

# New technical choice models in the Industrial Demand Module, with steel and paper results



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*For*

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# Overview

- Definitions
  - What is a process flow industry?
  - What is primary production?
- AEO2016 cases
- AEO2016 Industrial results for all industries
- AEO2016 Steel Results: Energy consumption, Technology choice, and selected side cases
- AEO2016 Paper results: Energy consumption and technology choice

# Definitions

- Processing
  - Primary processing: producing goods mostly from raw materials
  - Secondary processing: producing new goods by recycling old goods
- Waste fuel: either byproducts of a production process or waste (e.g. tire derived fuel) that can provide heat or power to an industrial process
- Industry types
  - Process flow industry: industry with homogeneous products whose energy consumption can be measured by discrete process step
  - End use industry: industry with heterogeneous products; model end use such as heating, cooling and machine drive

# AEO2016 cases: Reference case and those of interest to industrial sector

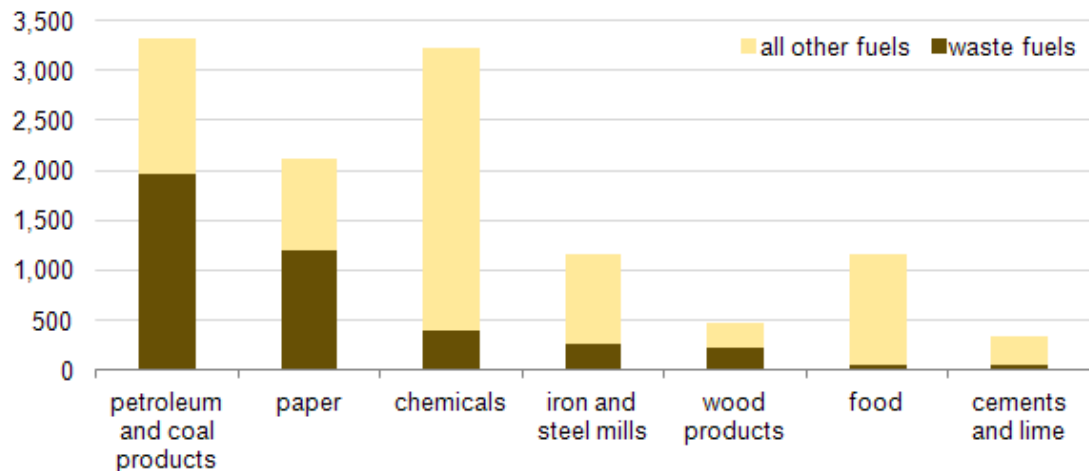
- Reference case: energy consumption given current laws & regulations
- Macroeconomic Growth cases: effect of differing shipments growth on energy consumption; Low and High versions
  - Usually have greatest effect of all the side cases
  - Increase in energy consumption is less than the increase in shipments owing to efficiencies over time
- Industrial efficiency incentive: energy consumption given input incentive via increased prices; Low and High versions; lead to lower energy consumption, though effects vary by fuel
- Energy efficient technology for process flow industries only
  - More efficient technology available and adopted sooner; capacity retires sooner
  - Lowers natural gas heat and power consumption significantly

# Secondary processing in steel and paper

- Steel
  - Primary processing manufactures steel from iron ore using a blast furnace and basic oxygen furnace (BOF) and is energy intensive; also carbon intensive because blast furnaces use coal
  - Secondary processing reforms steel from scrap using an electric arc furnace (EAF) to melt down scrap steel using electricity and natural gas. An EAF is much less energy intensive than a BOF
- Paper
  - Primary processing uses wood, secondary processing uses recycled pulp

# Manufacturing industries where waste/byproduct fuel use is or has the potential to be significant

Fuel consumption by type and manufacturing industry  
trillion Btu



- Current

- Refining (petroleum & coal products)
- Paper
- Chemicals
- Steel
- Wood products

