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The US Regional Test Center Program

Sandia National Laboratories

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The US DOE Regional Test Center Program

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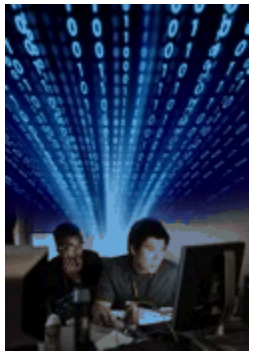
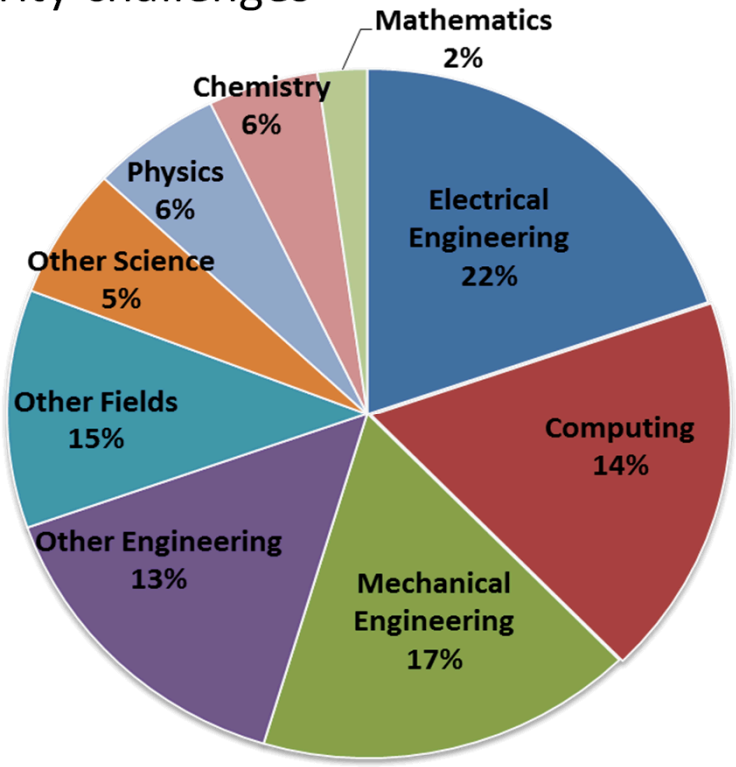
Sandia National Laboratories

- Large, multi-program research and engineering laboratory
- Broad mission in developing science and technology applications to meet our rapidly changing, complex national security challenges
- Our work aligns with DOE goals:





- **On-site workforce: ~10,500**
- **> 56% have higher degrees**

Examples of Sandia's impact

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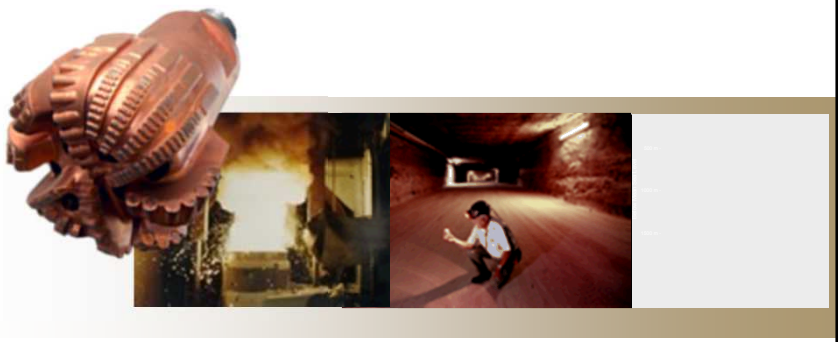
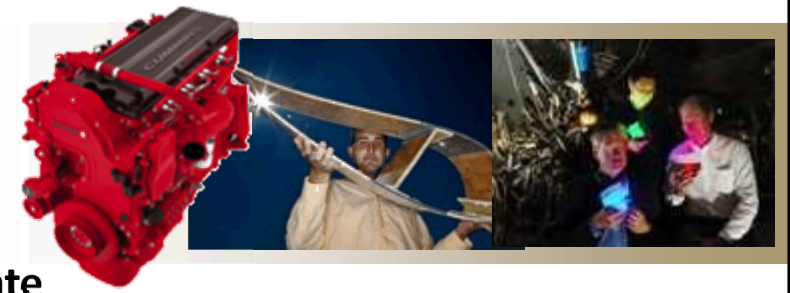


