Manufacturing Demonstration Facilities Workshop

U.S. Department of Energy

Advanced Manufacturing Office

March 12, 2012 Chicago, IL

Welcome

- Agenda:
  - 8:00: Registration and Breakfast
  - 9:00: Welcome and Introductory Remarks
  - 9:30: The Advanced Manufacturing Partnership
  - 10:00: Manufacturing Demonstration Facility Overview
  - 10:30: Break
  - 10:45: MDF Form and Function
  - 11:45: Question and Answer Session
  - 12:15: Lunch and Networking Session
  - 1:30: Manufacturing Ecosystems
  - 2:00: Keystone Technologies
  - 2:30: Question and Answer Session
  - 3:15: Closing Remarks

Welcome

- We want your feedback
- Discussion times are fluid and will be adjusted as needed
- Comments will be collected in person and online
- Live webinar, recorded workshop, and FAQs available through the Advanced Manufacturing Office website

Advanced Manufacturing Office

http://youtu.be/D2nrizDZJHk

New materials and manufacturing methods can change the landscape of the world

The New York Times

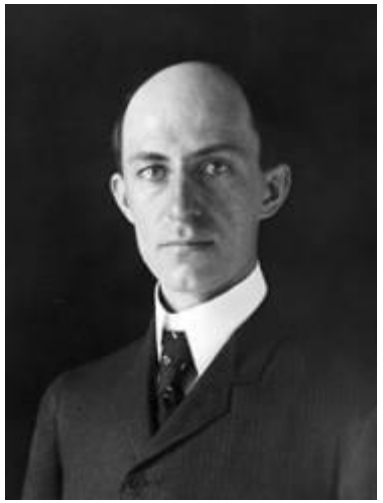
"The machine
which will really fly
might be evolved by the
combined and continuous
efforts of mathematicians
and mechanicians
in from one million
to ten million years"

October 9, 1903

"We started assembly today"

Orville Wright's Diary

October 9, 1903



Terry Wisser, DARPA/DSO, 2006

New materials and manufacturing methods can change the landscape of energy solutions

In 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.

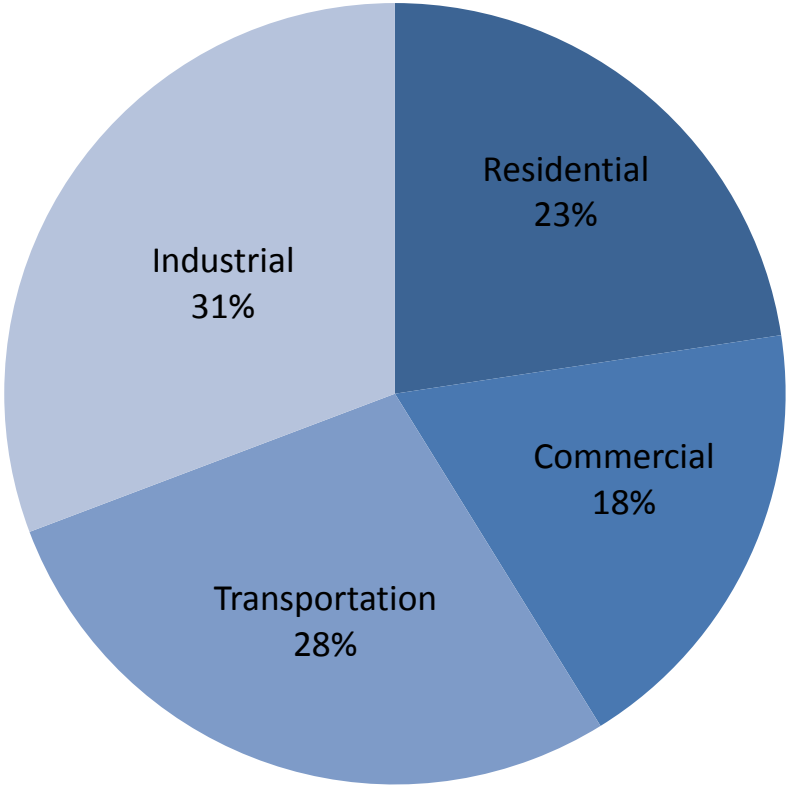
Today's prices: Al = 6¢/ oz Au ~ $1776/oz.

Steve Chu, DOE, 2012

Manufacturing is Important

Industry and Manufacturing:

- **Constitutes 11% of GDP**
- **Employs 12 million people**
- **Employs 60% of engineers and scientists**
- **Accounts for ~30% of all energy consumption in the United States**

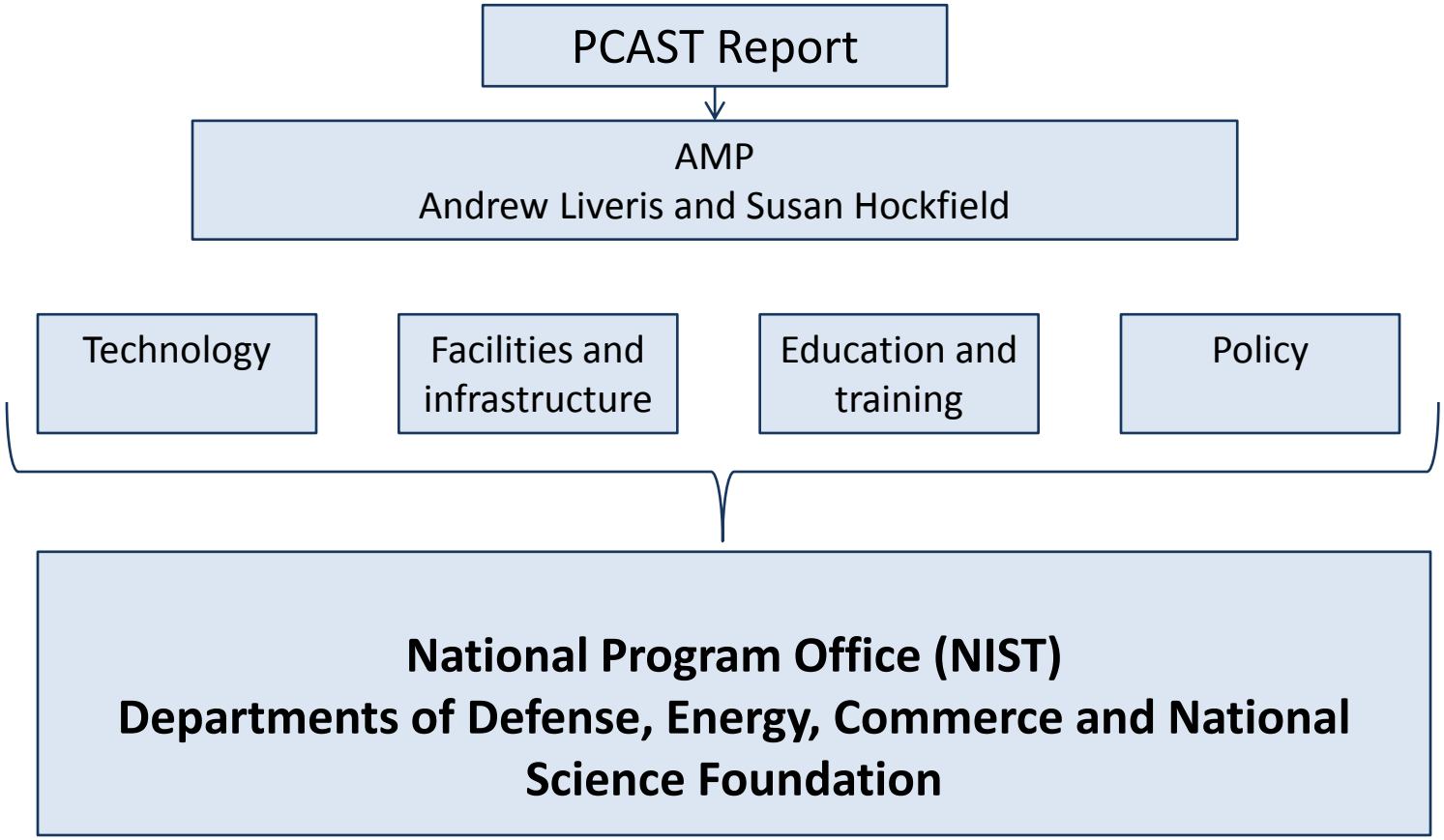


***Includes total primary energy direct use and electricity use in end-use sectors including losses**
Source: *Annual Energy Review 2010*, US EIA

A National Vision for U.S. Manufacturing

President Obama unveiled ***The Advanced Manufacturing Partnership (AMP)*** to develop transformational manufacturing technologies and innovative materials.

