U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

Solar Energy Technologies Office

Quarterly Stakeholder Webinar

energy.gov/solar-office

Solar Energy Technologies Office

Solar Energy Technologies Office

Dr. Charlie Gay
Director

Dr. Becca Jones-Albertus
Deputy Director and Acting Soft Costs Program Manager

Dr. Elaine Ulrich
Senior Advisor

Ebony Brooks
Operations Supervisor

Dr. Lenny Tinker
Photovoltaics Program Manager

Dr. Avi Shultz
Concentrating Solar-Thermal Power Program Manager

Dr. Guohui Yuan
Systems Integration Program Manager

Garrett Nilsen
Technology to Market Program Manager

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.

Office of Energy Efficiency and Renewable Energy

U.S. DEPARTMENT OF ENERGY

OFFICE OF THE UNDER SECRETARY OF ENERGY

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

ENERGY EFFICIENCY
- Advanced Manufacturing
- Buildings
- Federal Energy Management
- Weatherization and Intergovernmental

RENEWABLE POWER
- Geothermal
- **Solar**
- Wind
- Water

SUSTAINABLE TRANSPORTATION
- Bioenergy
- Hydrogen and Fuel Cells
- Vehicles

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

energy.gov/solar-office

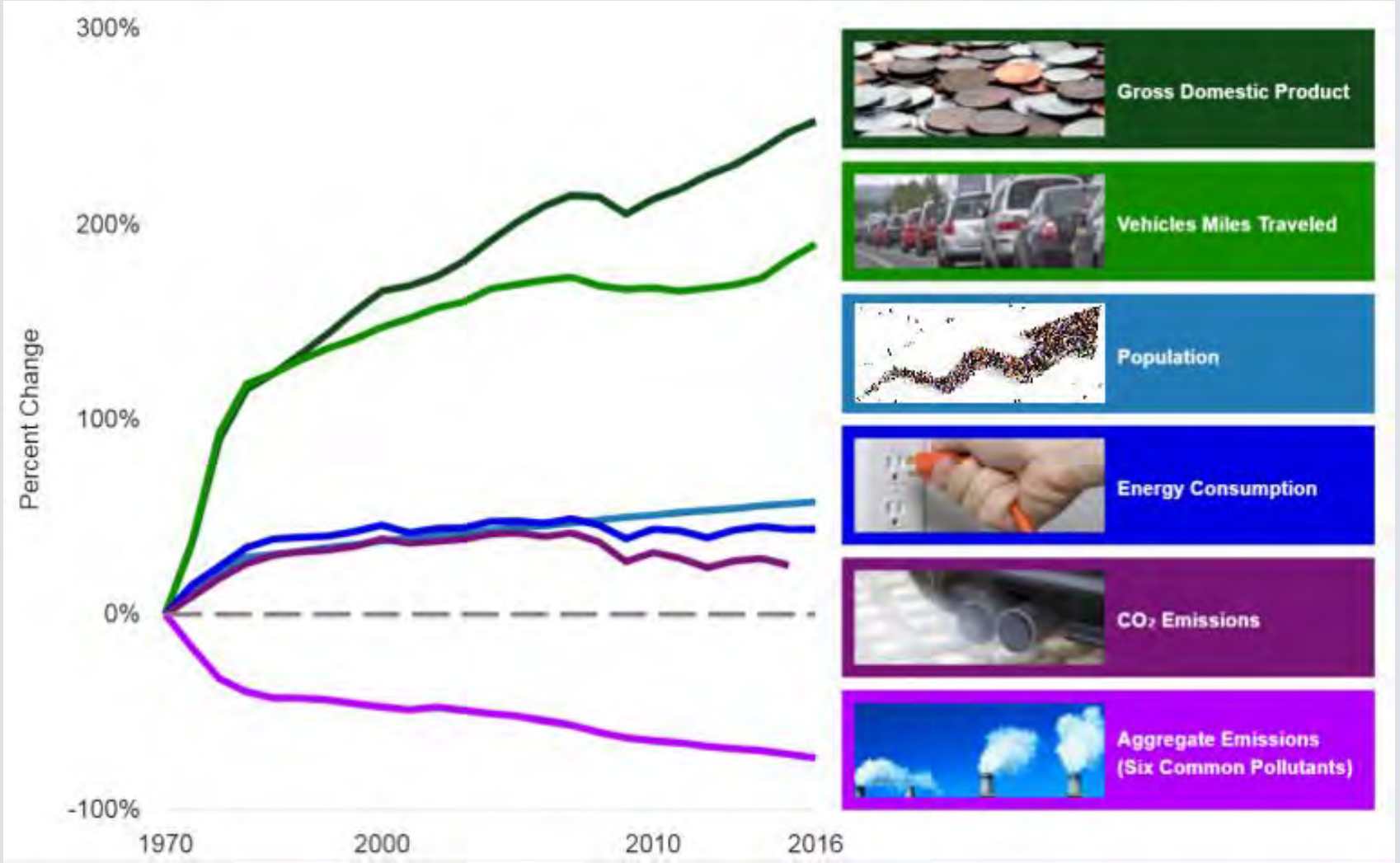
U.S. DEPARTMENT OF ENERGY

Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

Daniel R Simmons

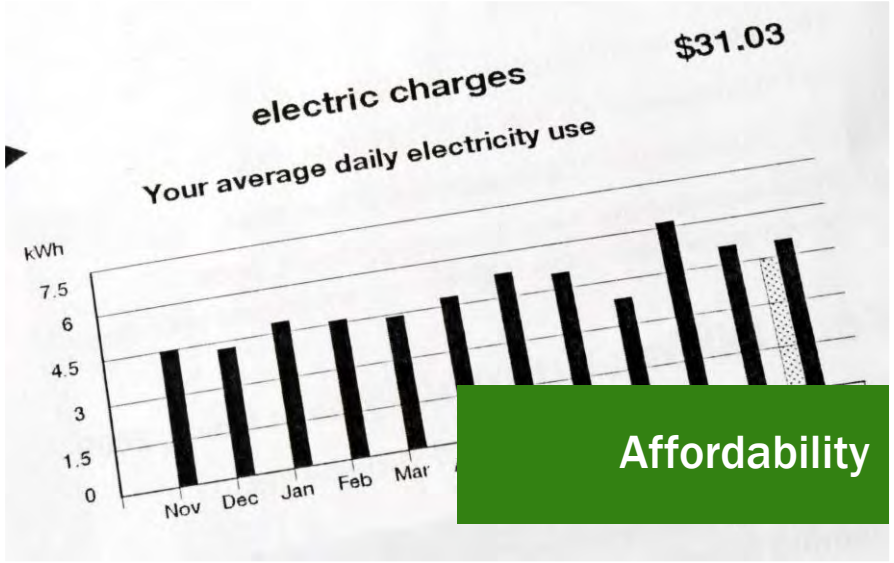
October 10, 2019

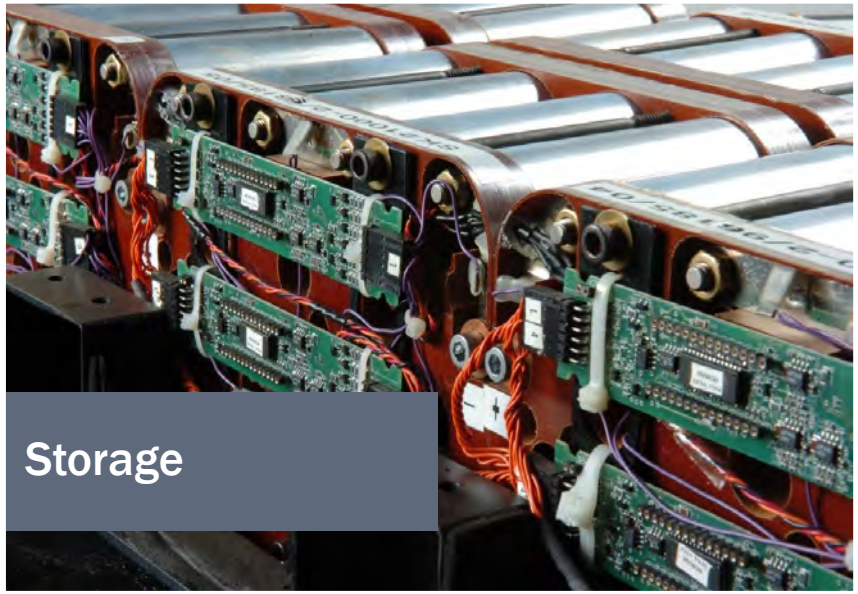
Productivity and the Environment



Source: U.S. Environmental Protection Agency

EERE Priorities





Affordability

Storage

Integration

Thank You

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

energy.gov/eere

QUESTIONS?

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

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

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

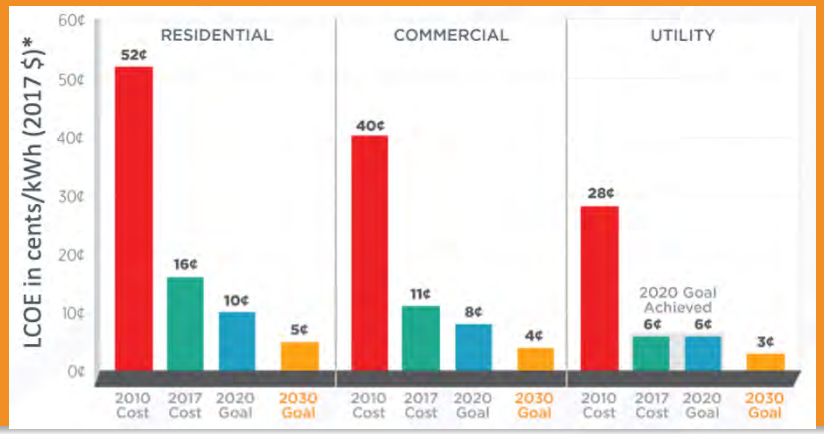
Cutting-edge **technology development** that drives U.S leadership and supports a growing and skilled workforce.

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

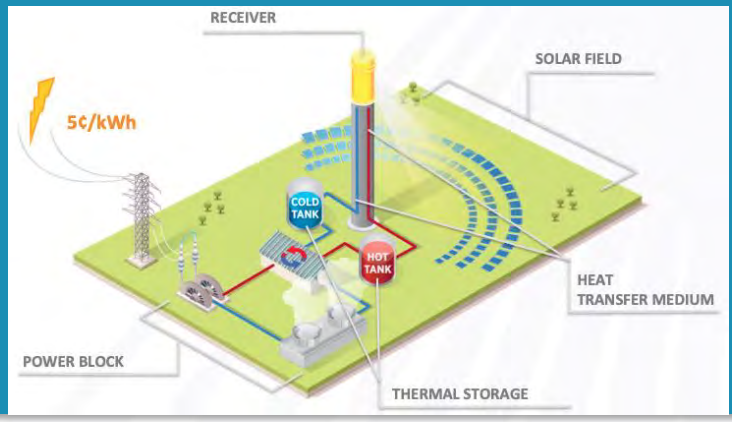
Relevant and objective technical information on solar technologies to stakeholders and decision-makers.

