U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

Enabling Materials and Processes for Clean Energy and Electric Power

August 26, 2015

OE / DOE Workshop on Materials for Grid

Oak Ridge, TN

Mark Johnson

Director

Advanced Manufacturing Office

www.manufacturing.energy.gov

Clean Energy and Manufacturing: Nexus of Opportunities

- **Energy self-reliance**
- **Stable, diverse energy supply**

- **Competitiveness in clean energy**
- **Domestic jobs**

- **Clean air**
- **Climate change**
- **Health**

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

- Fossil Energy
  - O&G
  - CCS
- Nuclear Energy
- Electricity
- ARPA-E
- Science
- EM
- NNSA
- EPSA

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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

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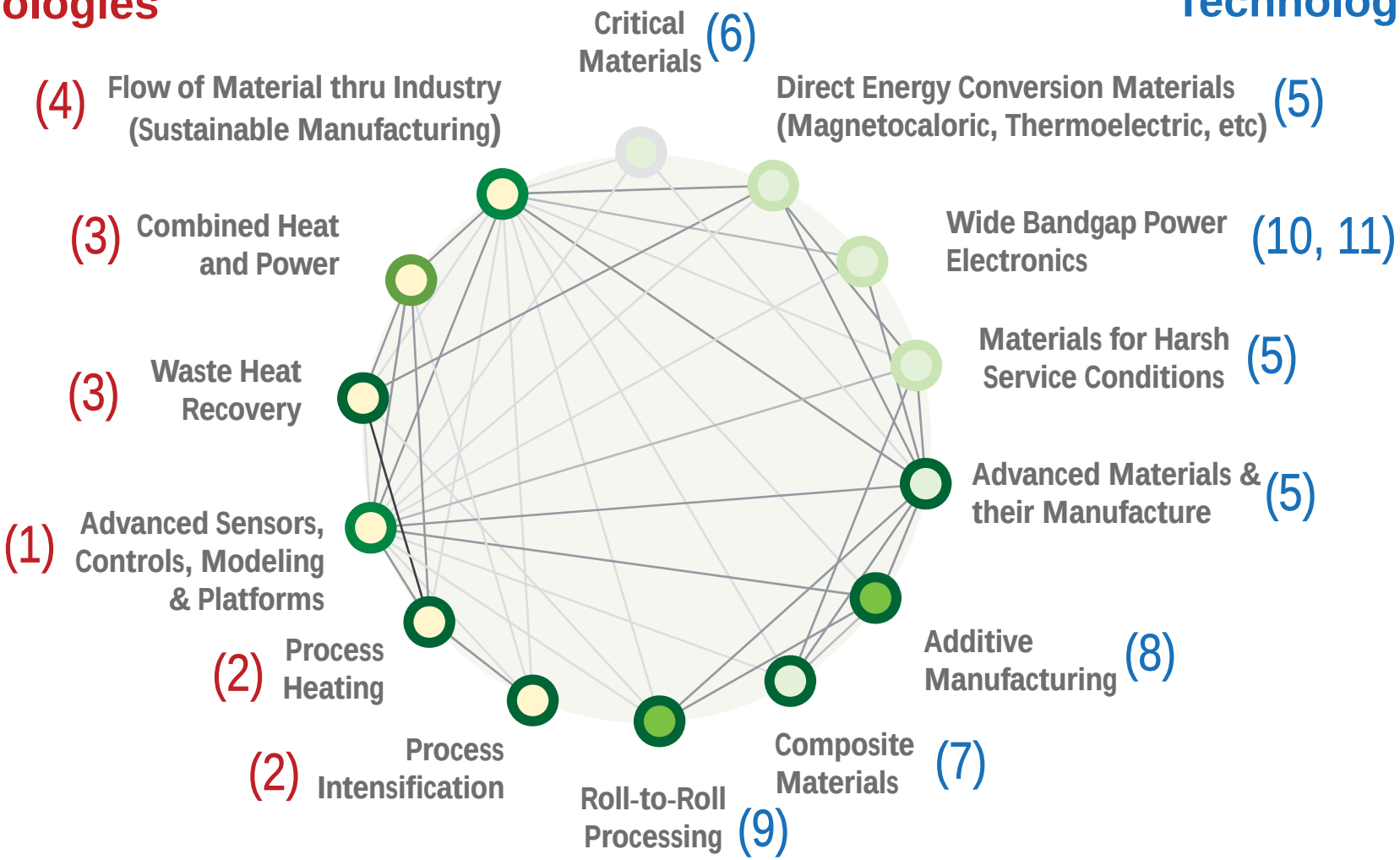
DOE QTR: Manufacturing Technology

Efficiency Technologies

Enabling Platform Technologies



Information & Data | Processes | Materials

Energy & Resource Management	**Advanced Manufacturing Processes**	Materials Development

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Advanced Manufacturing Topical Priorities

Efficiency Technologies for Manufacturing Processes (Energy, CO_2)

