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

for

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by

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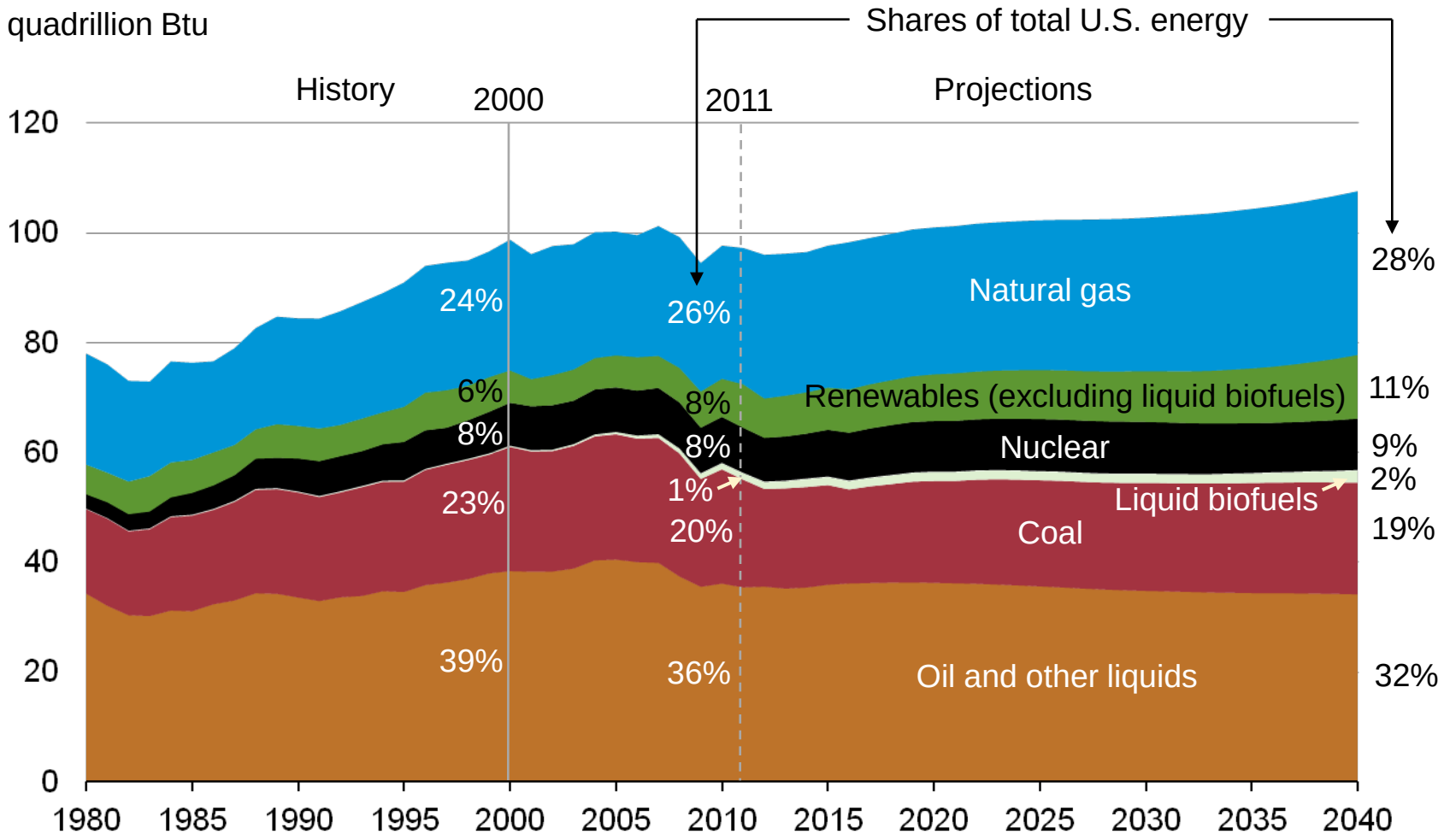
Annual Energy Outlook 2013 projections to 2040

- 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

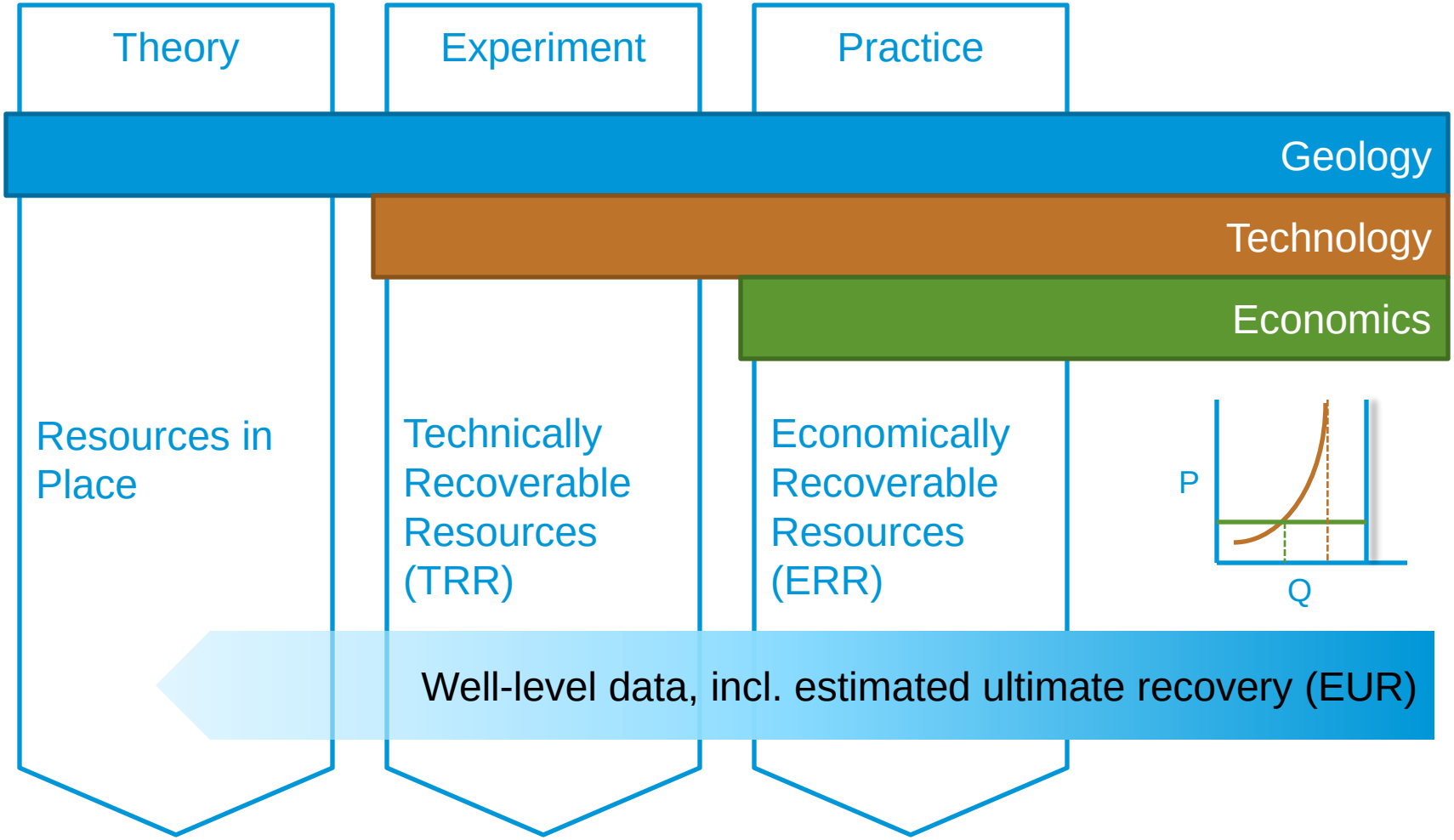
U.S. primary energy consumption
quadrillion Btu



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



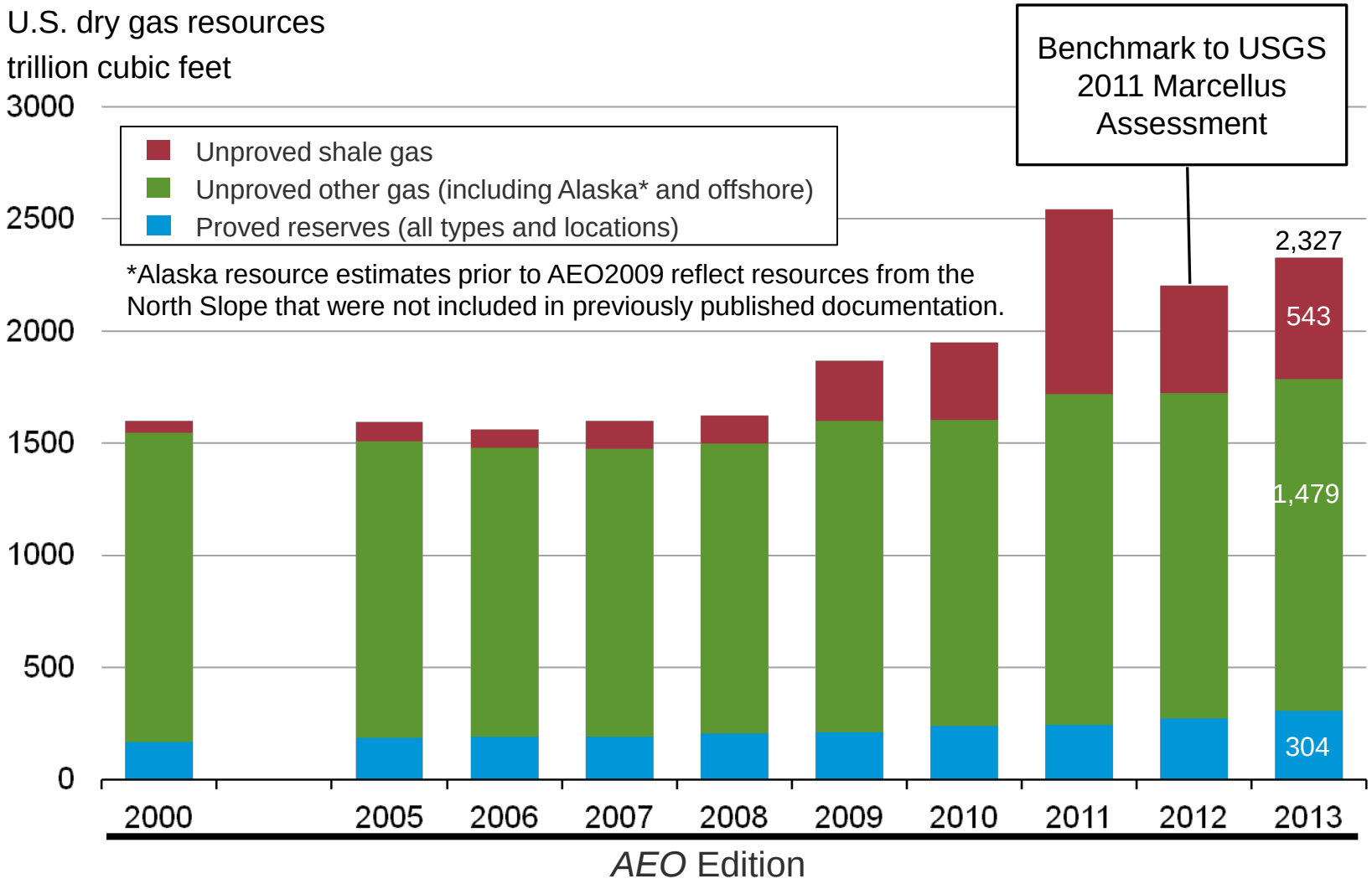
EIA's focus is on the timing of production; the modeling focuses on these parameters

