



BCSE BRIEF: Combined Heat and Power – A High-Efficiency, Sustainable Energy Solution

The [Business Council for Sustainable Energy](#) is pleased to share the findings from the recently released [2018 Sustainable Energy in America Factbook](#). This brief focuses on the deployment trends and sustainability benefits of combined heat and power (CHP) technology applications.

The Business Council for Sustainable Energy (BCSE) is a broad-based clean energy trade association representing energy efficiency, natural gas and renewable energy industries. Its membership includes independent power producers, equipment manufacturers, investor-owned utilities, public power utilities, project developers and energy and environmental service providers. The coalition of companies and trade associations is united around the continued revitalization of the U.S. economy and a sustainable energy future.

The Business Council for Sustainable Energy supports the utilization of a broad portfolio of readily available clean energy technology solutions to meet energy, environmental and sustainability goals. The energy efficiency and emissions benefits of CHP are significant, and when coupled with the cost savings and reliability benefits provided by onsite generation of electricity and thermal energy, CHP firmly fits into the sustainable energy solution set.

About the 2018 Sustainable Energy in America Factbook

The Sustainable Energy in America Factbook¹ is an annual report commissioned by the BCSE and is independently written by energy market analyst Bloomberg New Energy Finance. It details the rapid clean energy transformation occurring in the U.S. and includes important data on technology deployment and costs as well as greenhouse gas emissions trends. The Council hopes that this information can be useful as energy and sustainability investments and policies are considered.

Clean Energy is Transforming the U.S. Energy Economy and CHP's Role as a Sustainable Energy Solution

The 2018 Factbook shows that expanded deployment of energy efficiency, natural gas and renewable energy generated economic benefits without requiring increases in energy consumption or greenhouse gas emissions. In fact, at the end of 2017, U.S.

greenhouse gas emissions were at a 27-year low and U.S. power sector carbon emissions were at a 25-year low, representing a 28 percent reduction below 2005 levels. Further, continued declining technology and fuel costs resulted in American households spending the smallest proportion of

Combined Heat and Power Produced 8.5% of U.S. Electricity Generation in 2017 – offering businesses and communities, efficient, cost-effective, reliable and sustainable energy.

¹ For more information, please see: <http://www.bcse.org/sustainableenergyfactbook.html>

their annual budgets on energy and electricity expenses since the early 1960s. The Factbook data affirms that the growth of a broad portfolio of sustainable energy technologies and resources has contributed to greater economic competitiveness, job creation, lower emissions and the expansion of the American economy.

Combined heat and power is an important sustainable energy technology solution. CHP systems are highly efficient and enable universities, hospitals, industrial plants and other facilities to generate power and thermal energy onsite. In 2017, CHP systems provided 8.5 percent of U.S. electricity generation and offer significant energy efficiency, emissions, economic and reliability benefits. See Figure 3 for more information on U.S. CHP capacity and electricity generation.

According to the U.S. Environmental Protection Agency (EPA), combined heat and power applications range from 60 to 80 percent system efficiency, compared to conventional systems that generally achieve around 33 percent system efficiency. See Figure 1 showing an example of a 5-megawatt natural gas-fired combustion turbine CHP system that results in 75 percent system efficiency.²

Figure 1. Conventional Generation vs. CHP: Overall Efficiency

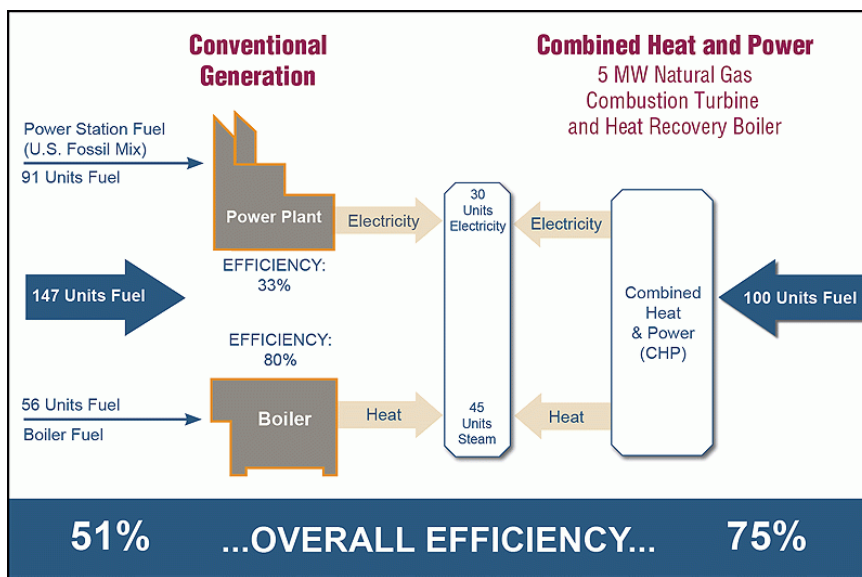


Figure 1: This is an example of a typical CHP system. To produce 75 units of electricity and useful thermal energy, the conventional system uses 147 units of energy inputs-91 for electricity production and 56 to produce useful thermal energy-resulting in an overall efficiency of 51 percent. However, the CHP system needs only 100 units of energy inputs to produce the 75 units of electricity and useful thermal energy, resulting in a total system efficiency of 75 percent. Source: U.S. Environmental Protection Agency

According to the EPA, “CHP’s high efficiencies dramatically reduce energy use and greenhouse gas emissions compared to purchased electricity and generating thermal energy onsite. By capturing and utilizing heat that would otherwise be wasted from the production of electricity, CHP systems require less fuel to produce the same amount of energy. Because less fuel is combusted, greenhouse gas emissions, such as carbon dioxide (CO₂), as well as other air pollutants like nitrogen oxides (NO_x) and sulfur dioxide (SO₂), are reduced.”

