Introduction - AMO Strategic and Technology Analysis

U.S. DEPARTMENT OF ENERGY

AMO Peer Review
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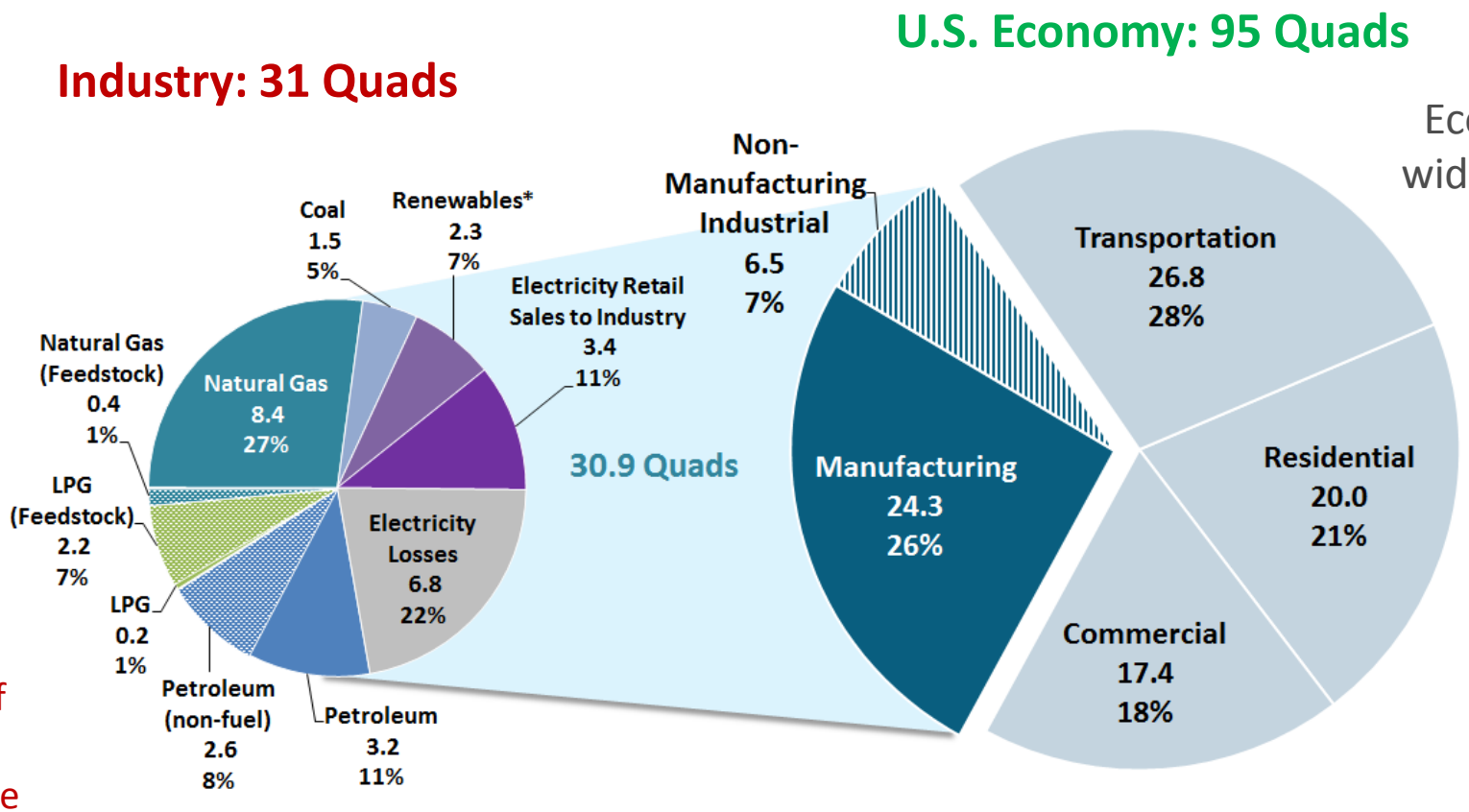
Industry and Manufacturing Energy Use by fuel type…

