

# Overview of the PV Track

Lenny Tinker

PV R&D Program Manager

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# The PV R&D Team



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Technical Project Officer



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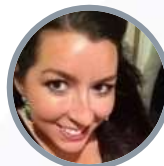
Andrew Dawson  
Technical Advisor



Marie Mapes  
Technology Manager



Tasso Golnas  
Technology Manager



Emily Marchetti  
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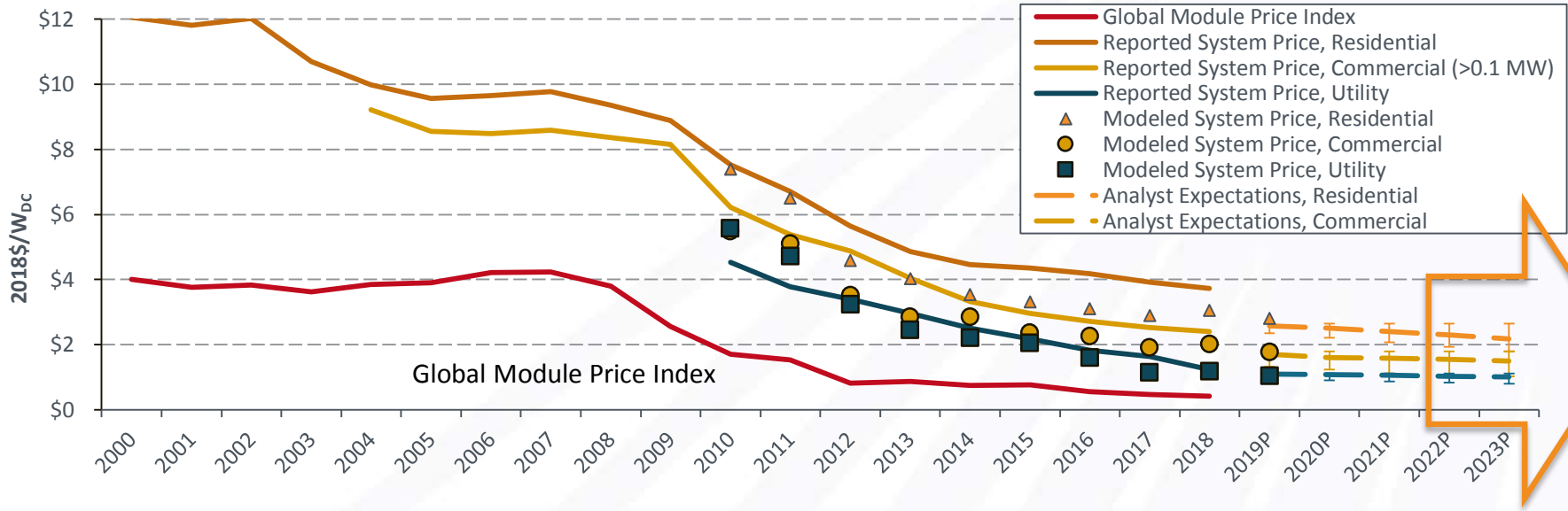
# Solar Energy Technologies Office Mission

Our mission is to accelerate the development and application of technology to advance low-cost, reliable solar energy in the U.S.

To achieve this mission, solar energy must:

- ▶ Be **affordable** and **accessible** for all Americans
- ▶ Support the **reliability**, **resilience**, and **security** of the grid
- ▶ Create a sustainable industry that **supports jobs**, **manufacturing**, and the **circular economy** in a wide range of applications

# A Brief Perspective on SETO PV R&D History



**Where we're going:** Low incremental value of PV at some times of day; TWyrs of US system data

- Moving from qualification tests to durability tests
- “Big data” aggregation with increased experience and observing degradation at the system level
- Ultra-cheap PV enabling different system constructions and room for increased product differentiation

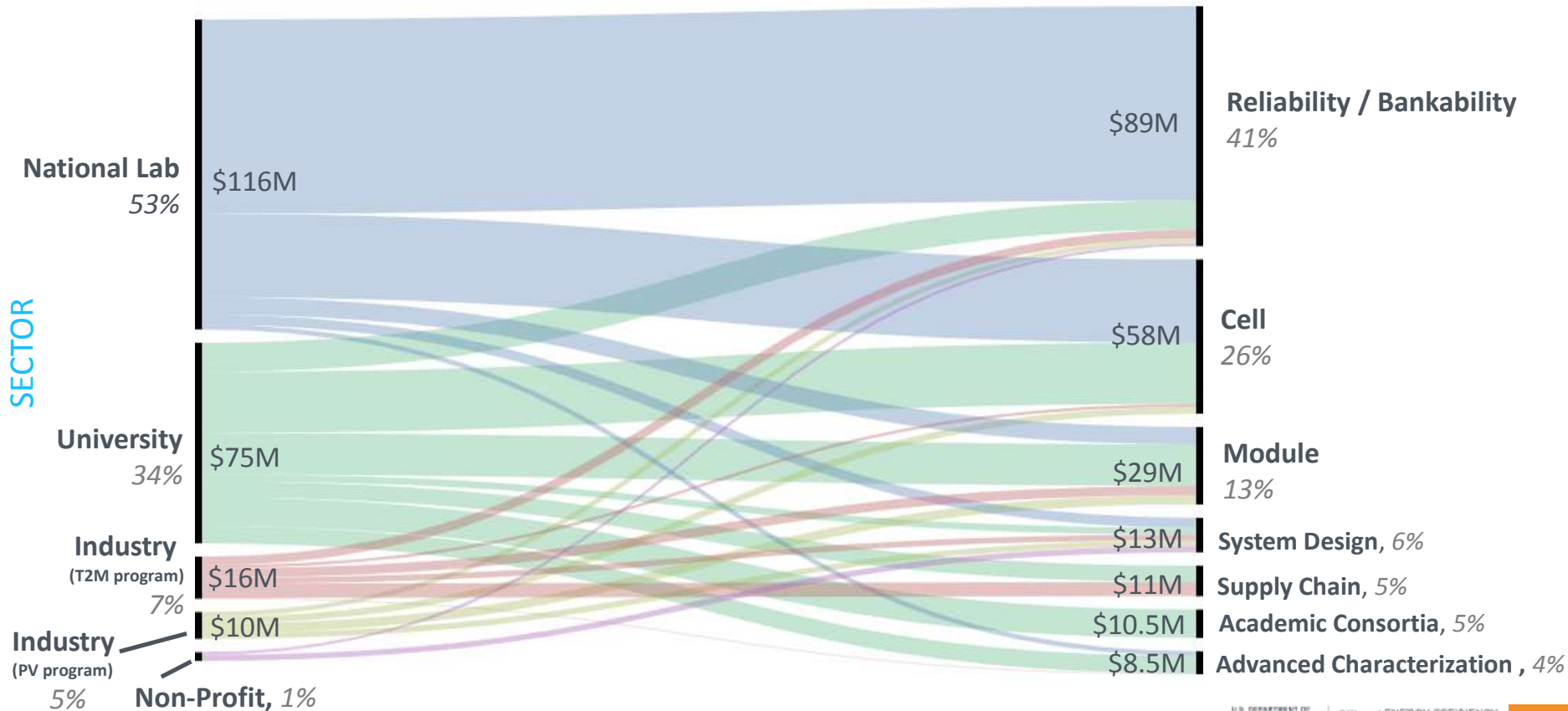
**Note:** Reported prices represent the median national U.S. averages. Error bars represent the high and low analyst expectations.