The specific benefits of a system will depend on the emissions profile of the local electricity mix. See Figure 2 showing the emission reduction benefits of CHP.

² For more information, please see: <https://www.epa.gov/chp/chp-benefits>

Figure 2. Conventional Generation vs. CHP: CO₂ Emissions

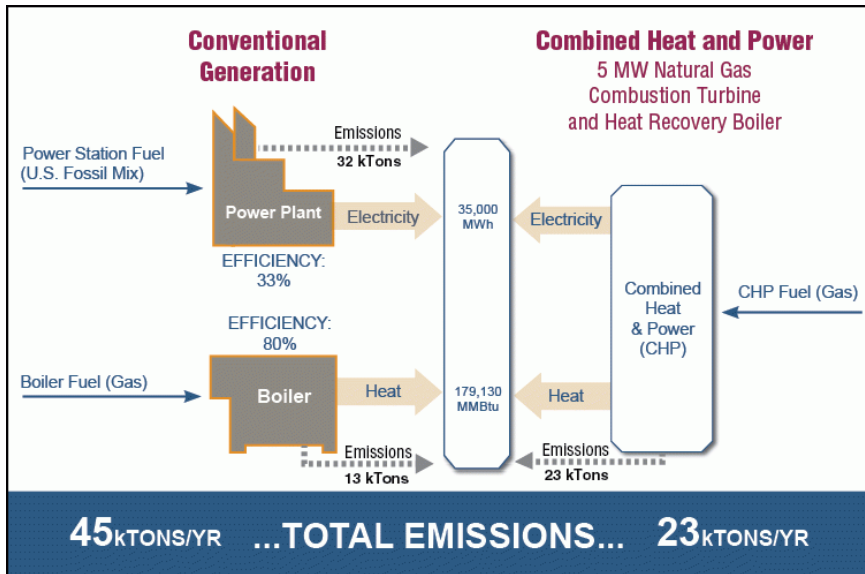
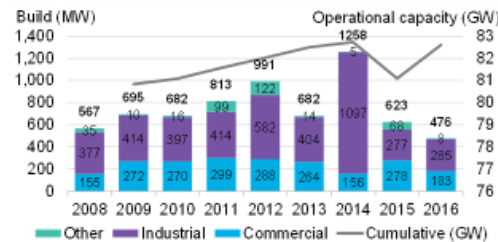


Figure 2: This diagram illustrates the CO₂ emissions output from electricity and useful thermal energy generation for two systems: (1) a fossil fuel-fired power plant and a natural gas-fired boiler; and (2) a 5-megawatt combustion-turbine CHP system powered by natural gas. The separate heat and power system emits a total of 45 kilotons of CO₂ per year (13 kilotons from the boiler and 32 kilotons from the power plant), while the CHP system, with its higher efficiency, emits 23 kilotons of CO₂ per year. Source: U.S. Environmental Protection Agency

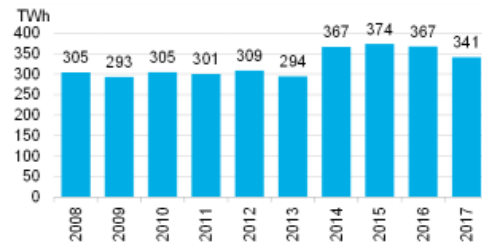
Figure 3. Deployment: U.S. CHP Build and Generation
Source: 2018 Sustainable Energy in America Factbook

Deployment: U.S. CHP build and generation

U.S. CHP build and cumulative capacity



U.S. CHP generation (EIA-tracked plants)



- New CHP Installations dropped in 2016 to 476MW, from 623MW in 2015. Since spiking in 2014 to 1.3GW, build has fallen each year as industrial installations contracted.
 - The total operational CHP capacity in the U.S. has remained relatively stable in recent years. In 2016, the operational capacity ticked back up to 82.6GW, rebounding from the slight dip in 2015 to 81.1GW due to site retirements and industrial plant closures.
 - The sharp jump in installations in 2014 also provided a lasting uptick in CHP generation. Further, in 2015 and 2016, low gas prices continued to encourage greater CHP generation. According to EIA net generation data, CHP units produced an estimated 341TWh in 2017, or 8.5% of total U.S. generation. EIA data may underestimate total CHP production as they do not capture some newer installations, which tend to be smaller and excluded from EIA estimates (see notes below).
 - In 2016, the U.S. added 76 large-scale CHP projects (500kW or greater) and 97 small- to medium-sized projects (1-500kW). This represents a growth in installations over 2015 levels, when the U.S. added 73 large-scale facilities and 91 small- to medium-size projects.
- Source: Bloomberg New Energy Finance, DOE CHP Installation Database (maintained by ICF). Notes: EIA is the best available source for generation data, but is not comprehensive for CHP. The generation figures here are thus 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 2017 are projected, accounting for seasonality, based on latest monthly values from EIA (data available through November 2017).

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