



**SOLAR ENERGY
TECHNOLOGIES OFFICE**
U.S. Department Of Energy

PORTFOLIO REVIEW

2018



**SOLAR ENERGY
TECHNOLOGIES OFFICE**
U.S. Department Of Energy

2018 SETO Portfolio Review

Photovoltaics Subprogram

SETO Portfolio Review

February, 2018

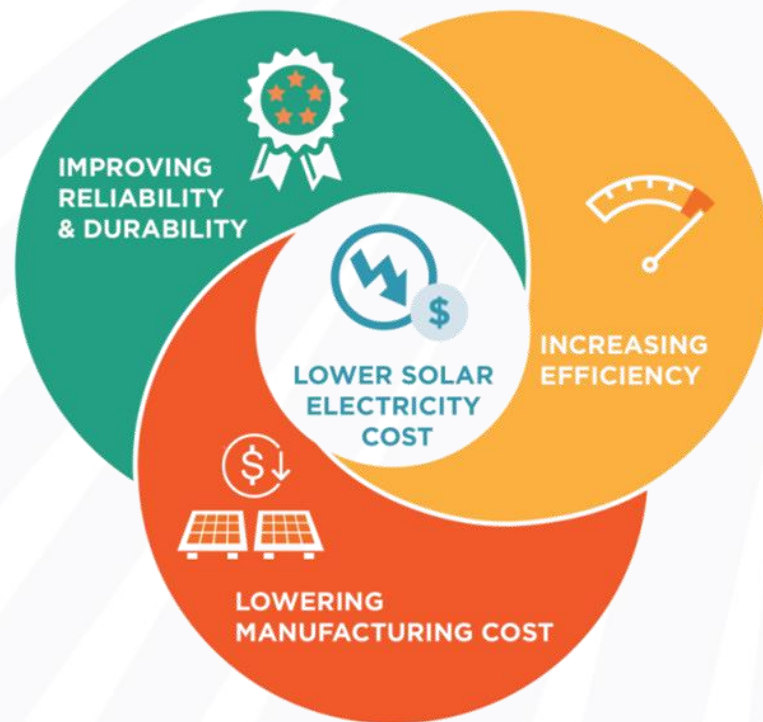
Dr. Lenny Tinker, Program Manager

Photovoltaics Subprogram

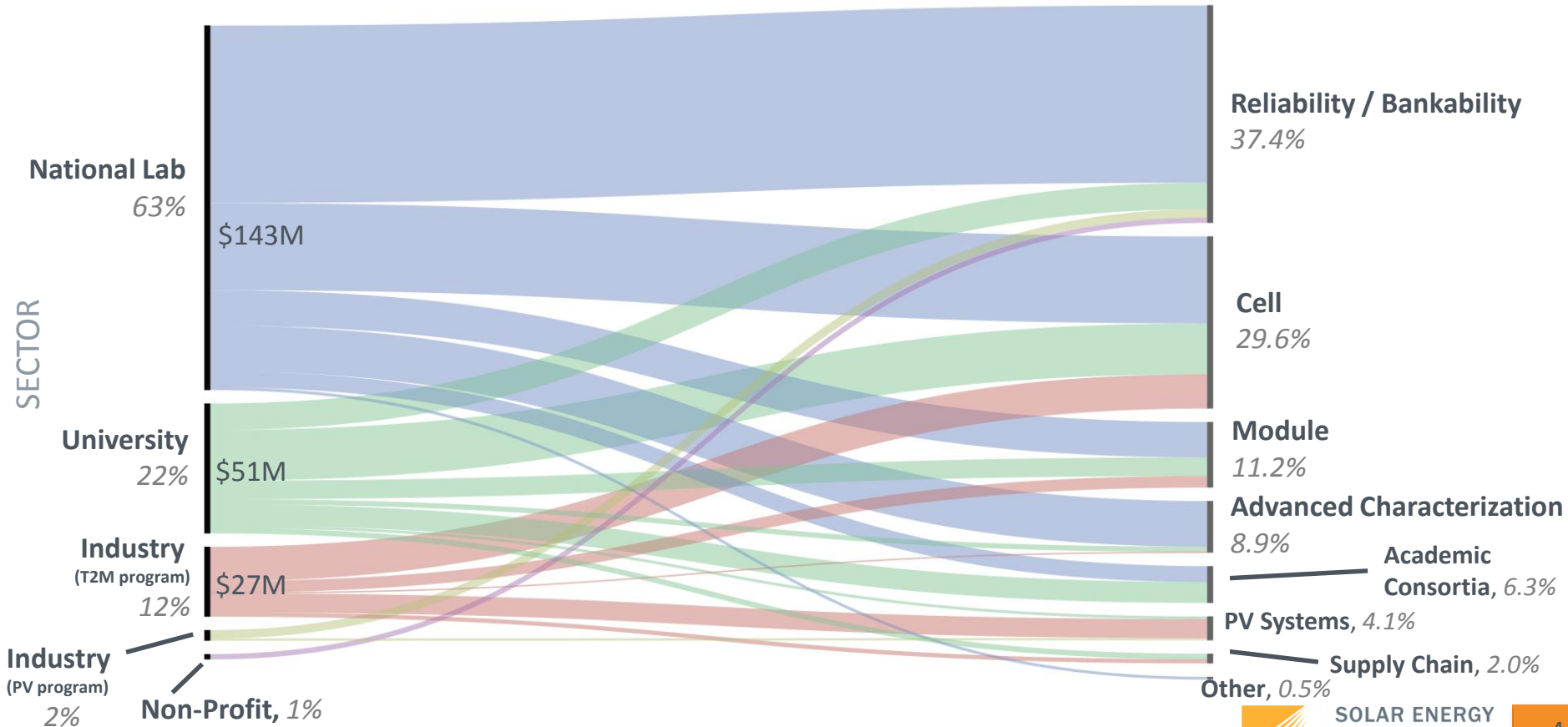
Funds research with a 10-15 year horizon, which is beyond industry focus or capabilities

