Solar Energy Technologies Office
Quarterly Stakeholder Webinar
Solar Energy Technologies Office

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ergy.gov/solar-office
Agenda

Office of Energy Efficiency and Renewable Energy Vision and Priorities
Daniel R Simmons, Assistant Secretary, Office of Energy Efficiency and Renewable Energy

SETO Overview and Updates
National Community Solar Partnership
Becca Jones-Albertus, Deputy Director, Solar Energy Technologies Office

Sustainable and Holistic Integration of Energy Storage and Solar PV
Guohui Yuan, Program Manager, Solar Energy Technologies Office
Guest Speaker, Shay Bahramirad, Vice President of Engineering and Smart Grid at ComEd
QUESTIONS?

Please use the Q&A feature to ask your questions.
Productivity and the Environment

Source: U.S. Environmental Protection Agency
EERE Priorities

Affordability

Storage

Integration
Affordability
Storage
Integration
Thank You

Daniel Simmons
Assistant Secretary
Office of Energy Efficiency and Renewable Energy
U.S. Department of Energy

energy.gov/eere
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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.

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 Subprograms

PHOTOVOLTAICS

CONCENTRATING SOLAR POWER

SYSTEMS INTEGRATION

INNOVATIONS IN MANUFACTURING COMPETITIVENESS

BALANCE OF SYSTEMS SOFT COST REDUCTION

1% Permitting, Installations, Interconnection
2% Sales Tax
5% Installation Labor
5% Supply Chain Costs
6% Installer/Developer Profit
12% Indirect Corporate Costs
43% Financing Costs

74%

Sensors throughout the grid system allow grid operators to better understand how energy moves along the grid.

202 Awards

152 Small Businesses

Nearly $6.3B of
Follow on Funding

Over $248M
Invested

RESULTING IN A 25x Investment Multiplier

energy.gov/solar-office
DOE Solar Office Funds 375+ Active Projects

Projects and partners in **38** states
plus the District of Columbia

- **40%** of projects at national labs
- **35%** of projects with universities
- **25%** of projects with businesses & non-profits*

*2% of state and local government

FY2019 BUDGET: $246,500,000
Update of SETO Activities in Q3 2019

- Announced **Winners of Round 1 of the American-Made Solar Prize**, in addition to:
  - Twenty Teams Selected for **Round 2**
  - Launched **Round 3**—Submit Ideas by December 10!
- Launched the **National Community Solar Partnership**
- Teams Selected for the **Solar District Cup**
- Announced New Prize Competition: **Solar Desalination Prize**
Solar Energy Technologies Office FY2019 Funding Program

$130 Million for Advanced Solar Energy Research

The U.S. Department of Energy Solar Energy Technologies Office is looking to fund up to 80 projects that lower the cost of photovoltaic and concentrating solar-thermal power technologies, improve grid integration, develop manufacturing solutions, and lower soft costs by reducing regulatory burdens.

Funding Opportunity Topic Areas

- Photovoltaics Research and Development
- Concentrating Solar-Thermal Power Research and Development
- Balance of Systems Soft Costs Reduction
- Innovations in Manufacturing – Hardware Incubator
- Advanced Solar Systems Integration Technologies
FY 2019 FOA Timeline

- **Letter of Intent Due**
  - May 7, 2019
- **Concept Paper Due**
  - May 14, 2019
- **Full Application and SIPS Applications Due**
  - July 25, 2019
- **Reply to Reviewer Comments Due**
  - Sept 6, 2019
- **Receive Notification of Selection/Non-Selection**
  - November 2019

*Stay tuned: selections to be announced in November!*

Expected Timeframe for Award Negotiations: November 2019 - February 2020
$3 million prize competition
Ready!, Set!, and Go! Contests

National network of support organizations
American-Made Network

U.S. DEPARTMENT OF ENERGY
PURPOSE

Re-energize American ingenuity in solar innovation and manufacturing

Empower innovators with knowledge, resources, and access to rapidly transform ideas into prototypes

Network-powered pathway to disruptive innovation so ideas can become real products in months, not years
Phase3 Photovoltaics (Portland, OR)
- Prefabricated Solar Systems

Solar Inventions (Atlanta, GA)
- Configurable Current Cell: C3

Learn more at energy.gov/solar-prize
ROUND 3 IS OPEN

Register by December 10, 2019 at americanmadechallenges.org/solarprize
The National Community Solar Partnership is a coalition of community solar stakeholders working to expand access to affordable community solar to every American household by 2025.
Goals of the Program

- All Americans have a choice and sufficient education to make an informed decision about participation
- Overall energy cost burden does not increase as a result of participating in community solar
- Communities realize supplementary benefits and other value streams from community solar installations, such as increased resiliency and workforce development
Approach

- **Network Infrastructure**: Partners have access to an online community platform, virtual and in-person meetings, webinars and other tools to engage with U.S. Department of Energy (DOE) staff and each other.