President Obama announced the Pilot **Manufacturing Innovation Institute**



The Advanced Manufacturing Partnership and the Advanced Manufacturing National Program Office

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DOE Manufacturing Demonstration Workshop

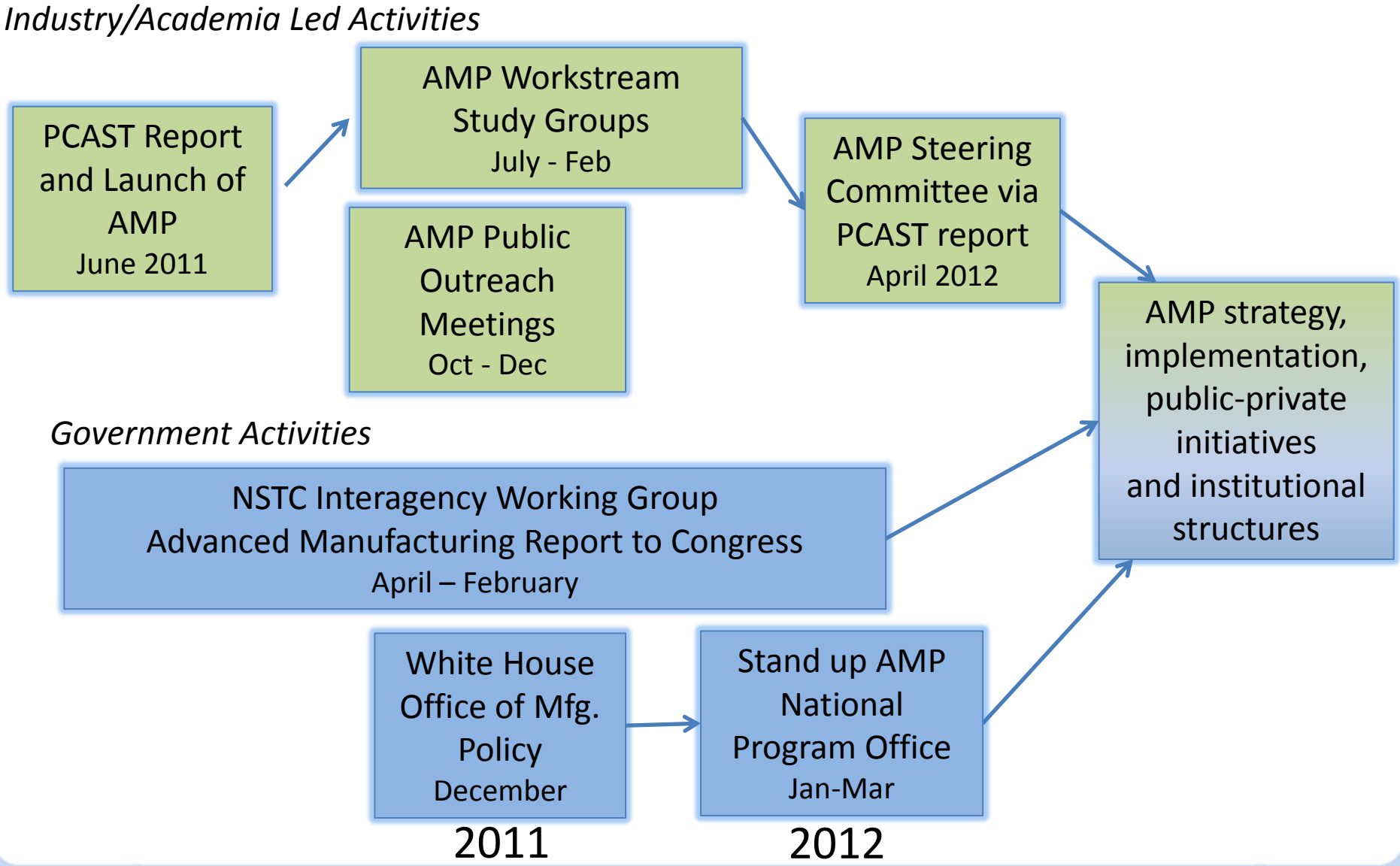
12 March 2012

Mike Molnar
Chief Manufacturing Officer
National Institute of Standards and Technology

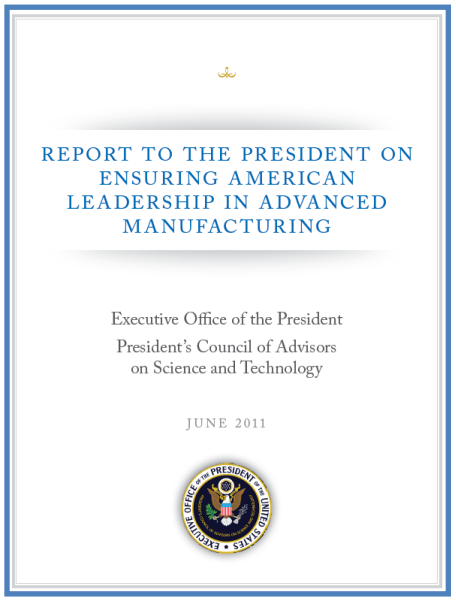
Overview

- Advanced Manufacturing Activities
- Advanced Manufacturing Partnership (AMP)
- AMP Steering Committee
- AMP Workstream Study Groups
- Office of Manufacturing Policy (OMP)
- NSTC Working Group on Advanced Manufacturing
- Advanced Manufacturing NPO
- National Network of Manufacturing Institutes

Advanced Manufacturing Partnership (AMP) Timeline



Advanced Manufacturing Recommendations: PCAST



1) Launch a Federal Advanced Manufacturing Initiative

- Concerted, whole-of-government effort, led by DOC, DOD, DOE and NSF
- Report to President on priority needs for Federal investments, including:
  - Coordinated Federal support to academia and industry for applied research on new technologies and design methodologies
  - Development and dissemination of design methodologies
  - Shared facilities and infrastructure to help small and medium-sized firms compete globally
  - Public/Private Partnerships (PPPs) to advance such technologies through pre-competitive consortia

2) Improve Tax Policy

- Reform corporate income taxes, extend the R&D tax credit permanently and increase the rate to 17%, as advocated in the President's Innovation Strategy.

3) Support Research

- Strengthen research of three key science agencies: NSF, DOE O/S, NIST

4) Strengthen the Workforce

- Strengthen science, technology, engineering and mathematics (STEM) education

Partnership for a US Manufacturing Renaissance

"Today, I'm calling for all of us to come together- private sector industry, universities, and the government- to spark a renaissance in American manufacturing and help our manufacturers develop the cutting-edge tools they need to compete with anyone in the world…

With these key investments, we can ensure that the United States remains a nation that 'invents it here and manufactures it here' and creates high-quality, good paying jobs for American workers."

President Obama,

on establishing Advanced

Manufacturing Partnership

June 24, 2011.

