



# DuraMAT Spring Workshop

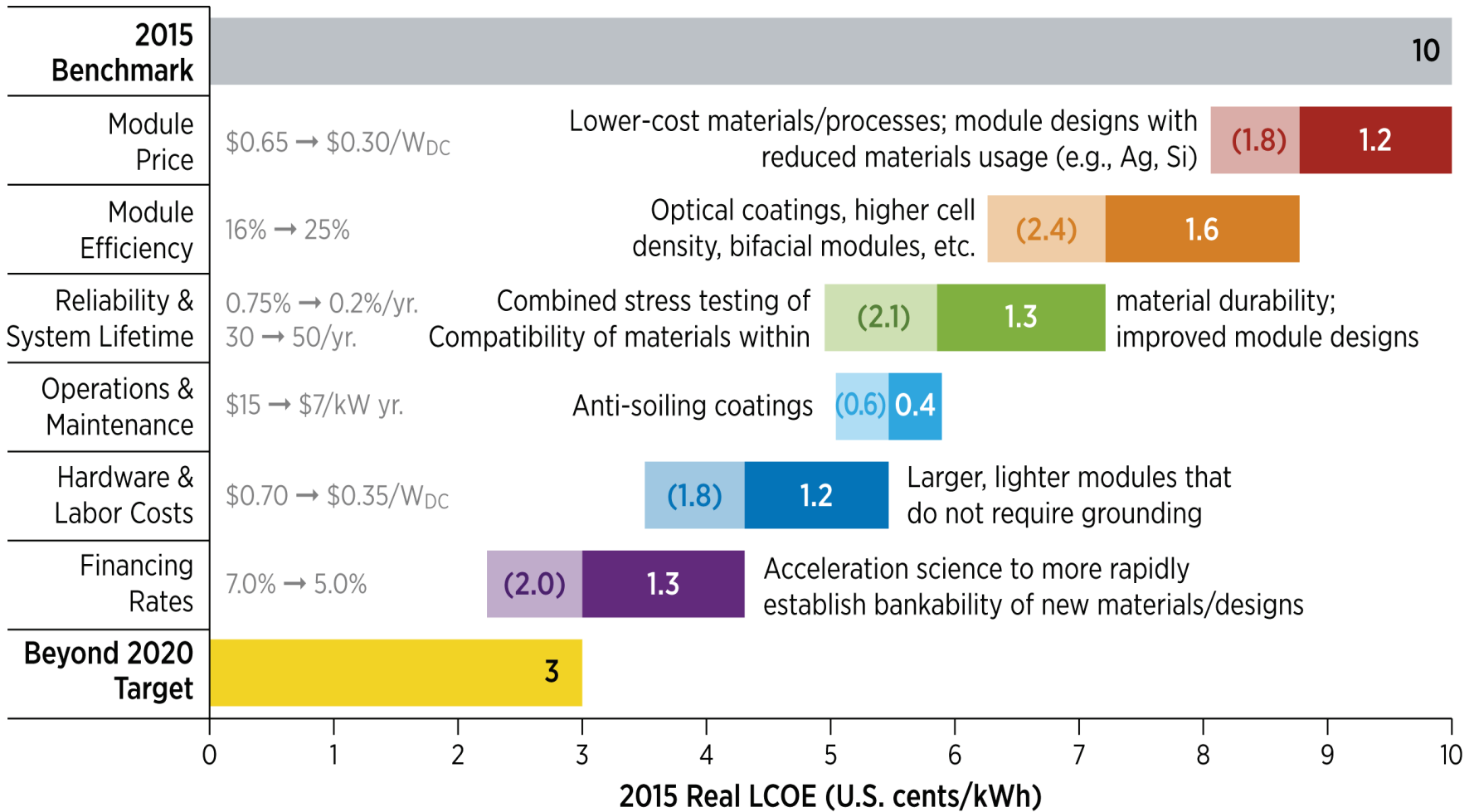
Stanford University

5/22/17

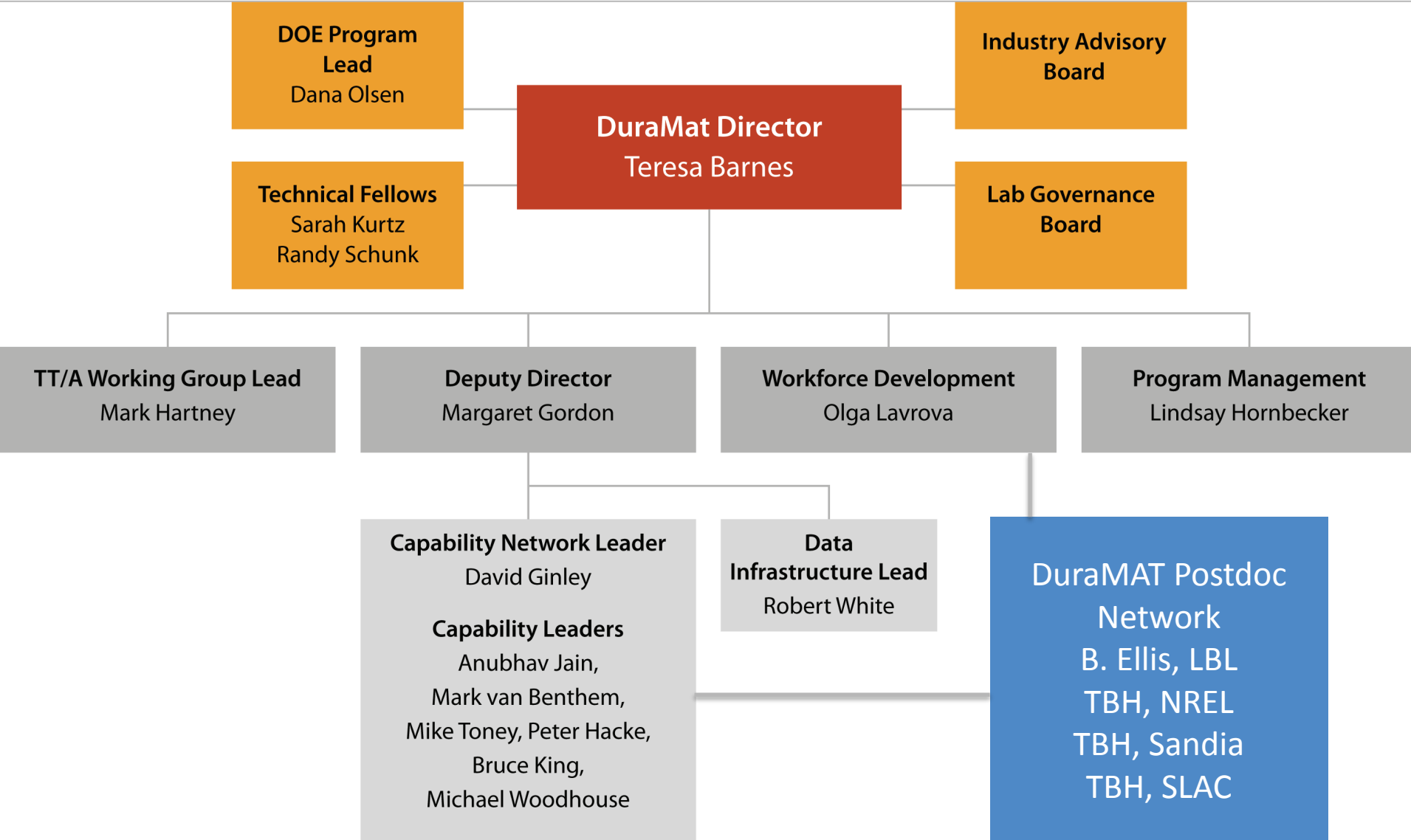
# What Is DuraMAT?

- An Energy Materials Network research consortium
- Five Year Program
- Four National Laboratories
- Three University Research Consortia
- 14-20 member Industrial Advisory Board
- Funding Opportunities for Capabilities, Industry led projects and university research in module durability