- 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

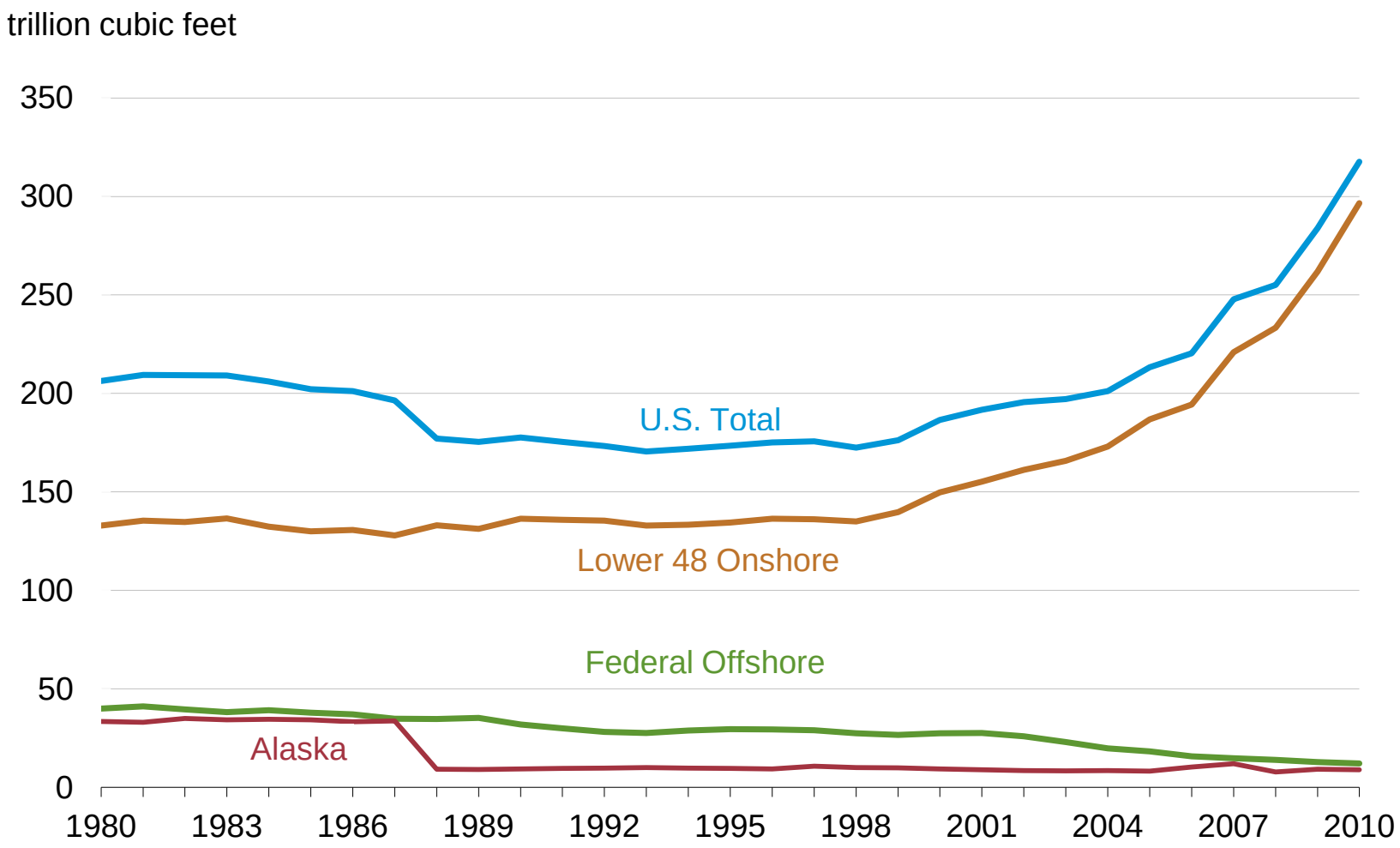
- drilling and operating costs
- number of active rigs
- how many wells a rig can drill (rig efficiency)
- well spacing

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



Source: EIA, Annual Energy Outlook 2013 Early Release

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

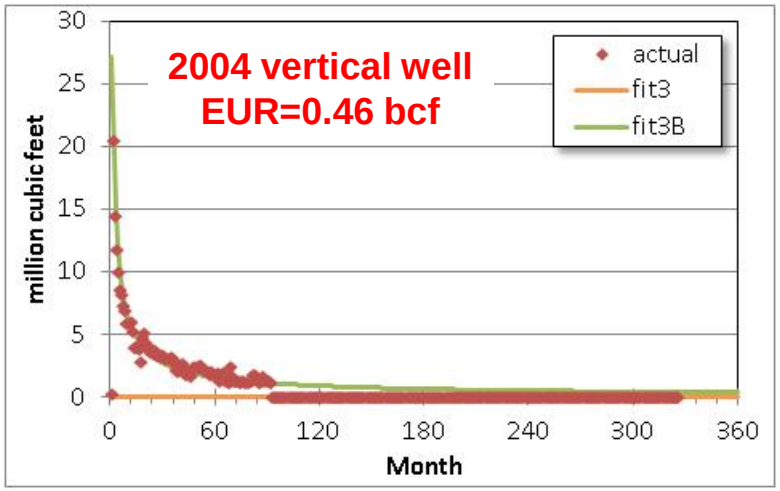


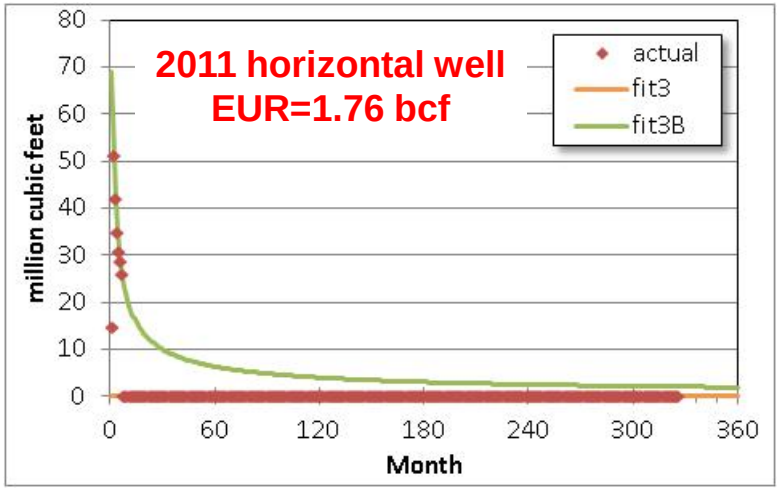
Source: U.S. Energy Information Administration

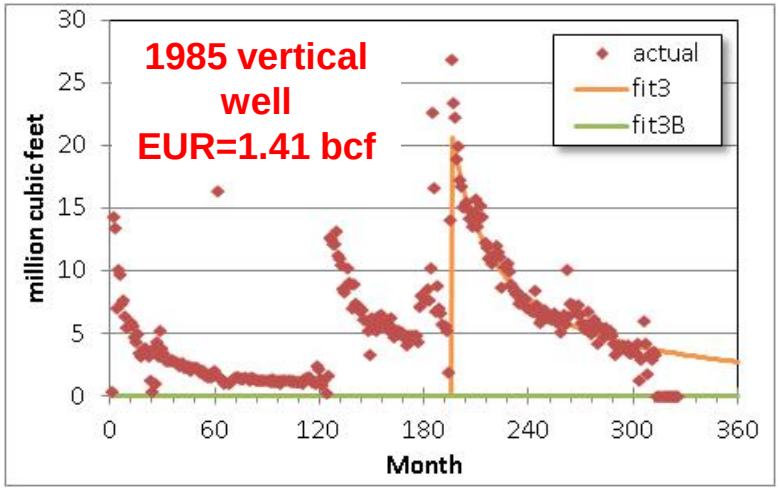
EIA fits well production data to hyperbolic decline curves to estimate EUR

Classic hyperbolic decline curve (Arps 1945):

