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

SOLAR ENERGY TECHNOLOGIES OFFICE

Solar Energy Technologies Office

Quarterly Stakeholder Webinar

January 23, 2020

energy.gov/solar-office

Solar Energy Technologies Office

Solar Energy Technologies Office Webinar Speakers

Dr. Becca Jones-Albertus
Director

Dr. Lenny Tinker
Photovoltaics Program Manager

Dr. Avi Shultz
Concentrating Solar-Thermal Power Program Manager

Dr. Guohui Yuan
Systems Integration Program Manager

Andrew Dawson
Manufacturing and Competitiveness Technology Development (Contractor)

Andrew Graves
Soft Costs Technology Manager

Thank You, Charlie!

Charlie Gay

Retired November 2019 from DOE

We are grateful to Charlie for his 3 years leading and sharing his expertise with the Solar Office.

Agenda

SETO Overview
Becca Jones-Albertus, Director, Solar Energy Technologies Office

SETO Fiscal Year 2019 (FY2019) Funding Program Selections Overview & Highlights
Becca Jones-Albertus, Director, Solar Energy Technologies Office
Solar Energy Technologies Office Program and Technology Managers:
Andrew Dawson, Andrew Graves, Avi Shultz, Lenny Tinker, and Guohui Yuan

SETO Latest Updates
Becca Jones-Albertus, Director, Solar Energy Technologies Office

Solar Energy Technologies Office Leadership

Dr. Becca Jones-Albertus
Director

Maria Vargas
Deputy Director (on Detail)

Dr. Elaine Ulrich
Senior Advisor

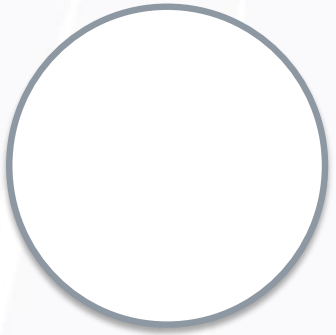
Ebony Brooks
Operations Supervisor

Dr. Lenny Tinker
Photovoltaics Program Manager

Dr. Avi Shultz
Concentrating Solar-Thermal Power Program Manager

Dr. Guohui Yuan
Systems Integration Program Manager

Garrett Nilsen
Manufacturing and Competitiveness Program Manager



Open Position
Soft Costs Program Manager

Interested in Joining Us?

Join our team. Design national R&D strategies across:

- Photovoltaics
- Systems Integration
- Manufacturing and Competitiveness
- Concentrating Solar-Thermal Power
- Soft Costs (Balance of Systems)

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Email ops.solar@ee.doe.gov for more information.

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SOLAR ENERGY TECHNOLOGIES OFFICE

Solar Energy Technologies Office Overview

WHAT WE DO

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

HOW WE DO IT

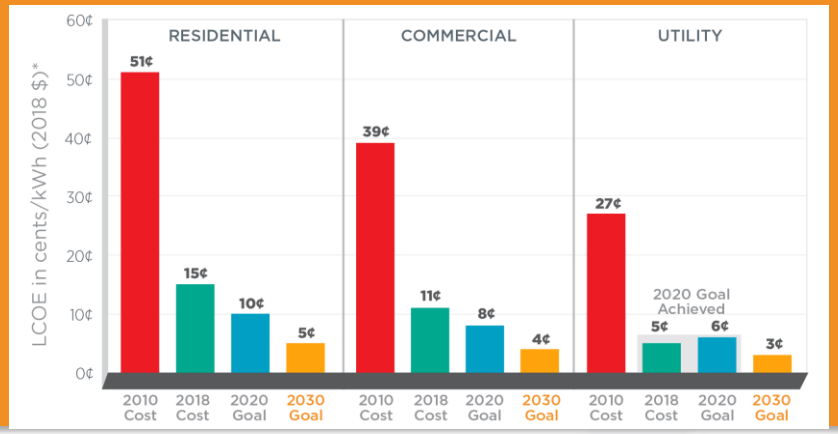
Advance solar technology to drive U.S leadership in innovation and reductions in solar electricity costs.

Enable solar to **support grid reliability** and pair with storage to provide new options for **community resilience.**

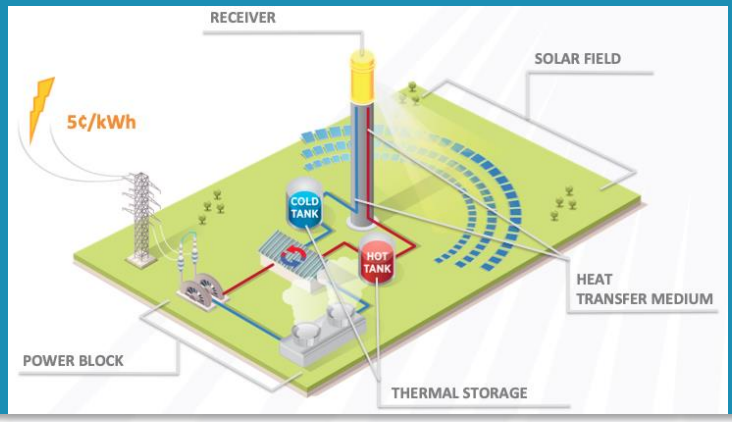
Provide **relevant and objective technical information** on solar technologies to stakeholders and decision-makers.

