

# *Annual Energy Outlook 2016*



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*AEO2016 Rollout Presentation*

*Johns Hopkins School of Advanced International Studies*

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*by*

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## Key takeaways from AEO2016

- Energy use per dollar of Gross Domestic Product declines through 2040 allowing for economic growth without upward pressure on energy consumption and related emissions
- Electricity demand growth slows while non-power sector generation increases, dampening the need for central power station generation
- Market forces drive up oil prices throughout the projection and U.S. production increases in response
- Natural gas production increases despite relatively low and stable natural gas prices
- Technological improvements are key drivers of U.S. oil and gas production
- Net exports of liquefied natural gas range between 3.5 Tcf and 10.6 Tcf in 2040 depending on relative prices in foreign markets
- EPA's proposed medium and heavy-duty vehicle Phase 2 standards would increase fuel economy, resulting in 18% lower diesel consumption in 2040 compared with the Reference case

## Key takeaways from AEO2016 (continued)

- EPA's Clean Power Plan (CPP) requires states to reduce carbon dioxide emissions from existing fossil generators:
  - Details of the CPP implementation strategies selected by the states affect the overall generation mix, as well as consumer prices
  - CPP effects on coal production vary across regions
  - CPP, along with renewable tax credit extension and lower natural gas prices, contributes to a shift in the generation mix, with increases in generation from natural gas and renewables and reduced coal generation
  - Even if the CPP is not implemented, key factors combine to support a transition from coal to natural gas as the predominant fuel for electric generation
- Extending or expanding existing laws and regulations, including efficiency policies for appliances and vehicles, the CPP, and EPA's proposed Phase 2 standards for medium- and heavy-duty trucks results lower energy consumption and CO2 emissions than projected in the Reference case

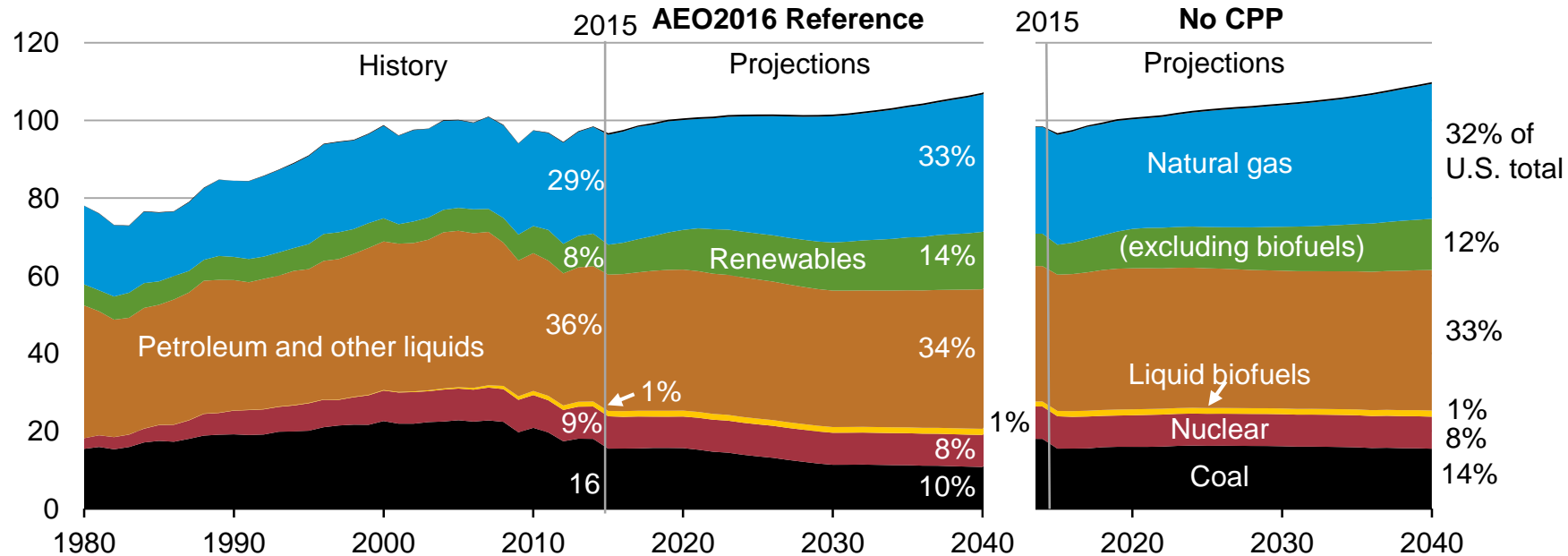
# Overview

## The AEO2016 includes a full range of CPP and other alternative cases, including:

- Alternative CPP cases: Rate-based implementation (applying limits on CO<sub>2</sub> emissions per kilowatthour from covered sources), other mass-based implementation options (wider trading, allowance allocation to generators), hybrid case (mass-based in Northeast and California, rate-based elsewhere), extended case (further reductions beyond 2030)
- High and low world oil price
- High and low macroeconomic growth
- High and low oil and natural gas resources/technology
- High and low technology efficiency innovation
- Phase 2 standards for medium- and heavy-duty trucks
- Extended policies: extends current tax credits, adds follow-on efficiency standards, extends the end date of the CPP from 2030 to 2040, and adopts and extends the proposed Phase 2 Standards for medium- and heavy-duty trucks

# Reductions in energy intensity largely offset impact of gross domestic product (GDP) growth, leading to slow projected growth in energy use

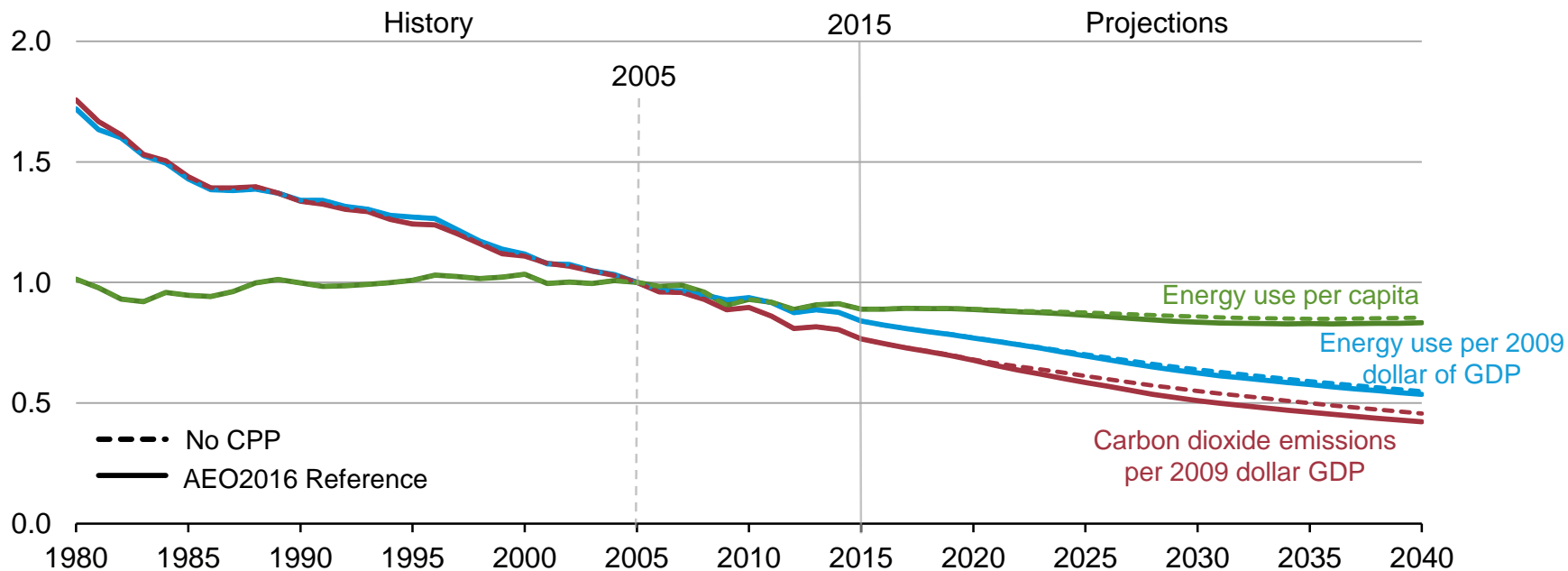
U.S. primary energy consumption  
quadrillion Btu



Source: EIA, Annual Energy Outlook 2016

# Shift towards low- and no-carbon fuels causes CO2 intensity to fall faster than energy intensity per dollar of GDP

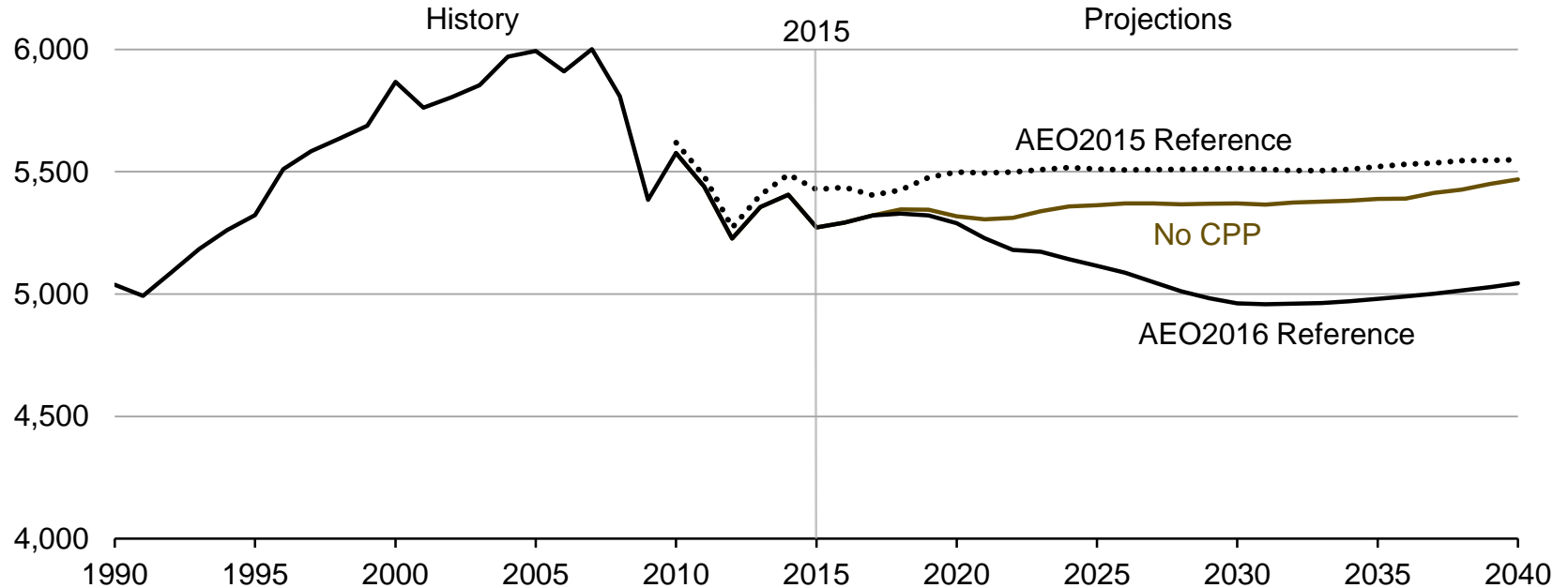
energy and emission intensity index, 2005=1