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

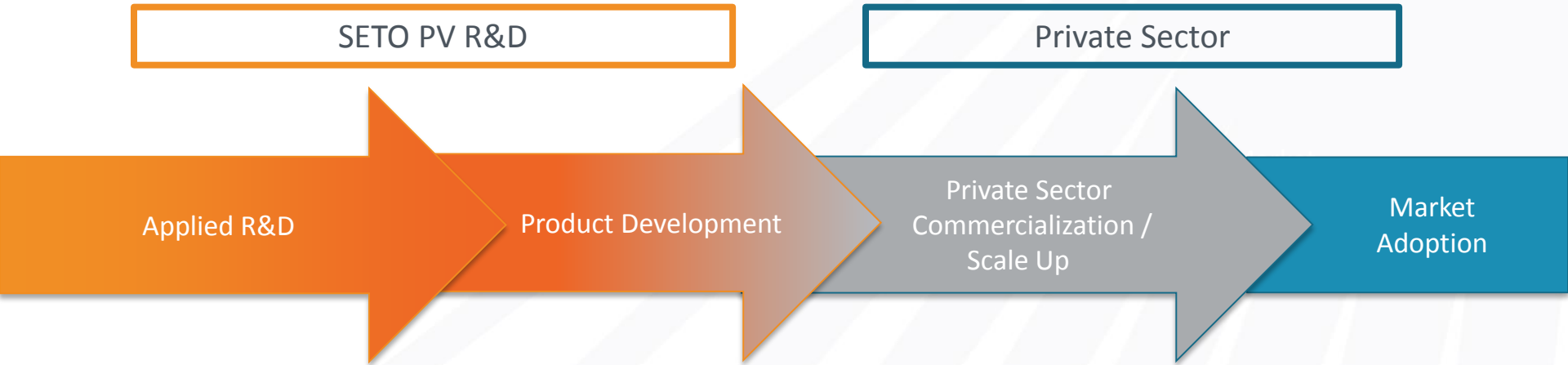
Current Focus: Improving reliability and efficiency of new and existing PV technology



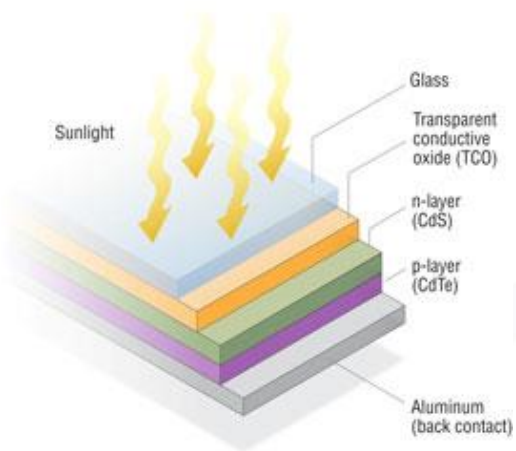
SETO PV Research Funding Allocation



Pipeline for Technology Development

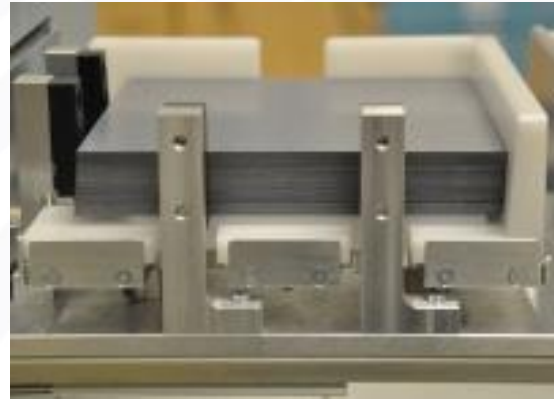


DOE Supported CdTe Research Leading to a U.S. Company Being the Major Supplier of CdTe Modules