# DuraMAT Mission



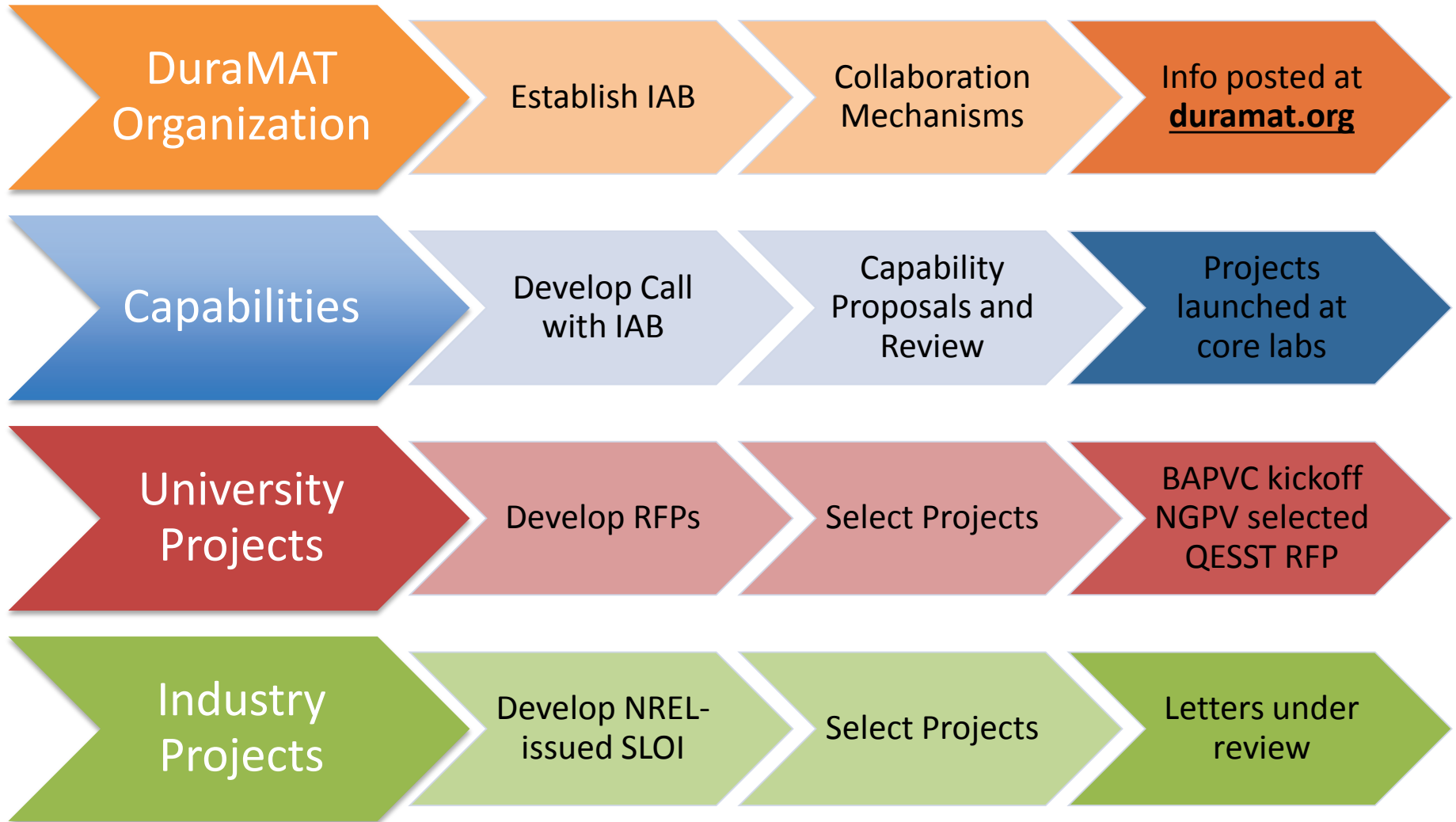
# DuraMAT Leadership Team



# DuraMAT Status

Nov. 2017 – April 2017

Current



# DuraMat Capability Network



## Data Mgmt. and Informatics

Lead: Anubhav Jain, LBNL

Infrastructure: Build datahub

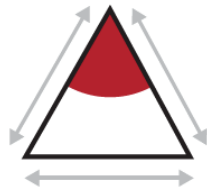
Demonstration Project: PVDAQ



## Predictive Simulation

Lead: Mark van Benthem,  
Sandia

Demonstration Project: Build full-size  
high aspect ratio module simulation  
toolset



## Materials Discovery and Forensics

Lead: Mike Toney, SLAC

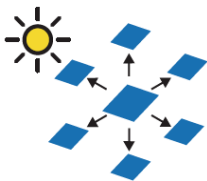
Demonstration Project: Multi-  
functional anti-soiling/AR coating



## Module Prototype and Testing

Lead: Peter Hacke, NREL

Demonstration Project: Combinatorial  
Accelerated testing of backsheet  
degradation



## Field Deployment

Lead: Bruce King, Sandia

Demonstration Project: Development of  
non-destructive field test methods  
Infrastructure: Upgrade data  
transmission

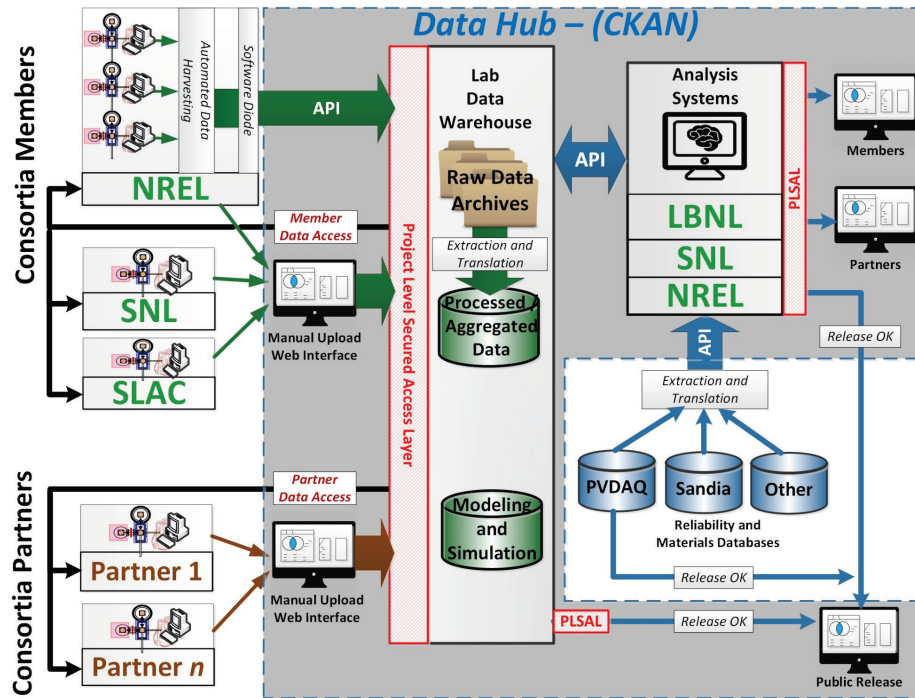
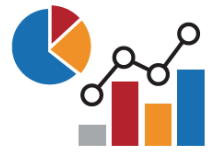


## Technology to Market

Lead: Mike Woodhouse, NREL

Infrastructure: Provide economic  
guidance impacts of capabilities and  
projects, critical industry issues

