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

Welcome and AMO Overview

2017 AMO Peer Review

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www.manufacturing.energy.gov

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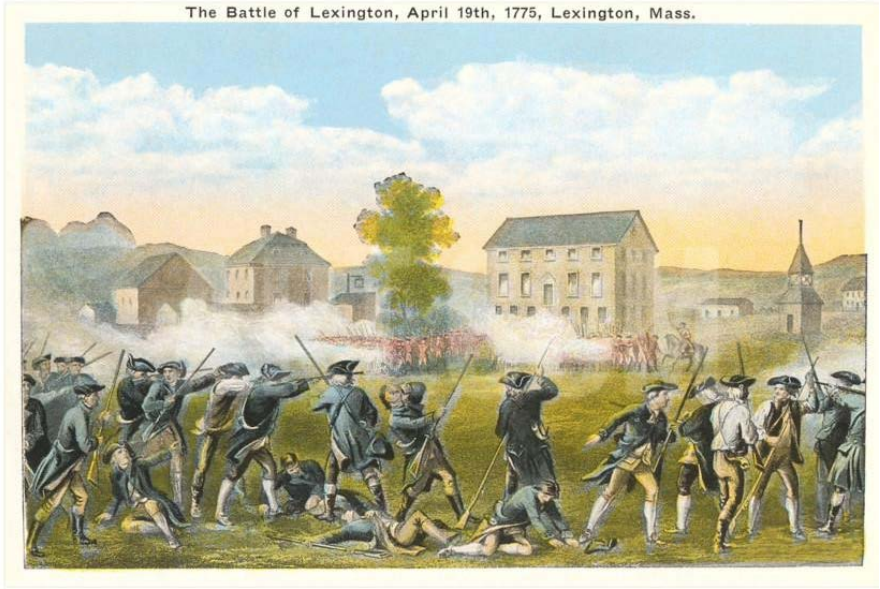
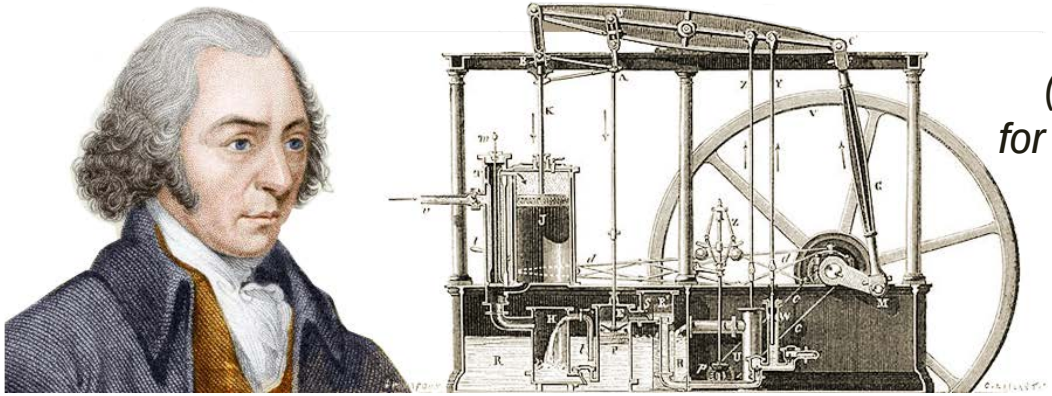
A little history: The Start of a pair of Revolutions



Lexington & Concord

1775

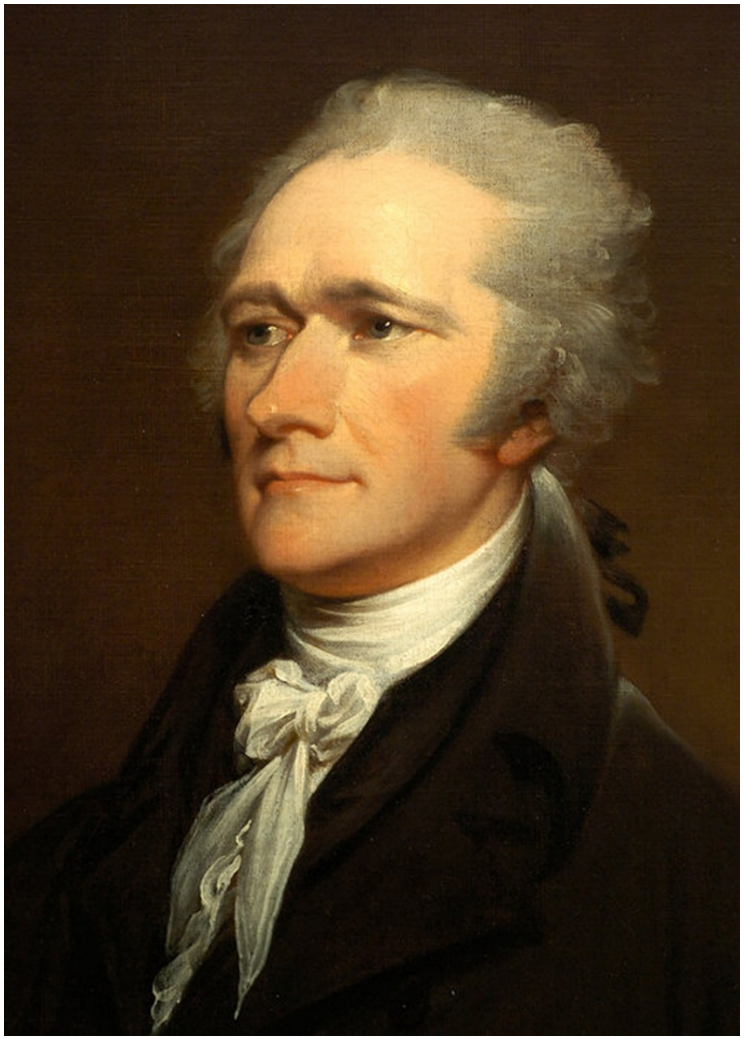


Watt, Boulton & Co.

1775

(intelligence: steam regulation for external combustion engines)

US Manufacturing Strategy for First Industrial Revolution



"… the encouragement of manufactures is the interest of all parts of the Union."

"Not only the wealth; but the independence and security of a country, appear to be materially connected with the prosperity of manufactures."

"… it is the interest of a community with a view to eventual and permanent economy, to encourage the growth of manufactures."

