

# Status and outlook for shale gas and tight oil development in the U.S.



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*for*

*Energy Symposium, University of Oklahoma, Price College Energy Institute  
March 05, 2013 / Norman, OK*

*by*

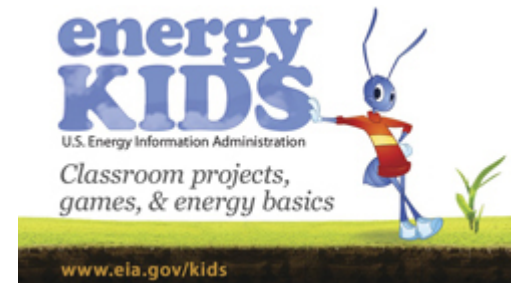
*Adam Sieminski, Administrator*

## EIA's mission and main functions

Independent Statistical and Analytical agency within the U.S. Department of Energy

- EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment.
- ***By law*, its data, analyses, and forecasts are independent of approval by any other officer or employee of the U.S. Government**

[EIA] ...is the gold standard for energy data around the world, and the accessibility of it is so much greater than other places – Dan Yergin, Platts Inside Energy

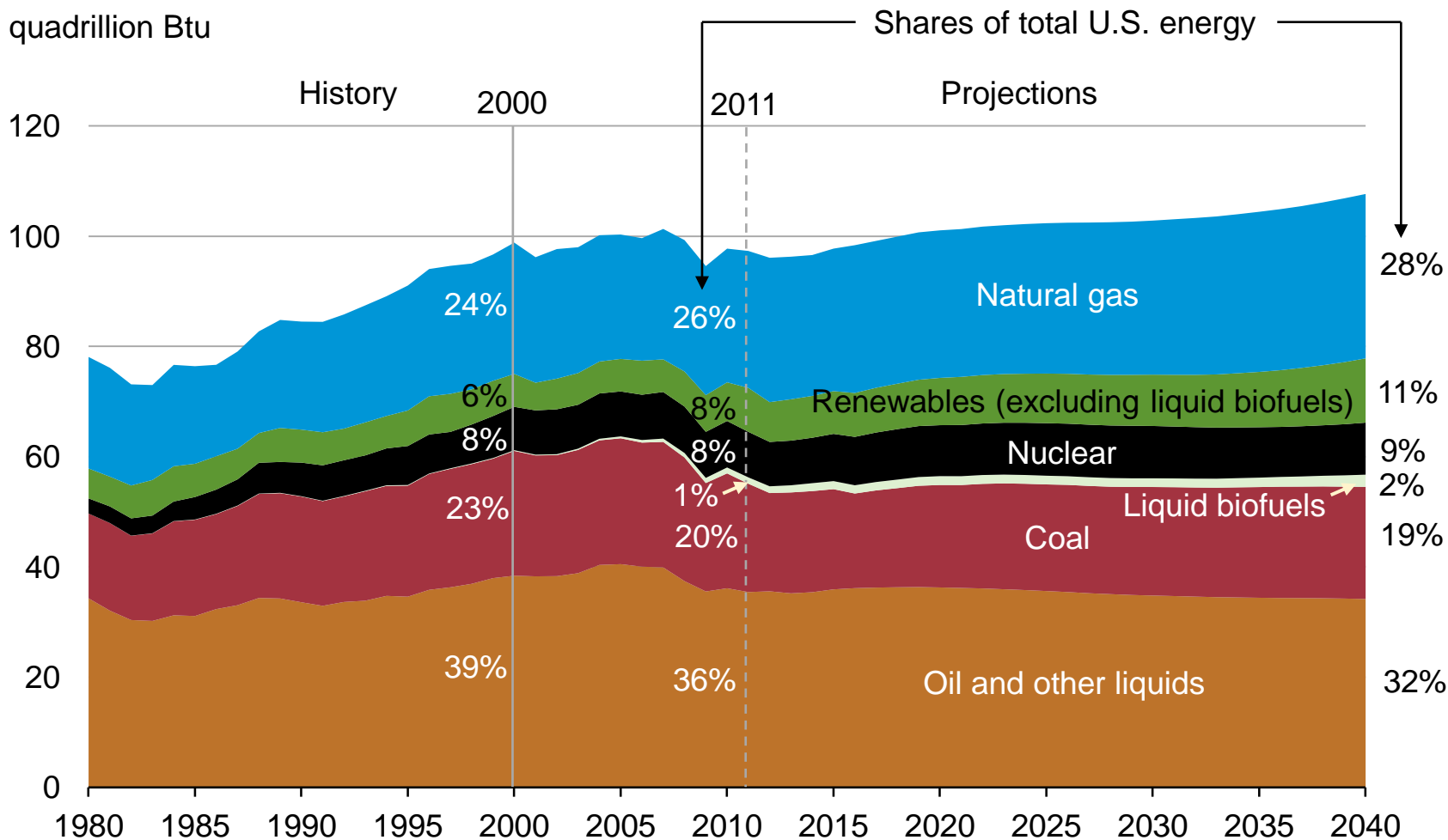


## *Annual Energy Outlook 2013* projections to 2040

- Growth in energy production outstrips consumption growth
- Crude oil production rises sharply over the next decade
- Motor gasoline consumption reflects more stringent fuel economy standards
- The U.S. becomes a net exporter of natural gas in the early 2020s
- U.S. energy-related carbon dioxide emissions remain below their 2005 level through 2040

# U.S. energy use grows slowly over the projection reflecting improving energy efficiency and slow, extended economic recovery

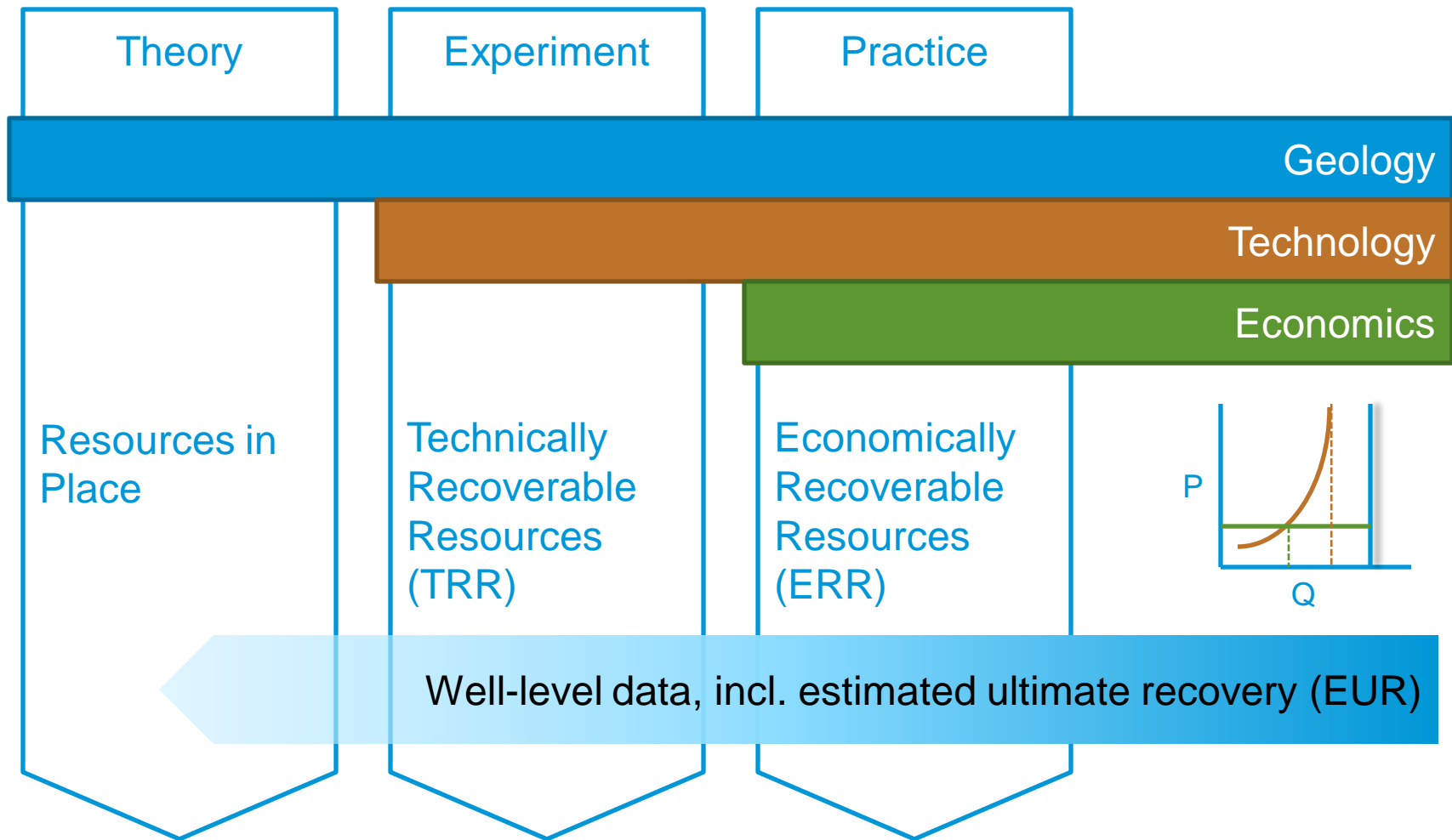
U.S. primary energy consumption  
quadrillion Btu



Source: EIA, Annual Energy Outlook 2013 Early Release

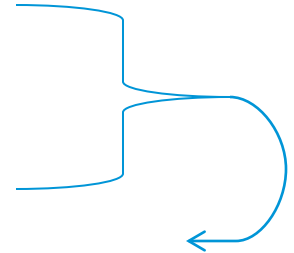
# U.S. Shale Gas

# These three drivers impact resource estimation metrics differently over time in an iterative process



EIA's focus is on the timing of production; the modeling focuses on these parameters

- average initial production (IP) rate per well
- average decline curve (can vary by region and vintage)
- IP & decline curve define the Estimated Ultimate Recovery (EUR) per well



### **Other parameters**

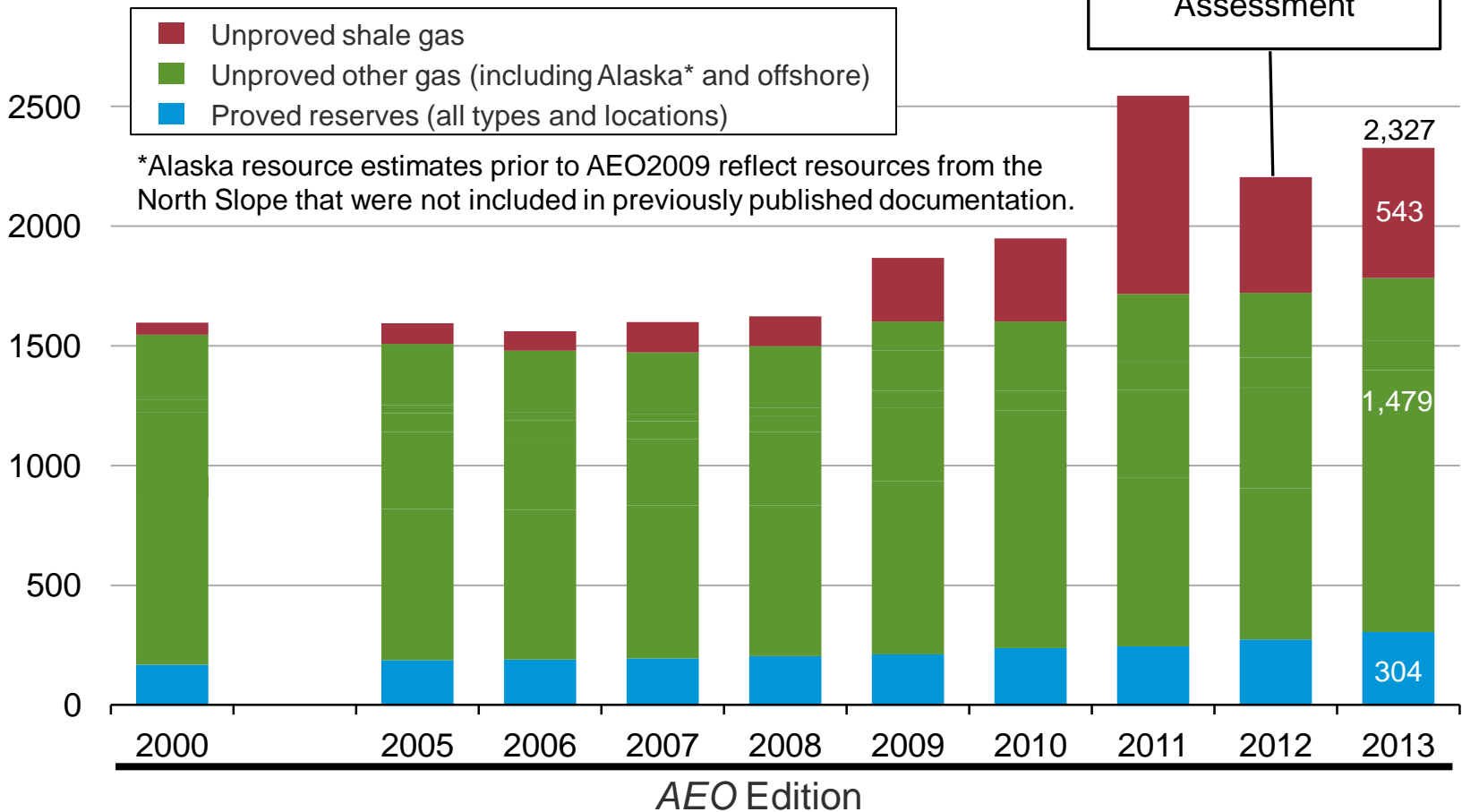
- drilling and operating costs
- number of active rigs
- how many wells a rig can drill (rig efficiency)
- well spacing