(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

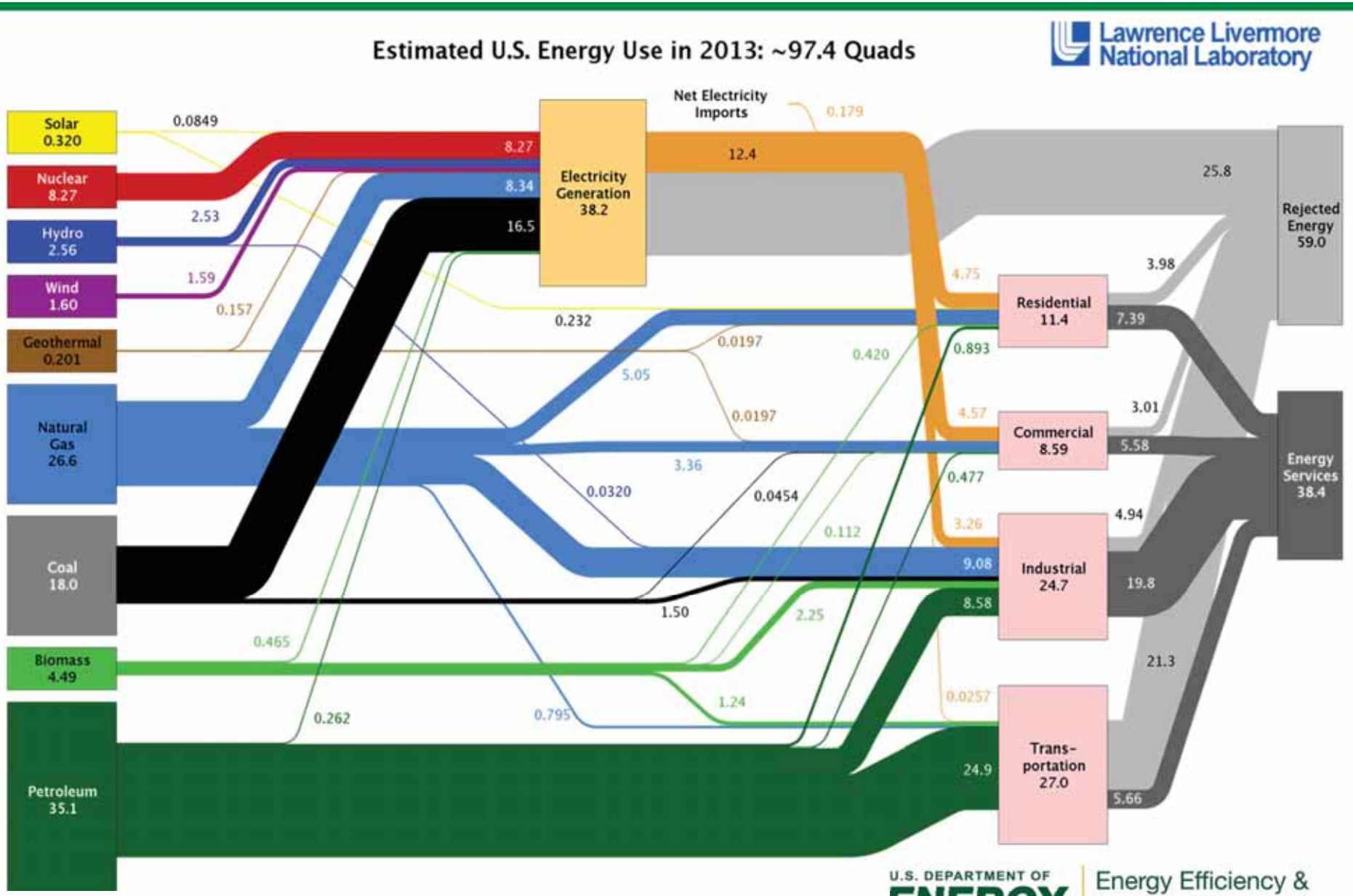
(9) 2D Manufacturing / Roll-to-Roll Processes

(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



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

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Processes for Clean Energy Materials & Technologies

