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

New Approaches to Manufacturing Innovation in DOE

March 6, 2013
TMS 2013 Annual Meeting

Dr. Robert Ivester
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Outline

U.S. Big Picture

EERE and the Advanced Manufacturing Office (AMO)

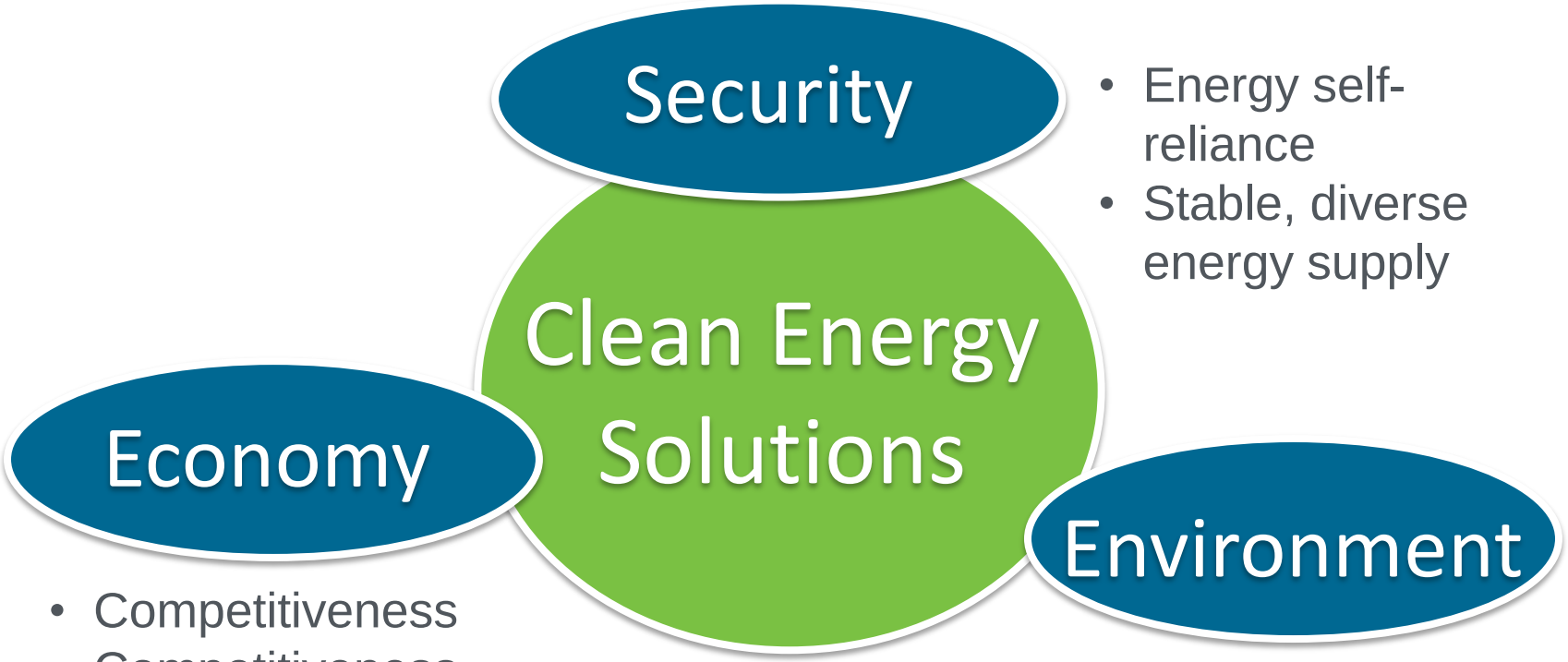
- Mission & Goals
- Portfolio management criteria
- Investment focus
- Technology focus

AMO Partnership-driven Approach

- R&D projects
- RD&D Infrastructure
- Technical assistance
- Advanced Manufacturing Partnership

Clean Energy: A Top Administration Priority

Part of All-the-above Strategy



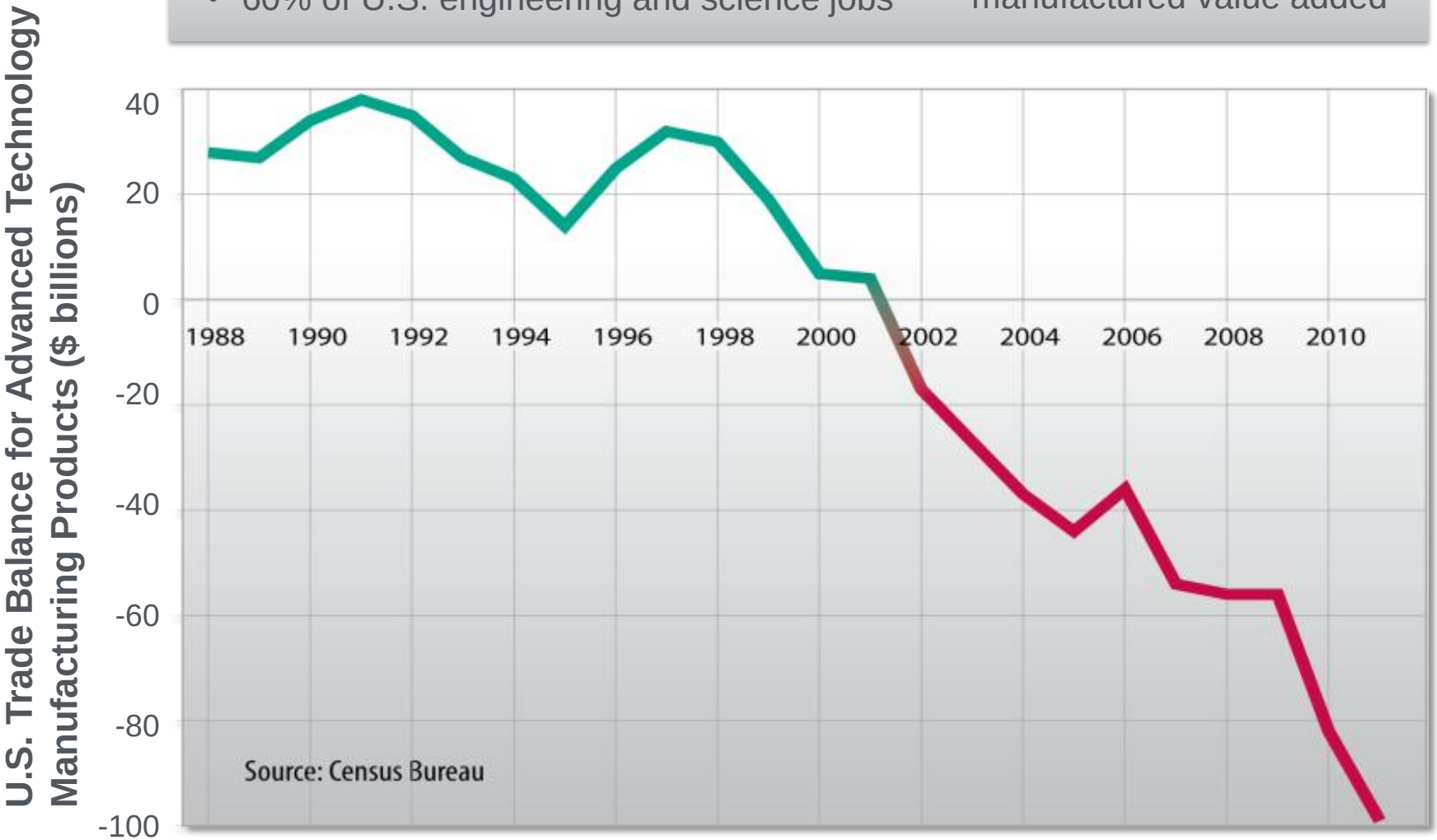
- Energy self-reliance
- Stable, diverse energy supply

