Consensus International Solar Resource Standards and Best Practices Development

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Abstract

- Standardization and best practices of data sets and models enable the solar energy industry to develop widely accepted protocols adapted to various stages of solar project development and operations.
- In collaboration with the International Energy Agency (IEA) Photovoltaic Power Systems (PVPS) Programme Task 16 and ASTM's radiometry subcommittee, the National Renewable Energy Laboratory (NREL) developed and regularly updates the *Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications*.
- Having a common terminology, common methods, and/or awareness of national and international best practices can lead to accurately quantifying the available solar resource and consequently assists in estimating the long-term performance of a given solar power plant by reducing deployment cost, bankability risks, and financing costs.

International Standards Activities

The development of consensus standards and handbooks for solar resource modeling and measurement includes various topics, such as:

- Calibration, measurement, application, and data processing
- Developing and providing guidelines or standard procedures for establishing data uncertainties
- Developing and validating test procedures for optical radiation applications
- Undertaking best practices measurement activities at selected high-value sites around the United States for benchmarking
- Understanding resource variability, solar resource modeling, and forecasting methodologies.

- NREL has been actively leading and participating in the IEA PVPS Programme Task 16.
- NREL leads the ASTM G03.09 radiometry subcommittee, which is under ASTM Committee G03: Weathering and Durability.
- NREL is also a U.S. Technical Advisory Group in the International Organization for Standardization (ISO)/Technical Committee (TC) 180/SC 1 Climate - Measurement and Data.

Fig. 1. Standards and best practices activities.

Some Standards and Uses

ASTM G167-15 Standard Test Method for Calibration of a Pyranometer Using a Pyrheliometer: This standard [1] details two types of calibration methods: one involves a self-calibrating, absolute cavity radiometer, similar to NREL's Broadband Outdoor Radiometer Calibration (BORCAL) method (Fig. 2), whereas the other uses a secondary reference pyrheliometer as the reference standard as defined by the World Meteorological Organization and ISO 9060 [2].

Fig. 2. NREL's BORCAL method, which involves a self-calibrating, absolute cavity radiometer (left) and a diffuse pyranometer on a tracker (right). Photos by NREL

ASTM G138-12 Standard Test Method for Calibration of a Spectroradiometer Using a Standard Source of Irradiance: In this standard, reference lamps that are traceable to national metrological institutes (NMIs) are used to calibrate spectroradiometers for the measurement of spectral irradiance. According to this standard, each NMI shall participate in intercomparisons of the spectral irradiance standards [3]. NREL's ISO 17025 spectral calibration accreditation depends on this standard (Fig. 3).

Fig. 3. NREL's spectroradiometer calibration setup traceable to the National Institute of Standards and Technology: a tungsten-filament, 1,000-W quartz-halogen FEL (top), and a spectroradiometer (bottom) are used to calibrate a solar simulator. Photos by NREL

NREL is leading the revision of the *Best Practices Handbook for the Collection and Use of Solar Resource Data for Solar Energy Applications: Second Edition* [4]. The third edition of this widely used handbook, slated for publication at the end of 2020, will include current progress of solar resource measurement and modeling, progress in solar forecasting, and expert advice on various solar resource aspects of solar energy applications.

Fig. 4. Best Practices Handbook. <https://www.nrel.gov/docs/fy18osti/68886.pdf>

ISO 9060:2018 Solar energy – Specification and classification of instruments for measuring: The ISO/TC 180/SC 1 subcommittee recently updated ISO 9060:2018. That standard describes the available international specifications for the performance classification for instruments that measure irradiance [2].

ASTM G173-03(2012) Standard Tables for Reference Solar Spectral Irradiances: Direct Normal and Hemispherical on 37° Tilted Surface: This standard is widely used by the solar community to generate spectral clear-sky reference data for use in understanding absorbance, reflectance, and transmittance of solar energy materials [5].

Fig. 5. Global irradiance spectral distribution on various tilts according to ASTM G173 and G197 [6].

ASTM G177-03(2012) Standard Tables for Reference Solar Ultraviolet Spectral Distributions: Hemispherical on 37° Tilted Surface: Similar to ASTM G173, this standard contains a reference spectral irradiance, but it is limited here to UV wavelengths (0.28–0.40 µm). The specified spectral irradiance distribution has many applications, such as in exposure testing where light sources are evaluated against this reference [7].

Fig. 6. Global irradiance spectral distribution in the UV according to ASTM G173 and G177.

Conclusion

- NREL's effort supports the development of international consensus standards in solar measurement and modeling to represent the state-of-the-art knowledge through continuous formal engagement of various stakeholders.
- Standardization and best practices of data sets and models enables the industry to develop fair and widely accepted protocols for various stages of solar energy project development and operations, strengthen consumer confidence, and assist in refining the efficiency and durability of their products.

References

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