# Infrastructure: DuraMat Data Hub

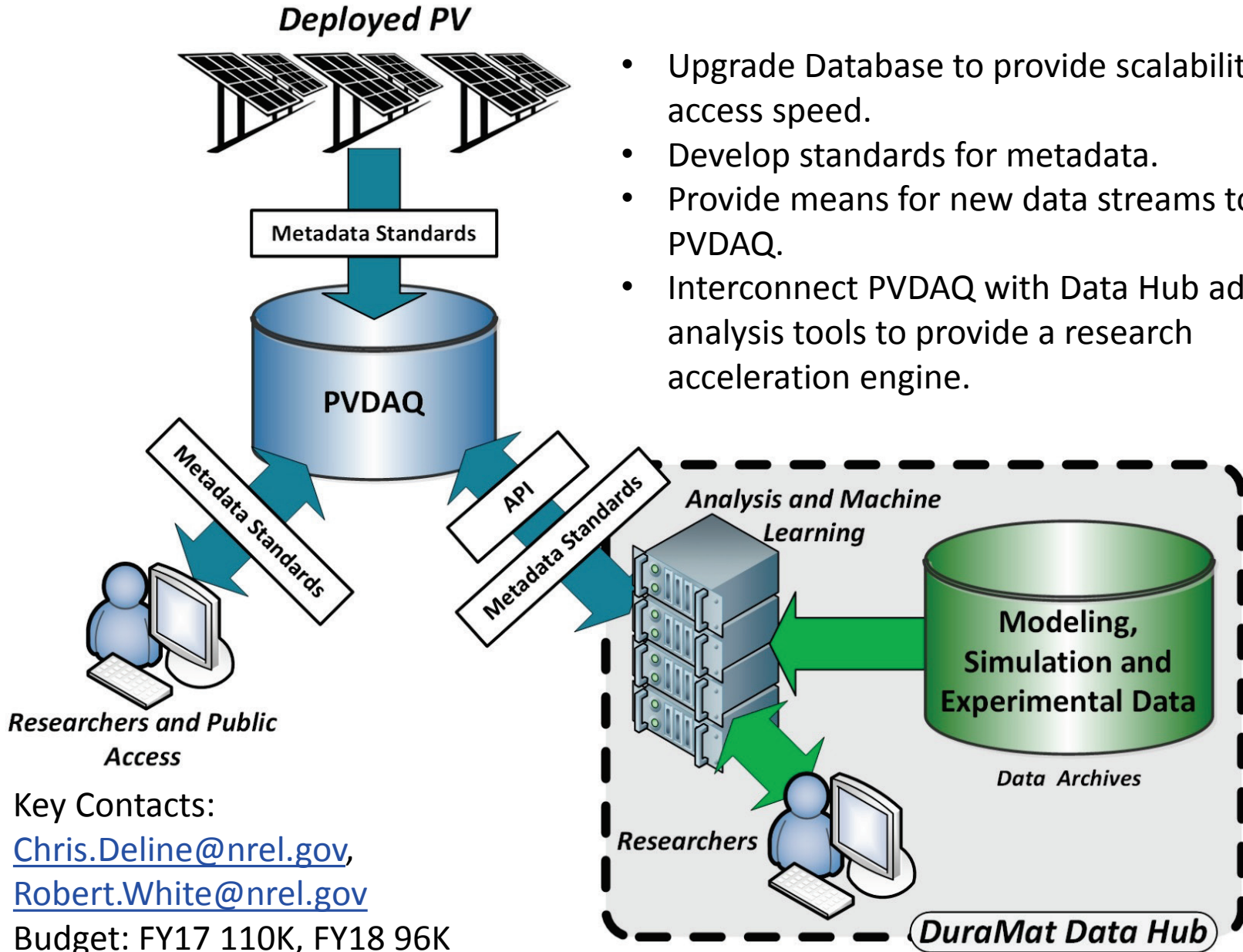


- Partners: NREL, Sandia, LBNL
- Build an accessible and secure datahub for highly heterogeneous data
- Contact [ajain@lbl.gov](mailto:ajain@lbl.gov) or [robert.white@nrel.gov](mailto:robert.white@nrel.gov)

- Year 1 will deliver a working prototype of the data hub, accessible externally with data sets from multiple capabilities
- Year 2 will deliver additional data sets, more metadata, production API and advanced search, and basic visualization



# Capability 1: Materials Informatics - PVDAQ



- Upgrade Database to provide scalability and access speed.
- Develop standards for metadata.
- Provide means for new data streams to feed PVDAQ.
- Interconnect PVDAQ with Data Hub advanced analysis tools to provide a research acceleration engine.

Key Contacts:

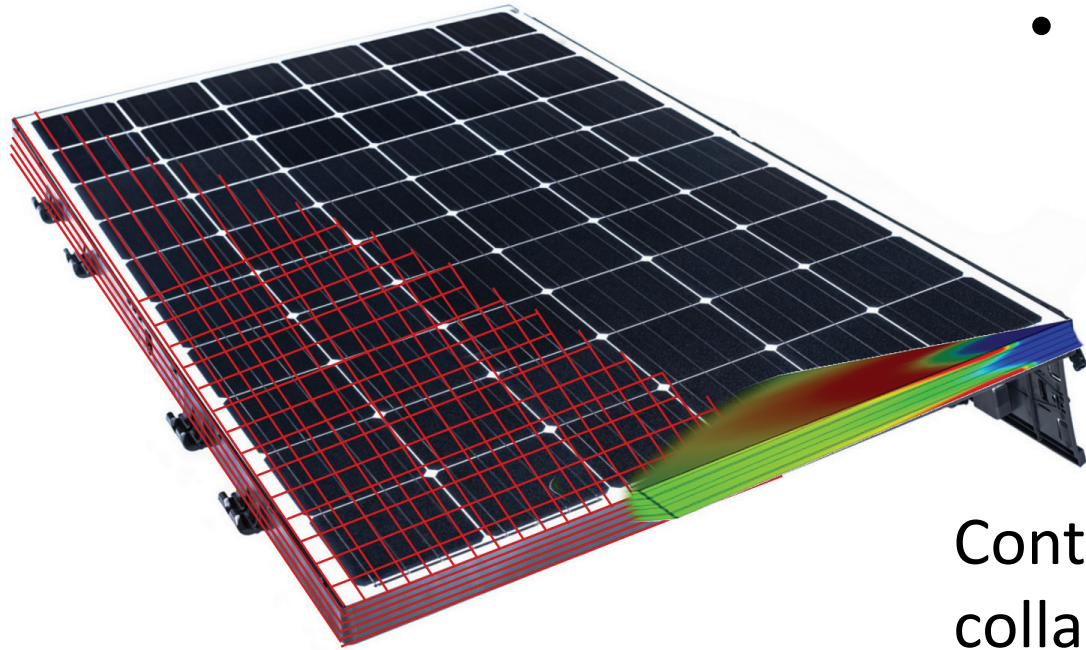
[Chris.Deline@nrel.gov](mailto:Chris.Deline@nrel.gov),

