Advanced Manufacturing Office

U.S. Department of Energy

Innovative Manufacturing Initiative Recognition Day

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U.S. DEPARTMENT OF ENERGY

What is manufacturing?

"The process of converting *ideas,* **raw materials, components, or parts into finished ~~goods~~** *products* **that meet a customer's** *desires,* **expectations or specifications."**

– Adapted from Businessdictionary.com, accessed 4/10/12

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

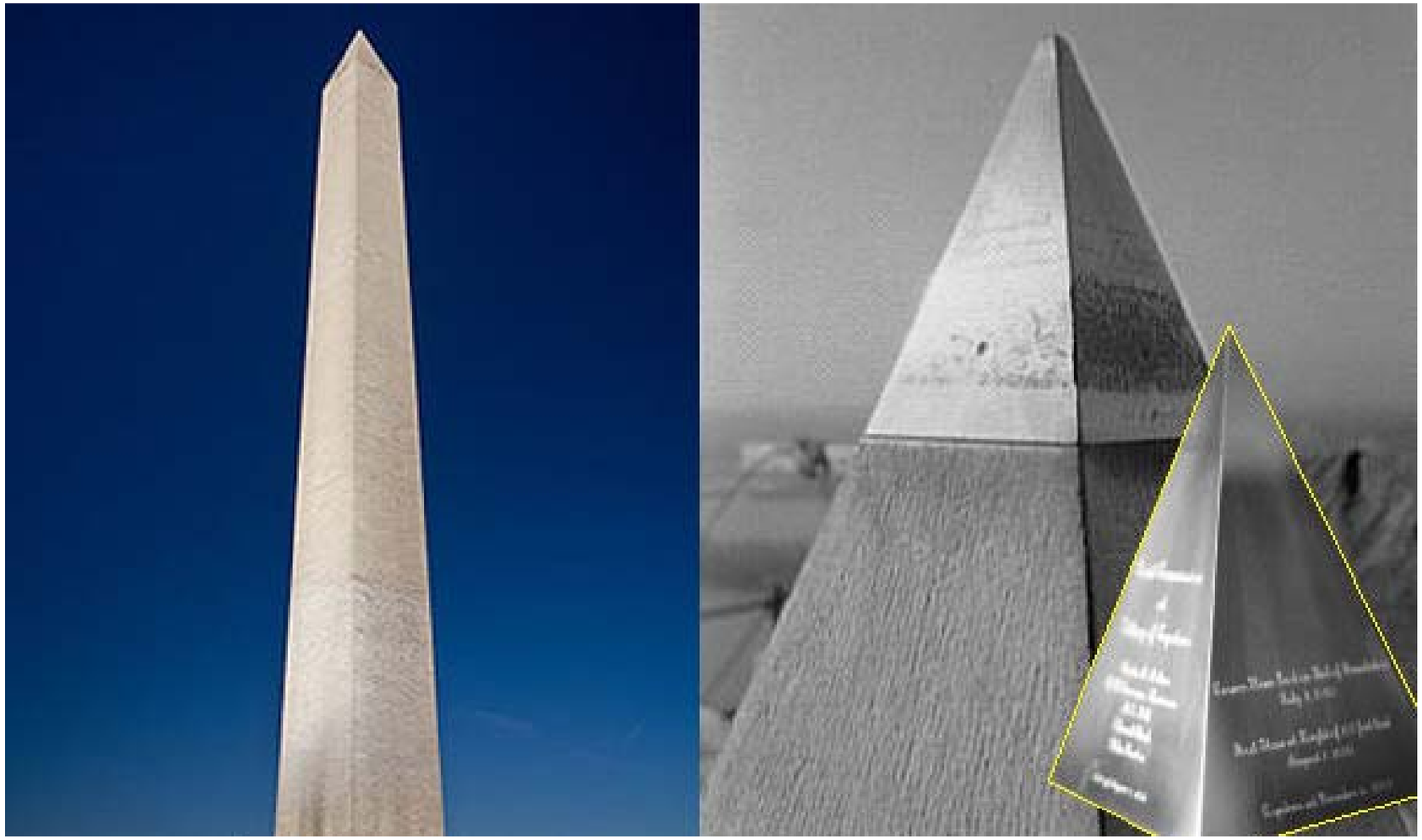
"We started assembly today"

- Orville Wright's Diary

October 9, 1903

Terry Wisser, DARPA/DSO, 2006

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.

