U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

2022 SETO PEER REVIEW

Manufacturing & Competitiveness

Technology-to-Market Activities

energy.gov/solar-office

Markus E. Beck, M&C Program Manager

Fania Barwick, Andrew Dawson, Kyle Fricker, Peter Lobaccaro, Robert Meagley, Emanuele Pecora, George Stefopoulos, and David Ung

Manufacturing and Competitiveness Team


Markus Beck


Vanina “Nina” Alanes


Fania Barwick


Andrew Dawson


Kyle Fricker


Tiffany Jones


Peter Lobaccaro


Robert Meagley


Emanuele Pecora


George Stefopoulos


David Ung

Agenda

- The Role of RDD&C at SETO—Manufacturing & Tech-to-Market Objectives
- The M&C Toolbox—Programs and Activities
- Select Focus Areas and Portfolio Highlights
  - Mature Technologies
  - Emerging Technologies
  - Emerging Sectors

Manufacturing & Competitiveness

Mission Statement

Manufacturing and Competitiveness: Securing a Sustainable, Robust and Resilient Solar Supply Chain

The SETO Manufacturing and Competitiveness (M&C) subprogram supports solar research, development, demonstration and commercialization (RDD&C) activities to:

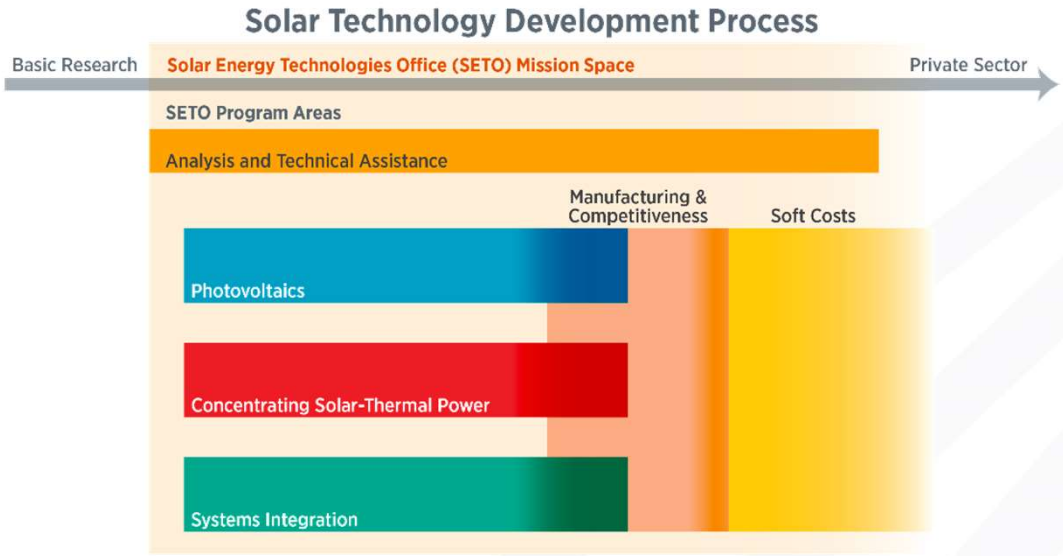
- Accelerate expansion of domestic manufacturing capacity
- Increase domestic content, value of solar products, and job creation across the entire supply chain;
- Advance innovative and impactful technologies and concepts;
- Reduce technical and commercial risk enabling greater private sector investment and scale; and
- Sustain and expand the solar innovation community to ensure technology leadership.

Programs cover a wide variety of technologies including photovoltaics, concentrating solar power, and power electronics. Programs target funding gaps that occur at various stages along the development cycle of new technologies; from conception to proof of concept, first article to low-volume production and market introduction, and ultimately high-volume manufacturing. Through inter-agency and inter-office collaborations M&C strives to accelerate the adoption and proliferation of innovative solar technologies.

M&C staff serve as experts to the public sector on solar technology RDD&C as well as the state of the domestic and international solar industries. M&C provides thought leadership to the R&D, entrepreneurial, and finance communities on technology evolution pathways, cost and performance requirements, and the competitive landscape.

M&C seeks to act in coordination with all relevant elements of the public and private RDD&C complex to ensure that the U.S. market has access to the materials, technologies, and products needed for a rapid, equitable, and sustained energy transition.

The Manufacturing & Competitiveness Program



Support businesses at all stages

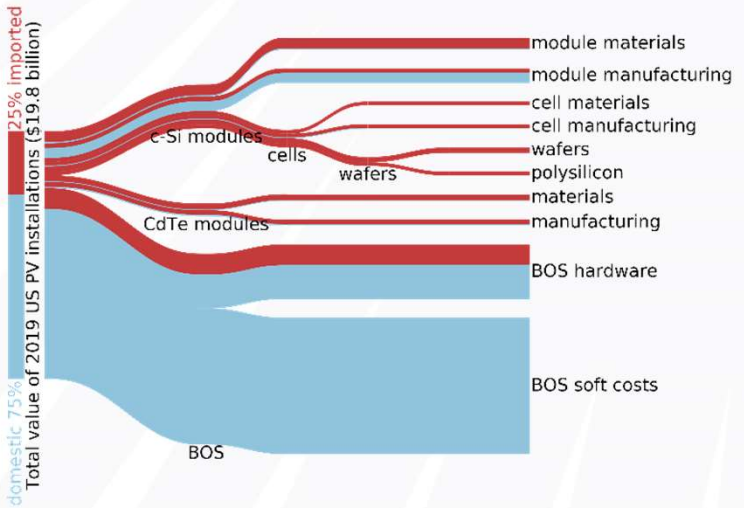
Collaborate with other technology offices and agencies

Engages in public-private partnerships to:

- Bring products out of the lab and closer to market
- Increase domestic manufacturing competitiveness
- Generate domestic value across the entire solar value chain
- Develop tools to lower costs and increase deployment

Context

- FY20 & FY21 M&C budget $60M
  - Congressional Direction $20M to be spent each on PVSK and CdTe each FY
- Prior administrations focus early-stage R&D
- Absence of consistent, long-term industry policy focused on establishing domestic content across the entire solar supply chain
- Domestic PV manufacturing capacity
  - Polysilicon 20-30GW$_{DC}$
  - Ingot, wafer, c-Si cells NONE
  - CdTe 2.3GW$_{DC}$
  - c-Si module assembly 4.7GW$_{DC}$
  - Inverters ~0.3-0.5GW$_{DC}$
  - Solar glass NONE
- At present the U.S. lacks a viable and mature solar supply chain



The value of a typical utility-scale PV system in the U.S. broken into its components. The thickness of each line is proportional to its monetary value. System installation includes all upfront system costs other than module and BOS. Red indicates imported content and blue indicates domestic content.

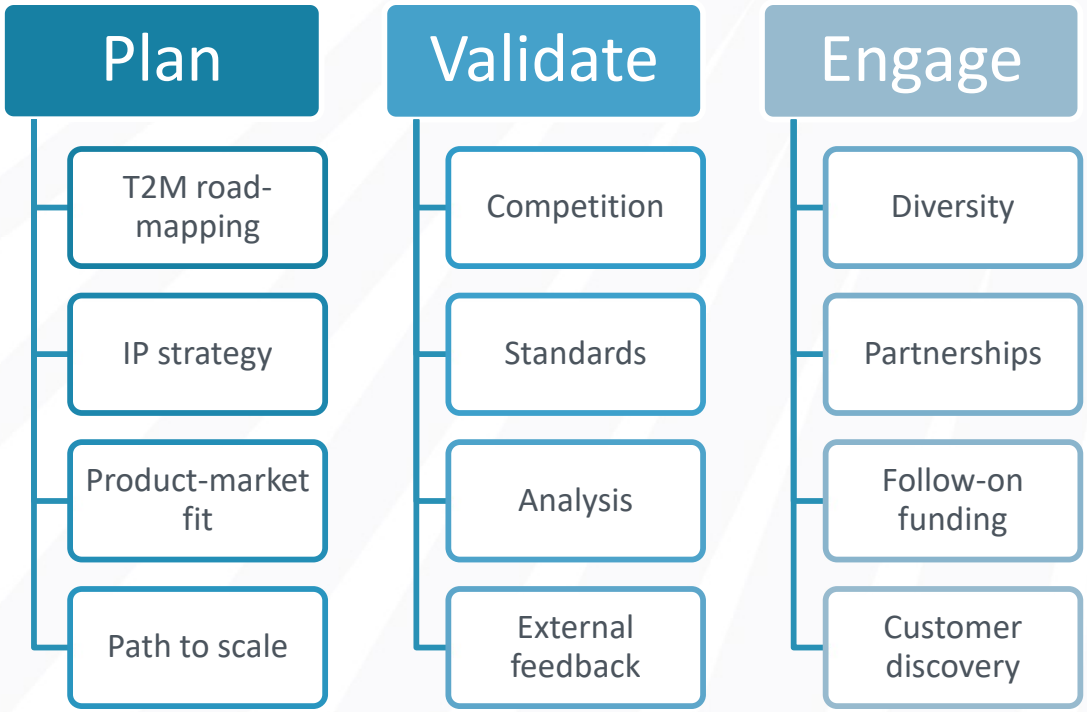
M&C T2M Project Approach

Promote activities that amplify the impact of R&D projects and enable technology transformations from prototypes to real-world, viable solutions (the D&C).

Research & Development

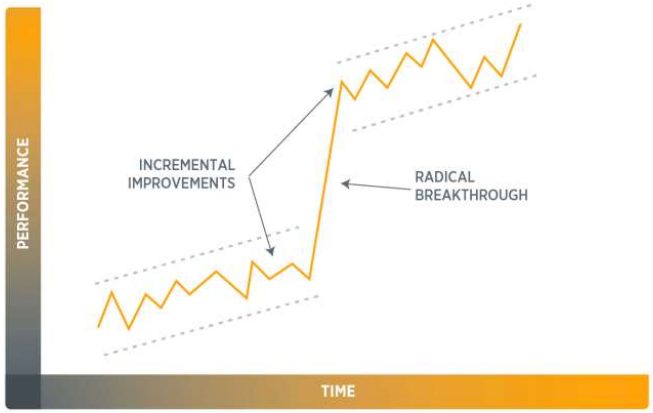
Demonstration & Commercialization

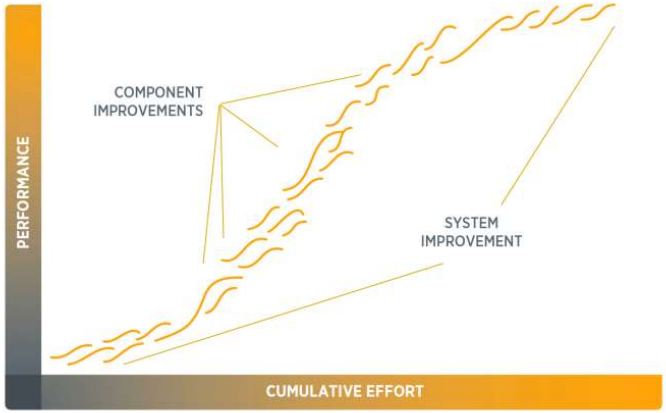
Market-relevant and self-sustaining technology



The Objective of Technology-to-Market Activities

- If the research we fund does not reach the market then it has little to no impact.
- If we fund things that would have reached the market on the same timeline without our funding we are also having little to no impact.