SETO Subprograms

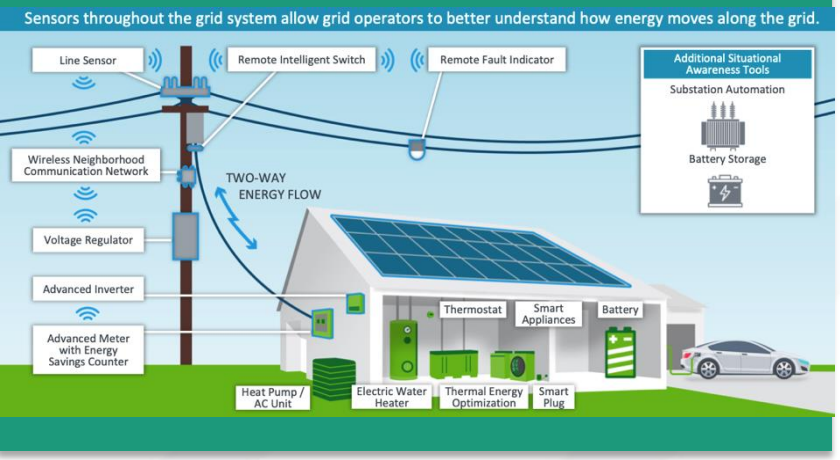
PHOTOVOLTAICS



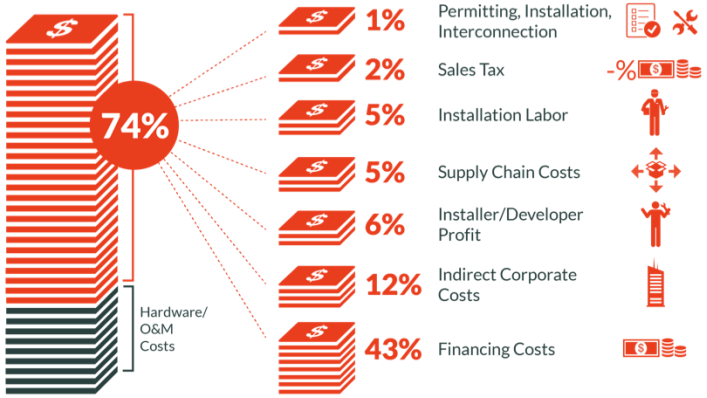
CONCENTRATING SOLAR POWER



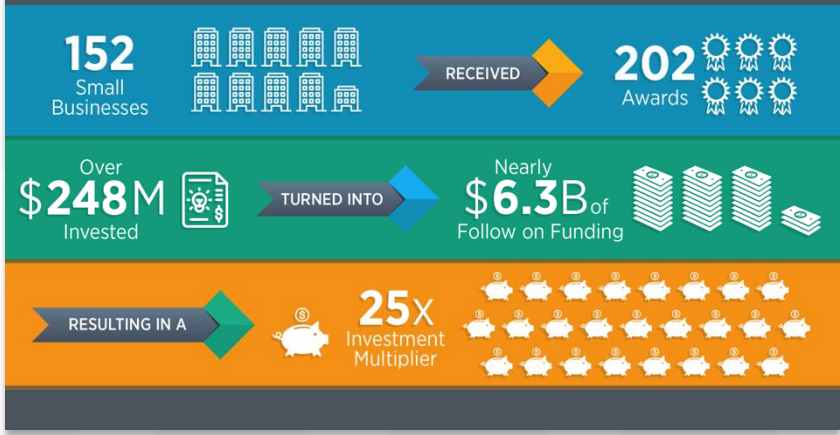
SYSTEMS INTEGRATION



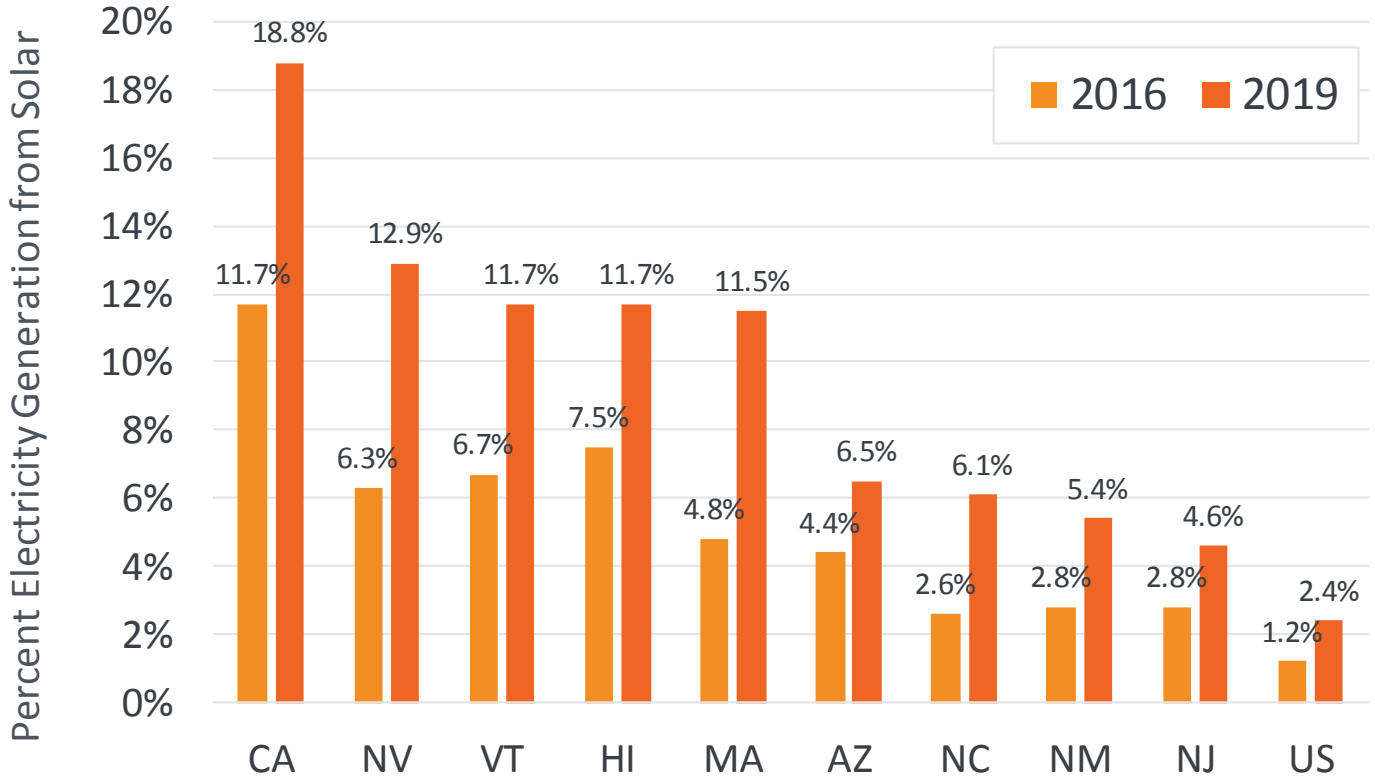
BALANCE OF SYSTEMS SOFT COST REDUCTION

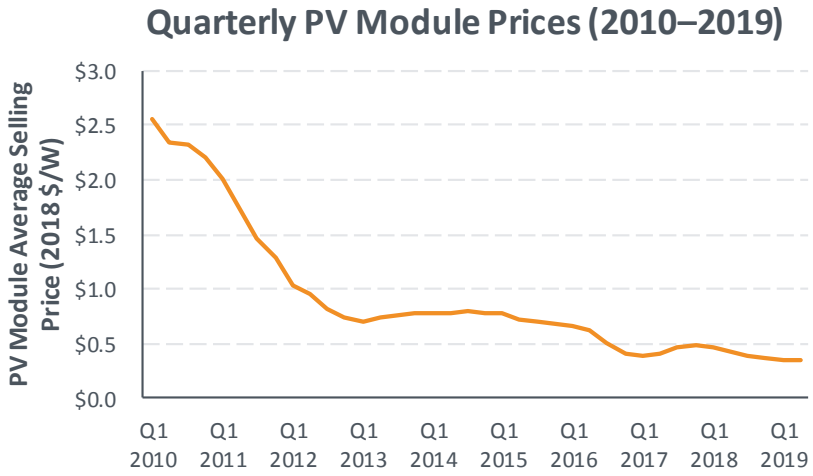


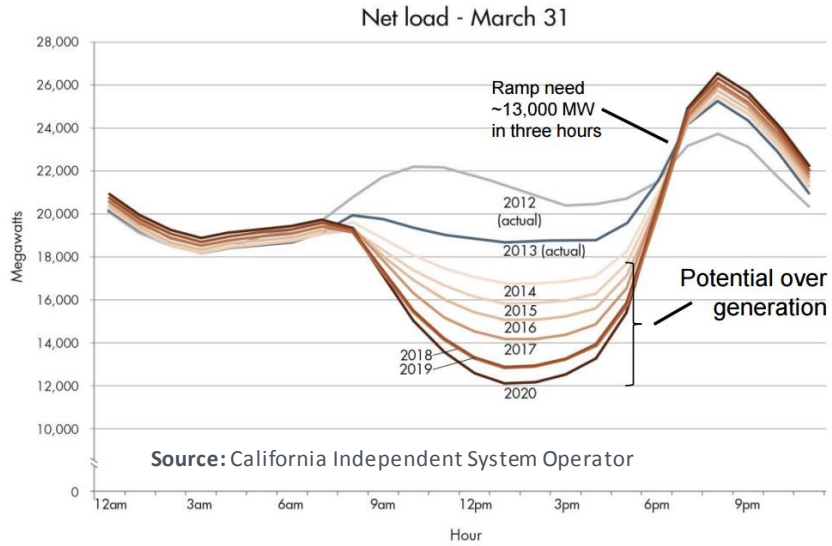
MANUFACTURING AND COMPETITIVENESS



Solar Trends: Falling Costs and Rapid Growth





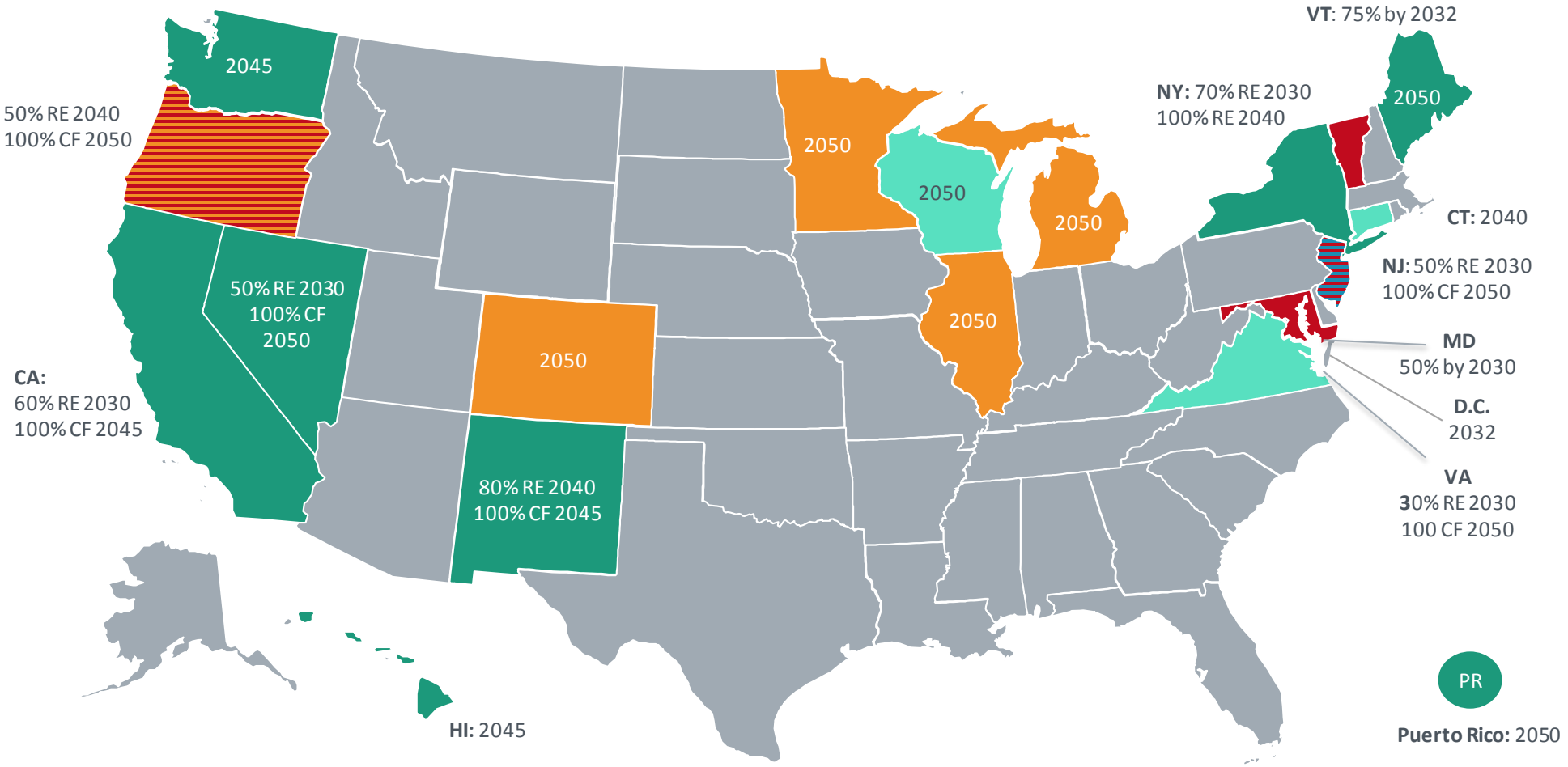


Source: California Independent System Operator

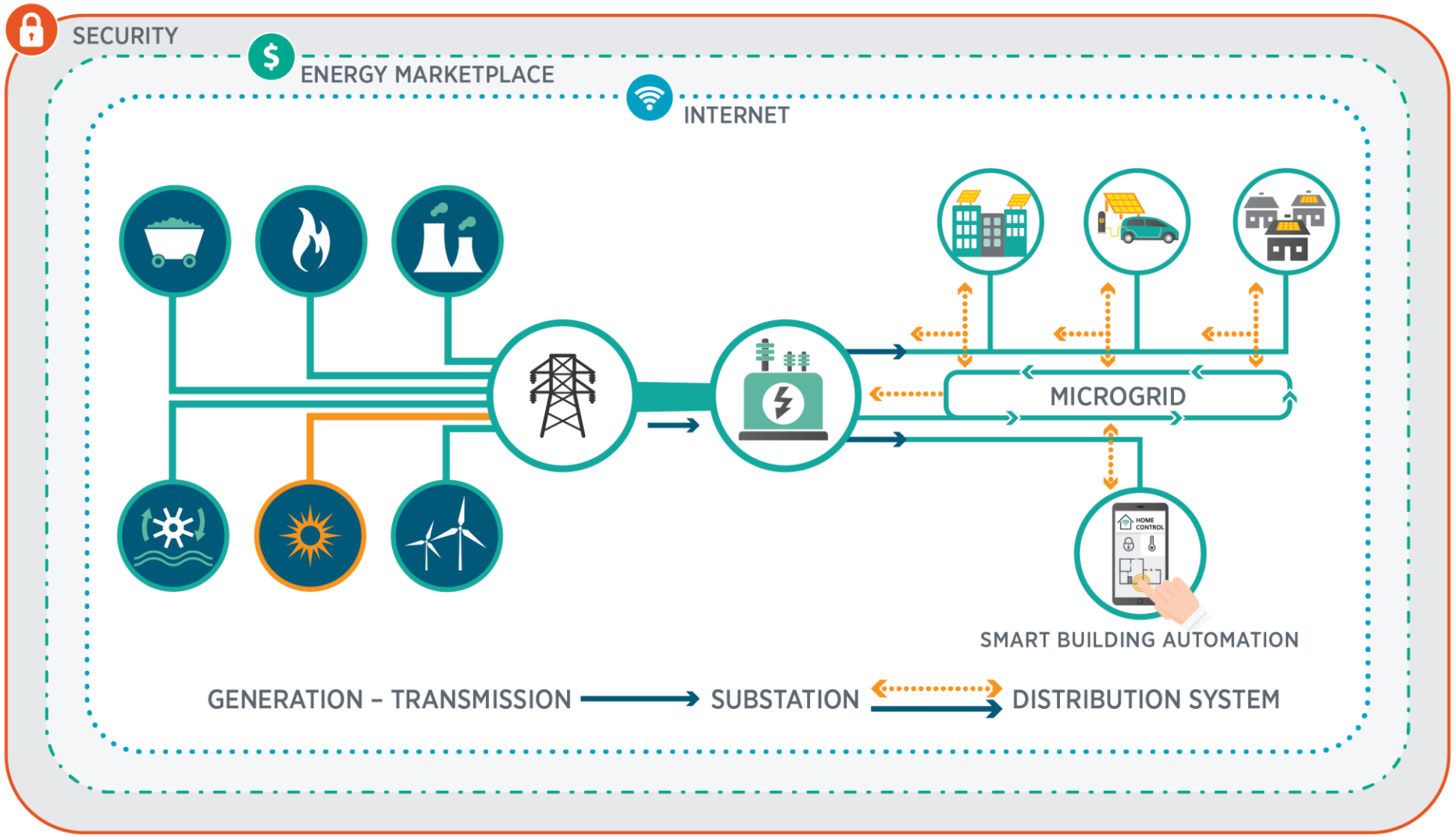
Sources: U.S. Energy Information Administration, "Electric Power Monthly," forms EIA-023, EIA-826, and EIA-861. U.S. Energy Information Administration, "Electricity Data Browser." Accessed October 30, 2019.

Note: EIA monthly data for 2019 are not final. Additionally, smaller utilities report information to EIA on a yearly basis, and therefore, a certain