Advanced Manufacturing Partnership (AMP)

President Obama Launches AMP
June 24, 2011
Carnegie Mellon University

AMP Mission
Identify opportunities for investments in R&D, pre-competitive collaboration, and shared facilities and infrastructure that have the potential to transform advanced manufacturing in the United States, and recommend collaborative approaches that will realize these opportunities

AMP Goals
- Sustain US advanced manufacturing capability
- Increase private sector investment in manufacturing
- Create new or enhance existing public private partnerships
- Leverage advanced infrastructure (e.g., facilities access)

AMP Steering Committee

AMP Steering Committee Leadership

Andrew Liveris
CEO, Dow Chemical

Susan Hockfield
President, MIT

AMP Steering Committee: Leading experts from industry and academia, operating under PCAST providing recommendations on advanced manufacturing

1. Technology Development
2. Infrastructure and Shared Facilities,
3. Education and Workforce Development
4. Manufacturing Policy

AMP Outreach workshops held October 14, November 28, December 5, and December 12. AMP Webcast scheduled for February 14, 2012. Steering Committee final meeting March 7 2012

AMP Workstreams

Manufacturing Policy

Workstream chairs: Stryker, Carnegie Mellon University

Study focus:

- Produce recommendations to improve the overall climate for advanced manufacturing with a unique AMP focus on industry/university interactions
- Recognize and encourage tax, regulatory and trade policy enhancements similar to earlier reports (Jobs Council, PCAST, Manufacturing Council etc.)

Technology Development

Workstream chairs: Honeywell International, University of California-Berkeley

Study focus:

- Identify top technologies with greatest impact on the retention and future growth of manufacturing in the USA, enabling differentiation & competitiveness for USA manufacturing from an end to end supply chain perspective
- Define Technology Roadmaps with actions, milestones, timelines for improving technology maturity and commercial usage

AMP Workstreams

Shared Infrastructure and Facilities

Workstream chairs: Caterpillar, University of Michigan

Study focus:

- Establish a network of *Manufacturing Innovation "Hubs"* to bridge this gap,
- Improve the competitiveness of small and medium size manufacturers by establishing a series of *Digital Manufacturing Innovation Hubs* to support design, simulation and modeling for manufacturing, and
- Establish a searchable national database of shared facilities.

Education and Workforce Development

Workstream chairs: Allegheny Technologies, Stanford University

Study focus:

- Repair the image of Manufacturing
- Enhance manufacturing education at Community Colleges (CC).
- Leverage Federal funding to CCs to encourage manufacturing curriculum
- Establish a nationwide network of CC's to coordinate AM curriculum
- Establish nationwide certificate programs for AM skills

Office of Manufacturing Policy (OMP)

Secretary Bryson
Department of Commerce

White House
Office of Manufacturing Policy
Co-chairs

Director Sperling
National Economic Council

Office of Manufacturing Policy: Operates within the White House NEC
First cabinet level meeting held January 20, 2012

Goal: Ensure effective coordination of manufacturing policy implementation and to serve as a resource for agencies to highlight and coordinate their manufacturing activities

NSTC Interagency Working Group on Advanced Manufacturing

NSTC Committee on Technology:

Interagency Advanced Manufacturing working group

- chartered March 30, 2011
- Co-chaired by DOE, DOD, and NIST

IAM Charter: to develop a strategic plan to guide Federal programs and activities in support of advanced manufacturing research and development

COMPETES REAUTHORIZATION 2010: Congress calls for strategic plan to address

- Foster transfer of R&D results into U.S. based manufacturing
- Strengthen education and training to ensure a well-trained workforce
- Assist SMEs in developing and implementing advanced manufacturing
- Specify objectives, metrics, and roles

Release of report to Congress February 22, 2012

Advanced Manufacturing National Program Office (NPO)

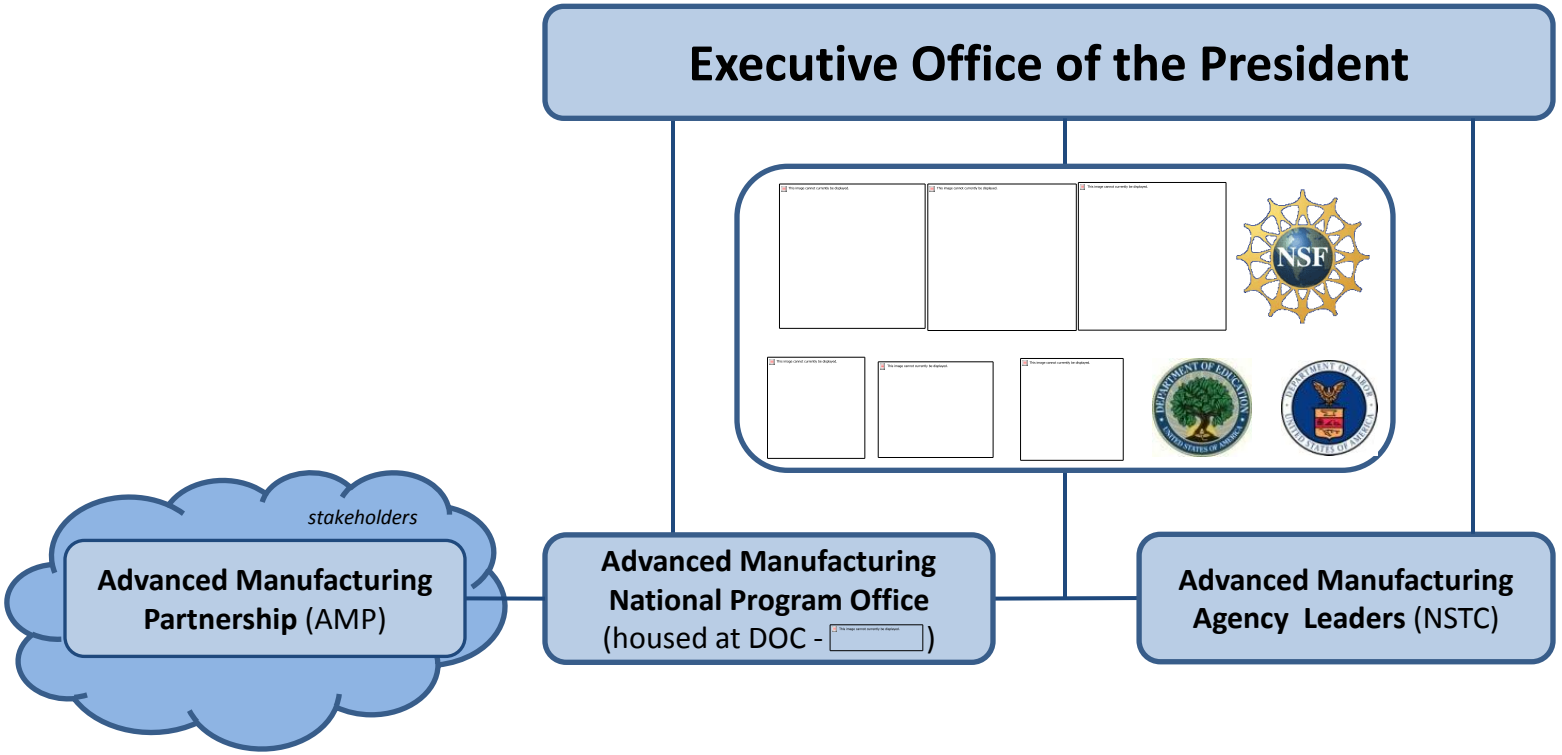
- Advanced Manufacturing National Program Office
  - Announced by Secretary Bryson, December 19, 2011
  - True interagency staff, with IPA/fellows from industry and academia
  - Hosted by Department of Commerce/NIST

- The AM-NPO will:
  - Lead other federal agencies involved in U.S. manufacturing and support interagency coordination of advanced manufacturing programs
  - Provide a linkage to the private-sector partnerships between manufacturers, government, and universities.
  - Satisfy the PCAST report recommendation to create an integrated private/public advanced manufacturing initiative.
  - Work to implement recommendations from AMP

Credit: Carnegie Mellon Univ.

