



SOLAR ENERGY
TECHNOLOGIES OFFICE
U.S. Department Of Energy

Advances in Solar Power Electronics for a Smarter Grid

Systems Integration Sub-program

energy.gov/solar-office

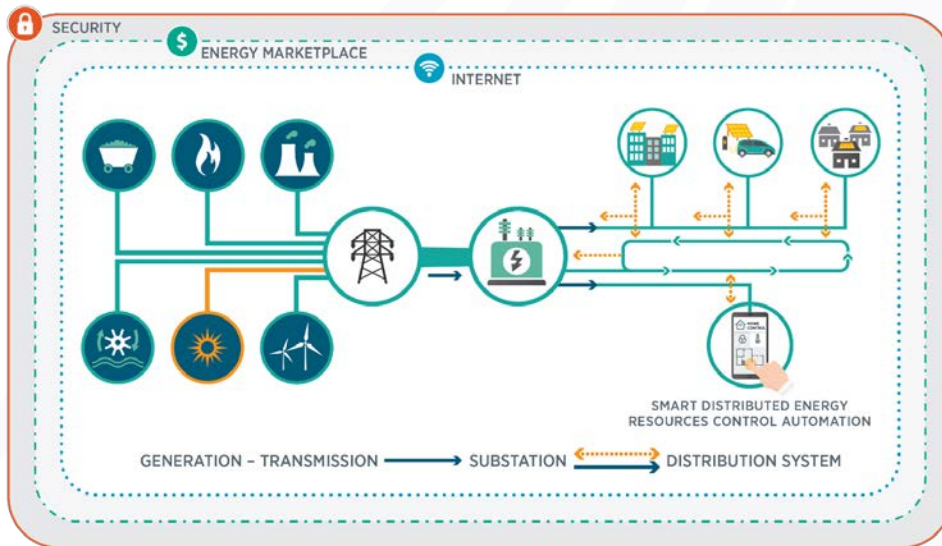
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Solar Energy Technologies Office

- **WHAT WE DO:** The U.S. Department of Energy Solar Energy Technologies Office (SETO) supports early-stage research and development to improve the affordability, reliability, and performance of solar technologies on the grid. The office invests in innovative research efforts that securely integrate more solar energy into the grid, enhance the use and storage of solar energy, and lower solar electricity costs.
- Subprograms
 - Photovoltaic R&D
 - Concentrating Solar Power (CSP)
 - Systems Integration
 - Balance of Systems Soft Cost Reduction
 - Innovations in Manufacturing Competitiveness

Systems Integration (SI) Subprogram

- Fund research projects to develop innovative technical solutions that enable large scale deployment of solar power onto a modernized electricity grid focusing on **reliability, resilience, and cybersecurity**
- Part of DOE Grid Modernization Initiative (GMI) and collaborate closely with national labs through Grid Modernization Laboratory Consortium (GMLC)



SETO Power Electronics R&D topics

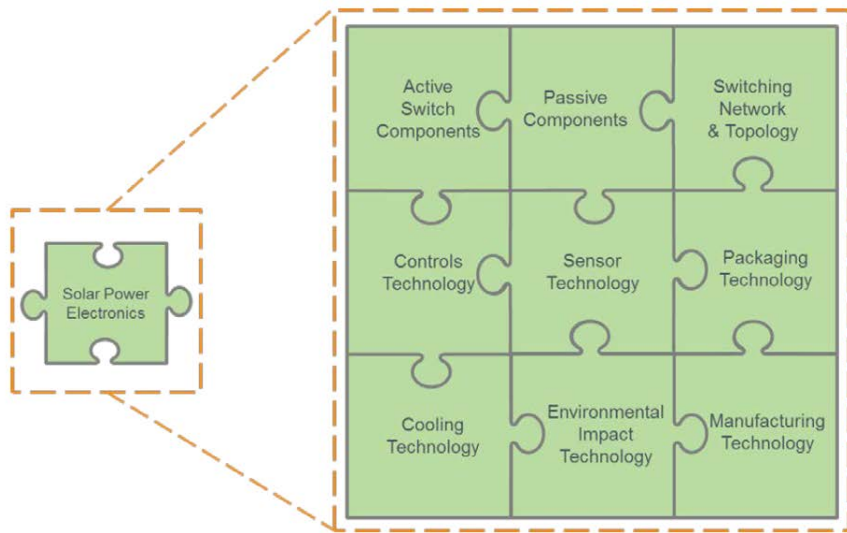
SETO funds power electronics research and development projects that aim to

- Lower power electronics hardware costs,
- Improve equipment efficiency
- Improve grid resilience, reliability and security
- Increase service life
- Enhance grid services such as inertia support, black-start, frequency control
- Coordinate with DERMS
- Develop and validate advanced control functionalities through hardware-in-the-loop and field tests
- Develop reliability test standards.

