UNCERTAINTY ANALYSIS OF SOLAR PHOTOVOLTAIC ENERGY YIELD PREDICTION

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Introduction

The uncertainty of commercially available PV system performance models is not published with the models, so the onus is currently on the system developer to try to quantify this uncertainty, albeit with limited available information. Indeed many developers may be unaware of the magnitude of uncertainty. Therefore it is imperative for the PV industry to

- Accurately quantify the uncertainty in performance predictions
- Identify the major sources of uncertainty & develop more accurate models
- Clearly publish performance uncertainty with software tools.

To make further improvements in the accuracy of E_{YIELD} models, a greater understanding of the uncertainties in individual parameters is needed. This poster reports on a comprehensive survey of model parameter tolerance data. This data will inform a better understanding of the uncertainty in PV performance prediction and identify how the accuracy of performance prediction can be improved.

Uncertainty in Irradiance data

In analysis at CREST, Classic PVGIS had a lower average percentage difference in comparison to measured data in average daily irradiation throughout the year (7.64%) than Meteonorm (9.84%). However for annual total irradiation, Meteonorm varied from measure data by only 0.45%, compared with 7.7% for classic PV GIS [1]. MeteoNorm data is usually averaged from 10 or 20 year datasets, longer datasets will not increase accuracy due to the long term trend for increasing global irradiance, as shown in Figure 1.

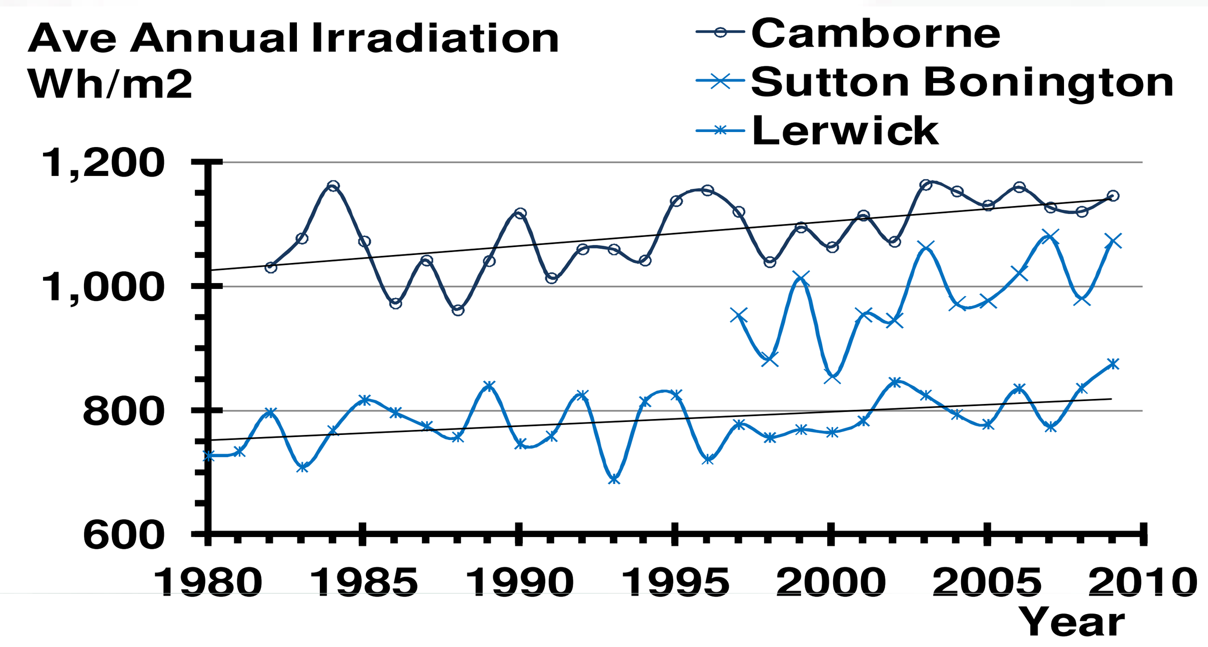


Figure 1 Long term trends for Diffuse Irradiance in the UK from measured data

The diffuse component of irradiance is reducing; (therefore the direct portion must be increasing , if overall global irradiance is increasing) (Figure 2).

