



U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



Sustainable Manufacturing: Advanced Manufacturing & Clean Energy Manufacturing

August 20, 2015

National Science Foundation Workshop
Arlington, VA

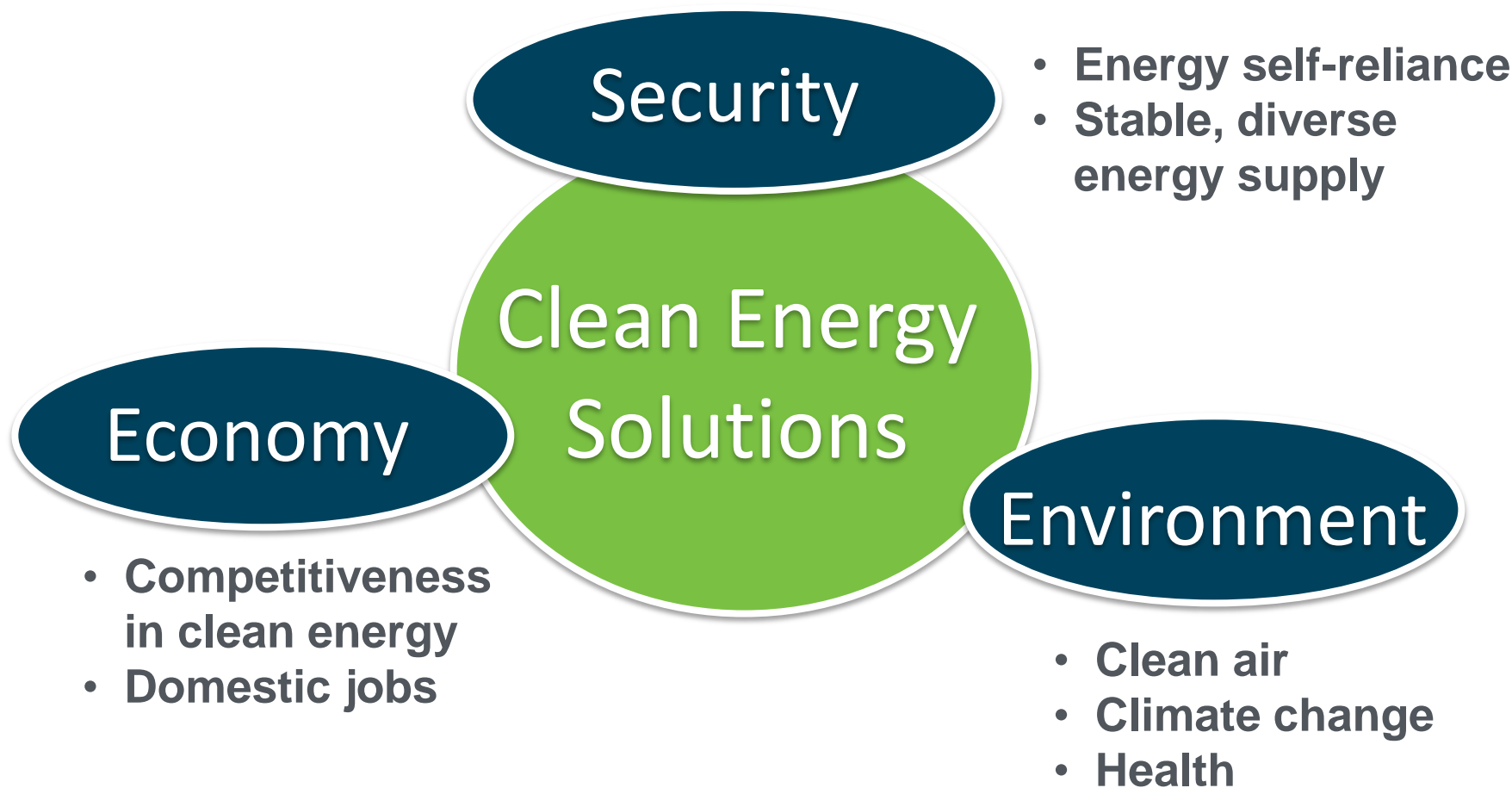
Mark Johnson

Director

Advanced Manufacturing Office

www.manufacturing.energy.gov

Clean Energy and Manufacturing: Nexus of Opportunities



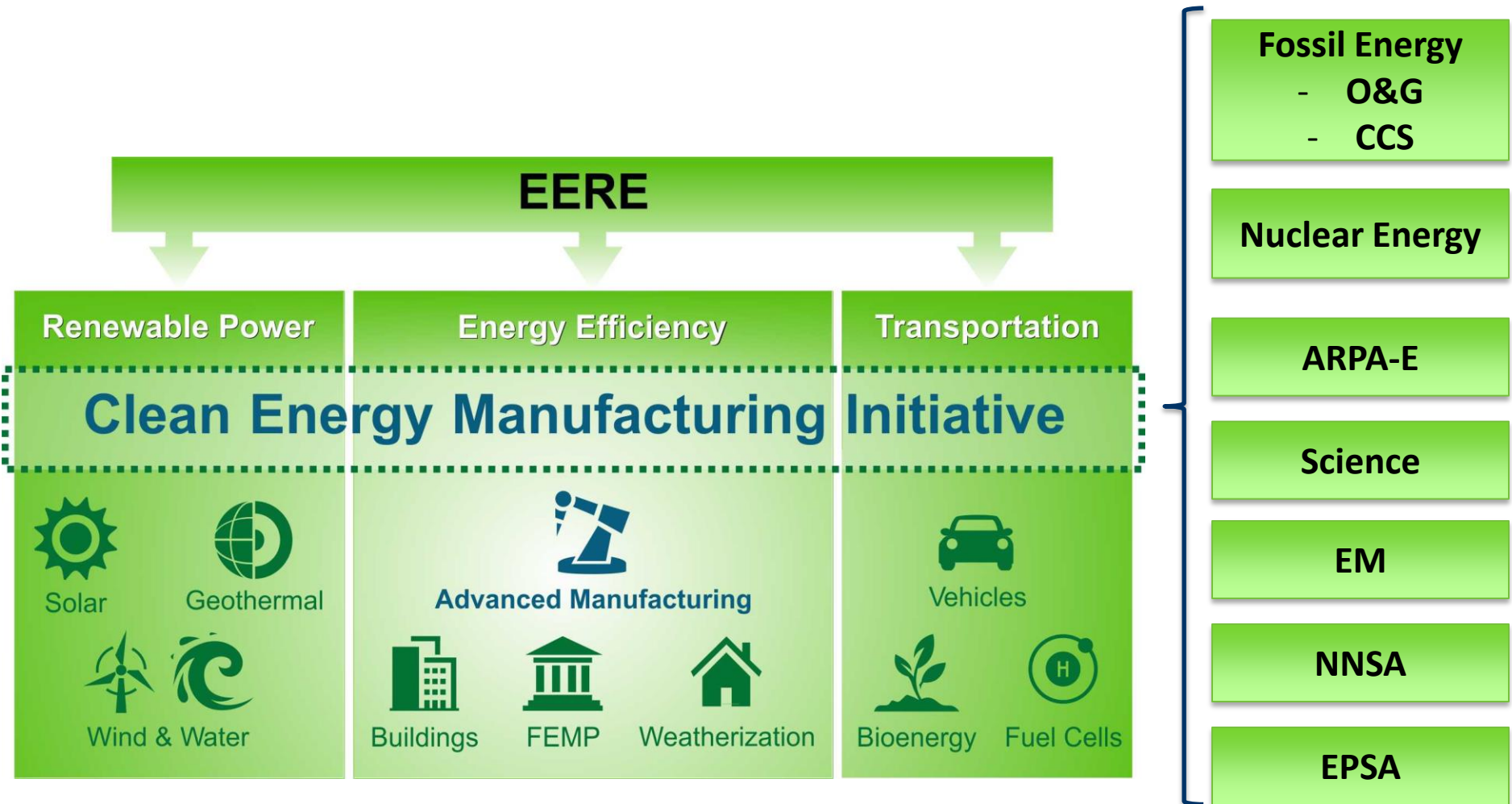
Clean Energy Manufacturing

Making Products which Reduce Impact on Environment

Advanced Manufacturing

Making Products with Technology as Competitive Difference

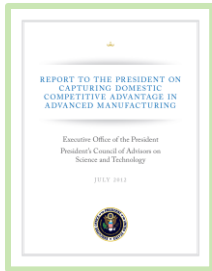
Clean Energy Manufacturing Initiative – Across DOE