SETO Subprograms

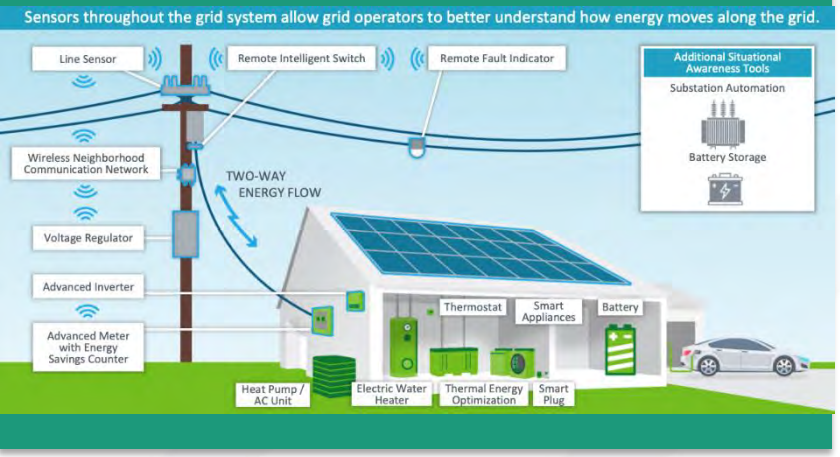
PHOTOVOLTAICS



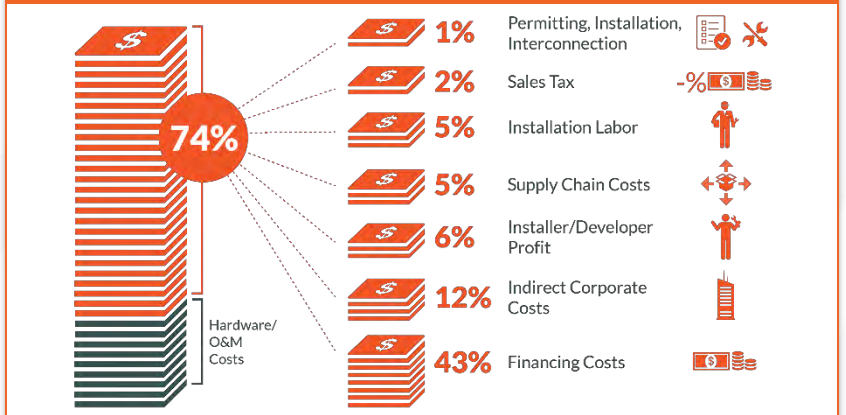
CONCENTRATING SOLAR POWER



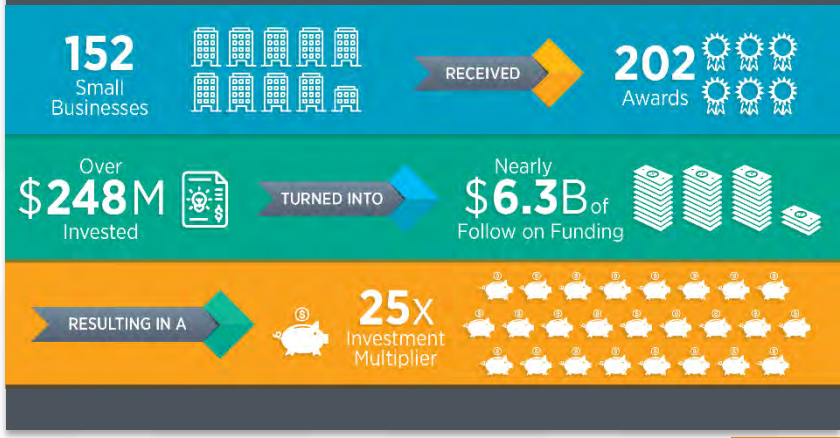
SYSTEMS INTEGRATION



BALANCE OF SYSTEMS SOFT COST REDUCTION



INNOVATIONS IN MANUFACTURING COMPETITIVENESS



DOE Solar Office Funds 375+ Active Projects

Projects and partners in **38** states

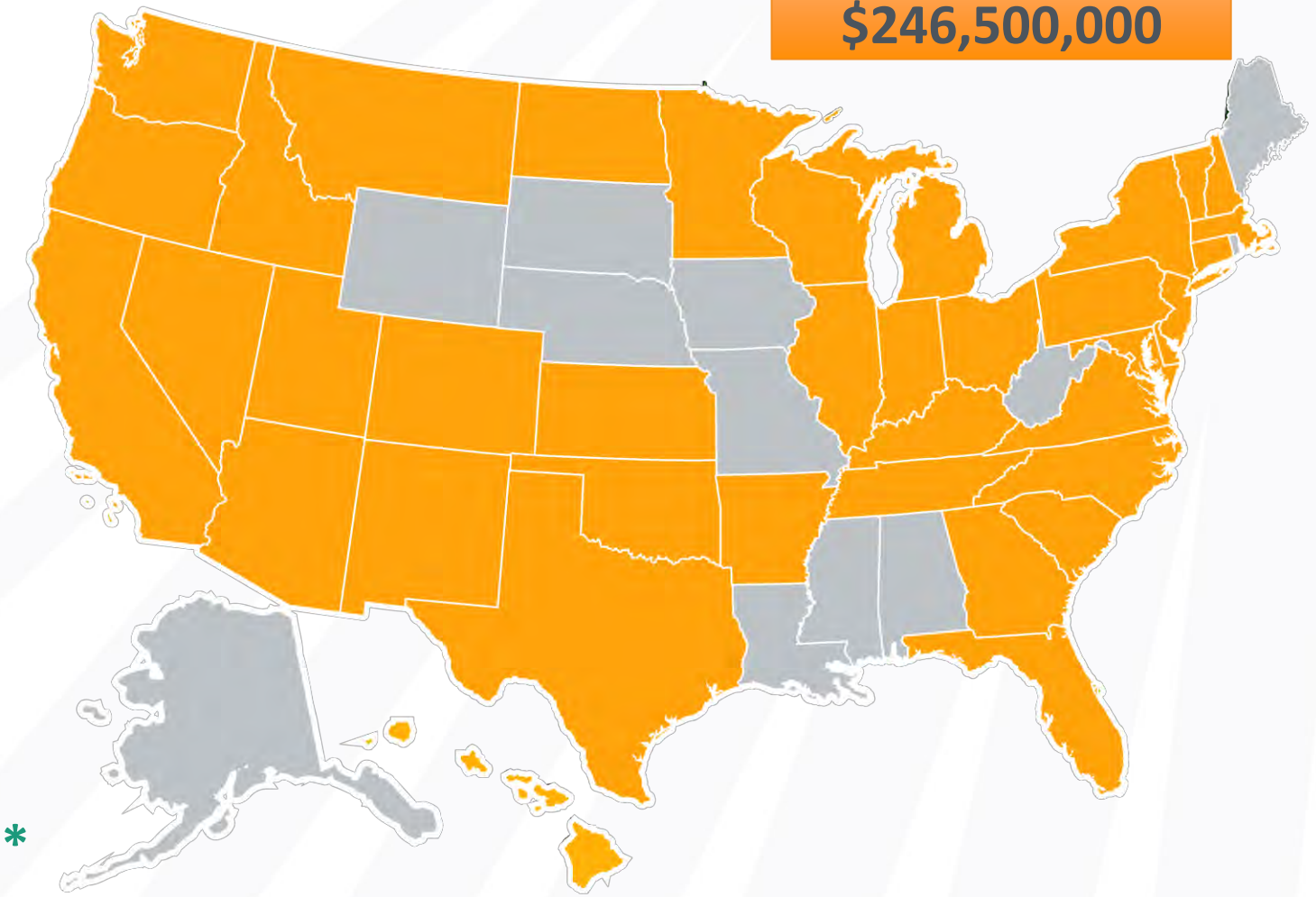
plus the **District of Columbia**

40% of projects at **national labs**

35% of projects with **universities**

25% of projects with **businesses & non-profits***

FY2019 BUDGET: $246,500,000



energy.gov/solar-office

*2% of state and local government

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

What's next for SOLAR?

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

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

AMERICAN MADE

SOLAR PRIZE

U.S. DEPARTMENT OF ENERGY

National network of support organizations

American-Made Network

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

ROUND 1 WINNERS

Learn more at energy.gov/solar-prize

AMERICAN MADE SOLAR PRIZE

U.S. DEPARTMENT OF ENERGY


ROUND 3 IS OPEN
Register by December 10, 2019 at
americanmadechallenges.org/solarprize
AMERICAN MADE
SOLAR PRIZE
U.S. DEPARTMENT OF ENERGY

National Community Solar Partnership

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

QUESTIONS?

