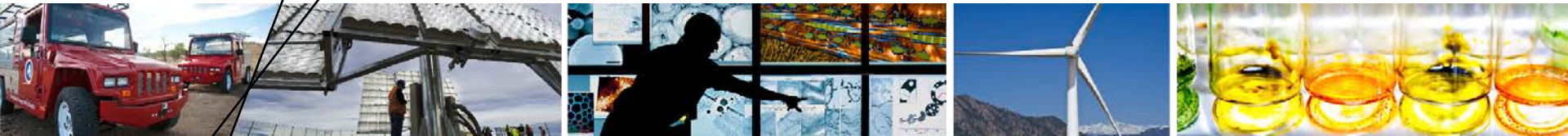


# Climatically Diverse Data Set for Flat-Plate PV Module Model Validations



**Bill Marion**

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Workshop  
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**NREL/PR-5200-58600**

# Background

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- **Work began in FY2011 to fulfill a FY2014 milestone for DOE's System Integration Technology Validation Project**
  - “Comprehensive data set, with low measurement uncertainty, of I-V curves and associated meteorological data for PV modules representing all flat-plate technologies and for weather conditions for three climatically different locations completed”.

# Intended Data Applications

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- **Validation of existing PV module models and/or the development of new models.**
- **Analysis of performance differences from climate.**
- **Data available to the public.**

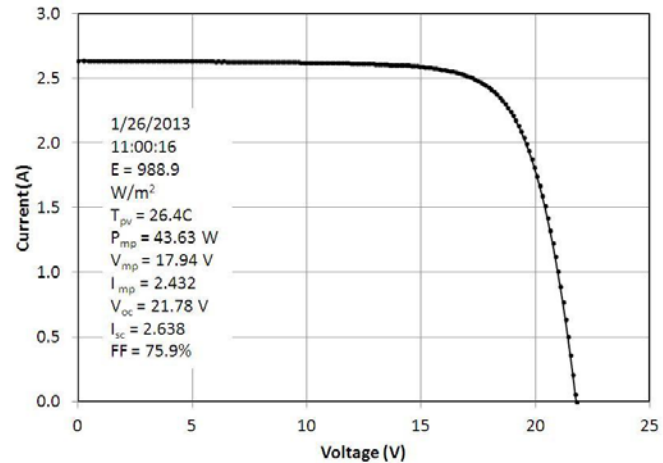
# Field Site Locations

- **Cocoa, FL**
  - Florida Solar Energy Center
  - Subtropical climate
  - Jan 2011 – Mar 2012
- **Eugene, OR**
  - University of Oregon
  - Marine west coast climate
  - Dec 2012 – Feb 2014
- **Golden, CO**
  - NREL
  - Semi-arid climate
  - Aug 2012 – Sep 2013



# PV Module Technologies Deployed

- single-crystal Si
- multi-crystal Si
- a-Si/x-Si HIT
- CdTe
- CIGS
- a-Si/a-Si and a-Si/a-Si/a-Si
- a-Si/nanocrystalline-Si tandem



# Data Measurements

- **PV Module Data**

- I-V curves ever 5 minutes
- Peak-power tracking 5-minute averages
- PV module back-surface temperature



- **Meteorological Data**

- POA irradiance with K&Z CM22 and LI-COR
- Direct normal, diffuse and global horiz. irradiance
- Wind speed and direction; dry bulb temperature; relative humidity; barometric pressure; precipitation

# Daily Operations

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- **Site**

- Daily maintenance, except weekends and holidays
- One of two identical PV modules cleaned for soiling assessment

- **NREL**

- Data retrieval and archiving
- Daily quality assessment of previous day's data

# Daily Quality Assessment

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- **Based on ISO 17025 procedures at NREL**
- **Automated checks each day with email notification**
  - Irradiance and other meteorological data
  - PV module temperatures
  - PV performance ratios
  - I-V curves acquired meet minimum and stable irradiance criteria



# PV Module Characterization

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- **Pre- and post-deployment baseline solar simulator measurements at STC**
- **Post-deployment characterization of each PV module to provide performance coefficients and data for PV models**
  - Sandia performance characterization method
  - IEC 61853 performance matrix
    - 23 I-V curves for a matrix of temperatures and irradiances ranging from 15°C to 75°C for temperatures and 100 W/m<sup>2</sup> to 1100 W/m<sup>2</sup> for irradiances

# Data Set Content and Format

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- **Comma Separated File (csv) for each module**
- **Time stamp of I-V curve**
- **POA irradiance**
  - Immediately before I-V scan,  $\text{W/m}^2$ , (CMP22)
  - Change during I-V scan,  $\pm\text{W/m}^2$ , (both CMP22 and LI-COR)
- **I-V curve characteristic data per ASTM 1036 data fitting procedures**
  - $I_{sc}$  (A),  $V_{oc}$  (V),  $P_{mp}$  (W),  $I_{mp}$  (A),  $V_{mp}$  (V), FF
- **I-V curve data pairs, as measured**

# Data Set Content and Format (continued)

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- **Meteorological Data**

- Precip (mm) – accumulated daily total prior I-V scan
- Ambient temperature ( $^{\circ}\text{C}$ ) – closest 5-sec sample
- Relative humidity (%) – closest 5-sec sample
- Barometric pressure (mb) – closest 5-sec sample

# Data Set Content and Format (continued)

- **Solar Data**

- Direct Normal ( $\text{W}/\text{m}^2$ )

- 5-second average containing I-V scan time
    - Standard deviation of 1-sec samples of 5-second average

- Global Horizontal ( $\text{W}/\text{m}^2$ )

- 5-second average containing I-V scan time
    - Standard deviation of 1-sec samples of 5-second average

- Diffuse Horizontal ( $\text{W}/\text{m}^2$ )

- 5-second average containing I-V scan time
    - Standard deviation of 1-sec samples of 5-second average

- Solar QA Residual ( $\text{W}/\text{m}^2$ )

- Direct Normal \*  $\cos(\text{zenith})$  + Diffuse Horizontal – Global Horizontal

- **Soiling Derate (example: 0.98 = 2% loss due to soiling)**

# Questions, Comments, Suggestions

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- **PV module characterization?**
- **Data set content or format?**
- **Other?**

**[bill.marion@nrel.gov](mailto:bill.marion@nrel.gov)**