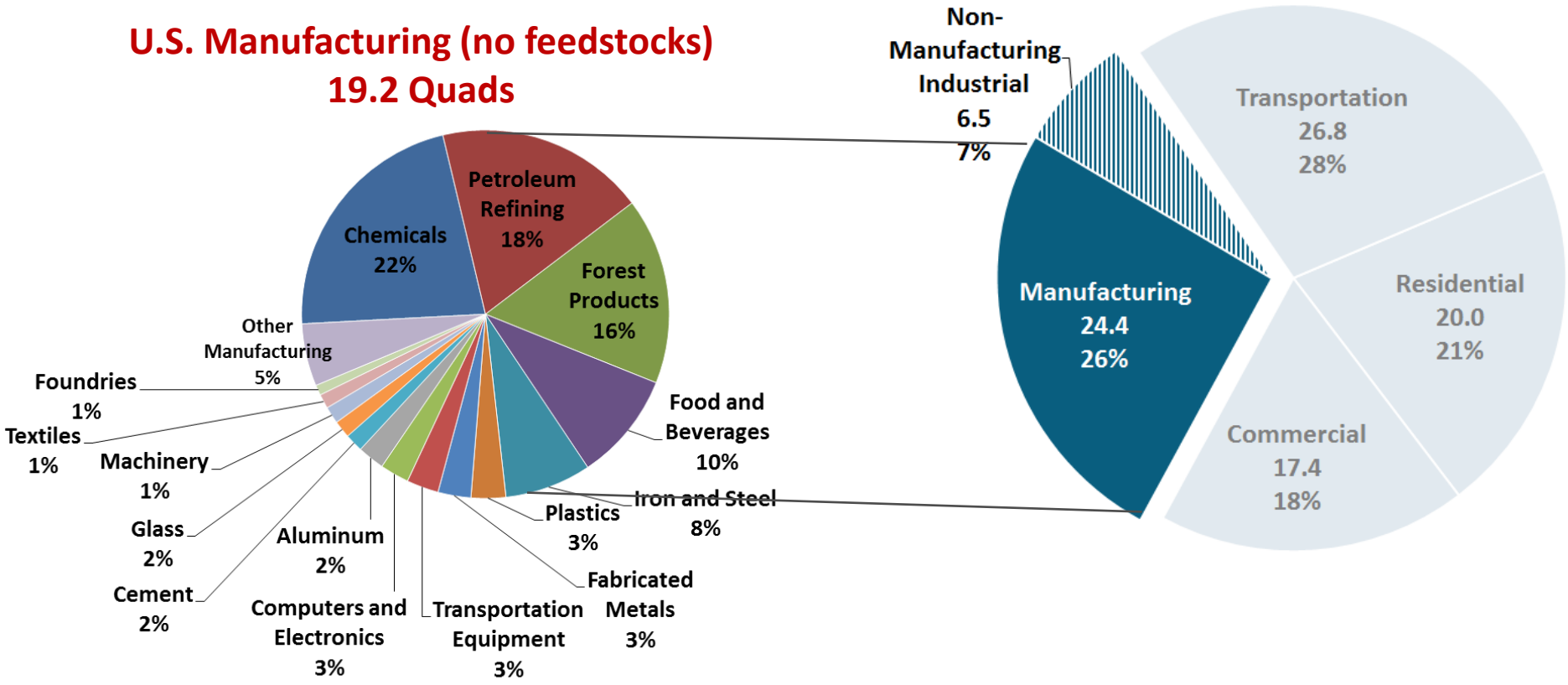


Fuel mix shows diverse nature of industry energy use

Source: EIA Monthly Energy Review, Aug 2014; AEO 2014

* Renewables consist primarily of biomass energy (2.238 Quads), with the remainder from onsite hydroelectric, geothermal, wind and solar energy.