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

Agenda

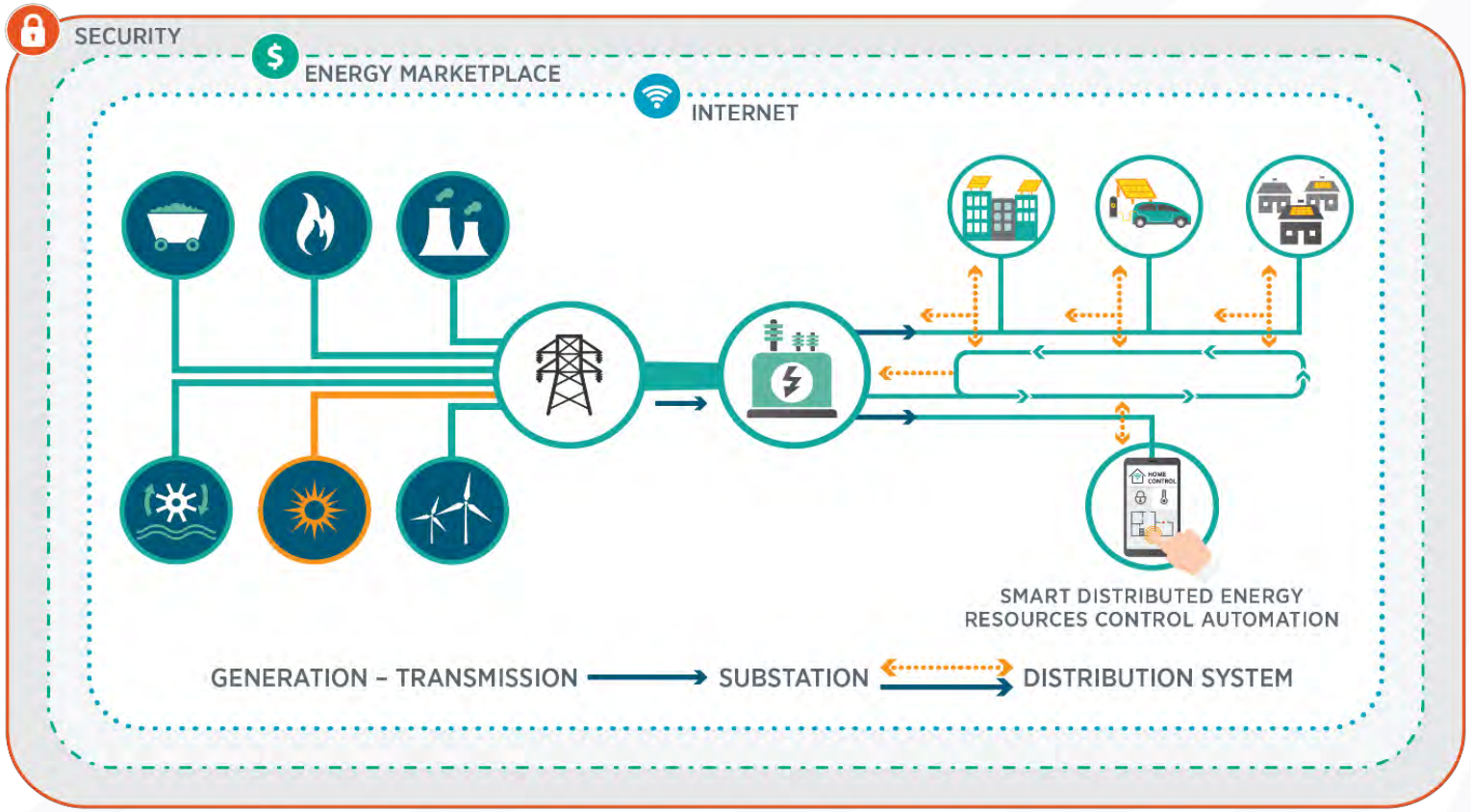
Office of Energy Efficiency and Renewable Energy Vision and Priorities
Daniel R Simmons, Assistant Secretary, Office of Energy Efficiency and Renewable Energy

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

SETO Systems Integration (SI) Program

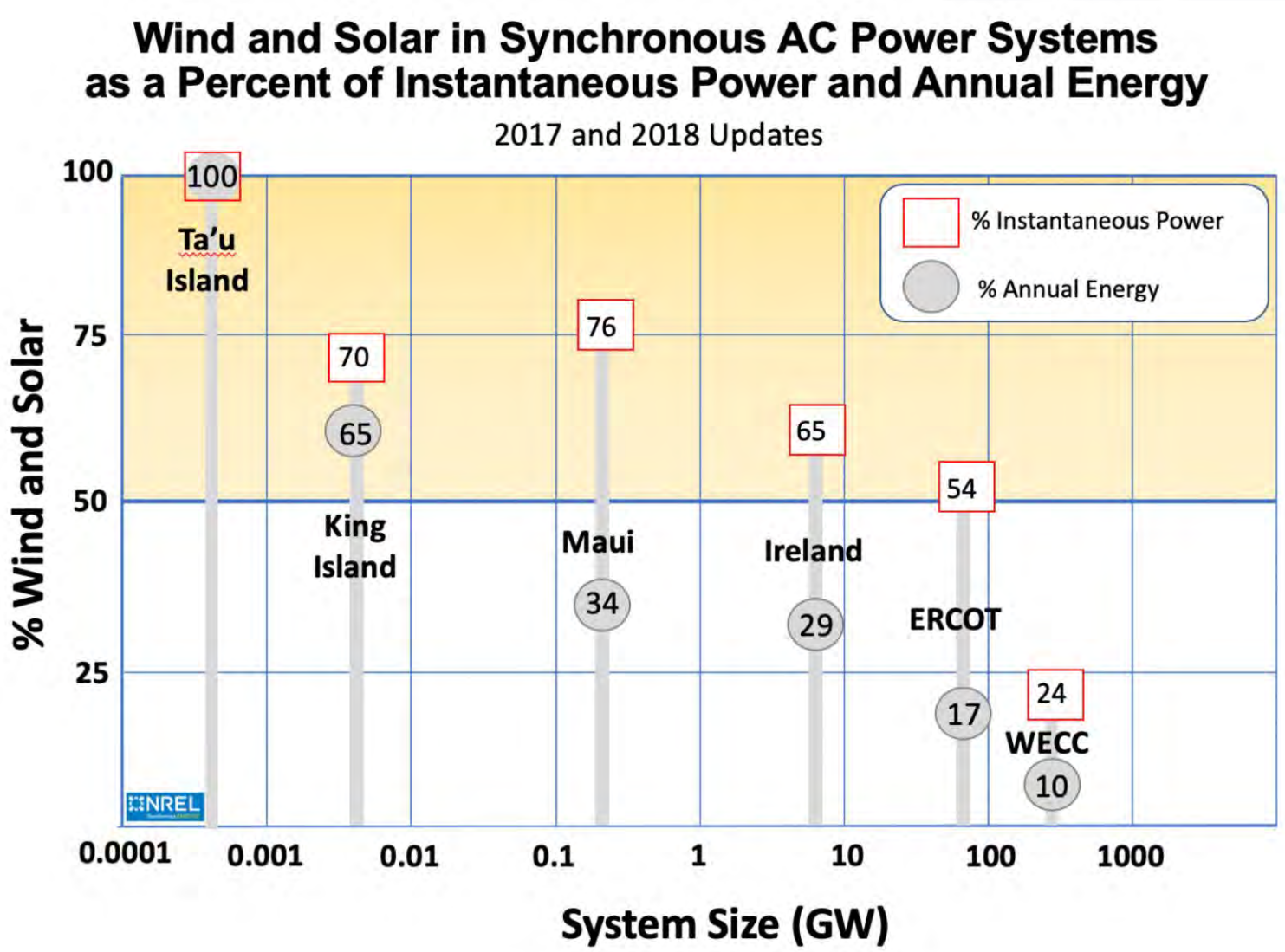
The Systems Integration (SI) subprogram supports early-stage research, development, and field validation for technologies and solutions that advance the **reliable, resilient, secure and affordable** integration of solar energy onto the U.S. electric grid.



