I-V curve statistic package

The I-V curve contains useful electrical data on solar cell or commercial module performance. Typically, to analyze these shapes researchers turn to physics-based models. The single diode model is one physical model that explains the I-V well, but implicit in any model are the assumptions of validity. For example, bypassed substrings are typically removed from study because they do not fit a model easily. As we show below in the figure, non-ideal curves (with bypass diodes on) are useful and an element of the real-world that should not be excluded.

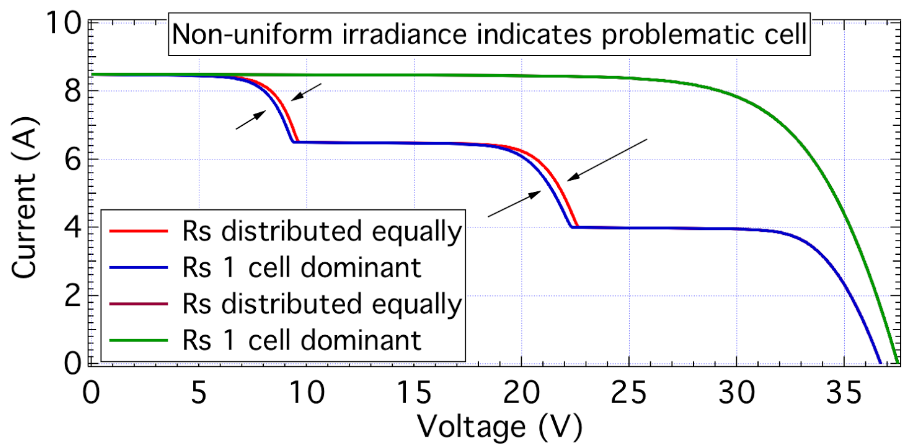

Figure 1. A simulation of a 60 cells PV modules using a numerical engine and circuit solver tool shows that, it is not possible to resolve the differences in I-V, Pmp datastreams where the Rs is equivalent but distributed equally over 60 cells, or concentrated in 1 cell, unless the irradiance is nonuniform as in soiling, or snow cover. According to these results we should find a method of finding the bypass diode turn-on voltage very precisely.

From Solar Durability and Lifetime Extension (SDLE) center's outdoor PV module test facility -- SDLE SunFarm, we have acquired over 1 million I-V, P_{mp} datastreams over 500 days. Hence automated algorithmic analytics are a necessity. The real-world is plagued by non-idealities, but according to the simulation shown above, we can extract information from these data, such as the variance in cell behavior. Indeed, simply counting the number of bypassed curves over time is useful in determining if substrings have deteriorated away from the norm. Non-uniform irradiance is caused by e.g. snow cover, soiling, shading, etc. and is present in the real world, as shown in Figure 2.

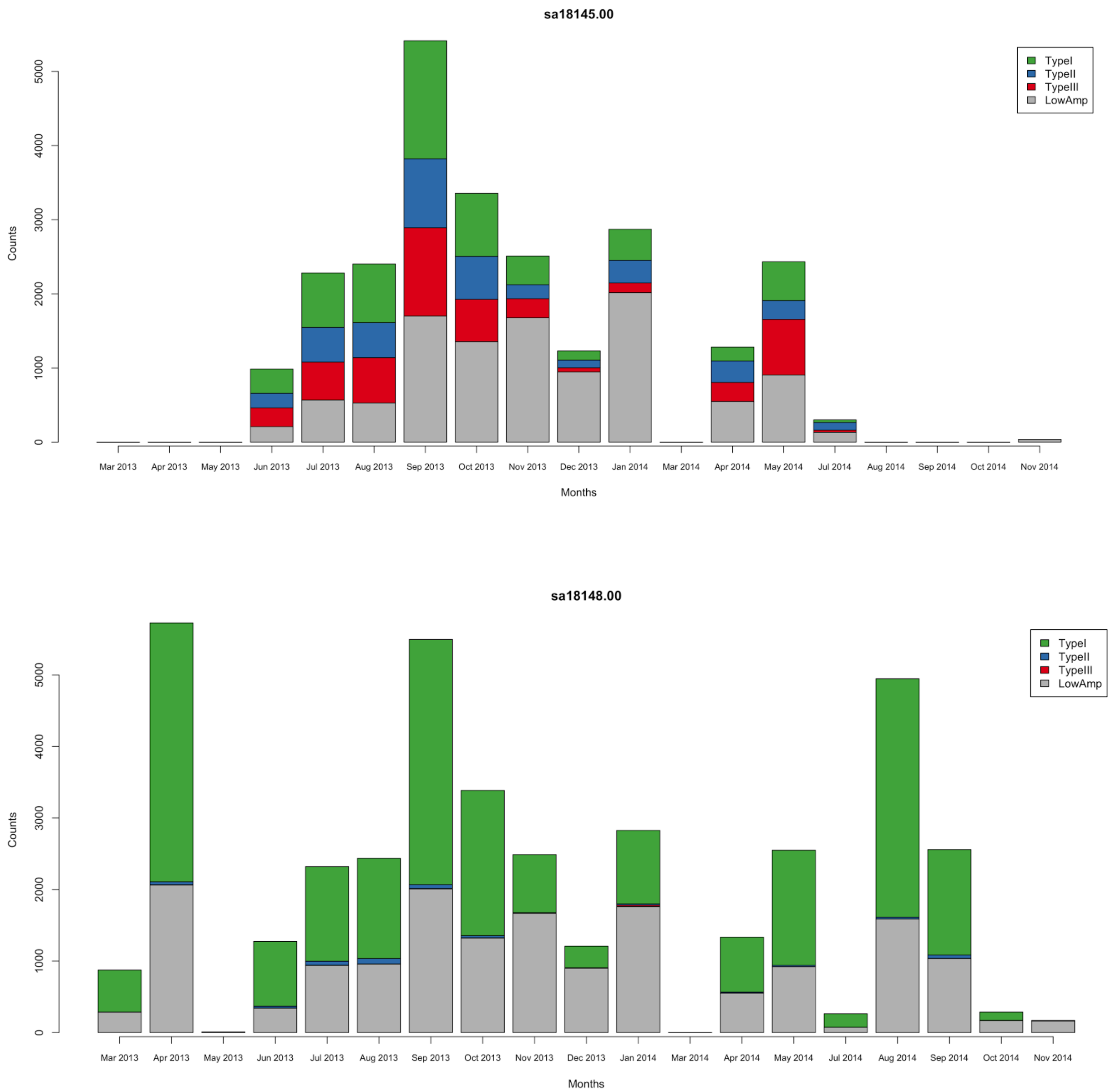

Figure 2. Automated change point detection classifies curves by bypass diode turn on. Two modules indicate varying degrees of non-uniformity over time by histogramming the number of Type I, II, and III curve features.

The I-V curve statistic package can automatically classify I-V, P_{mp} datastreams by the number of change points, or bypassed strings. Type I curves show 0 change points, Type II show 1, and Type III show 2. For the first time, to our knowledge, we can automatically process preliminary diode model parameters on non-uniformly illuminated I-V, P_{mp} datastreams and extract the shunt resistance of each substring and bypass diode turn on voltage. The method was developed by simply fitting an I-V, P_{mp} datastream to a moving local regression model and seeking points where the local error function spikes - the change point is identified and captured.