Source: EIA, Annual Energy Outlook 2016 Reference case

# CO2 emissions are lower in AEO2016 Reference case than AEO2015 Reference Case, even without consideration of CPP

energy-related carbon dioxide emissions  
million metric tons

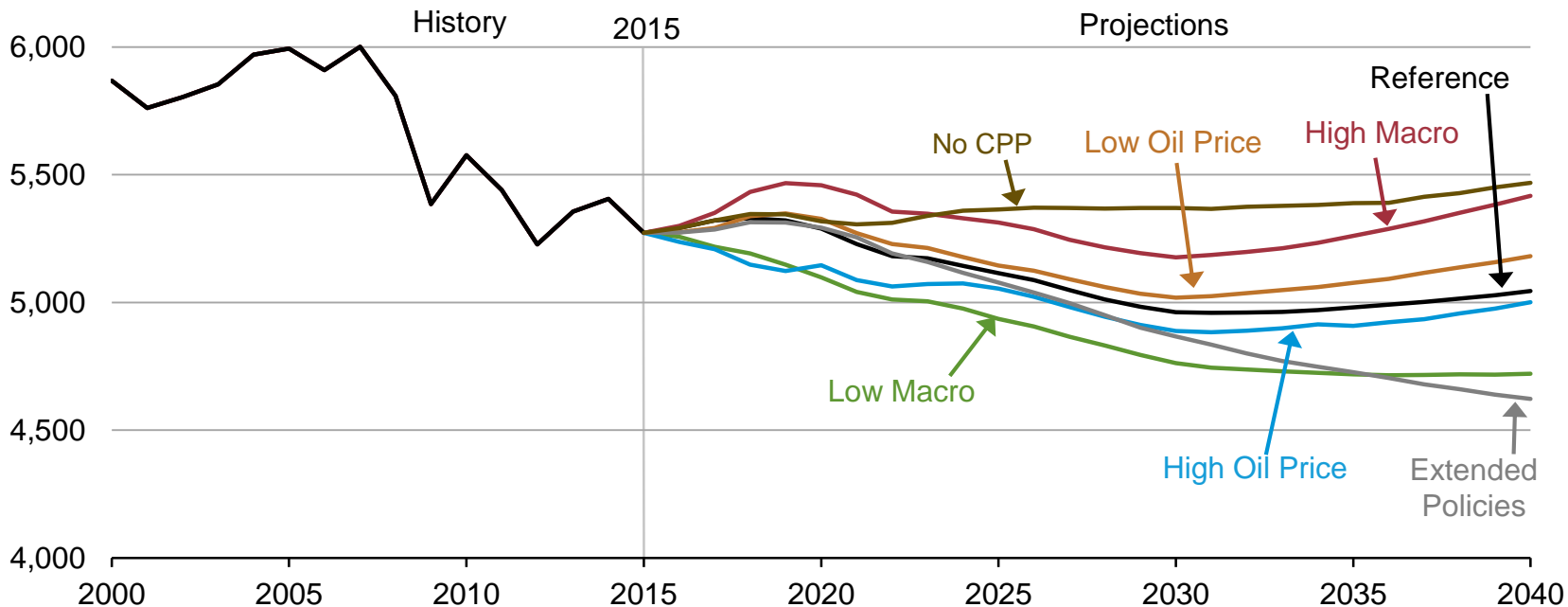


Source: EIA, Annual Energy Outlook 2016



# Energy-related carbon dioxide emissions across six cases, 2000 to 2040

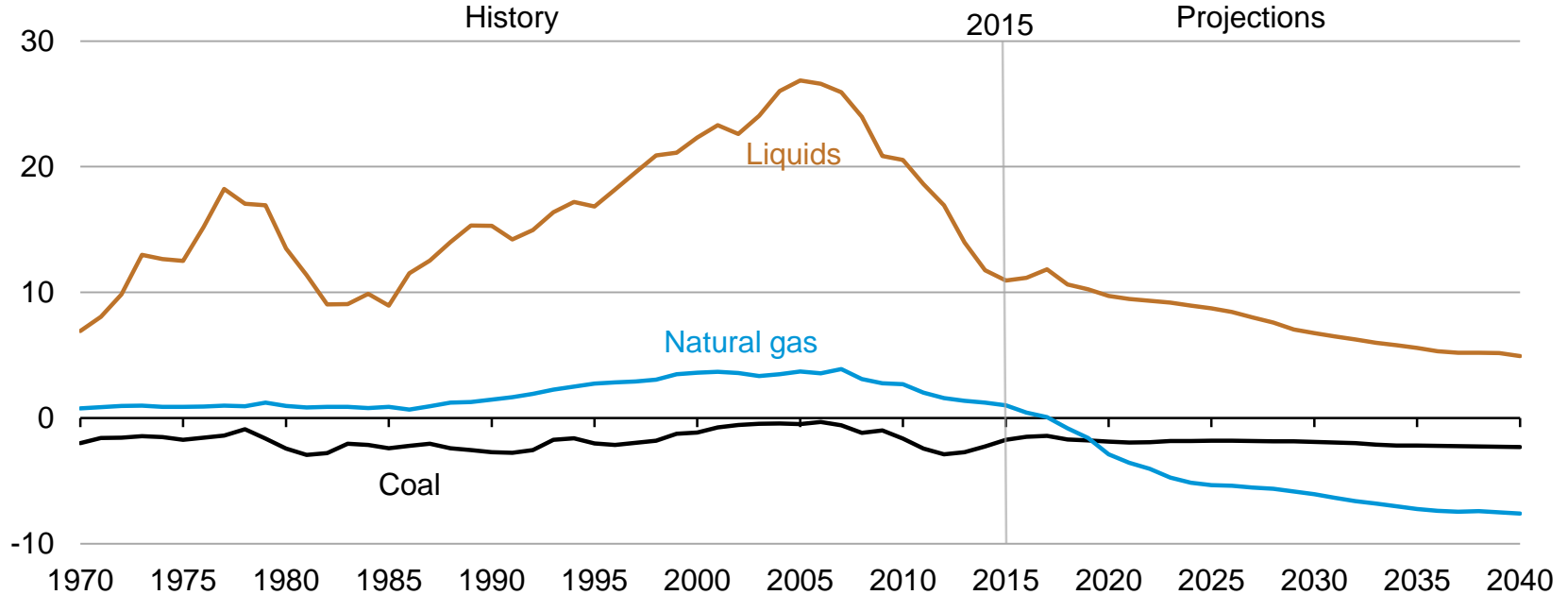
energy-related carbon dioxide emissions  
million metric tons



Source: EIA, Annual Energy Outlook 2016

# U.S. net energy imports trend downward, reflecting increased oil and natural gas production coupled with slowly growing or falling demand

U.S. net imports  
quadrillion Btu

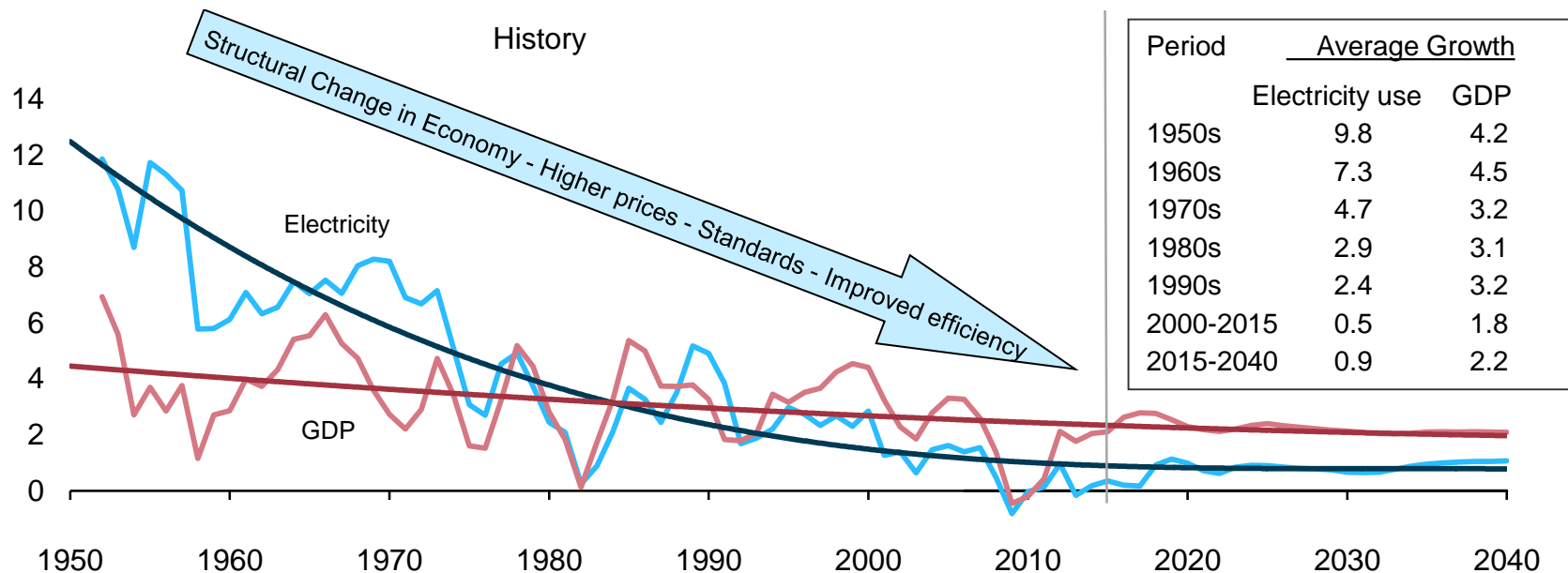


Source: EIA, Annual Energy Outlook 2016

# Electricity

# Electricity use (including direct use) continues to grow, but the rate of growth slows as it has almost continuously over the past 60 years

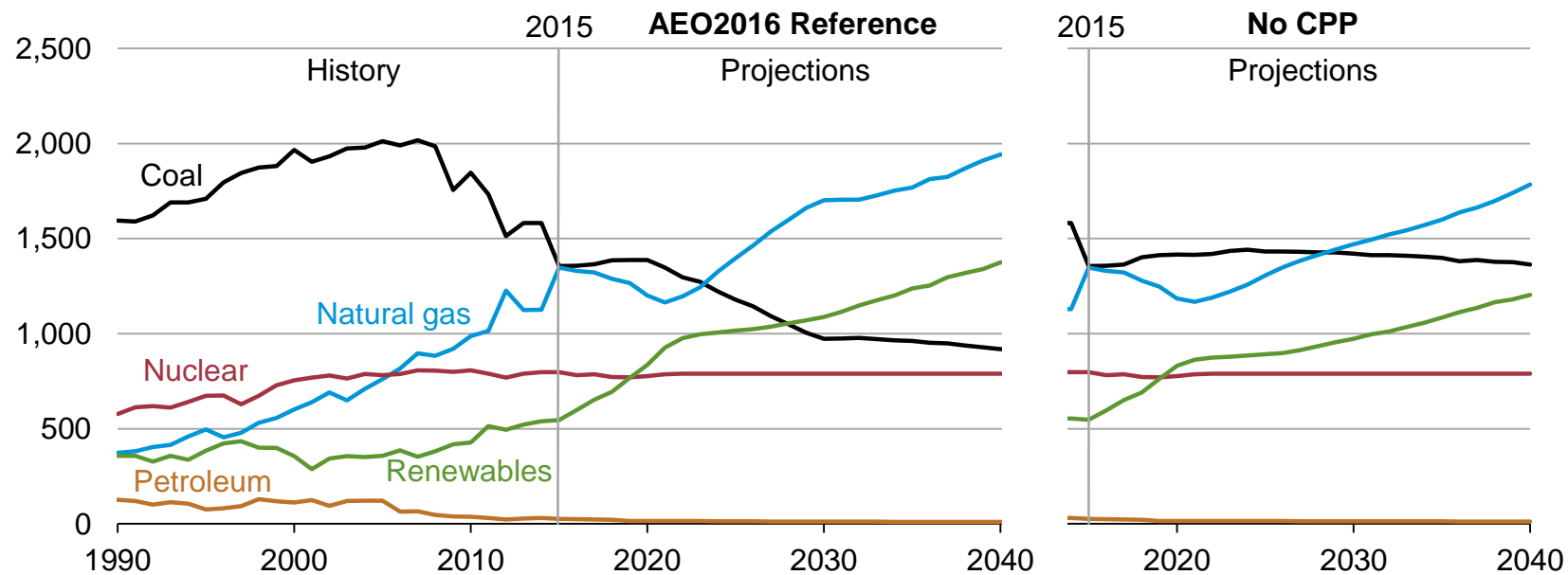
U.S. electricity use and GDP  
percent growth (rolling average of 3-year periods)