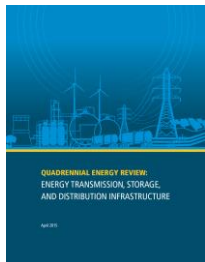
Advanced Manufacturing – Strategic Inputs



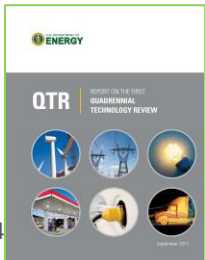
Climate Action Plan (EOP / CEQ / OSTP 2014)



Advanced Manufacturing Partnership (AMP2.0) (NEC / PCAST / OSTP 2014)



Quadrennial Energy Review (DOE / EPSA 2015)



Quadrennial Technology Review (DOE / Science and Technology 2015)

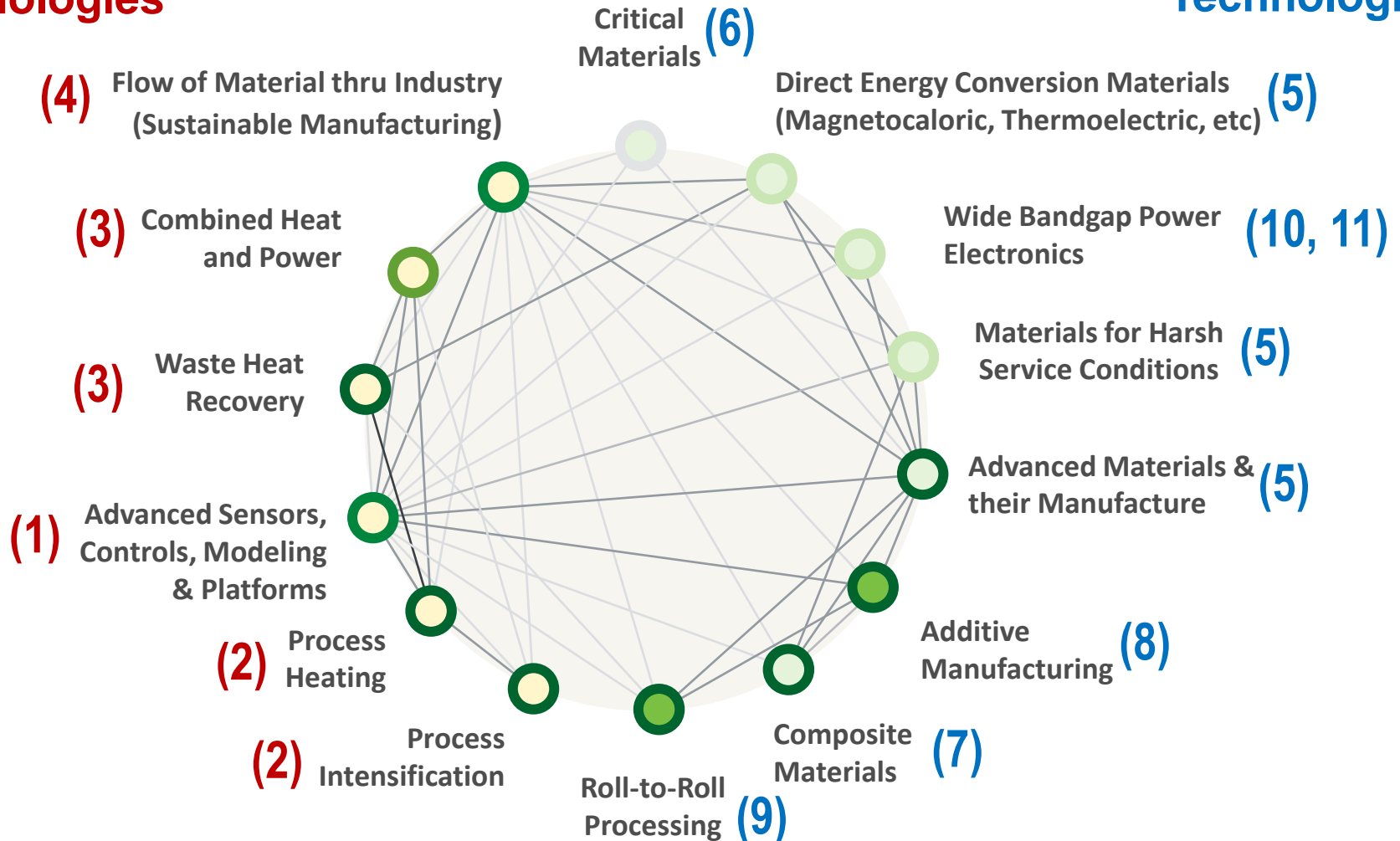
1) Broadly Applicable
Efficiency Technologies for
Energy Intensive and Energy
Dependent Manufacturing

2) Platform Materials &
Processes Technologies for
Manufacturing Clean Energy
Technologies

DOE QTR: Manufacturing Technology

Efficiency Technologies

Enabling Platform Technologies



Information & Data

Processes

Materials

Energy & Resource
Management

Advanced Manufacturing
Processes

Materials Development

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Advanced Manufacturing Topical Priorities

Efficiency Technologies for Manufacturing Processes (Energy, CO₂)

- (1) Advanced Sensors, Controls, Modeling and Platforms (HPC, Smart Manf.)
- (2) Advanced Process Intensification
- (3) Grid Integration of Manufacturing (CHP and DR)
- (4) Sustainable Manufacturing (Water-Energy, New Fuels & Feedstocks)