# Technically recoverable natural gas resources reflect new information, a combination of assessments and EIA updates

U.S. dry gas resources

trillion cubic feet

3000

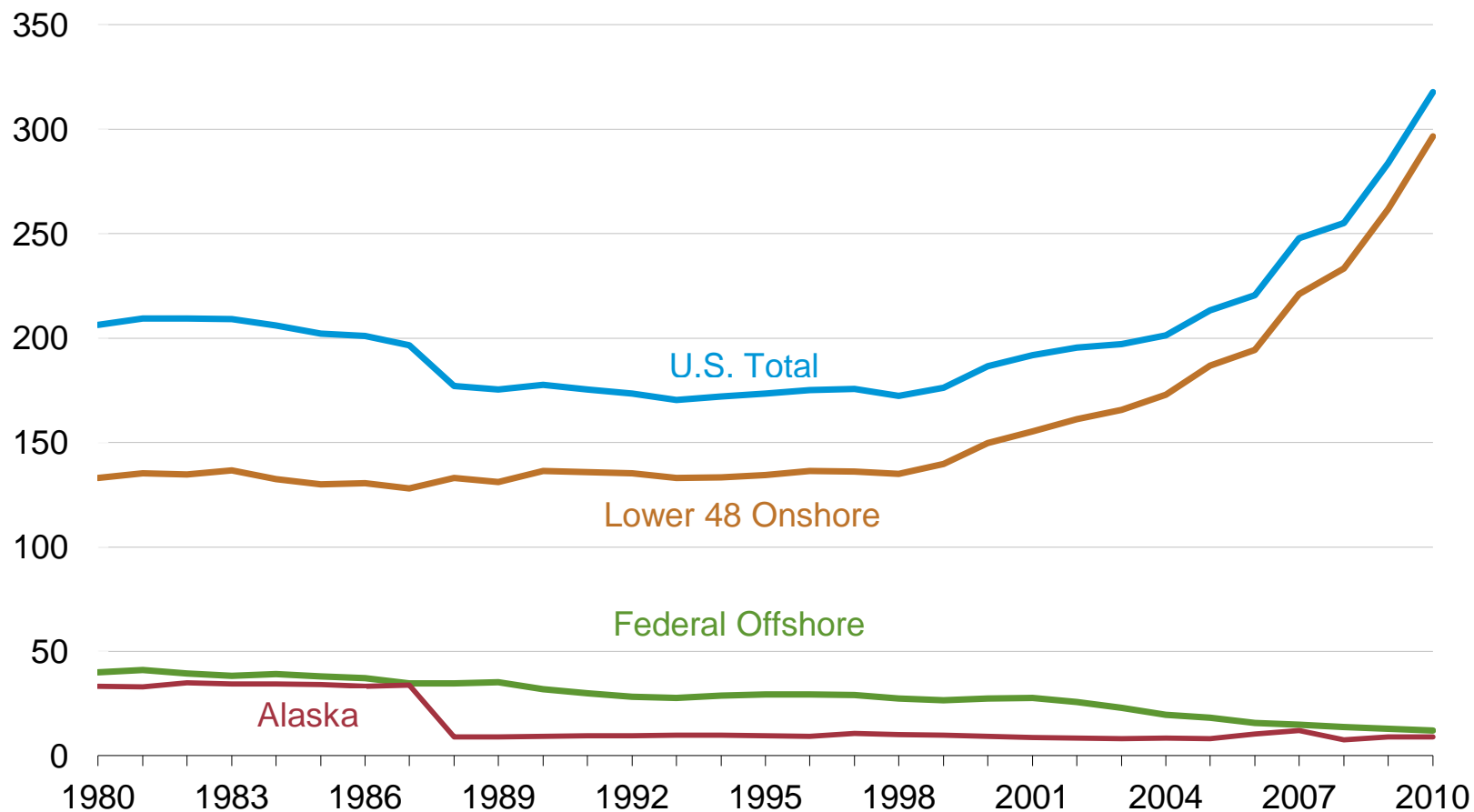


Source: EIA, Annual Energy Outlook 2013 Early Release



# U.S. wet natural gas proved reserves, 1980-2010

trillion cubic feet

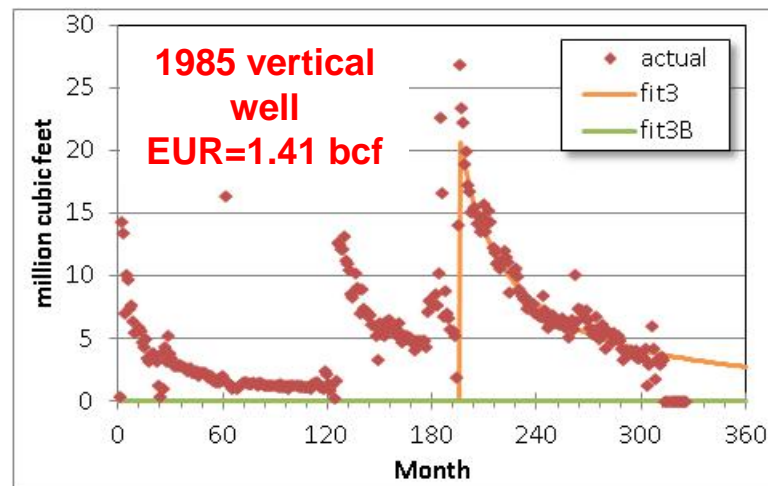
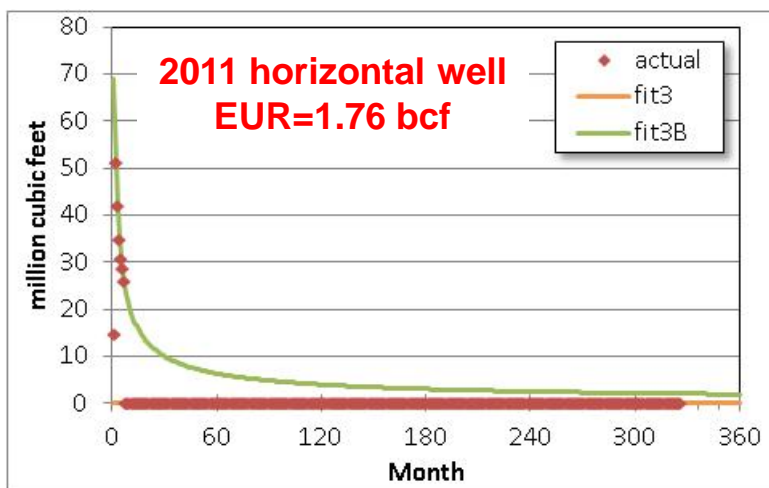
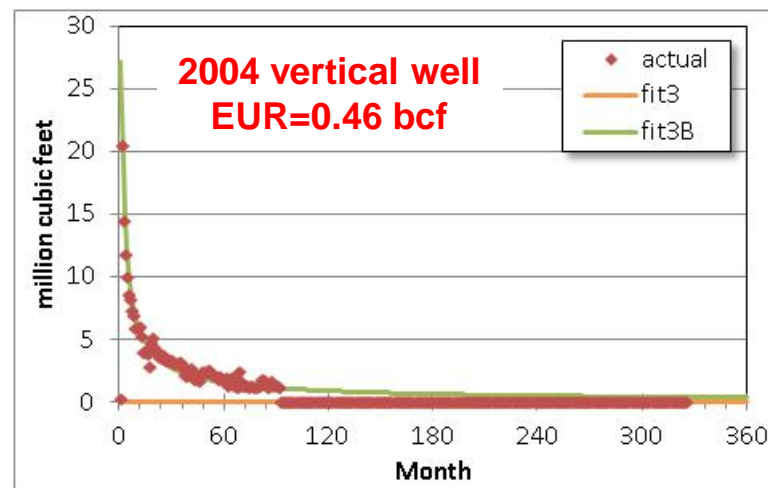


Source: U.S. Energy Information Administration

# EIA fits well production data to hyperbolic decline curves to estimate EUR

Classic hyperbolic decline curve  
(Arps 1945):

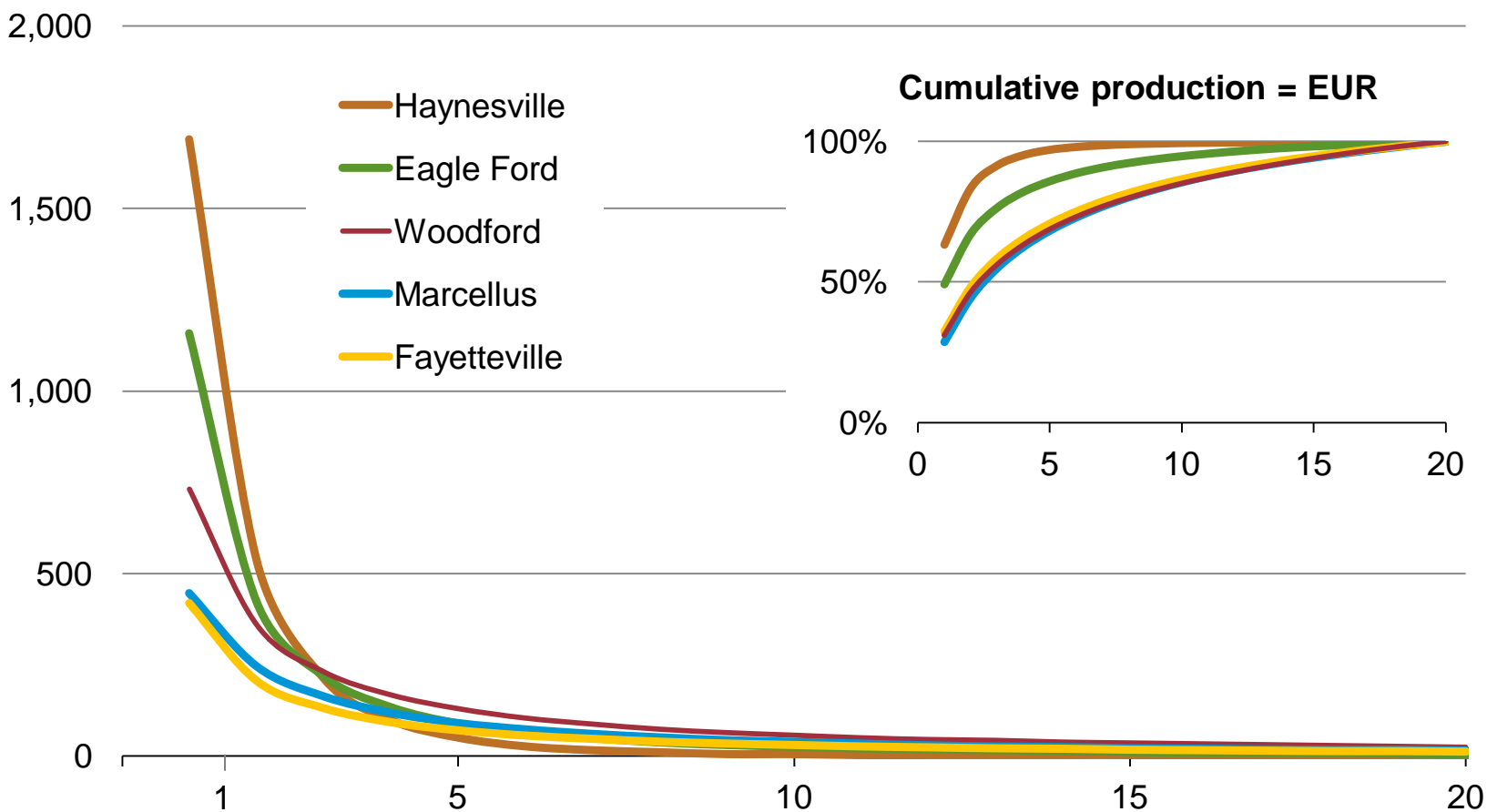
$$Q_t = \frac{Q_i}{(1 + b \times D_i \times t)^{1/b}}$$



Source: HPDI data from horizontal wells in the Newark East field in the Barnett Shale; EIA analysis

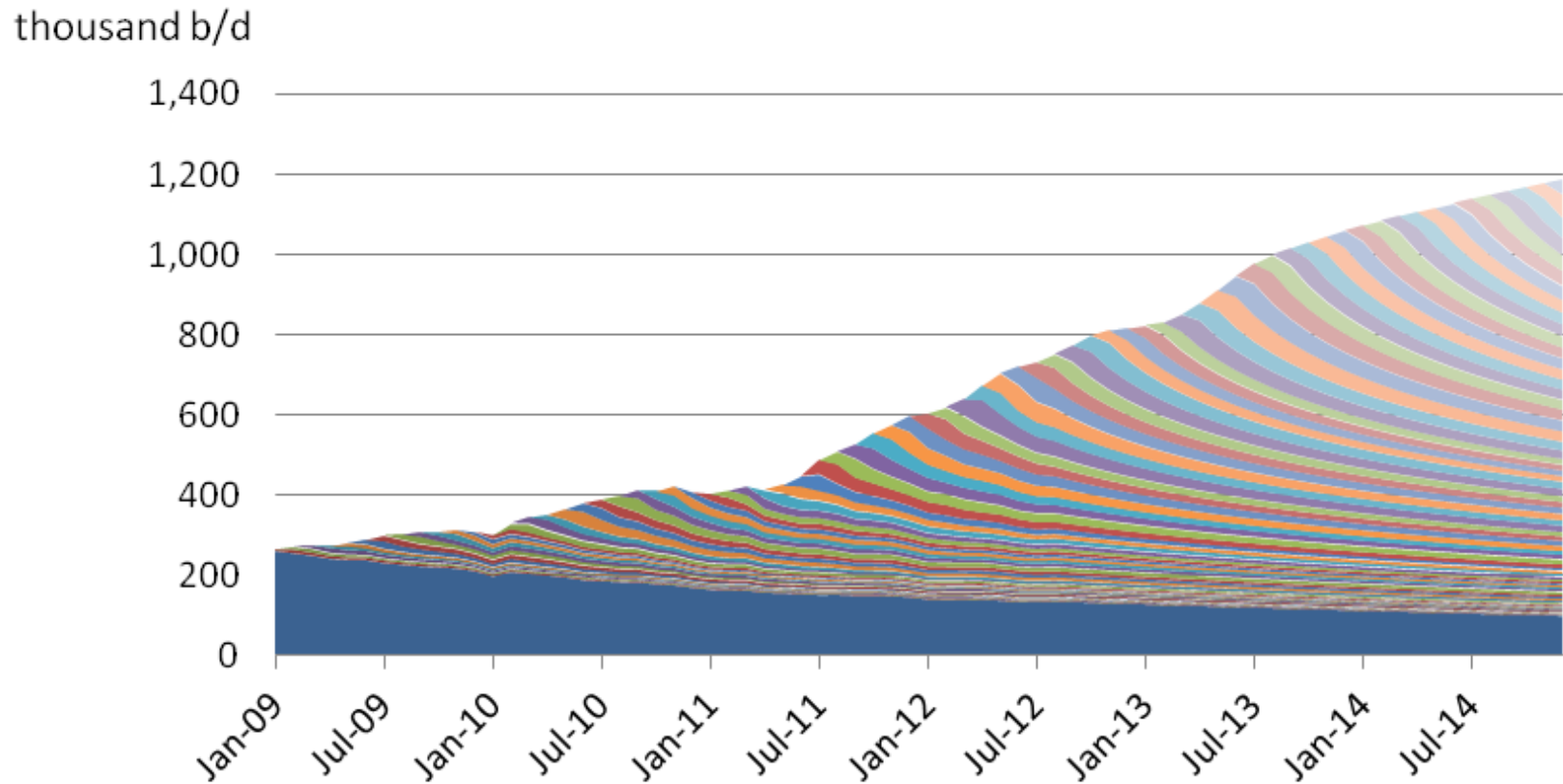
# An average well in shale gas and other continuous resource plays can also have steep decline curves, which require continued drilling to grow production

