Advanced Manufacturing Office

U.S. Department of Energy

Sustainable Nanomaterials Workshop

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U.S. DEPARTMENT OF ENERGY

What can we learn from the history of manufacturing?

New materials and manufacturing methods can change the landscape

The New York Times

"The machine which will really fly might be evolved by the combined and continuous efforts of mathematicians and mechanicians in from one million to ten million years"

October 9, 1903

Terry Wisser, DARPA/DSO, 2006

"We started assembly today"

- Orville Wright's Diary

October 9, 1903

Innovation Can Change the World

1884:

The price of aluminum was \$1/oz and the price of gold was \$20/oz.

The pay of the highest skilled craftsman working on the Washington Monument was \$2/day.

Today:

The price of Al ~ 6¢/ oz and the price Au ~ \$1776/oz.

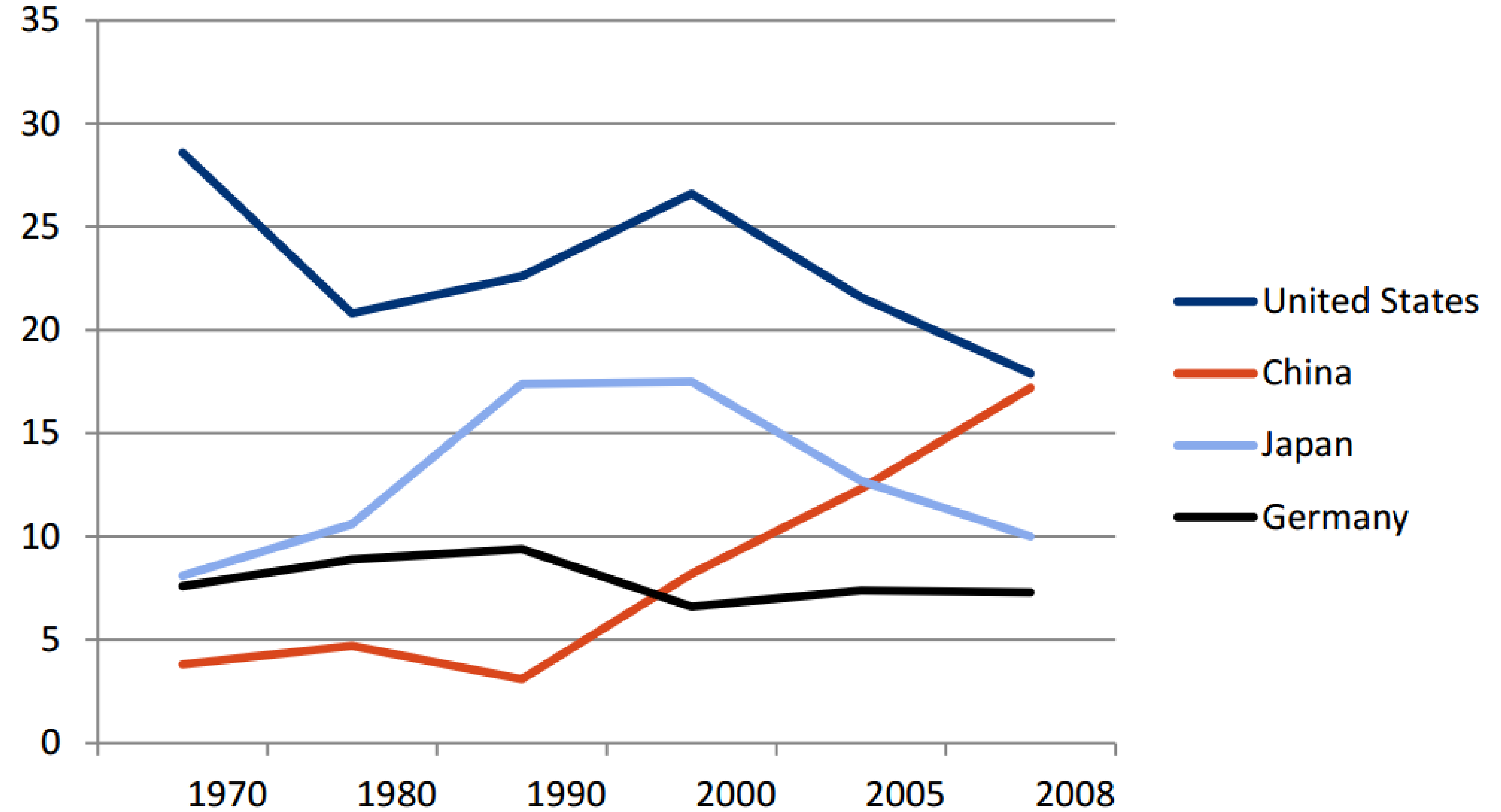
Reason:

Innovative process for extraction of Al from ore

What are the Challenges and Opportunities of OUR Times?