Energy Dependence: Energy Cost Considered in Competitive Manufacturing

Solar PV Cell

Carbon Fibers

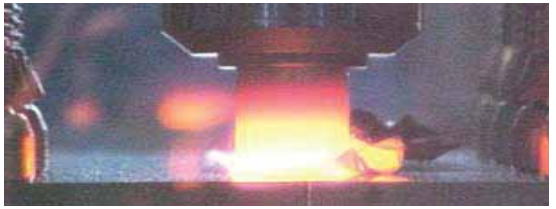
Light Emitting Diodes

Electro-Chromic Coatings

Membranes

EV Batteries

Multi-Material Joining



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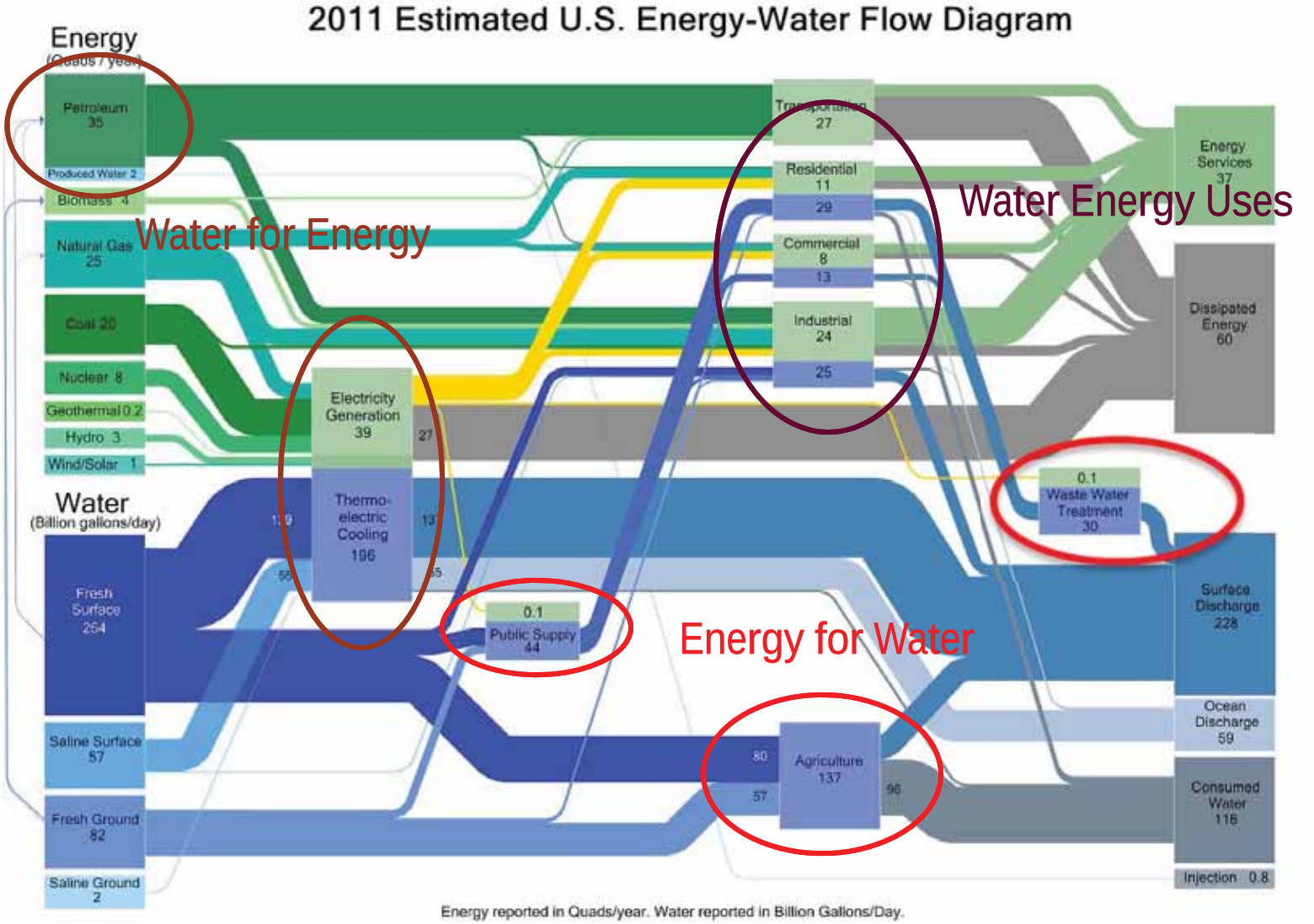
Water and Energy in Sustainable Manufacturing



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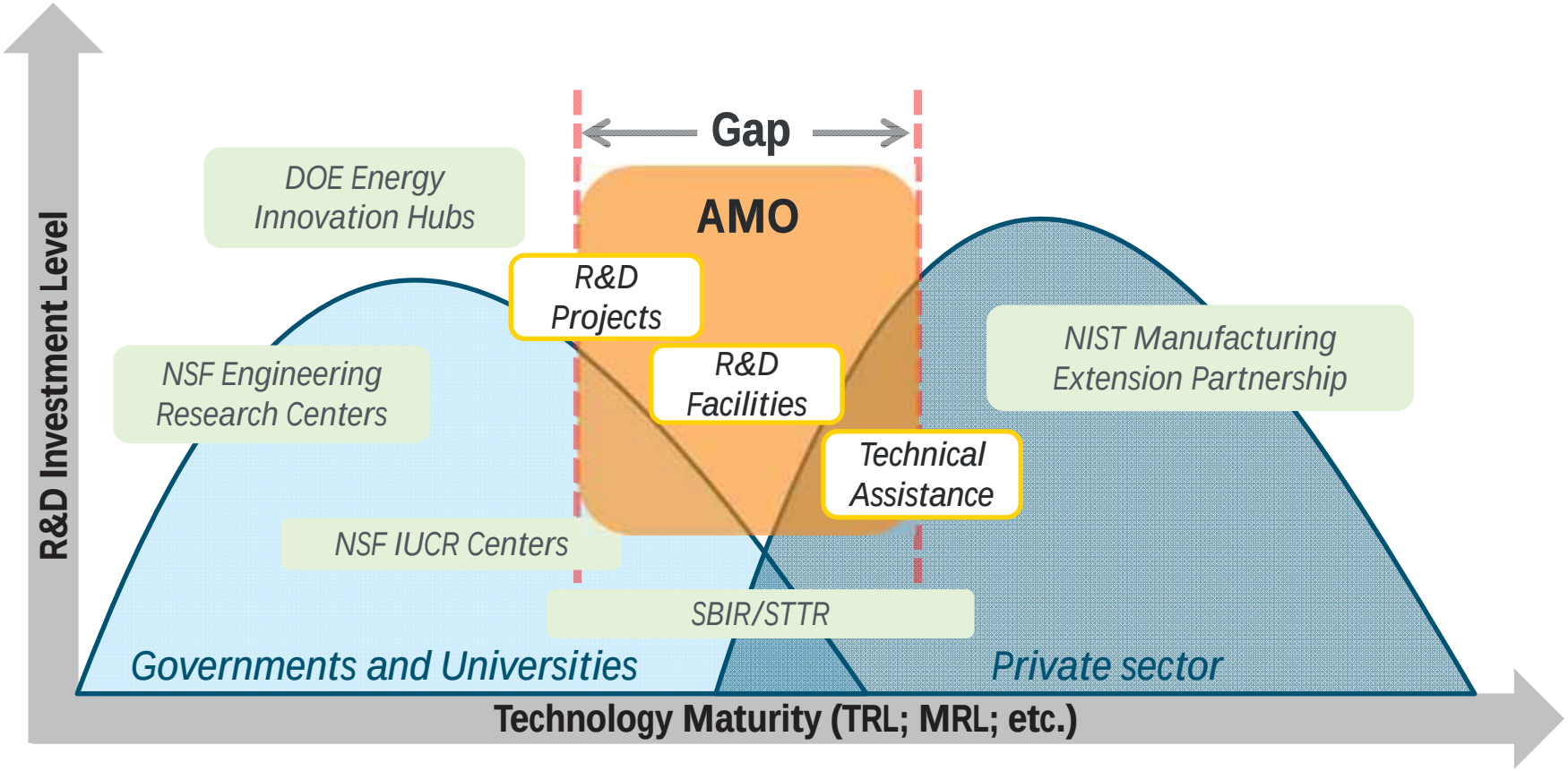
Possible Impact Areas of Cross-Cutting Technology for Energy Intensive Industry Sectors

