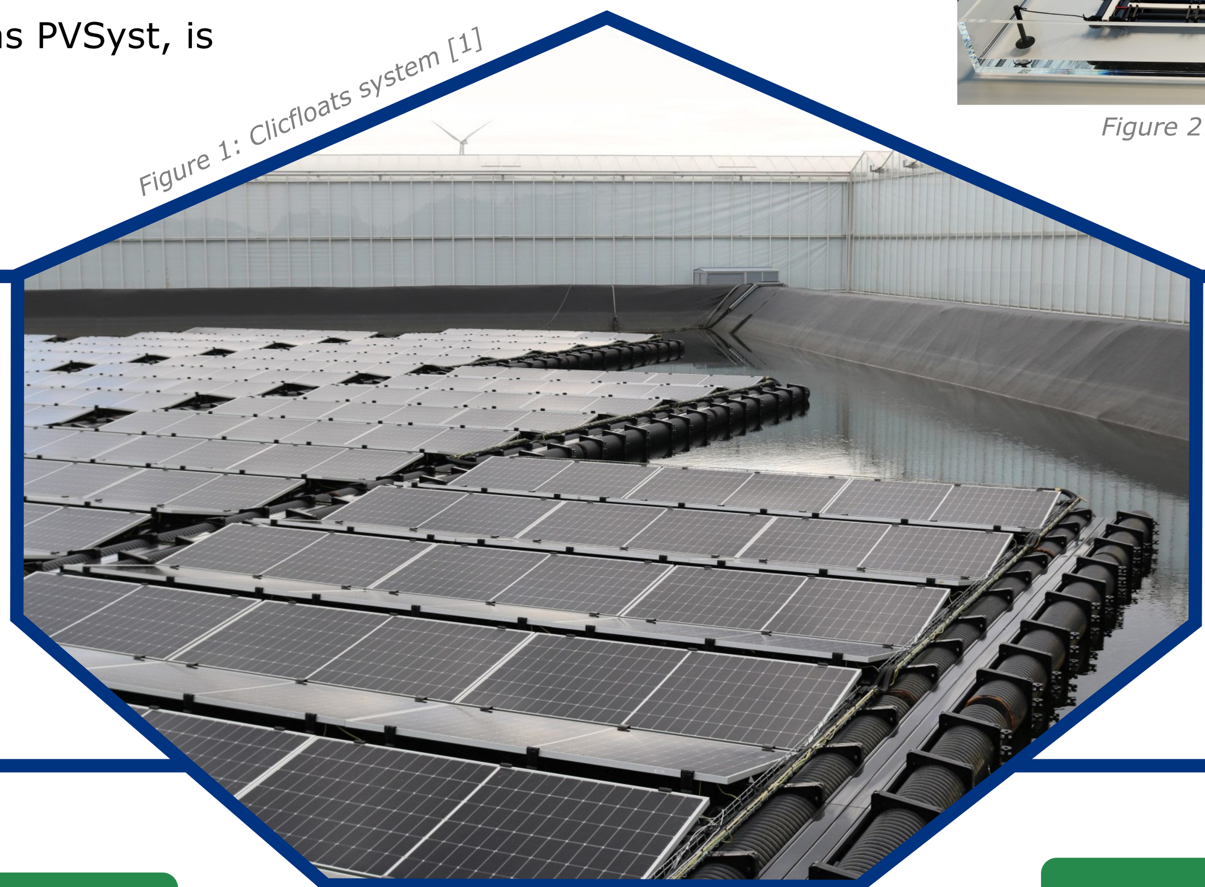

Figure 1: Clicfloats system [1]

Clicfloats Project 600, shown in Figure 1, is the system on which the simulations and data analysis are performed.

The floats used in the demonstrator are also inspired by the floats used in this system.

The partners that contributed to this project are:
VW Maxburg N.V., Connectum, Pulsar Power, imec and KU Leuven

Demonstrator

The design phase started by brainstorming to find ideas and exploring the possibilities. A CAD design was then made and evaluated after which the necessary parts were ordered or 3D printed. During the construction phase, the **table frame** was build and the **floats**, shown in Figure 2, were assembled. Finally, the **PV modules** were connected and the **measuring unit** was set up. The final demonstrator is a Clicfloats inspired FPV setup with working PV panels as can be seen in Figure 3.

