

2017

# Sustainable Energy in America

FACTBOOK

Understanding the U.S. Energy Transformation



## Combined Heat and Power in America

March 16, 2017

A webinar produced in partnership between Alliance for Industrial Efficiency, the Business Council for Sustainable Energy, and CHP Association



With participation from the American Gas Association and Solar Turbines

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#Factbook

# Combined Heat & Power in America Agenda

**Welcome / AIE Introduction** – [Alexandra Rekkas](#), Senior Research Associate, David Gardiner and Associate / Alliance for Industrial Efficiency

**CHP Association Introduction** – [Dale Louda](#), Executive Director, CHP Association

**Overview of 2017 Factbook with CHP Focus** – [Lisa Jacobson](#), President, Business Council for Sustainable Energy

**Panel – CHP Industry Views** – Moderator : [Alexandra Rekkas](#), DGA /AIE

## Panelists

[Gil Amengual](#), Director of Marketing and Product Strategies, Solar Turbines

[Dale Louda](#), Executive Director, CHP Association

[Richard Meyer](#), Director of Energy Analysis and Standards, American Gas Association

**Question & Answer** – Moderator: [Andy Barnes](#), Policy Associate, BCSE

# About the Alliance

The Alliance for Industrial Efficiency promotes state and federal policies to support U.S. manufacturing competitiveness through enhanced industrial efficiency. Our diverse coalition of businesses, labor groups, and non-profits work to improve energy efficiency in America's industrial sector. The Alliance is a project of [David Gardiner & Associates](#).



# CHP ASSOCIATION

- Voice of the CHP industry including WHP: manufacturers, developers, regional CHP organizations, etc, including Southern California Gas, General Electric, Solar Turbines, One Gas, Chevron, Johnson Matthey, ICF, Capstone, Tecogen, Texas Medical Center, AB Gruppo, Mosaic, Broad, DCO, SJI, Energy Solutions Center, Center for Sustainable Energy, Washington Gas, and more than 20 other companies.
- Regulatory Committee: PURPA, environmental regs
- Advocate for pro industry tax treatment as part of public policy debate.
- Business Allies: work closely with AGA, ELCON, NAM, API, ACC, IECA, AFPA, EEI, and others
- April Legislative Fly In to educate Congress about CHP
- May 23 Hospitality Conference in New York in conjunction with NYSERDA, National Grid, NECHPI
- CHP Study looking at valuing the resilience and reliability of CHP as part of Combined Heat and Power Foundation
- CHP Collaborative: cooperative with Edison Electric Institute and International District Energy Association
- The Slice and other communications with members and the general public
- CONTACT [winniewarner@chpassociation.org](mailto:winniewarner@chpassociation.org) for more information about CHP Association

# About the BCSE

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- The Business Council for Sustainable Energy (BCSE) is a coalition of companies and trade associations from the energy efficiency, natural gas and renewable energy sectors.
- The Council advocates for policies at state, national and international levels that:
  - increase the use of commercially-available clean energy technologies, products and services
  - support an affordable, reliable power system
  - reduce air pollution & greenhouse gas emissions

# 2017 BCSE Members



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## Clean energy wins for America by lowering costs, spurring economic growth and fostering job creation.

The 2017 edition of the Sustainable Energy in America Factbook – produced for the Business Council for Sustainable Energy by Bloomberg New Energy Finance, provides up-to-date, accurate market information about the broad range of industries – energy efficiency, natural gas and renewable energy – that are contributing to the country's move towards cleaner energy production and more efficient energy usage.

### THE SUSTAINABLE ENERGY TRANSFORMATION



Renewable energy is **22%** of the U.S. 2016 power fleet, with 244 GW of installed capacity across the country, an **83%** increase over 2007 levels.



Get the **2017 Factbook**



See State Spotlight



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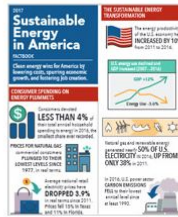
[Watch the Video](#) →



[View the Slideshow](#) →



## Infographic



## Get the Facts

- In 2016, consumers devoted less than 4% of their total annual household spending to energy, the smallest share ever recorded.
- American energy productivity has increased by 10% from 2011 to 2016.
- Natural gas and renewable energy generated 50% of U.S. electricity in 2016, up from 38% in 2011.
- Renewable energy is a prominent part (22%) of the U.S. 2016 power fleet, with 244GW installed capacity across the country, a 83% increase over 2007 levels.

## Executive Summary



### Industry Focus:

Energy Efficiency  
Natural Gas  
Renewable Energy

### Quick Facts On:

Alternative Fuel Vehicles  
Biomass/ Waste-to-Energy  
Carbon Capture & Storage

Combined Heat & Power  
Fuel Cells  
Hydropower

## State Spotlight

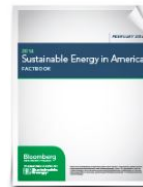
Learn about clean energy in the following states:

- Minnesota
- Nevada
- Pennsylvania
- Virginia
- See 2017 Factbook State & Regional Slides

## Previous Factbook Editions

Download previous editions of the Factbook here.

2014



2015



2016



[View the 2013 edition of the Factbook](#)

## About the Factbook Partners

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**Bloomberg New Energy Finance (BNEF)** is an industry research firm focused on helping energy professionals generate opportunities. With a team of 200 experts spread across six continents, BNEF provides independent analysis and insight, enabling decision-makers to navigate change in an evolving energy economy. Leveraging the most sophisticated new energy data sets in the world, BNEF synthesizes proprietary data into astute narratives that frame the financial, economic and policy implications of emerging energy technologies. Bloomberg New Energy Finance is powered by Bloomberg's global network of 19,000 employees in 192 locations, reporting 5,000 news stories a day. Visit [about.bnef.com](http://about.bnef.com) for more information.

**The Business Council**  
for Sustainable  
Energy®

**The Business Council for Sustainable Energy (BCSE)** is a coalition of companies and trade associations from the energy efficiency, natural gas and renewable energy sectors. The Council membership also includes independent electric power producers, investor-owned utilities, public power, commercial end-users and project developers and service providers for energy and environmental markets.