TOTAL SI BUDGET

~ $50M/year
~ 80 active projects

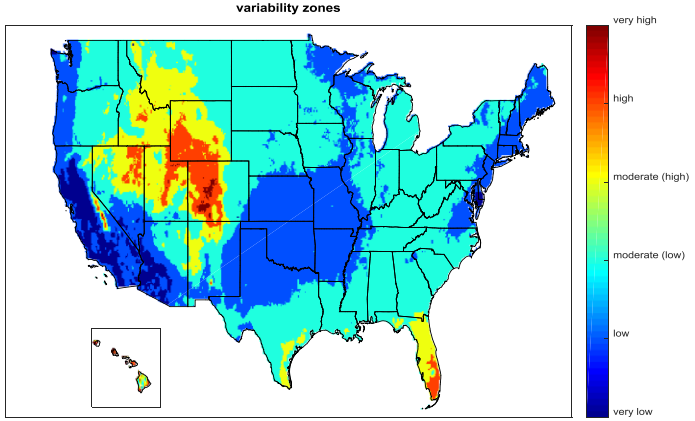
Addressing Near- and Long-Term Technical Challenges for High Penetration of Solar



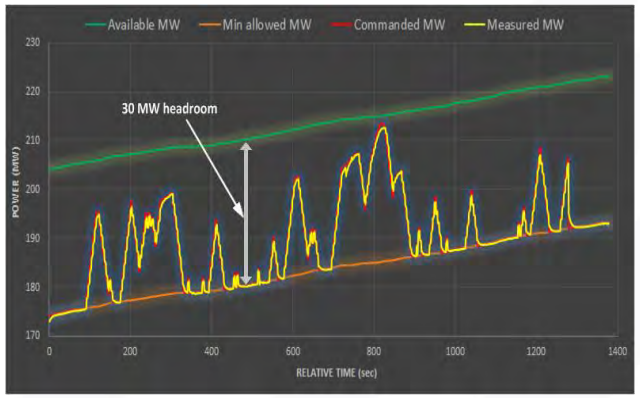
Ben Kroposki / NREL

A System Approach for Solar Grid Integration Research

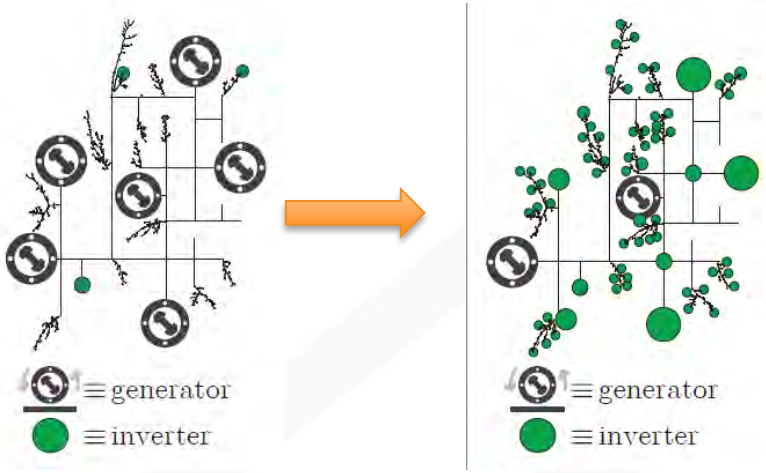
Solar Resource Data: NSRDB



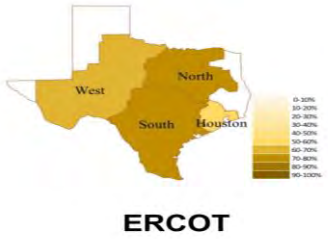
Grid Services: AGC following

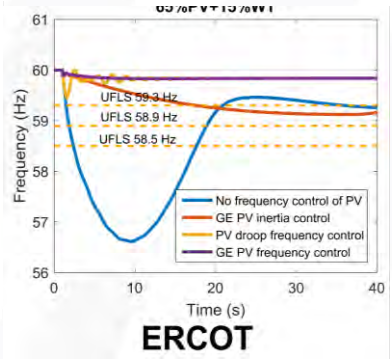


Advance Control: Grid Forming Inverters



System Modeling: Frequency Control





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

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
- pending

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

Microgrid Integrated Solar Storage Technology (MISST)

SHINES: DE-EE000716

October 10th, 2019

Shay Bahramirad, PhD, Vice President of Engineering and Smart Grid, ComEd

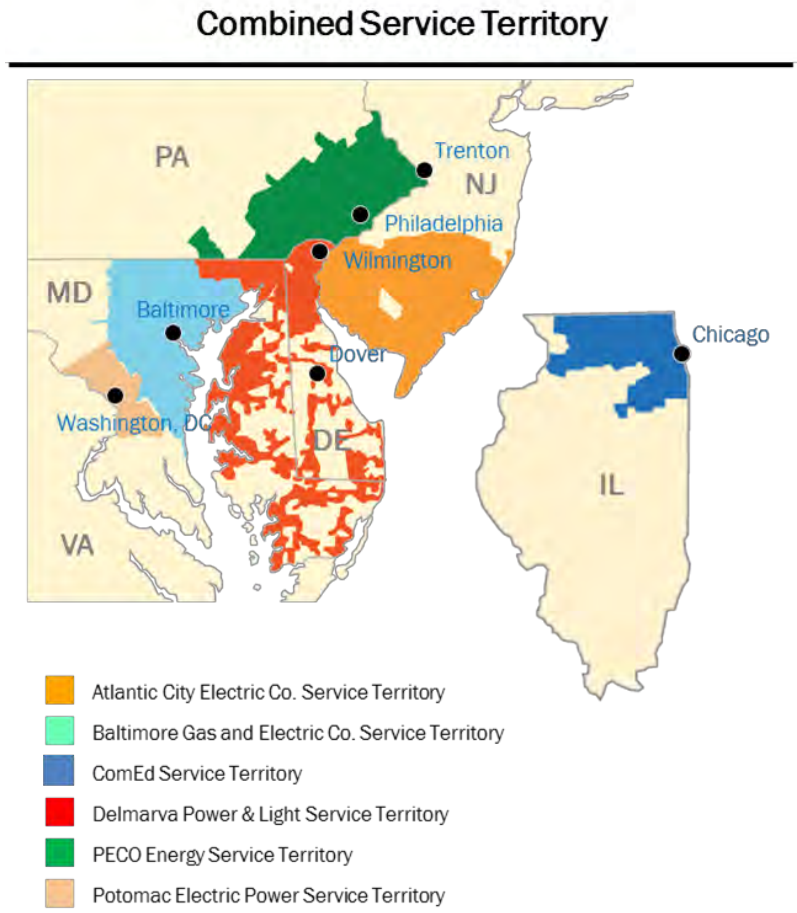
ComEd An Exelon Company | powering lives

