Natural gas, industrial, and electricity generation outlook

For
Council of Industrial Boiler Owners
March 8, 2023

By
Corrina Ricker, Peter Gross, and Lori Aniti

Natural gas markets

Key takeaways

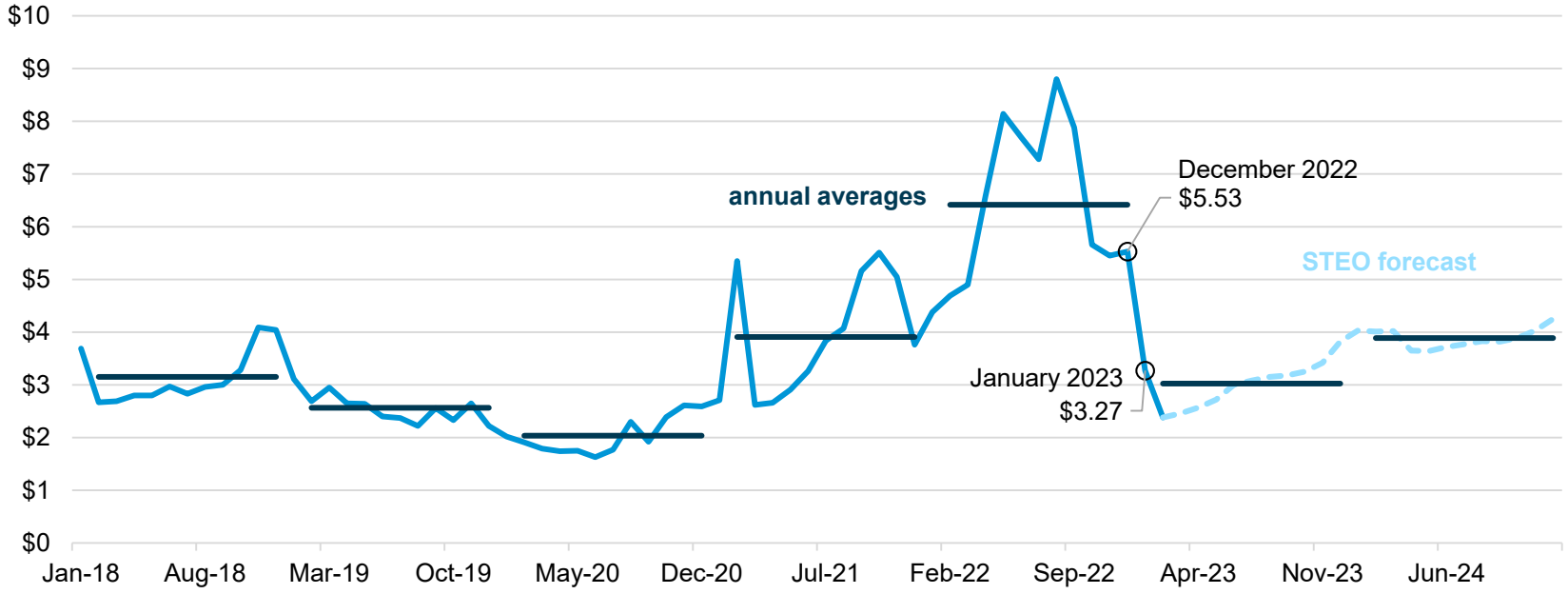
- The U.S. benchmark natural gas price at the Henry Hub declined 41% from December 2022 to January 2023 and remained relatively low in February.

- According to our S*hort-Term Energy Outlook* (STEO):
  - The U.S. benchmark natural gas price at the Henry Hub will remain close to or below $4.00/MMBtu for the next two years.
  - U.S. natural gas storage inventories will remain close to or above the 2018–2022 average for the next two years.
  - U.S. consumption of natural gas will decrease in 2023 and 2024 driven by the electric power and industrial sectors.
  - U.S. dry natural gas production will increase in 2023 and 2024.

Henry Hub spot price averages about $3.00/MMBtu in 2023 and close to $4.00/MMBtu in 2024

Monthly Henry Hub spot price

dollars per million British thermal units ($/MMBtu)

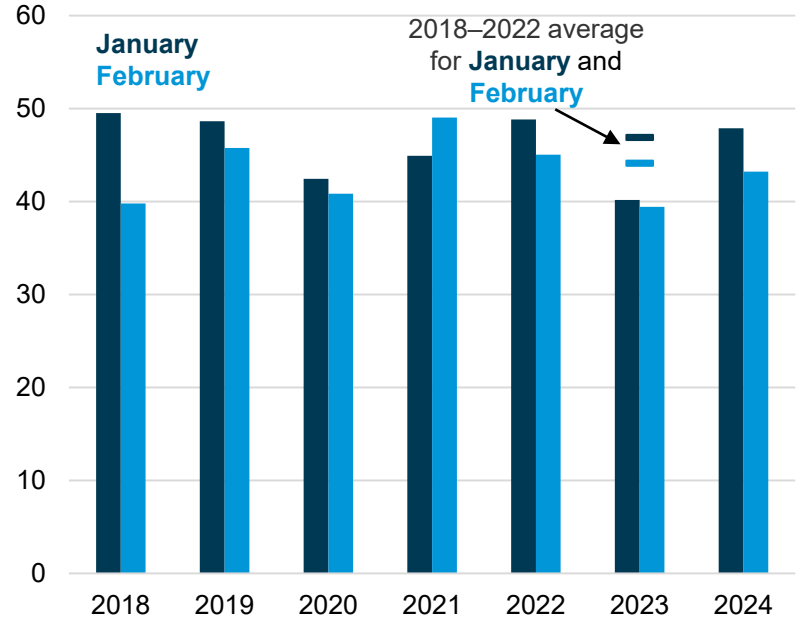


Data source: U.S. Energy Information Administration, *Short-Term Energy Outlook* (STEO), March 2023

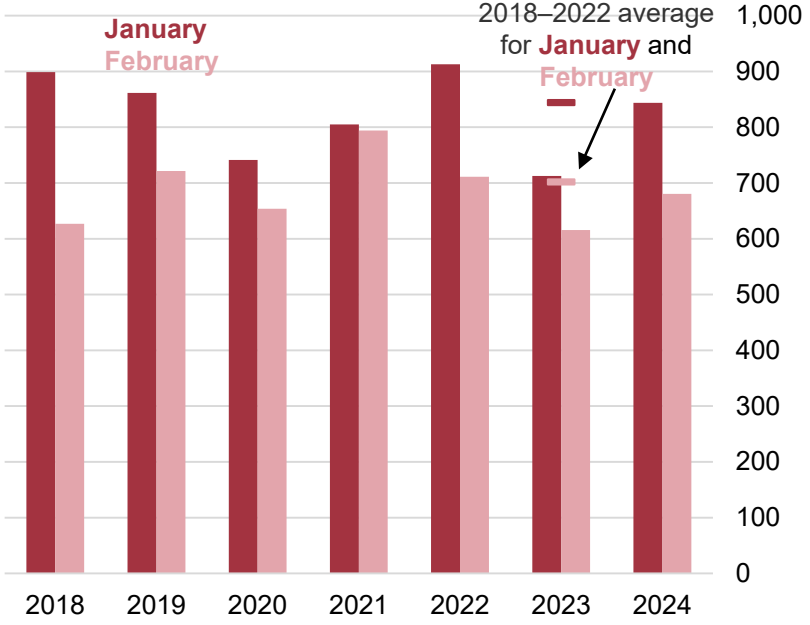
Residential and commercial sector consumption were low in January and February

residential/commercial consumption of natural gas

billion cubic feet per day



U.S. heating degree days



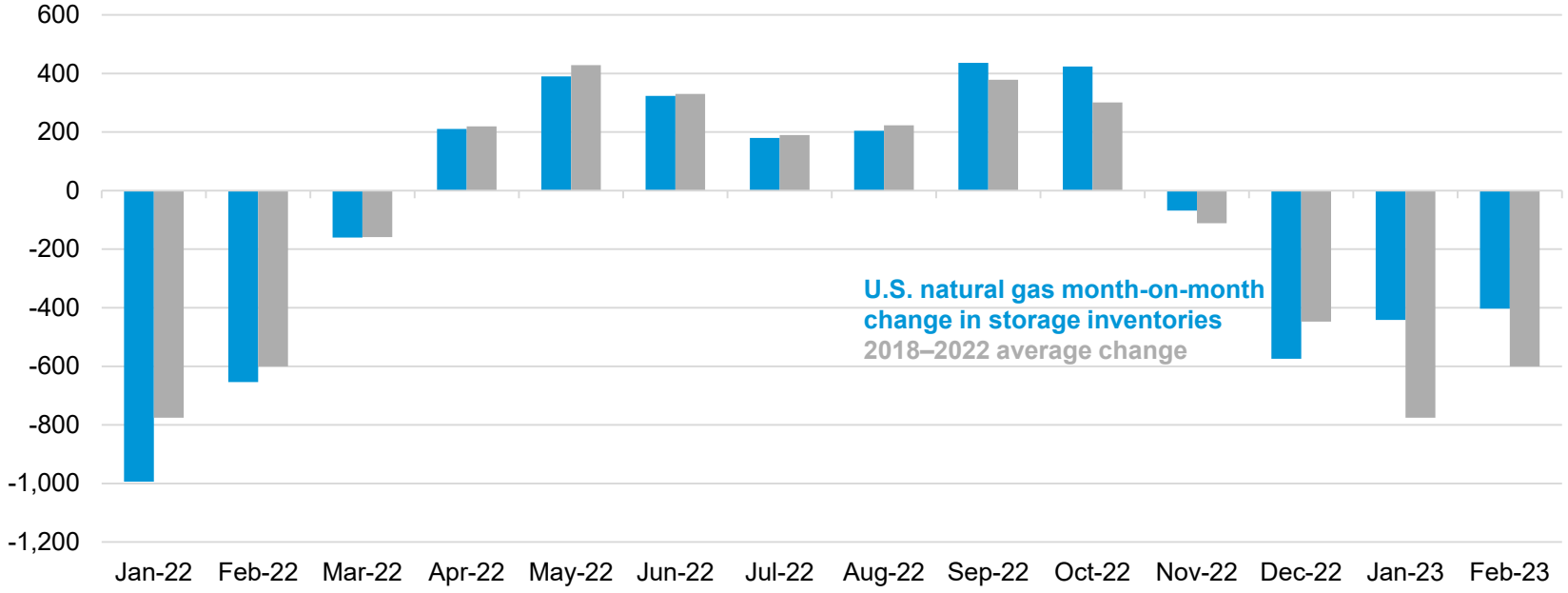
Data source: U.S. Energy Information Administration, *Short-Term Energy Outlook* (STEO), March 2023

Note: January and February residential/commercial consumption values are STEO estimates in 2023 and STEO forecasts in 2024. Heating degree days in 2024 are forecast.

U.S. natural gas storage withdrawals were below average in January and February

U.S. natural gas month-on-month change in storage inventories

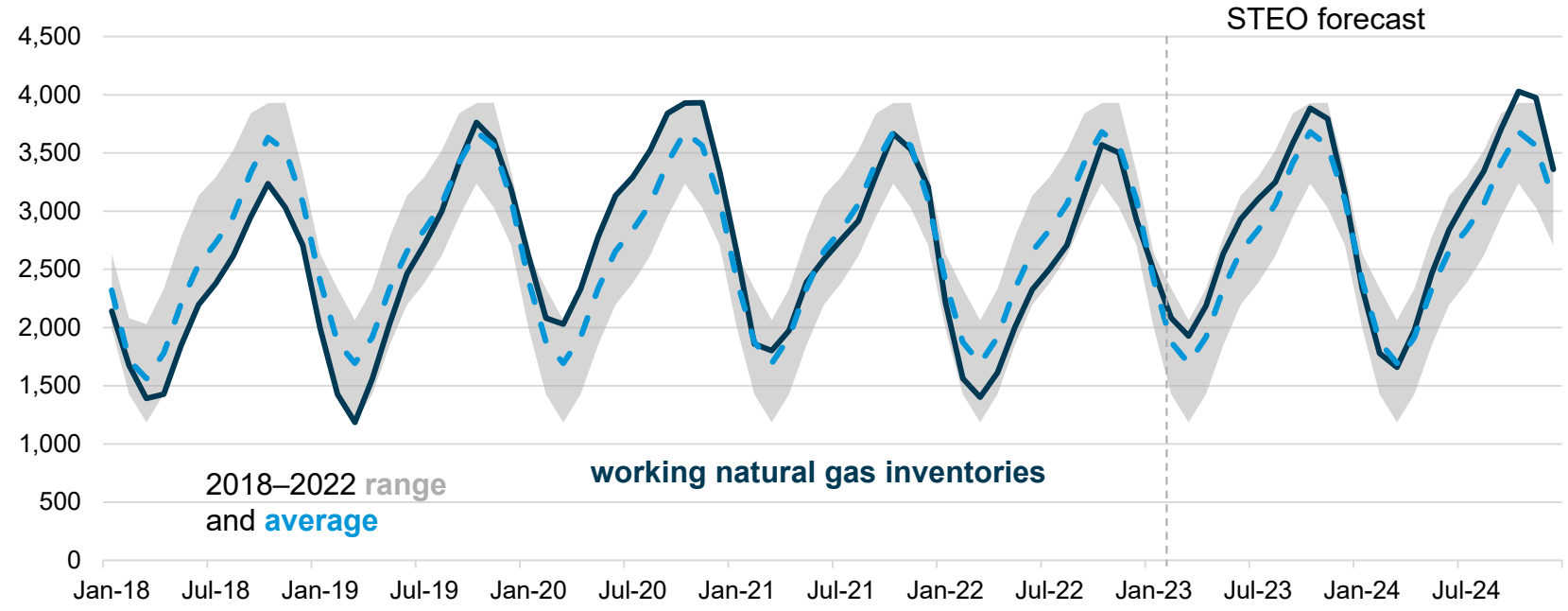
billion cubic feet



Data source: *U.S. Energy Information Administration, Short-Term Energy Outlook* (STEO), March 2023