Advanced Manufacturing – National Program Office

Office Structure and Role



- NPO composed of members from key federal agencies, industry and academia
  - All staff are federal employees via IPA, Federal Fellow or NIST direct hire/short term authority
  - Industry and academic personnel represent their sector and expertise, not their companies or institutions
- Guided by agency leaders within National Science and Technology Council
- Works with agencies to create an integrated interface for advanced manufacturing
- Works with external stakeholders to establish and strengthen AMP private-public partnerships

Adv. Mfg. NPO Planned Activities

- Respond to AMP, PCAST, IAM recommendations
- Coordinate federal advanced manufacturing strategic planning
- Coordinate AM planning and budget activities with EOP
- Produce annual AM supplements to the President's Budget
- Support advanced manufacturing public-private partnerships
- Establish broad engagement mechanisms among stakeholders in government, industry, and academia
- Hold public workshops throughout the US on initiatives and priorities

President Announces NNMI

"We have got to have this all across the country. I want everybody thinking about how are we making the best products, how we are harnessing the best ideas, and making sure they are located here in the United States. And sparking this network of innovation across the country it will create jobs and will keep America in the manufacturing game."

The President announced a proposal for a National Network for Manufacturing Innovation

- network of up to fifteen Institutes for Manufacturing Innovation around the country
- serving as regional hubs of manufacturing excellence that will help to make our manufacturers more competitive and encourage investment in the United States.
- The President's Budget proposes a $1 billion investment from mandatory funding to create this new National Network for Manufacturing Innovation.

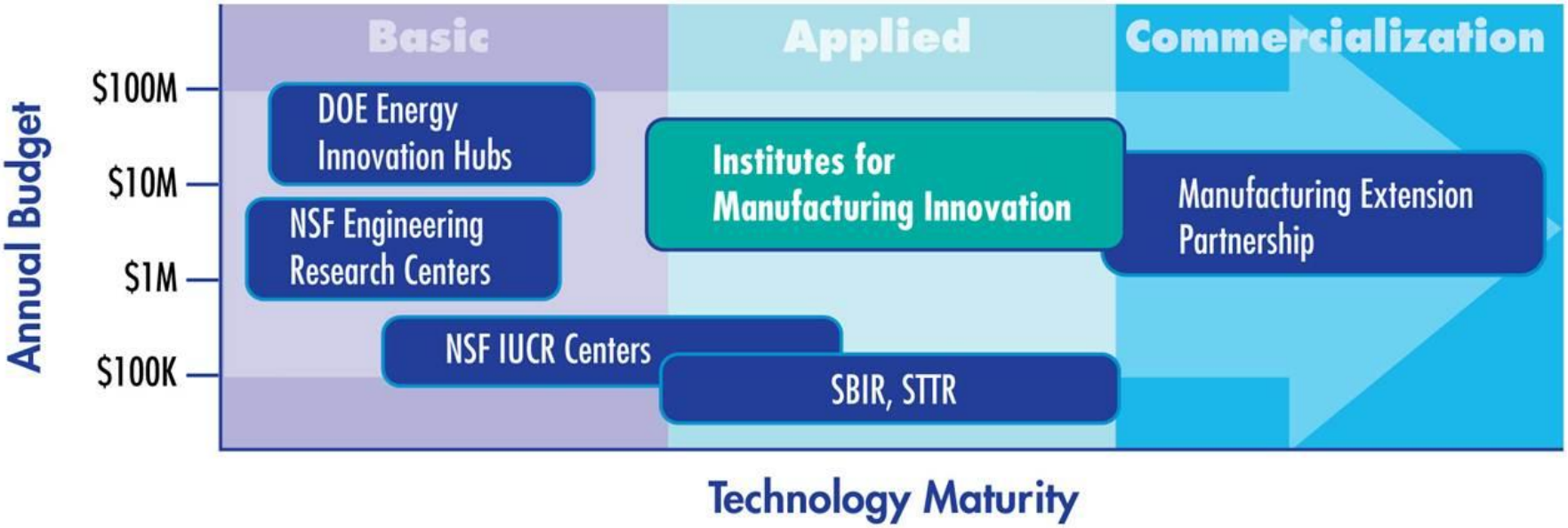
The President also announced that the Administration will take immediate steps to launch a pilot institute

- Pilot institute will be funded from $45 million of existing resources from the Departments of Defense, Energy, and Commerce and the National Science Foundation, and will be selected from a competitive application process.

Key Attributes - Institute for Manufacturing Innovation

1) Technology

- Well-defined technology focus with broad applications
- Focus on applied research, commercialization and manufacturability *(TRL/MRL 4-7 range)*
- For Pilot IMI, consistent with funding agency missions (agreed list of priority technologies)
- Addresses industrially-relevant challenges with clearly defined outputs



Key Attributes - Institute for Manufacturing Innovation

2) Budget

- Planned 5 year budget (including co-investment) of roughly $100 million
- Planned industry (multi-company) and 3rd party (state, foundation, etc.) co-investment of at least 50% of 5 year budget. State or regional organization is a key participant.
- Multi-agency start-up investment for Pilot
- Co-investment match of federal start-up investment
- Demonstrates a plan to be self-sustaining in roughly five years

3) Governance

- Grantee is self-assembled team of organizations
- Separate identity, linked to a research institution (university, national lab, or non-profit)
- Governing board representing all key stakeholders and plurality of industry representatives

Key Attributes - Institute for Manufacturing Innovation

4) Activities must extend beyond RD&D:

- Effective for Small and Medium size Enterprises (SMEs) through shared use of facilities and tools
- Enhances manufacturing education and workforce training opportunities for the local area

Thank you

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A National Vision for U.S. Manufacturing

Manufacturing requires a "whole of US-, local- and State-Government", industry, academia, labor, and other entities approach.

Execution of strategy relies on each Department or Agency to carrying out the activities within their respective mission. “All-hands-on-deck”

U.S. D.O.E.

Ensures America’s security and prosperity by addressing its energy, environmental and nuclear challenges through transformative science and technology solutions.

EERE

Manages America’s investment in research, development and deployment (RD&D) in clean energy technologies.

Advanced Manufacturing Office

Develops and demonstrates new, energy efficient manufacturing processes and materials technologies for both new and existing industries and encourages technology deployment to industry.

Advanced Manufacturing Office

AMO programs target:

- Research, Development and Demonstration of new, advanced processes and materials technologies that reduce energy consumption for manufactured products and enable life-cycle energy savings

- Efficiency opportunities through deployment of known technologies to existing manufacturing practices, especially for energy-intensive steam, process heating, and machine drive end-uses