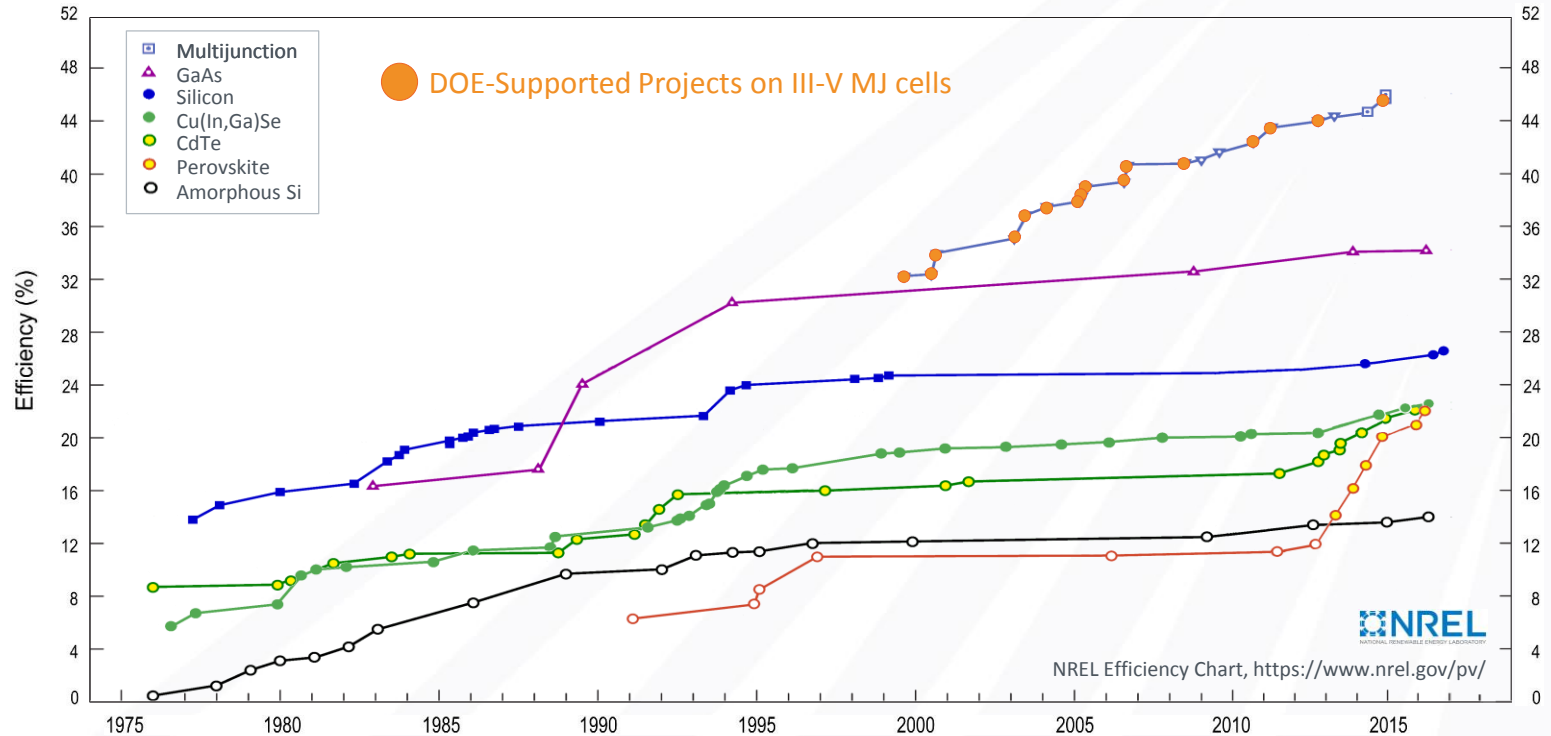
- Solar Cells Inc. and First Solar (acquired Solar Cells Inc.) have a history of working with NREL since 1990
- NREL and First Solar developed the “High Rate Vapor Transport Deposition Technique”, winning a 2003 R&D 100 award
- First Solar has produced more than 13.5 GW and is the only thin film manufacturer among the ten largest PV module makers in the world

Early Stage Research Leads to Domestic Companies



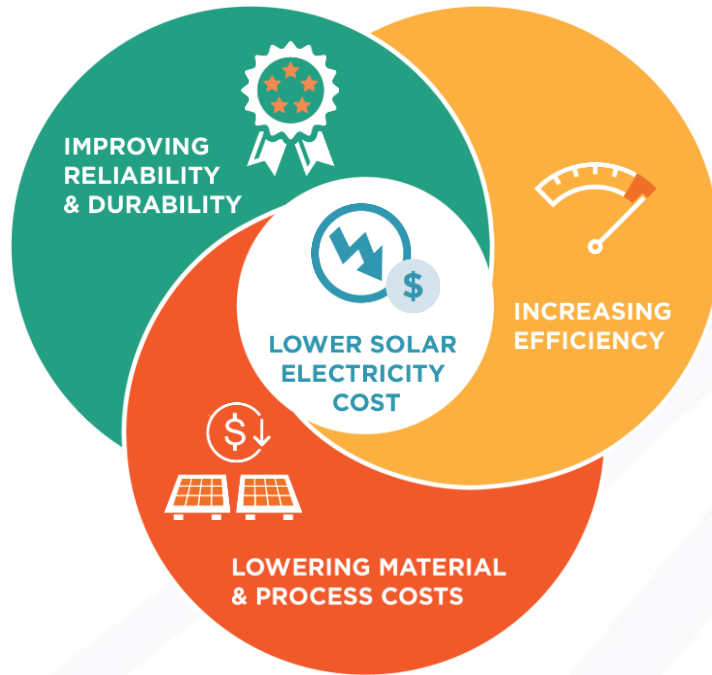
- Next Generation Photovoltaics program supported research at MIT on a **Direct Wafer Silicon process** from 2008 – 2011 contributing to the technology development of 1366 Technologies

DOE R&D Drives Solar Cell Efficiency Records




















- More than 40% all solar cell efficiency world records have been directly funded by DOE