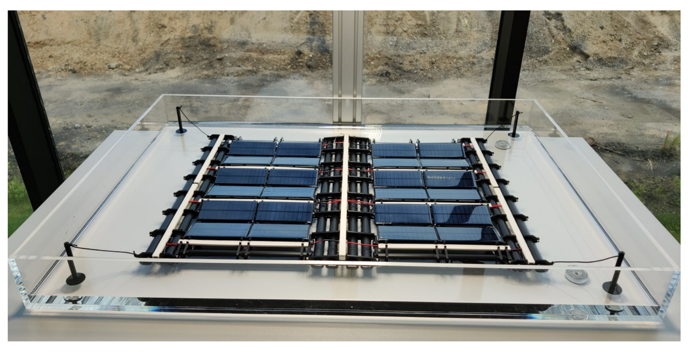

Figure 2: Close-up of the floats

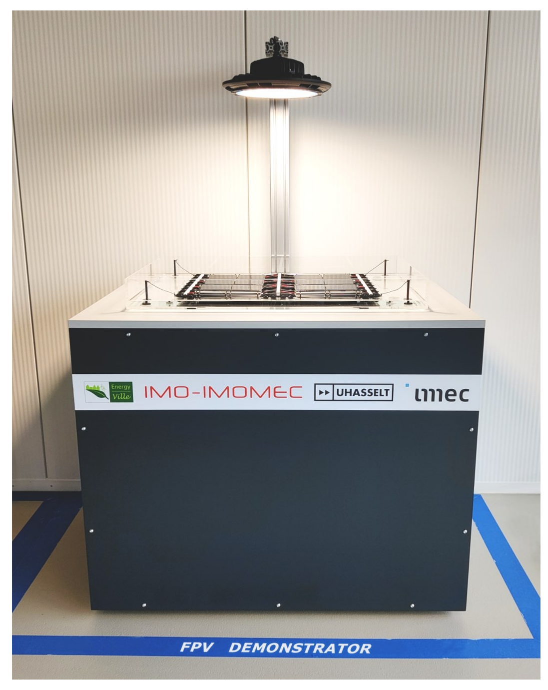

Figure 3: Final demonstrator

Data analysis

Two main **hypotheses** where analyzed:

- Does the **water temperature** influence module temperature?
  —> Figure 4 shows the correlation between module and water temperature.
- Does the **wind speed** influence module temperature?
  —> Figure 5 shows the correlation between module temperature and wind velocity.

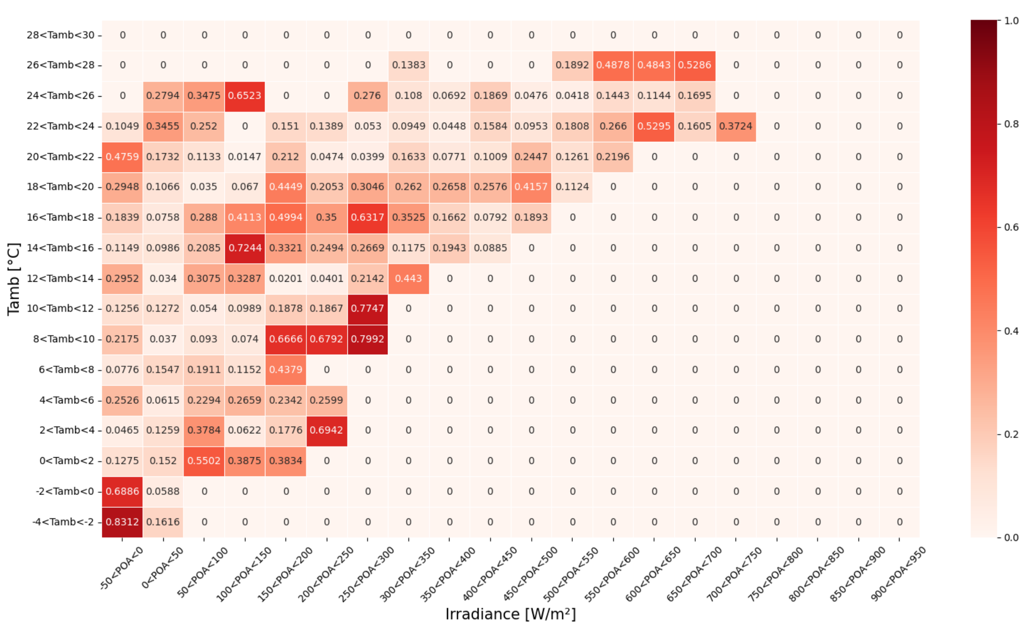

Figure 4: Heatmap showing the correlation between the module temperature and the water temperature for different ambient temperature and irradiance bins

After analysing this heatmap as well as the corresponding regression plots, it was concluded that **water temperature**, on its own, **does not have** a significant **impact** on **module temperature** in the Clicfloats system.