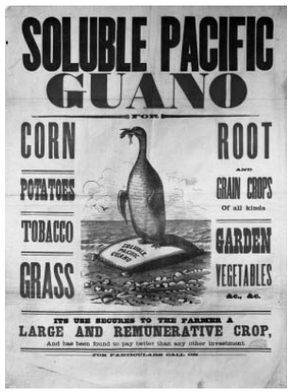
Reason:

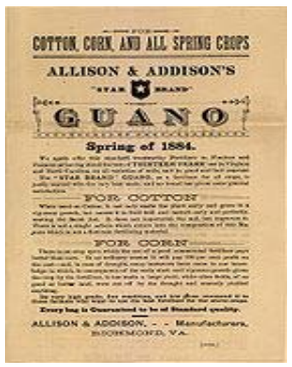
Innovative process for extraction of Al from ore

Keystone Technology

Adapted from Mark A Johnson, ARPA-E

"…the fixation of Nitrogen is vital to the progress of civilized humanity" - William Crookes (1898)
Royal Academy





Gunpowder

Fertilizer

1898:

Ammonia was the critical material of 1898; key to fertilizer and gunpowder

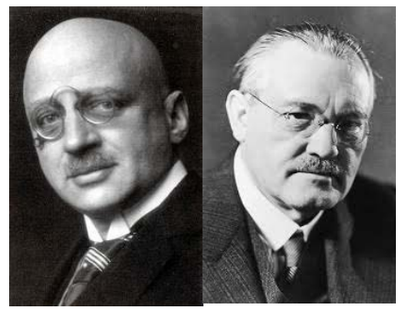
Global population on track to exceed 2,000,000,000

Today:

Ammonia costs fractions of a cent/mole

Reason:

Innovative process for the production of ammonia



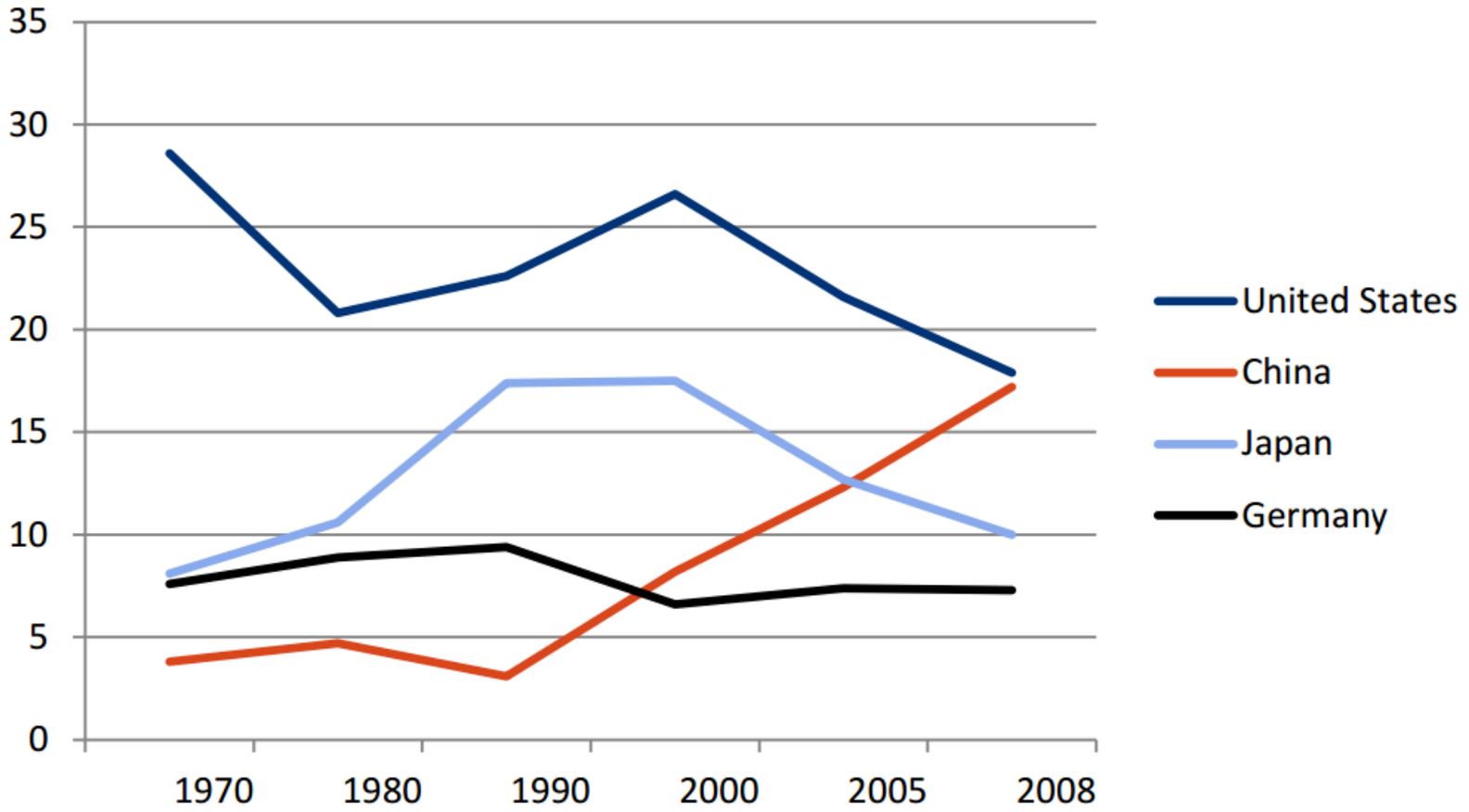
Haber **Bosch**

$N_2 + 3H_2 \rightarrow 2NH_3$

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.