Working natural gas inventories remain above five-year average until next year

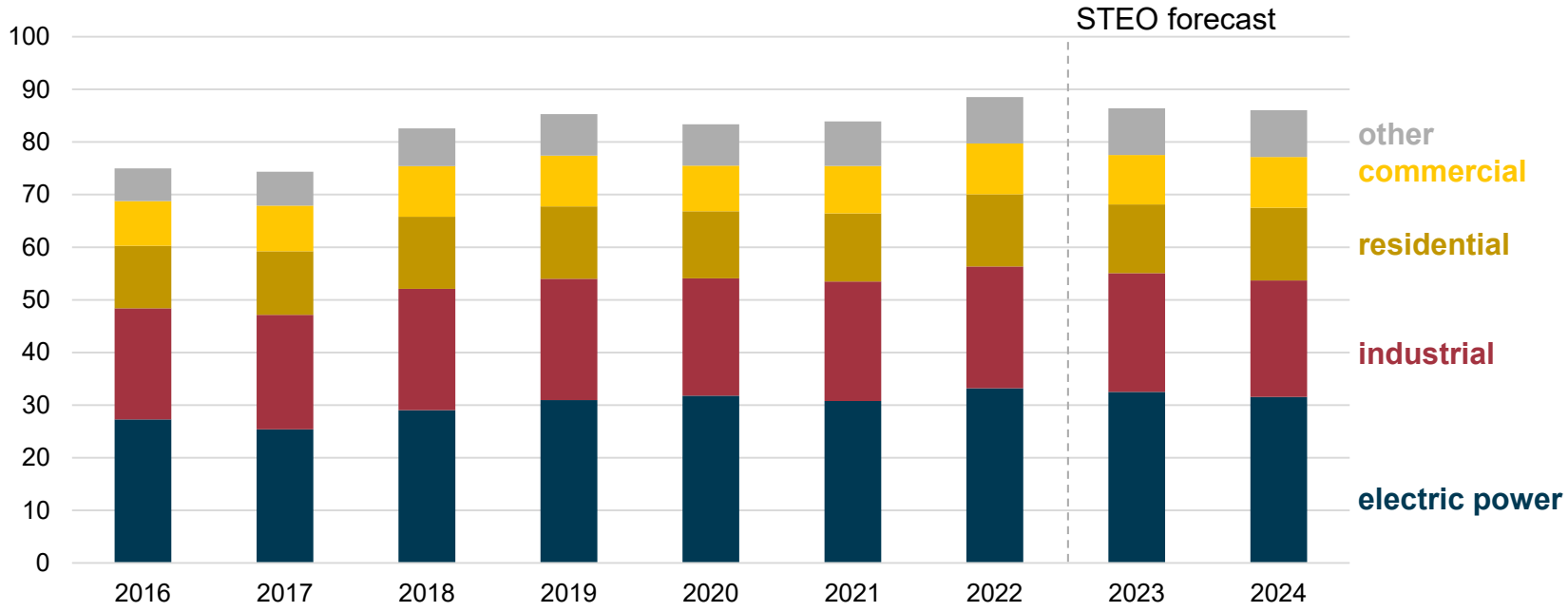
U.S. working natural gas inventories
billion cubic feet



Data source: U.S. Energy Information Administration, *Short-Term Energy Outlook* (STEO), March 2023

U.S. consumption of natural gas decreases in 2023 and 2024

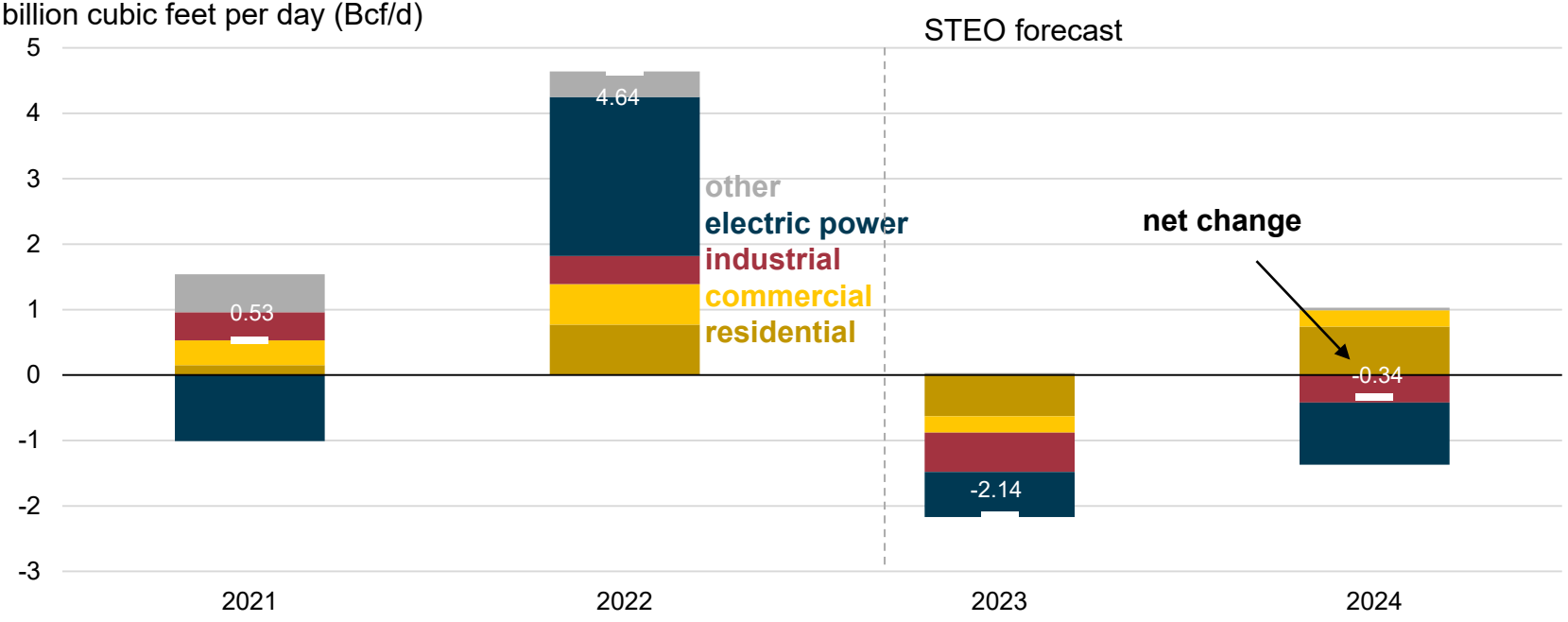
Annual U.S. consumption of natural gas by sector
billion cubic feet per day (Bcf/d)



Data source: U.S. Energy Information Administration, *Short-Term Energy Outlook* (STEO), March 2023

U.S. consumption of natural gas decreases in 2023 and 2024 driven by the industrial and electric power sectors

Year-over-year change in U.S. natural gas consumption
billion cubic feet per day (Bcf/d)

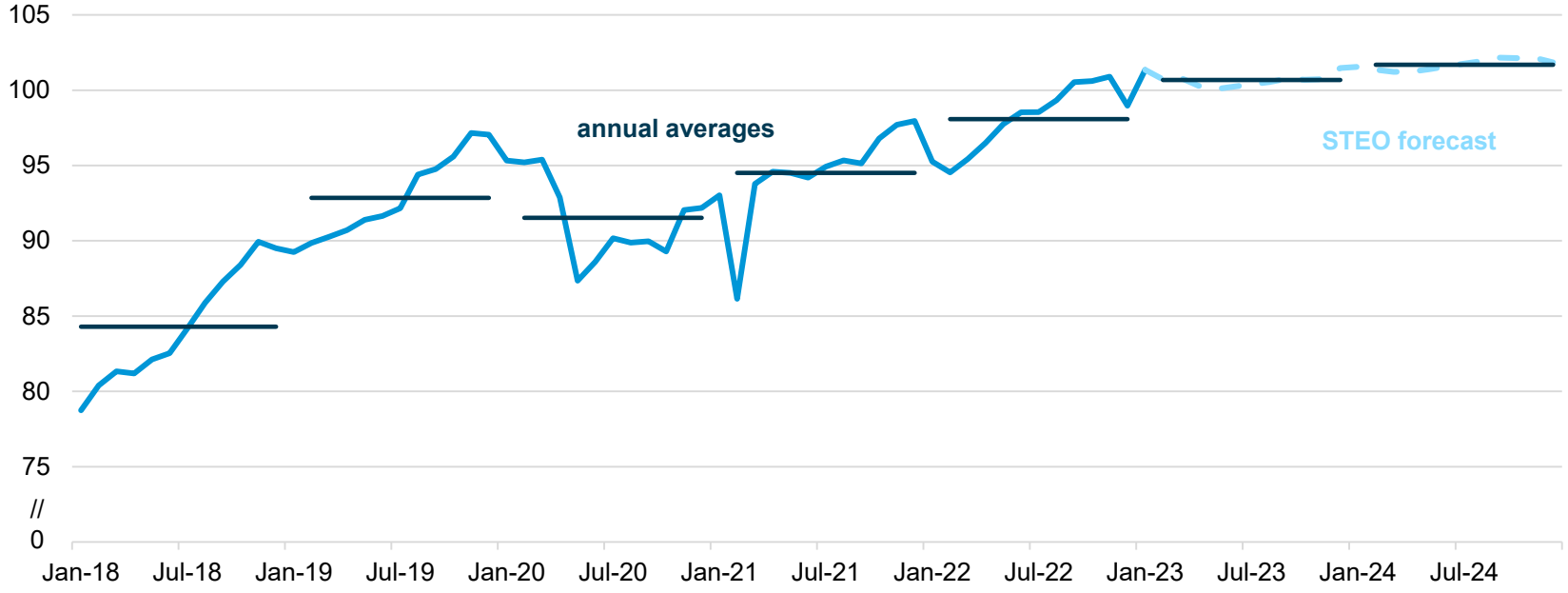


Data source: U.S. Energy Information Administration, *Short-Term Energy Outlook* (STEO), March 2023

U.S. natural gas production increases in 2023 and 2024

U.S. dry natural gas production

billion cubic feet per day (Bcf/d)



Data source: U.S. Energy Information Administration, *Short-Term Energy Outlook* (STEO), March 2023

Links and contact information

- Email: corrina.ricker@eia.gov
- *Short-Term Energy Outlook* | eia.gov/outlooks/steo/
- *Annual Energy Outlook* | eia.gov/outlooks/aeo/
- Relevant *Today in Energy* and *In the News* articles:
  - The Henry Hub natural gas spot price declined 41% in January
  - Increasing renewables likely to reduce coal and natural gas generation over next two years
  - EIA forecasts lower wholesale U.S. natural gas prices in 2023 and 2024

Industrial sector projections

Overview

- National Energy Modeling System (NEMS) and Industrial Demand Module (IDM) description
- Manufacturing Consumption Energy Survey update
- *Annual Energy Outlook 2022* (AEO2022) industrial energy projection results highlights
- Some coming attractions for AEO2023
  - AEO2023 will be released on March 16 (2:00 p.m. – 3:00 p.m. eastern time) at an event hosted by the Resources for the Future (RFF)

Annual Energy Outlook Preliminaries

- Projections in the Reference case of our *Annual Energy Outlook* (AEO) are not predictions of what will happen, but rather, they are modeled projections of what may happen given certain assumptions and methodologies. The Reference case serves as a baseline for comparison between side cases that explain alternative trends.

- We developed AEO by using the National Energy Modeling System (NEMS), an integrated model that captures interactions of economic changes and energy supply, demand, and prices.