million cubic feet per year



Source: EIA, Annual Energy Outlook 2012

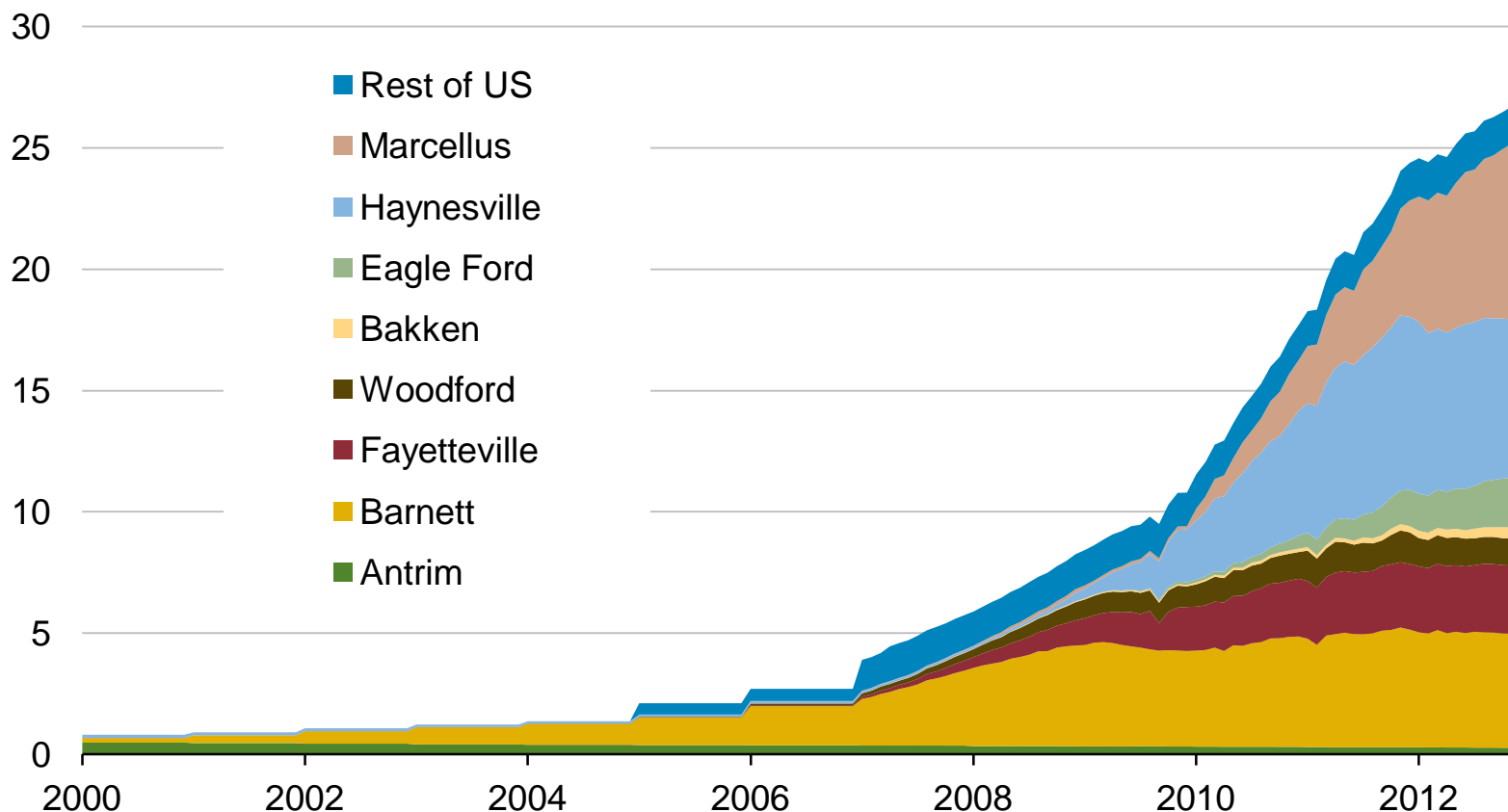
## For example: Oil production by monthly vintage of wells in the Williston Basin



Source: DrillingInfo history through August 2012, EIA Short-Term Energy Outlook, February 2013 forecast

# Domestic production of shale gas has grown dramatically over the past few years

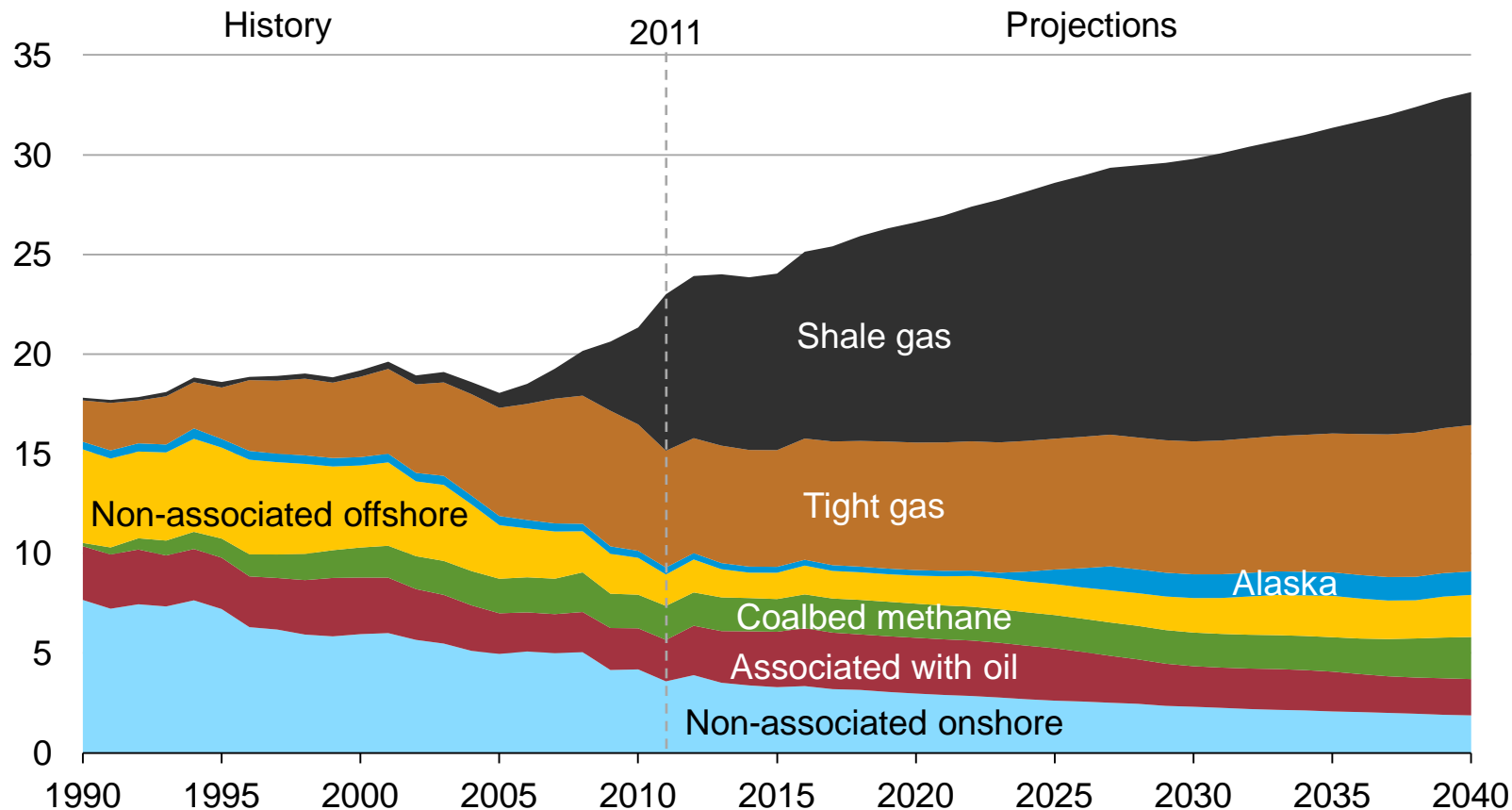
shale gas production (dry)  
billion cubic feet per day



Sources: LCI Energy Insight gross withdrawal estimates as of December 2012 and converted to dry production estimates with EIA-calculated average gross-to-dry shrinkage factors by state and/or shale play.

# Shale gas leads growth in total gas production through 2040

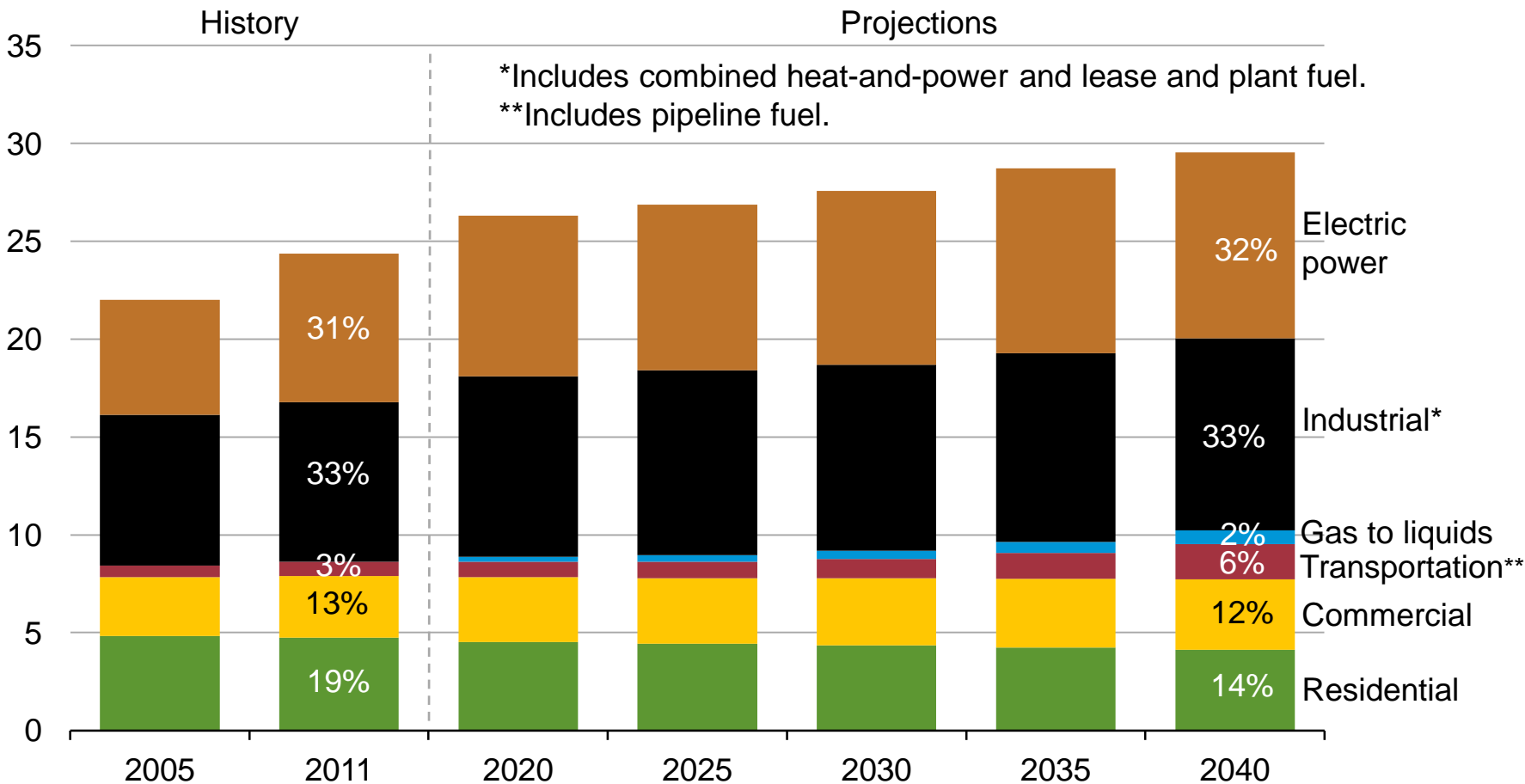
U.S. dry natural gas production  
trillion cubic feet



Source: EIA, Annual Energy Outlook 2013 Early Release

# Natural gas consumption is quite dispersed with electric power, industrial, and transportation use driving future demand growth

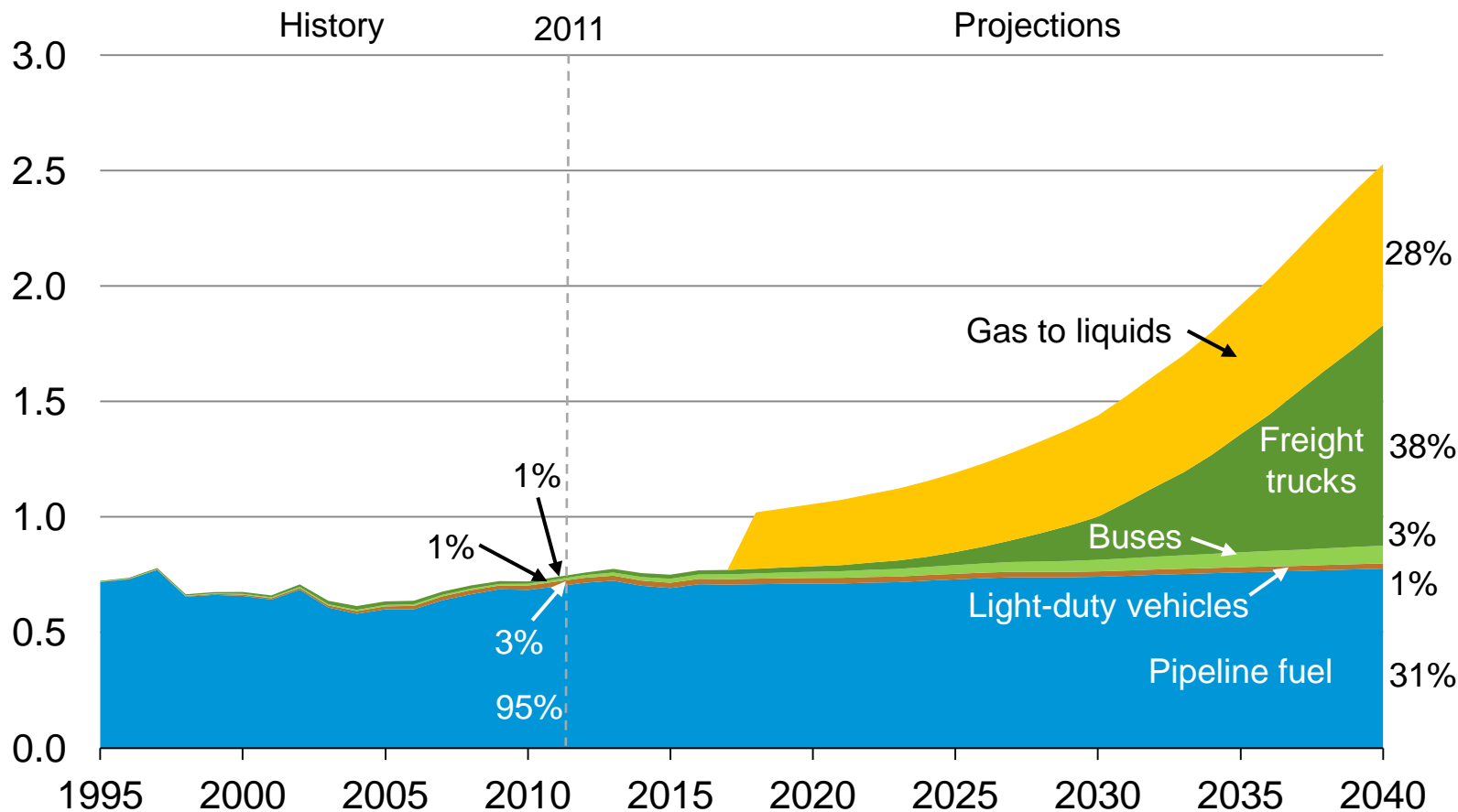
U.S. dry gas consumption  
trillion cubic feet



Source: EIA, Annual Energy Outlook 2013 Early Release

# Growth of natural gas in transportation led by heavy duty trucks (LNG) and gas to liquids (diesel)... marine and rail to come?

