Solar Energy Technologies Program: Photovoltaic R&D Overview

DOE Solar Energy Technologies Program

Tuesday, April 22, 2008

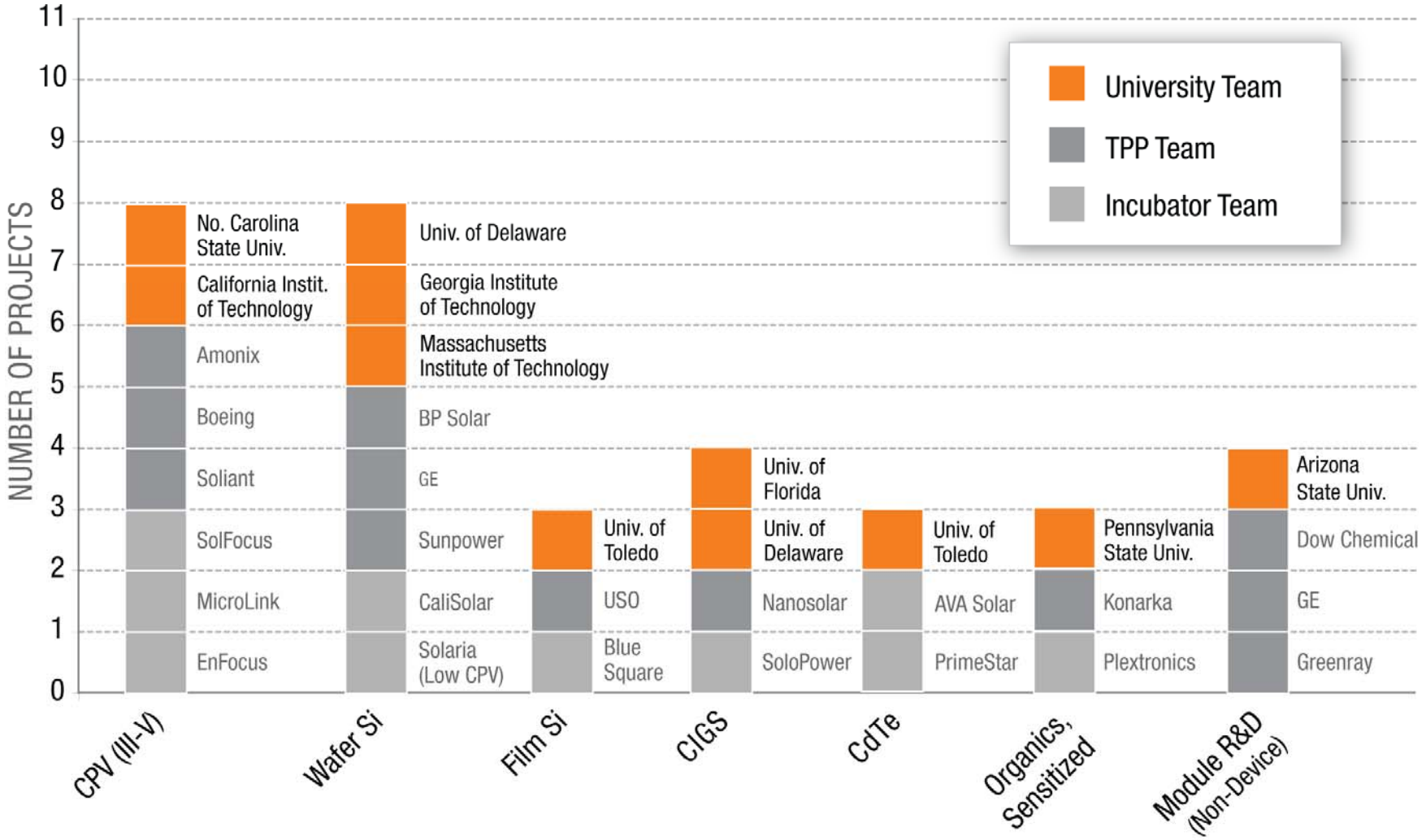
Contact: marie.mapes@ee.doe.gov

Current status of SAI R&D solicitations for companies and universities

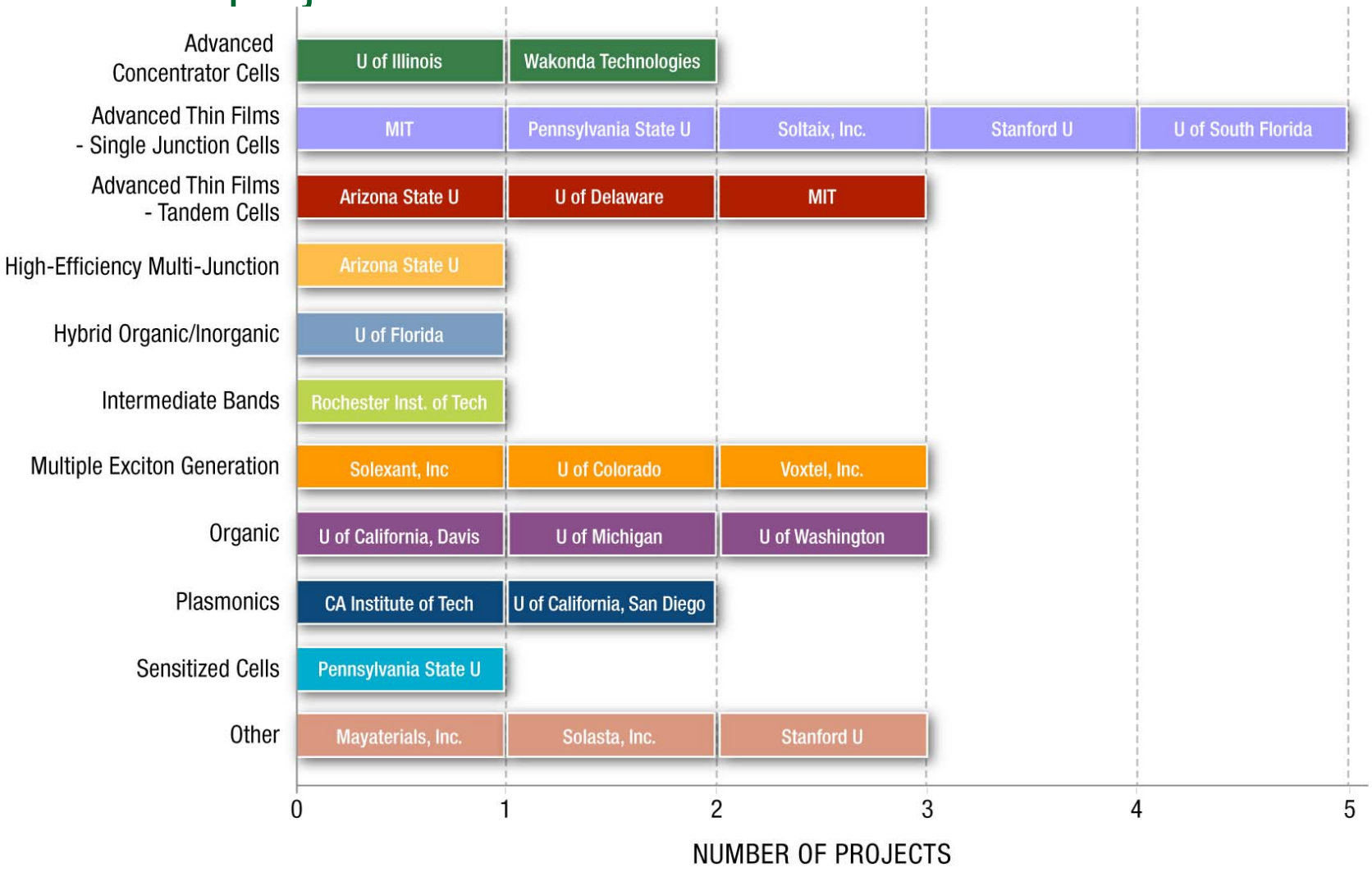
= Completed = In Process

Material & Device Concepts	Device & Process Proof of Concept	Component Prototype & Pilot Scale Production	System Development & Manufacturing
Solar Energy Utilization (BES) First Round • Award duration: **3 years** • **25 awards** • Award amount: **$0.15-$1.5 M/yr**	**Next Generation PV Device and Process** • Award duration: **3 years** • **25 awards** • Total: **Up to $21.7 over 3 years**	**PV Incubators First Round** • Award duration: **18 months** • **10 awards** • Total: **Up to $27 M over 18 months**	**Technology Pathway Partnerships** • Award duration: **3 years** • **11 awards** • Total: **Up to $168 M over 3 years**
Solar Energy Utilization (BES) Second Round • Award duration: **3 years** • Award amount: **$0.15-$1.5 M/yr**		**PV Incubators Second Round** • Award duration: **18 months** • Award amount: **Up to $2-3 M**	**University Product and Process Development Support** • Award duration: **3 years** • **11 awards** • Total: **Up to $13.7M over 3 years**
Energy Frontier Research Centers (BES) • Award duration: **5 years** • Award amount: **$2-$5 M/yr**		**Solar Energy Grid Integration Systems (SEGIS) Program** • Award duration: **3 years** • Award amount: **Up to $6.25 M**	**Supply Chain** • Award duration: **1-3 years** • Award amount: **$0.3-2 M**

Because the market has not settled on a dominant solution, DOE continues to fund projects across technology types



DOE's Next Generation PV seeds the beginning of the pipeline with high risk/ high payoff, technologically diverse projects



