Existing Field Performance Models Cannot Describe Perovskite Modules

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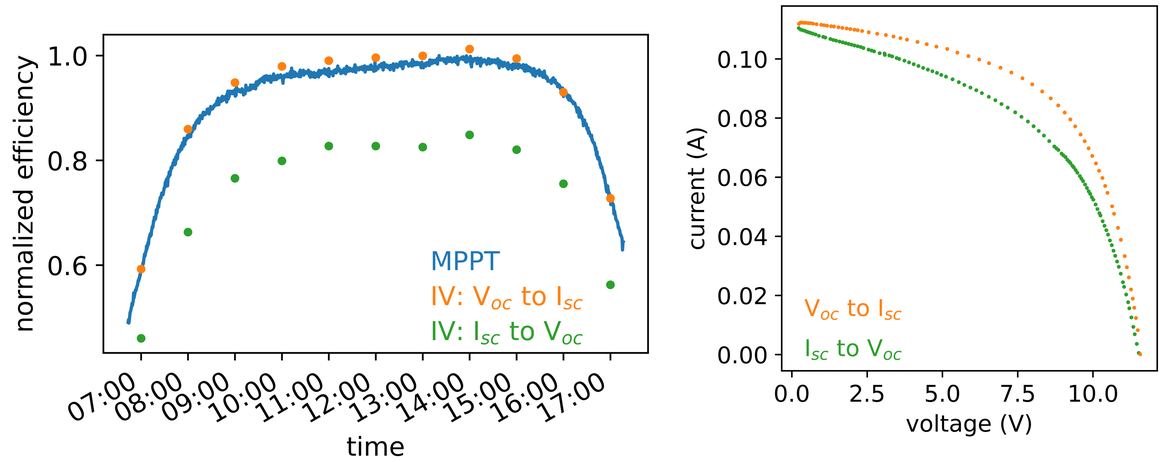
Summary

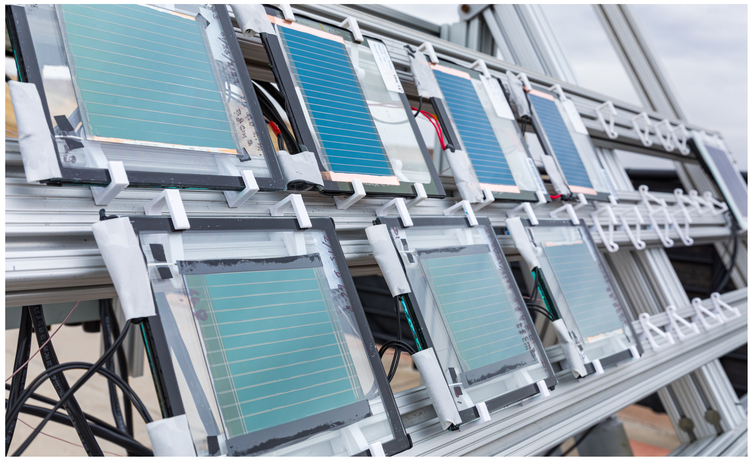
- Metal halide perovskites (MHP) have shown great promise achieving a module efficiency of 17.9%.
- MHPs behave differently than other commercialized materials. For successful commercialization, better understanding of real-world performance and durability is still needed.
- This poster shows outdoor testing data indicating that effects like daily metastability and hysteresis challenge energy yield models used for other technologies.

Key take aways

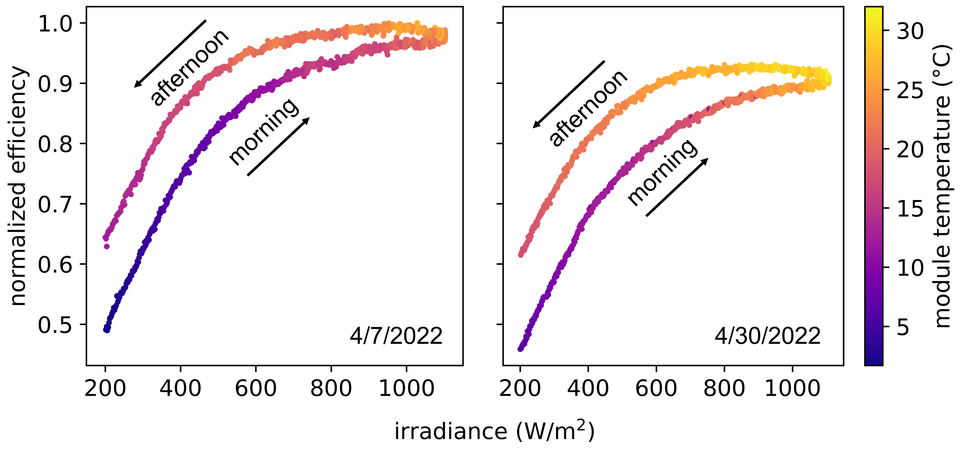
- IV curves are affected by hysteresis, maximum power point tracking (MPPT) is the most realistic way to assess performance.
- Daily metastability can have larger effects than temperature.
- Energy yield models capturing MHP-specific behavior are needed.



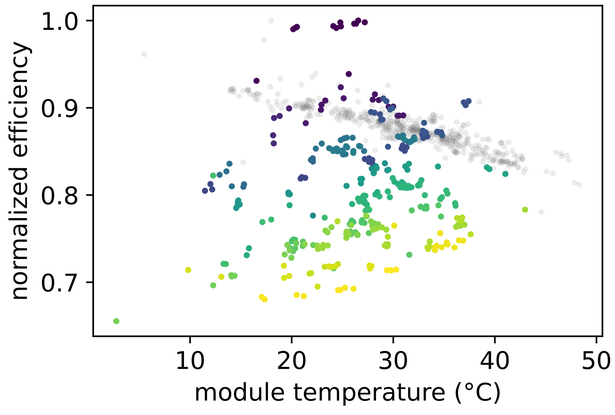
Perovskite modules can exhibit hysteresis on different time scales. Left: efficiency gradually increases during the high irradiance part of the day. This pattern is repeated day after day. Right: IV curves exhibit hysteresis depending on sweep direction. Maximum power extracted from the IV curves is also shown on the left. The maximum power that can be extracted under constant MPPT is slightly lower than that determined with the V_{oc} to I_{sc} IV curve.



PACT has been testing Perovskite modules outdoors since early 2022. The modules are individually monitored and maximum power point tracked (MPPT), with periodic IV curves. The MPPT perturb and observe update interval is set to 1 s (fairly slow) to account for the slow response of the modules.



Plotting efficiency vs. irradiance for two single days also shows the gradual daily performance increase. This effect is larger than any decrease in efficiency due to the warmer temperatures that occur in the afternoon. Effects like this are not universal, different formulations may behave differently.



Efficiency vs. module temperature near 1000 W/m^2 irradiance over the course of a module's outdoor deployment. Color indicates time, with purple being earlier. Degradation of the module is apparent. Gray points are for a Si module.

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