

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



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*Global Climate Change Research Seminar*

*Electric Power Research Institute*

*Howard Gruenspecht, Deputy Administrator*

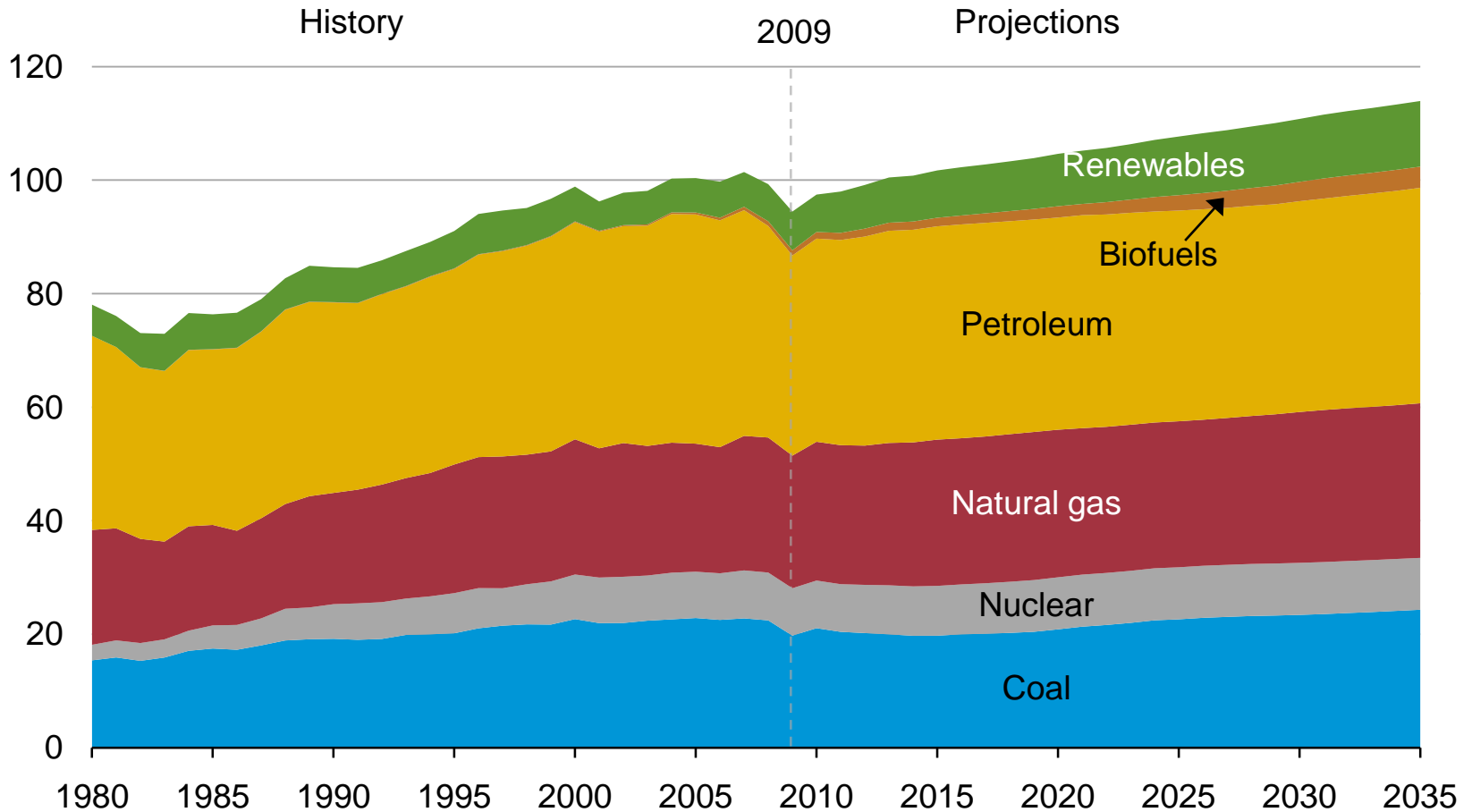
*May 25, 2011 | Washington, DC*

# Topics

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

# Primary energy use by fuel, 1980-2035

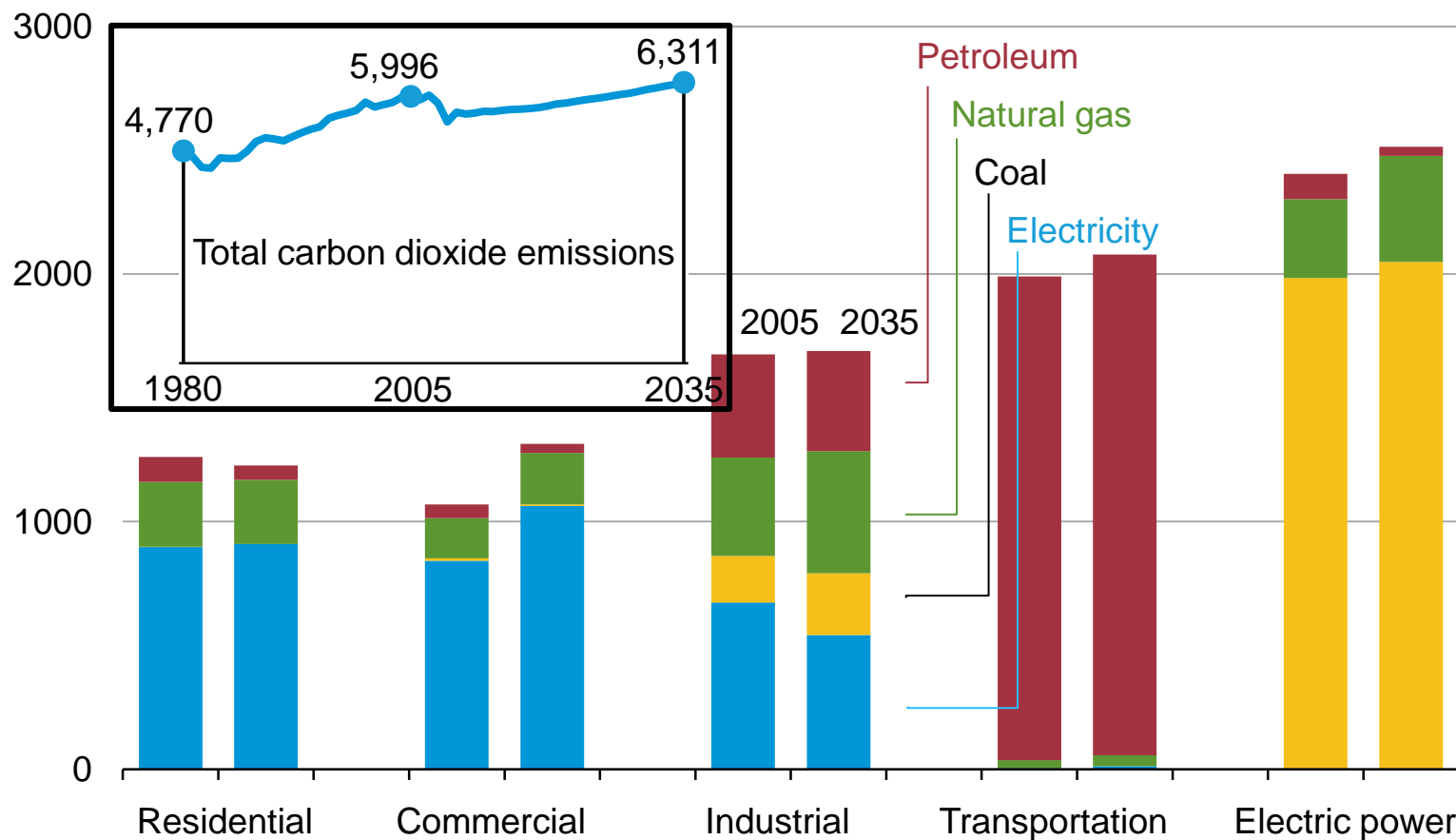
U.S. energy use  
quadrillion Btu



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

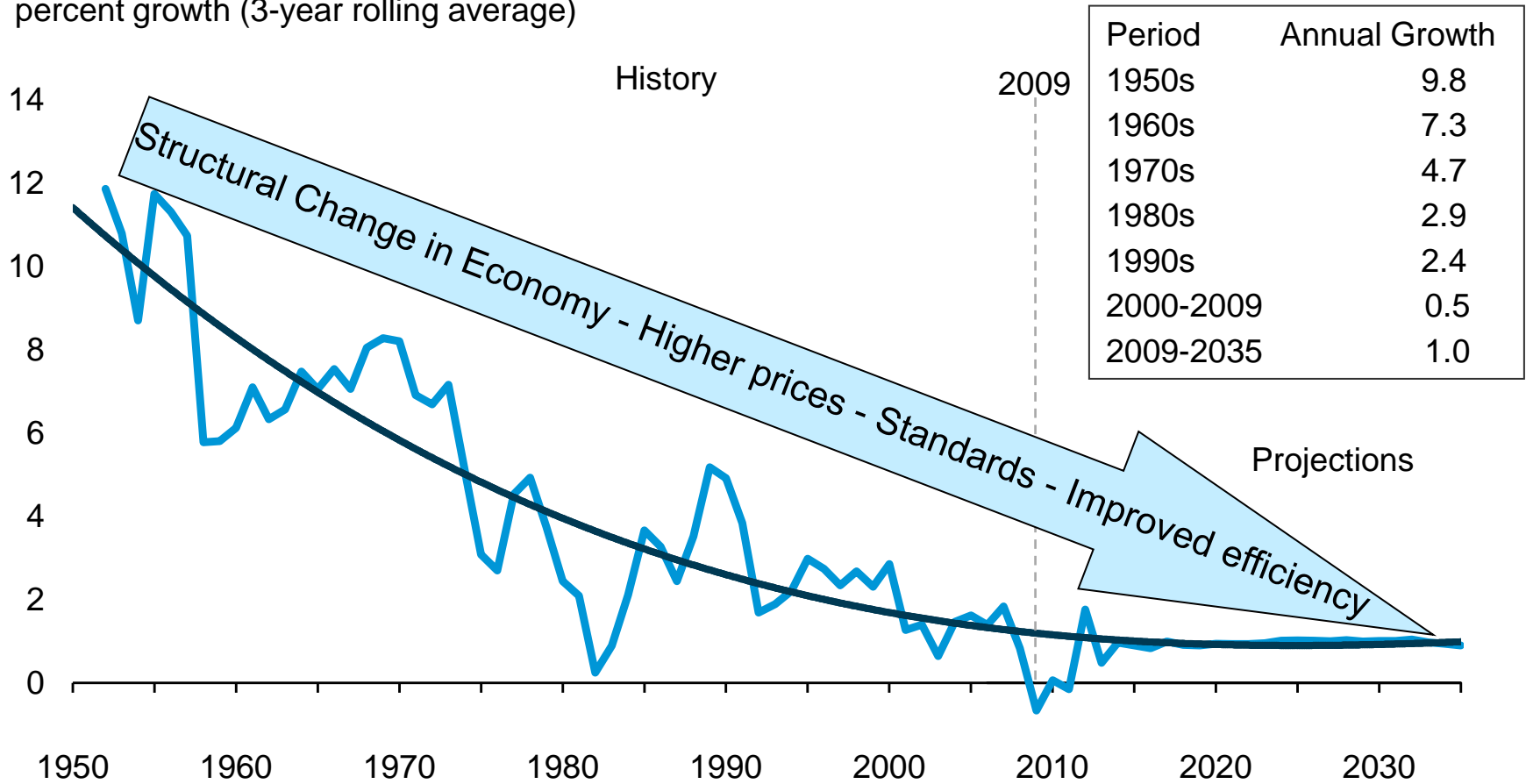


Source: EIA, Annual Energy Outlook 2011

# Electricity

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

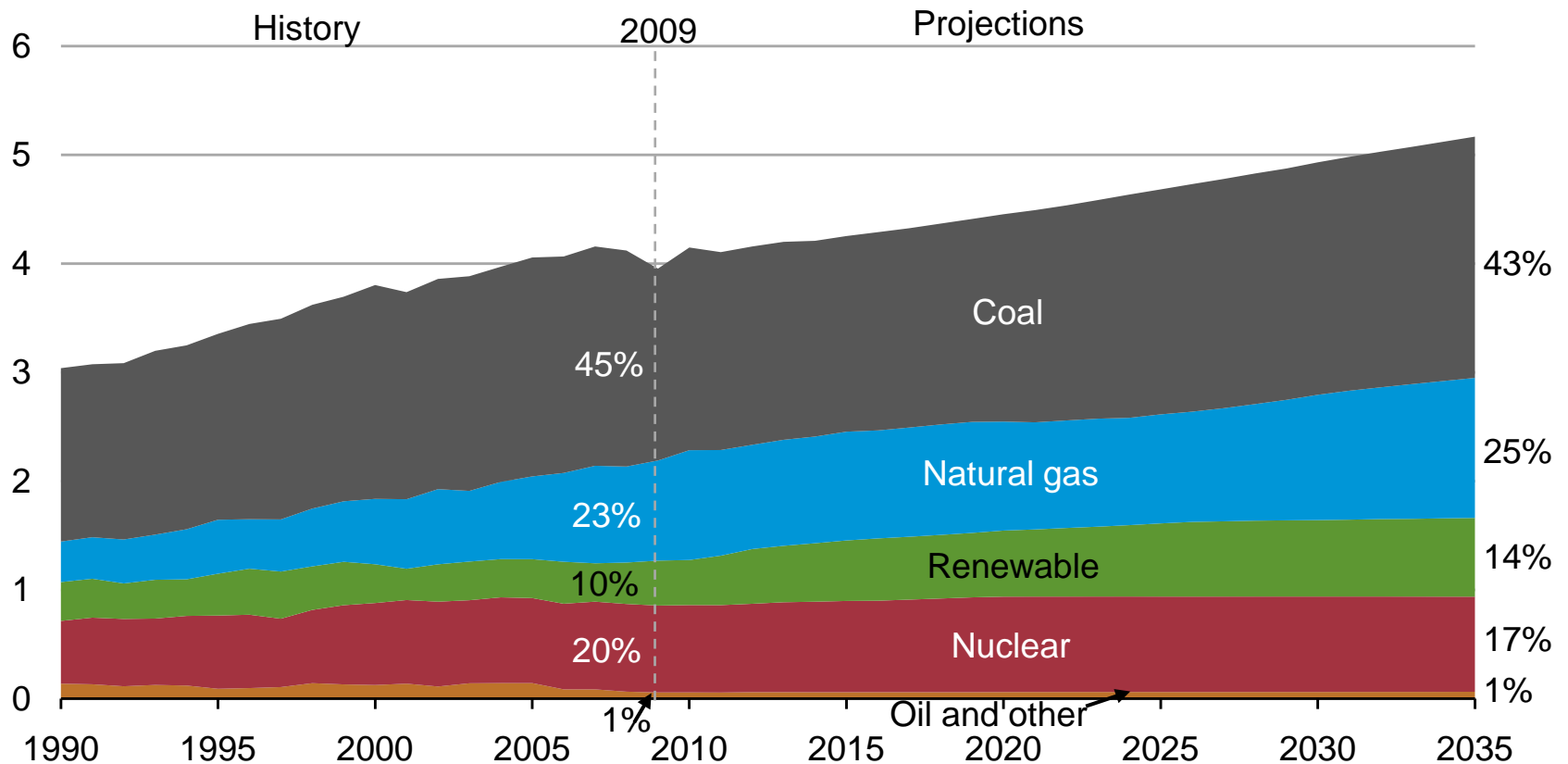
percent growth (3-year rolling average)



