# Drivers of future U.S. carbon dioxide emissions: insights from the *Annual Energy Outlook 2011*

*Global Climate Change Research Seminar*
*Electric Power Research Institute*
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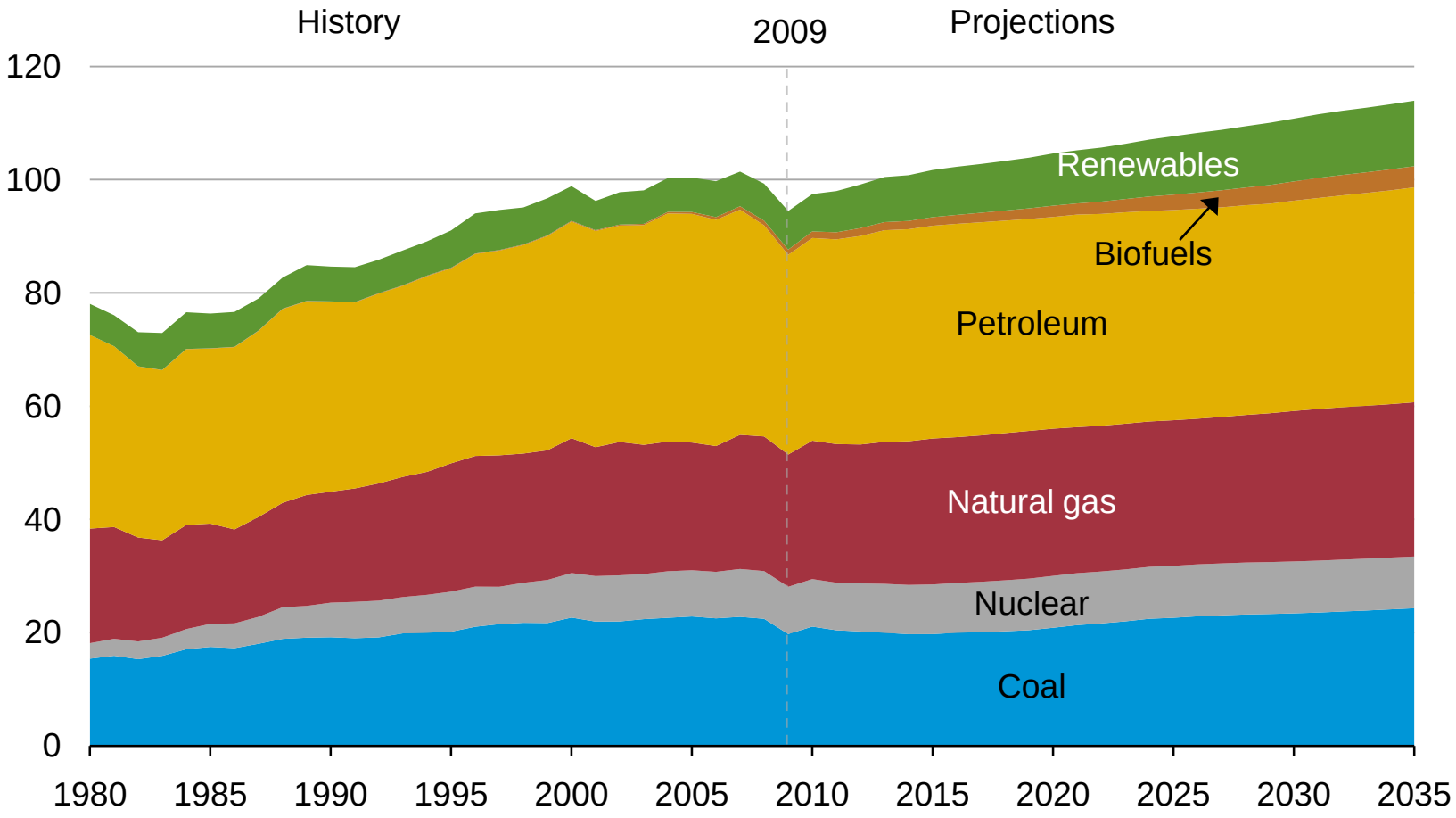
*May 25, 2011 | Washington, DC*

# Topics

- Reference case and its sectoral underpinnings
- Sensitivity analyses
- Conclusion