**Sources:** Reported residential and commercial system prices (Barbose and Darghouth 2019); reported utility system prices (Bolinger, Seal, and Robson 2019); modeled system prices (Feldman, Fu, Ramdas, Desai, and Margolis 2019); analyst expectations (NREL 2019 Annual Technology Baseline); The Global Module Price Index is the average module selling price for the first buyer (P. Mints SPV Market Research).

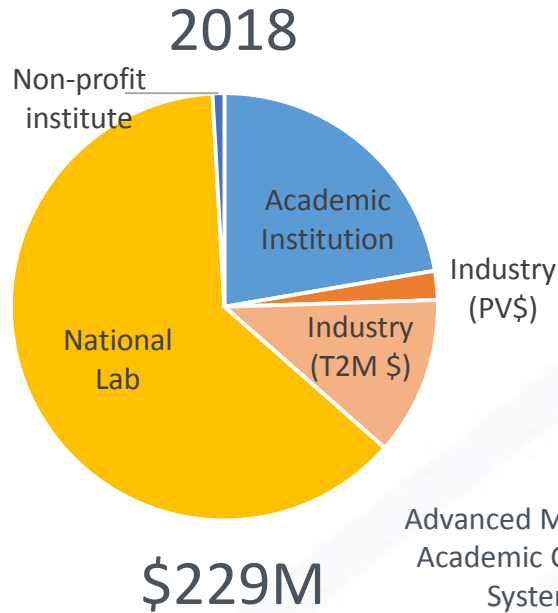
# Solar Energy Technologies Office Budget (\$K)

SETO SUBPROGRAM	2016	2017	2018	2019	2020	Active PV Projects (April 2020)
Concentrating Solar Power	\$48,400	\$55,000	\$55,000	\$55,000	\$60,000	-
Photovoltaic R&D	\$53,152	\$64,000	\$70,000	\$72,000	\$72,000	\$209,761
Systems Integration	\$52,447	\$57,000	\$71,200	\$54,500	\$53,000	-
Balance of Systems (Soft Costs)	\$34,913	\$15,000	\$11,000	\$35,000	\$35,000	\$800
Manufacturing and Competitiveness	\$43,488	\$16,600	\$34,400	\$30,000	\$60,000	\$8,763
NREL Facility Support	\$9,200					
<b>TOTAL</b>	<b>\$241,600</b>	<b>\$207,600</b>	<b>\$241,600</b>	<b>\$246,500</b>	<b>\$280,000</b>	<b>\$219,324</b>

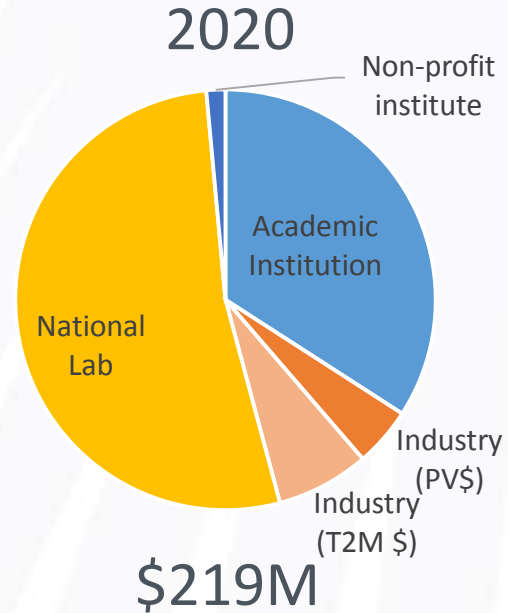
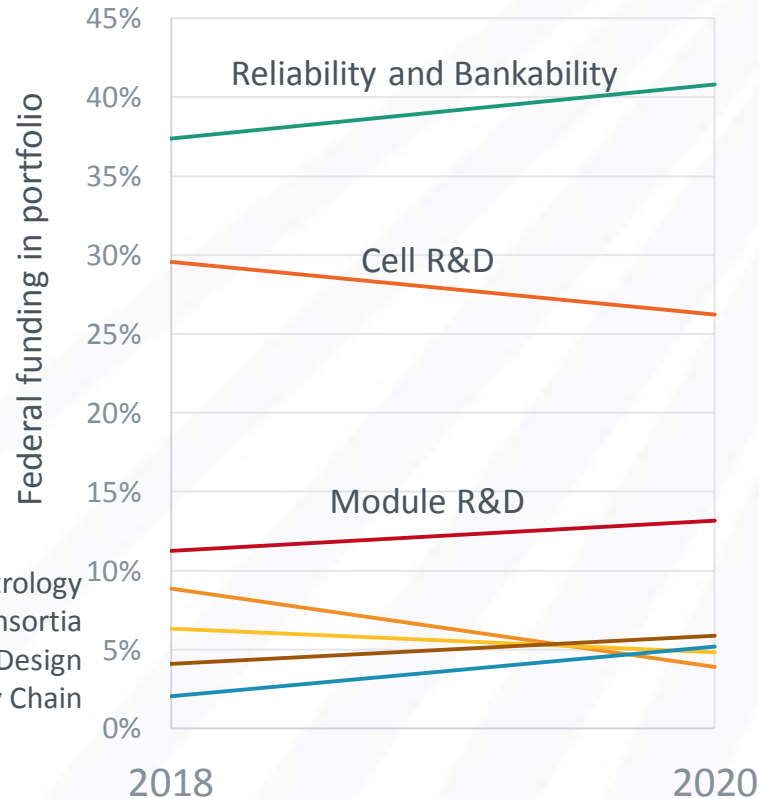
# SETO PV Research Funding Allocation - 2020 (\$219M)



