

U.S. DEPARTMENT OF
ENERGY

Office of
**ENERGY EFFICIENCY &
RENEWABLE ENERGY**

**ADVANCED MATERIALS &
MANUFACTURING
TECHNOLOGIES OFFICE**

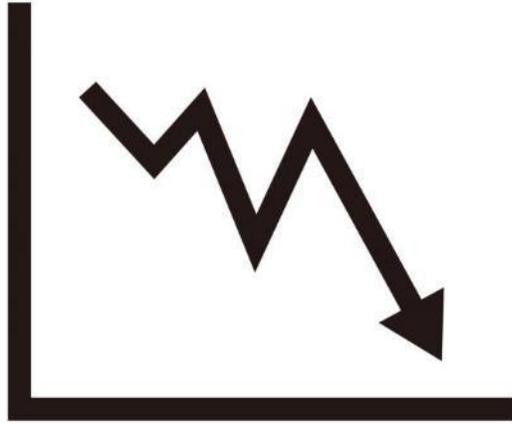


Clean Energy Manufacturing Innovation

**Christopher Saldaña, PhD
Director**

**US Department of Energy (DOE)
Advanced Materials
Manufacturing Technologies
Office (AMMTO)**

National Energy Goals



2030

U.S. greenhouse gas emissions 50-52% below 2005 levels



2035

100% carbon pollution-free electricity by 2035

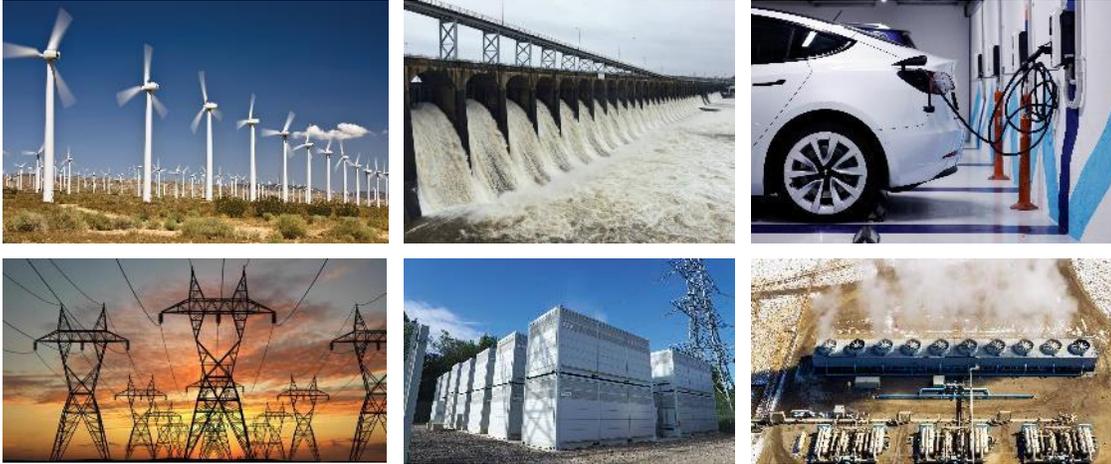


2050

Net-zero emissions economy by 2050

Overview: Energy Systems, Impact and Technology Areas

Energy System Focus



Impact Areas

Supply chain resilience

Product innovation

Industrial competitiveness

Workforce readiness

Environmental sustainability

Platform Technology Areas

- Manufacturing Technologies: smart manufacturing, AI/ML, cybersecurity, high performance computing, roll-to-roll manufacturing, additive manufacturing, circularity
- Advanced Materials: advanced composites/metals/ceramics, critical materials, high conductivity metals, harsh service condition materials
- Workforce: training programs, curricula development, entrepreneurship

Manufacturing at DOE



Secretary of Energy *Jennifer Granholm*
Deputy Secretary *David Turk*

Office of the Under Secretary for Science & Innovation (S4)
Gerri Richmond, PhD

Office of the Under Secretary for Infrastructure (S3)

Office of the Undersecretary for Nuclear Security (S5) & NNSA

ARPA-E, Assistance Secretary of Congressional & Intergovernmental Affairs, Other

Energy Efficiency & Renewable Energy (EERE)
Jeff Manaster

DOE Manufacturing Offices

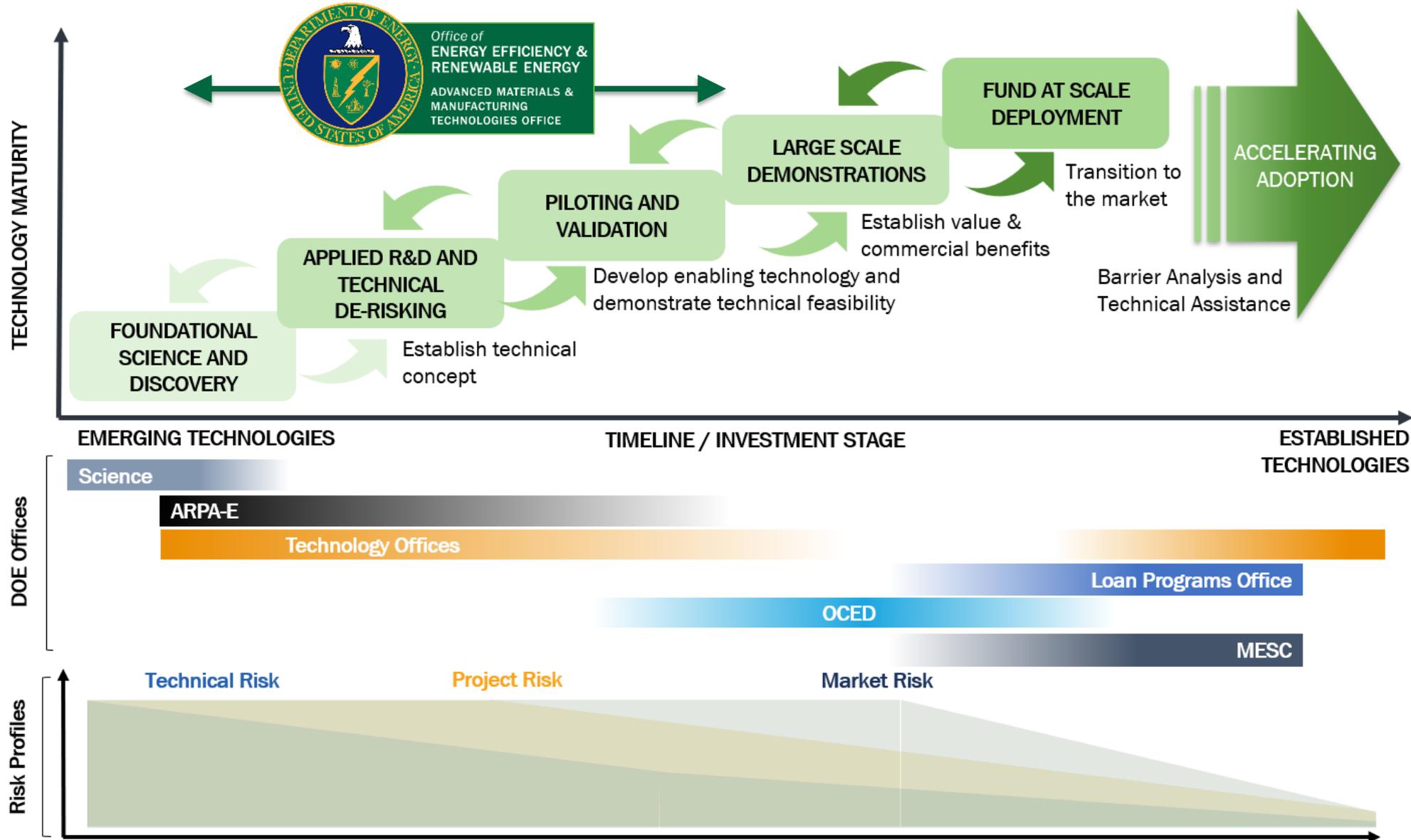
Advanced Materials and Manufacturing Technologies Office (AMMTO)
Industrial Efficiency and Decarbonization Office (IEDO)
Office of Manufacturing and Energy Supply Chains (MESOC)
Office of Clean Energy Demonstrations (OCED)