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

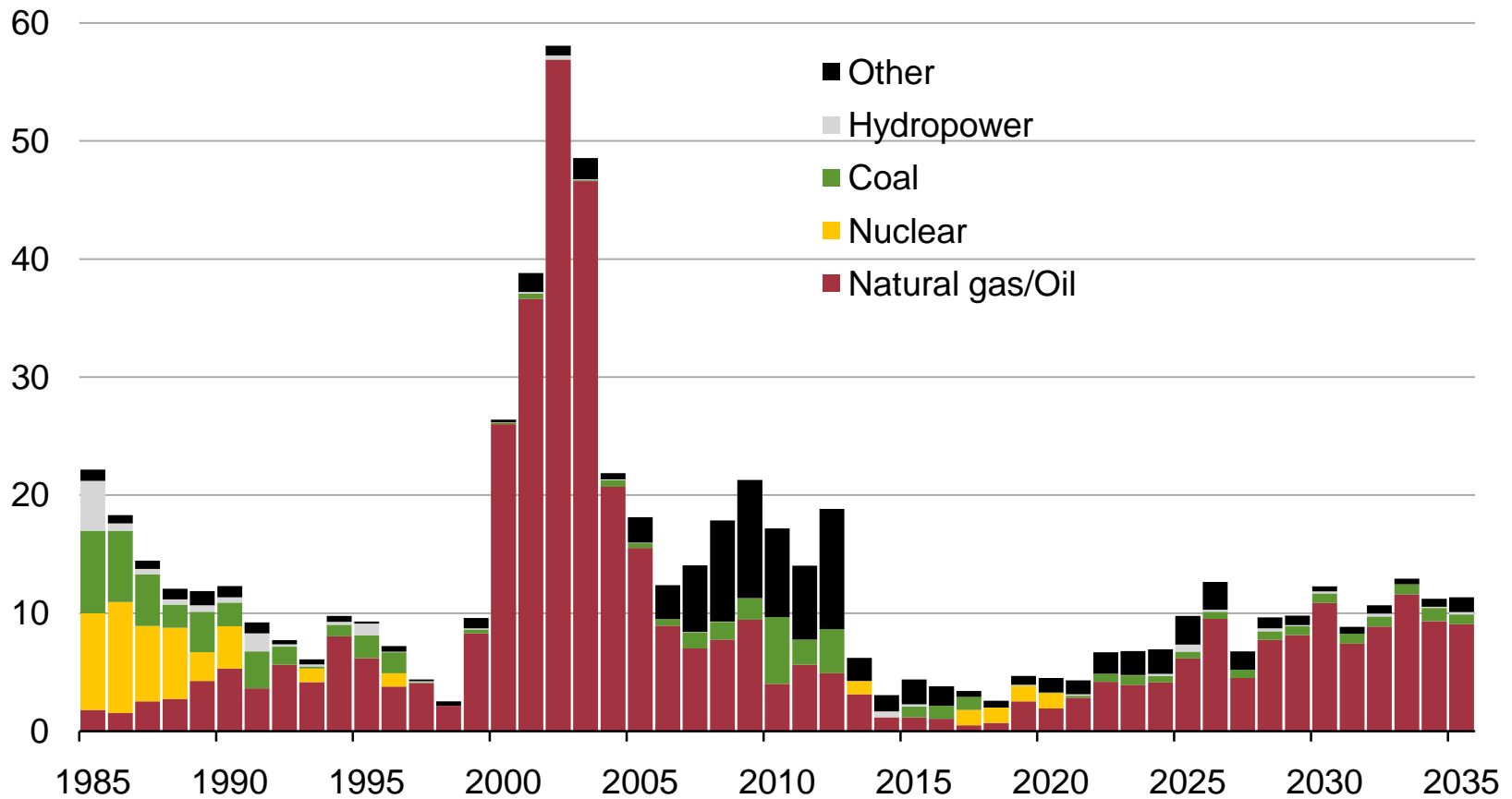
trillion kilowatthours per year



Source: EIA, Annual Energy Outlook 2011

# Additions to electricity generation capacity, 1985-2035

U.S. electricity generation capacity additions  
gigawatts

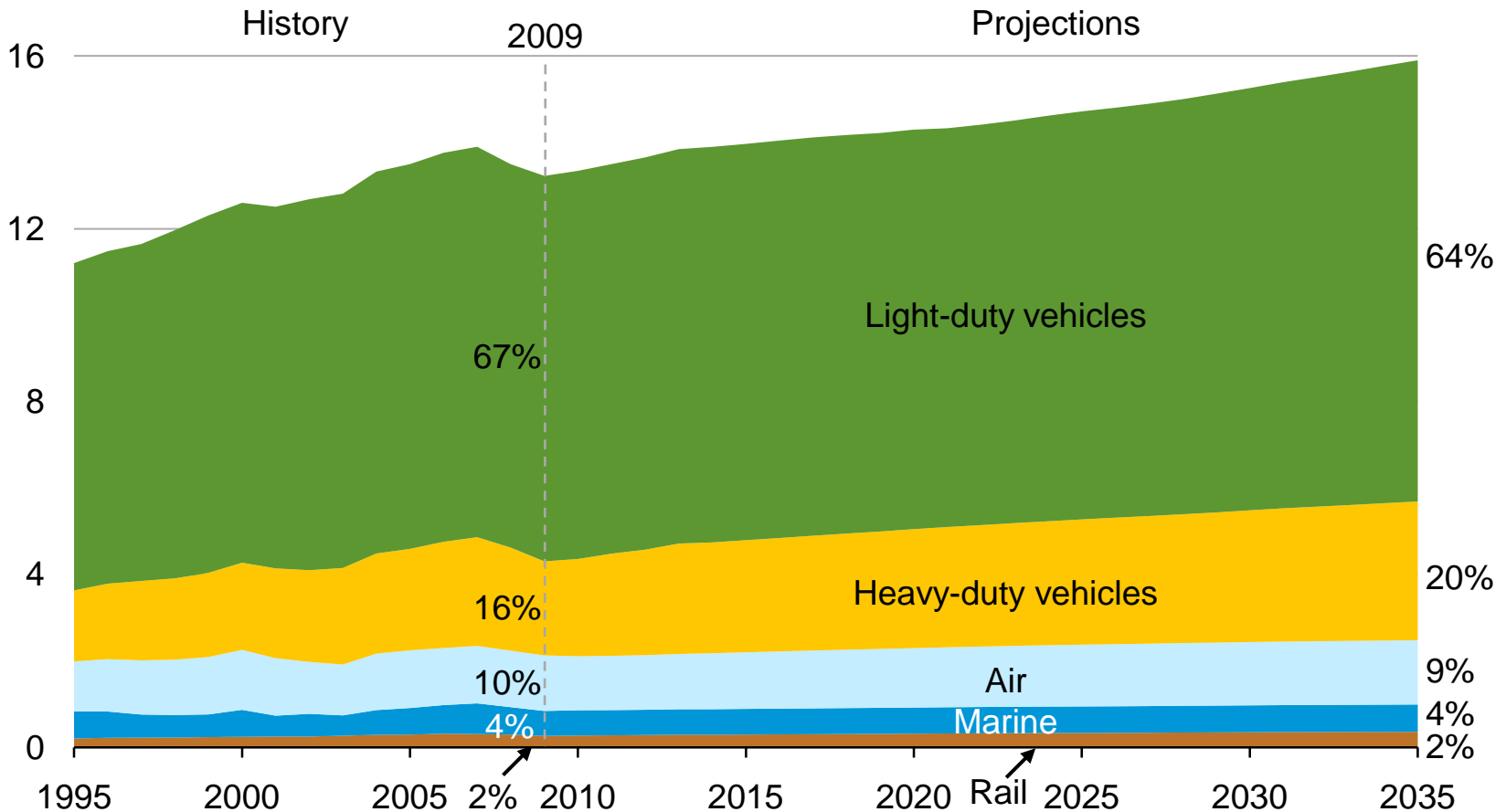


Source: EIA, Annual Energy Outlook 2011

# Transportation

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

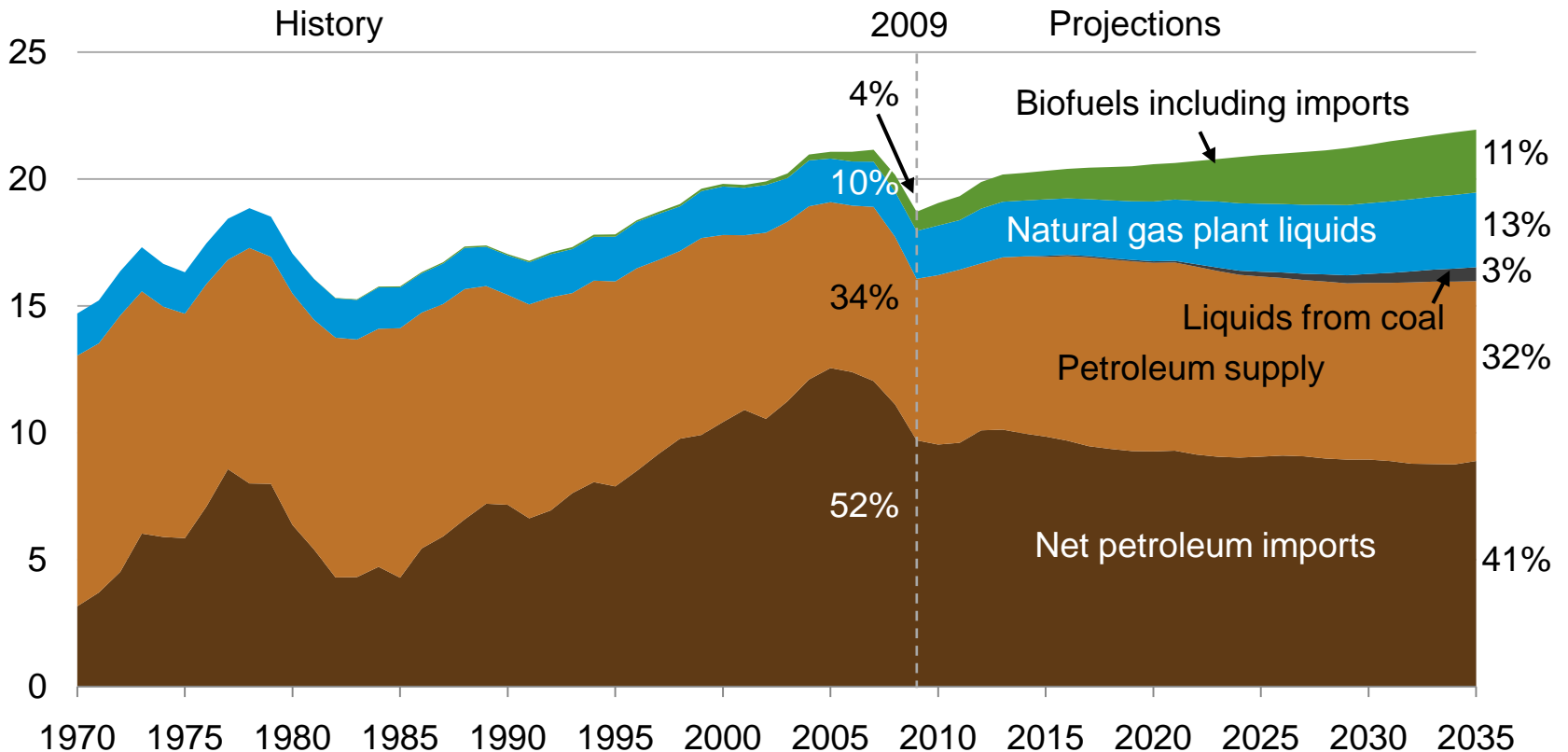
