Natural Gas & CHP:
State of the Market & Implications for the Future

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Who We Are

“The Alliance for Industrial Efficiency is a coalition of business, labor and environmental organizations that are committed to encouraging the use of CHP and WHP to enhance U.S. manufacturing competitiveness, increase energy efficiency, and improve the environment.”

Visit us at alliance4industrialefficiency.org

Follow us on twitter at @AllianceIndEff
Current CHP Projects

Source: CHP Installation Database, March 2014
CHP Technical Potential

- < 1,000 MW
- 1,000 - 3,000 MW
- 3,000 - 8,000 MW
- > 8,000 MW
Remaining Potential for CHP
Natural Gas and CHP:
State of the Market and Implications for the Future

March 9, 2016

GET THE FACTS: http://www.bcse.org/sustainableenergyfactbook #Factbook
About the BCSE

• 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
2016 BCSE Members
Clean Energy Coast to Coast

U.S. Clean Energy Jobs from Coast to Coast

The Council’s members are strengthening America’s energy future and creating American jobs in every state of the country.

Visit www.bcse.org to explore the interactive map.
It is a new era for American energy. In 2015, increased use of sustainable energy set the stage for a U.S. triple play of carbon reductions, cost savings and economic growth.

The 2016 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, renewable energy and natural gas — that are contributing to the country’s move towards cleaner energy production and more efficient energy usage.
Infographic

Get the Facts
- American energy productivity has increased by 13% from 2007 to 2015.
- 2015 was a record year for natural gas production, consumption, flows to power generation and volumes into storage.
- Renewable energy is a prominent part (20%) of the U.S. 2015 capacity mix, with 221 GW installed across the country, a 57% increase over 2008 levels.
- Total U.S. investment in clean energy topped $6 billion in 2015, the second highest level in the world.
- 2015 U.S. power sector carbon emissions fell to their lowest annual level since 1995.

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 2016 Factbook State & Regional Slides

Previous Factbook Editions
Download previous editions of the Factbook here.

2013
2014
2015

About the Factbook Partners

Bloomberg New Energy Finance (BNEF) provides unique analysis, tools and data for decision makers driving change in the energy system. With unrivalled depth and breadth, BNEF helps clients stay on top of developments across the energy spectrum from our comprehensive web-based platform. BNEF has 200 staff based in London, New York, Beijing, Cape Town, Hong Kong, Munich, New Delhi, San Francisco, São Paulo, Singapore, Sydney, Tokyo, Washington D.C., and Zurich.

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.

For more information please contact Laura Tierney of BCSE at 202-785-0567
About the Factbook (1 of 2):
What is it and what’s new

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 2015 wherever possible
• Employs Bloomberg New Energy Finance data in most cases, augmented by EIA, FERC, ACEEE, ICF International, 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 fourth 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(1) can continue to serve as a reference. The emphasis of this 2016 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.
• 2015 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 analyses of US levelized costs of electricity, corporate renewables procurement, US transmission build, small-scale CHP generation and additional energy efficiency data.

2015: A YEAR OF MILESTONES
US energy overview:
Economy’s energy productivity: GDP and primary energy consumption (indexed to 1990 levels)

- The US economy is increasingly energy productive, resulting in a decoupling between growth in GDP and growth in energy consumption. As US GDP expanded 83% over the last 25 years, energy consumption only ticked up 17%.
- By one measure (US GDP per unit of energy consumed), productivity has improved 56% since 1990, 13% since 2007, and 2.3% between 2014 and 2015.

Source: US Energy Information Administration (EIA), Bureau of Economic Analysis, Bloomberg Terminal
Notes: Values for 2015 energy consumption are projected, accounting for seasonality, based on latest monthly values from EIA (data available through September 2015). GDP is real and chained (2009 dollars); annual growth rate for GDP for 2015 is based on consensus of economic forecasts gathered on the Bloomberg Terminal as of January 2016.
From 2006 to 2011, US utility expenditure for energy efficiency grew 25% per year.

The budgeted amount for 2014 would represent a 25% growth between 2013 and 2014.

Maryland was the state with the largest increase in utility budgets for energy efficiency, with an increase from $119m in 2013 to $292m in 2014.

In December 2015, US Congress renewed the energy-efficient commercial buildings tax deduction and nonbusiness (ie, residential) Energy-efficient Property Credit that retroactively reinstates tax credits for projects completed in 2015 and 2016.

Source: CEE, ACEEE, Bloomberg New Energy Finance
Natural gas production in 2015 was up 7% from 2014 levels, 26% from 2007 levels. Shale production now accounts for almost half of total.

