SOLAR ENERGY
TECHNOLOGIES OFFICE
U.S. Department Of Energy

Solar Grid Integration R&D and System Resilience

GMLC-RDS Sandia SAG Meeting

January 22-23, 2020

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Solar Energy Technologies Office

WHAT WE DO

The Solar Energy Technologies Office funds early-stage research and development in three technology areas: **photovoltaics**, **concentrating solar power**, and **systems integration** with the goal of improving the affordability, reliability, and performance of solar technologies on the grid.

HOW WE DO IT

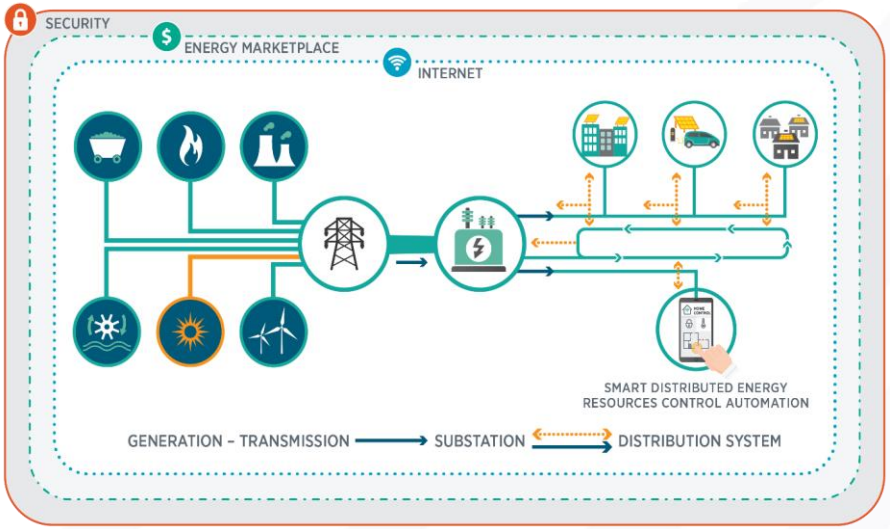
Cutting-edge **technology development** that drives U.S leadership and supports a growing and skilled workforce.

Research and development to **address integration of solar** to the nation's electricity grid.

Relevant and objective technical information on solar technologies to stakeholders and decision-makers.

SETO Systems Integration (SI) Program

The Systems Integration (SI) subprogram supports early-stage research, development, and field validation for technologies and solutions that advance the reliable, resilient, secure and affordable integration of solar energy onto the U.S. electric grid.



- System Planning Model and Simulation
- System Operation and Reliability
- PV for Resilience Design
- Power Electronic Devices and Control

DOE Grid Modernization Initiative

EERE, OE, FE, NE, CESER

MYPP → GMLC Lab Call (2016) → Resilient Distribution System (2017) → GMLC Lab Call (2019)

Focus Areas:

- Devices and integrated systems
- Sensing and measurement
- System operations and control
- Design and planning tools
- Security and resilience
- Institutional support

Multi-Lab Collaboration:

- $220M
- 88 projects
- Foundational
- Program specific
- Regional partnerships

Multi-Lab Collaboration:

- $32M
- Resilient distribution systems
- 6 field validation projects
- 1 valuation analysis team
- Utility and industry partners
- Focus on DERs

Multi-Lab Collaboration:

- $80M
- 6 topic areas
- 20 projects

Latest Initiatives

- March 2019 – ASSIST FOA, $34M, 10 awards
  - improve situational awareness of solar energy systems, especially at critical infrastructure sites, increase resilience to cyber and physical threats, and strengthen solar integration on the grid.
- November 2019 – FY19 FOA, $50M, 15 awards
  - Adaptive Distribution Protection,
  - Grid Services from Behind-the-Meter DERs
  - Advanced PV Controls and Cybersecurity
- North American Energy Resilience Model (NAERM)
  - collaboration with Wind, Water, and OE
  - Use cases
    - NG-BES interdependency use case
    - DER inverter tripping
    - Polar vortex

Award Profiles: https://www.energy.gov/eere/solar/systems-integration-competitive-awards

GMLC Resilience Distribution System (RDS) Program

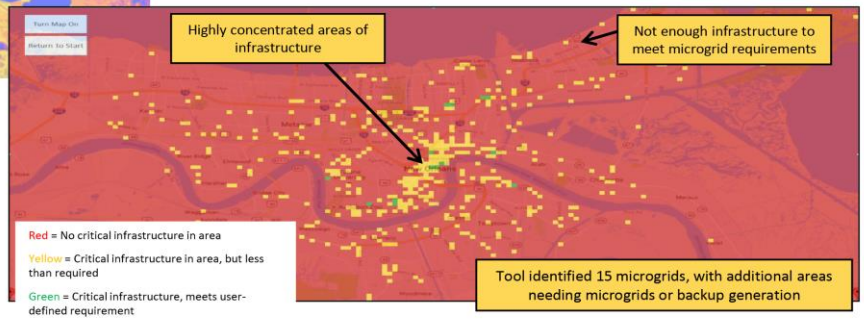
- **Objectives:** develop and validate the integration of DERs, such as solar PV, storage, and emerging grid technologies to enhance the resilience of distribution grids.