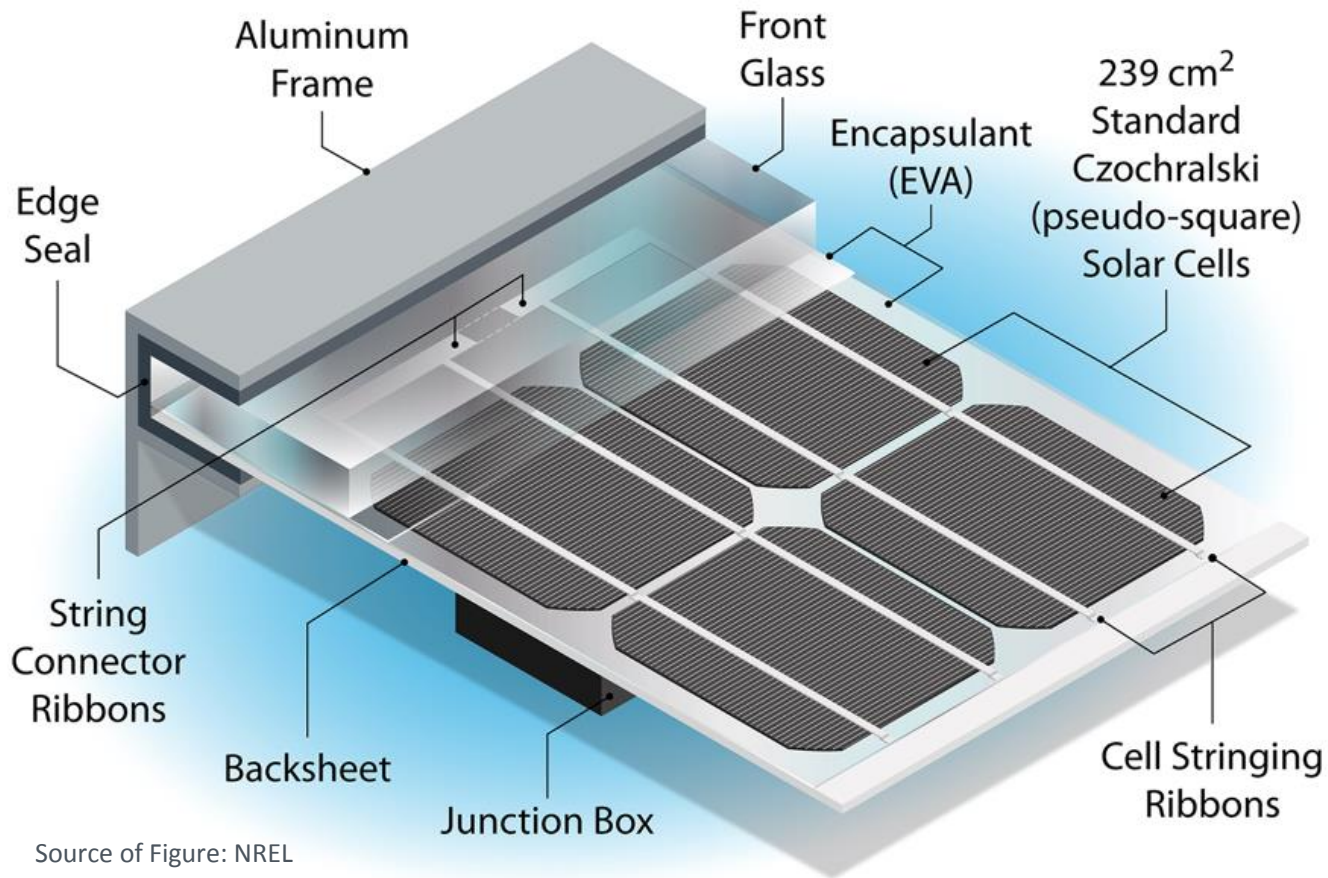
Photovoltaics R&D Subprogram



SETO PV FUNDING PROGRAMS:

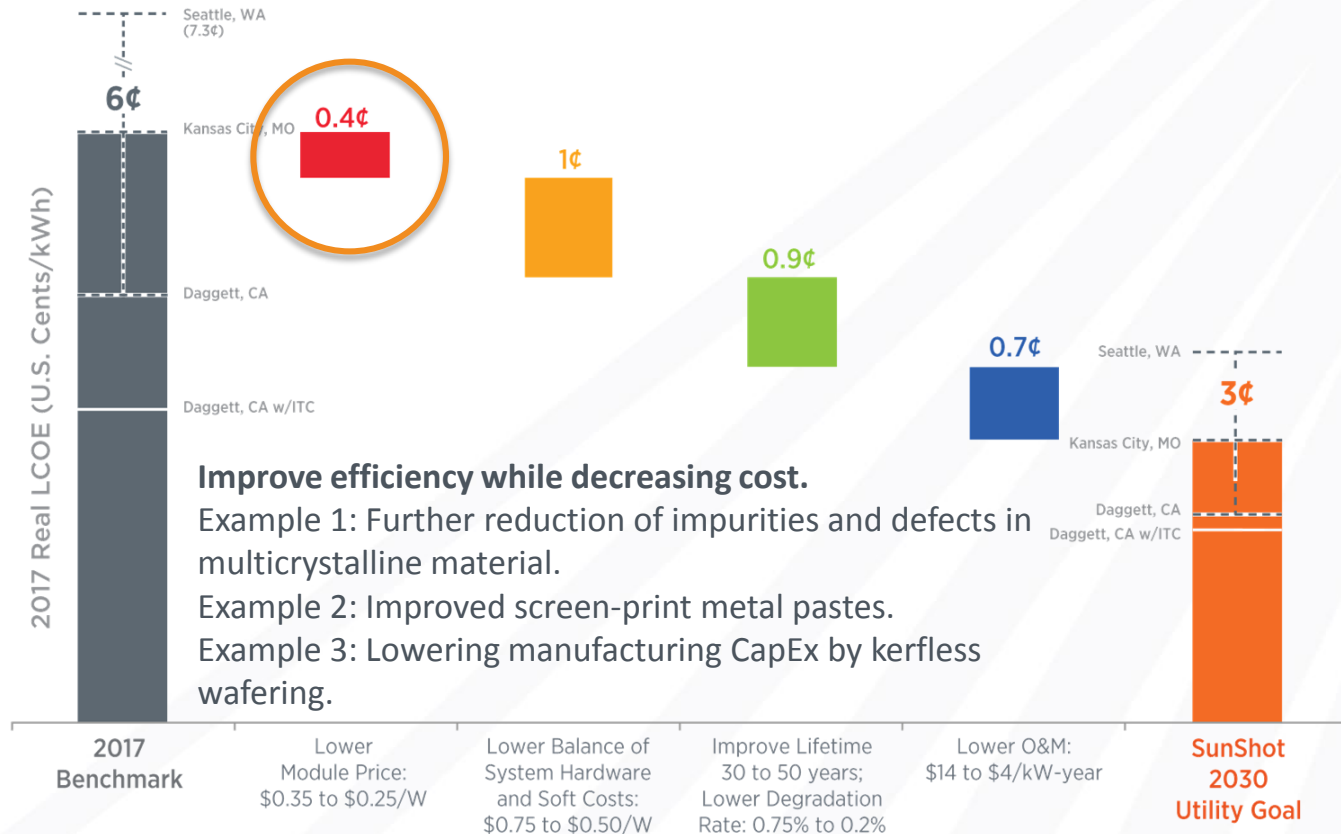
-  PVRD2 (2017, \$25M)
-  DuraMat (2016, \$30M)
-  PVRD (2016, \$17M)
-  PVRD-SIPS (2016, \$2M)
-  Natl. Labs (SuNLaMP 2016-18, \$103M)
-  PREDICTS 2 (2015, \$10M)
-  Next Gen 3 (2014, \$15M)
-  DISTANCE (2013, \$1M)
-  F-PACE 2 (2013, \$16M)
-  PREDICTS (2013, \$2.5M)
-  Natl. Labs (LPDP, 2013-15, \$95M)
-  SERIIUS (2012, \$6.2M)
-  BRIDGE (2012, \$8M)
-  F-PACE (2011, \$30M)
-  Next Gen 2 (2011, \$23M)
-  QESST (2011 - 20, \$18M)
-  MURA (2010, \$2M)

What are the Opportunities for Module Innovation?



Source of Figure: NREL

A Pathway To 3 Cents per kWh for Utility PV



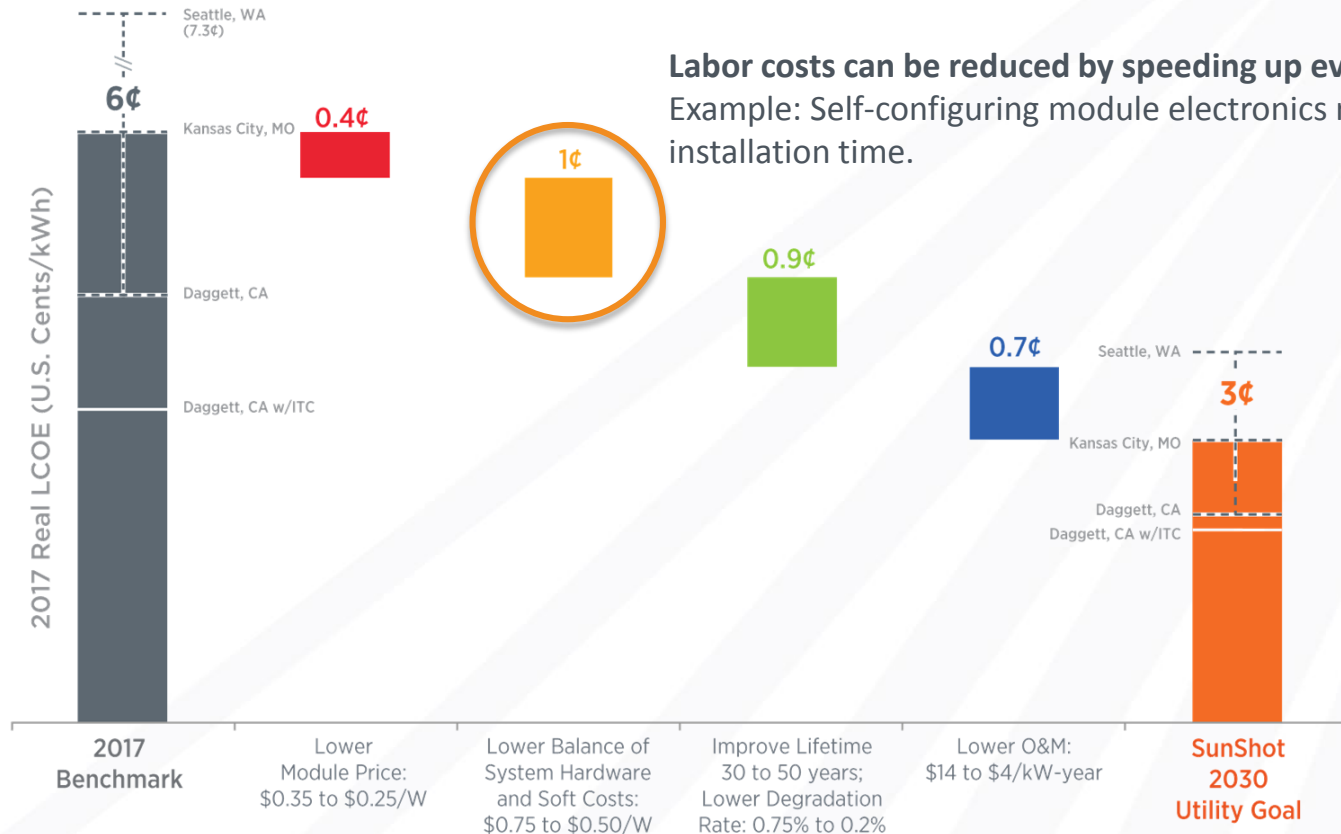
Improve efficiency while decreasing cost.