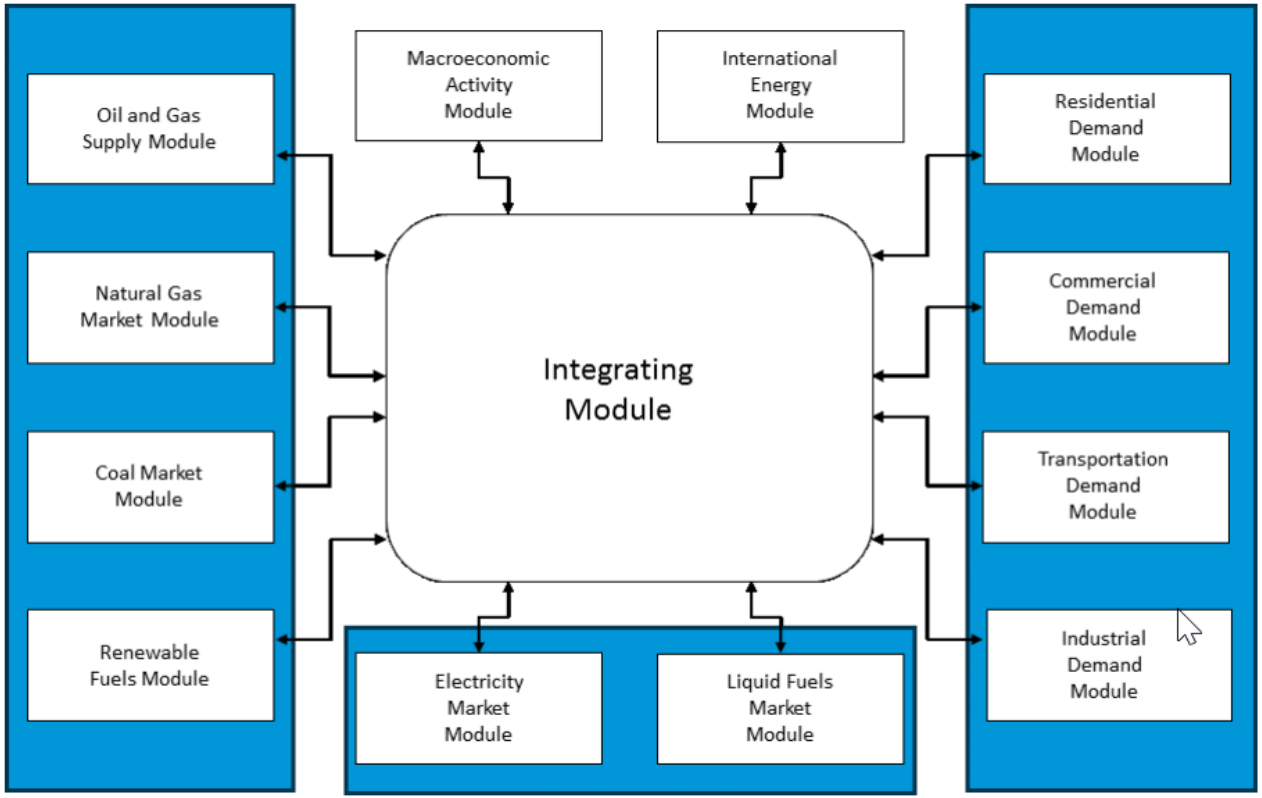
- We publish the AEO to satisfy the Department of Energy Organization Act of 1977, which requires the EIA Administrator to prepare annual reports on trends and projections for energy use and supply.

- Core side cases: High and Low Oil Price, High and Low Macro, High and Low Renewables Cost, High and Low Oil & Gas Supply cases

- Variety of *Issues in Focus* scenario analyses

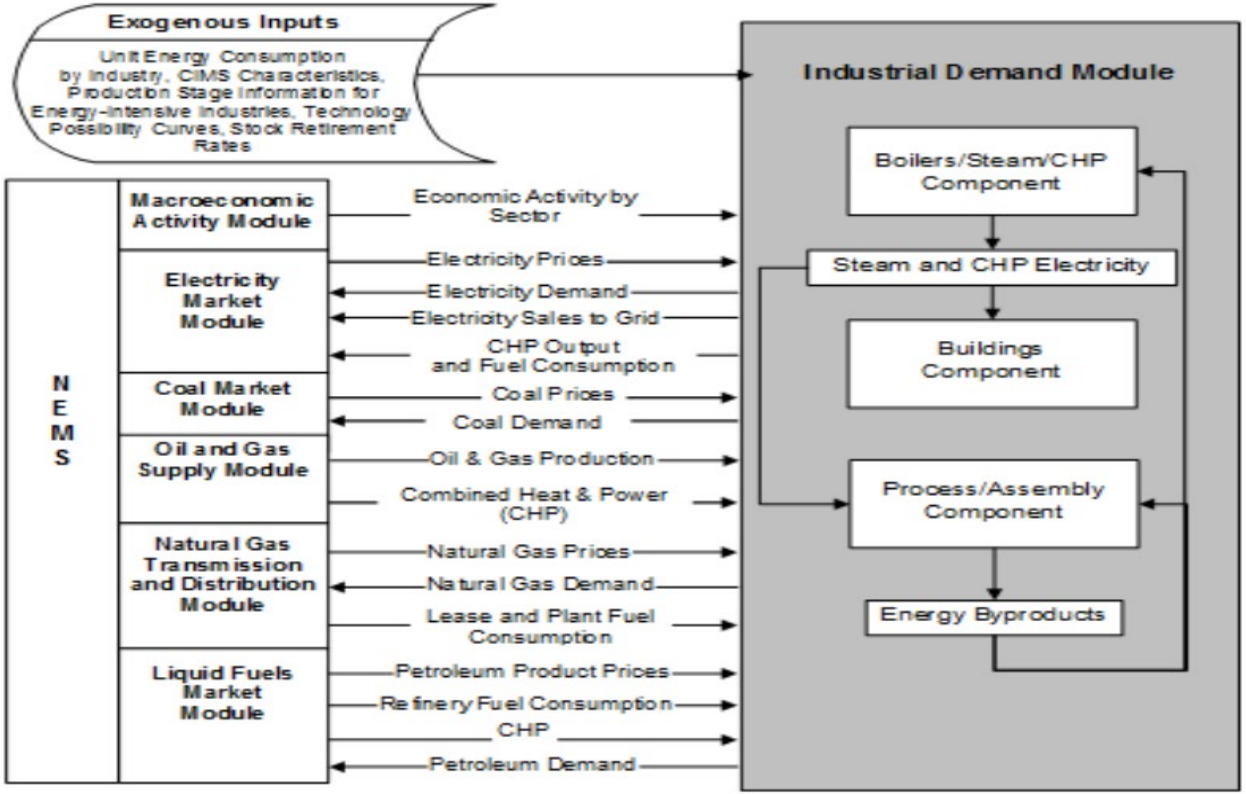
Overview of the Model

Basic National Energy Modeling System (NEMS) Flow



Source: U.S. Energy Information Administration, *The National Energy Modeling System: An Overview 2018*

Industrial Demand Module (IDM) interactions with NEMS



Source: U.S. Energy Information Administration, *Model Documentation Report: Industrial Demand Module of NEMS*

Overview of the IDM

- The NEMS industrial demand module (IDM) models energy consumption for 21 individual industries (15 manufacturing and 6 non-manufacturing)
  - Energy comprised of fuel for heat & power and feedstock
  - Energy consumption modeled by census region but disaggregated into census division via historical SEDS shares
  - Manufacturing industries consists of *end-use* and *process-flow* industries
- Basic structure of IDM: Process & Assembly (PA); Boiler, Steam, Cogeneration (BSC); Building (BLD)
- In certain industries, the IDM models combined heat and power (CHP) energy consumption and electricity generation
- Base year is the last MECS year (2018 for AEO2022).

External Inputs to the IDM

- *Manufacturing Energy Consumption Survey* (MECS); every four years
  - Used to benchmark energy consumption by fuel in each of the manufacturing industries
- State Energy Data System (SEDS); annual
  - Historical consumption data for the industrial sector as a whole (*not* on an industry level)
- Quarterly Coal Report
- Economic Census, Annual Survey of Manufacturers (ASM)
- *Short-Term Energy Outlook* (STEO)
- Combined-heat-and-power data: capacity and generation, by fuel
- USDA (National Agricultural Statistics Service)

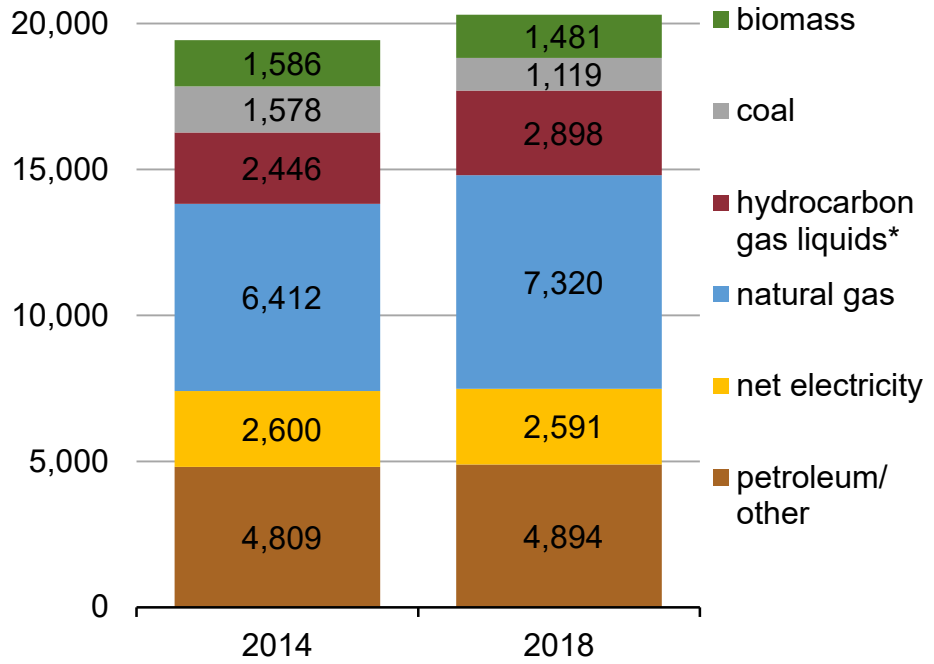
MECS update for AEO2022

Corrina Ricker, Peter Gross, and Lori Aniti
Council of Industrial Boiler Owners, March 8, 2023

MECS energy consumption changes from 2014 to 2018

- Survey done every 4 years, with 2018 data released this year
- MECS supplies baseline energy consumption by manufacturing industry and fuel
- 2018 MECS versus 2014 MECS
  - Higher natural gas, hydrocarbon gas liquid consumption
  - Lower coal consumption
  - Similar electricity purchases

MECS first use of fuel and feedstock
trillion British thermal units

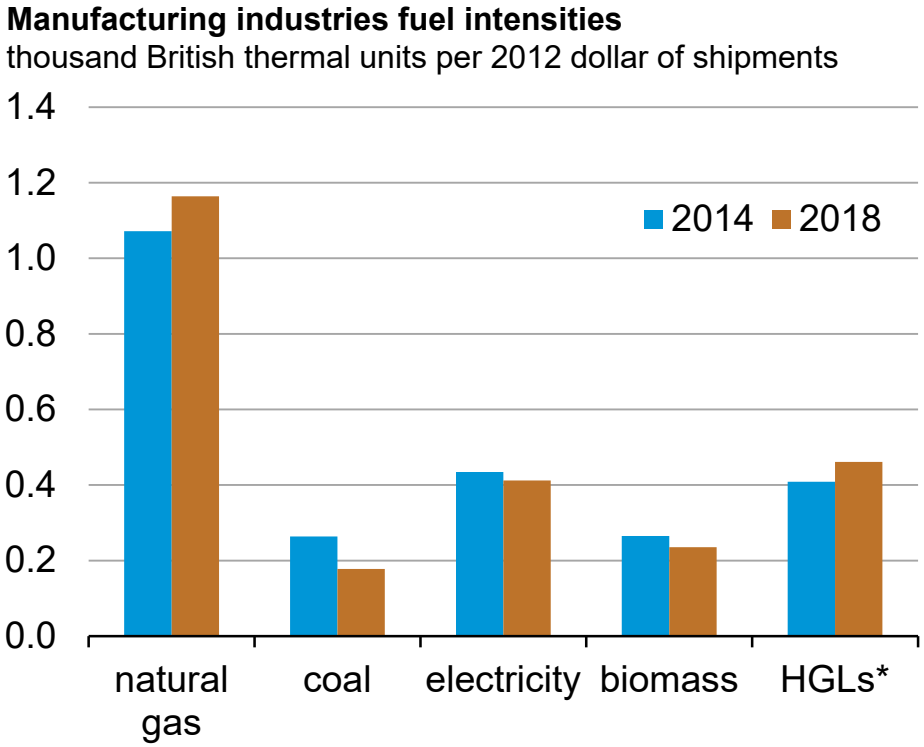


Data source: U.S. Energy Information Administration, *2014 MECS, 2018 MECS*

**excluding natural gasoline*

Energy intensity increased for natural gas and HGLs

- Comparing 2018 MECS to 2014 MECS, manufacturing industries as a whole use more natural gas and less coal per unit of output
- Decrease in coal consumption most significant in paper and chemicals
- Higher hydrocarbon gas liquid (HGL) intensity
  - More use as chemical feedstock



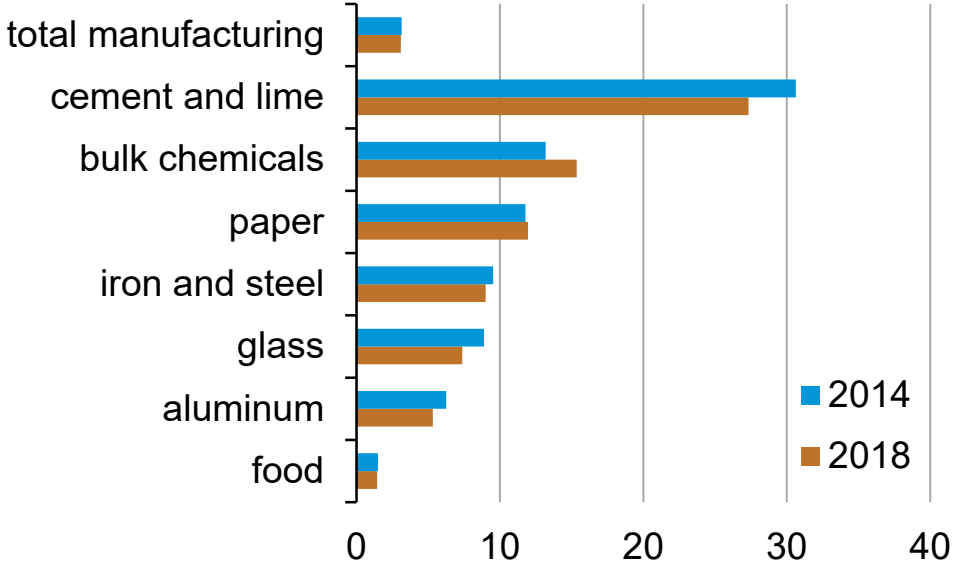
Data source: U.S. Energy Information Administration, *2014 MECS, 2018 MECS*