…and by Subsector…



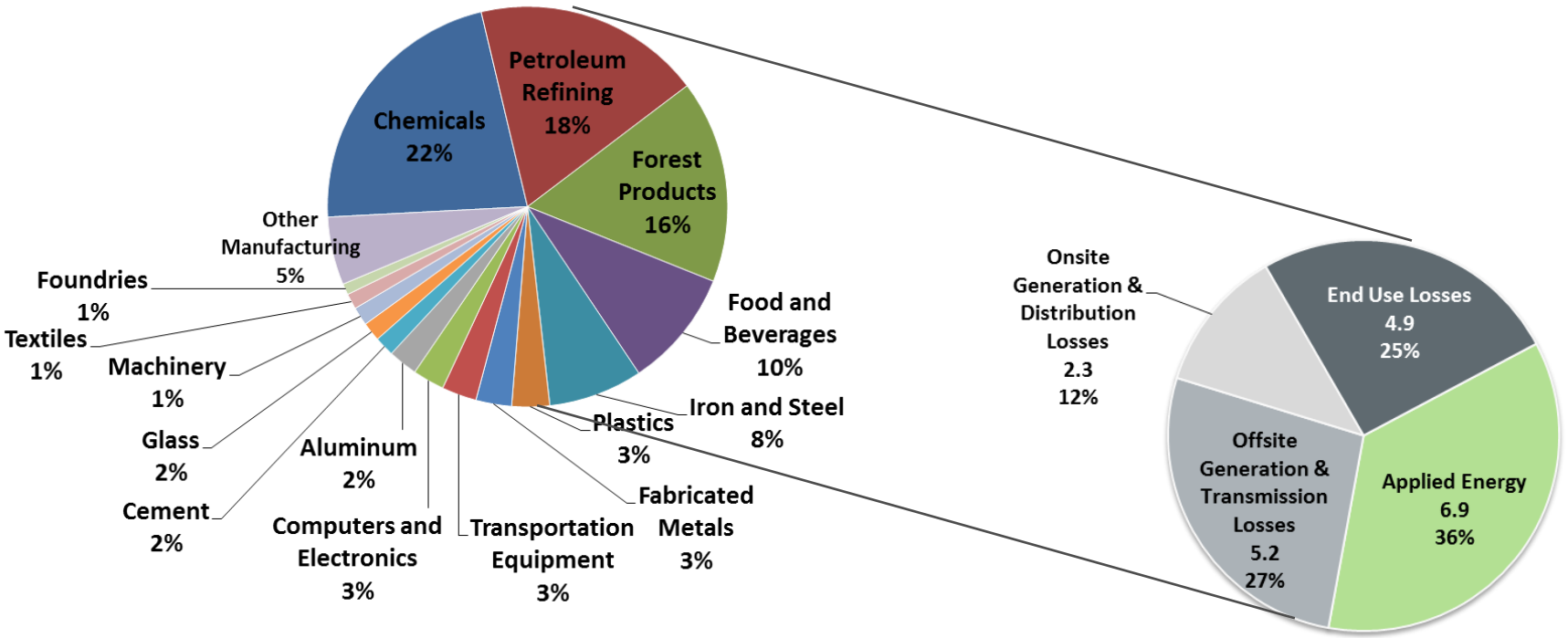
U.S. Economy: 95 Quads

Source: EIA Monthly Energy Review, Aug 2014

Source: AMO Manufacturing and Carbon Footprints. Feedstock energy not included

…to applied energy, reveals opportunities.