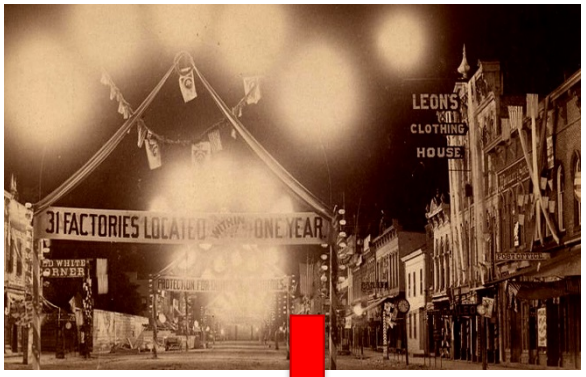
- Alexander Hamilton
US Treasury Secretary (1789-1795)

Reports to Congress

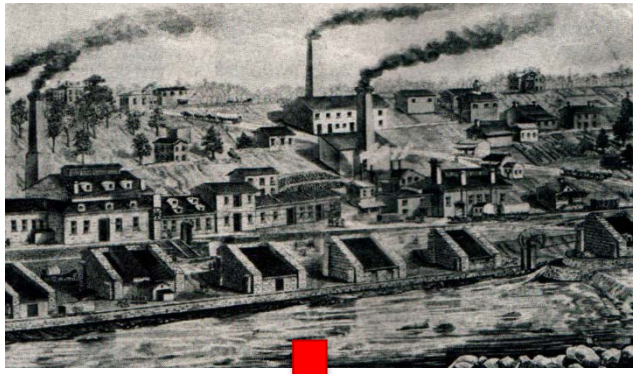
First Report on the Public Credit - 1790
Second Report on Public Credit - 1791
Report on the Subject of Manufactures - 1791

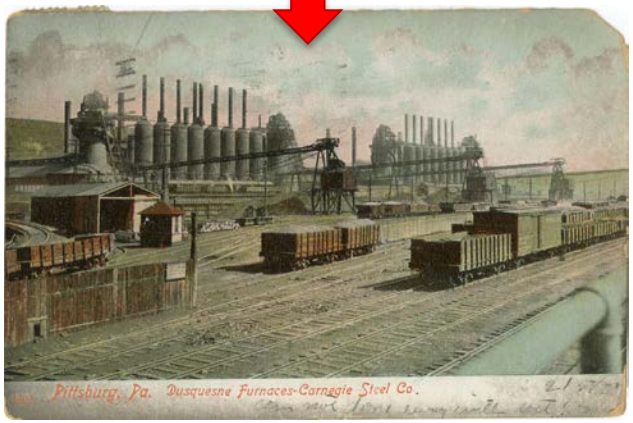
Second Industrial Revolution

Electrification

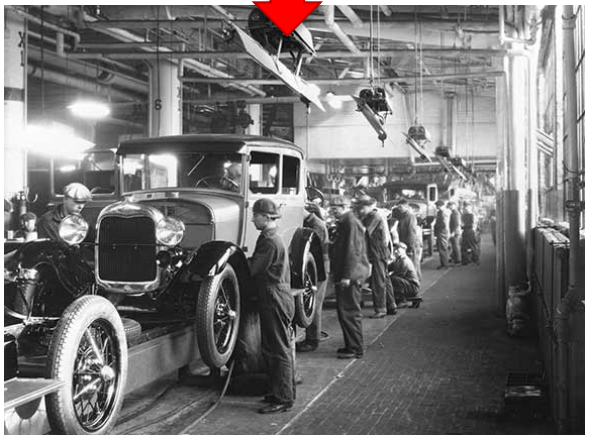


Process Scaling Energy & Materials





Standardization & Assembly Line



Energy Intensive Industries -Today

Primary Metals
1608 TBTU

Petroleum Refining
6137 TBTU

Chemicals
4995 TBTU

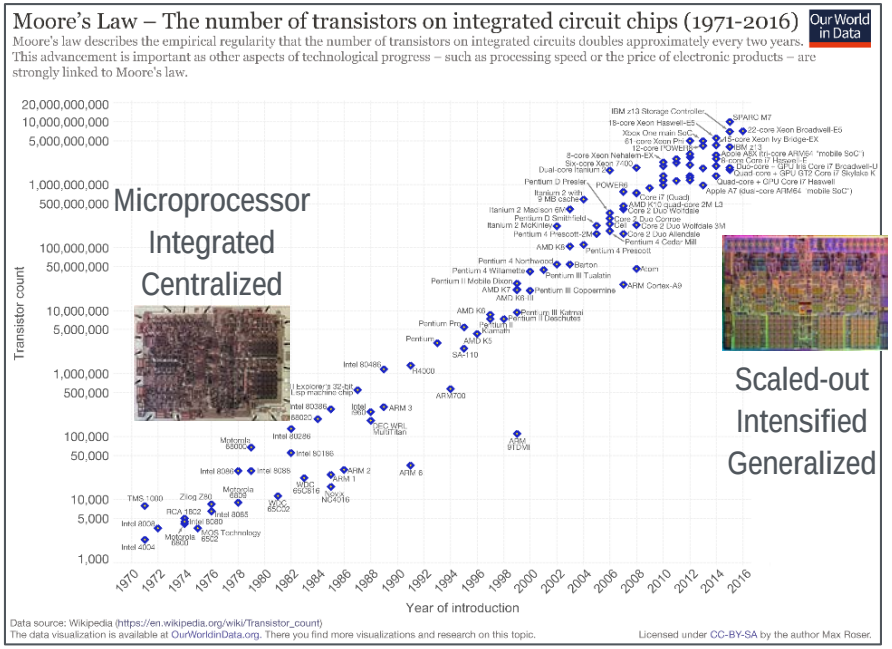
Wood Pulp & Paper
2109 TBTU

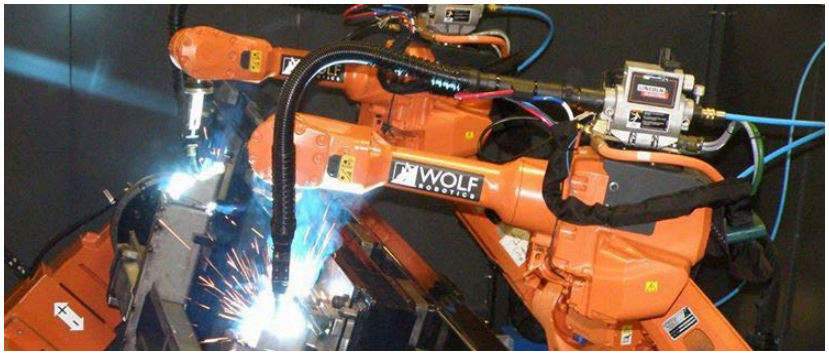
Glass & Cement
716 TBTU

Food Processing
1162 TBTU

Other Manufacturing
~1600 TBTU

Third Industrial Revolution - Today





How will Manufacturing, Economy and Security of the Nation depend on Information, Computation, Actuation and Communication Technologies in the 21st Century?