[Robert.White@nrel.gov](mailto:Robert.White@nrel.gov)

Budget: FY17 110K, FY18 96K



# Capability 2 – Predictive Simulation

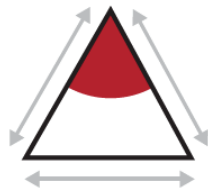


- Team: NREL, Sandia, & SLAC
  - Full scale modeling at high aspect ratio
  - Include the stresses of the operating environment

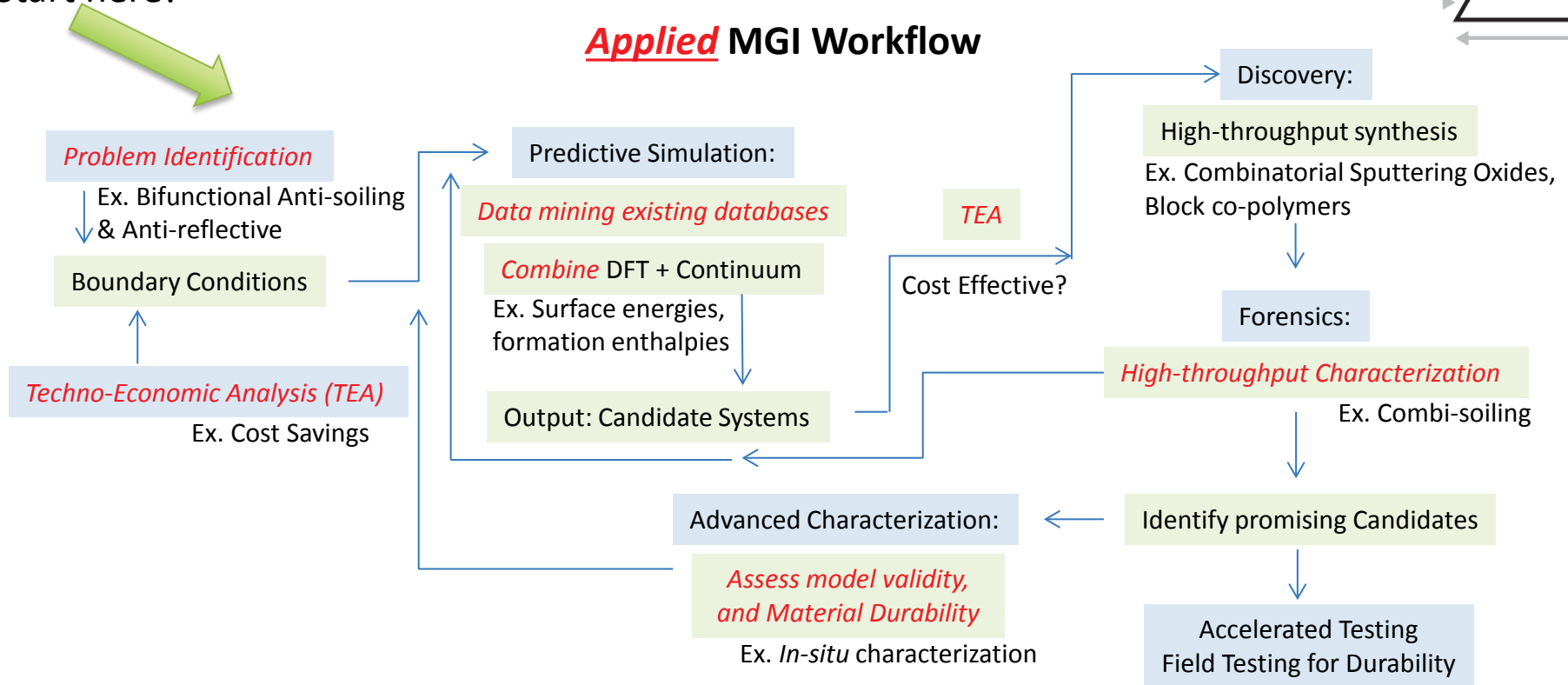
Contact [mhvanbe@sandia.gov](mailto:mhvanbe@sandia.gov) to collaborate

- Year 1 will scope module-scale model requirements as well as required sub-models, prepare equipment and test facilities to measure materials properties, and generate validation data.
- Year 2 will finalize module-level modeling strategy and demonstrate capability, design sub-model validation requirements, and make material property measurements

# Capability 3 – Materials Discovery and Forensics



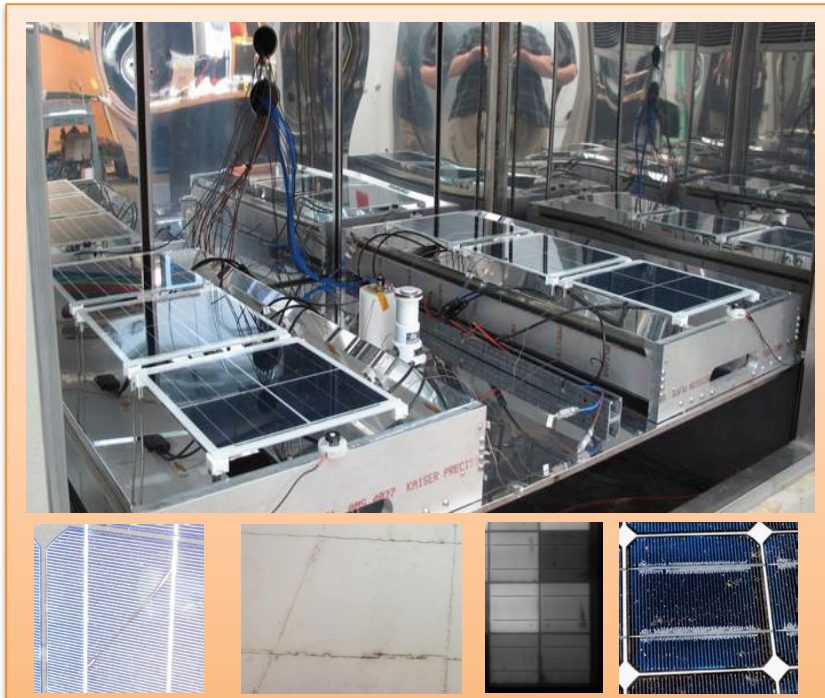
Start here!



