Area 7: Performance and Reliability of PV Modules

OPTIMISED FITTING OF INDOOR (E.G. IEC 61853 MATRIX) AND OUTDOOR PV MEASUREMENTS FOR DIAGNOSTICS AND ENERGY YIELD PREDICTIONS

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The IEC 61853 Matrix method defines taking PV performance measurements at 23 different irradiance and module temperature pairs. The points need to have interpolated curves to predict energy yield at arbitrary irradiances and temperatures. Previously this has been done by bi-linear interpolation but this is not ideal as it is between curved lines with no understanding of random errors. Many different empirical PV performance models have been studied for their accuracy fitting matrix points. Some empirical models have coefficients that are unphysical and result in poor fits to data by e.g. forcing the module to have a non-constant gamma factors or poor fitting at low and high light levels. An optimized "Mechanistic Performance Model" [1] (MPM) equation 1 has been developed and validated on a wide range of indoor and outdoor data. The MPM uses up to 6 normalised coefficients and has been tested on c-Si, CIGS and CdTe measurements.

MPM: $PR_{DC} = C_1 + C_2 * dT_{MOD} + C_3 * Log_{10}(G_I) + C_4 * G_I + C_5 * WS + C_6 / G_I$ **(1)**
(where G_I = Irradiance kW/m^2; $dT_{MOD} = T_{MOD} - 25$; WS = windspeed ms-1)

With only 23 points in the matrix method great care must be taken to understand systematic and random errors so they do not affect the fit and hence the predicted energy yield. Examples of MPM fits to 4 different Matrix measurements and two models (SAPM and PVSYST) are shown. Note they do not all have the same irradiance and temperature values as defined in IEC 61853 expected but the MPM can fit any measurements indoor and outdoor. Comments on each fit are

N2: ASU slight random scatter in the measured dots c-Si (mesh calibration?) but a good fit rms=0.5%
N27: ISPRA mc-Si rms=0.26%, slight deviation at 0.1kW/m2 measurement
N29: ISPRA rms=0.2% to a CdTe module with lower gamma and poorer low light than the c-Si shown here.
N10: Sandia c-Si rms 0.2% low scatter and good low light level values.
N23: Very close fit rms=0.01 to modelled data for a c-Si from the Sandia Array performance model
N24: Rms 0.26% to a PVSYST 1-diode model of a CdTe. Slight disagreement in Gamm a at low light

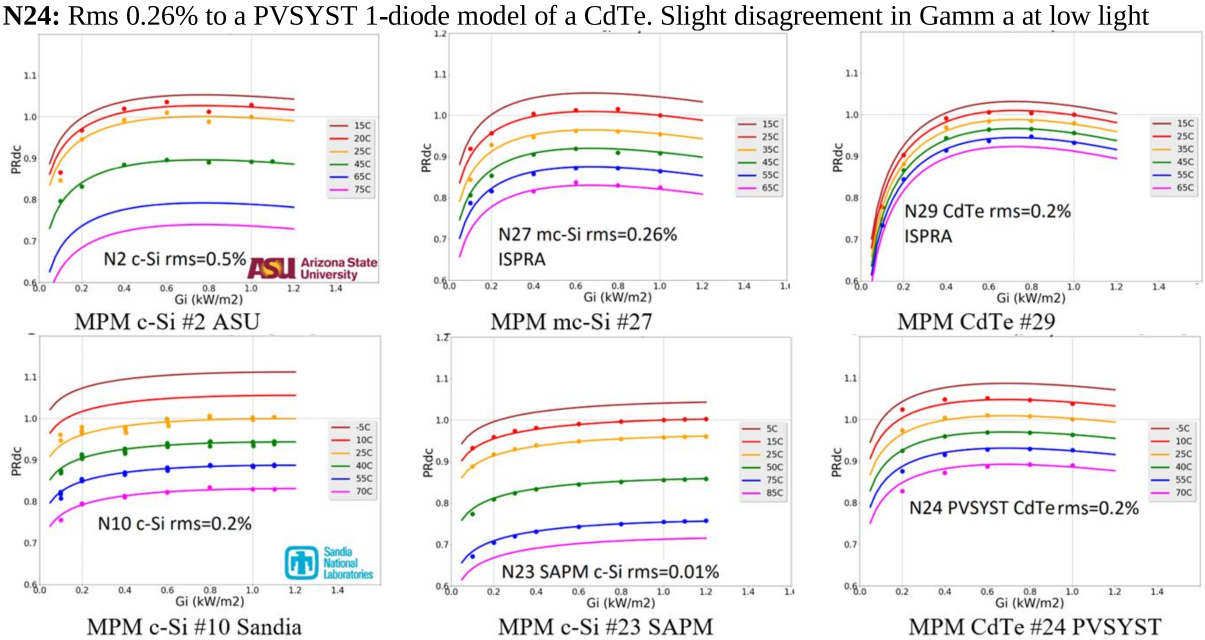

Figure 1: MPM fits of PR_{DC} vs G_I and T_{MOD} to 4 Matrix measurements; SAPM and PVSYST models.

Gantner Instruments [2][3] have added this MPM analysis method to their Outdoor Test Facility (individual module) and their large power plant measurements and this will be fully described and illustrated in the final presentation

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References:

[1] Choosing the best empirical model for predicting energy yield; PVPMC7 Supsi 2017
[2] http://www.gantner-webportal.com
[3] Optimized PV Performance using State of the Art Monitoring for Increased Asset Value PVPMC8 2017