An Overview of Strategic Energy Analysis by DOE’s Advanced Manufacturing Office

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Context for Advanced Manufacturing Office (AMO) Strategic Analysis

**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, environmental or economic value.
**More Analysis Context - AMO Office Structure and Drivers**

**R&D Projects** - High impact R&D focused on foundational energy-related advanced manufacturing technologies.

- A focus on *energy-intensive and energy-dependent* manufacturing processes.
- *Platform technologies* widely applicable across manufacturing industries.

**R&D Facilities** - Public-private partnerships facilitate the transition of innovative advanced materials, information, and process technologies to industry and enable manufacturing scale-up.

- *Foundational technologies that are pervasive in multiple industries and markets, with potentially transformational technical/manufacturing productivity impact.*
- *Create spillover benefits* from clean energy sectors into multiple industries and improve U.S. competitive advantage, especially for small- and medium-sized enterprises.

**Technical Assistance** - Support to the deployment of advanced energy efficiency technologies and practices.

- *Provide U.S. industry with the education and tools* to adopt energy efficiency technologies in their existing facilities.
- *CHP Technical Assistance Partnerships (TAPs); Better Plants; Superior Energy Performance; Industrial Assessment Centers (IACs).*
Opportunity Space for Manufacturing

- Improve the productivity and energy efficiency of U.S. manufacturing.
- Reduce life cycle energy and resource impacts of manufactured goods.

Manufacturing Goods

More efficient manufacturing reduces energy losses.

Use of Manufactured Goods

More efficient manufacturing enables technologies that improve energy use throughout the economy:
- Transportation
- Buildings
- Energy Production and Delivery

U.S. Energy Economy by Sector
95.1 quadrillion Btus, 2012

1 Energy consumption by sector from EIA Monthly Energy Review, 2012
2 Industrial non-manufacturing includes agriculture, mining, and construction
3 US economy energy losses determined from LLNL Energy Flow Chart 2012 (Rejected Energy)
4 Manufacturing energy losses determined from DOE AMO Sankey/Footprint Diagrams (2010 data)
Considerations for AMO Strategic Analysis – Assess Potential Impacts

Provide positive energy, environmental, and economic impacts, including:

• Reduce the energy intensity of production
• Produce items which reduce life cycle energy use
• Reduce degree of technical uncertainty and risk which limit potential private sector investment;
• Opportunity for long term positive impact on domestic manufacturing.

AMO technology focus areas:

“Support manufacturing process, information and materials technologies, and directly align with the fourteen high priority energy-related advanced manufacturing technologies identified through the 2015 DOE Quadrennial Technology Review (QTR).”*

A comprehensive assessment of science and energy technology R&D opportunities to address our nation's energy-linked economic, environmental, and security challenges.

http://www.energy.gov/quadrennial-technology-review-2015

AMO’s Strategic Analysis was the foundation for Chapter 6 of the 2015 DOE Quadrennial Technology Review
# QTR 2015

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Composite Materials

**Cross-Energy Connections**

- **Fuels:** hydrogen fuel storage
- **Electric Power:** lightweight wind turbine blades
- **Transportation:** compressed gas storage for mobile applications; automotive lightweighting

**Intra-Manufacturing Connections**

- **Additive Manufacturing:** 3-D printing of reinforced polymers and other composites
- **Materials for Harsh Service Conditions:** lightweight, durable structural components for automobiles; erosion-resistant composites for wind turbine blades and turbomachinery
- **Advanced Sensors, Controls, Platforms and Modeling for Manufacturing:** inspection techniques for quality control; automated tape laying and automated tape placement
- **Sustainable Manufacturing:** Lightweight materials manufacturing for life-cycle energy savings

**Scope**

- Structural composite materials for lightweighting, including automotive, wind, and gas storage applications
- Forming and curing technologies for thermosetting and thermoplastic polymer composites
Supply-Chain Systems
Develop technologies that reduce embodied energy and manufacturing GHG emissions of carbon fiber reinforced polymer (CFRP) by 75% compared to 2015 current typical technology.

Production/Facility Systems
Reduce production cost of finished CFRP components for targeted clean energy applications by 50% compared to 2015 state-of-the-art technology.

Manufacturing Systems/Unit Operations
Develop composite molding process with <90 second part-to-part cycle time for a structural component with surface area >0.5m²
Panel on Resource Efficiency and Supply Chain/Value Chain

Advanced Manufacturing Impacts at the Supply Chain Level

Panel on Advanced Manufacturing Technology Analysis

Advanced Manufacturing Technologies
Impacts at the Unit Operations & Plant/Facility Levels

Analysis Methodology & Tools Development
Impacts across the manufacturing systems levels

AMO Strategic Analysis – Current Activities

Water – Energy – Material Nexus
AMO Strategic Analysis – Current Activities

Technologies
- Industrial Process Heating – ORNL
- Industrial Waste Heat Recovery - ORNL
- Additive Manufacturing Extensive Review – ANL
- Additive Manufacturing LCA tool ORNL
- Bandwidth Analysis NREL, Energetics
- Life cycle GH gas, Technology & Energy through the Use-Phase (LIGHTEn-UP) Tool LBNL

Analysis Methodology & Tools Development
- Market Penetration Tool ANL, LBNL
- Materials Flow through Industry (MFI) Tool NREL

Impacts at the Supply Chain Level
- Electronics Manufacturing LBNL, ORNL
- Critical Materials ANL, NREL
- Composites ORNL, LBNL
- Foundational Analysis: Bandwidth Studies (Desalination, Water in Mfg.) LBNL, Energetics
- Plant Water Profiler (PWP) ORNL
- Water – Energy – Material Nexus
- Regional Analysis Great Lakes Study ANL

Data Mining NREL

Smart Manufacturing ANL