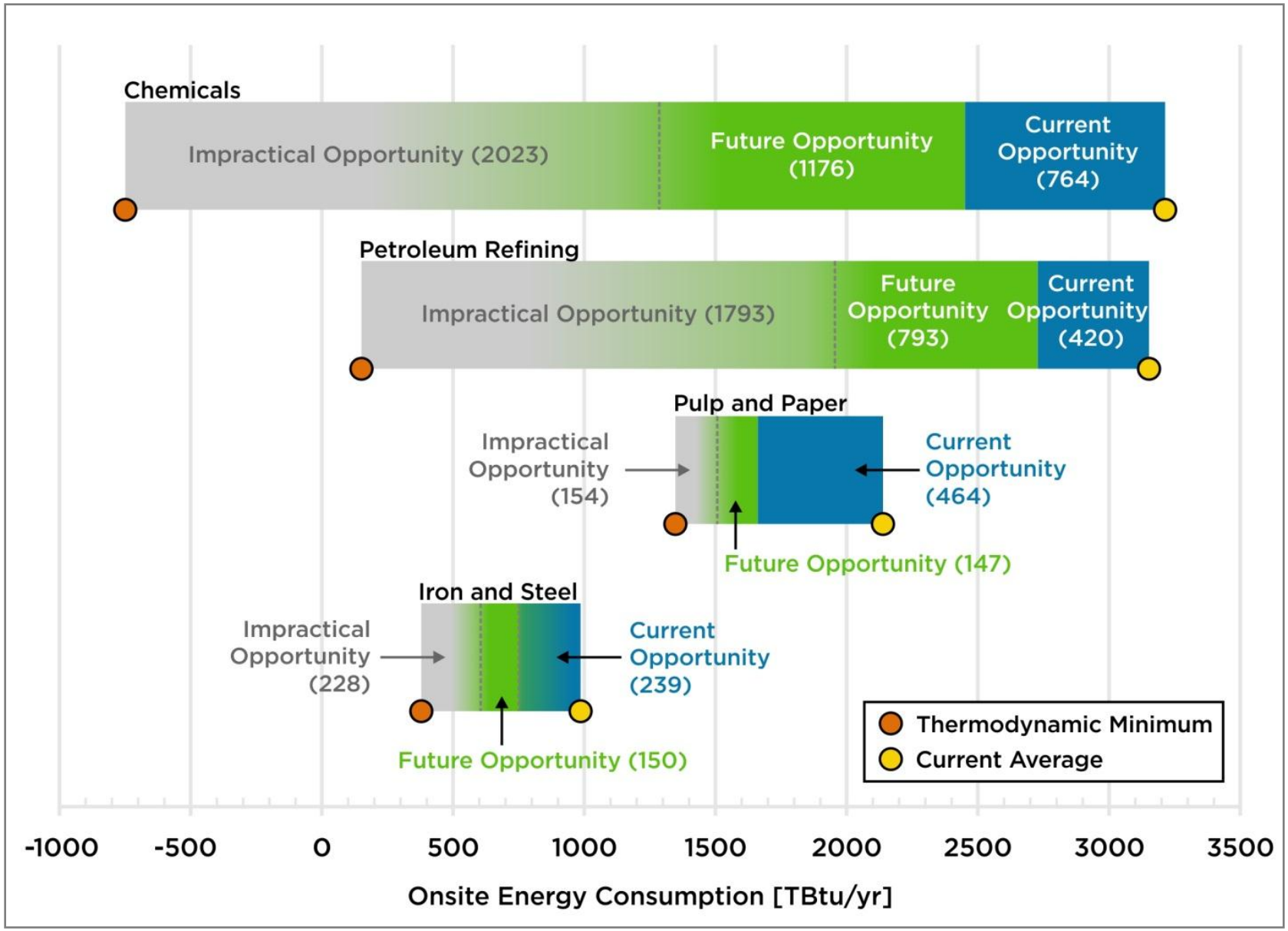
U.S. Manufacturing (no feedstocks)
19.2 Quads



Source: EIA Monthly Energy Review, Aug 2014

Source: AMO Manufacturing and Carbon Footprints. Feedstock energy not included

Driver: Energy Intensity – Bandwidth Studies



System Highlights: Opportunity Space Impacted by Manufacturing

Manufacturing, facility, and supply-chain improvements reduce the 12 quads lost within the industrial sector

Energy Production

Energy Delivery

U.S. Energy Economy
95 quads

Transportation Sector 27 quads	Industrial Sector 31 quads
Residential Sector 20 quads	Commercial Sector 17 quads

Energy-efficient technologies reduce the 58 quads lost throughout the U.S. Energy Economy

Industrial Systems
31 quads

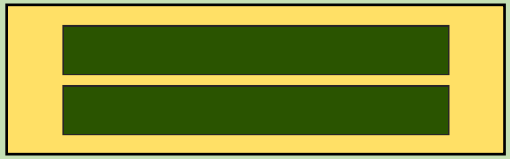
Supply-Chain Systems

Network of facilities and operations involved in moving materials through industry, from extraction of raw materials to the production of finished goods.