amount of solar data has not yet been reported. "Net Generation" includes DPV generation. Net generation does not take into account imports and exports to and from each state and therefore the percentage of solar consumed in each state may vary from its percentage of net generation.

State Commitments Continue to Drive Deployment



Solar Supporting Grid Modernization



Solar Supporting Reliable Grid Operation

Today: PV only contributes energy to the grid; PV doesn't support grid operation and reliability

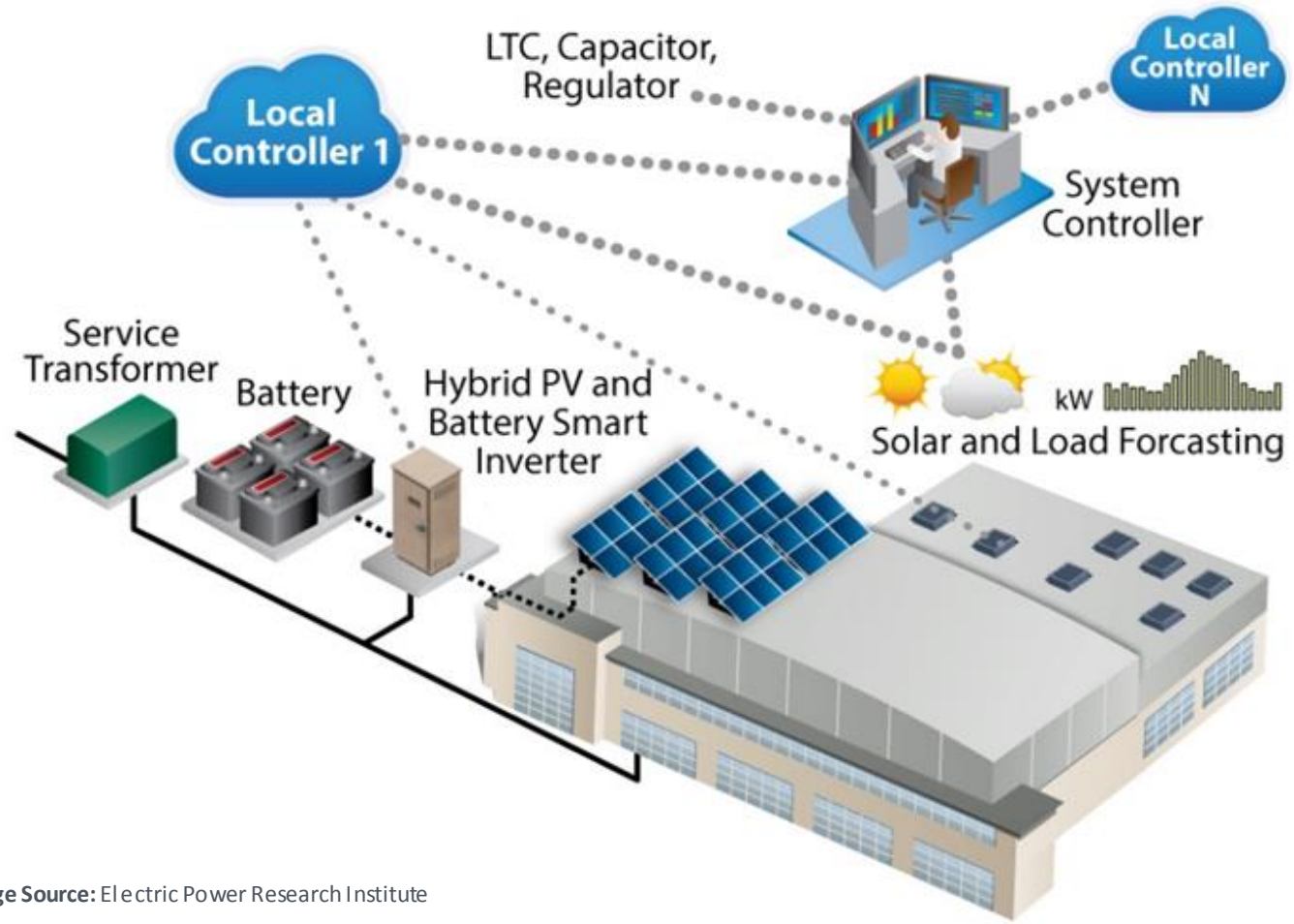
Next 5 Years: Smart PV inverters contribute essential grid reliability services like a conventional generator (e.g., voltage and frequency regulation)

Next 10 Years: Harness the fast-responding 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 (e.g., PV cyber-security, situational awareness, integration with storage, controllable loads, and distributed energy resource management systems)

