# Solar Energy Technologies Office Overview

### **MISSION**

We accelerate the advancement and deployment of solar technology in support of an equitable transition to a decarbonized energy system by 2050, starting with a decarbonized power sector by 2035

### WHAT WE DO

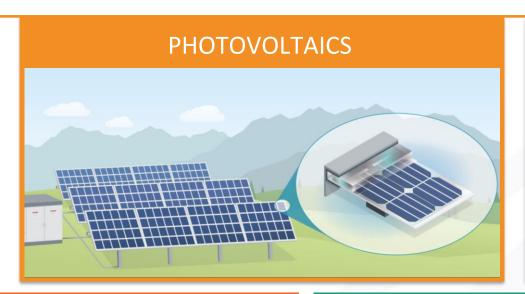
Drive innovation in technology and soft cost reduction to make solar **affordable** and **accessible** for all Americans

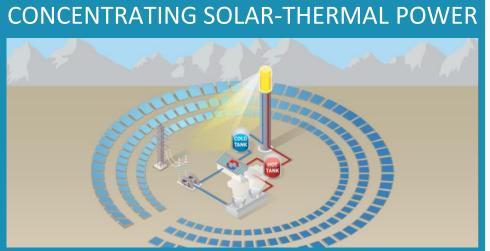
Enable solar to support the reliability, resilience, and security of the grid

Support job growth,
manufacturing, and the circular
economy in a wide range of
applications

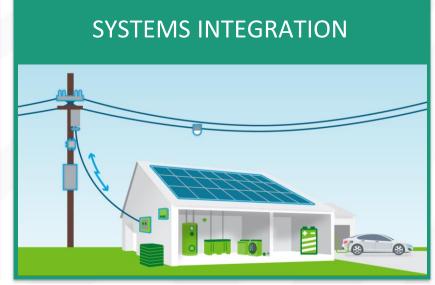


# **SETO Program Areas**





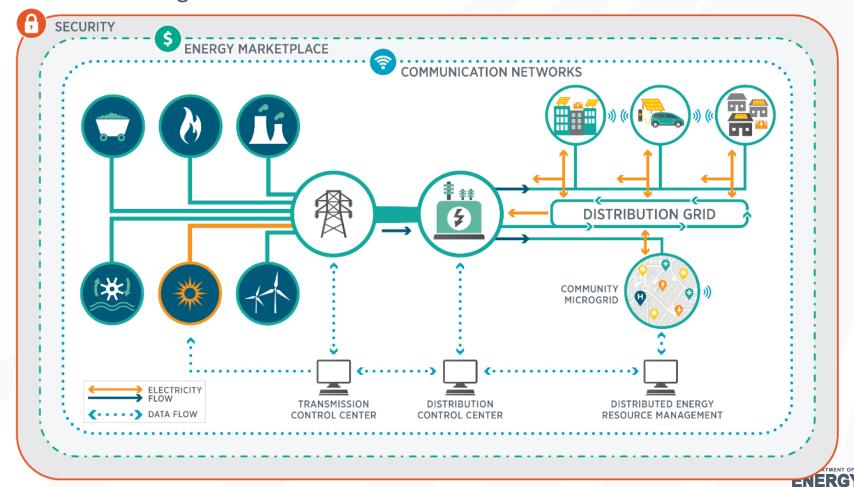






# **SETO Systems Integration (SI) Program**

The SI program supports research, development, and demonstration of data, analytics, controls, and hardware technologies that advance the **reliable**, **resilient**, **secure**, **and affordable** integration of solar energy onto the U.S. electric grid.



### **DOE-wide Collaboration on Grid Modernization**

DOE's Grid Modernization Laboratory

Consortium – 14 National Labs – 100+ Partners





# **Solar Supporting Reliable Grid Operation**

Today: PV only contributes energy to the grid; PV doesn't support all aspects of grid stability (e.g., frequency and voltage regulation)

Next 5 Years: Smart PV inverters contribute essential grid reliability services like a conventional generator (e.g., frequency and voltage regulation)

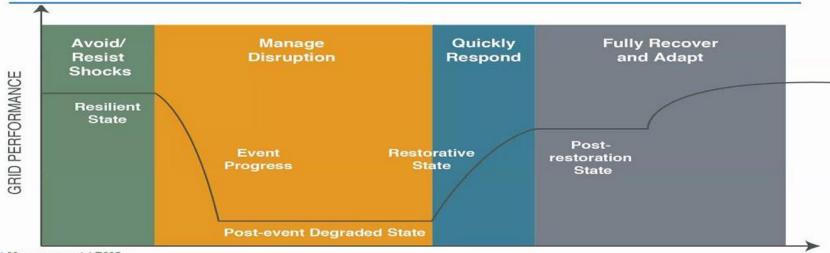
Next 10 Years: Harness the fastresponding capabilities of power electronics-based generators to improve the efficiency and reliability of the grid in areas with high penetrations of wind and solar