**excluding natural gasoline*

Energy intensity declined in most heavy industries

- Retirement of less-efficient equipment, replacement with newer, more-efficient equipment decreased energy intensity for many industries
- Bulk chemical saw the buildout of many new, energy-intensive facilities (like ethylene crackers)
  - Feedstock has been a major source of demand growth, but doesn't become more efficient

Energy intensities of selected manufacturing industries
thousand British thermal units per 2012 dollar of shipments



Data source: U.S. Energy Information Administration, *2014 MECS, 2018 MECS*

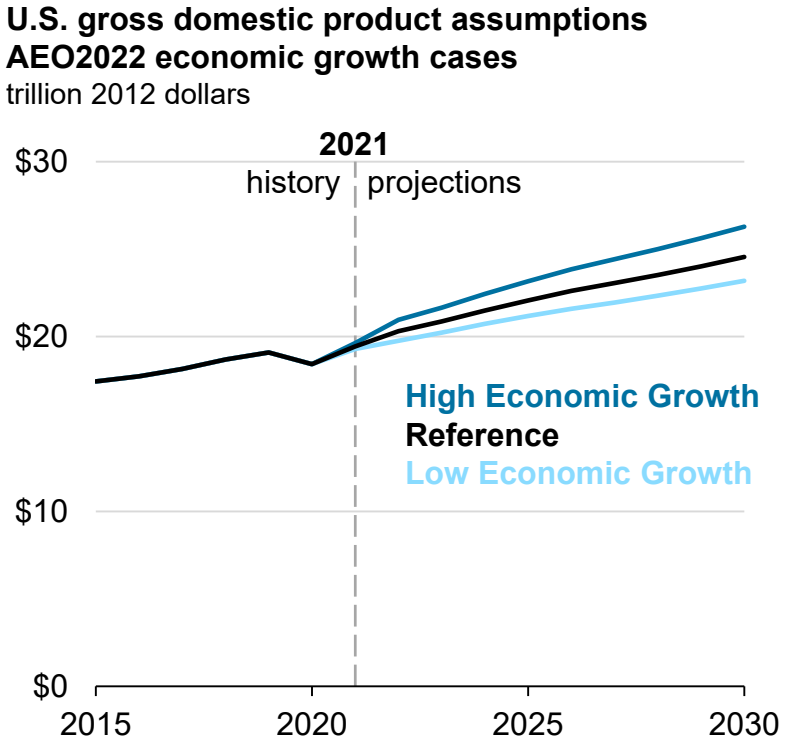
AEO2022

AEO2022 Highlights

- Petroleum and natural gas remain the most-consumed sources of energy in the United States through 2050, but renewable energy is the fastest growing
- Wind and solar incentives, along with falling technology costs, support robust competition with natural gas for electricity generation, while the shares of coal and nuclear power decrease in the U.S. electricity mix
- U.S. crude oil production reaches record highs, while natural gas production is increasingly driven by natural gas exports

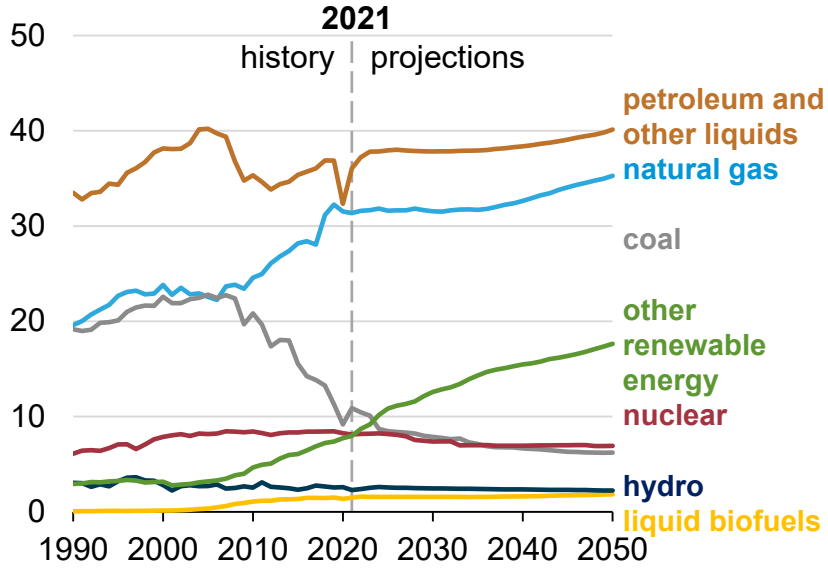
Changes in AEO2022: Pandemic and Legislation

- COVID-19 continues to be a major source of uncertainty, especially in the near term.
- AEO2022 includes provisions from the Bipartisan Infrastructure Law

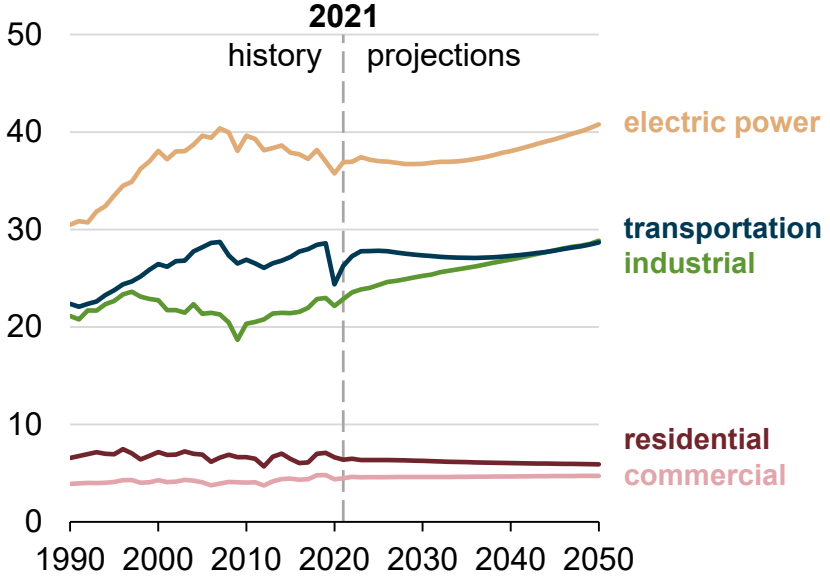


Renewables consumption grows fastest but remains far below petroleum and other liquids consumption in 2050

Energy consumption by fuel
AEO2022 Reference case
quadrillion British thermal units



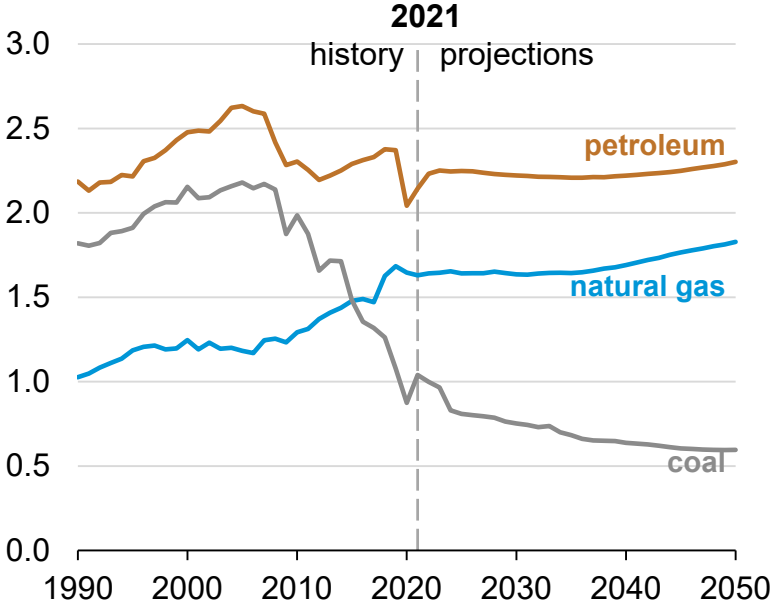
Energy consumption by sector
AEO2022 Reference case
quadrillion British thermal units



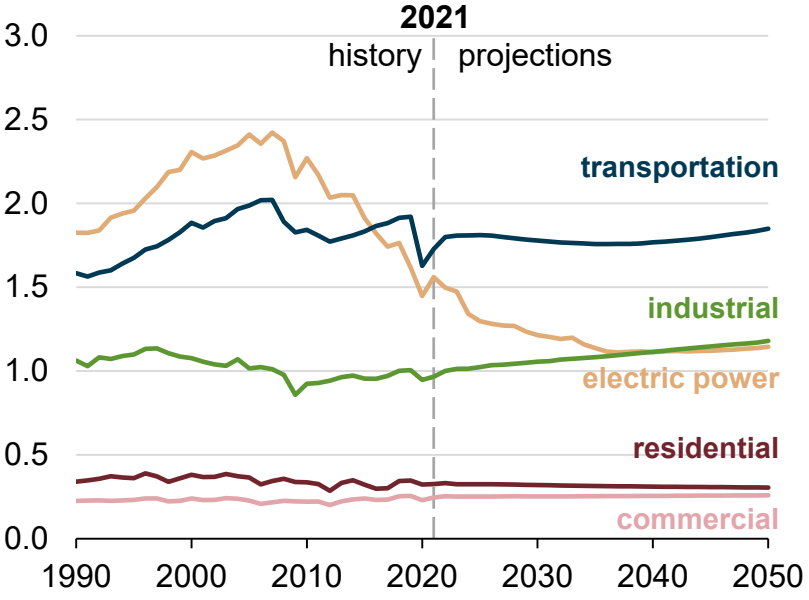
Note: Biofuels are shown separately and included in petroleum and other liquids.

Energy-related CO_2 emissions by sector and fuel

Energy-related CO_2 emissions by fuel
AEO2022 Reference case
billion metric tons

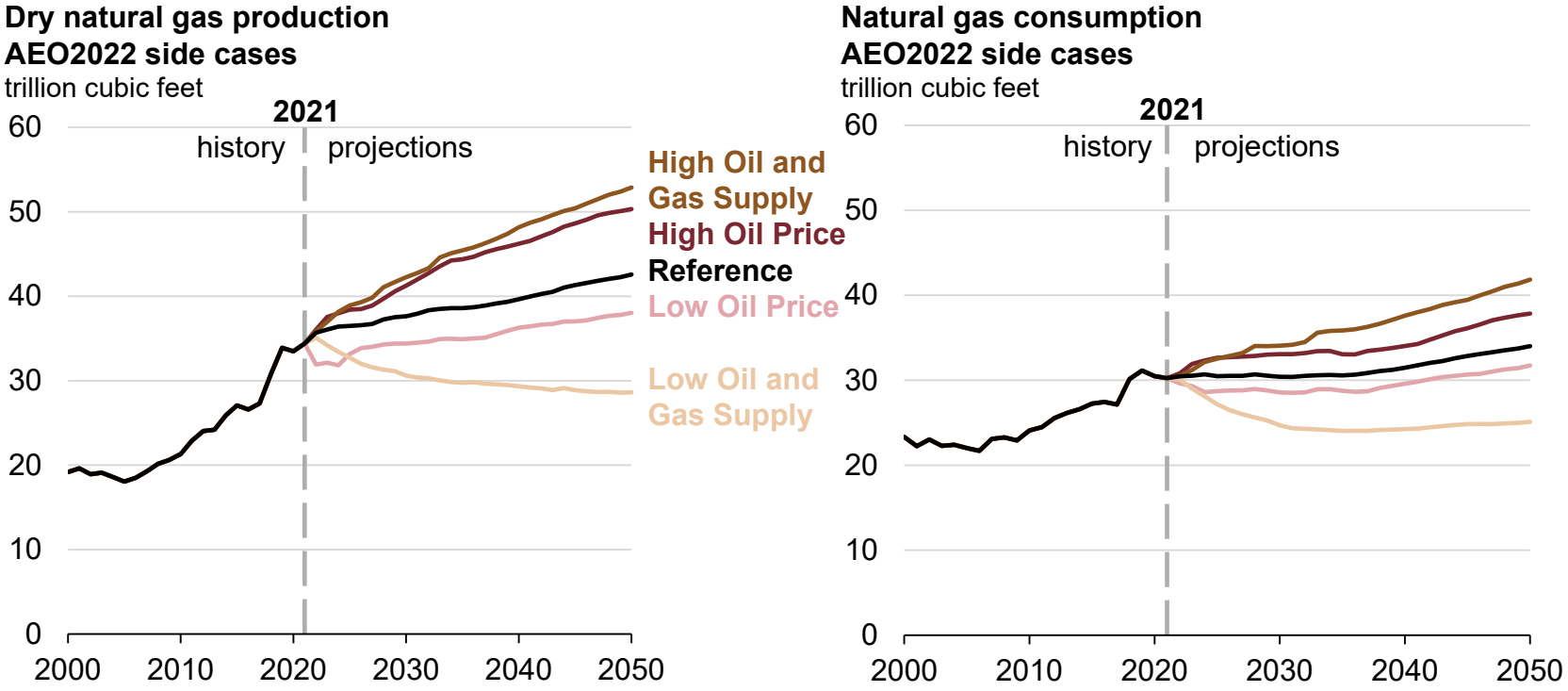


Energy-related CO_2 emissions by sector
AEO2022 Reference case
billion metric tons



Note: Series does not include greenhouse gases other than CO_2. Industrial sector CO_2 emissions do not include process emissions, such as the emissions from cement clinker production.

