

# The US Regional Test Center Program

[rtc.sandia.gov](http://rtc.sandia.gov)



# The US DOE Regional Test Center Program

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Sandia National Laboratories

**PV Market Insights Conference**

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# History of the RTC Program

**2011** – US Dept of Energy launches the SunShot Initiative;  
Hosts a series of workshops to identify R&D priorities

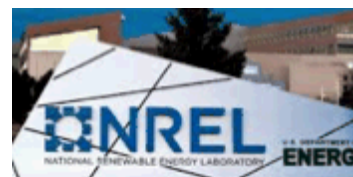
- March: *PV Manufacturing* in Berkeley, CA
- August: *PV Validation and Bankability* in San Jose, CA



**2012** – The RTC program is funded



- Sandia is named lead lab; the National Renewable Energy Laboratory is a partner



**2012-2013** – The RTC program takes shape



# The Regional Test Center Vision

*Create a robust and technically exacting R&D program that:*

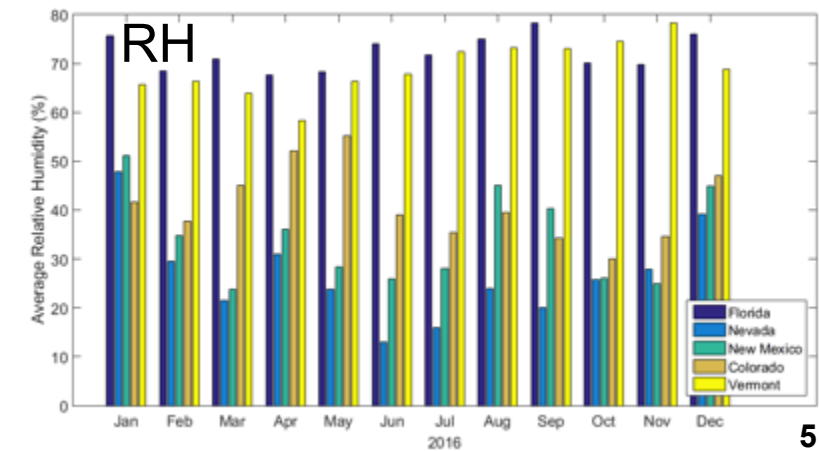
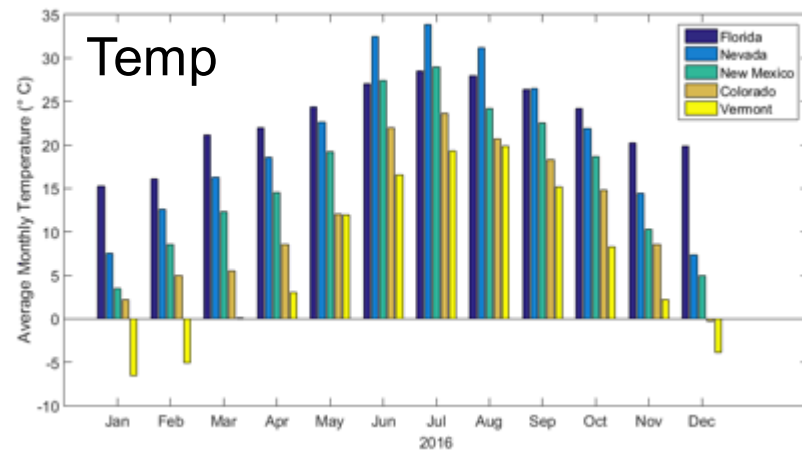
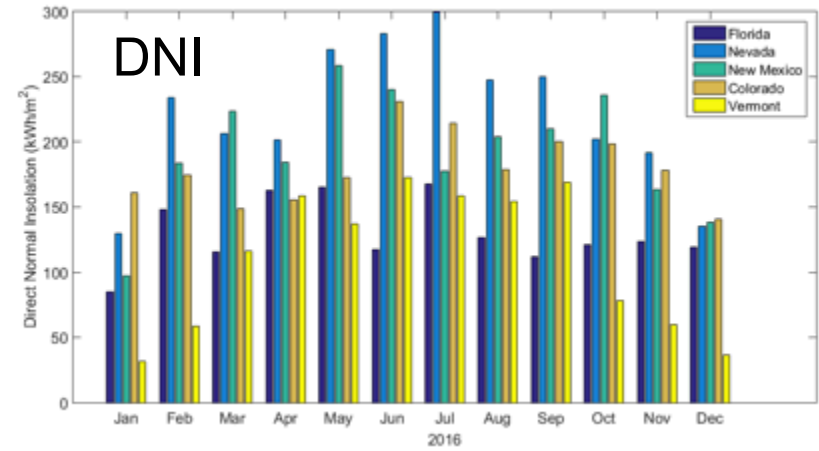
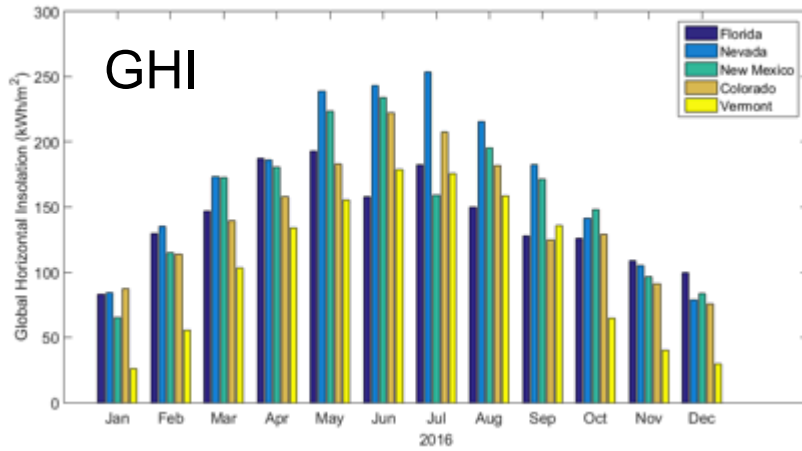
- Brings technical excellence to the performance validation and reliability analysis of PV components & systems
- Assists manufacturers in demonstrating the bankability of their products (manufacturers gain high-fidelity, multi-climate performance data and analysis)
- Helps drive innovation in the solar industry by providing companies with access to the technical excellence, engineering capabilities and credibility of the national labs