Solar Enhancing Grid Resilience

Solar + storage can power critical loads in the event of an outage



Coordination of controls and enhanced communication capabilities by solar inverters that can restart power on segments of the distribution system (or microgrids) during an outage

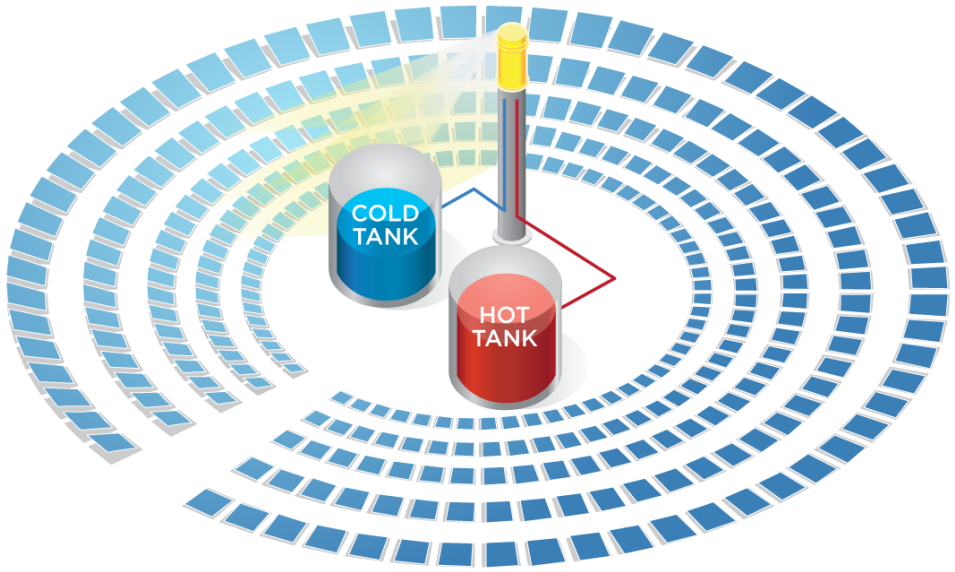
Image Source: Electric Power Research Institute

Concentrating Solar-Thermal Technology for Power and Heat-Based Applications

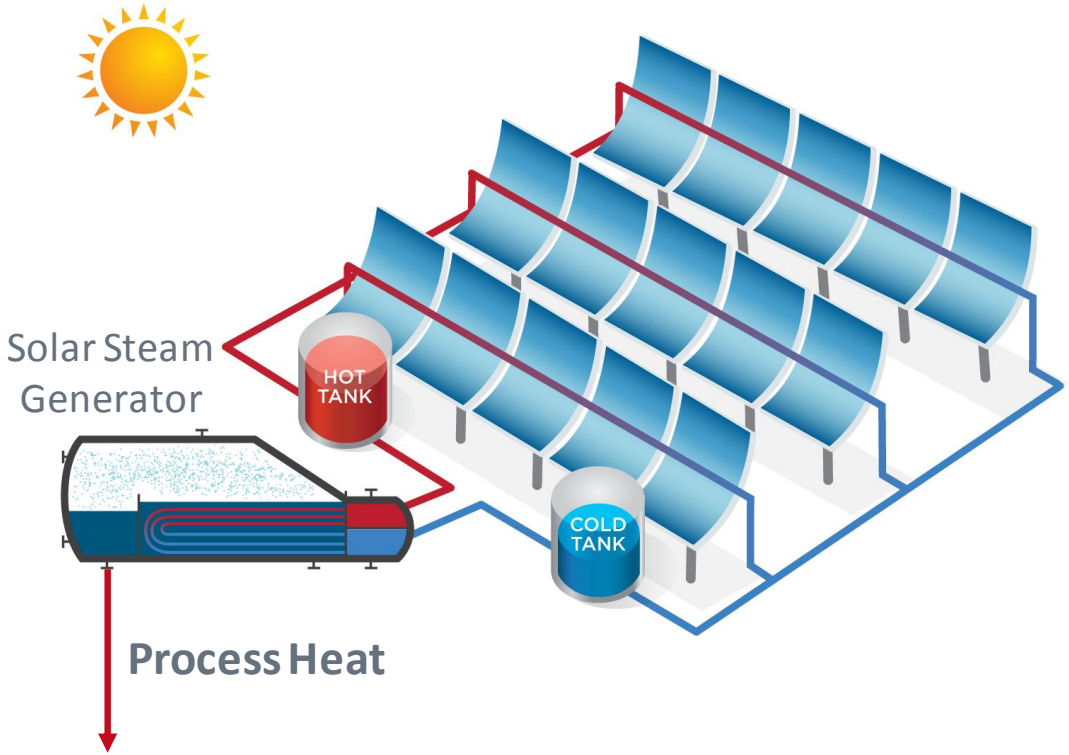
BASELOAD POWER

(≥12 hours of storage)

2030 Goal: **5¢/kWh**



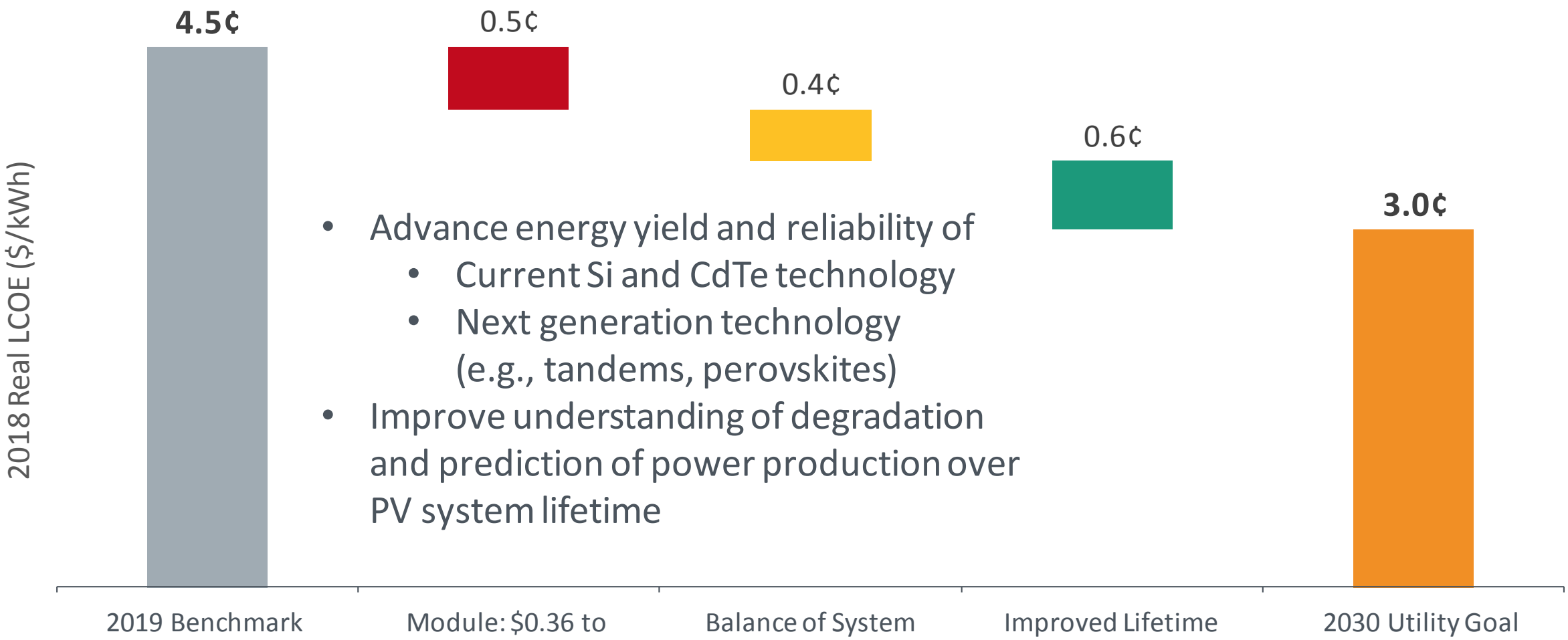
SOLAR PROCESS HEAT



Thermally-Driven Industrial Processes:

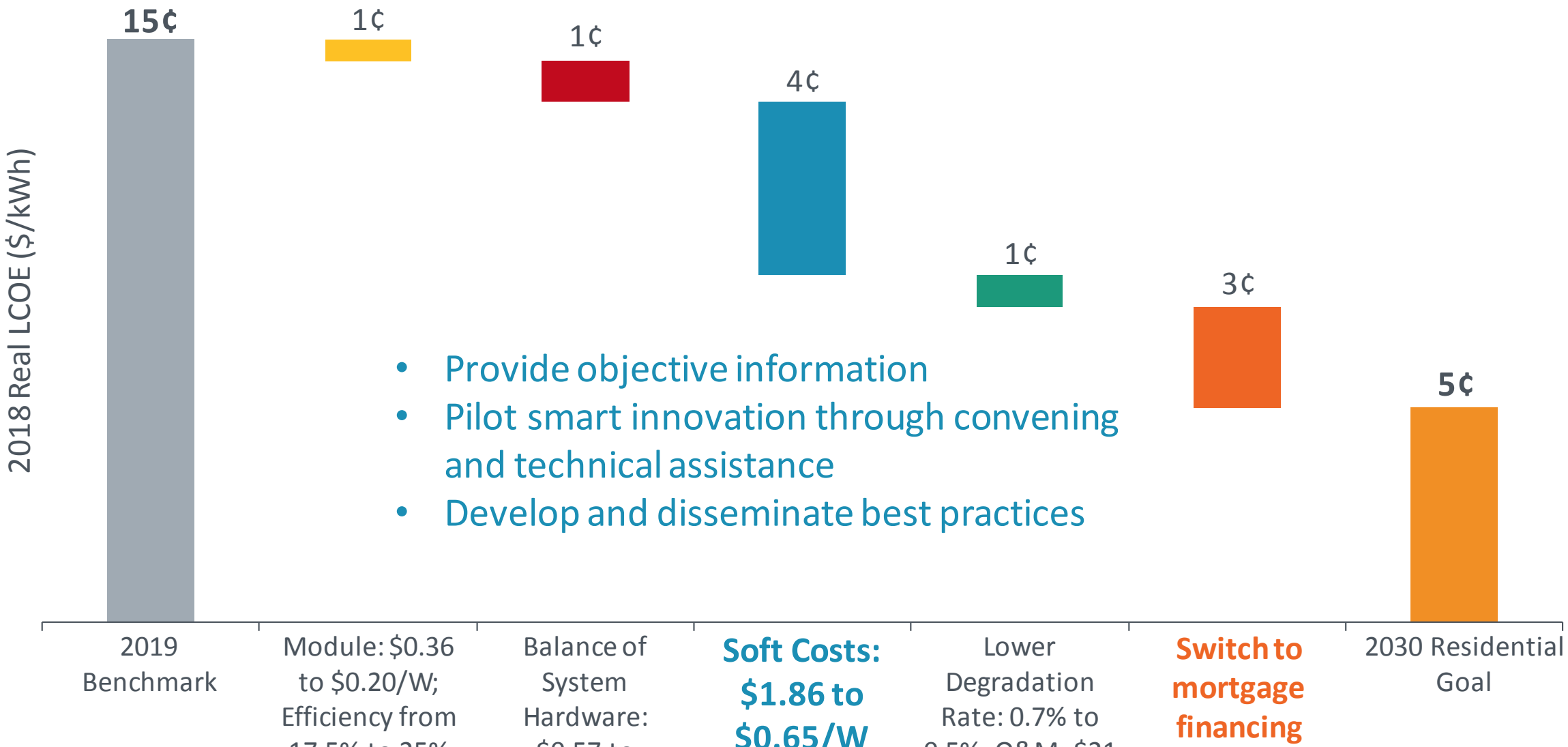
- Desalination
- Enhanced Oil Recovery
- Agriculture and Food Processing
- Fuel and Chemicals Production
- Mining and Metals Processing

Photovoltaics R&D: Utility-scale PV Roadmap



- Advance energy yield and reliability of
  - Current Si and CdTe technology
  - Next generation technology (e.g., tandems, perovskites)
- Improve understanding of degradation and prediction of power production over PV system lifetime

Residential PV Roadmap to 2030



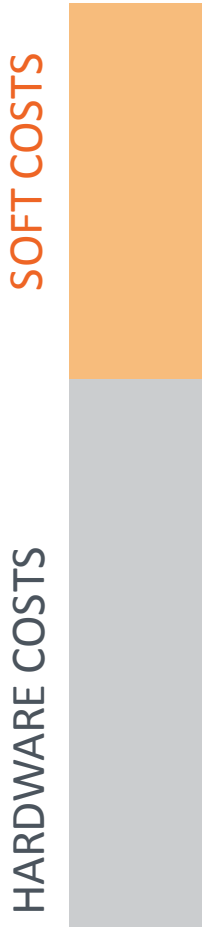
- Provide objective information
- Pilot smart innovation through convening and technical assistance
- Develop and disseminate best practices

Source: NREL, "Q1 2019 Benchmark Report." Forthcoming.

Defining and Addressing Soft Costs

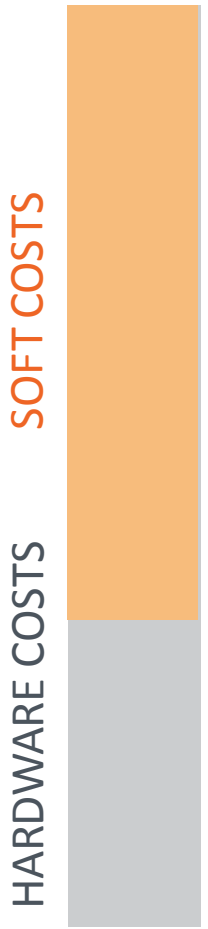
Utility-scale PV

Soft Costs = $0.39/watt



Residential/Commercial PV

Soft Costs = $1.86/watt



More Complex Applications (e.g.,Agricultural PV)

