Impact of measured spectrum variation on solar photovoltaic efficiencies worldwide

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Abstract

In photovoltaic power ratings, a single solar spectrum, AM1.5, is the de facto standard for record laboratory efficiencies, commercial module specifications, and performance ratios of solar power plants. More detailed energy analysis that accounts for local spectral irradiance, along with temperature and broadband irradiance, reduces forecast errors to expand the grid utility of solar energy. Here, ground-level measurements of spectral irradiance collected worldwide have been pooled to provide a sampling of geographic, seasonal, and diurnal variation. Applied to nine solar cell types, the resulting divergence in solar cell efficiencies illustrates that a single spectrum is insufficient for comparisons of cells with different spectral responses. Cells with two or more junctions tend to have efficiencies below that under the standard spectrum. Silicon exhibits the least spectral sensitivity: relative weekly site variation ranges from 1% in Lima, Peru to 14% in Edmonton, Canada.