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

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Interested in Joining Us?

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

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

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

energy.gov/solar-office
Solar Trends: Falling Costs and Rapid Growth

Quarterly PV Module Prices (2010–2019)

Percent Electricity Generation from Solar

<table>
<thead>
<tr>
<th>State</th>
<th>CA</th>
<th>NV</th>
<th>VT</th>
<th>HI</th>
<th>MA</th>
<th>AZ</th>
<th>NC</th>
<th>NM</th>
<th>NJ</th>
<th>US</th>
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<tbody>
<tr>
<td>2016</td>
<td>18.8%</td>
<td>11.7%</td>
<td>11.7%</td>
<td>11.7%</td>
<td>11.5%</td>
<td>7.5%</td>
<td>6.5%</td>
<td>6.1%</td>
<td>5.4%</td>
<td>4.6%</td>
</tr>
<tr>
<td>2019</td>
<td>12.9%</td>
<td>6.3%</td>
<td>6.7%</td>
<td>4.8%</td>
<td>4.4%</td>
<td>2.6%</td>
<td>2.8%</td>
<td>2.8%</td>
<td>1.2%</td>
<td>2.4%</td>
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</tbody>
</table>


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

- **CA**: 60% RE 2030, 100% CF 2045
- **HI**: 2045
- **VT**: 75% by 2032
- **CT**: 2040
- **NJ**: 50% RE 2030, 100% CF 2050
- **MD**: 50% by 2030
- **D.C.**: 2032
- **NY**: 70% RE 2030, 100% RE 2040
- **PR**: 2050
- **NJ**: 50% RE 2030, 100% CF 2050
- **NY**: 70% RE 2030, 100% RE 2040
- **NJ**: 50% RE 2030, 100% CF 2050
- **VA**: 30% RE 2030, 100% CF 2050
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
energy.gov/solar-office
Concentrating Solar-Thermal Technology for Power and Heat-Based Applications

BASELOAD POWER
(≥12 hours of storage)
2030 Goal: 5¢/kWh

SOLAR PROCESS HEAT

Process Heat
Solar Steam Generator

Thermally-Driven Industrial Processes:
- Desalination
- Enhanced Oil Recovery
- Agriculture and Food Processing
- Fuel and Chemicals Production
- Mining and Metals Processing

2030 Goal: 5¢/kWh

50 MW
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

2019 Benchmark
- Module: $0.36 to $0.20/W; Efficiency from 17.5% to 21%
- Balance of System Hardware and Soft Costs: $0.67 to $0.54/W
- Improved Lifetime 30 to 50 years, higher debt with no tax equity

2030 Utility Goal
- $3.0¢

2018 Real LCOE ($/kWh)
Residential PV Roadmap to 2030

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

2018 Real LCOE ($/kWh)

- **2019 Benchmark**
  - Module: $0.36 to $0.20/W; Efficiency from 17.5% to 25%
  - Balance of System Hardware: $0.57 to $0.30/W
  - Soft Costs: $1.86 to $0.65/W
  - Lower Degradation Rate: 0.7% to 0.5%, O&M: $21 to $10/kW-year

- **2030 Residential Goal**
  - Switch to mortgage financing
  - 5¢
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

**Complexity**
- Existing benchmarks and practices don’t work
Manufacturing and Competitiveness

- 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)
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
QUESTIONS?
Please use the Q&A feature to ask your questions.
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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.
SETO FY2019 Projects Across the United States