- Potential

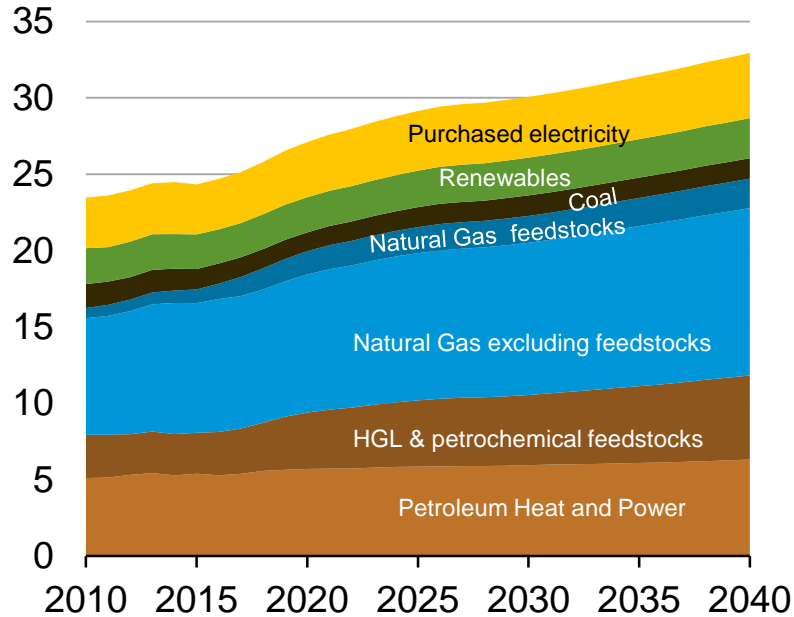
- Cement
- Food

Source: MECS 2010, consolidated Tables 3.5 and 3.6

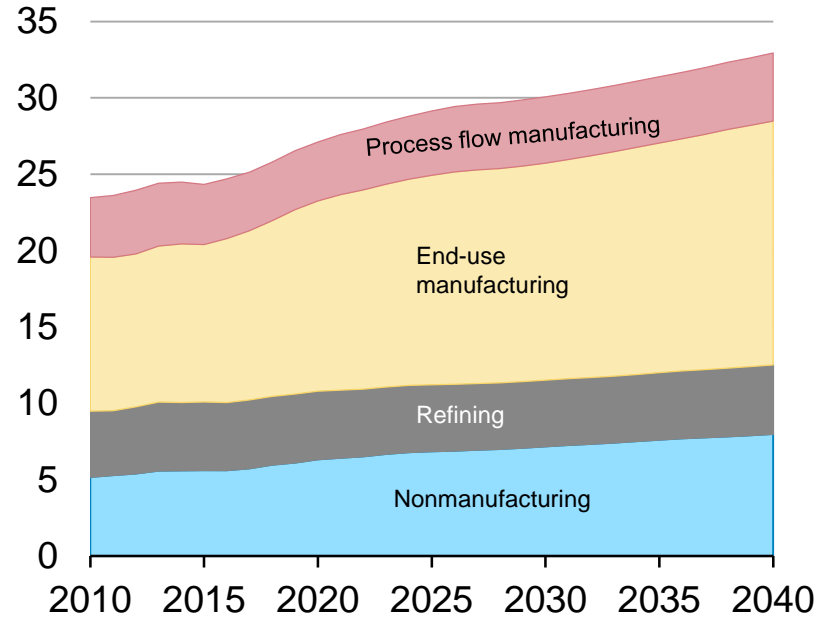
# AEO2016 Energy Consumption by Process Flow Industries