### **Ongoing foundational research topics:**

- PV cybersecurity
- Situational awareness
  - Solar forecasting
- Integration with storage, controllable loads, and other distributed energy resources
  - Distributed energy resource management systems

# **Designing for Resilient Systems**

### **Phases of Electric System Resilience**



SNL (Jeffers, Broderick)

- Asset Management / BMS
- · Advanced Planning Process
- Vegetation Management & EAB Focused Tree Trimming
- Distribution Standards Including Storm Hardening
- Inspection & Maintenance Program
- Targeted Minor Storm Hardening
- · Flood Mitigation
- · Side Tap Fusing
- Substation Perimeter Fence
- Intrusion Detection
- Cyber Security

#### TIME

- Sub-Transmission Automation
- FLISR
- Recloser Loops Scheme Programs
- Remote Terminal Units
- Line Sensors
- Mobile Transformer Fleet
- Critical Spares
- Damage Appraisal & iPads
- Emergency Response Plan
- Outage Management System
- Mutual Aid agreements

- Reliability and Emerging Risk Assessments
- Event Analysis
- Event Forensics
- Reliability Guidelines and technical reference documents
- System Operator Certification and Credential Maintenance
- System Operator Training
- Periodic Review

# Solar + Storage Enhancing Grid Resilience

### **Today**

- PV + storage can power simple building loads in the event of an outage for a short period
- PV can reduce need for fuel storage for back-up power

#### **Next 5 Years**

- PV black-start capabilities validated in field trials
- PV + storage operating in microgrid mode for longer durations
- PV can provide significant fuel savings compared with back-up generators

#### Next 10-15 Years

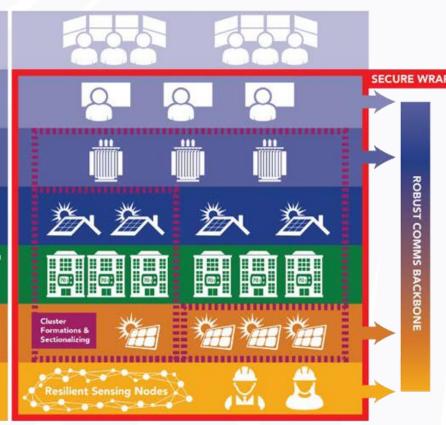
- PV + storage black-start solutions adopted to start up microgrids in the event of an electricity outage
- New design and control capabilities enable grid reconfiguration to supply critical loads during an outage

### **Ongoing foundational research topics:**

- PV cybersecurity
- Solar forecasting
- Control optimization algorithms
- Integration with storage, controllable loads, and other distributed energy resources
  - Distributed energy resource management systems

## **GMLC-RDS: CleanStart DERMS (LLNL)**

- Approach: Achieve black start and restoration objectives through combination and application of advanced co-simulation and architecture design, measurement and analytics, controls and optimization, communications and cyber security
- TD&C co-simulation planning tools 1-2hr will be used to design, validate and evaluate CSDERMS controls and scale up results for metrics and impact
- Master Control Control Establish Local Overarching **Master Control** Control >> CUSTOMER CONNECTION ACHIEVED Legacy & New PCC's to Controls Dist Grid Interaction **Establishment** Uncontrollable Of Island Drives 2-3hr Reconnection **Analytics Driven** BMS & **Automated Load Control** Response First Layer Grid **Robust Controllable** Establishment **DER Blackstart Devices** >> SHUTDOWN Analytics, Sensors & Prescription & Measurement Prediction



- Distinctive characteristics
  - Development of dynamic ad-hoc microgrids, which form around resilience objectives integrating both traditional and non traditional DER
  - Solves critical problems for partner utilities yet applicable throughout the nation at similar facilities

# **Building Resilient Power System in Puerto Rico**

Objective: DOE Office of Electricity and SETO have tasked national laboratories to perform near-, medium-, and long-term modeling activities to support the rebuilding of a more resilient electric power grid system in Puerto Rico after the devastation of Hurricane Maria in late September 2017.

### Phase 2 Approach:

- 1. Build on insight from research in Hawaii and elsewhere
- 2. Develop integrated portfolio
- 3. Rigorous modeling and analysis
- 4. Broad stakeholder engagement (federal, state, local community, and industry)

### Fuels/Interdependencies

- LNG Infrastructure
- Telecom Infrastructure
- Solar Resource and Supply Curves

#### **Bulk Power System**

- Investment Support Tools
- Capacity Expansion Modeling (AURORA)
- Production Cost Modeling (FESTIV)
- System Stability Modeling (Epfast)
- Dynamic Modeling (MAFRIT)

#### Lead Lab Key:

- ANL
- NREL
- ORNL
- PNNL
- SNL

#### **Transmission**

- Protection and R/T Info
- Risk-Based Contingency Analysis
- · Grid Asset Benefit-Cost Evaluations

#### **Distribution & Edge**

- System Advisory Model & PVWatts
- DER Interconnection Standards
- DER Feeder Hosting Methodology
- Contingencies, Operations, and Storage Sizing for Islandable Sections
- GIS Resiliency Improvement Tool