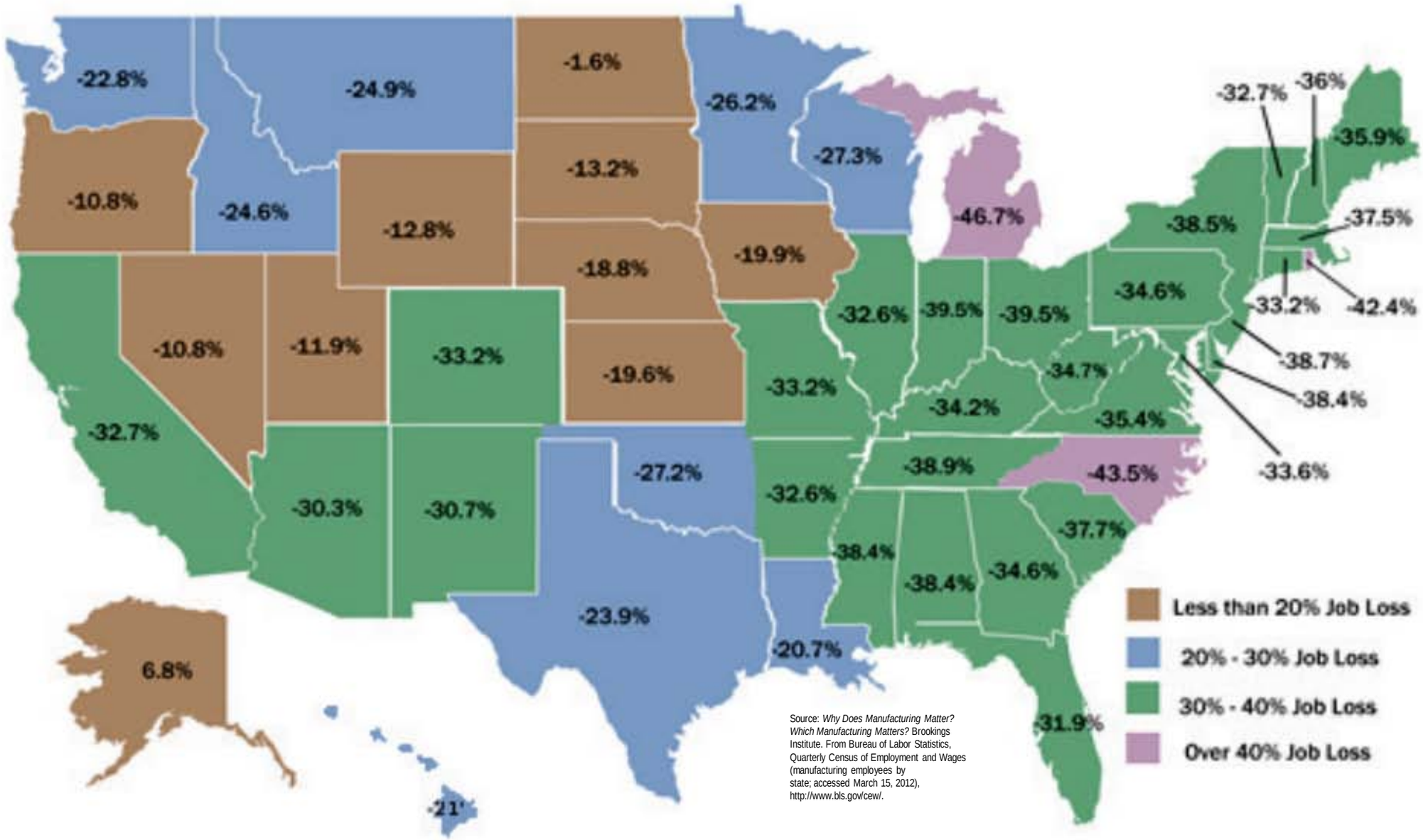
Select Country Share of World Manufacturing Output, 1970-2008**

*"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)