Technology Roadmaps were developed in 2007 to help guide PV R&D investments

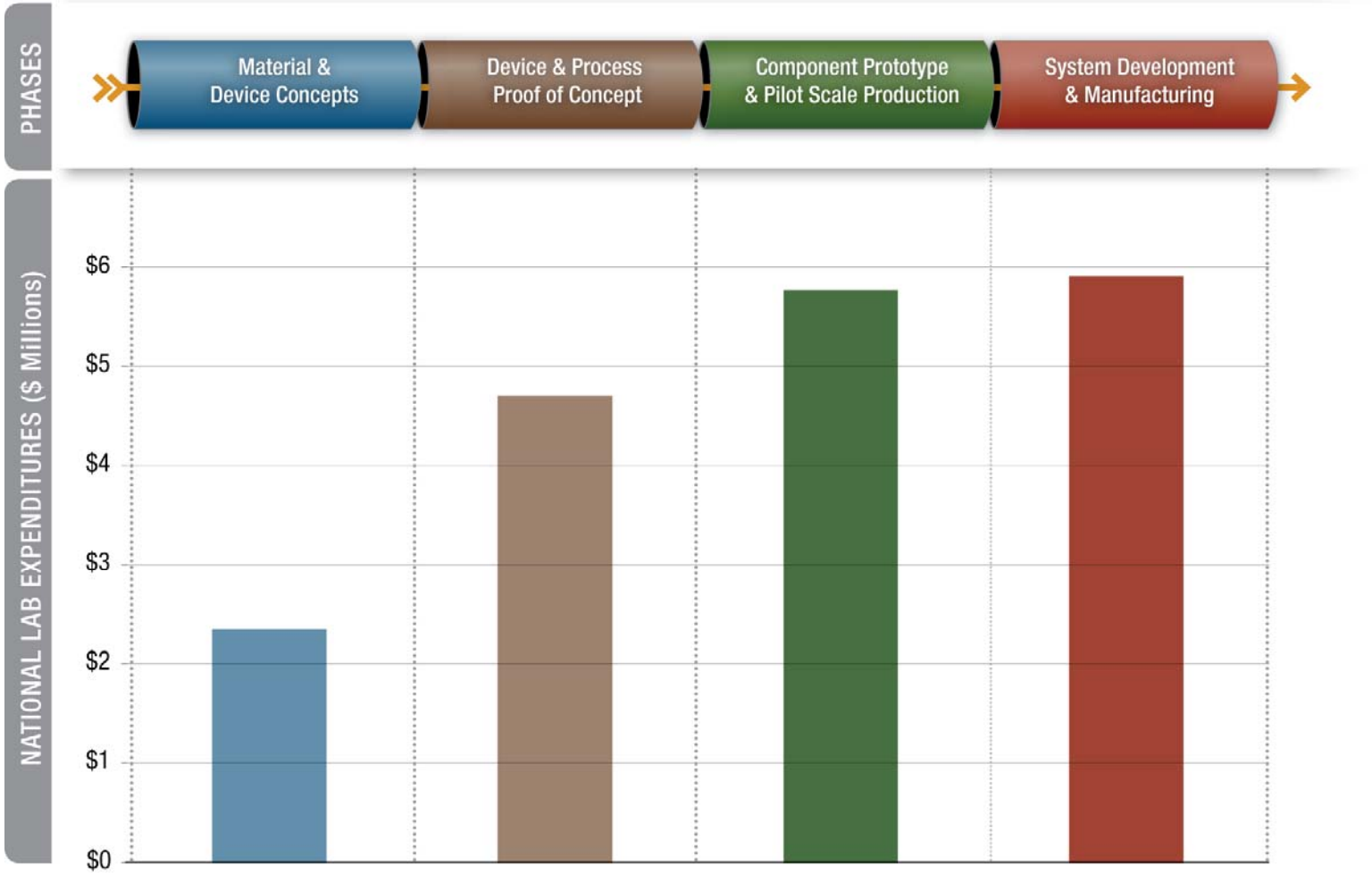
Metrics

Parameter
$/W installed cost
¢/kWh
System reliability – IEC qual. sp
Commercial system efficiency
Champion device efficiency
Commercial device efficiency
Optical efficiency
III-V cell cost, $/cm^2

Identified Needs

Need	Significance	University	Nat'l Lab			Industry		
			NREL	Sandia	Other	TPP	Incubator	Other
Establish reliability of prototypes	Needed for market entry. Address at all levels, from detailed understanding of individual failure mechanisms through field testing of systems.	x	x	x	x	x	x	x
Optimize design of overall system	Many opportunities for cost reduction; system-level approach needed.					x	x	
Reduce system cost	Address cell, optics, and tracker; cell cost reduction alone could reduce system cost by 10%–15%.	x	x	x	x	x	x	x
Increase system efficiency	Reduce system losses from optics; increase cell efficiency; increase of cell efficiency from 35% to 39% could reduce the ¢/kWh by 10%.	x	x	x	x	x	x	x
Develop industry product and rating standards	Market entry	x	x	x	x	x		x
The following address the above general needs in more depth								
Develop next-generation, high-efficiency cell structures	Includes multijunctions and other high-efficiency approaches	x	x				x	x
Establish science underpinnings of semiconductor growth and	Enable higher-efficiency cell designs over long term; reduce	x	x					

Focus on National Labs: internal research binned along pipeline according to which stage industry could use results



National Lab research has “something for everyone”, but efforts are weighted toward later stages in pipeline to be consistent with near-term SAI goals