Example 1: Further reduction of impurities and defects in multicrystalline material.

Example 2: Improved screen-print metal pastes.

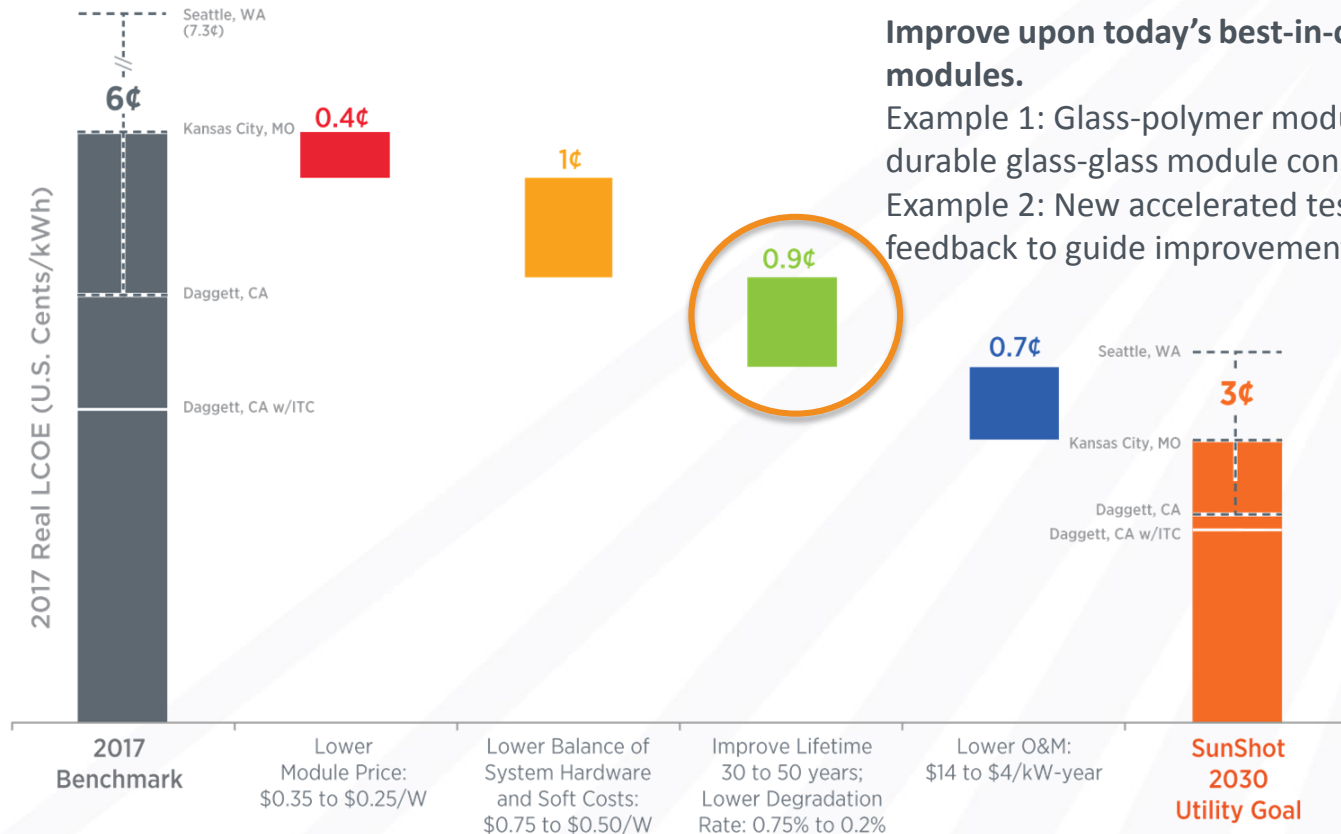
Example 3: Lowering manufacturing CapEx by kerfless wafering.

A Pathway To 3 Cents per kWh for Utility PV



Labor costs can be reduced by speeding up every step.
 Example: Self-configuring module electronics reduce installation time.