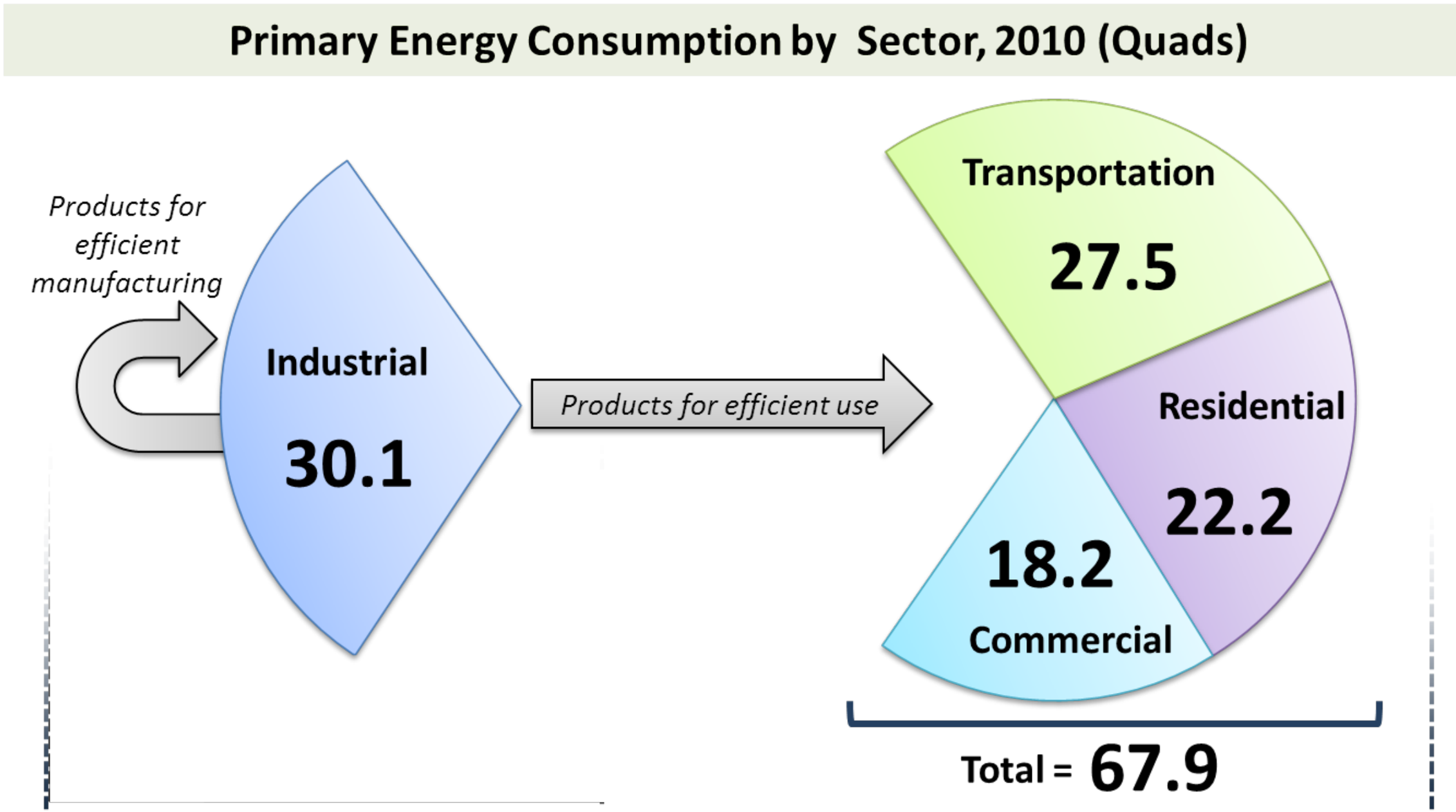
Technology	Facilities and infrastructure	Education and training	Policy

Manufacturing National Program Office
National Institutes for Manufacturing Innovation

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

Lets examine our investment strategy (reverse order)