Manufacturing is fundamental to the U.S. economy

- 11% of U.S. GDP
- 57% of U.S. exports
- 12 million U.S. jobs
- 60% of U.S. engineering and science graduates
- U.S. accounts for almost 20% of the worlds manufactured value added.



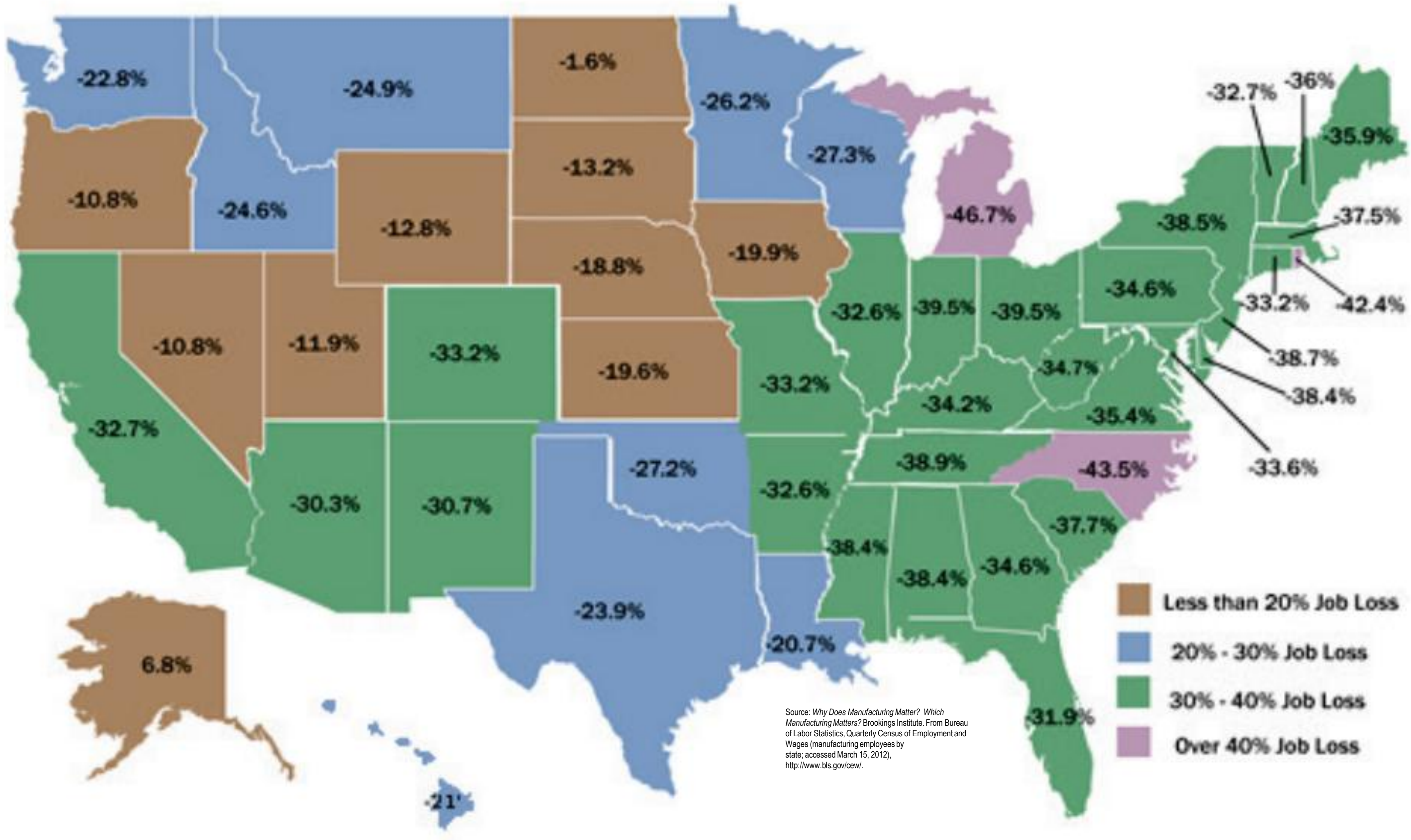
Select Country Share of World Manufacturing Output, 1970-2008**