# Primary energy use by fuel, 1980-2035

U.S. energy use
quadrillion Btu

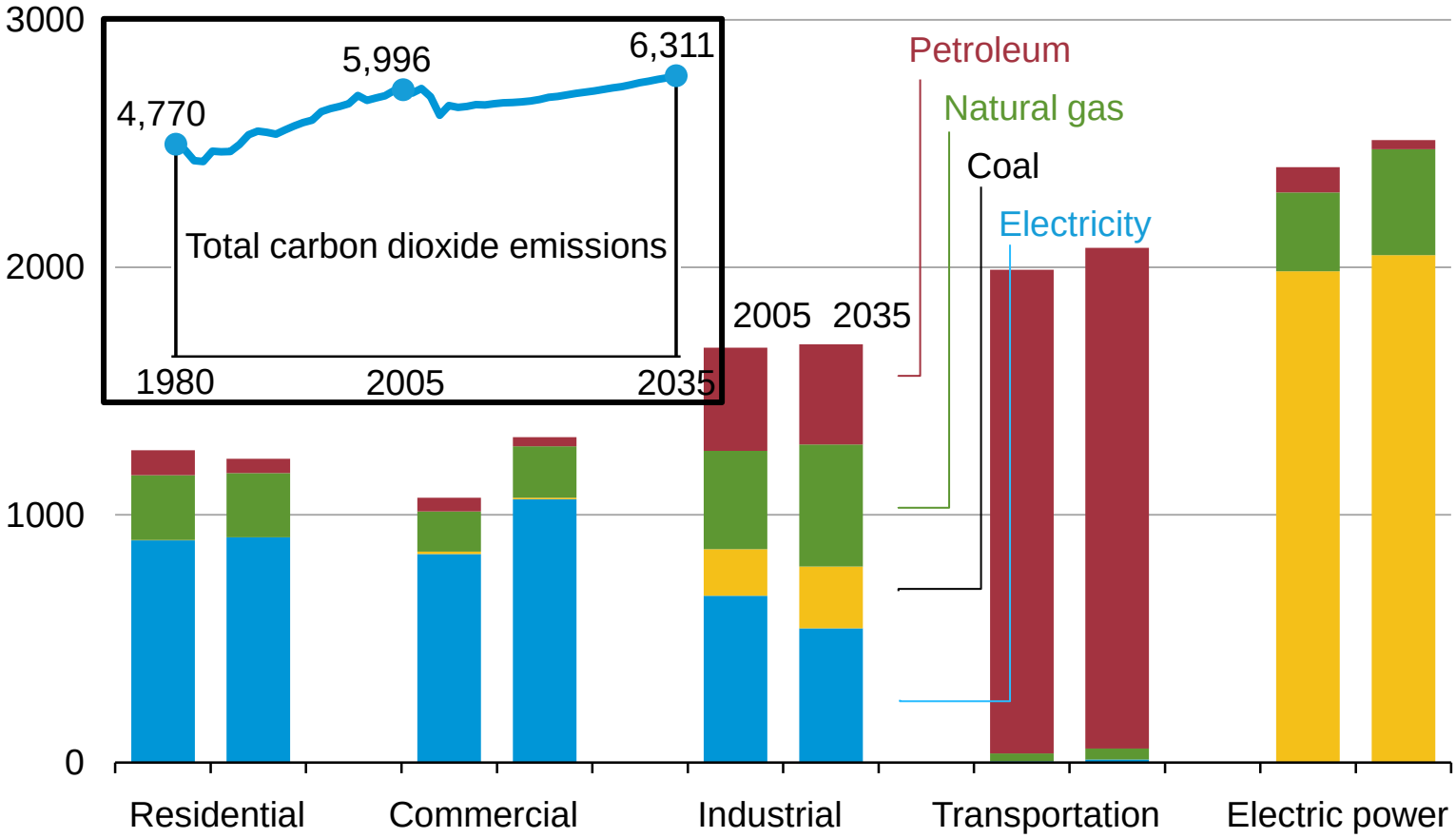



*Source: EIA, Annual Energy Outlook 2011*

# U.S. carbon dioxide emissions by sector and fuel, 2005 and 2035: *AEO2011* Reference case

U.S. carbon dioxide emissions

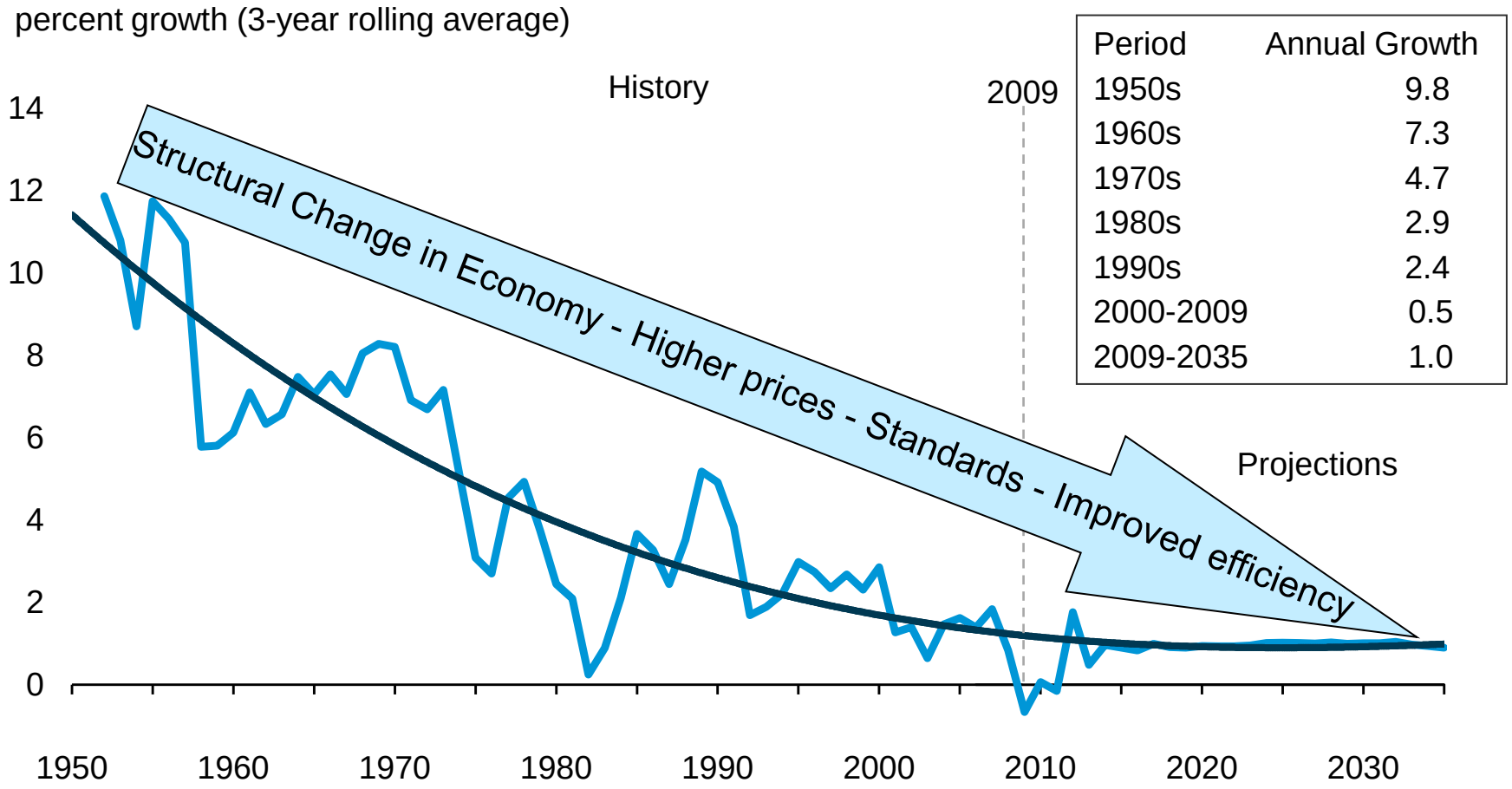
million metric tons




*Source: EIA, Annual Energy Outlook 2011*

# Electricity

# While projected electricity consumption grows by 30%, the rate of growth has slowed



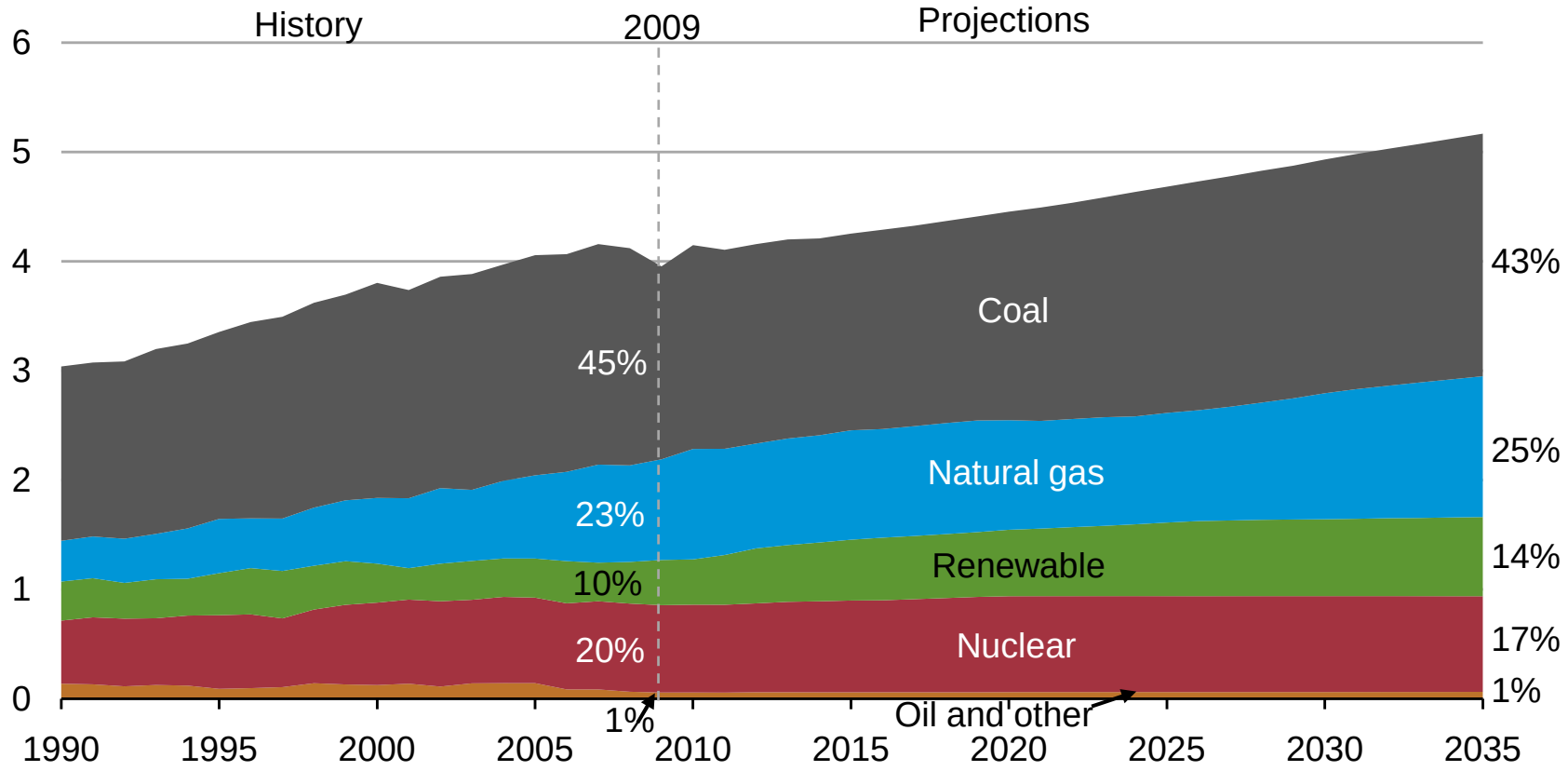

| Period | Annual Growth |
|---|---|
| 1950s | 9.8 |
| 1960s | 7.3 |
| 1970s | 4.7 |
| 1980s | 2.9 |
| 1990s | 2.4 |
| 2000-2009 | 0.5 |
| 2009-2035 | 1.0 |

*Source: EIA, Annual Energy Outlook 2011*

# The Reference case electricity mix in AEO2011 gradually shifts to lower-carbon options, with generation from natural gas rising 40% and renewables rising 75%