Technological improvements in efficiencies (like pad drilling and longer laterals) and drilling in productive “sweet spots” has allowed production to increase even as rig counts drop.

Source: Bloomberg New Energy Finance, EIA, Baker Hughes. Data up through the latest comprehensive numbers available (September 2015).
Policy: US coal power plant retirements completed and announced by year (GW)

- 2015 saw the largest wave of coal retirements ever, with 11GW going offline through October 2015 and another 3GW of retirements announced. An additional, undetermined number of plants (likely less than 5GW in total) also converted from coal to burn natural gas and, in a few cases, biomass.
- Record low gas prices, old age, and increasing operating costs – partly due to US Environmental Protection Agency (EPA) regulations covering sulfur, nitrogen, and mercury emissions from power plants – have forced many coal plants to retire earlier than originally planned.

Source: Bloomberg New Energy Finance
Notes: “Retirements” does not include conversions from coal to natural gas or biomass; retirement numbers through end-October 2015.
US ENERGY IN TRANSITION
US energy overview:  
US electricity generation by fuel type (%)

- Generation from natural gas plants increased by 17% from 2014 to 2015, while coal generation fell by 11%.
- The US power sector is gradually decarbonizing. From 2007 to 2015, natural gas increased from 22% to 32% of electricity generation, and renewables climbed from 8% to 13%. Coal's share slipped from 49% in 2007 to only 34% in 2015.

Source: EIA

Notes: Values for 2015 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2015). 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.
Solar experienced another year of strong build, adding 7.3GW of PV in 2015 – a record.
Small-scale solar continues to grow as the economics make it a viable alternative to retail rates in many regions of the country.
Wind build surged to 8.5GW in 2015 as developers rushed to capture the Production Tax Credit (PTC) before it was due to expire at the end of 2016.
Other sectors (biomass, biogas, waste-to-energy, geothermal, hydro) are idling without long-term policy support.

Source: Bloomberg New Energy Finance, EIA   Notes: Numbers include utility-scale (>1MW) projects of all types, rooftop solar, and small- and medium-sized wind.
In 2015, power-sector emissions sunk to their lowest levels (1,985Mt) since 1995 as cleaner-burning natural gas has displaced generation from coal-fired power plants.

Emissions are 18% below 2005 levels.

The Clean Power Plan targets a 32% cut from 2005 levels by 2030.

Source: Bloomberg New Energy Finance, EIA, EPA

Notes: Values for 2015 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through September 2015).
AN ERA OF LOW PRICES
US energy overview:
Retail and wholesale power prices

Wholesale prices fell by about a third in 2015, as natural gas prices fell and more renewables connected to the grid.

Retail power prices in most regions remain well below the peak prices seen in 2008-09.

In 2015, retail electricity rates fell by 1.3% on average nationwide. New York (-5.8%) and Texas (-2.7%) saw the biggest year-on-year declines.

Exceptions included California and New England where retail prices rose marginally (1.8% and 1.3%, respectively).

Source: Bloomberg New Energy Finance, EIA, Bloomberg Terminal
Notes: Data through end-November 2015. Wholesale prices taken from proxy power hubs in each ISO. Prices are in real 2014 dollars.
OUTLOOK
Global context: Total new investment in clean energy by country or region ($bn)

- Total new investment in clean energy set a new record high at $329bn in 2015.
- Investments climbed 8% in the US, mostly in wind and solar. The US currently makes up 17% of world investment in clean energy.
- China was #1 again, investing $111bn.

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.
At the end of 2015, Congress enacted major subsidy extensions for clean energy projects.

The Production Tax Credit (PTC) for wind projects was extended through the end of 2019. The credit is $23/MWh for projects beginning construction in 2015 and 2016, then steps down through 2019.

The Investment Tax Credit (ITC) for solar projects was extended and now applies to projects beginning construction before 2022. The credit begins at 30% for projects breaking ground before 2020, then steps down gradually to 10%.

Extensions were also granted for the production of second-generation biofuels and energy from geothermal, biomass and landfill gas, hydroelectric projects and ocean energy; however, the majority of these technologies received extensions of only two years, compared to five year for wind and solar.

Deductions and credits were extended for energy efficiency building improvements and the construction of efficient homes.
Emissions reductions required by the Clean Power Plan between 2012 and 2030, under mass-based compliance.

- EPA finalized the Clean Power Plan (CPP), its regulation on carbon emissions from the existing power fleet, in August 2015.
- The Plan could cut power-sector emissions 32% from 2005 levels by 2030.