Buildings and Industry (B&I)
Carolyn Snyder, PhD

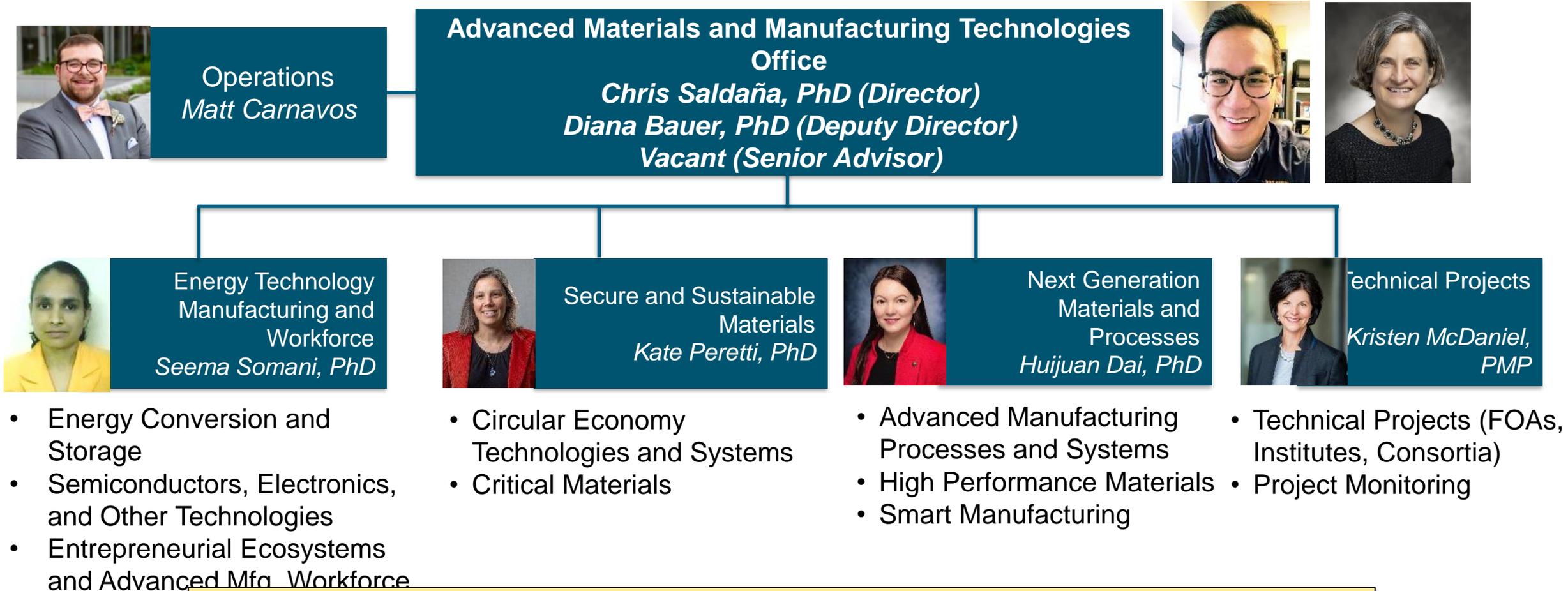
Advanced Materials & Manufacturing Technologies Office (AMMTO)



Overview: Bridging Innovation From Discovery to Deployment



Overview: Office Structure



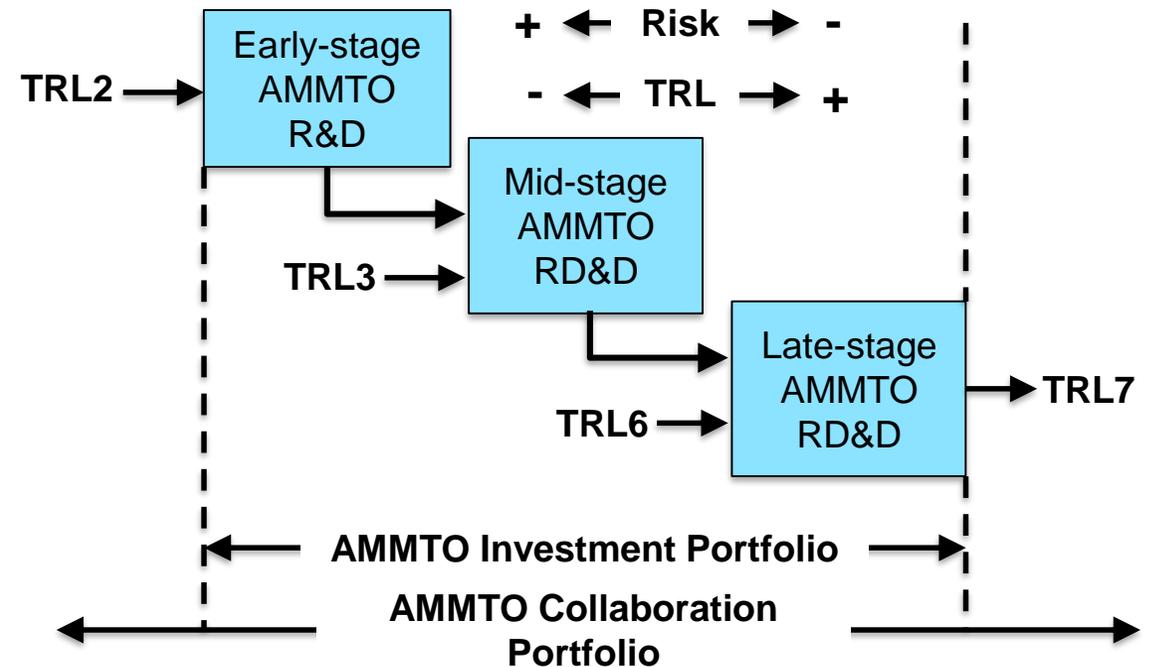
FY2025 Budget Request: \$220M \$62M (Energy Technology Manufacturing and Workforce)
 \$76M (Secure and Sustainable Materials)
 \$82M (Next Generation Materials and Processes)

Overview: Engagement Model

Investment Approaches. Financial investments are targeted to address elements of the TRL spectrum. AMMTO maintains a balanced portfolio with roughly equal support across early R&D to late-stage R&D.