U.S. transportation energy consumption  
million barrels per day oil equivalent



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

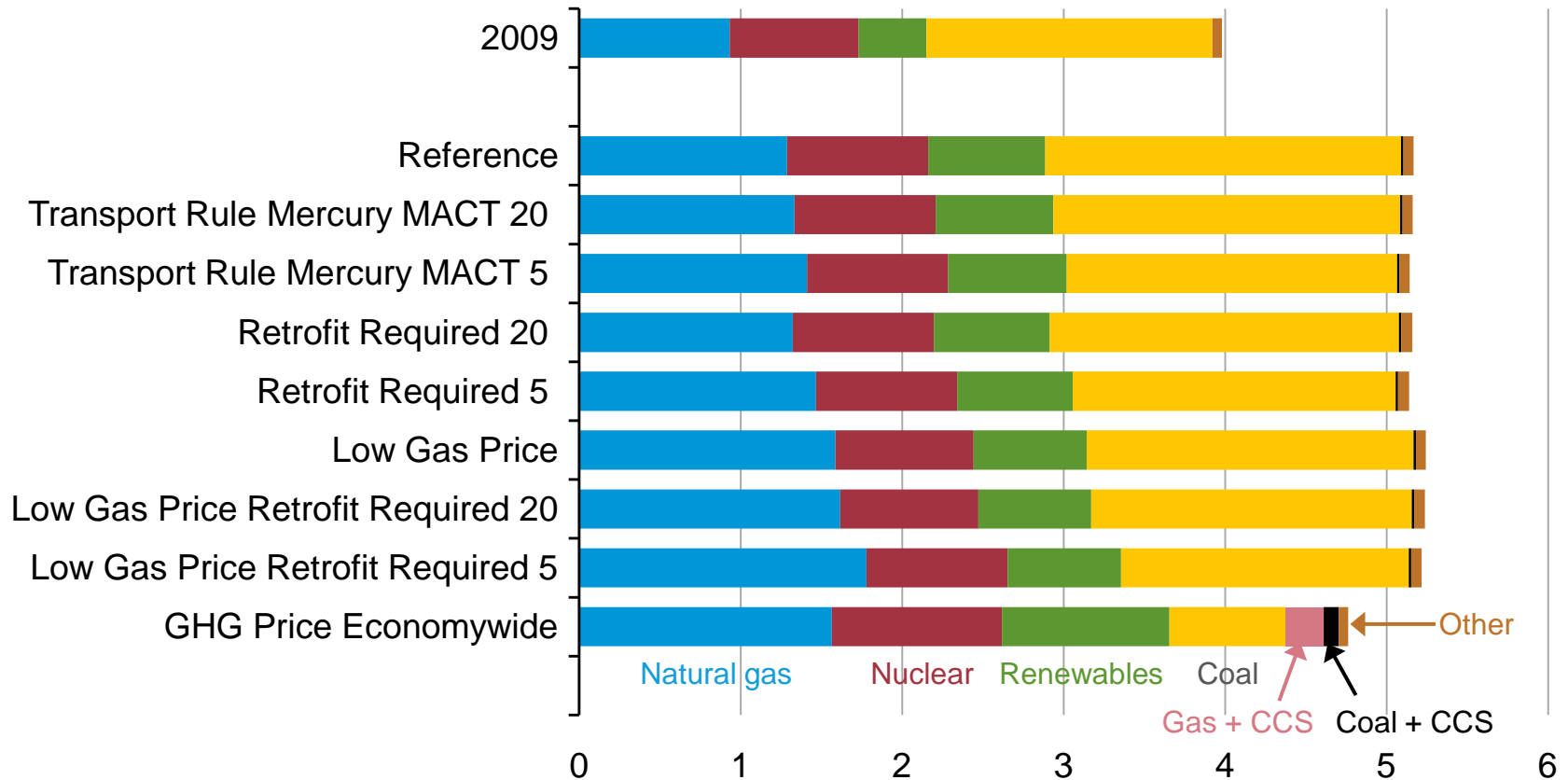
## *AEO 2011* includes 57 sensitivity cases, many of which have significant implications for projected carbon dioxide emissions

- 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

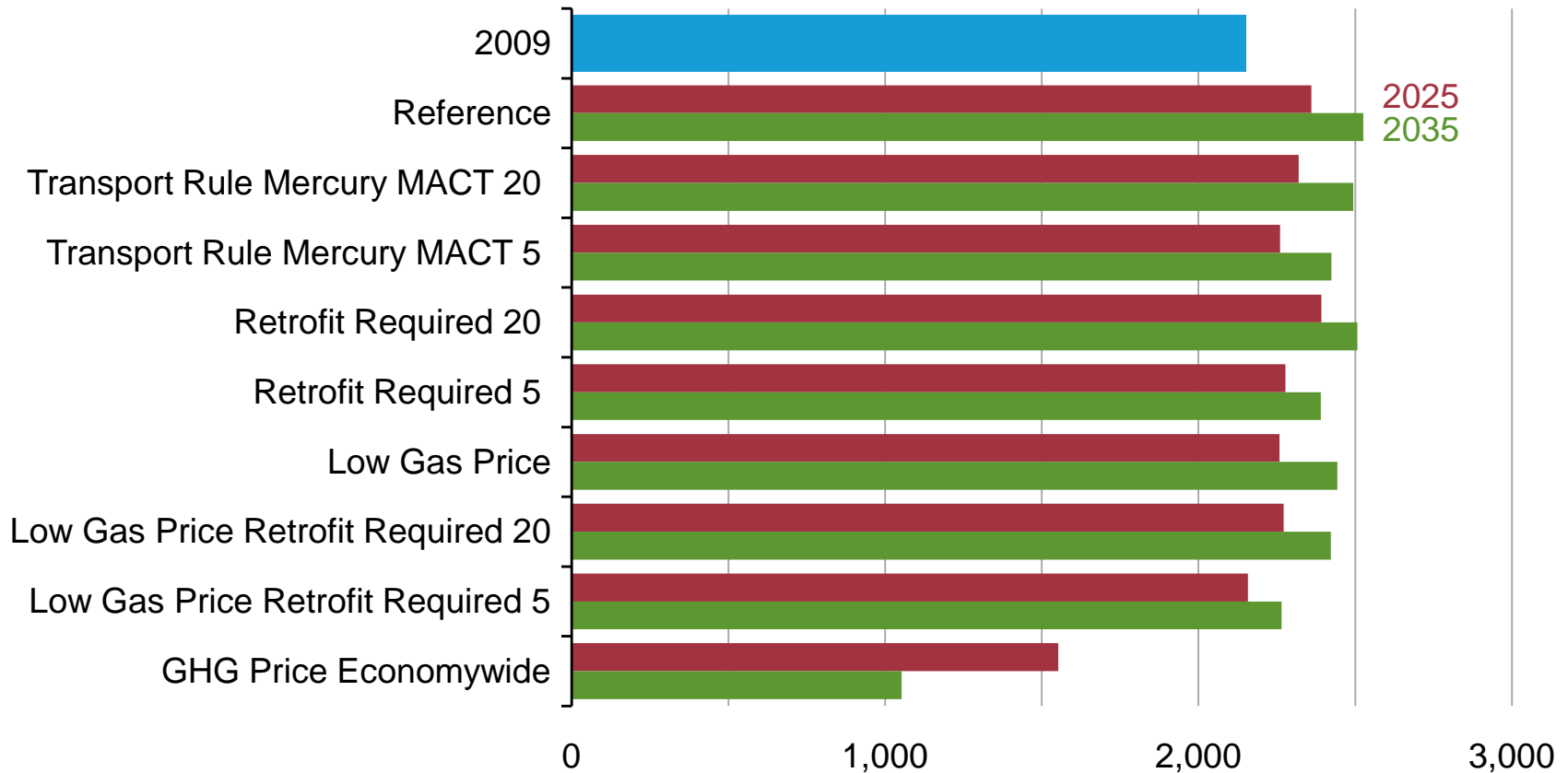
U.S. electricity generation  
trillion kilowatthours



