

2017

Sustainable Energy In America

FACTBOOK



Energy
Efficiency



Natural
Gas



Renewable
Energy

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What is it?

- Aims to augment existing, reputable sources of information on US energy
- Focuses on **renewables, efficiency, natural gas**
- **Fills important data gaps** in certain areas (eg, investment flows by sector, contribution of distributed energy)
- Contains data through the end of 2016 wherever possible
- Employs **Bloomberg New Energy Finance data** in most cases, augmented by EIA, FERC, ACEEE, LBNL, and other sources where necessary
- Contains the very **latest information on new energy technology costs**
- Has been graciously underwritten by the **Business Council for Sustainable Energy**
- Is in its **fifth edition** (first published in January 2013)

What's new?

- **Format:** This year's edition of the Factbook (this document) consists of Powerpoint slides showing updated charts. For those looking for more context on any sector, the 2014 edition can continue to serve as a reference. The emphasis of this 2017 edition is to *capture new developments that occurred in the past year*.
- **Updated analysis:** Most charts have been extended by one year to capture the latest data.
- **2016 developments:** The text in the slides highlights major changes that occurred over the past year.
- **New coverage:** This report contains data shown for the first time in the Factbook, including transmission investment, PURPA-driven solar build, battery pricing, natural gas exports, energy spending, biofuel blending and electric vehicle model availability.

About the Factbook (2 of 4): Understanding terminology for this report

	FOSSIL-FIRED / NUCLEAR POWER	RENEWABLE ENERGY	DISTRIBUTED POWER, STORAGE, EFFICIENCY	TRANSPORT
SUSTAINABLE ENERGY (as defined in this report)	<ul style="list-style-type: none"> Natural gas CCS 	<ul style="list-style-type: none"> Solar Wind Geothermal Hydro Biomass Biogas Waste-to-energy 	<ul style="list-style-type: none"> Small-scale renewables CHP and WHP Fuel cells Storage Smart grid / demand response Building efficiency Industrial efficiency (aluminum) Direct use applications for natural gas 	<ul style="list-style-type: none"> Electric vehicles (including hybrids) Natural gas vehicles
OTHER CLEAN ENERGY (not covered in this report)	<ul style="list-style-type: none"> Nuclear 	<ul style="list-style-type: none"> Wave / tidal 	<ul style="list-style-type: none"> Lighting Industrial efficiency (other industries) 	



2016: achieving new highs



Sustainable energy: the new normal



Falling costs to consumers

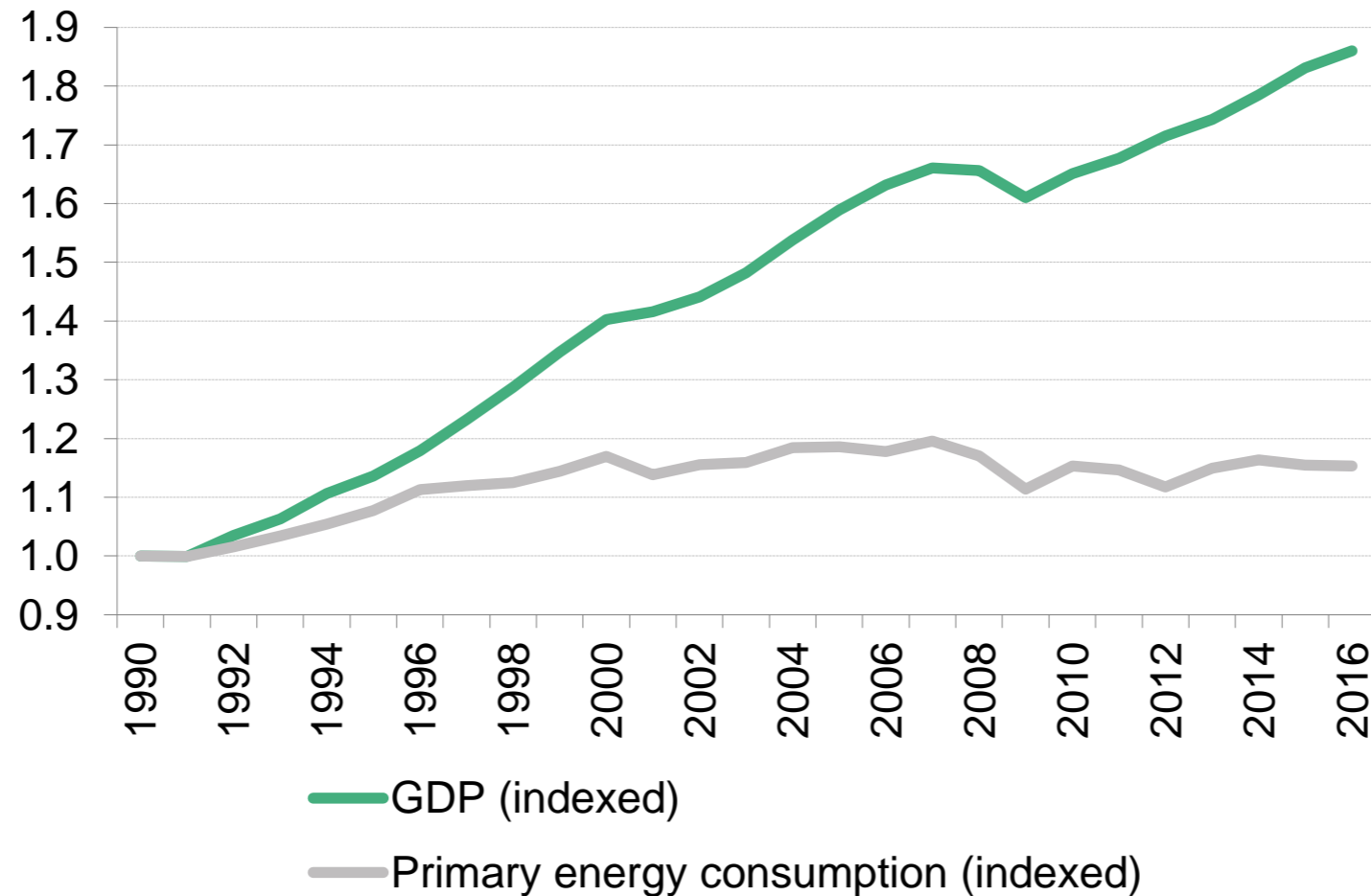


Wrap-up

2016: achieving new highs

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US energy overview: The economy is more energy productive than ever



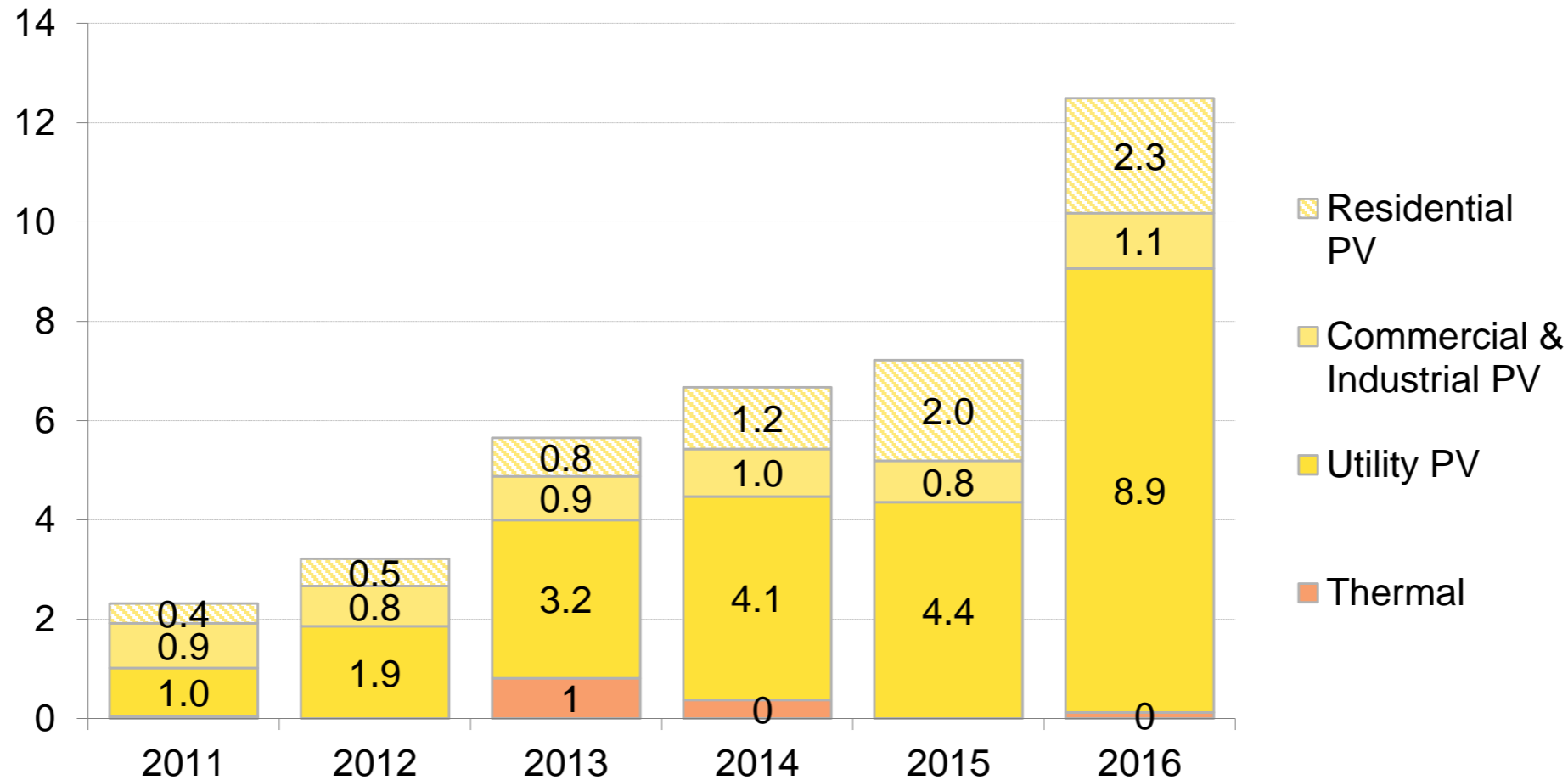
- Energy productivity continues to rise: in 2016, GDP rose 1.6% while total primary energy consumption fell by 0.2%.

Source: US Energy Information Administration (EIA), Bureau of Economic Analysis, Bloomberg Terminal

Notes: Values for 2016 energy consumption are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2016). GDP is real and chained (2009 dollars); annual growth rate for GDP for 2016 is based on consensus of economic forecasts gathered on the Bloomberg Terminal as of January 2017.