# SETO PV Research Funding Allocation 2018 to 2020



Advanced Metrology  
Academic Consortia  
System Design  
Supply Chain

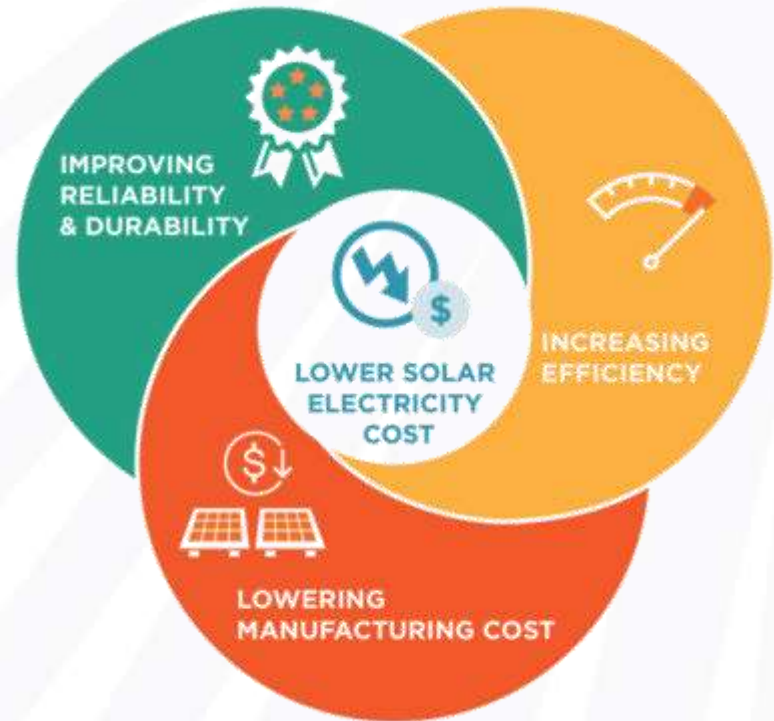


# The Photovoltaics Subprogram Approach

Funds research with a 3-15 year horizon, which is beyond industry focus or capabilities

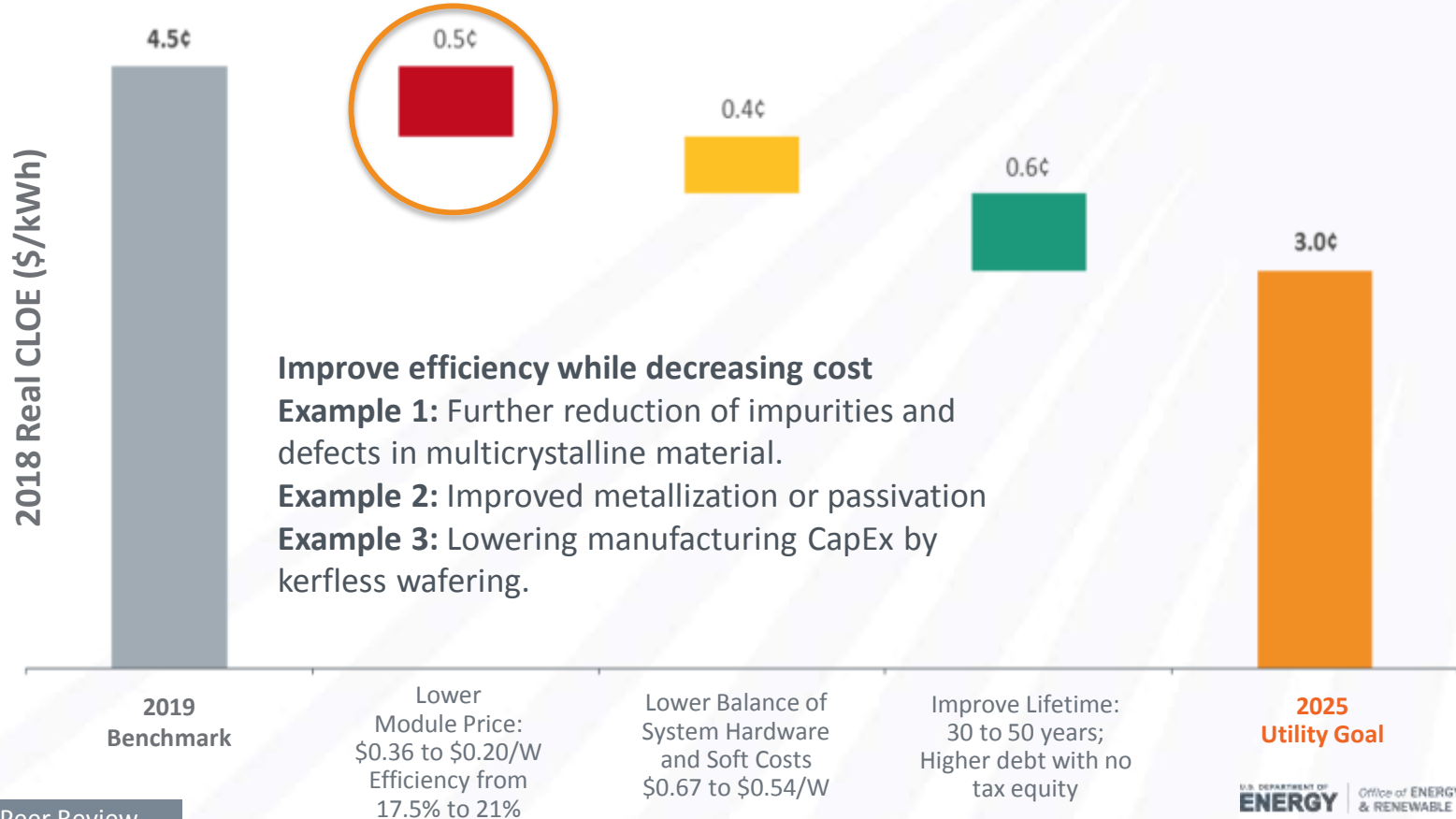
Supports an innovation ecosystem that includes universities, students, professors, and the private sector