*"Over the prior decade, manufacturing accounted for approximately 65 percent of U.S. trade, and thus a weak manufacturing sector has contributed substantially to large and chronic trade deficits."**

*Bureau of Economic Analysis, U.S. International Transactions Accounts Data (U.S. International Transactions; accessed March 23, 2011), http://www.bea.gov/international/

**United Nations Conference on Trade and Development, UNCTAD Handbook of Statistics 2009 (New York: United Nations, 2009), http://www.unctad.org/en/docs/tdstat34_enfr.pdf

Percentage Loss in Manufacturing Jobs, 2000-2010



Source: *Why Does Manufacturing Matter? Which Manufacturing Matters?* Brookings Institute. From Bureau of Labor Statistics, Quarterly Census of Employment and Wages (manufacturing employees by state; accessed March 15, 2012), http://www.bls.gov/cew/.

31.8% of all manufacturing jobs lost from 2000-2011*

*Source: U.S. Department of Labor BLS and MGB Information services, 2011.

Advanced Manufacturing Office

Office Goals and National Importance

Presidential Initiative

Advanced Manufacturing Partnership
(Andrew Liveris and Susan Hockfield)

Technology

Facilities and infrastructure

Education and training

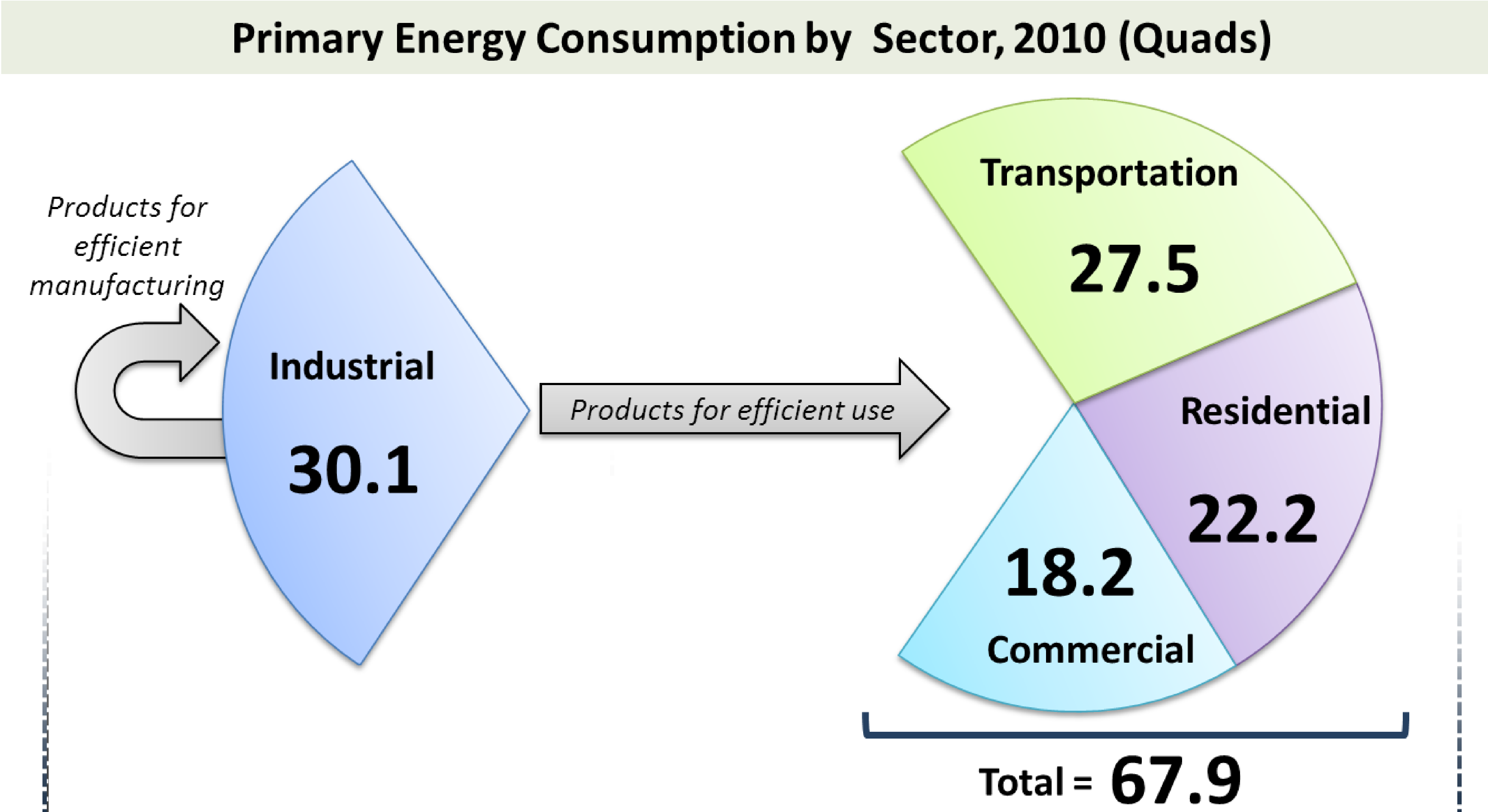
Policy

Manufacturing National Program Office
National Network for Manufacturing Innovation Institutes

EERE/AMO Focus

- **Manufacturing in the US**
- **GDP and employment enhancement**
- **Energy efficiency and clean energy industry**
- **Energy intensity and energy life cycle cost reduction**

Energy Economy-wide lifecycle impacts