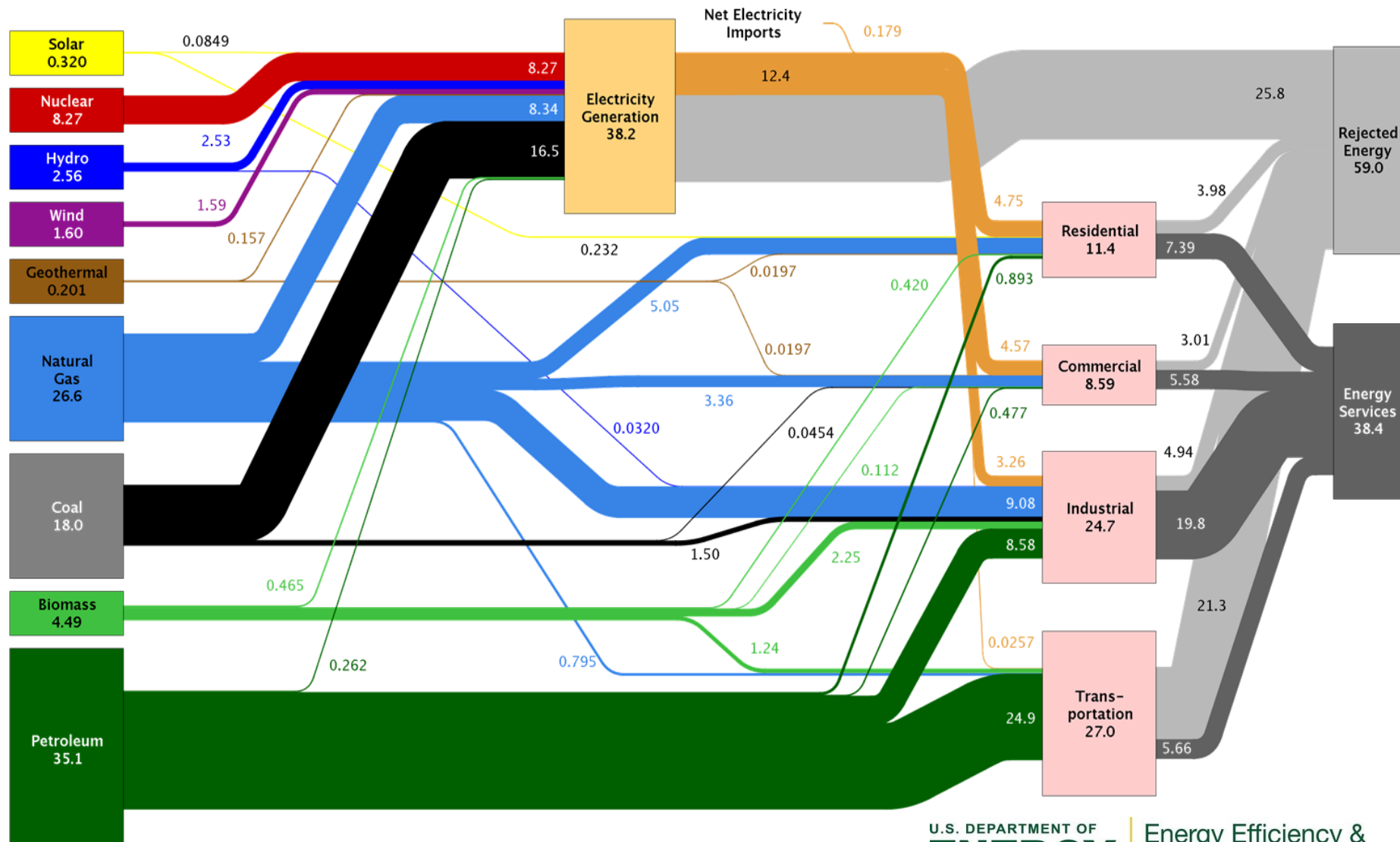
Platform Materials & Technologies for Clean Energy Applications

- (5) Advanced Materials Manufacturing
(incl: Extreme Mat'l., Conversion Mat'l., etc.)
- (6) Critical Materials
- (7) Advanced Composites & Lightweight Materials
- (8) 3D Printing / Additive Manufacturing
- (9) 2D Manufacturing / Roll-to-Roll Processes
- (10) Wide Bandgap Power Electronics
- (11) Next Generation Electric Machines (NGEM)

QTR Manufacturing Focus Areas Mapped to Advanced Manufacturing Topical Areas for Technology Development