Fosters the transition of research developments into the marketplace

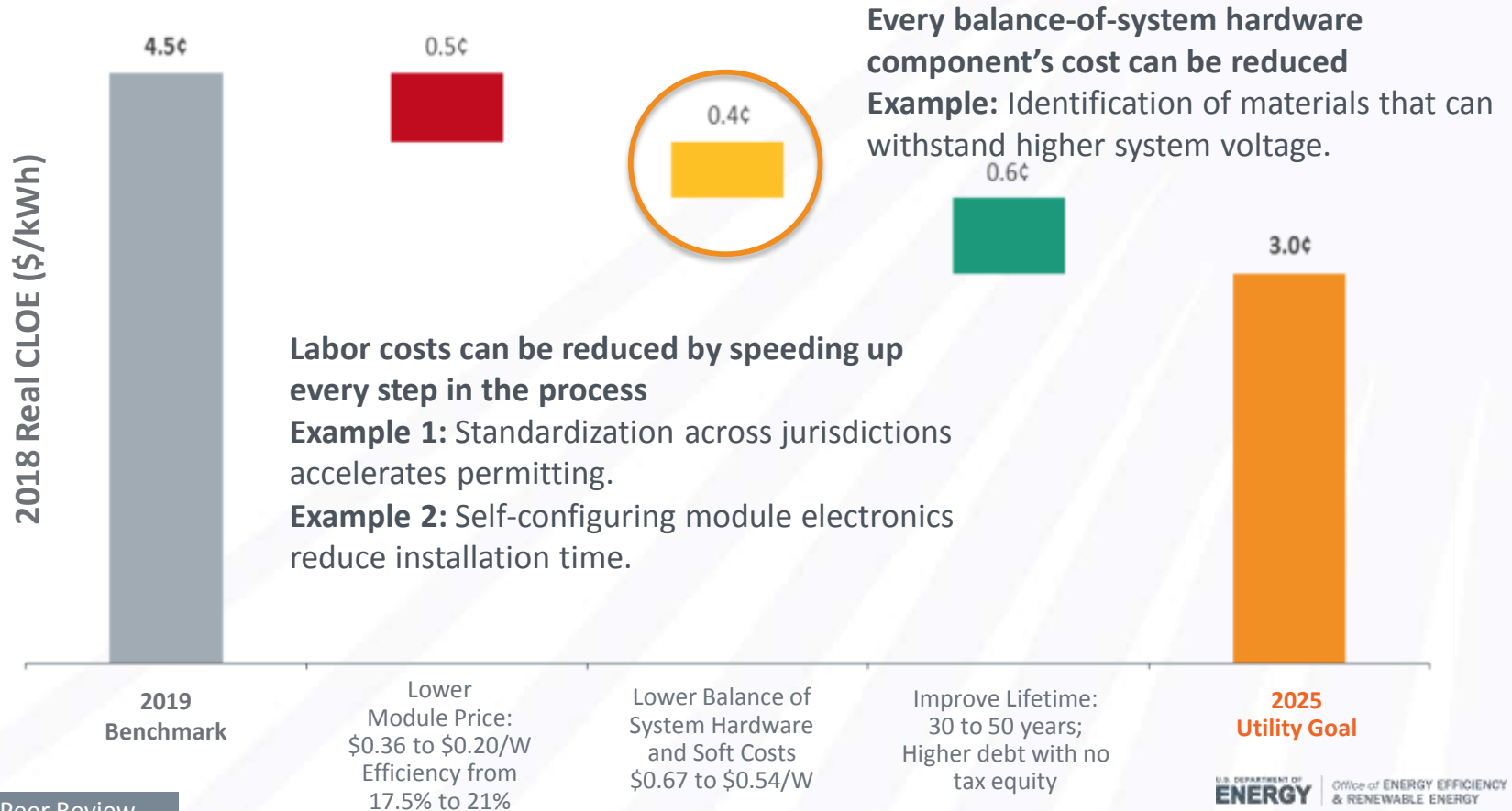




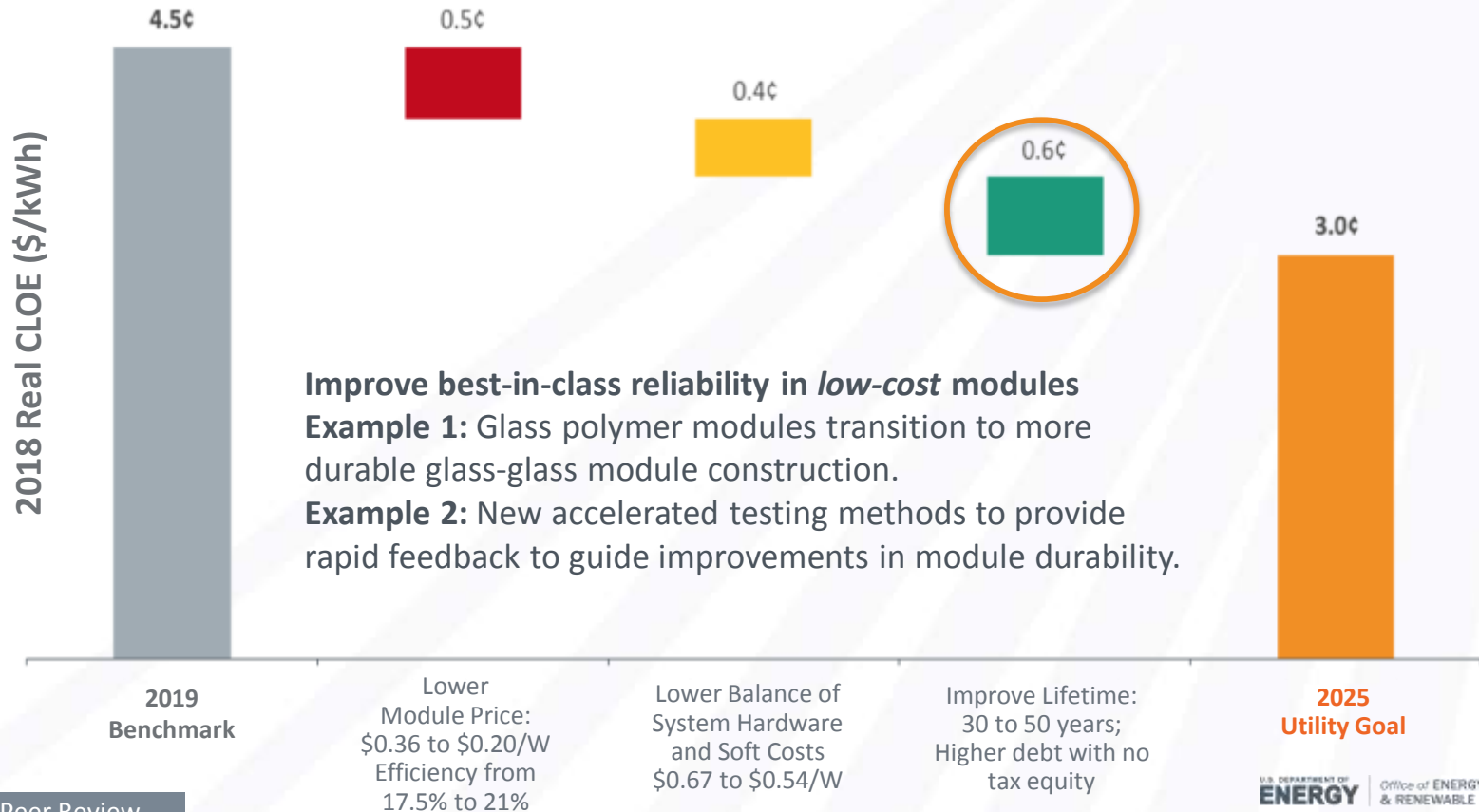