U.S. natural gas production and consumption

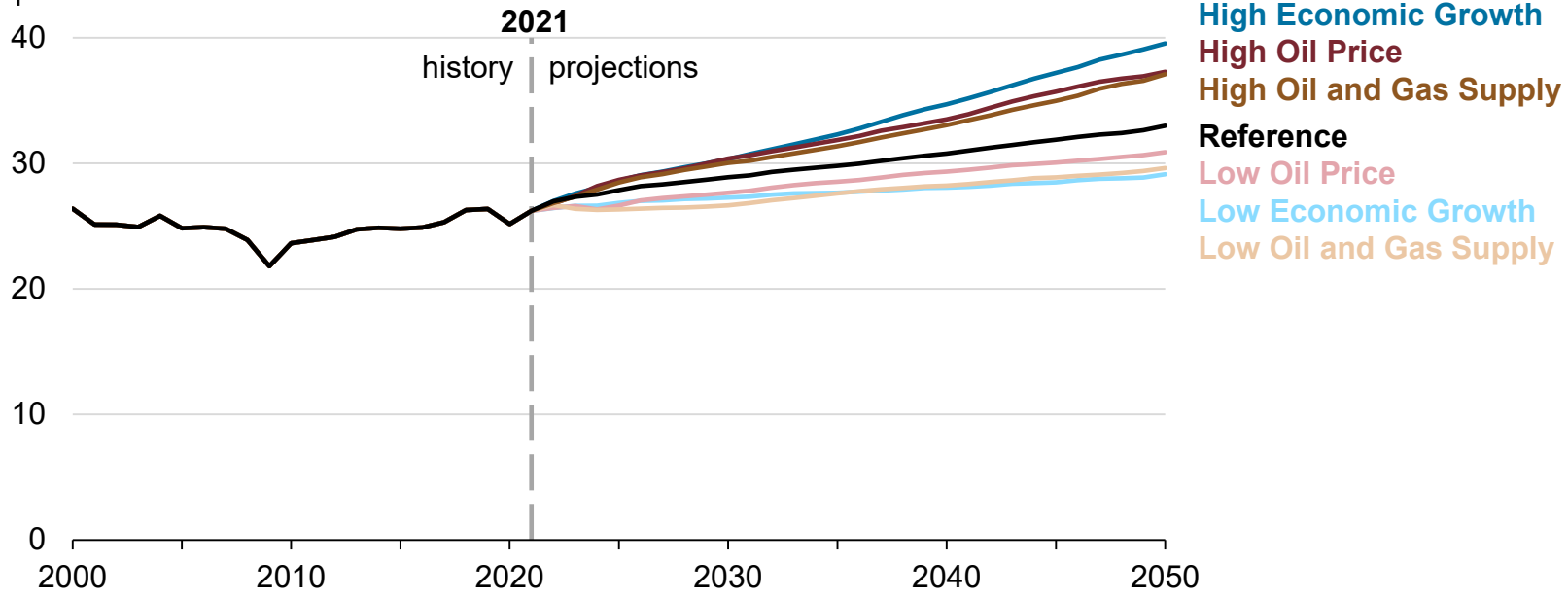


Industrial sector delivered energy consumption across cases

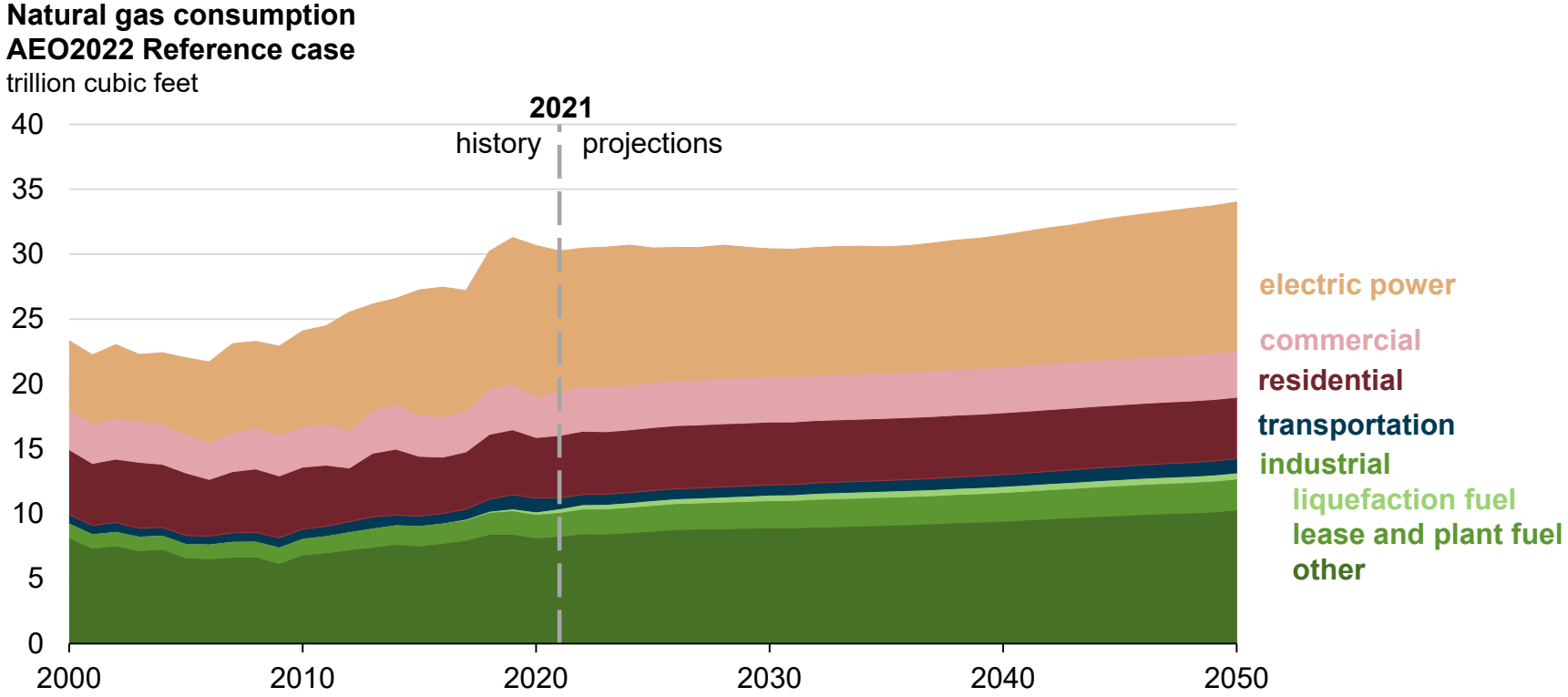
Industrial delivered energy consumption

AEO2022 selected side cases

quadrillion British thermal units

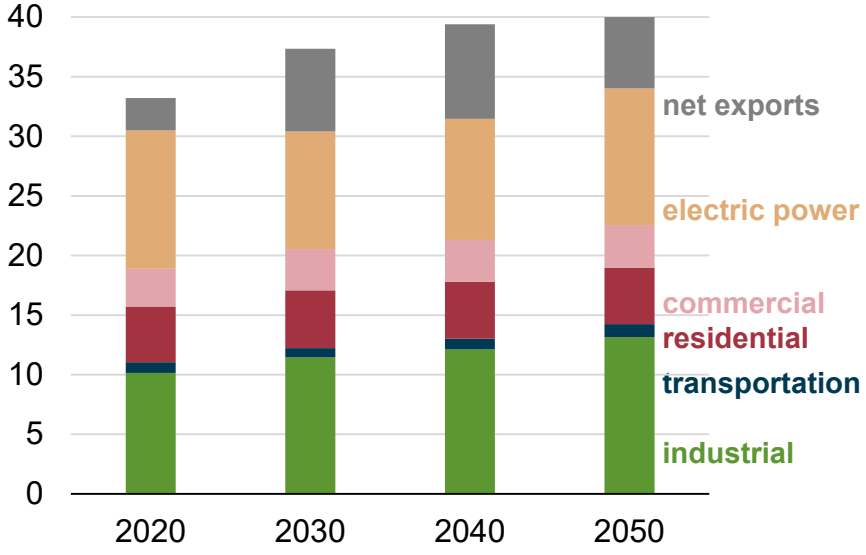


U.S. natural gas consumption by sector

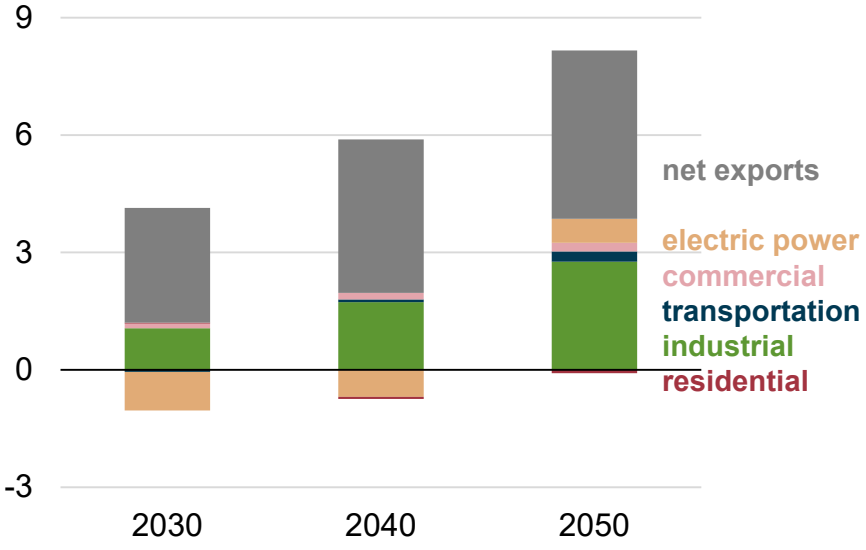


Natural gas consumption rises mostly because of industrial use and exports

Natural gas disposition and net exports
AEO2022 Reference case
trillion cubic feet

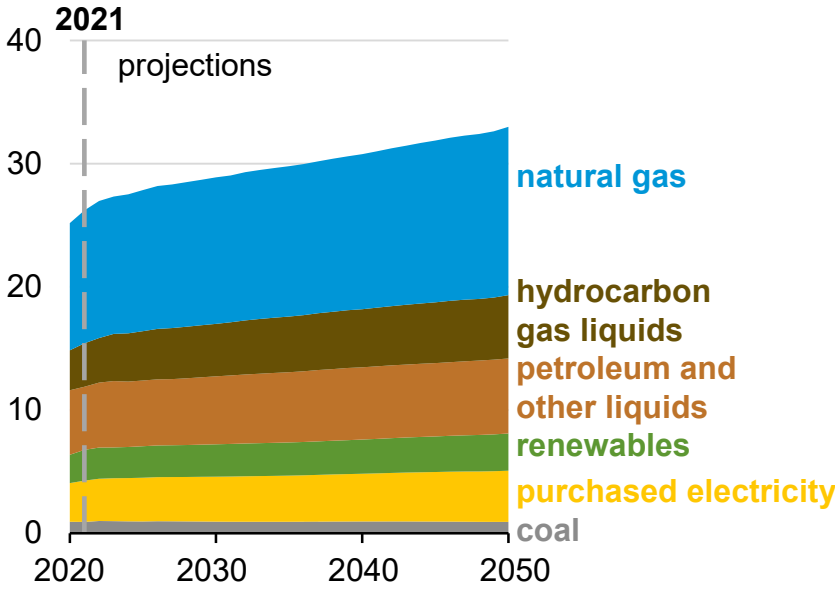


Change in natural gas disposition and net exports
AEO2022 Reference case
relative to 2021 in trillion cubic feet

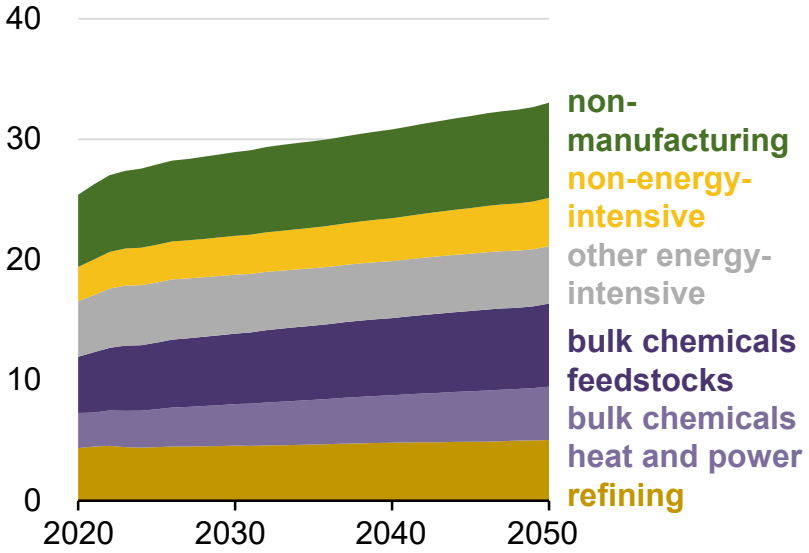


AEO2022 Reference case industrial sector energy consumption by fuel and sector

Industrial energy consumption by fuel
AEO2022 Reference case
quadrillion British thermal units



Industrial energy consumption by subsector
AEO2022 Reference case
quadrillion British thermal units