**PV technology must be predictable to be “bankable” – investors need to know how systems will function in across environments and climates.**

# Achieving the Vision: Equal but Different



# The RTCs Represent Diverse Climates



# The RTCs Support Diverse Technologies

## Photovoltaic Cell Types

- Mono-Si, Poly-Si
  - PERC, IBC, HIT
- “Shingled” mono and multi Si
- CIGS (discrete and monolithic)
- CPV (HighX)

## Module Types

- Bifacial
- Multiple back-sheet types
- Framed and frameless modules

## Other Products

- Thermocouples
- Meteorological stations

## Mounting Types

- Fixed-tilt
- Single-axis tracker
- Dual-axis tracker

## Tilt Angles

- 10°, 15°, 30°, 35°, 90°

## Module Orientations

- South
- West
- Vertical– EW and NS

~21 technology companies  
 ~42 distinct technologies  
 >50 PV systems  
 >550 kW capacity



# The RTCs Have World-Class Infrastructure..



## 1. RTC Meteorological Station

Irradiance: DHI	Eppley 8-48
Irradiance: GHI	Kipp & Zonen CMP 22
Irradiance: DNI normal	Kipp & Zonen CHP 1
Spectral sensor*	Black photon BPI-IT1
GPS solar tracker w/ shading ball	Kipp & Zonen SOLYS 2
Barometric pressure	Vaisala CS106
Wind speed and direction	RM Young 03002-L
Relative humidity and temp	Vaisala HMP60-L
Rain gauge, heated	Met One Instruments 375



## 2. Baseline, or Reference, PV Array

**6kW c-si mono  
270W Suniva modules**

**POA irradiance:  
EETs reference cells  
CMP-11 pyranometer  
Thermocouples  
DC current shunts  
DC voltage dividers**