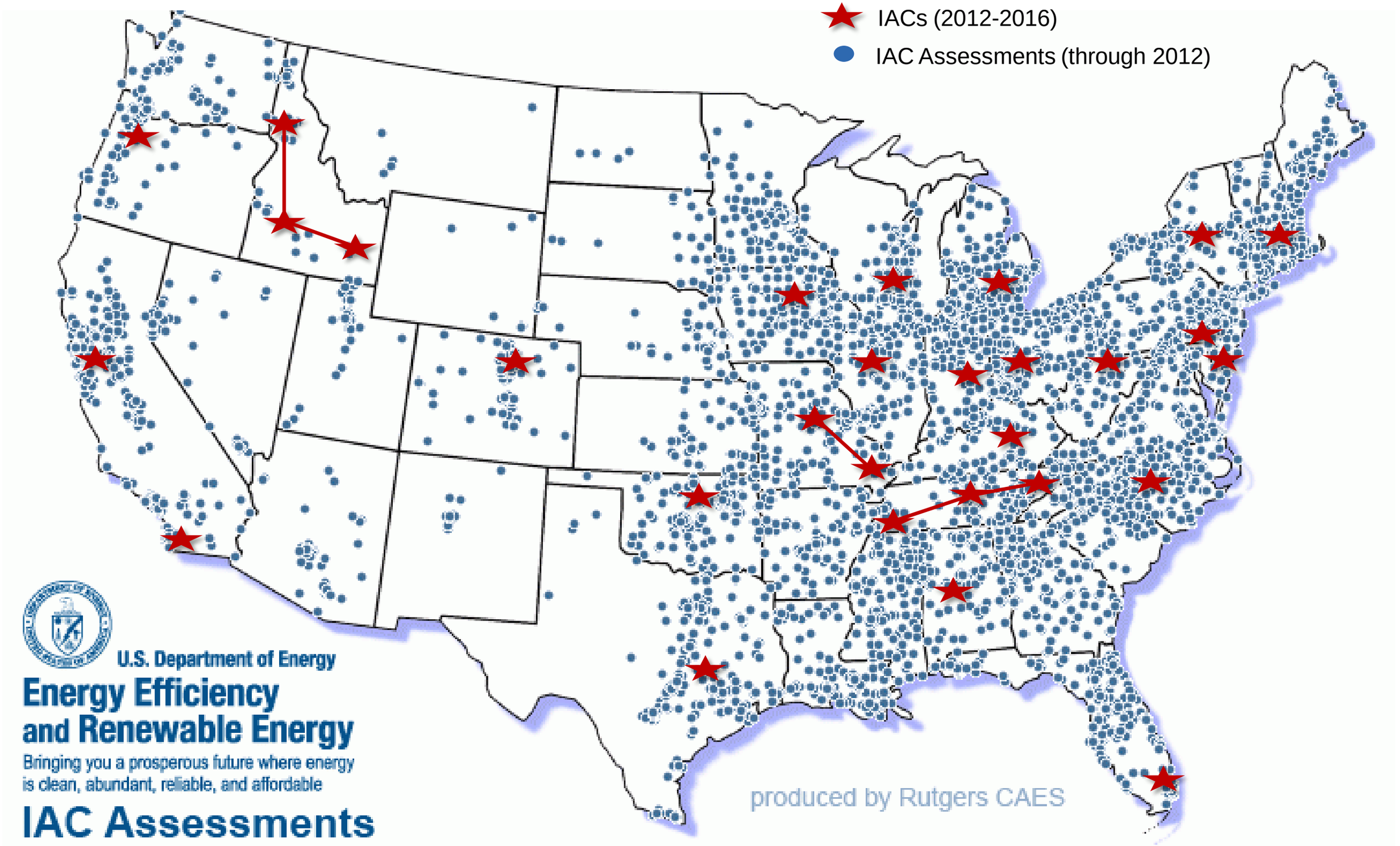
3. Technology Deployment.

Technology Deployment to Industry

Tech Deployment Activities include

1. Measurement
2. Standards
3. Knowledge diffusion
4. Training
5. Recognition
6. Identifying Market Barriers

Industrial Assessment Centers (IACs)



2. Manufacturing Demonstration Facilities.

Manufacturing Demonstration Facilities (MDFs)

Two pathways through the MDF

INPUT: New Processes, techniques, tools, capabilities and other ***production enabling innovations and technologies***

INPUT: Innovations and ideas for the ***creating new materials or products***

Advanced Manufacturing Technologies: ***e.g. Additive Manufacturing***

Legacy Manufacturing Technologies: ***e.g. melding, joining, welding***

Virtual, model-driven library: ***e.g. foundries, chemicals***

Process control / metrology

Design Capabilities

Characterization ***e.g. testing and validation, prognosis, shared quality control technologies***

Manufacturing Demonstration Facility

OUTPUT: **Business case for manufacturing** new materials or products:

- Production rate
- Processes established
- Partners Identified
- Risks identified
- Cost estimates based on production data
- The case for commercialization

Innovative material or product to market

OUTPUT: Equipment sales, control systems, robotics, services and other ***production enabling products***