Source: EIA, Annual Energy Outlook 2011

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

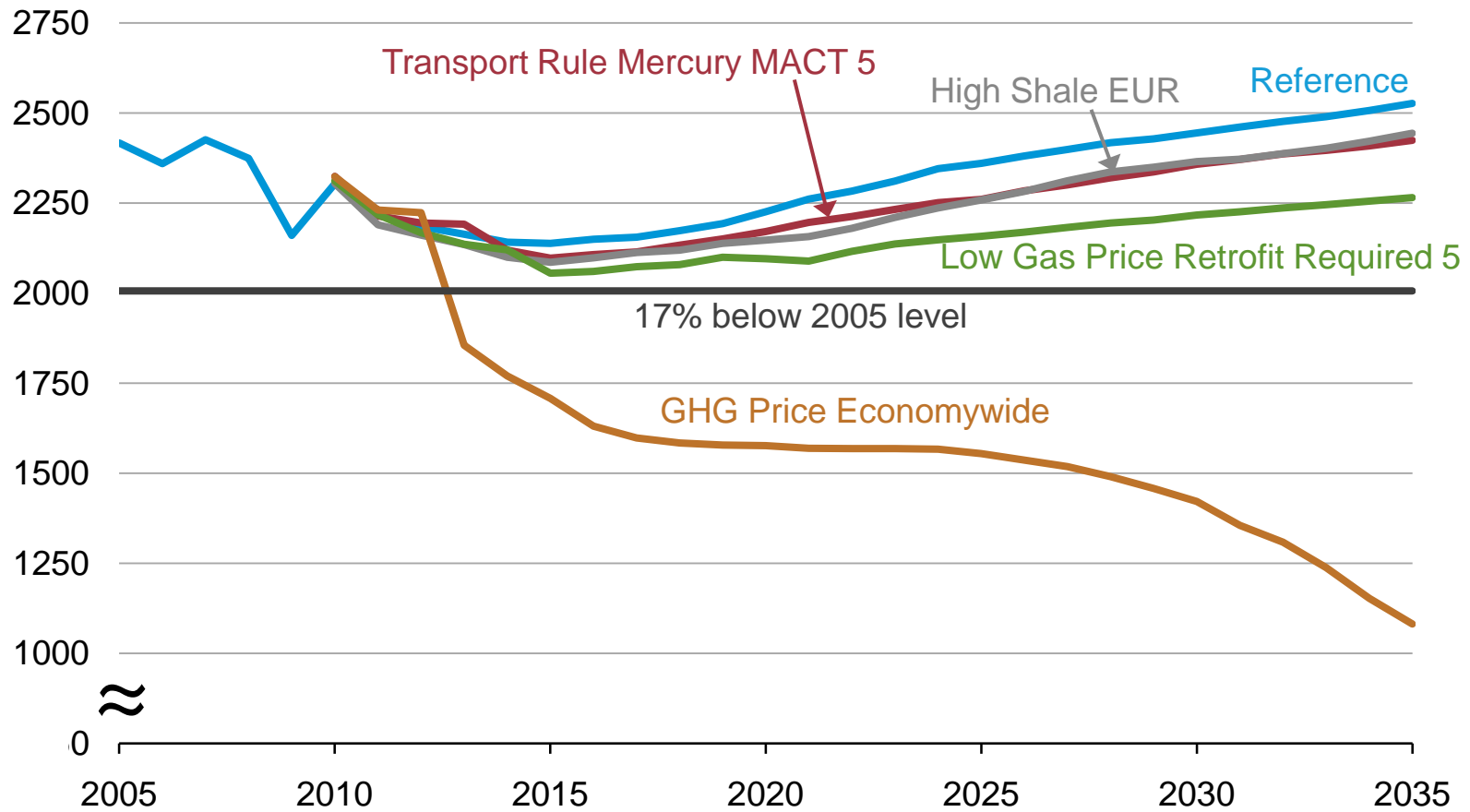
U.S. electric power sector carbon dioxide emissions  
million metric tons



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

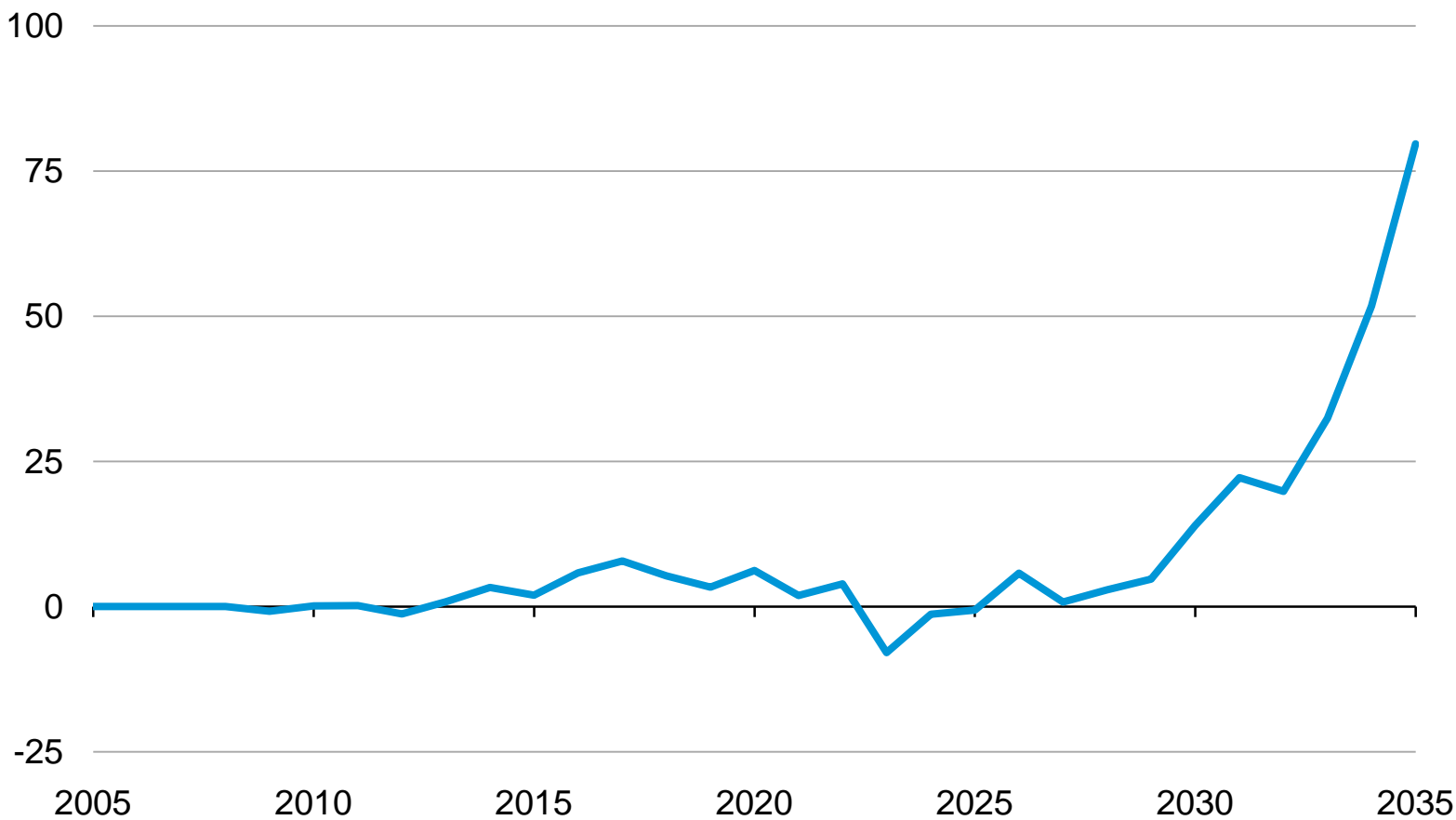


Source: EIA, Annual Energy Outlook 2011

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

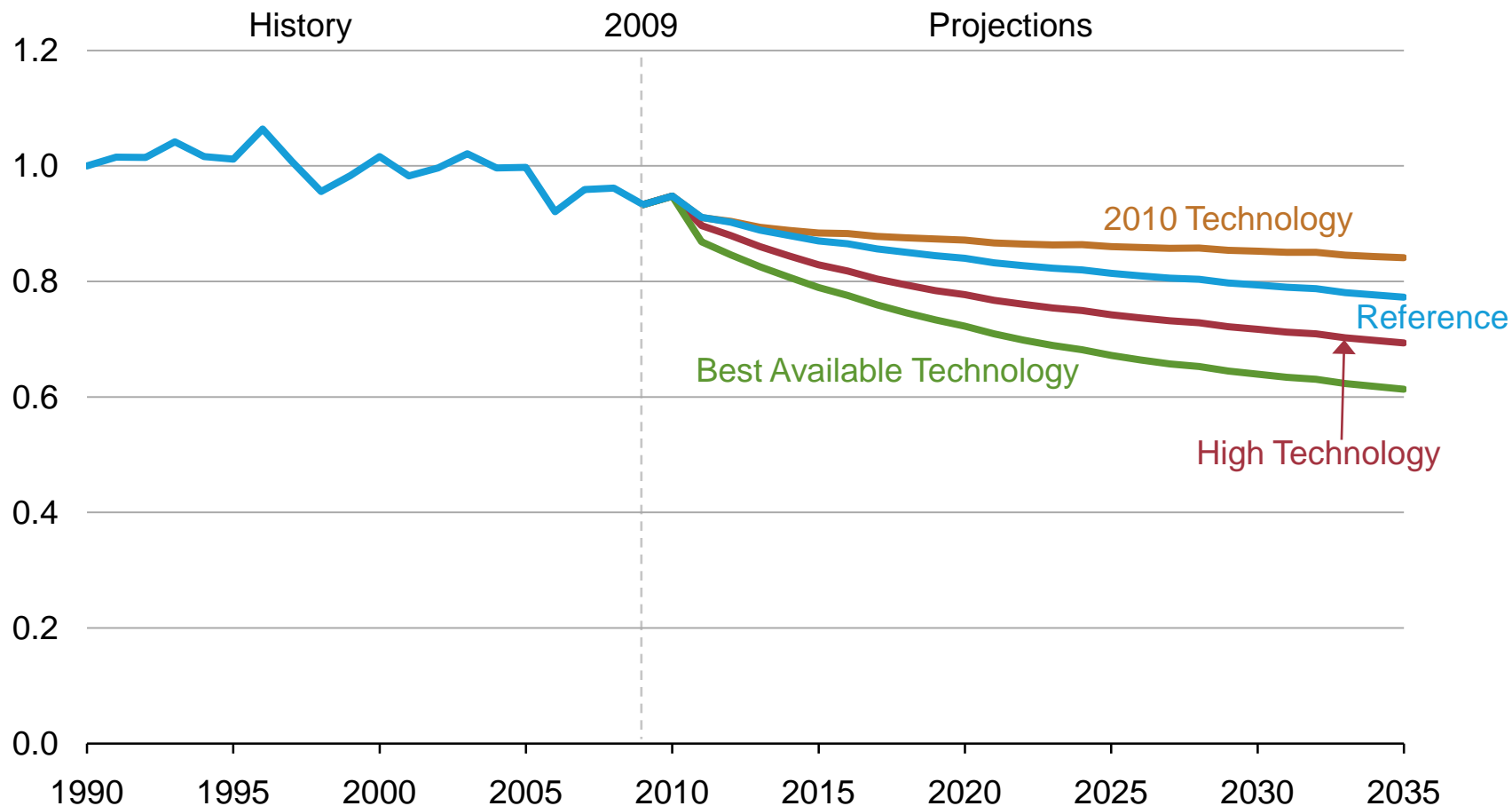


Source: EIA, Annual Energy Outlook 2010

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

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

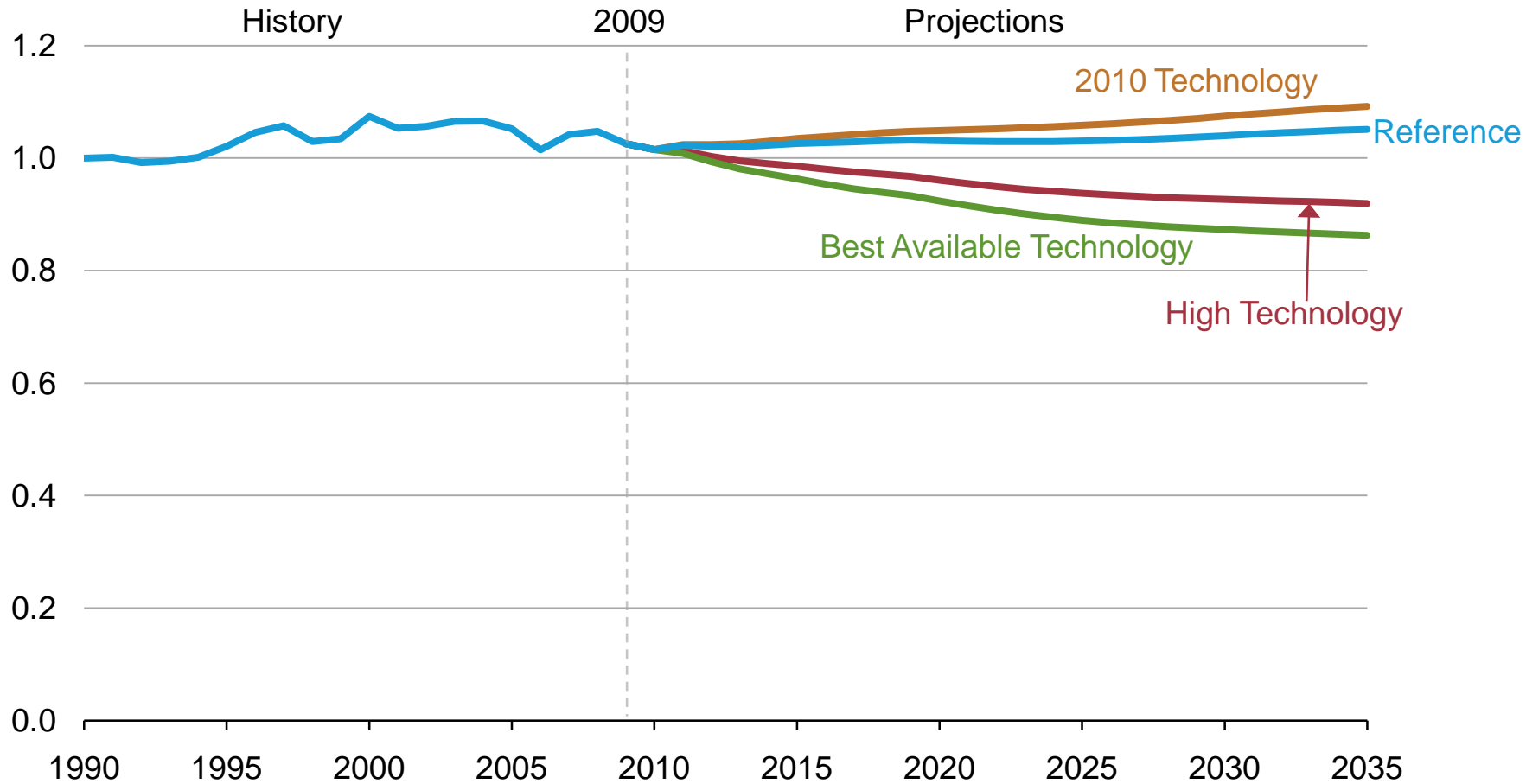
U.S. residential energy use per capita index, 1990=1



