Energy performance of different photovoltaic technologies in real outdoor conditions at Ecole Polytechnique

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Introduction

- A study of the energy performance of different photovoltaic (PV) module technologies under real outdoor conditions at Ecole Polytechnique.
- Crystalline silicon (c-Si), Heterojuntion with Intrinsic Thin layer (HIT) and micromophous silicon (a-Si/mc-Si) are 3 PV module technologies which were investigated in this study.
- The data was collected from PV platform at SIRTA with 6 months data for HIT and more than 1 year for c-Si and a-Si/mc-Si.

PV platform at SIRTA

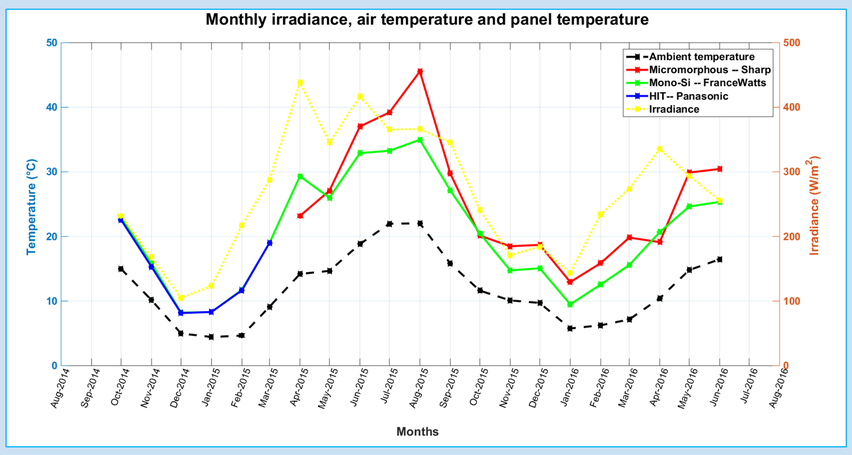
a-Si/mc-Si	C-Si	CIS	HIT	CdTe
P_M^{STC} = 128 W	P_M^{STC} = 250 W	P_M^{STC} = 150 W	P_M^{STC} = 240 W	P_M^{STC} = 82.5 W
η* = 9.5%	η = 15%	η = 12.2%	η = 19%	η = 11.4%

η*: Efficiency

Daily data calculated from the measurements

- Daily energy: $E_{daily}(Wh) = \int_{sunrise}^{sunset} P_M(t).dt$
- Daily irradiation: $H_{daily}(Wh/m^2) = \int_{sunrise}^{sunset} G(t).dt$
- Daily yield: $Y_{daily}(Wh/Wp) = \frac{E_{daily}}{P_M^{STC}}$
- Daily reference yield: $Y_{daily}^R(Wh/W) = \frac{H_{daily}}{G_{STC}}$
- Performance ratio: $PR(\%) = \left(\frac{Y_{daily}}{Y_{daily}^R}\right).100$
- Daily efficiency: $\eta_{daily} = \frac{E_{daily}}{H_{daily}.Area}.100$