A National Vision for U.S. Manufacturing

PCAST Report

AMP
Andrew Liveris and Susan Hockfield

Technology

Facilities and infrastructure

Education and training

Policy

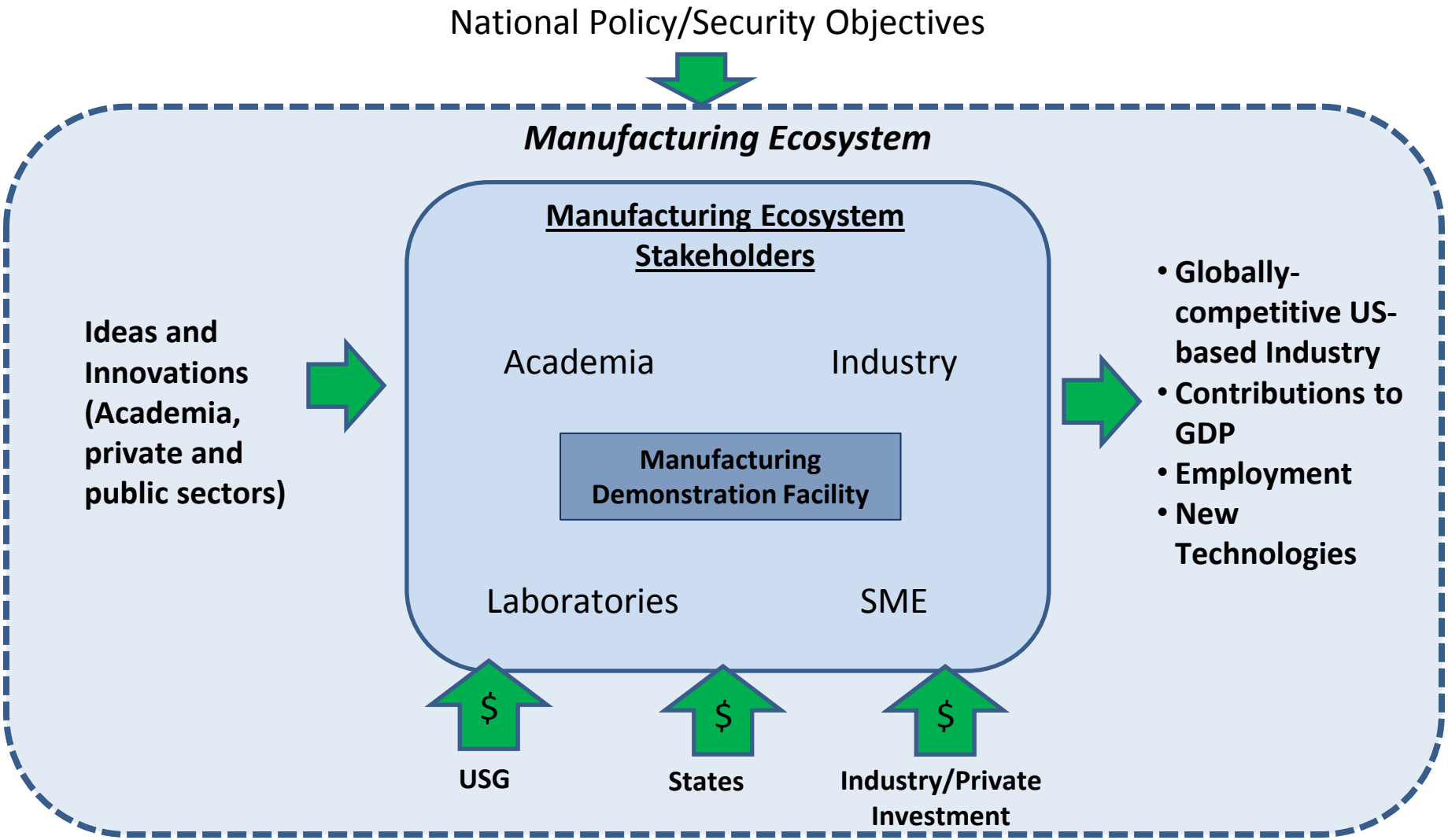
DOE: AMO

1. Keystone investments (**IMI**)
2. Advanced manufacturing partnership initiatives
   - MDFs, Institutes, Hubs
3. Manufacturing Challenges
4. Education and training (**IACs, internships**)
5. State and Local Government programs

Attributes

- Manufacturing in the US
- GDP and employment enhancement
- Energy efficiency and renewable energy industry
- Energy intensity and energy life cycle costs

Proposal for Pilot Manufacturing Innovation Institute



Manufacturing Demonstration Facilities (MDFs)

Vision:

The objective of the MDFs is to create collaborative, shared infrastructure around targeted technical areas that will facilitate the development and exploitation of energy efficient, rapid, flexible manufacturing technologies and to promote broad and rapid dissemination of manufacturing technologies.

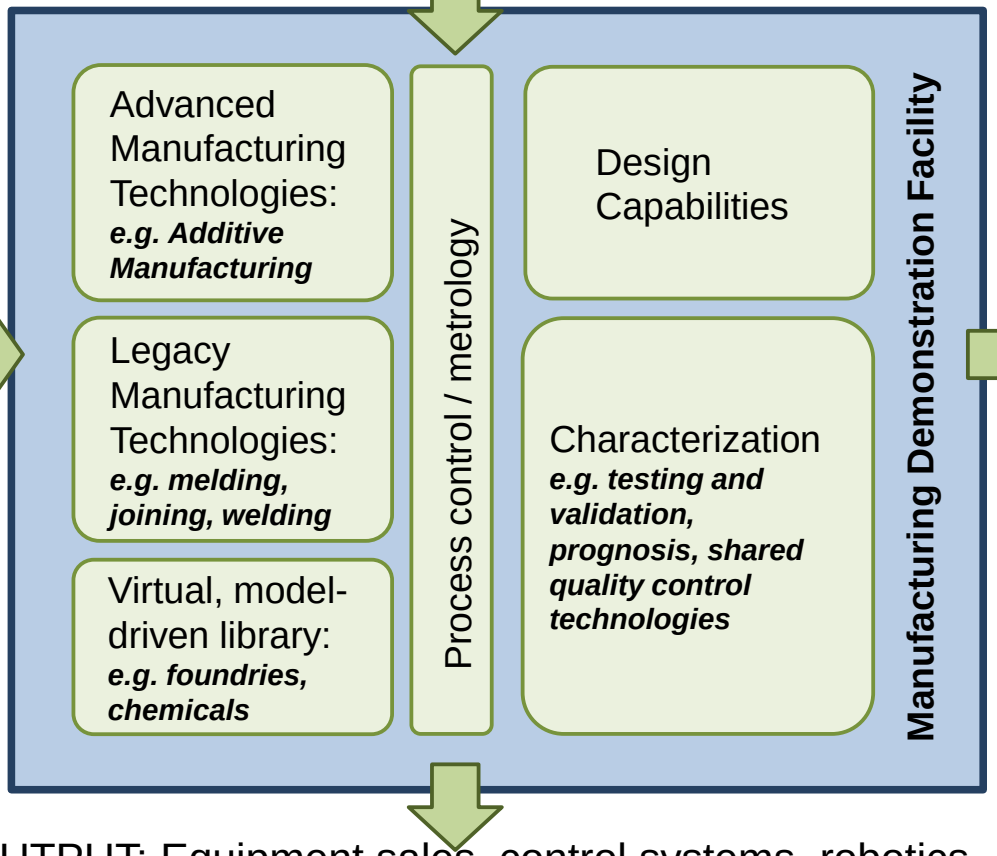
Approach:

- Provide manufacturers and product developers access to physical and virtual tools from design to evaluation for rapidly prototyping new technologies and optimizing critical manufacturing processes.
- Staff with designers, manufacturing experts and product evaluators to guide and train users as well as maintain the infrastructure.
- Act as a center for education and training, hosting interns and guest workers from industry, academia and government.

Manufacturing Demonstration Facilities (MDFs)

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

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



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***

MDF Form and Function

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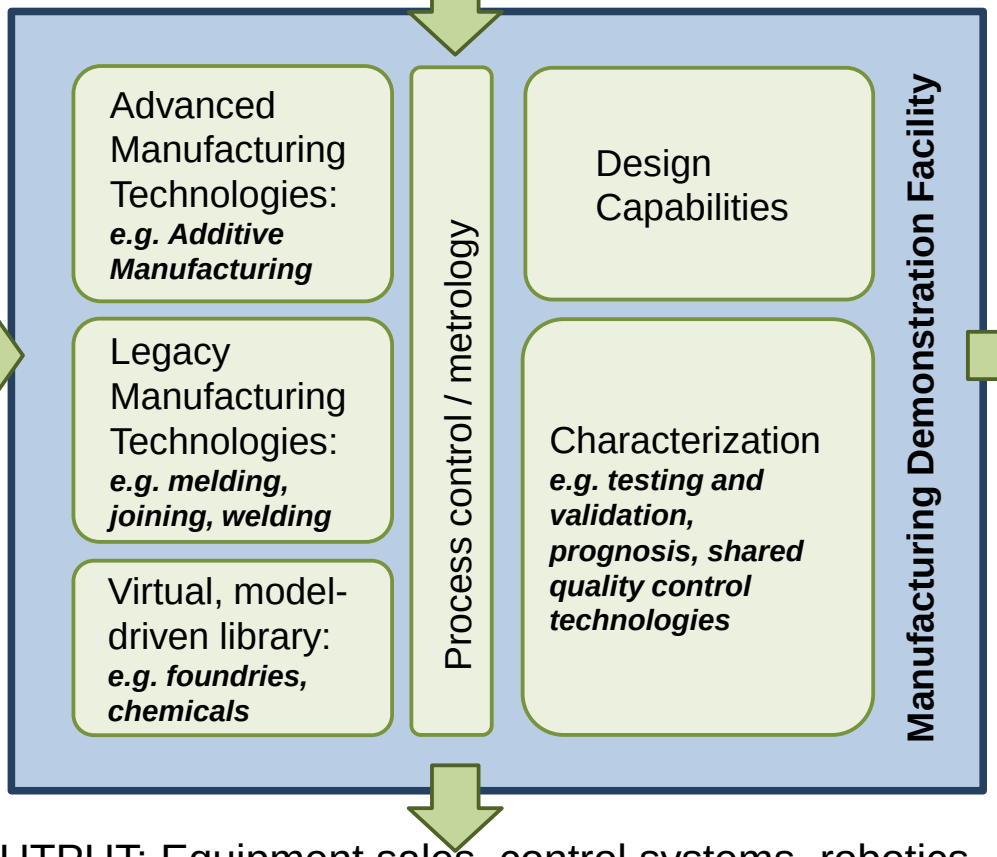