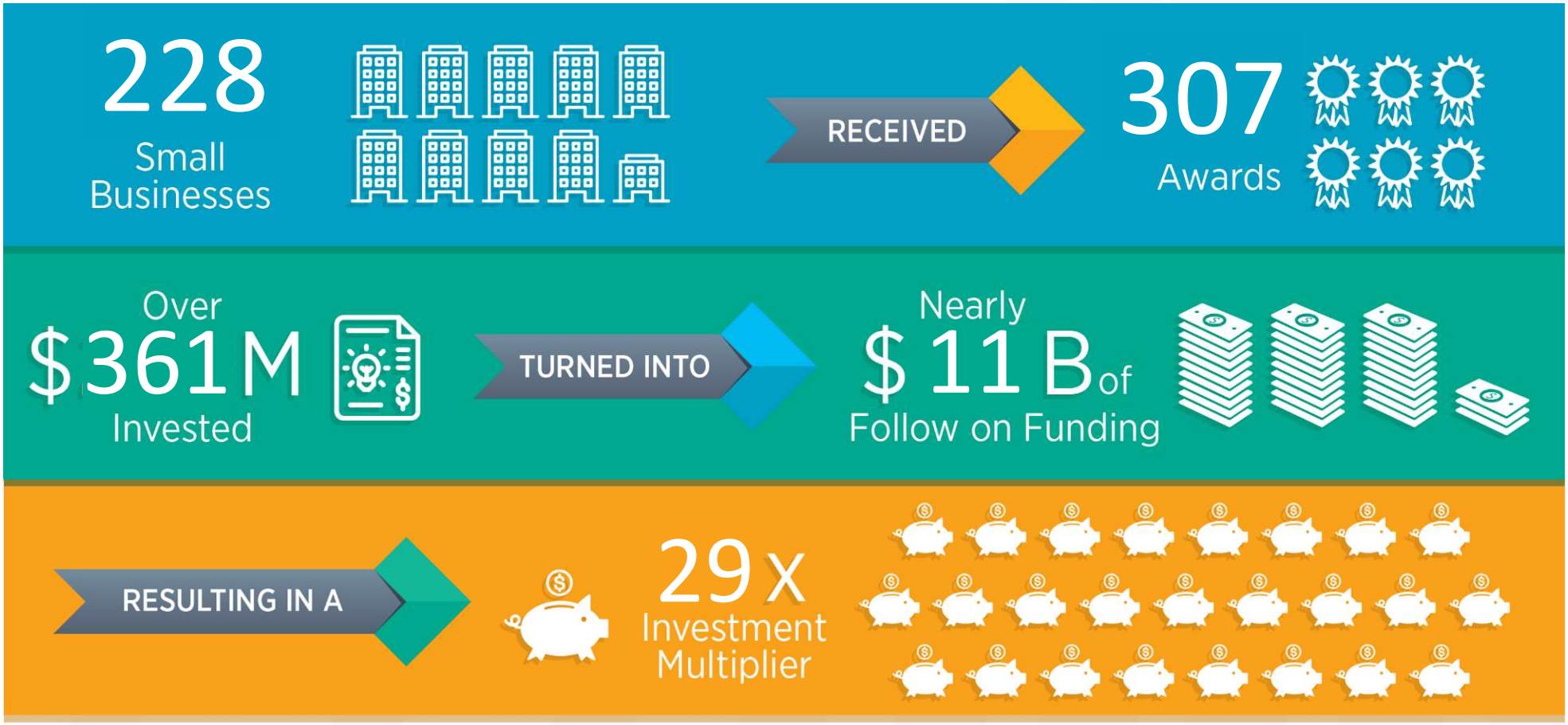




Failure:

- Creating a product to spec, on time, and on budget that no one wants.
- Finding a market need people want solved but not delivering product to spec.
- Funding redundant work at the private sector which does not help expedite a solution getting to market

Private Sector Taking Innovation to Market (2007-2021)



M&C MYPP Goals for 2025

- LCOE < $0.03/kWh in utility-scale PV systems
- 1GW/y of new U.S. PV manufacturing capacity is based on technology that was not yet commercialized in 2020
  - E.g. hybrid inverters, SiC power electronics, a new PV absorber technology, ECB IBC or MWT module architecture …
- 1 GW_{AC} of PV installed in 2025 is combined with another use, such as agriculture or building surfaces
- Solar hardware installed has at least 40% domestic value

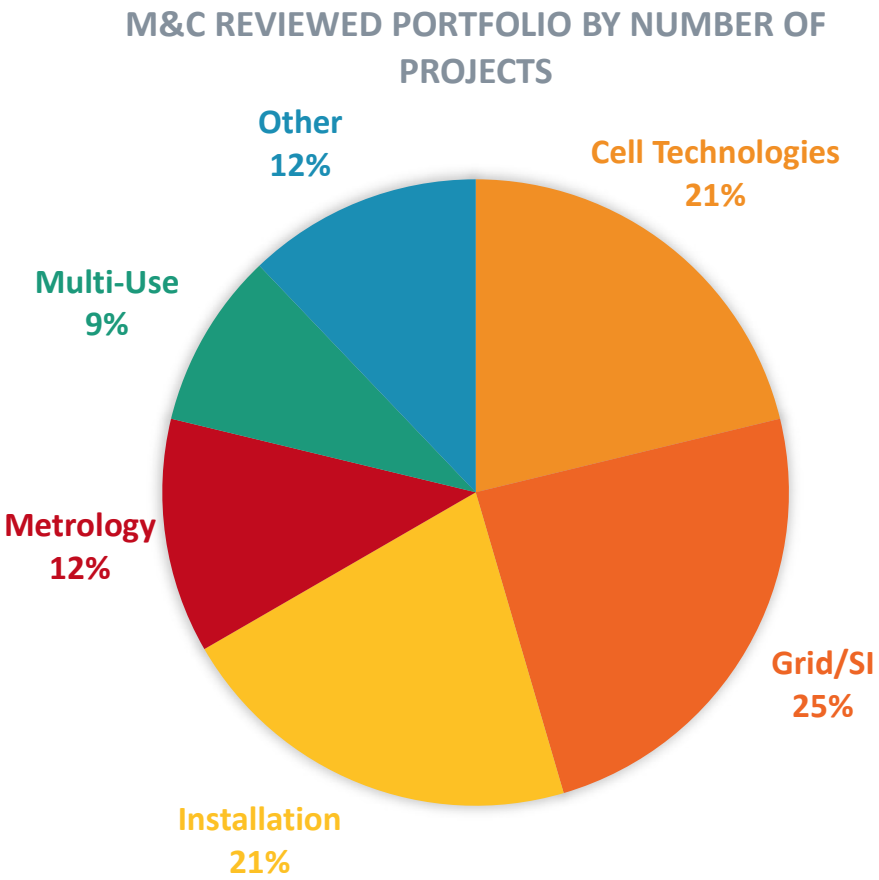
M&C Working Toward 2025

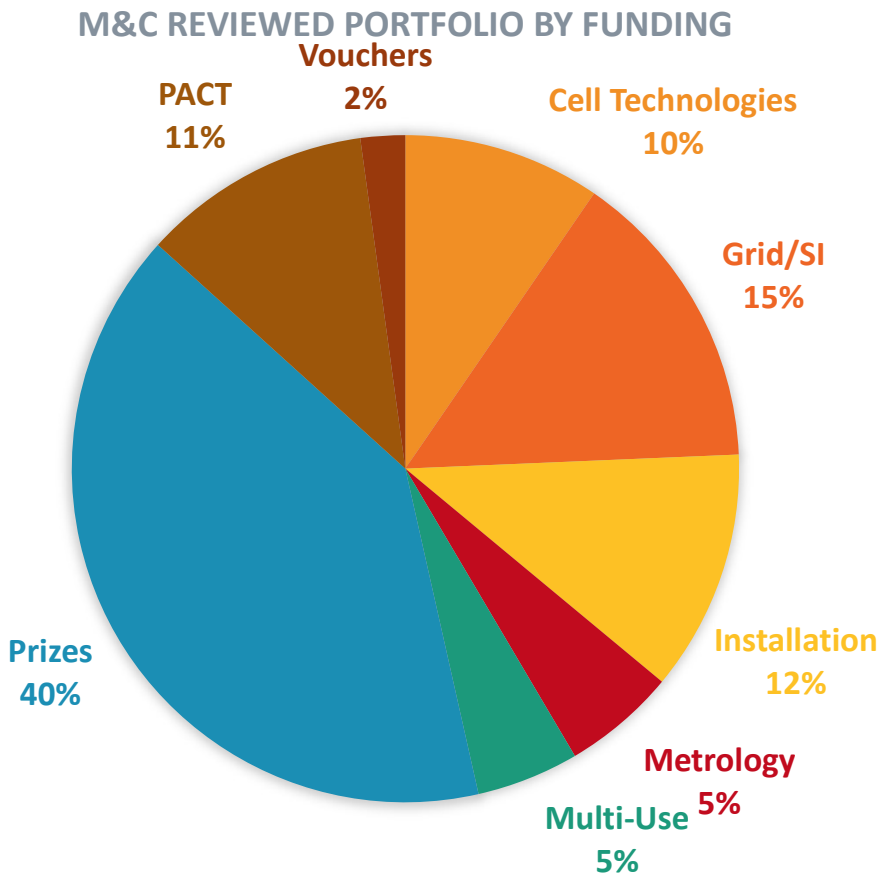
New technologies enter U.S. manufacturing

U.S. solar manufacturing capacity increases across the value chain

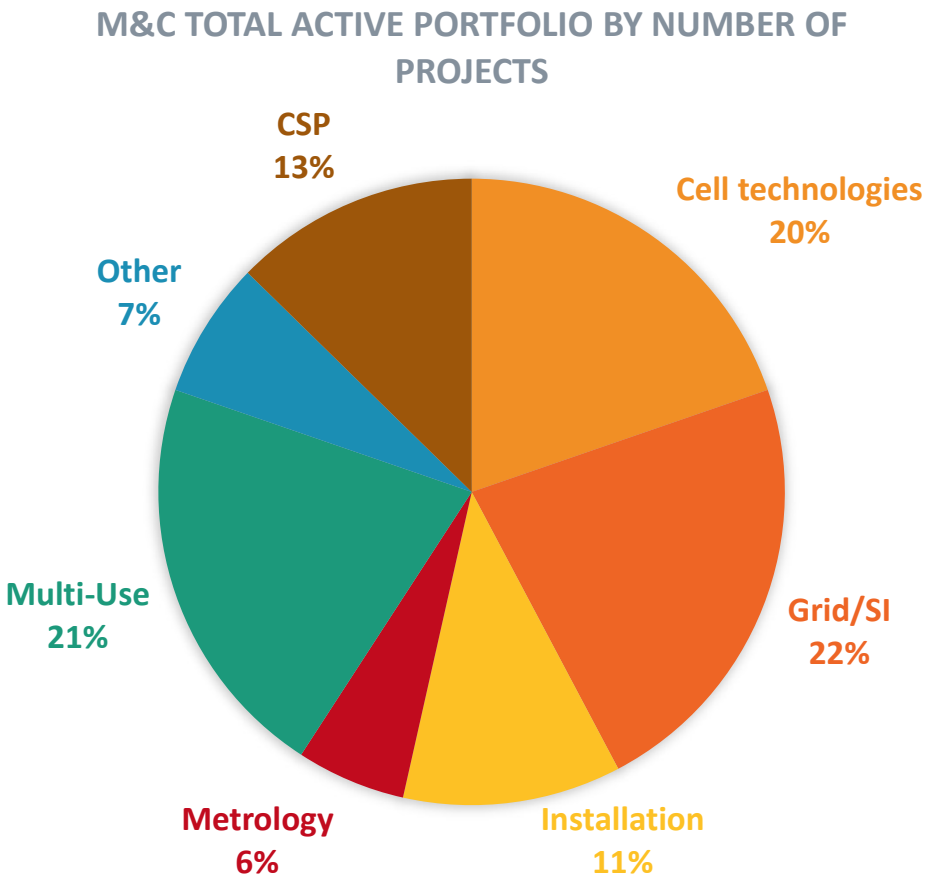
- Supporting proof of concept, pilot production, technology transfer and scale-up of new products from U.S. businesses
- Development of new technologies and business models