Monthly mean daytime temperature and irradiance

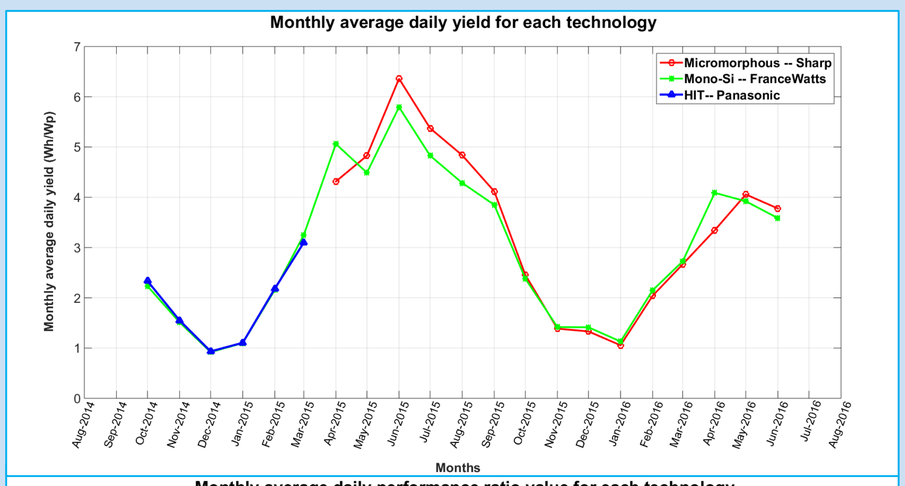


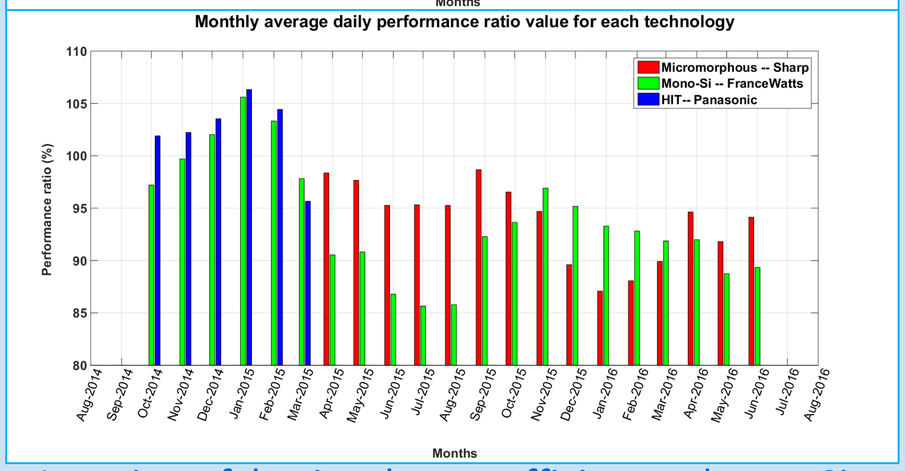
Overall, there is a similar fluctuation of irradiance, air temperature and PV temperature.

The ambient temperature varies from 3°C in winter to 22°C in summer.

PV temperature of a-Si/mc-Si module is higher than HIT and c-Si.

Energy performance results



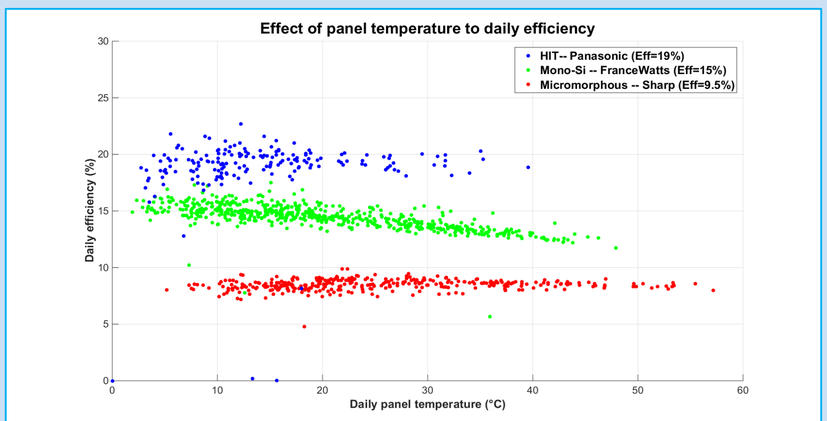


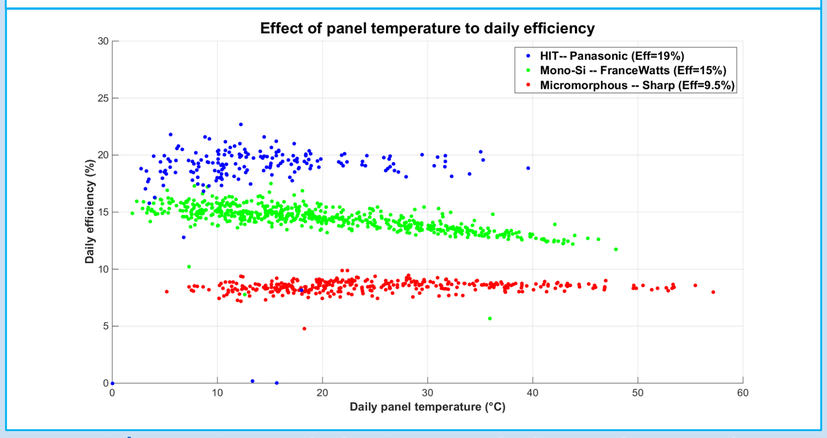
Although the monthly average daily yield is very similar for all modules (follow the trend of irradiance), their performance ratio (PR) are very different.

HIT and c-Si modules have higher PR values for winter months, while a-Si/mc-Si module has higher PR values for summer months.

In spite of having lower efficiency than c-Si and HIT modules, the obtained result illustrate that a-Si/mc-Si module performs better under real outdoor conditions.

Effect of temperature and irradiance





The daily efficiency is strongly dependent on the temperature for the c-Si module and lower dependence in the case of HIT.

All the modules have greater daily efficiency at low irradiance than the high ones due to the effect of temperature that is correlated with irradiance.

a-Si/mc-Si module is much less dependence on the temperature and irradiance.

Conclusion

The comparative energy performance was studied with 3 different PV module technologies under the same conditions at Ecole Polytechnique.

Under real conditions, the daily efficiency is strongly dependent on temperature and irradiance for c-Si, lower in the case of HIT and a-Si.

Moreover, with these conditions, c-Si and HIT modules present better performance for winter months while a-Si module performs better in summer and it shows the best energy performance in this study.

References

C. Cañete, J. Carretero, M. Cardona, “Energy performance of different photovoltaic module technologies under outdoor conditions”