electricity net generation

trillion kilowatthours per year

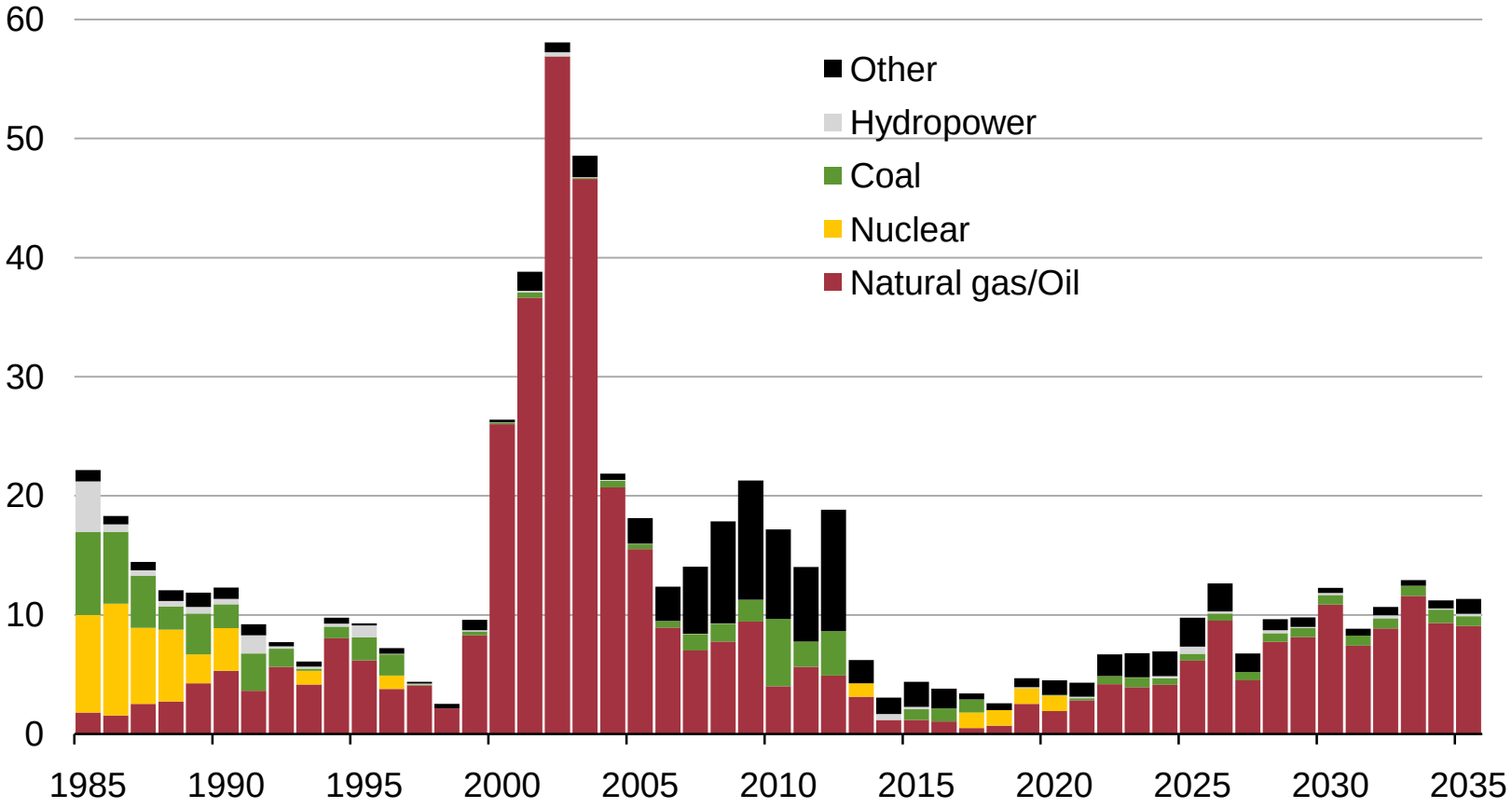



*Source: EIA, Annual Energy Outlook 2011*

# Additions to electricity generation capacity, 1985-2035

U.S. electricity generation capacity additions

gigawatts

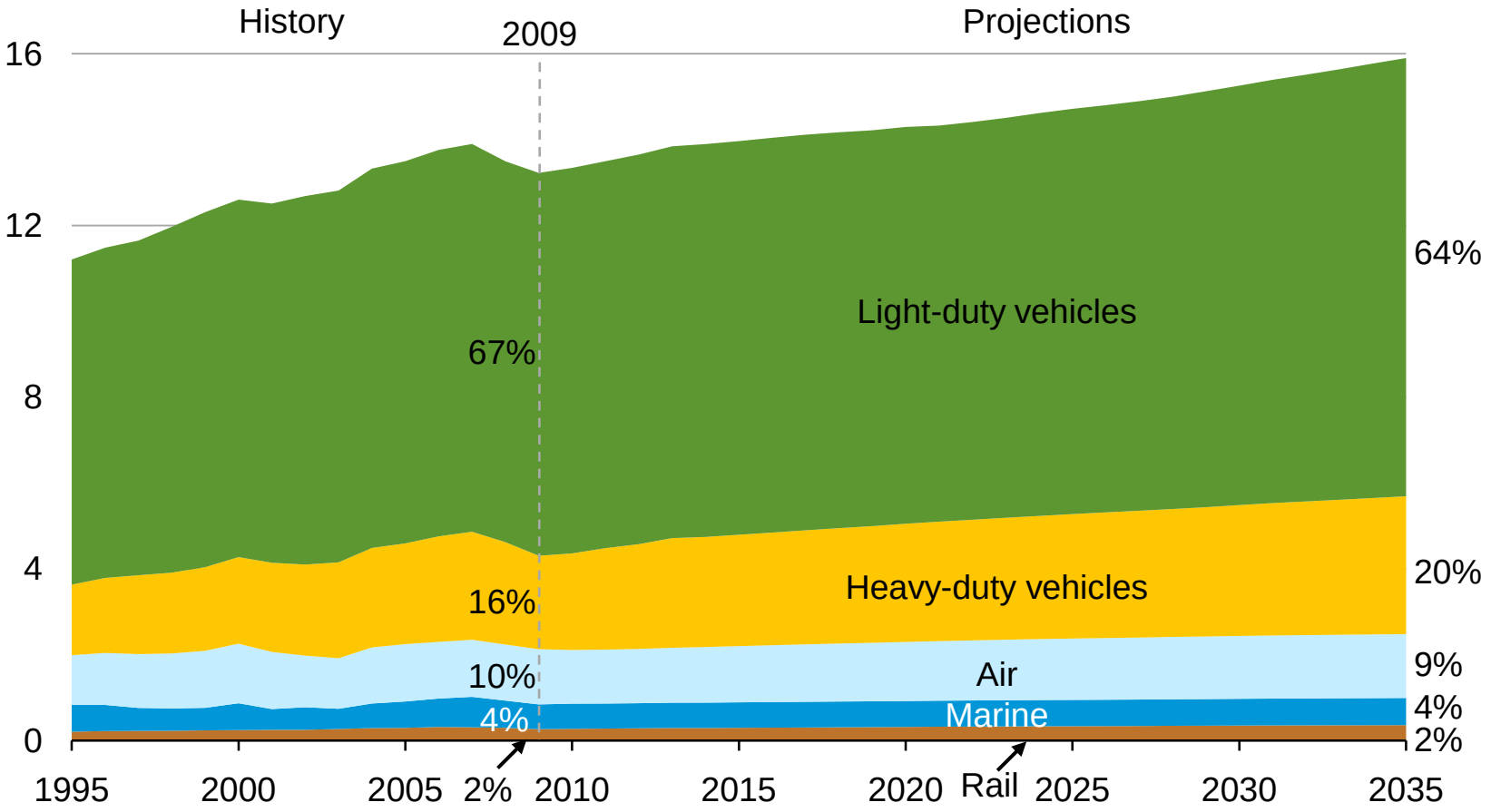



*Source: EIA, Annual Energy Outlook 2011*

# Transportation

# Most transport fuel growth is in light and heavy duty vehicles

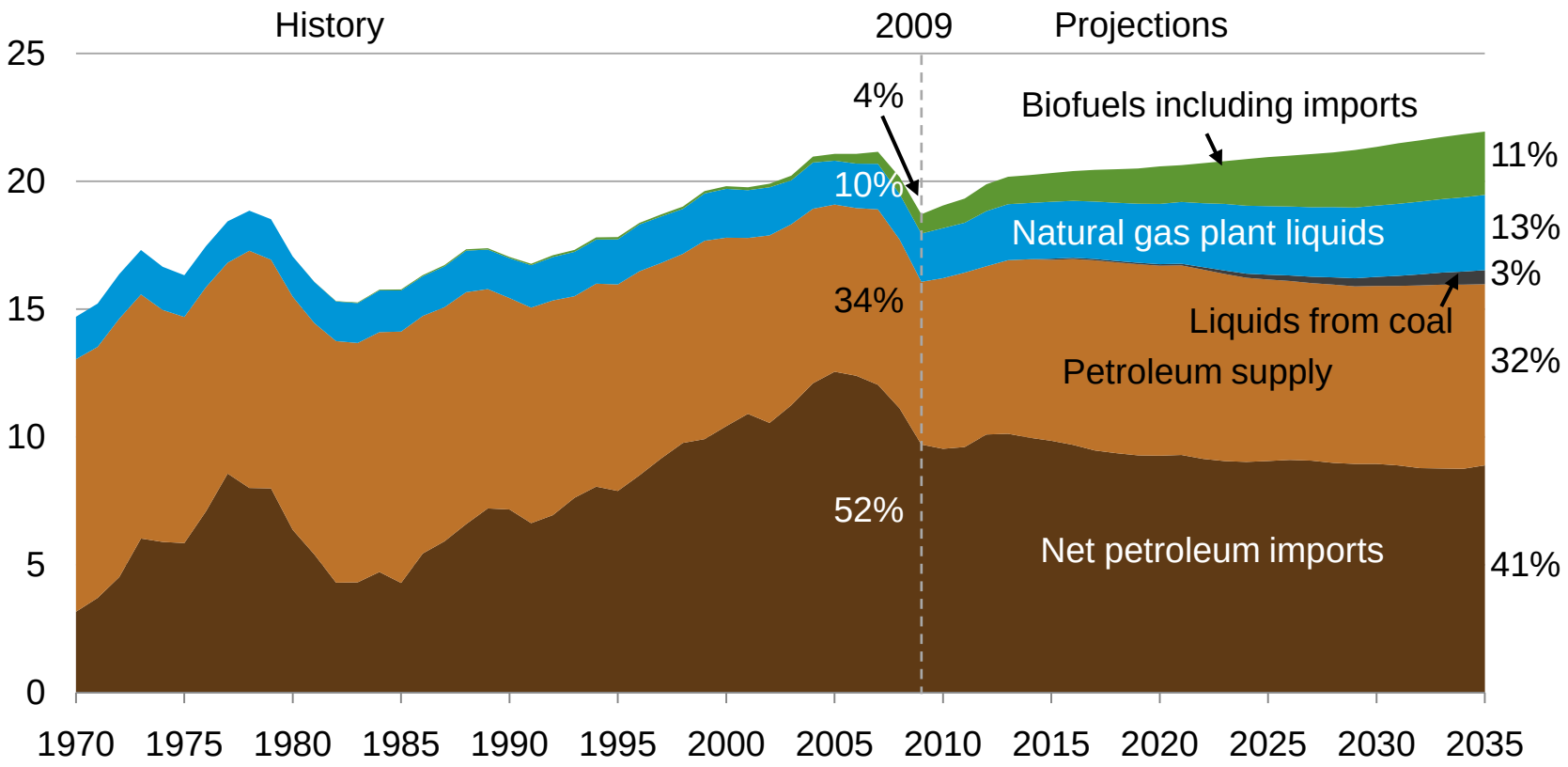
U.S. transportation energy consumption
million barrels per day oil equivalent




*Source: EIA, Annual Energy Outlook 2011*

# Greater fuel efficiency and increased reliance on biofuels limit growth in petroleum use and imports

U.S. liquid fuels consumption
million barrels per day




*Source: EIA, Annual Energy Outlook 2011*

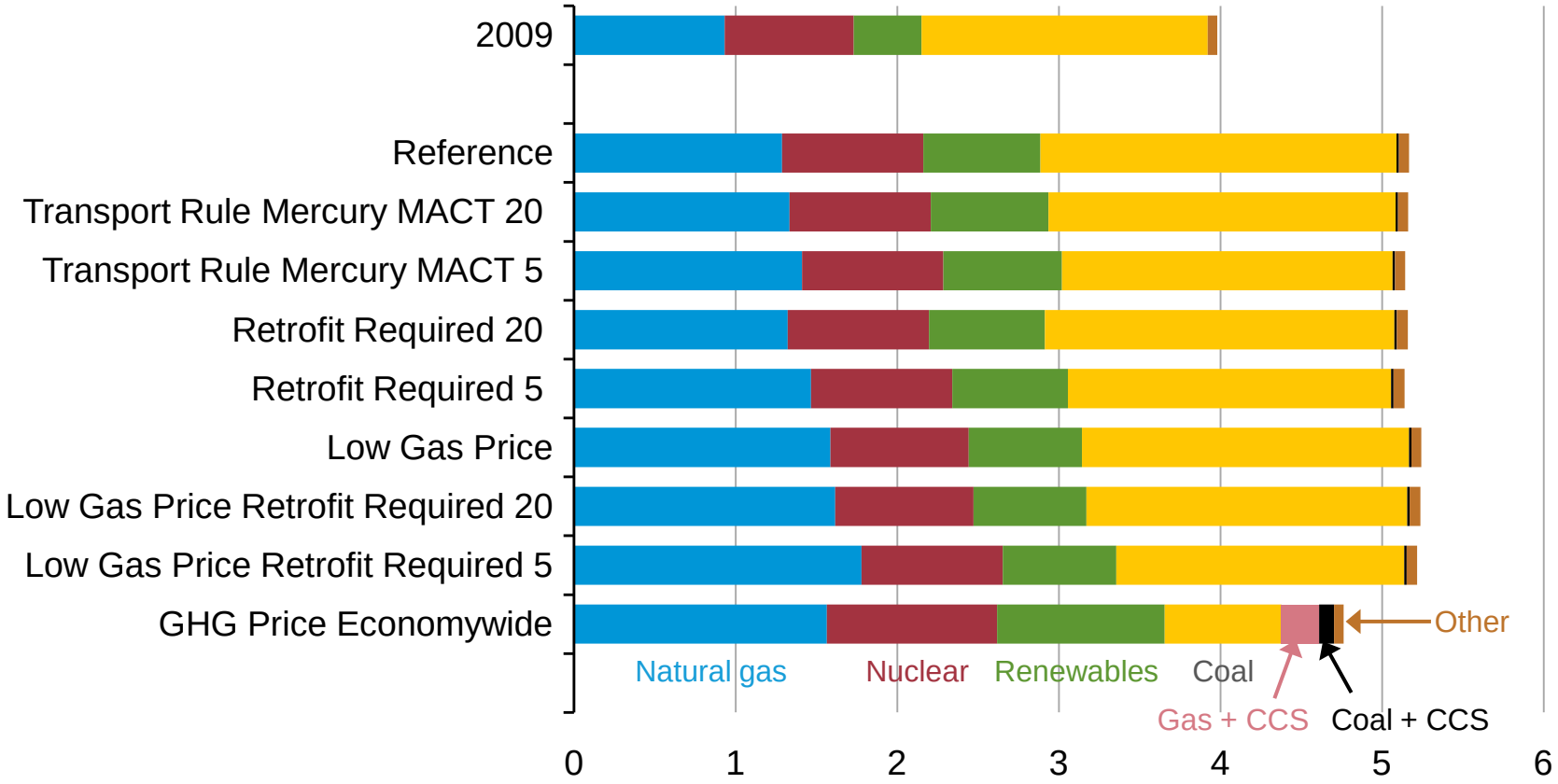
# *AEO 2011* includes 57 sensitivity cases, many of which have significant implications for projected carbon dioxide emissions

- Electricity sector policies
  - Possible impacts of pending regulatory actions to address issues other than GHG emissions
- No sunset and extended policies
  - No sunset looks at extension of existing energy tax expenditures, many of which have been repeatedly extended in the past
  - Extended policies considers a scenario of future policy action under current laws
- Possible/pending fuel economy standards
  - Light duty vehicles MY 2017 thru MY 2025
  - Heavy duty vehicles
- Economic growth and oil price scenarios

# *AEO2011* sensitivities surrounding pending EPA regulations affecting electricity generation

# Electricity generation by fuel in nine cases, 2009 and 2035

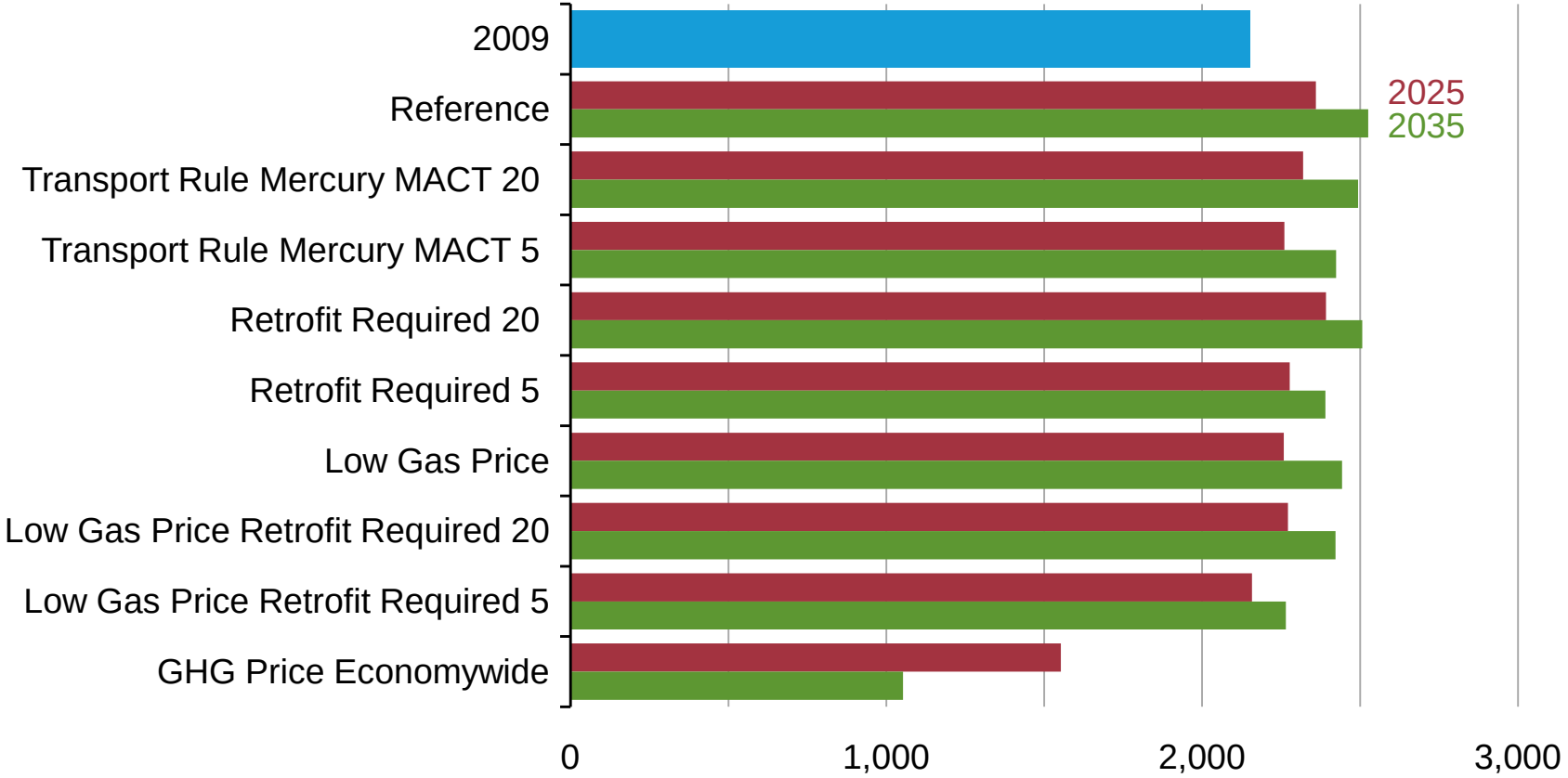
U.S. electricity generation
trillion kilowatthours