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# Sustainable Energy in America

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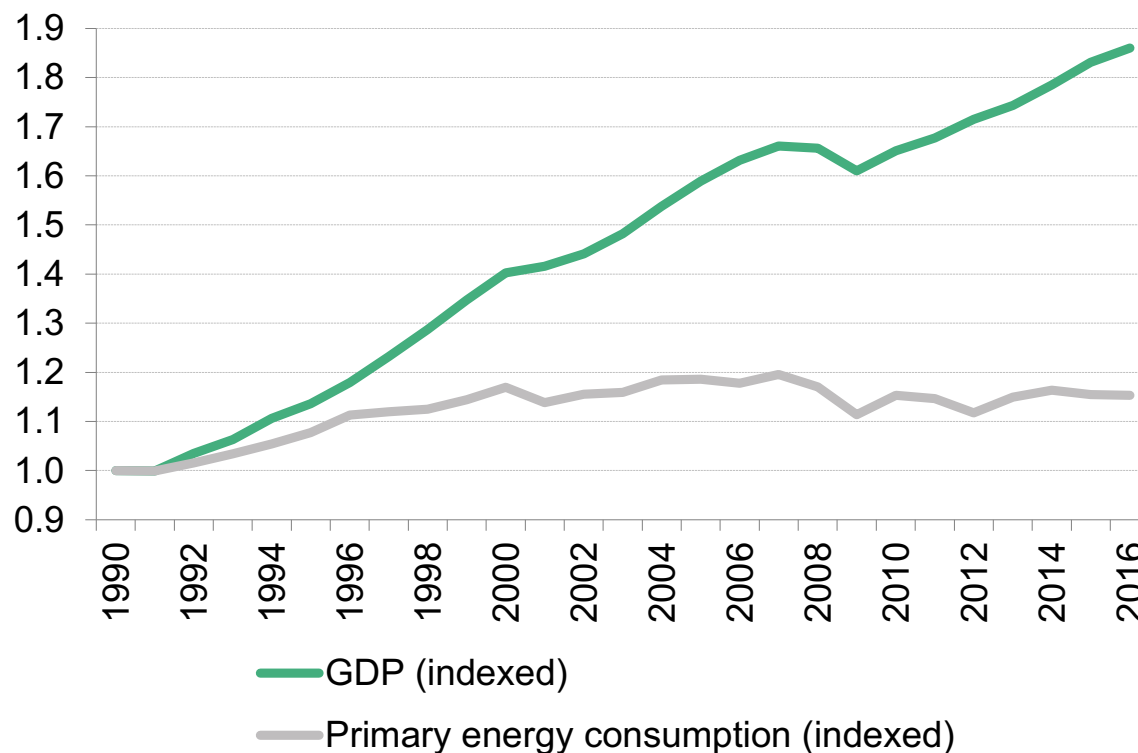
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- **2016 saw a number of new landmarks in US energy:**
  - GDP grew 1.6%, while energy consumption fell 0.2%
  - Record solar PV build (12.5GW)
  - The US became a natural gas net exporter
- **Sustainable energy is the new normal:**
  - 92% of power 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:**
  - Wind and solar costs have fallen dramatically and are competitive with gas and coal in many regions of the country
  - Consumers are dedicating less of household spending to electricity, natural gas, and overall energy than any other time on record

## The economy is more energy productive than ever

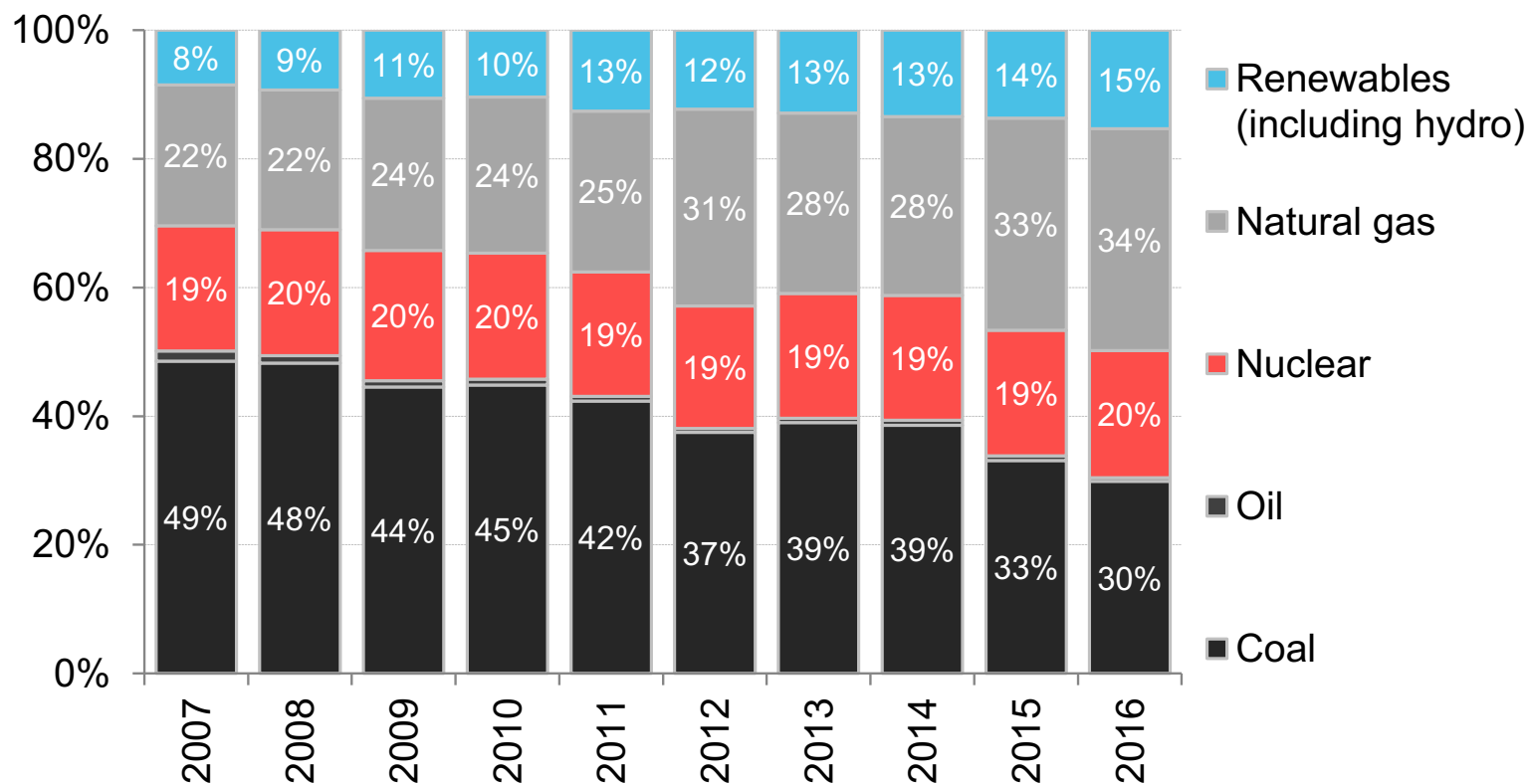


- Energy productivity continues to rise: in 2016, GDP rose 1.6% while total primary energy consumption fell by 0.2%.

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.