- Competitiveness
- Competitiveness in clean energy
- Domestic jobs

- Clean air
- Climate change
- Health

An Issue of U.S. Economic Competitiveness

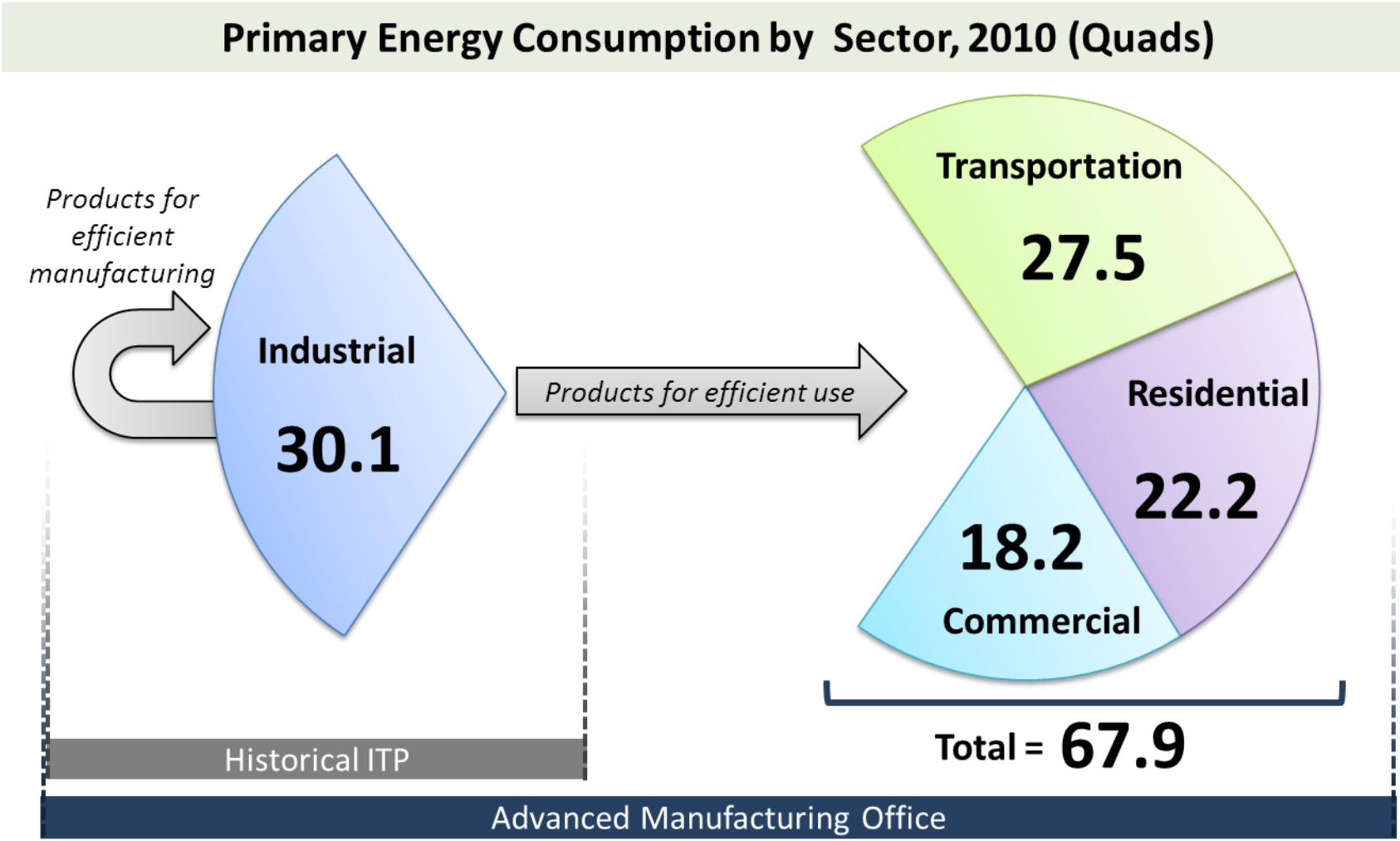
- 11% of U.S. GDP
- 12 million U.S. jobs
- 60% of U.S. engineering and science jobs
- 57% of U.S. Exports
- Nearly 20% of the world's manufactured value added



EERE and the Advanced Manufacturing Office (AMO)

- **Mission & Goals**
- **Portfolio management criteria**
- **Investment focus**
- **Technology focus**

AMO aims for economy-wide lifecycle impacts



Source: US EIA Annual Energy Review 2010, Table 2.1a. http://205.254.135.24/totalenergy/data/annual/pdf/sec2_3.pdf

EERE & the Advanced Manufacturing Office

Advanced manufacturing challenges are common to multiple clean energy technology production systems.

AMO Goals

RD&D

- Reduce the **life-cycle energy consumption** of manufactured goods by 50 percent over 10 years for AMO supported technologies
- Assist EERE to manufacture **clean energy technologies**

Technical Assistance

- Encourage a culture of continuous improvement in **corporate energy management**
- Support achievement of **40 GW of new combined heat and power** by 2020