Mechanisms	Early-stage R&D	Mid-stage RD&D	Late-stage RD&D
Lab Calls	X		
Lab Directed Funding	X		
Lab Consortia	X		
FOA		X	
Prize		X	X
PIA		X	X
CRADA Call		X	X
Public-Private Consortia		X	X
Small Business Methods		X	X
Technical Assistance			X
Interagency Agreements	X	X	X

Innovation Pathways. Stagger investments to build pathways for technologies to advance to demonstration-scale maturity. Technologies enter portfolio through prior AMMTO support or other sources. Collaboration with outside groups spans investment portfolio and beyond.



AMMTO's Innovation Ecosystems

Energy Innovation Hubs

- Integrated, multidisciplinary research centers that combine basic and applied research with engineering to accelerate scientific discovery and address critical energy issues.

Manufacturing USA Institutes

- Network of manufacturing innovation institutes created to secure U.S. global leadership in advanced manufacturing through large-scale public-private collaboration on technology, supply chain, and education and workforce development.

Lab-led R&D Consortia

- Leverages unique facility capabilities and expertise in advanced manufacturing at national laboratories to work collaboratively on industrial-relevant, pre-competitive R&D.

Lab-led R&D Manufacturing Facilities and Infrastructure

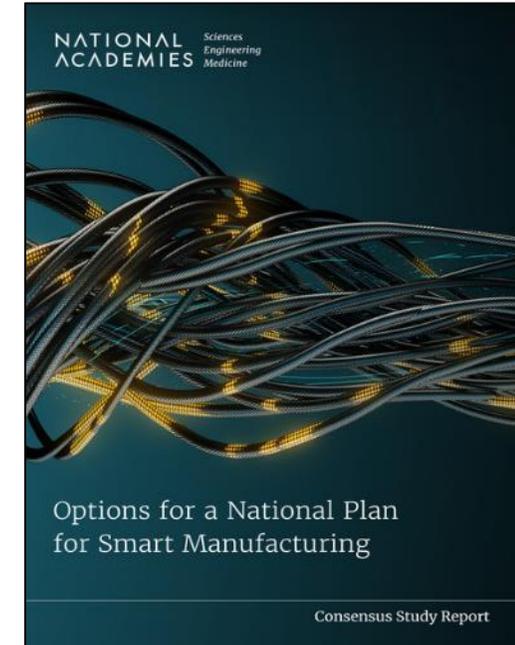
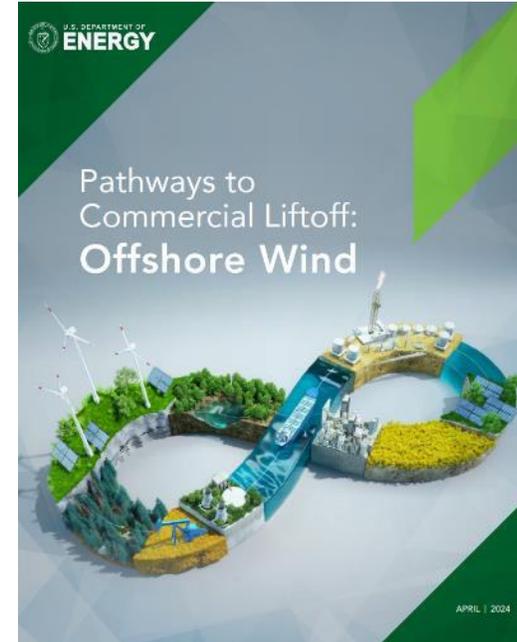
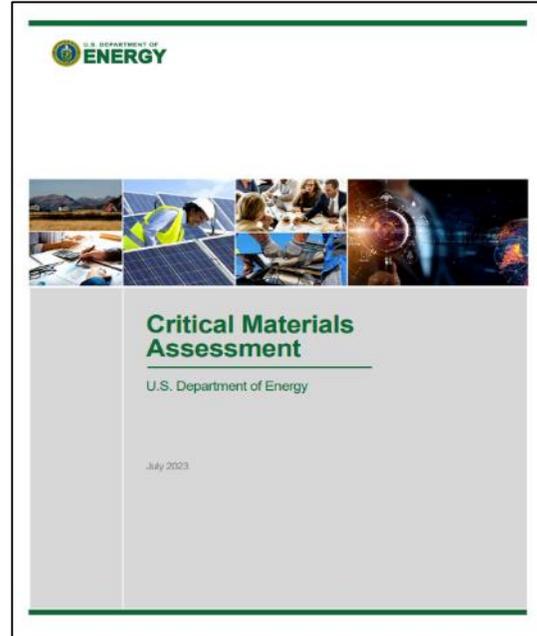
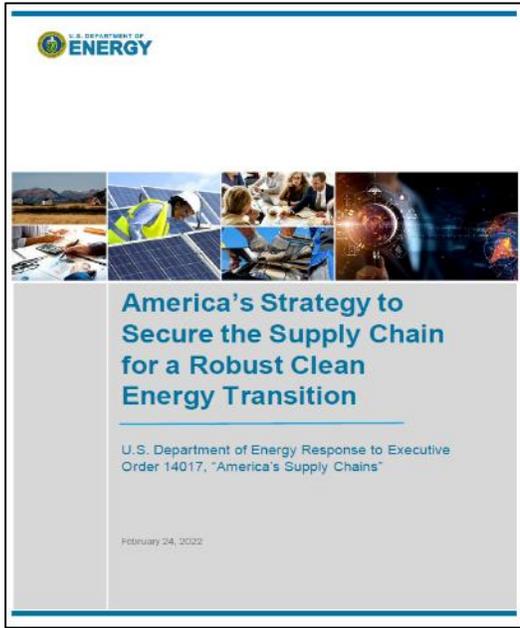
- Strategic investments in physical assets at labs to advance clean energy manufacturing.

Lab-led Infrastructure for Manufacturing Industry

- Provides access and connectivity to lab programs, codes, facilities and experts in areas of entrepreneurial incubation and high-performance computing.