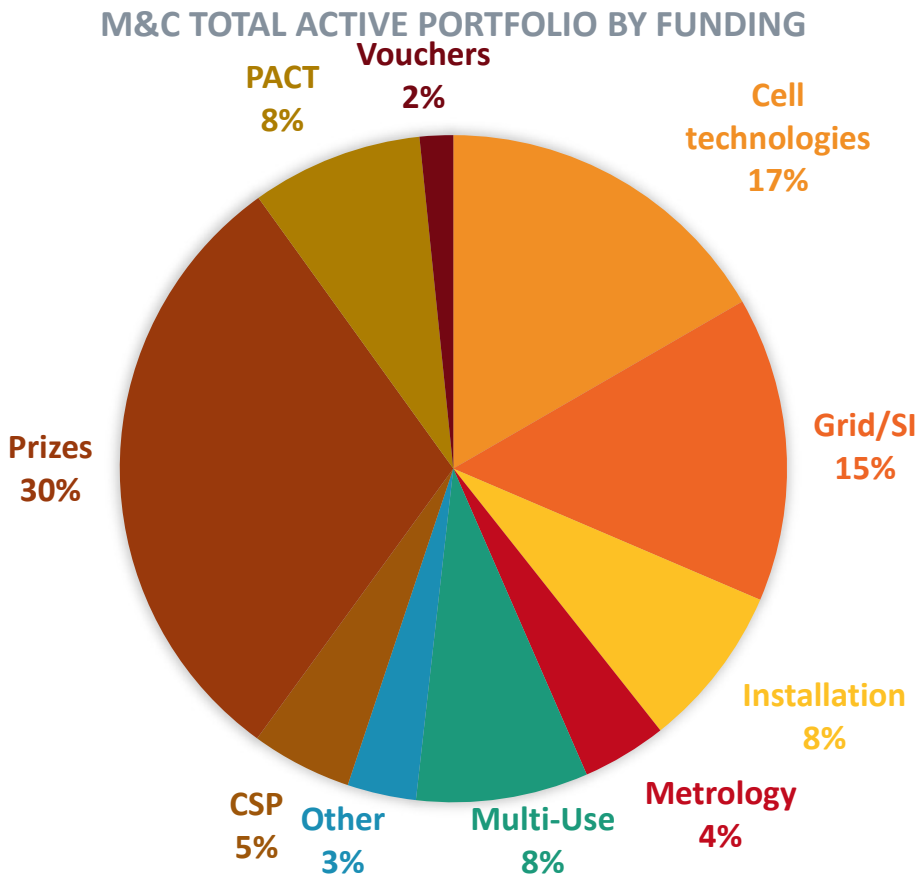
M&C Peer Reviewed Project Portfolio





M&C Total Active Project Portfolio





How can we spend money?

How can we spend money?

Prize authority

- Only winners get cash prize
- Demo day to judge competitors
- Fast program with low barrier to entry

How can we spend money?

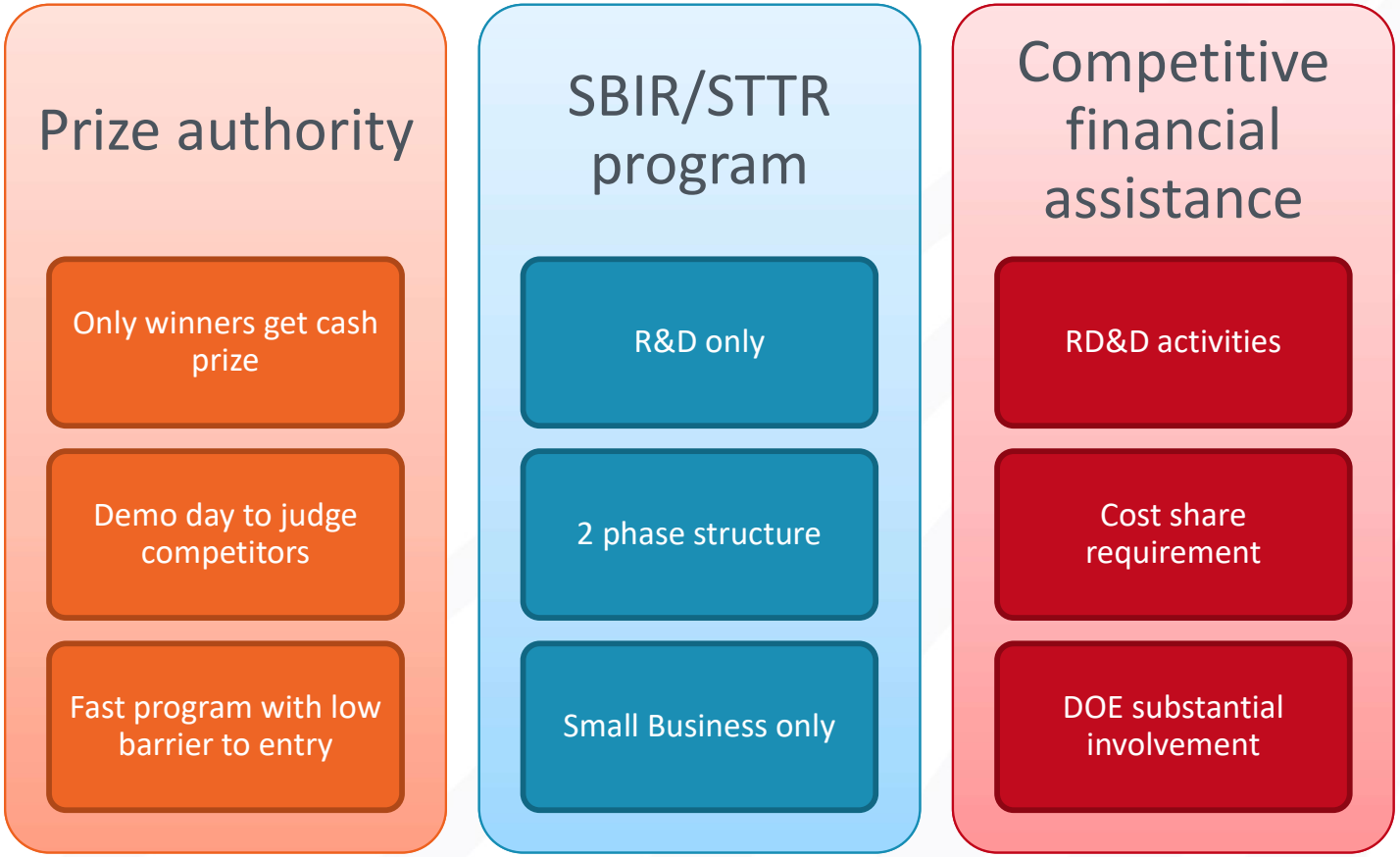
Prize authority

- Only winners get cash prize
- Demo day to judge competitors
- Fast program with low barrier to entry

SBIR/STTR program

- R&D only
- 2 phase structure
- Small Business only

How can we spend money?



How can we spend money?

Prize authority

- Only winners get cash prize
- Demo day to judge competitors
- Fast program with low barrier to entry

SBIR/STTR program

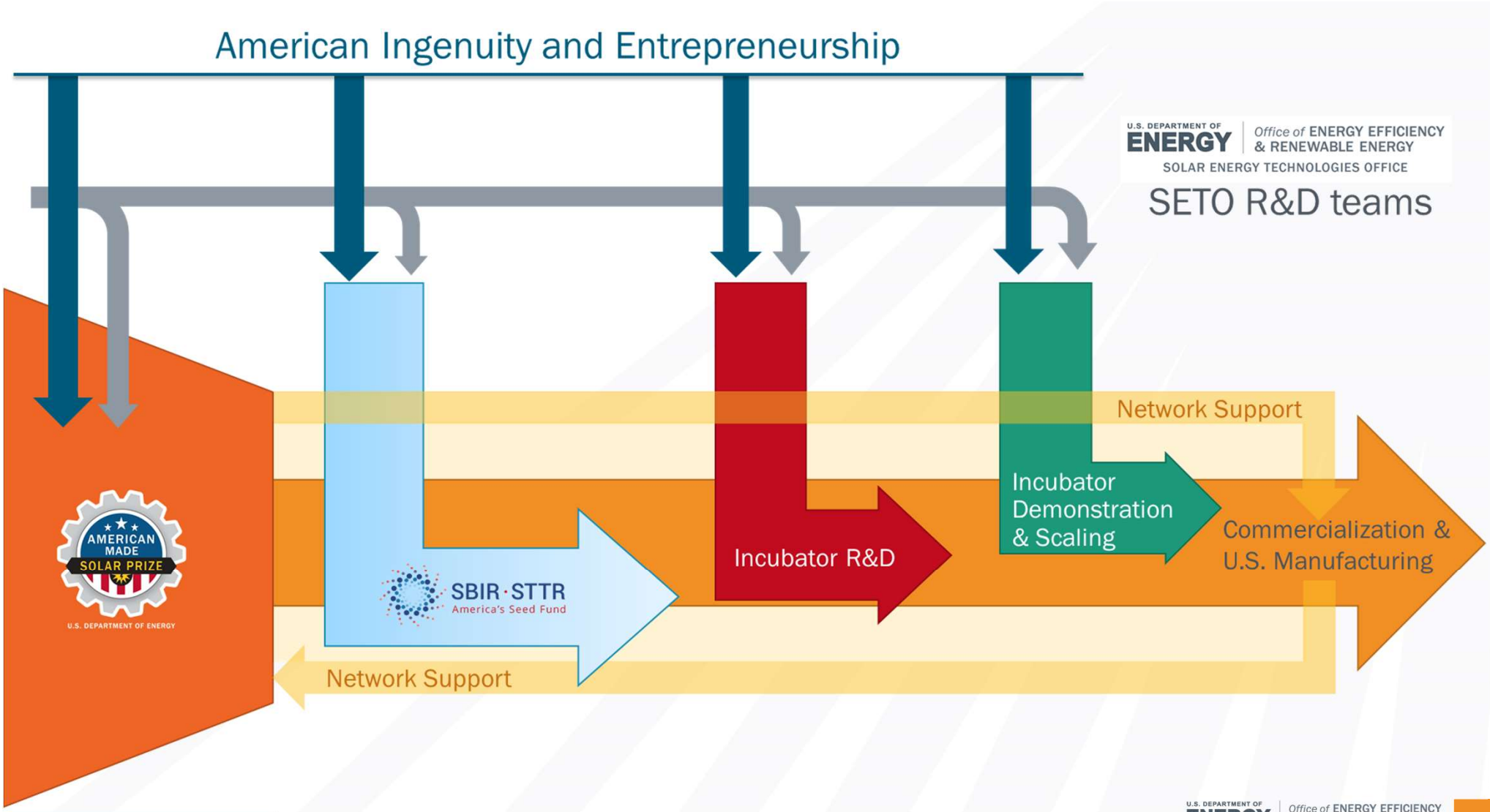
- R&D only
- 2 phase structure
- Small Business only

Competitive financial assistance

- RD&D activities
- Cost share requirement
- DOE substantial involvement

Work at National Laboratories

- TCF
- American-Made Network
- Lab voucher to awardees


American Ingenuity and Entrepreneurship
U.S. DEPARTMENT OF ENERGY
Office of ENERGY EFFICIENCY & RENEWABLE ENERGY
SOLAR ENERGY TECHNOLOGIES OFFICE
SETO R&D teams
AMERICAN MADE SOLAR PRIZE
U.S. DEPARTMENT OF ENERGY
SBIR·STTR
America's Seed Fund
Incubator R&D
Incubator Demonstration & Scaling
Commercialization & U.S. Manufacturing
Network Support
Network Support

American-Made Challenges

SOLAR PRIZE

American-Made SOLAR PRIZE

A $3 million competition designed to energize innovation in U.S. solar manufacturing.