Core: Long term research that solves the nation's immense prob

- Nuclear reactor safety, nuclear waste disposal, and global climate change



Dynamic: Addressing current nation Needs on a 5-10 year timeframe

- Efficient engines, wind energy, and solid-state lighting

Rapid Response: Quick mobilization of expertise for urgent national nee

- Fukushima, Deepwater Horizon, Ebola

Photovoltaics (PV) Research at Sandia

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- **Mission:**
  - To help develop cost-effective, high-performing PV energy systems and accelerate the integration of PV into the electric grid
  - To support DOE SunShot goals and help make solar a cost-competitive source of electricity by 2020
- **Core Areas:**
  - Grid Integration
  - PV Performance & Reliability
  - Balance of Systems and Soft Costs
  - Materials and Fabrication

Sandia's Technical Capabilities

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Photovoltaic Systems Evaluation Lab (PSEL)

- Full-scale cell and module performance and characterization laboratory
- Controlled side-by-side system and component characterization
  - PV Arrays (PV, CPV, BIPV, bifacial, cells)
  - All other BOS components
- Fully configurable test platforms for indoor, outdoor and long-term testing

Distributed Energy Technology Lab (DETL)

- Reconfigurable test bed for PV and DER R&D
- Can simulate microgrid, commercial and community-scale energy systems, off and on grid
- Pre-commercial testing and validatation
- Interoperability testing
- Reliability & Safety
- Multiple energy sources, energy storage, controllable loads
- Hardware and controls

The Regional Test Center (RTC) Program

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- The RTC program began in 2012
- Funded by the US DOE to accelerate the commercialization of new products and expand solar deployment in the US
- Bankability a key challenge for US companies
- DOE wanted to leverage the technical expertise, capabilities and credibility of the national labs and asked Sandia and the National Renewable Energy Laboratory to co-manage the program

PV technology must be predictable to be “bankable” so that investors understand how the systems will function in a variety of environments and climates.

Uncertainty in the performance, reliability, and safety of components/systems prevails in the solar industry.

The RTC Vision: Four Objectives

- Bankability/Technological Validation

  Develop a comprehensive approach to performance validation; demonstrate that a technology performs as predicted over time and in multiple climates

- Product Development

  Work with industry partners to identify opportunities to improve specific technologies/approaches and accelerate their adoption

- Research Platform

  Address research challenges, including impact of climate on performance and optimization of grid-tied PV, provide site-specific data to research community

- Standards Development

  Build a foundation of field-based knowledge and replicable methodologies to inform the development of bankability standards (monitoring, analysis, O&M)

Predicated on Partnerships

- **DOE SunShot**
  - Funding and Project Management
- **RTCs provide:**
  - Site and electrical infrastructure
  - Validation plan
  - Monitoring equipment for PV systems and met station
  - Data management and analysis
  - O&M and log all O&M events
  - Regular reports on performance
- **RTC partners provide:**
  - PV system (modules, racks, inverters, etc.)
  - Manufacturing specs and performance data
  - System design (or design information) to RTC Team
  - Commitment to multiple locations
  - Technical support, including participation in team meetings

RTC Multi-site Approach

- Climatically and geographically distinct
- Identical infrastructures:
  -- Meteorological instrumentation
  -- Reference PV systems
  -- Soiling stations
  -- Grid-tied 480V 3ϕ
- Efficient installations
- Different technical capabilities; different ownership structures

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- Committed to consistency, uniformity and collection of high-fidelity data

- Encourage—but do not require—installations at two or more sites

- Validate a range of technologies for minimum of 3 years

RTC Validation Process

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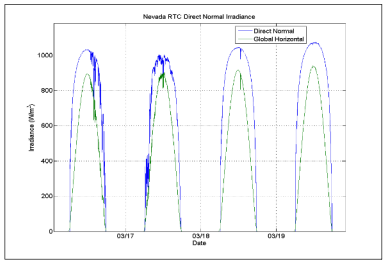
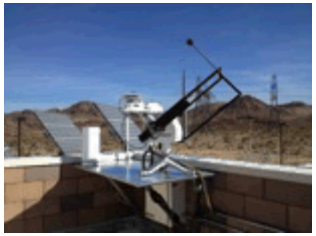
Validation Plan--customized to meet the needs of each RTC partner—includes:

- System Design
  - Array orientation, tilt angle, spacing, BOS components, etc.; also O&M needs
- Baseline Characterization
  - Electrical performance, statistical performance variation, visual inspection, development of model coefficients
- Operational Data
  - A/C and D/C system power, meteorological data
  - Module failure
  - Reliability
- Analysis and model comparisons
  - Predict performance of field systems and compare to measured performance