Overview: Technology Analysis and Strategy



- Analysis guided research to drive impact of manufacturing innovation for supply chain resiliency and industrial decarbonization goals.
- Technology roadmapping for key manufacturing and materials technologies.
- Strategy development for manufacturing innovation in multiple areas including critical materials, smart manufacturing, circular economy, power electronics, microelectronics, harsh environment materials.

Smart Manufacturing: Importance to Federal Strategy

National Strategy for Advanced Manufacturing

- 2022 NSTC report (AMMTO co-led)
- Provides strategic vision for enabling US leadership in advanced manufacturing.
- **Smart Manufacturing Callouts:**
 - Digital Manufacturing: Enable the application of advanced sensing and control technologies and machine learning across the industrial sector.
 - AI in Manufacturing: Prioritize R&D in machine learning, data access, confidentiality, encryption and risk assessment to enable adoption of AI in manufacturing.
 - Cybersecurity in Manufacturing: Develop standards, tools, and testbeds and disseminate guidelines for implementing cybersecurity in smart manufacturing systems.



NATIONAL STRATEGY FOR ADVANCED MANUFACTURING

A Report by the
SUBCOMMITTEE ON ADVANCED MANUFACTURING
COMMITTEE ON TECHNOLOGY

of the
NATIONAL SCIENCE AND TECHNOLOGY COUNCIL

1.5: Lead the Future of Smart
Manufacturing

1.5.1: Digital Manufacturing

1.5.2: AI in Manufacturing

1.5.3: Human-Centered Technology Adoption

1.5.4: Cybersecurity in Manufacturing

Smart Manufacturing: Impact Across Portfolio Areas

Energy Technology Manufacturing and

Workforce

Advanced Semiconductors

- Power Electronics (WBG/UWBG)
- Microelectronics

Energy Storage

- Long Duration Energy Storage
- Next Generation Batteries

Workforce Development

- Advanced Technical Education

Secure and Sustainable Materials

Critical Materials Processing

- Extraction and processing for designated critical minerals and materials (Li, Co, Ni, Ir, Pt, Ga, SiC, Mg, Nd, Pr, Dy, Tb, Gr)

Circular Economy

- Material Sortation
- Recovery - Separation/Extraction
- Upcycling
- Material Reuse

Next Generation Materials and Processes

Advanced Materials Processing

- Lightweight Composites
- Conductors for Transmission
- Harsh Environment Materials

Advanced Processes

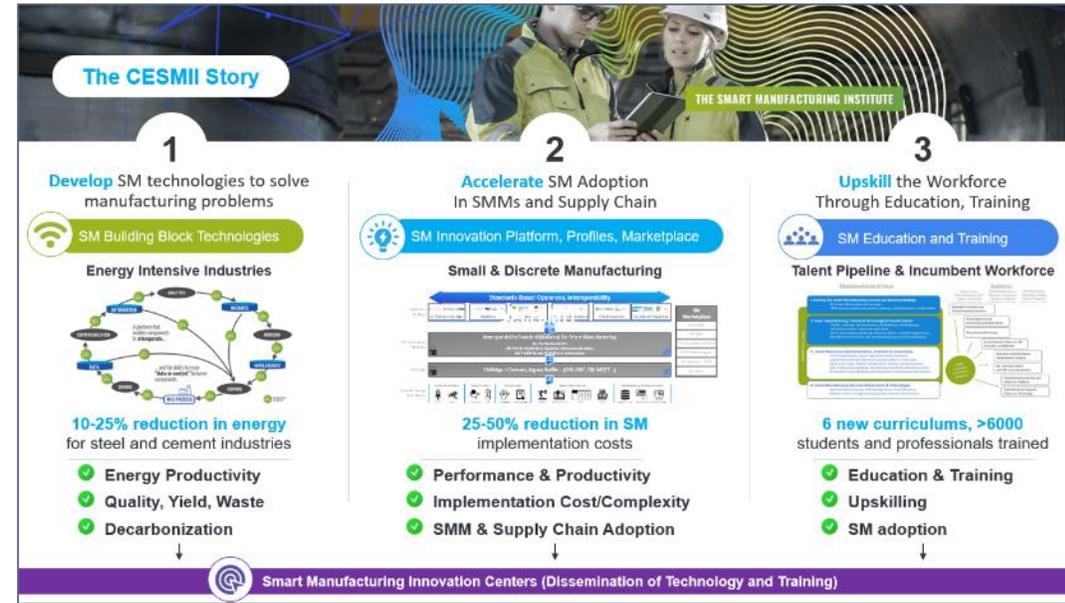
- Net Shape Manufacturing
- Roll-to-Roll Manufacturing
- Solid-State Forming
- Field Assisted Sintering

Smart Manufacturing, Cybersecurity

Smart Manufacturing: Consortia-Related Activities

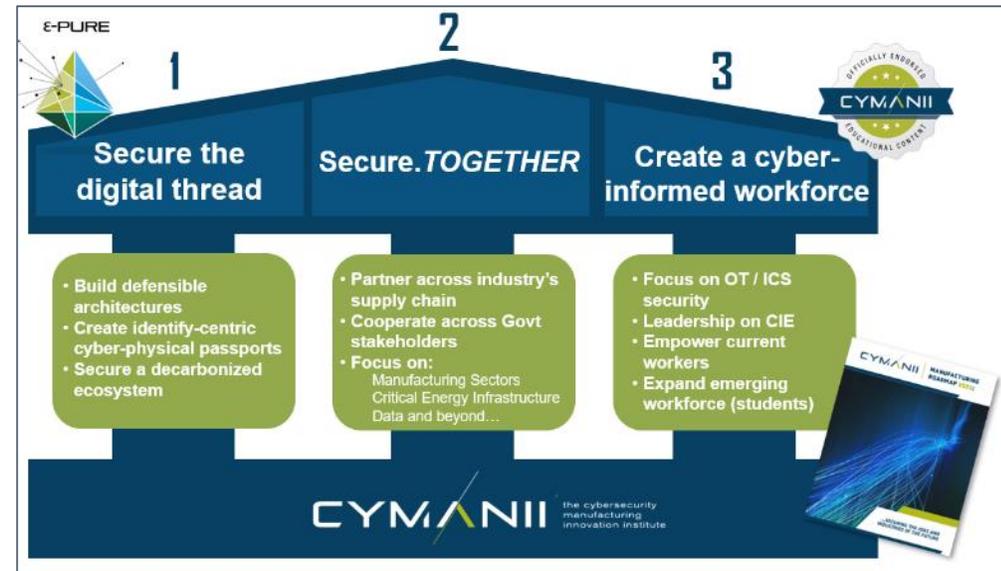
Clean Energy Smart Manufacturing Innovation Institute (CESMII)

- **Mission:** Accelerate the development, adoption, and deployment of advanced sensors, controls, platforms, models, and training to enable Smart Manufacturing to become the driving sustainable engine that delivers innovations for clean energy manufacturing and productivity.