Photovoltaic Conversion R&D

NATIONAL LAB EXPENDITURES

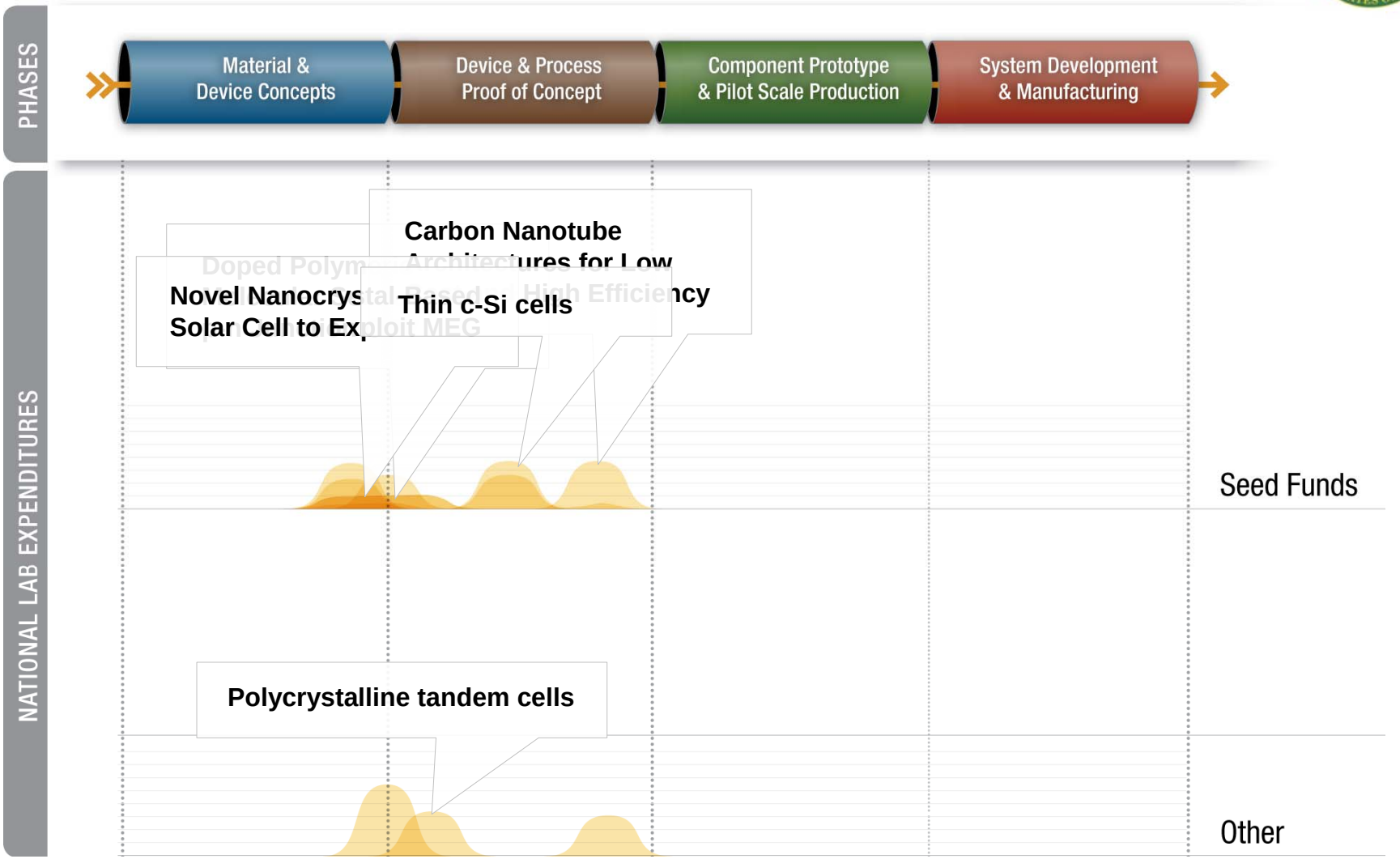
Reliability of cell components

- Reliability / degradation / acceleration factors for existing cells
- Tunnel jn stability under extremes of operating condition,
- of antireflective coats.

Crystalline film silicon on low-cost, low temp substrates

- aim for high quality film for 5-20 μm cells
- quality seed layers and scalable epitaxy
- choose borosilicate glass ($26/m2) instead of glass ceramic substrates (likely $100/m2)
- choose not to work at 1 micron grain sizes (like CSG)