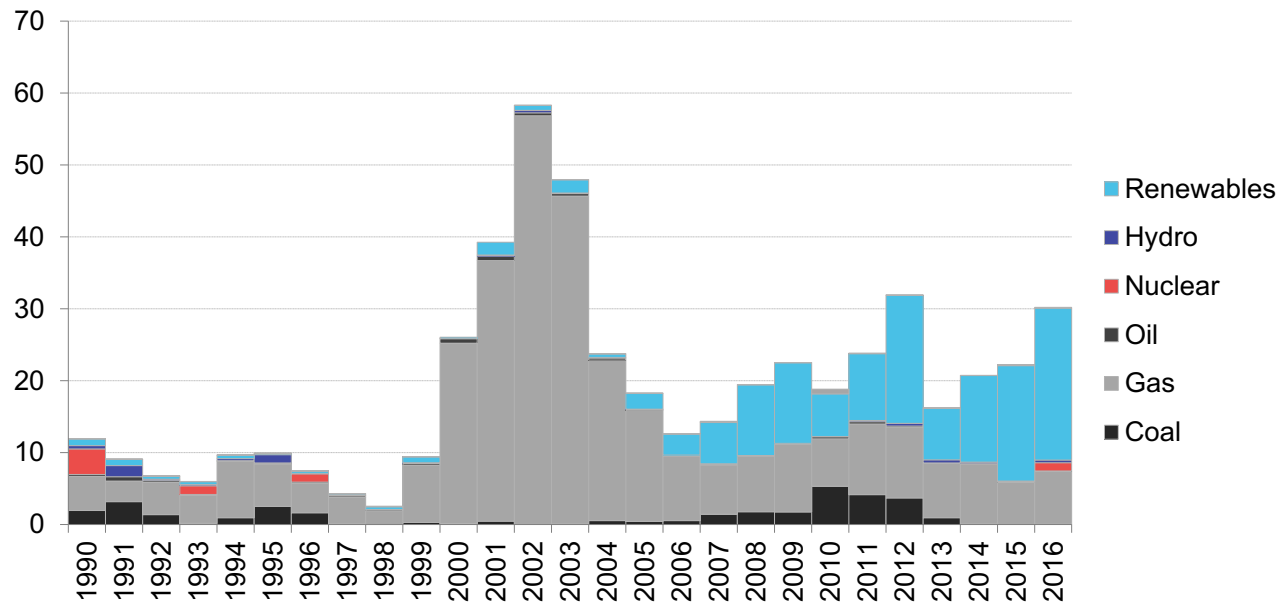
# US energy overview: Electricity generation mix



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

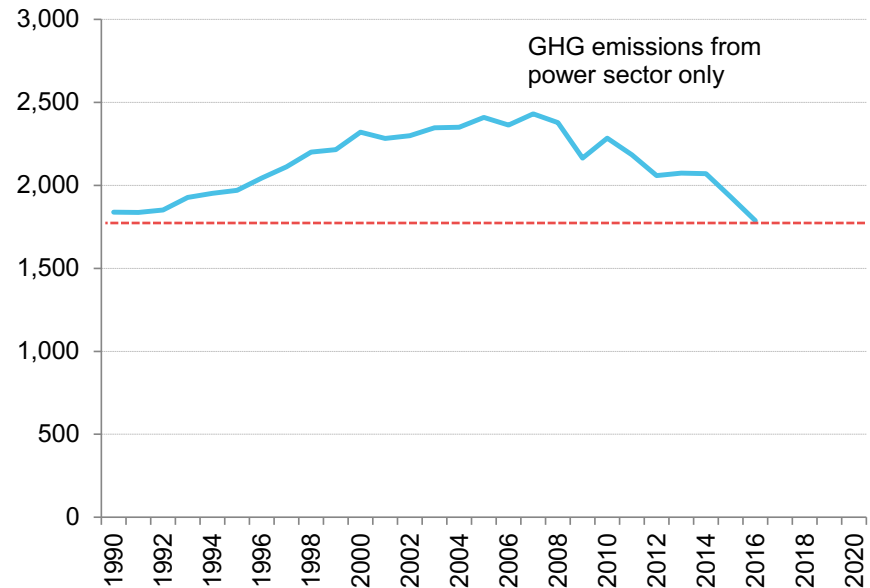
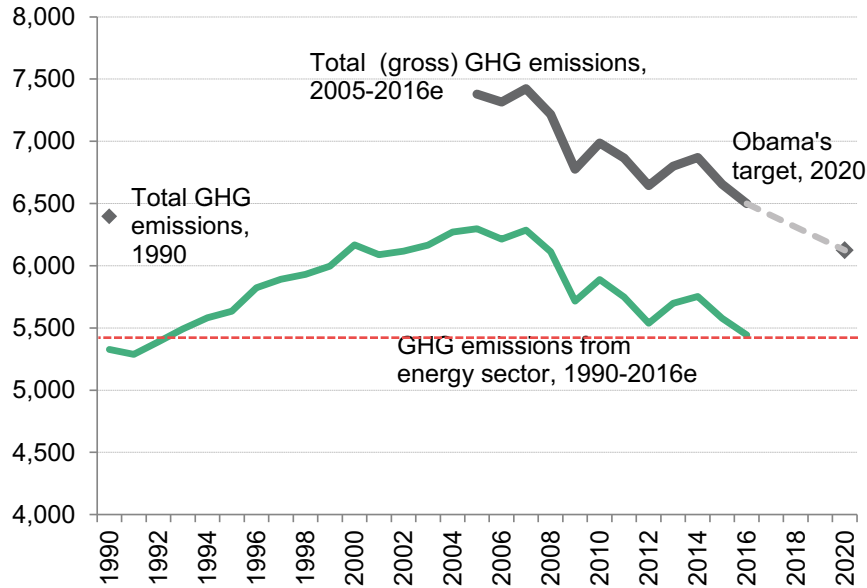


- Last five years: 62% of new capacity additions have been renewable energy projects.
- Last 25 years: 92% has been natural gas plants or renewable energy projects.
- In 2016, renewables added 22GW of capacity, or roughly 70% of total build for the second straight year. Gas build totaled 7.4GW, and for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

## Greenhouse gas emissions, power sector, energy sector and economy-wide (MtCO<sub>2</sub>e)



- US GHG emissions are at their lowest levels in 25 years, falling to an estimated 6.5GtCO<sub>2</sub>e 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 CO<sub>2</sub> emissions from the energy sector comes from the EIA's Monthly Energy Review.

