Advanced Manufacturing at the US Department of Energy
Verification and Validation Symposium

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manufacturing.energy.gov

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Advanced Manufacturing – Opportunity

Technology Innovation through Applied Research and Development in Advanced Manufacturing is a Foundation for Economic Growth and Jobs in the US

Manufacturing Goods

More efficient manufacturing reduces energy losses.

More efficient manufacturing enables technologies that improve energy use throughout the economy:
- Transportation
- Buildings
- Energy Production and Delivery

Use of Manufactured Goods

Energy Losses

Transportation 27.1
Residential 21.5
Commercial 18.3
Non-Mfg 7.0

U.S. Energy Economy by Sector
98.3 Quadrillion Btu, 2014

24 QBTU (25% of National Total) – Manufacturing
2/3 Manufacturing Energy is in Intensive Sectors

$2T Manufacturing GDP
12.4M Manufacturing Direct Employment Jobs
0.8 / 1.0 – Indirect / Direct Jobs - All Manufacturing
2.2 / 1.0 – Indirect / Direct Jobs - Advanced Sub-Sectors
Current opportunities represent energy savings that could be achieved by deploying the most energy-efficient commercial technologies available worldwide. R&D opportunities represent potential savings that could be attained through successful deployment of applied R&D technologies under development worldwide. More info can be found at: https://www.energy.gov/eere/amo/energy-analysis-data-and-reports
AMO Vision and Mission

VISION: U.S. global leadership in sustainable and efficient manufacturing for a growing and competitive economy.

MISSION: Catalyze research, development and adoption of energy-related advanced manufacturing technologies and practices to drive U.S. economic competitiveness and energy productivity.

MULTI-YEAR PROGRAM PLAN:
- Describes the Office mission, vision, and goals
- Identifies the technology, outreach, and crosscutting activities the Office plans to focus on over the next five years.
AMO Multi-Year Program Plan (MYPP)
AMO Success Indicators

- Validate selected advanced manufacturing technologies and deploy practices that increase the rate of energy intensity improvement from business as usual (~1 % per year) to 2.5% per year.

- Advance materials and manufacturing technologies with the potential to reduce lifecycle energy by 50% by 2025 compared to the 2015 state-of-the-art.

- Establish partnerships resulting in 30,000 U.S. manufacturing facilities implementing AMO-recognized energy management products, practices and measures by 2025.

- Double supported technical education and training activities in advanced manufacturing made available for private entities, universities, community colleges, and high schools by 2025.
AMO: Three complementary strategies

R&D Projects: Bridging the innovation gap

Research and Development Projects to support innovative manufacturing processes and next-generation materials

R&D Consortia: Public-Private consortia model

R&D Consortia offer affordable access to physical and virtual tools, and expertise, to foster innovation and adoption of promising technologies

Technical Assistance: Direct engagement with Industry

Driving a culture of continuous improvement and wide scale adoption of proven technologies, such as CHP, to reduce energy use in the manufacturing sector
R&D Consortia: Consortia Model

Each Consortium has:

- Clear technology focus
- TRL level suited to specific technology challenge
- Shared user facilities
- Ability to address critical challenges
- A balanced portfolio of projects

Innovation that builds regional advanced manufacturing ecosystem
Development of advanced manufacturing workforce in key technology areas
Accelerated RD&D and commercialization of new technology products in the U.S.
R&D Goals

- Improved Performance Characteristics of AM Components Through Materials-Process Development
- Qualification and Certification Framework for AM Components
- AM Systems Optimized to Achieve Mainstream Manufacturing
- Comprehensive Understanding of AM Process Capabilities and Limits Through Physics-Based Simulation and Advanced Characterization
Manufacturing USA Institutes

Participating members in Manufacturing USA Institutes

- **Digital Manufacturing & Design**
  - Manchester, NH
  - DMDII

- **Sustainable Manufacturing**
  - Rochester, NY
  - REMADE Institute

- **Integrated Photonics**
  - Albany, NY
  - AIM Photonics

- **Regenerative Manufacturing**
  - Manchester, NH
  - armi

- **Advanced Fibers and Textiles**
  - Cambridge, MA
  - affera

- **Modular Chemical Process Intensification**
  - New York, NY
  - RAPID

- **Smart Manufacturing**
  - Los Angeles, CA
  - SMART manufacturing Europe

- **Lightweight Metals**
  - Detroit, MI
  - Lift

- **Additive Manufacturing**
  - Youngstown, OH
  - America Makes

- **Advanced Composites**
  - Knoxville, TN
  - IACMI

- **Advanced Robotics**
  - Pittsburgh, PA
  - AIM

- **Wide Bandgap Semiconductors**
  - Raleigh, NC
  - PowerAmerica

- **Bio-pharmaceutical Manufacturing**
  - Newark, DE
  - NIIMBL
PowerAmerica: Wide-Bandgap Power Electronics