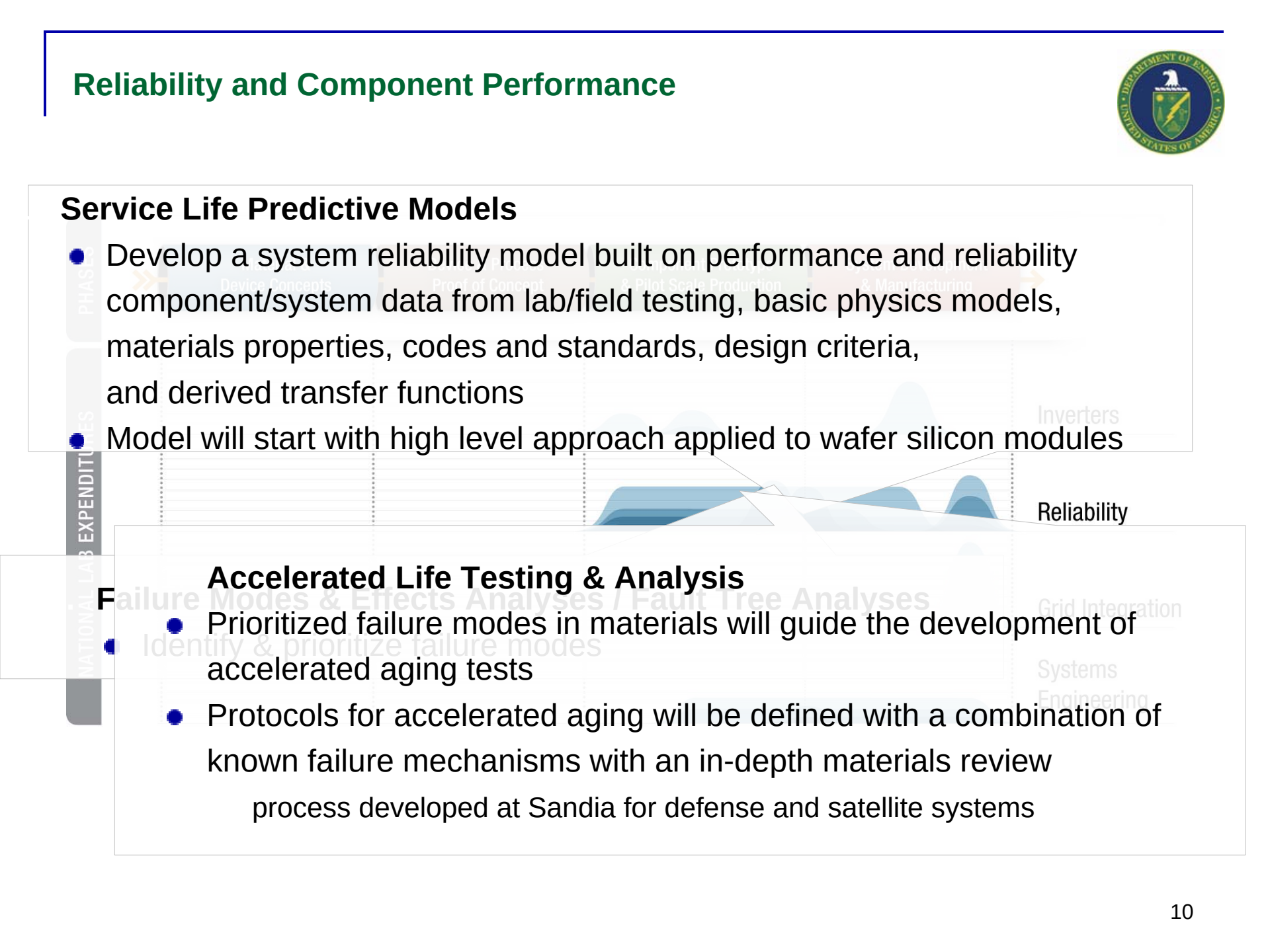
Next Gen Concepts



Reliability and Component Performance

Service Life Predictive Models

- Develop a system reliability model built on performance and reliability component/system data from lab/field testing, basic physics models, materials properties, codes and standards, design criteria, and derived transfer functions
- Model will start with high level approach applied to wafer silicon modules