U.S. natural gas consumption  
quadrillion Btu



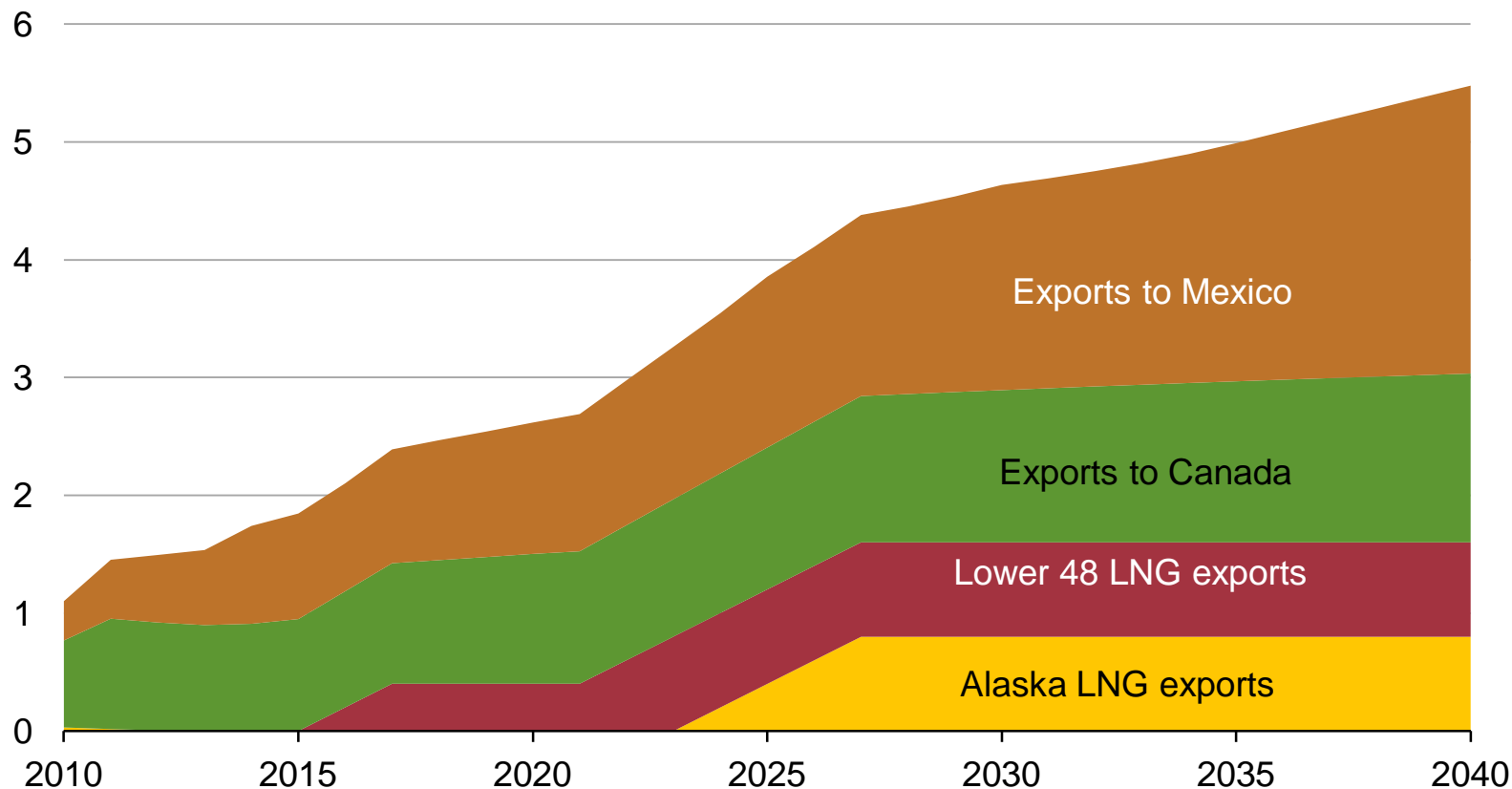
Note: Gas to liquids includes heat, power, and losses.

Source: EIA, Annual Energy Outlook 2013 Early Release



# Total natural gas exports nearly quadruple by 2040 in the *AEO2013* Reference case

U.S. natural gas exports  
trillion cubic feet

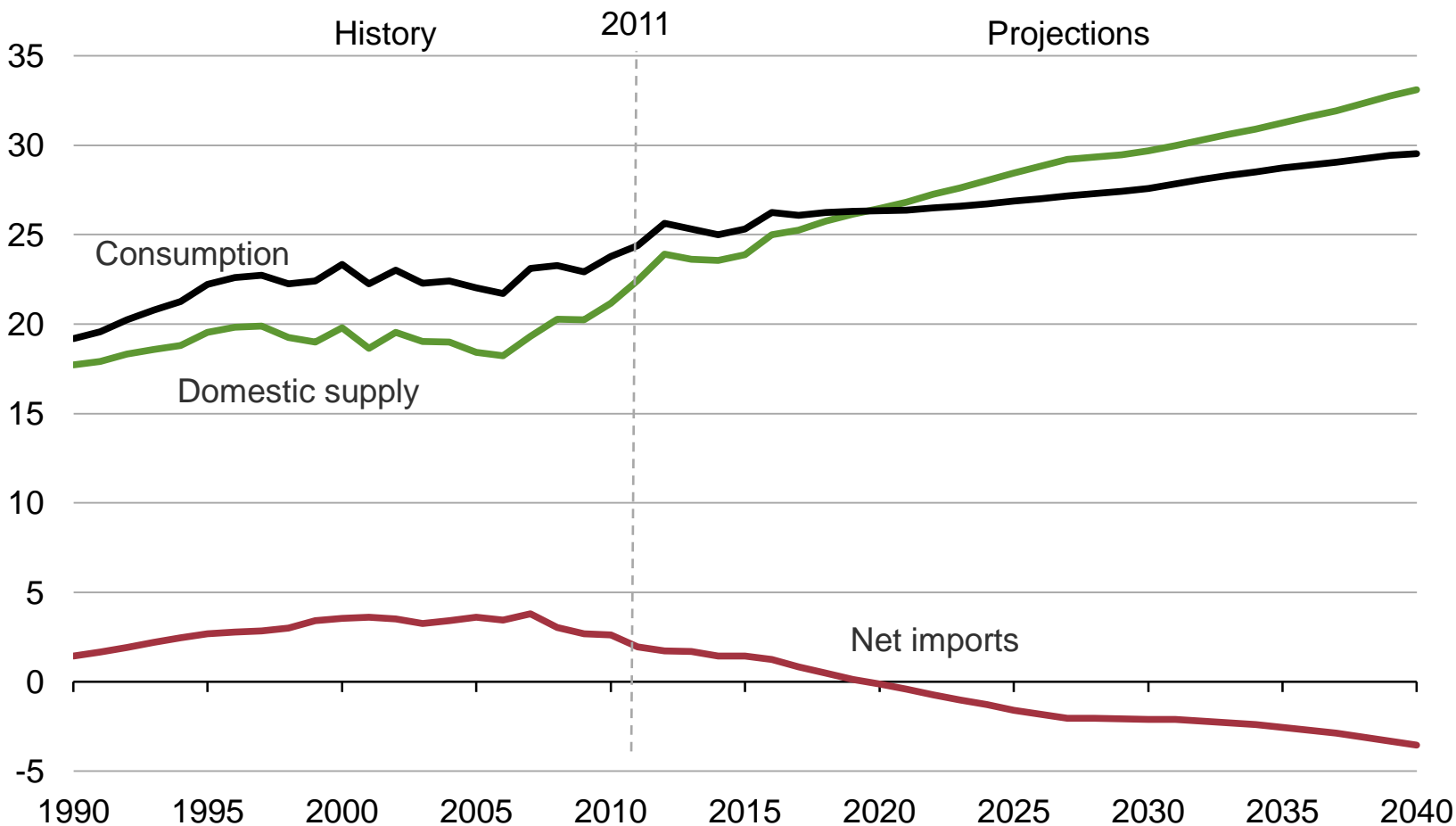


Source: EIA, Annual Energy Outlook 2013 Early Release

# Domestic natural gas production grows faster than consumption and the U.S. becomes a net exporter of natural gas around 2020

U.S. dry gas

trillion cubic feet

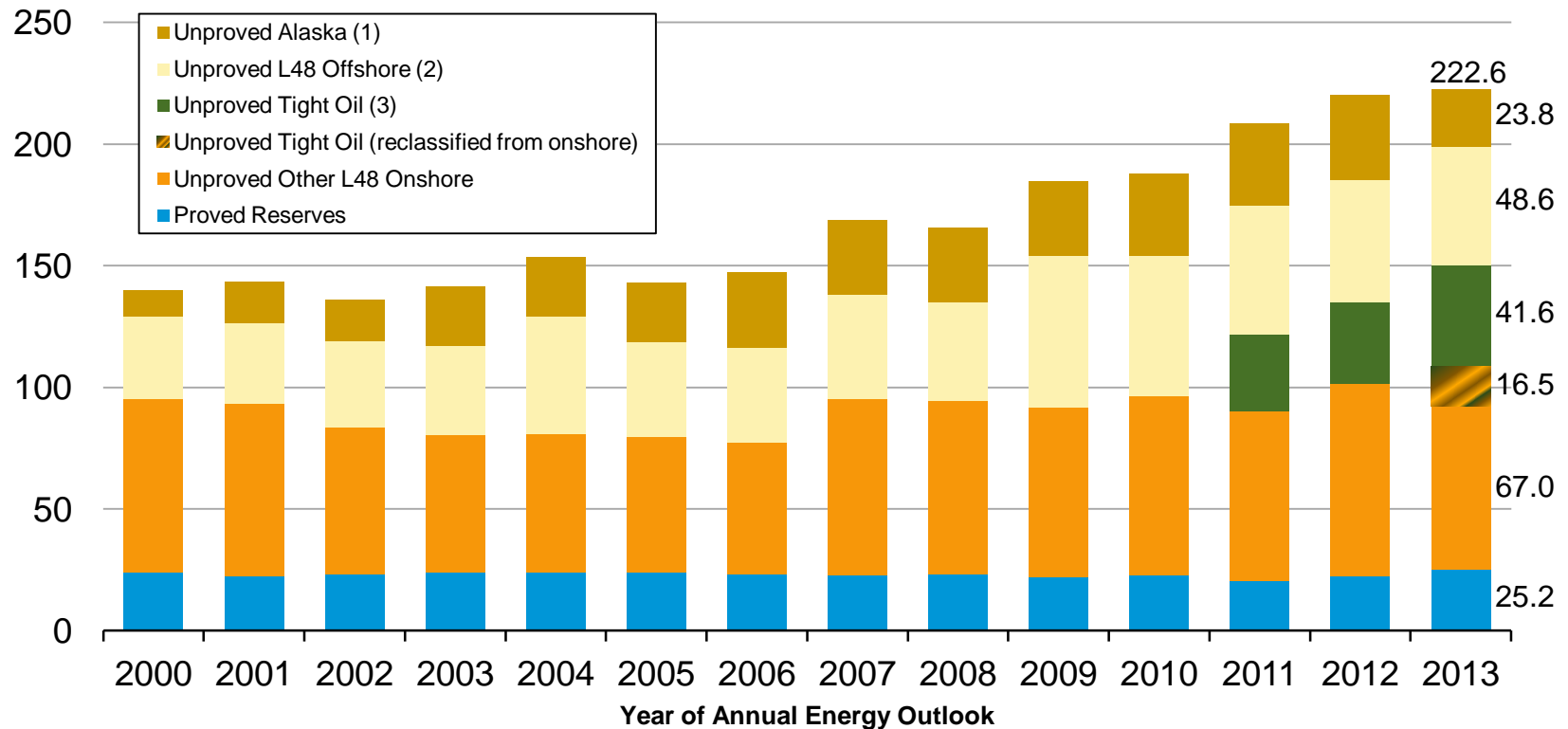


Source: EIA, Annual Energy Outlook 2013 Early Release

# U.S. Tight Oil

# Multiple factors have contributed to U.S. crude oil resource estimate increases over the years, with tight oil contributing recently

U.S. crude oil and lease condensate resources in non-prohibited areas  
billion barrels

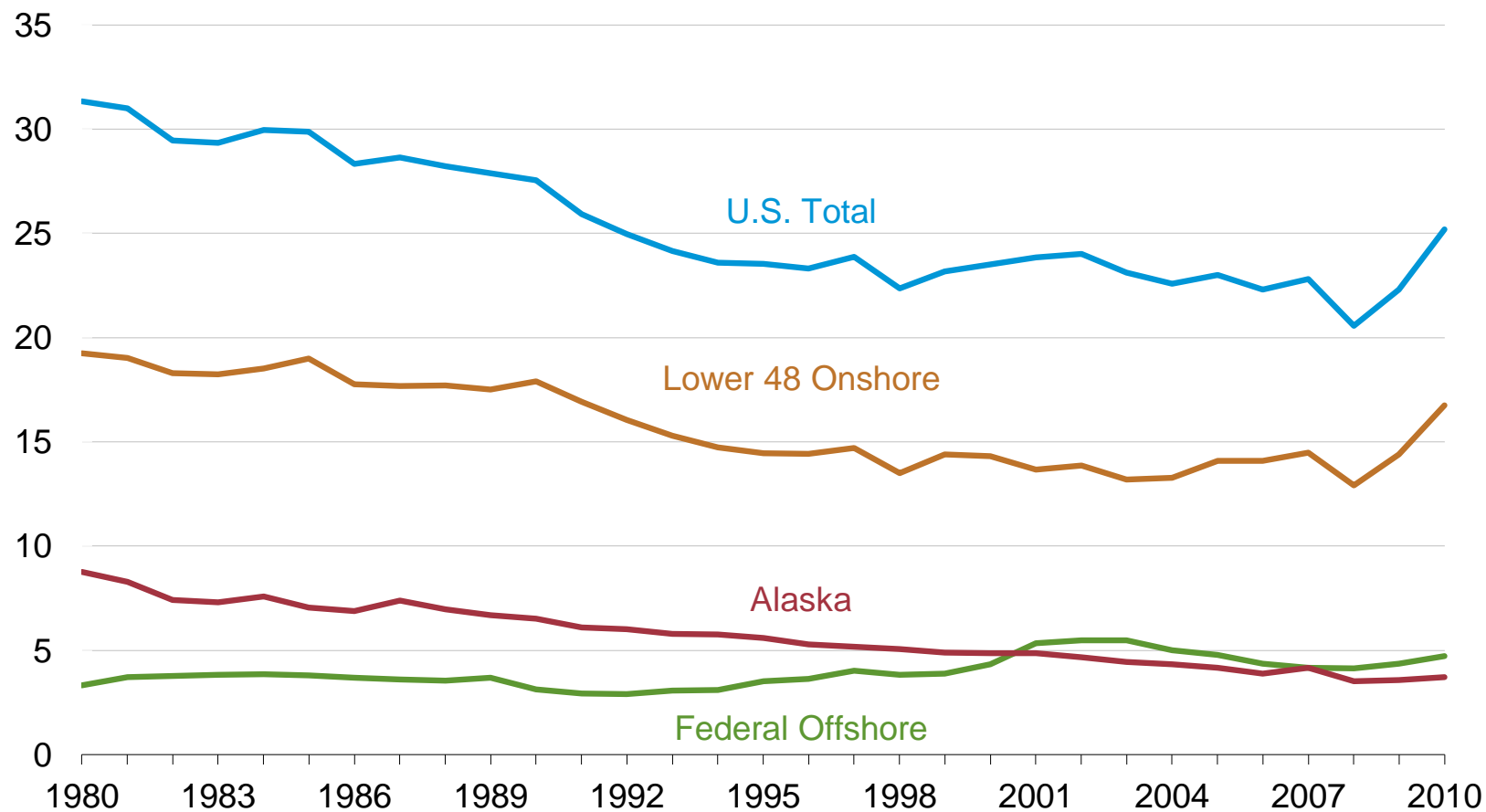


- (1) The USGS reduced NPR-A resource estimates, which is responsible for the lower AEO2013 Alaska resources.
- (2) Prior to AEO2009, resources in Pacific, Atlantic, and Eastern GOM OCS were under moratoria and not included.
- (3) Includes shale oil. Prior to AEO2011, tight oil is included in unproved other lower-48 onshore category.