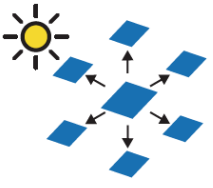
What will this capability development provide? (Highlighted in red)

1. Integrate DuraMat capabilities
  - Facilitate development of feedback loops/communication within DuraMat capability network
2. Hardware: Combi-soiling stage design

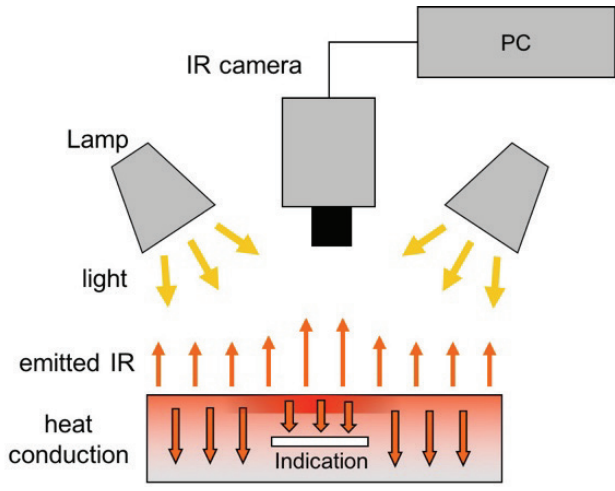
# Capability 4: Combined-Accelerated Stress Testing



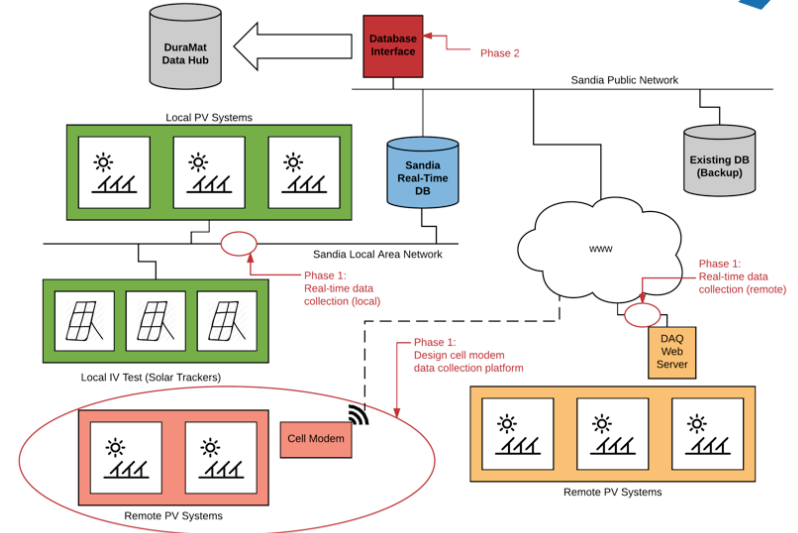
- NREL, Sandia, Industrial partners
  - Contact [peter.hacke@nrel.gov](mailto:peter.hacke@nrel.gov) to collaborate
  - Historically, we developed many 1-2 stress factor tests to address degradation mechanisms after they have been identified in the field (i.e., PID, snail trails → delamination).
  - C-AST will show the degradation processes in a single test with stress factors representing the natural environment.
- 
- Failure mechanisms in new materials and designs are expected to reveal themselves in C-AST, before field deployment. We can reduce residual risk, accelerate time to market and bankability, & reduce costly overdesign.
  - **Year 1:** Demonstrate the basic hardware capability of the weathering chamber for C-AST. Design experiments, build mini-modules, and evaluate a candidate C-AST stress cycle through modeling and experimentation.
  - **Year 2:** Use C-AST to distinguish the durability of backsheets (as a demonstration case) in mini-modules, establish early-indicator metrics for degradation, apply rate equations to model degradation.