Clean Energy Manufacturing Competitiveness Thrust

Strategy

Identify timely, high-impact, foundational clean energy technologies with the potential to transform energy use and accelerate their introduction into the US economy

1. Invest in competitively-selected, cost-shared **Projects** to support ***innovative manufacturing processes*** and ***next-generation materials manufacturing*** for clean energy and energy efficiency industry

2. Establish **Manufacturing Demonstration** (User) **Facilities *to reduce barriers to exploration of new ideas***

3. Engage with industry and other stakeholders to create a robust and scalable **Technology Deployment** program for existing technologies
   - Measurement and Verification
   - Information Sharing
   - Training

1. Innovative Manufacturing Initiative **Projects** in Foundational Technologies.

Foundational technologies: Definition

Foundational Technology: A technology capable of *transforming* technoeconomic systems

- **Transformative:** Results in significant change in the life-cycle impact (energetic or economic) of manufactured products
- **Pervasive**: Creates value in multiple supply chains, diversifies the end use/markets, applies to many industrial/use domains in both existing and new products and markets
- **Globally Competitive**: Represents a competitive/strategic capability for the United States
- **Significant in Clean Energy Industry**: Has a quantifiable *energetic* or *economic* value, embodied energy, economic (increase in GDP, increase in export value, increase in jobs created)