ComEd, An Exelon Company

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

Solar PV

Battery Energy Storage

ILLINOIS INSTITUTE OF TECHNOLOGY

SIEMENS

UNIVERSITY of DENVER

QUANTA TECHNOLOGY

Argonne NATIONAL LABORATORY

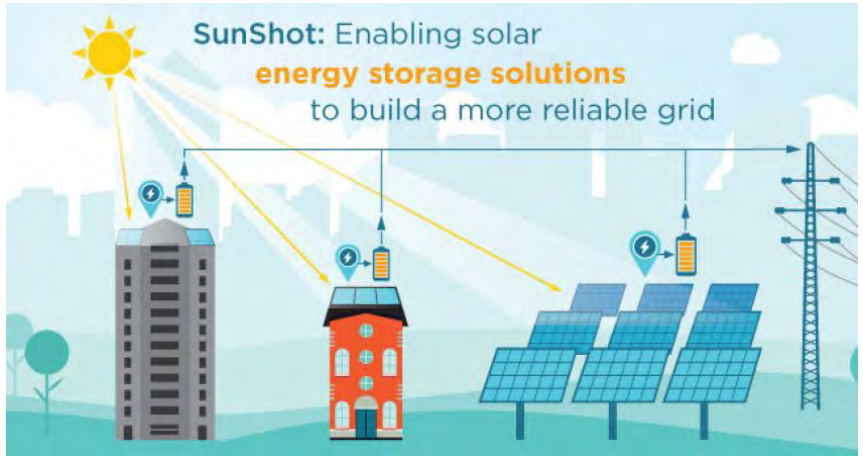
NREL Transforming ENERGY

Smart Inverter Technology

Mode of Operation	Description
Anti-Islanding	Refers to the ability to detect loss of utility source and cease to energize
Adjustable constant power factor	Refers to Power Factor set to a fixed value. Some manufactures refer to this as 'Specified Power Factor'
Voltage – Reactive (Volt-var)	Refers to control of reactive power output as a function of voltage
Ramp Rates	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
Voltage Ride through	Refers to ability of Smart Inverter to ride through a certain range of voltages before tripping off
Frequency Ride through	Refers to ability of Smart Inverter to ride through a certain range of frequencies before tripping off
Voltage – Active Power (Volt/Watt)	Refers to control of real power output as a function of voltage
Frequency - Watt	Refers to control of real power as a function of frequency
Grid Forming	Refers to ability of Smart Inverter to act as grid forming source in islanded mode
MPPT	Refers to the capability of the Inverter to maintain Power at maximum power point.

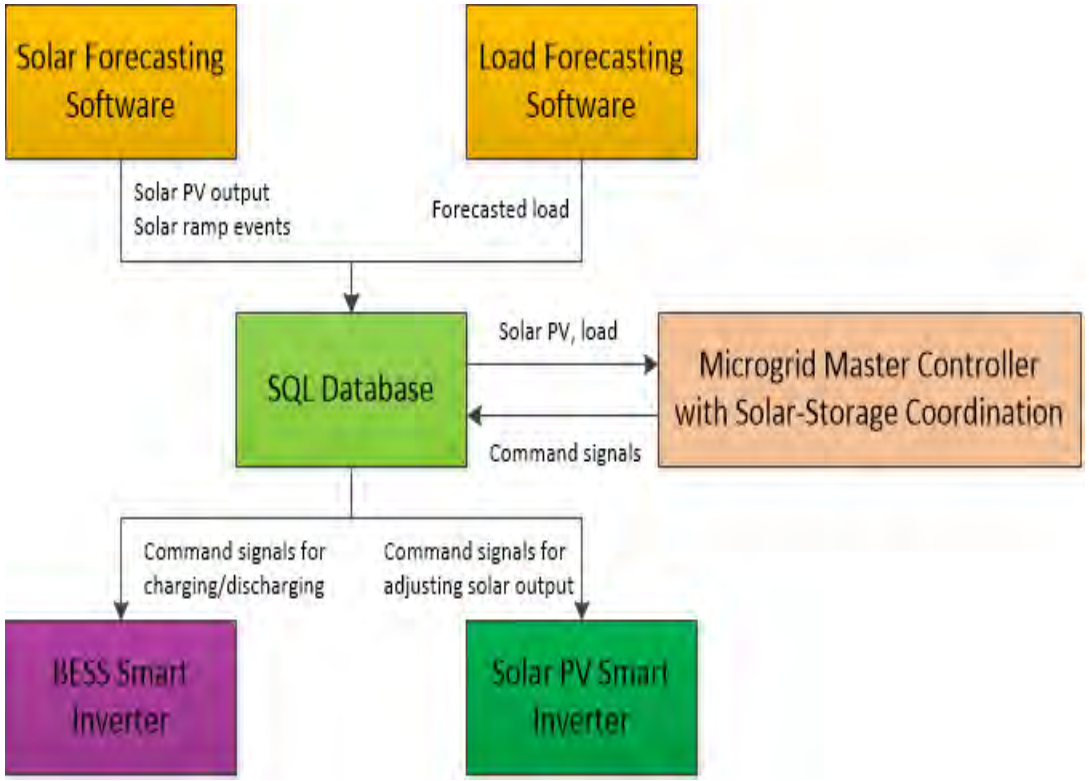
Tested Inverter Functionalities

- 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.



Solar-storage controller high-level architecture

▪Multi-time scale model

- The model considers the sub-hourly variation of the PV outputs to handle the rapid changes

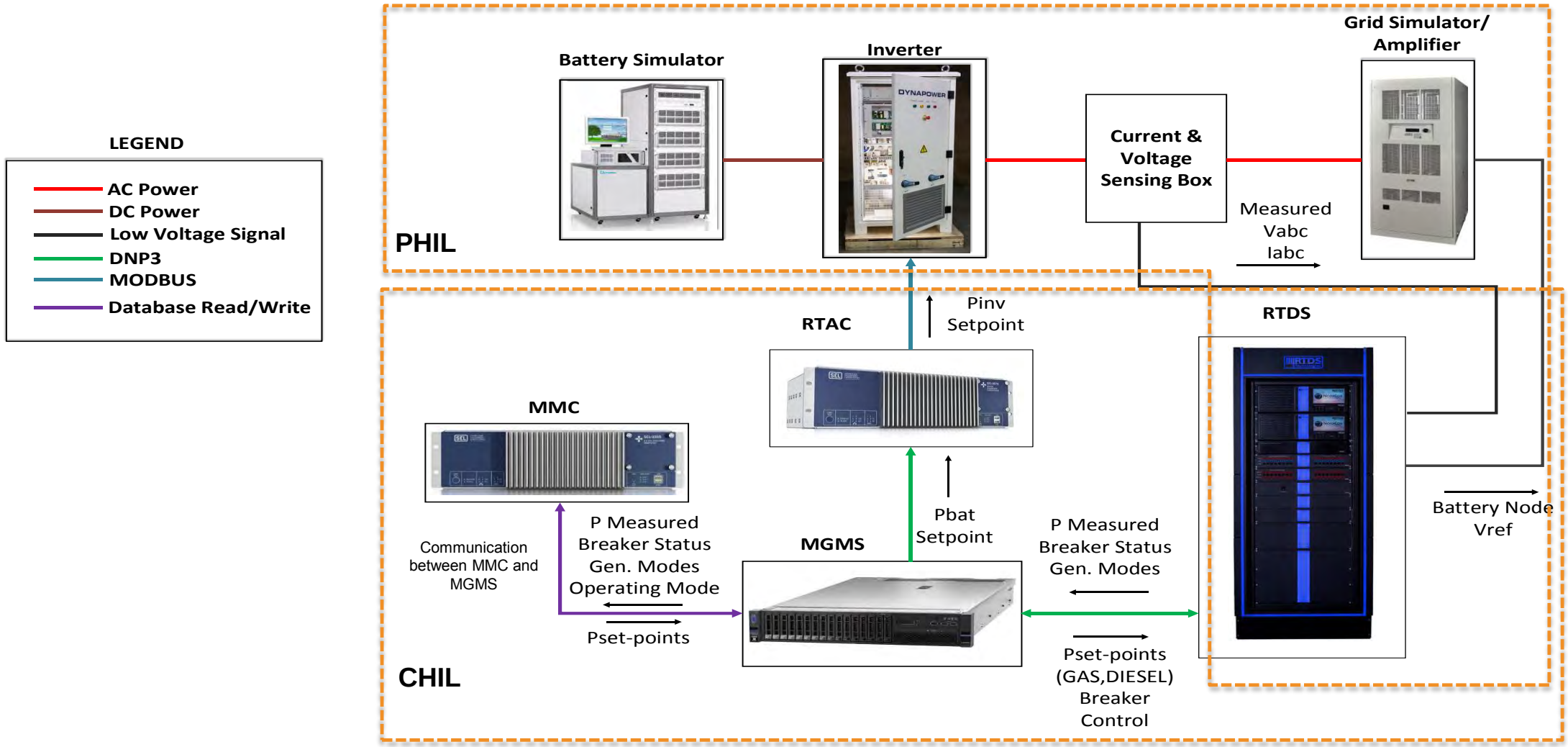
▪Robust modelling

- The model considers all possible scenarios to mitigate the forecasting error or uncertainty