Costs are unknown

?
- Siting restrictions
- Land use concerns

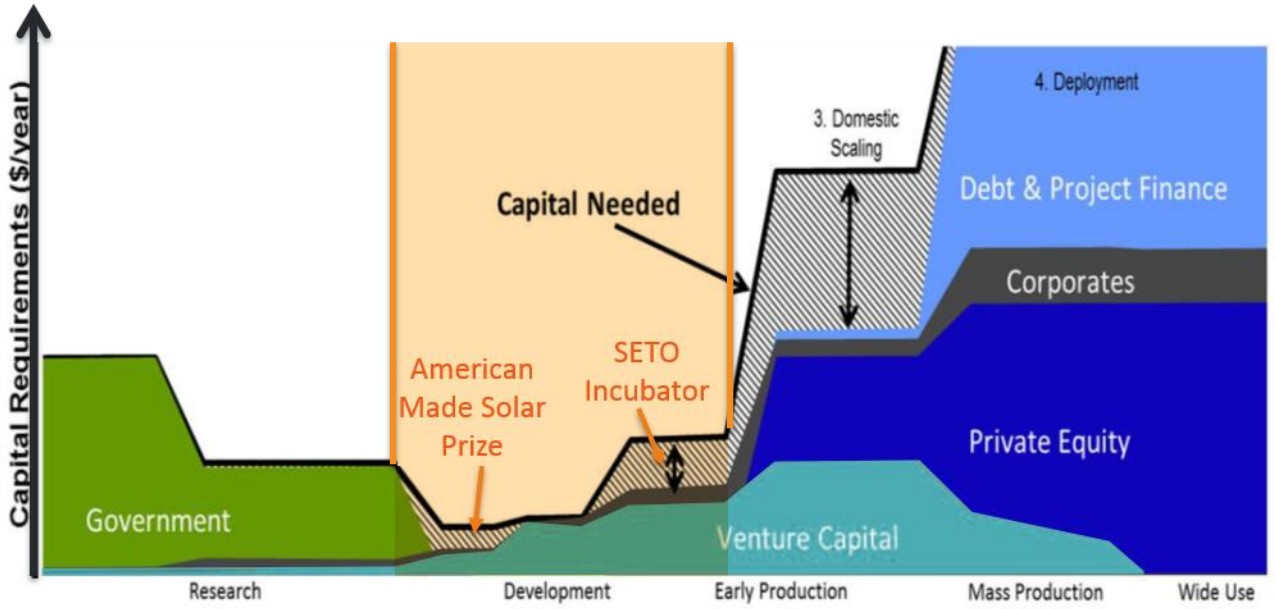
?
- New installation practices

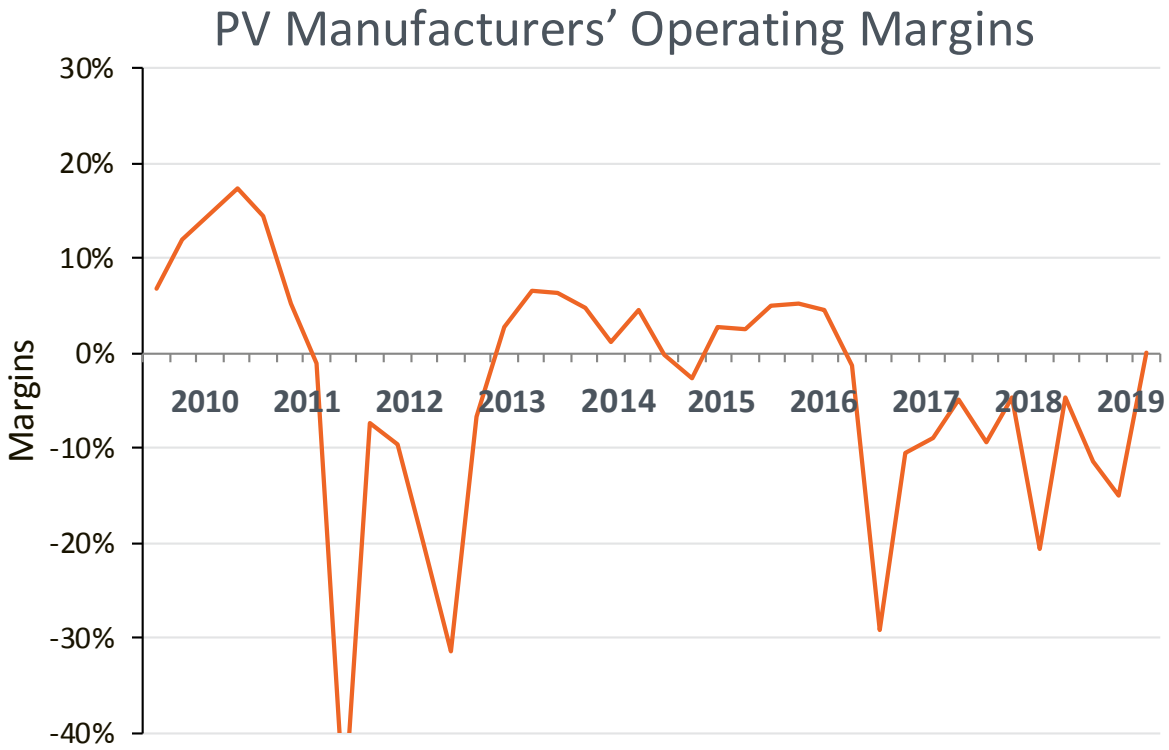
?
- Need new structures

Existing benchmarks and practices don't work

COMPLEXITY

Manufacturing and Competitiveness



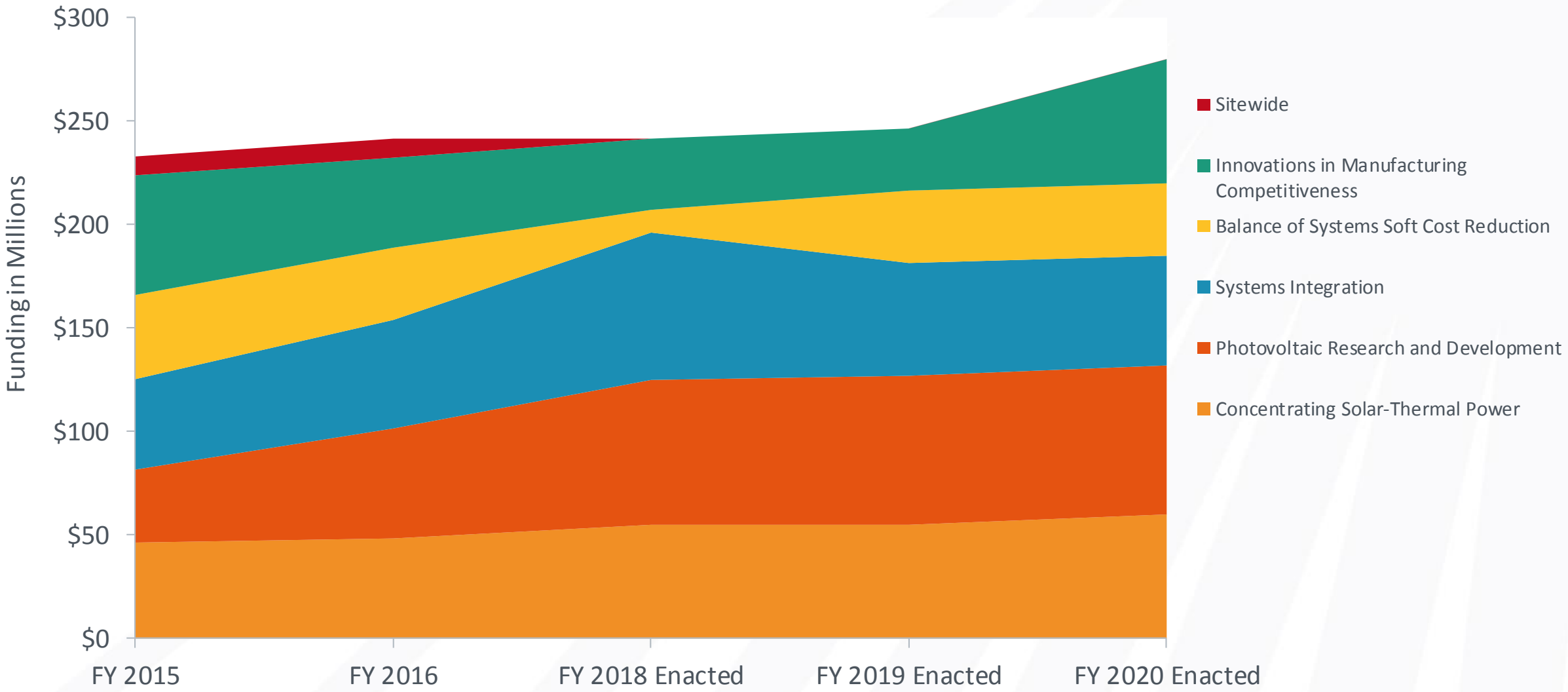


Orange line represents the median, with error bars representing 80th and 20th percentiles for the following companies in Q2 2019: Canadian Solar, First Solar, HT-SAAE, Jinko Solar, LONGi, Motech Industries, Neo Solar Power, ReneSola, and SunPower. When they are available, margin data from Hanwha Q Cells, JA Solar, Trina, Yingli, and Hareon Solar are also included from Q1 2010 to Q1 2019.

- Looking across the solar value chain for best opportunities for U.S. manufacturing to focus efforts
- Solar Prize, Incubator and SBIR/STTR programs address technological and commercialization valley of death, but domestic scaling not capable of being addressed by SETO

Sources: Company figures based on data from Bloomberg Terminal, Yahoo Finance and SEC filings by the respective companies. Greentech Media(10/24/2019)

SETO Budget Overview



Congratulations to Alex Huang

With a history of SETO awards dating from 2013, Alex Q. Huang at the University of Texas at Austin has received the **2019 IEEE Industry Applications Society Gerald Kliman Innovator Award**.

His current project with SETO falls under the Advanced Power Electronics Design for Solar Applications funding program and involves **developing a utility-scale PV inverter that will eliminate the need for a transformer**. Huang has been a pioneer in promoting silicon and silicon carbide devices in power electronics.

Congratulations!

Notice of Intent to Issue 2020 SETO Funding Program

The Solar Energy Technologies Office (SETO) intends to release a funding opportunity announcement (FOA) to promote early-stage research and development of solar technologies that support use and integration of solar technologies onto the electric grid.

Potential areas of interest:

- Photovoltaics Hardware Research
- Integrated Thermal Energy Storage and Brayton Cycle Equipment Demonstration (Integrated TESTBED)
- Solar Energy Evolution and Diffusion Studies 3 (SEEDS 3)
- Innovations in Manufacturing: Hardware Incubator
- Systems Integration: Resilient Community Microgrids, Addressing Cybersecurity Gaps, and Inverter-Based Hybrid Plants
- Solar and Agriculture: System Design, Value Frameworks, and Impacts Analysis
- Artificial Intelligence (AI) Applications in Solar Energy with Emphasis on Machine Learning
- Small Innovative Projects in Solar (SIPS): PV and CSP

LEARN MORE!

QUESTIONS?

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

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SETO Latest Updates
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What's next for SOLAR?

Solar Energy Technologies Office FY2019 Funding Program

$128 Million for Advanced Solar Energy Research

The U.S. Department of Energy Solar Energy Technologies Office has selected 75 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.

FOA Issue Date	Application Deadline	Projects Announced	Award Negotiations	Project Timeframe
March 26, 2019	July 25, 2019	November 6, 2019	November 2019 – February 2020	2019 – 2022

LEARN MORE!