# A Pathway to \$0.03 per kWh for Utility-Scale PV



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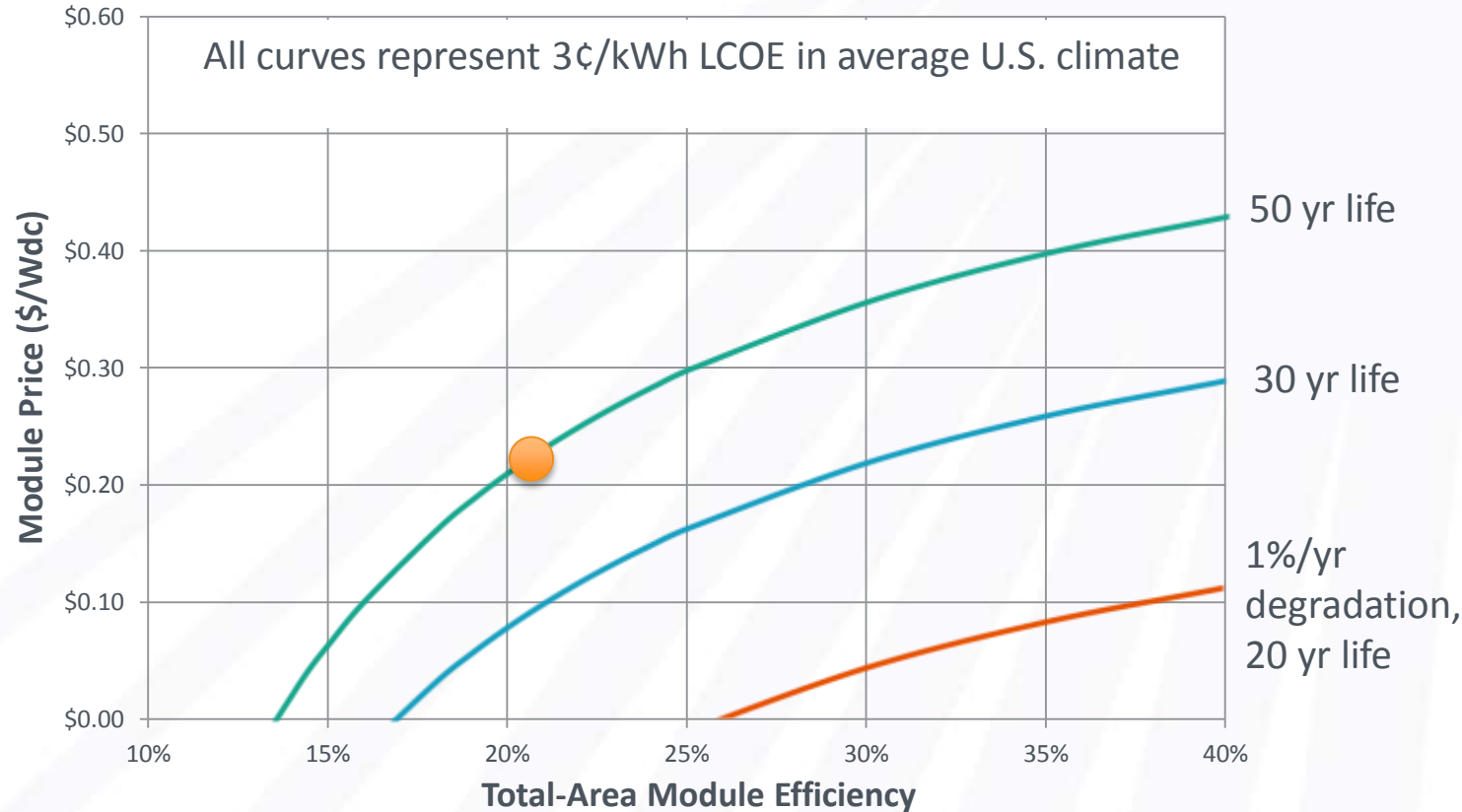