5 Rounds initiated to date

729 submissions
from over 491 unique teams
over 5 rounds

$12 million in cash plus
$3.6 million in vouchers have already been awarded to
80 teams

Be Revolutionary

JEDI Prize Addition to Software Prize

- JEDI = Justice, Equity, Diversity, and Inclusion
- Opt-in Structure
- Describe how solution addresses solar market barriers facing underserved communities and work to substantially advance their approach toward JEDI goals as they progress through the competition
- Additional funding available at each contest (Ready!, Set!, and Go!) for successful JEDI submissions
- Specific American-Made Network support available to refine and improve JEDI concepts

$300,000 in additional prizes

	JEDI Contest Winners	Prize*
Ready!	Up to 10 Ready! semifinalists	$10,000 to $30,000 in cash
Set!	Up to 5 Set! finalists	$20,000 to $60,000 in cash
Go!	Up to 1 Go! competitor	$100,000 in cash

*Prizes are shown as funding ranges when they depend on the number of winners.

SBIR·STTR
America's Seed Fund

SUPPORTING small business SOLAR INNOVATIONS

SBIR/STTR

Small businesses

2 Phase structure

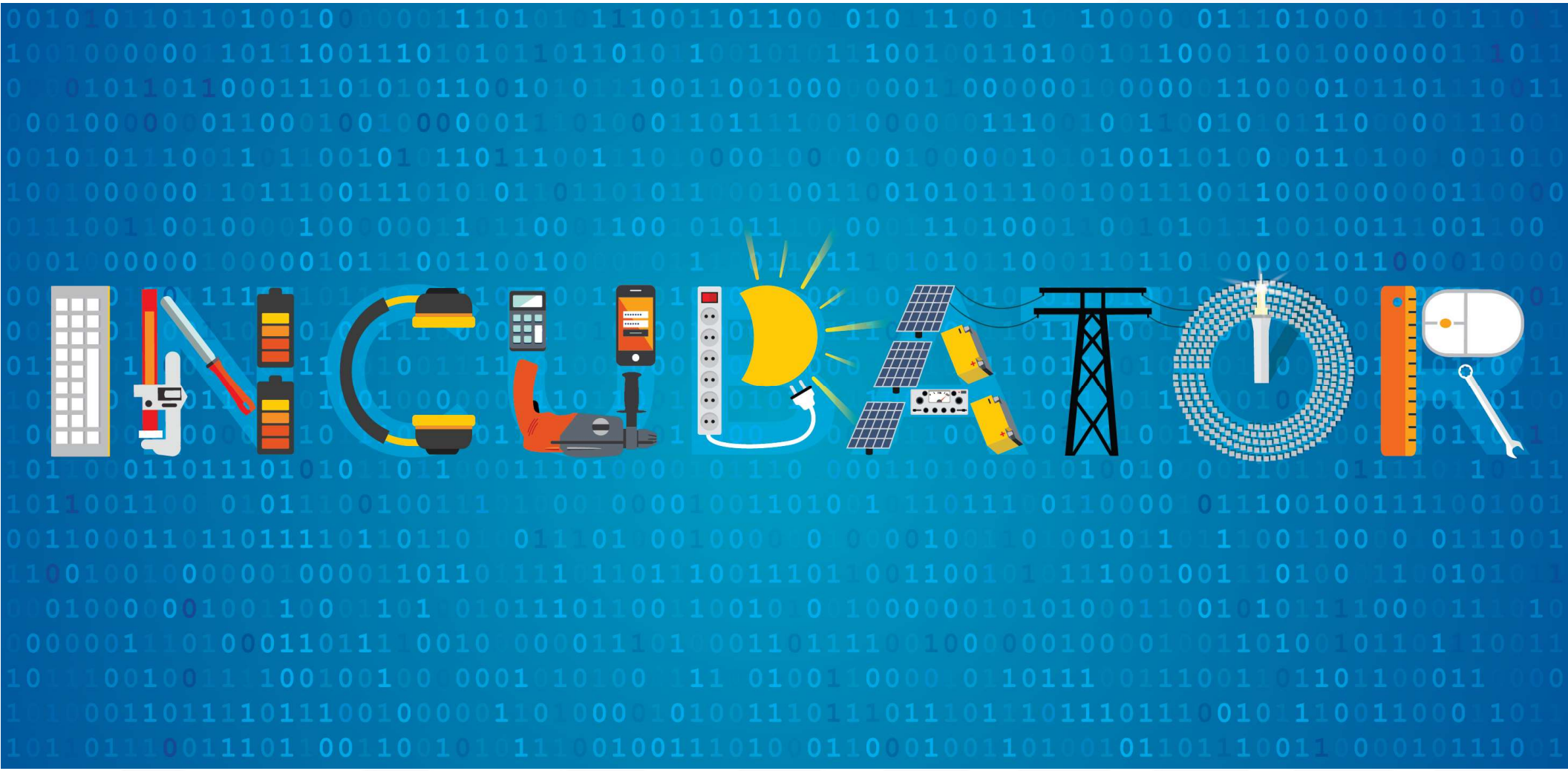
9 months (Phase I) + 2 years (Phase II)

No Cost Share

$200k (Phase I) + $1.1M (Phase II)

- Phase I is meant to conduct a feasibility study
- Phase II is meant to develop a prototype / proof of concept
- STTR encourages collaboration with research institutions
- It has a vehicle to support technology transfer (TTO) - provide funding to companies developing and commercializing a patented technology developed by a research institution