Example: Petroleum Refining

Production/Facility Systems

Equipment, process flow, and energy strategies that comprise a goods-producing facility



Manufacturing Systems/ Unit Operations

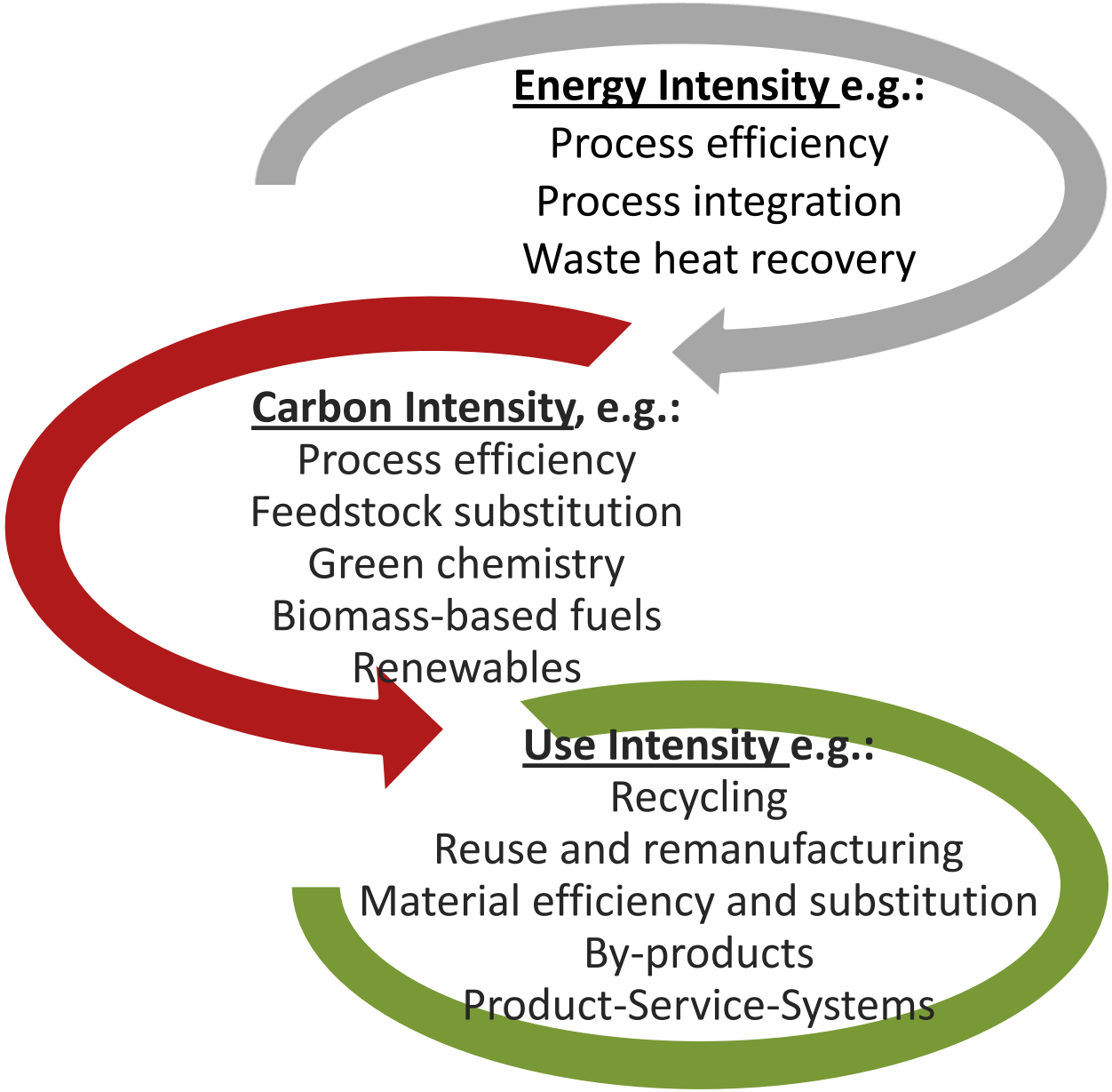
Equipment used for manufacturing process and nonprocess unit operations

Atmospheric Distillation Unit	Hydro cracker	Catalytic Reformer
~4 TBtu	~2 TBtu	~3 TBtu