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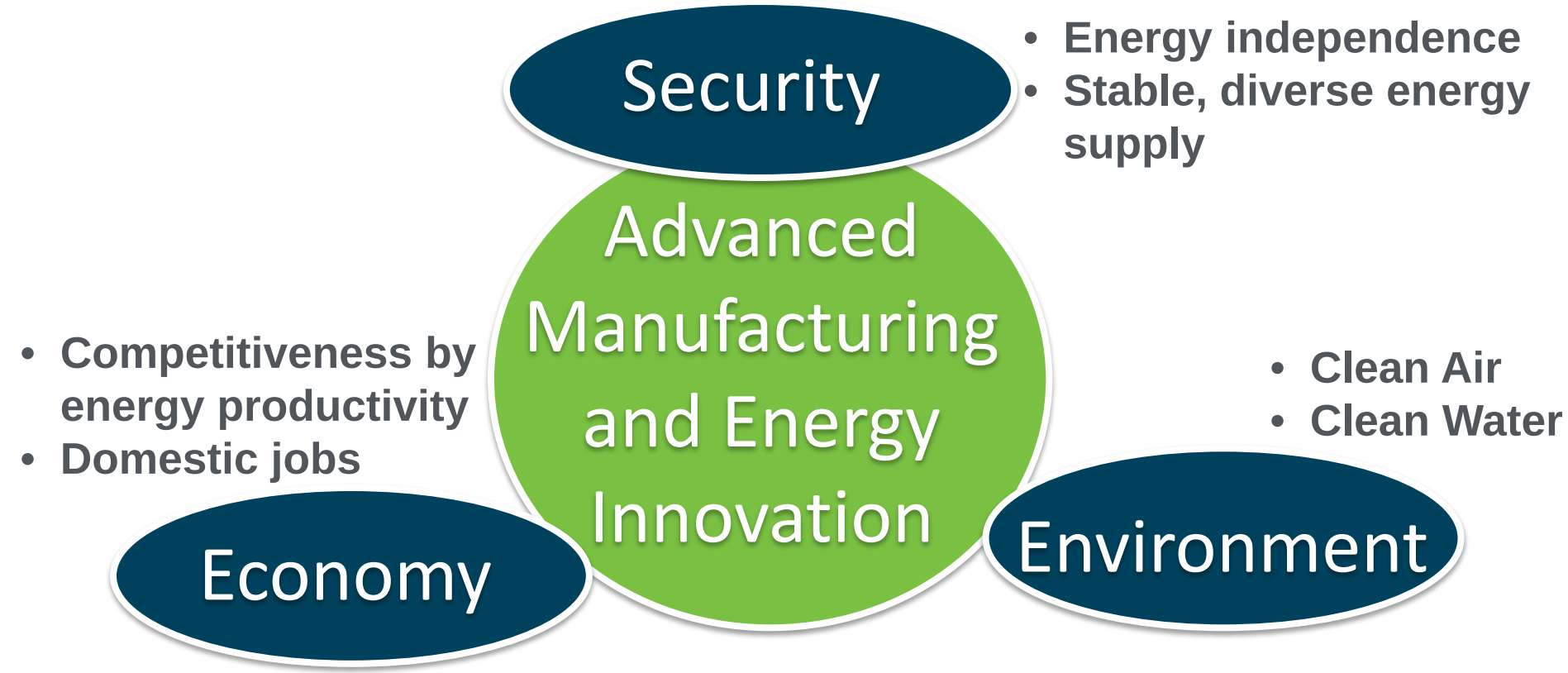
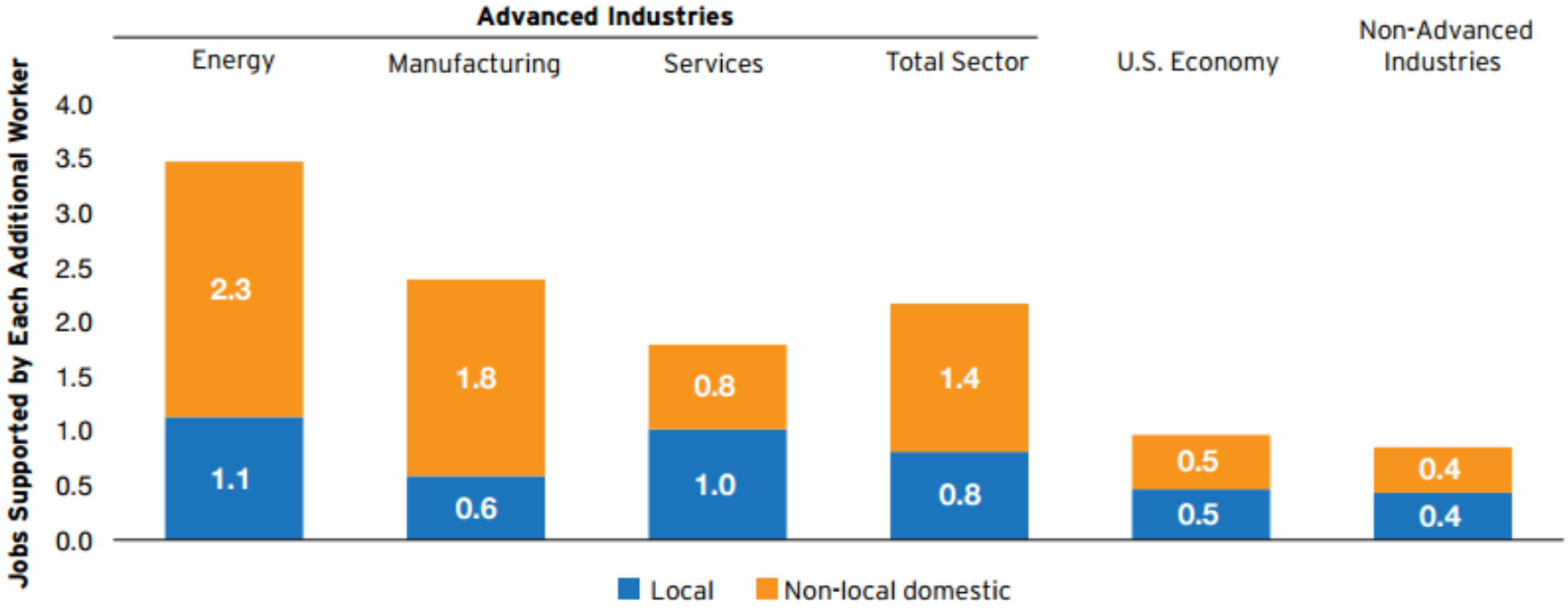
Energy and Manufacturing Innovation Today



Technology Innovation through Early-Stage Research and Development In Manufacturing and Energy is a Foundation for Economic Growth & Jobs

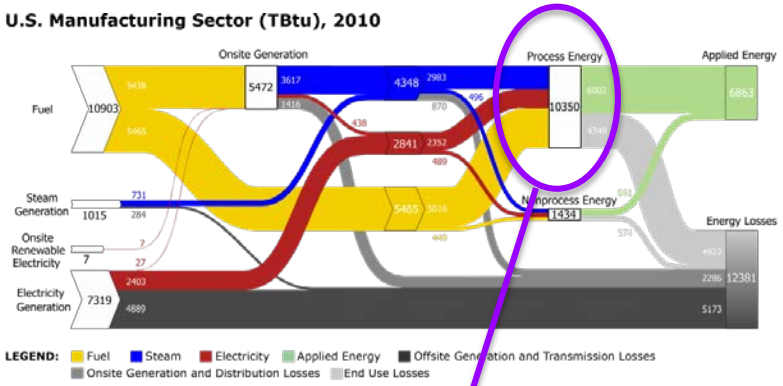
Innovation, Talent and Jobs

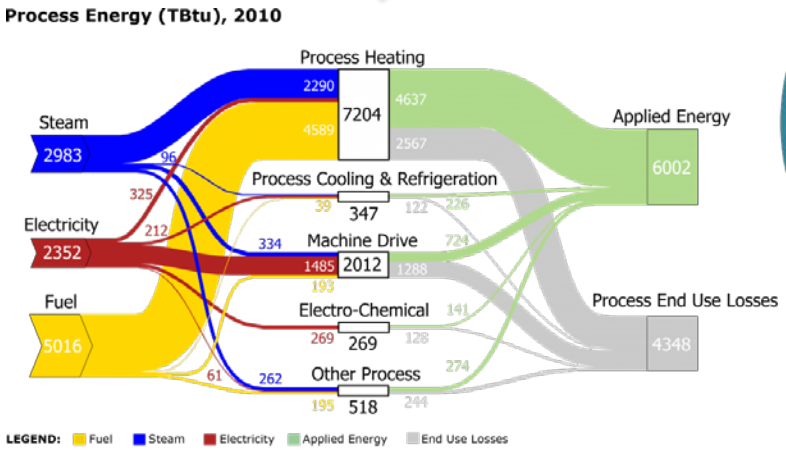
Powerful multiplier effects mean every new advanced industry job supports more than two others