SBIR·STTR
America's Seed Fund



Innovations in Manufacturing: Hardware Incubator

For Profit Team Lead

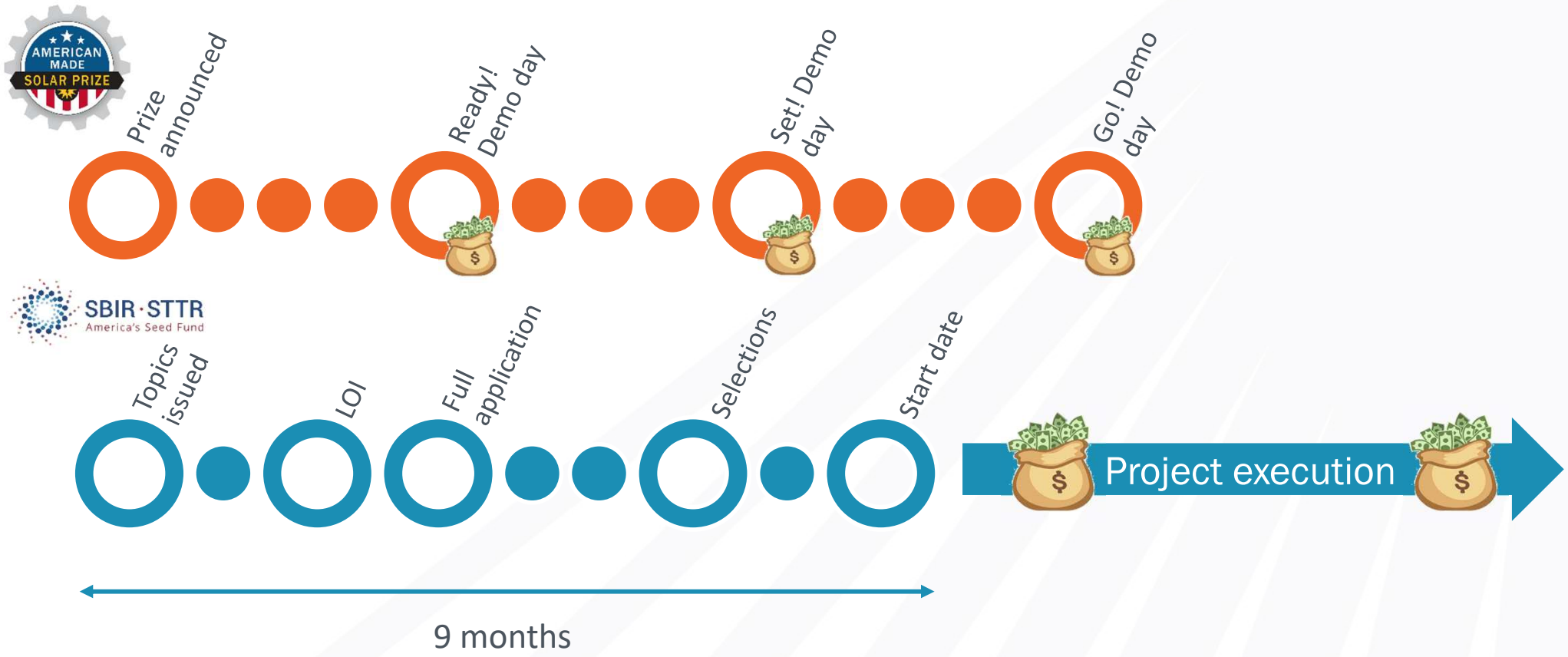
Periods of performance 1 – 3 years

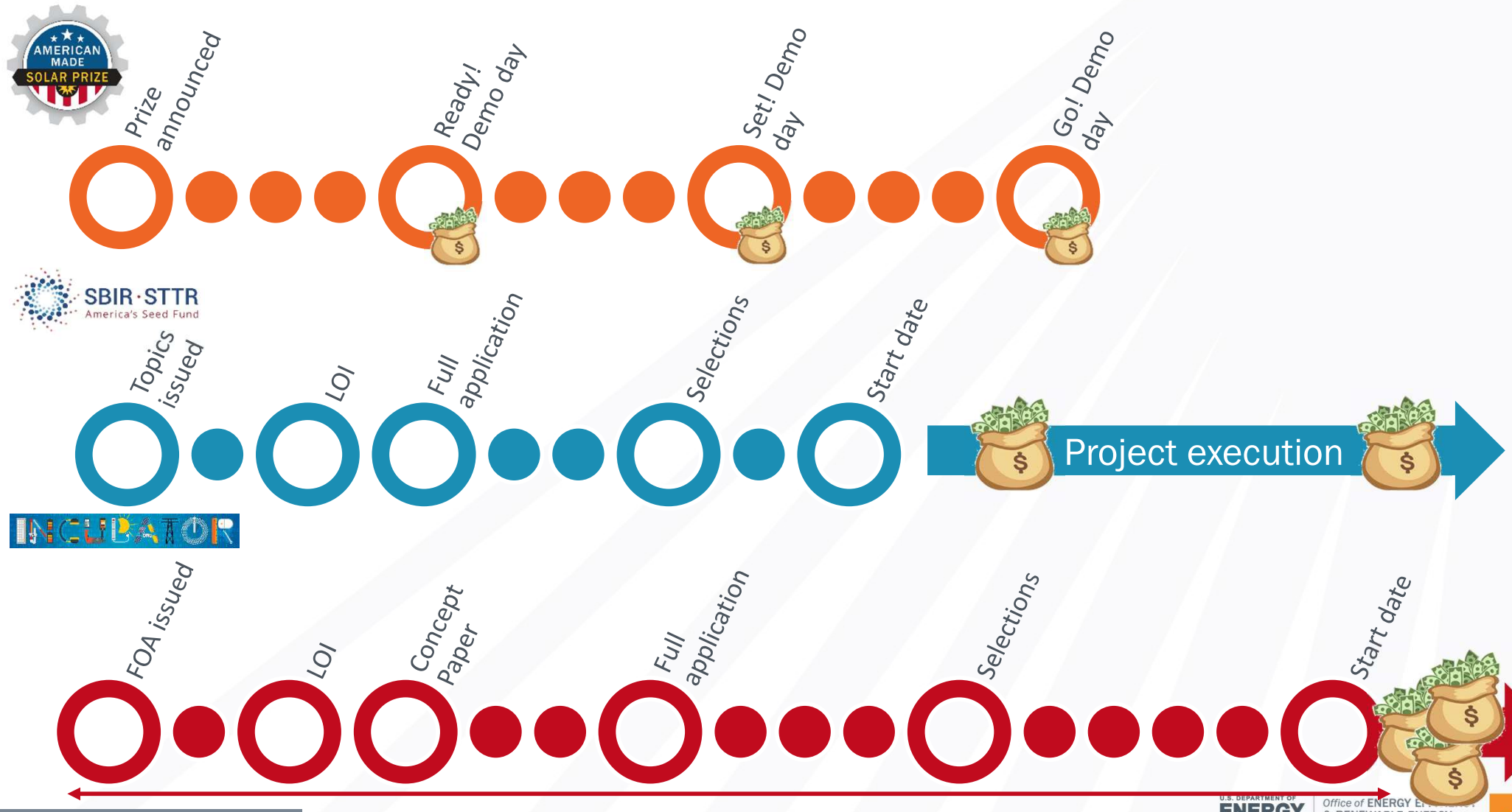
20 - 50% Cost Share

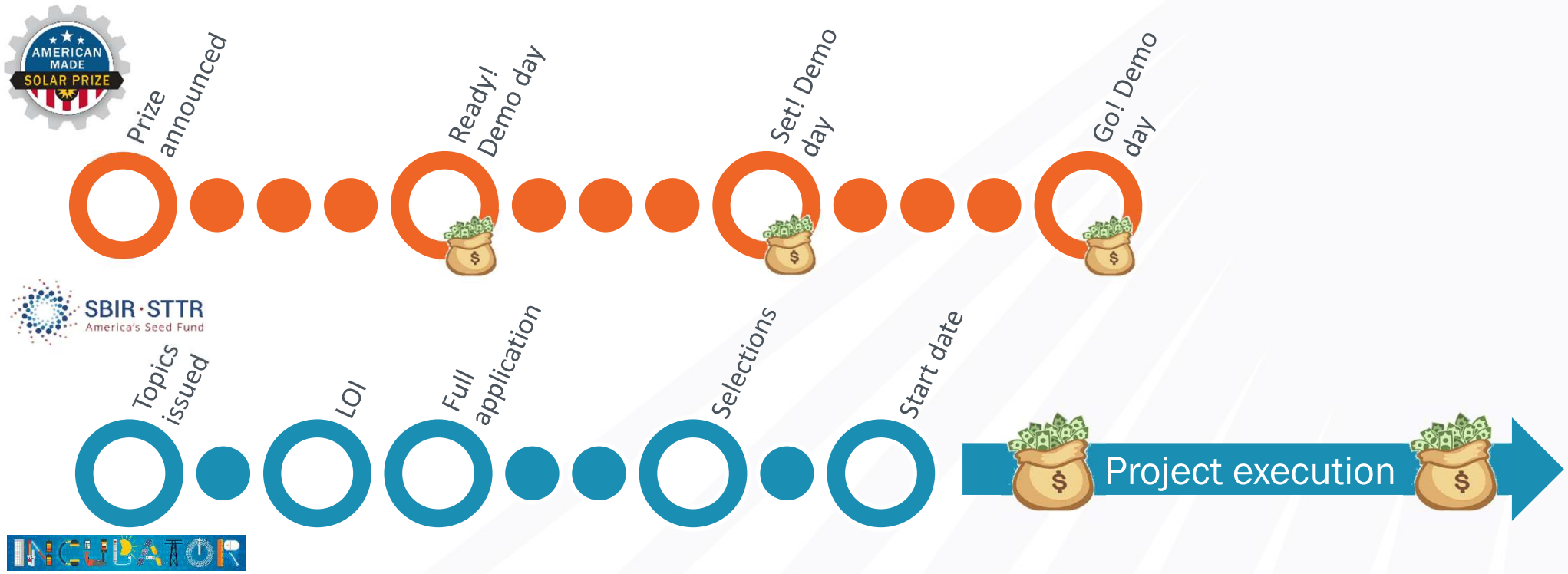
Awards range Up to $3M

- Open topic to all hardware solutions relevant to the solar industry
- Interest in projects with potential to support a strong U.S. solar manufacturing sector and supply chain
- Focus on products with a clear pathway to reduce solar electricity costs that are too risky for private investment but have the potential for rapid commercialization
- Ideal applicant advances an existing early-stage prototype to a manufacturing and commercially relevant prototype


Prize announced
Ready! Demo day
Set! Demo day
Go! Demo day
1 year

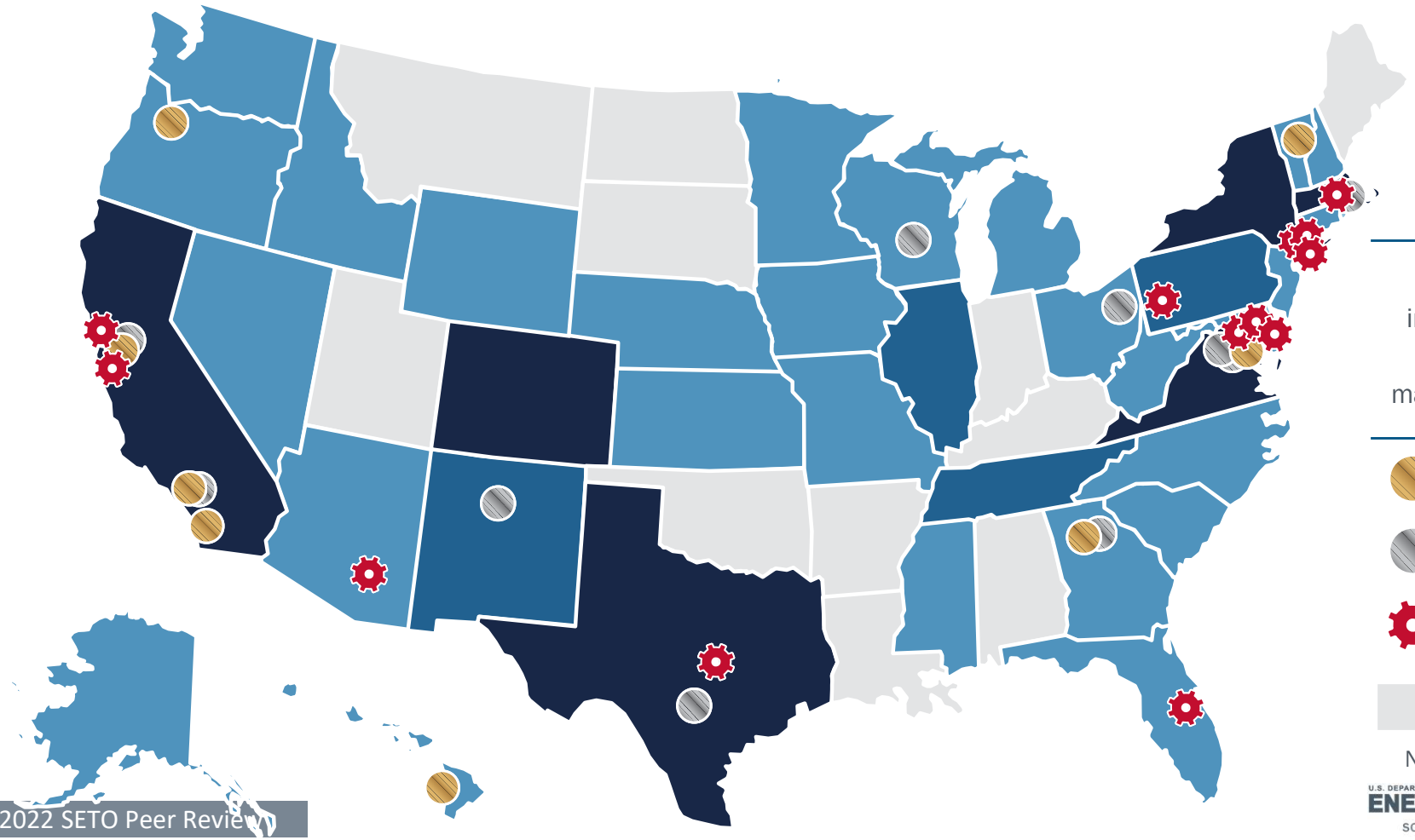

AMERICAN MADE SOLAR PRIZE
Prize announced
Ready! Demo day
Set! Demo day
Go! Demo day
SBIR·STTR America's Seed Fund
Topics issued
LOI
Full application
Selections
Start date
Project execution
9 months


AMERICAN MADE SOLAR PRIZE
Prize announced
Ready! Demo day
Set! Demo day
Go! Demo day
SBIR·STTR America's Seed Fund
Topics issued
LOI
Full application
Selections
Start date
Project execution
INCUBATOR
FOA issued
LOI
Concept Paper
Full application
Selections
Start date
16 months


AMERICAN MADE SOLAR PRIZE
Prize announced
Ready! Demo day
Set! Demo day
Go! Demo day
SBIR·STTR America's Seed Fund
Topics issued
LOI
Full application
Selections
Start date
Project execution
INCUBATOR
FOA issued
LOI
Full application
Selections
Start date
14 months

American-Made NETWORK

Work at National Laboratories



200+ National labs, industry experts, and fabrication and manufacturing facilities