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Private sector perspective: 4 companies

A. New manufacturing process:

1. Enters into an agreement with a MDF and establishes a presence drawing on the expertise and facilities available at the MDF for developing, documenting and "qualifying" the process (cGMP equivalent).
2. Once company A is satisfied with progress, it pursues its own business model.
3. A prototypical capability stays at the MDF and is maintained for use by others.
4. If others choose to use the capability they pay an agreed upon fee.

B. Need for a specific part:

1. Enters into an agreement with a MDF and evaluates multiple approaches before selecting one for ultimate production.
2. Pays appropriate fee for use of others' technology.

C. Existing manufacturing process:

1. Enters into an agreement with a MDF and lodges its capability (or the information) into the Facility.
2. Potentially identifies synergies with other technologies and improves its process.
3. If others choose to use the capability they pay an agreed upon fee.

D. Manufacturing a new product:

1. Enters into an agreement with a MDF and reaches out to ALL manufacturing processes or the expertise and facilities available at the MDF and selects the most appropriate.
2. Pays appropriate fee for use of others' technology.
3. Employs MDF capabilities to access/qualify its component.
4. Pursues its own business model.

Functional Aspects

- Technical Plan
- Management Plan
- Financial Sustainability
- Intellectual Property Strategy
- Impact in the relevant communities

Functional Aspects

- Technical Plan
  - Goals and objectives in the focus area
  - Facilities and resources
- Management
  - MDF organization and direction
  - Members/users/partners
- Financial Sustainability
  - How to sustain the MDF financially
  - Accessibility for users

Functional Aspects

- Intellectual Property Strategy
  - How to create a collaborative environment
  - How to create a secure environment
- Impact in the relevant communities
  - Training and workforce development
  - STEM outreach and education

Intellectual Property

- A structure must be in place to allow for the protection of IP yet enable the sharing of pre-competitive best practices.
- MDFs will act as “trusted brokers” to maintain confidentiality of the IP and special know-how, and, if needed, assist in the negotiating of IP rights to other participants in the MDF.

MDF Proposed Objectives:

- Act as impartial centers of expertise with capital in a given domain
- Provide capability for handling open and proprietary activities
- Facilitate users in development, testing, demonstration, and qualification of new manufacturing/fabrication technologies
- House and maintain models/capabilities profiles of newly developed and commercial/existing processes
- Assist in the selection, optimization, and modeling of potential products
- Assist in the development of testing protocols and standards across all stages of manufacturing
- Establish formal and ad hoc networks that post non-proprietary capabilities, schedules and availability for services and products
- Establish processes for compensating IP holders (process developers and model builders) for use of their technologies by other users/evaluators

MDF Example: ORNL

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.

End of Morning

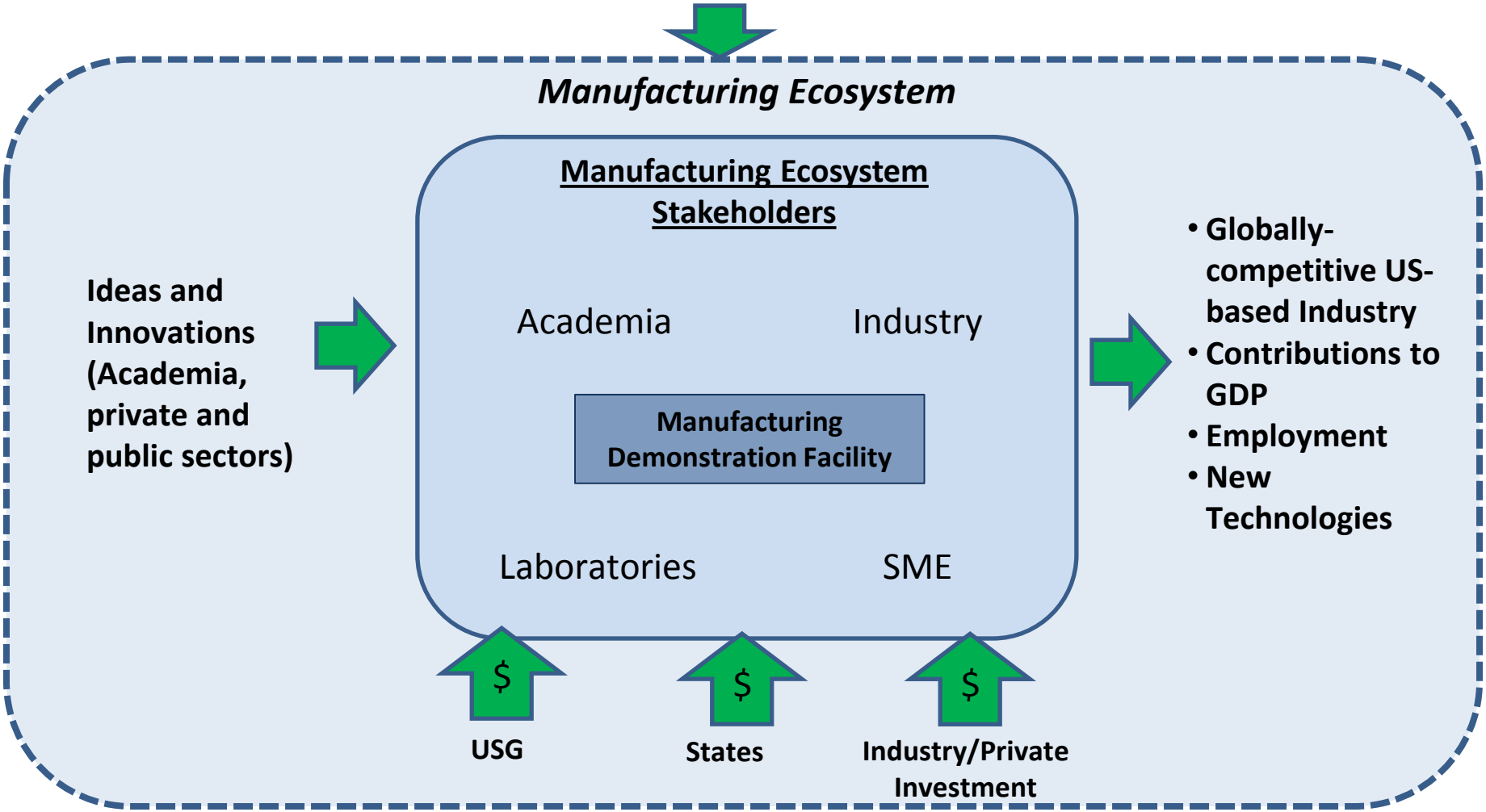
We invite your input:

- What did you hear that you liked?
- What did you hear that you did NOT like?
- What did you not hear at all?