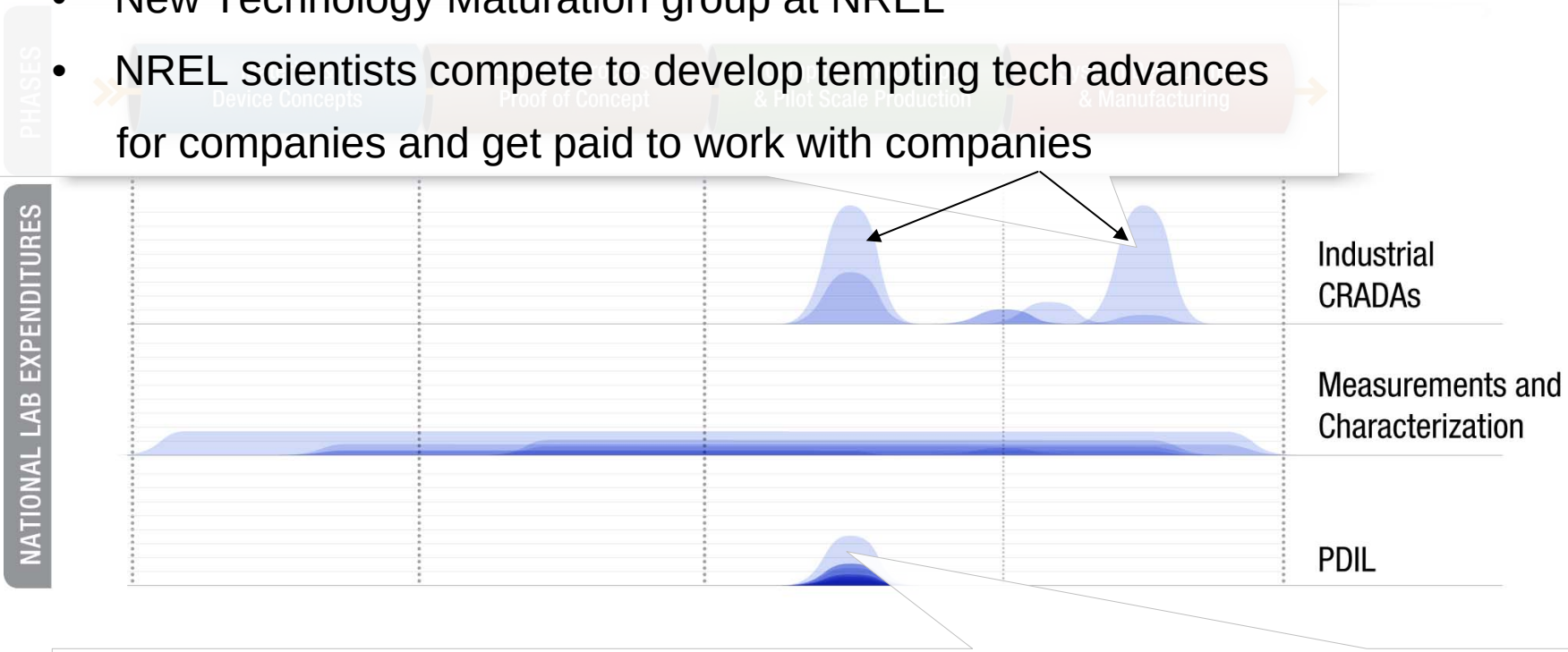
Accelerated Life Testing & Analysis

- Prioritized failure modes in materials will guide the development of accelerated aging tests
- Protocols for accelerated aging will be defined with a combination of known failure mechanisms with an in-depth materials review
  - process developed at Sandia for defense and satellite systems

Lab to Partner Support

CRADAs with Industrial Partners

- New Technology Maturation group at NREL
- NREL scientists compete to develop tempting tech advances for companies and get paid to work with companies



Process Integration and Development Laboratory

- NREL personnel can work with companies with their new rapid throughput tools
- New facility at NREL with atmospheric tool set, vacuum based film tools, and characterization and measurement tools
  - possible to isolate effects in separate layers with load lock capabilities

