Combined Heat and Power

Combined heat and power (CHP) systems, also referred to as *cogeneration*, generate on-site electricity and useful thermal energy in an integrated system. As a result, well-designed CHP systems consume less fuel than would be required to obtain electricity and thermal energy separately. Since less fuel is consumed, CHP systems offer greenhouse gas (GHG) reduction benefits over the conventional method of obtaining heat from a boiler and power from the electric grid. Furthermore, since much of the energy of a CHP system is consumed on-site as a form of distributed generation, less energy is lost through transmission, adding to the energy savings.

CHP can also provide opportunities to use renewable fuels. For example, wastewater treatment plants are ideal for developing CHP systems as they use the waste heat on-site to warm the digesters and export excess renewable electricity to the grid.[1] Other potential bioenergy sites that could use CHP include dairies, food processing plants, and forestry camps. However, the feasibility of developing CHP at such sites depends on a large and constant need for waste heat throughout the year.

Two state policies set the goals for CHP development in California. One is Assembly Bill 32 (AB 32, Núñez, Chapter 488, Statutes of 2006), the Global Warming Solutions Act. Under this act, the California Air Resources Board (CARB) prepared an *AB 32 Scoping Plan*[2] that includes a reduction goal of 6.7 million metric tons (MMT) of carbon dioxide (CO_2) from CHP resources.[3] In May 2014 the CARB published the *First Update to the Climate Change Scoping Plan,*[4] which reiterated the goals outlined in the original Scoping Plan. A second update to the Scoping Plan, which will incorporate this target, is in progress.[5] In 2016, the Legislature passed Senate Bill 32 (Pavley, Chapter 249), setting a GHG emissions reduction target of 40 percent below 1990 levels by 2030. Also, Governor Edmund G. Brown Jr.'s 2010 *Clean Energy Jobs Plan* calls for 6,500 megawatts (MW) of new CHP capacity by 2030.

California's goals align with an executive order issued by President Obama calling for 40 gigawatts of new CHP by 2020.[6]

---

1 O'Neill, Garry and John Nuffer. 2011. *2011 Bioenergy Action Plan.* California Energy Commission, Efficiency and Renewables Division. Publication Number: CEC-300-2011-001-CMF.

2 http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf.

3 A metric ton is 1,000 kg or 2,205 lbs.

4 http://www.arb.ca.gov/cc/scopingplan/2013_update/first_update_climate_change_scoping_plan.pdf.

5 https://www.arb.ca.gov/cc/scopingplan/scopingplan.htm.

6 http://www.whitehouse.gov/the-press-office/2012/08/30/executive-order-accelerating-investment-industrial-energy-efficiency7 http://www.cpuc.ca.gov/General.aspx?id=5935.

These policy goals have a significant effect on electric system planners and operators. Sites that use CHP electricity on-site reduce the need for grid electricity, thereby affecting the retail electric sales forecast and the amount of renewable generation needed to meet California's Renewables Portfolio Standard (RPS) requirements. For more information about the RPS, see http://www.energy.ca.gov/renewables/tracking_progress/documents/renewable.pdf.

CHP Market Potential

As of the end of 2017, there was about 7,649 MW of CHP installed statewide. About 6,206 MW was either under contract with an investor-owned utility (IOU) or uncontracted but within an IOU service territory. Of the CHP power plants in an IOU service territory, eight power plants shut down, two scaled down, and one scaled up.

A 2011 report by ICF International, Inc. studied the long-term potential for CHP in California and the degree to which CHP can reduce potential GHG emissions over the two decades leading up to 2030. The report examines three possible scenarios using existing state policies in a base case and two additional cases (medium and high) to show the market effects of additional CHP policy actions and incentives, including, but not limited to, an extension of the Self-Generation Incentive Program[7] (the program is discussed further on page 5), reduction of standby and demand charges, and changes to export pricing. The additional cases were designed to prompt discussion and provide perspective as to what degree of development may occur if certain policy actions are taken. A summary of the results are provided in **Table 1**.[8]

Table 1: ICF Study of Combined Heat and Power Potential: 2030 Cumulative New Market Penetration by Scenario (MW)

Scenarios	On-Site	Export	Avoided Air Conditioning	Total
Base Case	1,513	213	160	**1,886**
Medium Case	1,782	1,661	186	**3,629**
High Case	3,289	2,458	361	**6,108**

Source: ICF International, Inc.

A subset of this information was the focus of a 2009 Energy Commission report on wastewater treatment plants.[9] This study concluded that there could be as much as 450 MW of market potential for CHP at wastewater treatment plants in California "by adding biodegradable waste from California dairies, food processing plants, and restaurants' oil and grease to the sludge in the anaerobic digesters."

7 http://www.cpuc.ca.gov/General.aspx?id=5935.

8 http://www.energy.ca.gov/2012publications/CEC-200-2012-002/CEC-200-2012-002-REV.pdf.

9 http://www.energy.ca.gov/2009publications/CEC-200-2009-014/CEC-200-2009-014-SD.PDF.

In November 2016, ICF International, Inc. was awarded an Energy Commission grant to conduct a new CHP technical and market assessment with a specific emphasis on small and microscale (less than 5 MW) systems. The study will consider companion technologies such as absorption chillers, as well as identify sectors and market applications with the greatest potential. The study is expected to be published in the fall of 2018.