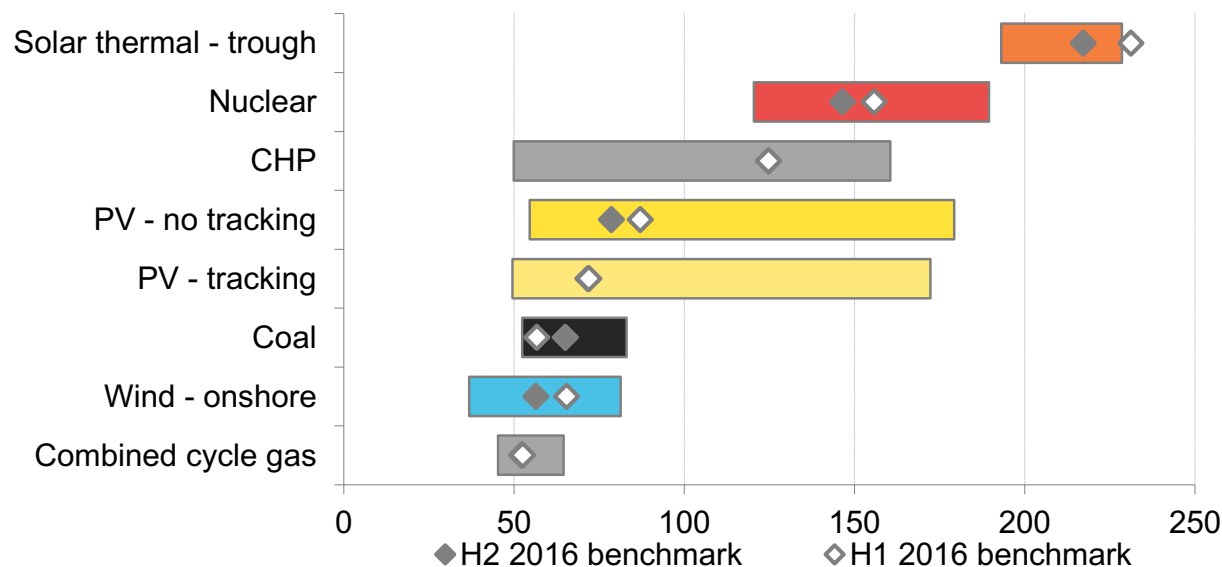


**Falling costs for consumers**

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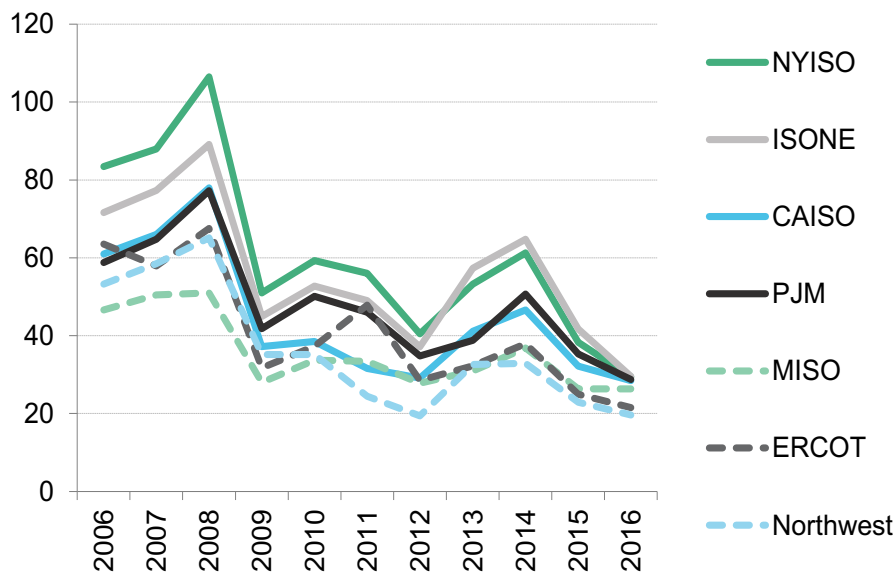
# Economics: US levelized cost of electricity (*unsubsidized*) across power generation technologies, H2 2016 (\$/MWh)



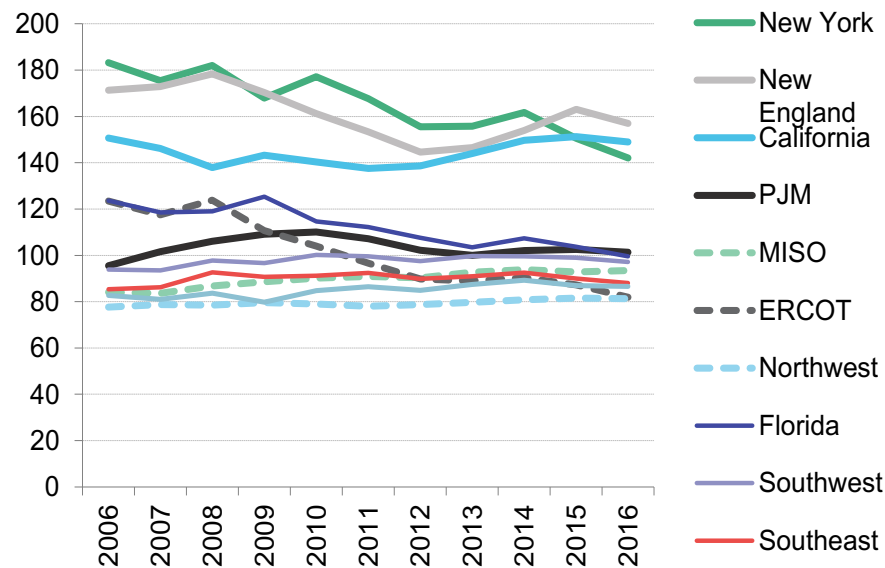
- On a levelized cost basis, renewables are competitive with coal and natural gas-fired power.
- The *unsubsidized* LCOE for wind came in as low as \$37/MWh in Texas, the cheapest of all technologies assessed. Solar PV can be built for as low as \$50/MWh, again in Texas and the Southwest.
- Natural gas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

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

## Wholesale power prices (2016 \$/MWh)



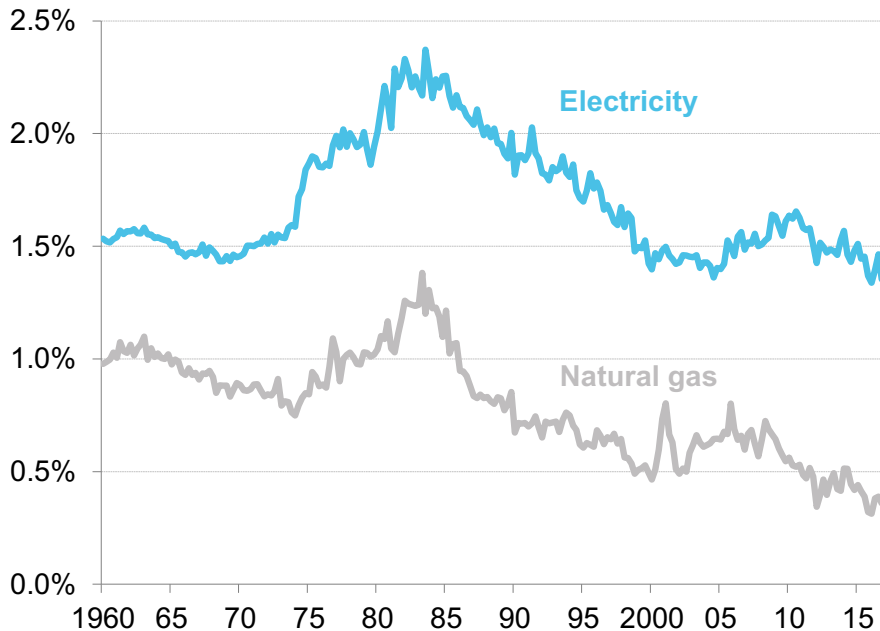
## Average retail power prices (2016 \$/MWh)