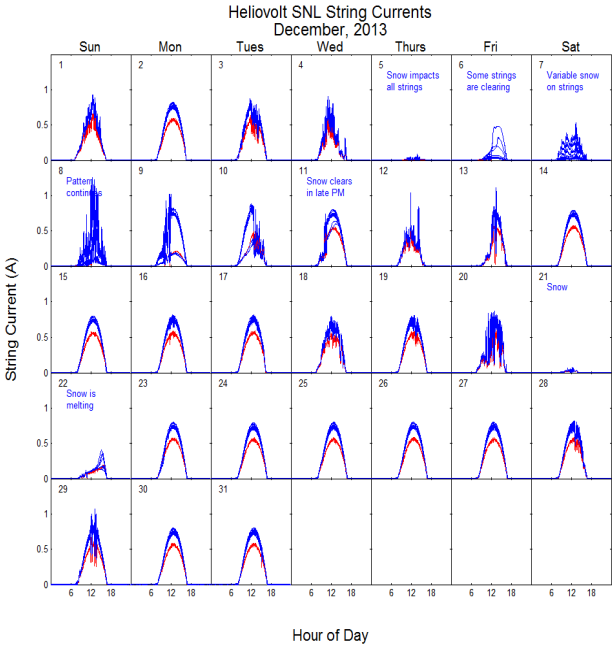
Validation is Rigorous Process

- **Customized Validation Plan**
- **High-Fidelity Data Collection**
  - Meteorological Data
    - Irradiance: DNI, GHI, DHI, POA, spectroradiometer
    - Wind speed and direction
    - Ambient temperature and relative humidity; precipitation
  - Module Characterization
    - Voc, Isc, FF, Pmax, Vmax, efficiency
    - Imaging: IR, EL, optical
  - System Data
    - DC electrical (current and voltage)
    - AC electrical (current, voltage, power, power factor, frequency)
    - Solar cell temperatures
    - Additional data (tracking accuracy, inverter codes, heat-sink temperature...)





- **Detailed Performance Analysis**
  - Matlab scripts automate performance analyses
  - Monthly analysis
  - Quarterly or semiannual reports to partners.



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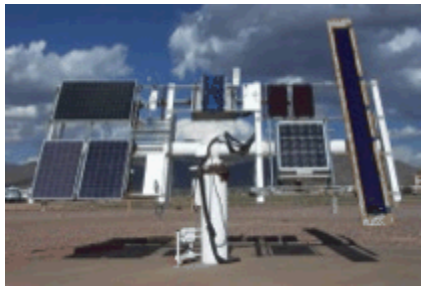
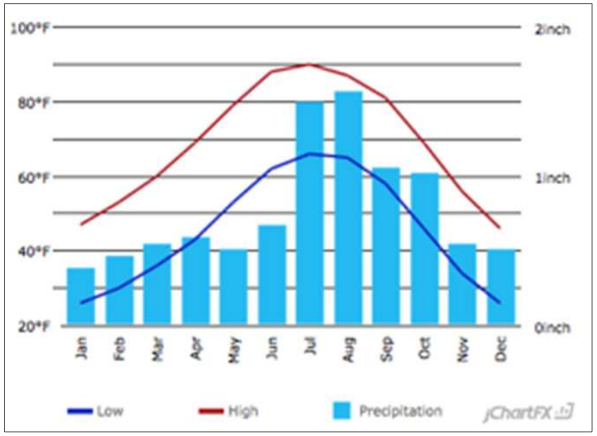
Five RTC Sites

New Mexico RTC

Located at Sandia National Laboratories in Albuquerque – adjacent to the Photovoltaics Systems Evaluation Laboratory (PSEL.)