Source: EIA, Annual Energy Outlook 2013 Early Release

# U.S. crude oil plus condensate proved reserves, 1980-2010

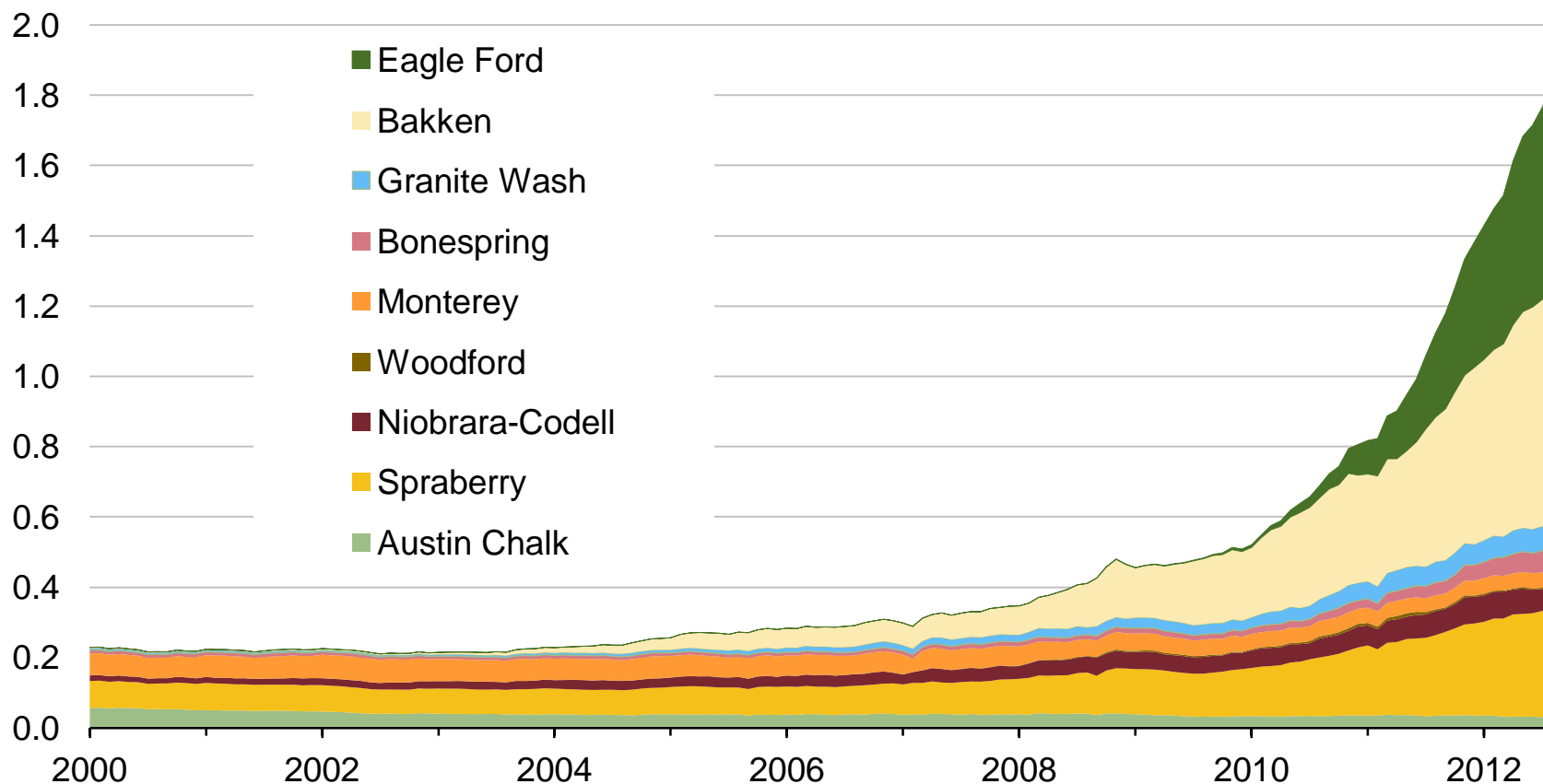
billion barrels



Source: U.S. Energy Information Administration

# Domestic production of tight oil has grown dramatically over the past few years

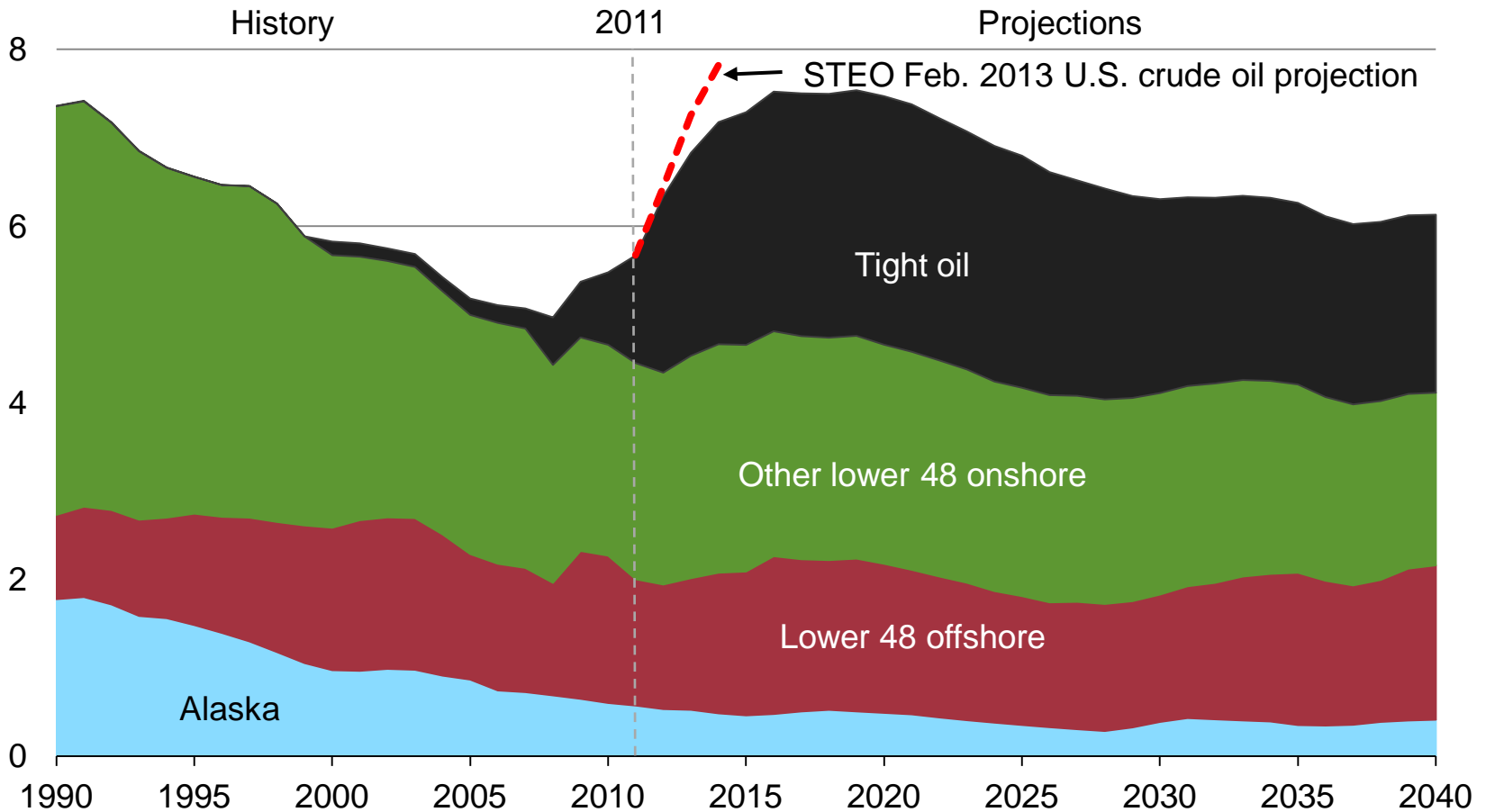
tight oil production for select plays  
million barrels per day



Source: Drilling Info (formerly HPDI), Texas RRC, North Dakota department of mineral resources, and EIA, through August 2012

# U.S. tight oil production leads a growth in domestic production of 2.6 million barrels per day between 2008 and 2019

U.S. crude oil production  
million barrels per day

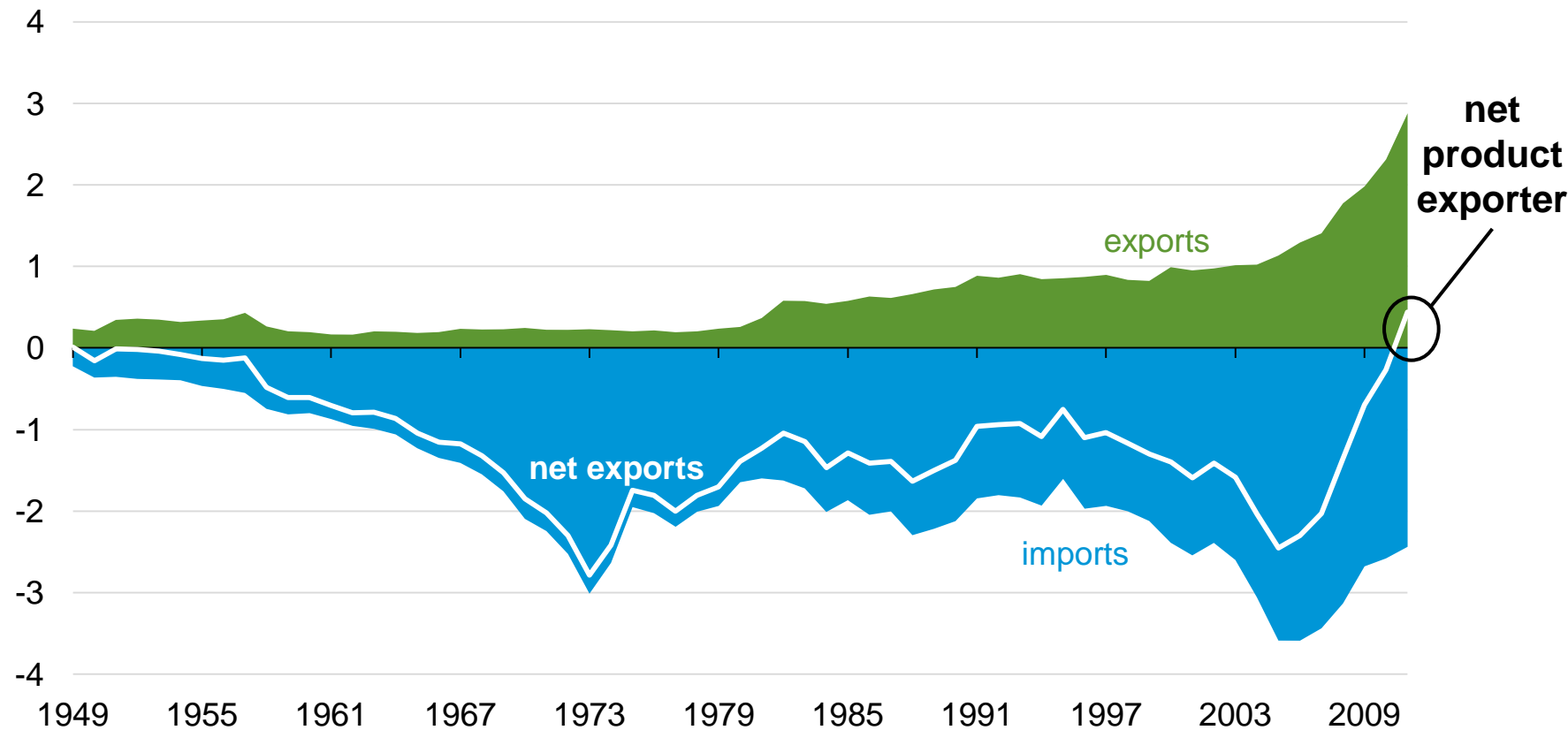


Source: EIA, Annual Energy Outlook 2013 Early Release and Short-Term Energy Outlook, February 2013