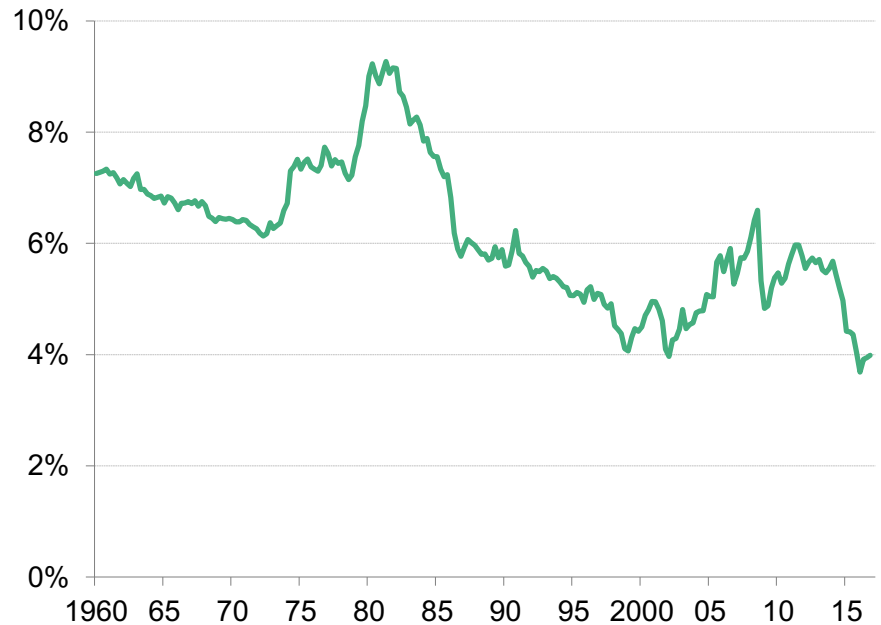
- Wholesale power prices continued their descent in 2016, as natural gas prices touched an 18-year low in March and more zero-marginal cost renewables bid into the market. Year-on-year, around-the-clock prices dropped by as much as 29% in New England (ISONE), 23% in New York (NYISO) and 18% in PJM in real terms. In the Midwest (MISO), prices held relatively flat, falling 0.2% year-on-year. The declines in 2016 followed after roughly 30% slides in 2015 for most regions.
- Retail prices also declined, at an average clip of 2.2% across the country. Regionally, the falloff in retail prices was most visible in New York and Texas (ERCOT), which saw decreases of 5.6% and 6.2%, respectively. Retail prices are typically less responsive to changes in the fuel mix or in fuel prices, because wholesale power costs make up only a portion of retail bills.
- 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.

### 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.

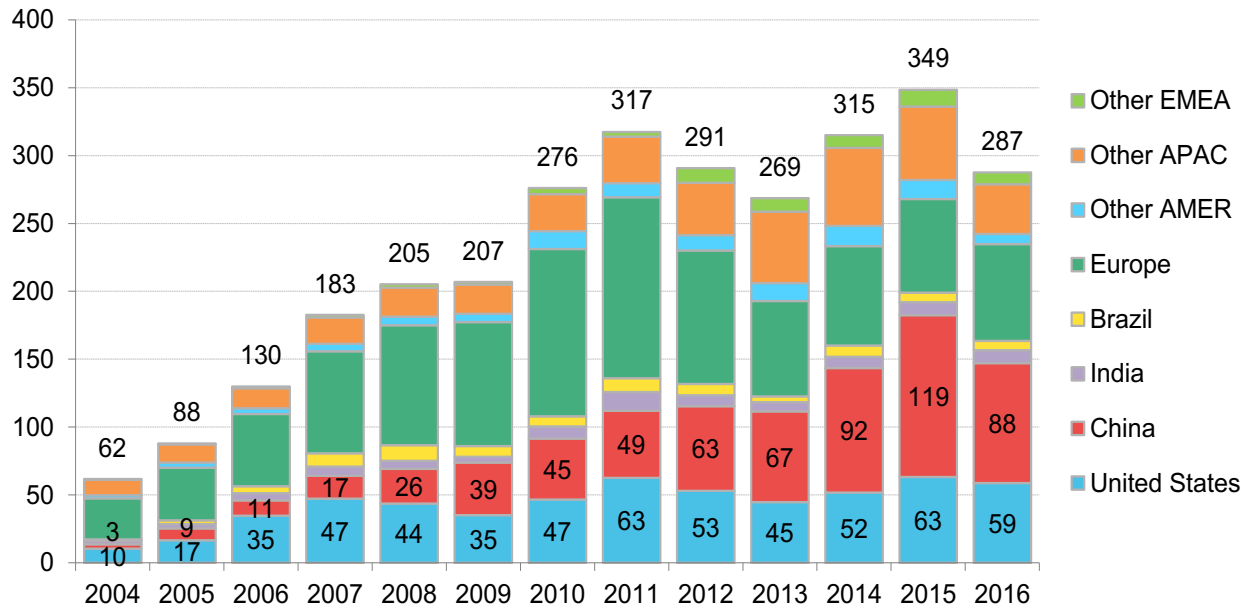
Source: Bureau of Economic Analysis, Bloomberg New Energy Finance Notes: Values for the fourth quarter of 2016 are preliminary.