Source: Bloomberg New Energy Finance, based on analysis of EPA Clean Power Plan

Notes: Darker colors indicate deeper emissions cuts. Yellow states may actually increase their overall emissions, while remaining in compliance with the EPA’s Clean Power Plan. Data is not available for Alaska and Hawaii; Vermont and DC are not covered by the EPA’s regulations. Data is based on EPA modelling and EPA historical emissions inventories.
Policy: State policy barriers to net energy metering erected in 2015

- States across the country imposed policies against net energy metering (NEM), a practice key to the economics of distributed generation.
- For example, Nevada regulators approved higher fixed charges and lower compensation for surplus generation from NEM customers. In response, SolarCity and Sunrun announced plans to leave the state. State regulators are now considering grandfathering in existing NEM customers so that they are not subject to the new rule.

On March 31, 2015, the US released its official pledge for US emissions cuts as part of the United Nations climate negotiations: to reduce emissions to 26-28% below 2005 levels by 2025. An earlier target proposed by President Obama set a 2020 goal of 17% below 2005 levels.

In 2013, the last year with complete data, net emissions (ie, including sinks) stood 10% below 2005 levels.

The new pledge builds off existing and coming programs (eg, CAFE standards, EPA Clean Power Plan), but more policy may be needed to achieve the targets.

Source: Bloomberg New Energy Finance, EIA, EPA, US Department of State. Notes: Net GHG emissions include total emissions less sequestration. Full data only available through 2013. Scenarios 1 and 2 show two trajectories for US emissions growth, based on a combination of Bloomberg New Energy Finance (BNEF) forecasts and EPA, EIA and US Department of State analyses. Both scenarios use BNEF’s forecast for US power-sector emissions, assuming full compliance with the EPA Clean Power Plan. Both scenarios assume transportation growth as per the EIA’s AEO2015 reference case and assuming existing CAFE standards. Scenario 1 assumes residential, commercial and industrial sectors’ energy growth as per the EIA AEO2015 reference case; and agricultural, waste and forestry and land use sectors’ growth as per the 2014 US Climate Action report. Scenario 2 assumes the historical decline rate for the residential and commercial sectors; assumes the industrial, agricultural and waste sectors’ emissions level remain constant from 2013; and assumes forestry and land use emissions follow the “high sequestration case” in the 2014 US Climate Action report.
WRAP-UP
2015 was a watershed year for sustainable energy in the US:
- GDP grew 2.4%, while energy consumption grew only 0.1%
- Record natural gas production and consumption
- Record coal retirements (14GW+)
- Record solar PV build (7.3GW)

These changes are signs of a permanent shift:
- Natural gas has been displacing coal within the power sector
- Renewables (excluding hydro) provided 7.4% of power, up from 2.2% in 2005
- Power sector emissions 18% below 2005 levels
- Hybrid vehicle sales fell and gasoline consumption rose, but long-term trend still positive

Meanwhile, energy prices remain low:
- Natural gas prices hit lowest levels since 1999, allowing gas to outcompete coal
- Solar, wind costs continue to decline
- Retail power prices 6% below 2008 peak

And the outlook is strong:
- US remains key destination for clean energy investment
- Critical policy developments (Paris, Clean Power Plan, tax credit extensions)
The American Gas Association (AGA), founded in 1918, represents more than 200 local natural gas utilities that deliver natural gas to 177 million Americans nationwide. In addition, AGA’s broader membership includes natural gas pipelines, Canadian local distribution companies, natural gas gatherers, marketers and storage companies and more than 350 associate members who provide critical products and services to the natural gas industry.
Natural Gas Records in 2015

- **Domestic Annual Production** – 27.1 Tcf
- **Proved Reserves** – 368 Tcf (dry)
- **Undiscovered Gas Resources** – more than 2,500 Tcf
- **Domestic Natural Gas Consumption** – 27.4 Tcf
- **Natural Gas Consumed for Power Gen** – 9.4 Tcf
- **Working Gas in Underground Storage** – 4,009 Bcf

Sources: Bentek Energy, Energy Information Administration, Potential Gas Committee
Despite falling rig counts, natural gas production continues to grow.

US dry gas production record: February 19, 2016 – 73.8 Bcfd (Bentek)
Huge shale gas production begins to level


US Shale Gas Production

- Antrim (MI, IN, & OH)
- Bakken (ND)
- Woodford (OK)
- Barnett (TX)
- Fayetteville (AR)
- Eagle Ford (TX)
- Haynesville (LA & TX)
- Marcellus (PA & WV)
- Utica (OH, PA & WV)
- Rest of US 'shale'

Record annual production in 2015
New daily records already in 2016

Daily Dry Natural Gas Production
US Lower-48

Billion Cubic Feet per Day

Source: Bentek Energy LLC
Gas Breakevens Before and After the Oil Rout

($/MMBtu Henry Hub)

Median cost reduction for these plays = $0.66/MMBtu
Average = $0.72/MMBtu

Reduction takes into account 18% drop in drilling costs and 25% drop in completion costs, and uses 2018 - rather than forward 12-month - basis (to Henry Hub).