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

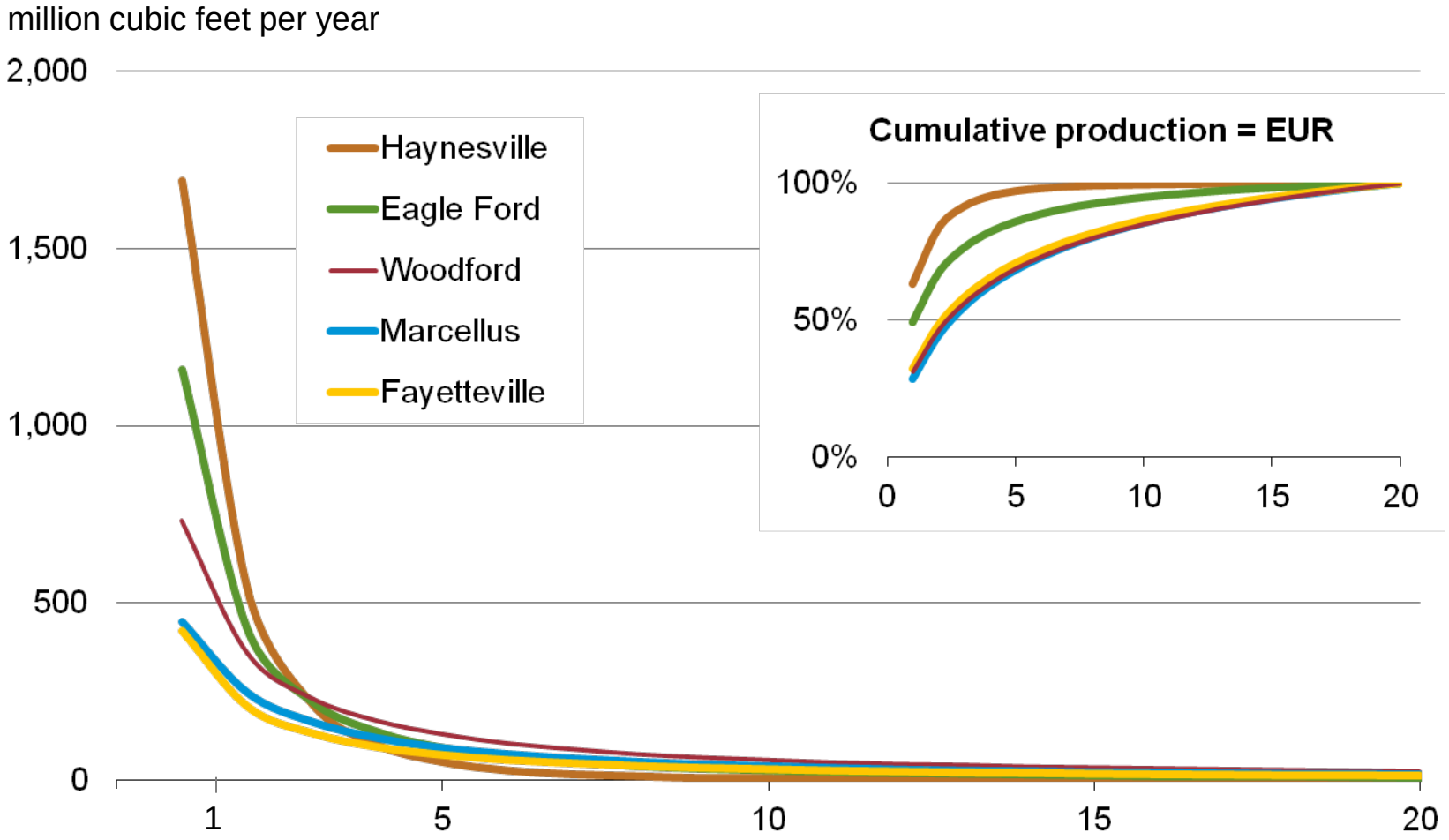






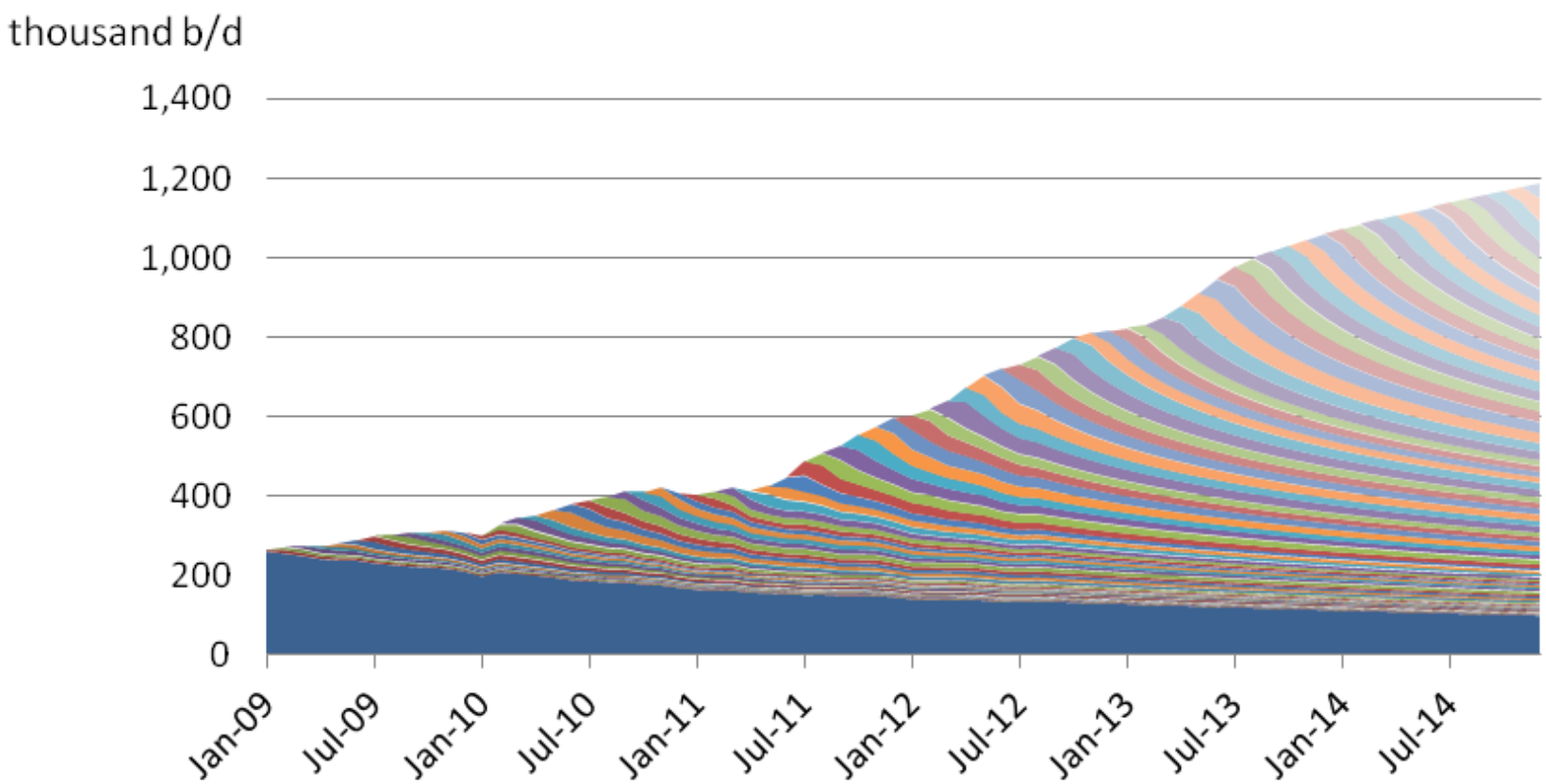
Source: HPDI data from horizontal wells in the Newark East field in the Barnett Shale; EIA analysis

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



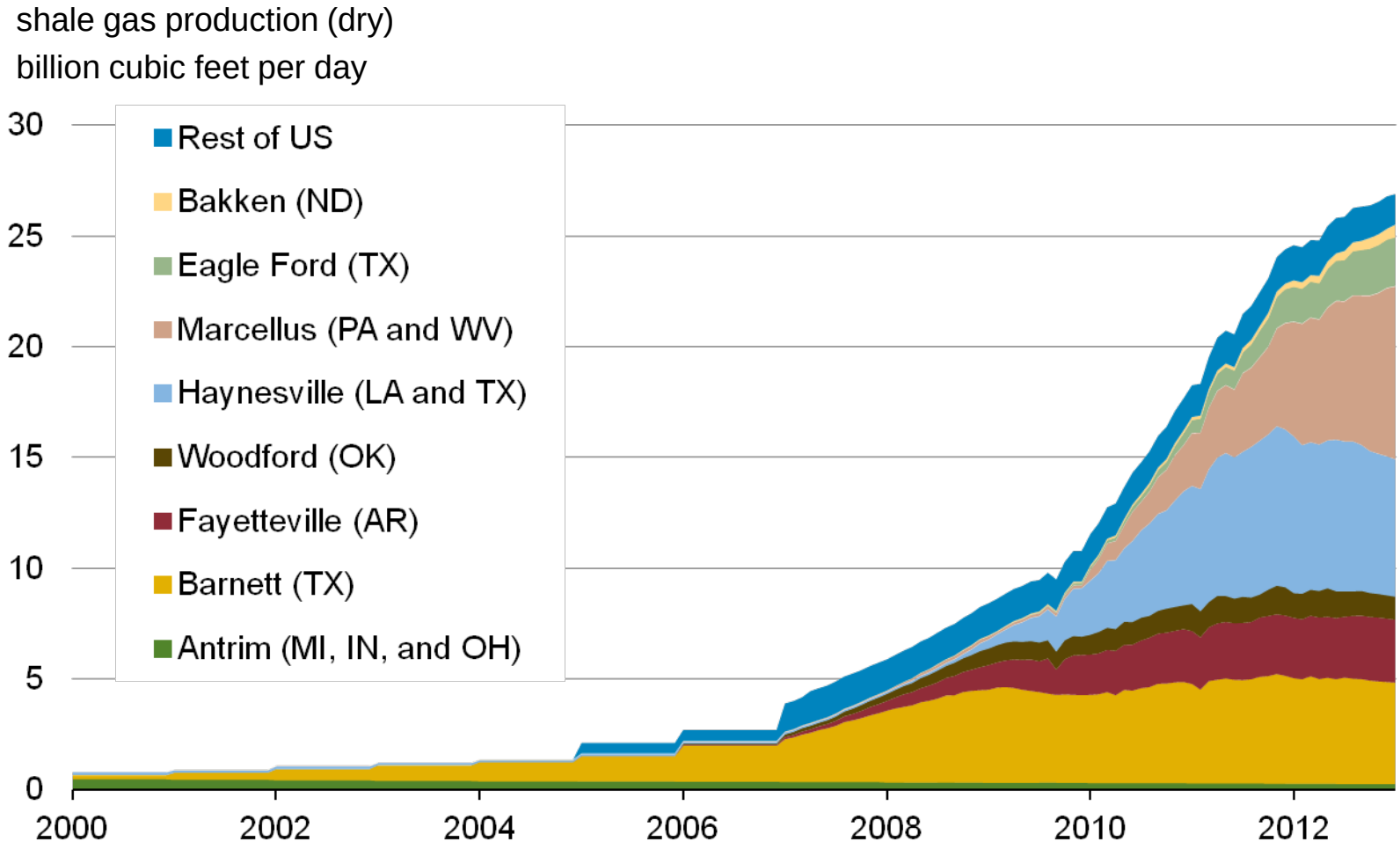
Source: EIA, Annual Energy Outlook 2012

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

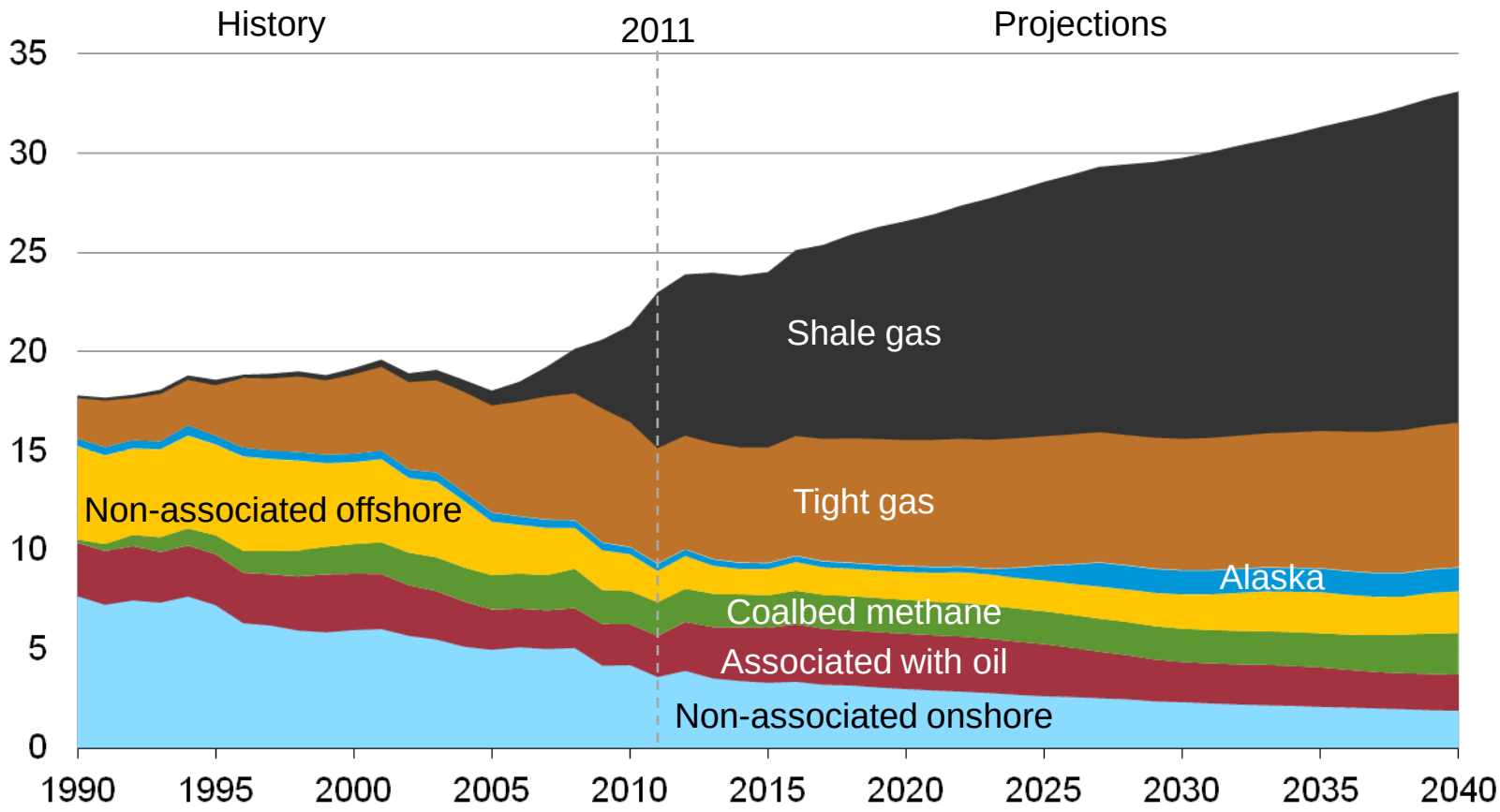
Domestic production of shale gas has grown dramatically over the past few years



Sources: LCI Energy Insight gross withdrawal estimates as of January 2013 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