Gold Connectors

Silver Connectors

Power Connectors

None 1-5 6-9 10+

AMN Support to SBIR

Work at National Laboratories

Recruitment and Education

THE UNIVERSITY OF ARIZONA CENTER FOR INNOVATION

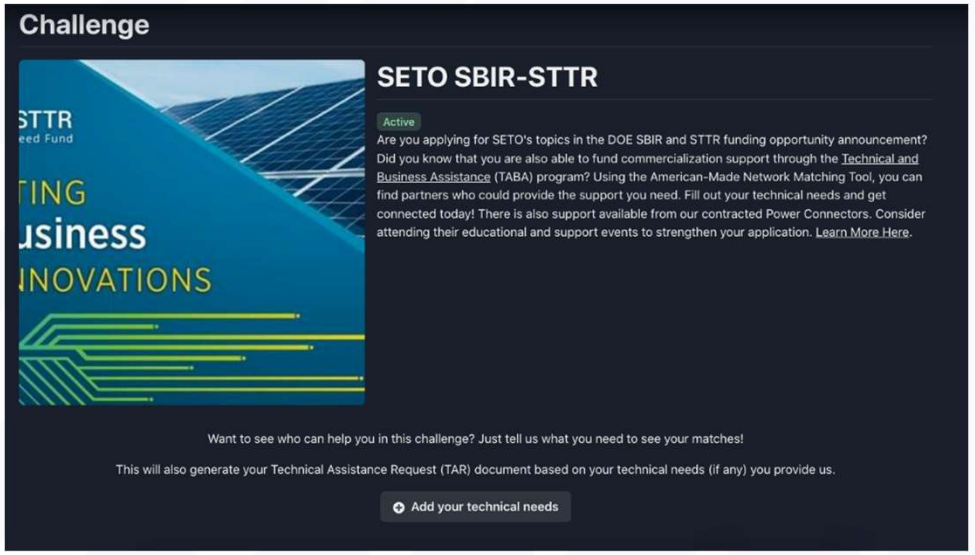
EFN Entrepreneur Futures Network

ADL MONETIZING INNOVATION

CLEAN ENERGY BUSINESS NETWORK

- Spread awareness and targeted outreach
- Application process training

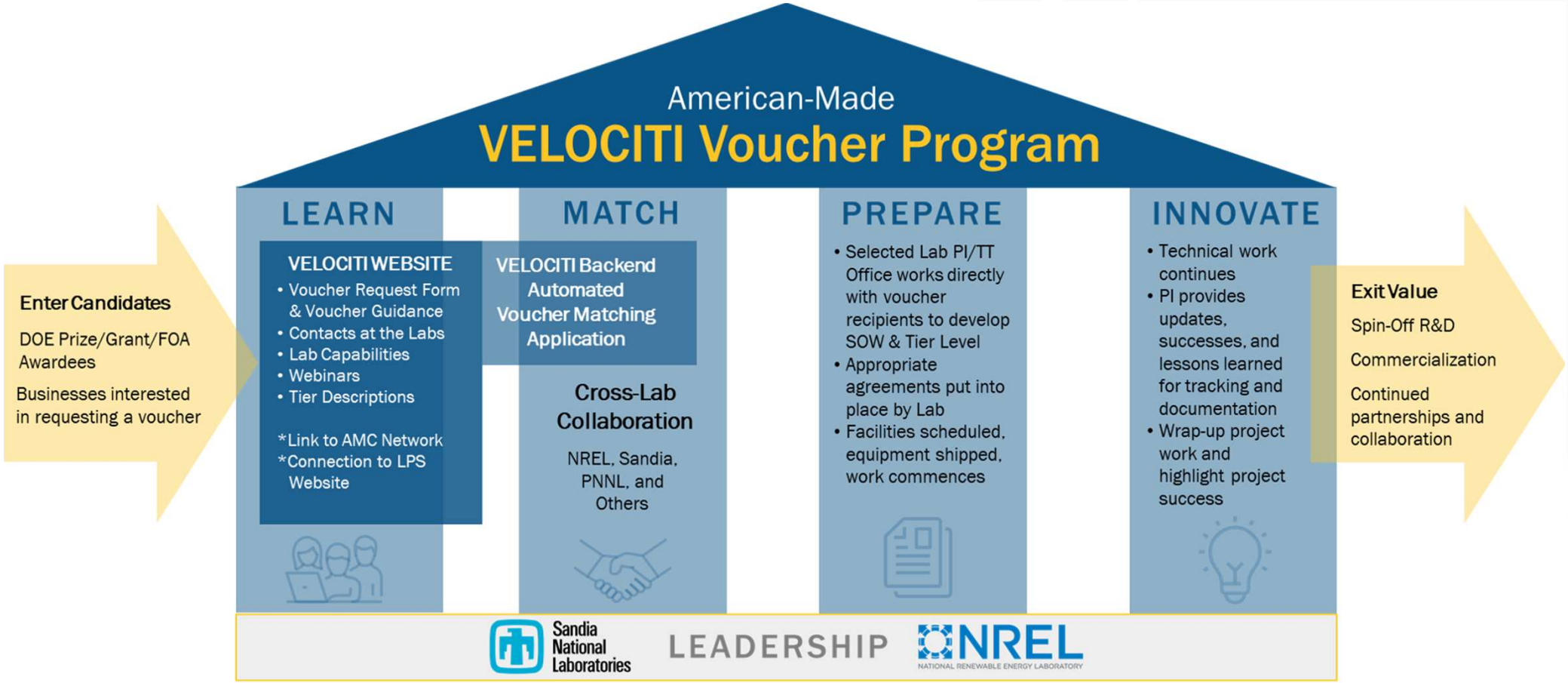
Teaming Support



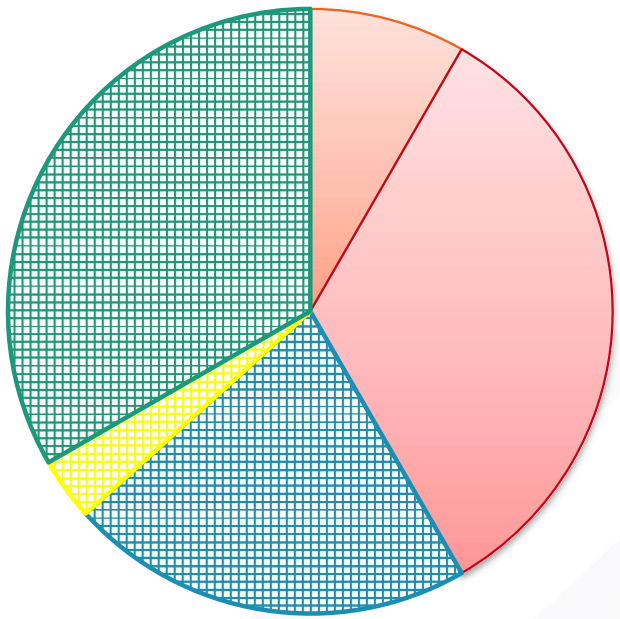
- Leverages matching platform
- SBIR applicants can find potential commercialization vendors

National Lab Vouchers - VELOCITI

Work at National Laboratories



FY21 M&C Budget



- More than 50% of the team's budget is committed to Congressionally-mandated programs
  - SBIR/STTR
  - TCF
  - Perovskite FOA
  - CdTe consortium
- Most of the remaining budget is allocated to Incubator, a program with long history of successes

Focus Area 1 – Mature Sectors

Manufacturing

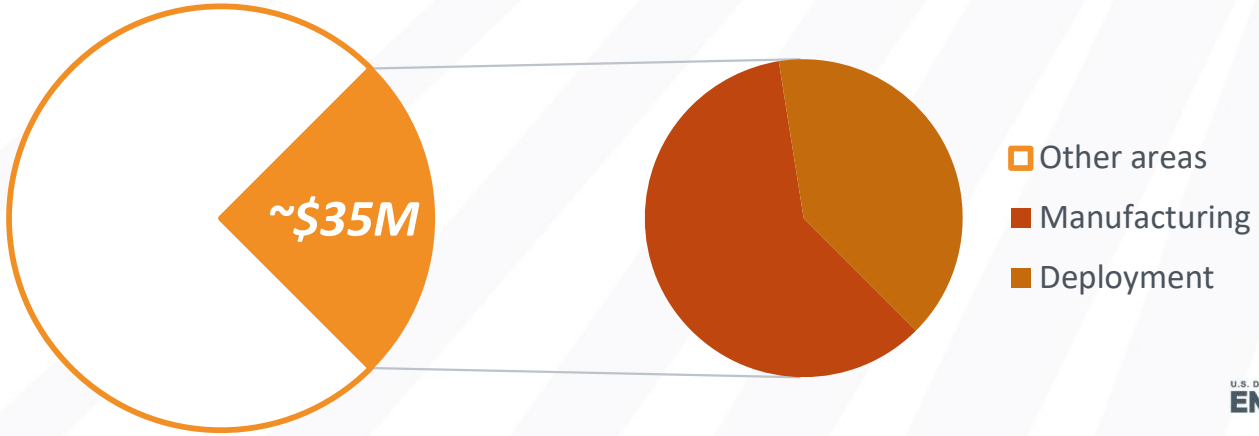
- Supply Chain
- Direct Materials
- Capital Equipment
- Production of Ingots, Cells, Modules, Electrical BOS, Structural BOS

Deployment

- Project Design, Development, and Installation
- Sales
- Distribution
- Financial Services

Operation

- Controls and Market Participation
- Operations & Maintenance
- Financial asset management
- End of Life



Mature Sector Portfolio Highlights

PV Supply Chain & Manufacturing

Balance of System

Installation Automation

PV Supply Chain

Halo Industries

LeadingEdge Equipment Technologies

Wafering

osazda ENERGY

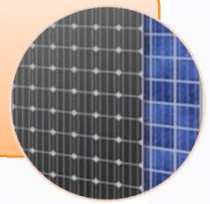
BERT THIN FILMS LLC

Silicon Valley Materials Technology SVMT LLC

Metallization

SWIFTCOAT

Coatings



PV Manufacturing

= prize winner

SBIR·STTR America's Seed Fund

INCUBATOR

SILFAB SOLAR (*)

Module Manufacturing

Sinton instruments

SciONPLASMA

Tau Science Built for Solar

Equipment Development

nexTC

TOLEDO SOLAR

CdTe PV Accelerator

CdTe Manufacturing

(*) under negotiation

Balance of System

= prize winner

SBIR·STTR America's Seed Fund

INCUBATOR

- Residential
  - Phase3 Photovoltaics
  - Span
- Commercial
  - Quest Renewables
  - Tectonicus Constructs
- Utility
  - Atonometrics
  - Sandia National Lab & Array Technologies (TCF)

Installation Automation

terabase

- Field Factory for Cost Reduction and Deployment Acceleration of PV Power Plants
- Autonomous Control System for PV Table Delivery and Placement

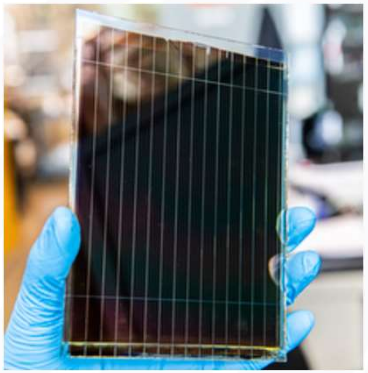
re² ROBOTICS

- Outdoor Autonomous Manipulation of Photovoltaic Panels (O-AMPP)

Focus Area 2 – Emerging Technologies

Perovskite Photovoltaics and Hybrid Tandems

- Key Challenge: Bankability (reliant on verified durability, manufacturability)
- Joint Area with PV Subprogram
- Portfolio: Approximately ***$90M federal***



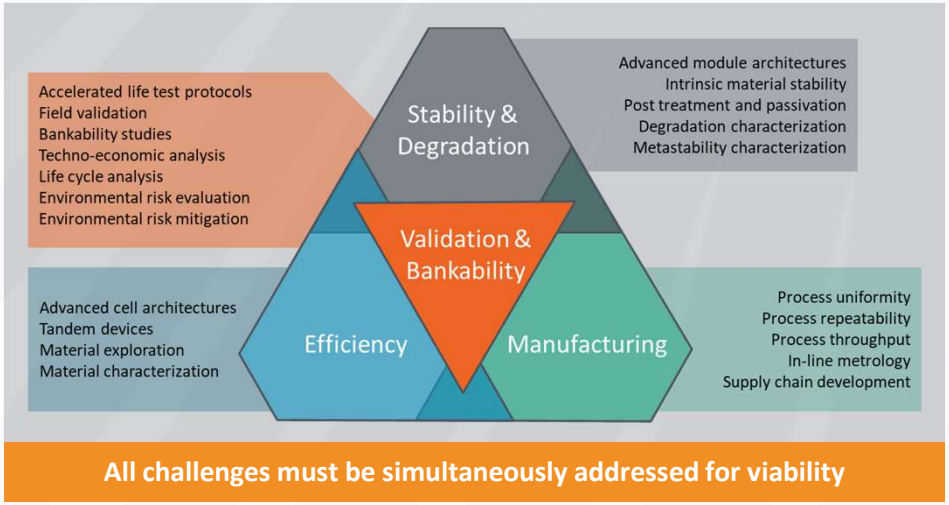
Wide Band-Gap Power Electronics (SiC, GaN)

- Key Challenge: Product fit, cost-competitiveness
- Joint Area with SI Subprogram
- Portfolio: Approximately ***$10M federal***

How Do We Develop Strategies and Programs?