# A Pathway to \$0.03 per kWh for Utility-Scale PV



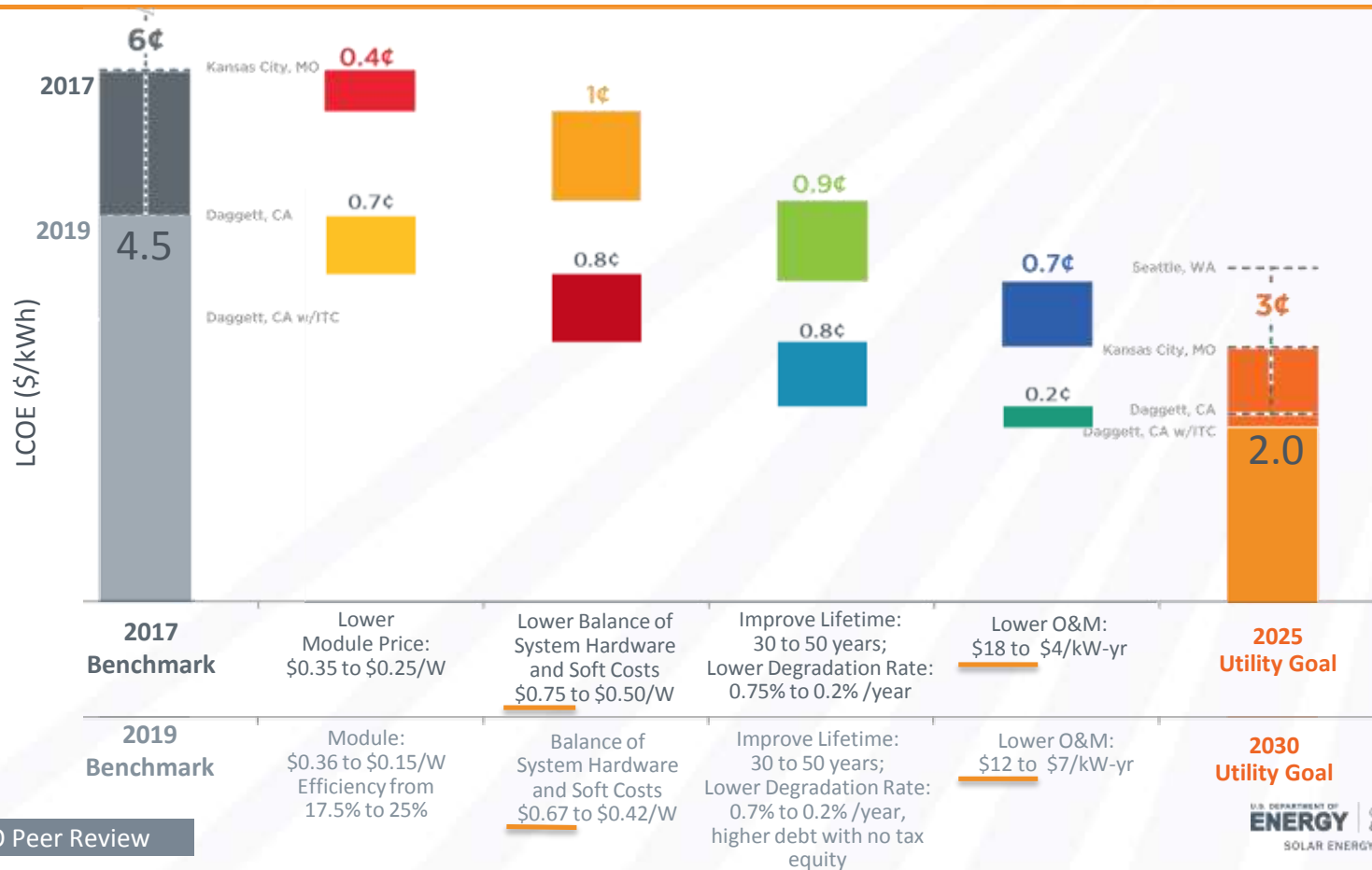
# There are Many Technology Pathways to \$0.03/kWh

- Cost and performance tradeoffs open up numerous pathways.
- All pathways require sustained, multifaceted innovation.