Deployment: US solar build sets new records

Build by sector (GW)

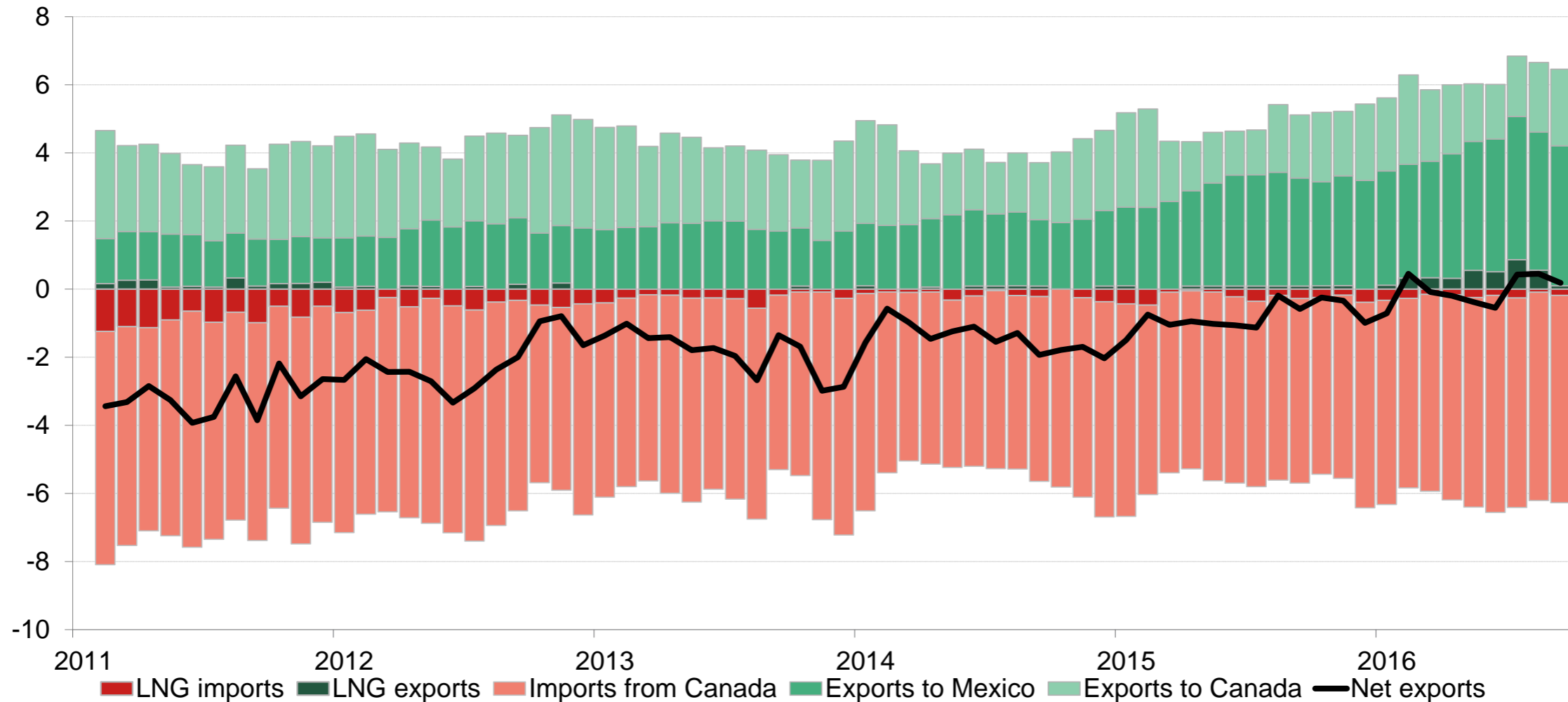


- At 8.9GW, 2016 utility-scale PV installations more than doubled the prior record of 4.4GW set in 2015.
- The small-scale PV markets also achieved another record in 2016, installing 3.4GW of solar capacity. 12 states experienced more than a 100% growth in residential PV build.

Source: Bloomberg New Energy Finance Notes: Values are in GW DC.

Deployment: US becomes a natural gas net exporter

Exports and imports of natural gas (Bcfd)

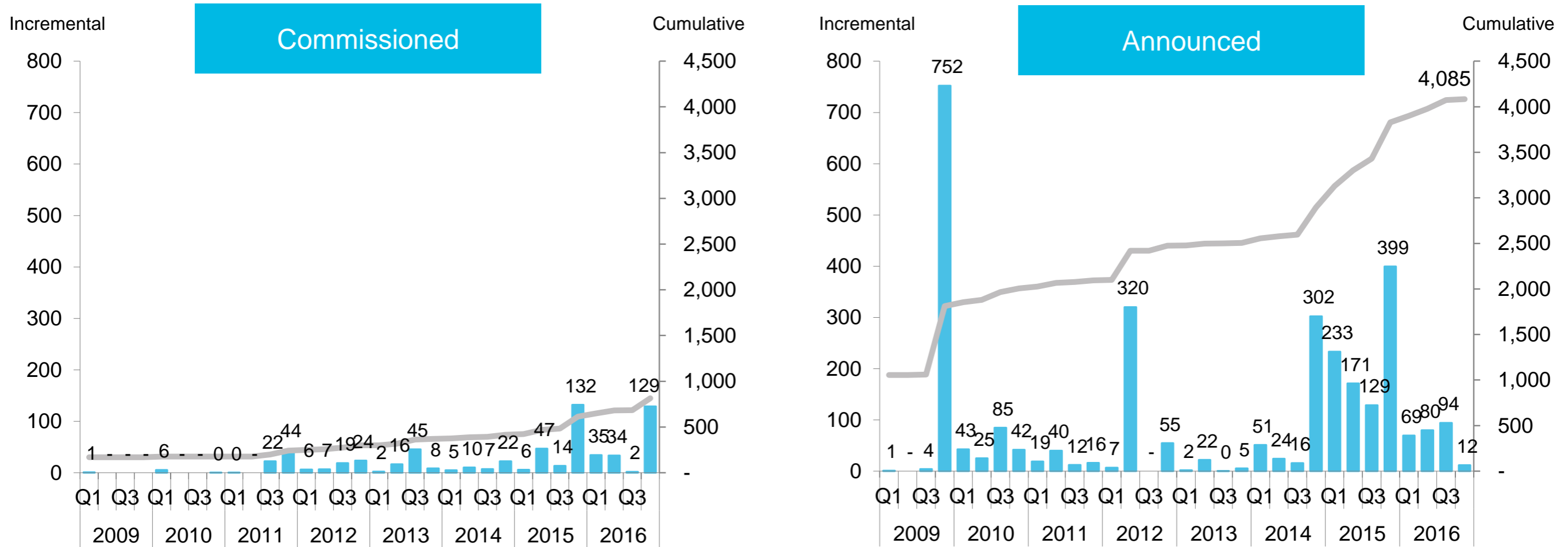


- Exports to Mexico have been growing steadily.
- 2016 marked the opening of two trains at the Sabine Pass LNG export terminal, which, combined with a decrease in imports, made the US a net LNG exporter.

Source: Bloomberg New Energy Finance, EIA Note: data is through October 2016.

Deployment: US non-hydropower energy storage picks up steam

Commissioned and announced capacity (MW)



- Energy storage is gaining momentum: the US installed a record 199MW in 2016, bringing the total to 814MW.
- And more is on the way: 4,085MW have been announced to date.

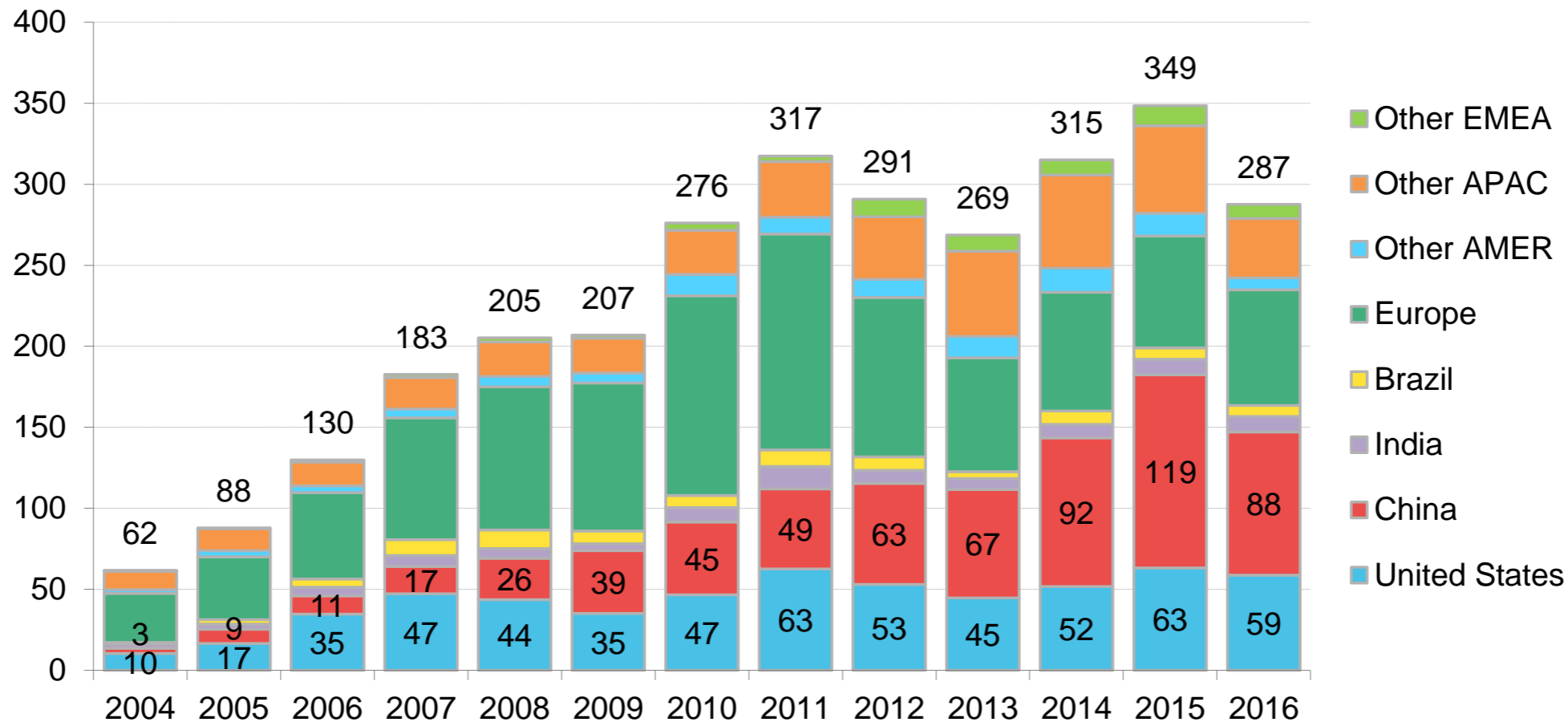
Source: Bloomberg New Energy Finance. Notes: Does not include pumped hydropower, underground compressed air energy storage, or flooded lead-acid batteries. Minimum project size for inclusion in this analysis is 100kW or 100kWh.