Manufacturing Ecosystems

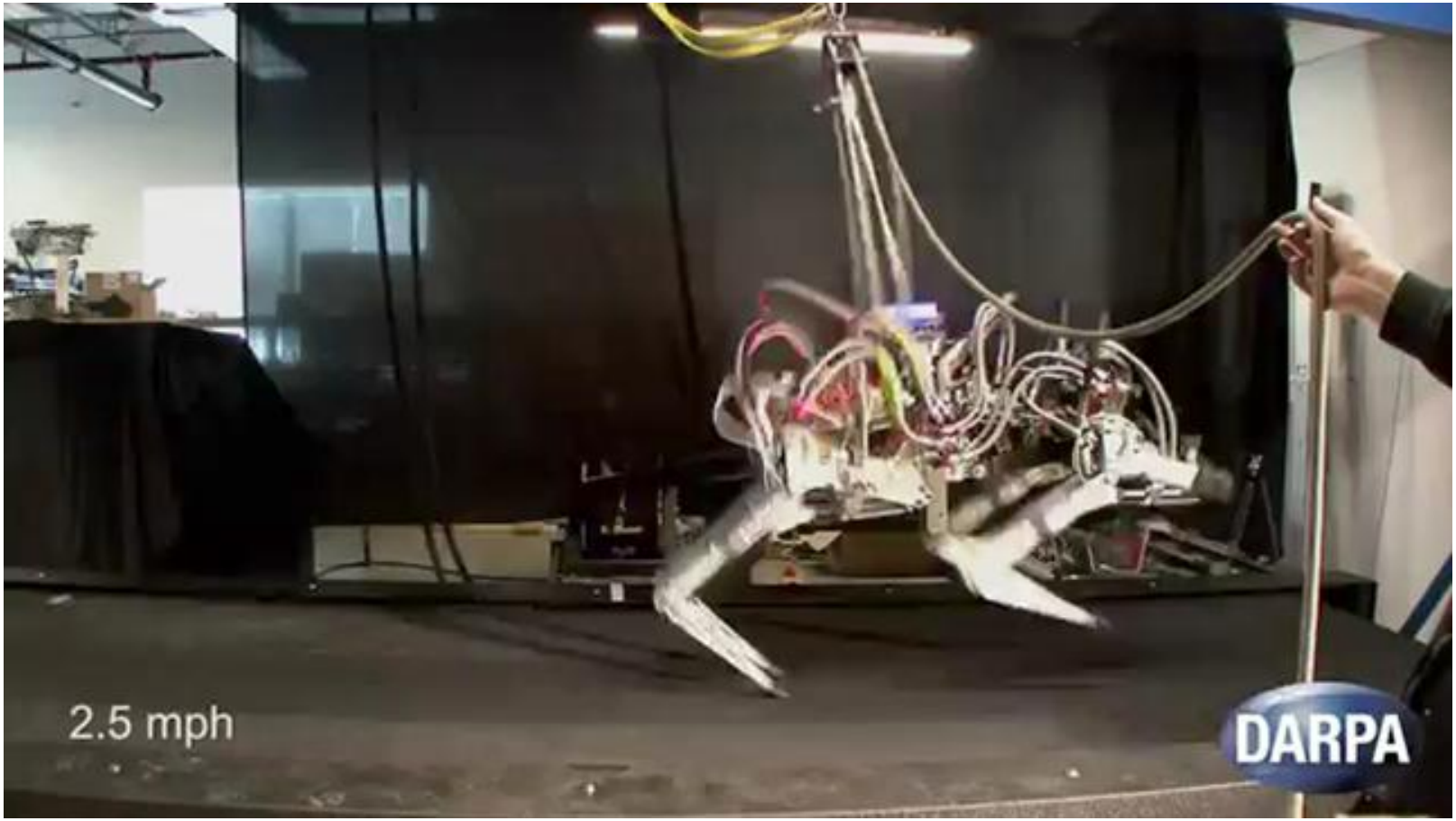
Manufacturing Ecosystems

National Policy/Security Objectives



Keystone Technologies

Bio-inspiration



http://youtu.be/d2D71CveQwo

Source: DARPA

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Biological ecosystems

- Many individual organisms interacting with one another and the abiotic environment
- Vital abiotic resources (e.g. nutrients) passed from organism to organism in complicated and interconnected food webs

Techno-economic systems

- Many individuals, firms, and governments interacting with one another in an information rich system
- Money, information and other resources are transferred through complicated and interconnected supply chains

Similar dynamics strong incentives to use resources efficiently

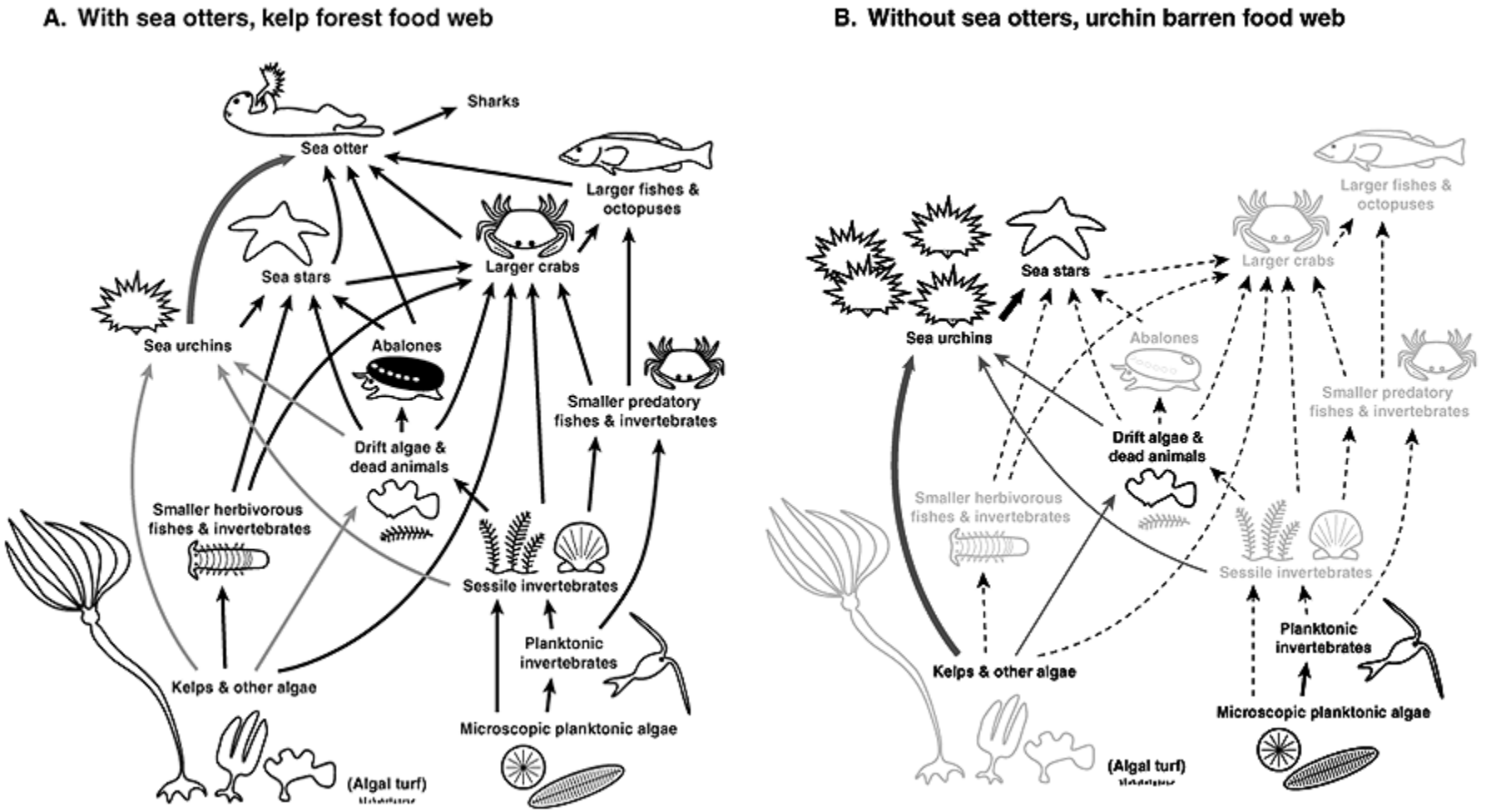
Biological Keystone Species

- A species whose effect on ecosystem structure and organization is disproportionate to its abundance
- Keystone species **transform the state of the system**

http://www.theweekenderblog.com/; http://irishmarinelife.files.wordpress.com; http://en.wikipedia.org/wiki/File:Sea-otter-morro-bay_13.jpg