Advanced Manufacturing -- Opportunity

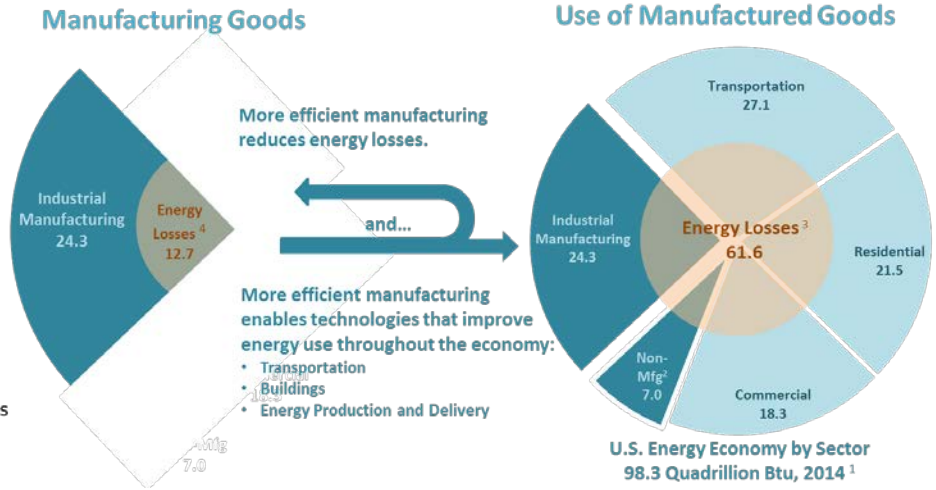
Technology Innovation through Early Stage R&D in Advanced Manufacturing and Energy is a Foundation for Economic Growth and Jobs in the US





$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

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



QTR, 2015

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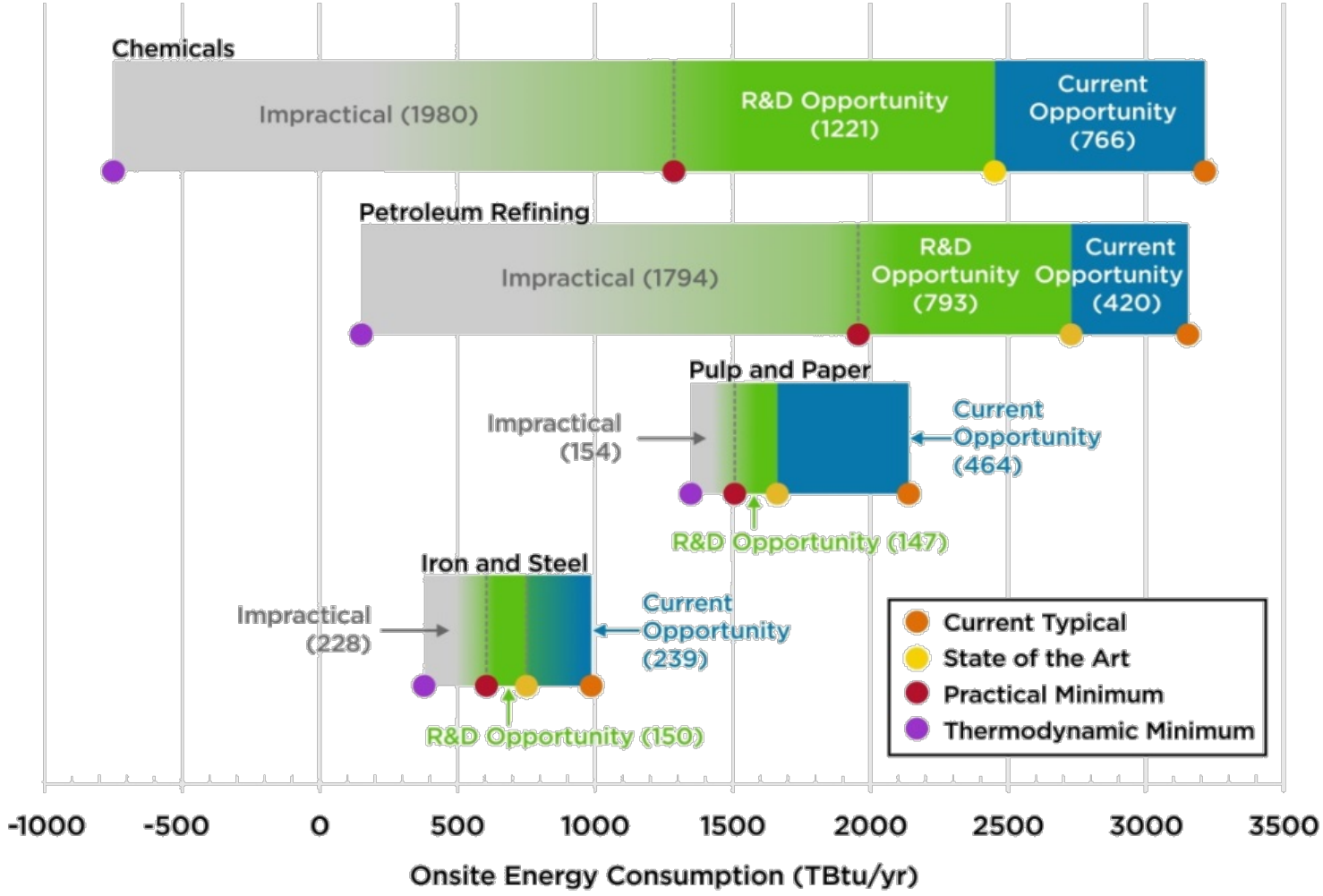
Manufacturing Bandwidth Studies: Energy Savings Potential