Sustainable energy: the new normal

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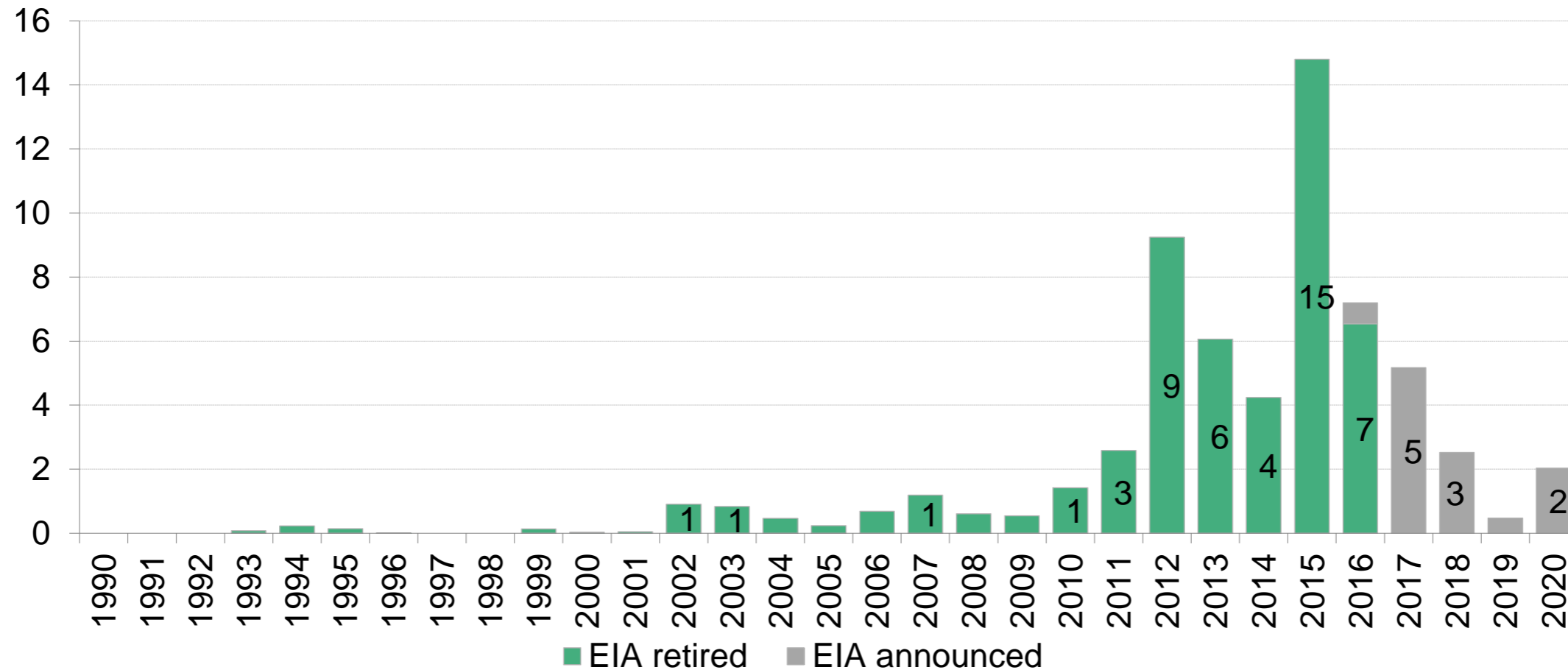
Global context: Total new investment in clean energy by country or region (\$bn)



- The US has invested \$507bn into clean energy technologies in just the last 10 years, and remains the second-largest destination globally for clean energy investment.
- Investment, on average, has grown significantly since the early 2000s, despite precipitous drops in costs.

Source: Bloomberg New Energy Finance Notes: For definition of clean energy, see slide in Section 2.2 of this report titled "Finance: US clean energy investment (1 of 2) – total new investment, all asset classes (\$bn)". AMER is Americas; APAC is Asia-Pacific; EMEA is Europe, Middle East, and Africa. Investment figures are nominal.

Deployment: US coal power plant retirements completed and announced by year (GW)

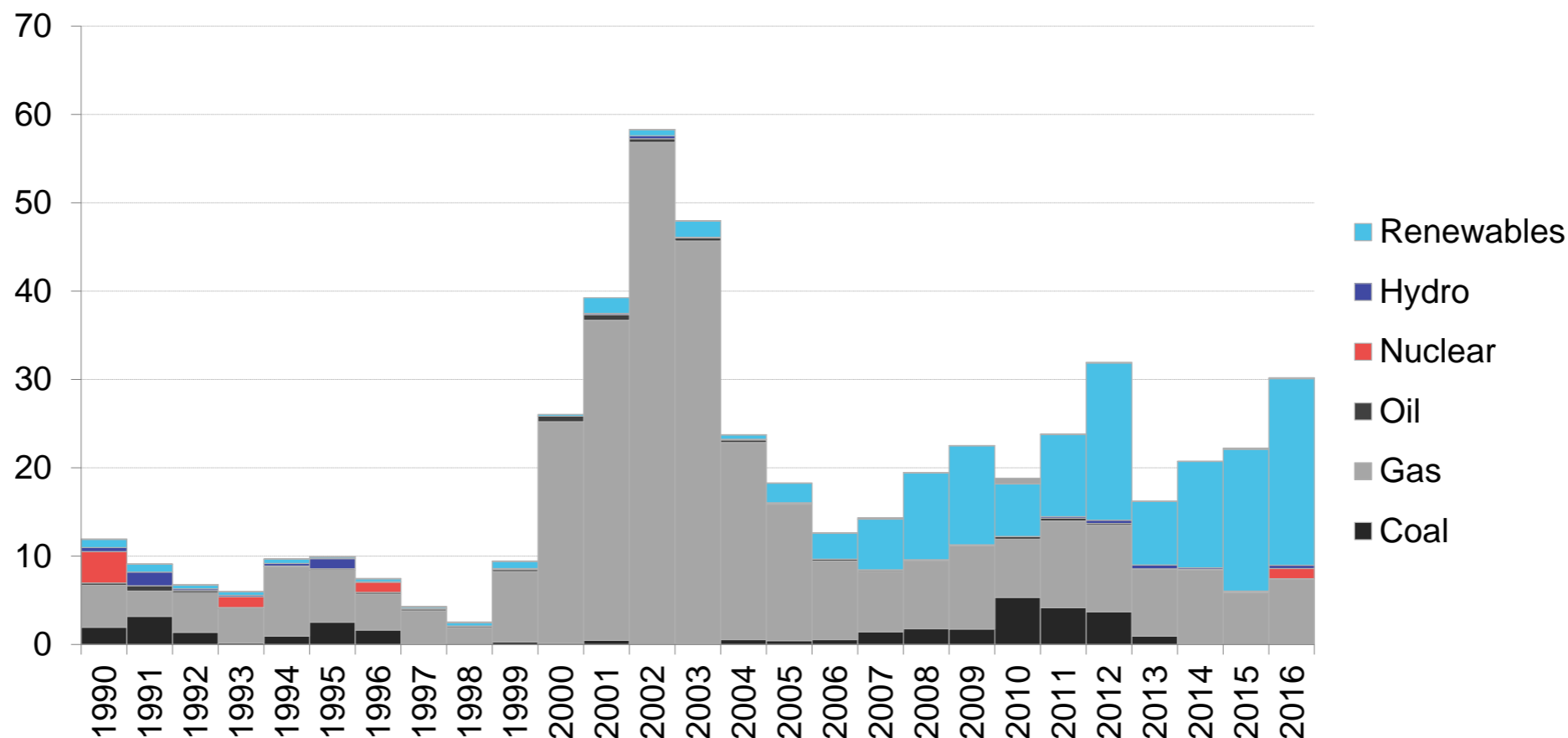


- 2016 saw another 7.2GW of coal-fired power plants drop offline, after 2015 marked the largest single year of coal retirements ever (at just under 15GW). Since 2011, the coal fleet has shrunk 12% from its peak size of 308GW.
- This does not account for coal plants that are mothballed or on standby – ie, not generating.

Source: Bloomberg New Energy Finance, EIA

Notes: 'Retirements' does not include conversions from coal to natural gas or biomass; includes retirements or announced retirements reported to the EIA through end-November 2016.

US energy overview: Electric generating capacity build by fuel type (GW)

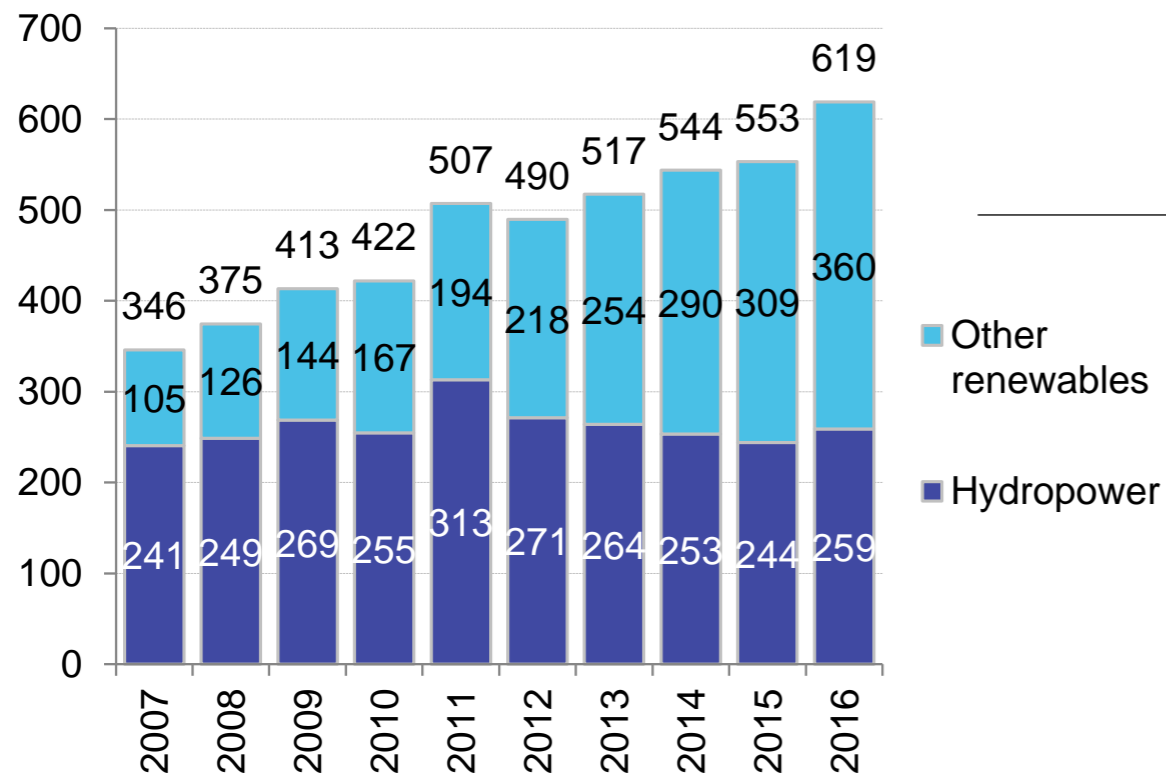


- Last five years: 62% of new capacity additions have been renewable energy projects.
- Last 25 years: 92% has been natural gas plants or renewable energy projects.
- In 2016, renewables added 22GW of capacity, or roughly 70% of total build for the second straight year. Gas build totaled 7.4GW, and for the first time since the 1990s, there was also nuclear build of 1.1GW.