**Launched:** December 2014  
**Hub Location:** Raleigh, NC  
**Lead:** North Carolina State University  
**Current Number of Members:** 34  
**Federal Funding:** $70 Million  
**Cost share:** $70 Million

**FOCUS AREAS**

- Enable Wide-Bandgap (WBG) Power Semiconductor Foundries in the U.S.
- Establish supply chain from WBG semiconductor die and package to power electronic assemblies and applications
- Enable advanced WBG Power Electronic Applications
- Train U.S. workforce to ensure technical leadership and to create manufacturing jobs

**Goals**

- Provide Energy Savings through higher voltage, speed and temperature capabilities of WBG power semiconductors:
- Achieve comparable cost of WBG power devices (SiC and GaN) compared to Silicon within 5 years
- Reduce volume and weight by 50% for targeted power electronics systems compared to Silicon equivalents
- Enable grid-scale power electronics for resiliency
IACMI: Carbon-Fiber Composites

**Goals**

- 25% reduction in production costs
- 50% reduction in embodied energy for carbon fiber-reinforced polymers (CFRP)
- Production of fiber-reinforced polymers (FRP) with:
  - Cost and embodied energy parity with current glass fiber-reinforced polymers
  - Performance parity with currently available CFRP
  - Relevant production speeds for the target market
- Validate technologies for at least 80% recyclability

**TECHNICAL AREAS**

- WIND ENERGY
- VEHICLES
- COMPRESSED GAS STORAGE

**CROSS-CUTTING AREAS**

- MATERIALS & PROCESSING
- MODELING & SIMULATION

**Launched:** January 2015  
**Hub Location:** Knoxville, TN  
**Lead:** Collaborative Composites Solutions  
**Current Number of Members:** 177  
**Federal Funding:** $70 Million  
**Cost share:** $95 Million
CESMII: Smart Manufacturing

**Goals**

- 15% improvement in energy efficiency in first-of-a-kind demonstrations
- 50% reduction in cost and time to deploy SM in existing processes
- 25% improvement in energy productivity

**Launched:** December 2016  
**Hub Location:** Los Angeles, CA  
**Lead:** UCLA  
**Current Number of Members:** 102  
**Federal Funding:** $70 Million  
**Cost share:** $70 Million

**TECHNICAL FOCUS AREAS**

- Business Practices
- Enabling Technologies
- Workforce Development
- SM Platform Infrastructure
RAPID: Chemical Process Intensification

Goals

MCPI = Modular Chemical Process Intensification

- MCPI with >20% energy efficiency
- Reduce the cost of deploying MCPI in existing processes by 50%
- 10x reduced capacity cost
- Establish comprehensive Body of Knowledge for MCPI

TECHNICAL FOCUS AREAS

- Intensified Process Fundamentals
- Modeling & Simulation
- Module Manufacturing
- Chemical & Commodity Processing
- Natural Gas Upgrading
- Renewable Bioproducts

Launched: March 2017
Hub Location: New York, NY
Lead: American Institute of Chemical Engineers
Current Number of Members: 76
Federal Funding: $70 Million
Cost share: $84 Million
REMADE: Recycling and Remanufacturing

Goals
25% improvement in embodied energy efficiency
Secondary feedstocks at cost parity with primary feedstocks
10x reduction in primary material feedstock and 20% reduction in associated GHG emissions
30% decrease in the energy required to process secondary feedstocks

TECHNICAL FOCUS AREAS

- Systems Analysis & Integration
- Design for Re-X
- Manufacturing Materials Optimization
- Remanufacturing & End-of-life Reuse
- Recycling & Recovery
Clean Energy Manufacturing Institute: Cybersecurity in Energy Efficient Manufacturing Funding Opportunity Announcement

FOA Released: March 26, 2019  
Federal Funding: $70M (pending appropriations)  
Cost share: 20%  
Concept Papers Due: 5/15  
Full Applications Due: 8/20  
Led by the Advanced Manufacturing Office (AMO) in partnership with the Office of Cybersecurity, Energy Security and Emergency Response (CESER)

A critical path to improving energy efficiency for manufacturing is increased automation and integration across the supply chain.

• Topic 1. Securing Automation innovations:  
  – Enabling greater energy efficiency  
  – Vulnerabilities in automated control systems  
  – Securing communication for smart and digital manufacturing  
  – Computing architectures and hardware customized for cybersecurity  
  – Identification, alerting and mitigating threats  
  – Communicating threats across industry

• Topic 2. Securing the Supply Chain Network innovations:  
  – Security for agile supply chain networks  
  – Standardization of protocols leading to greater energy efficiency  
  – Secure asset and energy management  
  – Prescriptive data analytics for security threats  
  – Security related network efficiency

Manufacturing Innovation Institutes are designed to bring together a wide range of private and public stakeholders to accelerate innovation in industry-relevant technologies, provide education and training for the American workforce, and transition to a privately funded model.

• Link: https://eere-exchange.energy.gov/#Foalddfdeec54-a32a-4113-bd78-04aa84185034
Critical Materials Institute

Eliminate materials criticality as an impediment to the commercialization of clean energy technologies for today and tomorrow.