# Capability 5: Non-Destructive Inspection and Field Data



*Conceptual Application of Pulsed Thermography*

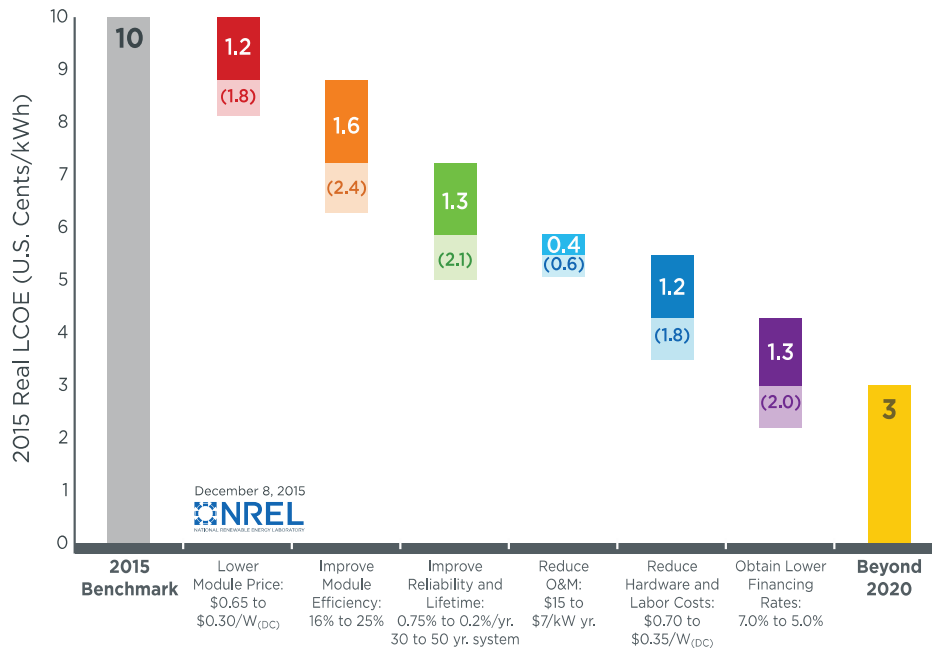


*Development of local and remote data collection for SNL managed PV and IV tracing systems*

- FY17 Milestones:
  - Proof of concept demonstration of Pulsed IR thermography and Ultrasonic inspection methods
  - Demonstrate secure data sharing interface to enable transfer between Sandia’s internal storage and the DuraMat Data Hub.
- FY18 Milestone:
  - Candidate inspection techniques evaluated for their effectiveness and where necessary, adapted with new software/analysis techniques. Once established, characterization techniques will be made available to other Duramat capability areas and industry stakeholders.

- Conducted by Sandia National Labs in close coordination with Cap4 (NREL) and Cap1 (LBNL) activities.
- Total Budget
  - FY17: \$118.8k
  - FY18: \$54k
- Contact Bruce King (bhking@sandia.gov) to collaborate

# Capability 6, Technoeconomic Analysis



- Partners: NREL, DuraMat Industry Advisory Board
- FY17: \$90K
- FY18: \$90K
- Contact [micheal.woodhouse@nrel.gov](mailto:micheal.woodhouse@nrel.gov) to collaborate.

- Models will be continually updated to reflect industry needs and priorities.
- Year 1 will deliver updated LCOE and IRR models incorporating RTC data along with input to materials discovery and other capabilities.
- Year 2 will deliver bottoms up manufacturing cost models for newly identified materials and designs.

# Collaborative Projects – Universities and Industry

- Goal: Build collaborations with the DuraMAT capability network to develop materials, measurements, data analysis, simulations, and module designs to address critical problems in module material durability
- Requirements: All projects must engage the lab capabilities in a meaningful way
  - Collaboration with lab researchers on a paper
  - Fill a critical capability gap in the lab network
  - Send students to work in the labs



# DuraMAT University Projects

- BAPVC
  - Y. Zhu, U. Akron, “Highly-conductive, Low-cost Polymer Adhesive Composites with Complex Dimensional Fillers”
  - S. Graham, Georgia Tech, “Scalable Packaging Materials for Roll-To-Roll Processed Thin Film Solar Cells”
  - A. Lyons, CUNY, “A Hybrid Hydrophobic-Hydrophilic Coating with Combined Anti-Reflective and Anti-Soiling Properties “
  - R. Dauskardt, “New Concepts in Solar Module Encapsulation and Barrier Technologies”
- Next Generation PV
  - CSU, “Discovering New Materials For PV Encapsulation”
  - CSU, “Low Cost Hydrophobic Coating Materials To Reduce Module Soiling and Reflection “
- QESST
  - RFP Out now, Closes 5/24

# DuraMAT Industry Projects

- NREL issued solicitation for Letters of Interest
- LOIs currently under review
  
- Technical Services Agreements/Strategic Partnerships
- CRADAs
  
- Participation on Industry Advisory Boards
- Workshop participation
- Input to next collaboration opportunity
  - Help identify critical materials problems
  - Develop optimal partnership/teaming strategies

# Technical Working Groups – FY18

- Beginning in FY18 – encourage additional collaboration across labs, industry, universities in technical work areas
  - Leverage DuraMAT postdoc network to run these
  - University and industry liaison in each group
- Goal: Increase collaboration with useful interactions
- **Front surface coatings** – optical coatings, anti-soiling, etc.
- **Interface design** – adhesion, chemistry, interactions, stability, etc.
- **Data standards and development**
- **Flexible Modules and New Form Factors**

# Plans for FY18

- National Labs
  - Gap analysis in capability network
  - Call to fill gaps Fall 2017
  - Launch Capability Sparks
  - Encourage additional lab/industry/university collaboration
- Universities
  - Eligible to collaborate with labs and industry
  - Universities can be capabilities
  - Intend to start second round of university projects in FY19
- Industry
  - Awards for DuraMAT solicitation expected Summer 2017
  - Intend to issue second solicitation Winter 2017/2018

# DuraMAT Sessions

## Monday

- Session 1: PV Durability in the Lab and Outdoors
- Session 2: Introduction to the DuraMAT Capability Network