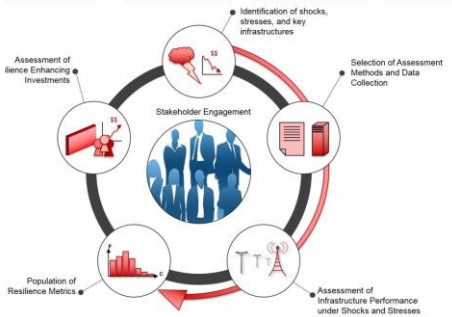
Demo projects:
- SLAC
- SNL
- PNNL
- ORNL
- LLNL
- INL

Valuation Analysis project
- LBNL

Results of Hurricane Inundation Modeling for New Orleans and surrounding regions

Area size of 1000 ft x 1000 ft | minimum of 4 buildings per microgrid

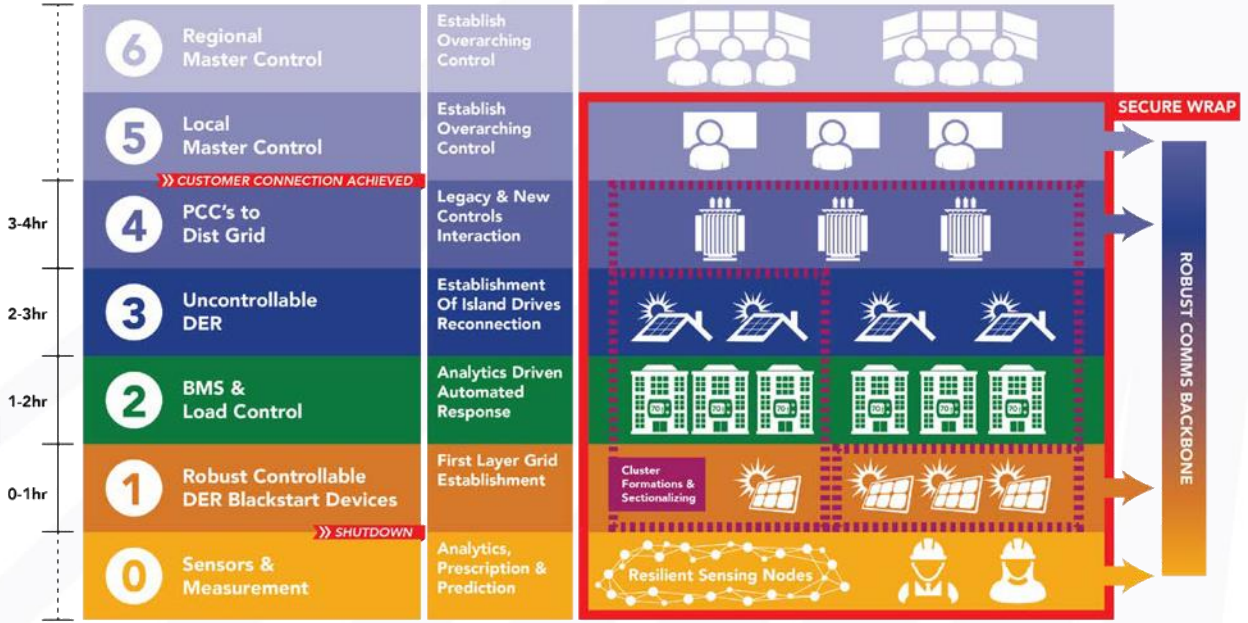




- Applying grid and infrastructure modeling to determine grid investments that will improve community resilience.
- **Resilience metric:** use microgrid designs to maximize the number of people with access to key services during flooding scenarios.

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 will be used to design, validate and evaluate CSDERMS controls and scale up results for metrics and impact



- 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)

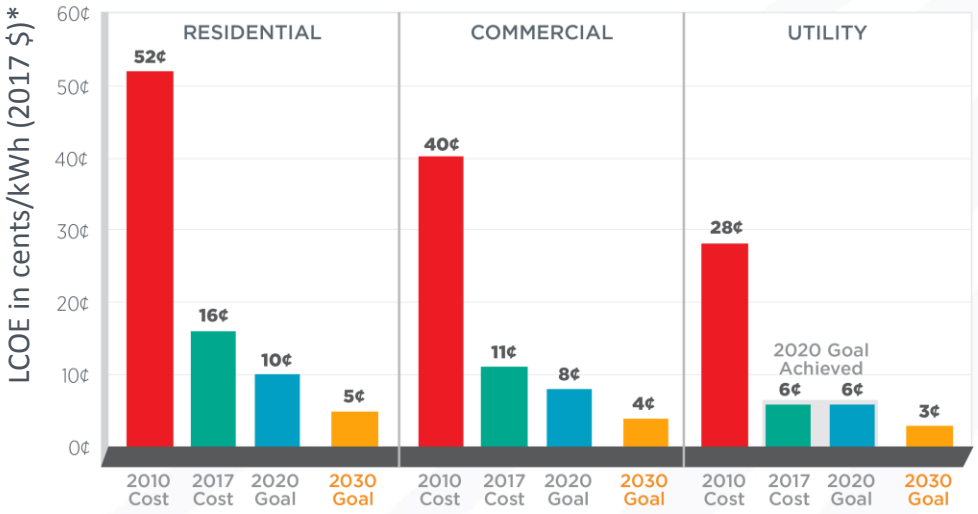
Transmission
- Protection and R/T Info
- Risk-Based Contingency Analysis
- Grid Asset Benefit-Cost Evaluations