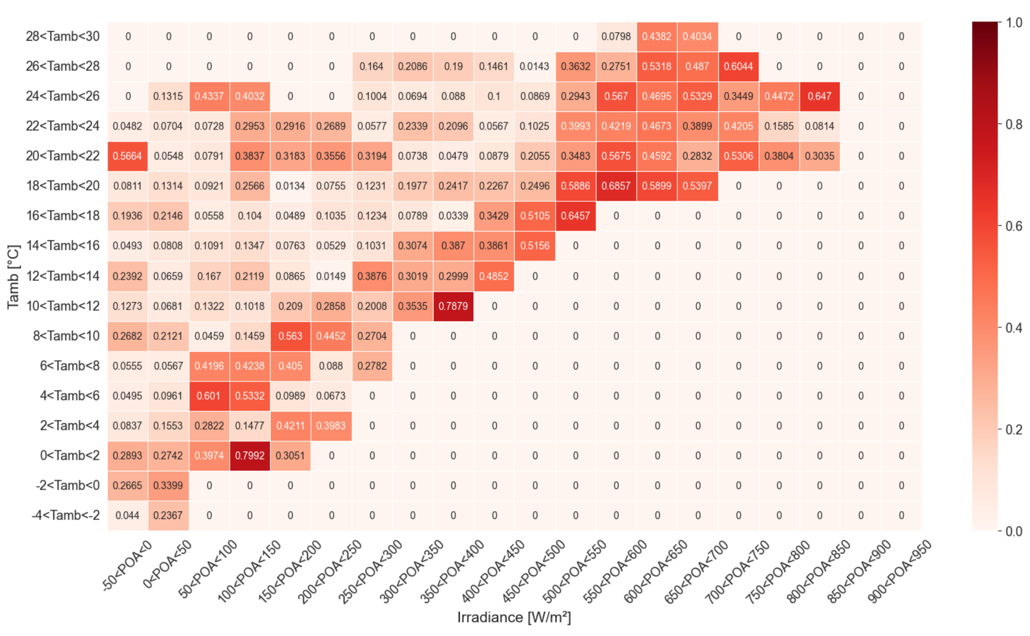

Figure 5: Heatmap showing the correlation between the module temperature and the wind velocity for different ambient temperature and irradiance bins

This heatmap clearly shows that a combination of **low ambient temperatures** and a respectively **high irradiance** creates a scenario where the wind velocity has a **higher correlation** with module temperatures. Studying the corresponding regression plots shows there is a negative correlation and thus wind velocity has a **positive impact** on module cooling.

Simulations

PVSyst is used to **simulate** the Clicfloats system over the span of **5 months**. The results are then **compared** with both the measured data and imec's own framework.