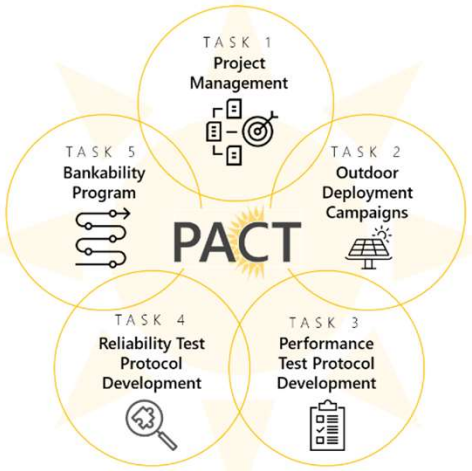
- **Motivation:** Perovskites show potential for high efficiency; low production cost, low CapEx
- **Objectives:** Substantial market entry in <10 years (multiple entities, MMW-GW/yr)
- **Requirements:** Competitive, validated performance:
  - Power density [W/m^2]
  - Energy yield [kWh/kW-year]
  - Production cost [$/W]
- **Key Challenge Areas**
- **Program Development**
  - SETO PVSK FOA - $40M selected (22 projects)
  - FY21 PVRD FOA - $1M selected (4 projects)
  - FY22-FY24 National Labs programs launched

→ ***Based on start date, few of these are being individually reviewed***



Validation & Bankability: How Do We Build Confidence…

About Where We Are…



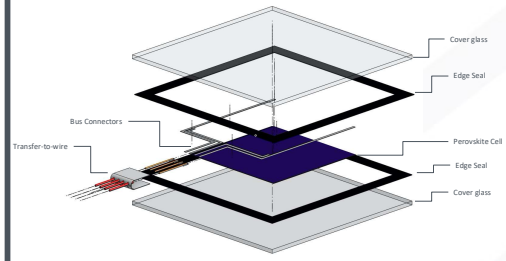


Fig.1. Exploded view of proposed packaging structure

About Where We're Going…

Perovskite Performance Targets

- Establish common objectives
- Align community efforts
- Provide evidence of readiness for initial production

→ ***Under revision following RFI in fall 2021***

Configuration	Aperture Area PCE[1]	Total Module Area[2]	Durability	Sample Population Requirements
Single Junction	18% PCE	>=500 cm^2 with at least 4 inter-connected cells	Pass IEC 61215 MQT 10, 11, and 21 and ISOS-L-2 at specified durations with <10% relative performance loss per test[3] 6 months continuous outdoor testing with <3% relative degradation overall and <1% degradation in the final 3-month span[4]	>1kW total, at least 20 modules for outdoor testing[5]
PVSK-only Tandems	24% PCE			
Hybrid Tandems	27% PCE			

Perovskite Portfolio Selections

= prize winner

EMC Energy Materials Corporation HIGH SPEED, ROLL-TO-ROLL PRODUCTION OF DURABLE, LOW-COST, BIFACIAL PEROVSKITE PHOTOVOLTAIC MODULES	First Solar HIGH –THROUGHPUT AND –YIELD PROCESS USING IN-LINE METROLOGY FOR SHEET-TO-SHEET MANUFACTURING OF PEROVSKITE MODULES
Tandem PV FULL SCALE PEROVSKITE/ SILICON TANDEM MODULES	SwiftSolar HIGH-THROUGHPUT VAPOR DEPOSITION FOR PEROVSKITE-PEROVSKITE TANDEM MODULES

Variety of industry approaches: Wet vs dry processing, single junction, 2T and 4T tandems

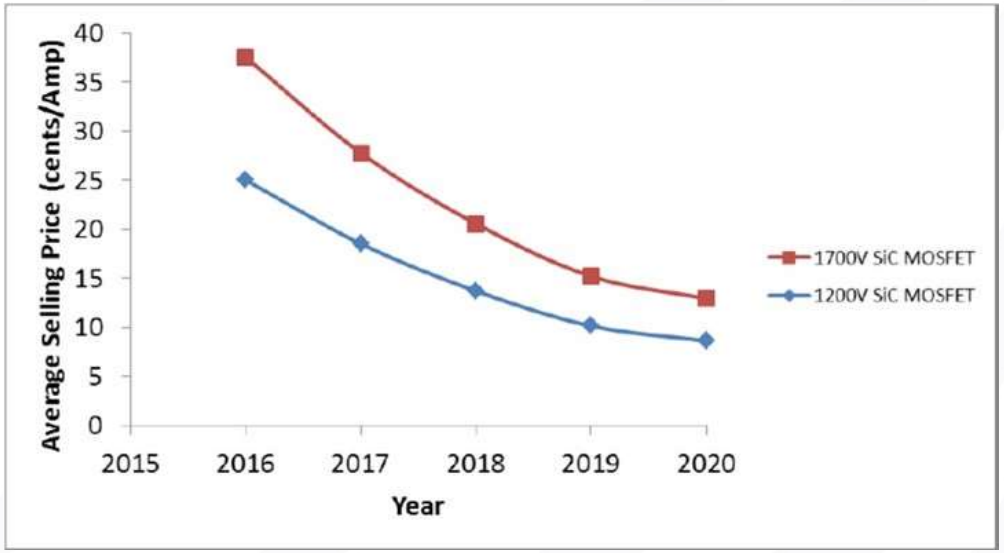
Perovskite Portfolio Selections

Advanced Devices and Tandems	NREL NATIONAL RENEWABLE ENERGY LABORATORY	ADVANCED PEROVSKITE CELLS AND MODULES; TANDEM PHOTOVOLTAIC DEVICES; FROM DEVICES TO ATOMS: ASSESSING PEROVSKITE STABILITY AND METASTABILITY BY SPATIALLY RESOLVED IN-SITU AND TARGETED EX-SITU
	THE UNIVERSITY OF TOLEDO	TOWARD LOW-COST, EFFICIENT AND STABLE PEROVSKITE THIN-FILM MODULES
Fabrication and Stabilization	Stanford University	OPEN-AIR MANUFACTURING OF EFFICIENT LARGE-AREA PEROVSKITE SOLAR CELLS TO MEET STABILITY AND COST TARGETS
	THE UNIVERSITY of NORTH CAROLINA at CHAPEL HILL	STABILIZING FORMAMIDINIUM-CESIUM MIXED CATION PEROVSKITES
Metrology and Characterization	University of Colorado Boulder	STUDYING PEROVSKITE SOLAR CELLS IN REVERSE BIAS TO ACCELERATE AND INVESTIGATE DEGRADATION DUE TO ELECTROCHEMISTRY AND HALOGEN MIGRATION
	SLAC NATIONAL ACCELERATOR LABORATORY	TOTAL CHARACTERIZATION OF PEROVSKITE FILMS FOR ENHANCED STABILITY
	UNIVERSITY of WASHINGTON	FORECASTING PEROVSKITE PHOTOVOLTAIC DEVICE PERFORMANCE USING DARK-FIELD IMAGING AND MACHINE LEARNING

Wide-Bandgap Power Electronics – Motivation

Next-generation inverters/converters for solar applications and hybrid solar systems utilizing SiC and GaN modules

- Accelerated WBG-device market growth and dropping chip prices, driven by the expanding electric vehicle industry
- Leverage prior investments from AMO, VTO and others



https://www.nist.gov/system/files/documents/pml/high_megawatt/Banerjee-APPROVED.pdf

Opportunity to use WBG chips in **power-electronics components for the solar** industry in a **cost-competitive way** compared to incumbent technologies.

The United States is a pre-eminent supplier of high-quality SiC wafers and chips making a **compelling case for domestic manufacturing**.

Wide-Bandgap Power Electronics – Focus and Goals

- Develop the next generation of power-electronic devices leveraging the **benefits of wide-band-gap materials** (like SiC and GaN)
- Extend the state of the art in areas such as:
  - innovative inverter/converter **designs and topologies**,
  - **transformer-less** designs and **planar magnetics**,
  - **faster switching** frequency applications,
  - **high-power** applications,
  - **high-voltage** applications,
  - **design and build processes**.
- Create **cost**-competitive, high-**performance**, high-**reliability** alternatives to silicon-based equipment
- Combine technical innovation with promoting the case for **domestic manufacturing** of equipment (e.g. inverters)

Wide-Bandgap Power Electronics – Portfolio Selections

= prize winner

SBIR·STTR America's Seed Fund

INCUBATOR

Component Manufacturing

Halo Industries

Advanced silicon carbide wafer manufacturing for low-cost, high-efficiency power electronics in solar applications – **Halo Industries, Inc.** (INCUBATOR FY19)

Advanced Inverters

BREK ELECTRONICS

250 kW solar string inverter using silicon carbide (SiC) modular architecture and grid support functionality – **BREK Electronics Corp.** (SBIR/STTR FY19)

YASKAWA SOLECTRIA SOLAR

The BREKTRIA 500: A breakthrough in technology and power density for an advanced 500kW utility-scale string inverter – **Solectria Renewables, LLC** (INCUBATOR FY20)

IMAGEN

Compact, high-power, direct-medium-voltage solar PV inverter – **Imagen Energy, LLC*** (INCUBATOR FY21)

Multi-Port Devices for PV + Storage

A modular and flexible multi-terminal power converter with grid-forming capability for integrated PV solar and battery energy storage – **General Electric Company** (INCUBATOR FY21)

TOSHIBA

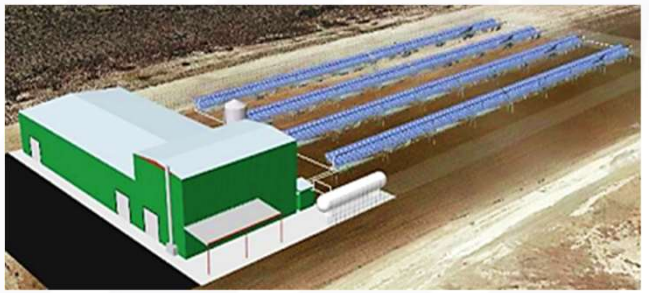
TOSHIBA INTERNATIONAL CORPORATION

Commercialization of M4 inverter: Modular, multifunction, multiport and medium voltage utility-scale SiC PV + storage inverter – **Toshiba International Corporation*** (INCUBATOR FY21)

** Selected – Currently under negotiation*

Focus Area 3—Emerging Sectors

- Application-specific/multi-use integration of solar
  - **BIPV** — Building Integrated Photovoltaics
  - **Agrivoltaics** — Agricultural Photovoltaics
  - **Floatovoltaics** — Floating Photovoltaics
  - **Concentrating Solar Power** — Industrial Process Heat



Building Integrated Photovoltaics

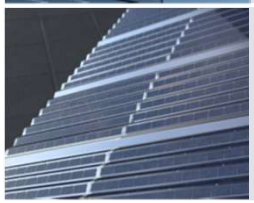
= prize winner

SBIR·STTR America's Seed Fund

INCUBATOR

Windows

Facades



Roofing

Aesthetic

Building Integrated PV

- Toledo Solar (FY20)
- *Next Energy (FY18)*
- ***Nanoflex (FY19)***
- Toledo Solar (SBIR FY20)
- Enviromation (SBIR FY21)
- Otherlab (SBIR FY21)

Aesthetic PV:

- Sistine Solar (*FY15*, FY21)
- Asoleyo Solar (AMSP R2; SBIR FY21)
- r&d lab (AMSP R4)

Training/Education

- NREL/Architectural Solar Association
  - Jointly with SAIS & BTO
  - Selected, not finalized