▪Constant hourly aggregated solar-storage output

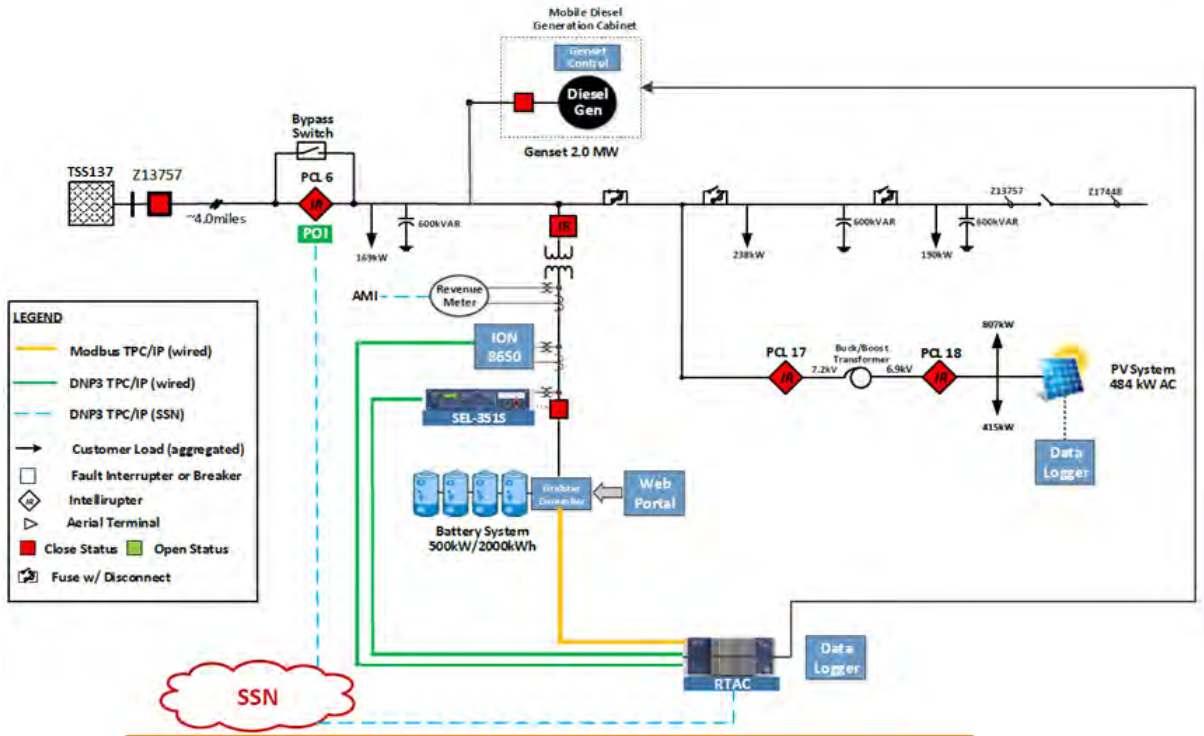
- The output of the solar-storage system in the proposed model will remain unchanged on an hourly basis even if the PV unit outputs deviate from the forecasted values.

Hardware in the Loop (HIL) Test Setup

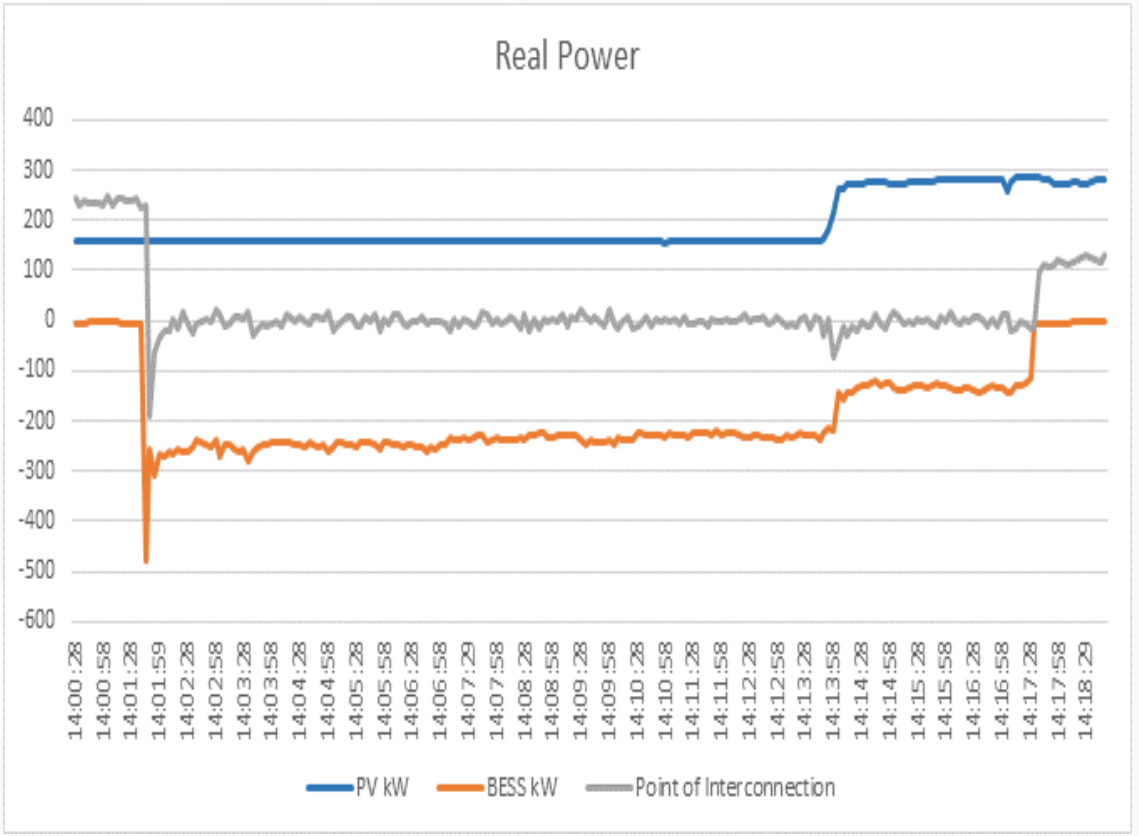


Demonstrating Resilience through Islanding Capability

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



Schematic diagram of the test system



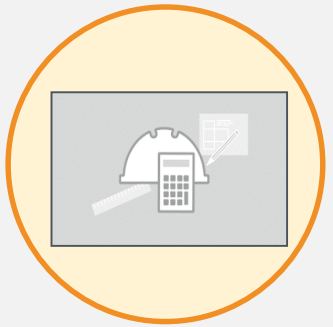
Next Steps

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.