Cybersecurity Manufacturing Innovation Institute (CyManII)

- **Mission:** Secure U.S. manufacturers as they digitize by fortifying their physical systems with embedded cybersecurity and energy efficient solutions.



Smart Manufacturing: Platform Technologies Innovation Program

Overview: This \$33M FOA will accelerate adoption of smart manufacturing technologies by domestic clean energy manufacturers, helping them to deliver product innovations and enhance competitiveness.

Goals:

- De-risk technologies through collaboration with industry to advance smart manufacturing technologies and processes.
- Foster partnerships across supply chains to accelerate the adoption of smart manufacturing technologies and processes for more efficient, resilient, and responsive US manufacturing.
- Demonstrate innovations that can be deployed across the clean energy manufacturing sector to improve US competitiveness.

FY24 Funding: \$33.7M

Office: AMMTO

Programs: NGMP, SSM

TRL Range: 2 to 6

Project Duration: 24 to 36
months

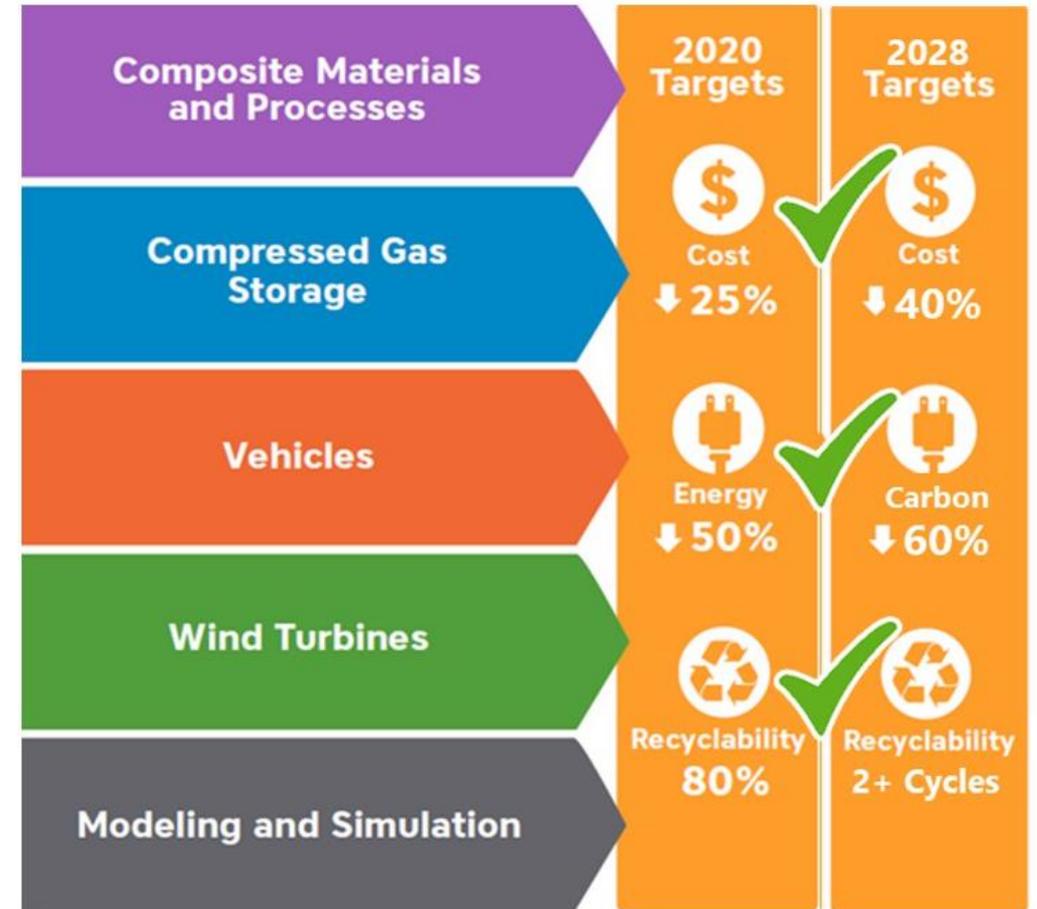
Synergistic with related AMMTO consortia:

- ORNL Manufacturing Demonstration Facility (MDF) Digital Factory Initiative
- Clean Energy Smart Manufacturing Innovation Institute (CESMII)
- Cybersecurity Manufacturing Innovation Institute (CYMANII)
- Sustainable Materials and Manufacturing Alliance for Renewable Technologies (SM2ART)

Composites Manufacturing for Clean Energy Applications

Consortia-related activities

- IACMI: public-private consortium accelerating development and adoption of innovative composites manufacturing technologies.
- MDF: lab-led facility focused on developing/enabling adoption of additive manufacturing and composite technologies for energy.
- CFTF: lab user facility for carbon fiber innovation, providing a platform for identifying high-



Composites Manufacturing for Clean Energy Applications

Large Wind Turbine Materials & Manufacturing

- Develop manufacturing platform technologies and address barriers that limit composite materials in wind energy applications.
- Enable additive manufacturing processes for rapid prototyping, tooling, fabrication, and testing of large wind blades.
- Apply additive manufacturing to non-blade wind turbine components.
- Mature nascent technologies and processes, and methods that improve one or more aspects of advanced composites manufacturing, including automation, and sustainability (including recycling) of these materials.