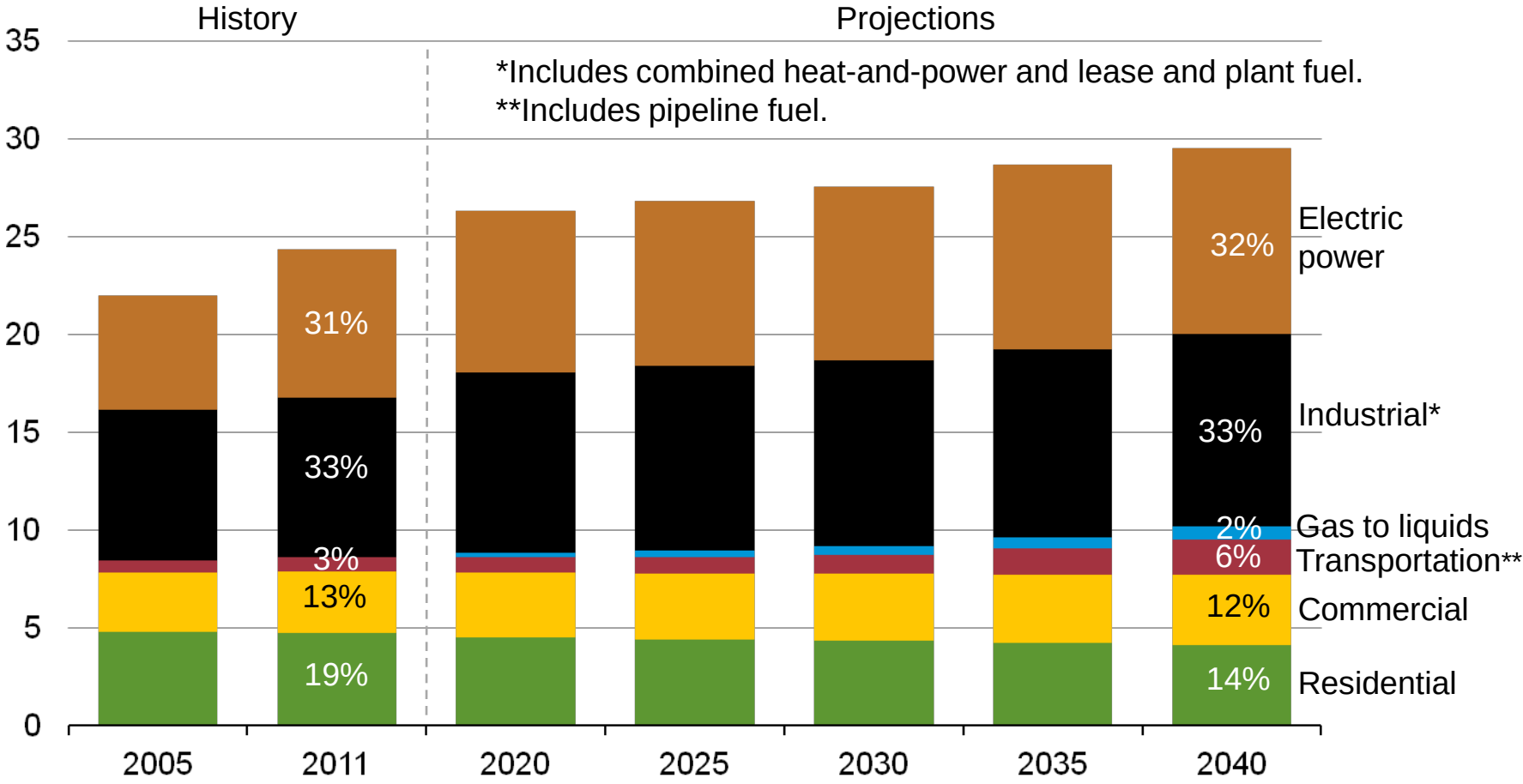
U.S. dry natural gas production
trillion cubic feet



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

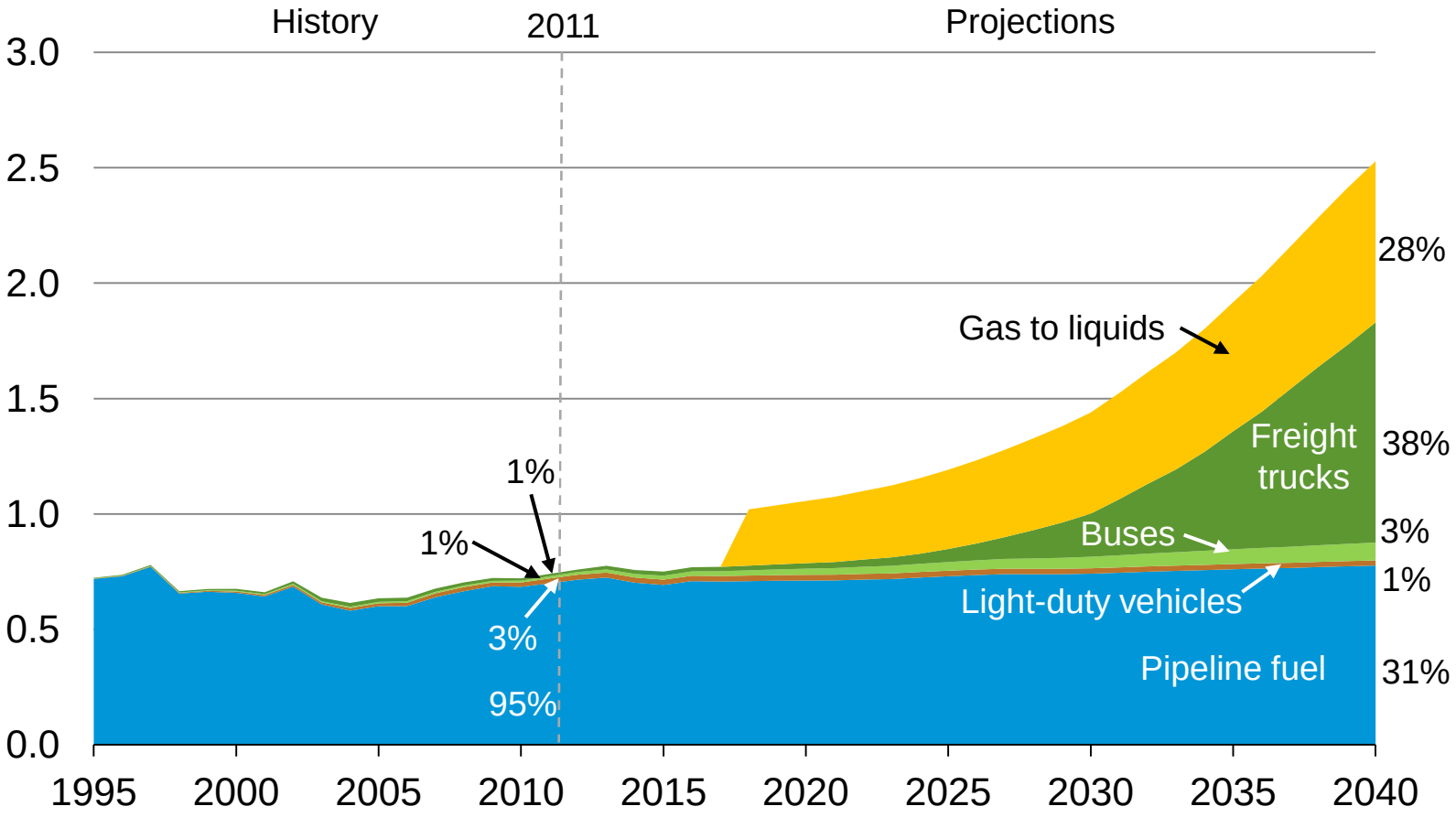
U.S. dry gas consumption
trillion cubic feet



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

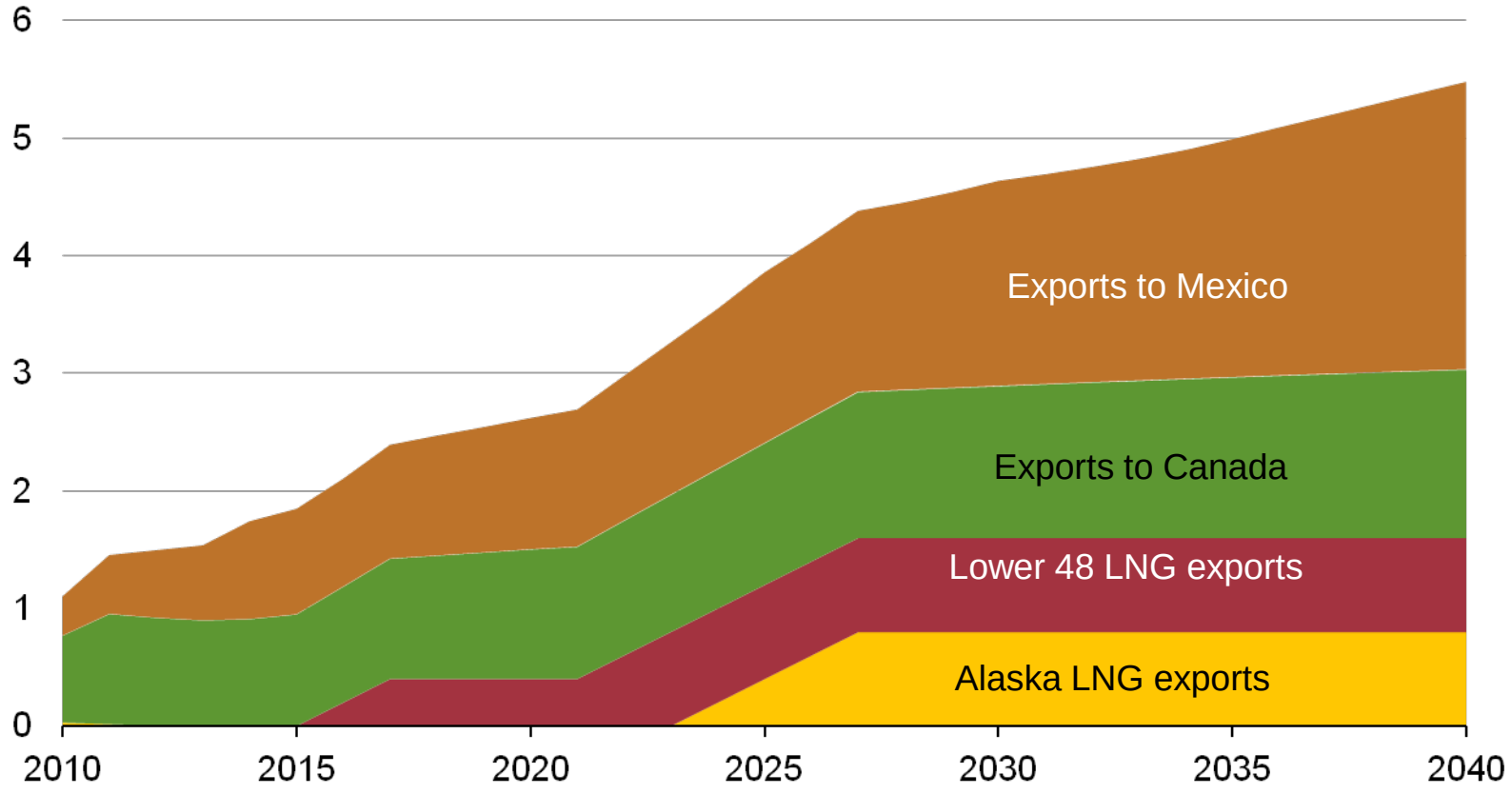


Note: Gas to liquids includes heat, power, and losses.