Industry response to Innovative Manufacturing Initiative

Massive industry interest

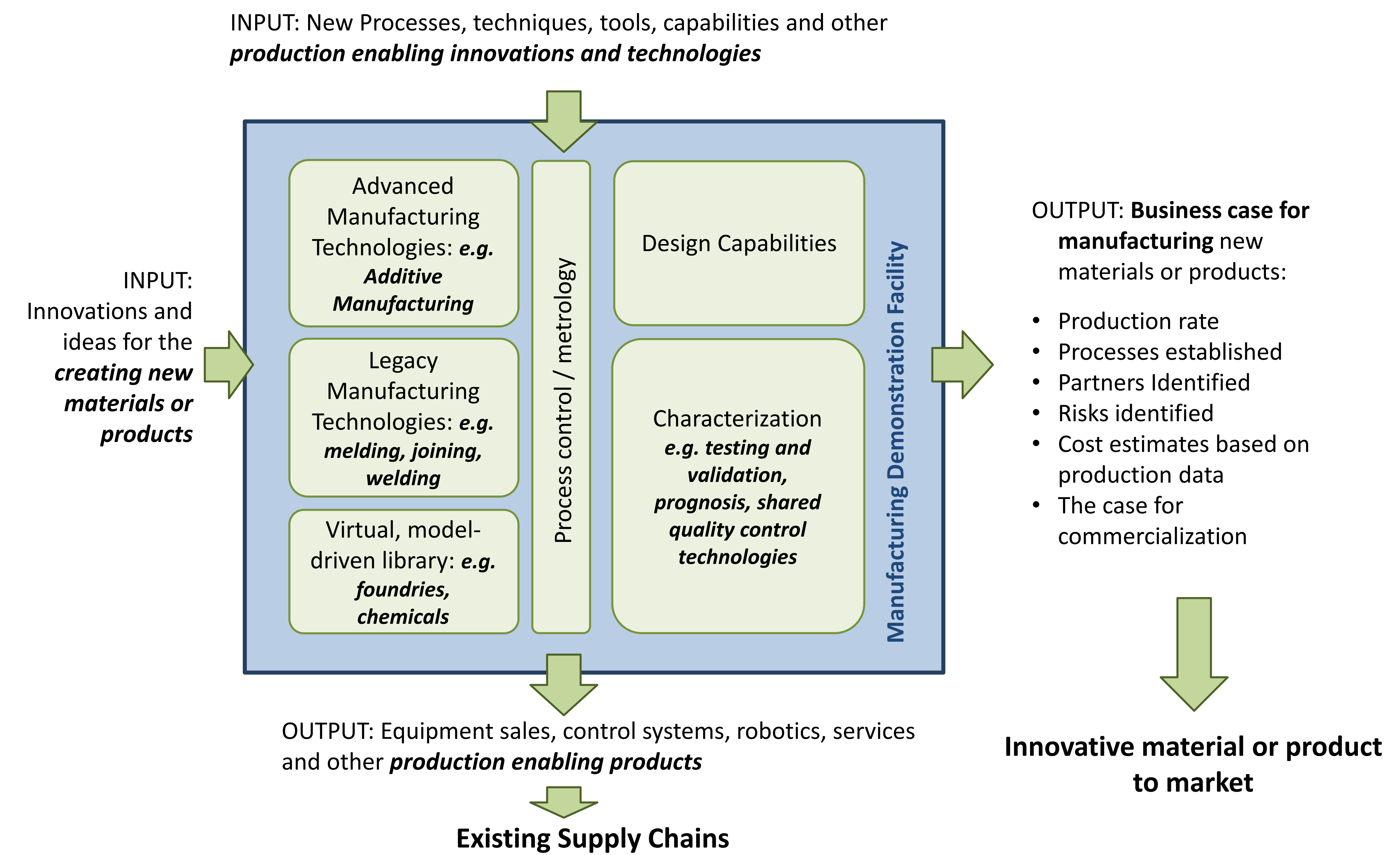
• Total Letters of Intent received (September 2011)	1408
• Applications for <$1 million each ($444,050,811 total)	532
• Applications for $1-9 million each ($3,902,771,450 total)	876
• Total Funds Requested	$4,346,822,261
• 672 small (<500 employees) companies of 859 total industry-led teams	78%
• Total Pre-proposals received (October 2011)	~1200
• Total Full Proposals received (December 2011)	253

As of FY12, only 13 projects could be funded due to budget constraints

2. Manufacturing Demonstration Facilities.

Manufacturing Demonstration Facilities (MDFs)

Two pathways through the MDF



MDF Example: Oak Ridge National Laboratory

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.

Carbon Fiber

Exit end of Microwave Assisted Plasma (MAP) process, jointly developed by ORNL and Dow

Program goal is to reduce the cost of carbon fiber composites by improved manufacturing techniques such as MAP, which if scaled successfully could reduce carbonization cost by about half compared to conventional methodology.