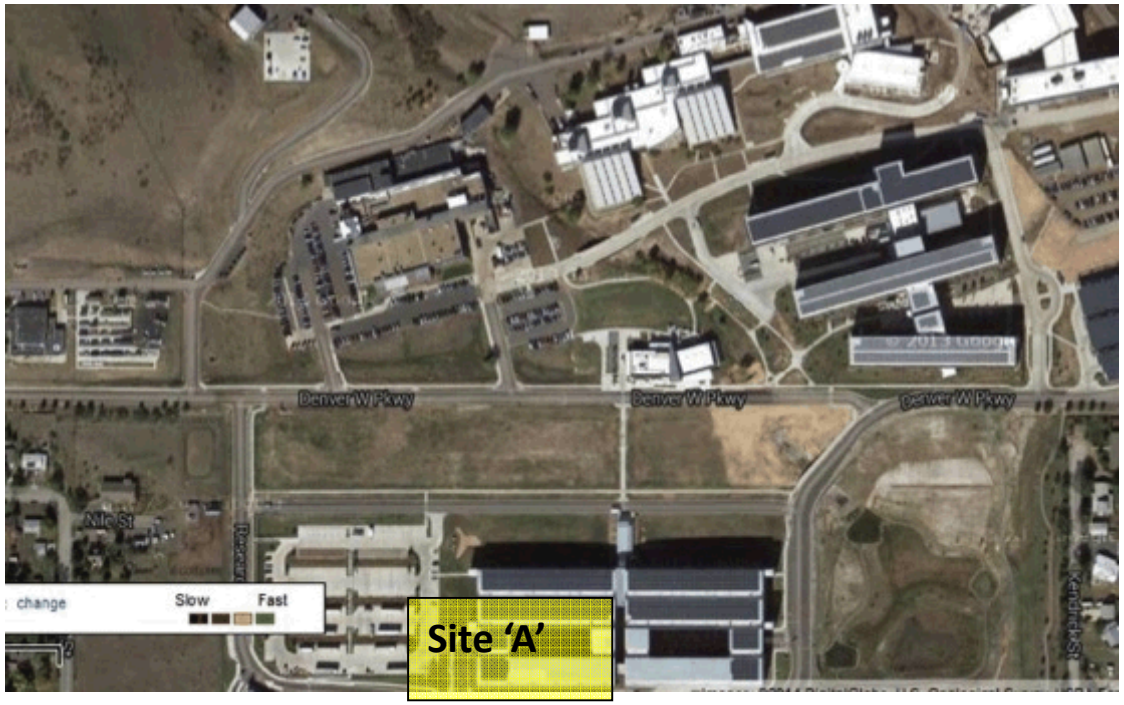
- Capacity of ~250kW
- Can accommodate systems as large as 50kW
- Ballasted racking for easy installation
- Characterization and testing facilities on-site



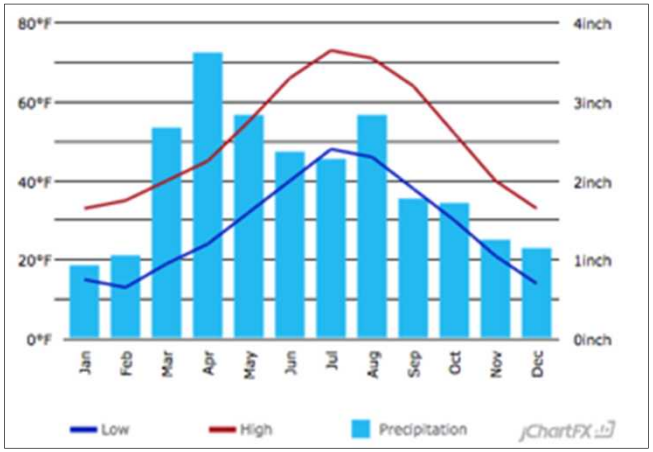


Latitude 35°; Hot and arid; high DNI; wide temperature range

Colorado RTC

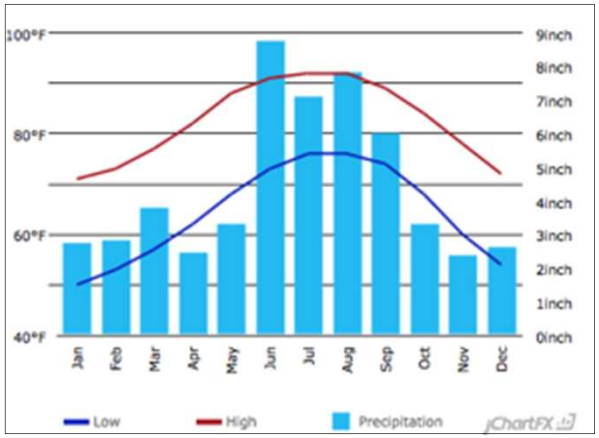


- Located at NREL in Golden, CO
- 25 kW 2-axis trackers
- 80 kW fixed tilt (30-degree tilt)
- Characterization capabilities onsite