Source: EIA, Annual Energy Outlook 2013 Early Release

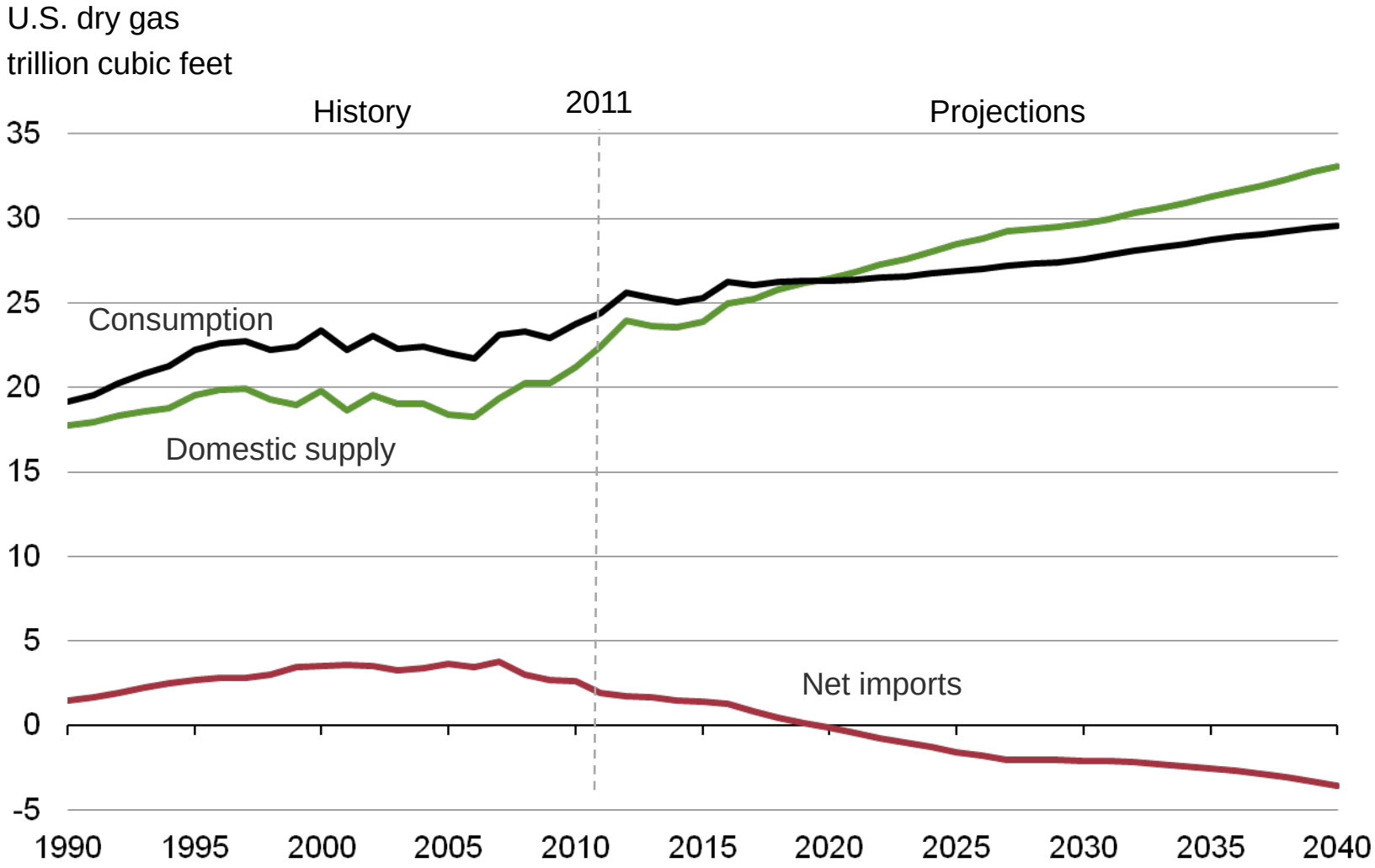
Total natural gas exports nearly quadruple by 2040 in the *AEO2013* Reference case

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



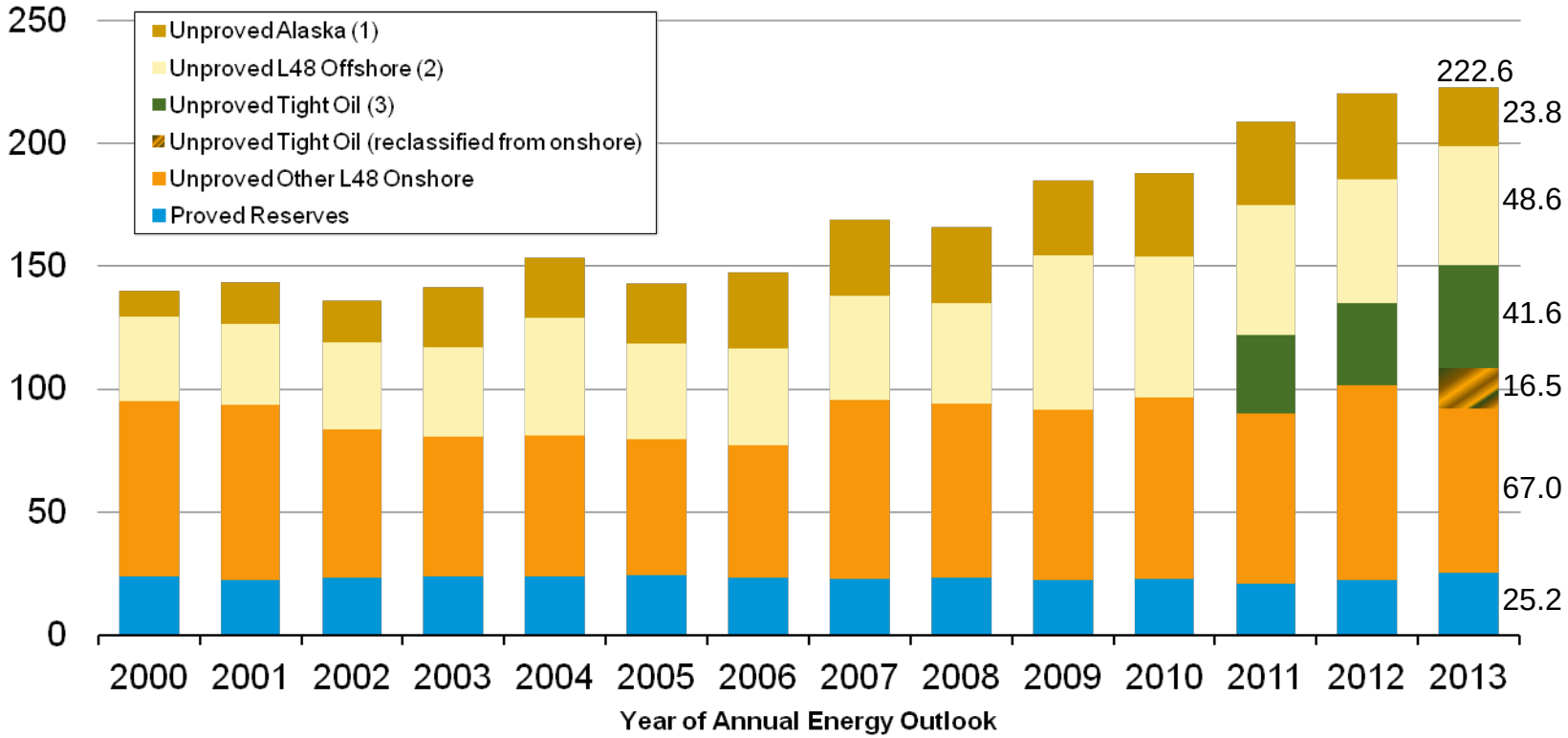
Source: EIA, Annual Energy Outlook 2013 Early Release

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



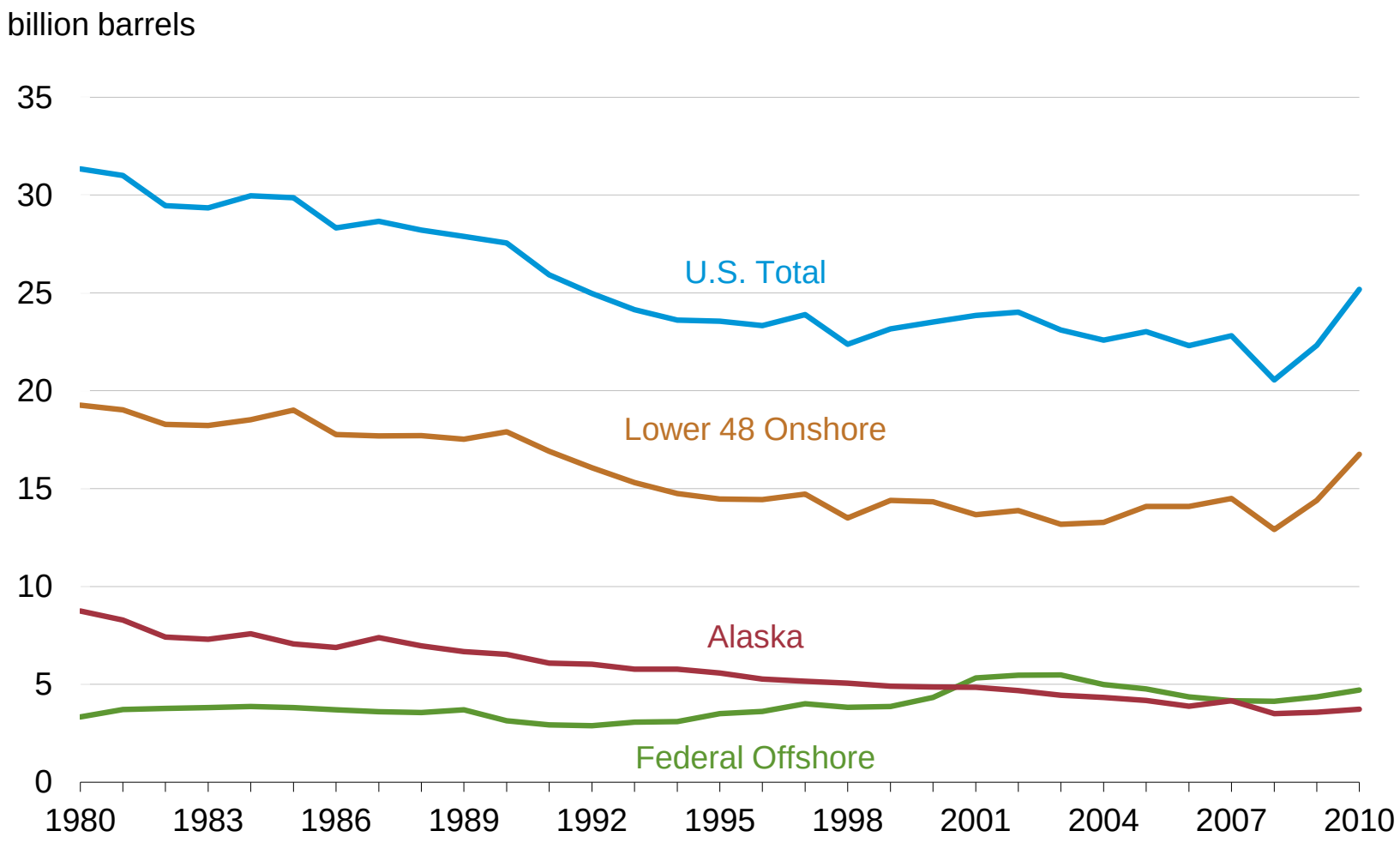
(1) The USGS reduced NPR-A resource estimates, which is responsible for the lower AEO2013 Alaska resources.