Achieving American Leadership in the Wind Supply Chain



Floating Offshore Wind™



>70% Reduction



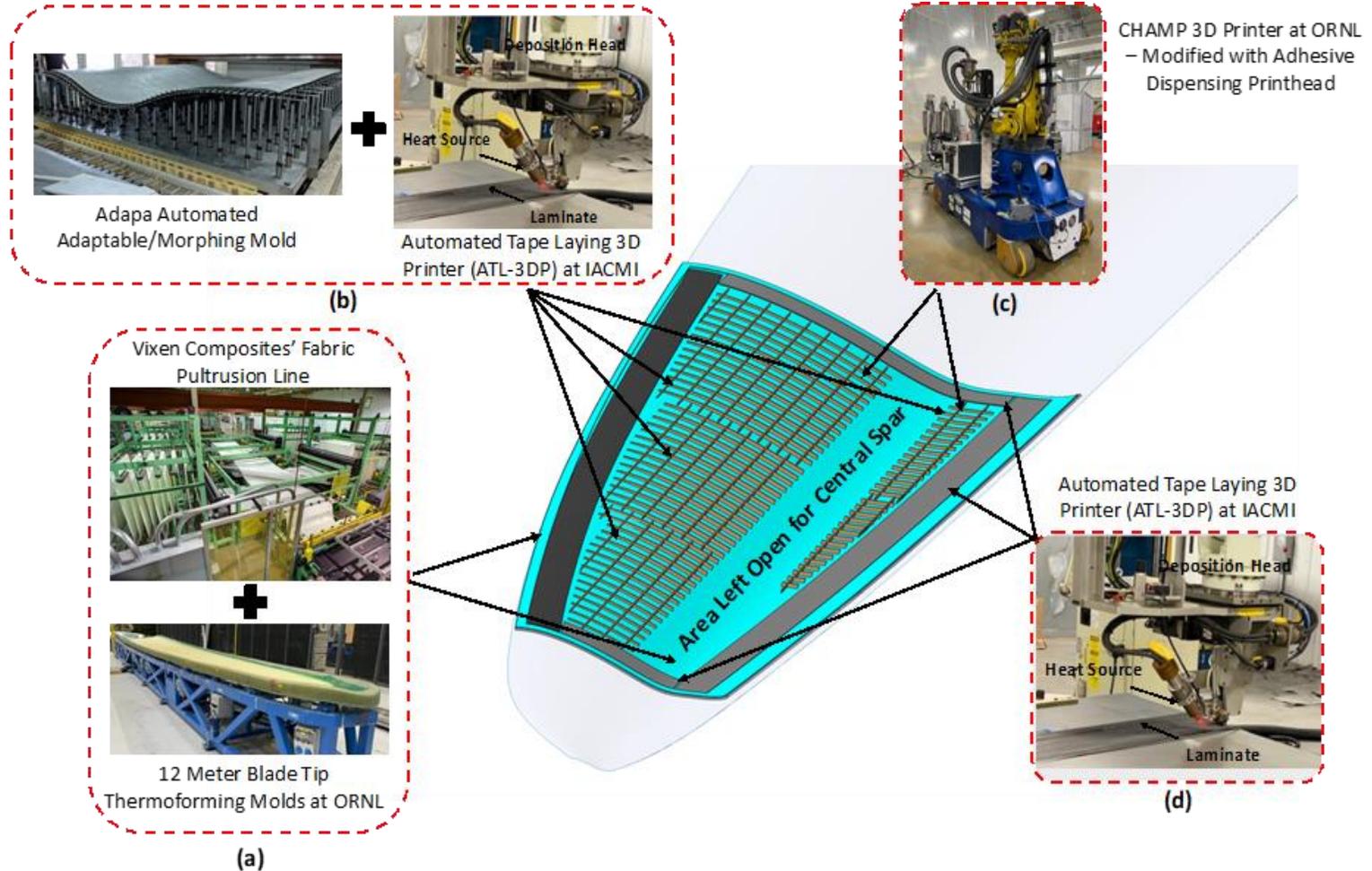
2035

Innovations for Large Wind Blade Manufacturing

Project Overview (\$2M)

- **Goal:** Demonstrate automated manufacturing of modular mid-span wind blade shells using thermoforming of pultruded fiberglass skins and continuous fiber 3D printed anti-buckling grids suitable for large blades.
- **Partners:** ORNL, IACMI, TPI Composites, Arkema, Vixen Composites, METYX USA, Adapa
- **Technical Effort:**
 - Develop adaptable morphing mold and integrate with automated tape laying composite printer.
 - Leverage pultrusion line to produce 12-meter blade tip thermoforming molds.
 - Develop CHAMP 3D printer to use modified adhesive dispensing printhead.
- **Technical Goals:** production capability, labor/LT reduction

Manufacturing Innovation – Automated and Adaptable Manufacturing

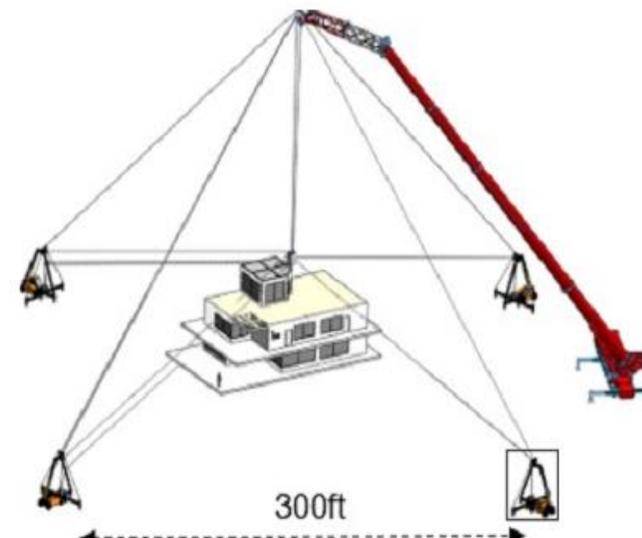
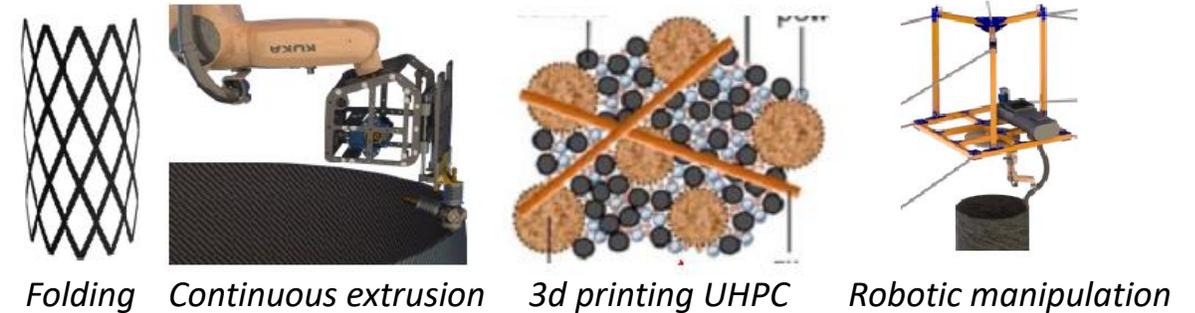


Innovations for Manufacturing Wind Structural Systems

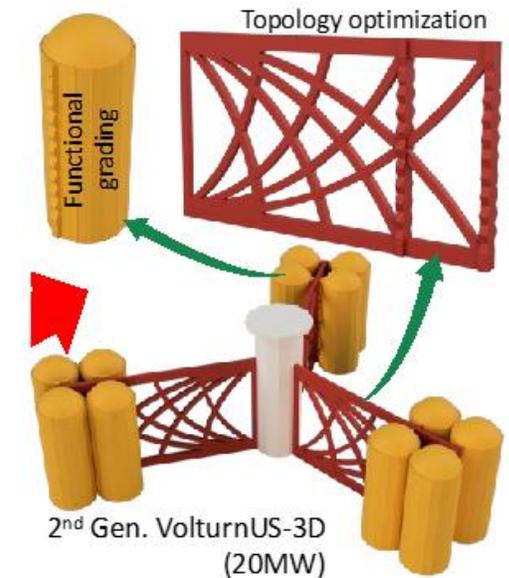
Project Overview (\$2.5M)