Source: EIA, Annual Energy Outlook 2016

# Both natural gas and renewable generation surpass coal by 2030 in the Reference case, but only natural gas does so in the No CPP case

net electricity generation  
billion kilowatthours

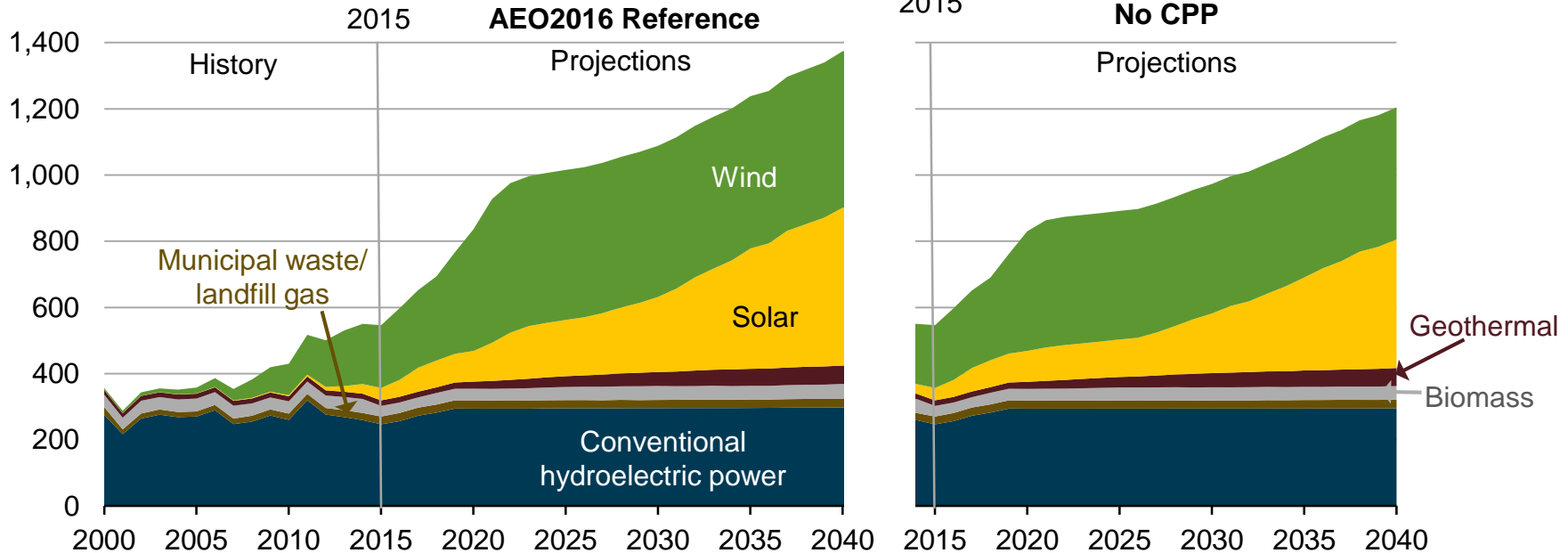


Source: EIA, Annual Energy Outlook 2016

# Changing tax and cost assumptions contribute to stronger solar growth, with the CPP providing a boost to renewables

renewable electricity generation by fuel type

billion kilowatthours



Source: EIA, Annual Energy Outlook 2016

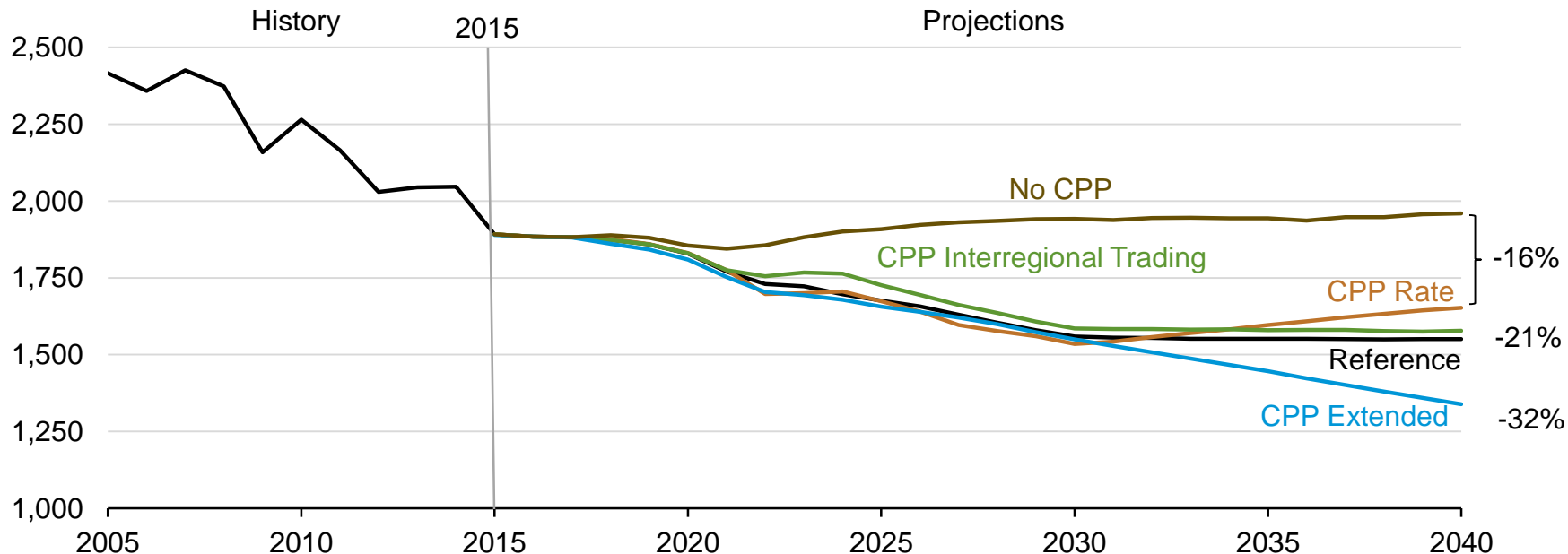
## CPP implementation options affect results

Case	Target Type	Trading	Credit Allocation	CO2 Reduction Below 2005	Impact vs. Reference
Reference	Mass	Regional	Load	35% by 2030	N/A
No CPP	N/A	N/A	N/A	20% by 2030	Stable coal generation
CPP Rate	Rate	Regional	N/A	36% by 2030	More renewable generation
CPP Interregional Trading	Mass	Interconnect	Load	34% by 2030	More renewable generation
CPP Allocation to Generators	Mass	Regional	Generators	35% by 2030	Higher electricity prices
CPP Extended	Mass	Regional	Load	45% by 2040	More coal retirements, gas, renewables

Source: EIA, Annual Energy Outlook 2016

# Alternative CPP implementation decisions can lower power-sector CO2 emissions in 2040 and extending CPP targets past 2030 could reduce emissions even further

