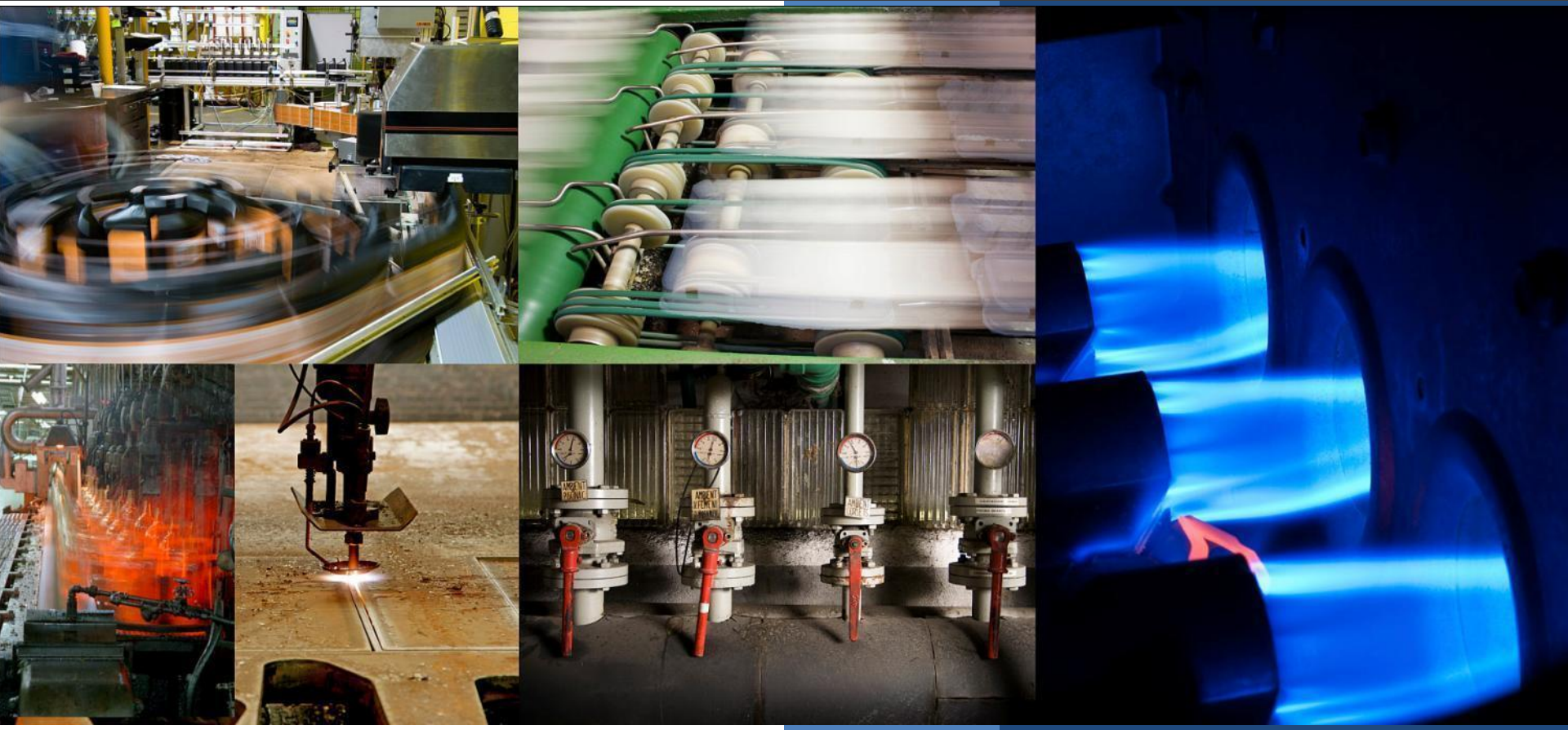
Office of Energy Efficiency & Renewable Energy
Advanced Manufacturing Office

U.S. DEPARTMENT OF ENERGY



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

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AMO Peer Review

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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.*