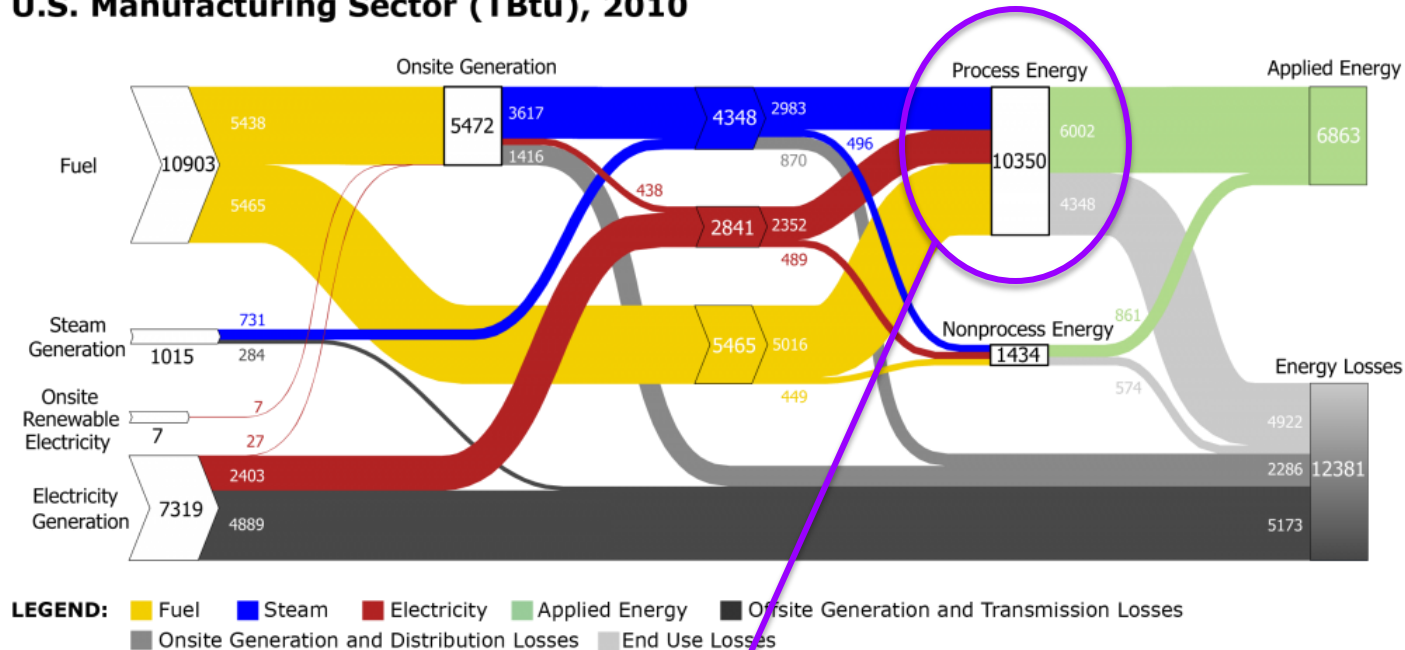
Energy Consumption by Sector

Estimated U.S. Energy Use in 2013: ~97.4 Quads

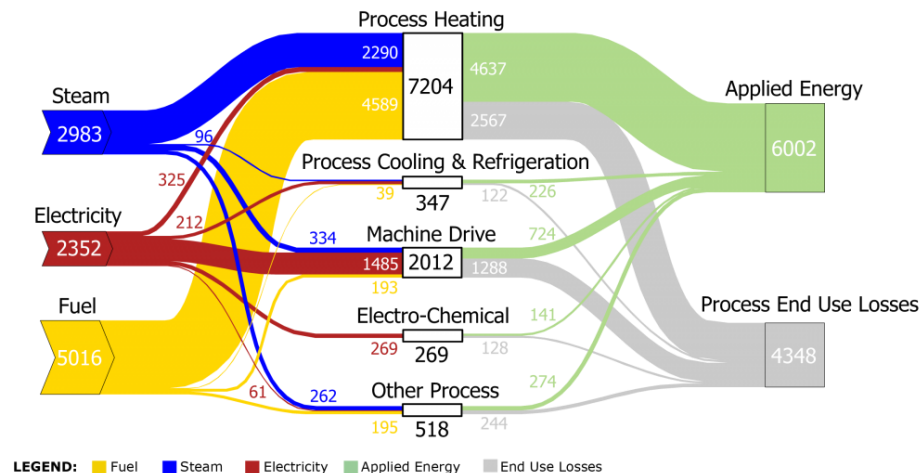


Energy Use in the Manufacturing Sector

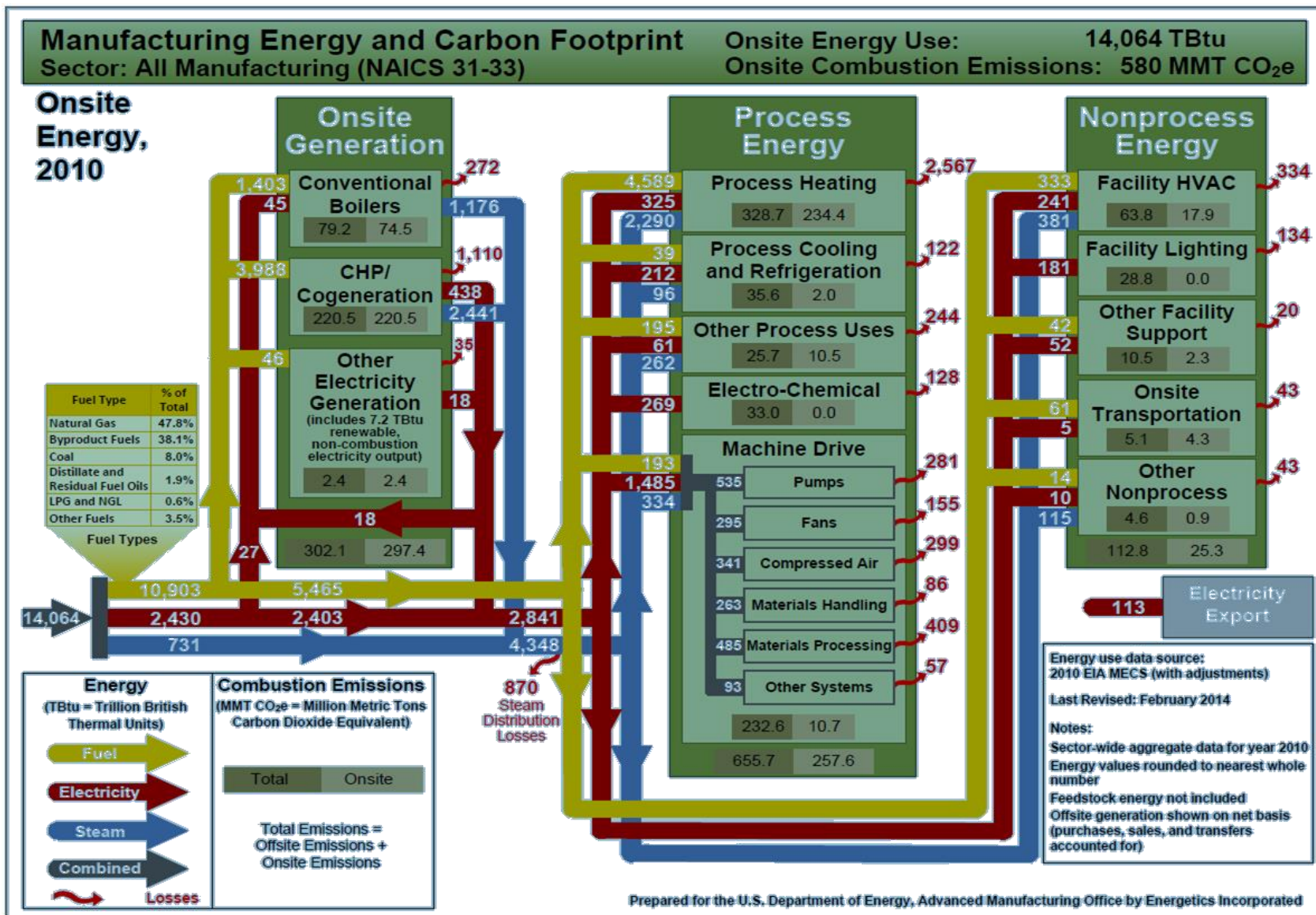
U.S. Manufacturing Sector (TBtu), 2010



Process Energy (TBtu), 2010



Deeper Look at Energy in Manufacturing



Energy Intensive Industries

Primary Metals

1608 TBTU



Petroleum Refining

6137 TBTU



Chemicals

4995 TBTU



Wood Pulp & Paper

2109 TBTU



Glass & Cement

716 TBTU



Food Processing

1162 TBTU



Processes for Clean Energy Materials & Technologies

Energy Dependence: Energy Cost Considered in Competitive Manufacturing

Solar PV Cell



Carbon Fibers



Light Emitting Diodes



Electro-Chromic Coatings



Membranes



EV Batteries

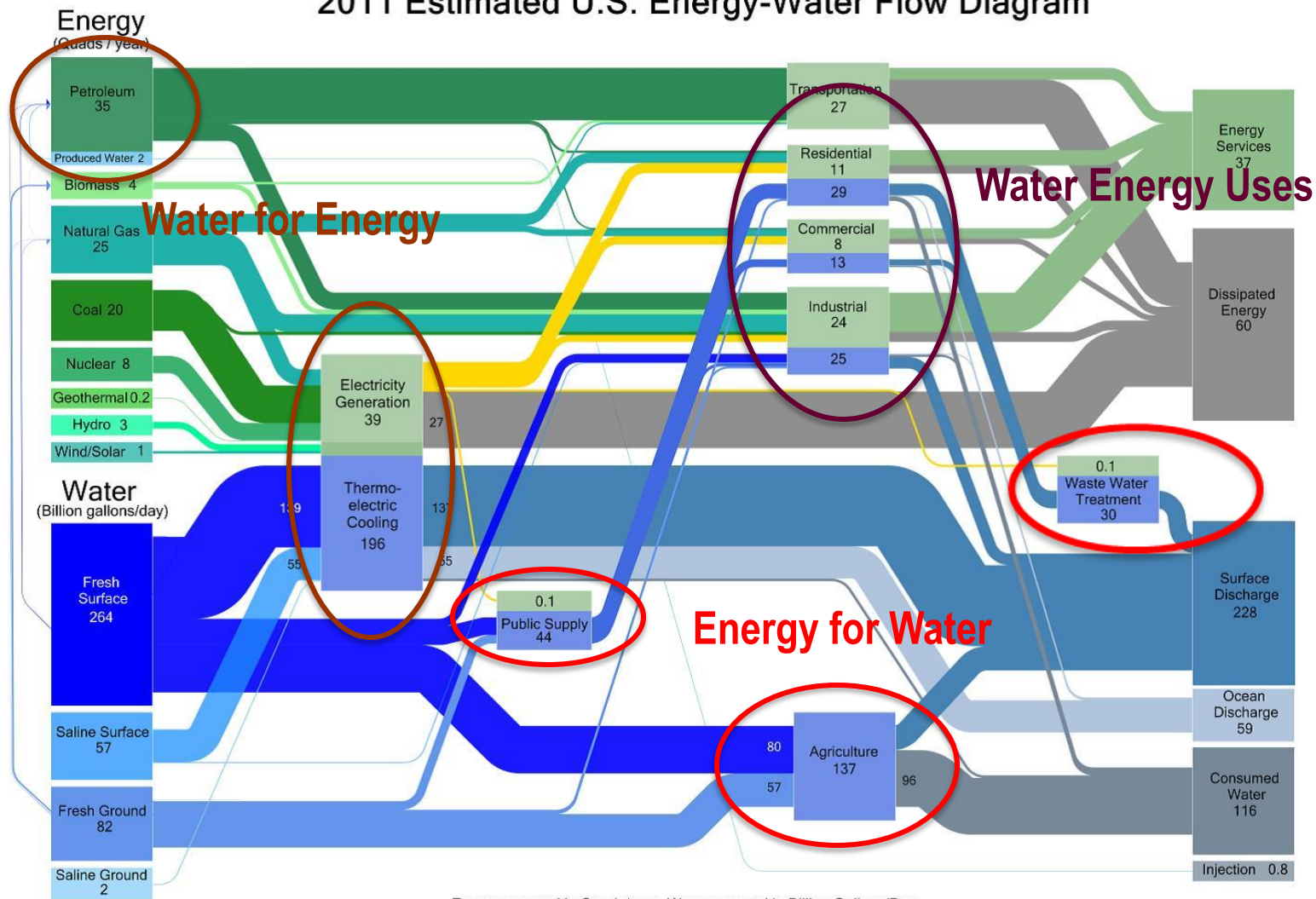


Multi-Material Joining






















Water and Energy in Sustainable Manufacturing

2011 Estimated U.S. Energy-Water Flow Diagram



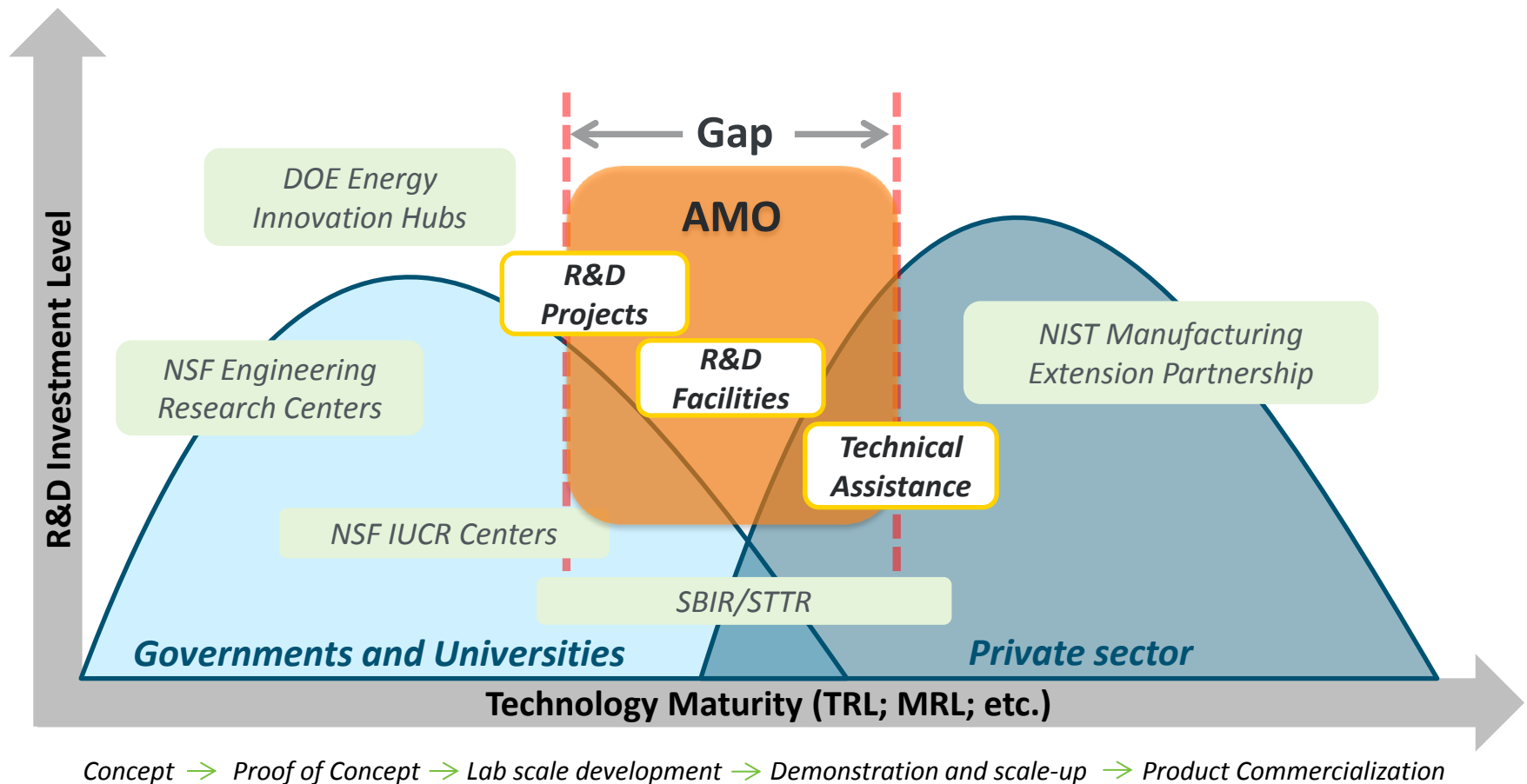
Energy reported in Quads/year. Water reported in Billion Gallons/Day.

Possible Impact Areas of Cross-Cutting Technology for Energy Intensive Industry Sectors

		Chemicals & Bio- chemicals	Petroleum Refining	Primary Metals	Forest & Food Products	Clean Water
SMART Manufacturing						
Process Intensification						
CHP & Grid Integration						
Sustainable Manufacturing						

Bridging the Gap to Manufacturing

AMO: Advanced Manufacturing Office



Modalities of Support

Technology Assistance: (Dissemination of Knowledge)

Better Plants, ISO-50001 / SEP, Industrial Assessment Centers, Combined Heat and Power Tech Assistance Centers, Energy Management Tools & Training