		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



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)

Energy-Saving Partnership

Better Buildings, Better Plants,

Industrial Strategic Energy Management

Student Training & Energy Assessments

University-based Industrial Assessment Centers

Better Plants
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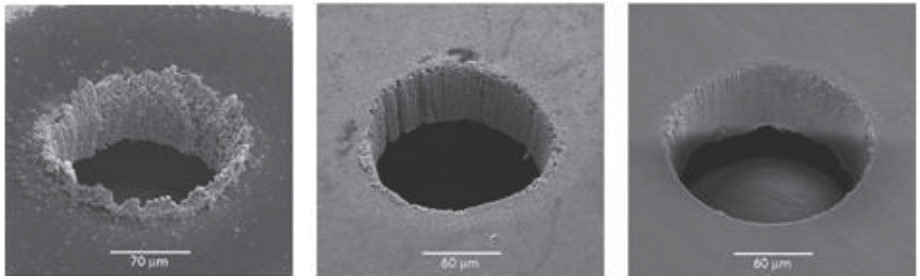
AMO Elements

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

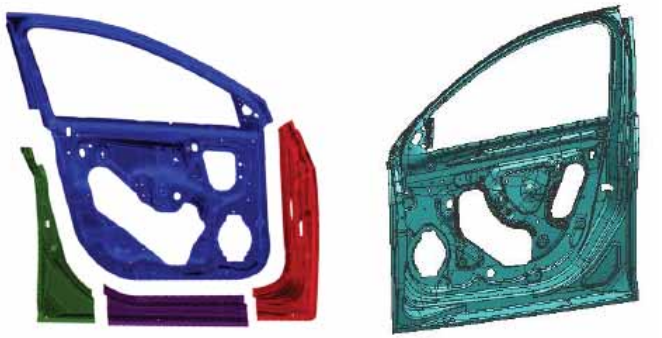
1. Technical Assistance
2. **Research and Development Projects** - to support innovative manufacturing processes and next-generation materials
3. Shared R&D Facilities

R&D Projects: Manufacturing Processes



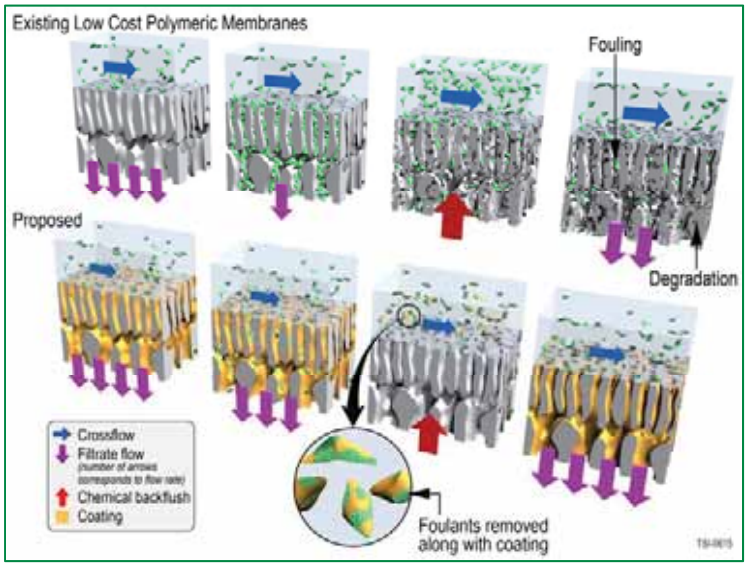
Ultrafast, femtosecond pulse lasers (right) will eliminate machining defects in fuel injectors.

Image courtesy of Raydiance.



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

Graphic image provided by General Motors.



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

Image courtesy of Teledyne

A water-stable protected lithium electrode.