Source: EIA, Annual Energy Outlook 2011

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

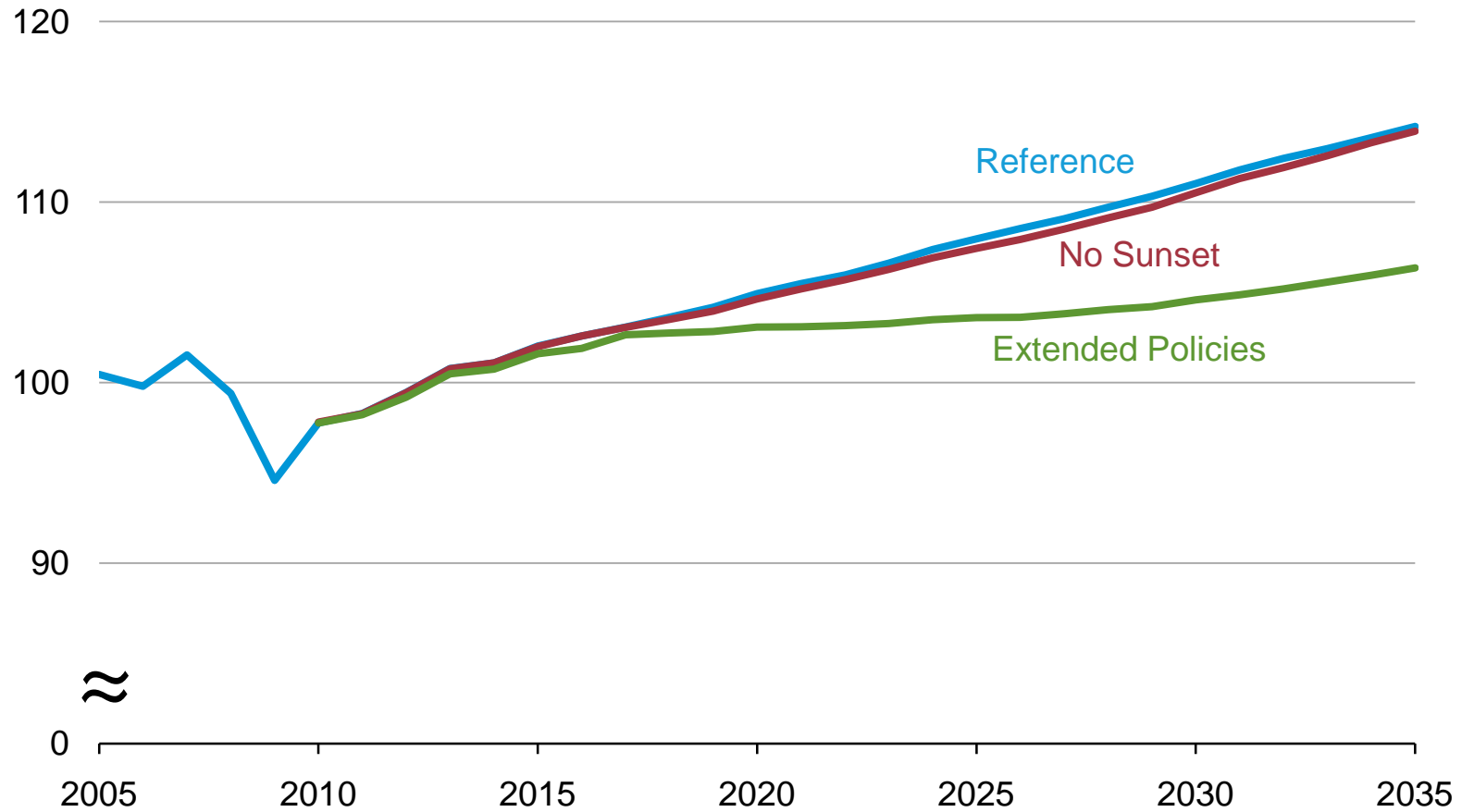
U.S. commercial energy use per capita index, 1990=1



Source: EIA, Annual Energy Outlook 2011

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

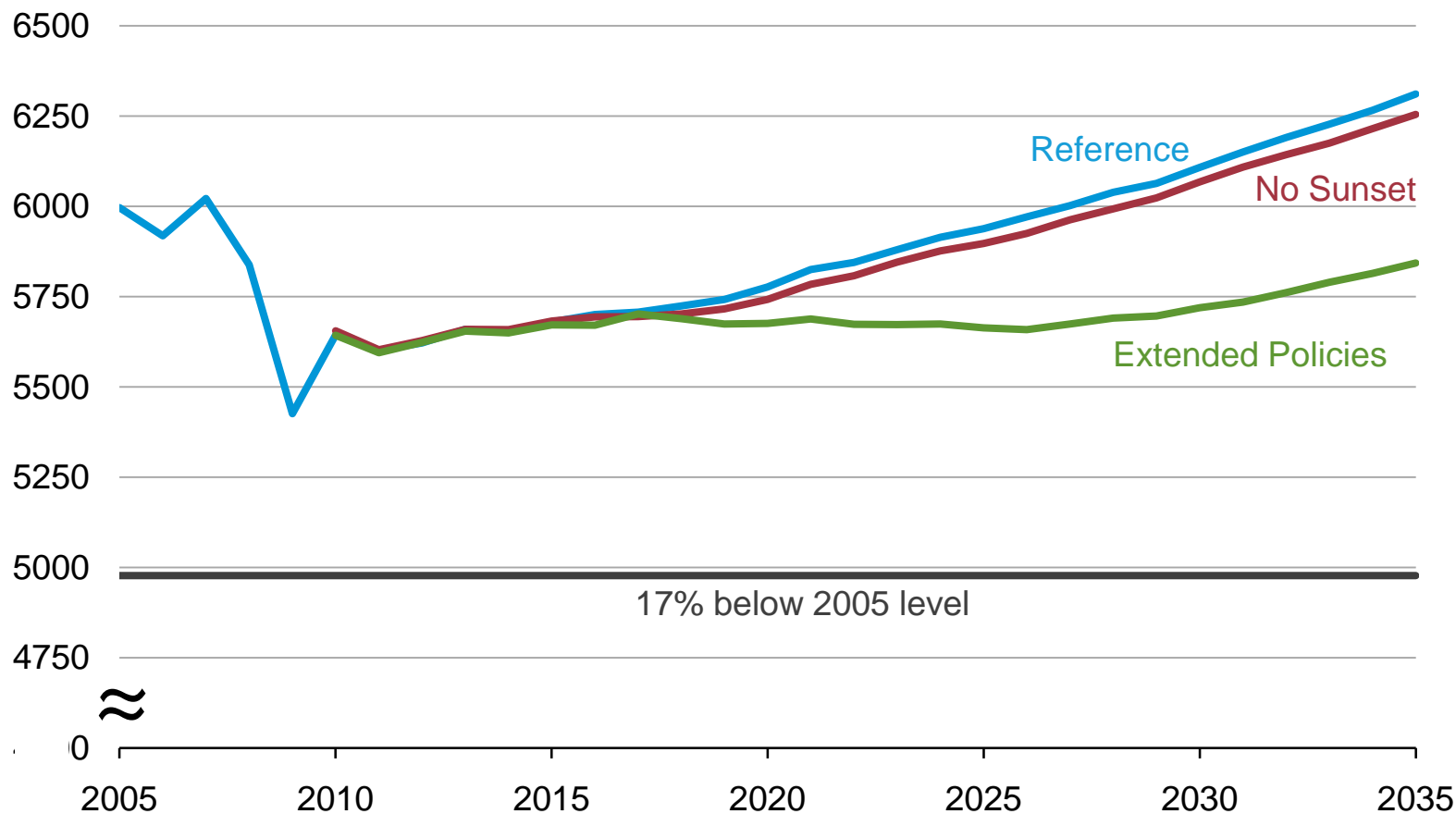
U.S. energy consumption  
quadrillion Btu