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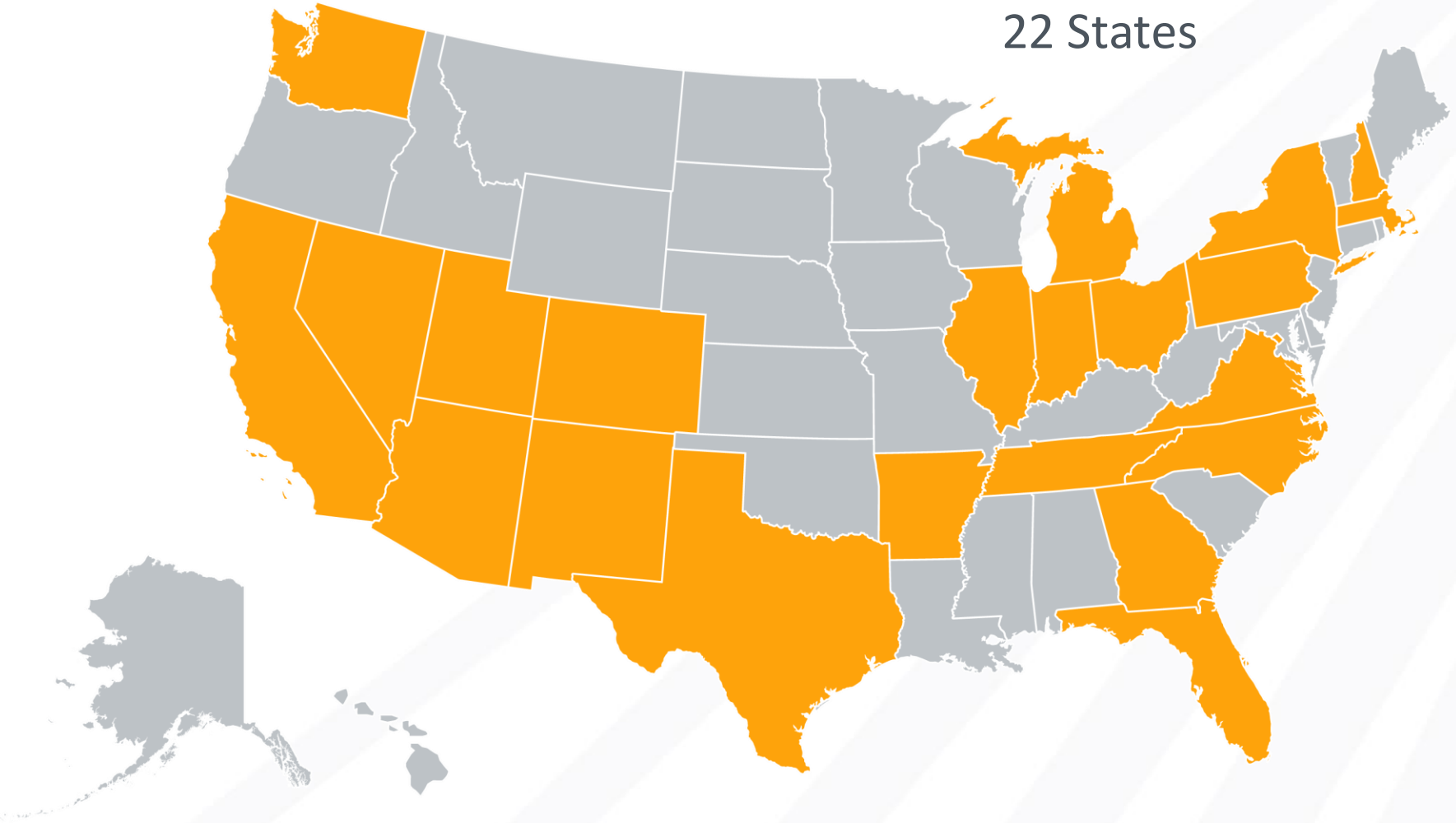
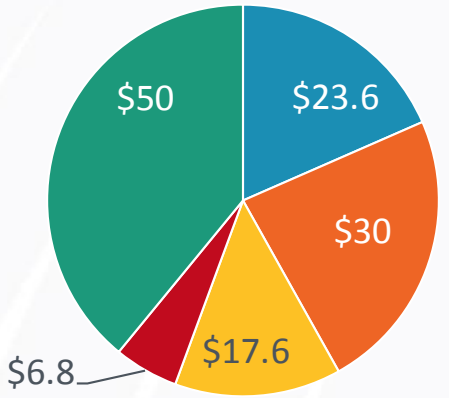
SETO FY2019 Projects Across the United States

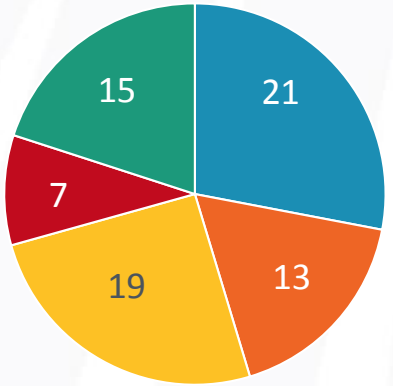


PV R&D
CSP R&D
Soft Costs
Hardware Incubator
Systems Integration

$128 MILLION IN FUNDING



75 PROJECTS



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SETO FY2019 Topic Breakdown – $128M

TOPIC AREA 1: Photovoltaics Research and Development ($23.6M) — 21 projects

- 1.1 Multi-Year Photovoltaics Applied Research Collaborations — 7 projects
- 1.2 Small Innovative Projects in Solar (SIPS) — 14 projects

TOPIC AREA 2: Concentrating Solar-Thermal Power Research and Development ($30M) — 13 projects

- 2.1 Firm Thermal Energy Storage — 4 projects
- 2.2 Materials and Manufacturing for CSP — 8 projects
- 2.3 Autonomous Solar Collector Fields — 1 project

TOPIC AREA 3: Balance of System Soft Costs Reduction ($17.6M) — 19 projects

- 3.1 Collaborative Partnerships to Address Regulatory Burdens — 8 projects
- 3.2 Data and Methodologies to Assess Avian Impacts — 3 projects
- 3.3 Increasing Solar Affordability through Innovative Solar Finance — 5 projects
- 3.4 Rapid Solar Software Development — 3 projects

TOPIC AREA 4: Innovations in Manufacturing – Hardware Incubator ($6.8M) — 7 projects

TOPIC AREA 5: Advanced Solar Systems Integration Technologies ($50M) — 15 projects

- 5.1 Adaptive Distribution Protection — 4 projects
- 5.2 Grid Services from Behind-the-Meter (BTM) Solar and other DERs — 3 projects
- 5.3 Advanced PV Controls and Cybersecurity — 8 projects

Sampling the FY2019 Selections: Manufacturing

Preparing Next-Generation Technologies for the Market

Project Profile: University of Toledo

High-Speed Perovskite Manufacturing and Accelerated Stress Testing

PROJECT DESCRIPTION

- Develop high-efficiency perovskite mini modules
- Investigate deposition techniques that can be scaled up for high-speed manufacturing.
- Test reliability through accelerated stress-testing methods that can detect what degrades perovskite modules outdoors.

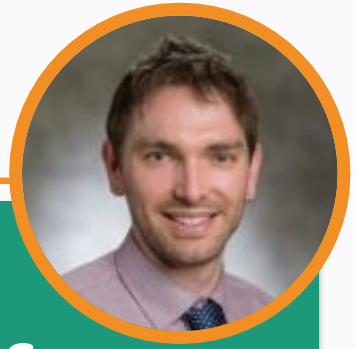
PROJECT DETAILS

Project Partners:

- Yanfa Yan, University of Toledo (PI)
- Randy Ellingson, University of Toledo
- Michael Heben, University of Toledo
- Nikolas Podraza, University of Toledo
- Dirk Weiss, First Solar, Inc.
- Joseph Berry, National Renewable Energy Laboratory

DOE Award Amount: $4.5 million

Project Profile: Energy Materials Corporation



Roll-to-roll perovskite manufacturing for gigawatt-scale production

PROJECT DESCRIPTION

- Develop low-cost, high-efficiency, high-stability, bifacial, thin-film solar modules
- Use roll-to-roll printers at a Kodak facility
- Create new methods to deposit layers of material to make the cell, develop a high-speed process using intense pulsed light to fuse the layers, resolve causes of degradation, and produce prototypes.

PROJECT DETAILS

Project Partners:

- Tom Tombs, Energy Materials Corporation (PI)
- Stephan DeLuca, Energy Materials Corporation
- Maikel van Hest, NREL
- Joseph Berry, NREL
- Daniel Ocorr, Eastman Kodak
- Thad Druffel, U. Louisville
- Laura Schelhas, SLAC
- Zachary Holman, Swift Coat

DOE Award Amount: $4 million

Project Profile: General Electric Company, GE Research

Advanced manufacturing of nickel-alloy-based components for sCO_2 power cycles

PROJECT DESCRIPTION

- Reduce the cost of advanced supercritical carbon dioxide (sCO_2) power cycles for Gen3 CSP plants by developing processes for fabricating high-cost turbine parts from next-generation nickel alloys, like Haynes 282 for advanced sCO_2 power cycles for Gen3 CSP plants.
- By directly pressing and sintering metal powders, reduce the manufacturing cost of these components by at least half through reduction of the number of manufacturing steps and reducing the total amount of utilized material.
- Develop a process for fabricating structures incorporating multiple alloys in a single component, demonstrated on small, realistic parts.

PROJECT DETAILS

Project Partners:

- Jason Mortzheim, GE (PI)
- Shenyan Huang, GE
- Timothy Hanlon, GE
- Victor Samarov, Synertech
- Dmitry Seliverstov, Synertech

DOE Award Amount: $2.5 million

Project Profile: National Renewable Energy Laboratory

Design thermal energy storage tanks using industrial byproducts

PROJECT DESCRIPTION

- Lower the cost of molten salt thermal energy storage tanks by replacing metal structure with all-concrete designs.
- Improve the mechanical strength and thermal stability of the tanks' internal insulation by developing new composite concrete composites that use low-cost, highly insulating ceramic materials that are obtained as industrial byproducts.

PROJECT DETAILS

Project Partners:

- Youyang Zhao, NREL (PI)
- Judith Vidal, NREL
- Elsa Olivetti, Massachusetts Institute of Technology
- Thomas Viverito, Morgan Advanced Materials
- Ryan Bowers, Worley
- Joe Rigby, JT Thorpe & Son

DOE Award Amount: $1.7 million

Project Profile: Halo Industries

Advanced silicon carbide wafer manufacturing for low-cost, high-efficiency power electronics in solar applications

PROJECT DESCRIPTION

- Mechanically fracture wafers off blocks of silicon carbide without wasting material for power electronics devices.
- Leverage an existing, early-stage prototype technology and advance that system to a manufacturing and commercially relevant prototype.

PROJECT DETAILS

Project Reseachers:

- Andrei Iancu (PI)
- Philip Van Stockum
- Andrew Bollman
- Charlie Rudy
- Luke Asperger

DOE Award Amount: $1 million

Project Profile: Terabase Energy

Bring a factory approach to PV plant installation

PROJECT DESCRIPTION

- Create a new field factory facility that will help construct PV power plants at reduced costs.
- Design and field-test key subsystems of this approach to project construction and then conduct an integrated field demonstration.