electric power sector carbon dioxide (CO2) emissions  
million metric tons

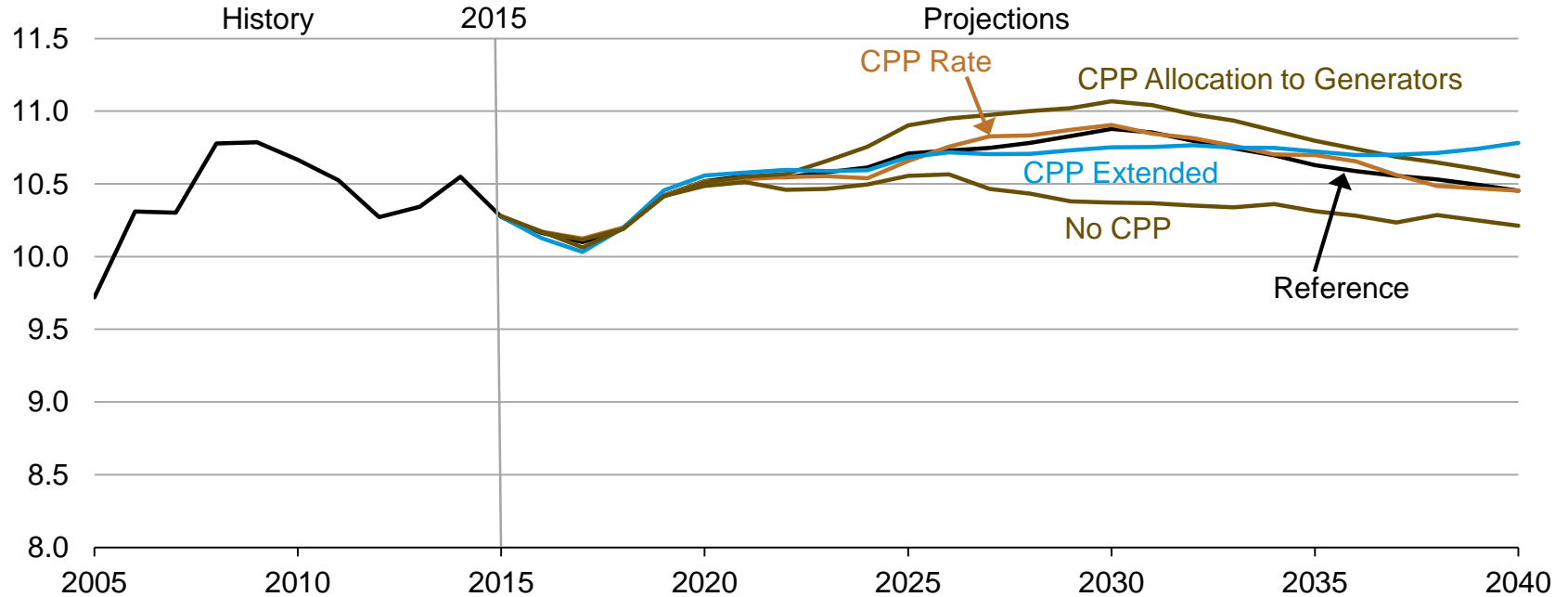


Source: EIA, Annual Energy Outlook 2016



# Retail electricity prices in 2030 are 4%-7% higher than in No CPP case

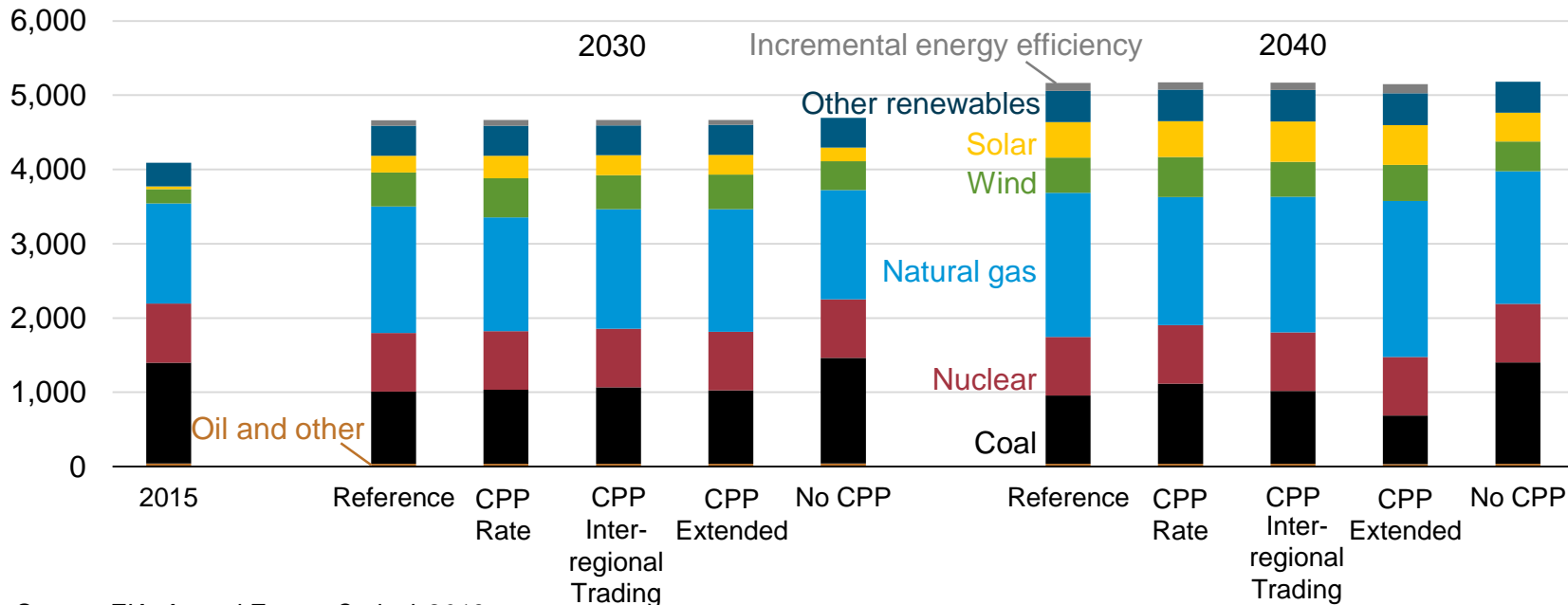
average electricity price  
2015 cents per kilowatthour



Source: EIA, Annual Energy Outlook 2016

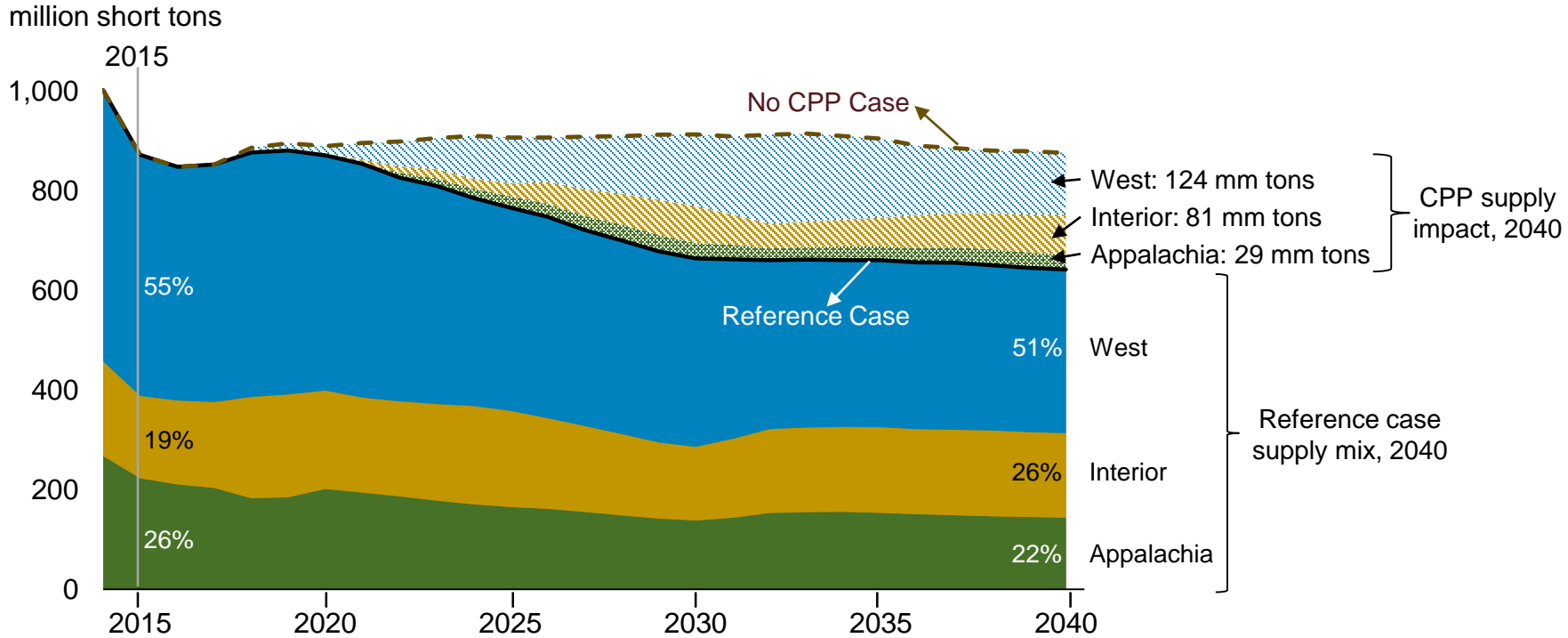
# CPP reduces coal generation and increases renewable and natural gas generation; mass-based standards result in more natural gas and less renewables than rate-based targets

net electricity generation  
billion kilowatthours



Source: EIA, Annual Energy Outlook 2016

# All coal supply regions are challenged when the CPP is implemented

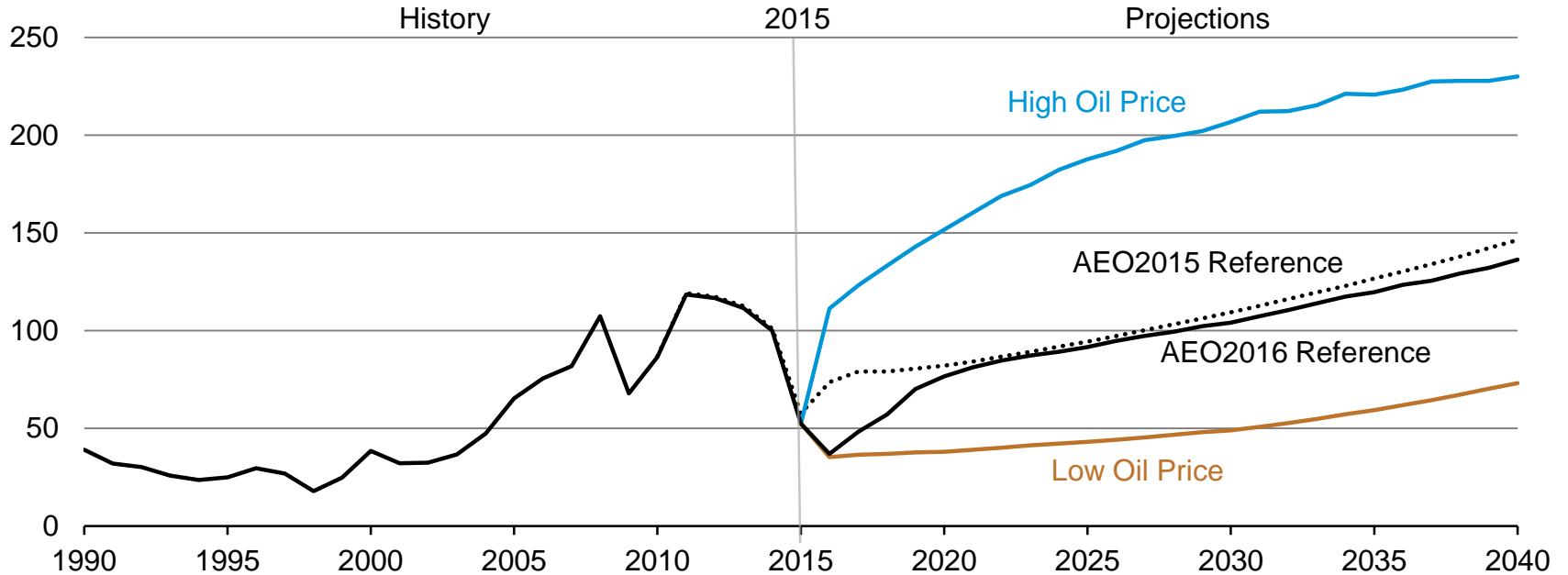


Source: EIA, Annual Energy Outlook 2016

# Petroleum and other liquids

# Near-term crude oil price scenario is lower in AEO2016

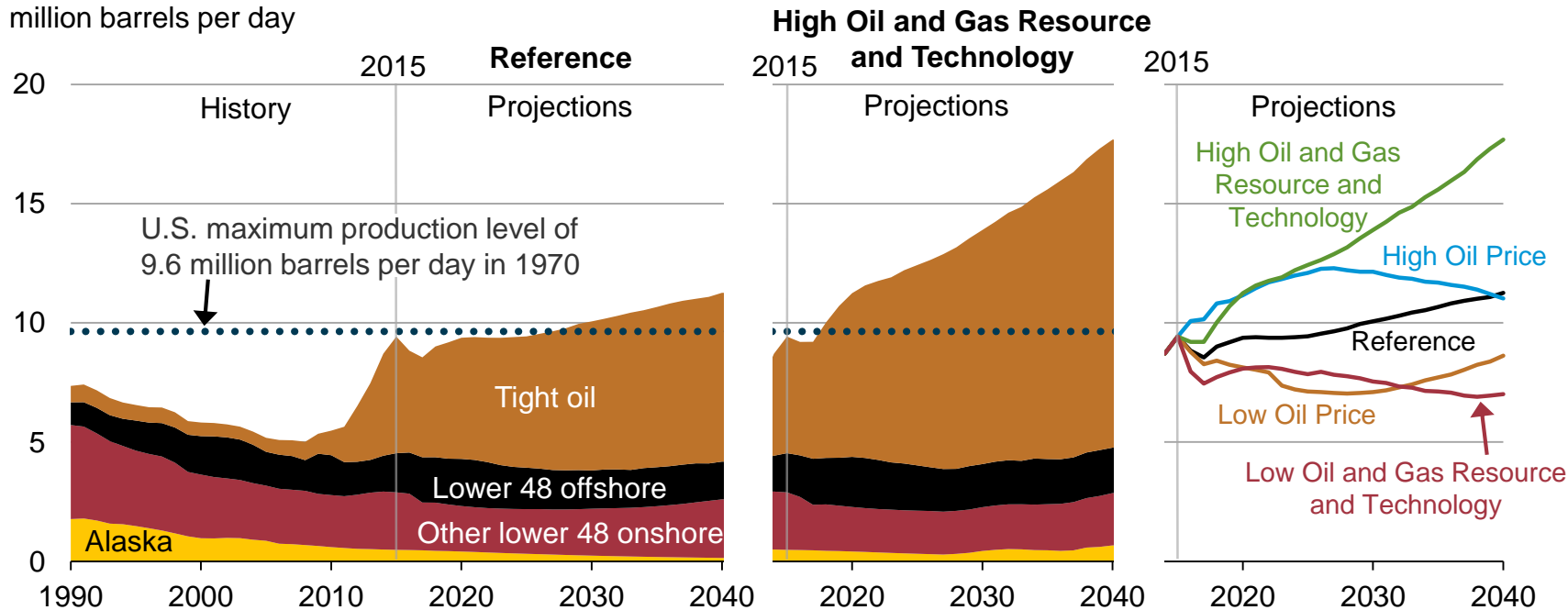
Brent crude oil spot price  
2015 dollars per barrel