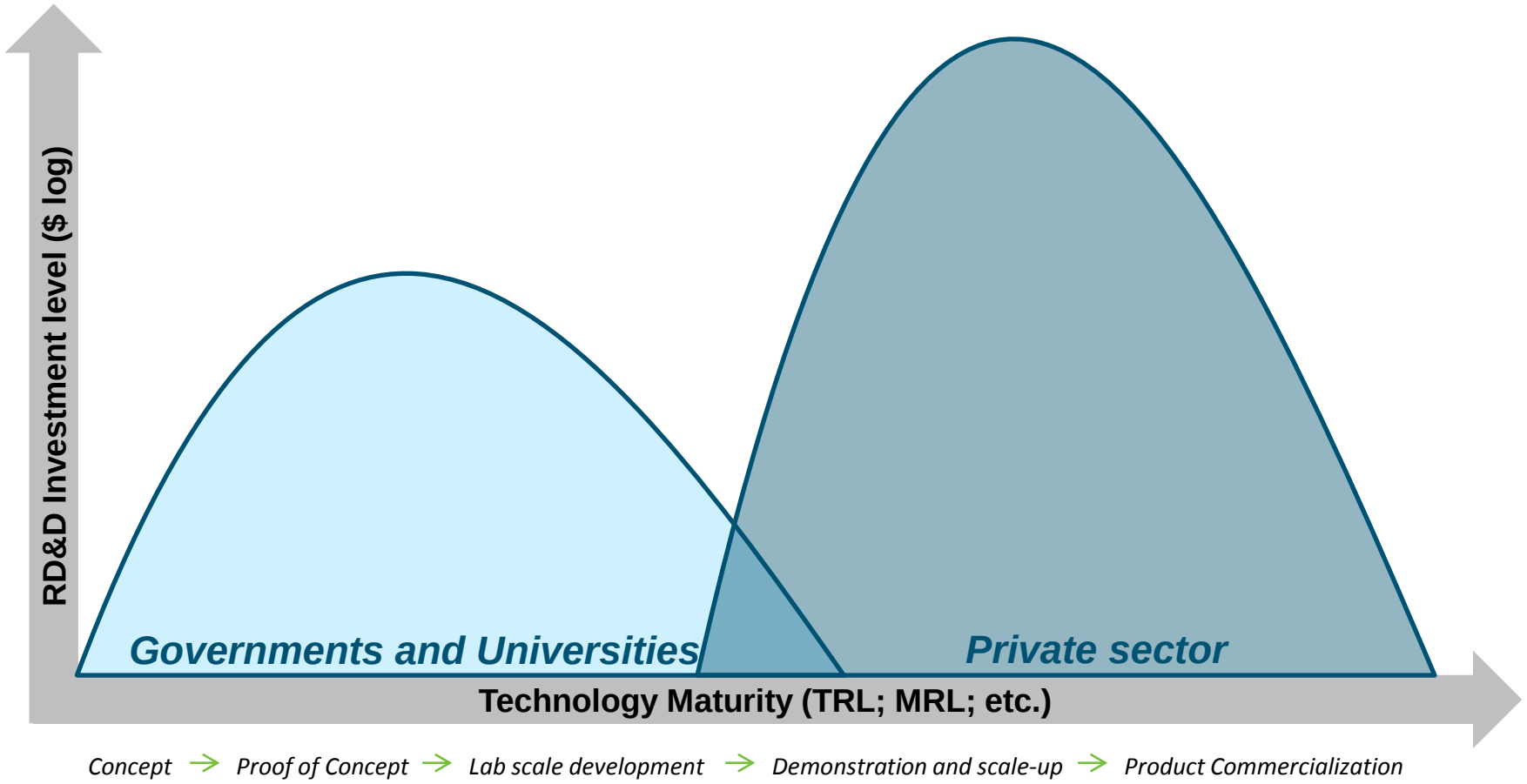
AMO RD&D *portfolio* management criteria

1. ***High Impact*** — high marginal returns and leveraged investments
2. ***Project Diversity*** — spread risk and increase chances for big wins
3. ***Nationally Important Projects at the Critical Phase*** – provide only the minimal marginal investment required to encourage a larger private sector investment
4. ***Invest in Energy Impacts*** — enable better energy systems throughout the economy

*"Report to the President on Capturing Domestic Competitive Advantage in Advanced Manufacturing" PCAST , July 2012.
http://www.whitehouse.gov/sites/default/files/microsites/ostp/pcast_amp_steering_committee_report_final_july_27_2012.pdf

AMO RD&D Focus: Bridging the Gap

AMO Investments leverage strong Federal support of basic research by partnering with the private sector to accelerate commercialization



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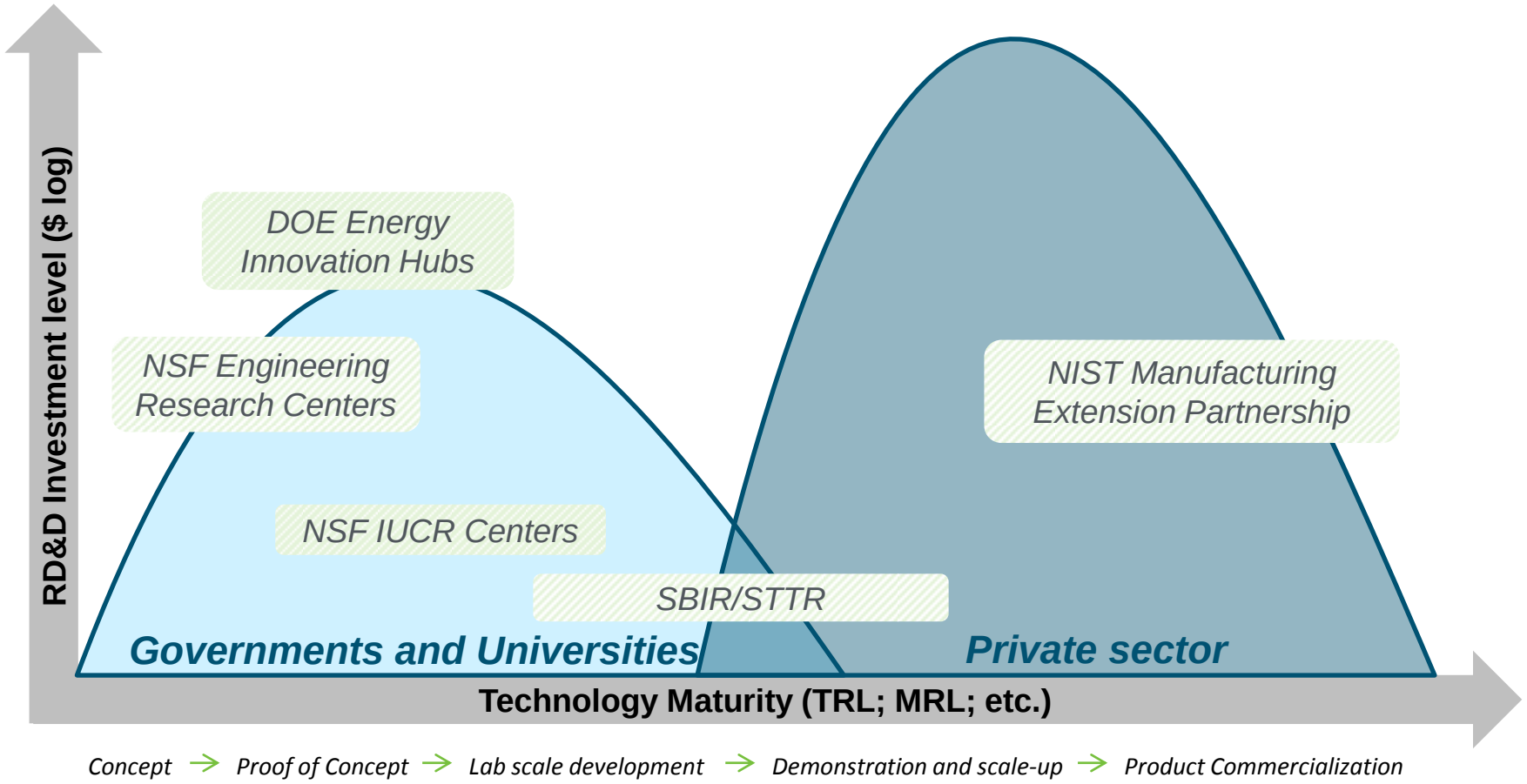