**Global context**

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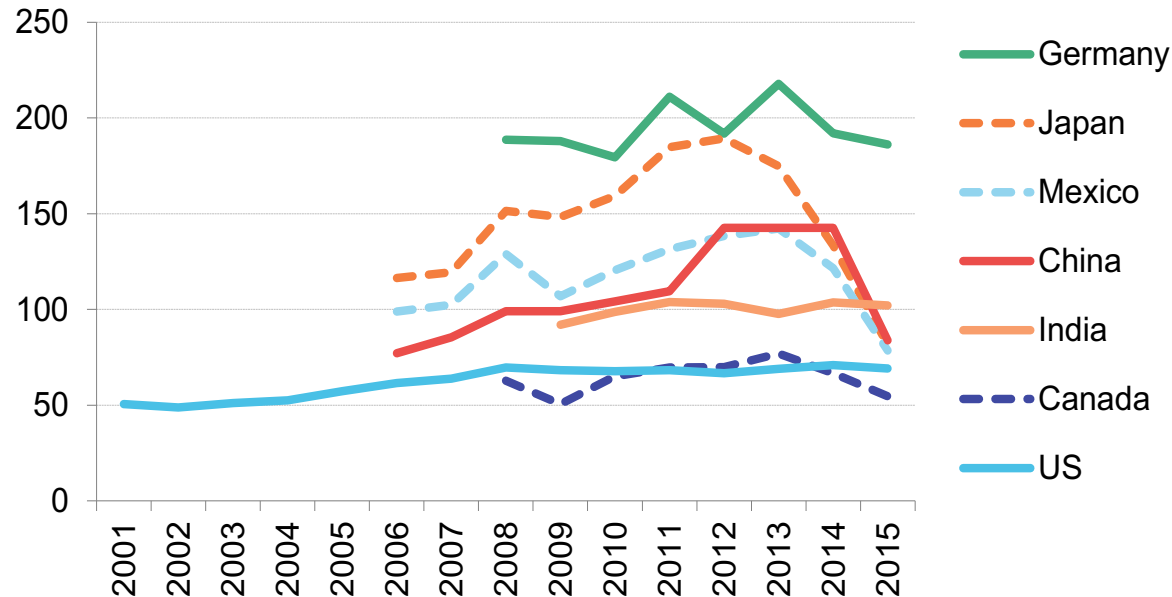
# Global context: Total new investment in clean energy by country or region (\$bn)



- Total global new investment in clean energy ebbed 18% in 2016 to \$287.5bn, after hitting a record high of \$348.5bn in 2015. The dropoff partly reflects steep declines in equipment prices, especially for solar PV.
- The most significant retreat in absolute terms occurred in China, where investment shrank \$31bn (-26%) from 2015 levels. China is stepping back from building new utility-scale renewables and instead taking time to integrate existing renewable capacity. Investment stayed roughly the same in India while falling \$17bn (32%) in the rest of APAC.
- In the US, investment fell 7% to \$59bn, after an exceptional 2015. For details, please see section 2.2.
- European clean energy investments climbed by \$2.4bn (+3%) in 2016.

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.

# Global context: Energy prices – average electricity rates for the industrial sector by country (\$/MWh)



- The US – and North America in general – has among the lowest costs of electricity in the world for industrial customers (6.91¢/kWh for the US industrial sector in 2015, according to the EIA).
- Regions in the US with the lowest costs of power include the Midwest, Southwest and Northwest.
- The steep power price declines in Japan, Mexico and China in 2015 are to a large extent due to the depreciation of their currencies against the US dollar. Similarly, the weakening of the Indian rupee over the past year has limited the extent of India's power price increase when represented in USD (as the chart above does).

Source: Bloomberg New Energy Finance, government sources (EIA for the US)

Notes: Prices are averages (and in most cases, weighted averages) across all regions within the country.



**Corporate action**

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# Finance: Corporate procurement of clean energy and energy efficiency

## Key players: corporate clean energy procurement



## Key players: corporate energy efficiency



- Corporate clean energy procurement has continued to gain momentum. 83 companies have pledged to source 100% of their energy consumption from renewables by signing onto the “RE100” initiative. Notable signees include Apple, BMW, HP, Johnson & Johnson, Kingspan, and P&G. Google also announced in 2016 that it is on track to meet this milestone by 2017.
- Corporations are also increasingly taking action on energy efficiency, with more companies adopting ISO 50001, an energy management systems standard for reducing costs and carbon emissions. The US Department of Energy Superior Energy Performance program, which certifies facilities that have implemented the ISO 50001 standard, continued to expand in 2016: new buildings certified include multiple facilities from Schneider Electric and 3M, and the JW Marriott in Washington, DC. In addition, the new “EP100”, an initiative where companies pledge to double their energy productivity, launched in early 2016. Member companies include Johnson Controls and Swiss Re.

Source: Bloomberg New Energy Finance, company announcements, DOE. Note: The key corporate energy efficiency players displayed here are drawn from EP100 members and the list of ISO 50001 certified facilities. ISO 50001 certification means that a company has met established efficiency standards at one or more of its facilities.



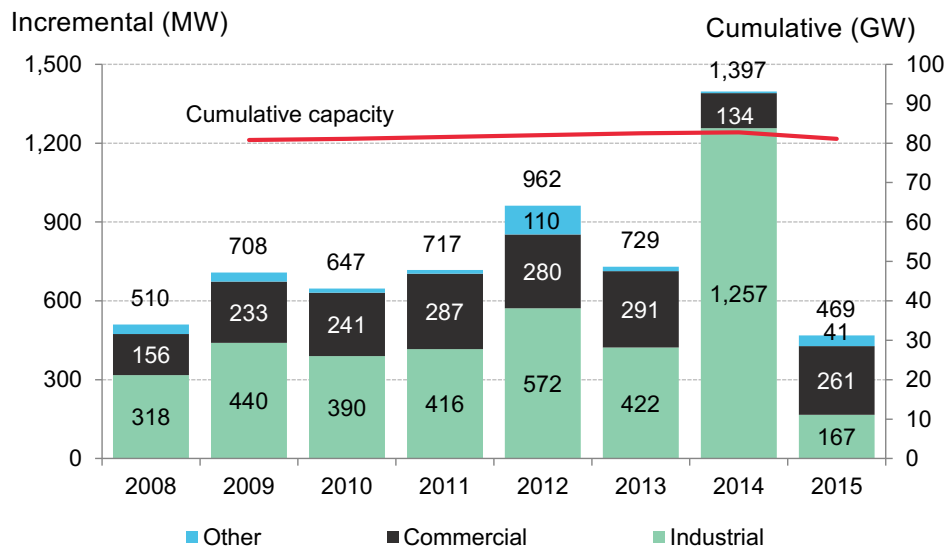


# Combined Heat and Power Markets

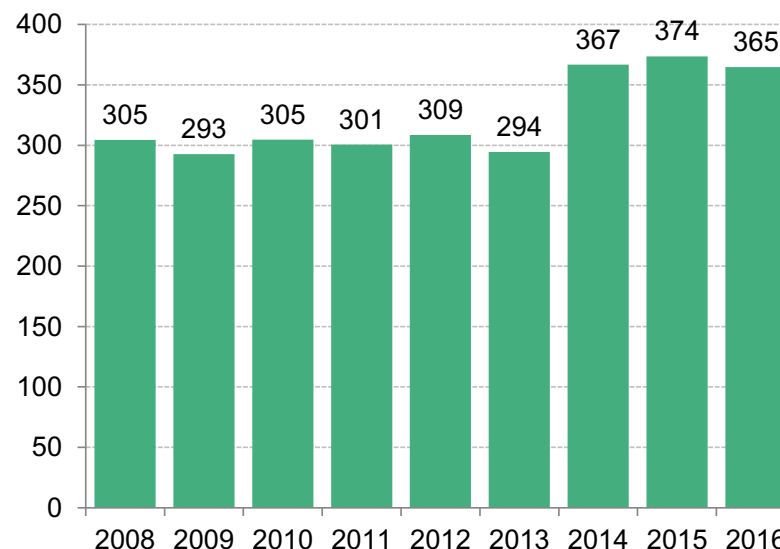
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# Deployment: US CHP build and generation