*Source: EIA, Annual Energy Outlook 2011*

# Carbon dioxide emissions from the electric power sector in nine cases, 2009, 2025, and 2035

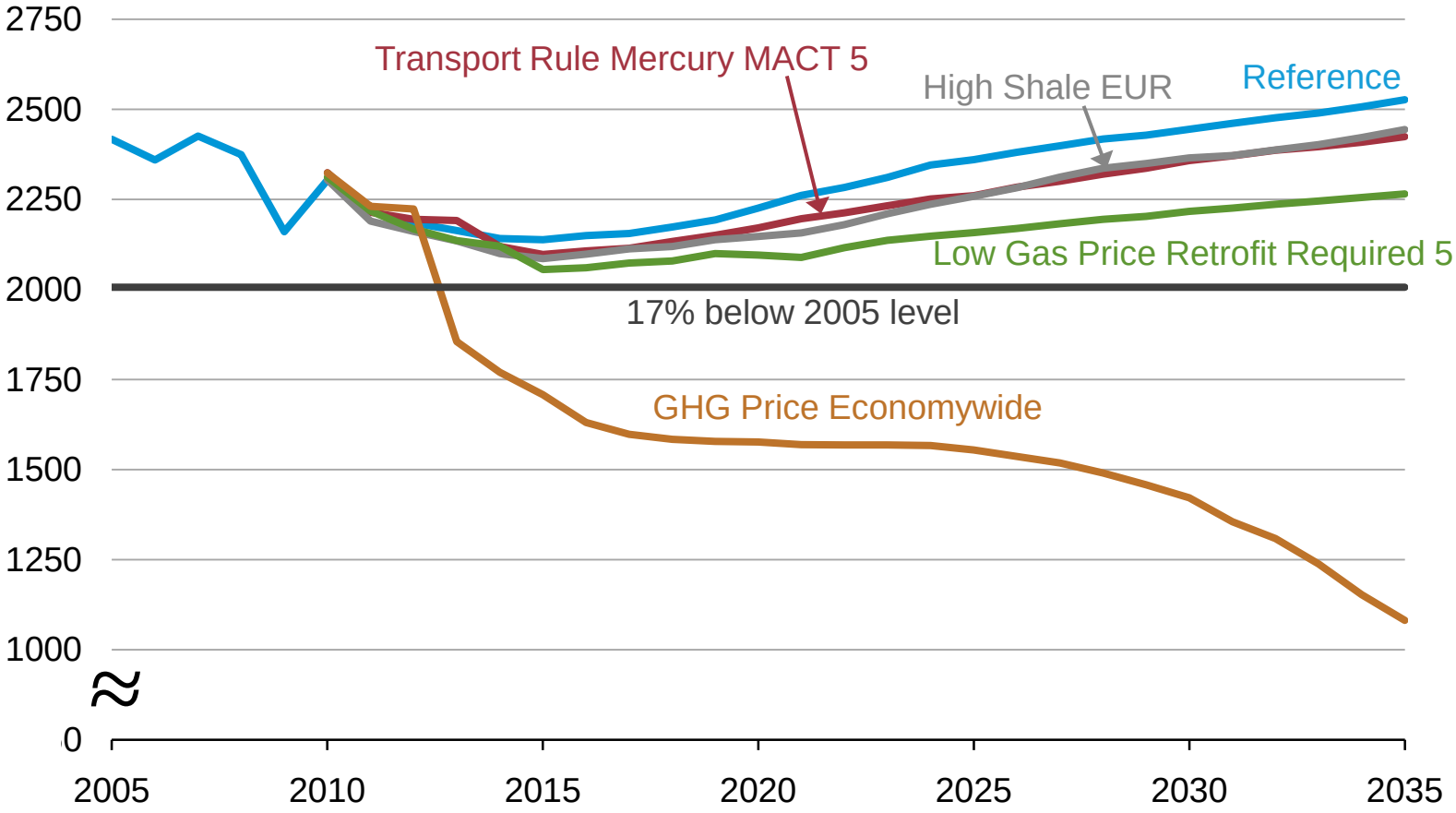
U.S. electric power sector carbon dioxide emissions
million metric tons