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

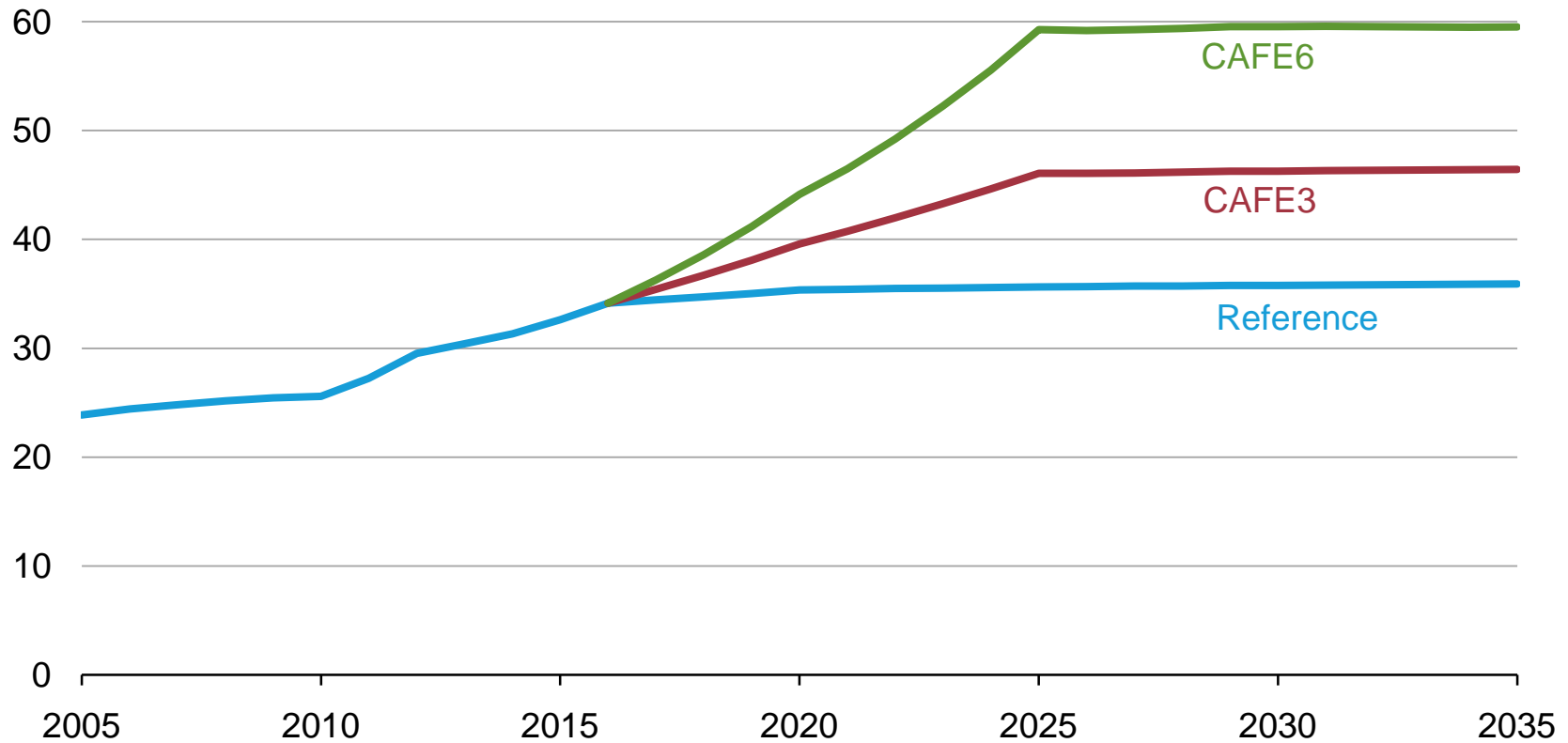


Source: EIA, Annual Energy Outlook 2011

# Fuel Economy Sensitivities

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

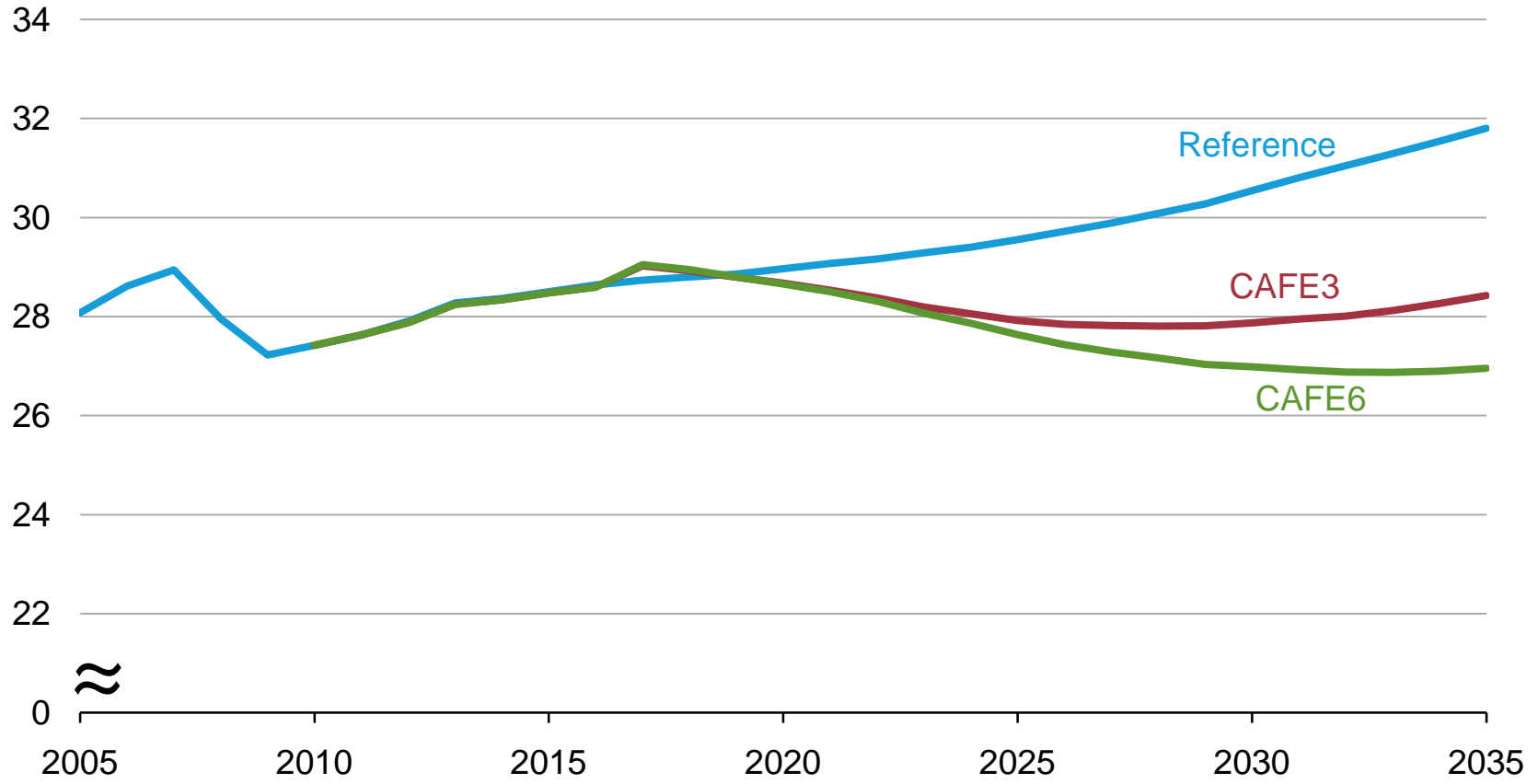
new light-duty vehicle fuel economy  
miles per gallon



Source: EIA, Annual Energy Outlook 2011

# Total transportation energy consumption

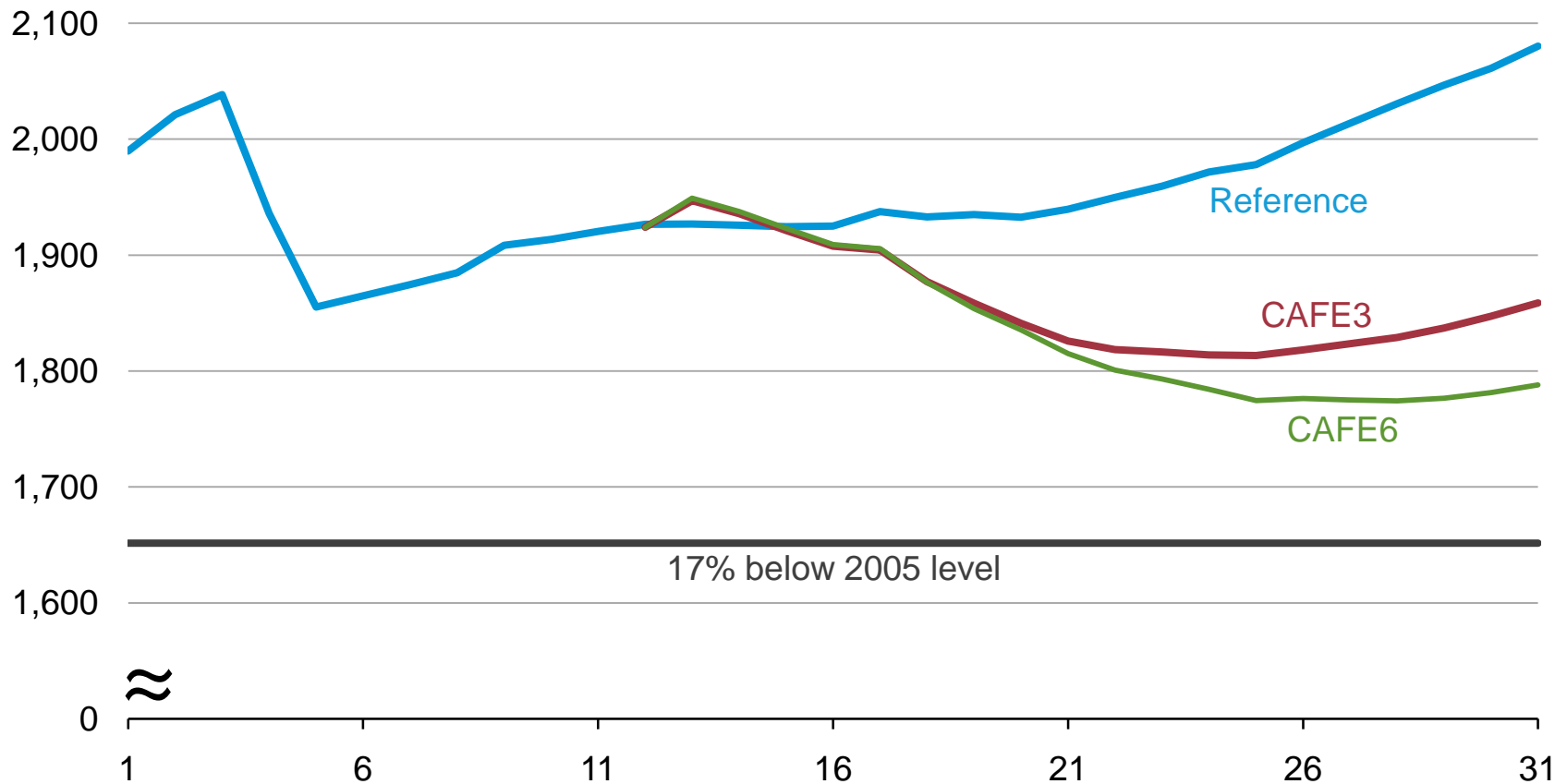
U.S. energy consumption  
quadrillion Btu



Source: EIA, Annual Energy Outlook 2011

# Total transportation carbon dioxide emissions

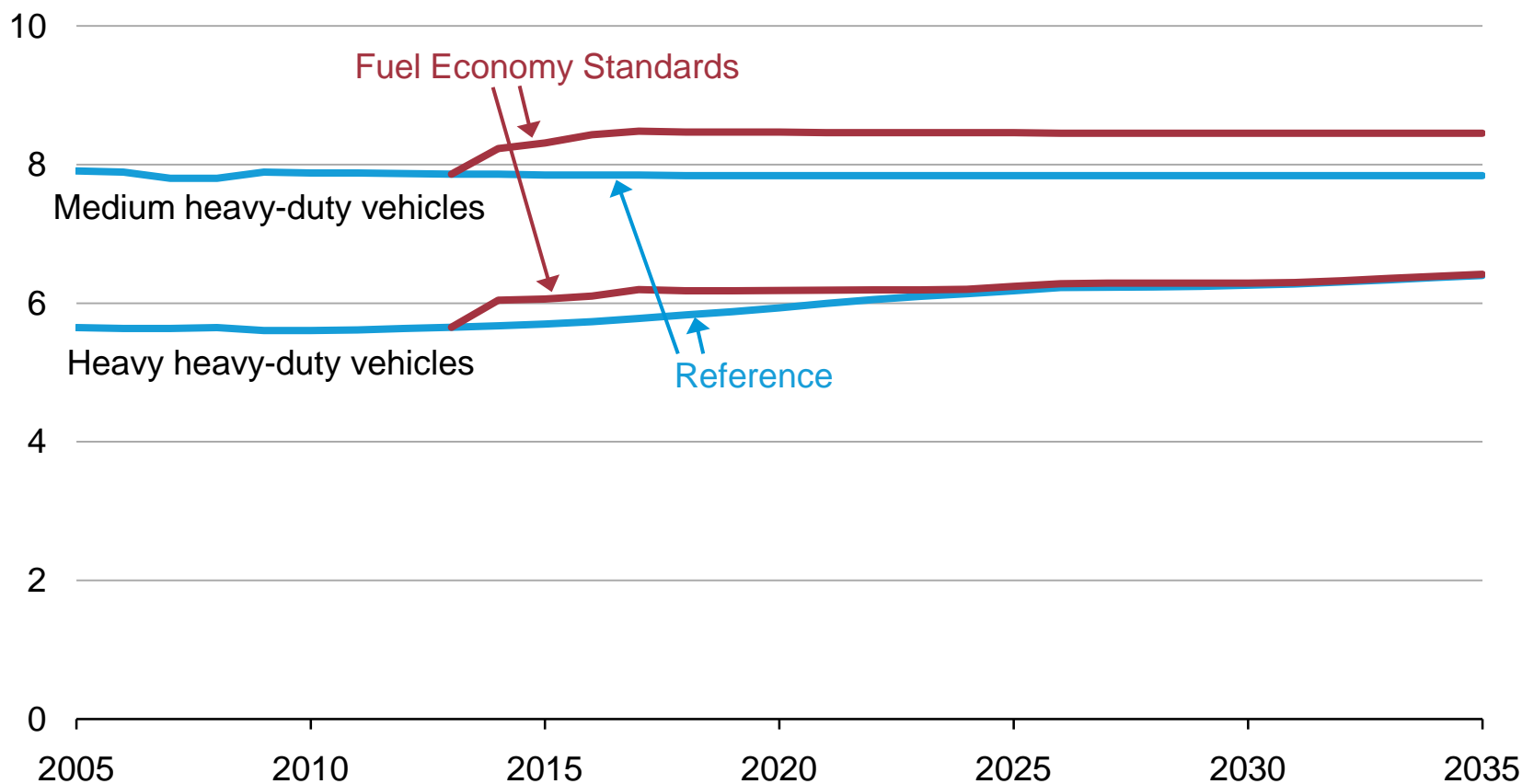
U.S. transportation carbon dioxide emissions  
million metric tons