PROJECT DETAILS

Project Partners:

- Terabase Energy - Dan Cohen (PI), Matt Campbell, Pierre Gousseland, Thang Le, Julien Blarel, Luan Truong, Giovanni Vanore
- Derek Daymond, Daymond Consulting LLC
- Josh Finn, Navajo Power

DOE Award Amount: $1 million

Sampling the FY2019 Selections: Collaborative Teams

Collaborations accelerate the achievement of scientific and technological outcomes

Project Profile: Electric Power Research Institute

Machine learning to automate PV plant performance

PROJECT DESCRIPTION

- Identify reasons for unplanned maintenance events at utility-scale solar PV plants
- Eliminate false alarms, decreasing the labor required to review underperformance, lower the levelized cost of PV electricity, and increase energy output.

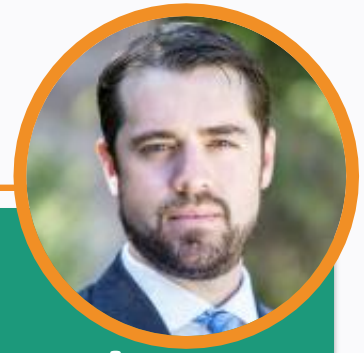
PROJECT DETAILS

Project Partners:

- Michael Bolen (Electric Power Research Institute) (PI)
- Tim Lieuwen (Turbine Logic)
- Kamran Paynabar (Georgia Institute of Technology
- Anthony Morabito (DTE Energy)
- Will Hobbs (Southern Co.)
- James Dixon (Consolidated Edison Clean Energy Businesses)

DOE Award Amount: $2 million

Project Profile: Interstate Renewable Energy Council



Streamline solar and solar + storage code enforcement and permitting approvals

PROJECT DESCRIPTION

- Make permitting approvals more efficient by focusing on filling knowledge gaps
- Stakeholder collaboration to learn what complicates code enforcement and discuss challenges and solutions
- Develop recommendations that advance adoption of permitting and inspection best practices

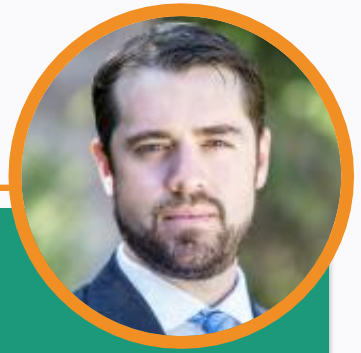
PROJECT DETAILS

Project Partners:

- Sustainable Energy Action Committee
- International Assn of Electrical Inspectors
- UL LLC
- International Code Council
- International Assn of Fire Fighters
- National Assn of State Fire Marshals
- Energy Storage Assn
- Solar Energy Industries Assn
- California Solar + Storage Assn

DOE Award Amount: $1.5 million

Project Profile: National Association of State Energy Officials and National Association of Regulatory Utility Commissioners



Cybersecurity toolkit for decision-makers

PROJECT DESCRIPTION

- Create a solar cybersecurity working group to improve the ability to respond to cybersecurity threats with state energy officials, public utility commissioners, solar industry, cybersecurity experts, utility representatives, etc
- Develop a cybersecurity tool kit to help decision-makers pursue policies, plans, and partnerships for cybersecure solar infrastructure in their jurisdictions.

PROJECT DETAILS

Project Partners:

- NASEO: Sandy Fazeli, Shemika Spencer, Jeff Pillon, Campbell Delahoyde
- NARUC: Lynn Constantini, Matthew Acho,

DOE Award Amount: $500,000

Project Profile: University of Arkansas

Cyberattack defenses for PV systems

PROJECT DESCRIPTION

- Develop a two-level cyberattack defense approach at the inverter and system levels
- Advising and review from a U.S.-based solar inverter manufacturer and photovoltaic systems operator
- Field-test solutions at Today's Power Incorporated solar farm in Northwest Arkansas.

PROJECT DETAILS

Project Partners:

- University of Arkansas
- Argonne National Laboratory
- University of Georgia
- University of Illinois Chicago
- NREL
- Texas A&M University Kingsville
- Today's Power Incorporated
- General Electric Global Research Center

DOE Award Amount: $1.1 million

Project Profile: NV Energy

Capturing the value of grid services from DER

PROJECT DESCRIPTION

- Develop and demonstrate grid services provided by multiple distributed energy resources (DER)
- These services will be enabled by artificial intelligence (AI) and blockchain-powered smart contracts
- Develop AI to use excess storage capacity for grid operations and to pay customers for their extra capacity.

PROJECT DETAILS

Project Partners:

- University of Nevada, Reno
- University of Nevada, Las Vegas
- eVolution Networks

DOE Award Amount: $2.4 million

QUESTIONS?

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

Agenda

SETO Overview
Becca Jones-Albertus, Director, Solar Energy Technologies Office

SETO Fiscal Year 2019 (FY2019) Funding Program Selections Overview & Highlights
Becca Jones-Albertus, Director, Solar Energy Technologies Office
Solar Energy Technologies Office Program and Technology Managers:
Andrew Dawson, Andrew Graves, Avi Shultz, Lenny Tinker, and Guohui Yuan

SETO Latest Updates
Becca Jones-Albertus, Director, Solar Energy Technologies Office

SETO's Newest Online Content

- New success story—*Spreading Sunshine: SolSmart Recognizes 300th Community for Going Solar*
- PV Cells 101 2-part series:
  - A Primer on the Solar Photovoltaic Cell
  - Solar Photovoltaic Cell Research Directions
- CSP workshops:
  - SETO CSP Program Summit 2019
  - DOE sCO2 Workshop 2019
  - *Upcoming* – 2020 SolarPACES Conference in Albuquerque, NM this October
- DOE announced $80 Million For New Grid Modernization Lab Call Projects

SETO 2020 Peer Review

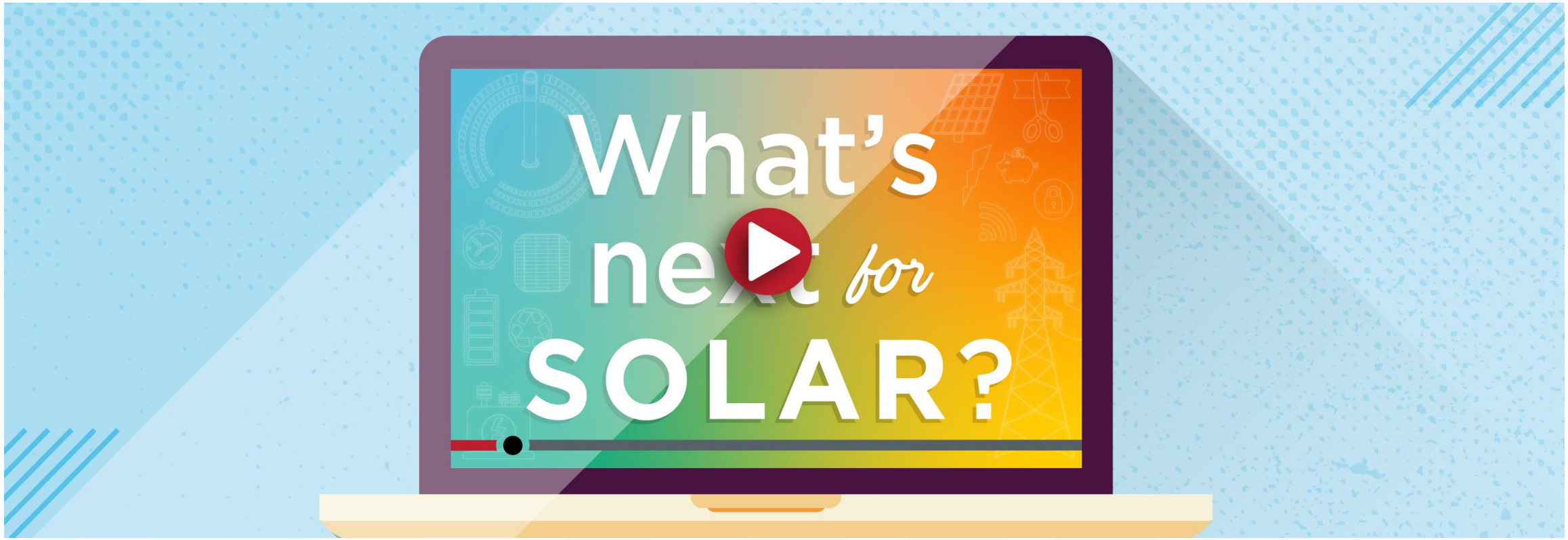
The Solar Energy Technologies Office will hold its **2020 Peer Review** on **April 6-7, 2020** in Washington, D.C.

This event gathers representatives from all of **SETO's active projects** along with **leading solar industry experts** to review progress across the portfolio. The findings will help identify strategies that will **shape SETO's work in the future**.

After a careful **review of around 400 projects**, the feedback collected from independent, third-party reviewers will be **consolidated into a report** that will be made available to the public.

Next Webinar

The next SETO Quarterly Webinar will be April 23, 2020 at 1:00 p.m. ET.
Visit energy.gov/seto-webinars for the registration link!



SETO Newsletter – Stay in Touch

The SETO newsletter highlights the key activities, events, funding opportunities, and publications that the solar program has funded.

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