

# OUTDOOR TESTING



1 Modules fabricated in Fraunhofer CSE's Photovoltaic Technologies Laboratory undergo outdoor performance testing in Massachusetts and New Mexico.

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## Providing Field Performance and Durability Data for the Solar Industry

The Fraunhofer Center for Sustainable Energy Systems (CSE) maintains outdoor testing facilities for long-term exposure tests under varying climate conditions in Massachusetts and New Mexico. CSE's outdoor test sites are designed to address a pressing industry need for enhanced feedback on actual field performance and durability of both existing and new PV technologies.

Fraunhofer's Outdoor Test Fields (OTF) supports PV module and component manufacturers in assessing the actual field performance and durability of their products and to enable systems integrators to obtain the crucial data they need to meet ever-tightening performance and lifetime expectations.

Primarily used for PV solar testing, these facilities also have capabilities to conduct field evaluations of advanced building envelope materials/assemblies and are developing capabilities to demonstrate and test smart grid systems.

## PV Testing Services at Fraunhofer's Outdoor Test Fields

Services offered at these facilities include:

### Multichannel I-V Curve Tracing Under Load

- Modules biased at maximum power point, open circuit or short circuit between traces
- Local irradiance measured with both a secondary class pyranometer and PTB calibrated monocrystalline reference cell
- Module temperature monitoring

### Grid Connected System Performance Evaluation

- String / module level performance monitoring
- Comparative analysis of system performance ratio
- Long-Term Lifetime Testing of Modules and Systems
- Soiling studies
- Potential induced degradation
- Thin film stabilization analysis



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**PV Testing Services at Fraunhofer's  
 Outdoor Test Fields (Cont.)**  
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**IEC Outdoor Testing**

- PVsyst .PAN file determination – Sandia Performance Model coefficient determination

**Model-Based Testing**

- Temperature coefficient; angle of incidence; irradiance dependence, spectrum dependence

**Grid-Connected Systems Hosted Monitoring**

- String/module level performance monitoring
- Performance ratio determination

**Concentration PV (CPV) System Monitoring and Characterization**

- CSOC Determination
- Angle of Acceptance
- Temperature Testing

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**OTF Characteristics in Albuquerque, NM**  
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The Outdoor Test Field (OTF) opened in June 2012. This facility is part of Fraunhofer CSE's Albuquerque solar research branch, and is co-located with the CFV Solar Test Laboratory. Its capabilities include:

- Over 310 days of sunshine annually
- Climate capable of inducing module temperature changes of over 60°C over the course of a single day
- Solar resource (including spectrum) and meteorological monitoring
- I-V curve measurements of PV modules, strings, and systems up to 60 kWp
- Automated multichannel continuous I-V curve measurements
- DC/AC monitoring and analysis
- Microinverters and string inverters
- Listed and non-listed equipment
- Grid capacity above 25 kWp
- Fixed rack mounting systems with adjustable mounting angle, single-axis, and dual-axis tracking

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**OTF Characteristics in Revere, MA**  
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CSE's test site in Revere, Massachusetts, is co-located with a 3-acre, 750 kW solar power plant operated by National Grid. The site provides unique test capability for the northeastern climate zone. Notable site features:

- Solar resource and meteorological instrumentation
- Test modules compared against grid-connected commercial arrays
- Capacity for 40 commercial-sized modules
- Automated 24-hour monitoring
- Peak power tracking Solar spectrum analysis I-V curve tracing
- Hot spot testing
- NOCT characterization
- Thermal imaging in operation



2 Testing of commercial modules under load with periodic I-V sweeps at OTF-1 in Albuquerque, New Mexico.

3 On-site testing at Fraunhofer CSE's advanced outdoor testing facility in Revere, Massachusetts.