Source: EIA, Annual Energy Outlook 2016 Reference case and Annual Energy Outlook 2015 Reference case

# U.S. crude oil production rises above previous historical high before 2030; alternative price and resource/technology cases can differ

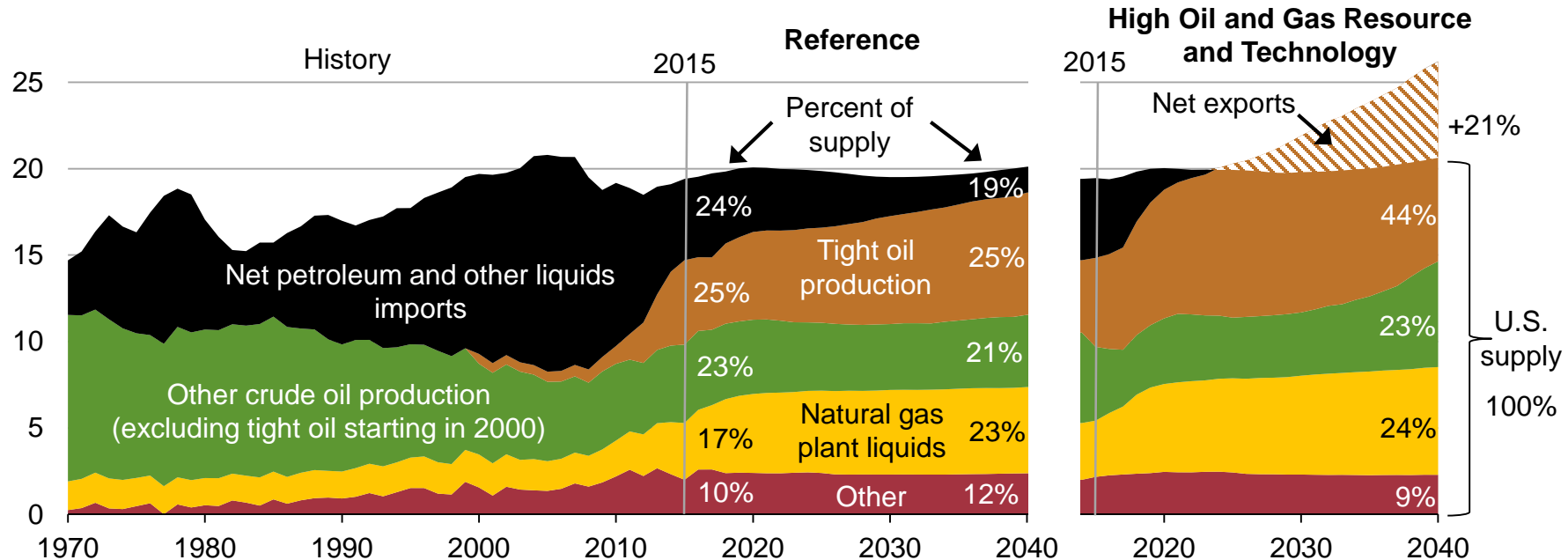
U.S. crude oil production  
million barrels per day



Source: EIA, Annual Energy Outlook 2016

# Combination of increased tight oil production and higher fuel efficiency drives projected decline in oil imports

U.S. liquid fuels supply  
million barrels per day

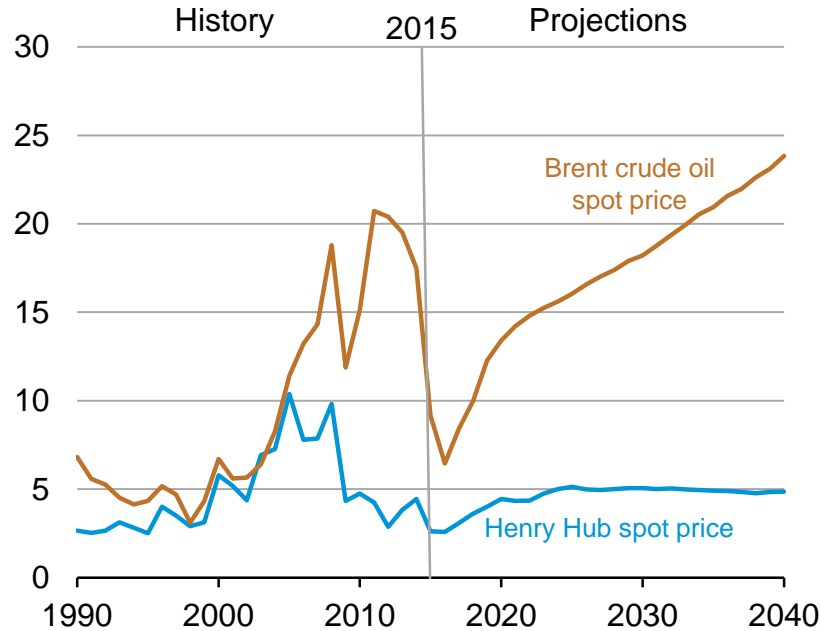


Note: "Other" includes refinery gain, biofuels production, all stock withdrawals, and other domestic sources of liquid fuels

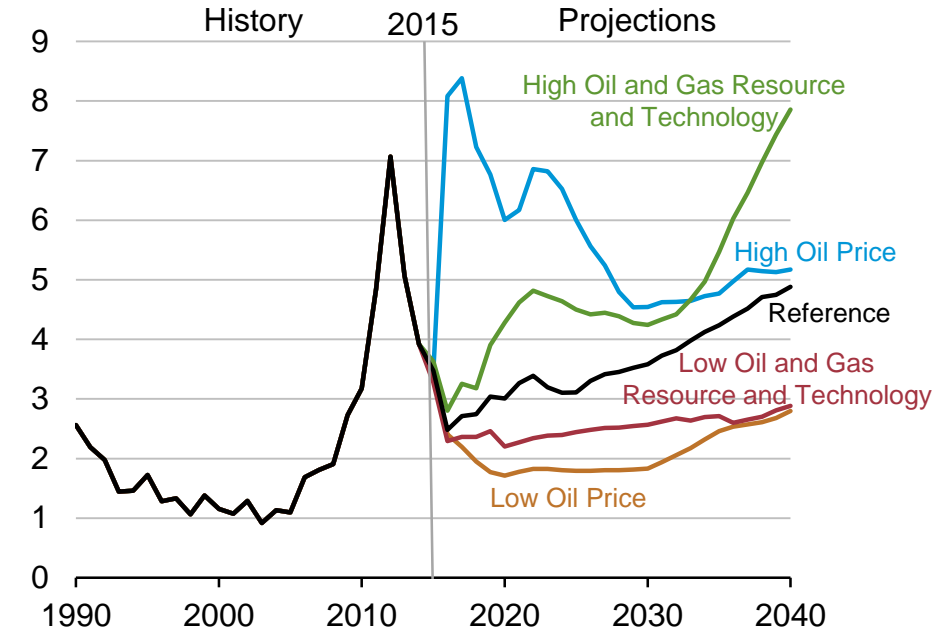
Source: EIA, Annual Energy Outlook 2016

# The price relationship between crude oil and natural gas impacts producer economics and production levels for both commodities

energy spot prices under Reference case  
2015 dollars per million Btu



Oil-to-gas price ratio

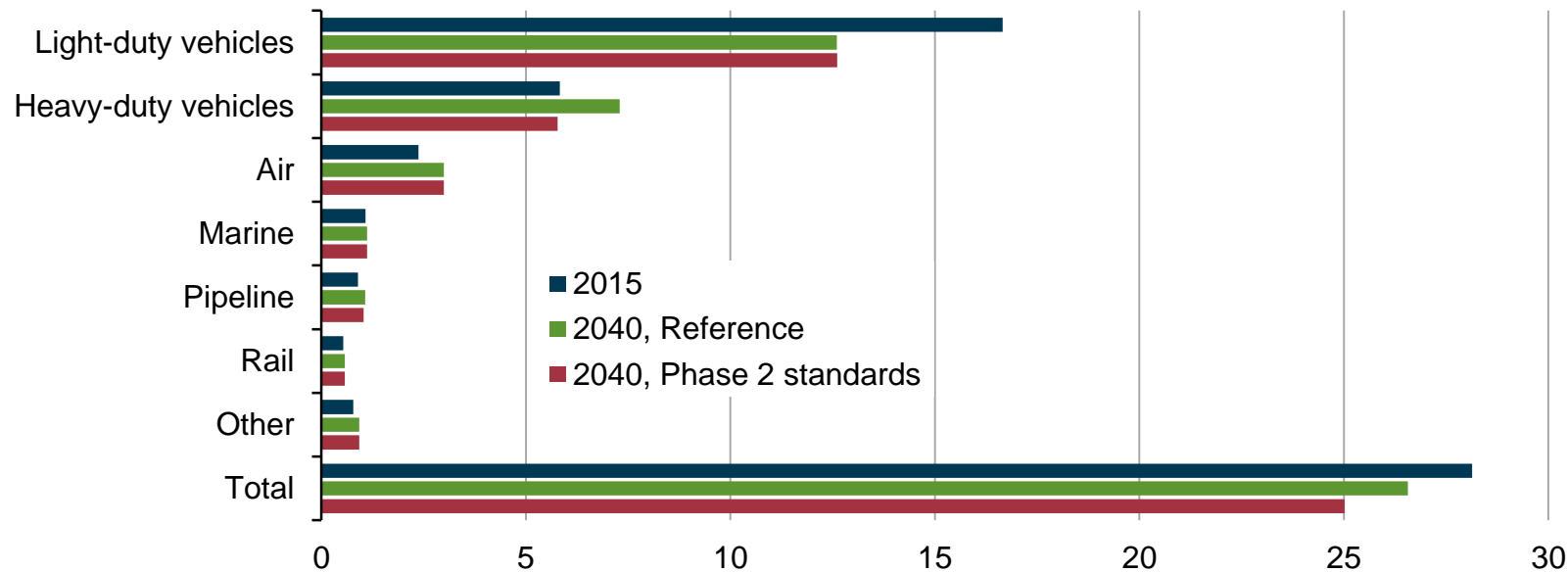


Source: EIA, Annual Energy Outlook 2016



# Light-duty vehicle share of energy consumption declines because of new vehicle fuel economy standards and in case with proposed Phase 2 standards