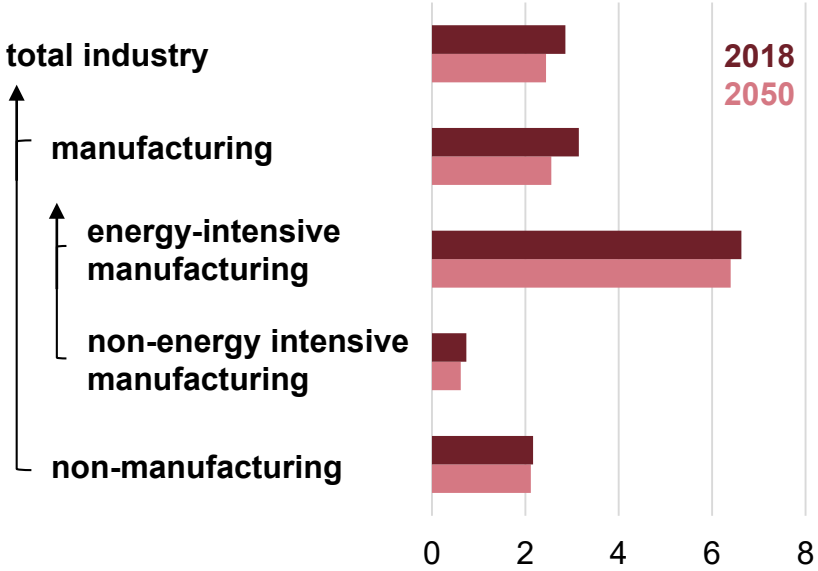


AEO2022 Reference case industrial sector energy intensity

Energy intensity by subsector

AEO2022 Reference case

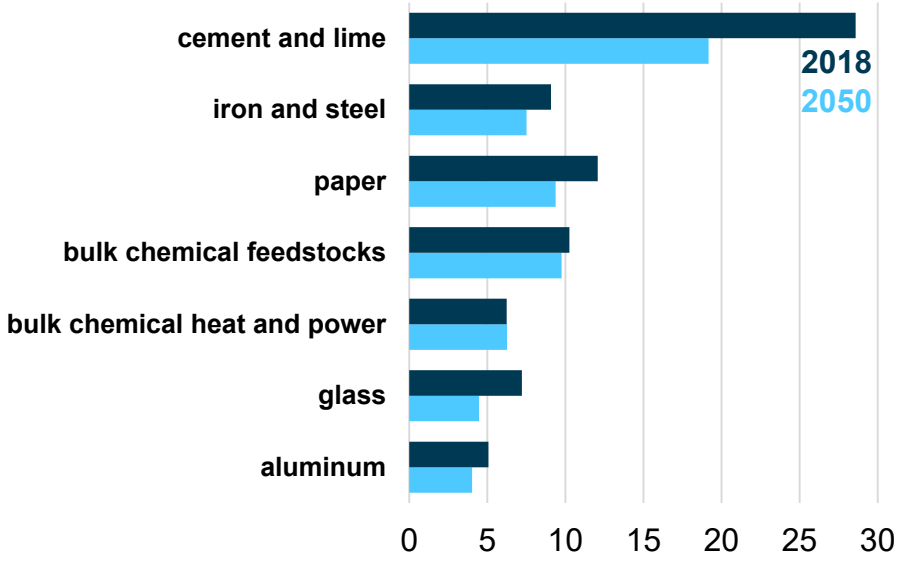
trillion British thermal units per billion 2012 dollar shipments



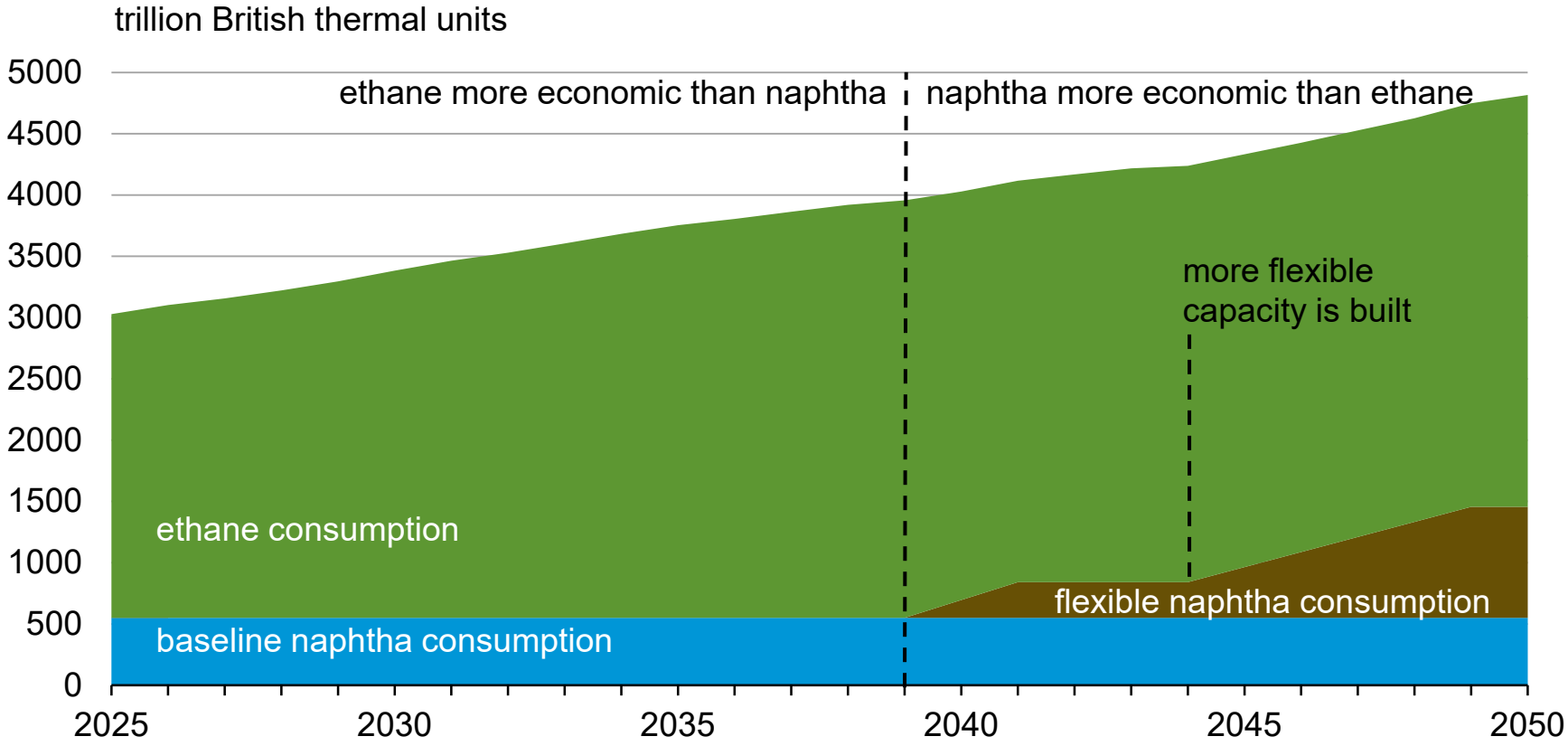
Energy-intensive manufacturing by industry

AEO2022 Reference case

trillion British thermal units per billion 2012 dollar shipments



Ethane/naphtha capacity switching



Data source: U.S. Energy Information Administration, *AEO2022 preliminary run*

Some AEO2023 Industrial Coming Attractions

AEO2023 major updates for the IDM

- Use industry-level data from EIA's *Quarterly Coal Report* to benchmark steam coal use by manufacturing industry
- Modify cement fuel use, including assumptions limiting new coal-fired capacity
- Make the iron and steel industry furnace technology choice more sensitive to fuel price
- Add electric boilers as a technology choice
- Publish cement and lime process emissions

Industrial coal consumption is lower in AEO2023

- Decrease in steam coal consumption from:
  - *Quarterly Coal Report* benchmarking
  - New assumption that decreases likelihood of coal-fired cement kilns will be built
- Decrease in metallurgical coal consumption:
  - Steel submodule changes increase use of electric arc furnaces (EAF) and decrease use of basic oxygen furnaces (BF/BOF)

Industrial-related changes resulting from the Inflation Reduction Act

- Combined-heat-and-power tax credits extended through the end of 2024 (completed)
- Clean hydrogen production credits (not in AEO2023 but will be reflected once NEMS implements a hydrogen module)
- Enhancement to carbon capture, utilization, and storage (CCUS) tax credits (not in AEO2023, but will be reflected once NEMS implements CCUS)
- $5.8 billion in financial assistance for clean energy investment for energy-intensive industries (not in AEO2023 but will review for potential inclusion in future AEOs)

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Electricity Markets

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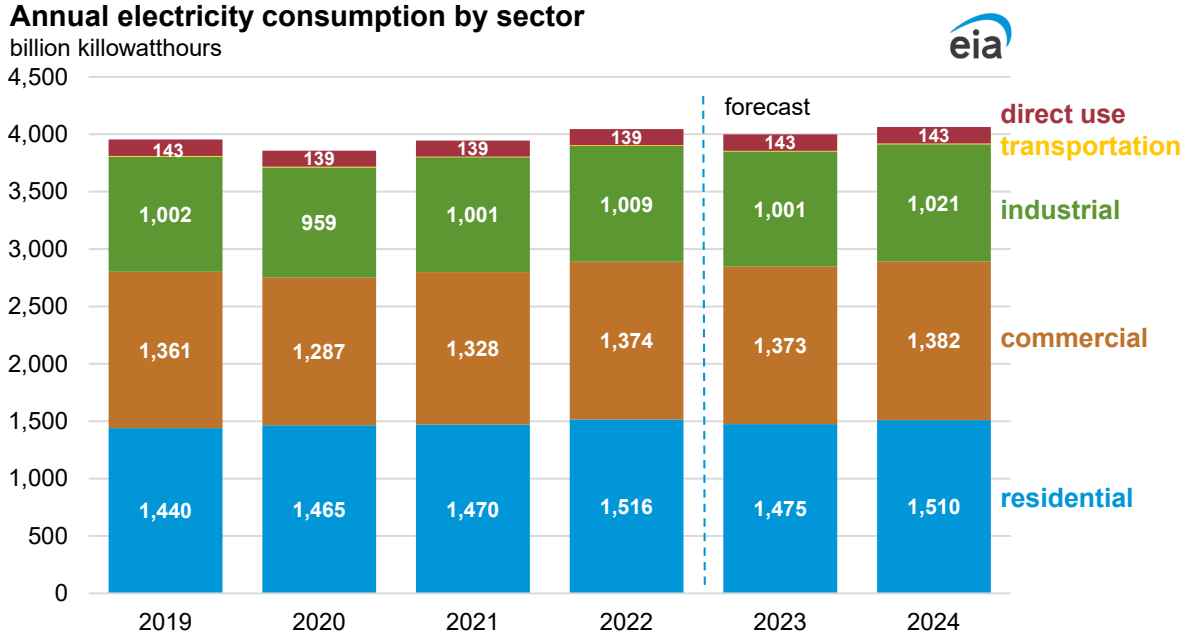
Key takeaways

- Residential and industrial electricity consumption fall slightly in 2023 as the economy slows.
- Solar, wind, and battery storage make up the bulk of new generating capacity.
- Natural gas and coal generation decrease while wind and solar generation increase.
- Wind and solar generation grow in every region of the United States.
- Oil and natural gas fuel costs to electric generators are expected to moderate over the next two years.
- Wholesale electricity prices will moderate in 2023 and 2024 due to lower fuel prices and more renewable generation after two years of high prices and volatility.

Electricity Consumption

Residential and industrial electricity consumption fall in 2023 but rise in 2024

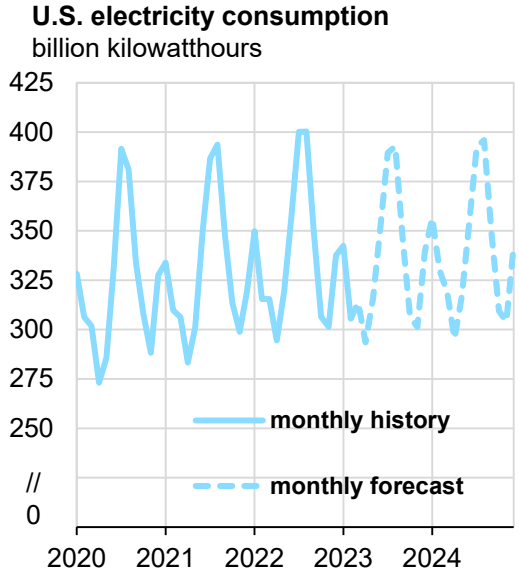
- Residential and industrial electricity consumption fall slightly in 2023 as the economy slows.
- On-site generation fell slightly between 2020 and 2022 but will rise in 2023.