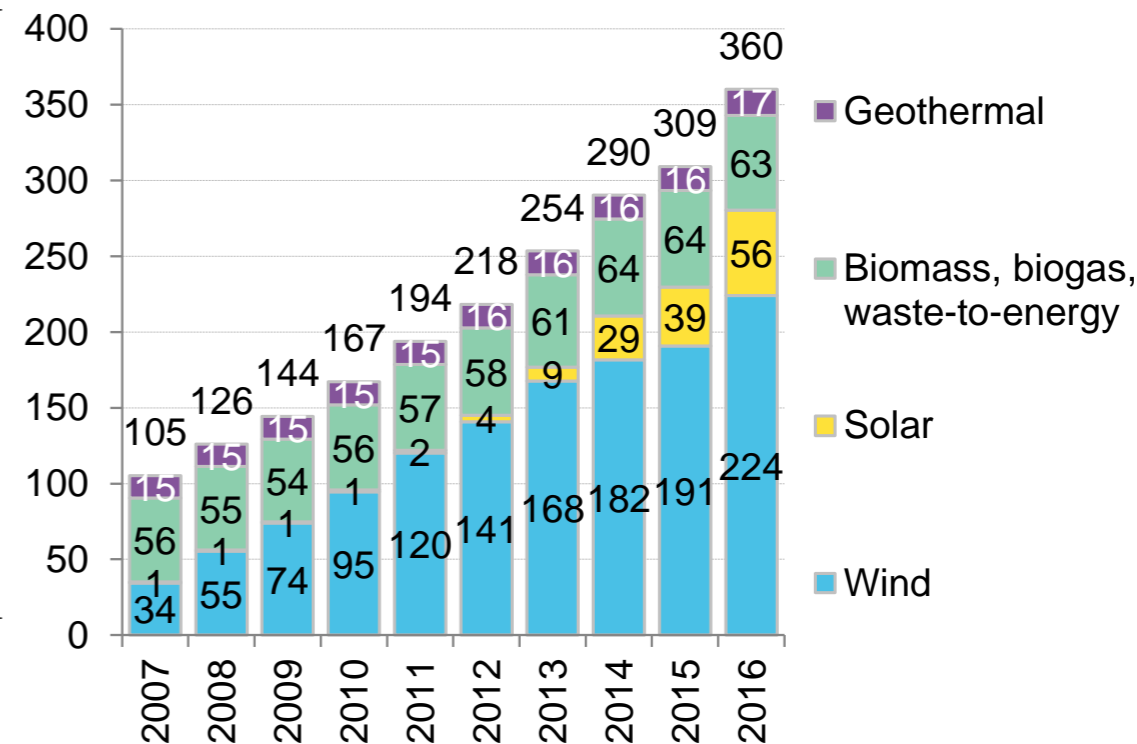
Source: EIA, Bloomberg New Energy Finance Note: All values are shown in AC except solar, which is included as DC capacity. "Renewables" here does not include hydro, which is shown separately. Last year's Factbook included anticipated nuclear build; however, the Watts Bar reactor was in fact turned on in 2016; accordingly, the nuclear build is shown here in 2016.

US energy overview: Renewable energy generation by technology

US renewable generation by technology
(including hydropower) (TWh)



US non-hydropower renewable generation by
technology (TWh)

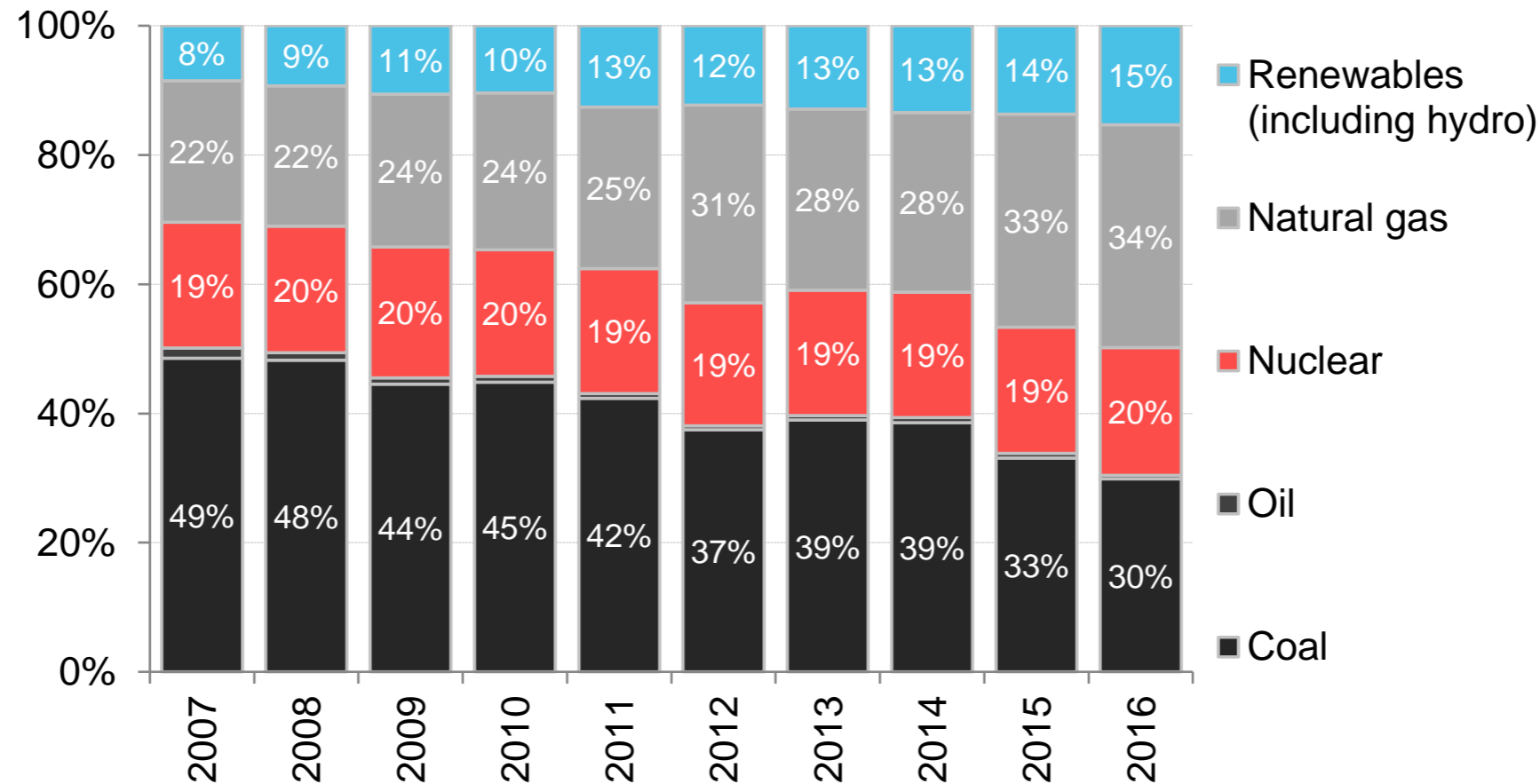


- Renewable generation surged in 2016, increasing 12% over 2015 levels. Hydropower remains the largest single source of renewable generation (42%), but wind (36%) is catching up quickly.
- Non-hydro renewable generation has more than tripled over the past ten years.

Source: Bloomberg New Energy Finance, EIA

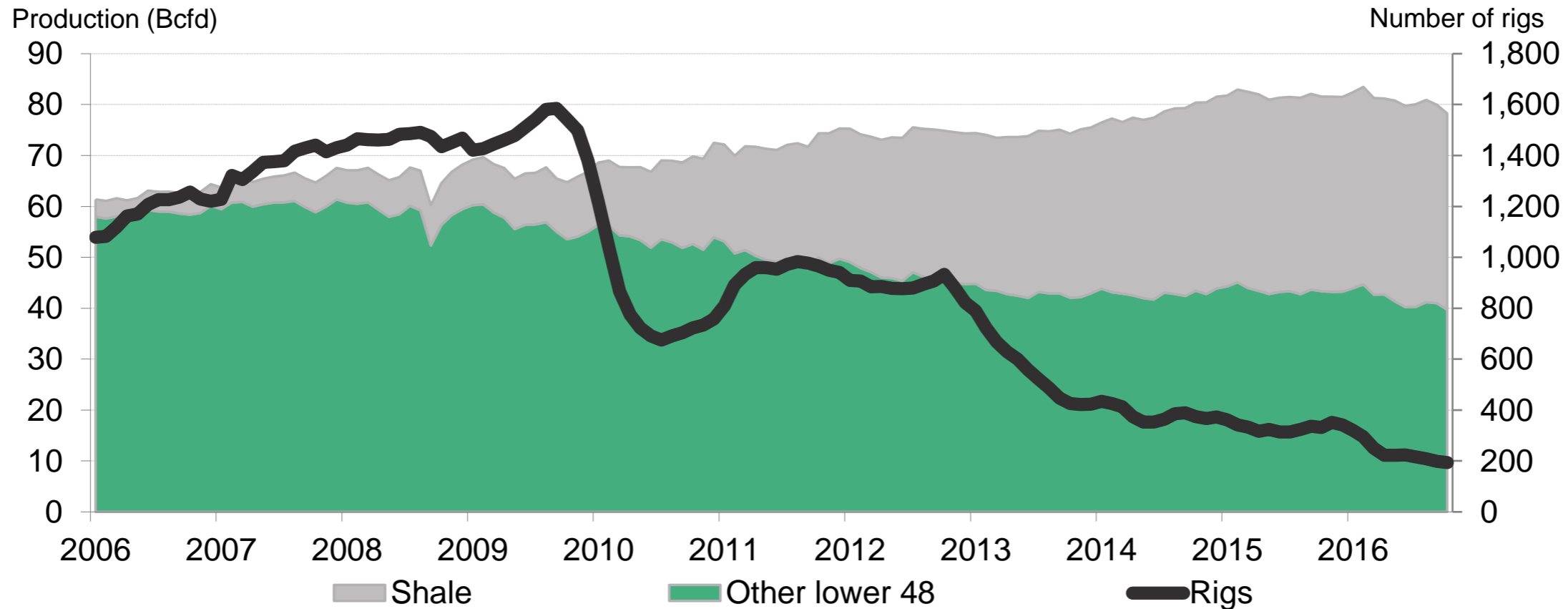
Notes: Values for 2016 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through November 2016). Includes net energy consumption by pumped hydropower storage facilities. Totals may not sum due to rounding. Beginning in 2014, numbers include estimated generation from distributed solar; generation from other distributed resources is not included.

