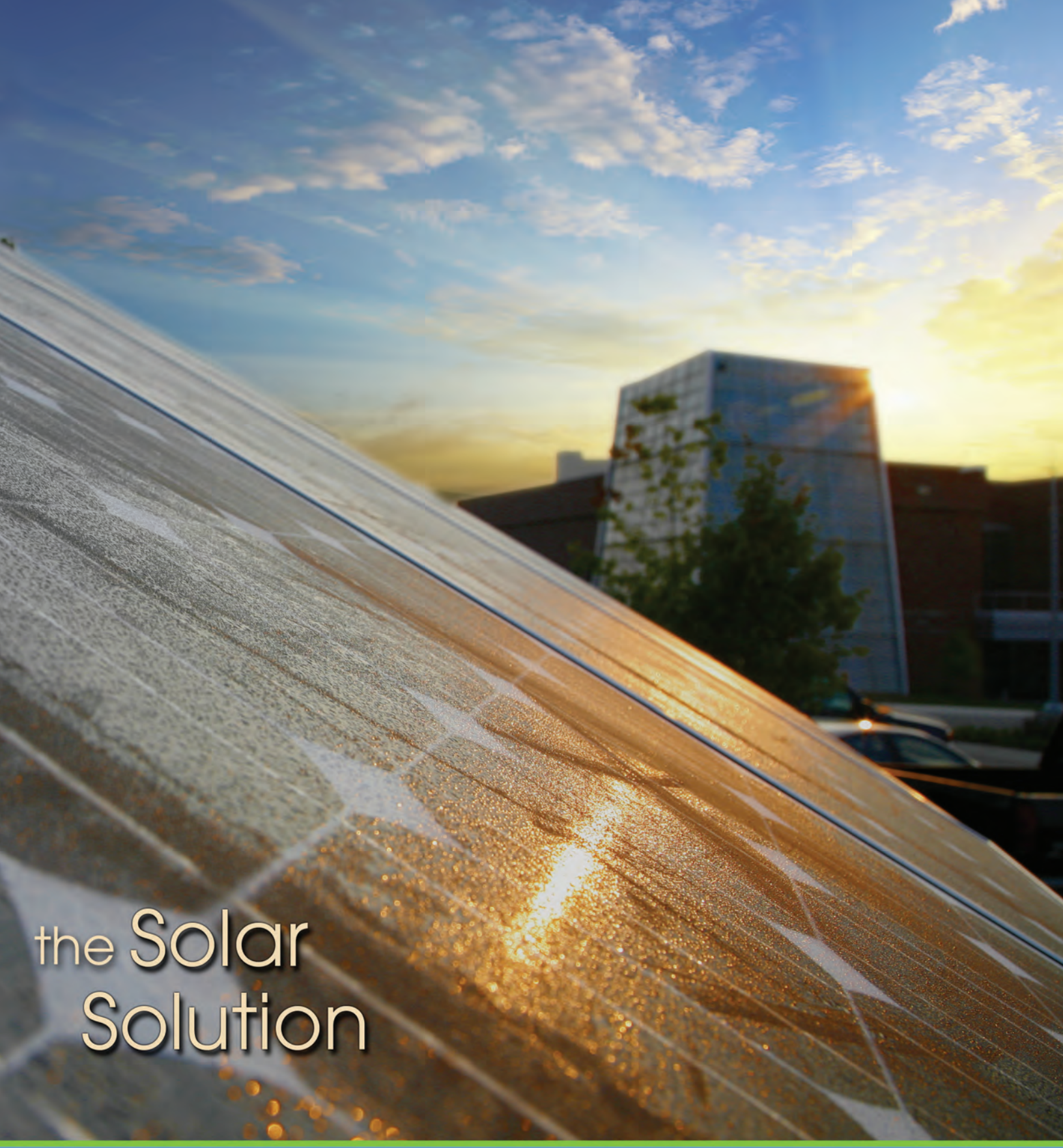


the Solar Solution

Increasing solar cell efficiencies, reducing manufacturing costs, and effectively integrating with the power grid to satisfy America's demand for electricity

OAK RIDGE NATIONAL LABORATORY
MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

Research, Development, and Commercialization

Solar energy is a clean, abundant renewable energy source that is vital to our energy security and independence. However, it is imperative to develop a low-cost approach for efficiently collecting and converting solar energy into useful electricity in order to ensure that America's energy portfolio supports a cleaner environment, stronger economy, and strengthened national security.

Optical characterization specifically focused on solar cell research

Oak Ridge National Laboratory (ORNL) is helping to meet these challenges by conducting aggressive research, development, and deployment of solar energy technologies and systems to significantly reduce the cost of solar electricity by 2015.

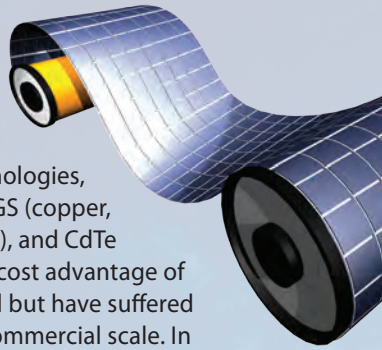
Science to Energy – Fundamental Issues and New Frontiers

ORNL's characterization tools for thin film and nanostructured hybrid materials are unparalleled, encompassing state-of-the-art facilities such as the Center for Nanophase Materials Sciences, the High Temperature Materials Laboratory, and the Spallation Neutron Source. These facilities house the world's highest-resolution electron microscopes as well as unique capabilities for using neutron scattering to characterize photovoltaic materials.