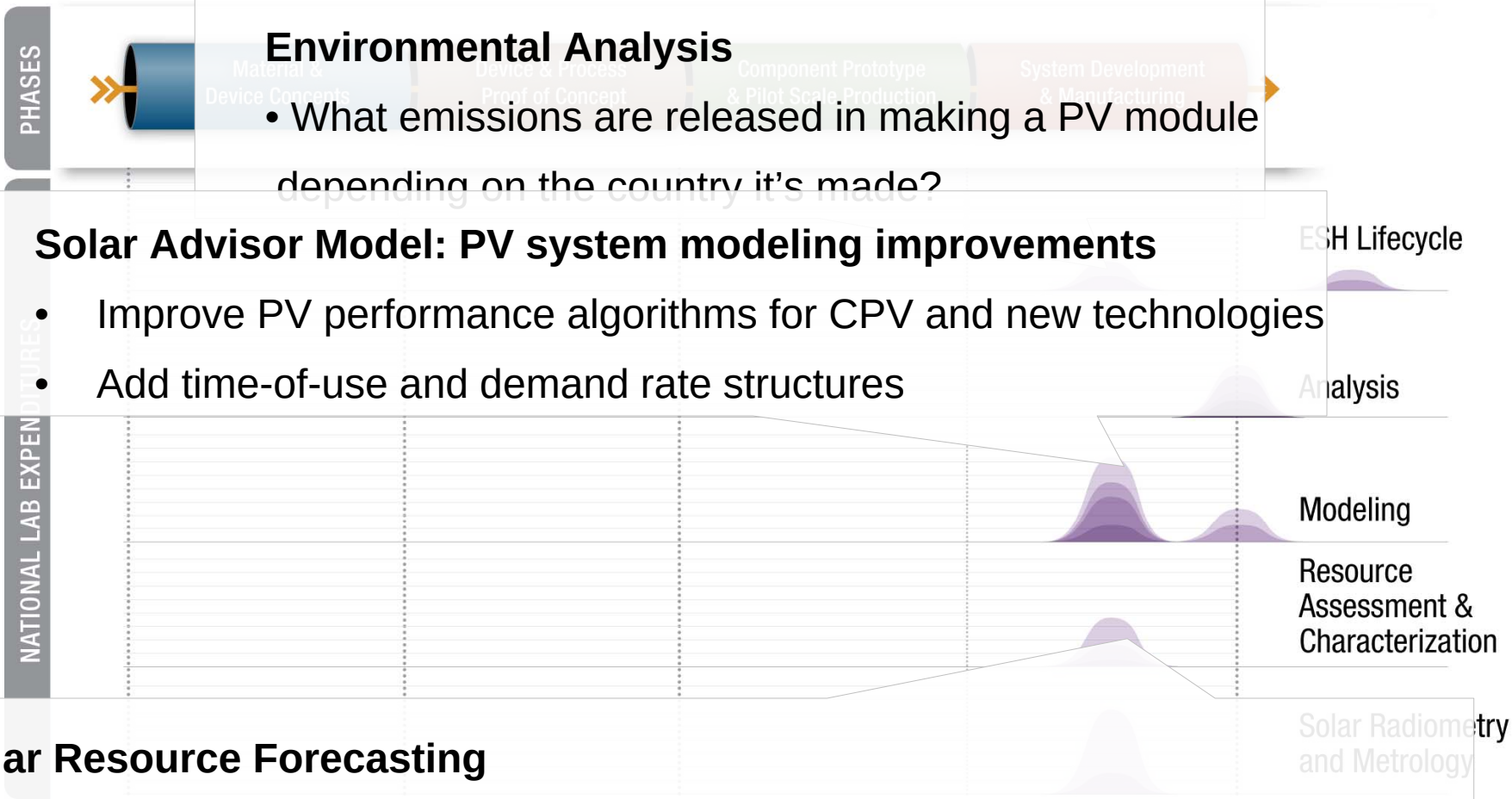
Studies with Cross-cutting benefits

Environmental Analysis

- What emissions are released in making a PV module depending on the country it's made?

Solar Advisor Model: PV system modeling improvements

- Improve PV performance algorithms for CPV and new technologies
- Add time-of-use and demand rate structures



Solar Resource Forecasting

- sub-hourly, 1-3-hr, day-ahead, climatic trend forecasting are desired by utilities and ISO's as a critical need for improved planning and operation of grid-tied PV

More information

- Marie Mapes – marie.mapes@ee.doe.gov
- Scott Stephens – scott.stephens@ee.doe.gov
- Tom Kimbis – tom.kimbis@ee.doe.gov