US energy overview: Electricity generation mix



- Natural gas has eclipsed coal as the largest contributor to the US electricity mix, hitting 34% in 2016. Coal sank to second place, providing 30% of the mix – its lowest share on record.
- Since 2007: coal's share plummeted from 49% to 30%, while natural gas's grew from 22% to 34% and renewables from 8% to 15%.

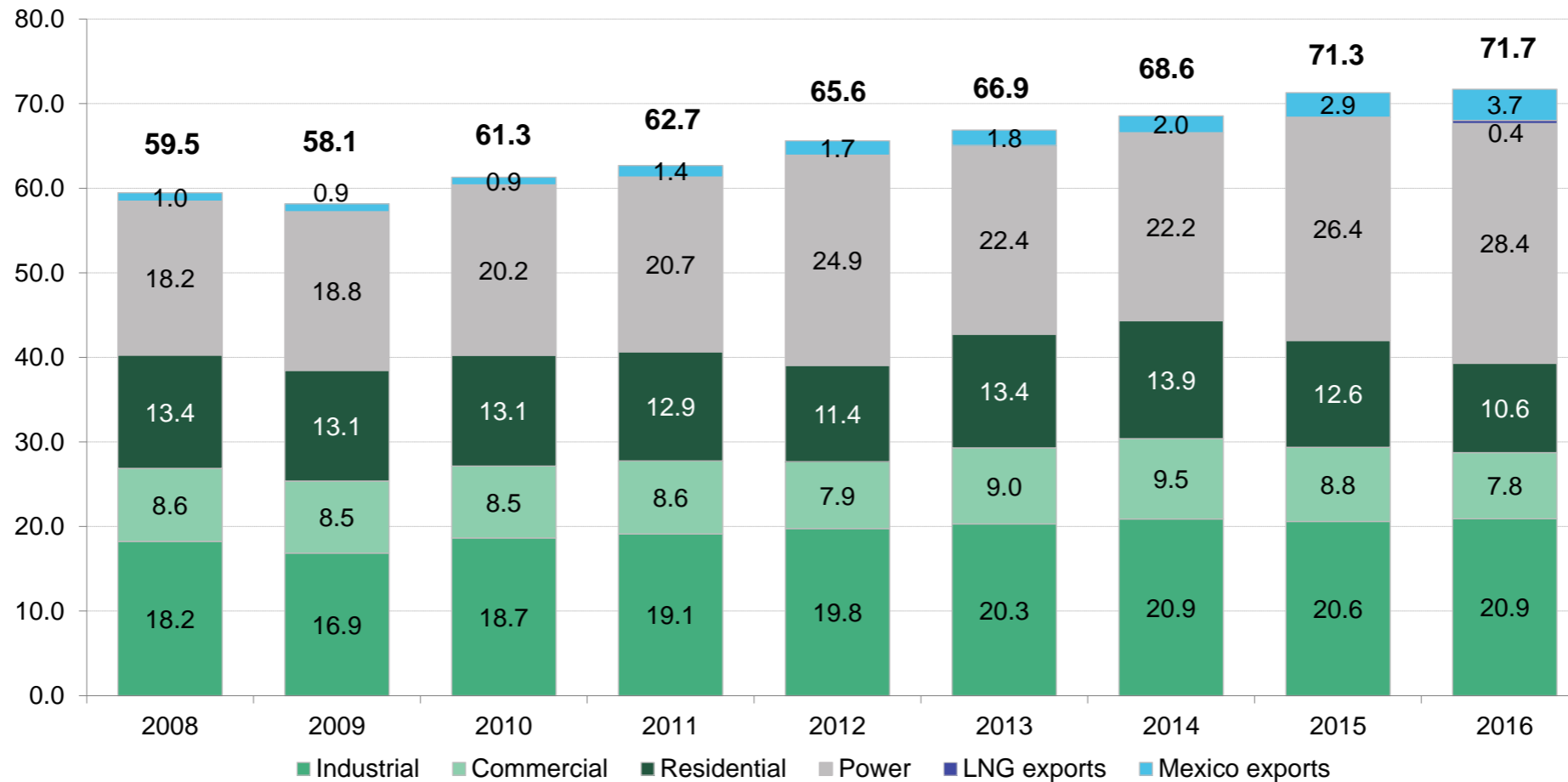
Source: EIA Notes: Values for 2016 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through November 2016). In chart at left, contribution from 'Other' is not shown; the amount is minimal and consists of miscellaneous technologies including hydrogen and non-renewable waste. The hydropower portion of 'Renewables' includes negative generation from pumped storage.



- US natural gas production held steady despite rig counts falling 48% year-on-year.
- Producers are selectively drilling in productive ‘sweet spots’ and turning to an inventory of drilled but uncompleted wells (DUCs) to cost-effectively extract gas, and the industry has made technological improvements in efficiencies.

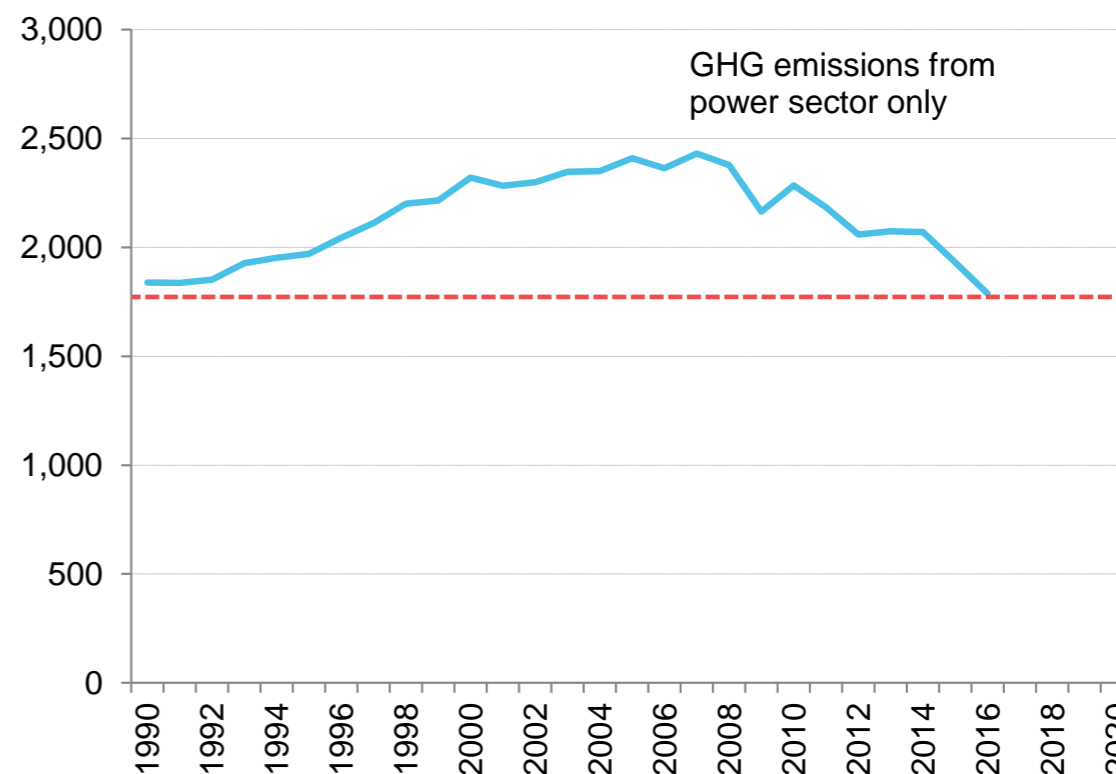
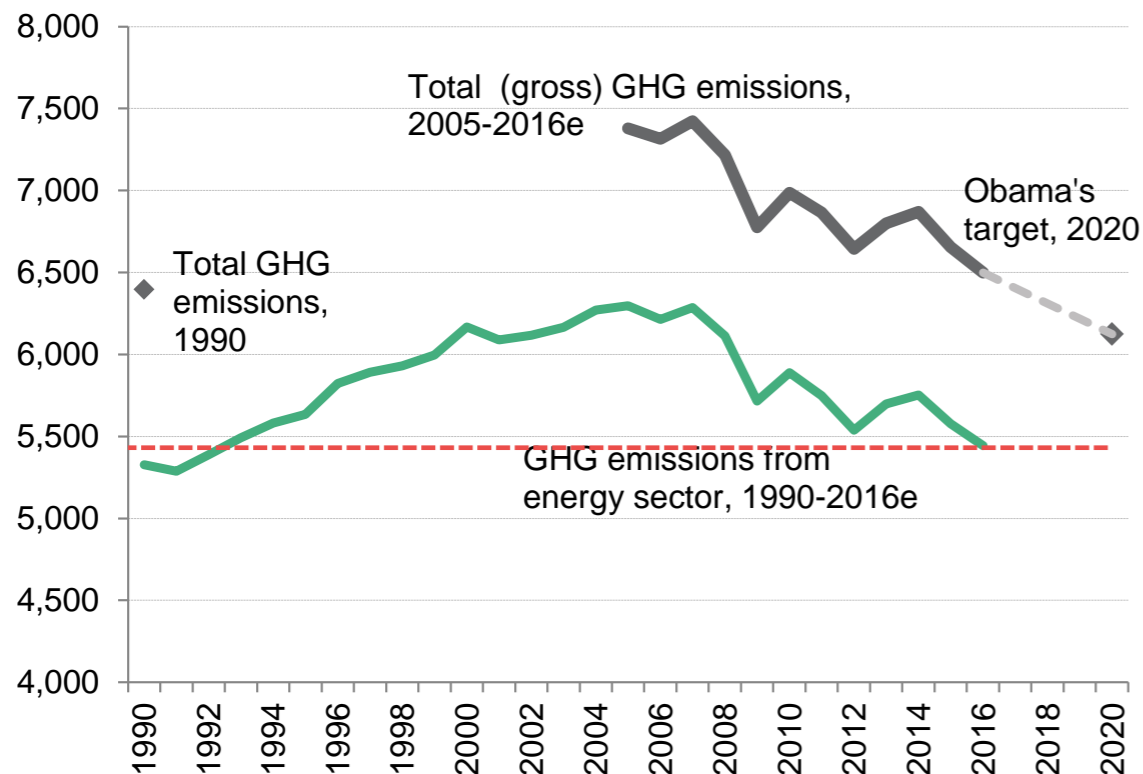
Source: Bloomberg New Energy Finance, EIA, Baker Hughes. Data up through the latest comprehensive numbers available (October 2016).

Deployment: US natural gas demand by end use (Bcfd)



- 2016 demand represented a 21% increase from 2008 levels, and a slight year-on-year rise from 2015.
- The power sector drove domestic demand growth, jumping 7% compared to 2015.
- Pipeline exports to Mexico have nearly quadrupled since 2008, and the US started exporting liquefied natural gas (LNG) this past year.

Source: Bloomberg New Energy Finance, EIA Note: Values for 2016 are projected based upon the latest available data (October 2016).