# U.S. petroleum product exports exceeded imports in 2011 for first time in over six decades

annual U.S. net exports of total petroleum products, 1949 – 2011

million barrels per day

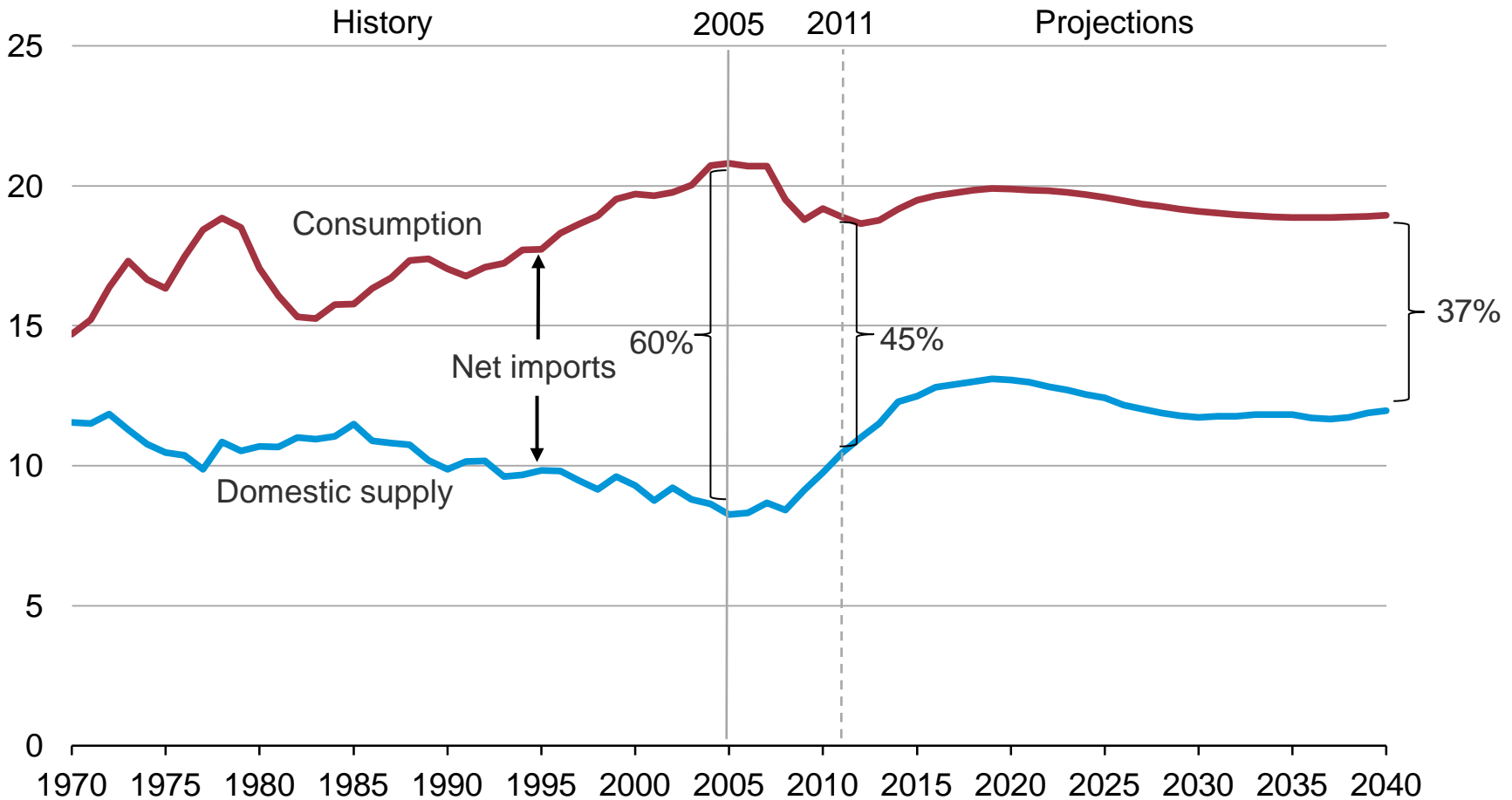


Source: EIA, Petroleum Supply Monthly



# U.S. dependence on imported liquids depends on both supply and demand

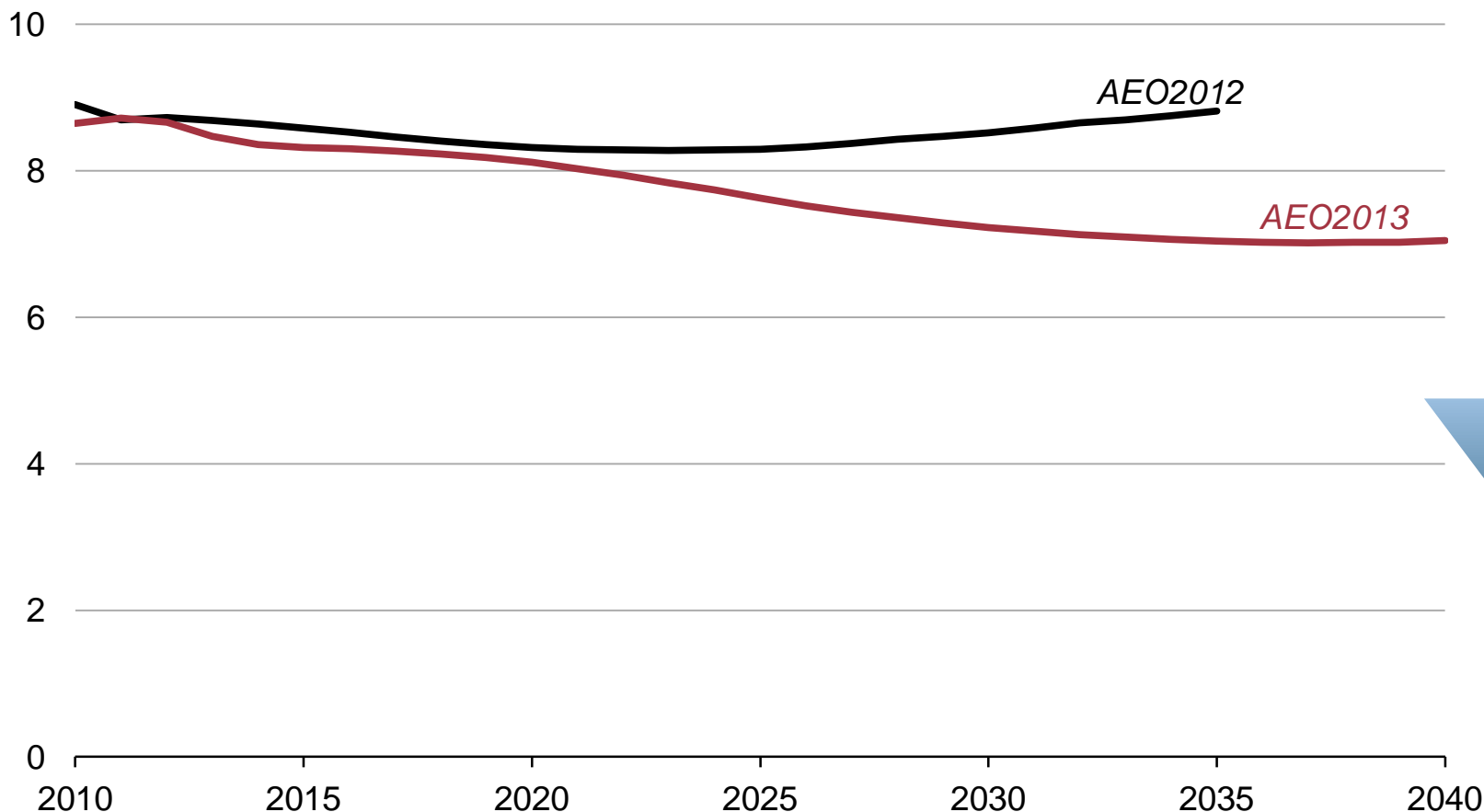
U.S. liquid fuel supply  
million barrels per day



Source: EIA, Annual Energy Outlook 2013 Early Release

# Light-duty vehicle liquids consumption is lower primarily due to more stringent CAFE standards

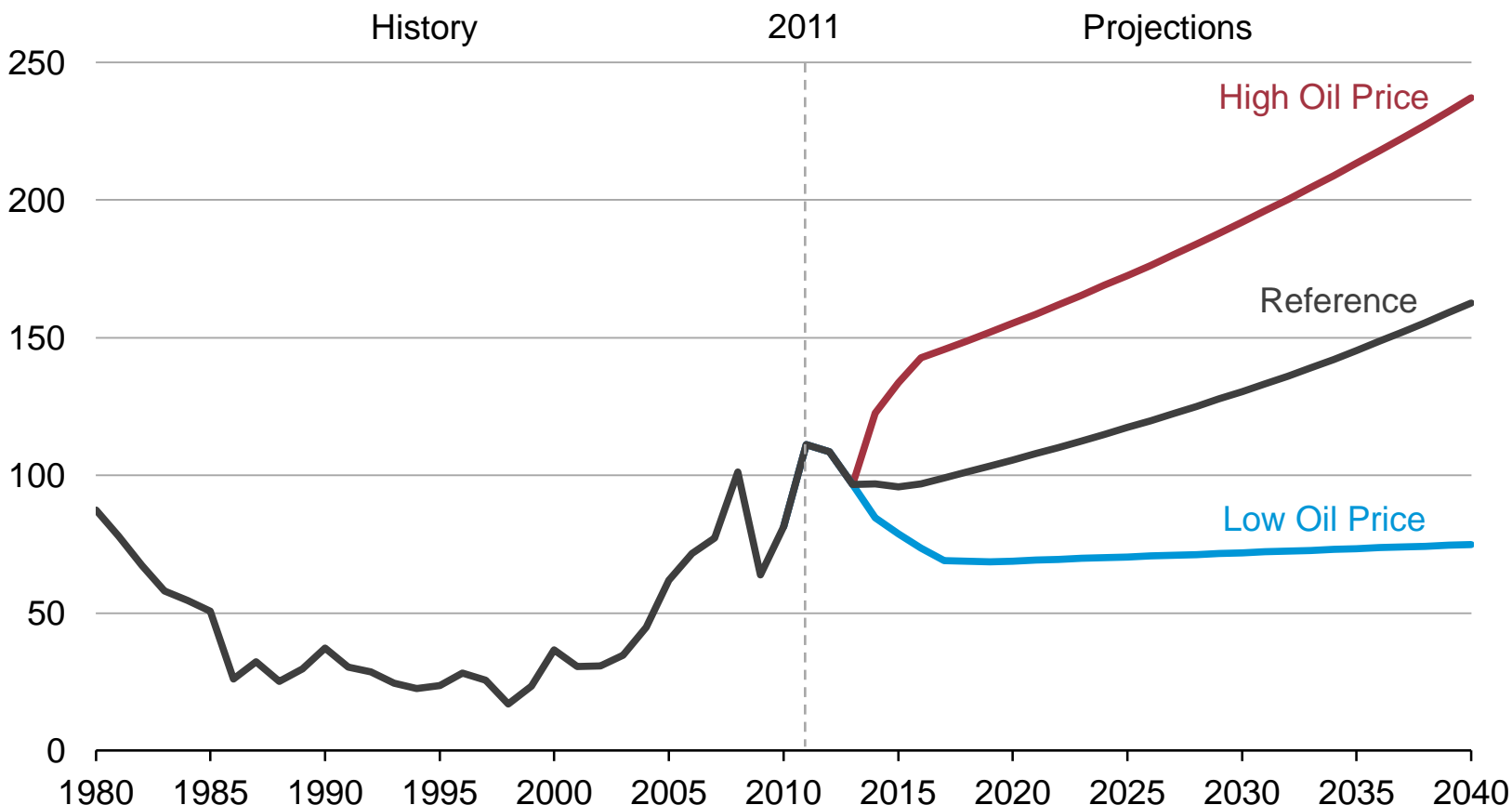
light-duty vehicle liquids consumption  
million barrels per day



Source: EIA, Annual Energy Outlook 2013 Early Release

# Reference case oil price initially drops and then rises steadily, but there is uncertainty about the future trajectory

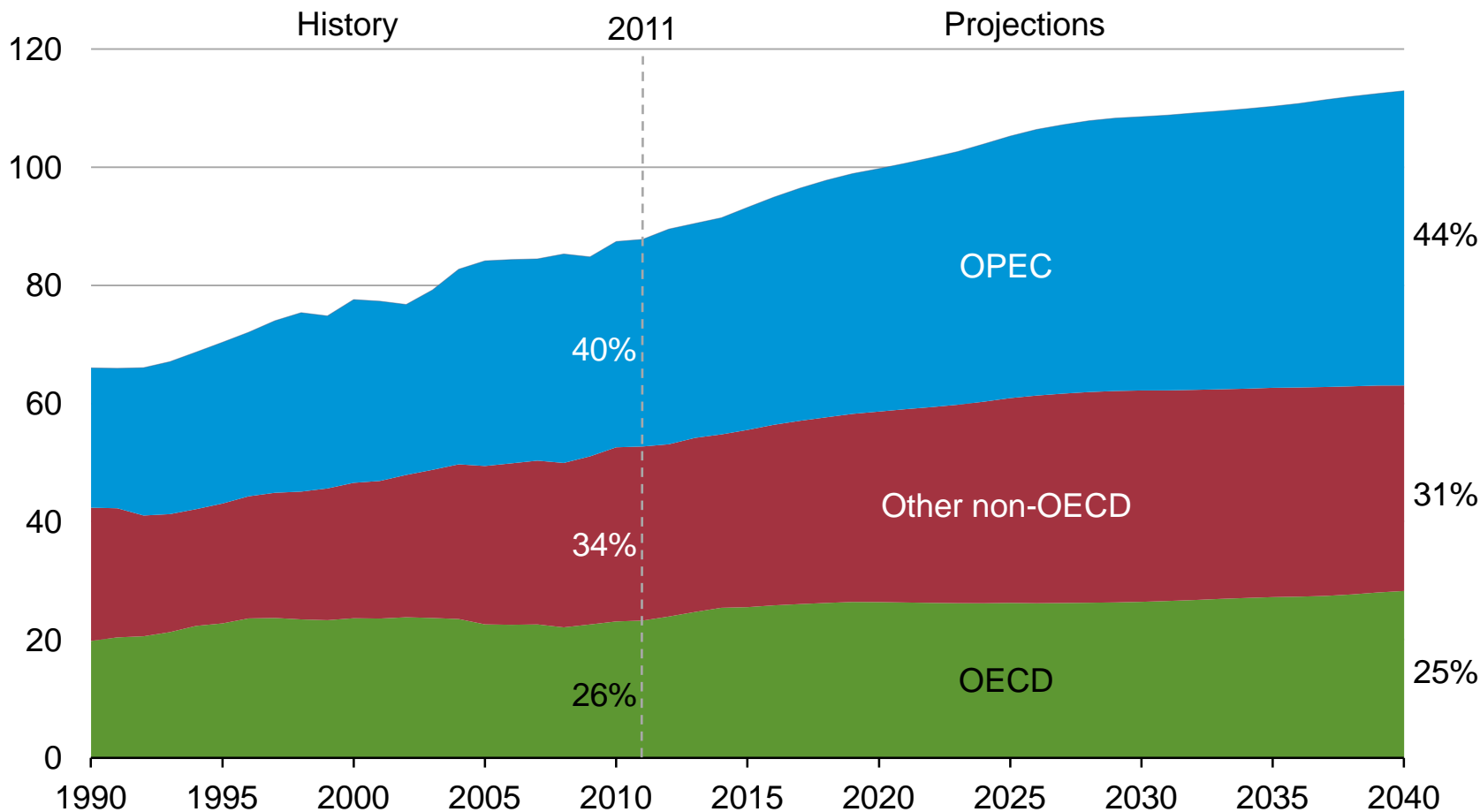
Annual average spot price of Brent crude oil  
2011 dollars per barrel



Source: EIA, Annual Energy Outlook 2013 Early Release

# Global liquids supply increases 26 percent with regional market shares relatively stable

Global liquids supply  
million barrels per day



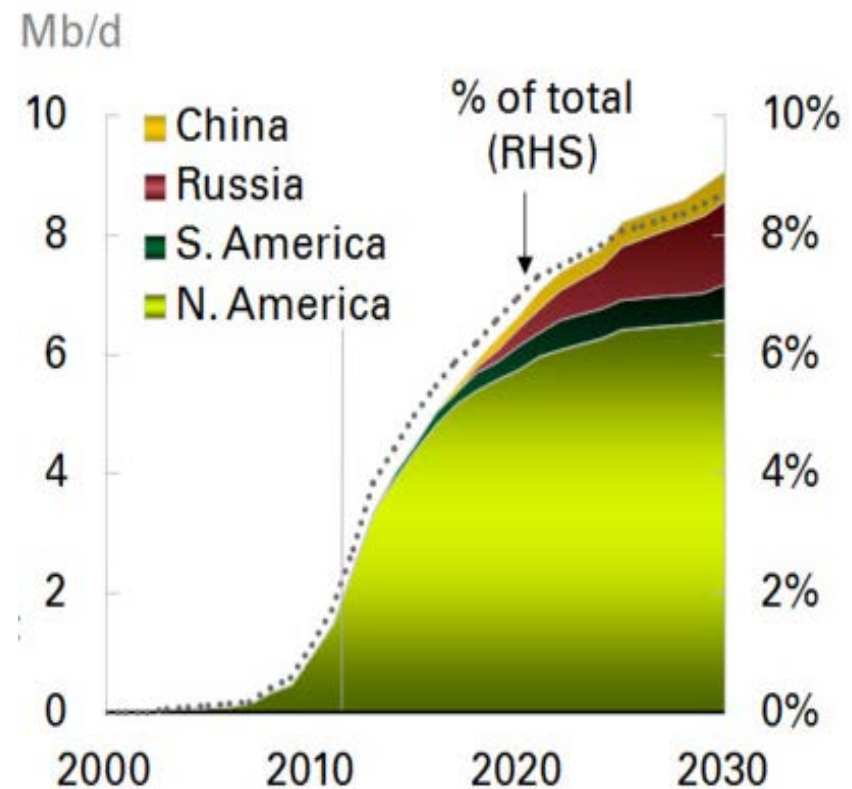
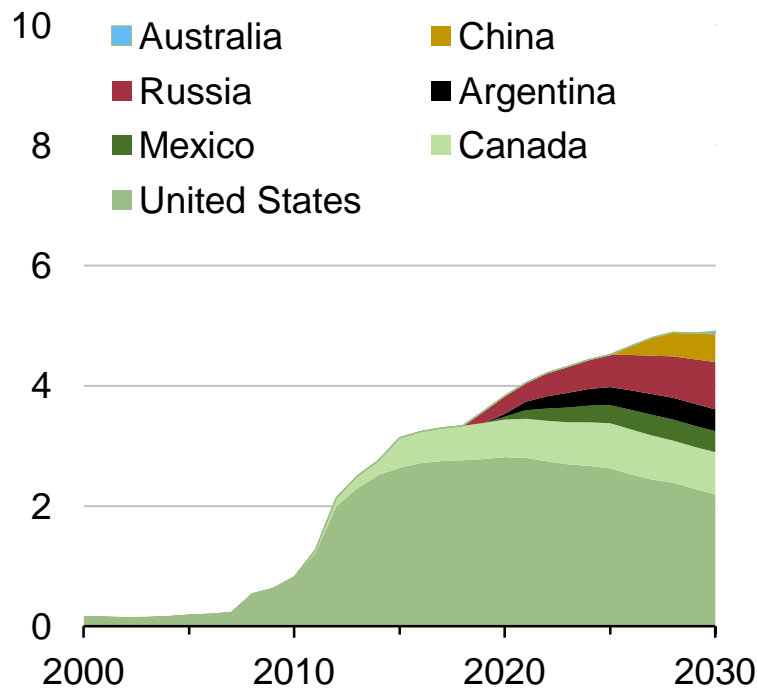
Source: EIA, Annual Energy Outlook 2013 Early Release