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

Advanced Manufacturing Office Framework

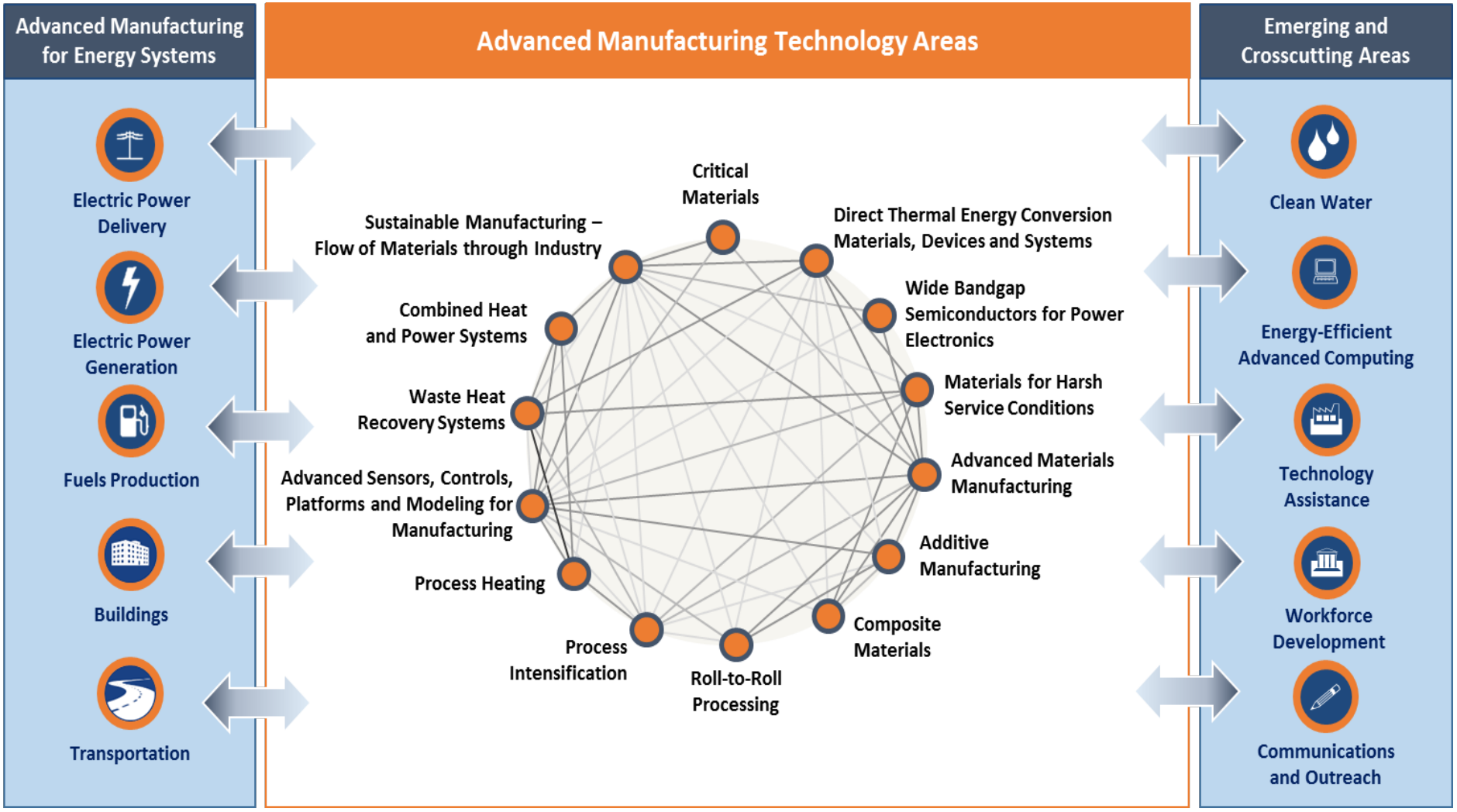
Focus on Early Stage Applied Research and Development

Technology Areas with Knowledge Gaps Applicable to Manufacturing and Energy

Merit-based R&D at National Laboratories, Universities, Companies (for profit and not for profit) and Consortia

Partner with Private Sector to Identify Technical Knowledge Gaps and Transfer Learning for Subsequent Adoption

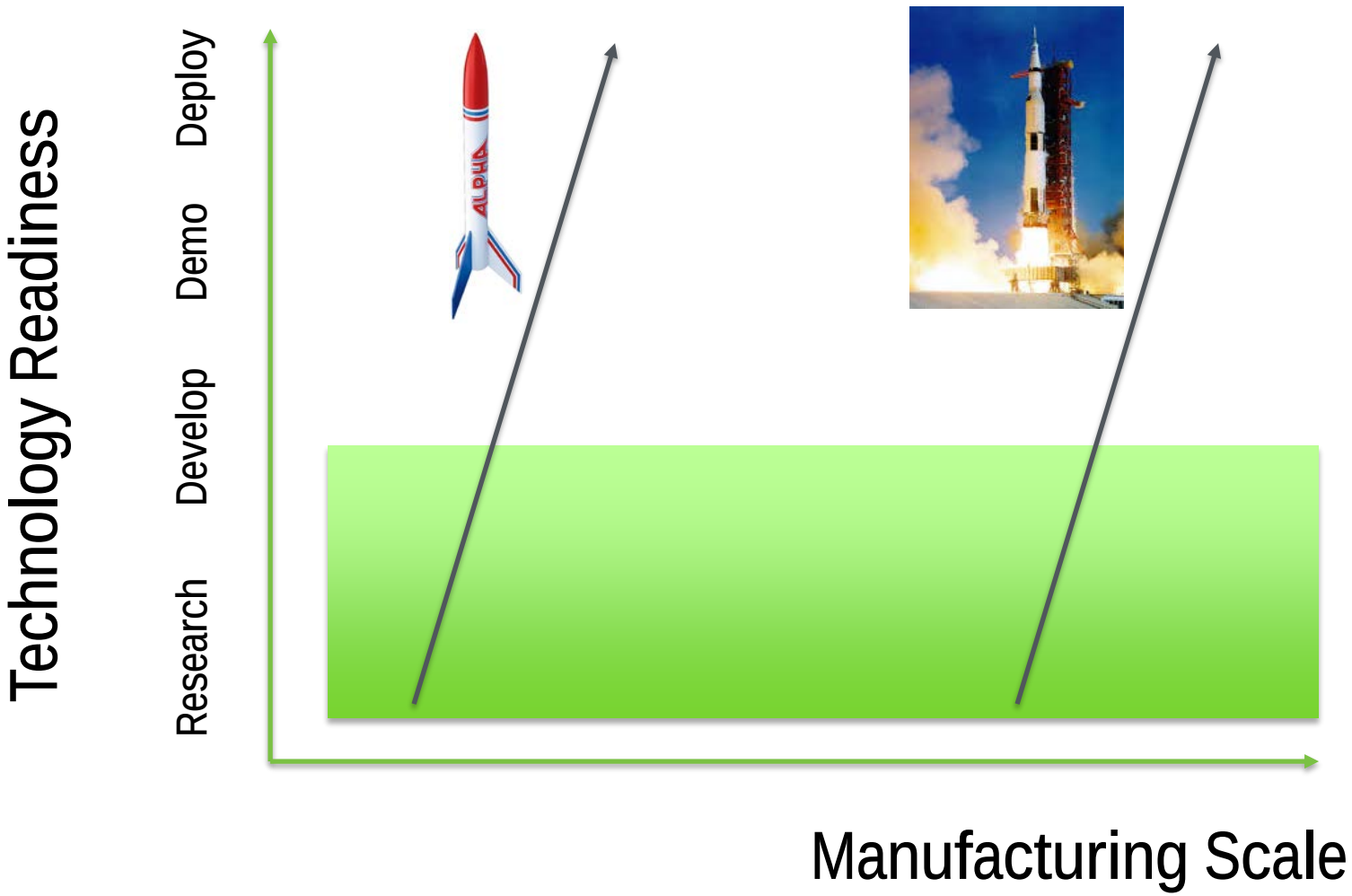
AMO Technical Focus Areas (2017 MYPP / DRAFT)