Source: EIA, Annual Energy Outlook 2011

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

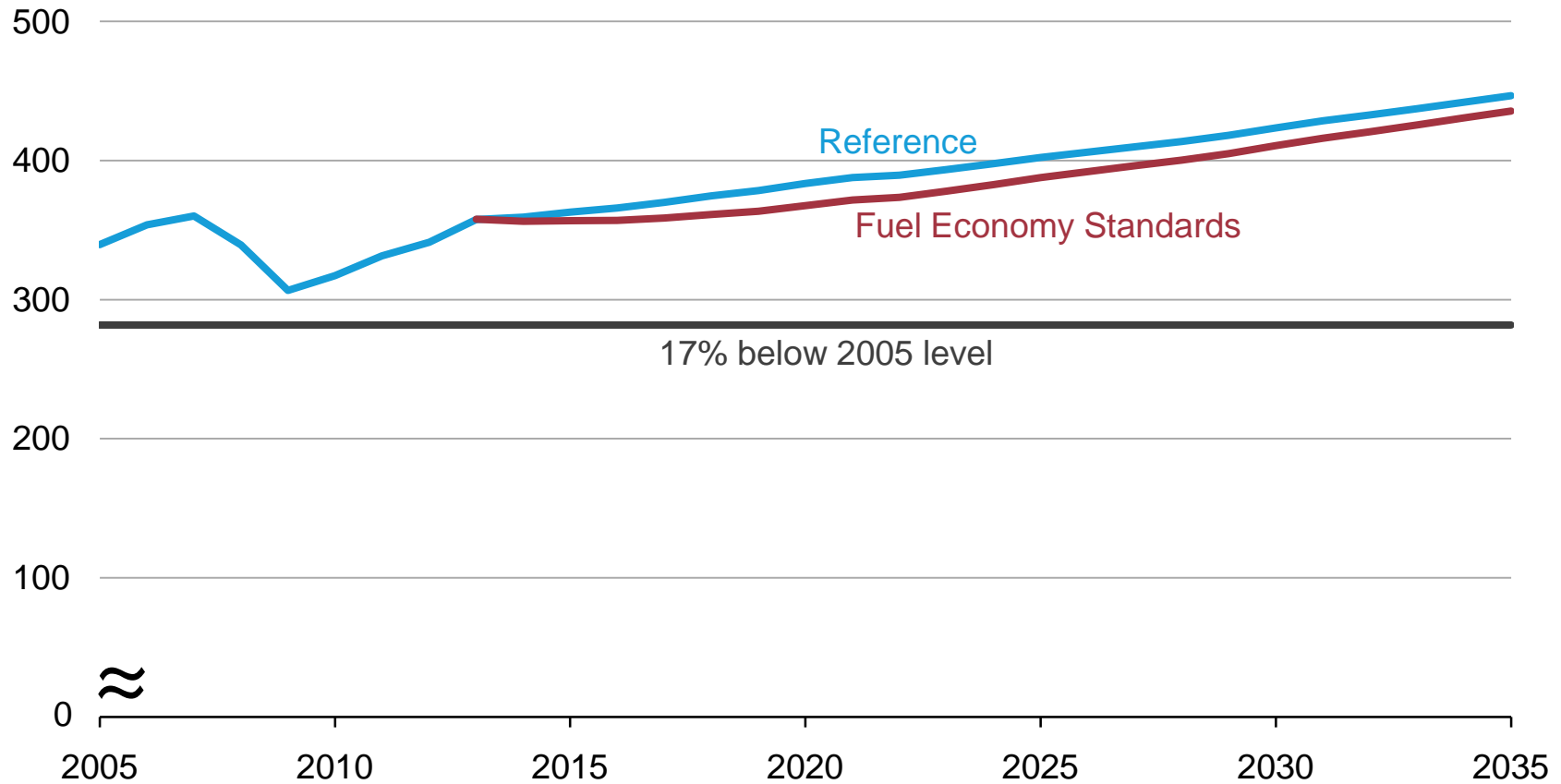
new vehicle fuel economy  
miles per gallon gasoline equivalent



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

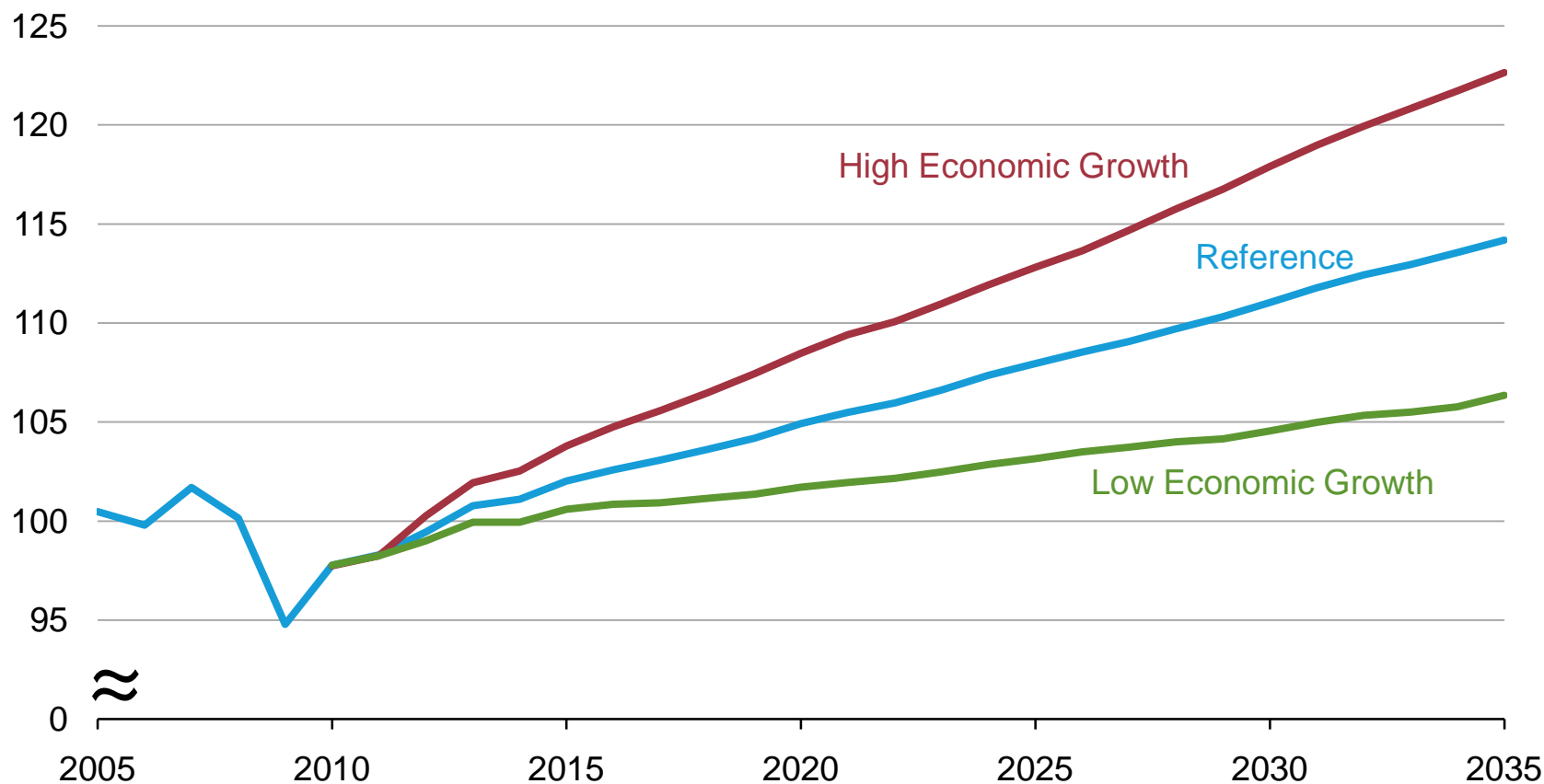


Source: EIA, Annual Energy Outlook 2011

# Economic growth affects energy use and emissions in all sectors

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

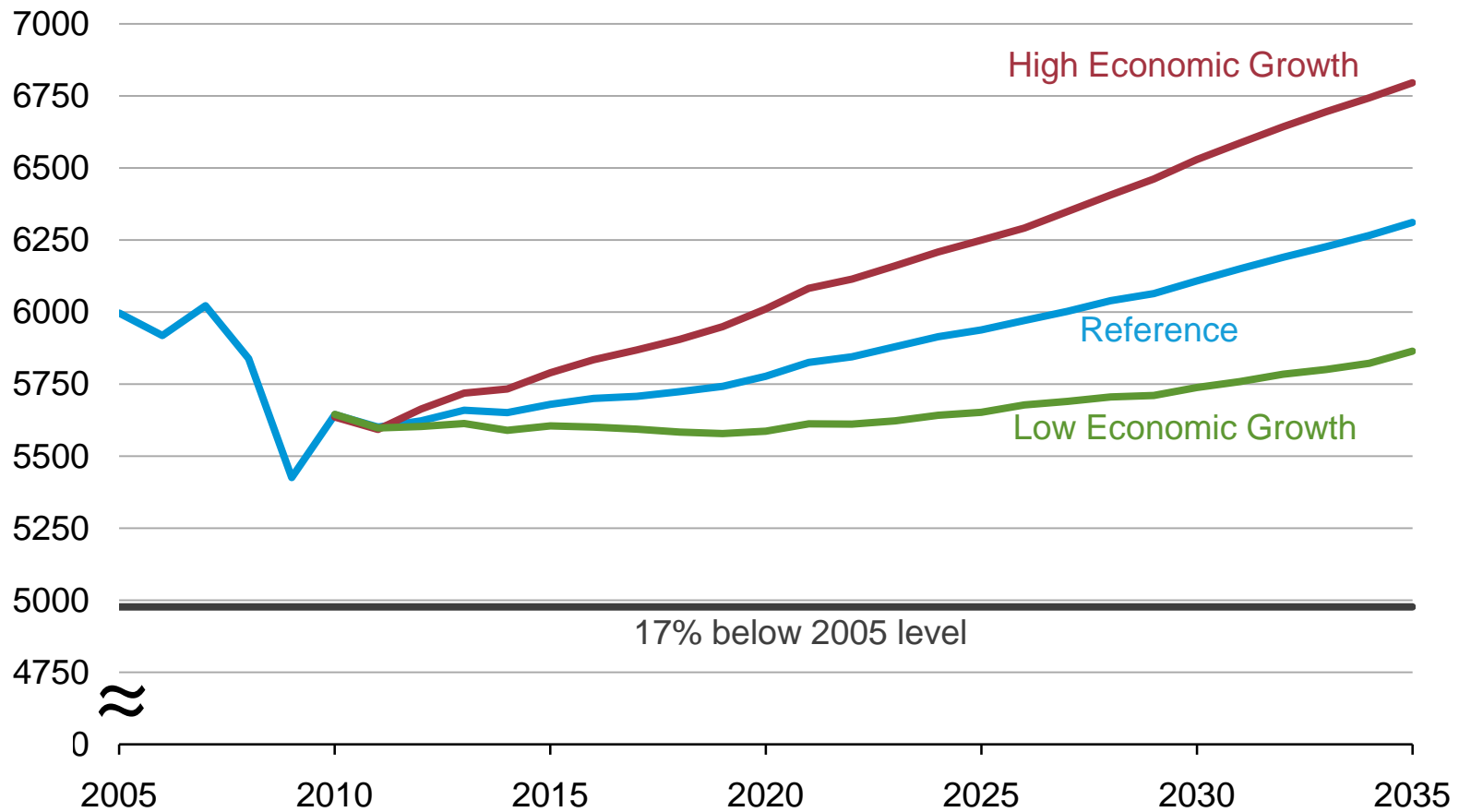
U.S. energy consumption  
quadrillion Btu