A Pathway To 3 Cents per kWh for Utility PV

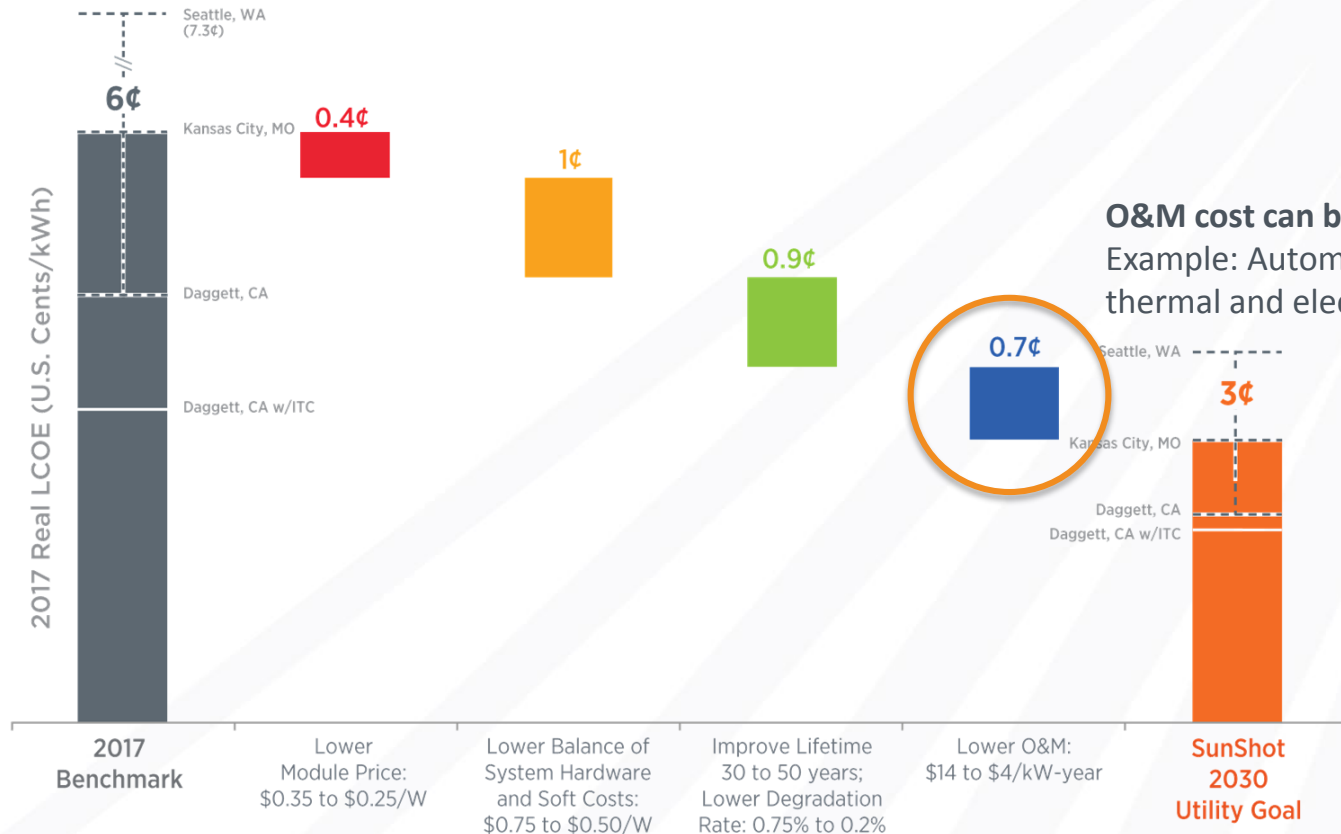


Improve upon today's best-in-class reliability in *low-cost* modules.

Example 1: Glass-polymer modules can transition to more durable glass-glass module construction.

Example 2: New accelerated testing methods to provide rapid feedback to guide improvements in module durability.