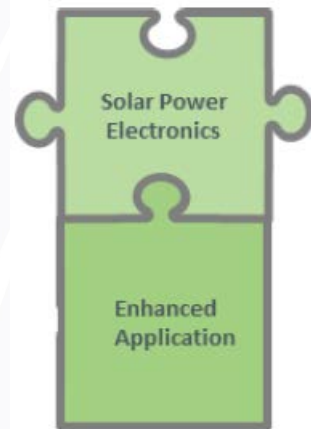
<https://www.energy.gov/eere/solar/power-electronics>

DE-FOA-0001740: Advanced PE Design for Solar

- FOA goals: Lower lifetime costs of solar PV power electronics AND enable versatile control functionalities to support PV integration for enhanced grid services



Topic Area 1: Optimization of constituent technologies for reduced lifetime costs



Topic Area 2: Conceptual modular PE for enhanced grid services

Funded research topics under FOA 1740



New projects recently announced by SETO take a few different approaches:

- *Advanced component technologies and novel circuit designs* that reduce the number of parts within an inverter, leading to better packaging, fewer parts that can fail, improved efficiency
- *Modular inverter designs* that focus on improving individual components can enhance PV system reliability and extend its operational lifetime in the field.
- *Wide-band gap semiconductor switches* enable inverters to operate at much higher temperatures and less power losses, leading to less power failures and longer system lifetimes in the field.
- *Provide grid services* like regulate voltage and frequency, detect cyber and physical threats to the grid, and control power flow from solar and storage systems in order to respond to grid disturbances and power outages with solar resources.
- Solutions that *leverage customer-owned solar systems combined with other DER/energy storage* to enhance the value of energy produced over the lifetime of a PV system—which contributes to lower LCOE—while also enabling the safe and reliable operation of the electric grid.

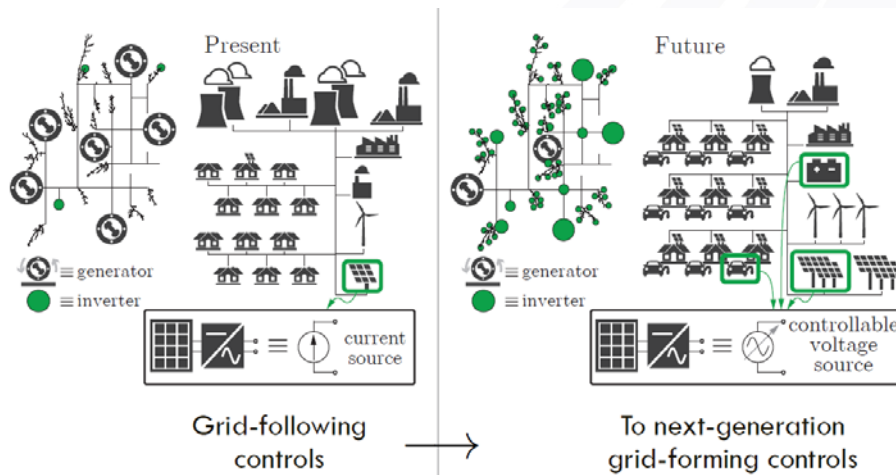
PE Award Selections

Organization	Title
Flex Power Control Inc	Solar Power Electronics Modular Integrated Node Platform
Georgia Tech	Modular HF Isolated Medium-Voltage String Inverters Enable a New Paradigm for Large PV Farms
North Carolina State University	PV Inverter Systems Enabled by Monolithically Integrated Silicon Carbide-Based Four Quadrant Power Switch
Oak Ridge National Laboratory	Multiport Autonomous Reconfigurable Solar Power Plant
University of Arkansas	A Reliable, Cost-Effective Transformerless Medium-Voltage Inverter for Grid Integration of Combined Solar and Energy Storage
University of Maryland: College Park	Compact and Low-Cost Microinverter for Residential Systems
University of Texas at Austin	Modular, Multifunction, Multiport, and Medium-Voltage Utility Scale Silicon Carbide PV Inverter
University of Washington	Modular Wide-Bandgap String Inverters for Low-Cost Medium-Voltage Transformerless PV Systems
Virginia Tech	Ultra Compact Electrolyte-Free Microinverter with Megahertz Switching

SUNLAMP Project Highlight: Evolving from Grid-Following to Grid Forming Inverter Controls (NREL)

In 2030, **80%** of electricity could flow through power electronics.

L.M. Tolbert, et al., ORNL, 2005.



- NREL SunLamp project, Brian Johnson and Yashen Lin, 2015-18
- Project answers key questions on how to achieve synchronism among a set of grid-forming inverters using virtual oscillator control

Solar Photovoltaic Inverter will play a major role in Power
Electronics based grids of the future

Thank you!