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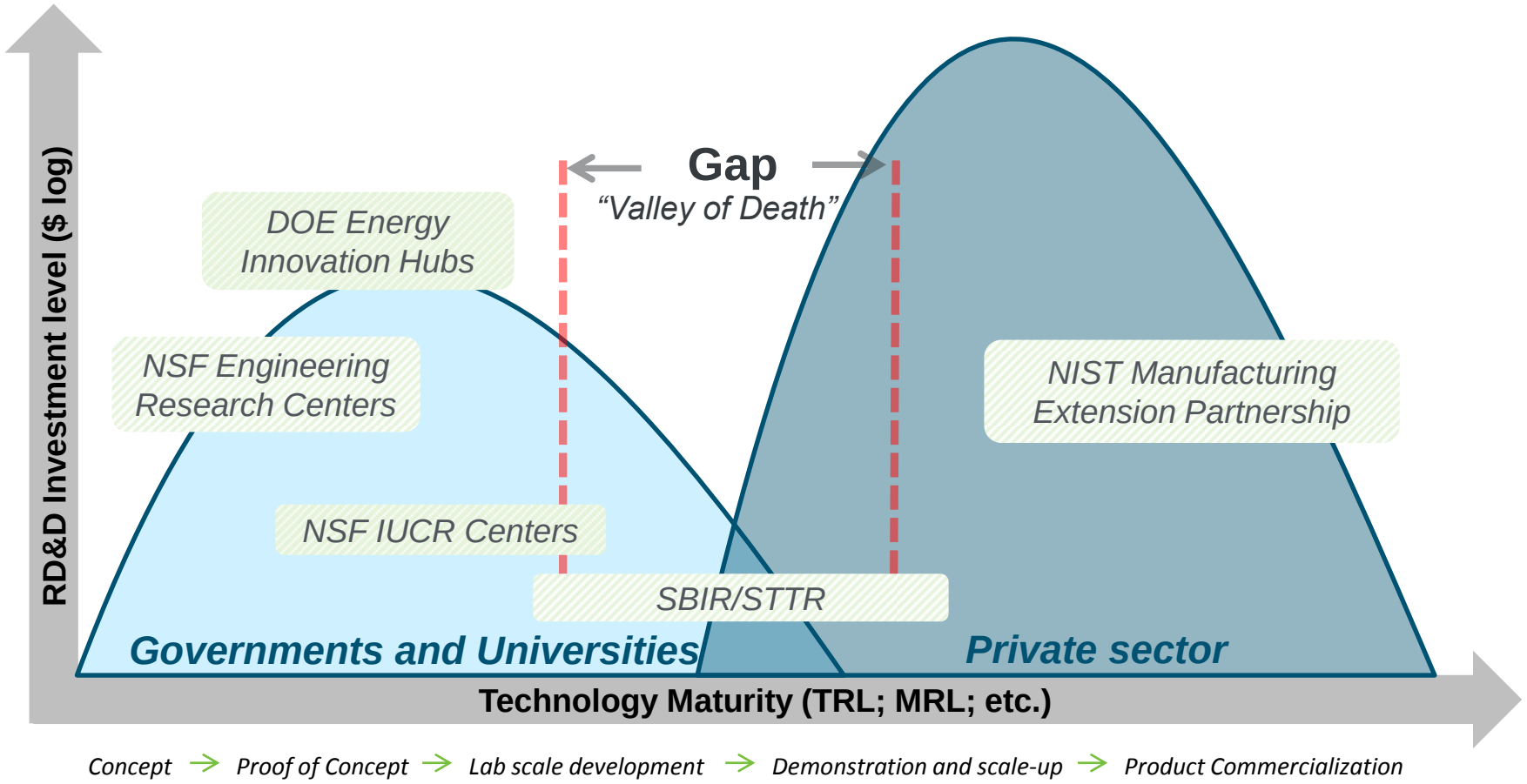

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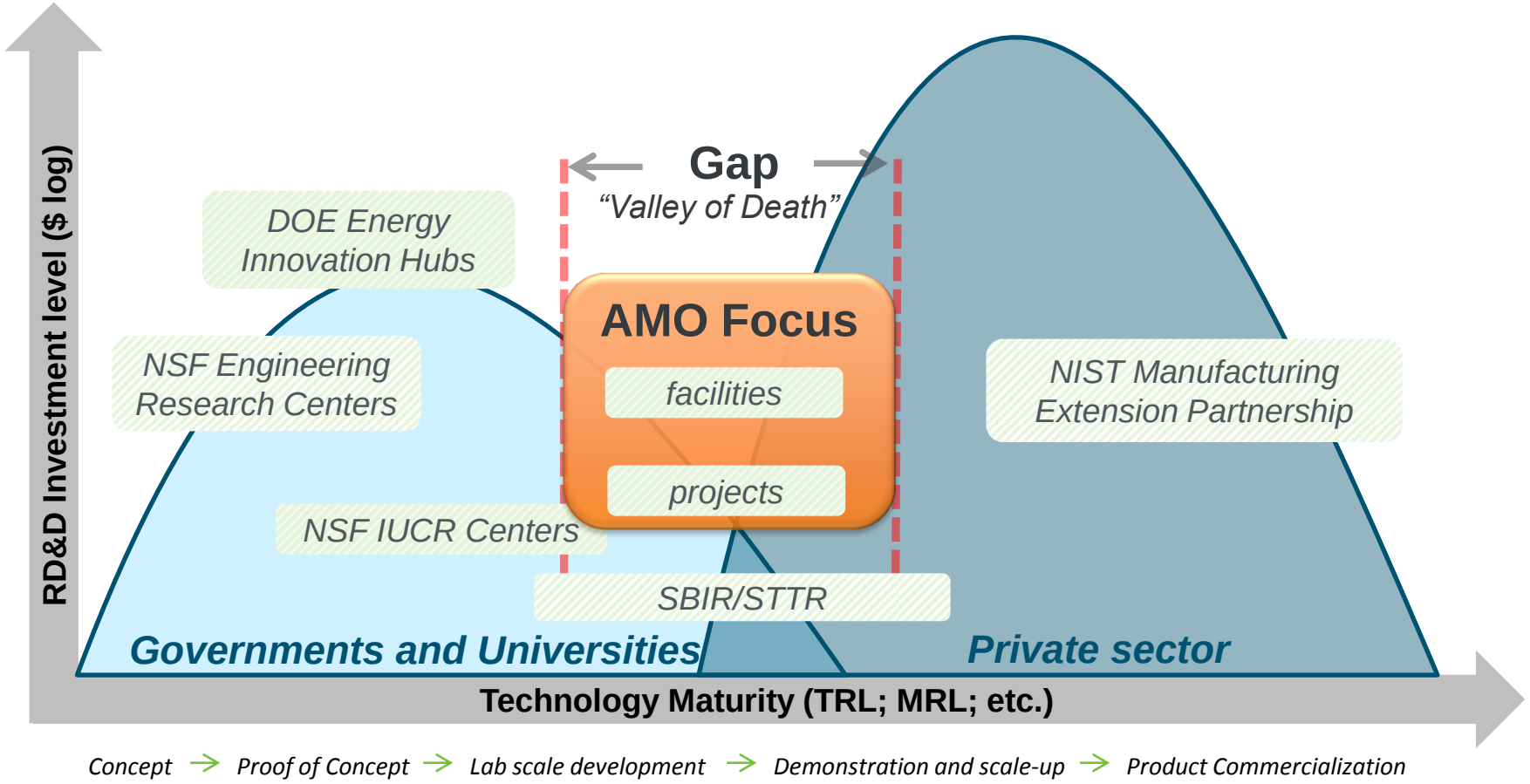