(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

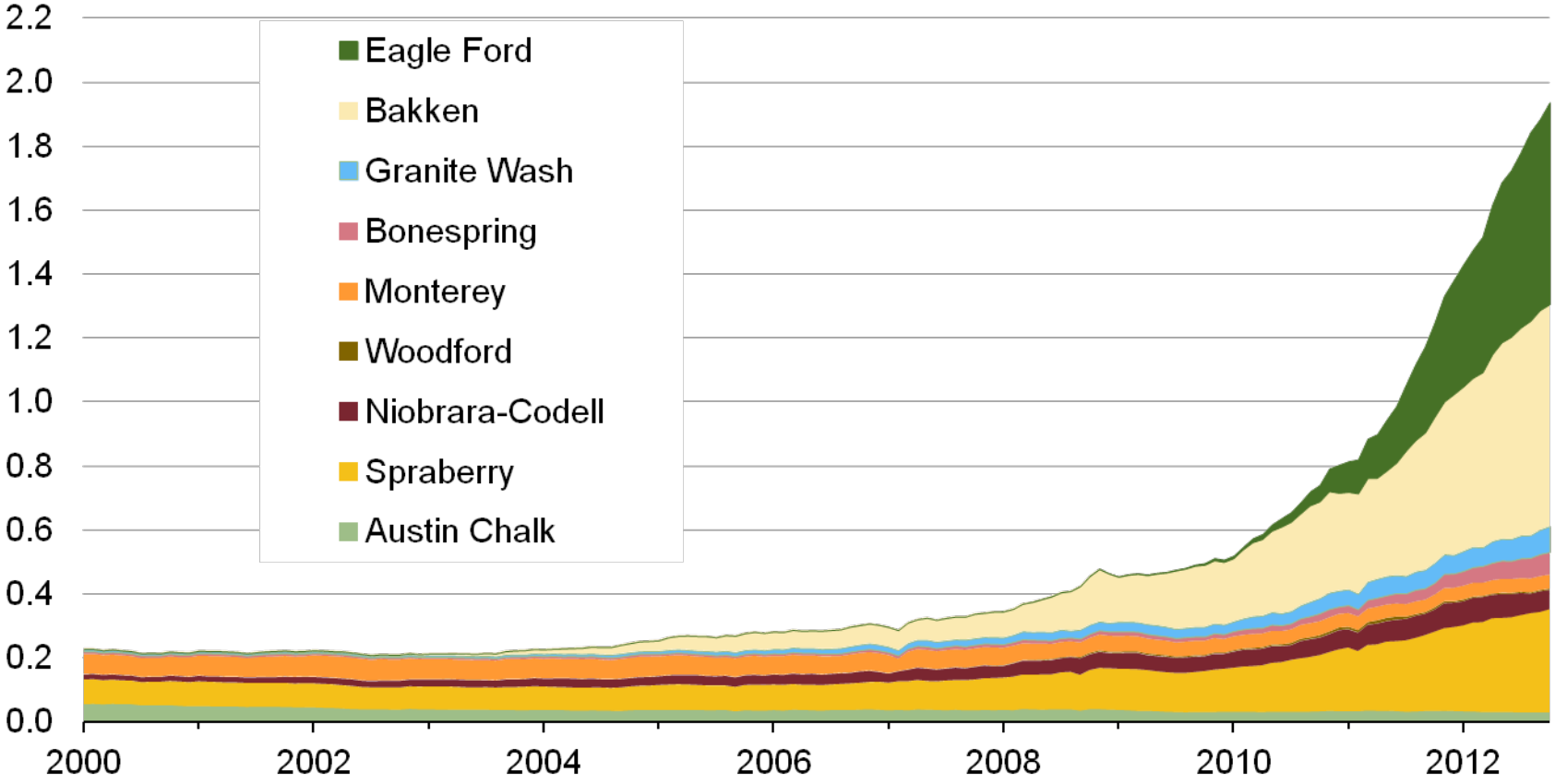
U.S. crude oil plus condensate proved reserves, 1980-2010



Source: U.S. Energy Information Administration

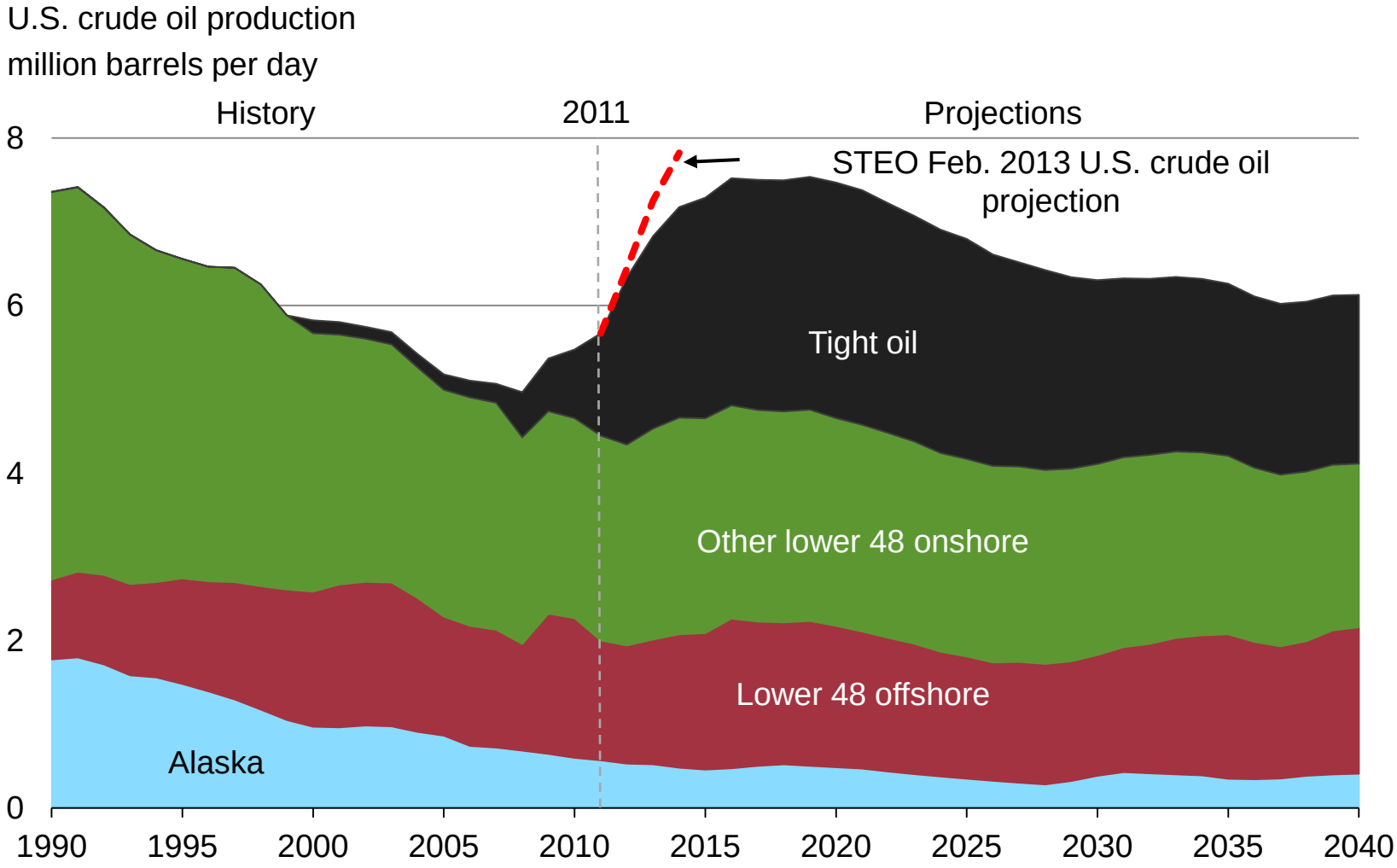
Domestic production of tight oil has grown dramatically over the past few years

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 October 2012.

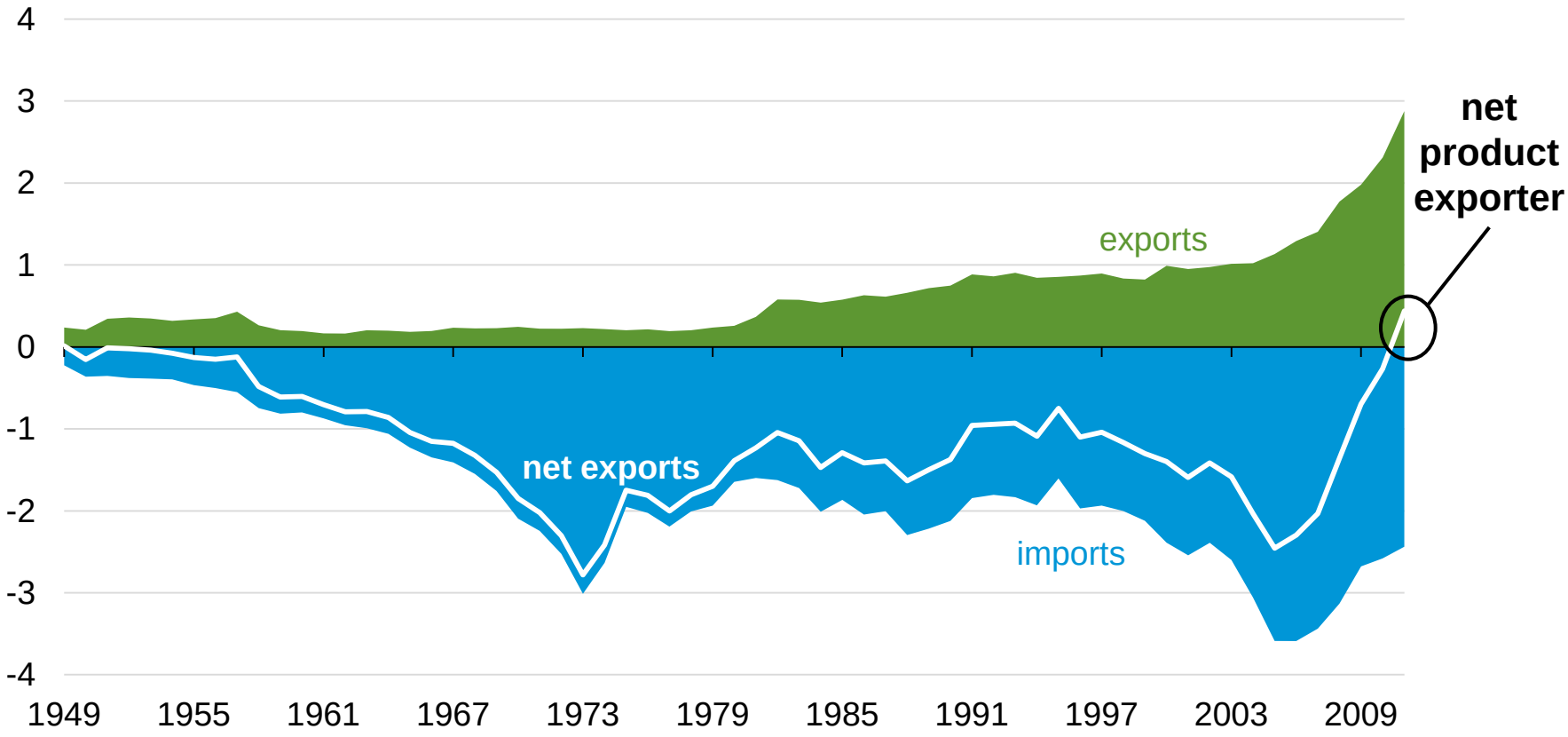
U.S. tight oil production leads a growth in domestic production of 2.6 million barrels per day between 2008 and 2019