- **Goal:** Enable rapid and cost-effective deployment of OSW technologies by additive manufacturing of lightweight concrete floating foundations at the port using US-made materials and equipment.
- **Partners:** Orbital Composites
- **Technical Effort:**
 - Optimize VoltturnUS hull by combining a novel additive manufacturing (AM) system (SkyBAAM) with ultra-high-performance concrete and carbon fiber reinforced polymer reinforcement.
 - This integrated AM approach will achieve the following: (1) significant improvement in structural performance; (2) guaranteed cost-reduction; and (3) significant reduction of used materials per MW rating.
- **Technical Goals:** structural performance, cost reduction, material reduction

Manufacturing Innovation – Large Scale Additive Manufacturing



SkyBAAM AM platform

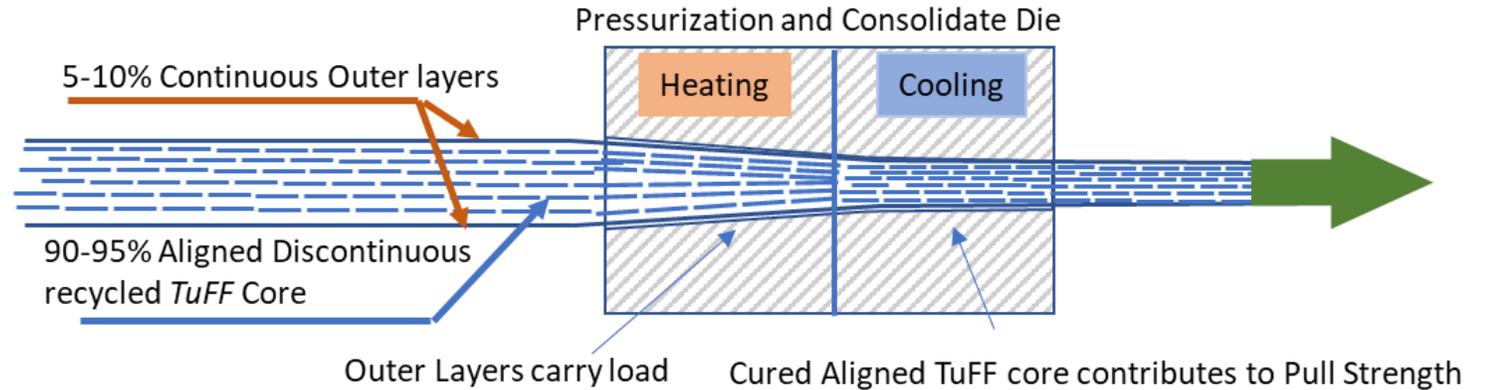


Innovations for Large Wind Blade Materials

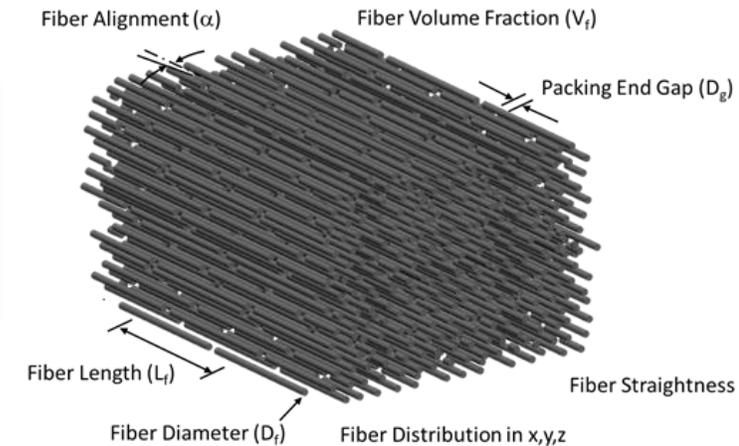
Project Overview (\$3M)

- **Goal:** Develop advanced and sustainable materials and processes to support manufacture of large OSW blade spar caps.
- **Partners:** ORNL, IACMI, TPI Composites, Arkema, Vixen Composites, METYX USA, Adapa
- **Technical Effort:**
 - Develop novel pultrusion approach enabling processing with discontinuous fiber material.
 - Substitute virgin carbon fiber content with recycled, discontinuous fibers (rCFs) @ high fiber volume fraction with aligned, discontinuous fiber feedstock.
 - Replace petroleum-based polymers with bio-derivable resin systems.
- **Technical Goals:** material cost reduction, weight reduction, material performance increase

Materials Innovation – Hybrid Composite Material Pultrusion



Major Objectives of Sustainable Spar Cap Program		
	Goal	Stretch Goal
Embodied Energy Reduction	>50%	>80%
Spar Cap Weight	<110%	<100%
Material Cost	<100%	<50%
Material Performance	>90%	~100%



Castings/Forgings: Large Components Critical for Energy Transition

Role in Clean Energy

- Large scale components are major parts of renewable power and nuclear energy systems.
- These critical components are difficult to manufacture due to their sheer size and the manufacturing infrastructure required to produce these components.

Impact to Deployment Goals

- Future deployment goals will require significant quantities of these components:
 - Onshore/offshore wind - 500% demand increase
 - Nuclear - 400% demand increase
- Supply chain reports identify limited production capacity/resiliency due to casting/forging production offshoring.

Wind power



Rotor Hubs

Hydro power

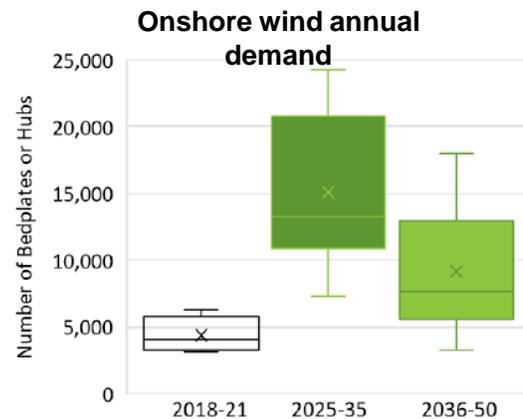


Francis Runners

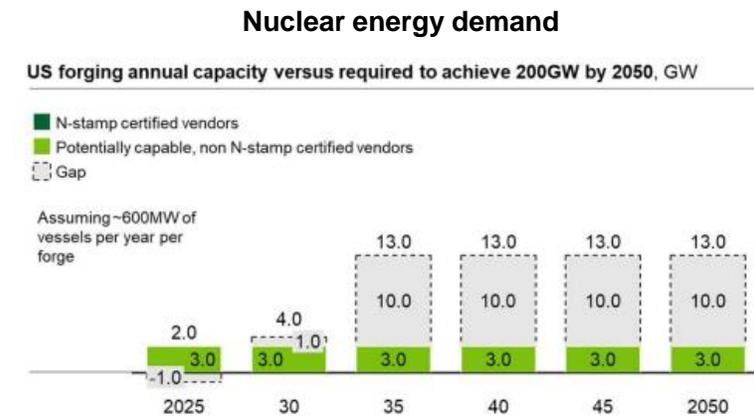
Nuclear



Steam Generator Tubes



NREL Castings Report, 2023.