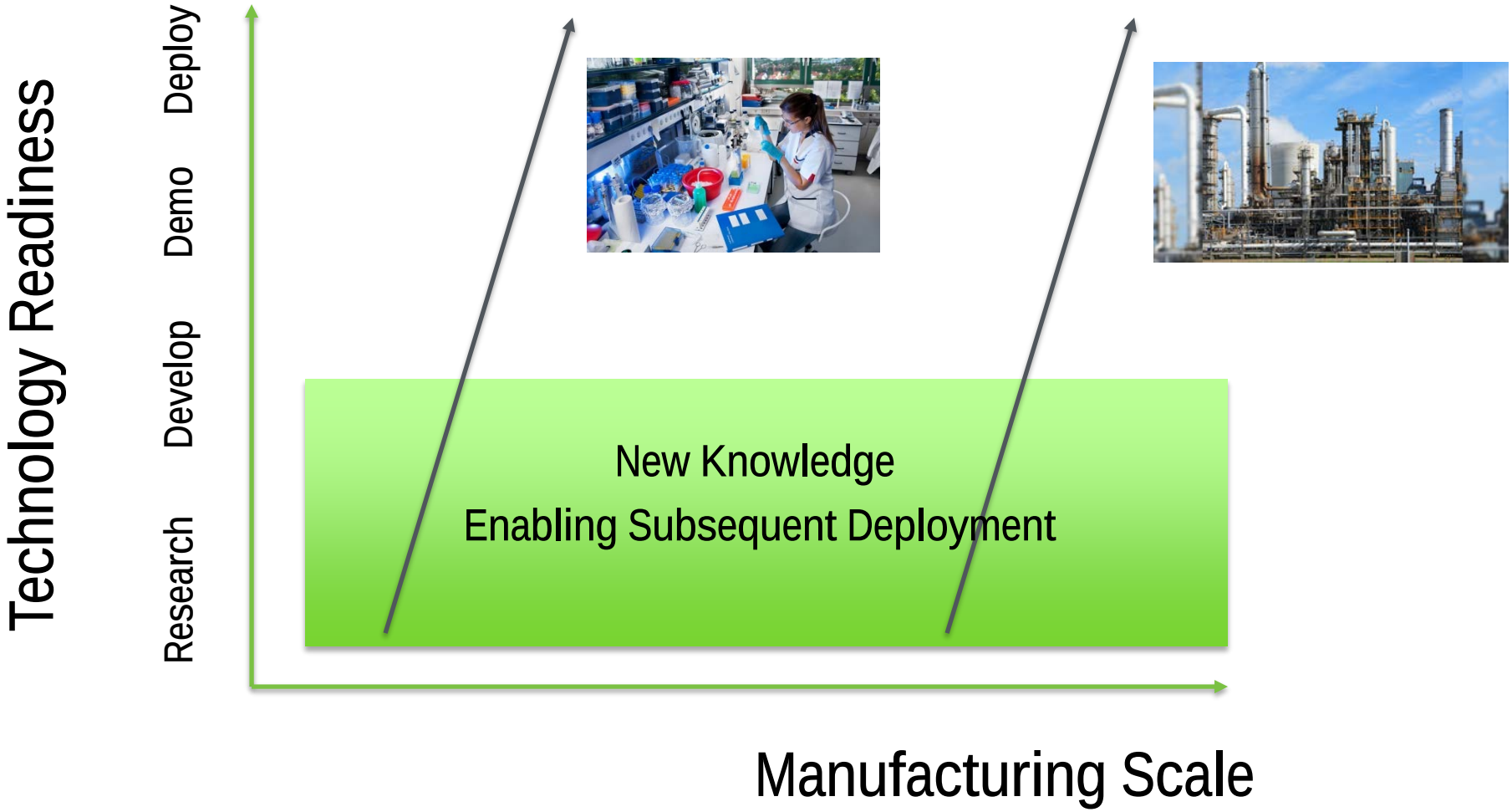
Impact Areas of Cross-Cutting Efficiency Technology R&D for Energy Intensive Industry Sectors

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

Early Stage R&D and Manufacturing Technology



Early Stage R&D and Manufacturing Technology



AMO: Three complimentary modalities

Technical Partnerships with Industry

Partnerships and tools to accelerate adoption of early-stage research and development by private sector with potential impact of improved energy efficiency and productivity for U.S. firms and manufacturing facilities.

R&D Consortia: Public-Private Partnerships

National lab and university-based consortia focused on early stage research and development to create new knowledge about underlying scientific challenges in key manufacturing technical areas.

R&D Projects: Creation of New Technical Knowledge

Merit-based early-stage research and development projects into manufacturing relevant materials, information and process technologies

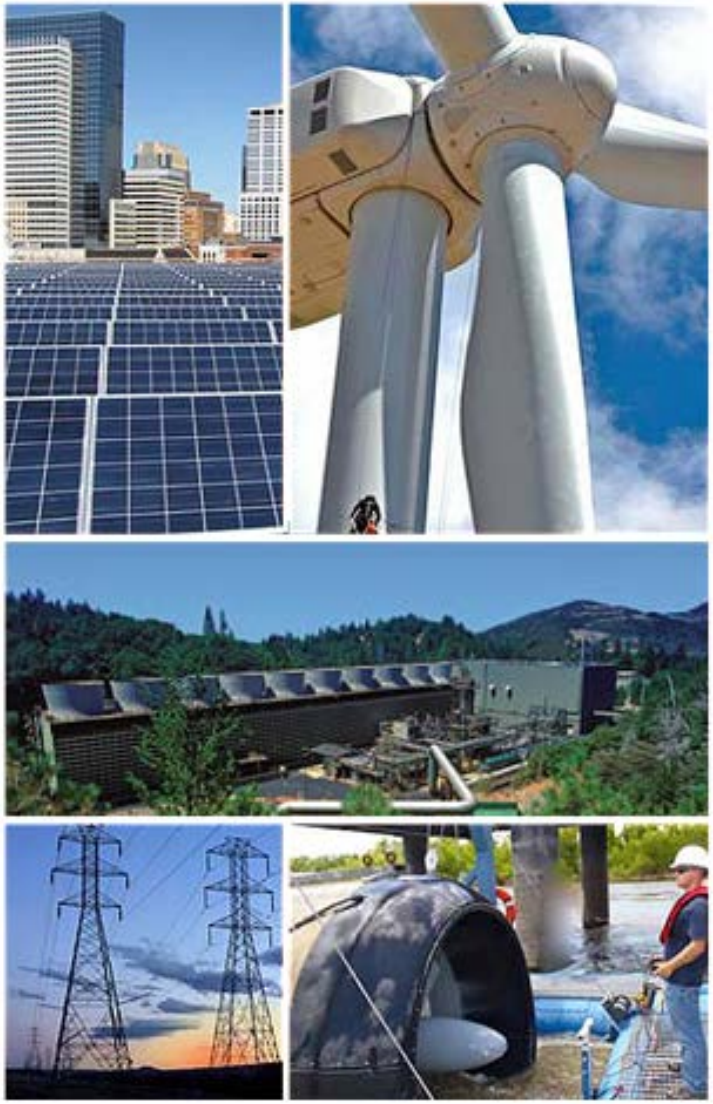
R&D: Next Generation Electric Machines (NGEM)

- Focus on developing energy efficient, high power density, integrated medium voltage drive systems.

Current efforts:

- Manufacturing of high performance thermal and electrical conductors
- Manufacturing of low-loss silicon steel
- High temperature superconducting wire manufacturing
- Manufacturing of other enabling technologies to increase performance.