Scenarios assume: 7% WACC, 2.5% inflation, \$4/kW-yr O&M, 21% capacity factor

# Can we get to \$0.02/kWh?



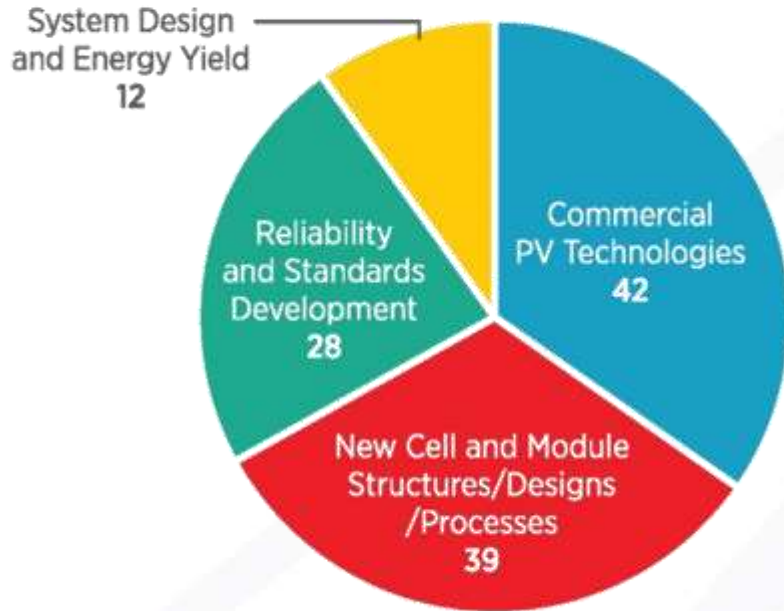
# SETO Photovoltaics R&D

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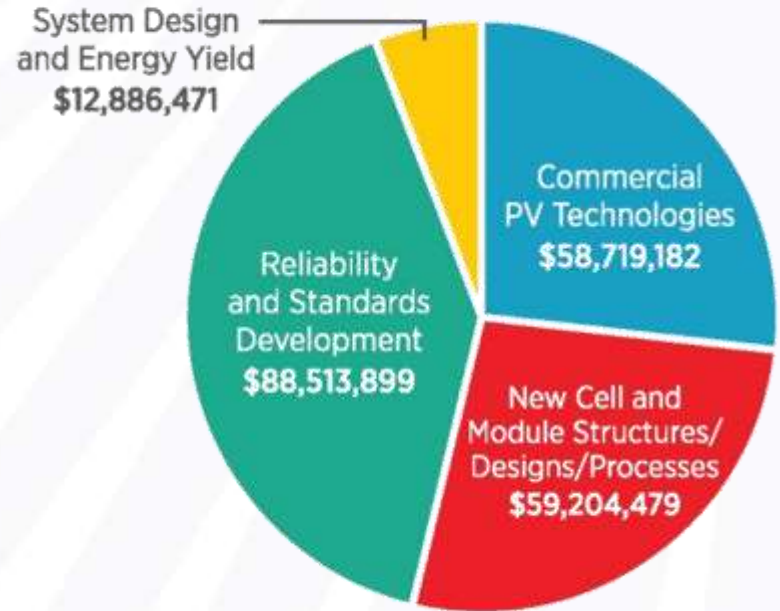
- Commercial Photovoltaic Technologies (Monday)
- New Cell and Module Structures, Designs, and Processes (Tuesday)
- Reliability and Standards Development (Tuesday)
- System Design and Energy Yield (Tuesday)

# Active PV Projects (121 projects, \$219M)

## Photovoltaics (PV) Projects by Topic Area



## Photovoltaics (PV) Funding by Topic Area

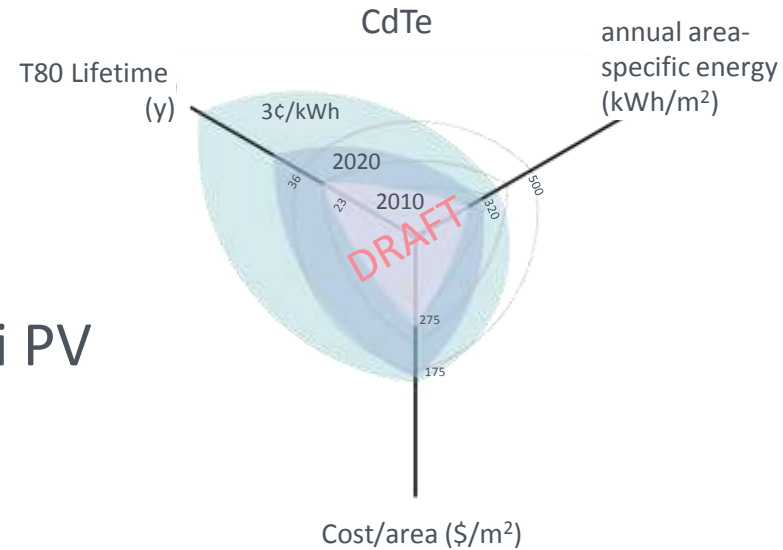


# SETO Advances Commercial PV Technologies

- Currently a \$59M portfolio
- Federal funds used to accelerate advancement in the most competitive technologies
- Bulk of funding directed to CdTe and Si PV

Examples:

- Passivation and heterojunction Si cells
- Understanding defects to increase CdTe performance
- Metallization and paste development