Source: Bloomberg New Energy Finance
Relatively Low and Stable Natural Gas Prices

Dollars per Million BTU

Natural Gas Prices
Prompt-Month Futures at Henry Hub

Price Range
2006-2010

Source: Energy Information Administration
US distribution expenditures reached nearly $10 billion in 2014.
Change in Production, 2014-2020

Source: Bloomberg New Energy Finance.
Change in Production, 2020-2030

MidCon +4.1
Eagle Ford +2.1
Barnett -1.9
ROX +1.9
App +8.7

Canada +8.5

Permian -0.2
F'ville -0.9
H'ville -3.8
Eagle Ford +2.1

All other -5.8

Source: Bloomberg New Energy Finance.
BNEF Long-Range Henry Hub Gas Price
(real 2015$/MMBtu)

2016/H1 2017: Glut eases as ex-Northeast supply drops/demand rises slightly
H2 2017/H1 2019: Rapidly growing demand forces producers back into Haynesville, MidCon and Canada
2019-23: Demand continues to grow, but at a calmer pace
2024+: More Canadian LNG exports, permanent declines in the Haynesville and the Marcellus plateauing push prices to a higher steady-state

Source: Bloomberg New Energy Finance.
CHP: State of the Market and Implications for the Future

Alliance for Industrial Efficiency Webinar

9 March 2016
Comparison of Energy Efficient CHP to Typical Utility

- **Power Plant**: 35% Efficiency, 100 Units of Fuel
- **Boiler/Furnace**: 75% Efficiency, 60 Units of Fuel
- **CHP**: 80% Efficiency, 100 Units of Fuel

**Combined Efficiency**
- Power Plant: ~50%
- Boiler/Furnace: ~75%
- CHP: ~80%

**Fuel Savings** = Financial Savings and Emission Reduction
CHP: Attractive Capital Cost
Competitive LCOE – but US lags Europe

A number of renewable energies have comparable and, at times, cheaper LCOEs than “conventional” power sources.

Source: Bloomberg New Energy Finance, EIA

Notes: LCOE is the per-MWh inflation-adjusted lifecycle cost of producing electricity from a technology assuming a certain hurdle rate (i.e., after-tax, equity internal rate of return, or IRR). The target IRR used for this analysis is 10% across all technologies. All figures are derived from Bloomberg New Energy Finance analysis. Analysis is based on numbers derived from actual deals (for inputs pertaining to capital costs per MW) and from interviews with industry participants (for inputs such as debt/equity mix, cost of debt, operating costs, and typical project performance). Capital costs are based on evidence from actual deals, which may or may not have yielded a margin to the sellers of the equipment; the only 'margin' that is assumed for this analysis is 10% after-tax equity IRR for project sponsor. The diamonds correspond to the costs of actual projects from regions all over the world; the hollow circles correspond to 'global central scenarios' (these central scenarios are made up of a blend of inputs from competitive projects in mature markets). For nuclear, gas, and coal, the light blue squares correspond to US-specific scenarios. 'CHP' stands for combined heat and power; 'CCGT' stands for combined cycle gas turbine; 'c-Si' stands for crystalline silicon; 'CSP' stands for concentrated solar power; 'LFR' stands for linear Fresnel reflector. EIA is source for capex ranges for nuclear and conventional plants.
Over the past twenty years, the average size of a CHP system shrank, suggesting a lack of market incentives for large-scale projects. 2003 saw total construction starts nearly double from the previous year (from 118 to 219 projects) amid an increase in projects sized between 500 and 1000 kilowatts.

In the past decade, annual new build has been muted. Absent any financial enticements, facility owners appeared reluctant to upgrade to newer small-scale technologies like fuel cells and microturbines, when conventionally reliable technologies provide cheaper power at a larger scale.

Source: Bloomberg New Energy Finance, DOE CHP Installation Database (maintained by ICF International)
2014 saw a jump in installations from 679MW to 847MW, including the most industrial CHP build of the past seven years. However, cumulative capacity remains static as CHP systems using dirtier fuels have been retired. Overall, growth is still stymied due to a lack of supportive policies at the federal or state level and demanding standby charges that undermine system economics.

Annual generation has been notably higher in 2014 and 2015 than in the previous five years. Higher utilization of CHP may be due to cheaper gas.

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 International)  
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 2015 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through October 2015).
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