- Focused on advancing cost-effective separation, processing, and substitution of critical materials, to support U.S.-based supply chains for high-value add technologies that rely on these materials (magnets, aerospace components, lasers, etc.).
- In its first 5 years the CMI has filed 75+ invention disclosures, filed 40+ patent applications, and licensed 9 technologies to industry.
Energy-Water Desalination Hub – update to similar format as cyber institute

• Status: Application window closed May 7th, 2019
• Up to $120M pending appropriations
• Establishes AMO’s second Energy Innovation Hub
• Focused on desalination technologies that reduce the energy and cost requirements of providing clean and safe water.

AMO: Three complementary strategies

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**Technical Assistance: Direct engagement with Industry**

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Combined Heat & Power (CHP) Program

Provides a cost-effective, near-term opportunity to improve our nation's energy, environmental, and economic future

Research and Development

– R&D to further the utilization of cost-effective, highly efficient CHP to provide support to the electric grid
  • Area of Interest 1 – Power Electronics and Control Systems
  • Area of Interest 2 – Electricity Generation Components

Market Analysis and Tracking

– Supporting analyses of CHP market opportunities in diverse markets including industrial, federal, institutional, and commercial sectors

CHP Technical Assistance Partnerships (CHP TAPs)

– Promote and assist in transforming the market for CHP, waste heat to power, and district energy technologies/concepts throughout the United States

To learn more, visit www.betterbuildingssolutioncenter.energy.gov/chp
Better Plants Partnership

- What is Better Plants? A voluntary, public-private partnership program for manufacturers and industrial organizations

- Through Better Plants:
  - Partners set long-term strategic energy intensity reduction goals

- Manufacturers have two opportunities to engage in Better Plants:
  1. Broader-based *Program* level
  2. Higher-level *Challenge*

207 partners representing 3,100+ plants
$5.3B in cumulative energy cost savings
Over 1 Quadrillion TBtu saved
53 total goal achievers, including 10 this year
Technical Partnerships: 50001: Increased Energy Performance

DOE field validated the energy savings potential of ISO 50001

- Findings of ISO 500001 ~4.5%/year
- 3M & Schneider-Electric showed a 2x improvement vs. internal BAU

“ISO 50001 is a standard that drives results directly to the bottom line. ISO 50001 systematically drives down energy costs and improves competitiveness through the assignment of responsibilities and raising the visibility of energy management within the organization.”
—Andrew Hejnar, 3M
Industrial Assessment Centers

No-cost energy audits provided by DOE’s IACs.

IACs are university-based centers, led by professors and staffed by engineering students.

Students gain unique, hands-on assessment training and gain knowledge of industrial systems.

Typical audit uncovers savings equal to about 8% of plant-wide energy consumption.

The IAC program has conducted over 17,582 assessments.
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FY18/FY19 Lab Call

- Over $127M in FY 18 and FY19 funding to support 33 projects across the National Lab network
- Topics include Harsh Environment Materials, Wide Band Gap Semiconductors, Combined Heat and Power, Additive Manufacturing, and more*

* Topics mapped to AMO’s MYPP and congressional direction
HPC4Mfg program

Bringing the many benefits of high-performance computing to US industry

- Accelerate innovation
- Lower energy costs
- Reduce testing cycles
- Reduce waste/reduce rejected parts
- Quality processes and Pre-qualify
- Optimize design
- Shorten the time to market
Lab-Embedded Entrepreneurship Programs
Recently Announced Multi-Topic FOA

FOA Released: May 7th, 2019
Federal Funding: $89M
Cost share: 20%
Concept Papers Due: 6/20
Full Applications Due: 8/29
Led by the Advanced Manufacturing Office (AMO)

Supports in innovative, early-stage advanced manufacturing applied R&D projects that focus on specific high-impact manufacturing technology, materials, and process challenges. The topics are aimed at foundational energy-related advanced manufacturing technologies that impact areas relevant to manufacturing processes and broadly applicable platform technologies.

• Link: https://eere-exchange.energy.gov/Default.aspx#Foaldeaf73ef3-8146-47bd-9f99-a5d7af08a6b6

• Topic 1. Advanced Materials
  – Advanced Energy Conversion and Storage Materials
  – Innovative Manufacturing Processes for Battery Energy Storage
  – Materials and Manufacturing for Nanocrystalline Metal Alloys
  – Harsh Service Conditions

• Topic 2. Low Thermal Budget Processes
  – Advanced Drying Technologies
  – Thermal Process Intensification

• Topic 3. Connected & Flexible Manufacturing and Energy Systems
  – Medium-Voltage Power Conditioning Systems to Enable Grid-Dispatchable and Resilient Manufacturing Facilities
  – High Efficiency Combined Heat and Power
  – Validation of CHP and District Energy Systems
Thank You

For additional information:
energy.gov/eere/amo/advanced-manufacturing-office