Technology Development Facilities: (Innovation Consortia)

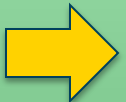
Critical Materials Hub, Manufacturing Demonstration Facility (Additive), Power America NNMI, IACMI NNMI, CyclotronRoad, HPC4Manufacturing

Technology Development Projects: (Individual R&D Projects)

Individual Projects Spanning AMO R&D Space - University, Small Business, Large Business and National Labs. Each a Project Partnership (Cooperative Agreement).

AMO Elements

Three partnership-based approaches to engage industry, academia, national labs, and state & local government:

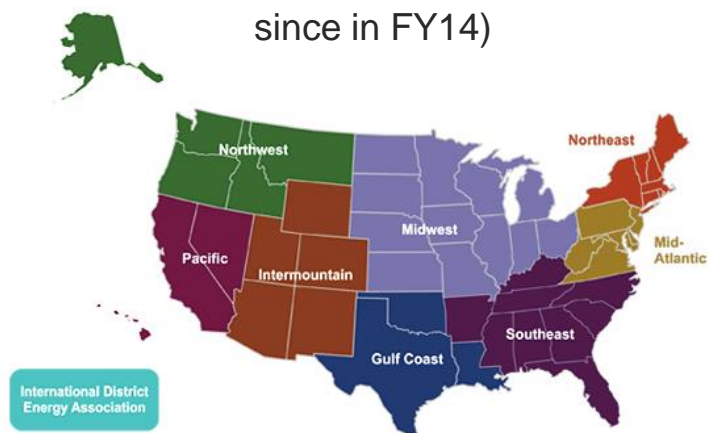
- 
- 1. Technical Assistance** – driving a corporate culture of continuous improvement and wide scale adoption of proven technologies, such as CHP, to reduce energy use in the industrial sector
 - 2. Research and Development Projects**
 - 3. Shared R&D Facilities**

Industrial Technical Assistance

Efficient On-Site Energy

Clean Energy Application Centers

(to be called Technical Assistance Partnerships
since in FY14)



Simplot
Bringing Earth's Resources to Life

SAINT-GOBAIN

NISSAN

legrand®



3M

Schneider Electric



Johnson Controls

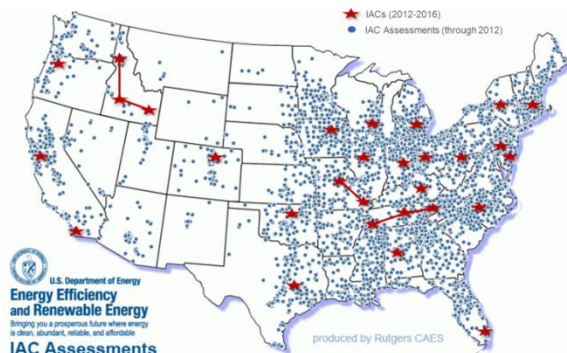


Energy-Saving Partnership

Better Buildings, Better Plants,
Industrial Strategic Energy Management

Student Training & Energy Assessments

University-based Industrial
Assessment Centers



Better Plants
U.S. DEPARTMENT OF ENERGY

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

AMO Elements

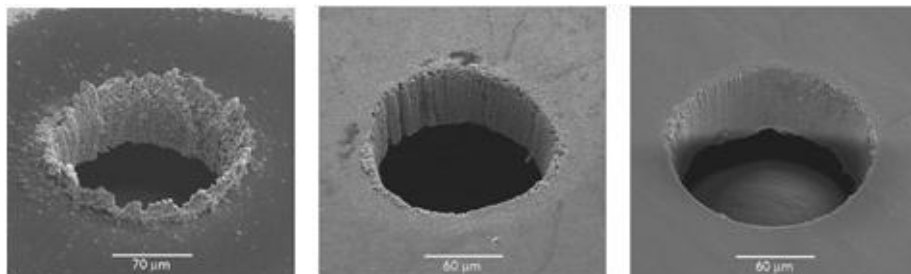
Three partnership-based approaches to engage industry, academia, national labs, and state & local government:

1. Technical Assistance

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

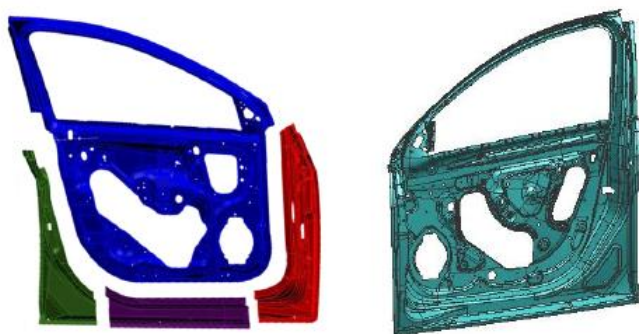
3. Shared R&D Facilities

R&D Projects: Manufacturing Processes



Ultrafast, femtosecond pulse lasers (right) will eliminate machining defects in fuel injectors.

Image courtesy of Raydiance.

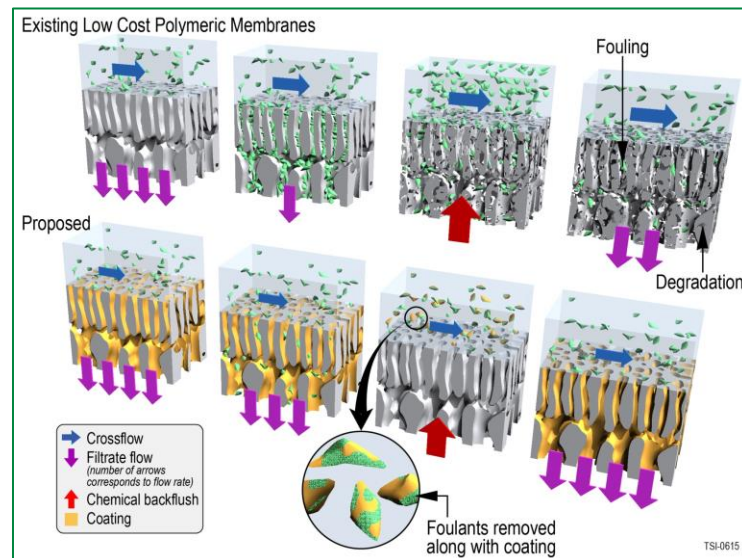


Energy-efficient large thin-walled magnesium die casting, for 60% lighter car doors.

Graphic image provided by General Motors.

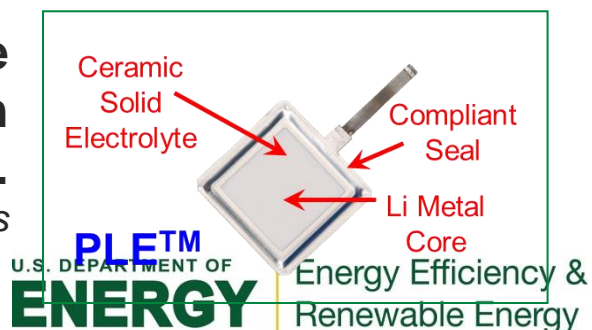
A water-stable protected lithium electrode.

Courtesy of PolyPlus



Protective coating materials for high-performance membranes, for pulp and paper industry.

Image courtesy of TeledyneE




AMO Elements

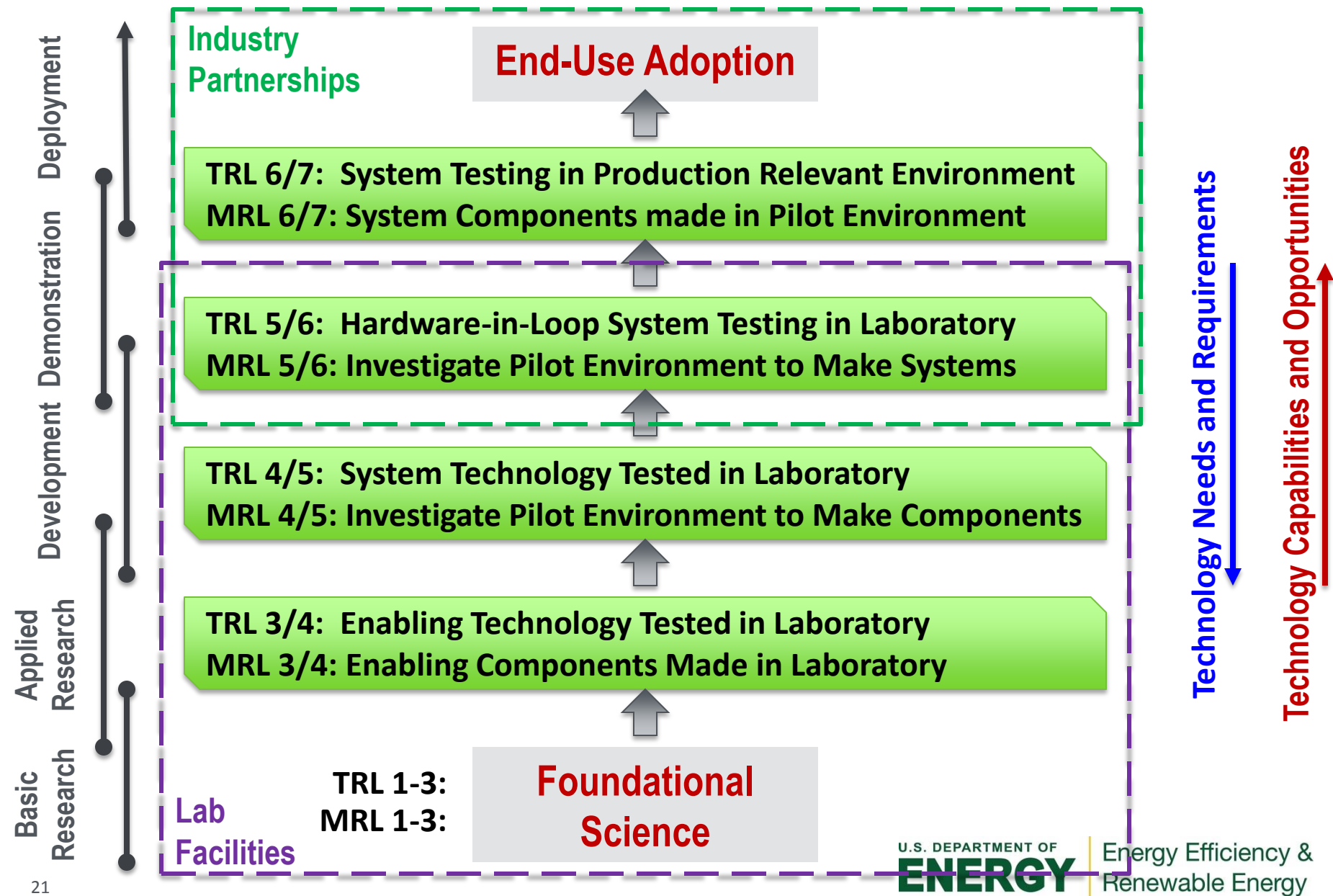
Three partnership-based approaches to engage industry, academia, national labs, and state & local government:

1. Technical Assistance

2. Research and Development Projects

 3. **Shared R&D Facilities** - affordable access to physical and virtual tools, and expertise, to foster innovation and adoption of promising technologies