- **Technical Assistance**: Partners have access to technical assistance resources from DOE, its National Laboratories, and independent third-party subject-matter experts for support on unique local challenges.

- **Collaboration**: Multi-stakeholder teams of partners form groups around specific goals to address common barriers to solar adoption by learning from each other and sharing resources.
Areas of Interest

- **Inclusive community solar models** that enable market adoption in underserved communities
- Community solar models that reduce energy bills for **multifamily affordable housing** dwellers and owners
- **Utility partnerships** around community solar models to expand solar access in their communities
Interested in Joining the Network?

Visit: energy.gov/community-solar
Email: community.solar@ee.doe.gov
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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.

**TOTAL SI BUDGET**

~ $50M/year  
~ 80 active projects
Addressing Near- and Long-Term Technical Challenges for High Penetration of Solar
A System Approach for Solar Grid Integration Research

**FOCUS AREAS**

- PV and Power System Modeling
- Integration with Energy Storage
- Power Electronics
- Solar Forecasting
- Situation Awareness
- Grid Services
- Cybersecurity
- Resilient Distribution and Microgrid
- Long-Term Resource Planning
- Real-Time Operation and Control
- Codes and Standards
- Stakeholder Collaboration
DOE Grid Modernization Initiative

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

Resilient Distribution System (2017)

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

MYPP

GMLC Lab Call (2016)

Multi-Lab Collaboration
• pending

GMLC Lab Call (2019)
Microgrid Integrated Solar Storage Technology (MISST)

SHINES: DE-EE000716
October 10th, 2019

Shay Bahramirad, PhD, Vice President of Engineering and Smart Grid, ComEd
Our Company:
- One of six utilities owned by Exelon. (Exelon also owns generation and energy sales businesses.)
- 6,400 Employees
- Service Territory: 11,428 square miles

Our Customers:
- Over 4 million customers in northern Illinois including the City of Chicago

Our Grid:
- Peak Load: 23,753 MW (7/20/2011)
- 553,800 distribution transformers
- 66,200 circuit miles of primary distribution
- 53% overhead, 43% underground
- 5,800 circuit miles of transmission
- 93% overhead, 7% underground
Today’s Energy Landscape Is Evolving

1. Climate change is requiring action.
   - Clean energy policy (renewables, Energy Efficiency)
   - Increase in weather related outages

2. Technology innovation is accelerating.
   - Increased penetration of Distributed Energy Resources (DER)
   - Costs of solar/storage are declining.

3. Customers are increasingly digital.
   - Customer segments of “one”
   - Pervasive connectivity

Clean
Resilient
Secure
Community
Demonstrating Cutting Edge MISST as Part of the Bronzeville Community Microgrid

The Bronzeville Community Microgrid will be a 7 MW microgrid serving 1000 residences, businesses and public institutions.

Development and demonstration of integrated, scalable, and cost-effective technologies for solar PV that incorporate energy storage in a microgrid.

Addresses availability and variability issues inherent in solar PV by: utilizing smart inverters for PV/battery storage, and working synergistically with other components within a community microgrid.

Represents an enabling technology for the widespread sustainable deployment of low-cost, flexible, and reliable PV generation.