## US CHP build (MW) and capacity (GW)



## US CHP generation (from plants tracked by EIA generation data) (TWh)

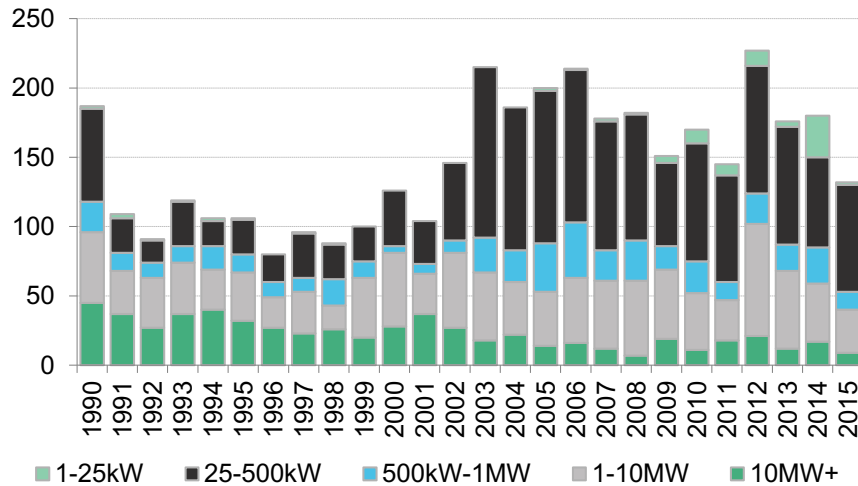


- Installations sunk in 2015 to 469MW, following a 2014 peak of 1,397MW. The drop-off came on the back of a 87% year-on-year decline in industrial installments.
- Cumulative capacity for CHP dipped from 82.7GW to 81.1GW due to site retirements and industrial plant closures.
- The exceptional CHP build in 2014 was accompanied by a corresponding uptick in generation, which persisted in 2015. 2016 generation is expected to remain close to the previous year's level and contribute 9% of total US generation.
- Data may underestimate total CHP production because they do not reflect some newer installations, which tend to be smaller in size and excluded from EIA estimates (see notes below).

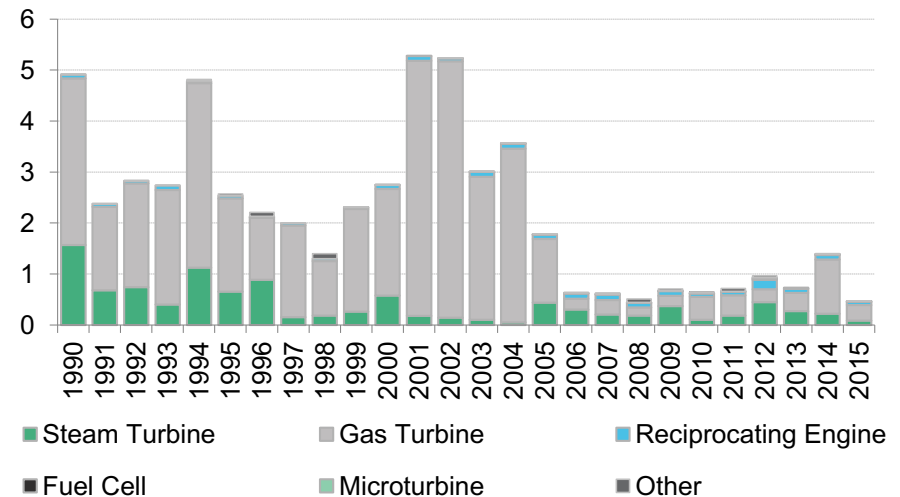
Source: Bloomberg New Energy Finance, DOE CHP Installation Database (maintained by ICF, Inc.) Notes: EIA is the best available source for generation data. However, EIA data on CHP is not comprehensive and so the generation figures are underestimated. Specifically, EIA does not collect data for sites <1MW; EIA may not be aware of certain installations and thus may not send these sites a survey for reporting; and EIA categorizes some CHP systems as 'electric power' rather than 'industrial CHP', if these systems sell power to the grid while providing steam to an adjacent facility. Values for 2016 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through November 2016).

# Deployment: US small-scale CHP build

US Annual CHP build by system size (# of projects)



US Annual CHP build by technology (GW)

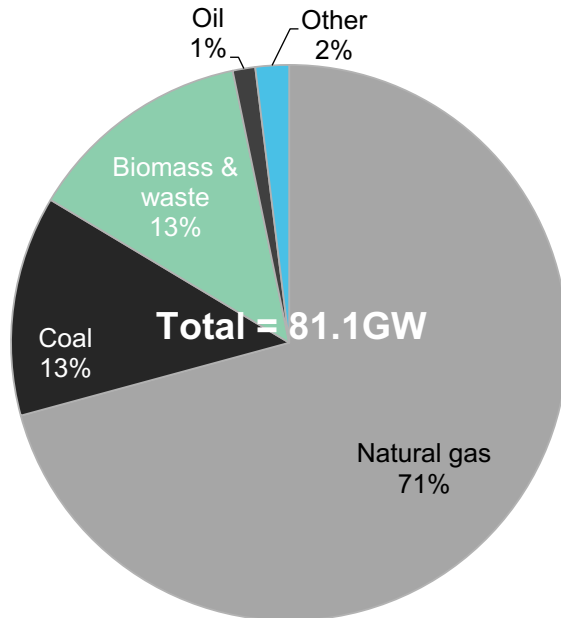


- In 2015, the average CHP system size continued to fall. Installations for both large systems (500kW-10MW) and small ones (1-25kW) failed to match the levels seen in 2014.
- While gas turbines were still the preferred technology for CHP build in 2015, its number of installations have dropped.