Courtesy of PolyPlus

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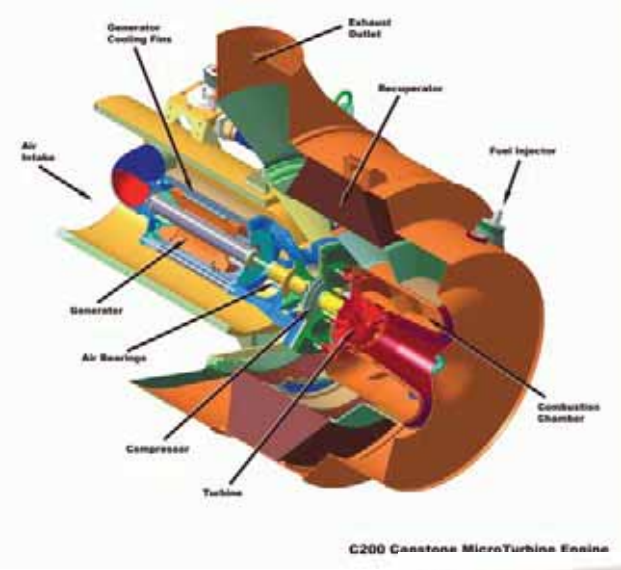
R&D Projects: Combined Heat and Power(CHP)

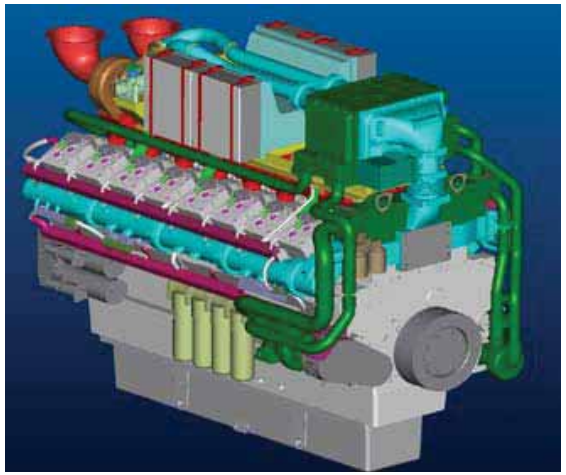
Advanced MicroTurbine System (AMTS) R&D Program



C200 MicroTurbine Engine

Capstone photos source: capstoneturbines.com

Advanced Reciprocating Engine Systems (ARES) R&D Program



QSK60G engine

AMO Elements

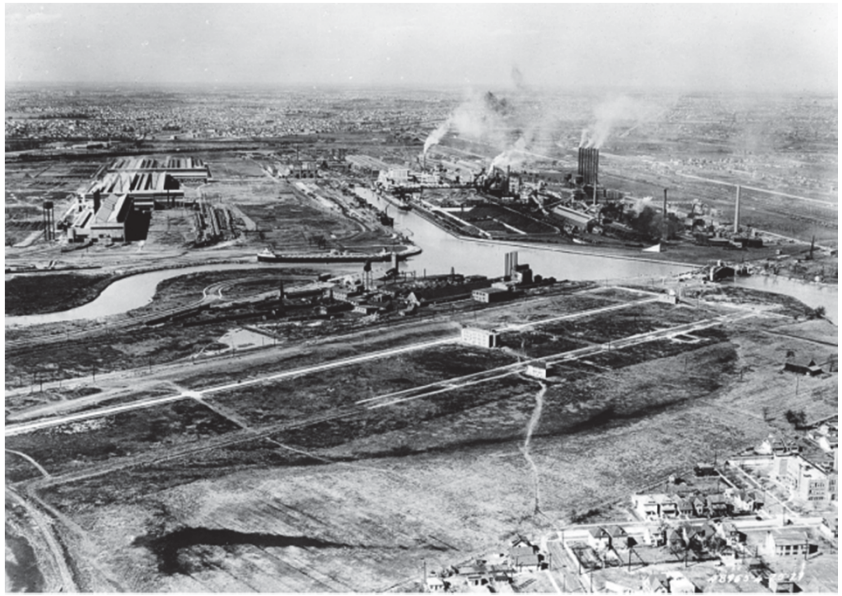
Three partnership-based approaches to engage industry, academia, national labs, and state & local government:

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

Shared R&D Facilities

Address market disaggregation to rebuild the industrial commons

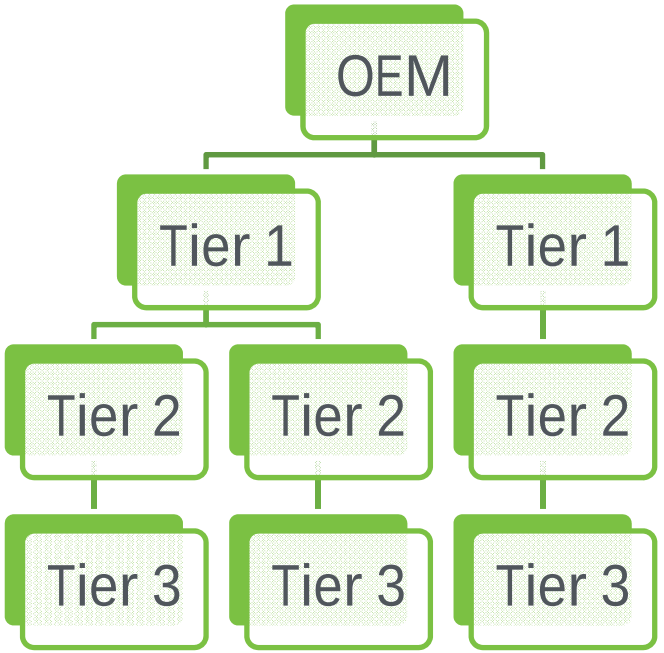
Then



Ford River Rouge Complex, 1920s

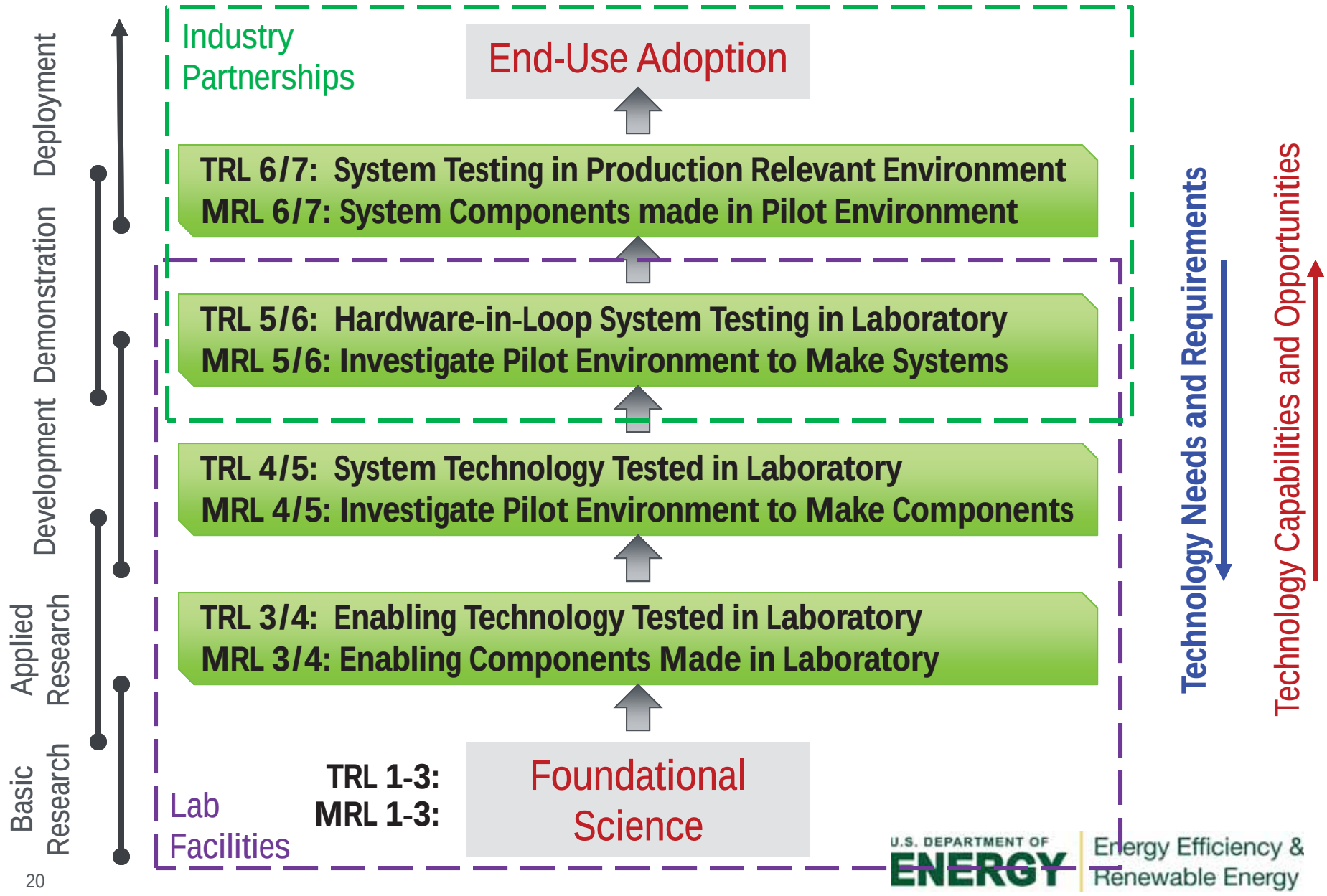
Photo: Library of Congress, Prints & Photographs Division, Detroit Publishing Company Collection, det 4a25915.

Now



How do we get innovation into manufacturing today?