- US GHG emissions are at their lowest levels in 25 years, falling to an estimated 6.5GtCO₂e in 2016, 12% below 2005 levels.
- In 2016, power-sector emissions shrank 5.3% year on year, bringing them to 24.1% below 2005 levels.

Source: Bloomberg New Energy Finance, EIA, EPA

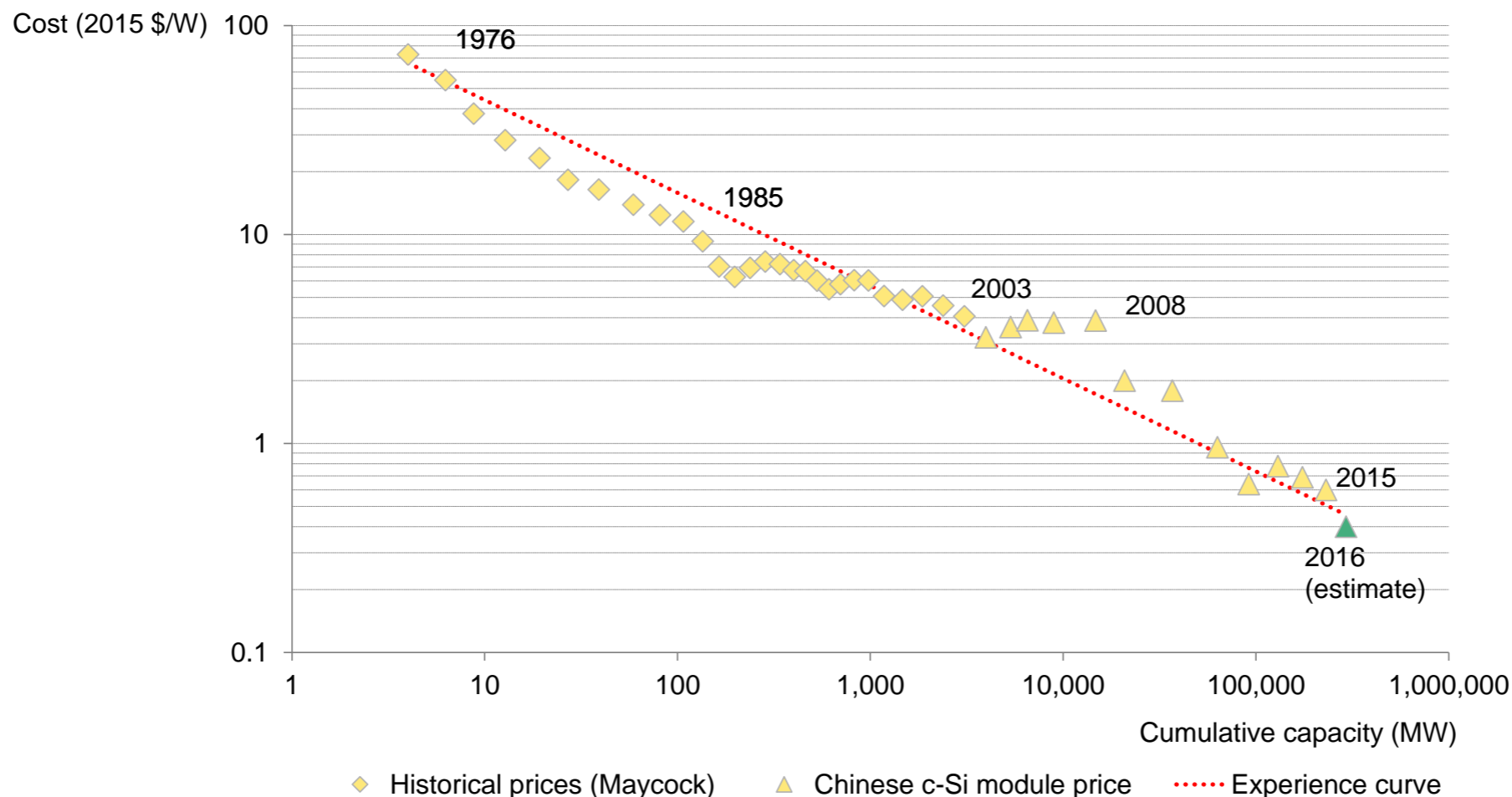
Notes: 'Sinks' refer to forests and green areas which absorb carbon dioxide. Values may differ from last year's, due to recalculations and revisions published by the EPA, primarily to methane emissions. Values for 2016 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2016). 'Obama's target' refers to a pledge made in Copenhagen climate talks in 2009. The target shown here assumes 17% reduction by 2020 on 2005 levels of total GHG emissions, but the actual language of the announcement left vague whether the reductions applied to economy-wide emissions or just emissions of certain sectors. Data for total GHG emissions comes from EPA's Inventory of US Greenhouse Gas Emissions and Sinks (1990-2014), published April 2016. Data for CO₂ emissions from the energy sector comes from the EIA's Monthly Energy Review.



Falling costs for consumers

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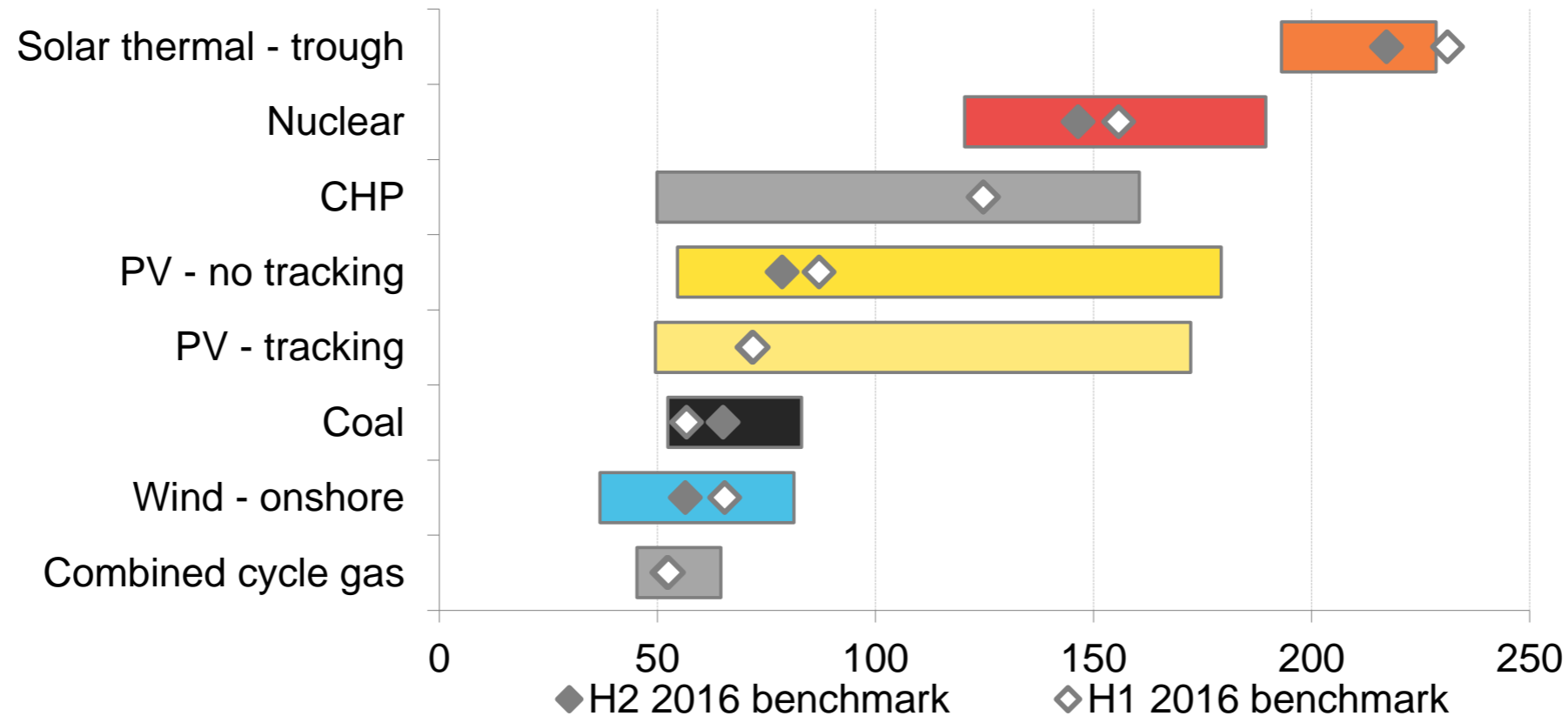
Economics: Price of solar modules and experience curve (2015\$/W as function of global cumulative capacity)



- PV module prices have fallen 26.5%, on average, for every doubling of installed capacity
- At the end of 2016, the global average module price was \$0.41/W, down 90% from 2008 levels (\$3.88/W).
- Global oversupply will likely depress prices further in 2017.

Source: Bloomberg New Energy Finance, Paul Maycock Notes: The precise learning rate depends on the end-point chosen, but we believe \$0.41/W to be slightly below the experience curve at the end of 2016. Figures in real 2015 dollars.

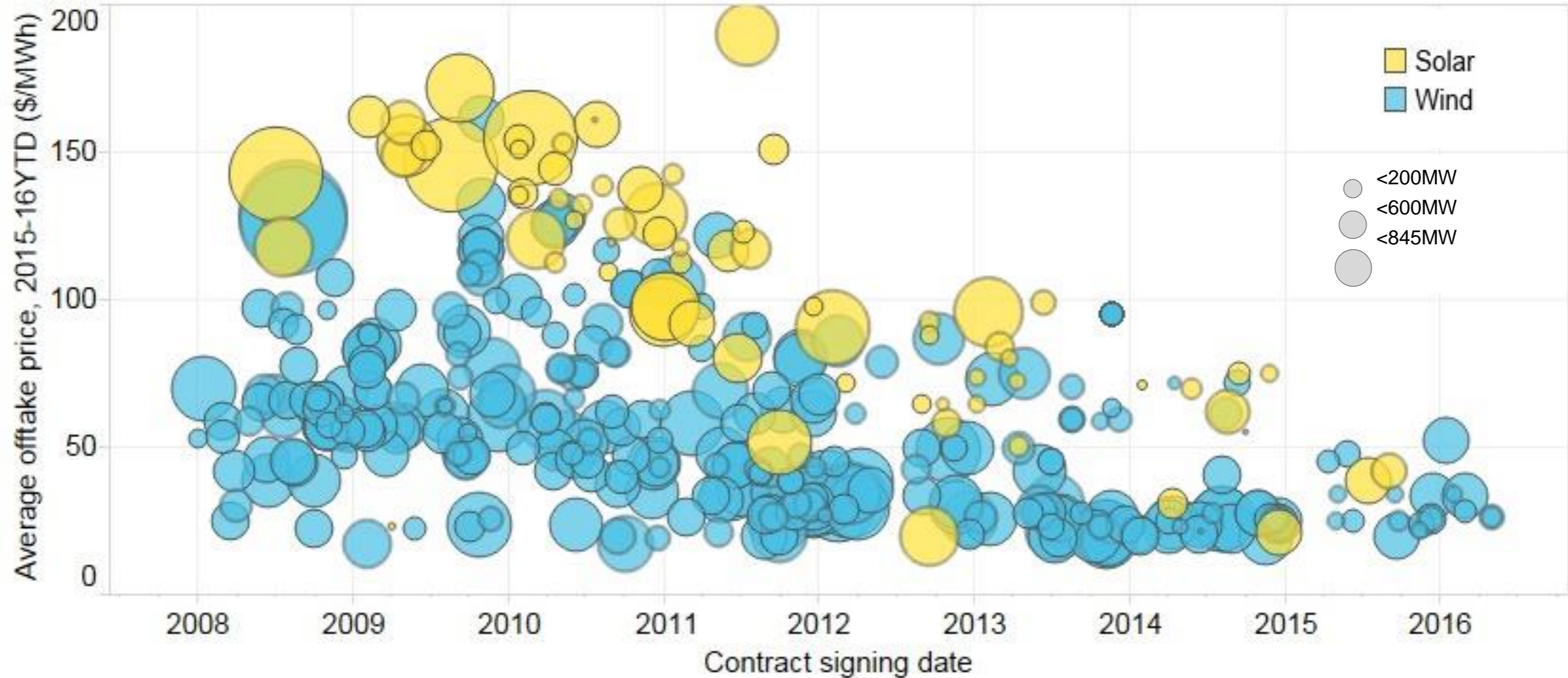
Economics: US levelized cost of electricity (*unsubsidized* across power generation technologies, H2 2016 (\$/MWh)