*Source: EIA, Annual Energy Outlook 2011*

# Electric power sector carbon dioxide emissions in 4 AEO2011 sensitivity cases, 2005-2035

U.S. carbon dioxide emissions
million metric tons



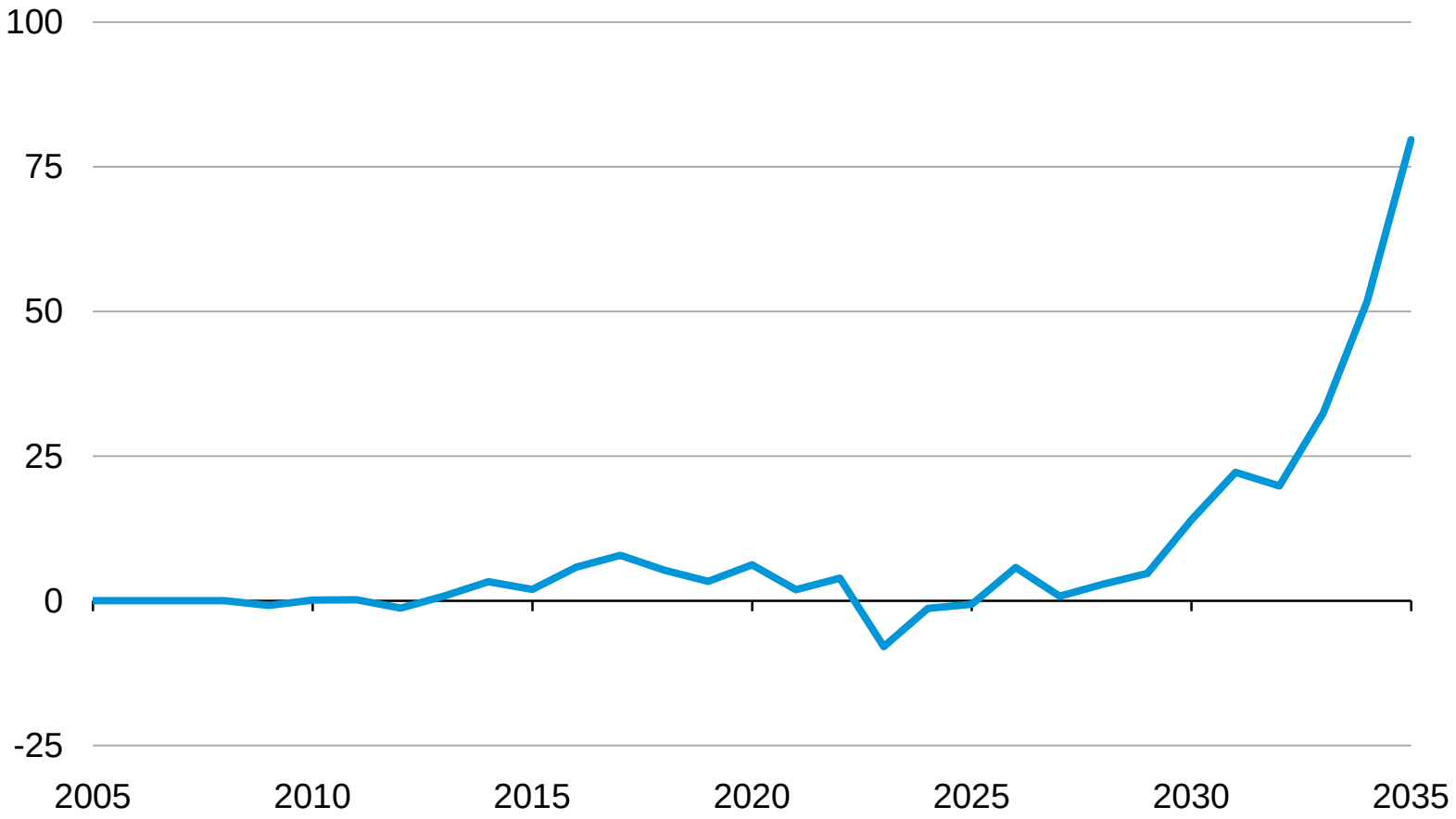

*Source: EIA, Annual Energy Outlook 2011*

and, recent events remind us about potential nuclear retirements

# Carbon dioxide emissions change in *AEO2010* nuclear retirement case, 2005-2035

U.S. carbon dioxide emission change from reference case

million metric tons

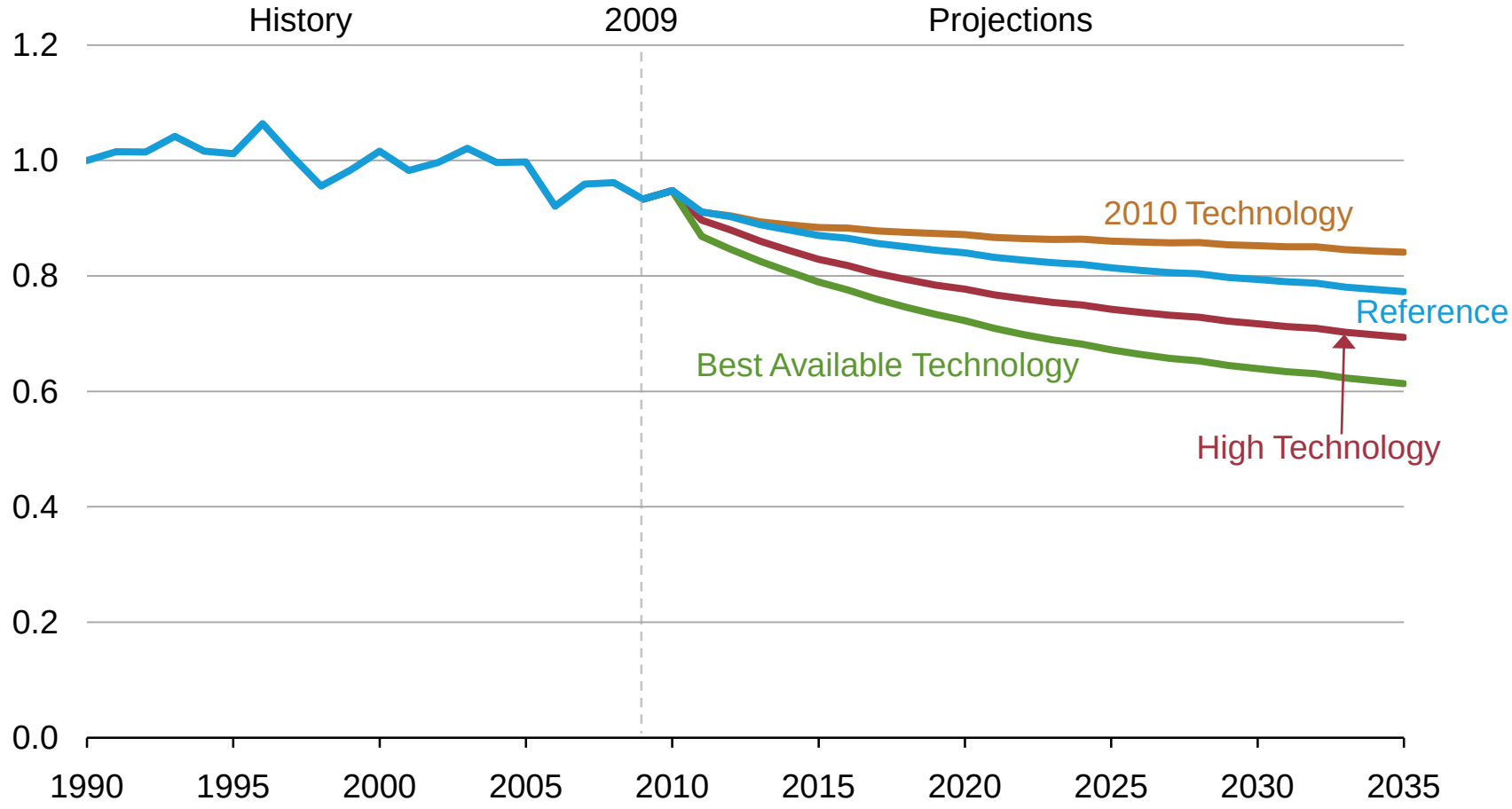



*Source: EIA, Annual Energy Outlook 2010*

# No Sunset, Extended Policies, and Expanded Codes and Standards sensitivities

# Residential delivered energy consumption per capita in four cases, 1990-2035

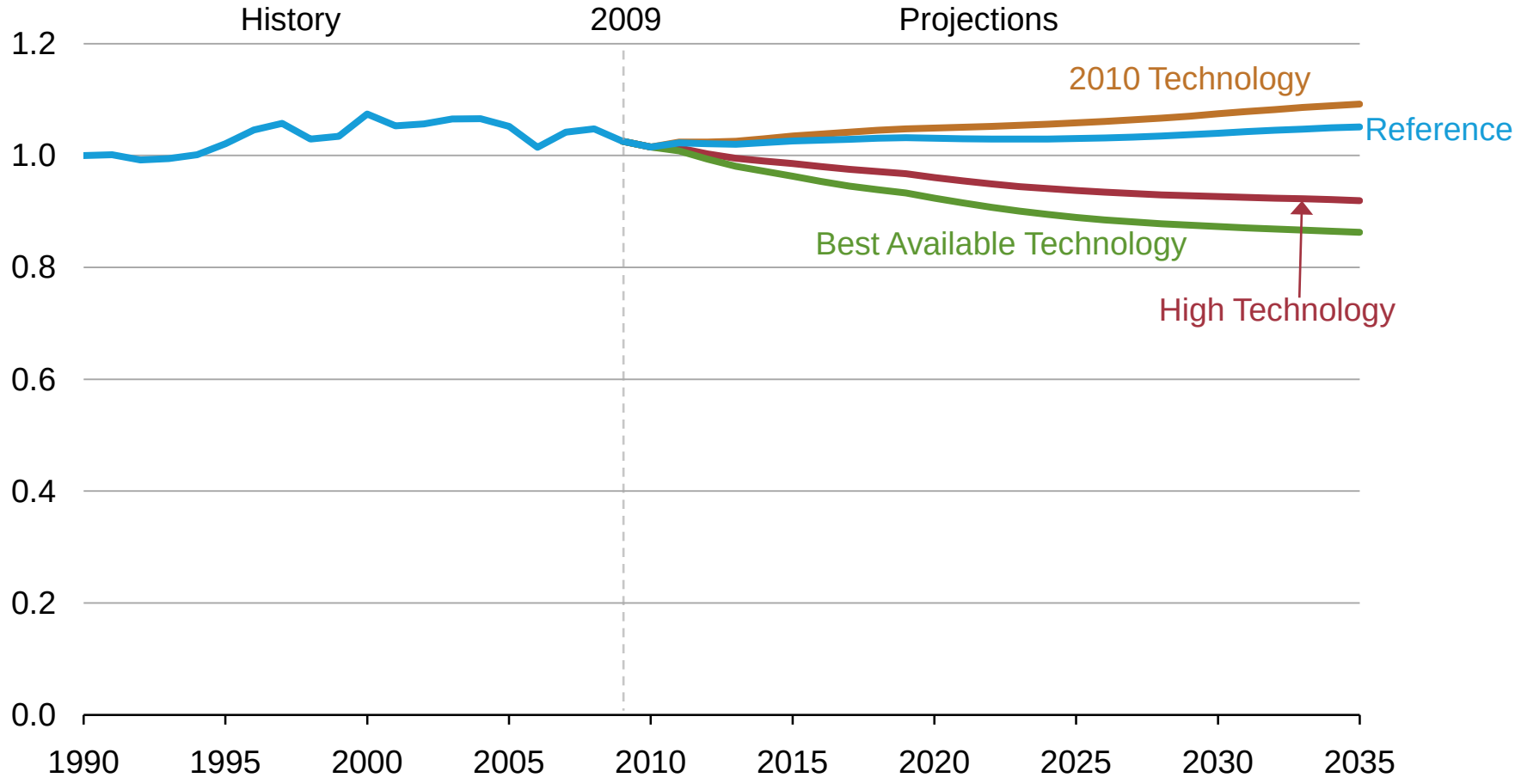
U.S. residential energy use per capita
index, 1990=1




*Source: EIA, Annual Energy Outlook 2011*

# Commercial delivered energy consumption per capita in four cases, 1990-2035

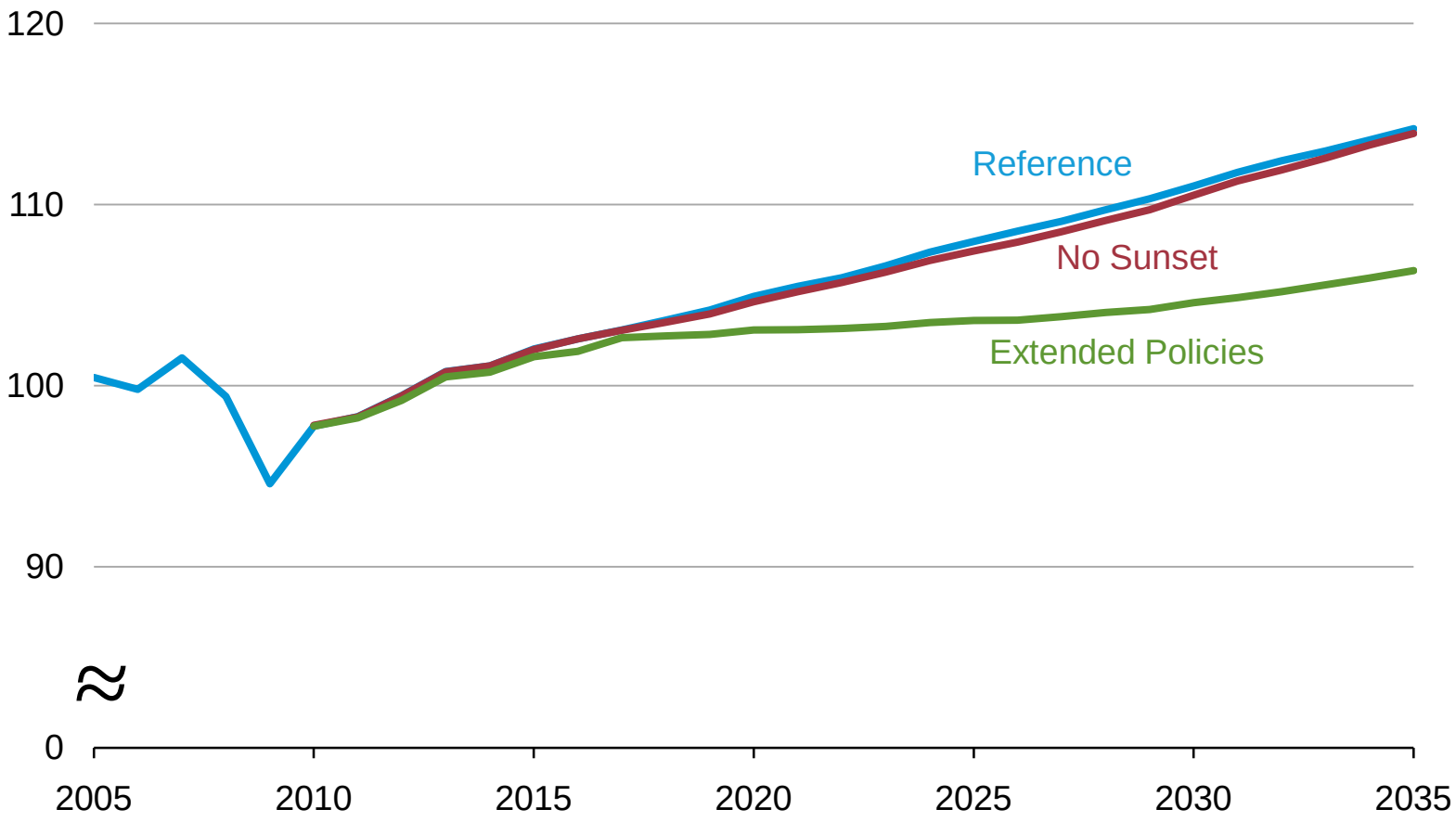
U.S. commercial energy use per capita
index, 1990=1