Programs:

- Topic Areas within SBIR
- Incubator RFI
- BIPV RFI (Planned, Joint with BTO)

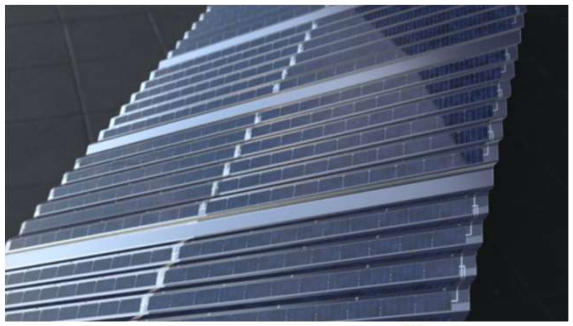
Active program area for SETO
Total projects in last 5 years ~$15M

BIPV – Technology Examples

= prize winner

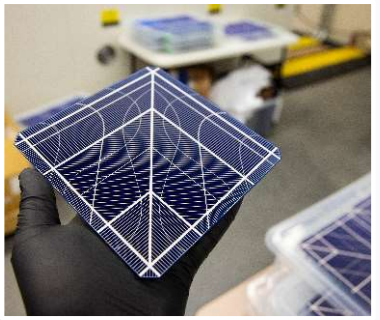
SBIR·STTR America's Seed Fund

INCUBATOR



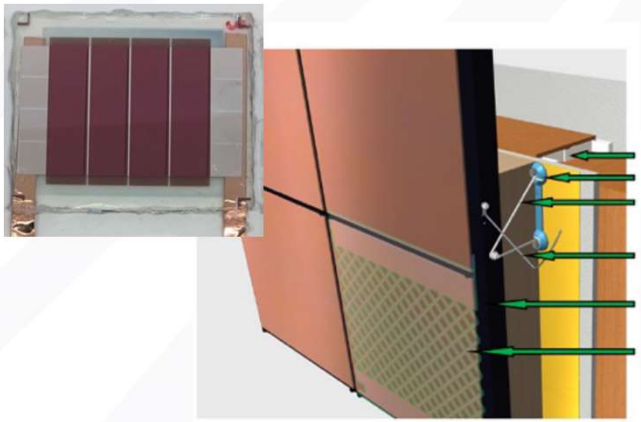
OtherLab

Sistine Solar



Asoleyo

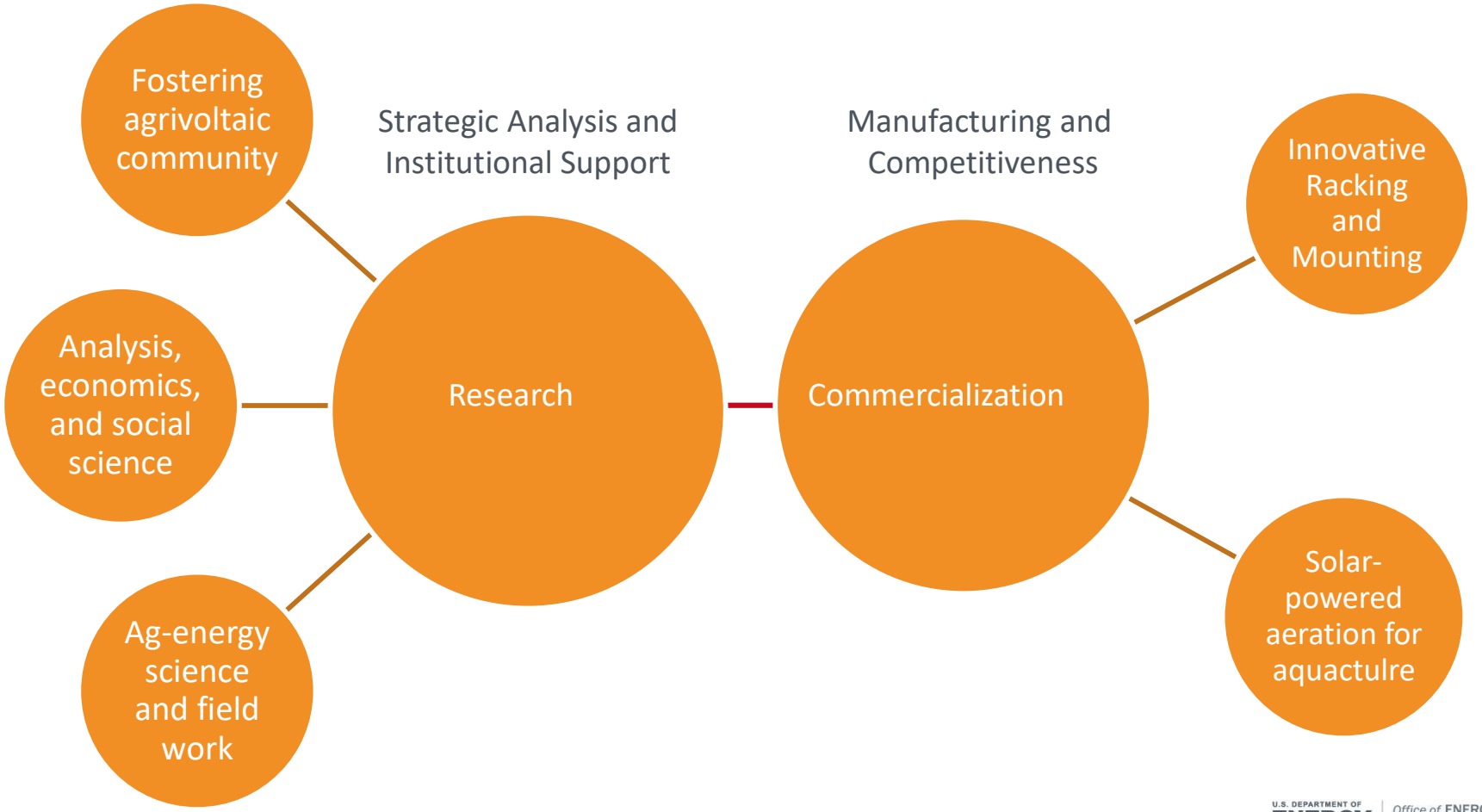
Toledo Solar



NanoFlex

r&d lab

SETO Research and Commercialization Activities in Agrivoltaics



Agrivoltaics Example

- **FarmAfield – SBIR Phase-II project integrates PV with livestock feeding structures improves quality *and* LCOE**

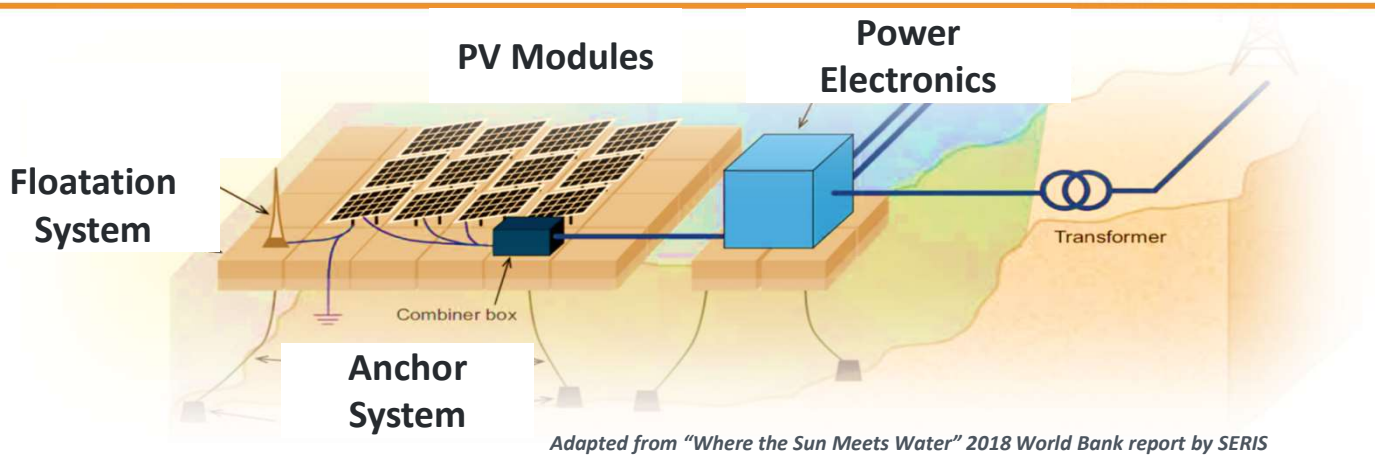
- **Their SBIR Phase-I floating solar aeration project is to improve water and fish quality in aquaculture**

Agrivoltaics– SBIR New Cohort

= prize winner

- Solar racking/mounting design optimized for co-location:
  - Blue Rock Solutions – suspended solar racking ($200,000, 1Y, FY2021 SBIR)
  - Rute Foundation Systems – cable stayed solar racking ($199,999, 1Y, FY2021 SBIR)
  - Taka Solar Corporation – tube-based photovoltaic system ($206,300, 1Y, FY2021 SBIR)
  - TrackerSled – modular solar trackers for rural application ($195,382, 1Y, FY2021 SBIR)

Floating Solar Photovoltaics



Adapted from "Where the Sun Meets Water" 2018 World Bank report by SERIS

- "Floatovoltaics" uses solar photovoltaic (PV) modules on flotation systems to convert sunlight into electricity on bodies of water
- Strategies to float, anchor, rack the PV and waterproof the systems distinguish competitors
- Potentially lower temperature operation can boost efficiency
- Durability to corrosion, biofouling, etc. can be a challenge

Floatovoltaic Advantages

- Floating solar installations make use of water resources to deploy solar, often where large areas of open land are unavailable
- Floatovoltics can bring solar electricity to industry-related bodies of water, such as municipal wastewater, that also face land constraints
- NREL identified >24,000 floatovoltaic-suitable US artificial water resources

SETO Funded Floating Solar PV projects

- **Accusolar:** new racking system and advanced manufacturing (selected for $1.5M Federal/ $7M cost share cooperative agreement, 2 Y, FY21)
- **Dissigno International**: new float and racking system design (selected for $3M, 1Y, FY 2021)
- **Dissigno International**: aeration for integration into existing large-scale floating solar energy projects deployed on wastewater ($199,438, 1Y, FY2021 SBIR)
- **FarmaField Labs**: integrates solar into existing floating pond aeration to improve fishery production ($0.2M, 1Y, FY21 SBIR)
- **Floating Island International**: solar and nanobubble aeration integrated with natural appearing floating island platform for improved water quality ($0.2M, 1Y, FY2021 SBIR)
- **Hawaii Fish Company**: efficient, floating water aeration system powered by solar and wind with storage for fish farmers ($0.21M, 1Y, FY2021 SBIR)
- **Epsilon Innovation Group**: self-sufficient floating solar aeration system coupled with energy storage to improve water quality and protect underwater organisms and habitats. ($0.2M, 1Y, FY21 SBIR)
- **University of Central Florida:** Study of the environmental impacts and performance of FPV on human-made bodies of water ($0.85M, 3 years, FY18 SAIS)
- **INL/NREL:** Study of the economic and regulatory barriers to FPV deployment on hydropower dams, reservoirs, and estuaries ($2.5M, 3 years, FY21 SAIS)
- M&C partners outside SETO with WPTO and other agencies to facilitate floatovoltaic development

U.S. DEPARTMENT OF ENERGY | Office of ENERGY EFFICIENCY & RENEWABLE ENERGY

SOLAR ENERGY TECHNOLOGIES OFFICE

2022 SETO PEER REVIEW

Thank You

Markus E. Beck, M&C Program Manager

Markus.Beck@ee.doe.gov