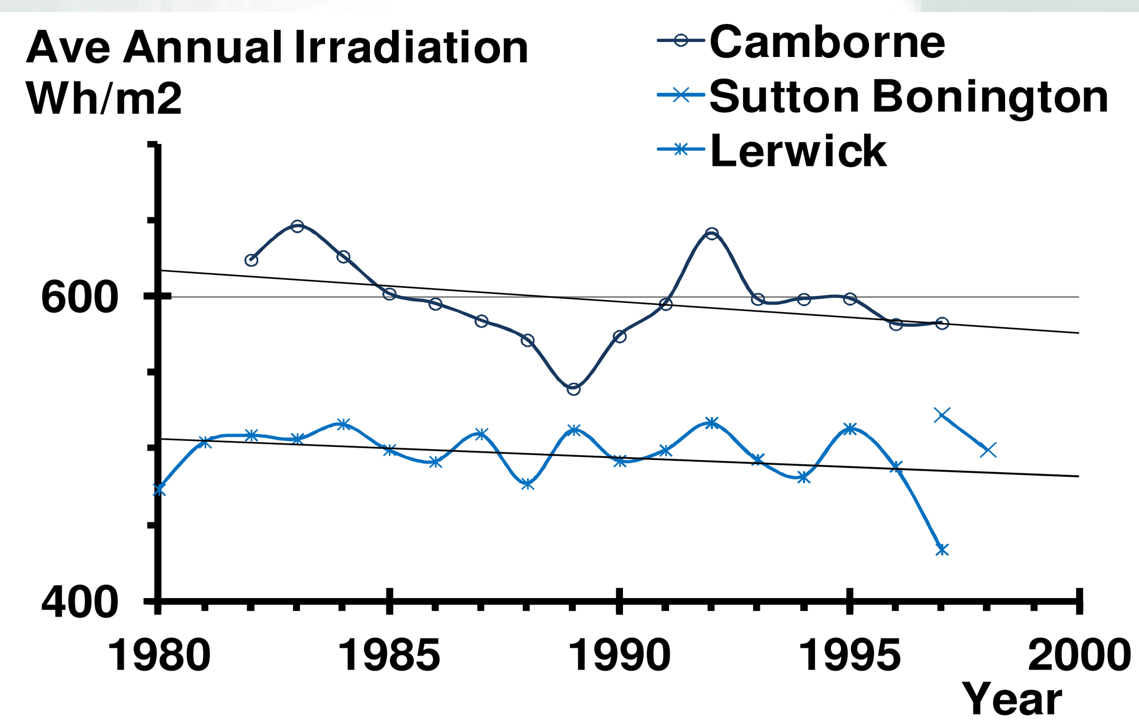


Figure 2 Long term trends for Diffuse Irradiance in the UK from measured data

Uncertainty in module power

PV module datasheets typically only give tolerances for the maximum power at STC (P_{MPP}) and not for the other parameters. However IV translation using the single diode model also requires the current and voltage at maximum power point (I_{MPP} and V_{MPP}) and the short circuit current (I_{SC}). Flash test data for 4800 PV modules from 6 different manufacturers was analysed to identify any relationships between the deviation in the different parameters. Figure 3 shows the frequency distribution of the % deviation of the flash test results away from the datasheet P_{MPP}