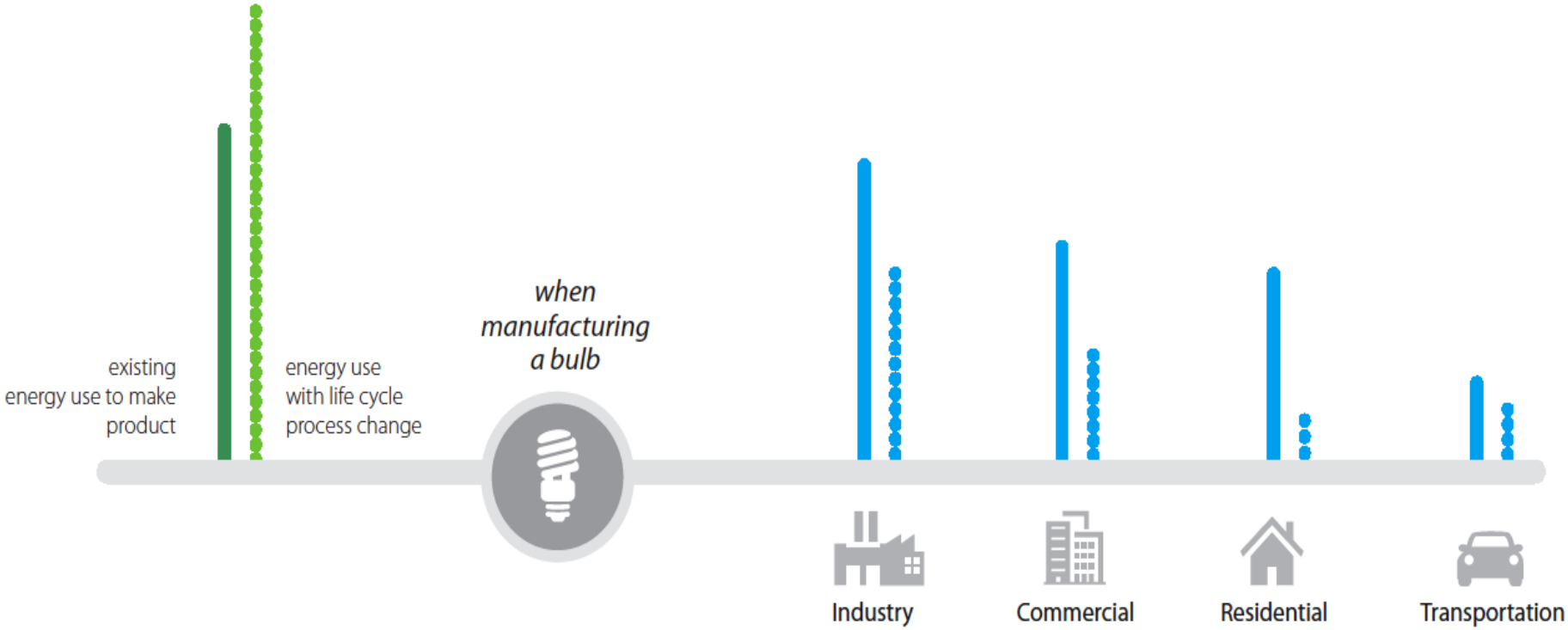
Note: 1 quad = 1,000 TBtu

- *Technologies for clean & efficient manufacturing*
- *Technologies to improve energy use in transportation*
- *Technologies to improve energy use in buildings*
- *Technologies to improve energy production and delivery*