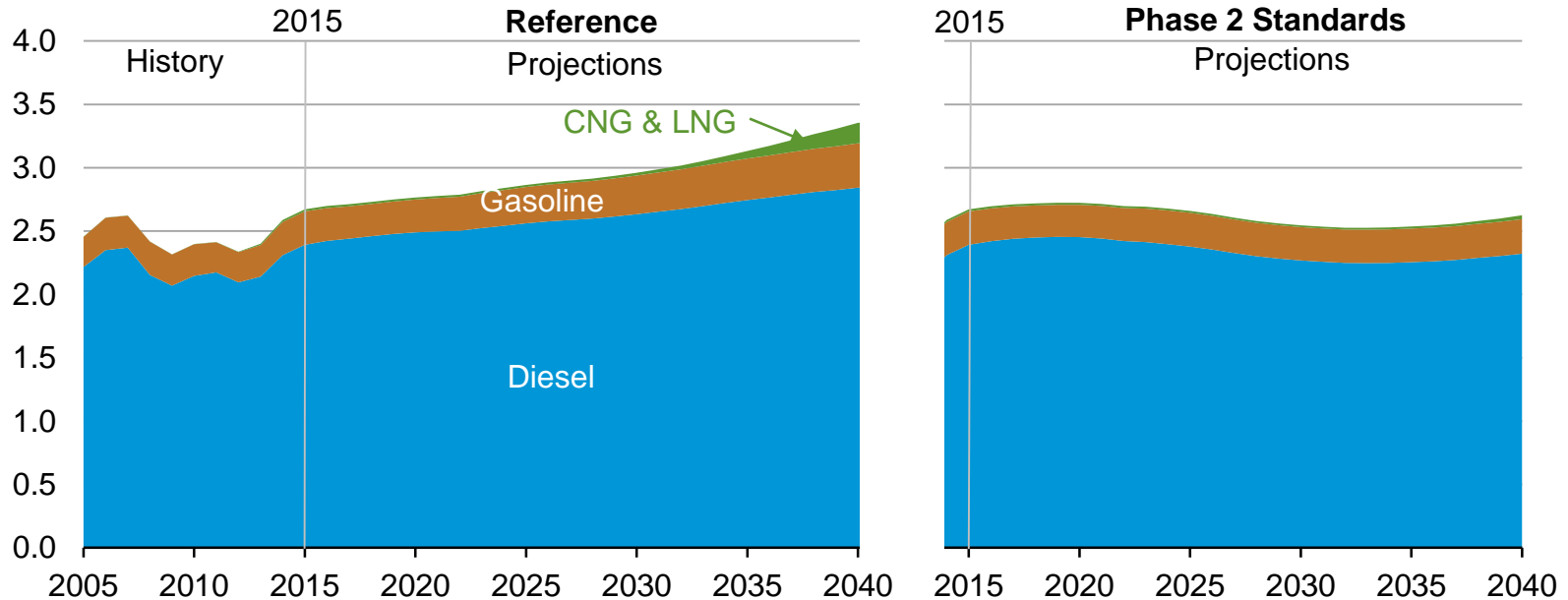
energy consumption  
quadrillion Btu



Source: EIA, Annual Energy Outlook 2016

# Diesel consumption decreases by a cumulative 2.5 billion barrels from 2021 to 2040 with impact of proposed Phase 2 standards

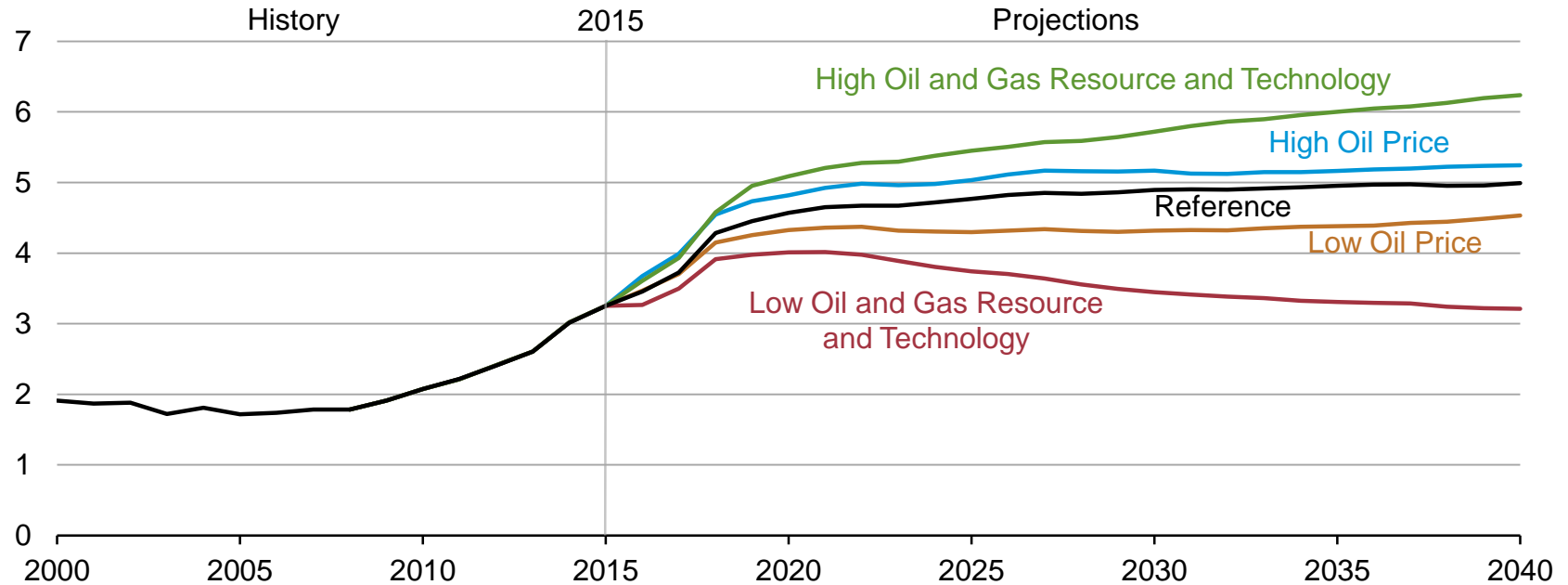
medium- and heavy-duty vehicle fuel consumption by type  
million barrels per day oil equivalent



Source: EIA, Annual Energy Outlook 2016

# Future domestic natural gas plant liquids production depends on both domestic resource endowment and world crude oil prices

U.S. total natural gas plant liquids production  
million barrels per day



Source: EIA, Annual Energy Outlook 2016

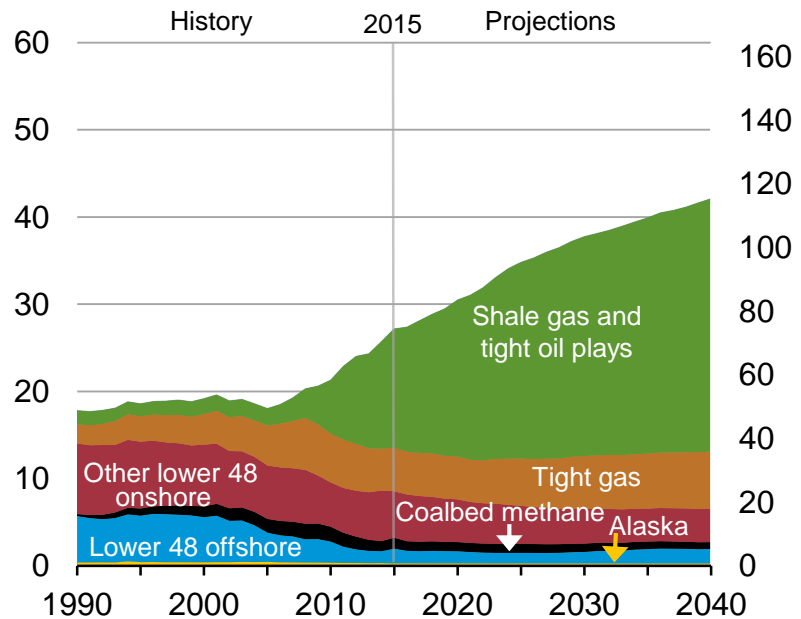
# Natural gas

# U.S. natural gas production dominated by shale resources; alternative price and resource /technology assumptions could be quite different