Potential to save 1.6% of total U.S. electricity consumption each year



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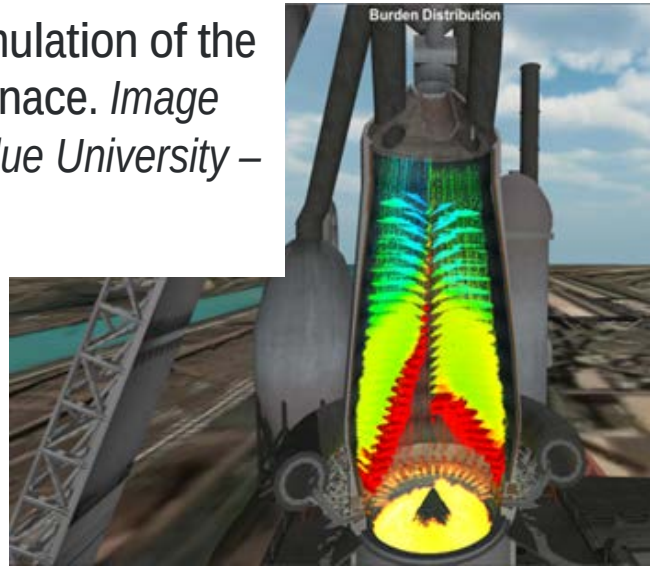
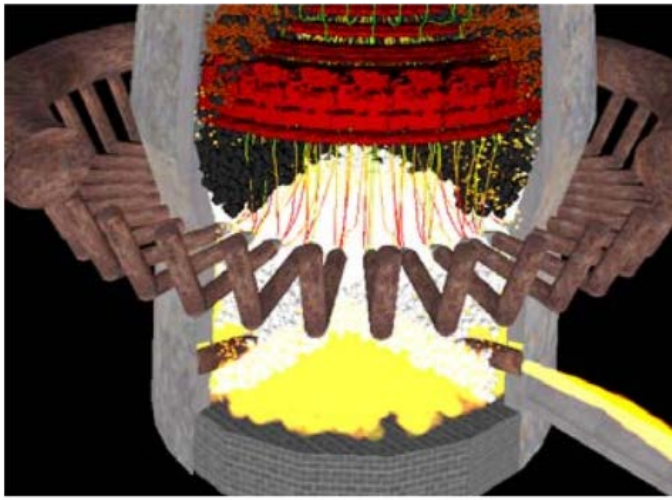
High Performance Computing for Manufacturing

Apply modeling and simulation capabilities to manufacturing challenges

A computer simulation of the virtual blast furnace. *Image courtesy of Purdue University – Calumet.*



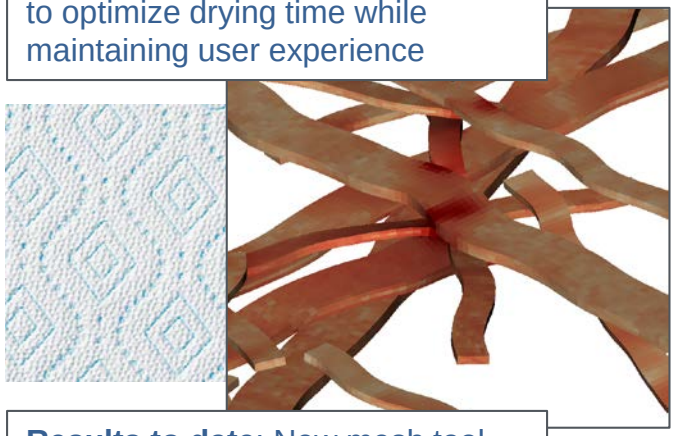


- Industry defined challenges
- Partner with National Labs to Address R&D Using HPC
- Streamlined partnering process

HPC to research processes at scale in energy intensive industries

Paper Towel Manufacturing

Goal: Use HPC to evaluate different microfiber configurations to optimize drying time while maintaining user experience

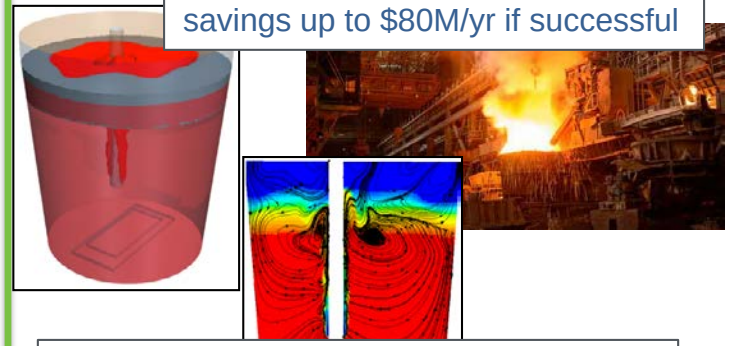


Results to date: New mesh tool reduces product design cycle by 2X cycle; additional cores by another 8X; largest non benchmark run of Paradyn code at LLNL

Team: Proctor and Gamble with LLNL

Reducing Coke Usage in Steel

Goal: Use models of complex reacting flows HPC to optimize blast furnace processes to reduce carbon loads and coke usage; savings up to $80M/yr if successful



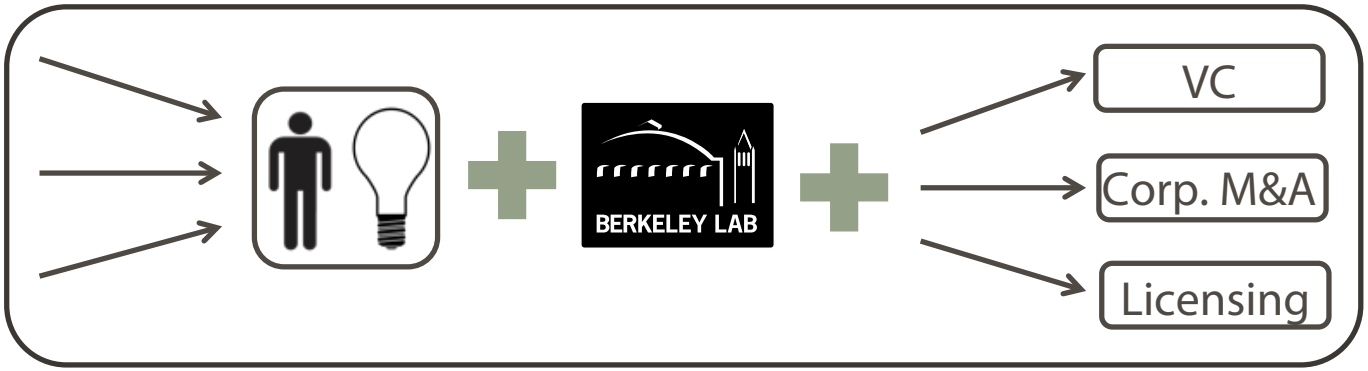
Results to date: 1000X improvement in computational speed of parametric studies to examine factors such as CO2 enrichment, wind rate. Scaling code up to 2000 cores

Team: Purdue Calumet with LLNL

Post-Doc Innovation Accelerator at National Laboratories

Lab Embedded Accelerator Model:

Post-Doc innovators "spin in" to national labs for R&D



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CHAIN REACTION INNOVATIONS

INNOVATION CROSSROADS

1. **Recruit** the world's best energy technology innovators
2. **Leverage** experts and facilities at a world-class R&D institute
3. **Deploy** people, IP, and technology