Drivers to Reduce Energy & Emissions through the Product Life Cycle



Systems approach to industrial & manufacturing analysis



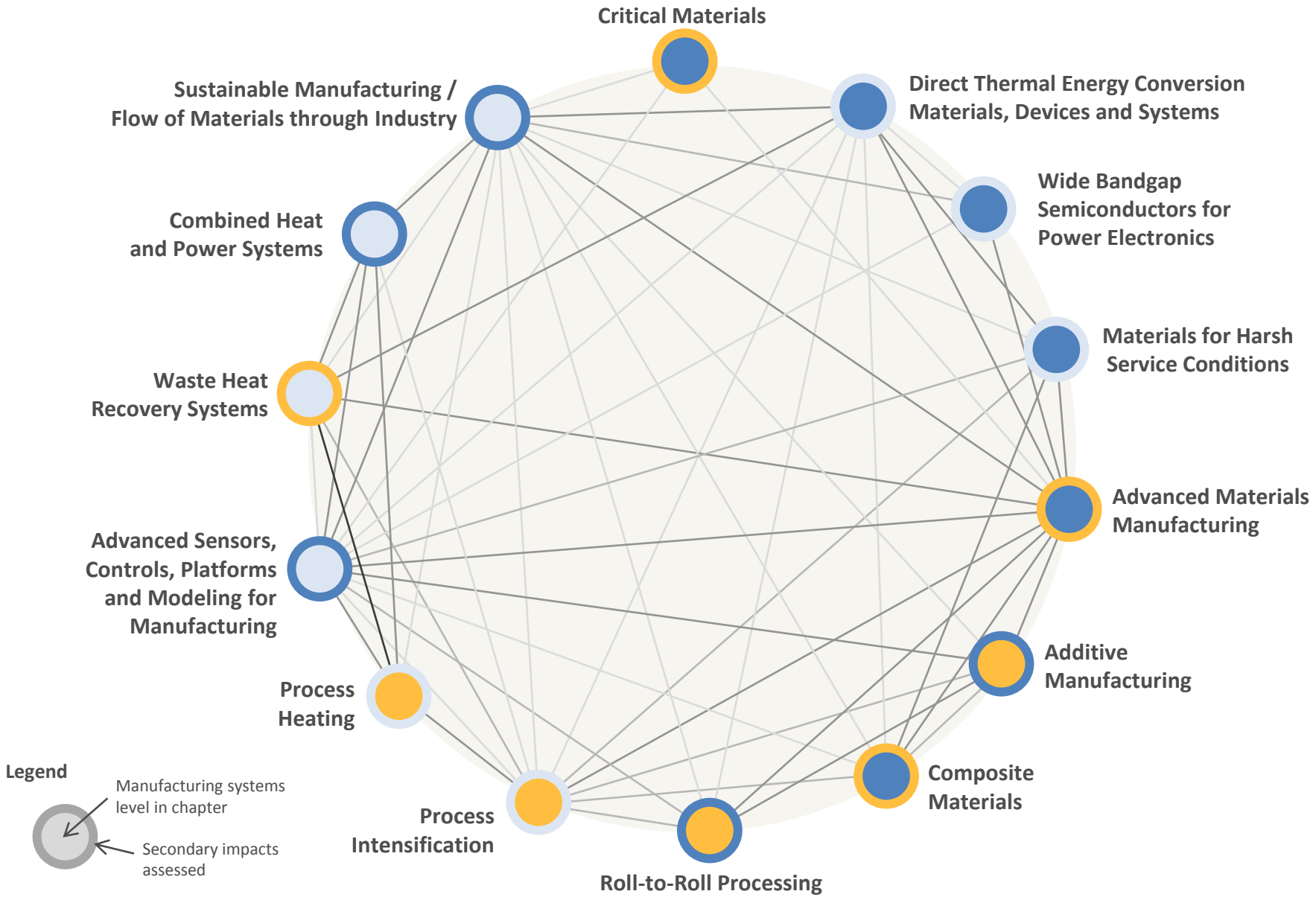
Energy Use in Manufacturing Process

New products or processes may lead to change in energy use in manufacturing sector.

