Pitfalls of Energy Yield Prediction Models Based on Time 0 and STC Module Characterization

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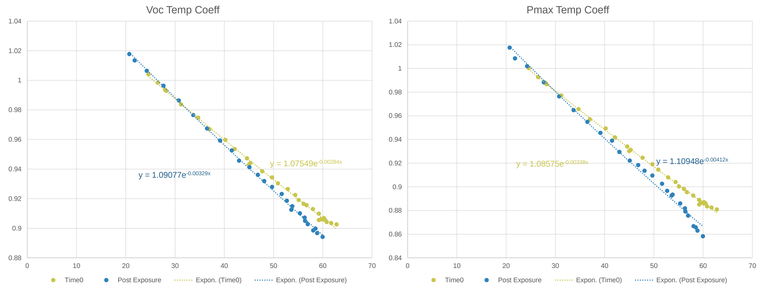
Abstract

- Many parameters are required for generating prediction models. While these models are quite sophisticated, the output is only as good as the input. Module manufacturers are responsible for developing a module PAN file. This file is used by PVSYST to predict energy yield for the lifetime of a system. Some of these input parameters include temperature coefficients, operating temperature, module mismatch, performance verses irradiance, Rseries and Rsh, angle of incidence modifier, and initial degradation rate. These parameters can be tested and real characterization results can be used to generate the most practical and accurate PAN files possible. However, many of these parameters can change upon exposure. In some cases, these shifts can occur within the first year or less causing the energy yield predictions for the remaining 24yrs to be less than accurate. Furthermore, especially in thinfilm modules, specific care must be taken to prevent metastability in the module performance to give erroneous results. In this paper we will discuss real world energy yield compared to modeled energy yield for several PV systems and show where the models have fallen short as a result of actual parametric shifts in module characteristics upon exposure.

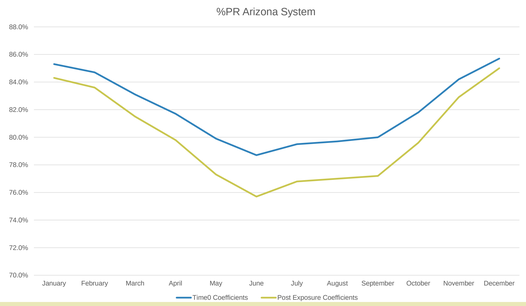
Temperature Coefficients

- Temperature coefficients (alpha, beta, and gamma) are used to model system level energy yield for various climates and seasons.
- Temperature Coefficients can change upon outdoor exposure.



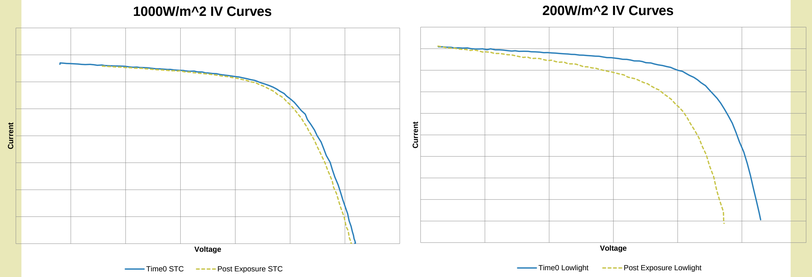
Impact to Modeling

- After exposure, less than 6 months in this case, the temperature coefficents degraded for both Voc and Pmax.
- The impact of this shift in temperature coefficients will result in significant loss in energy yield (predicted and actual) for this Arizona system.



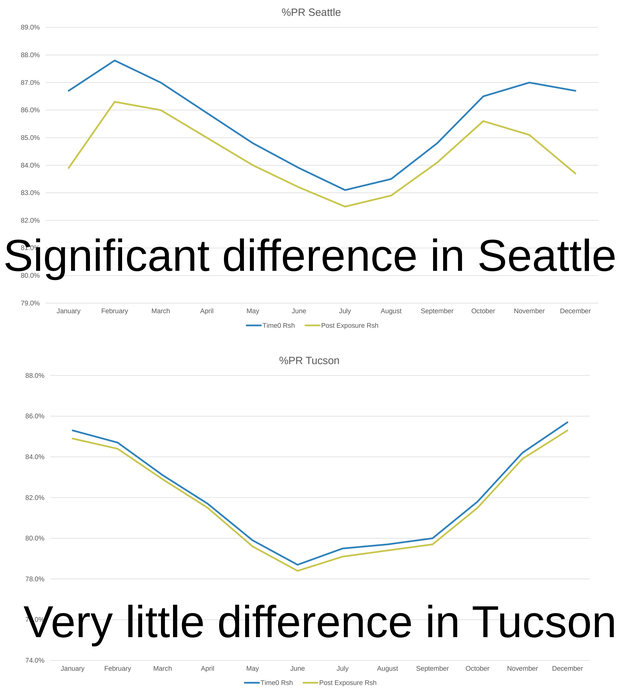
Performance vs Irradiance

- PVSYST PAN files include the modules performance vs irradiance characteristics.
- This is primarily dependent on the module Rsh at various light levels and fit with an exponential.
- Some degradation mechanisms drastically change the module Rsh after outdoor exposure.
- This degradation in Rsh may only be evident in lowlight conditions.



Impact to Modeling

- Adjusting the Rsh vs Irradiance exponential in the PAN file to more accurately represent post light soaked characterization is important in energy yield predictions for cloudier climates.

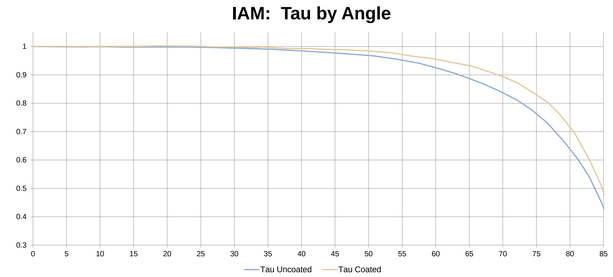


Significant difference in Seattle

Very little difference in Tucson

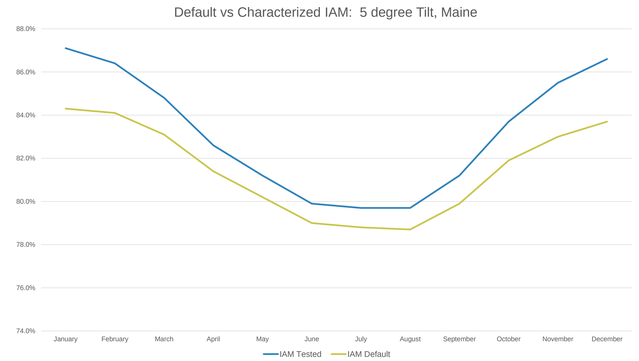
Incident Angle Modifier

- The Incident Angle Modifier (IAM) is used in PVSYST to model performance at various angle of incidence (AOI).
- Manufacturers that use AR coatings or have surface structure should test IAM to get a more accurate performance vs AOI.
- These coatings and surface structures may change with exposure or significantly impact soiling and should therefore be tested post exposure.



Impact to Modeling

- Characterizing IAM can make a significant difference to energy yield predictions, especially for installations that are not at optimum tilt



Conclusions

- Generating accurate PAN files for PVSYST energy yield modeling is important for ensuring energy yield predictions and installation financials are as sound as possible.
- Many inputs into module PAN files have been shown to change with time and exposure.
- Characterizing PAN file parameters after real world exposure can make a significant difference in modeling results.
- PAN file characterization should be done periodically, as certain shifts in materials and/or processes may change these performance behaviors as well.