*Source: EIA, Annual Energy Outlook 2011*

# Total energy consumption in the No Sunset and Extended Policies cases, 2005-2035

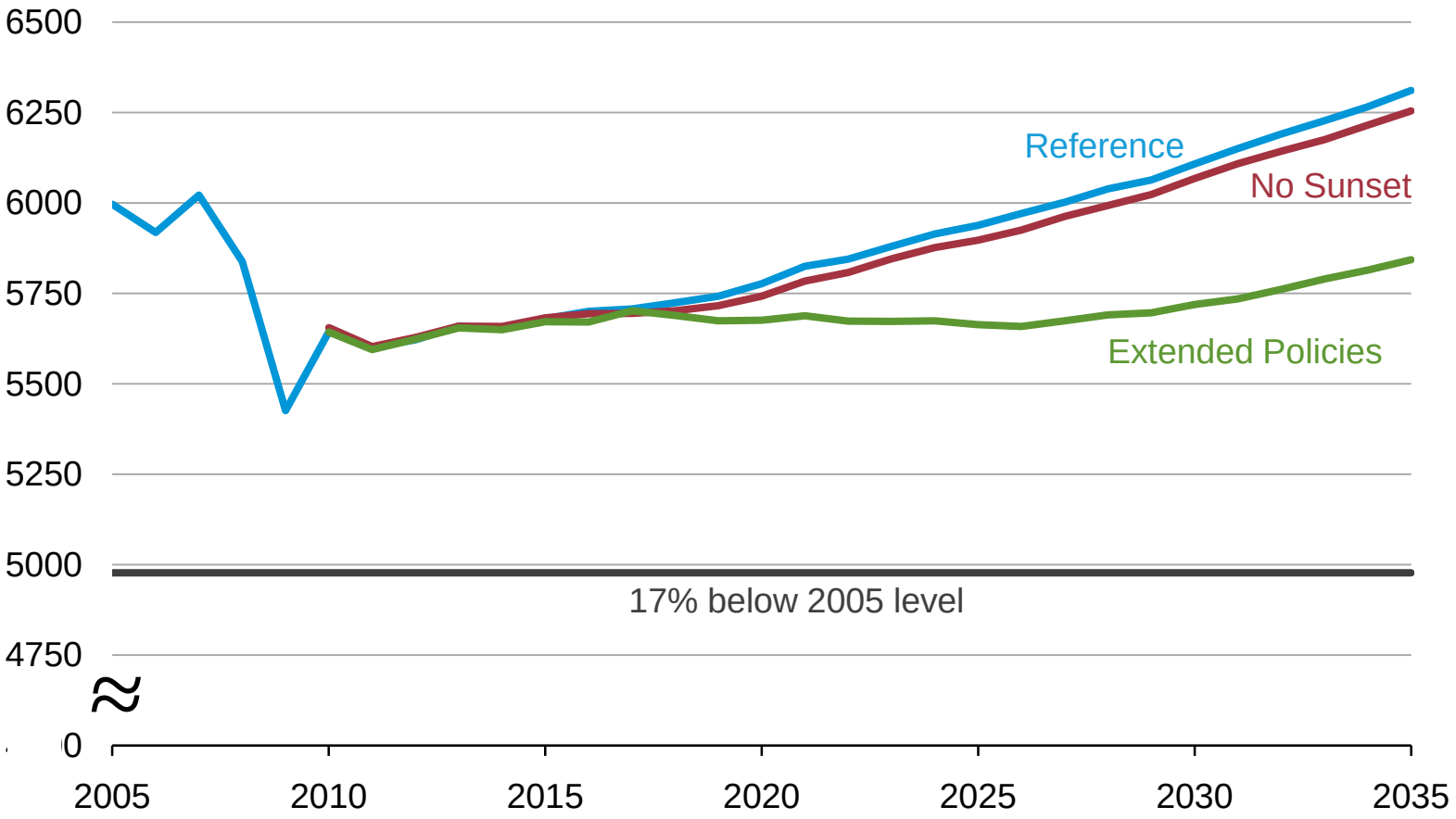
U.S. energy consumption
quadrillion Btu




*Source: EIA, Annual Energy Outlook 2011*

# Energy-related carbon dioxide emissions in the No Sunset and Extended Policies cases, 2005-2035

U.S. carbon dioxide emissions
million metric tons

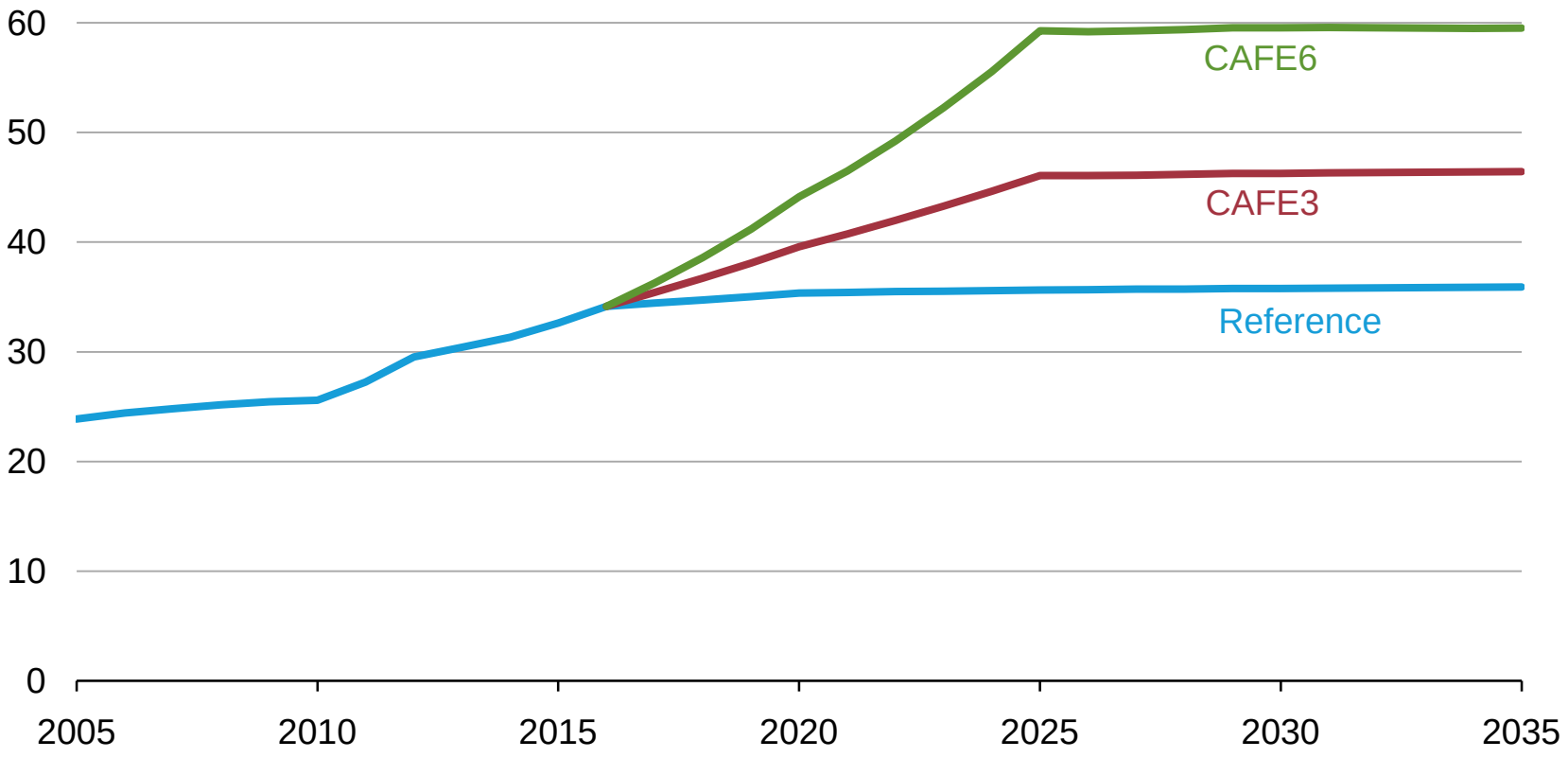



*Source: EIA, Annual Energy Outlook 2011*

# Fuel Economy Sensitivities

# Combined CAFE standards for light-duty vehicles in three cases, 2005-2035

new light-duty vehicle fuel economy
miles per gallon

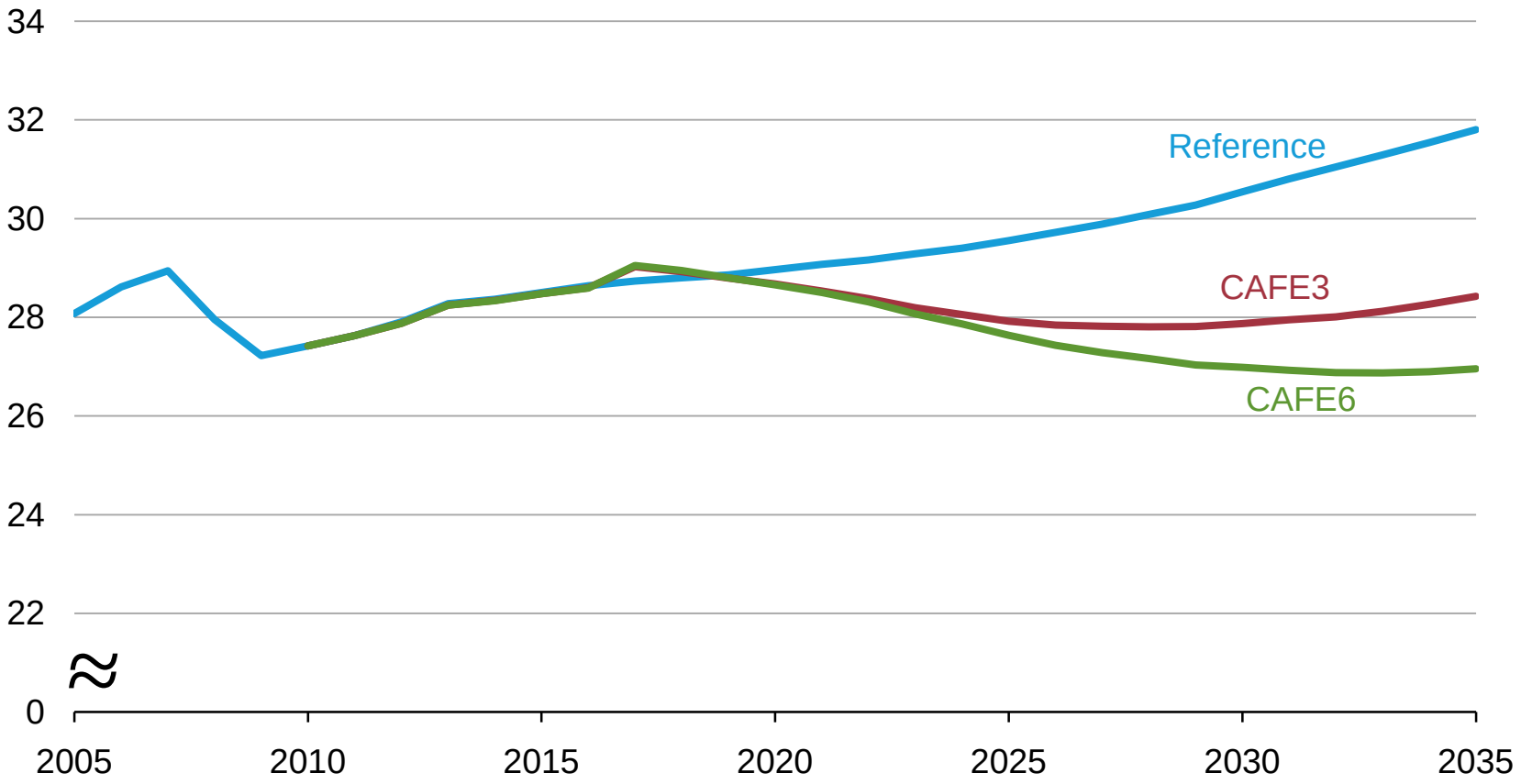



*Source: EIA, Annual Energy Outlook 2011*

# Total transportation energy consumption

U.S. energy consumption

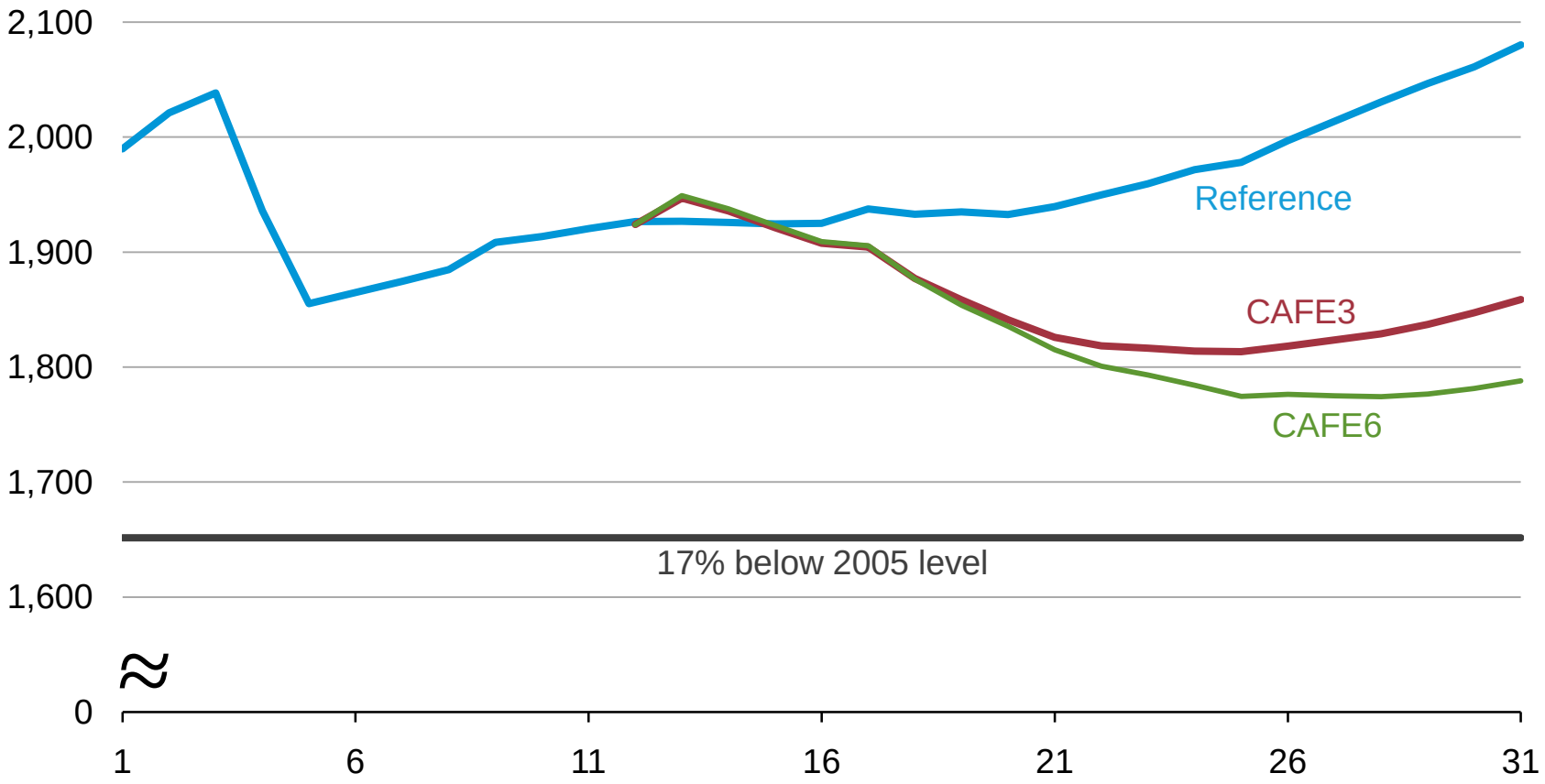
quadrillion Btu




*Source: EIA, Annual Energy Outlook 2011*

# Total transportation carbon dioxide emissions

U.S. transportation carbon dioxide emissions
million metric tons

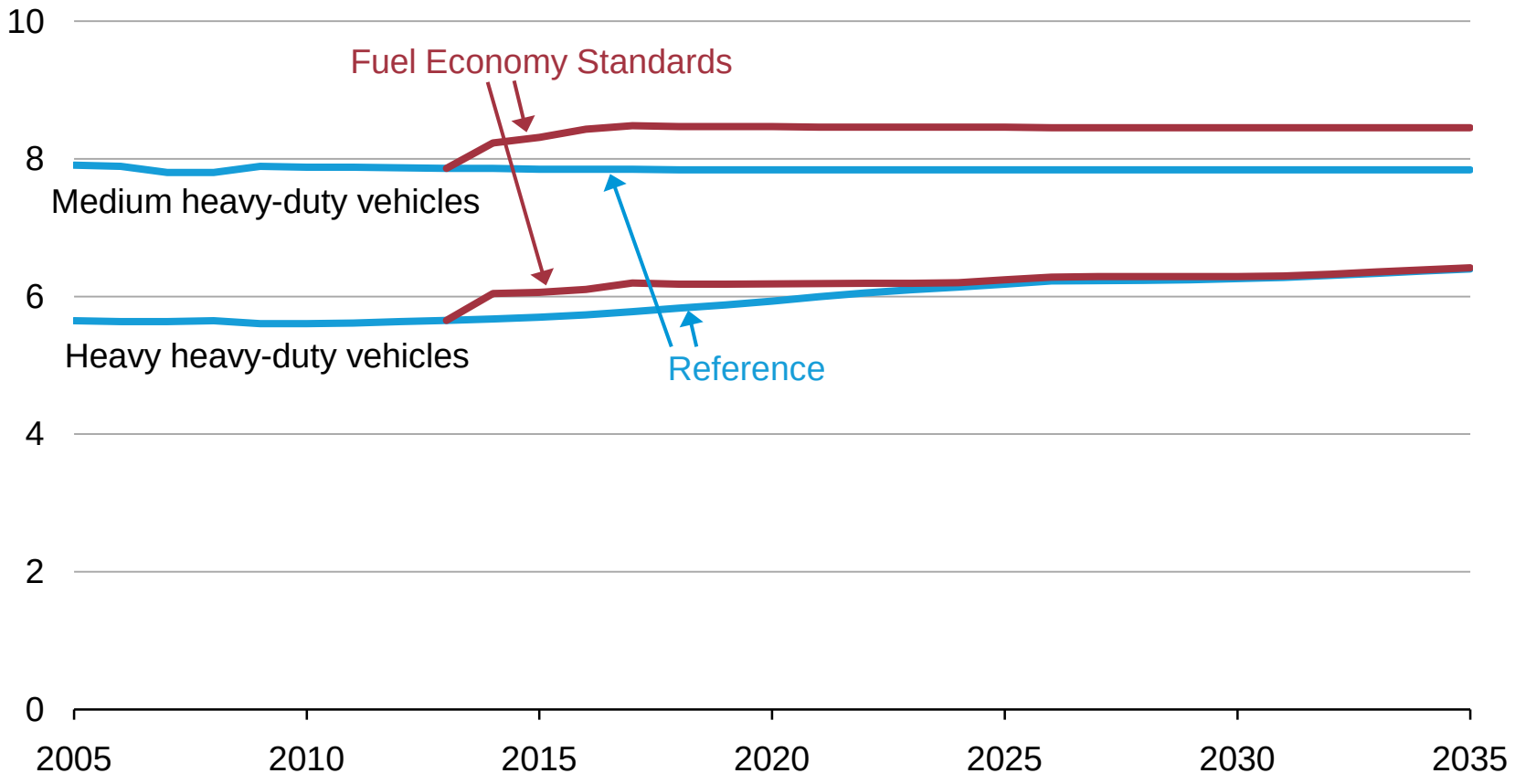



*Source: EIA, Annual Energy Outlook 2011*

# On-road fuel economy of new medium and heavy heavy-duty vehicles in two cases, 2005-2035

new vehicle fuel economy