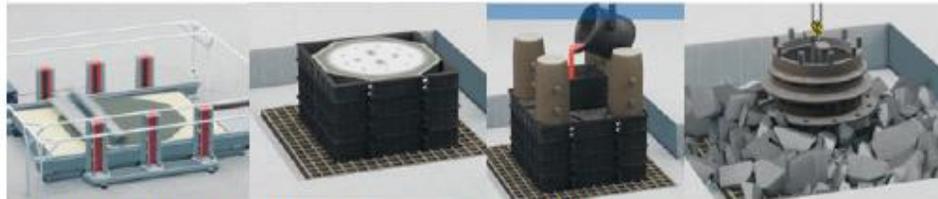
DOE Nuclear Liffoff Report, 2023.

Castings/Forgings: Large Parts Manufacturing Innovation Program

Program Goal: Accelerate development of innovative manufacturing routes to competitively manufacture large (10+ tons) NNS metallic components. The technical and economic viability of the manufacturing methods will be established by producing a full-scale component using the proposed technology.

1. Enhance productivity of existing processes (\$15M)

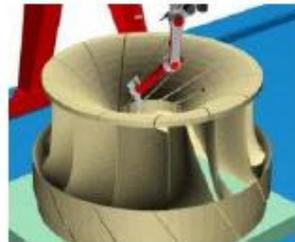
- **Goal:** Develop/demonstrate advanced sand casting mold printing for large-scale complex structures.
- **Partners:** GE, voxeljet USA, GE Verona, GE hydro, ORNL, Clemson University, Hoesch/Fluic Foundry



(a) The Advance Casting Cell production process for casting.



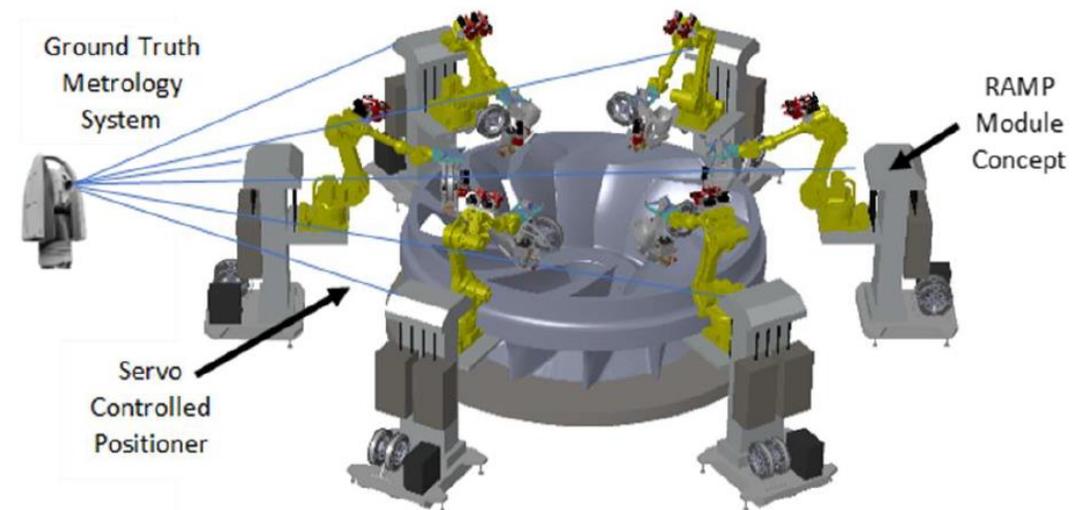
(b) The Advanced Casting Cell (ACC), a sand binder jet printer for castings molds. Build volume to be 29.5' x 23' x 4'.



(c) Hybrid casting and robotic welding assembly of hydro runner.

2. Innovate new processes/systems (\$15M)

- **Goal:** Develop/demonstrate net shape multi-agent hybrid manufacturing for large-scale structures.
- **Partners:** ORNL, TVA, Voith, HII, ARC Specialties, Newport News Shipping, EPRI, Open Mind



Current Engagement Opportunities



DOE Seeks Input To Enhance Coordination of the Lab-Embedded Entrepreneurship Program

A request for information seeks to gather input regarding optimal strategies and opportunities to expand the quality, reach, impact, and equity of the Lab-Embedded Entrepreneurship Program.

JULY 25, 2024

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DOE Announces Phase 1 Winners of Re-X Before Recycling Prize To Extend Product and Part Lifetimes and Promote Circularity

After Phase 1, 20 teams across 13 states have been awarded \$50,000 in cash prizes plus national lab support as Phase 2 opens in the Re-X Before Recycling Prize.

JUNE 17, 2024

[LEARN MORE](#)



\$33 Million in Funding Available To Advance Smart Manufacturing Technologies To Help Accelerate a Clean Energy Economy

A \$33 million funding opportunity aims to accelerate the advancement of smart manufacturing technologies and processes necessary to develop and deploy the innovative technologies and materials needed for the nation's clean energy transition.

JULY 18, 2024

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Advanced Materials and Manufacturing Fellowships

Advanced Materials & Manufacturing Technologies Office

Advanced Materials & Manufacturing Technologies Office » AMMTO Careers & Fellowships » Advanced Materials and Manufacturing Fellowships

ORISE Science and Technology Policy Fellowship

The Oak Ridge Institute for Science and Education (ORISE) Science, Technology and Policy (STP) Program provides opportunities for advanced degree graduates, postgraduates, established scientists, and faculty with a range of experience levels to apply their expertise to current and

Advanced Materials and Manufacturing Technologies Office Careers

Advanced Materials & Manufacturing Technologies Office » AMMTO Careers & Fellowships » Advanced Materials and Manufacturing Technologies Office Careers

Ready to Start Building Our Clean Energy Future?

The Department of Energy's (DOE) is dedicated to improving energy and material efficiency, productivity, and competitiveness of manufacturing. We invest in manufacturing innovation to accelerate and strengthen the clean economy, supporting the growth of a modern, equitable manufacturing industry.

If you are passionate about developing innovative solutions to address the most pressing challenges

[Fellowships](#)

[Sign up for up](#)

Let's Connect and Find Ways to Work Together!



- **Chris Saldaña & Diana Bauer**
 - Strategic collaborations, consortia/stakeholder engagement, interagency coordination
- **Kate Peretti – Secure & Sustainable Materials**
 - Circular economy, critical materials
- **Huijuan Dai – Next Generation Materials & Processes**
 - High performance materials (composites, metals, ceramics), additive manufacturing, smart manufacturing, high performance computing
- **Seema Somani – Energy Tech. Mfg. & Workforce**
 - Semiconductor manufacturing, power electronics, battery manufacturing, education and workforce development innovation, lab embedded entrepreneurship

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