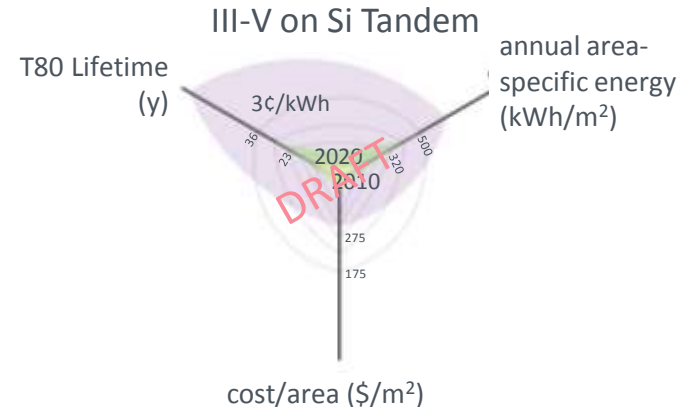
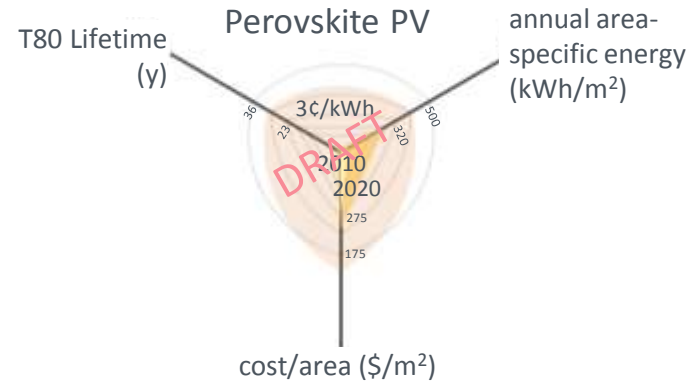


# SETO Supports Development of New PV Hardware

- Currently a \$60M portfolio
- Provide technology options and diversification of R&D portfolio to enable potentially radially low-cost PV
- Aim to fund areas where there US could have a competitive advantage or strategic capability

Examples:

- Perovskite PV
- New ways to grow III-V cells and reuse substrates
- Tandem modules



# ... and Advanced System Designs to Increase Energy Yield

- \$13M portfolio that has been growing
- Federal funds used to increase the energy yield (kWh/kW) in a variety of climates
- Research and development to expand PV deployment options so that the solar resource can be more fully utilized

## Examples:

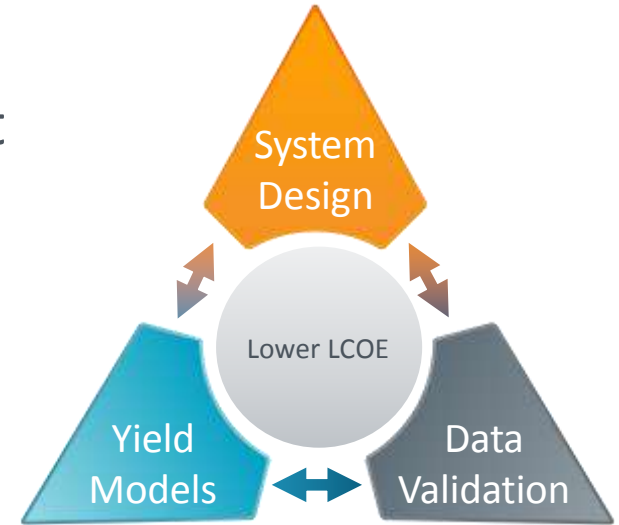
- Characterizing bifacial gain and creating an albedo database
- Improved performance in snowy climates
- Low-cost PV mounting systems

Bifacial test centers at NREL and SNL



# SETO Works to Ensure Systems Deliver as Expected

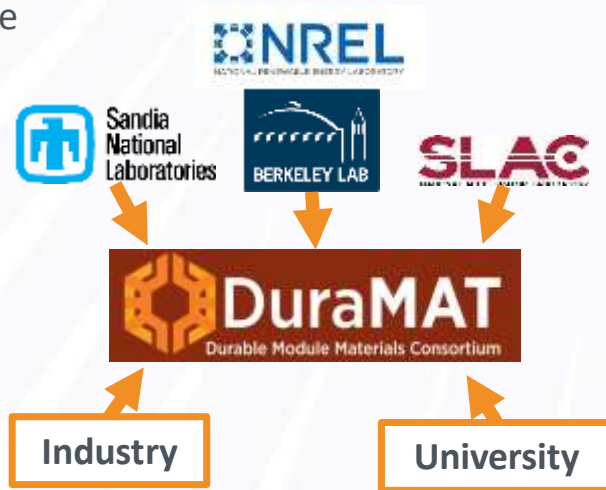
- Currently an \$89M portfolio
- System lifetime is a large lever on LCOE but must be reliable and financeable
- Most of global fleet is young and technologies are continually changing
- PV deployment is accelerating and the industry needs to be able to predict, understand, and mitigate degradation
- We need performance data, acceleration protocols, and advanced modules to extend the bankable service life of PV systems



# DuraMat: Durable Module Materials Consortium

- Brings *national laboratory* and *university* infrastructure together with photovoltaic (PV) *supply chain and manufacturing industry* to accelerate development of durable packaging materials and technology transfer
- Industry Advisory Board guides strategic and technical direction of consortium

Capability Network						
	Data Management & Analysis	Predictive Simulation	Materials Forensics	Module Prototyping & Test	Outdoor Testing	Techno-economic Analysis
DuraMAT Projects	DataHub	Multi-scale Module Simulation	Material Properties and Aging	Accelerated Testing	Non-Destructive Testing	Quantity LCDE
	Software Development and Machine Learning	Materials Modeling	Correlating Accelerated Testing and Field Data	UV Ionization Damage	Field Aged Module Library	Decision Support
	PVDAQ Upgrade	Flexible Modules	Barrier and Encapsulants	ECA and Contacts	Wind Loading and Structural Materials	Financial Modeling
	Data Visualization	Materials Selection	Cell Cracking	Module Design and Fabrication		Circular Economy
			Front Coating			



Combined accelerated stress testing at NREL to identify PV degradation modes

# A Quick Recap

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- SETO funds a diverse PV portfolio that spans academic, industrial and National Lab research with the goal of driving down the LCOE costs of PV
- We emphasize information dissemination and diffusion that is appropriate for the activity
- Reliability is an increasing part of our portfolio which is guided by techno economic analyses
- We're looking forward to your feedback on how we can improve our program!

# QUESTIONS?