## 2. RTC Soiling Station

**10 mini-modules  
Tilt angles: 0 – 45 degrees  
Half of each is cleaned 2X/week**



## 4. Vermont Snow Station

**3 modules:  
45, 30, 15 degrees  
4 modules:  
0, 15, 30, 45 degrees  
Camera  
Short-circuit current**



# ...And an Exacting Approach to Validation



## 1. Validation Plan and System Design

- Technical objectives, length of study, roles & responsibilities



## 2. Module Characterization

- Flash testing for  $V_{oc}$ ,  $I_{sc}$ , FF,  $P_{max}$ ,  $V_{max}$ , efficiency
- Imaging: IR, EL, optical
- Performance coefficients



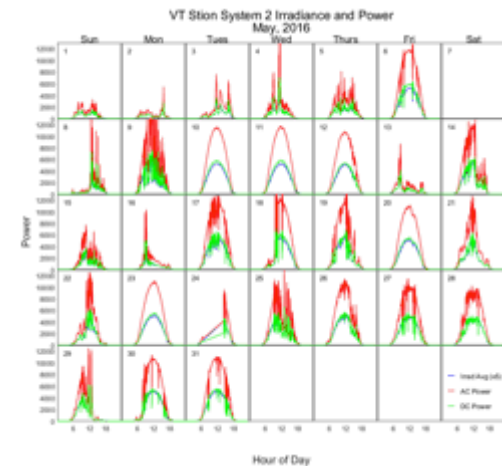
## 3. High-Fidelity Performance Data

- DC voltage: resistive voltage divider with accuracy of 0.1%.
- DC current: Empro current shunts, with accuracy of 0.1%.
- Solar cell temperatures – Omega Type-T thermocouples
- POA irradiance – Kipp & Zonen CMP-11
- PV reference cell -- EETs
- Custom data: tracking monitors, albedometers, AC data
- Data collected at  $\leq$  secs; averaged at 1 min intervals/



## 4. Performance Analysis

- Matlab scripts automate performance analyses
- Daily data review
- Twice yearly performance reports to partners



## 5. O&M Protocols

- Sensor cleaning and calibration
- Annual IV curves

# DOE and Industry Partners Share Costs



- **DOE SunShot**
  - Project oversight; some funding
- **RTCs provide:**
  - Site and electrical infrastructure
  - Validation plan
  - Monitoring equipment for PV systems and met station
  - Data management and analysis
  - O&M
  - Performance reports
- **RTC partners provide:**
  - PV system (modules, racks, inverters, etc.)
  - Manufacturing specs and performance data
  - Commitment to multiple locations
  - Technical support, including participation in team meetings

*Note: Because this program is subsidized by the US DOE, non-US companies are expected to cover the majority of costs*

# Industry Benefits Are Significant

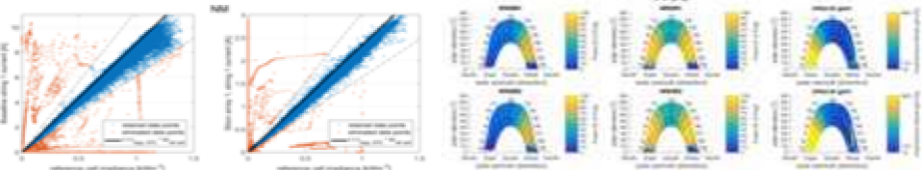
- Multi-climate field studies



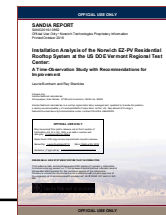
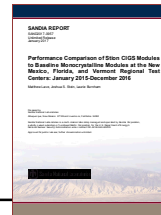
- High-fidelity performance and meteorological data



- Performance analysis by the nat'l labs



- Bankability/technological validation



- Product development: access to lab capabilities and expertise



# RTCs Also Help Address Soft Costs

- **Installation Time**

RTC Installation studies have quantified the time and effort involved, demonstrating reduced installation costs of new system designs.



- **Workforce Training**

Sandia’s technical experts work closely with installers and students at the RTC sites, teaching them about performance monitoring, new module technologies and O&M.



- **Data Availability**

The RTCs support a national data repository, making near-real-time data available publically from the weather stations and baseline PV arrays at the five RTC sites.



- **Technical Assistance**

States, towns and electric utilities seeking to better understand PV have sought data and technical advice from the RTC program and have toured the sites.