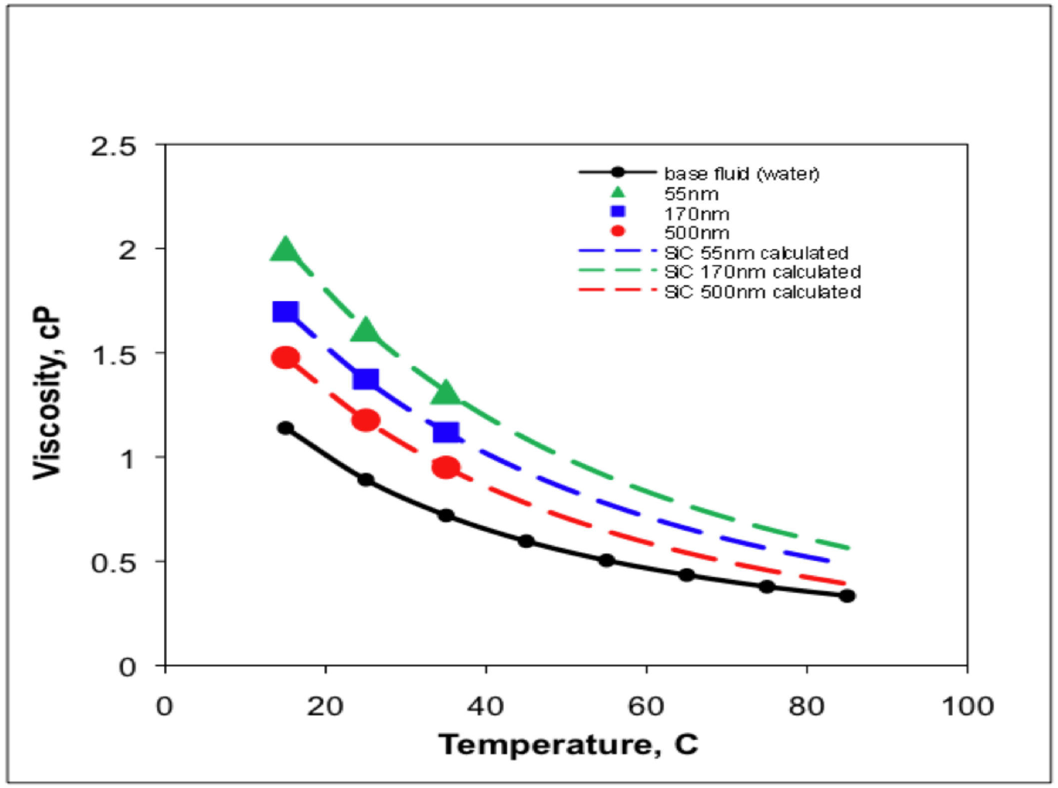
Potential MDF Focal Areas in Future Years

- **Low Cost Carbon fiber composites**
  Low cost, lower energy, high quality composites; impact for wind, automotive, aerospace and industrial applications
- **In-situ metrology and process controls**
  Optimization, reduced waste, lower cost; cross-cutting for many industries
- **Wide band gap semiconductor materials**
  Lower cost, improved quality for transformative use in power electronics, LEDs; broad reaching impacts from motors improvements, integration of renewables to the grid
- **Membranes**
  Lower energy separations; broad impact for petro-chemical industries, oil and gas, buildings.
- **Bio-manufacturing (sustainable nano-manufacturing)**
  Lower energy production pathways for useful products; impact to chemicals and other industries
- **Joining of disparate materials**
  Improved performance, quality; impact to automotive, aerospace and wind
- **Catalysis**
  Pervasive impact, conversion of methane to benzene
- **Materials processing**
  Low cost, lower energy, high performance metals; impact for aerospace, automotive, and industrial applications
- **Novel processing pathways**
  Low temperature processing, directed self assembly, high magnetic field processing, electrolytic
- **Directed/self assembly / architectured materials**
- **Amorphous materials/flexible materials**

DOE Nano Investment by Functional Applications.

Battery and Supercapacitors: A technology capable of *transforming* many industries including vehicles systems

Nanocoating/nanocomposites for thermal managment: Results in significant improvements in thermal conductivity for heat dissipation. Allow higher operating temperatures and increased efficiency.



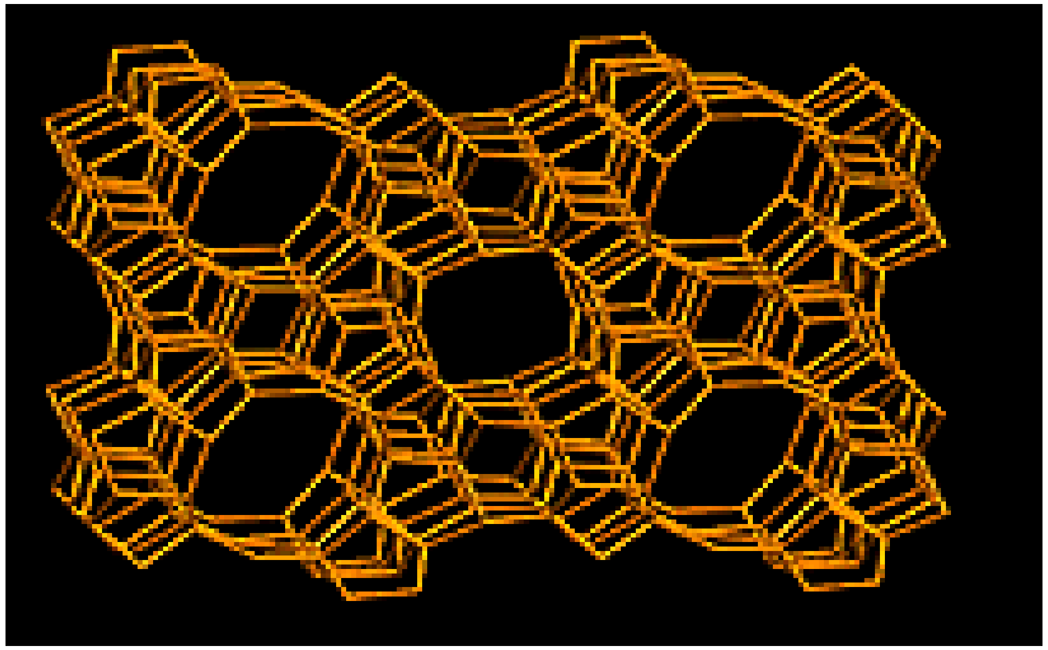
DOE Nano Investment by Functional Applications.