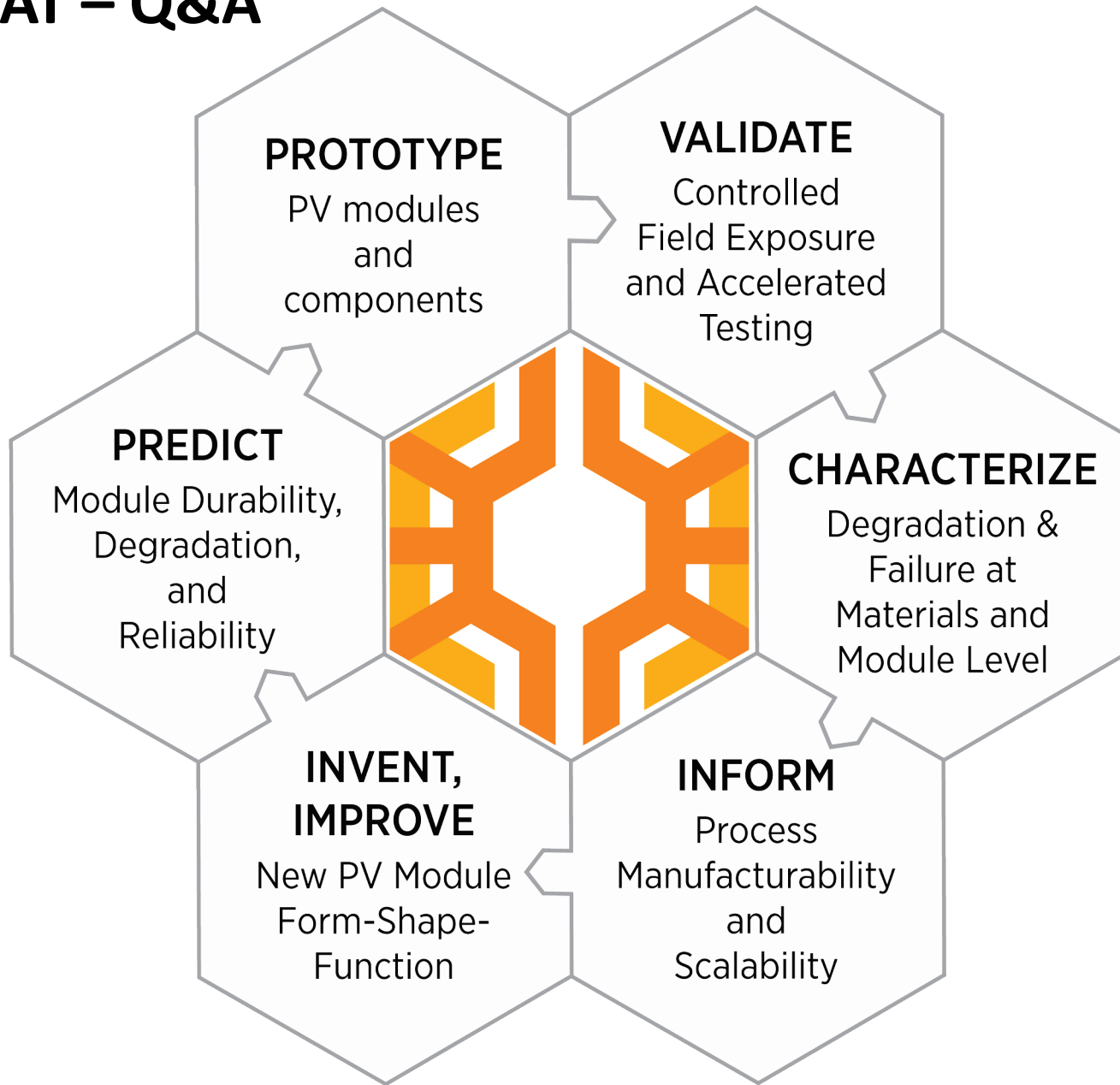
## Tuesday

- Session 3: Introduction to the DuraMAT Capability Network
- Session 4: Solar and Materials Data

## Format

- 3-4 talks, followed by questions to the speakers and panel
- Similar to PVRW workshop

# DuraMAT – Q&A





# Panel One Questions

- What are the most informative tests to screen new materials or designs?
- What are the biggest risks of incorporating new materials or designs?
- How good are we at predicting field failures using accelerated tests?
- What are the key research needs to improve our ability to predict field failures or service life?
- How will designing for recyclability affect module durability?

# Panel Two Questions – Capabilities I

- How will the Materials Discovery approach work in a mature industry?
- How can we design accelerated tests with predictive capabilities?
- Do we need different tests for Si, thin-film, or flexible modules?
- What are the key materials research needs to enable truly predictive accelerated tests and simulations?
- What are the unique challenges to simulating full-scale modules?

# Panel Questions – Capabilities II

- How can DuraMAT leverage the PVDAQ stream to drive module durability research?
- What is the most informative materials data to include in the datahub?
- What are the most difficult solar data analytics problems that need to be addressed now, or over the next five years?

# Panel Questions – Solar and Materials Data

- Can we share data in a way that benefits the entire solar community?
- What would drive consolidation to a single data format/resource?
- What are the largest barriers to standardization?
- How can the solar community work with the DuraMAT datahub?

# Consortium Status

- Consortium kickoff: Oct 2017
- Initial capability development call developed with industry advisory board – Dec. – Jan. 2017
- Capability network demonstrations launched March-April 2017
- BAPVC RFP – Winter 2017, projects announced 5/22/17
- NGPV – Industry Advisory Board project selection May 2017
- QESST – RFP Spring 2017
- DuraMAT Industry Led Project solicitation – Spring 2017, currently under review



# DuraMat

Durable Module Materials Consortium

Total Funding: \$30M/ 5 yrs

Lead Lab: NREL

Co-Lead: Sandia

Core Labs: SLAC and LBNL

Two funding calls in FY17

Goal: Reduce LCOE to < \$0.03/kWh by 2030 by improving module performance, reducing degradation, and building confidence in next generation module materials.