# Industrial delivered energy consumption by fuel source & type of industry

Industrial delivered energy consumption by fuel source  
quadrillion Btu



Industrial delivered energy consumption by industry type  
quadrillion Btu

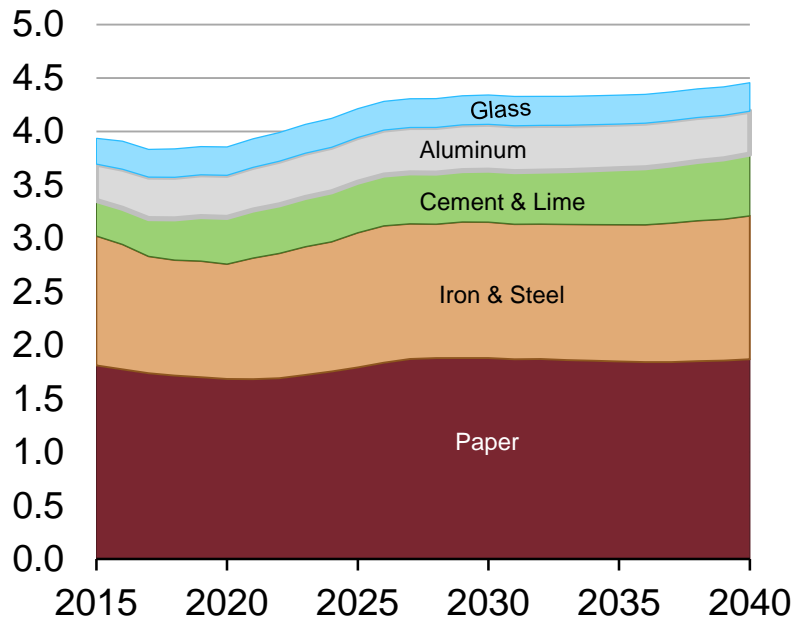


Source: EIA, Annual Energy Outlook Reference case (ref2016.0324a)

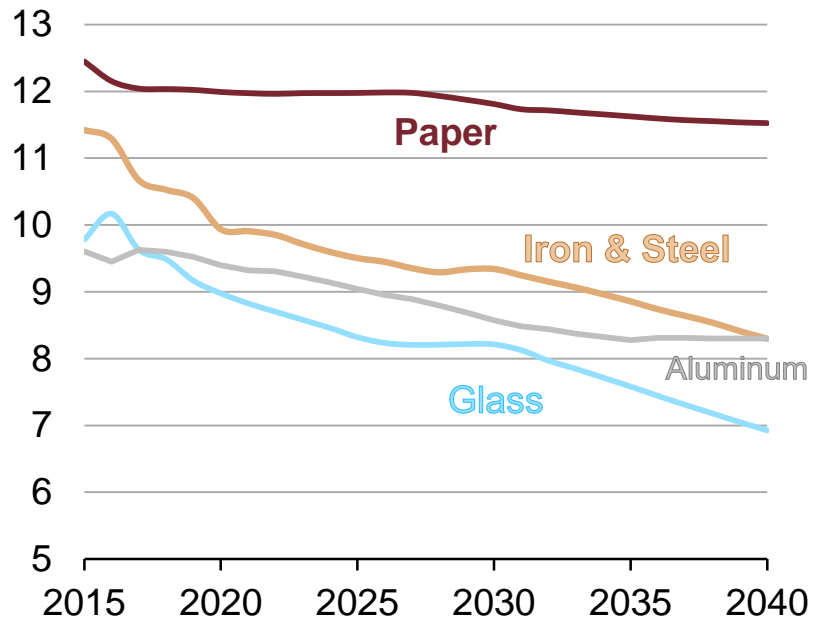


# Process flow industry energy consumption and intensity

Industrial energy consumption  
quadrillion Btu



Industrial energy intensity  
trillion Btu per billion 2009\$ in shipments



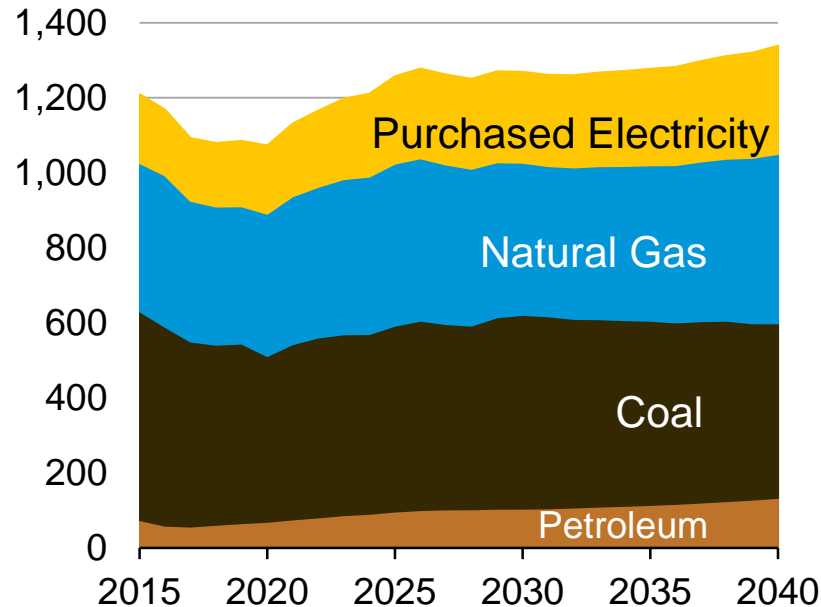
Source: EIA, Annual Energy Outlook Reference case (ref2016.0324a);