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

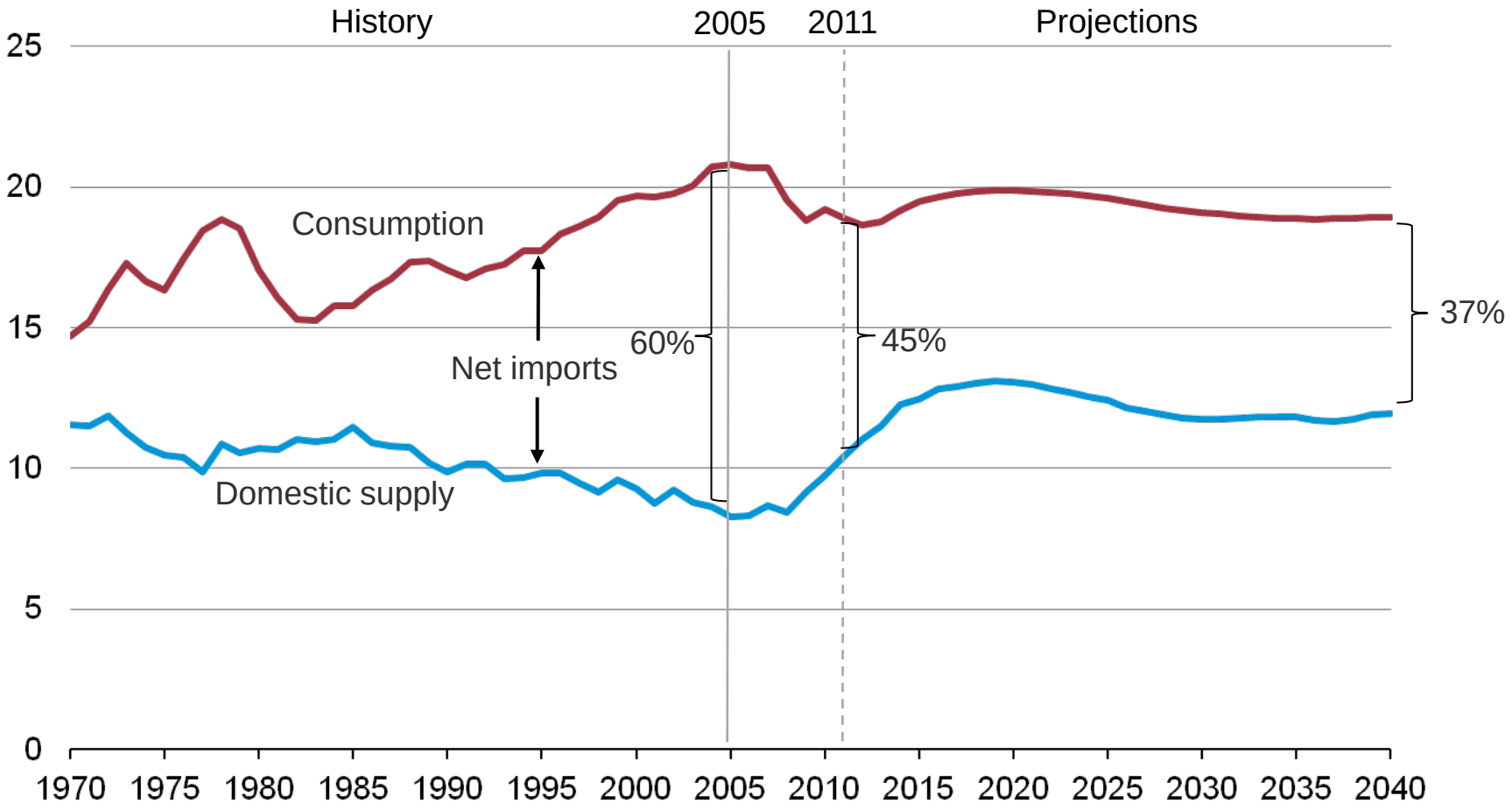
annual U.S. net exports of total petroleum products, 1949 – 2011
million barrels per day