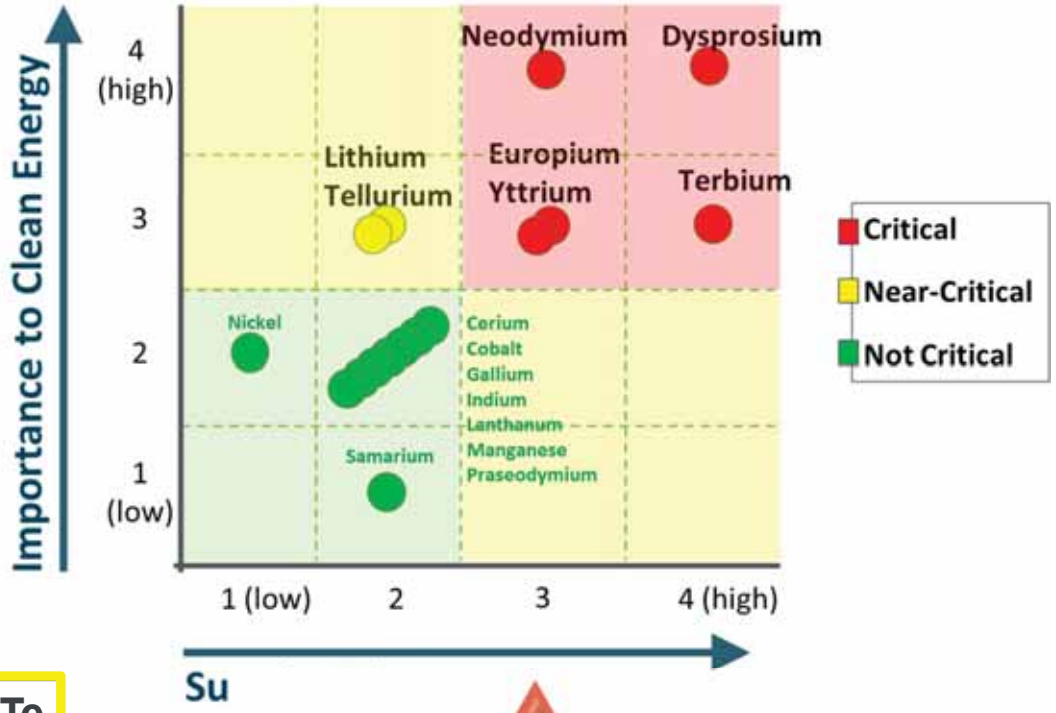
Manufacturing Technology Maturation



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.

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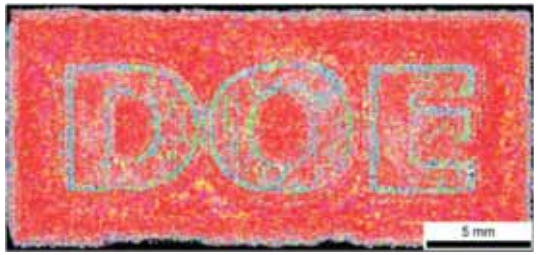
Manufacturing Demonstration Facility

Supercomputing Capabilities

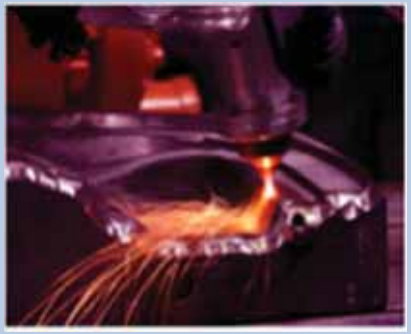
Spallation Neutron Source

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.

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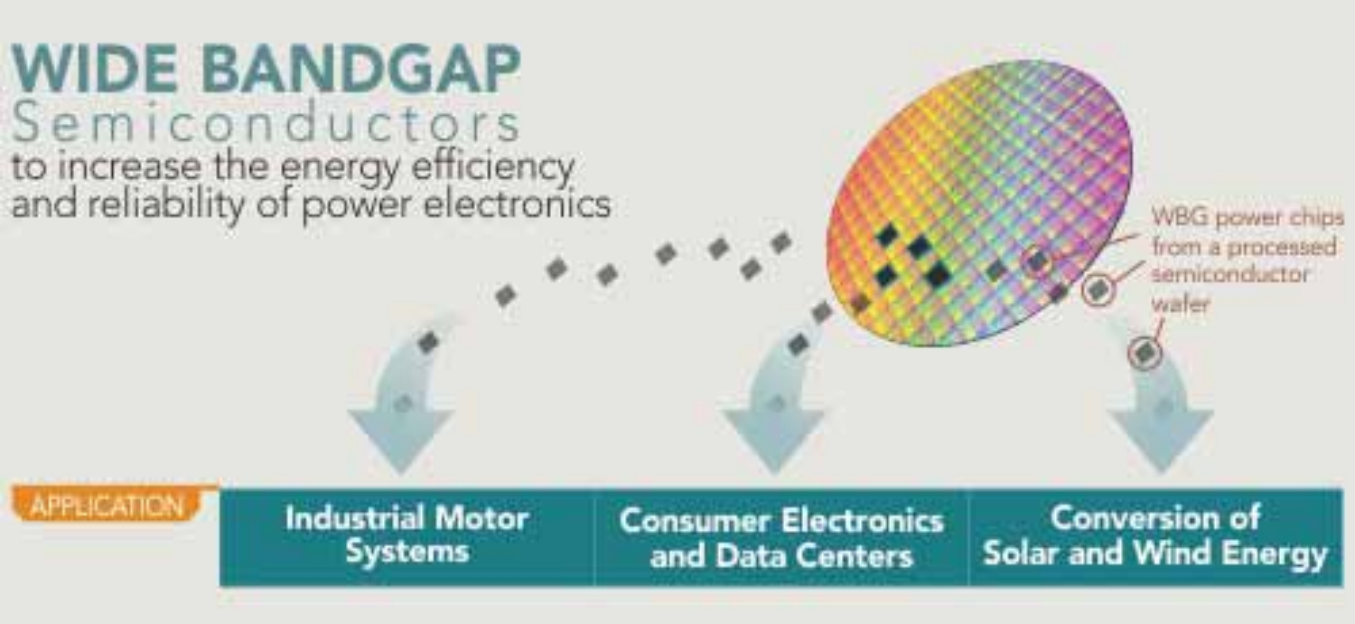
PowerAmerica:
Next Generation Power Electronics Manufacturing Institute



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.