$4 Million DOE Award
Smart Inverter Technology

<table>
<thead>
<tr>
<th>Mode of Operation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-Islanding</td>
<td>Refers to the ability to detect loss of utility source and cease to energize</td>
</tr>
<tr>
<td>Adjustable constant power factor</td>
<td>Refers to Power Factor set to a fixed value. Some manufactures refer to this as 'Specified Power Factor'</td>
</tr>
<tr>
<td>Voltage – Reactive (Volt-var)</td>
<td>Refers to control of reactive power output as a function of voltage</td>
</tr>
<tr>
<td>Ramp Rates</td>
<td>Refers to ability to have an adjustable entry service ramp rate when a DG restores output of active power or changes output levels over the normal course of operation</td>
</tr>
<tr>
<td>Voltage Ride through</td>
<td>Refers to ability of Smart Inverter to ride through a certain range of voltages before tripping off</td>
</tr>
<tr>
<td>Frequency Ride through</td>
<td>Refers to ability of Smart Inverter to ride through a certain range of frequencies before tripping off</td>
</tr>
<tr>
<td>Voltage – Active Power (Volt/Watt)</td>
<td>Refers to control of real power output as a function of voltage</td>
</tr>
<tr>
<td>Frequency - Watt</td>
<td>Refers to control of real power as a function of frequency</td>
</tr>
<tr>
<td>Grid Forming</td>
<td>Refers to ability of Smart Inverter to act as grid forming source in islanded mode</td>
</tr>
<tr>
<td>MPPT</td>
<td>Refers to the capability of the Inverter to maintain Power at maximum power point.</td>
</tr>
</tbody>
</table>

Tested Inverter Functionalities

- Smart inverter has enhanced capabilities to mitigate grid management challenges brought by DERs.
- The Robust Droop Control (RDC) technology was implemented in 100 kW smart inverter for PV and BESS applications and tested through the HIL tests.
Solar-Storage Coordinated Control

- The solar-storage coordinated control is the enhancement in the existing Microgrid Master Controller (MMC), developed during another DOE project.
- The control methodology considers robust modeling to accommodate the uncertainty in solar PV to dispatch a constant aggregated output.
- Developed algorithm has been tested through Hardware in the Loop tests via RTDS.

- **Multi-time scale model**
  - The model considers the sub-hourly variation of the PV outputs to handle the rapid changes.

- **Robust modelling**
  - The model considers all possible scenarios to mitigate the forecasting error or uncertainty.

- **Constant hourly aggregated solar-storage output**
  - The output of the solar-storage system in the proposed model will remain unchanged on an hourly basis even if the PV unit outputs deviate from the forecasted values.

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**Solar-storage controller high-level architecture**
Hardware in the Loop (HIL) Test Setup

**PHIL**
- Battery Simulator
- Inverter
- Current & Voltage Sensing Box
- Grid Simulator/Amplifier

**CHIL**
- MMC
- Communication between MMC and MGMS
- MGMS

**RTAC**
- Pinv Setpoint
- Pbat Setpoint
- P Measured Breaker Status Gen. Modes Operating Mode
- Battery Node Vref

**RTDS**
- Battery Node
- Vref

**Legend**
- AC Power
- DC Power
- Low Voltage Signal
- DNP3
- MODBUS
- Database Read/Write
Demonstrating Resilience through Islanding Capability

Successfully tested and demonstrated islanding ability on portion of the BCM feeder using BESS, PV and mobile generator

Schematic diagram of the test system

Real Power

- PV kW
- BESS kW
- Point of Interconnection
Next Steps

Commercialization of MMC
Integration & commercialization of developed MISST technology within Microgrid Master Controller into Microgrid Management System (MGMS)

HIL Testing
Build Hardware in the Loop testbed, install and configure selected hardware and MGMS via HIL through RTDS.

Field Implementation and Testing
Perform field islanding tests for microgrid islanding capability.

Data Collection and Analytics
Comprehensive data collection and analysis for budget period
3. Document analysis results and lessons learned.
Thank You!
Next Webinar

The next SETO Quarterly Webinar will be in January 2020. Sign up for our newsletter at energy.gov/solar-newsletter to be the first to know!
QUESTIONS?

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Smart Inverter Test Example: Volt-var

ComEd Volt-var Setting:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1</td>
<td>92</td>
</tr>
<tr>
<td>Q1</td>
<td>30</td>
</tr>
<tr>
<td>V2</td>
<td>96.7</td>
</tr>
<tr>
<td>Q2</td>
<td>0</td>
</tr>
<tr>
<td>V3</td>
<td>103.3</td>
</tr>
<tr>
<td>Q3</td>
<td>0</td>
</tr>
<tr>
<td>V4</td>
<td>107</td>
</tr>
<tr>
<td>Q4</td>
<td>30</td>
</tr>
</tbody>
</table>

ComEd Volt-var Setting: 100% Discharging

ComEd Volt-var Setting: 100% Charging
In the grid connected mode, only BESS and PV are used as DERs.

MMC calculates the BESS setpoint to retain the integrated BESS and PV output constant and to address the variability in PV.

In islanded mode, MISST algorithm provides optimal setpoint for BESS and PV along with other generators.