# Global tight oil production comparisons

IEO2013 DRAFT

BP Energy Outlook 2030

million barrels per day



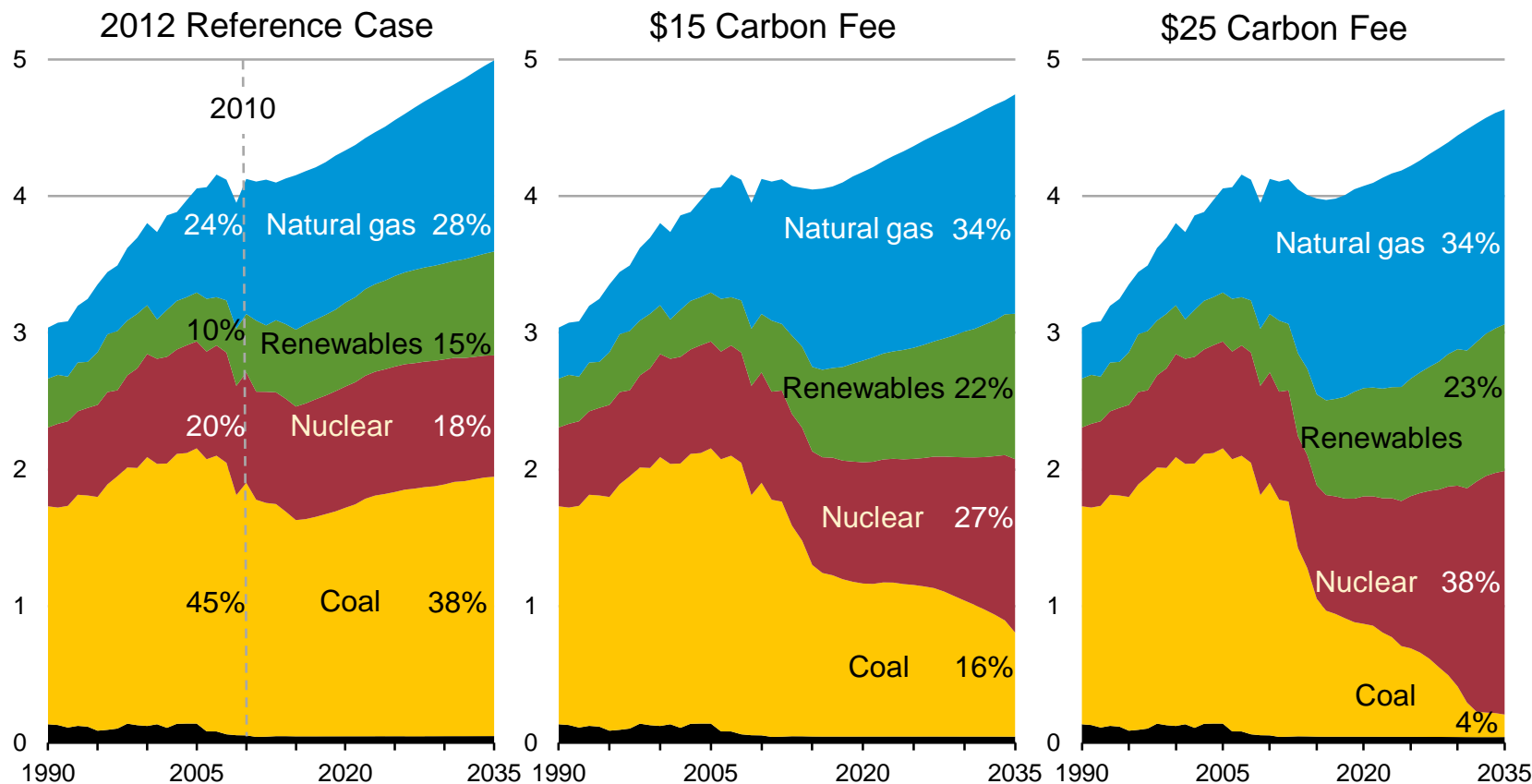
Source: Preliminary International Energy Outlook 2013, BP Energy Outlook 2030

## Uncertainties that could slow global growth of shale gas and tight oil

- Resource quantities and distribution
- Surface vs. mineral rights
- Risk appetite of industry participants
- Infrastructure and technology
- Environmental constraints

# Changing electricity generation mix in *AEO2012* reference case and carbon fee allowance side cases

U.S. electricity net generation  
trillion kilowatthours



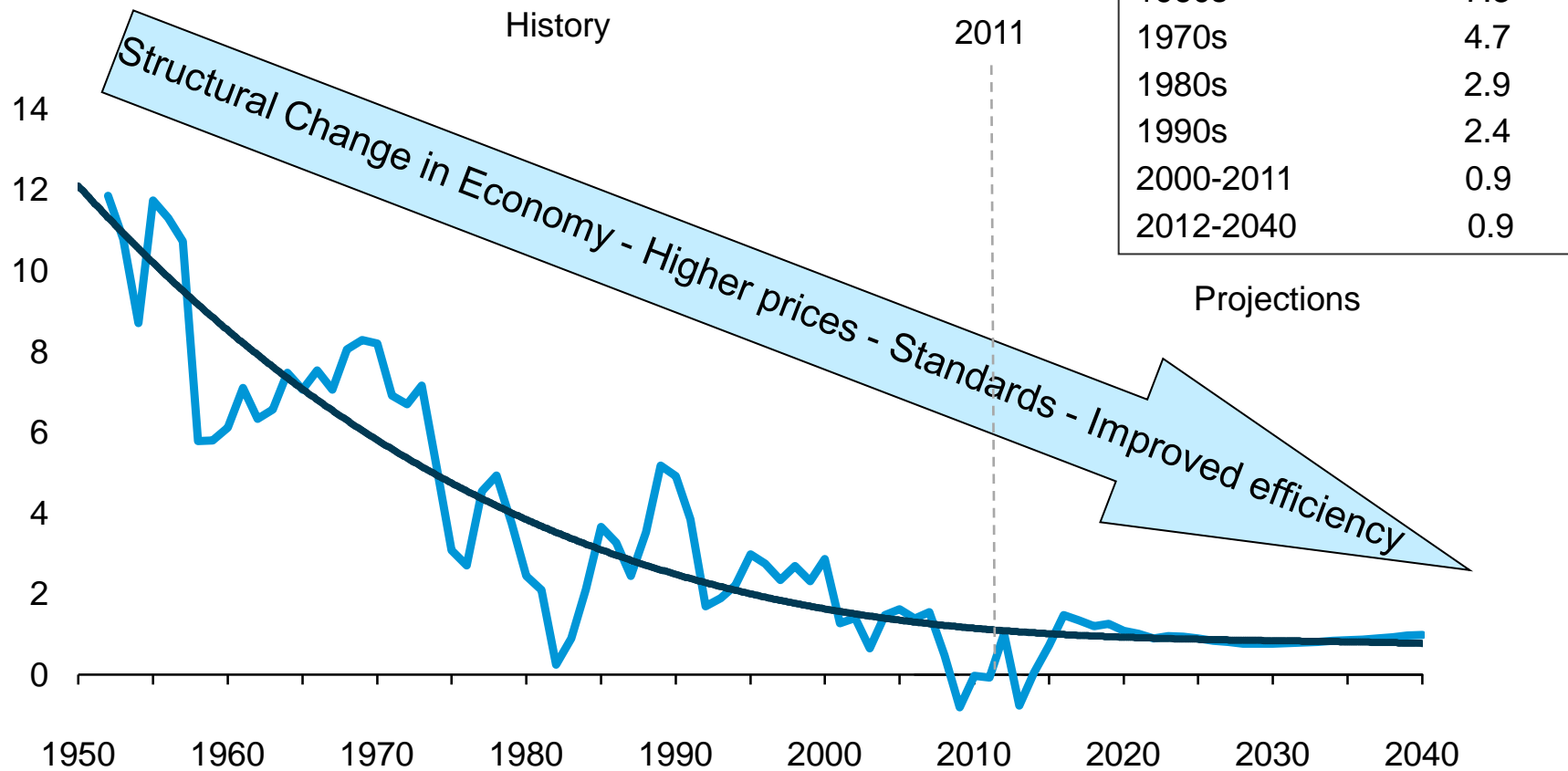
Source: EIA, Annual Energy Outlook 2012

# Coal and Electricity



# Growth in electricity use slows, but still increases by 28% from 2012 to 2040

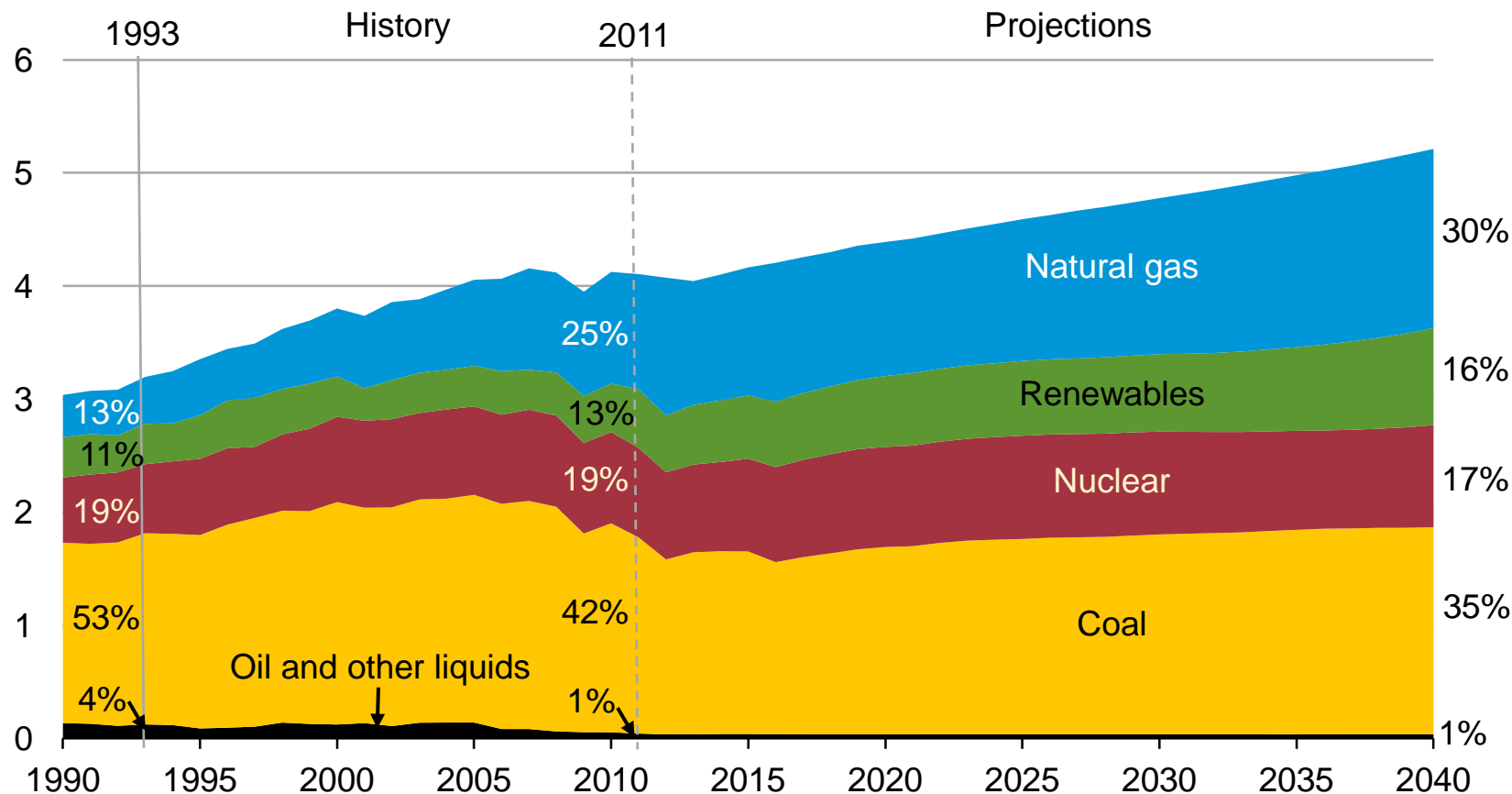
U.S. electricity use  
percent growth (3-year rolling average)