Existing Supply Chains

MDF Example: Oak Ridge National Laboratory

Additive Manufacturing

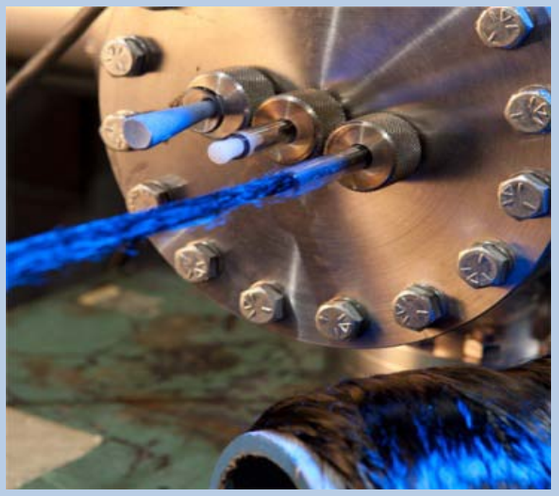
Arcam electron beam processing AM equipment

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

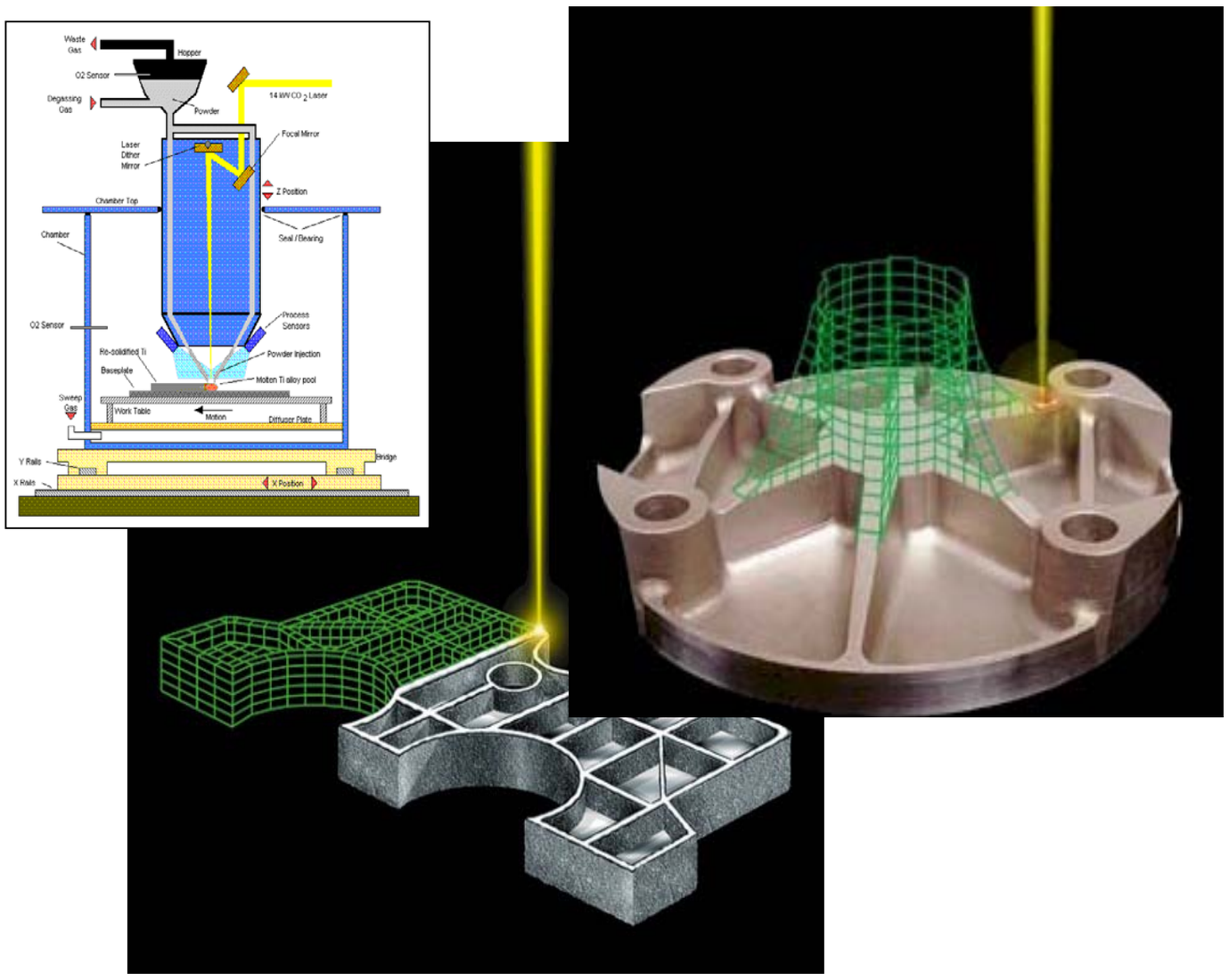
Exit end of Microwave Assisted Plasma (MAP) process, jointly developed by ORNL and Dow



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.

Advanced Processes?