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Institute for Advanced CompositeMaterials Innovation (IACMI)

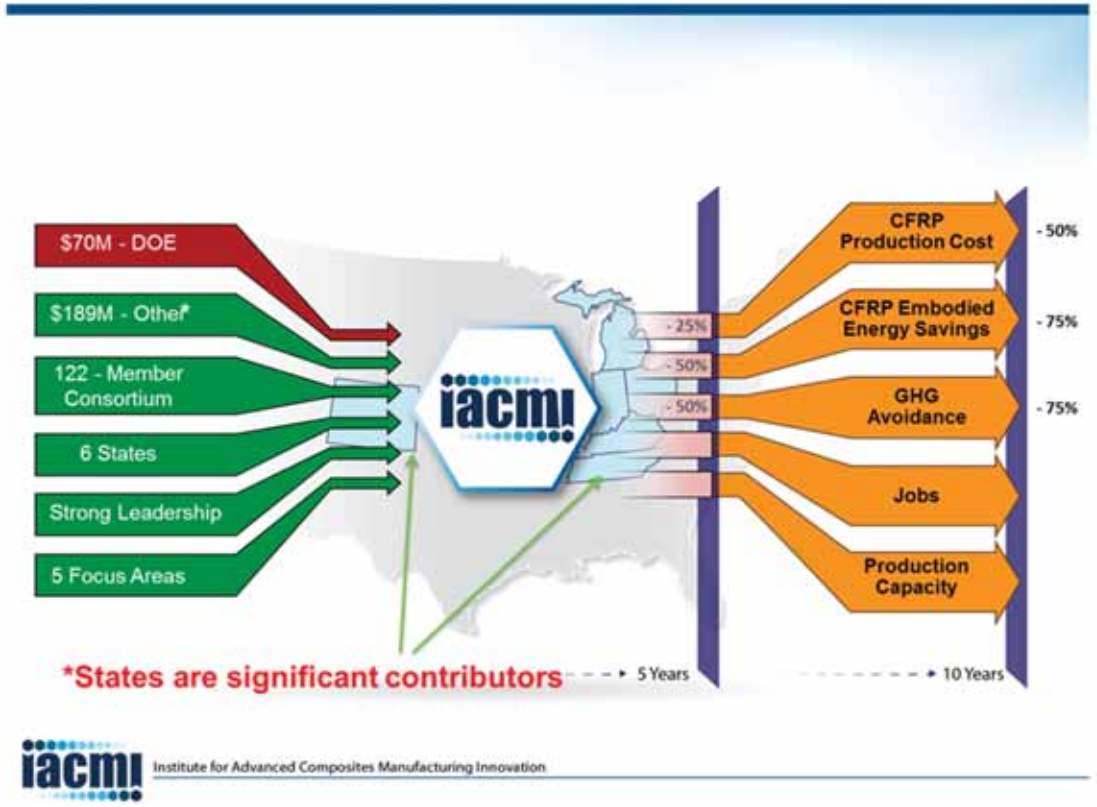
Objective

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

50% Lower Cost

Using 75% Less Energy

And reuse or recycle >95% of the material



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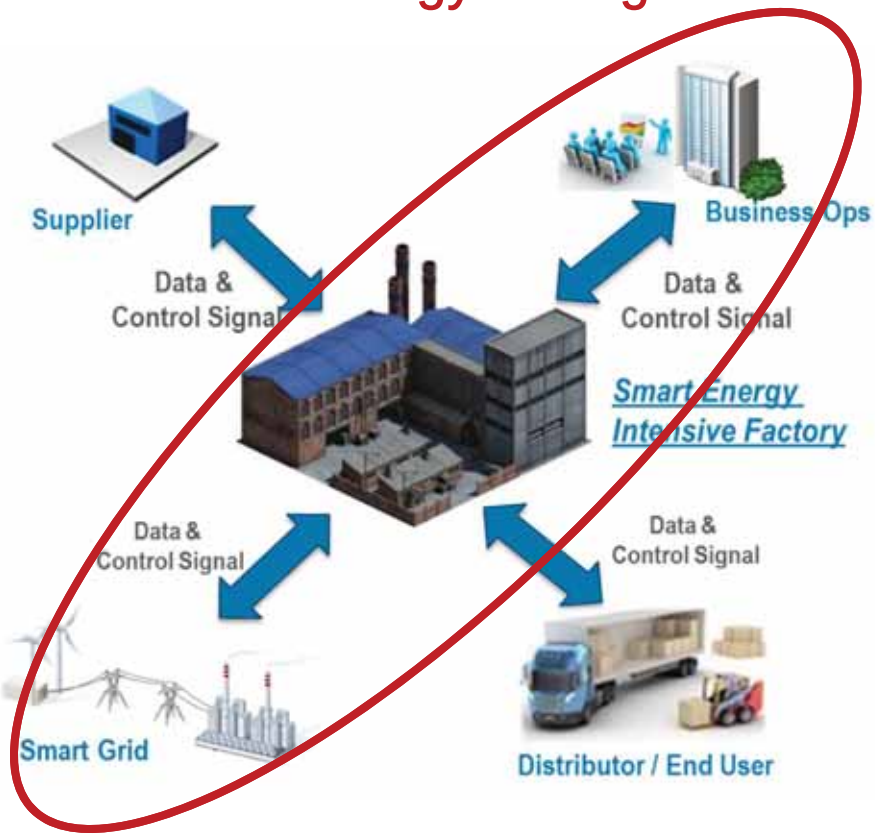
SMART Manufacturing: Advanced Controls, Sensors, Models & Platforms for Energy Applications

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

What does Success Look Like?

Energy Products Invented Here...

...And Competitively Made Here!

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Thank You

Questions?