$128 MILLION IN FUNDING

75 PROJECTS

22 States

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

energy.gov/solar-office
### SETO FY2019 Topic Breakdown – $128M

<table>
<thead>
<tr>
<th>TOPIC AREA 1: Photovoltaics Research and Development ($23.6M) — 21 projects</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 Multi-Year Photovoltaics Applied Research Collaborations — 7 projects</td>
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<tr>
<td>1.2 Small Innovative Projects in Solar (SIPS) — 14 projects</td>
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<tr>
<th>TOPIC AREA 2: Concentrating Solar-Thermal Power Research and Development ($30M) — 13 projects</th>
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<tbody>
<tr>
<td>2.1 Firm Thermal Energy Storage — 4 projects</td>
</tr>
<tr>
<td>2.2 Materials and Manufacturing for CSP — 8 projects</td>
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<tr>
<td>2.3 Autonomous Solar Collector Fields — 1 project</td>
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<tr>
<th>TOPIC AREA 3: Balance of System Soft Costs Reduction ($17.6M) — 19 projects</th>
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<tbody>
<tr>
<td>3.1 Collaborative Partnerships to Address Regulatory Burdens — 8 projects</td>
</tr>
<tr>
<td>3.2 Data and Methodologies to Assess Avian Impacts — 3 projects</td>
</tr>
<tr>
<td>3.3 Increasing Solar Affordability through Innovative Solar Finance — 5 projects</td>
</tr>
<tr>
<td>3.4 Rapid Solar Software Development — 3 projects</td>
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<tr>
<th>TOPIC AREA 4: Innovations in Manufacturing – Hardware Incubator ($6.8M) — 7 projects</th>
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<tr>
<th>TOPIC AREA 5: Advanced Solar Systems Integration Technologies ($50M) — 15 projects</th>
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<tr>
<td>5.1 Adaptive Distribution Protection — 4 projects</td>
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<tr>
<td>5.2 Grid Services from Behind-the-Meter (BTM) Solar and other DERs — 3 projects</td>
</tr>
<tr>
<td>5.3 Advanced PV Controls and Cybersecurity — 8 projects</td>
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Sampling the FY2019 Selections: Manufacturing

Preparing Next-Generation Technologies for the Market
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
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

**DOE Award Amount:** $4 million

**Additional Project Partners:**
- Joseph Berry, NREL
- Daniel Ocorr, Eastman Kodak
- Thad Druffel, U. Louisville
- Laura Schelhas, SLAC
- Zachary Holman, Swift Coat
# Project Profile: General Electric Company, GE Research

## Advanced manufacturing of nickel-alloy-based components for sCO₂ power cycles

### PROJECT DESCRIPTION

- Reduce the cost of advanced supercritical carbon dioxide (sCO₂) 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 sCO₂ 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

**DOE Award Amount:** $2.5 million

- Victor Samarov, Synertech
- Dmitry Seliverstov, Synertech
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

*DOE Award Amount: $1.7 million*

- Thomas Viverito, Morgan Advanced Materials
- Ryan Bowers, Worley
- Joe Rigby, JT Thorpe & Son
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 Researchers:
• 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**

<table>
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<th>PROJECT DESCRIPTION</th>
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<tr>
<td>• Create a new field factory facility that will help construct PV power plants at reduced costs.</td>
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<td>• Design and field-test key subsystems of this approach to project construction and then conduct an integrated field demonstration.</td>
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<tr>
<th>PROJECT DETAILS</th>
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<tr>
<td><strong>Project Partners:</strong></td>
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<tr>
<td>• Terabase Energy - Dan Cohen (PI), Matt Campbell, Pierre Gousseland, Thang Le, Julien Blarel, Luan Truong, Giovanni Vanore</td>
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<tr>
<td>• Derek Daymond, Daymond Consulting LLC</td>
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<tr>
<td>• Josh Finn, Navajo Power</td>
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<tr>
<td><strong>DOE Award Amount:</strong> $1 million</td>
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</table>
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

**DOE Award Amount:** $1.5 million

**International Assn of Fire Fighters**
- National Assn of State Fire Marshals
- Energy Storage Assn
- Solar Energy Industries Assn
- California Solar + Storage Assn
**Project Profile: National Association of State Energy Officials and National Association of Regulatory Utility Commissioners**

**Cybersecurity toolkit for decision-makers**

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<th>PROJECT DESCRIPTION</th>
<th>PROJECT DETAILS</th>
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| • 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. | **Project Partners:**  
• NASEO: Sandy Fazeli, Shemika Spencer, Jeff Pillon, Campbell Delahoyde  
• NARUC: Lynn Constantini, Matthew Acho, |
| • Develop a cybersecurity tool kit to help decision-makers pursue policies, plans, and partnerships for cybersecure solar infrastructure in their jurisdictions. | **DOE Award Amount:** $500,000 |
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

**DOE Award Amount:** $1.1 million

**Additional Partners:**
- Texas A&M University Kingsville
- Today's Power Incorporated
- General Electric Global Research Center
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
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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.

SIGN UP NOW:
energy.gov/solar-newsletter