



## THERMOPHOTOVOLTAICS

NREL thermophotovoltaics (TPV) researcher Myles Steiner in front of the reactor used to grow TPV cells. *Photo by Dennis Schroeder, NREL 42599*

# The Right Resources to Develop Thermophotovoltaic Technologies

**Photovoltaic technologies have come a long way, but new breakthroughs are always around the corner. Thermophotovoltaics (TPV) capture heat and convert it to electricity at high efficiency. NREL is comprehensively situated to advance this new energy pathway with breakthrough potential.**

## Converting Heat to Electricity

TPV captures the energy radiated as infrared light from hot objects and converts that radiation directly to electricity using specially designed photovoltaic cells. TPV is ideal for scaling to any size power plant without introducing moving parts. And NREL is creating the materials and methods that will allow TPV to have an impact in applications that include:

- Power recovery from waste industrial heat, such as steel mills
- Grid storage, with common electricity sources powering TPV cells
- Portable electronics, with power generation from conventional fuels
- Quiet electric generation from nuclear energy

## Why Partner with NREL?

NREL has a long heritage of developing record-efficiency photovoltaic devices that shape industry. Our impact starts in the lab with capabilities and expertise that are unmatched. Partnering with NREL means access to:

- Fabrication of novel TPV cell architectures, including rapid manufacturing with multiple vapor-phase epitaxy techniques
- Comprehensive III-V PV cell design and fabrication for custom applications
- Thermal and optoelectronic characterization at irradiances relevant to TPV application
- Technoeconomic and life cycle studies of product designs and costs
- Reliability and degradation testing, and root-cause failure analysis
- Scientific expertise of researchers who have designed record-setting and award-winning solar technologies
- Comprehensive modeling of TPV devices and their thermal management
- A legacy of innovation at the frontier of PV applications.

## Materials that Open New Roads to Renewable Energy

TPV can grow into a solution for devices and systems across the grid. To reach the technology's potential, NREL helps partner ideas move to market and reach new benchmarks for performance and efficiency.

- **Manufacturing:** We have infrastructure to develop ultra-high-performance, metamorphic, single- and multijunction TPV cells, including photolithographic processing and rapid vapor-phase epitaxy. We can also help partners study cost reduction pathways for manufacturing.
- **Characterization:** We are able to characterize thermal, reliability, and mechanical aspects of devices in experimental settings that replicate real-world operation, including the 800°C — 2500°C temperature range common for TPV applications.
- **Technoeconomic analysis:** We have models and analytical resources to study the supply chain, electricity costs, and future market deployment of TPV devices. We can help partners foresee the impact of new products in a range of technoeconomic scenarios.
- **Systems integration:** We use modeling, simulation, and integrated experiments with real power hardware to develop methods for real-time co-optimization with the grid. Housed in NREL's Energy Systems Integration Facility, our systems integration infrastructure allows us to study technological performance within larger systems.

## Partner with Us

We have multiple paths for partnering including licensing NREL intellectual property, testing and characterization, technoeconomic analysis, and generating new technology solutions through cooperative R&D agreements.

### Contact Us

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An NREL-developed metamorphic multijunction photovoltaic cell undergoing testing. *Photo by Dennis Schroeder, NREL 32512*



One application of TPVs is in small-scale systems that generate electricity from any combustible fuel by using TPV cells to convert heat from combustion. These systems could operate with few to no moving parts, minimizing maintenance and costs. This diagram shows a TPV-based system that Sierra Power is developing with NREL's support. *Illustration from of Sierra Power.*