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

Lead Lab Key:
- ANL
- NREL
- ORNL
- PNNL
- SNL

Progress and Goals: 2030 Photovoltaics Goals

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.

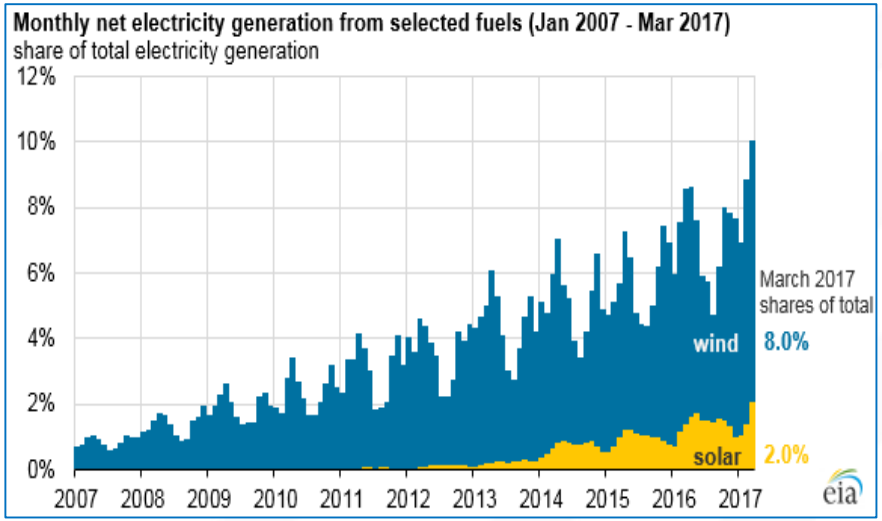


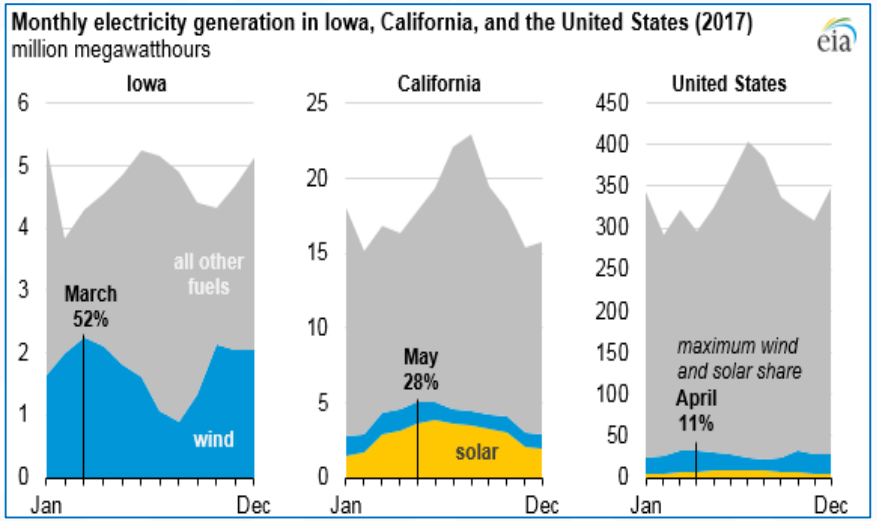
Lazard Report on Lowest Unsubsidized LCOE (end of 2018)	
Rooftop Residential Solar	$160/MWh
Simple Cycle GT	$152/MWh
Nuclear	$112/MWh
Rooftop C&I Solar	$81/MWh
Coal	$60/MWh
Combined Cycle GT	$41/MWh
Utility-Scale Solar	$36/MWh
Onshore Wind	$29/MWh

*Levelized cost of electricity (LCOE) progress and targets are calculated based on average U.S. climate and without the ITC or state/local incentives. The residential and commercial goals have been adjusted for inflation from 2010-17.

Addressing Renewable Integration Challenges

- United States in 2017 reached 8% for the year and peaked at 11% in April.
- California's annual solar share was 15.6%
- Wind and solar made up at least 20% of electric generation in 10 states in 2017





Thank You!

& Let’s Work together!