U.S. dry natural gas production

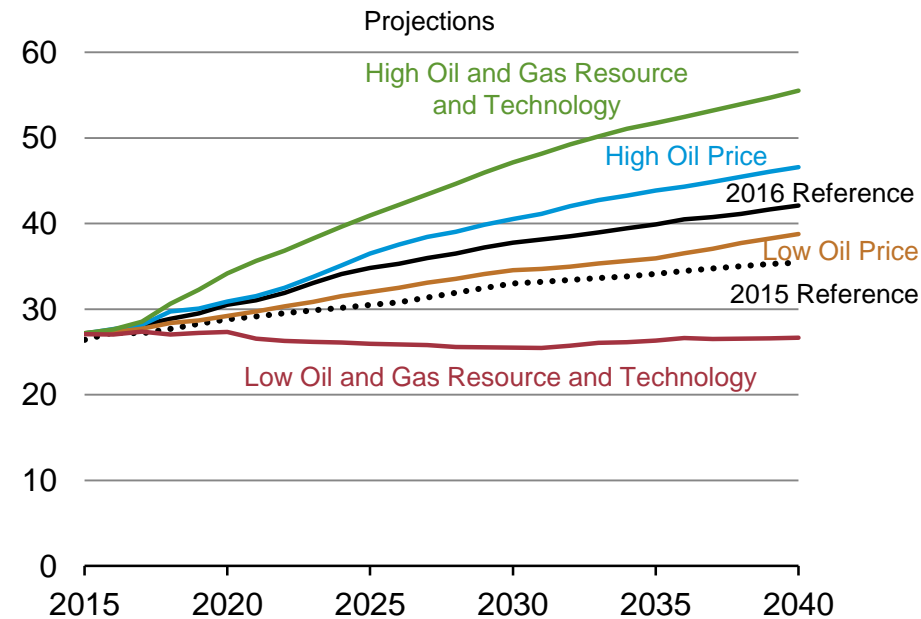
trillion cubic feet

billion cubic feet per day



U.S. dry natural gas production

trillion cubic feet

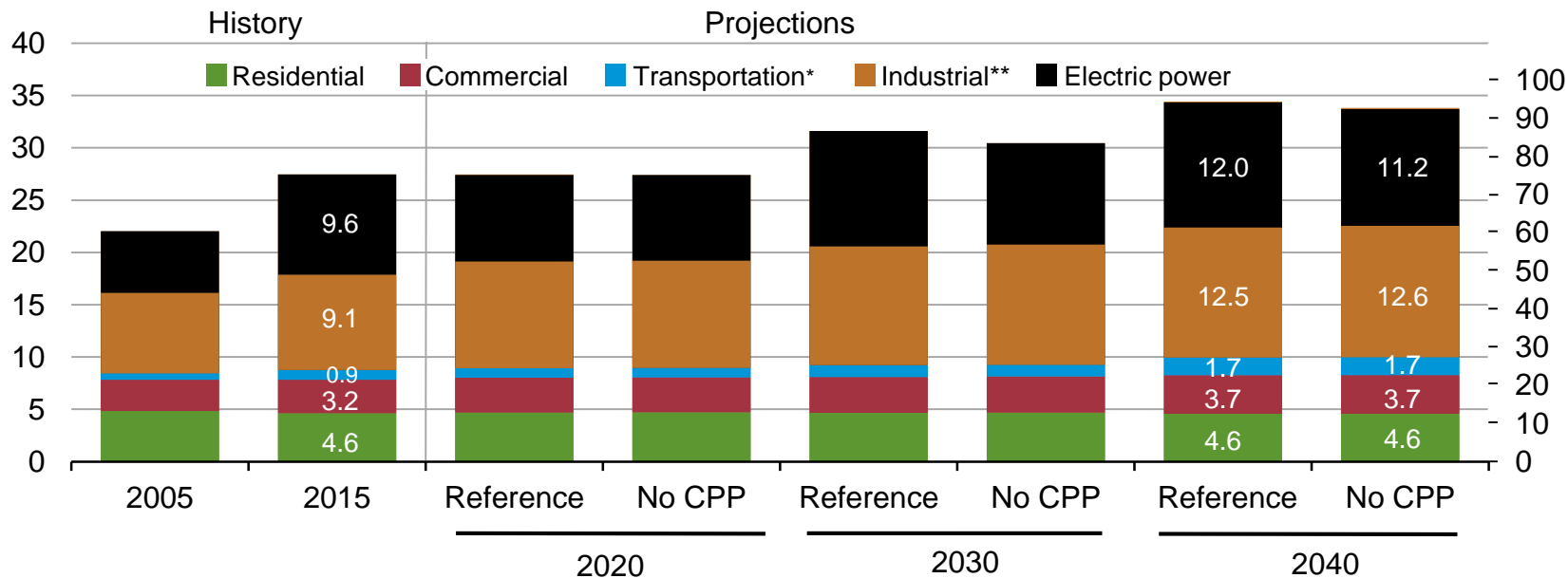


Source: EIA, Annual Energy Outlook 2016

# Natural gas consumption growth is led by electricity generation and industrial uses; natural gas use rises in all sectors except residential

U.S. dry gas consumption  
trillion cubic feet

billion cubic feet per day



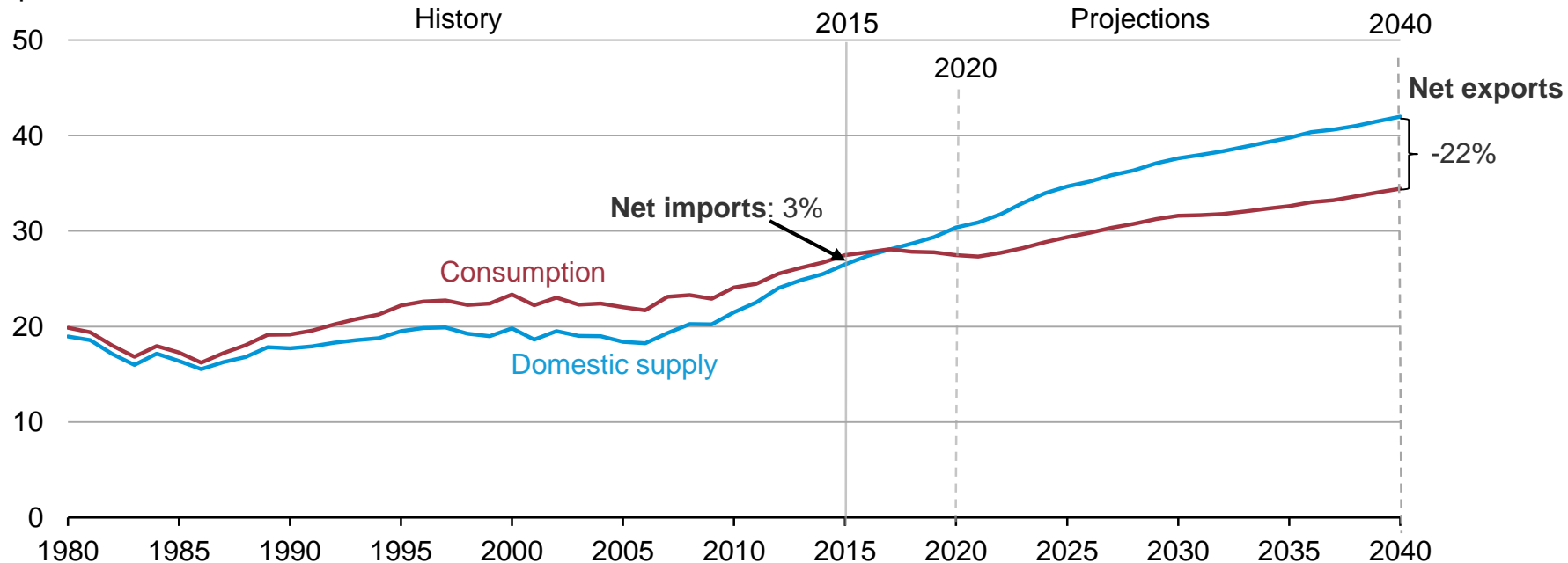
Source: EIA, Annual Energy Outlook 2016

\*Includes pipeline fuel

\*\*Includes combined heat-and-power and lease, plant, and export liquefaction fuel

# U.S. natural gas production will soon exceed consumption, making the United States a net exporter

U.S. energy production and consumption  
quadrillion Btu

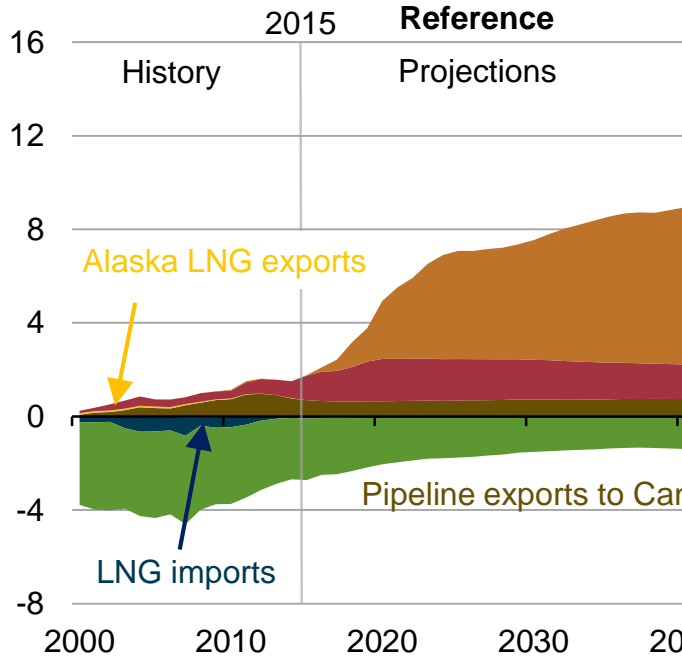


Source: EIA, Annual Energy Outlook 2016

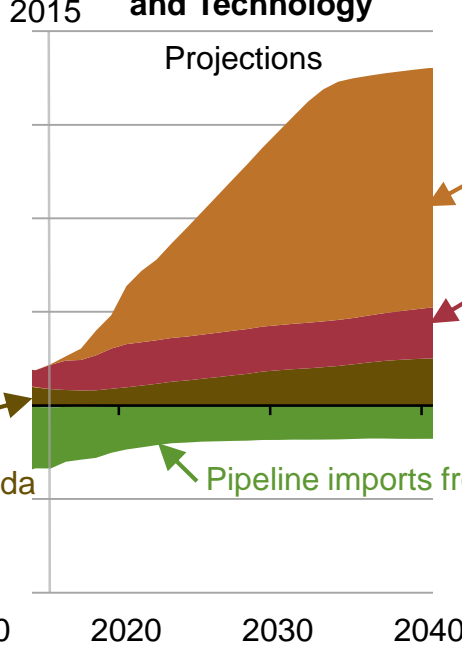
# Projected U.S. natural gas exports reflect the spread between domestic natural gas prices and world energy prices