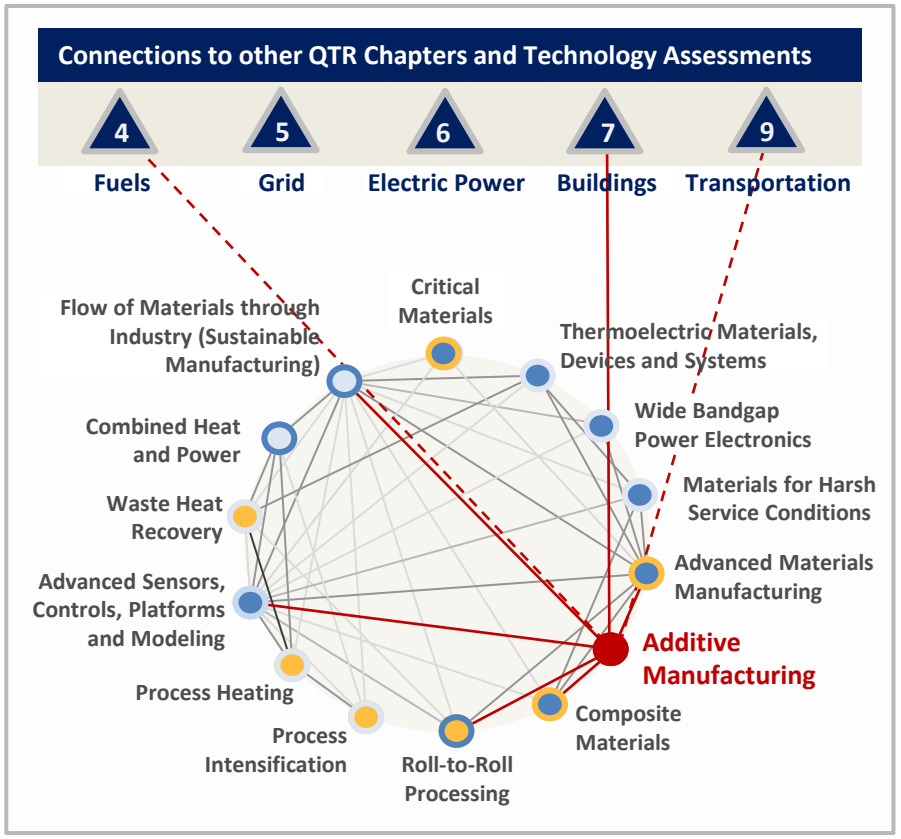
Energy Use in Environment

Change occurs in energy use across sectors as a result of deployment of new product.

QTR Technology Assessments investigated current technology status, R&D needs, and potential energy impacts.



Additive Manufacturing



Key Extra-Chapter Connections

- **Fuels:** *solid oxide fuel cells*
- **Buildings:** *heat exchangers for HVAC systems; window frames*
- **Transportation:** *Prototyping and tooling in automotive applications; fuel cells*

Ch. 8 - Additive Manufacturing Technology Assessment

Scope

- Additive technologies including powder bed fusion, directed energy deposition, material extrusion, vat photopolymerization, material jetting, and sheet lamination
- Material compatibility, including homogenous (e.g., metals) and heterogeneous materials (e.g., reinforced polymer composites)

Shelby Cobra sports car printed via additive manufacturing at the DOE Manufacturing Demonstration Facility*

*Source: Oak Ridge National Laboratory – Manufacturing Demonstration Facility

AMO Strategic and Technology Analysis

GOAL: Clear, transparent, credible, verifiable technology evaluation.

APPROACH: Perform detailed technology and manufacturing analyses; characterize the life cycle energy and emissions; and assess prospective cross-sectoral impacts.

ANALYTICS: Analyses, methodologies and tools to evaluate the energy and GHG impacts of changes in materials and industrial processes, material flows through the industrial sector, understand potential impacts of changes, and to help characterize improvement opportunities.

- *Cross-sectoral and life cycle impacts*
- *Embodied Energy & GHGs from "Mine-to-Materials"*
- *Targeted technology deep-dives.*
- *Bandwidth Studies*
- *Manufacturing Competitiveness Analyses*

AMO Strategic and Technology Analysis

TEAM: Supported by coordinated multi-lab analysis experts from:

- Argonne National Lab (ANL)
- Lawrence Berkeley National Lab (LBNL)
- National Renewable Energy Lab (NREL)
- Oak Ridge National Lab (ORNL)

TODAY: Introduction to two key methodologies under development, plus example of targeted technology analysis.

- *NREL, Maggie Mann - Embodied Energy & GHGs from "Mine-to-Materials" with **M**aterials **F**low through **I**ndustry (**MFI**) tool.*
- *LBNL, Bill Morrow - Cross-sectoral and life cycle impacts with the **L**ife Cycle **I**ndustry **GH** gas, **T**echnology and **En**ergy through the **U**se **P**hase (**LIGHTEnUP**) tool.*
- *ANL, Diane Graziano - Targeted technology deep-dives. Additive Mfg.*