In addition, ORNL recently established the Center for Advanced Thin-film Systems, which contains a suite of optical and electrical characterization equipment specifically focused on solar cell research. Having such capabilities in close proximity to world-class fabrication and processing facilities makes ORNL a truly unique place for solar research and development.

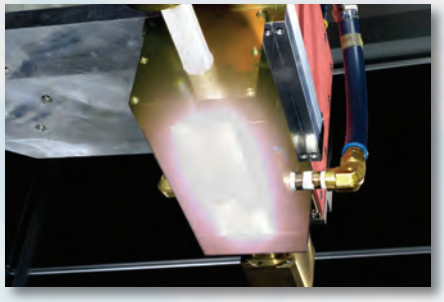
PV Materials

As the nation's largest material science laboratory, ORNL leverages decades of experience and extensive capabilities toward the fundamental understanding and development of a wide range of solar material systems. As the highest efficiency photovoltaic commercial systems, crystalline and polycrystalline silicon technologies dominate the solar market. However, significant challenges remain in order to reduce the manufacturing cost and material waste. Thin film technologies, such as amorphous silicon, CIGS (copper, indium, gallium, and selenium), and CdTe (cadmium telluride), offer the cost advantage of using less solar-active material but have suffered from low efficiencies on the commercial scale. In addition, ORNL is exploring innovative technologies for the next generation of solar materials, involving unique nanostructures and organic materials.



Advanced Manufacturing

Currently, the widespread adoption of solar energy is being hindered primarily by the high cost of solar cell technology. The average cost of installed solar energy is just over $3 per watt. Estimates from DOE indicate that this figure must be reduced to $1 per watt before achieving significant market penetration. In order to reduce manufacturing cost while maintaining high efficiency, new innovative manufacturing techniques must be developed. ORNL is working to integrate non vacuum, high-volume manufacturing techniques with unique thermal-processing technologies to produce high-efficiency, low-cost solutions for solar energy.



Pulse Thermal Processing

Concentrating Solar Power

Greater thermodynamic efficiency is needed to improve the feasibility of concentrating solar power and is dependent on equipment and fluids that can run at higher temperatures than current technologies. ORNL research is addressing the need for heat transfer fluids for solar power generation that are stable to temperatures approaching 600°C.

In addition, ORNL has conducted some of the pioneering work in the area of molten salts, which may be a viable heat transfer fluid for concentrated solar power towers.

ORNL is also working to qualify high-temperature materials and developing new alloys that are capable of sustained operation at elevated temperatures and are corrosion resistant.

Parabolic trough system

Systems Integration

ORNL's System Integration group addresses many of the issues that occur downstream of solar modules. For instance, while a solar module is usually warranted for 20 to 30 years, the inverter generally has an operational lifetime on the order of 10 to 12 years. Therefore, ORNL researchers are exploring wide band gap materials that are more reliable and have longer lifetimes than the current technology. They are also exploring the integration of solar technology into a "smart grid" system.

Volunteer State Solar Initiative

The State of Tennessee recently established the Volunteer State Solar Initiative in order to promote the growth of the solar industry across the state and to address key obstacles for the solar value chain. The Volunteer State Solar Initiative, which represents a $62 million investment, consists of two primary components: the West Tennessee Solar Farm and the Tennessee Solar Institute (TSI). The 5 megawatt solar farm, located near Brownsville, TN, will be one of the largest utility-scale solar power facilities in the Southeast.

TSI is a center of excellence between the University of Tennessee and ORNL that brings together scientists, students, policy makers, and industry partners to generate transformative changes to the field of solar-generated energy production. TSI is providing $9 million toward solar installation grants, which will account for more than 5.8 MW of solar installations across the state. TSI is also funding over $14 million in solar innovation grants to encourage the growth of Tennessee's solar industry.

TSI is building a strong foundation today that will shape our future in solar innovation tomorrow. Learn more about the Tennessee Solar Institute at http://solar.tennessee.edu/.

TENNESSEE SOLAR INSTITUTE

Market Transformation

ORNL has been working to accelerate the adoption of solar technology at the local and regional level by engaging city governments and industrial partners across the solar value chain. Through interactions with the Solar America Cities, ORNL provides technical and analytical support to prospective cities to tackle an array of technology barriers and opportunities with a limited set of decision makers. For instance, the Solar America City of Knoxville is installing three highly visible solar systems in strategic locations. ORNL has been instrumental in bringing these installations to fruition by providing design reviews, interfacing with the design contractor, and performing bid package reviews/evaluations. Knoxville and ORNL as a team are becoming a leader in the state outreach efforts through working with the solar community, utilities, and TVA in addressing policy and financing issues and maintaining a strong solar employment base.

KNOXVILLE

SOLAR AMERICA CITY

Committed to a Sustainable Solar Future

A Partnership Program with the U.S. Department of Energy

Tomorrow's Capabilities

Solar technology has the potential to harness the renewable energy of the sun to power everything from family homes to towering office buildings, and to do so virtually pollution free. Researchers from ORNL are utilizing ORNL's unique capabilities for modeling, synthesis, characterization, and processing to increase the performance and decrease the cost of solar cell technology.

The advanced materials research conducted by the lab's scientists and researchers represents a strategic strength for investigating solar technology, especially as the efficiency and manufacturing costs of solar cells are closely associated with fundamental materials issues. Utilizing the lab's strong foundation in materials science and unique processing capabilities, ORNL is finding new opportunities to optimize the manufacturing process for fabrication of high-efficiency, low-cost solar cells.

ORNL's solar technologies research directly supports and is funded through DOE's Office of Energy Efficiency and Renewable Energy. The research also receives funding from other DOE offices and programs, other government agencies, research organizations in the private sector, and private industry.

U.S. DEPARTMENT OF ENERGY

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SolarTechnologiesProgram

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