U.S. natural gas imports and exports

trillion cubic feet

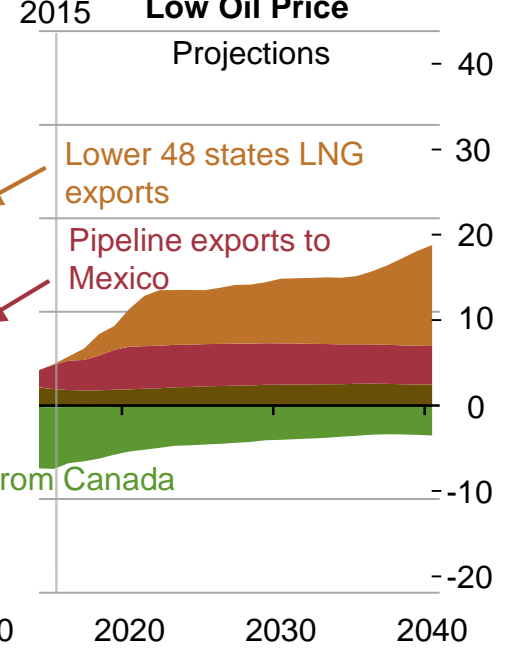


**High Oil and Gas Resource and Technology**



billion cubic feet per day

**Low Oil Price**

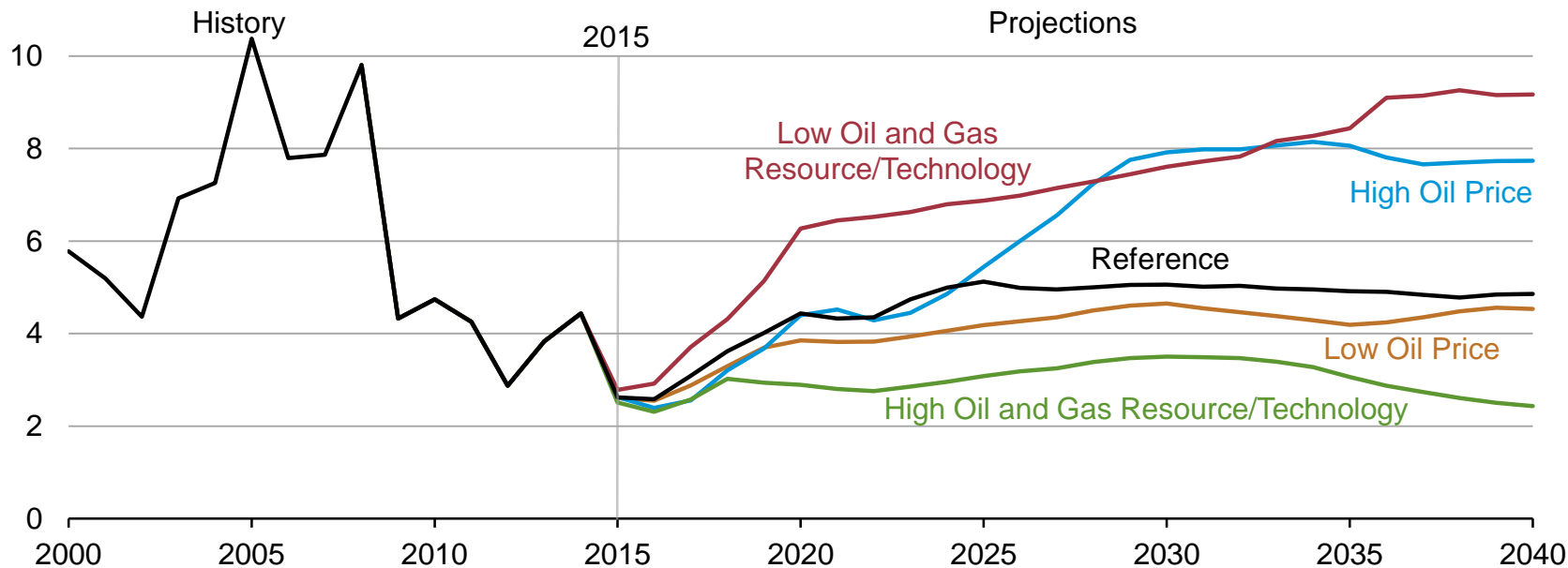


Source: EIA, Annual Energy Outlook 2016



# Future domestic natural gas prices depend on both domestic resource availability and world energy prices

average Henry Hub spot prices for natural gas  
2015 dollars per million Btu



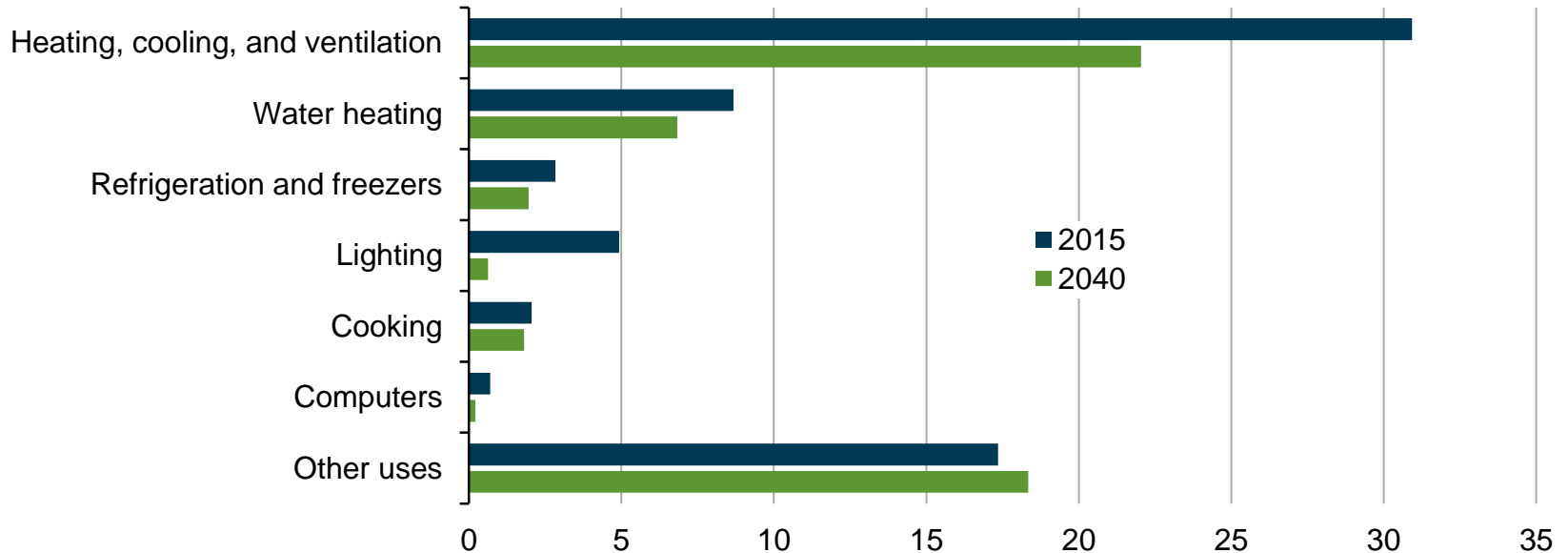
Source: EIA, Annual Energy Outlook 2016

# Buildings, Efficiency, Industry

# Energy efficiency policies and standards, and population shifts to warmer climates, contribute to declining energy intensity in the building sector

energy intensity

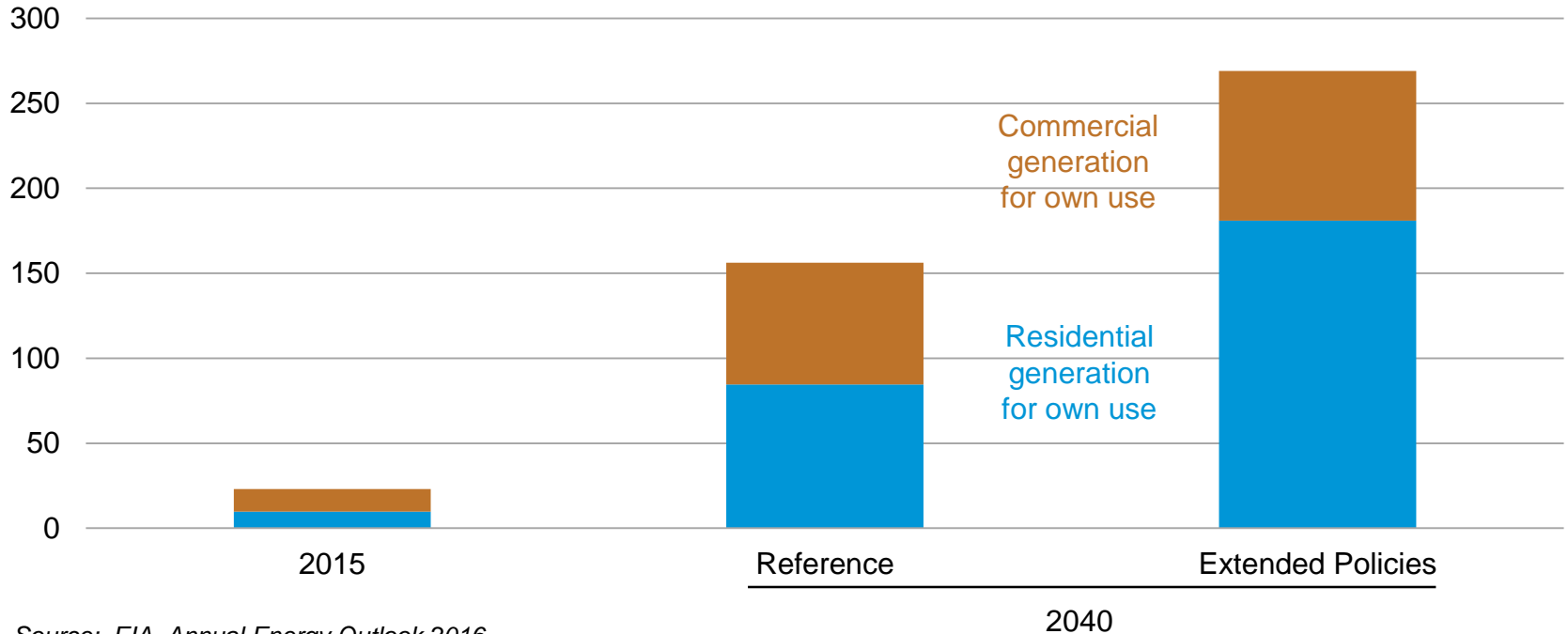
thousand Btu per square foot per year



Source: EIA, Annual Energy Outlook 2016

# Extended Policies case increases the rate at which the building sector generates its own electricity

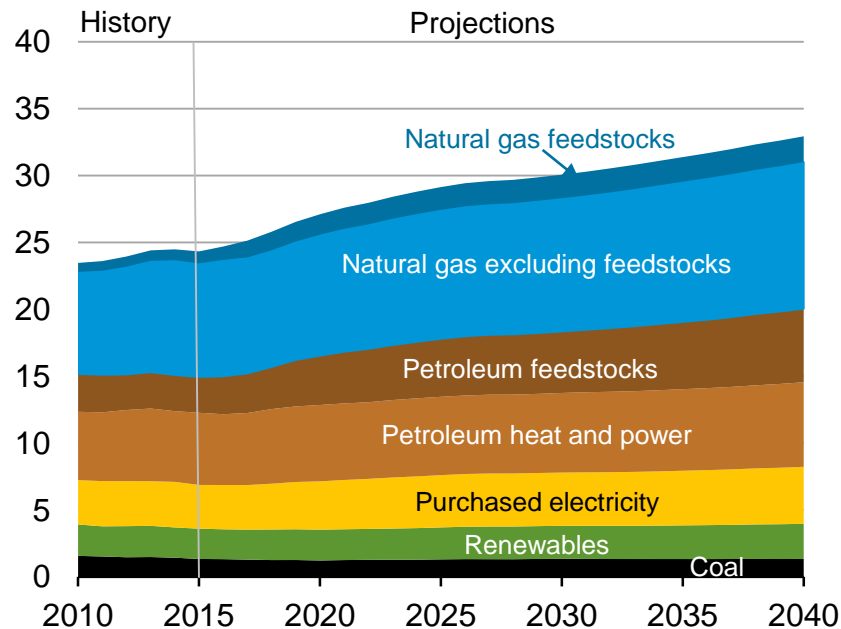
billion kilowatthours



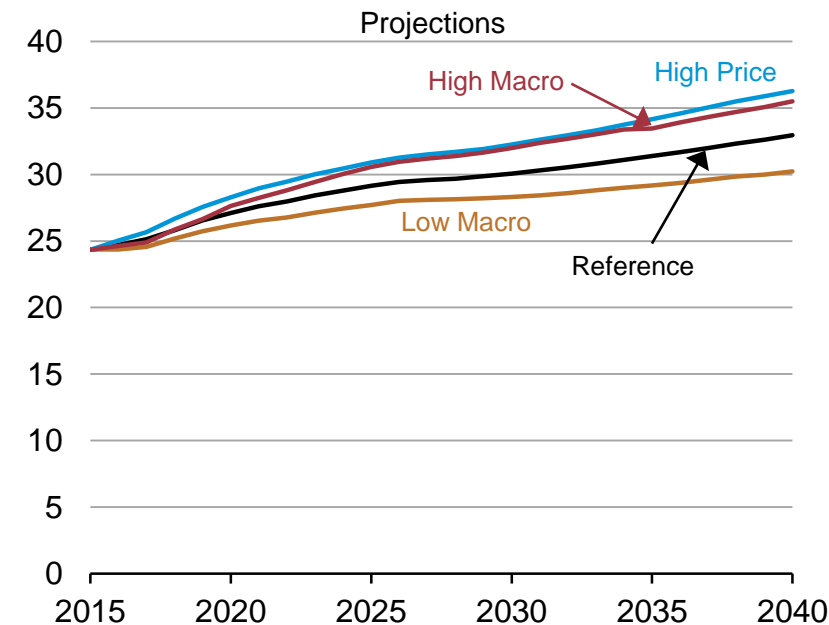
Source: EIA, Annual Energy Outlook 2016

# Industrial coal share falls, petroleum feedstock share rises; high price and high macro cases have similar effects on consumption

industrial delivered energy consumption  
quadrillion Btu



industrial delivered energy consumption  
quadrillion Btu



Source: EIA, Annual Energy Outlook 2016

## For more information

U.S. Energy Information Administration home page | [www.eia.gov](http://www.eia.gov)

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

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

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