AMO Technology focus

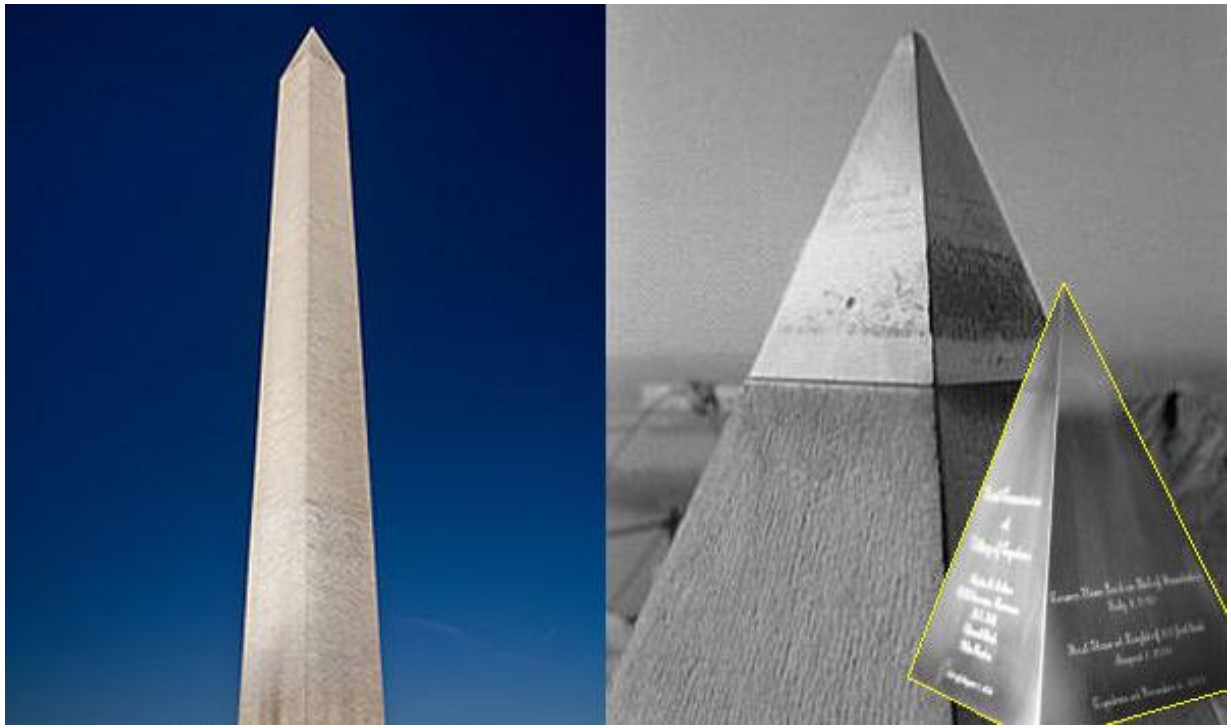
AMO invests in "**foundational technologies**"

A **foundational technology** has a high economic and energetic impact relative to the technology development cost. Foundational technologies are broadly applicable and pervasive across many industries and markets.

Example foundational technology areas include ***but are not limited to***:

- Low Cost Carbon Fiber Composites
- Low Cost, Lightweight Metal Structures
- Manufacturing of Biobased Products
- In-Situ Metrology and Process Controls
- Multimaterial Joining*
- Microwave (MW) and Radio Frequency (RF) for Advanced Manufacturing*
- Sustainable Nanomaterials*
- Membrane Technology*
- Wide Bandgap Semiconductors*

Foundational Technology Example



1884:

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

The highest skilled craftsman working on the Washington Monument was paid $2/day.

Today:

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

Reason:

Innovative process for extraction of Al from ore

Foundational Technology Example

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

1898:

- Ammonia was the critical material of 1898; key to fertilizer and gunpowder
- Global population on track to exceed 2,000,000,000
- Food production (wheat) in concentrated locations (US)

Today:

- Ammonia costs fractions of a cent/mole

Reason:

- Innovative process for the production of ammonia

Haber

Bosch

$N_2 + 3H_2 \rightarrow 2NH_3$

Partnership driven

Three primary partnership-based vehicles to engage with industry, academia, national laboratories, and local and federal governments:

1. **Research, Development, and Demonstration Projects - to support innovative manufacturing processes and next-generation materials**

2. **RD&D Infrastructure** - to reduce barriers to exploration of new ideas

3. **Technical Assistance -** to industry to create a culture of continuous improvement in corporate energy management

RD&D Projects

Innovative Manufacturing Initiative

- **Goal:** Enable a **doubling of energy productivity** in U.S. industry
- **Plan:** Public-private project partnerships to accelerate commercialization of new product or process technologies at industrially relevant scales
- **Focus:** Cross-cutting, foundational technologies
  - **Example:** Working with PolyPlus Battery Company to increase lithium batteries' energy density by 2-10X at 50% cost with a goal of increasing from small applications to vehicles within 10 years
- **Funding:** 13 initial selections in FY12 (~$54 M DOE); 26 projects held for potential funding based on pending FY13 budget

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RD&D Infrastructure: Manufacturing Demonstration Facilities