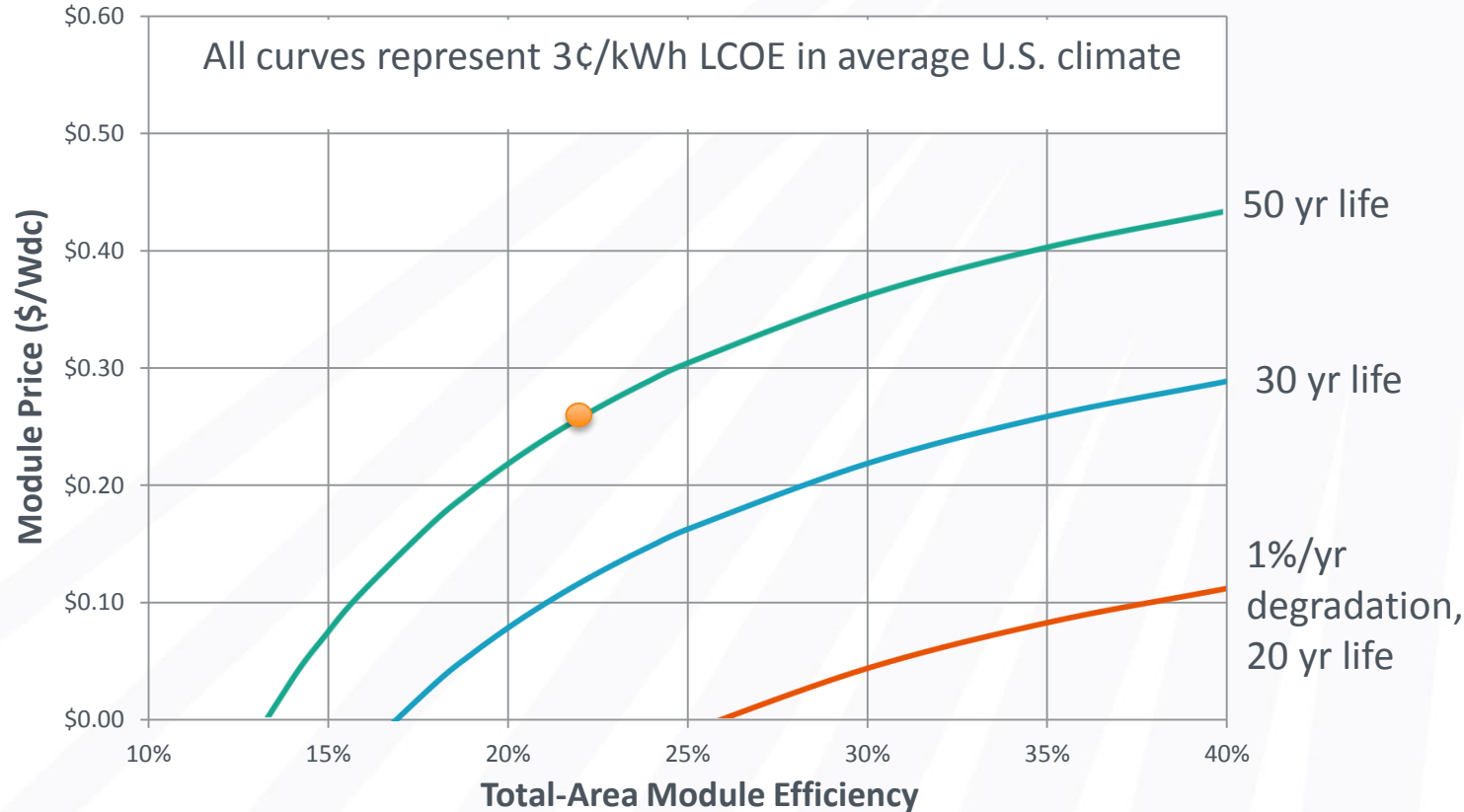
A Pathway To 3 Cents per kWh for Utility PV



O&M cost can be reduced by automation.
 Example: Automated field inspection by thermal and electroluminescence imaging.

There are Many Technology Pathways to \$0.03/kWh

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



The PV R&D Team



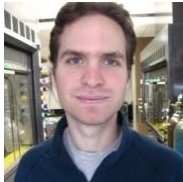
Christopher Anderson
Technical Project Officer



Marie Mapes
Technology Manager



Nancy Truong
Financial Analyst



Brion Bob
Technology Manager



Emily Marchetti
Operations



Susan Huang
Technical Advisor



Dana Olson
Technology Manager



Inna Kozinsky
Technical Advisor



Jonathan Trinastic
AAAS SunShot Fellow

Day 1	February 12	Location
11:00AM–12:00PM	<u>Photovoltaics Strategy and Vision</u>	Maryland Suite
	11:00 - 11:20 Dana Olson, SETO <i>PV Portfolio Highlights and Priorities</i>	
	11:20 - 11:40 Susan Huang, SETO <i>Techno-Economic Analysis and Research Priorities</i>	
	11:40 - 12:00 Marie Mapes, SETO <i>Evaluating the Impact of PV Research</i>	
12:00PM–1:00PM LUNCH		
1:00PM–3:00PM	<u>Photovoltaics R&D: Awardee Highlights</u>	Maryland Suite
	1:00 – 1:20 Wyatt Metzger, NREL <i>CdTe Material and Cell Development</i>	
	1:20 – 1:40 Michael McGehee, Stanford University <i>Perovskite-Silicon Tandem Solar Cells</i>	
	1:40 – 2:00 David Young, NREL <i>The R&D Trajectory for Silicon PV</i>	
	2:00 – 2:20 Aaron Ptak, NREL <i>Progress in the development of III-V solar cells using Dynamic Hydride Vapor Phase Epitaxy</i>	
	2:20 – 3:00 Jonathan Trinastic, SETO <i>PV R&D Discussion and Q&A Session</i>	
3:00PM–6:00PM POSTER SESSION		

Day 2	February 13	Location
11:00AM–12:00PM	Technology to Market: Hardware Innovations in Photovoltaics	Maryland Suite
12:00PM–1:00PM LUNCH		
1:00PM - 3:00PM	<u>Photovoltaics Durability and Characterization: Awardee Highlights</u>	Maryland Suite
	1:00 – 1:20 Roger French, Case Western Reserve Univ. <i>Using Distributed/High Performance Computing for Lifetime Performance of Photovoltaic Systems</i>	
	1:20 – 1:40 David Feldman, NREL <i>The Impact of R&D, Analysis, and Standardization on Solar Financing Cost</i>	
	1:40 – 2:00 Josh Stein, Sandia Natl. Lab <i>Performance Analysis of New and Innovative Photovoltaic Modules and Systems</i>	
	2:00 – 2:20 Mariana Bertoni, Arizona State Univ. <i>Understanding Photovoltaic Materials through Advanced Characterization</i>	
	2:20 – 2:40 Marco Nardone, Bowling Green Univ <i>PV Device Modeling: Challenges and Opportunities</i>	
	2:40 – 3:00 Teresa Barnes, NREL <i>The DuraMat Research Consortium</i>	
3:00PM–6:00PM POSTER SESSION and CLOSING		