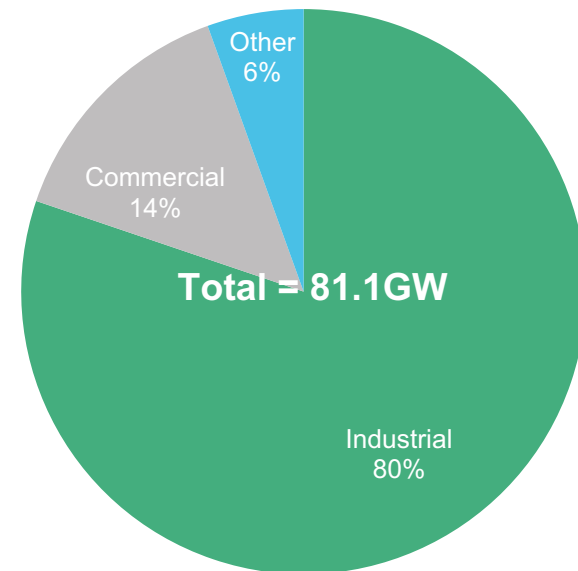
Source: Bloomberg New Energy Finance, DOE CHP Installation Database (maintained by ICF, Inc.)

# Deployment: US CHP deployment by fuel and by sector, 2015

US CHP deployment by fuel source



US CHP deployment by sector

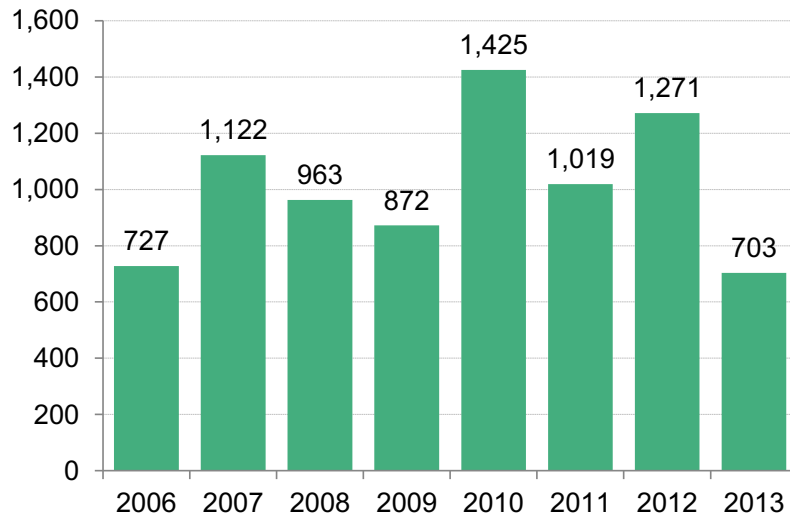


- Natural gas and biomass have taken small chunks of the market from coal, reflecting a broader transition away from coal-fired power. Natural gas remains the most popular source for cogeneration by far, representing 71% of installed CHP capacity.
- More broadly, growth across the CHP sector has also stalled: cumulative capacity has fluctuated around 82GW for the past five years.

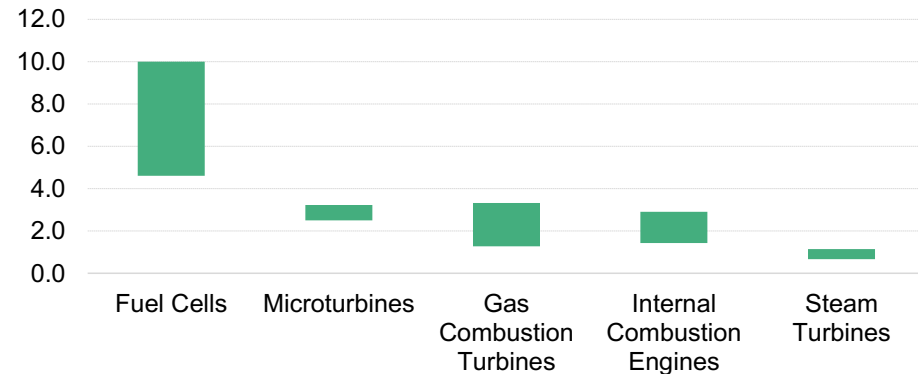
Source: Bloomberg New Energy Finance, DOE CHP Installation Database (maintained by ICF, Inc.)

# Financing and economics: US CHP asset finance and capex

## Asset finance for US CHP (\$m)



## Capital cost of CHP by technology (\$/W)



- Steam turbines, internal combustion engines and gas combustion turbines remain the cheapest to build.
- The price range of microturbines has continued to tighten.

Source: Bloomberg New Energy Finance, DOE CHP Installation Database (maintained by ICF, Inc.)

Notes: Values are estimated assuming a two-year lag between financing and deployment, and assuming a weighted average capex of \$1.7m/MW in 2006, falling to \$1.4m/MW by 2009, and then increasing to \$1.5m/MW in 2010 to reflect a recent trend toward smaller systems. Financing figures are only available through 2013 since deployment figures are only available through 2015 (and there is an assumed two-year lag between financing and deployment). Values are in nominal dollars.

Source: Bloomberg New Energy Finance; EPA Combined Heat and Power Partnership, Catalogue of CHP Technologies, prepared by ICF, Inc.

Notes: ICF, Inc. reports that CHP capex has remained fairly constant since 2008. BNEF data reflect capex for small CHP facilities powered by gas-fired reciprocating engines, gas turbines and microturbines and are based on an internal survey among industry participants.

## Investing in CHP Can...

- ◆ Save businesses \$141 billion from avoided electricity purchases;
- ◆ Save 184 million megawatt-hours of electricity in 2030; and
- ◆ Cut CO<sub>2</sub> emissions by 33 million short tons in 2030 – equal to the emissions from almost 9 coal-fired power plants.

*\*These findings are based on an Alliance for Industry Efficiency analysis that assumes each state installs a portion of its CHP technical potential with a payback period of less than ten years.*



**SOURCE:** The Alliance for Industry Efficiency, 2016, *State Ranking of Potential Carbon Dioxide Emission Reductions through Industrial Energy Efficiency*.

# Panel Discussion

**Moderator:** Alexandra Rekkas, Senior Research Associate, Alliance for Industrial Efficiency

**Panelists:**

- Dale Louda, Executive Director, CHP Association
- Richard Meyer, Director of Energy Analysis and Standards, American Gas Association
- Gil Amengual, Director of Marketing and Product Strategy, Solar Turbines

We will reserve ten minutes to answer questions after the moderated discussion. Please submit questions for the panelists through the question submission portal near the top of your screen.

# Thank you for Joining Us!

The 2017 *Sustainable Energy in America Factbook* is available for free to download at: <http://bit.ly/BCSEfactbook>

AIE's report, *State Ranking of Potential Carbon Dioxide Emission Reductions through Industrial Energy Efficiency* is available at: <http://bit.ly/AIEstateRankings2016>

As a reminder, a recording of this webinar will be sent out to all registrants within several days. Should you not receive a copy and wish to access a recorded version of this webinar please contact Andy Barnes at [abarnes@bcse.org](mailto:abarnes@bcse.org).

Participating organizations are listed below along with contact information of their representatives:

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