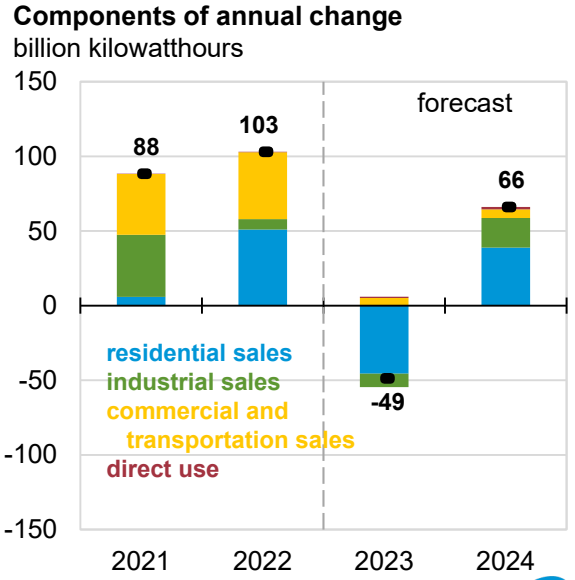


Data Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2023

Note: *Direct use* represents commercial and industrial facility use of on-site net electricity generation and electrical sales or transfers to adjacent or collocated facilities

Summer electricity consumption falls in 2023 in the residential and industrial sectors but rises a bit in 2024

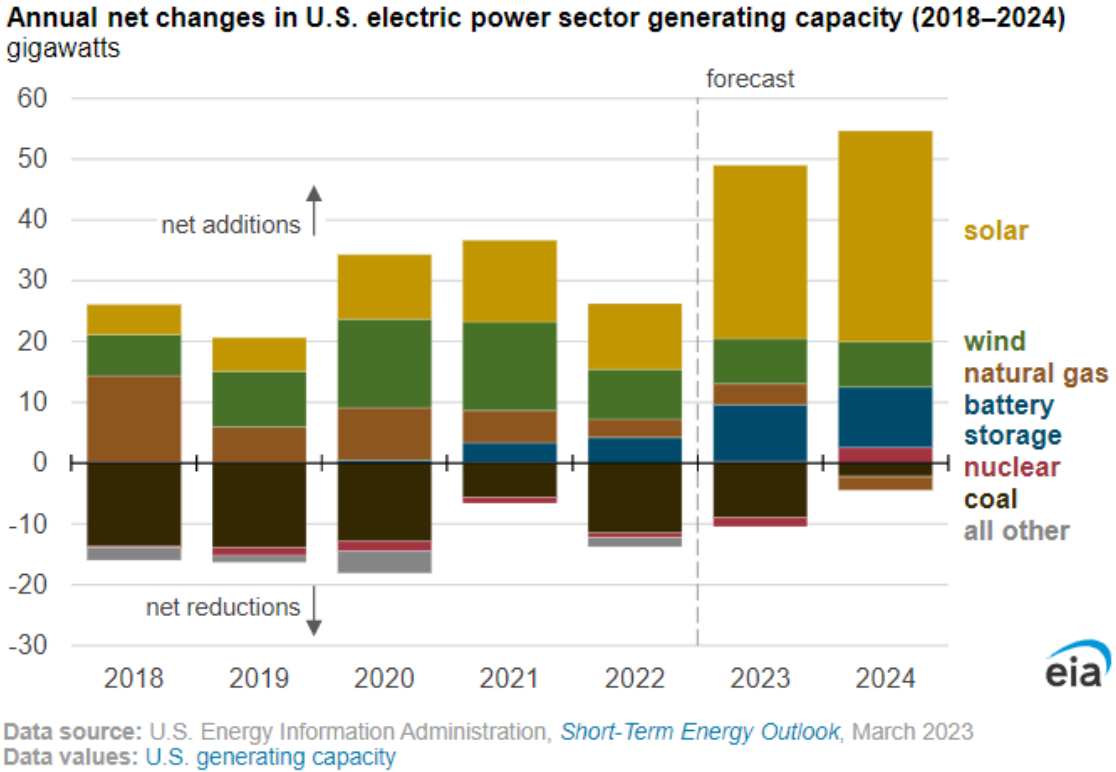




Data Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2023

Electricity Supply

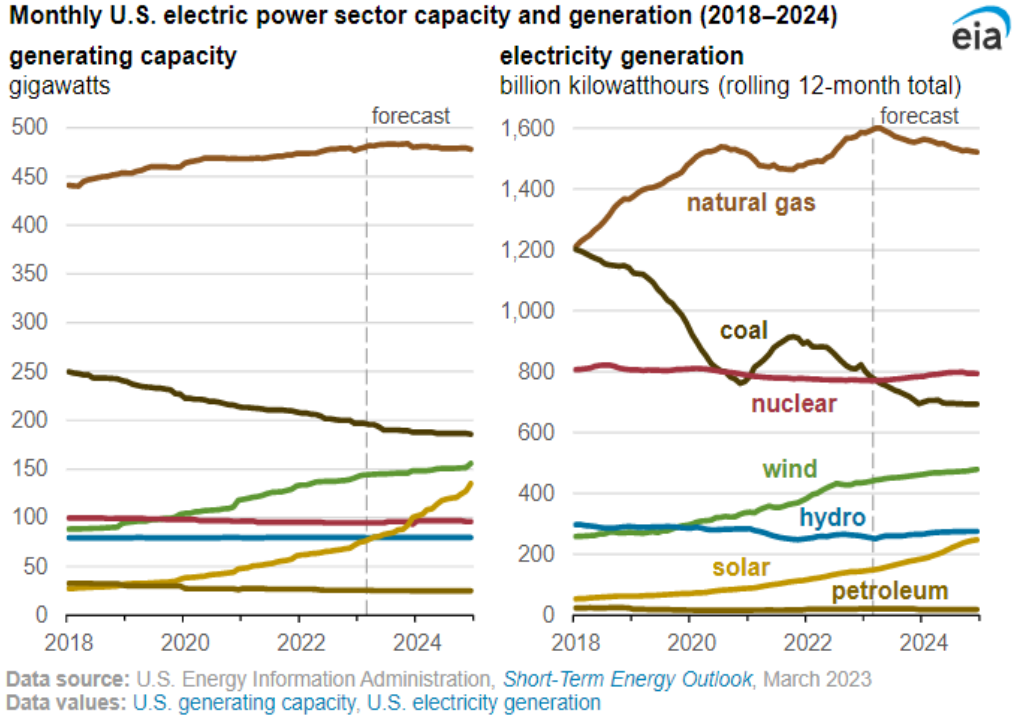
Solar, wind, and battery storage make up the bulk of new generating capacity



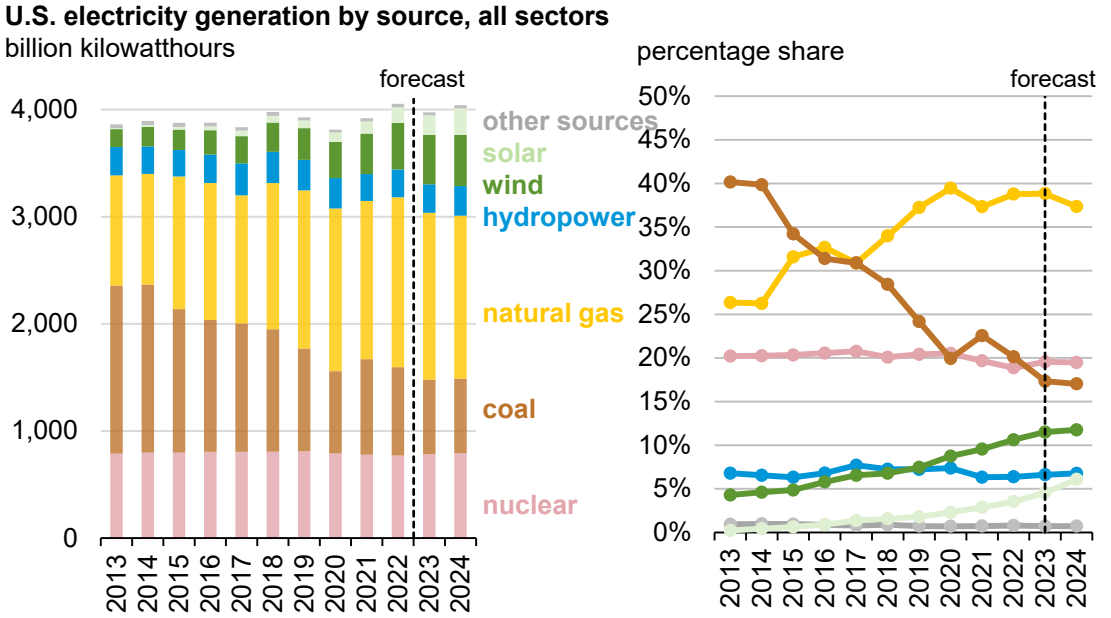
Wind and solar generation increase through 2024 while coal and natural gas generation decrease

From the end of February 2023 through December 2024:

- Wind generation increases by 10%.
- Solar generation increases by 71%.
- Coal capacity declines with 11 gigawatts of planned retirements.
- Natural gas generation decreases by 4%.
- Coal generation decreases by 16%.

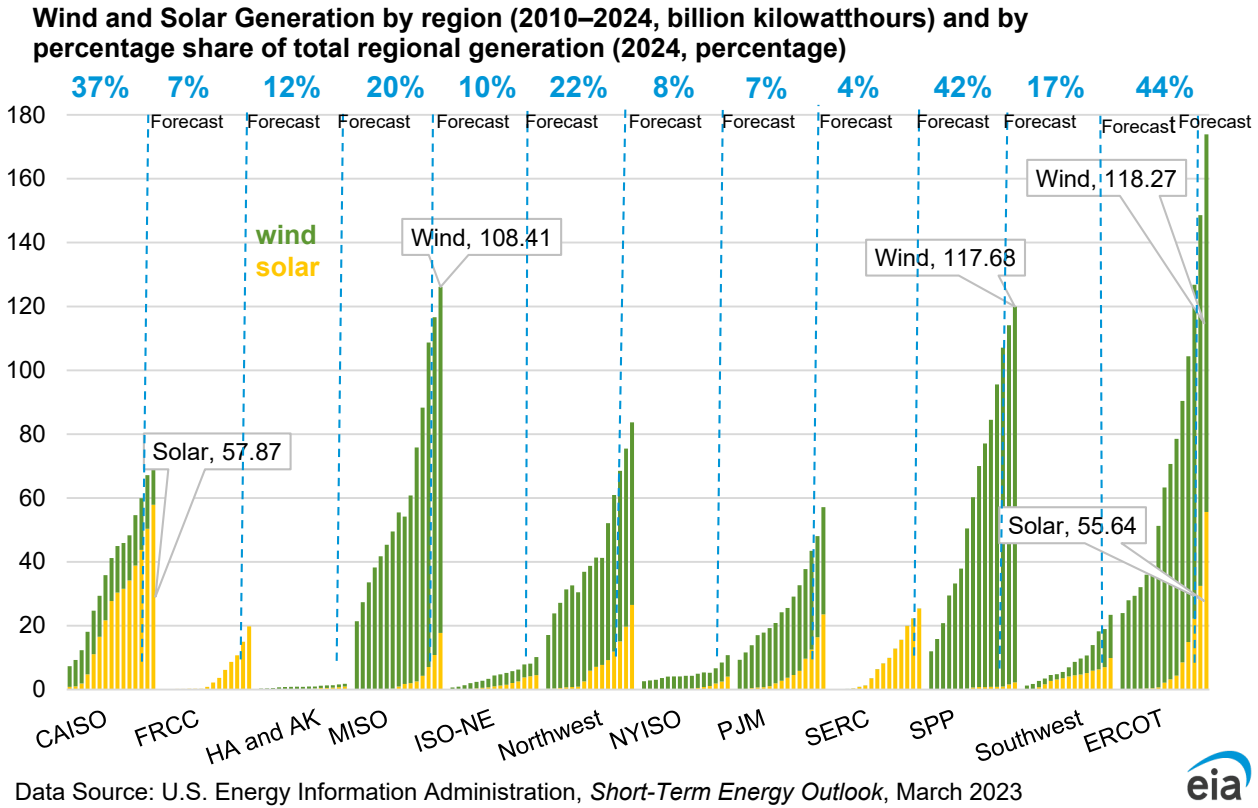


Percentage shares of wind and solar generation increase through 2024 while percentage shares of coal and natural gas generation decrease



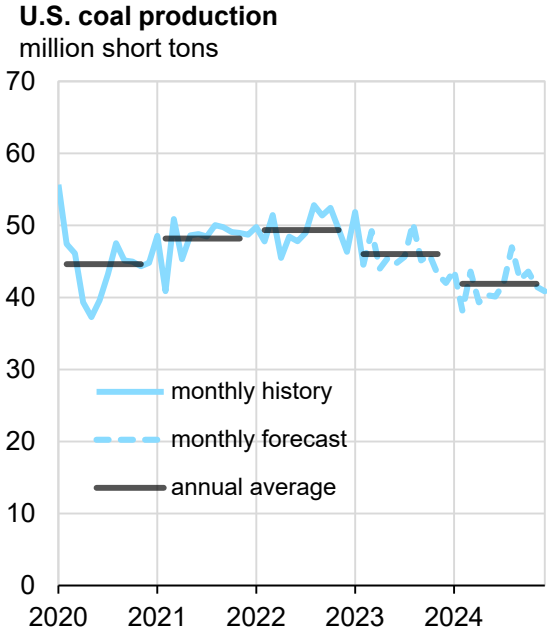
Data Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2023

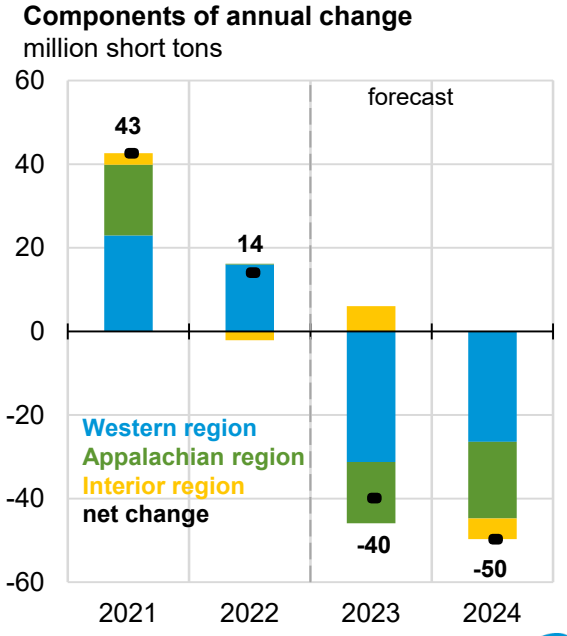
Wind and solar generation grow in every region from 2010 to 2024