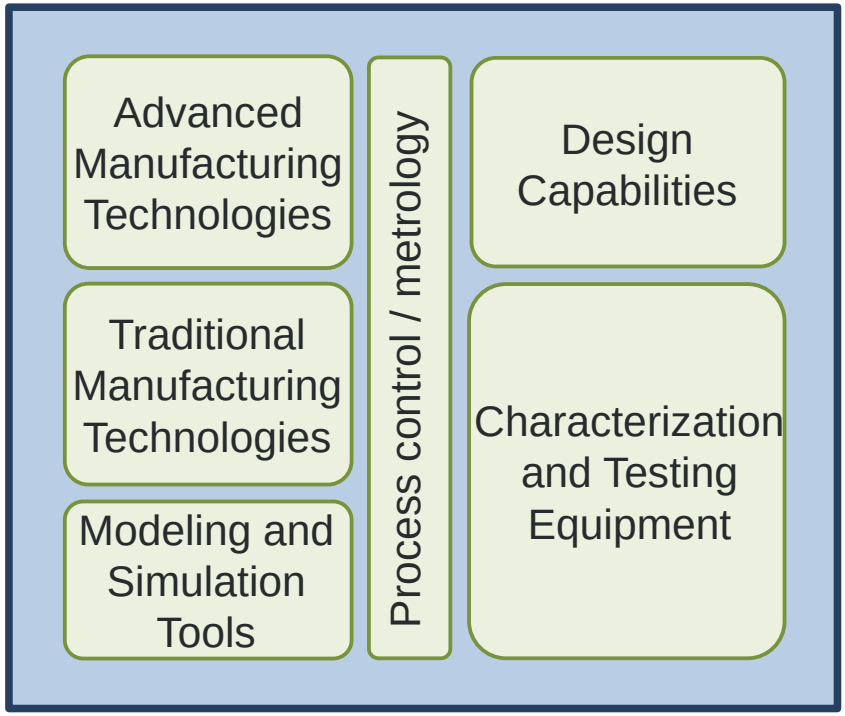
Barriers addressed:

- Access to expensive technologies and capabilities
- Sharing overhead costs - more efficient use of capital
- Increases visibility of unknown process options
- Accelerates partnership development and supplier relationships

Effect on U.S. competitiveness:

- Increased pool of domestic competitors, especially SMEs
- Increased rate of new product development
- Positive feedback between production and research/design accelerates both

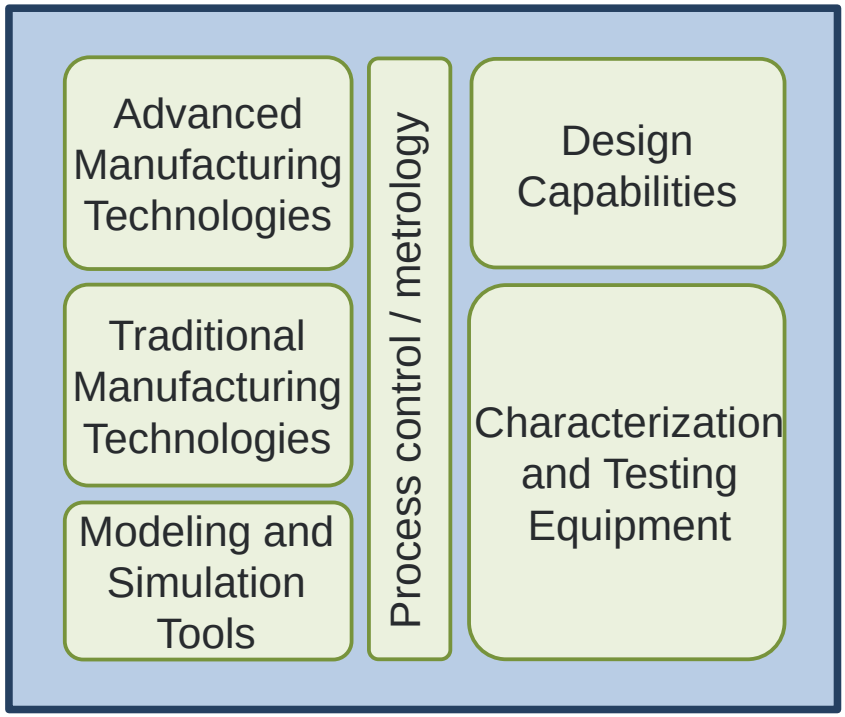
RD&D Infrastructure: Manufacturing Demonstration Facilities



Manufacturing Demonstration Facilities provide access to these physical and virtual tools to foster collaboration and act as a proving ground to accelerate progress

RD&D Infrastructure: Manufacturing Demonstration Facilities

INPUT: Innovators with ideas for ***new materials or products***

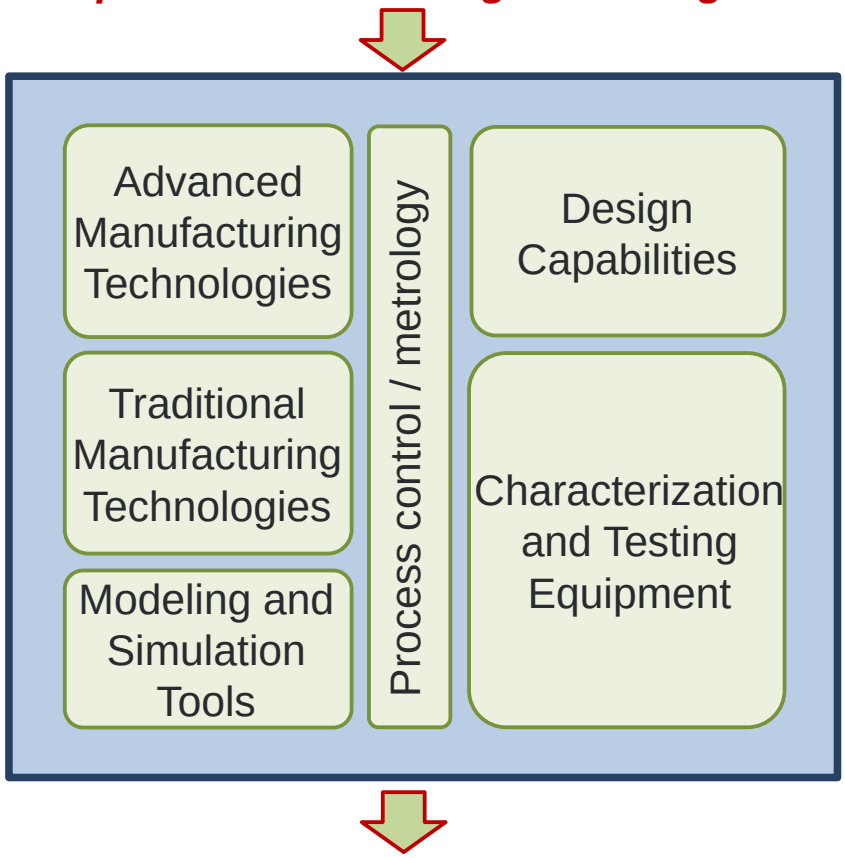


OUTPUT: Data to demonstrate **business case for manufacturing new materials or products:**

- Processes established
- Production rate data
- Cost estimates based on production data
- Risks understood / quantified
- Partners Identified