Manufacturing Technology Maturation





Accelerating
Energy
Innovations

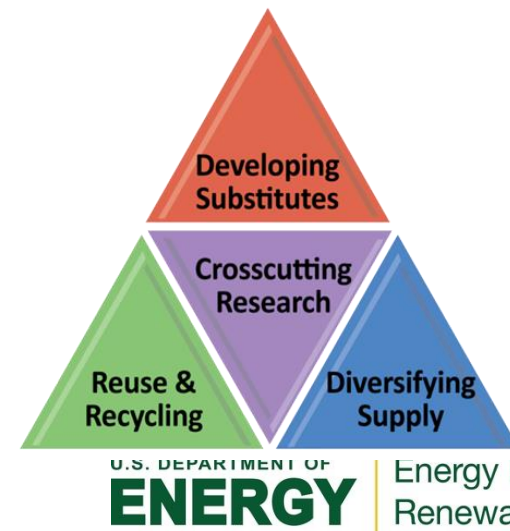
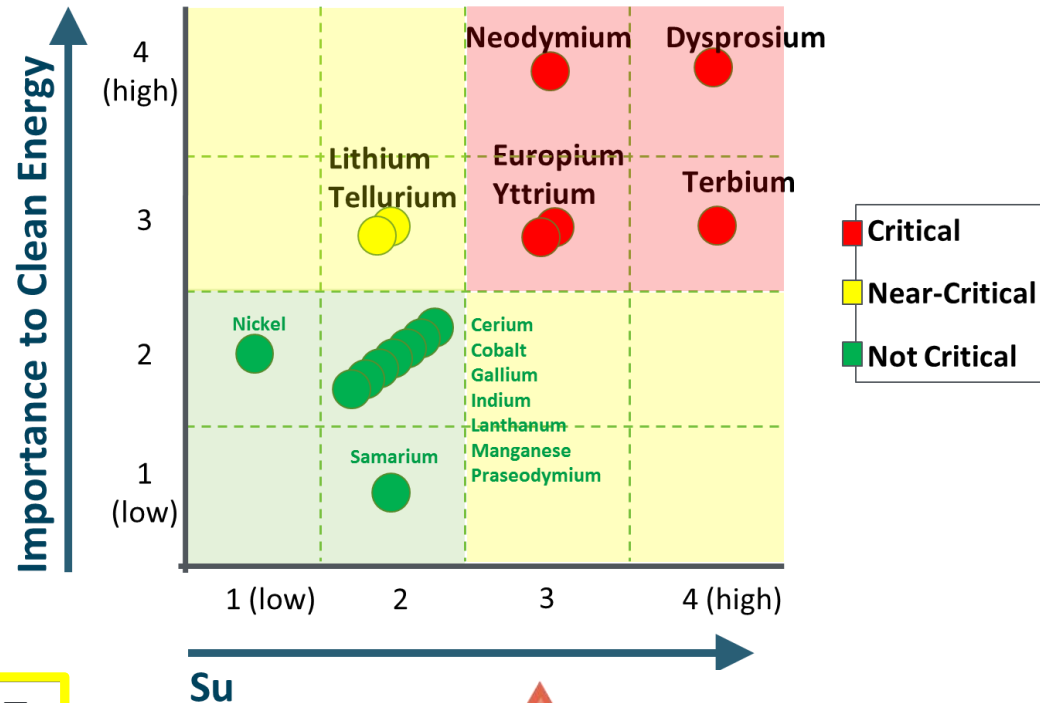
Critical Materials Institute

A DOE Energy Innovation Hub

- Consortium of 7 companies, 6 universities, and 4 national laboratories
- Led by Ames National Laboratory

	Dy	Eu	Nd	Tb	Y	Li	Te
Lighting		✓		✓	✓		
Vehicles	✓		✓			✓	
Solar PV							✓
Wind	✓		✓				

Critical Materials - as defined by U.S. Department of Energy, [Critical Materials Strategy](#), 2011.



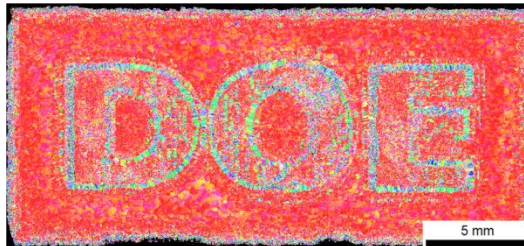
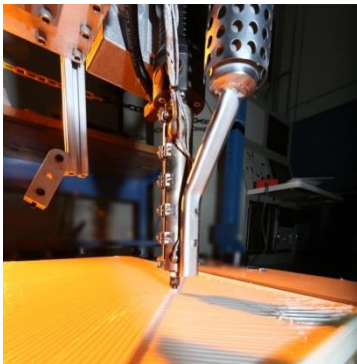
Manufacturing Demonstration Facility

Supercomputing
Capabilities

Spallation Neutron
Source



America Makes



Additive Manufacturing

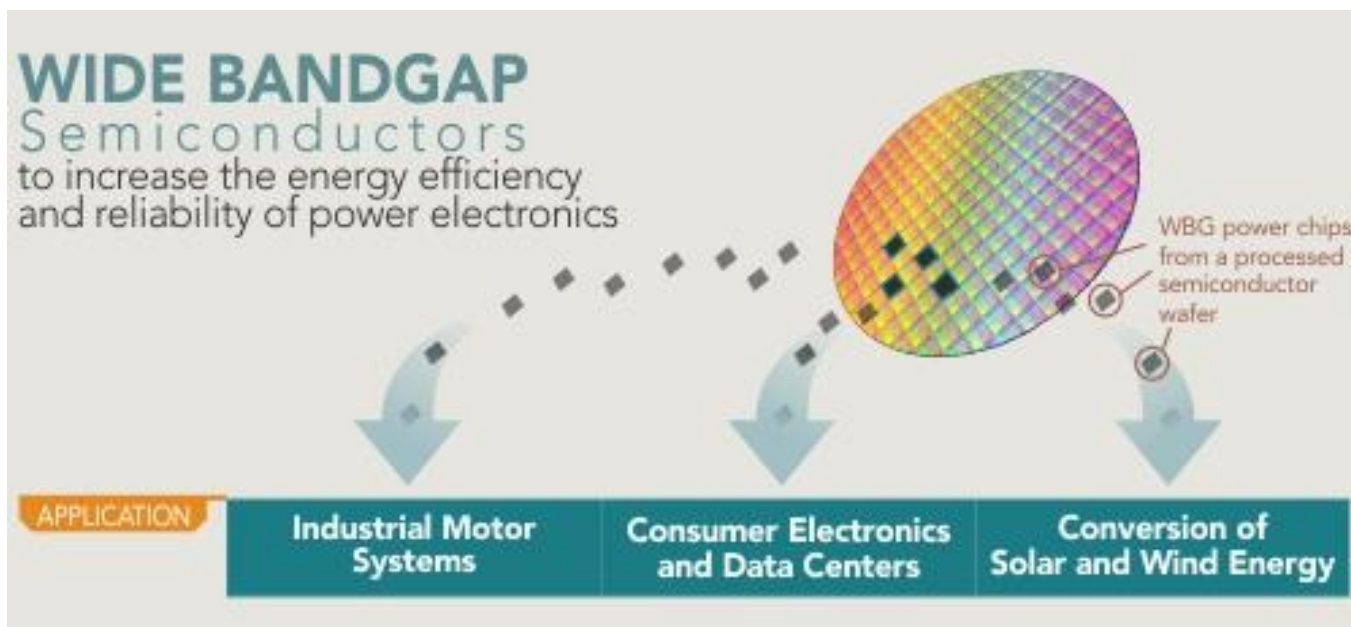


Arcam electron beam
processing AM equipment



POM laser processing AM
equipment

Program goal is to accelerate the manufacturing capability of a multitude of AM technologies utilizing various materials from metals to polymers to composites.