Note: These photos are not of the same ecosystem

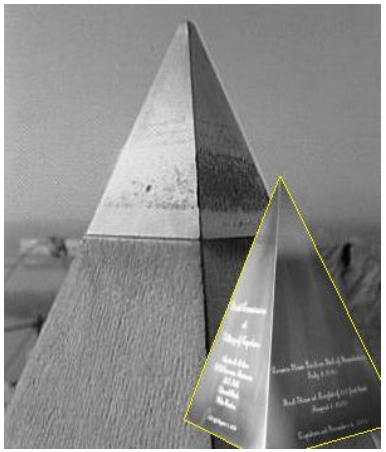
Keystone Species: Sea Otter



Source: American Museum of Natural History Center for Biodiversity and Conservation: http://cbc.amnh.org/crisis/foodweb.html

Keystone Technologies

Keystone technologies are technologies whose effect on techno-economic systems are disproportionate to their abundance. Keystone technologies are analogous to the keystone species concept of ecology and the architectural keystone.



Keystone technologies must:

- strongly affect the **organization** and **diversity** of technologies in the industrial base relative to other technologies,
- demonstrate **sustained, market-driven adoption** once performance and price targets are achieved, and
- be **transformative or broadly-applicable** across multiple production systems and supply chains.

Impact to the "Ecosystem"

- Organization
  - Support DOE/USG Agency Missions
    - Reduce life-cycle energy intensity and GHG emissions of processes and products
  - Increases U.S. GDP
    - Increases domestic manufacturing base
    - Increases U.S. exports
  - Alters supply chains
- Diversity
  - Creates new products, processes and services, new companies
  - Leads to an advanced workforce, creates new and higher wage jobs
- Sustained, market-driven adoption
  - There is a demonstrated market need for the technology
  - Market adoption is limited by cost or quality
- Transformative and/or cross-cutting
  - Transformative serves a unique and transformative role in few important systems
  - Applicable to many systems and supply chains

Example: Wide Band Gap Semiconductor Materials

- Organization
  - Increase energy efficiency of devices and systems
  - Enhance an existing U.S. based industry
- Diversity
  - Expand the market applicability of GaN, SiC, Diamond based devices
  - Complicated manufacturing process and requires high level of quality control
  - Requires an advanced workforce
- Sustained, market-driven adoption
  - Existing market for Si based devices that have reached their performance limitations, there is a demonstrated market need for the technology
  - Market adoption is limited by cost and quality
- Transformative and/or cross-cutting
  - Would create a step change in performance of devices based on the enhanced material properties over current state of the art
  - Applicable to many systems and supply chains

Example: Biomanufacturing

- Organization
  - Create lower energy intensive production methods, lower GHG, can be based on renewable feedstocks
  - Build on an existing U.S. based industry, doing this today for a select number of products
- Diversity
  - Applicable to a current range of industries but has really an even bigger potential
  - Complicated manufacturing process, requires high level of quality control
  - Requires an advanced workforce
- Sustained, market-driven adoption
  - Existing market demand for products through traditional routes is enormous
  - Market adoption is limited by cost and time to develop the process, high quality control needs
- Transformative and/or cross-cutting
  - Create completely new methods for production, transformative
  - Expanded role within several large industries in the near term chemicals, transportation and healthcare

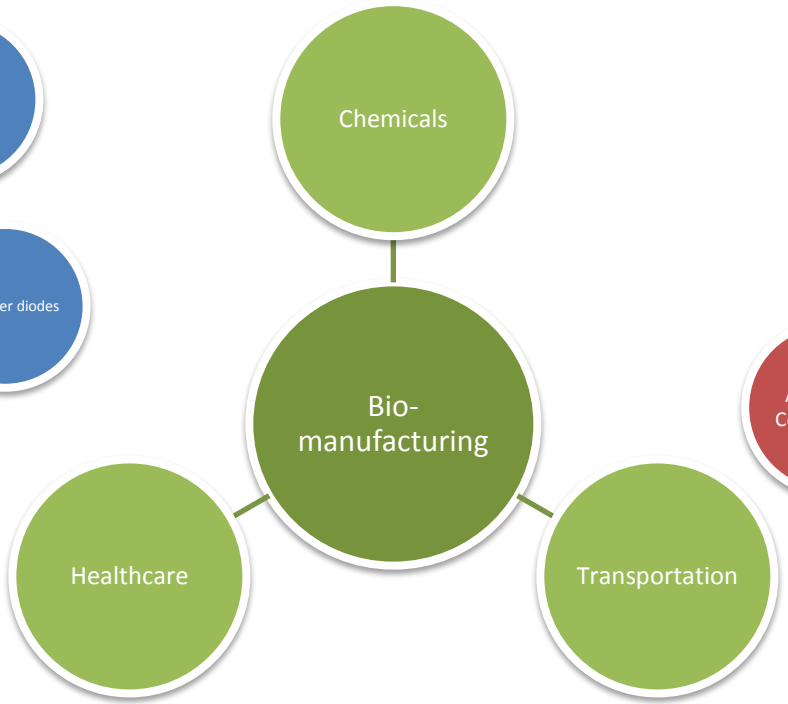
Example: Carbon Fiber Composites

- Organization
  - Create lower energy intensive production methods (Out of the Autoclave), lower GHG, lower cost
  - Early industries for use of these low cost CF composites are U.S. manufacturing strengths (aerospace, automotive, wind power)
- Diversity
  - Applicable to a current range of industries but has really an unlimited potential
  - Complicated manufacturing process, requires high level of quality control
- Sustained, market-driven adoption
  - Existing market for products by traditional manufacturing routes, replacement potential is high
  - Market adoption is limited by cost and time to develop, high quality control needs, automation needs
- Transformative and/or cross-cutting
  - Create completely new methods for production, transformative
  - Applicable to many systems and supply chains

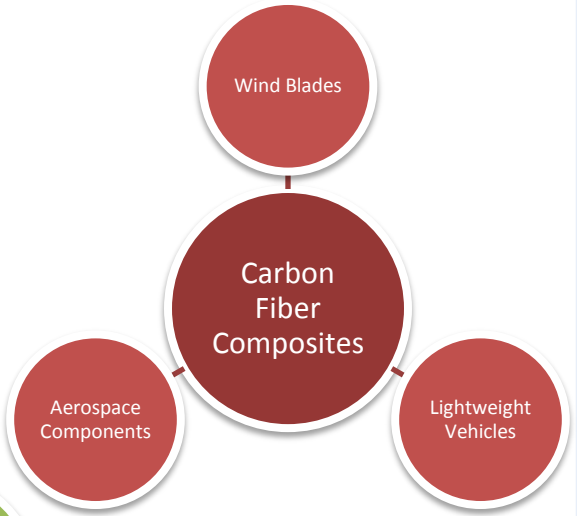
Keystone Technology Impacts

Diversity

Market Driven Adoption



Organization



Transformational and Cross-Cutting

Other Potential Keystone Technologies

- Low cost titanium (advanced low cost/light weight metals)
  - Aerospace, Automotive, Industrial applications, Desalination
- Advanced separations (membranes, lower cost ionic liquids)
  - Chemical industry, buildings, oil and gas, water, wastewater treatment
- In-Situ metrology and process controls
  - Across nearly all advanced manufacturing industries
- Joining of disparate materials
  - Aerospace, Automotive
- Natural gas technologies
  - Chemicals, Metals, CHP, Transportation, Buildings
- Powder metallurgy processes (related to new magnets)
  - Automotive, Wind Power, Industrial Motors

Keystone Technologies

- What are the technology “sea otters”?
- What are the technologies and capabilities that are transformative and will have impacts larger than their abundance?

End of Afternoon

We invite your input:

- What did you hear that you liked?
- What did you hear that you did NOT like?
- What did you not hear at all?