Latitude 40°; high altitude, temperate climate

Florida RTC

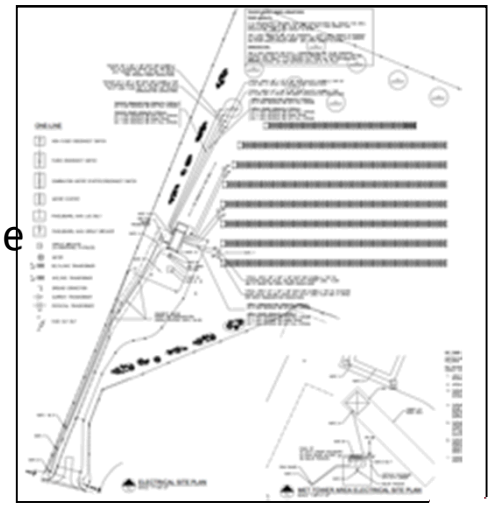


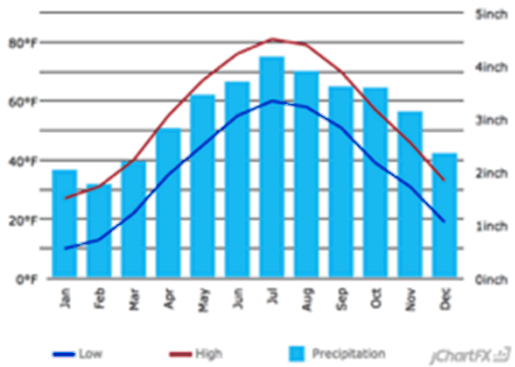
- 10 acres at the Florida Solar Research Center
- Has onsite technical expertise and testing capabilities
- Can accommodate 250kW fixed tilt

Latitude 28°; Hot, humid, subtropical; moderate DNI

The Vermont RTC

- Located near Burlington VT
- Seven acre, 300 kW capacity site designe for fixed-tilt (35 degree) and tracker PV

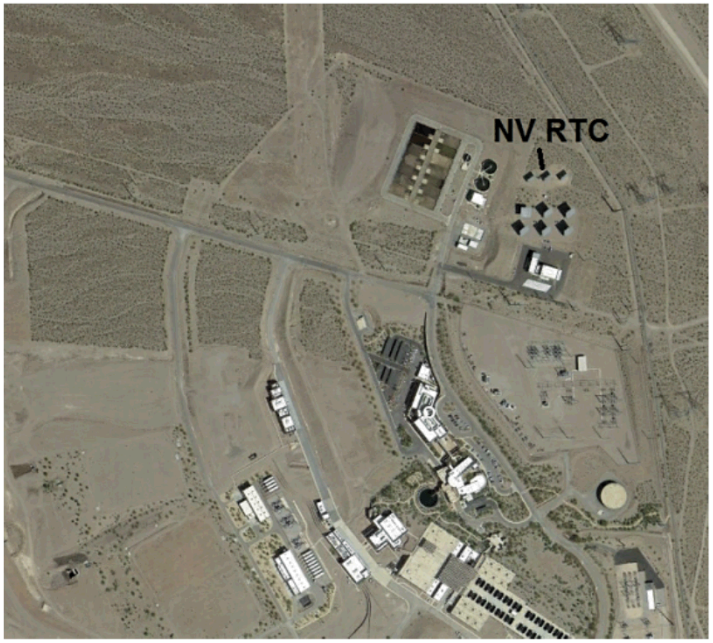


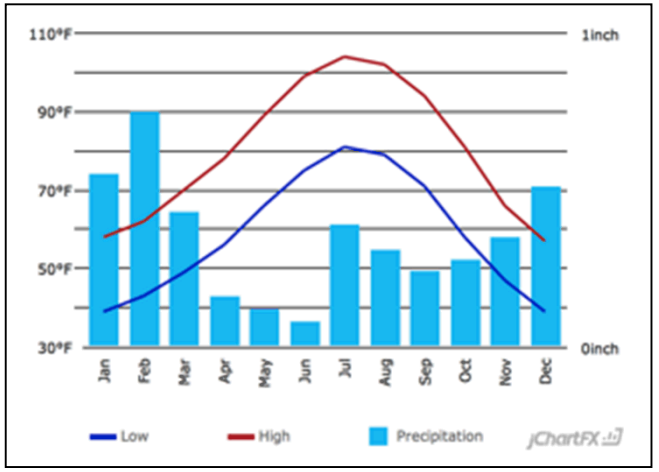


Latitude 44°; Moderate to high precipitation; harsh winter conditions; low DNI.

Nevada RTC

- Located southeast of Las Vegas in Henderson, Nevada
- Developed in partnership with the Southern Nevada Water Authority and the University of Nevada, Las Vegas
- Can accommodate fixed-tilt and trackers; PV and CPV
- Black photon spectral photometer





Latitude 36°; high DNI; high temperatures

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Regional Test Centers

Differentiating PV Quality

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Questions?

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RTC Objectives

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