RD&D Infrastructure: Manufacturing Demonstration Facilities

INPUT: Innovators with ***new production-enabling technologies***



OUTPUT: ***Market adoption*** of innovative new production-enabling technologies

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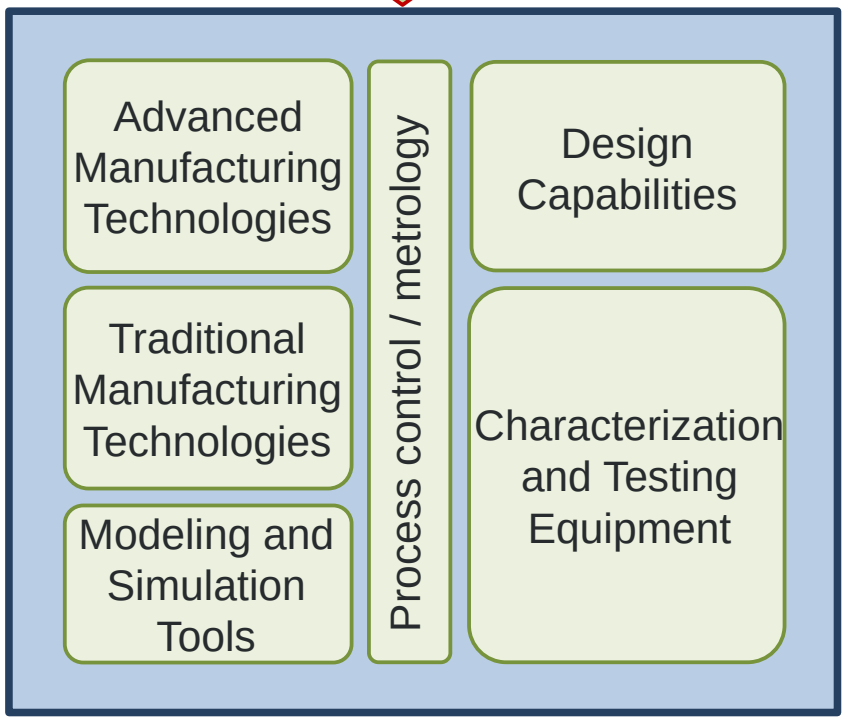

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Innovative materials or products to market

The Oak Ridge National Lab Manufacturing Demonstration Facility

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

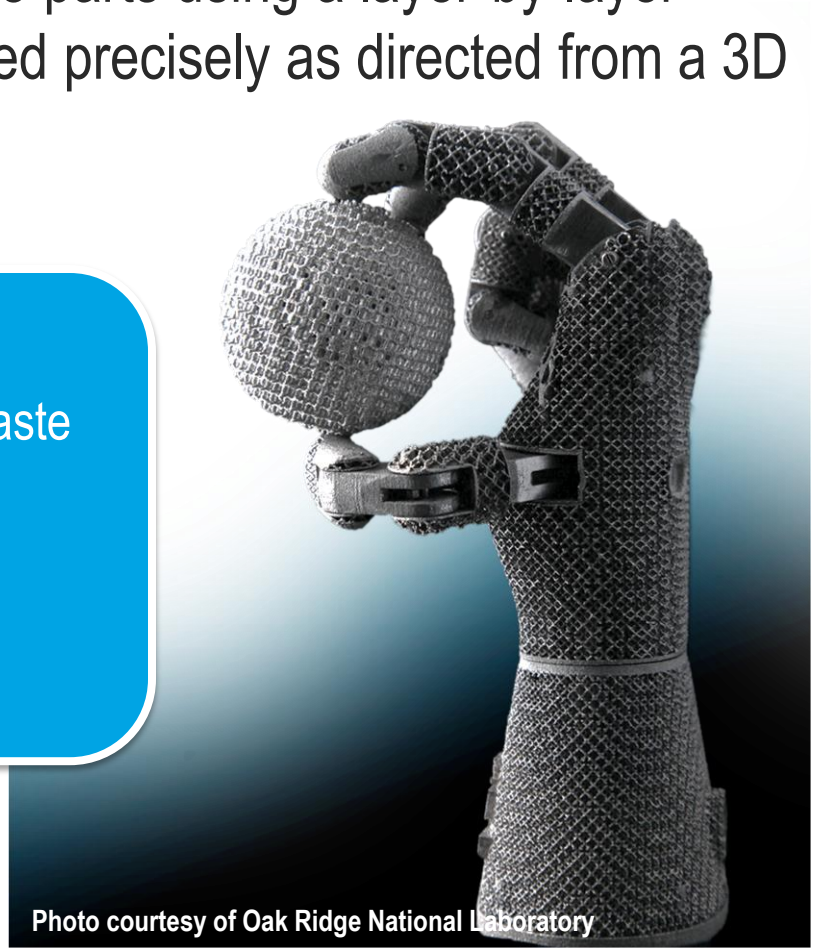
Program goal is to reduce the cost of carbon fiber composites by improved manufacturing techniques such as MAP, which if scaled successfully could reduce carbonization cost by about half compared to conventional methodology.

Additive Manufacturing

Additive manufacturing, commonly known as “3D Printing,” is a suite of emerging technologies to fabricate parts using a layer-by-layer technique, where material is placed precisely as directed from a 3D digital file.

Additive manufacturing can[1]:

- reduce energy intensity and waste
- enable remanufacturing
- support innovative designs
- create agile supply chains
- reduce time to market



[1] http://www1.eere.energy.gov/manufacturing/pdfs/additive_manufacturing.pdf

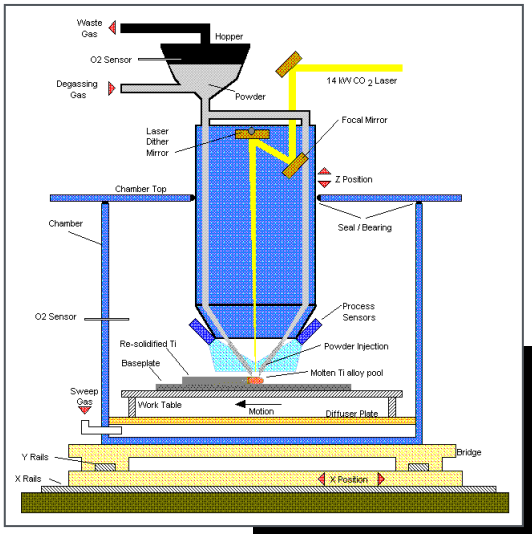
Promise of Additive Manufacturing

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

Example: Additive Manufacturing



AeroMet process □ Boeing, Northrup Grumman, NavAir

W. Coblenz, DARPA/DSO 2000

- **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**

RD&D Infrastructure:
The Critical Materials Energy Innovation Hub

Critical materials* – elements that are key resources in manufacturing clean energy technologies

- Enable wind turbines, solar panels, electric vehicles, and energy-efficient lighting

Goal – reduce the impact of supply chain disruptions and price fluctuations

- integrate scientific research, engineering innovation, and manufacturing and process improvements
- develop solutions including mineral processing, manufacture, substitution, efficient use, and end-of-life recycling

Funding – investing up to $120 million over five years (2013-2017)

- Consortium of 4 national laboratories, 7 universities and 8 companies
- Led by Ames National Laboratory

* As defined by U.S. Department of Energy. 2011. *Critical Materials Strategy*. Washington, DC: DOE.