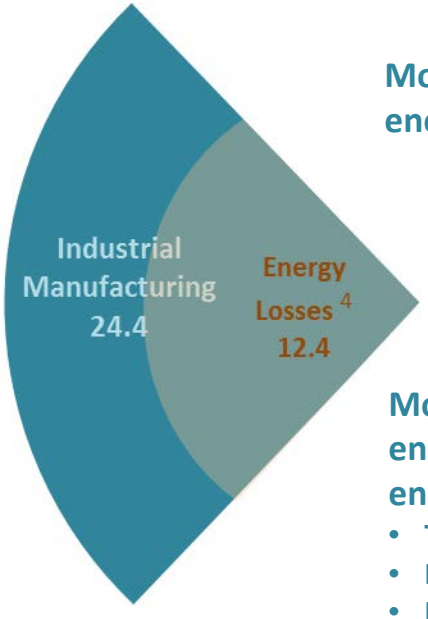
Technical Assistance - Support to the deployment of advanced energy efficiency technologies and practices.

- *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



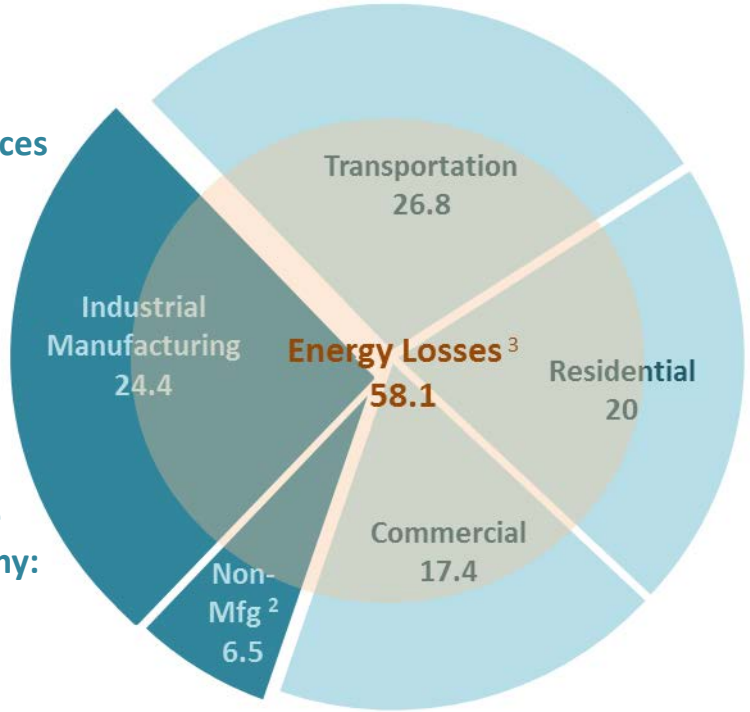
More efficient manufacturing reduces energy losses.

and…

More efficient manufacturing enables technologies that improve energy use throughout the economy:

- **Transportation**
- **Buildings**
- **Energy Production and Delivery**

Use of Manufactured Goods



U.S. Energy Economy by Sector
95.1 quadrillion Btus, 2012 [1]

[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)."*

**Excerpted from DOE FY 2016 Congressional Budget Request, page 197, http://energy.gov/sites/prod/files/2015/02/f19/FY2016BudgetVolume3_7.pdf*