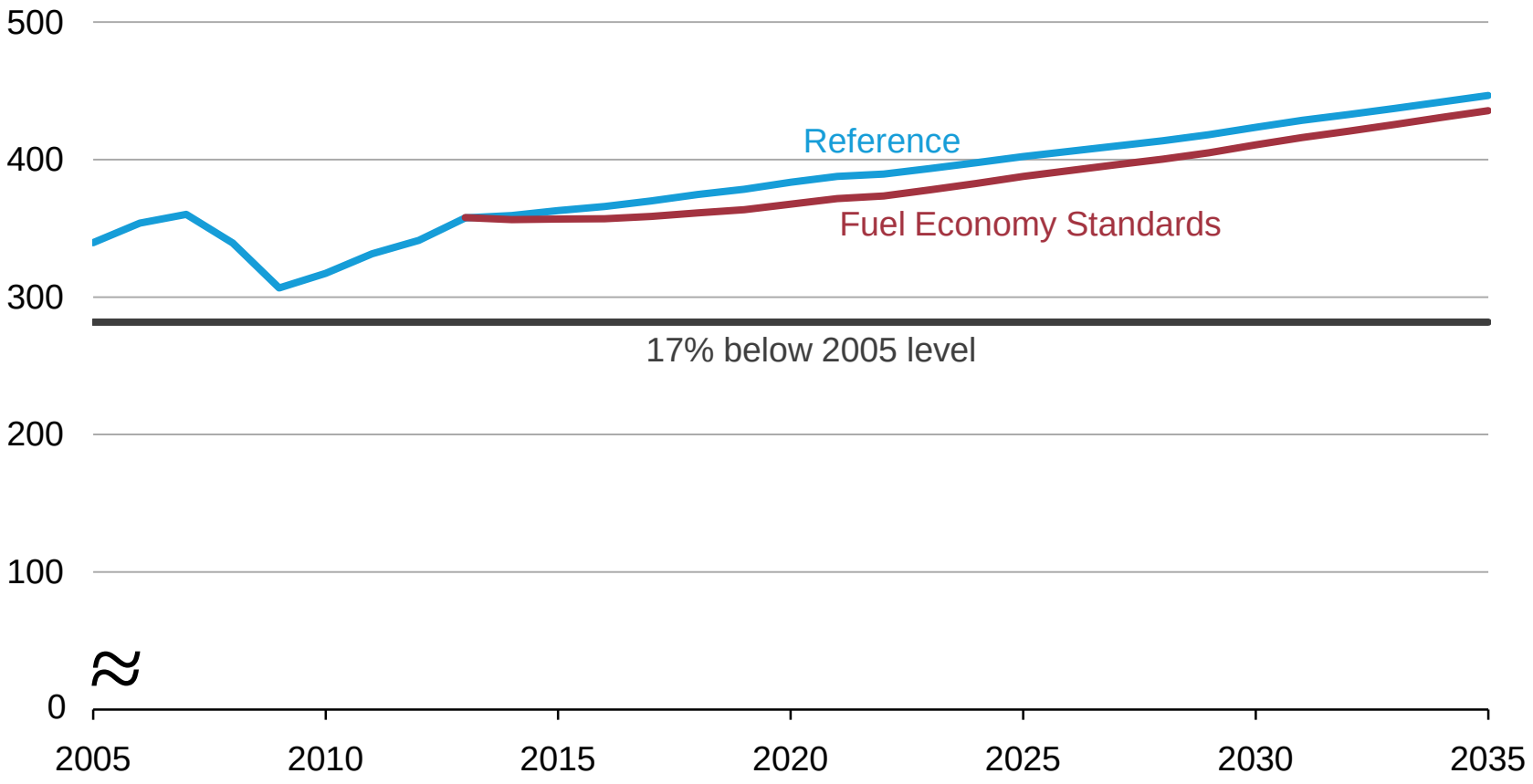
miles per gallon gasoline equivalent




*Source: EIA, Annual Energy Outlook 2011*

# Carbon dioxide emissions from heavy-duty vehicles in two cases, 2005-2035

U.S. heavy-duty vehicle carbon dioxide emissions
million metric tons

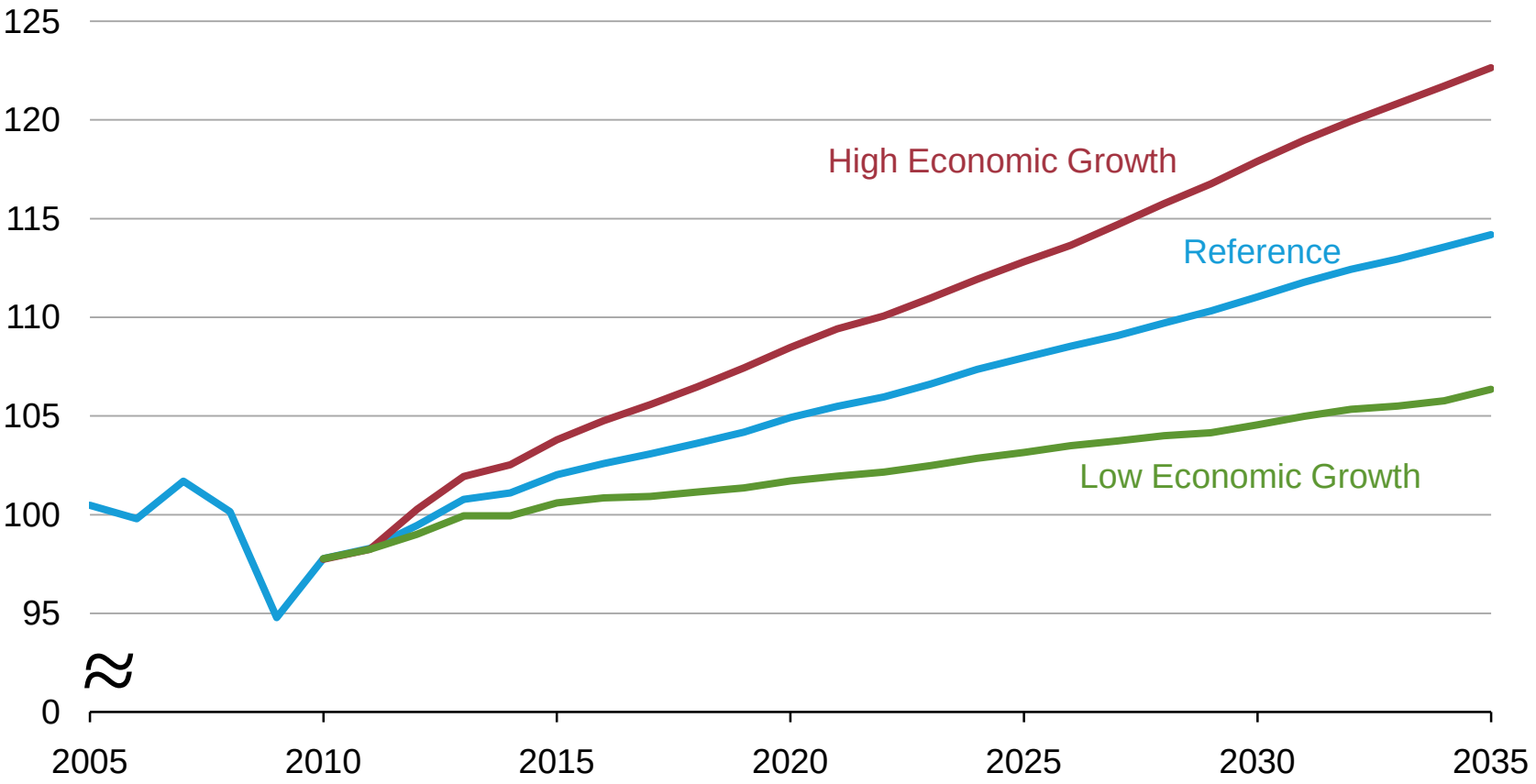



*Source: EIA, Annual Energy Outlook 2011*

# Economic growth affects energy use and emissions in all sectors

# Total energy consumption in three macroeconomic growth cases, 2005-2035

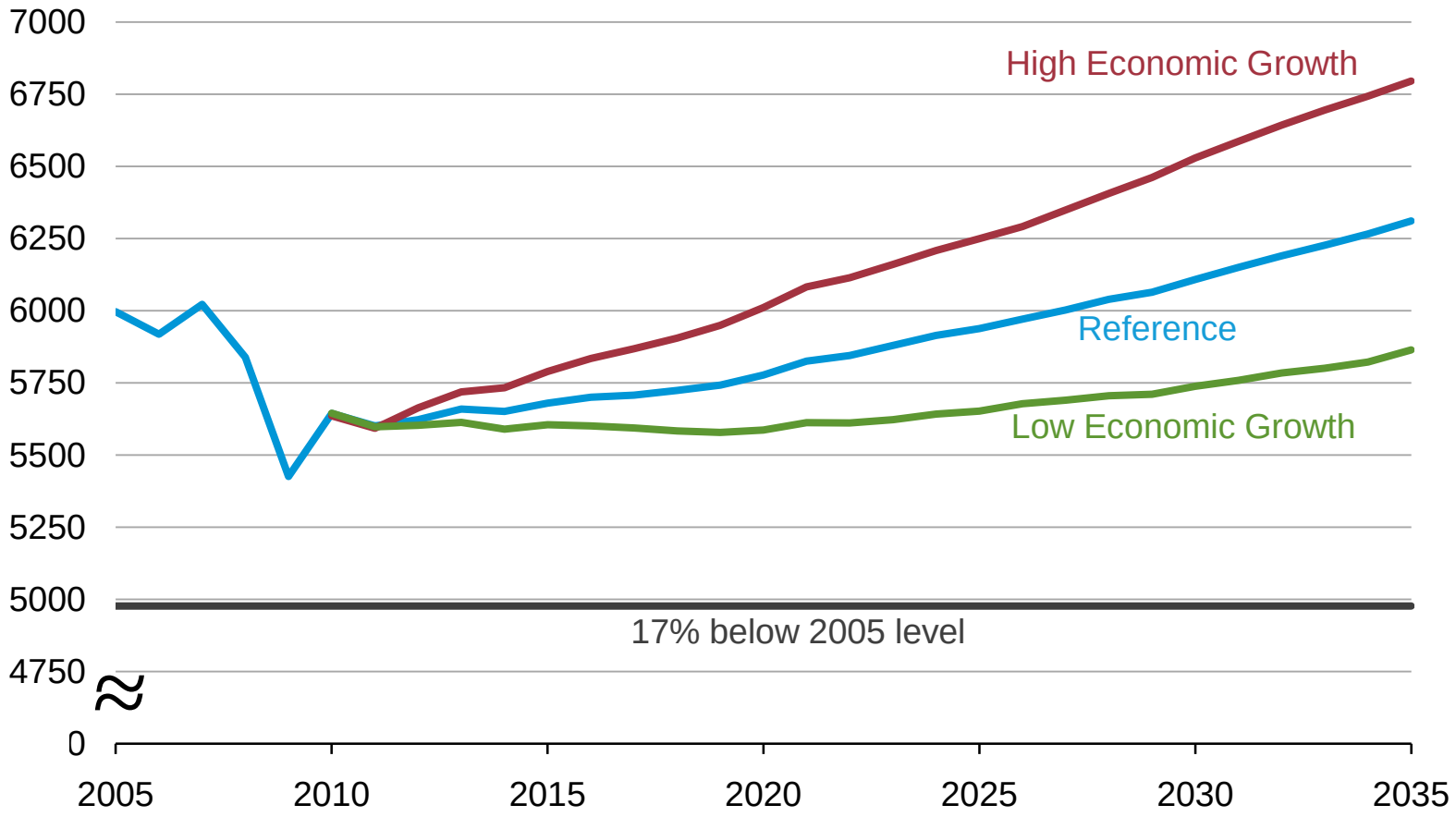
U.S. energy consumption
quadrillion Btu




*Source: EIA, Annual Energy Outlook 2011*

# Energy-related carbon dioxide emissions in three macroeconomic growth cases, 2005-2035

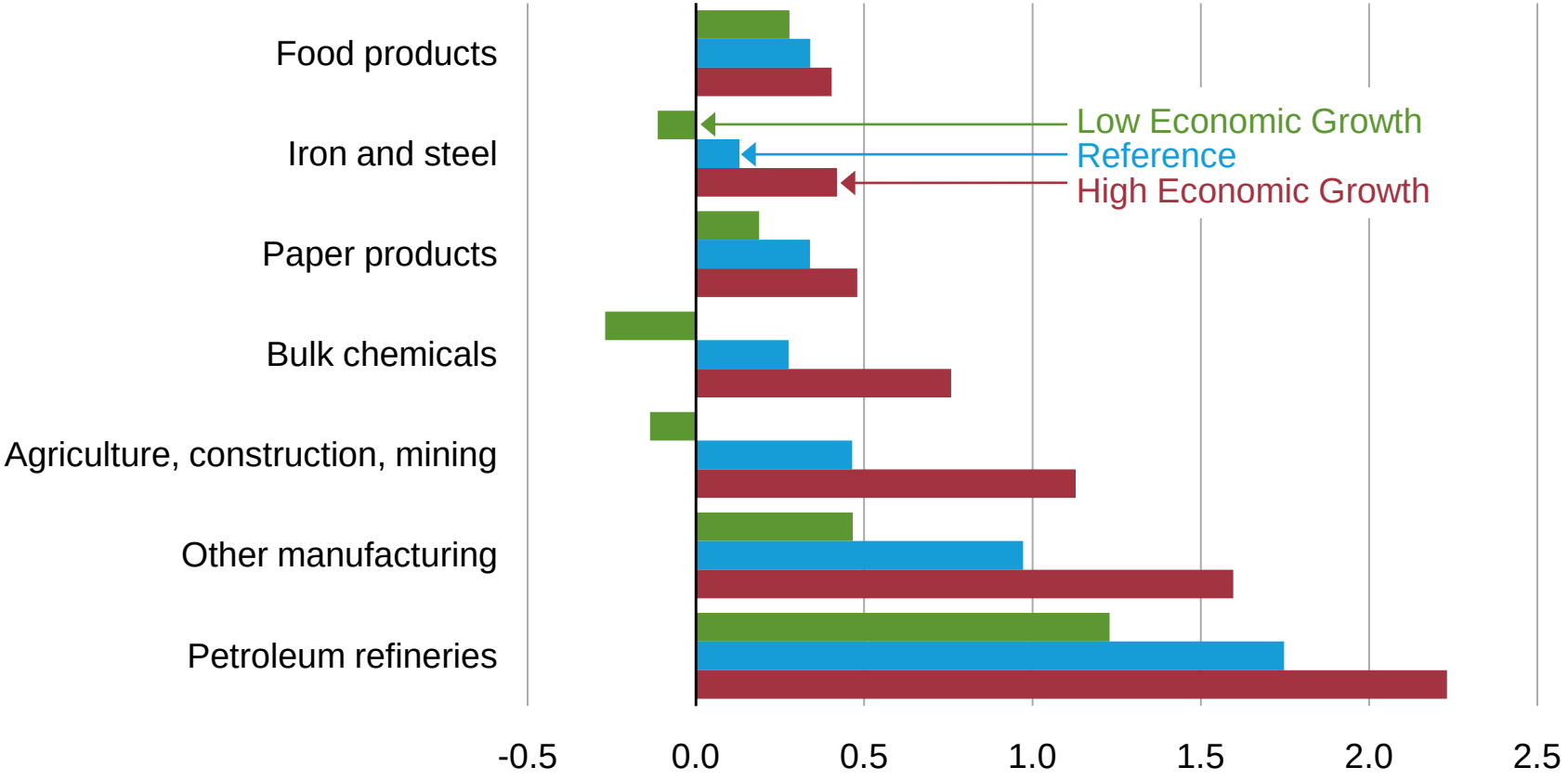
U.S. carbon dioxide emissions
million metric tons




*Source: EIA, Annual Energy Outlook 2011*

# Change in delivered energy consumption for industrial subsectors in three cases, 2009-2035

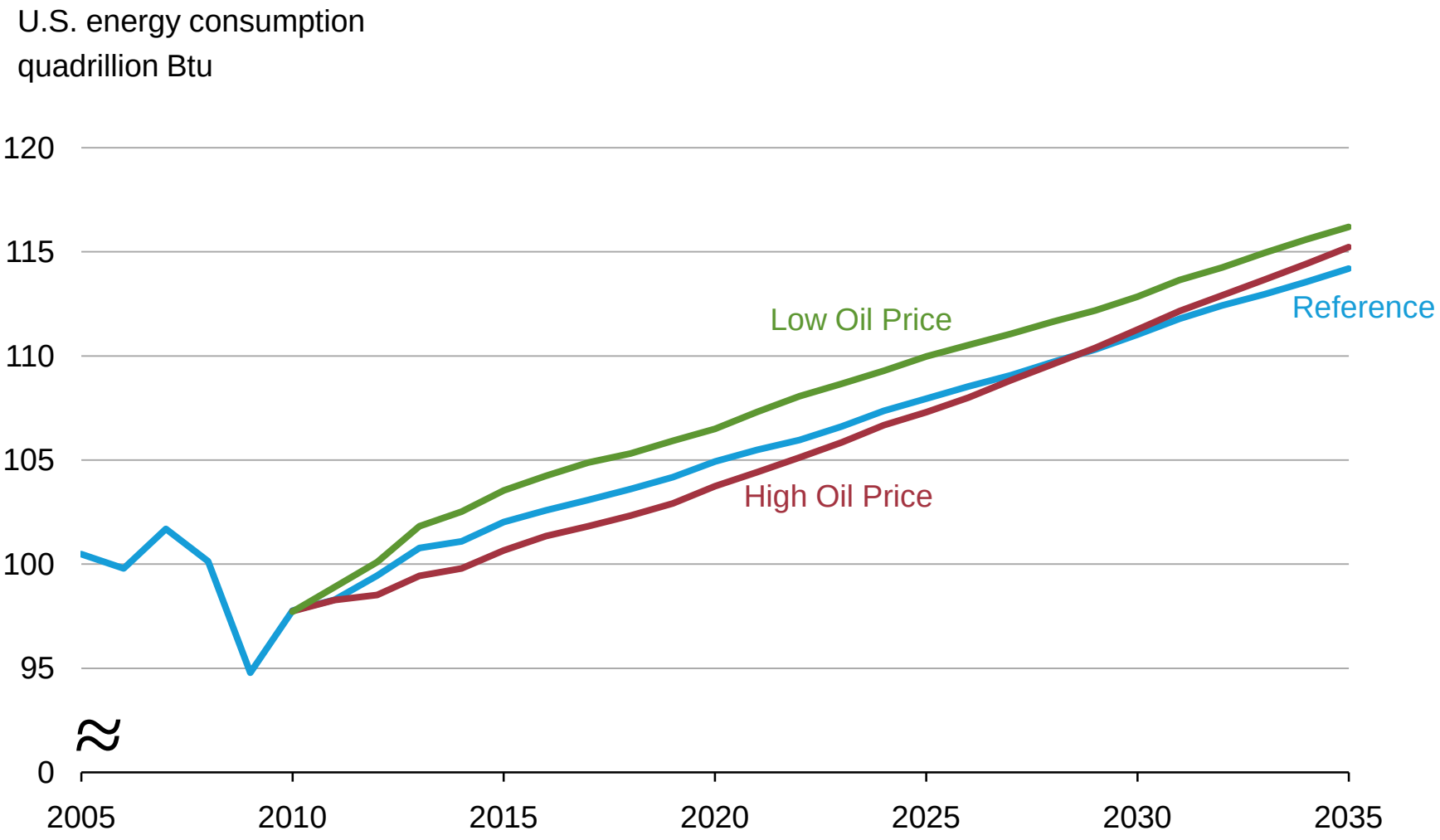
change in U.S. industrial energy use
quadrillion Btu




*Source: EIA, Annual Energy Outlook 2011*

# Oil price sensitivities

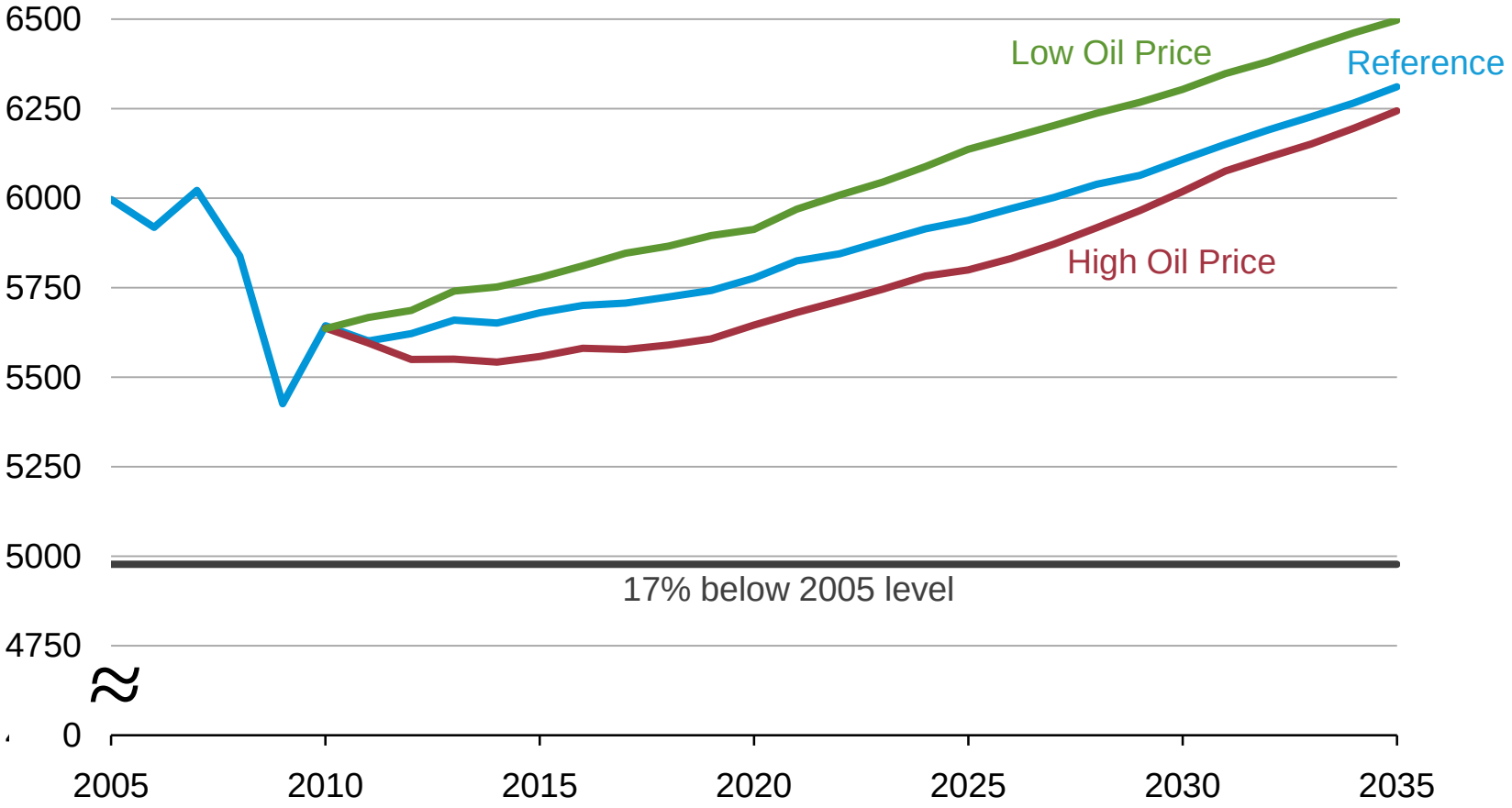
# Total energy consumption in three *AEO2011* oil price cases, 2005-2035




*Source: EIA, Annual Energy Outlook 2011*

# Energy-related carbon dioxide emissions in three *AEO2011* oil price cases, 2005-2035

U.S. carbon dioxide emissions
million metric tons




*Source: EIA, Annual Energy Outlook 2011*

# Summary

- Slow growth in Reference case energy-related $CO_2$ emissions, which remain below the 2005 level through 2026

- Significant potential for emissions below the Reference case
  - In the absence of GHG-directed policies, policies and fuel prices affecting the generation mix, and assumptions about economic growth and oil prices are key sources of uncertainty in projected emissions over the next decade
  - The projected pace of improvement in end-use efficiency becomes increasingly important over a 25-year horizon
  - Even without enactment of GHG-directed policies, U.S. emissions over the next decade could follow paths similar to those identified in analyses of cap-and-trade proposals considered in the last Congress
  - Continued emissions decline over a longer time horizon seems more difficult without GHG-directed policies