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

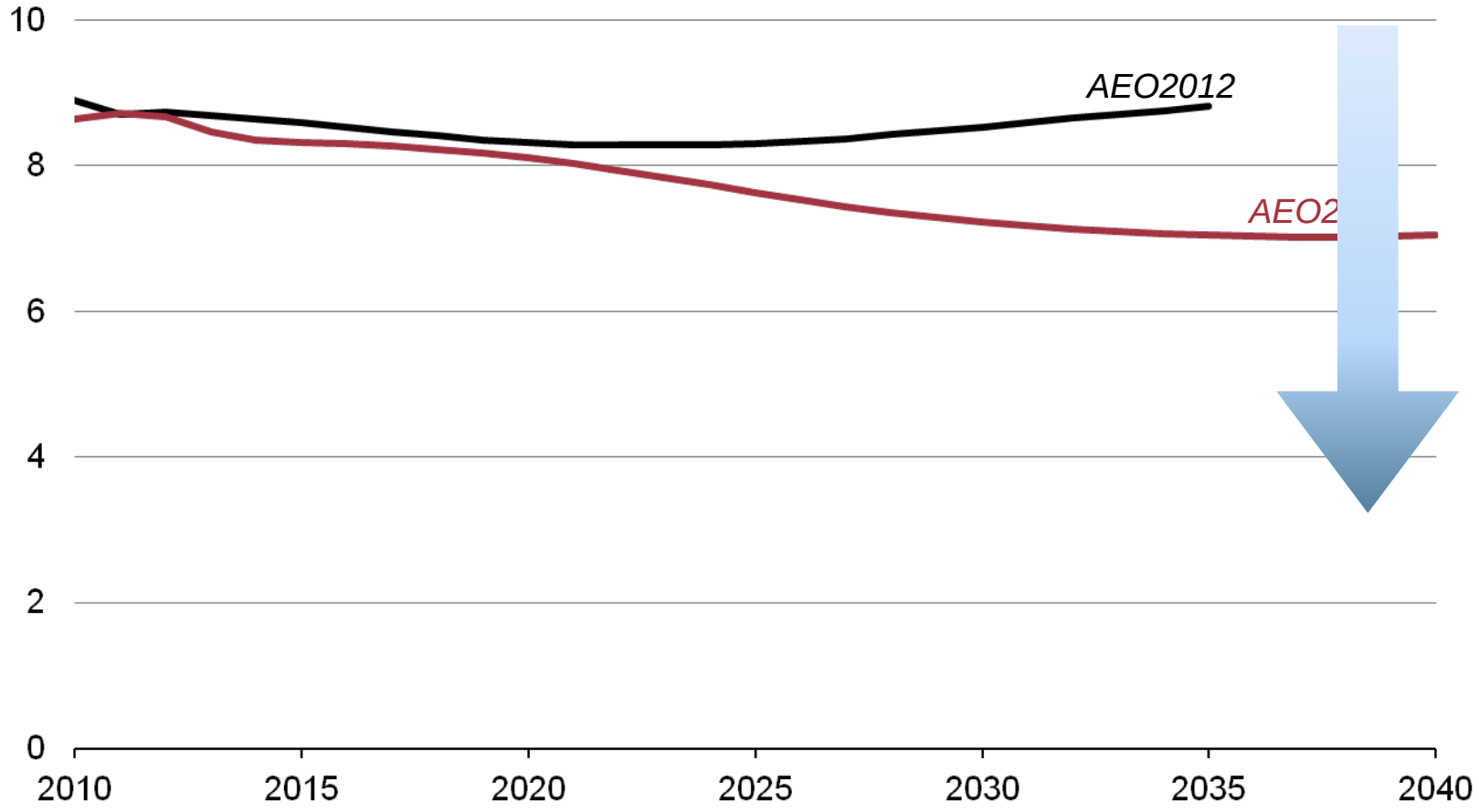


Source: EIA, Annual Energy Outlook 2013 Early Release

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

light-duty vehicle liquids consumption

million barrels per day

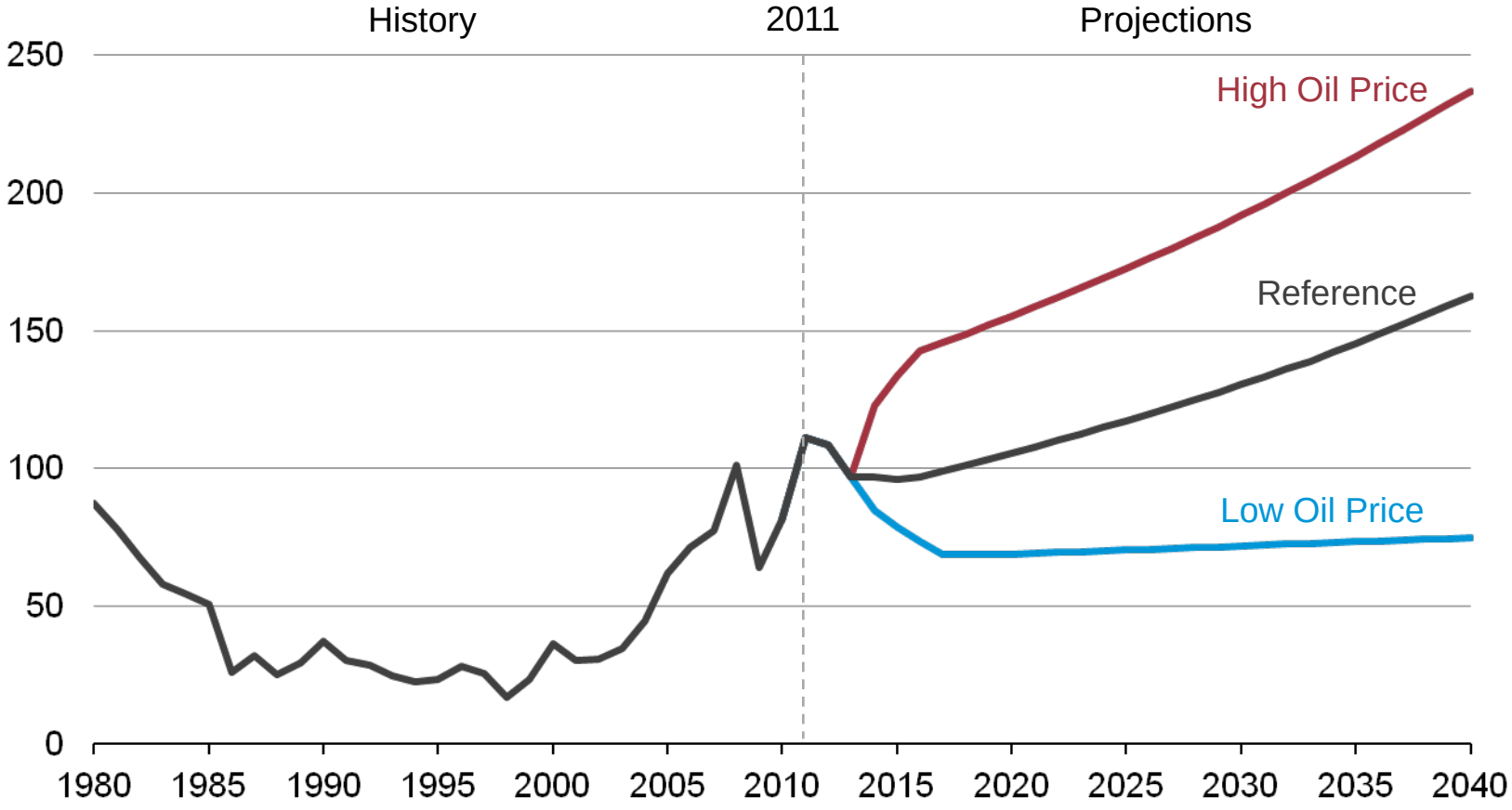


Source: EIA, Annual Energy Outlook 2013 Early Release

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

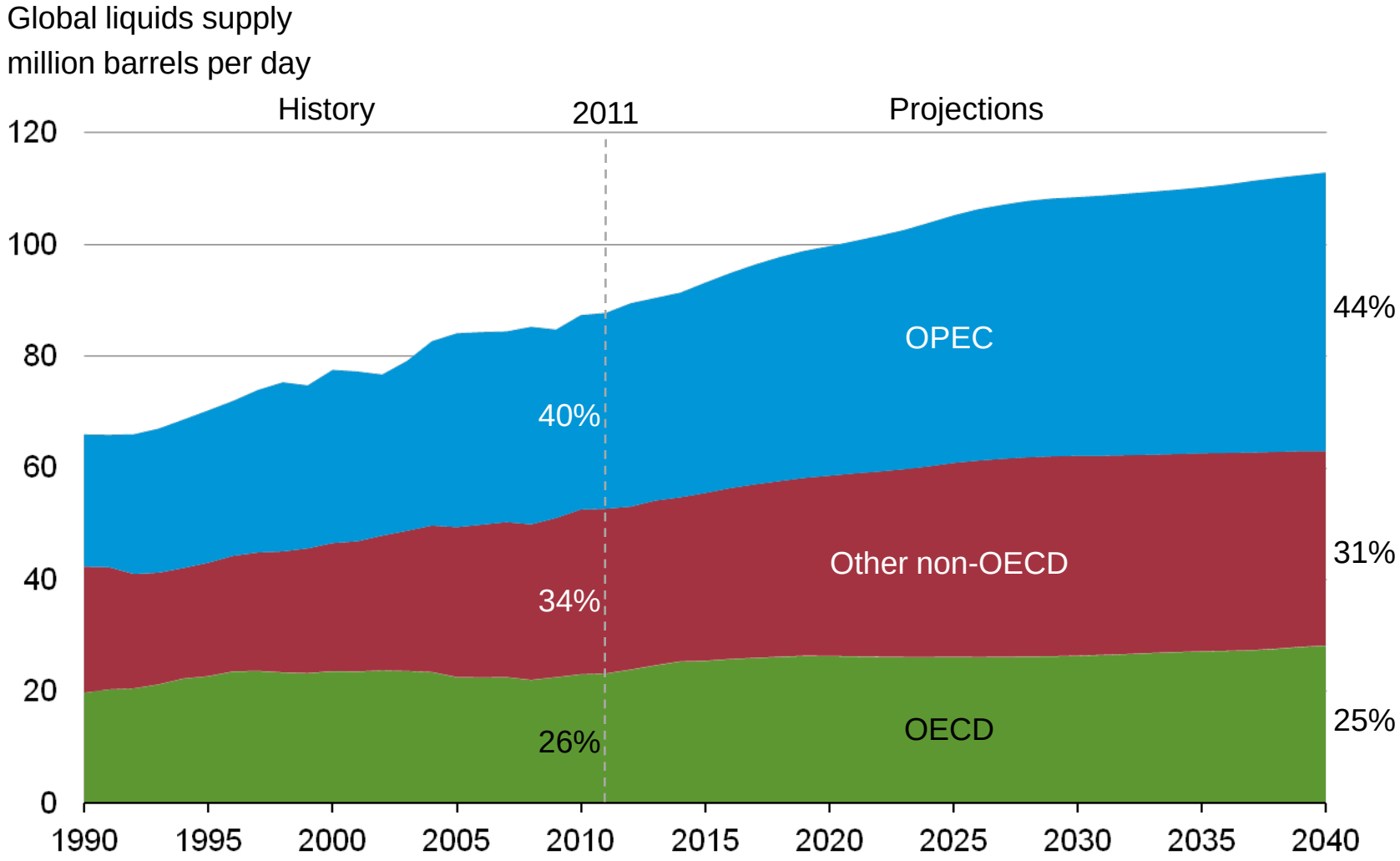
Annual average spot price of Brent crude oil

2011 dollars per barrel



Source: EIA, Annual Energy Outlook 2013 Early Release

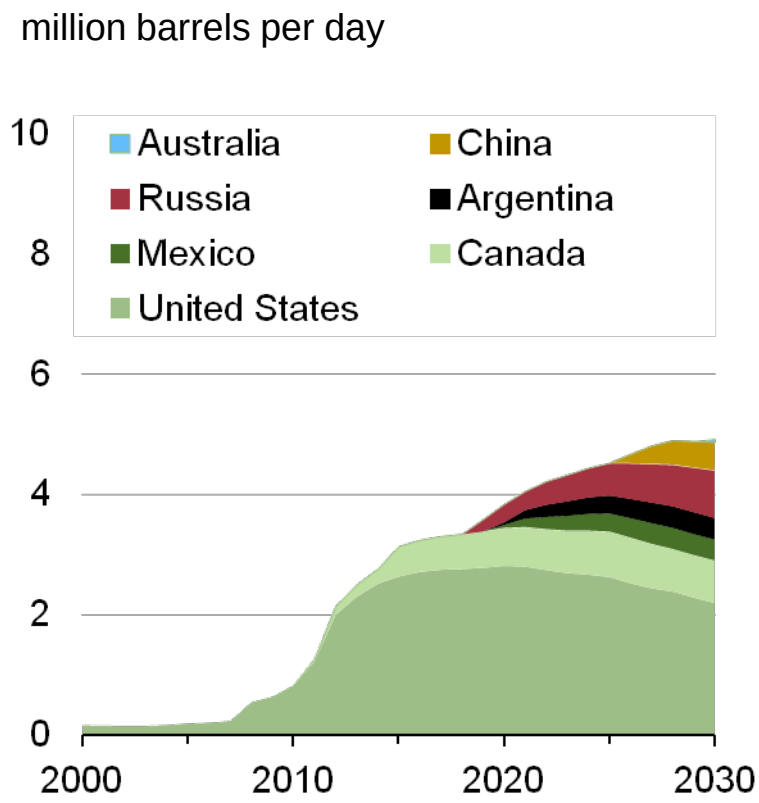
Global liquids supply increases 26 percent with regional market shares relatively stable



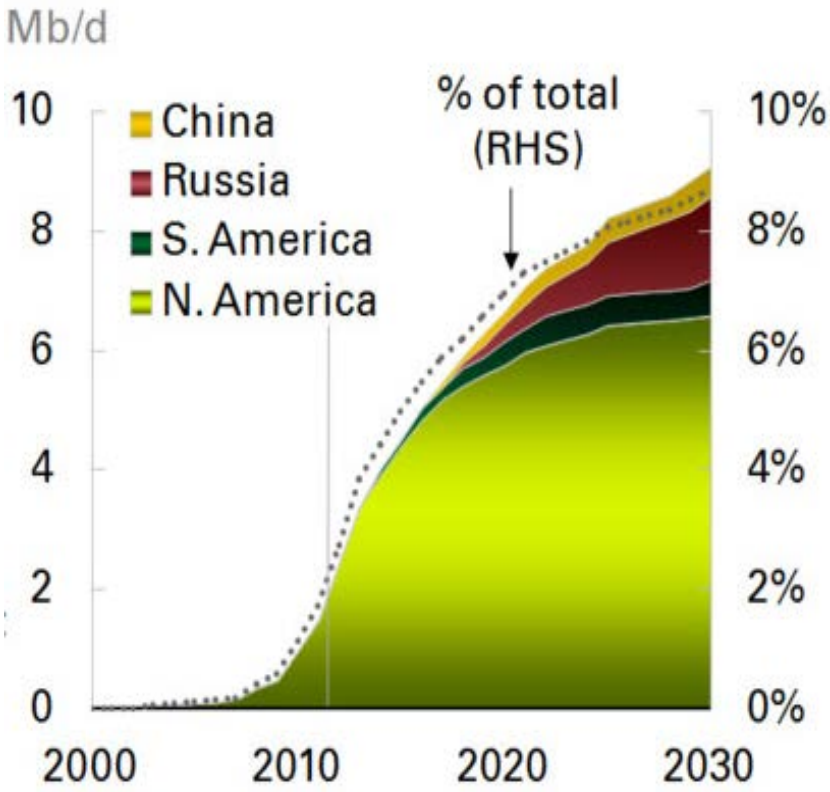
Source: EIA, Annual Energy Outlook 2013 Early Release

Global tight oil production comparisons

IEO2013 DRAFT



BP Energy Outlook 2030



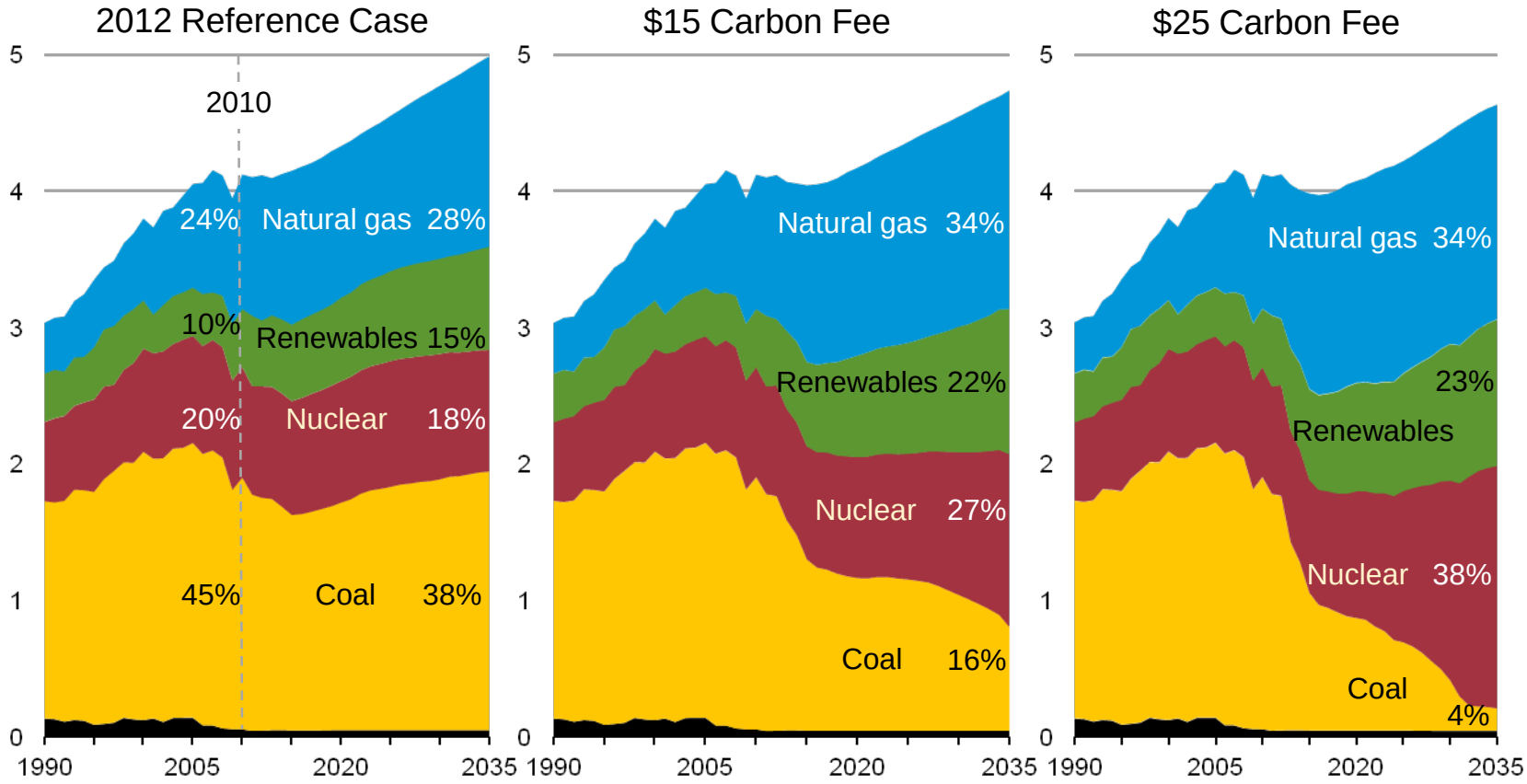
Source: Preliminary International Energy Outlook 2013, BP Energy Outlook 2030

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

For more information

U.S. Energy Information Administration home page | www.eia.gov

Annual Energy Outlook | www.eia.gov/forecasts/aeo

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

International Energy Outlook | www.eia.gov/forecasts/ieo

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Annual Energy Review | www.eia.gov/totalenergy/data/annual