# Lessons Learned

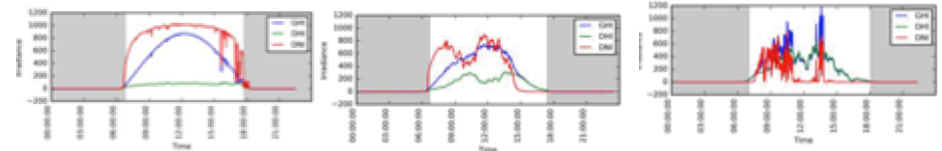
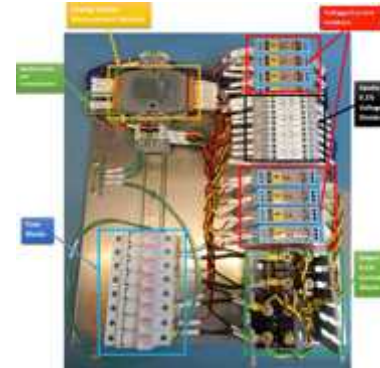
1. Streamline the installation process

1. Simplify when possible

2. Small is good

3. Baseline data drive value

4. Partner relationships are important





# Opportunities for Collaboration?



The RTCs welcome the opportunity to collaborate and to establish global partnerships to:

- Exchange data to understand more broadly and deeply the impact of climate on PV performance and reliability
- Enable partnered validation studies at sites around the world
- Help move the world toward a future increasingly powered by solar



**Thank you!**

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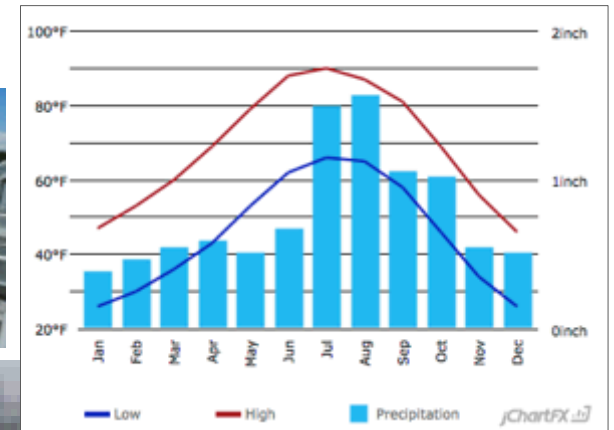
Questions?  
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**rtc.sandia.gov**

# New Mexico RTC

Located at Sandia National Laboratories in Albuquerque  
Systems Evaluation Laboratory (PSEL.)

- Capacity of ~250kW
- Can accommodate systems as large as 50kW
- Ballasted racking for easy installation
- Characterization and testing facilities on-site



Latitude 35°; Hot and arid; high DNI;  
wide temperature range



# Four-Pronged Success Strategy

{ Site Design } . . . . .

- Secure sites
- Identical Infrastructures
- World-class meteorological instrumentation

{ High-fidelity data collection } . . . . .

- High-fidelity data monitoring
- Daily data review
- O&M protocols
- Data-protection protocols
- Exacting calibration

{ Stream-lined installation approach } . . . . .

- Boilerplate data-acquisition systems
- Fast-track installation racking
- Publicly available, non-proprietary R&D data

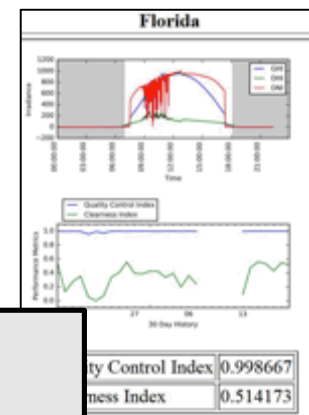
{ Publicly-available R&D data } . . . . .

- National resource for PV performance data

# The RTC Vision

To create a robust and technically exacting R&D program that

1. Provides industry with access to multi-climate sites where their products are validated by the national labs
2. Supports technical innovation by giving manufacturers access to the broad technical resources at the national labs
3. Generates critical, publicly available baseline data to support PV performance and reliability R&D



**PV technology must be predictable to be “bankable” – investors need to know how systems will function in across environments and climates.**