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Industrial Technical Assistance

Better Plants Program – companies publicly pledge to reduce energy intensity 25% in 10 years

- **118 companies** participating, representing 1,400 manufacturing plants and close to 6% of the total U.S. manufacturing energy footprint
- Partner companies **improved energy intensity 3.15% in 2011**
- **Recognition** and **technical guidance** for partner companies
- Always looking for **new companies to join** this partnership

Better Plants
U.S. DEPARTMENT OF ENERGY

Partnership driven

The Advanced Manufacturing Partnership

- a coordinated national strategy

AMO is a member of the **Advanced Manufacturing Partnership**

The Advanced Manufacturing Partnership

Spark a renaissance in American manufacturing through public private partnerships that help our manufacturers compete with anyone in the world

Office of Energy Efficiency and Renewable Energy

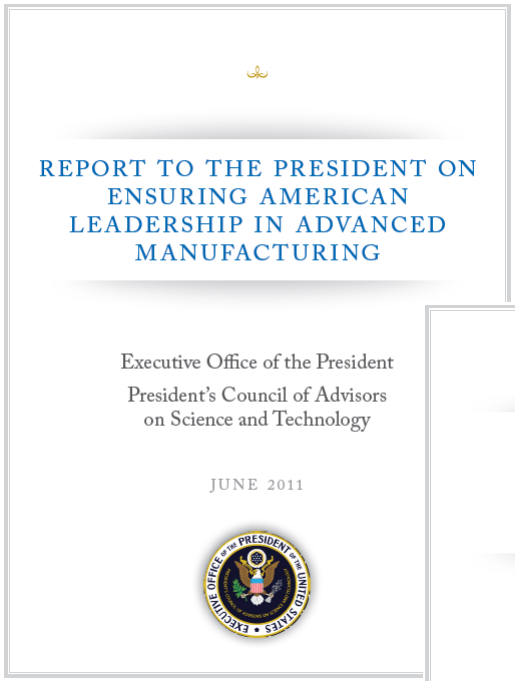
U.S. Dept. of Energy

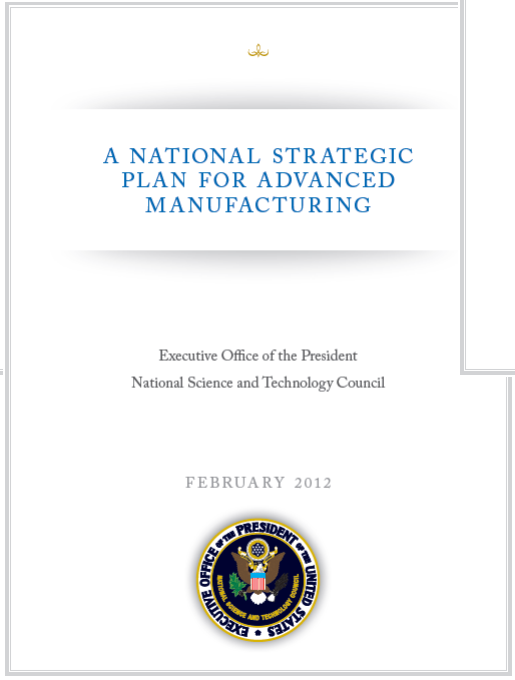
Strengthen America's energy security, environmental quality, and economic vitality through enhanced energy efficiency and productivity

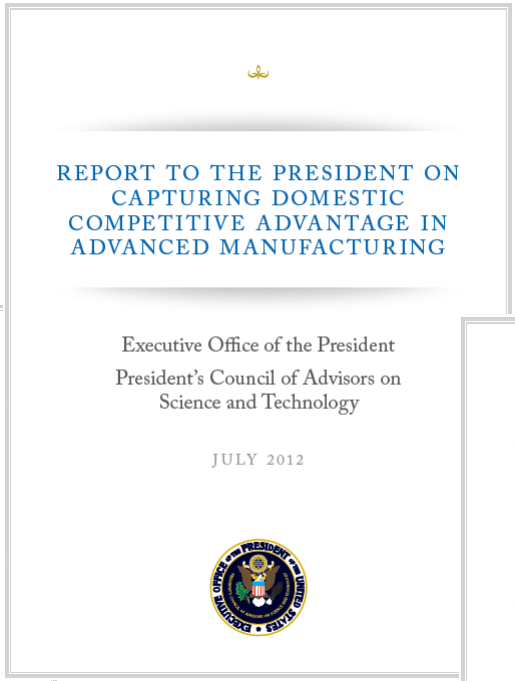
Advanced Manufacturing Office

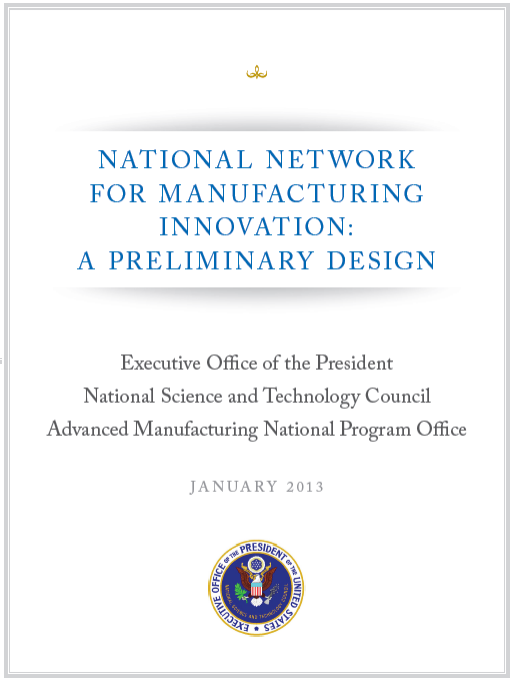
Co-invest with private and public partners to improve U.S. competitiveness, save energy, create high-quality domestic manufacturing jobs and ensure global leadership in advanced manufacturing and clean energy technologies

National Strategy









www.manufacturing.gov

National Additive Manufacturing Innovation Institute (NAMII)

The **National Additive Manufacturing Innovation Institute (NAMII)** is a public private partnership created through an interagency collaboration between the Departments of Defense, Energy, Commerce, NASA and NSF to **accelerate the adoption of additive manufacturing technologies** in the U.S. manufacturing sector and **to increase domestic manufacturing competitiveness.**

- The goal of the institute is to bridge the gap between basic research and technology adoption.
- NAMII will also serve as an example of best practices for the National Network for Manufacturing Innovation (NNMI) as proposed by the Administration in March 2012.
- The National Center for Defense Manufacturing and Machining (NCDMM) was selected through a competitive process led by Air Force Man Tech personnel for an award of $30M in government funding which the proposing team matched with $39M to establish NAMII.

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