Note: Cement & lime energy intensity about 25-27 trillion Btu/billion 2009\$ in shipments throughout projection

# Select AEO2016 Steel results

## Steel energy consumption: coal consumption declines, purchased electricity and natural gas consumption grow in AEO2016 Reference case

Steel energy consumption  
trillion Btu

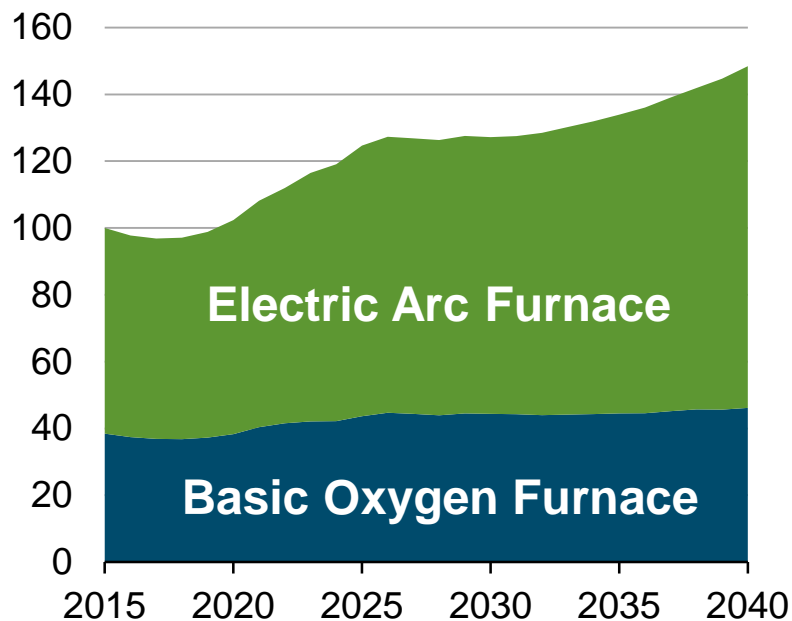


- Coal consumption declines; purchased electricity consumption increases substantially
- Significant share changes
  - Coal share declines: 46% of steel energy consumption in 2015; 35% in 2040
  - Purchased electricity share increases: 15% of steel energy consumption in 2015; 22% in 2040

Source: EIA, Annual Energy Outlook Reference case (ref2016.0324a)

# Nearly 70% of steel produced in electric arc furnaces by 2040 in AEO2016 Reference case

Index of crude steel output 2015=100



- Most growth in crude steel output is from electric arc furnaces (EAF)
- EAF output share is 62% in 2015 and 69% by 2040
- Steel energy intensity declines more than 25% from 2015 to 2040
  - More EAF use
  - New, more energy efficient technologies adopted over time

Source: EIA, Annual Energy Outlook Reference case (ref2016.0324a)

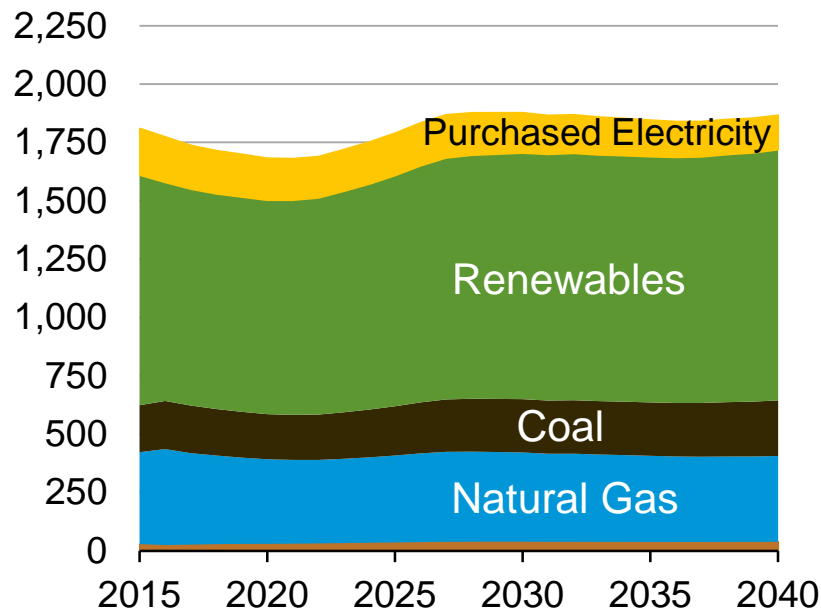
## Direct Reduced Iron: supplies high purity iron to electric arc furnaces and basic oxygen furnaces – new to United States