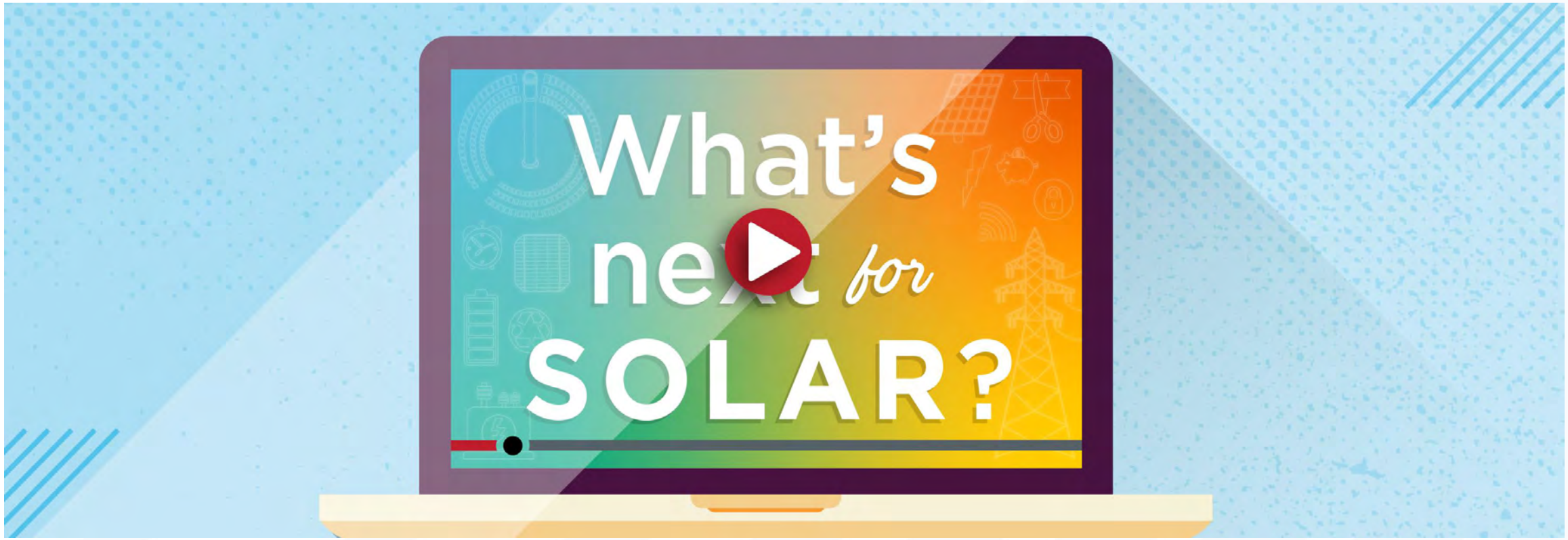
Data Collection and Analytics

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!



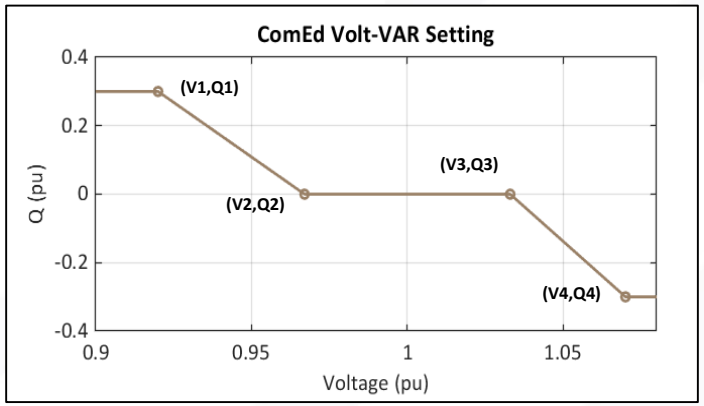
QUESTIONS?

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

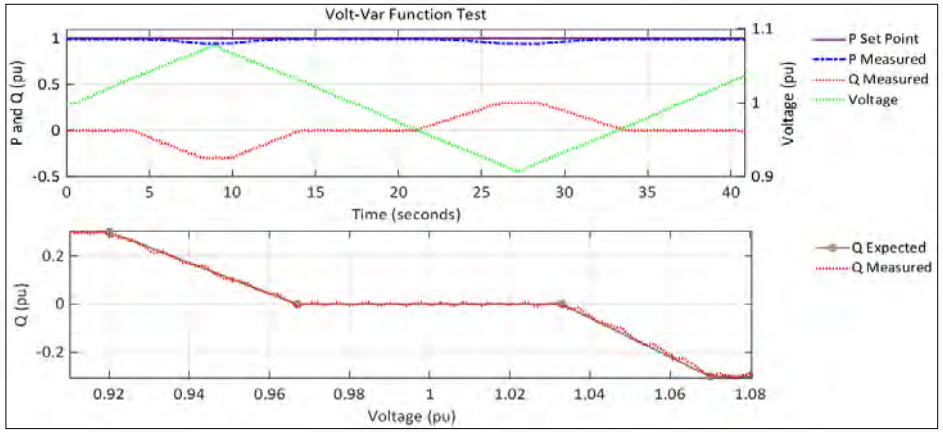
Smart Inverter Test Example: Volt-var

ComEd Volt-var Setting:

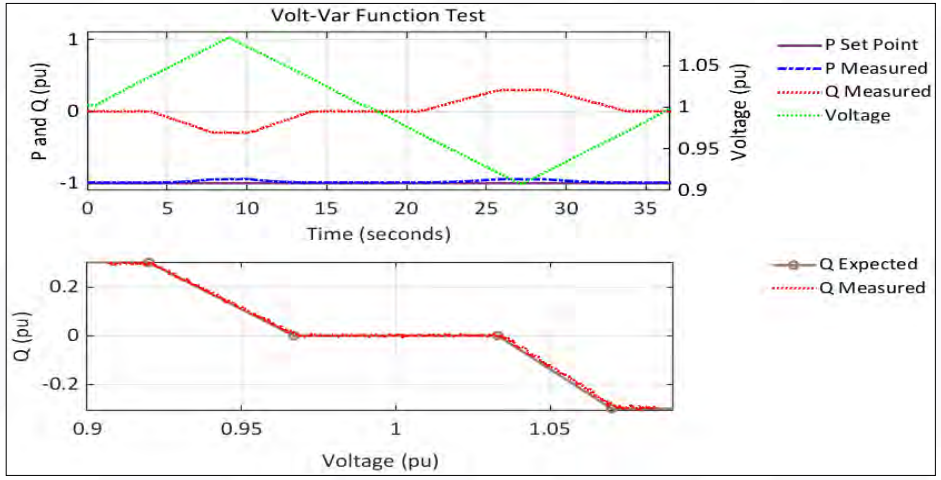
Parameter	Value (%)
V1	92
Q1	30
V2	96.7
Q2	0
V3	103.3
Q3	0
V4	107
Q4	30



ComEd Volt-var Setting: 100% Discharging



ComEd Volt-var Setting: 100% Charging



MISST in Grid Connected and Islanded Mode

- 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