Quadrennial Technology Review 2015

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

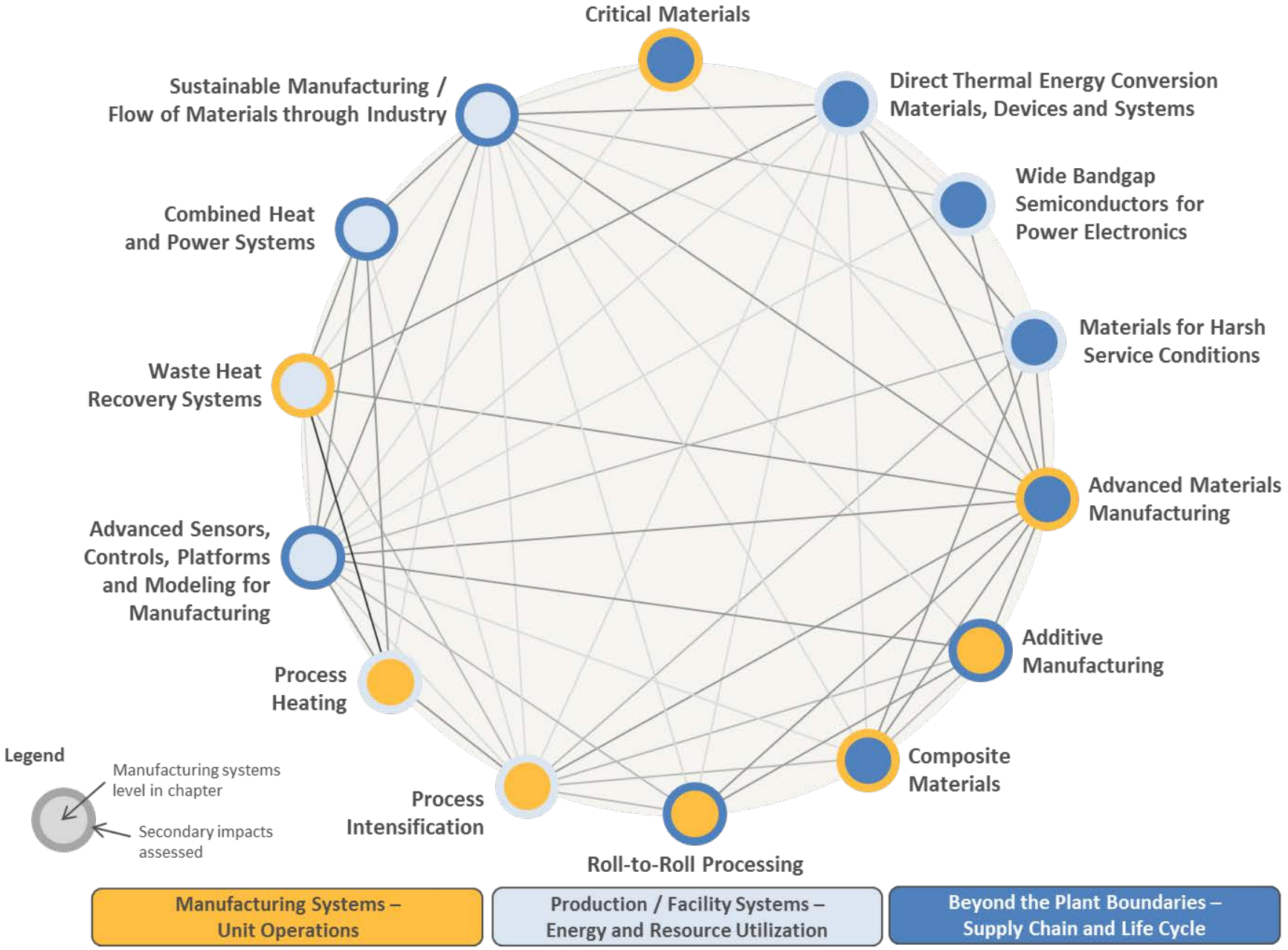
AMO's Strategic Analysis was the foundation for Chapter 6 of the 2015 DOE Quadrennial Technology Review