Data Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2023

U.S. coal production will decline over the next two years

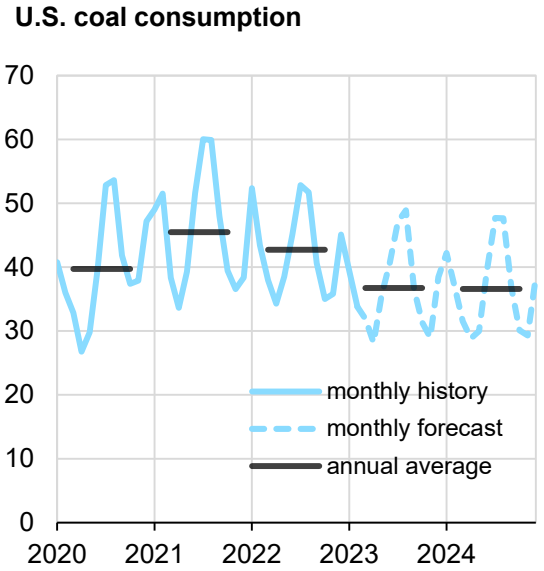


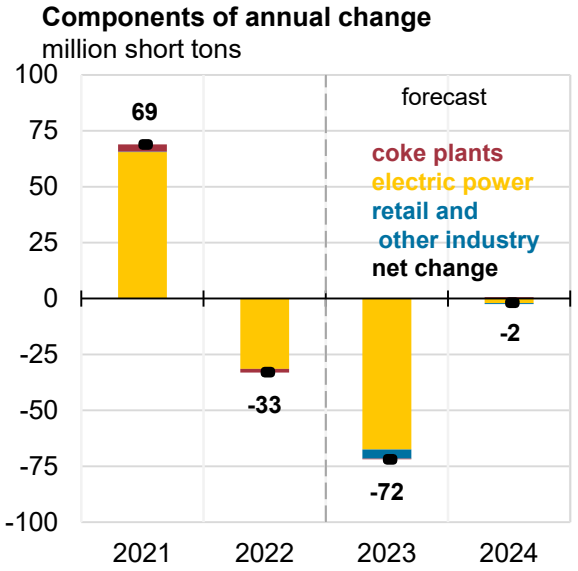


Data Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2023

U.S. coal consumption will decrease through 2024

- 11 gigawatts of electric power sector coal plants will retire.
- Natural gas prices to the electricity sector will decrease.

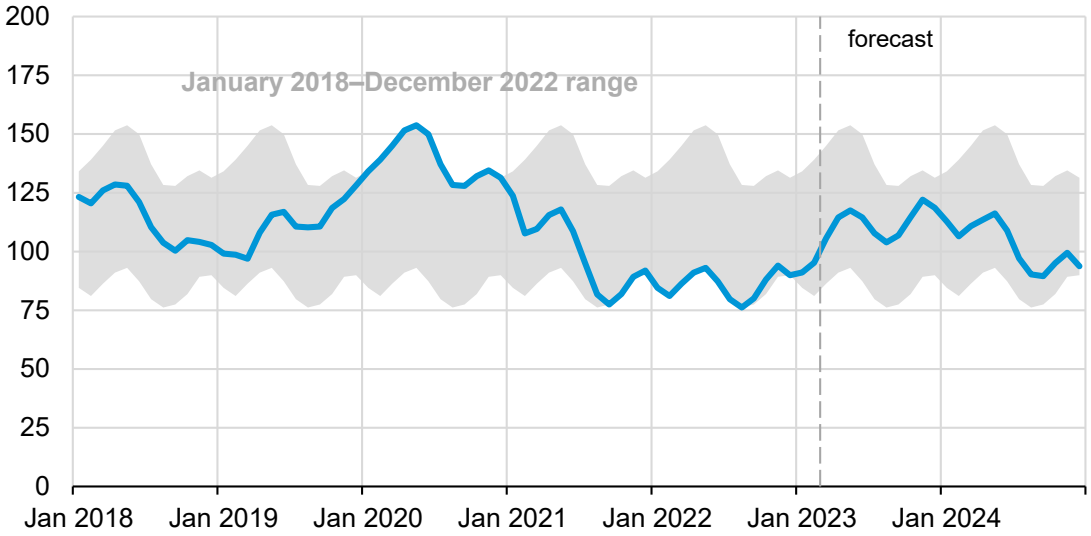




Data Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2023

After rising in 2023, coal inventories will decline in 2024

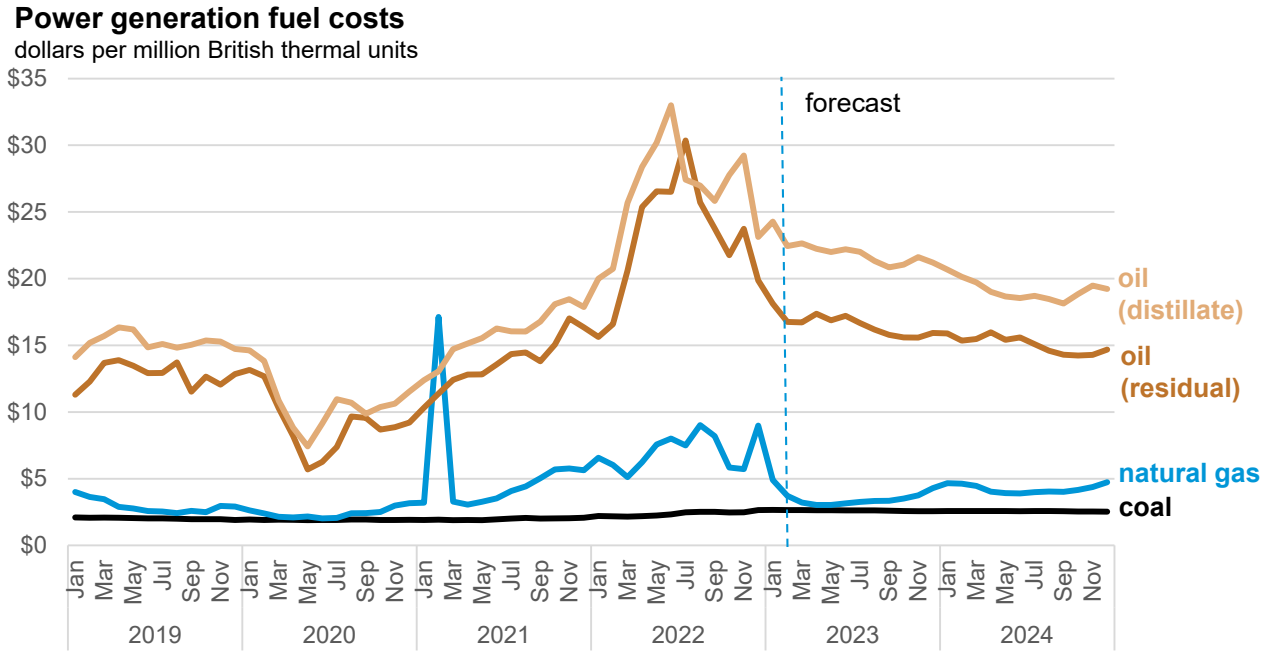
U.S. electric power coal inventories
million short tons



Data Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2023

Electricity Prices

Oil and natural gas fuel costs to electric generators are expected to moderate over the next two years

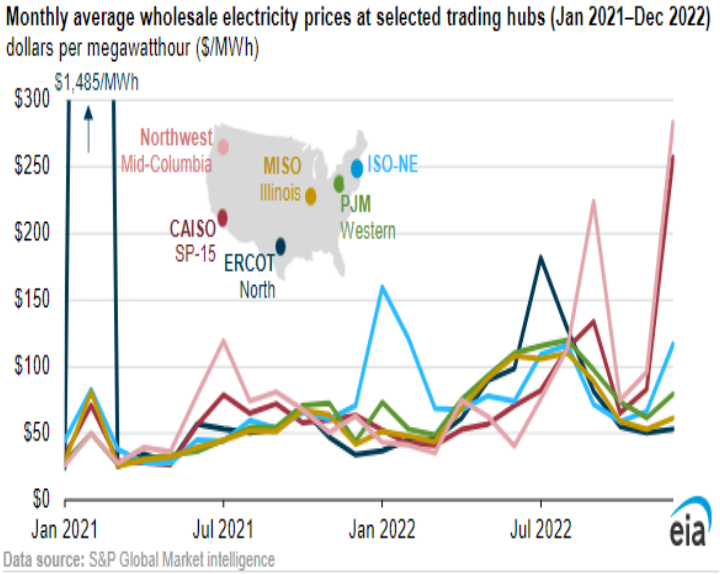


Data Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2023

Wholesale U.S. electricity prices were volatile in 2022

Four severe weather-related events caused major wholesale electricity price spikes in 2022:

- In January, cold temperatures, an Eastern blizzard, and natural gas pipeline constraints in New England caused wholesale electricity price spikes. ISO-New England prices averaged $160 per megawatthour (MWh) in January.
- In July, a Texas heatwave created record-breaking electricity demand in ERCOT, and wind generation provided less electricity than usual, increasing natural gas-fired generation. Wholesale prices at the ERCOT North trading hub averaged $182/MWh that month.
- In early September, a heatwave covered the western United States and resulted in record-breaking electricity demand. The Northwest Mid-Columbia market hub's whole electricity price averaged $224/MWh while CAISO's electricity price averaged $134/MWh that month.
- Cold weather and winter storms throughout December in the Western Pacific regions of the United States led to record-high electricity prices in December at the Northwest Mid-Columbia market hub ($283/MWh) and at the CAISO N-15 hub ($257/MWh) where natural gas prices at nearby hubs rose to about 10 times those at Henry Hub.

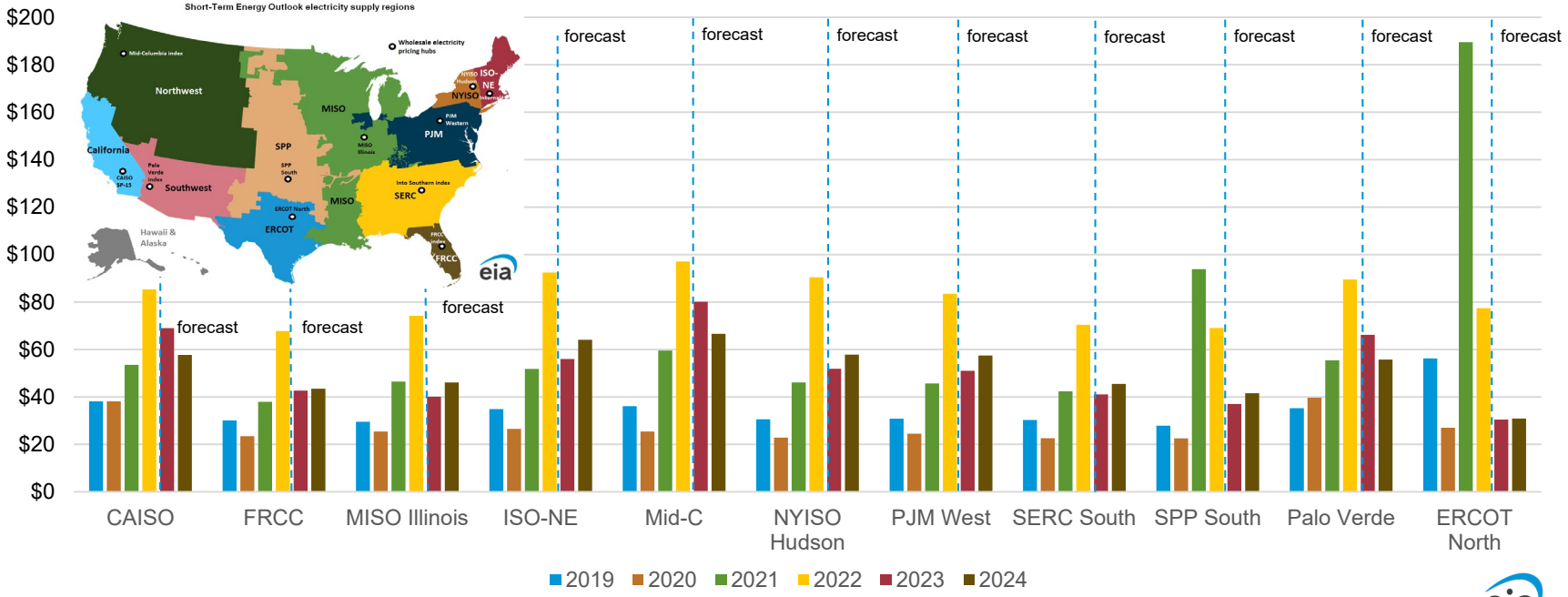


Source: Today in Energy, Wholesale U.S. Electricity Prices were Volatile in 2022, January 10, 2023

Wholesale electricity prices will moderate in 2023 and 2024 due to lower fuel prices and more renewable generation

Wholesale prices at select trading hubs

dollars per megawatthour



Data Source: U.S. Energy Information Administration, *Short-Term Energy Outlook*, March 2023

For more information

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Annual Energy Outlook | www.eia.gov/aeo

Short-Term Energy Outlook | www.eia.gov/steo

International Energy Outlook | www.eia.gov/ieo

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Questions or comments?