- On a levelized cost basis, renewables are competitive with coal and natural gas-fired power.
- The *unsubsidized* LCOE for wind came in as low as \$37/MWh in Texas, the cheapest of all technologies assessed. Solar PV can be built for as low as \$50/MWh, again in Texas and the Southwest.
- Natural gas is cheaper to build than coal across most of the country.

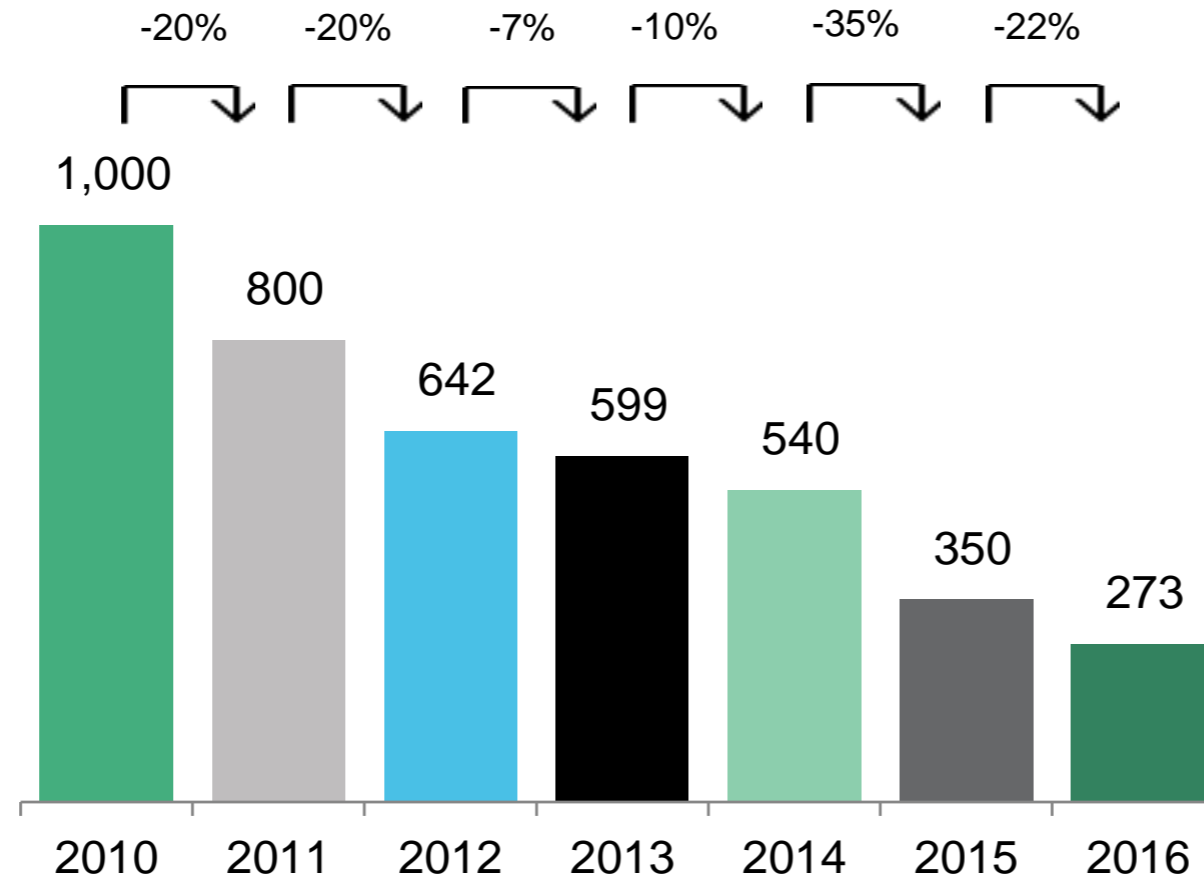
Source: Bloomberg New Energy Finance, EIA

Economics: Average 2015-H1 2016 offtake prices for wind and solar PPAs by signing date (\$/MWh)



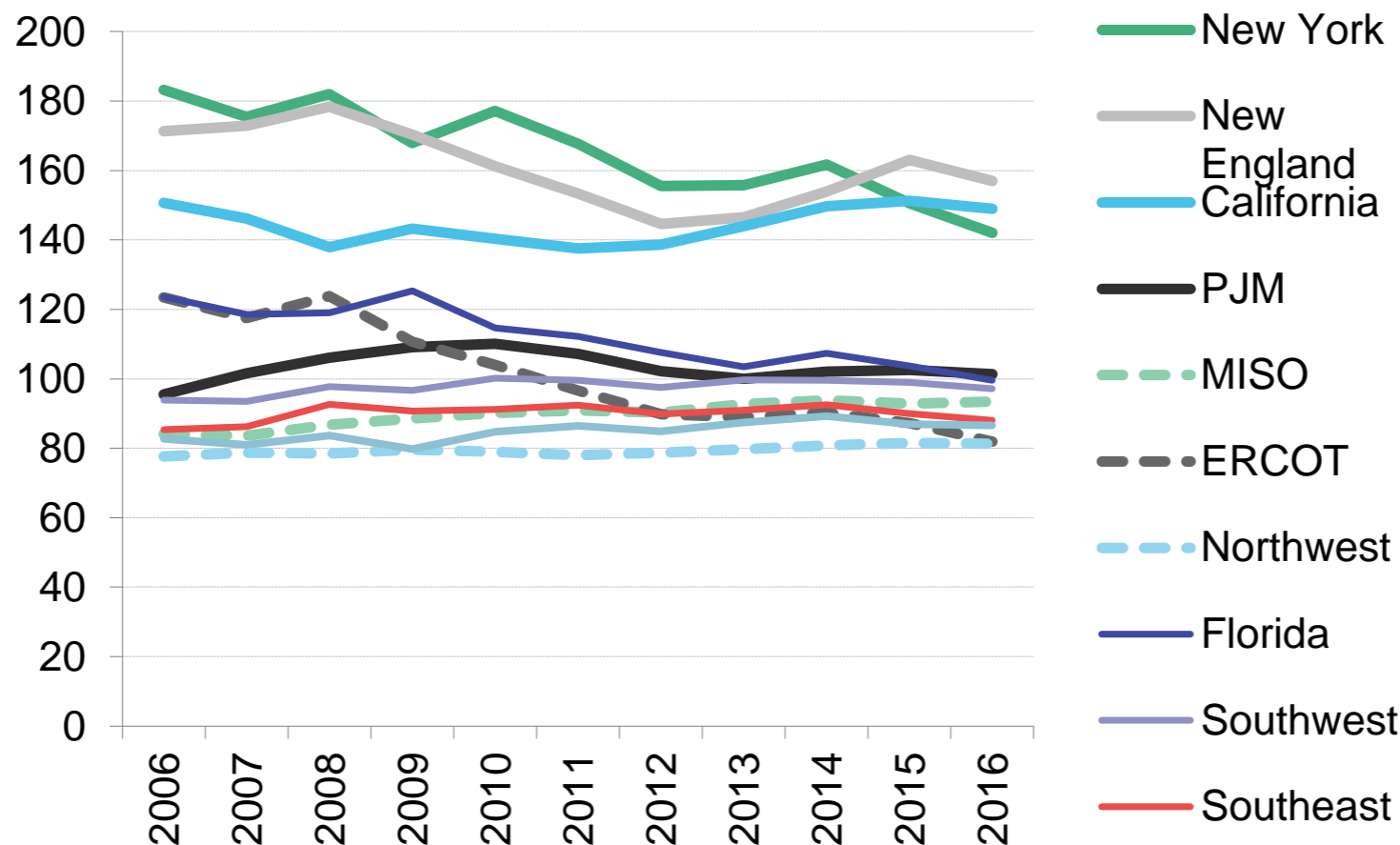
- Lower levelized costs translate into lower offtake prices: prices paid for solar and wind have fallen dramatically since 2008-2010.

Economics: Lithium-ion battery pack prices, 2010-2016 (\$/kWh)



- The costs of energy storage are also declining, with lithium-ion battery prices down 73% since 2010.
- Falling costs for battery packs are making battery electric vehicles competitive with traditional combustion engines, when accounting for purchasing incentives.