Source: EIA, Annual Energy Outlook 2013 Early Release

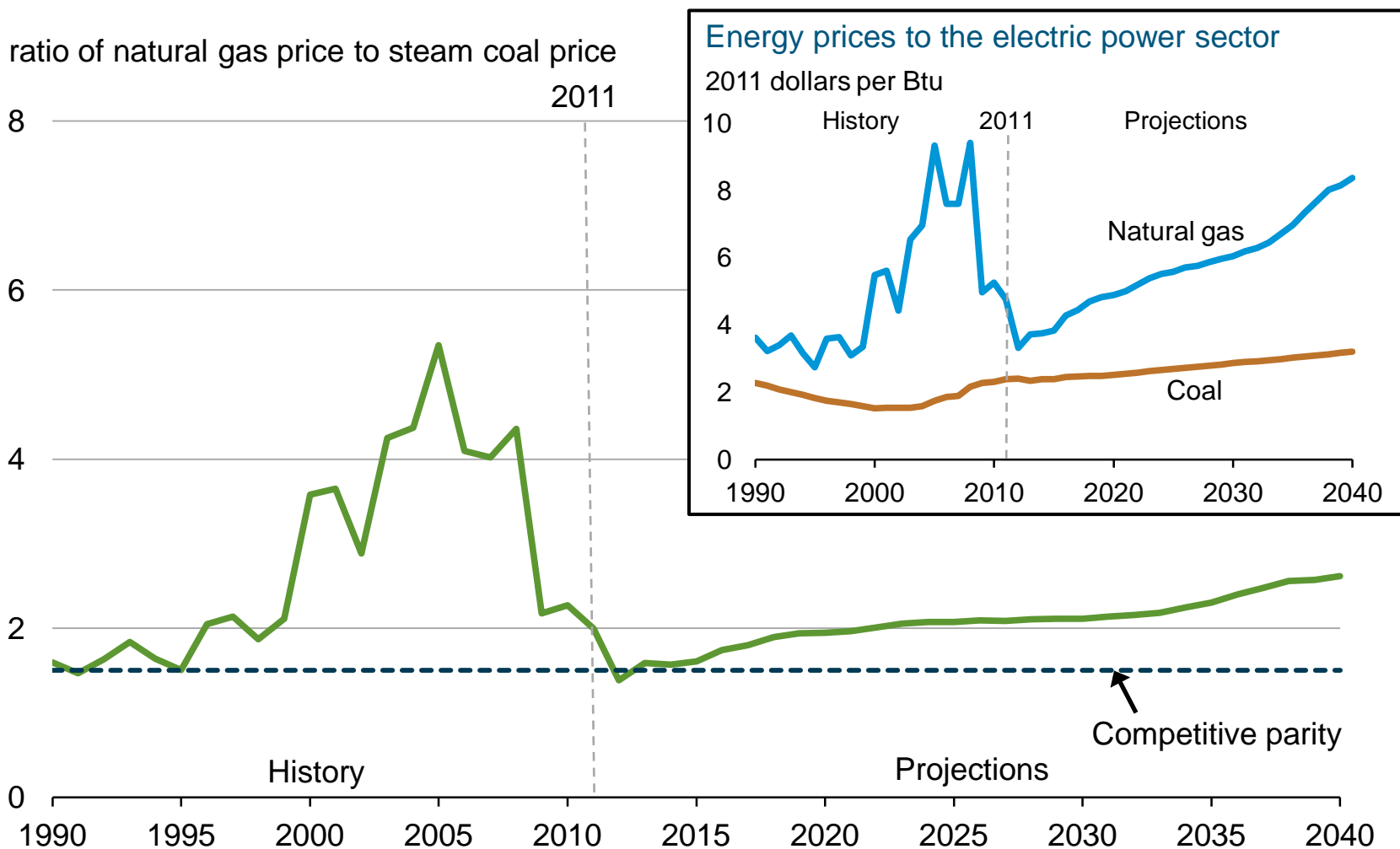
# Over time the electricity mix shifts toward natural gas and renewables, but coal remains the largest fuel source

U.S. electricity net generation  
trillion kilowatthours



Source: EIA, Annual Energy Outlook 2013 Early Release

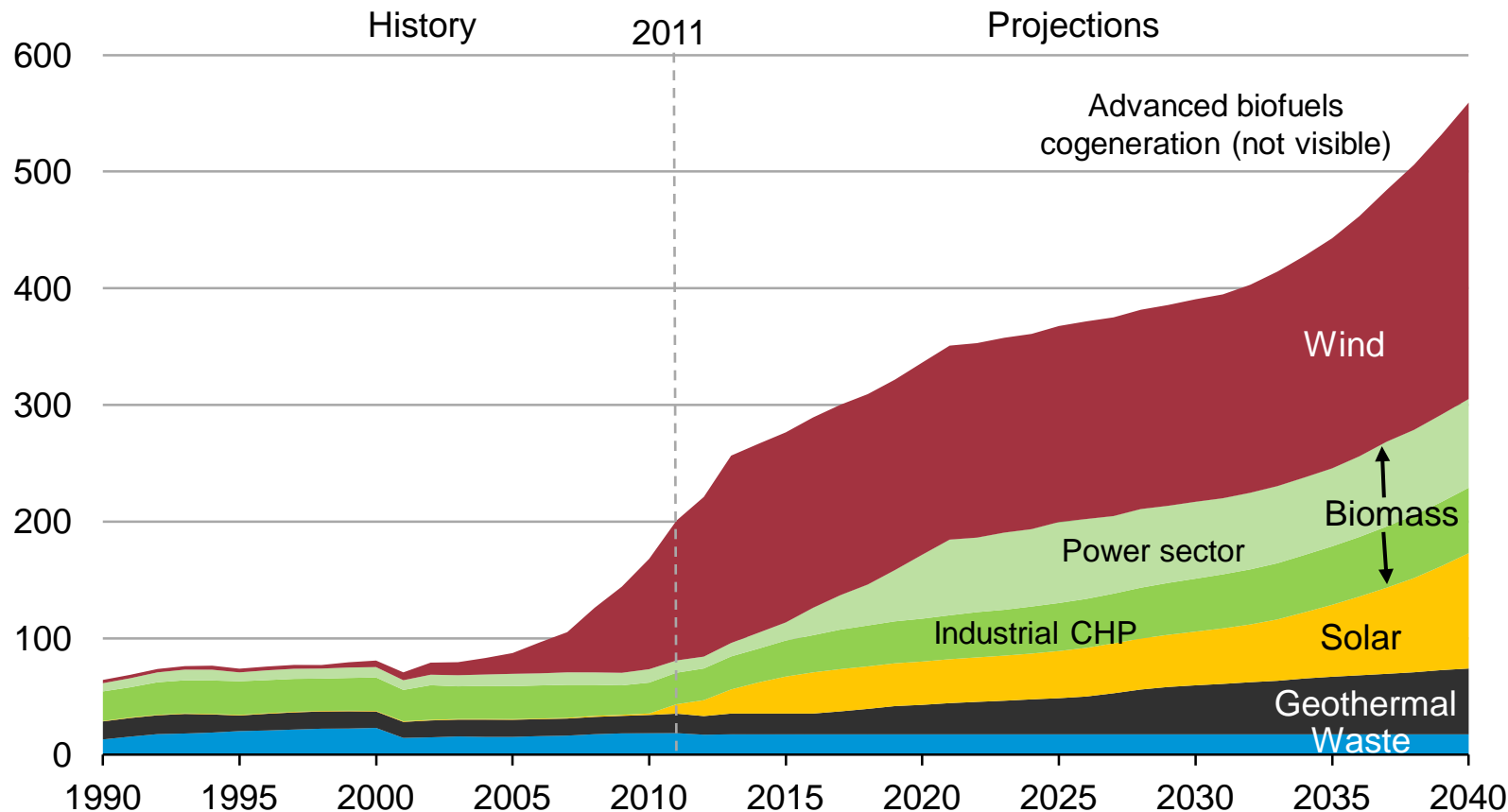
# Coal regains some competitive advantage relative to natural gas over time on a national average basis



Source: EIA, Annual Energy Outlook 2013 Early Release

# Non-hydro renewable generation more than doubles between 2011 and 2040

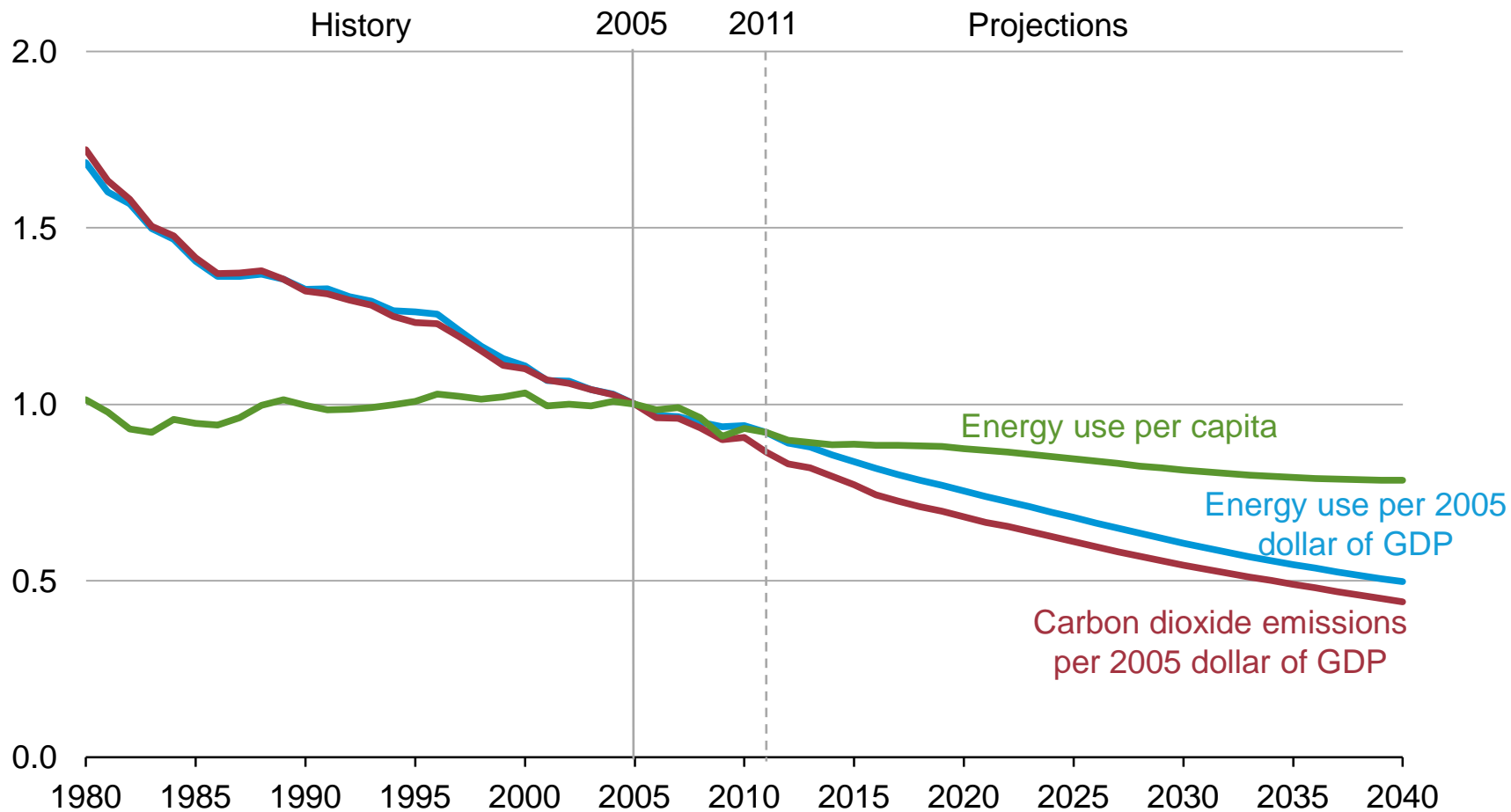
non-hydropower renewable generation  
billion kilowatthours per year



Source: EIA, Annual Energy Outlook 2013 Early Release

# Energy and CO<sub>2</sub> per dollar of GDP continue to decline; per-capita energy use also declines

energy and emission intensity  
index, 2005=1

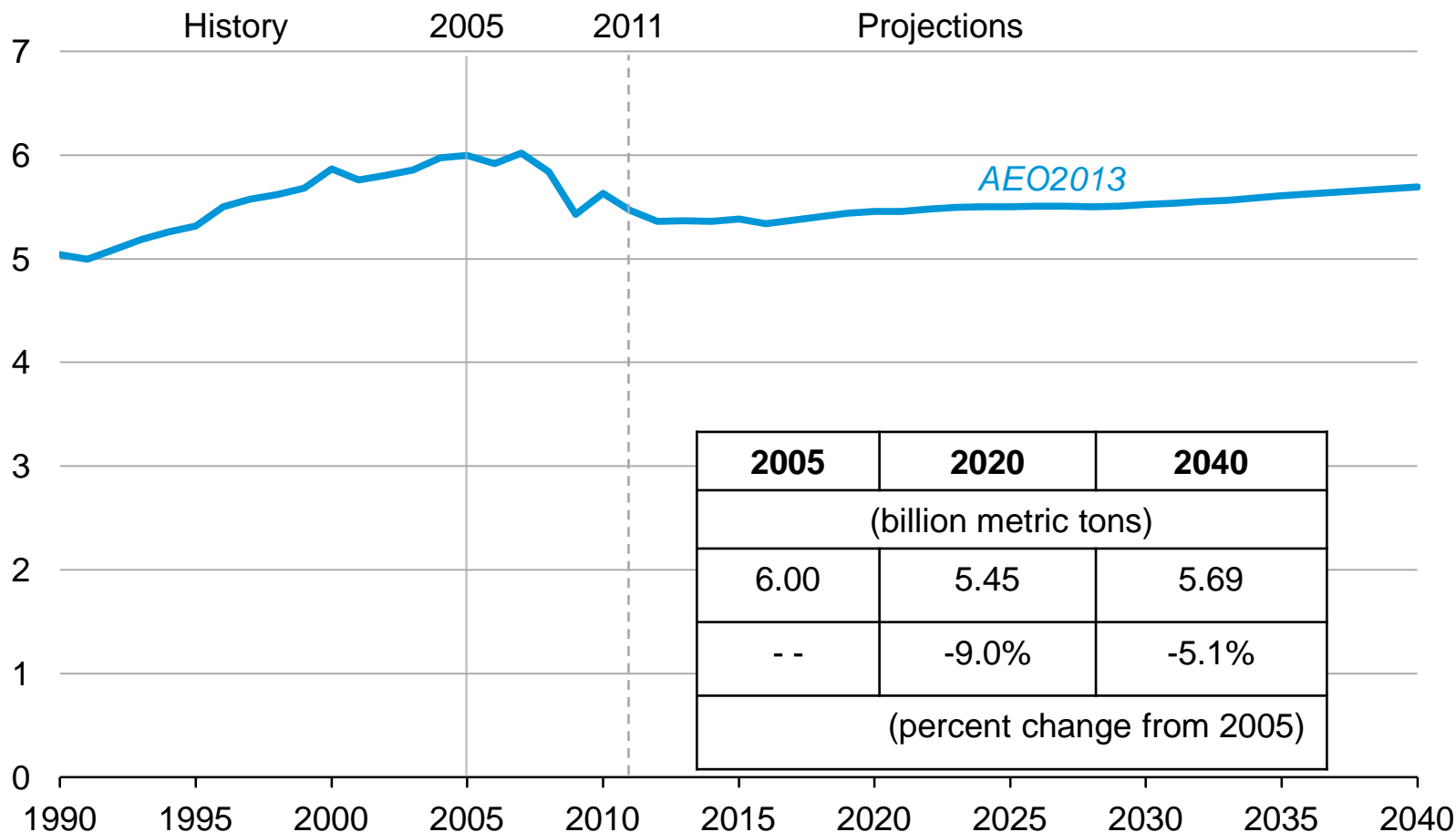


Source: EIA, Annual Energy Outlook 2013 Early Release

# In the *AEO2013* Reference case, energy-related CO<sub>2</sub> emissions never get back to their 2005 level

carbon dioxide emissions

billion metric tons



Source: EIA, Annual Energy Outlook 2013 Early Release

## 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)

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

Today In Energy | [www.eia.gov/todayinenergy](http://www.eia.gov/todayinenergy)

Monthly Energy Review | [www.eia.gov/totalenergy/data/monthly](http://www.eia.gov/totalenergy/data/monthly)

Annual Energy Review | [www.eia.gov/totalenergy/data/annual](http://www.eia.gov/totalenergy/data/annual)

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