Institute Mission:
Develop advanced manufacturing processes that will enable large-scale production of wide bandgap semiconductors

- Higher temps, voltages, frequency, and power loads (compared to Silicon)
- Smaller, lighter, faster, and more reliable power electronic components
- \$3.3 B market opportunity by 2020.¹
- Opportunity to maintain U.S. technological lead in WBG

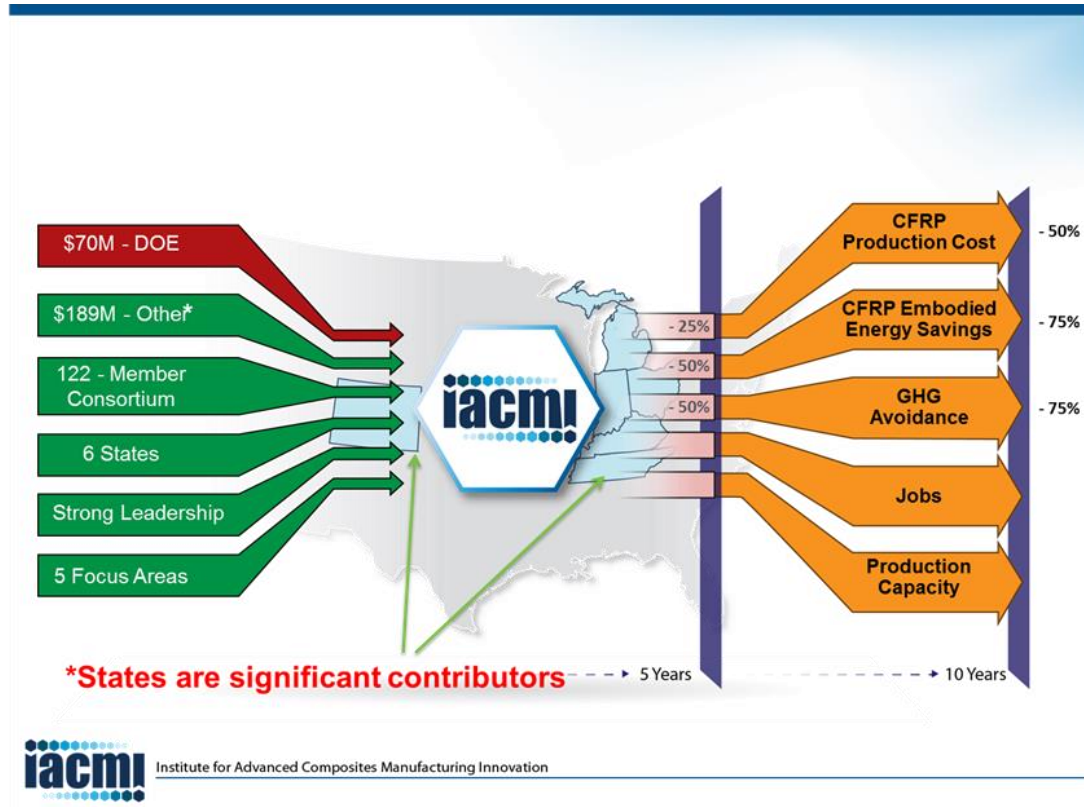
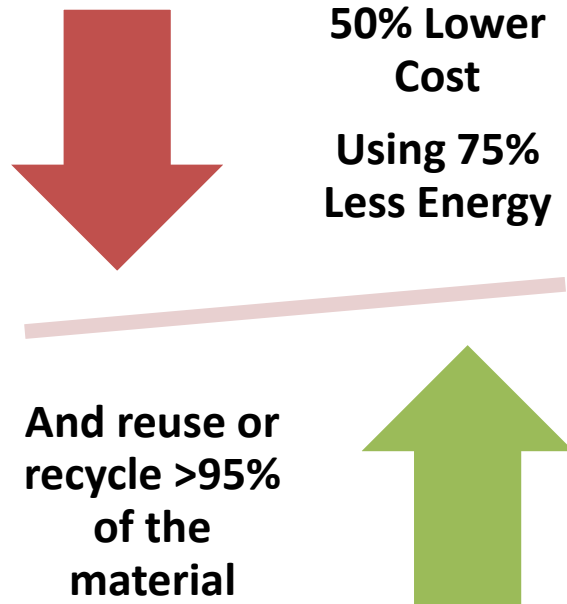
Poised to revolutionize the energy efficiency of electric power control and conversion

¹ Lux Research, 2012.

Institute for Advanced Composite Materials Innovation (IACMI)

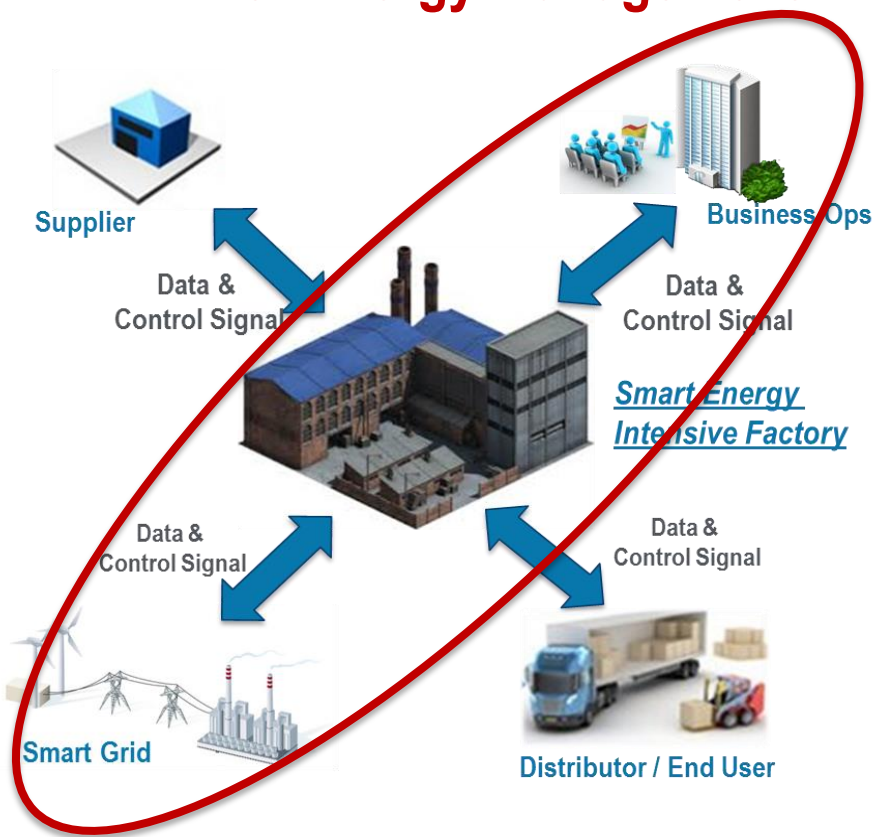
Objective

Develop and demonstrate innovative technologies that will, within 10 years, make advanced fiber-reinforced polymer composites at...



SMART Manufacturing: Advanced Controls, Sensors, Models & Platforms for Energy Applications

Focus on Real-Time For Energy Management



- Encompass machine-to-plant-to-enterprise real time sensing, instrumentation, monitoring, control, and optimization of energy
- Enable hardware, protocols and models for advanced industrial automation: requires a holistic view of data, information and models in manufacturing
- Leverage High Performance Computing for High Fidelity Process Models
- Significantly reduce energy consumption and GHG emissions & improve operating efficiency – **20% to 30% potential**
- Increase productivity and competitiveness across all manufacturing sectors:
Special Focus on Energy Intensive & Energy Dependent Manufacturing Processes

Leverages AMP 2.0

Areas for Public Engagement

- Advanced Materials Manufacturing: Materials in Extreme Conditions
- Process Intensification (Chemical)
- Process Intensification (Thermal)
- Roll-to-Roll Processing
- Sustainable Materials and Water in Manufacturing

What does Success Look Like?

**Energy Products
Invented Here...**



**...And Competitively
Made Here!**

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

Thank You

Questions?