QTR 2015

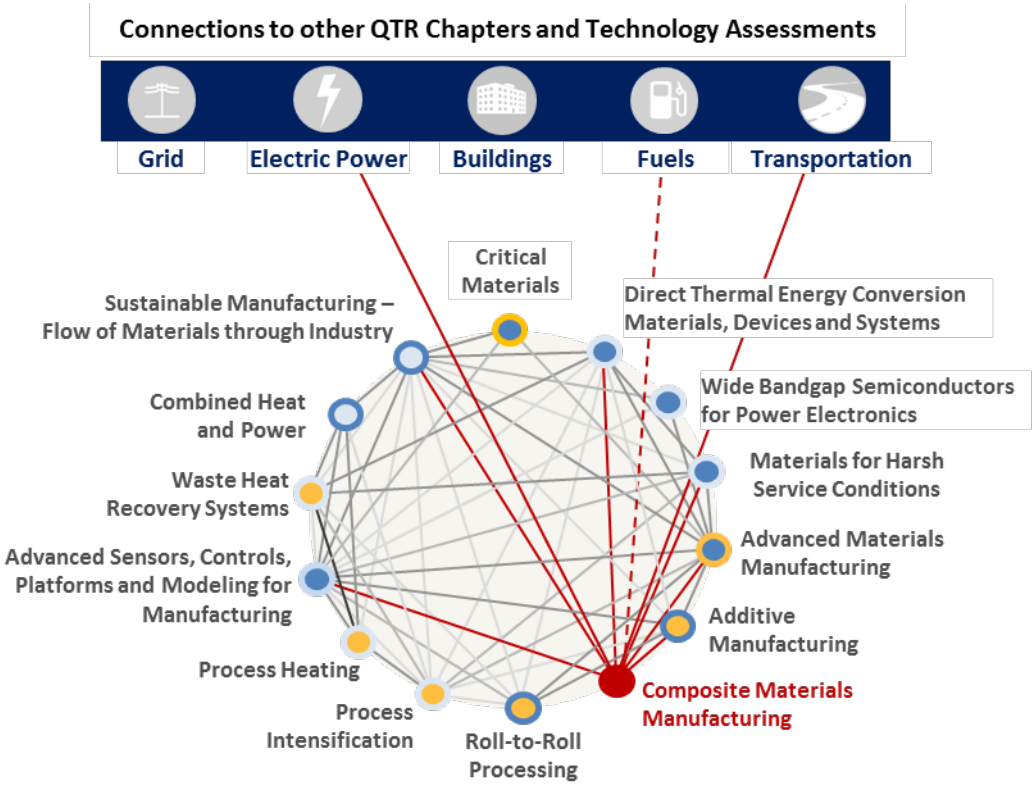
REPORT AND CHAPTERS	TECHNOLOGY ASSESSMENTS	SUPPLEMENTAL INFORMATION
[PDF] Quadrennial Technology Review 2015		
[PDF] Executive Summary		
[PDF] Chapter 1 — Energy Challenges		Supplemental Information
[PDF] Chapter 2 — Energy Sectors and Systems		
[PDF] Chapter 3 — Enabling Modernization of the Electric Power System	Technology Assessments	
[PDF] Chapter 4 — Advancing Clean Electric Power Technologies	Technology Assessments	
[PDF] Chapter 5 — Increasing Efficiency of Buildings Systems and Technologies		Supplemental Information
[PDF] Chapter 6 — Innovating Clean Energy Technologies in Advanced Manufacturing	Technology Assessments	Supplemental Information
[PDF] Chapter 7 — Advancing Systems and Technologies to Produce Cleaner Fuels	Technology Assessments	Supplemental Information
[PDF] Chapter 8 — Advancing Clean Transportation and Vehicle Systems and Technologies	Technology Assessments	
[PDF] Chapter 9 — Enabling Capabilities for Science and Energy		Supplemental Information
[PDF] Chapter 10 — Concepts in Integrated Analysis		Supplemental Information
[PDF] Chapter 11 — Summary and Conclusions		

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

2015 Quadrennial Technology Review (QTR)
Manufacturing Technology Assessments



Composite Materials



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*

Cross-Energy Connections

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

Scope

- Structural composite materials for lightweighting, including automotive, wind, and gas storage applications
- Forming and curing technologies for thermosetting and thermoplastic polymer composites

AMO Strategic Analysis and Multi-Year Program Planning

Quadrennial Technology Review 2015

Chapter 6: Innovating Clean Energy Technologies in Advanced Manufacturing

Technology Assessments

- *Additive Manufacturing*
- *Advanced Materials Manufacturing*
- *Advanced Sensors, Controls, Platforms and Modeling for Manufacturing*
- *Combined Heat and Power Systems*
- ***Composite Materials***
- *Critical Materials*
- *Direct Thermal Energy Conversion Materials, Devices, and Systems*
- *Materials for Harsh Service Conditions*
- *Process Heating*
- *Process Intensification*
- *Roll-to-Roll Processing*
- *Sustainable Manufacturing - Flow of Materials through Industry*
- *Waste Heat Recovery Systems*
- *Wide Bandgap Semiconductors for Power Electronics*