Source: EIA, Annual Energy Outlook 2011

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

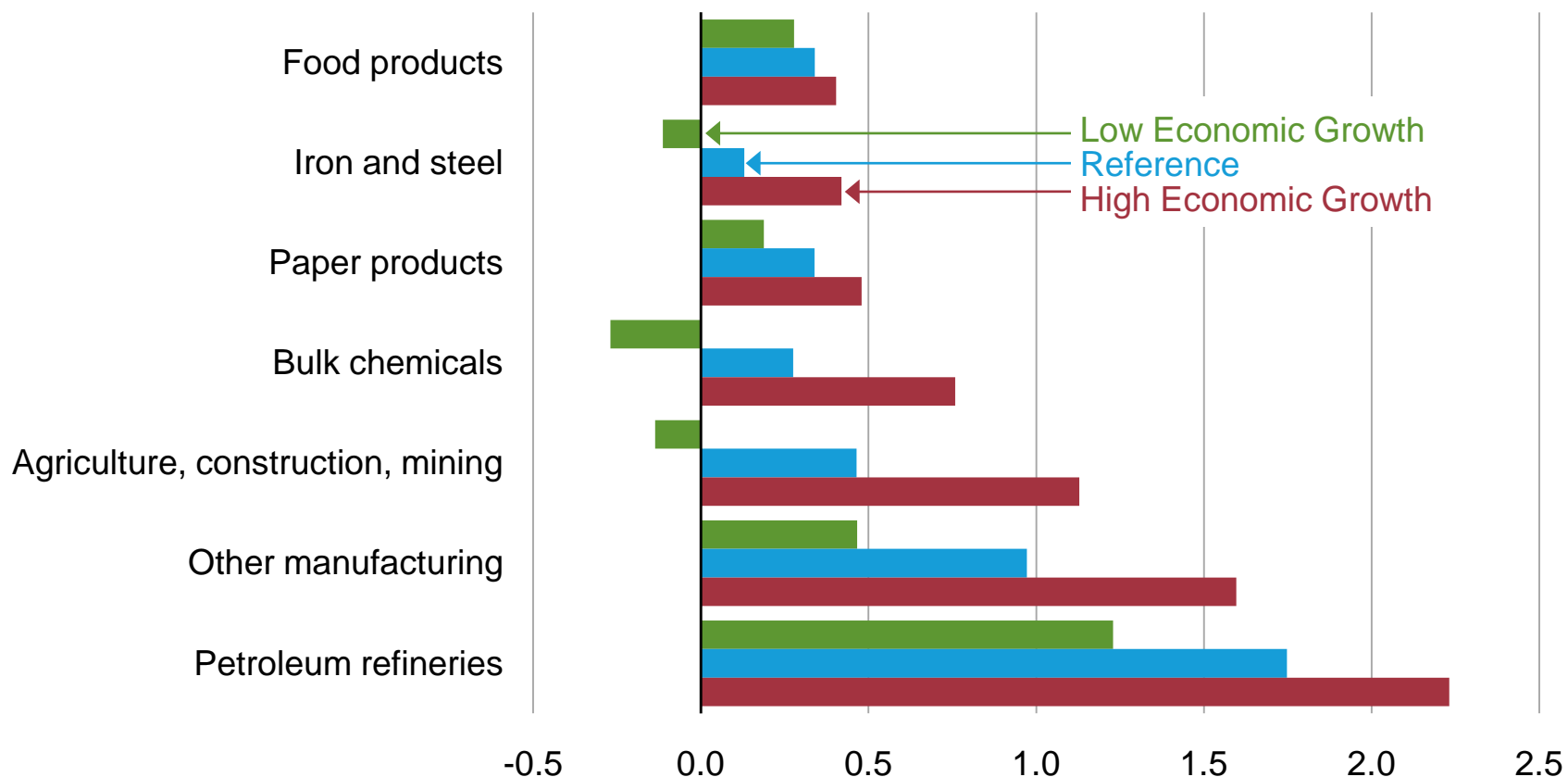
U.S. carbon dioxide emissions  
million metric tons



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

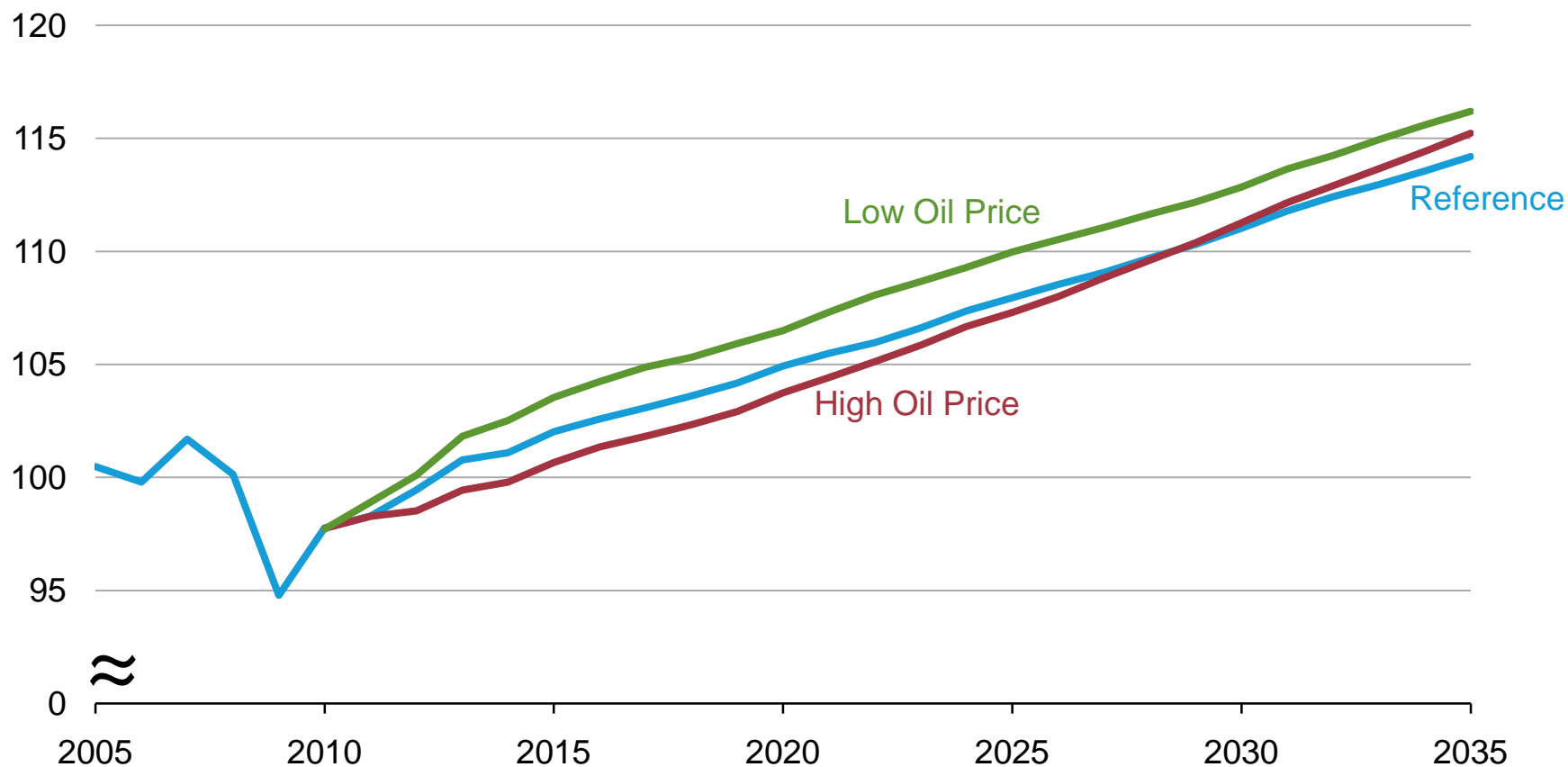


Source: EIA, Annual Energy Outlook 2011

# Oil price sensitivities

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

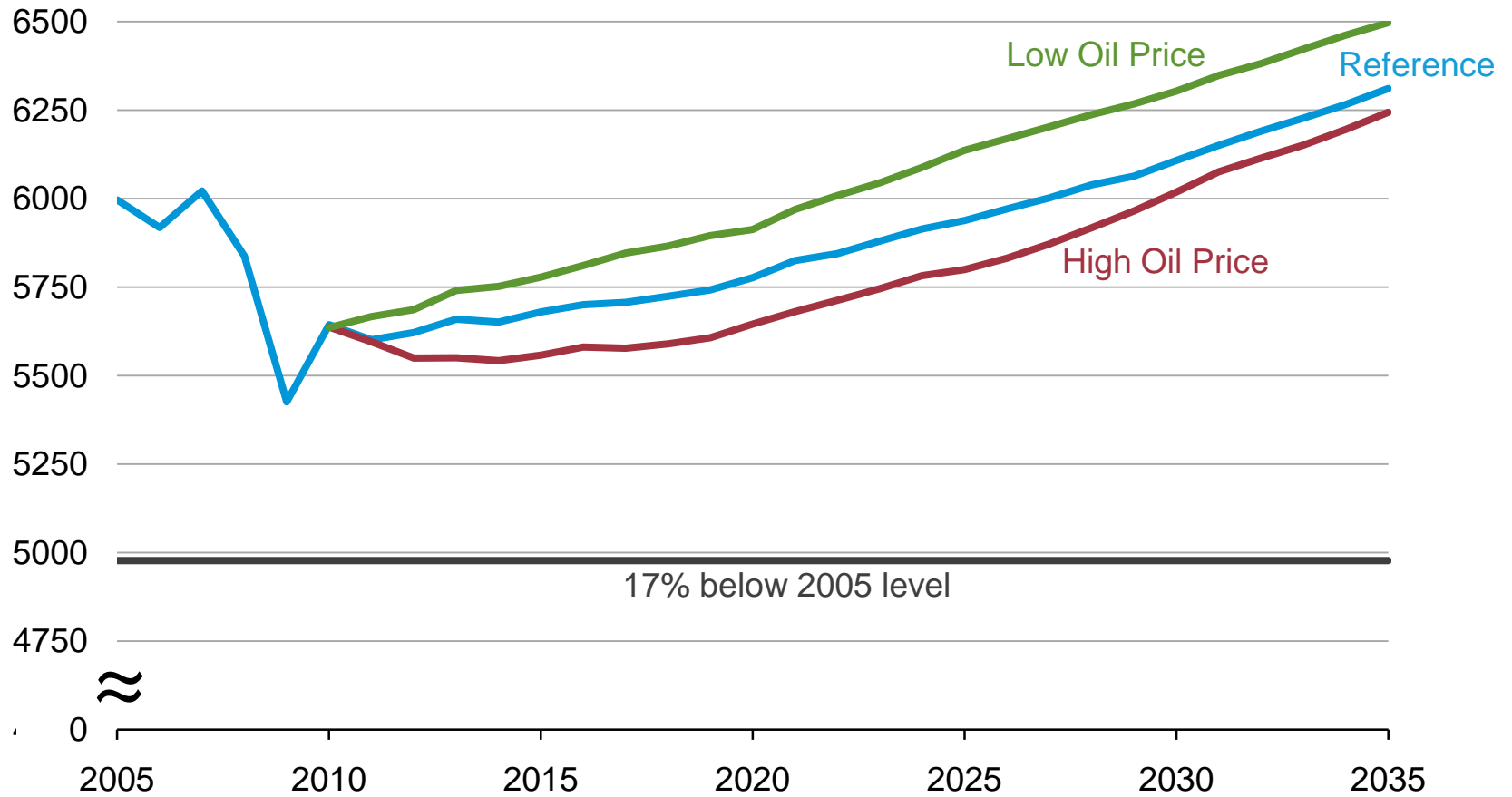
U.S. energy consumption  
quadrillion Btu



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<sub>2</sub> 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