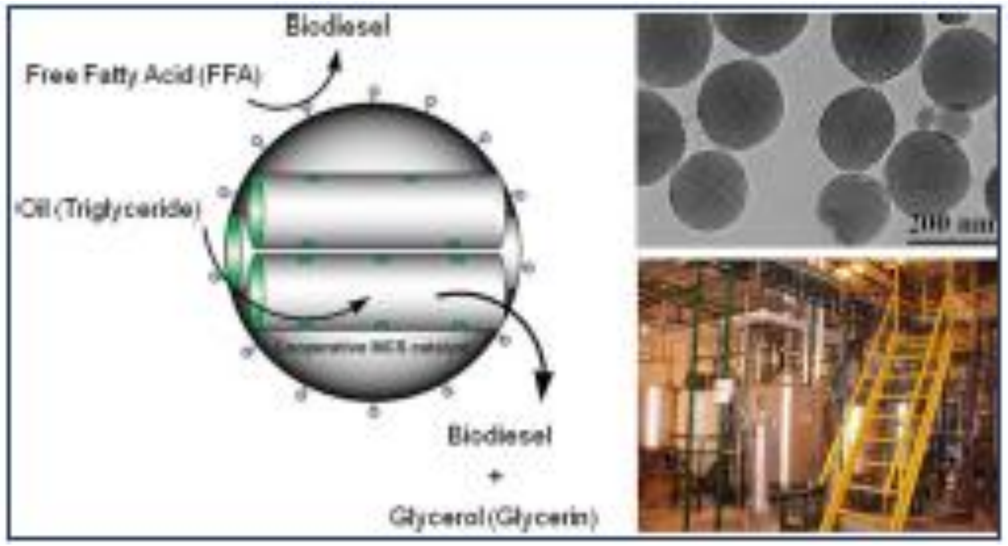
Catalysts for chemical, industrial, automotive applications:

Development of environmentally friendly catalysts that can enable more efficient processes are important for the chemical industry.

Catalysts for automotive applications can increase fuel efficiency and minimize harmful emissions.

New controlled synthesis technologies are needed to accelerate new catalyst development





NanoMaterial Research in High Efficiency Manufacturing:

Application of Wear-Resistant, Nanocomposite Coatings Produced from Iron-Based Glassy Powders

Purpose: Develop durable zeolite nanocatalysts utilizing urea as an NO_x reductant

- Benefits:
  - Increase the wear resistance and lifetime of steel parts
  - Application to various heavy industries

500 pound atomizer nanocomposite powders production

Workshop Goals

- EVALUATE the status and prospects for nanomaterial manufacture from sustainable resources. Quantify supply and demand in current markets and possible future scenarios
- IDENTIFY the key technologies and critical challenges in producing nano-materials from various sources for today's markets and for large-scale central and distributed production from renewable sources
- PRIORITIZE research and development needs to advance nanomaterials from renewable sources
- STRATEGIZE on how best to leverage R&D efforts in sustainable nanomaterials production among various government agencies

Closing Remarks

- Manufacturing in the U.S. is coming back
- Ideas abound in all sectors
- The 21 Century industrial revolution is going to be innovation and information driven and will be based on a clean, efficient and profitable industry

We are Partners.

How can we help you succeed?