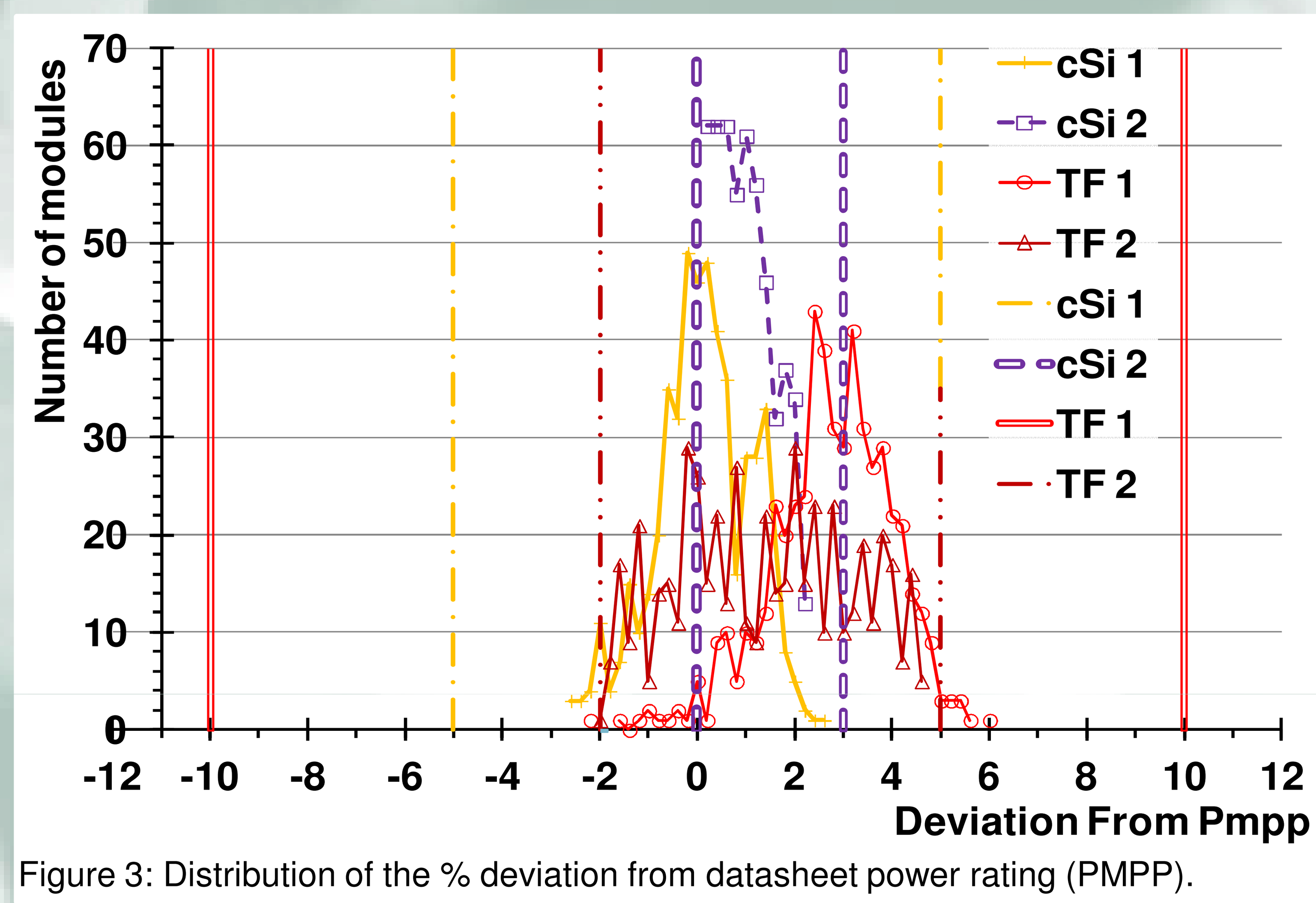


Figure 3: Distribution of the % deviation from datasheet power rating (PMPP).

Uncertainty in AC voltage

The nominal AC supply voltage in the UK is 230V +10%-6% (formerly 240V+/-6%). Voltage data from 8 properties with solar PV systems was analysed to quantify the actual voltage range.

