

PHOTOVOLTAIC TECHNOLOGIES



1 Module being prepared for testing in the Fraunhofer CSE's PV Technologies Laboratory.

Fraunhofer Center for Sustainable Energy Systems CSE

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Overview

Our mission is to accelerate the growth of photovoltaic (PV) energy generation by conducting applied research on innovative PV module concepts, new materials and components, and on PV systems.

We support the development of innovative PV module designs and materials through proof of concept, pilot production, full production, and lifetime testing. Our in-house R&D expertise includes module optical and thermal design, process development for novel materials, energy modeling, and durability assessment.

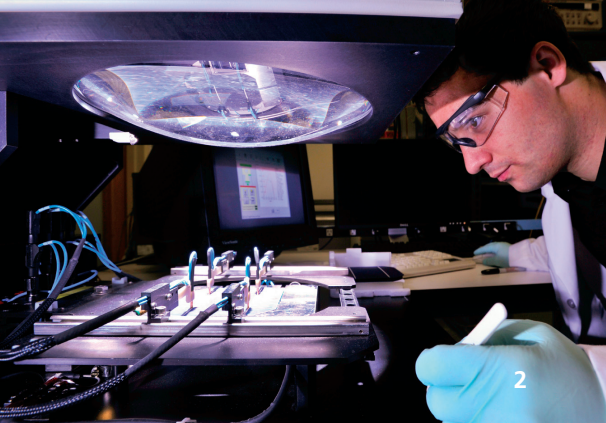
An experienced team of researchers, supported by a world-class network of research partners, addresses client needs by focusing on areas where there is the greatest need for innovation via reduced cost, increased efficiency, and enhanced durability of PV modules in support of our clients' technology commercialization efforts.

Skills and Capabilities

- Module manufacturing and quality assurance
- Cell and module performance and reliability assessment, based on:
 - Outdoor exposure
 - Accelerated stress
- Polymer science and engineering
- Numerical analysis and semiconductor device physics
- Silicon and III-V wafer process and defect analysis
- Failure analysis and materials characterization

Key Projects

- Plug-and-Play PV for American Homes
- PV Module Durability Initiative



Available Services

- **Modeling:** Mechanical, optical, and thermal modeling to compare the theoretical capabilities of various module designs; energy yield and cost analysis.
- **Module Design and Fabrication:** Capabilities required to turn cells into modules, with support for advanced encapsulants, edge sealants, back sheets, and solar glass.
- **Module/Materials Characterization:** Module energy yield prediction and testing, failure analysis using EL, IR imaging, and cross-sectioning.
- **Accelerated Aging:** Development of new test methods to simulate rigorous operating conditions.
- **Outdoor Exposure and Performance Monitoring:** Long-term, grid-connected and off-grid outdoor exposure testing in northeast and southwest climates.
- **Quality Analysis:** Durability and degradation, compliance with rated characteristics, energy output, and performance.

Equipment

Fraunhofer CSE offers an extensive range of equipment capabilities, including:

- **Pilot Module Fabrication Line**
- **Pulsed Class A+A+A+ Solar Simulators**
- **FEA Modeling**
- **Indoor Environmental Testing**
- **Imaging (EL, IR, SEM)**
- **Outdoor Testing** (New Mexico and Massachusetts)

Facilities

CSE's PV Technologies Lab is located in the Fraunhofer CSE's Living Laboratory, an innovative 50,000 ft² research center and clean energy demonstration project in the Boston Innovation District.

Fraunhofer CSE also maintains research facilities and outdoor test fields in Albuquerque, New Mexico, co-located with CFV Solar Test Laboratory.

Research Partners

- **Fraunhofer Institute for Solar Energy Systems (ISE):** ISE is the largest solar energy research institute in Europe. The work ranges from fundamental scientific research relating to solar energy applications, through the development of production technology and prototypes to the construction of demonstration systems.
- **CFV Solar Test Laboratory:** A joint venture of the CSA Group, VDE Testing and Certification Institute, Fraunhofer ISE, and CSE, CFV offers complete certification and non-certification testing services for a range of PV technologies, including flat panel, thin film and concentration PV (CPV).

CSE also cooperates with other leading governmental, academic and research institutions around the world.

2 *A steady-state solar simulator in the Fraunhofer CSE Module Innovation Laboratory.*

3 *Climate chamber for accelerated aging and testing.*