20

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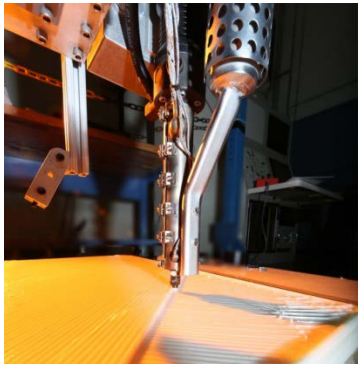
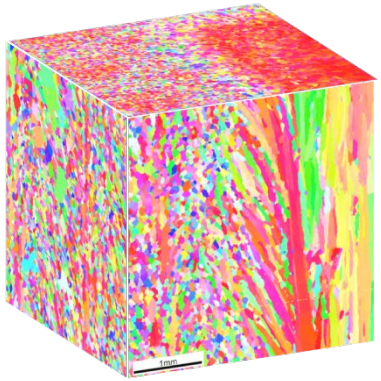
Manufacturing Demonstration Facility

- Supercomputing Capabilities
- Spallation Neutron Source

MDF Manufacturing Demonstration Facility

America Makes





Additive Manufacturing

Arcam electron beam processing AM equipment

POM laser processing AM equipment

Research in partnerships at MDF can provide validation and feedback to further research in AM technologies utilizing various materials from metals to polymers to composites.

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Collaborative R&D Project: AMO partnership with Wind

Bringing Manufacturing Innovation to the Renewable Energy Space

- Enable innovative blade designs
- Achieve lower overall costs and higher efficiencies
- Collaboration with Oak Ridge, Sandia, and TPI Composites
- Potential copper metal casting projects

Critical Materials Institute
AN ENERGY INNOVATION HUB

Manufacturing Demonstration Facility

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INNOVATION CROSSROADS

HPC4 MANUFACTURING

CHAIN REACTION INNOVATIONS

Better Plants®
U.S. DEPARTMENT OF ENERGY

PowerAmerica

CLEAN ENERGY SMART MANUFACTURING INNOVATION INSTITUTE

Superior Energy Performance
U.S. DEPARTMENT OF ENERGY

THE COMPOSITES iacmi INSTITUTE

INDUSTRIAL ASSESSMENT CENTERS

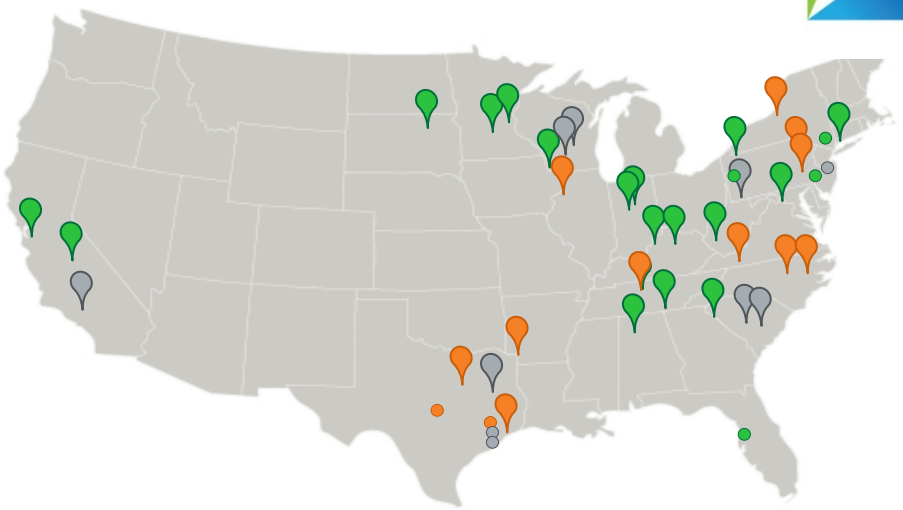
RAPID

REMADE INSTITUTE

Technical Partnerships and Tools: 50001

ISO 50001 is a foundational tool that any organization can use to manage energy

Superior Energy Performance
U.S. DEPARTMENT OF ENERGY



ISO 50001

Components in place:
- Top Management
- Energy Team
- Planning
- Baseline
- Performance Metrics

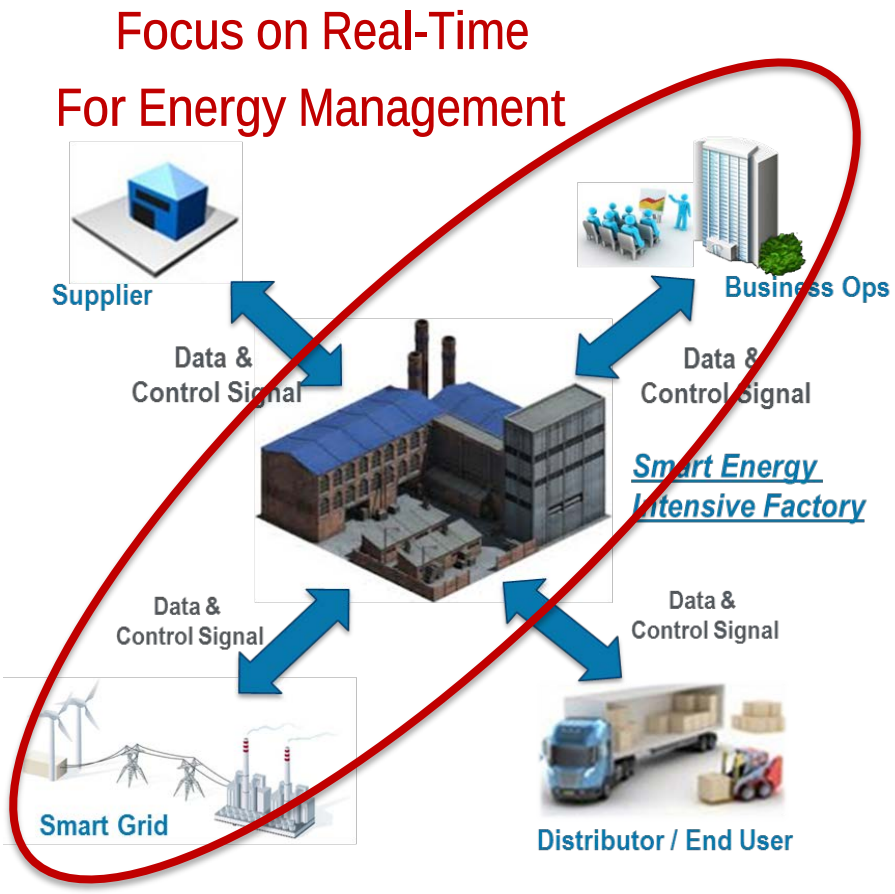
Superior Energy Performance

ISO 50001

Single facility ISO 50001 conformance with verified energy performance improvement

Smart Manufacturing- Technical Area

- Advanced sensors and controls for real-time process management



Goals for Use of Knowledge Goals

- >50% improvement in energy productivity
- >50% reduction in installation cost of Smart Manufacturing hardware and software
- 15% Improvement in Energy Efficiency at systems level
- Increase productivity and competitiveness across all manufacturing sectors

Merit Review Take-Aways

- Ensure High Technical Merit
- Meaningful Applicability to Advanced Manufacturing
- Expectation of Useful New Knowledge Creation
- Maximum Opportunity for Subsequent Impact
- Exchange of Knowledge and Insights

What does Success Look Like?

Energy Technologies Invented Here…

…And Productively Manufactured Here!

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