Example: Additive Manufacturing



AeroMet process □Boeing, Northrup Grumman, NavAir

- **3-D graphical models, parts built in layers**
- **No tools, dies, or forms**
- **Near final shape**
- **Reduced delivery times 75%**
- **Mechanical properties equivalent to wrought**
- **Reduced material use**
- **Reduced inventory**
- **Significant cost and energy savings**

W. Coblenz, DARPA/DSO 2000

Promise of Additive Manufacturing

Unprecedented capability to design and create products

Topology optimization. Same strength, half the weight

"…in our lifetime at least 50% of the engine will be made by additive manufacturing" **– Robert McEwan GE**

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**

OTHER!!!!!

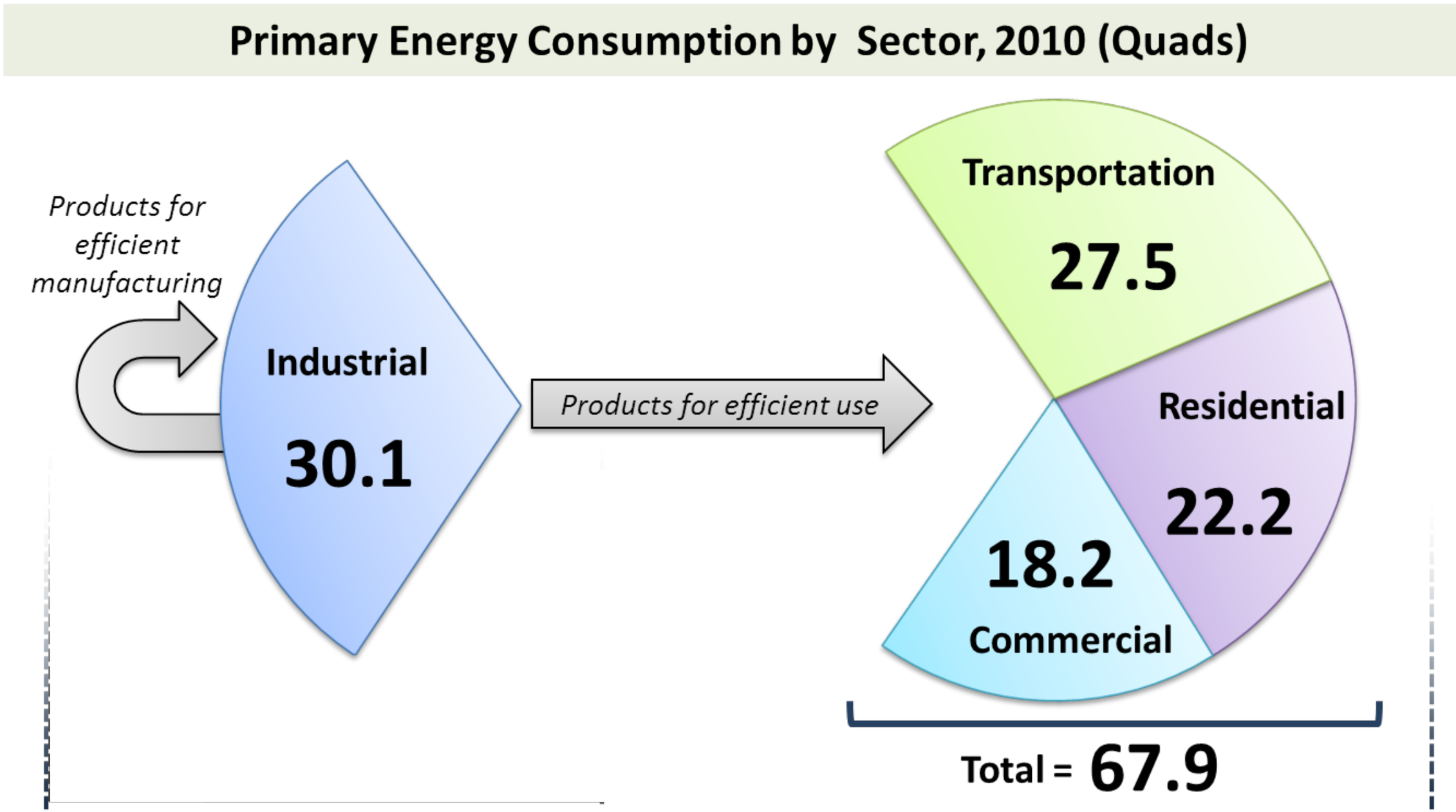
1. Innovative Manufacturing Initiative **Projects** in Foundational Technologies.