Composite Materials – MYPP Targets

Supply-Chain Systems

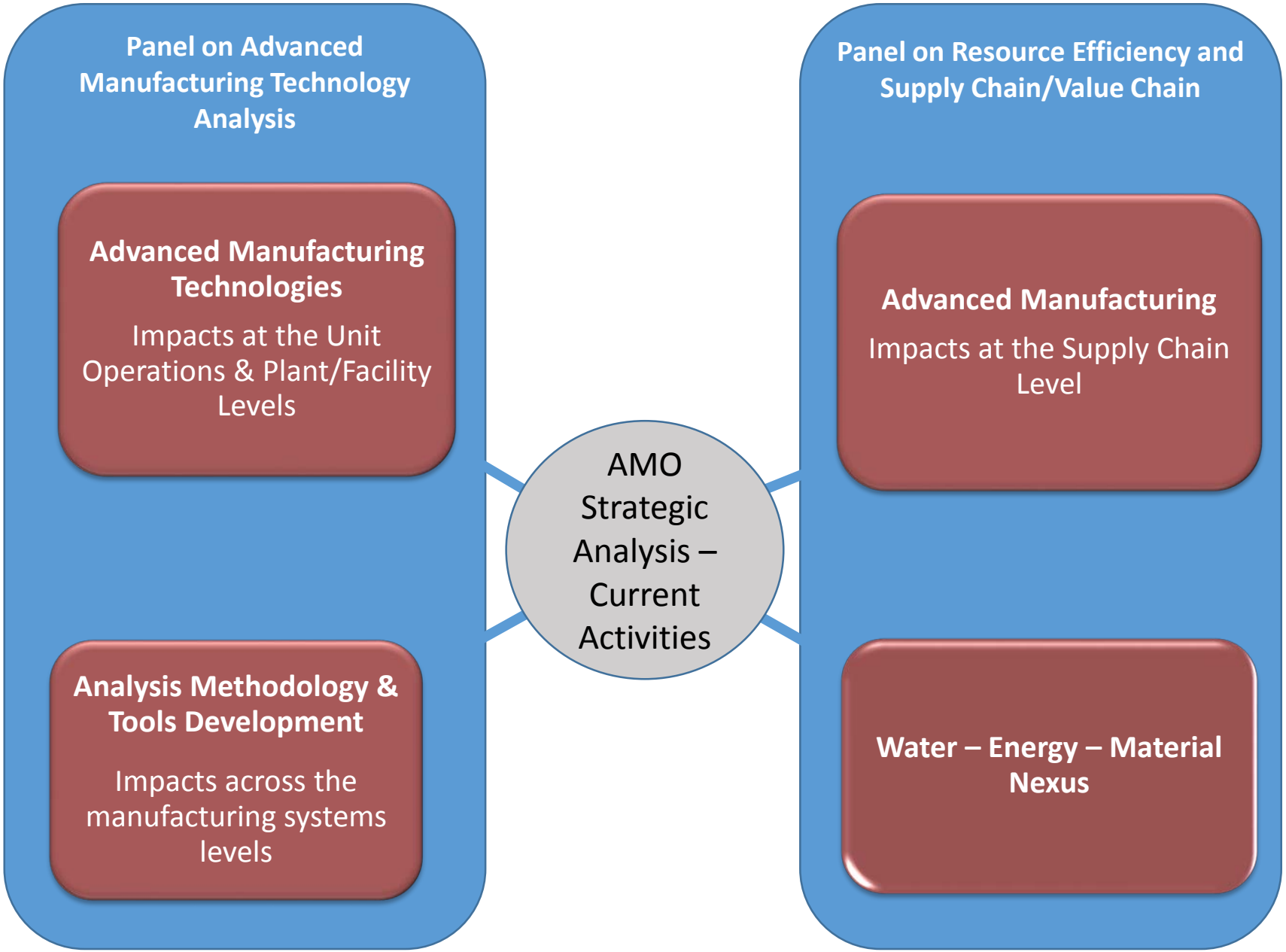
Develop technologies that reduce embodied energy and manufacturing GHG emissions of carbon fiber reinforced polymer (CFRP) by 75% compared to 2015 current typical technology.