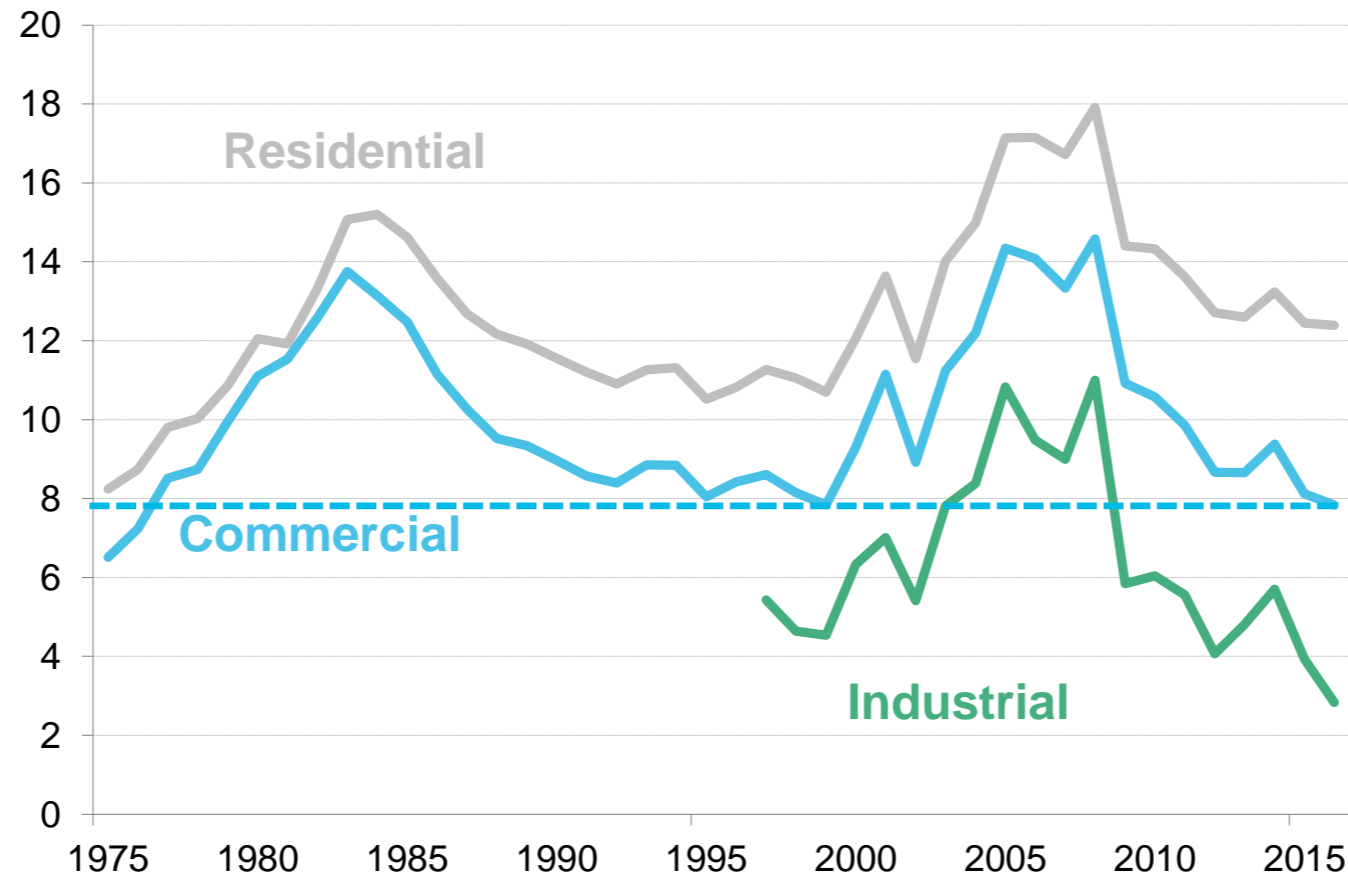
US energy overview: Retail power prices (2016 \$/MWh)



- Retail prices declined at an average of 2.2% across the country in 2016. New York and Texas (ERCOT) saw decreases of 5.6% and 6.2%, respectively.
- Since 2005, US average retail prices have risen only 1.4% in real terms. Prices are down 7% from their 2008 peak.

Source: Bloomberg New Energy Finance, EIA, Bloomberg Terminal. Notes: Wholesale prices are taken from proxy power hubs in each ISO and are updated through end-2016. The retail power prices shown here are not exact retail rates, but weighted averages across all rate classes by state, as published by EIA 826. Retail prices are updated through end-November 2016. All prices are in real 2016 dollars.

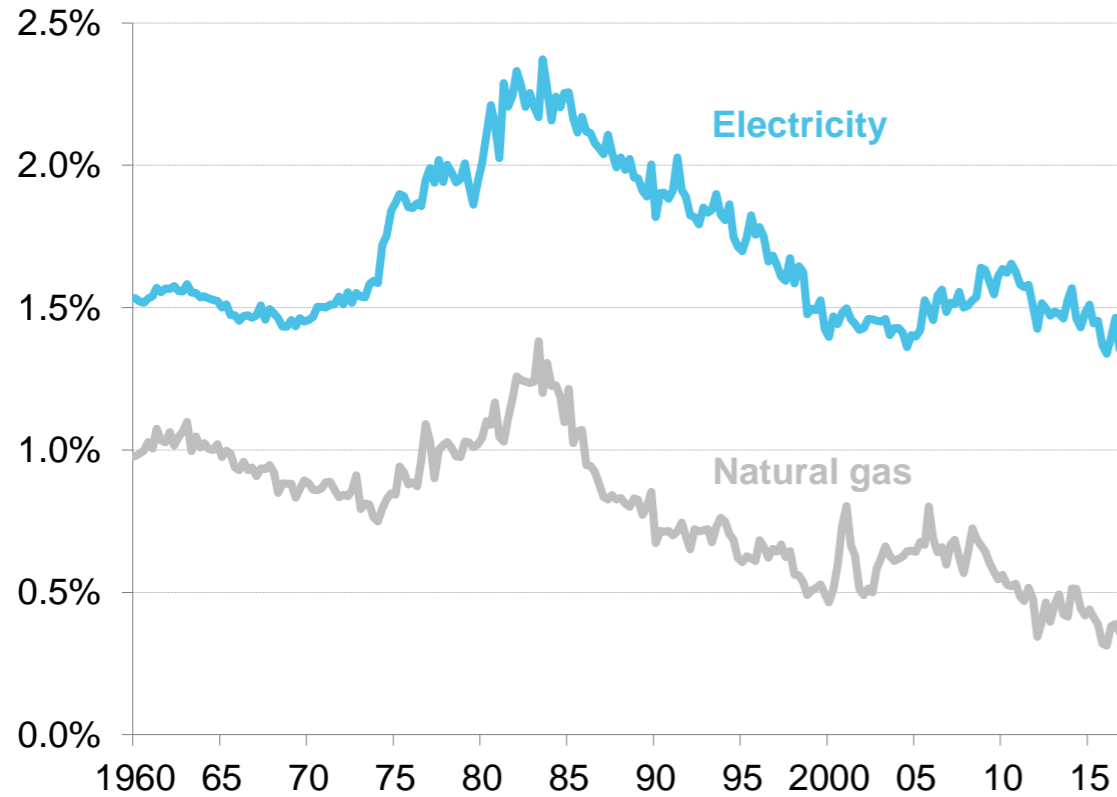
US energy overview: Retail natural gas prices by segment (2016 \$/Mcf)



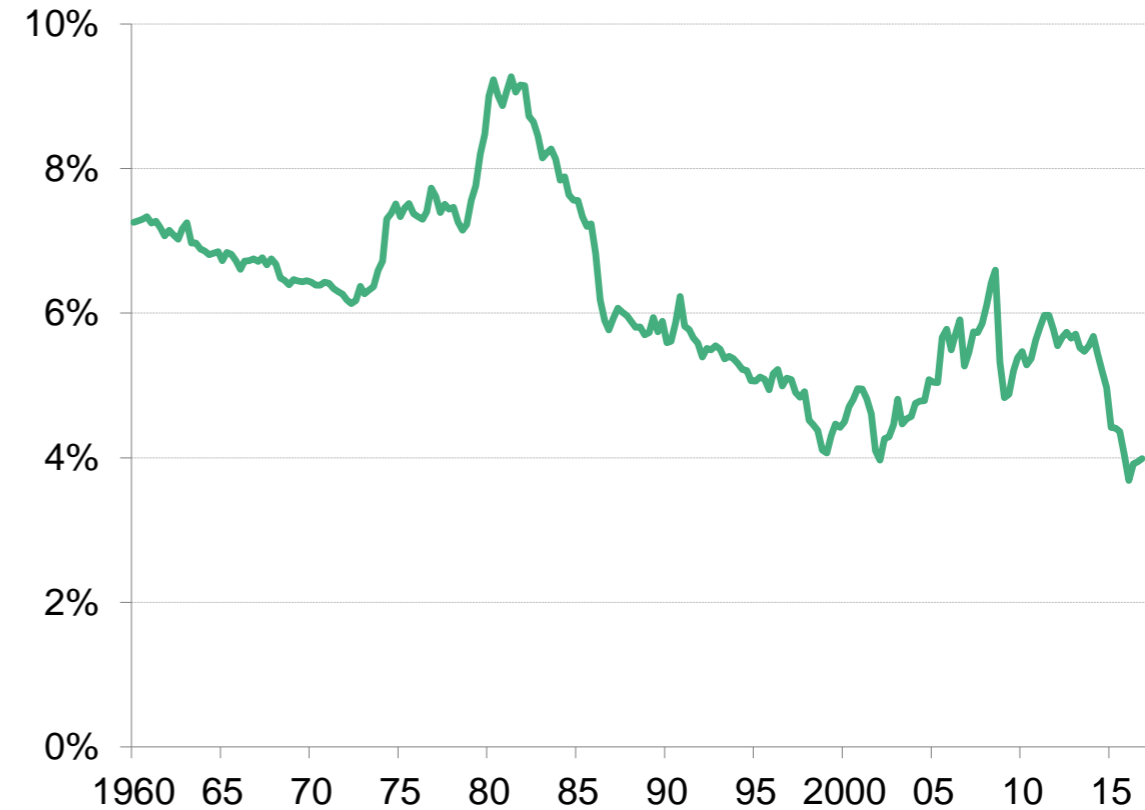
- Prices for natural gas delivered to commercial consumers are at their lowest levels since 1977.

Source: Bloomberg New Energy Finance, EIA Notes: 2016 values are annualized, accounting for seasonality, using data through October 2016. All prices are in real 2016 dollars.

Electricity and natural gas as a share of total consumption expenditure



Total energy goods and services as a share of total consumption expenditure



- Americans are dedicating less of their household spending to energy than at any other time on record: energy consumption as a share of total consumption expenditures averaged 3.9% in 2016, the first year in which this measure came in below 4% since at least 1959.
- Consumption costs for natural gas and electricity reflect a similar trend: natural gas represented under 0.4% of total spending, and electricity came in at 1.4%, both the lowest totals on record.

Source: Bureau of Economic Analysis, Bloomberg New Energy Finance Notes: Values for the fourth quarter of 2016 are preliminary.

Wrap-up

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- **2016 saw a number of new landmarks in US energy:**
 - GDP grew 1.6%, while energy consumption fell 0.2%
 - Record solar PV build (12.5GW)
 - The US became a natural gas net exporter
 - Storage deployment hit 200MW
- **Sustainable energy is the new normal:**
 - 92% of power generating capacity built in the past 25 years is renewable or natural gas
 - Natural gas has displaced coal as the largest source of power
 - Renewables provided 15% of power, up from 8% in 2007
 - Power-sector emissions 24% below 2005 levels, economy-wide down 12%
- **Meanwhile, energy prices are low and falling:**
 - Solar module prices are 90% below 2008 levels
 - Wind and solar costs are competitive with gas and coal in many regions of the country
 - Battery costs have fallen 73% since 2010, helping make EVs more competitive
 - Retail power prices have fallen 6.9% since the 2008 peak
 - Natural gas prices for commercial consumers are at the lowest since 1977
 - Consumers are dedicating less of household spending to energy than any other time on record

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