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)

Energy Economy-wide lifecycle impacts



Clean Energy Manufacturing Competitiveness Thrust

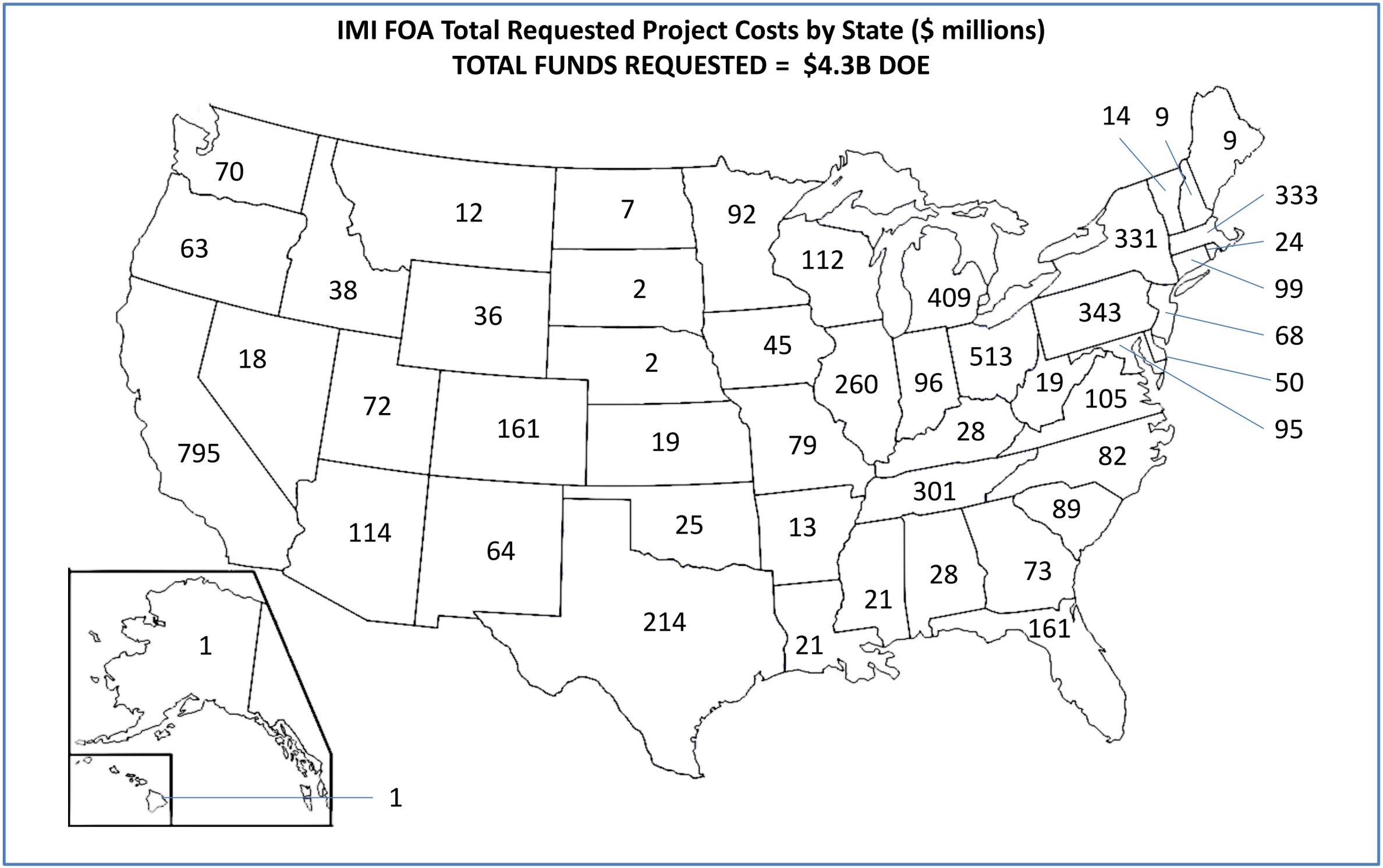
Industry response to Innovative Manufacturing Initiative

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

Industry response to IMI



2012 Awards

Technology Domain

1. **Chemicals**; Catalysts and Membranes
2. **Bio-processing**; Water reuse
3. **High temperature processing**; Iron making
4. **Waste Heat Recovery**; Waste heat, energy and chemical conversion
5. **Automation and equipment**; via Multi-scale Physics-based Process Modeling and Manufacturing
6. **Fabrication processes**; Machining; Die casting
7. **Thermal and degradation resistant materials**; Low-cost Production of Titanium
8. **Highly functional, high performance materials**; , Low Cost Bulk Gallium Nitride Substrates Growth, Low-Cost Carbon Fibers
9. **Energy storage materials**; Lithium Electrodes for Ultra High Energy Density Batteries

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?

IMI would not be possible without
expert review panels and technical experts

Thank you for your hard work and dedication!

Congratulations!!!

Lets be the “point of the spear” for the resurgence of US Manufacturing!!!!!