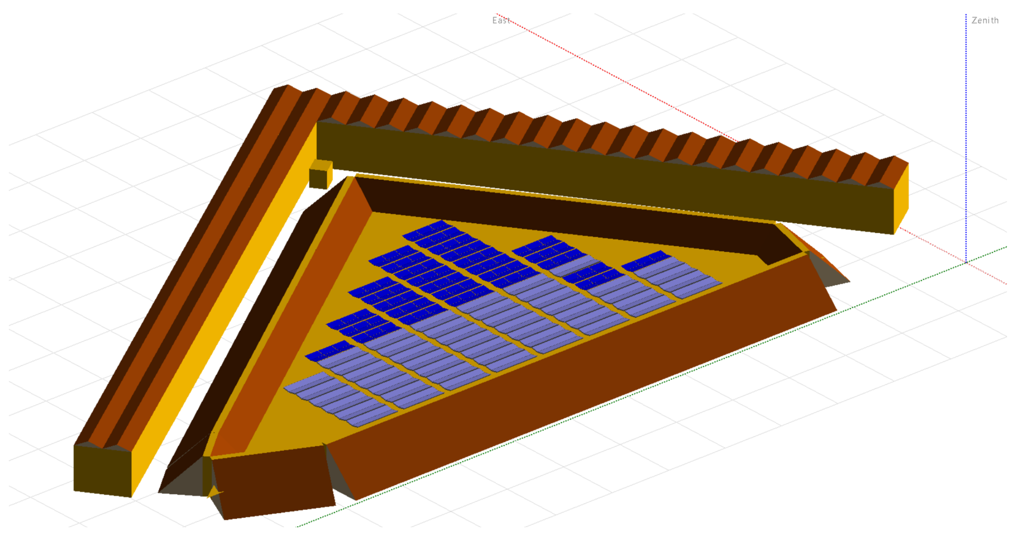

Figure 6: 3D model in PVSyst

Part of the PVSyst simulation is creating a **3D model** of the system to calculate the **near shading**. This is illustrated in Figure 6.

The comparison between PVSyst and imec's framework showed that both models **performed well** at simulating the Clicfloats system. This is visualised in Figure 7. They both underestimate the power output with a **mean bias error of less than 9%**. However, **PVSyst** did perform **slightly better** which is likely due to PVSyst underestimating the module temperatures and a poor shunt resistance calculation in the electrical model of imec's framework. This error in imec's framework is already being addressed and should be improved in the latest version.

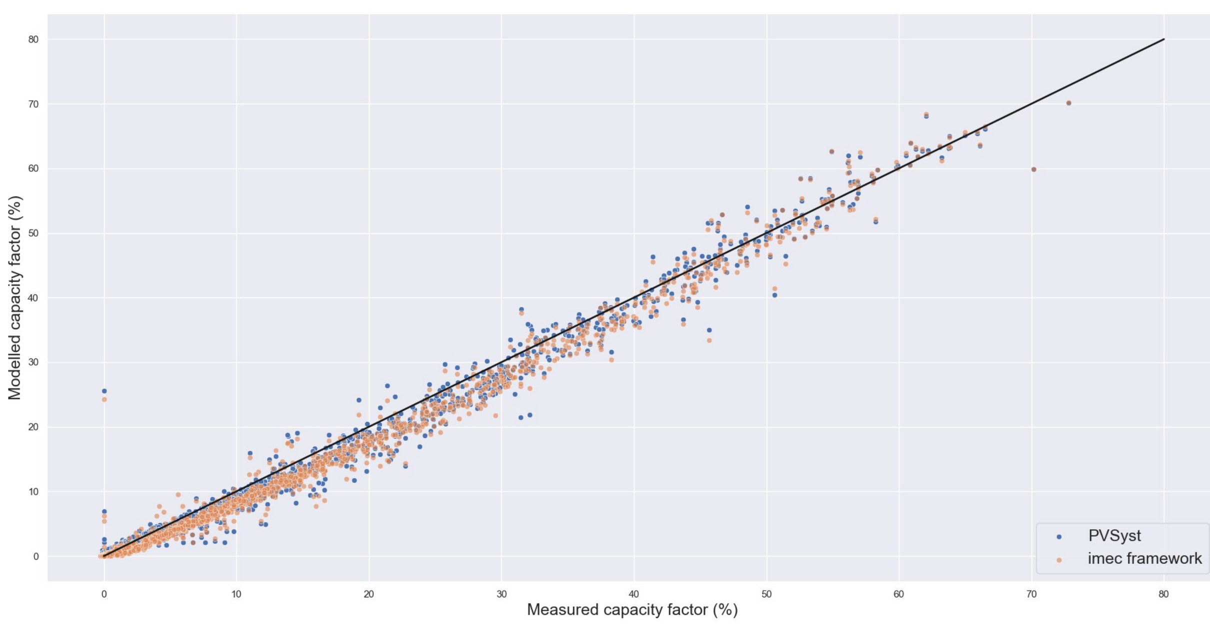

Figure 7: Comparison between PVSyst, imec's framework and the real data

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[1] "Clicfloats," *Connectum*. https://www.connectum.biz/clicfloats?lang=en (accessed Nov. 02, 2021).

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