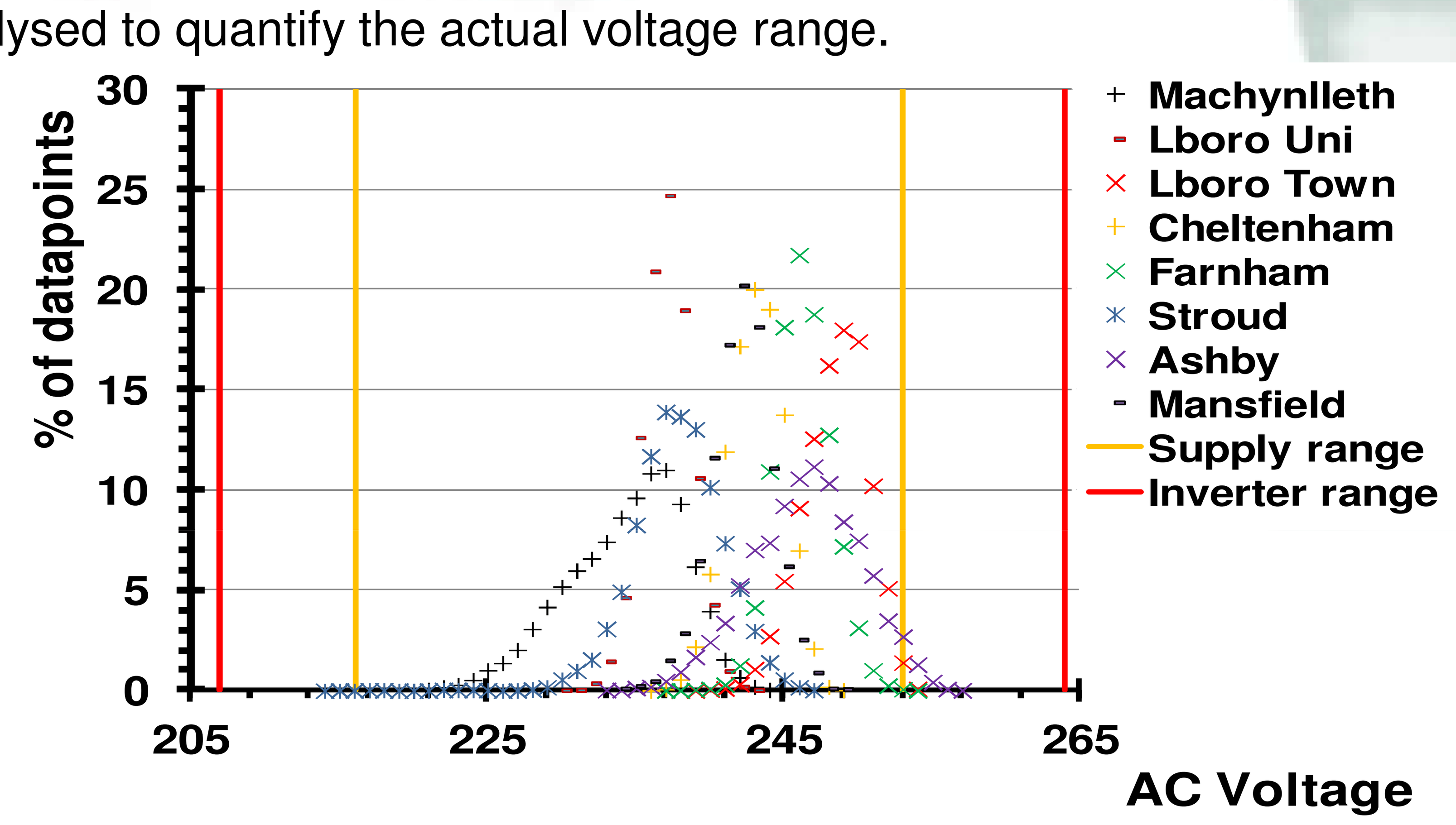


Figure 4: Distribution of AC Voltage for 8 locations in England and Wales [2].

The results for individual sites are shown in Figure 4. The sites can be divided into 2 classes, those averaging around 238V and those averaging around 245 volts.

The sites averaging 245 volts are all small residential properties connected directly to the LV utility network. Whereas those averaging 238V are special cases, either large sites with private networks or other non-standard installations. Better information about the supply voltage would enable improved value engineering of cable costs by designers rather than following a one size fits all specification, in this case the maximum 1% voltage drop [3].

[1] A. Thirkill, Personal communication, Loughborough, UK: CREST, Centre for Renewable Energy Systems Technology, 2011.

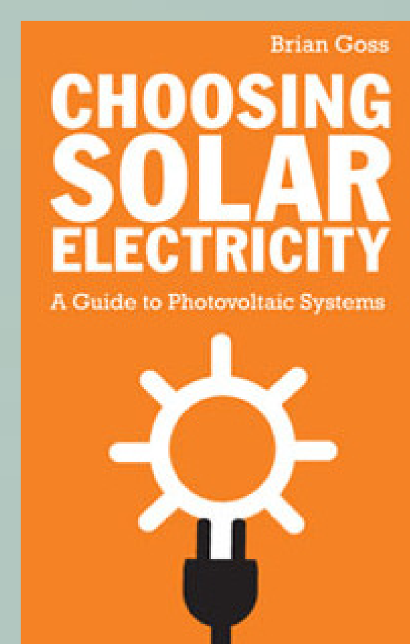
[2] Data courtesy of Nick Mills (Dulas Ltd); Jaise Kuriakose (Centre for Alternative Technology); Carl Benfield (Prescient Power Ltd); Shiva Beharrysingh and Murray Thompson (CREST)

[3] Sundog_Energy, Halcrow_Group, and Energy_Saving_Trust, "Photovoltaics in Buildings Guide to the installation of PV systems 2nd Edition," 2nd ed. London: UK Government, 2006.

Recommendations & Conclusions

Developers of PV systems need better information about the uncertainties in E_{YIELD} predictions in order to reduce the cost of financing systems. More information about PV module tolerance is required for accurate modelling; therefore PV module datasheets need to show tolerance values for I_{MPP}, V_{MPP} and I_{SC} in addition to the tolerance given for P_{MPP}. At present this information can only be deduced from flash test data of large batches of PV modules.

Analysis of AC voltage data, suggests there are 2 distinct classes of AC connection type, A) small properties with direct connection to the utility network B) Special cases (large sites with private networks or other non-standard installations). This classification would allow the user of PV modelling software to select connection type, and enable more accurate E_{YIELD} modelling and better inform cable sizing decisions. Models currently use the nominal AC voltage (230V) for modelling.



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