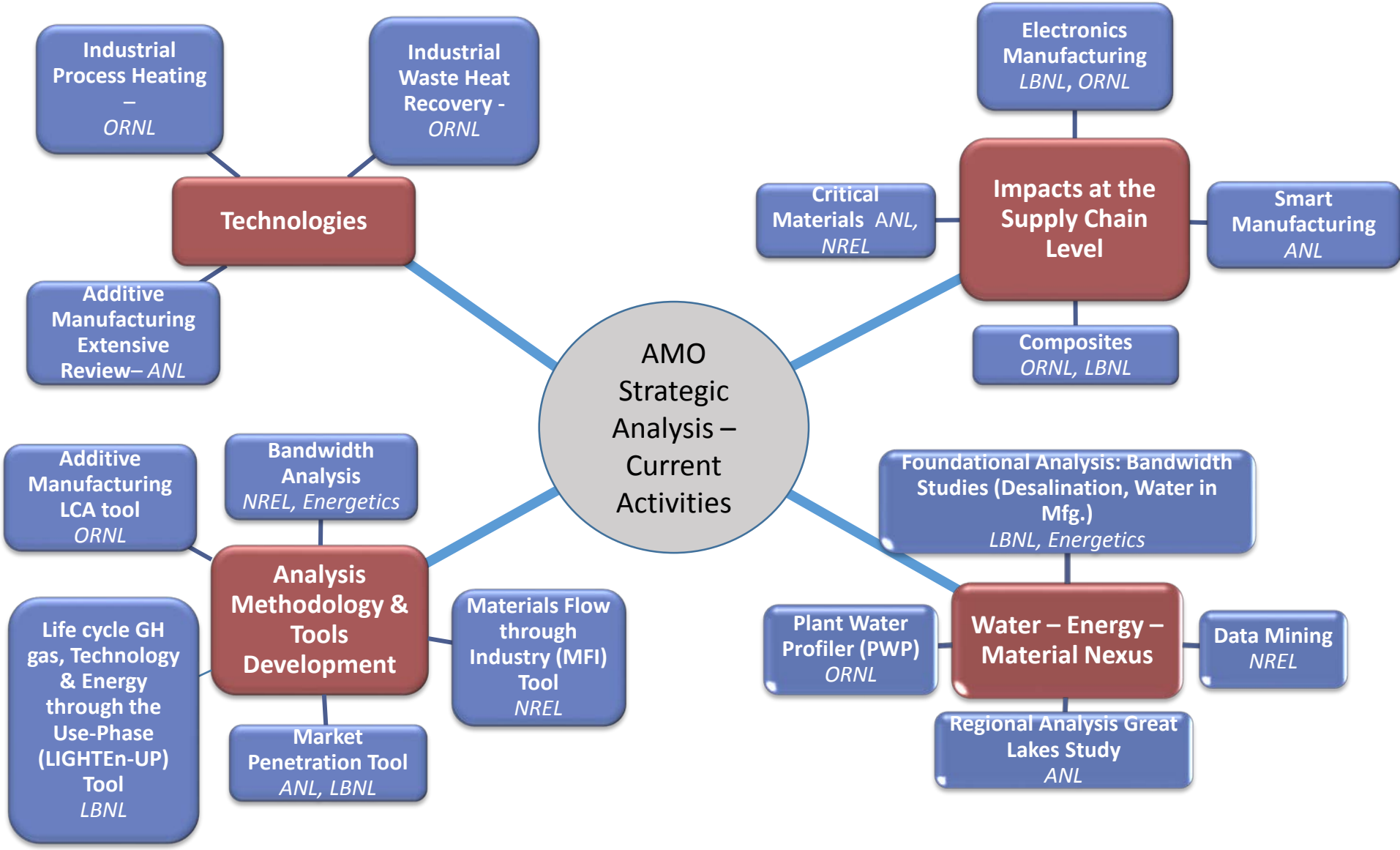
Production/Facility Systems

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 >0.5m^2


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
Panel on Resource Efficiency and Supply Chain/Value Chain
Advanced Manufacturing
Impacts at the Supply Chain Level
Water – Energy – Material Nexus


AMO Strategic Analysis – Current Activities
Technologies
Industrial Process Heating – ORNL
Industrial Waste Heat Recovery - ORNL
Additive Manufacturing Extensive Review– ANL
Impacts at the Supply Chain Level
Electronics Manufacturing LBNL, ORNL
Critical Materials ANL, NREL
Smart Manufacturing ANL
Composites ORNL, LBNL
Analysis Methodology & Tools Development
Additive Manufacturing LCA tool ORNL
Bandwidth Analysis NREL, Energetics
Life cycle GH gas, Technology & Energy through the Use-Phase (LIGHTEn-UP) Tool LBNL
Materials Flow through Industry (MFI) Tool NREL
Market Penetration Tool ANL, LBNL
Water – Energy – Material Nexus
Foundational Analysis: Bandwidth Studies (Desalination, Water in Mfg.) LBNL, Energetics
Plant Water Profiler (PWP) ORNL
Data Mining NREL
Regional Analysis Great Lakes Study ANL