- Direct Reduced Iron (DRI) is a feedstock that can be used in electric arc furnaces or basic oxygen furnaces
  - Basic Oxygen Furnace: DRI alternative to blast furnace output
  - Electric Arc Furnace: DRI can supplement scrap to improve quality of steel; can also be used in place of scrap
- DRI less energy and carbon intensive than a blast furnace
  - DRI does not melt iron; heats iron to about 1300<sup>0</sup>F/700<sup>0</sup>C
  - Blast furnace melts iron; iron melting point about 2800<sup>0</sup>F/1530<sup>0</sup>C
- DRI plants in United States use natural gas, though other processes can use coal

# Select AEO2016 Paper Results

# Paper energy consumption: energy share stable; energy intensity declines slightly as new technology adopted

Paper energy consumption  
trillion Btu

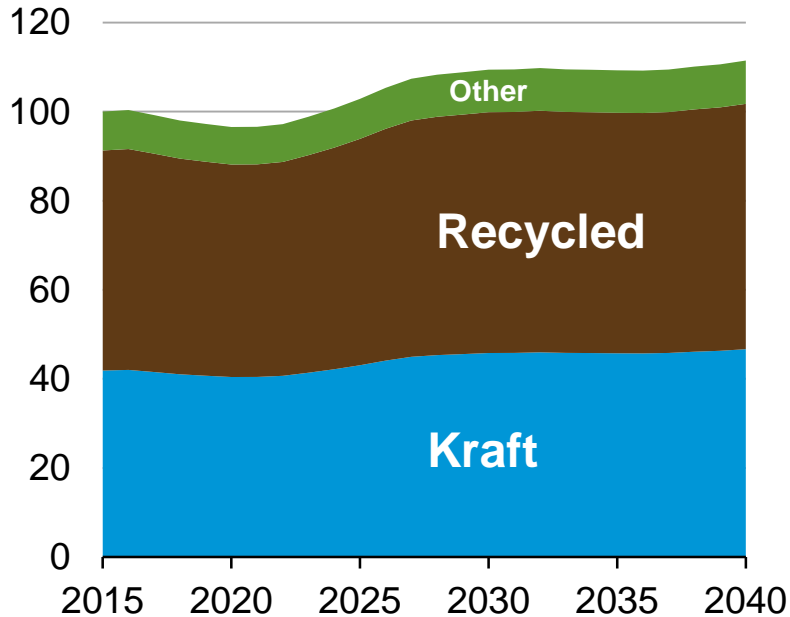


- Renewables about 55% of total energy consumption
  - Wood and wood waste
  - Black liquor
- Paper major user of combined heat and power (CHP)
  - Mostly renewables
  - About 30% of total electricity used from CHP in 2015, almost 40% by 2040

Source: EIA, Annual Energy Outlook Reference case (ref2016.0324a)

## Kraft and recycled pulp production dominate pulp production

Index of pulp output 2015=100



- Paper need usually dictates the pulp produced
- Kraft pulp used for paperboard in for packaging industry, coated papers and for strengthening paper and other pulps
- Recycled pulp used in the manufacture of folding boxboard (gray board), tissue, corrugated board, and newsprint

Source: EIA, Annual Energy Outlook Reference case (ref2016.0324a)



## For more information

Annual Energy Outlook | [www.eia.gov/aeo](http://www.eia.gov/aeo)

Short-Term Energy Outlook | [www.eia.gov/steo](http://www.eia.gov/steo)

International Energy Outlook | [www.eia.gov/ieo](http://www.eia.gov/ieo)

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