Program Support for CHP

Wastewater treatment plants in the Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), or San Diego Gas & Electric Company (SDG&E) service territories qualify for a standard contract for eligible CHP facilities up to 3 MW. Assembly Bill 1969 (Yee, Chapter 731, Statutes of 2006) created the program to encourage development of renewable energy at wastewater treatment facilities.

CHP plants up to 20 MW in size can also secure a revenue stream through the Waste Heat Recovery and Carbon Emissions Reduction Act, also known as Assembly Bill 1613 (Blakeslee, Chapter 713, Statutes of 2007).[10] This legislation created a feed-in tariff for certified CHP facilities that meet efficiency and performance requirements. The Energy Commission certifies AB 1613 facilities, while the rates are set by the California Public Utilities Commission (CPUC).[11] Certified AB 1613 facilities must submit performance information to the Energy Commission annually to maintain eligibility for the feed-in tariff.[12] As of October 2018, seven plants are certified as eligible under AB 1613. See **Table 2** for a list of currently certified facilities.

Table 2: AB 1613 Certified Facilities

Facility Name	Thermal Application	System Size (MW)
Sonoma County	Space conditioning	1.4
Chevron McKittrick	Crude oil extraction	10.3
Pixley Cogen	Ethanol distillation	12
Houweling Tomatoes	Greenhouse conditioning	13
Elk Grove Milling	Cooking	1
Technicast	Metal heating	1.4
SunSelect Produce	Greenhouse conditioning	6.2
Total Certified Capacity		45.3

Source: California Energy Commission staff

10 http://www.energy.ca.gov/wasteheat/.

11 http://www.cpuc.ca.gov/General.aspx?id=5293.

12 Annual performance data are submitted in April.

The Qualifying Facilities Settlement Agreement established a new vehicle for contracting with CHP facilities greater than 5 MW in the investor-owned utility service territories. The Qualifying Facilities Settlement Agreement set capacity targets for each utility to contract with eligible CHP plants through competitive solicitations, as well as GHG emissions reduction targets. The CPUC typically provides semiannual reports on utility progress toward meeting the targets of the settlement agreement each April and October. The most recently published reports are available at http://www.cpuc.ca.gov/General.aspx?id=5432.

In Decision 15-06-028, the CPUC, citing the likelihood that other preferred resources will provide greater GHG reduction potential in the future, reduced the utilities' GHG reduction targets. The decision describes the new targets as being "robust enough to achieve CHP policy objectives … other than GHG emission reductions, including considerations of cost and need."[13]

The settlement targets and progress to date are shown in **Table 3** and **Table 4.** The revised GHG targets and the utilities' progress toward both their procurement and GHG reduction targets are based on the investor-owned utilities' (IOUs') April 2016 semiannual reports to the CPUC and are subject to change as more data are made available. According to the reports, PG&E and SCE have met their capacity procurement targets. PG&E has also met its GHG reduction target.

Table 3: Tracking QF Settlement MW Targets (MW)

Utility	CHP Capacity Procured by IOUs to Date	IOU 2015 CHP Targets	Remaining Capacity to Procure
PG&E	1,497	1,387	0
SCE	1,455	1,402	0
SDG&E*	134	211	77
Total	3,086	3,000	77

*SDG&E has until December 31, 2018 to reach its target.

Source: CPUC

13 http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M152/K559/152559026.PDF, page 56.

Table 4: Tracking QF Settlement GHG Targets (in MMTCO$_2$ Equivalent)

Utility	Initial GHG Target (D.10-12-035)	Revised GHG Target (D.15-06-028)	Utility Progress Toward GHG Target	Remaining Reductions
PG&E	2.17	1.22	1.52	0
SCE	2.15	1.22	0.78	0.44
SDG&E	0.5	0.28	0.02	0.26
Total	4.8	2.72	2.32	0.70

Source: CPUC

Additional incentives are provided to small, clean, and efficient CHP units through the Self-Generation Incentive Program (SGIP). The SGIP provides rebates for eligible distributed energy systems installed on the customer's side of the utility meter. Eligible technologies include wind turbines, waste heat-to-power technologies, pressure-reduction turbines,[14] internal combustion engines, microturbines, gas turbines, fuel cells, and advanced energy storage systems. In June 2016, the CPUC issued Decision 16-06-055, which adopted several program modifications, including a more stringent GHG emissions threshold. Moreover, beginning in 2017, natural gas technologies must be fueled by a mixture of at least 10 percent biogas to retain program eligibility. This requirement becomes more stringent each year, up to 100 percent biogas in 2020.

In October 2015, the CPUC issued Decision 15-10-049 which approved, with modification, Southern California Gas Company's (SoCalGas) Application 14-08-007 to establish a Distributed Energy Resources Services (DERS) Tariff. The DERS Tariff allows SoCalGas to design, install, own, operate, and maintain advanced energy systems, including many forms of CHP, on or adjacent to the customer's premises. It is designed to help overcome barriers for potential customers that might lack the internal capital and experience necessary to develop and operate such facilities. The DERS Tariff could help develop the largely untapped market potential of CHP facilities with 20 MW or less in nameplate capacity. In May 2017, the CPUC approved Advice Letter 4918-G enacting the tariff, which is now available to SoCalGas customers on a voluntary basis.

CHP Research

The Energy Commission conducts research through its Research and Development Division that seeks to develop and help bring to market CHP technologies that provide increased

14 *Pressure-reduction turbines* can control the pressure in pressurized systems using a rotatable barrier device, which generates electricity from the resulting pressure drop.

environmental benefits, greater system reliability, and lower system cost for communities and utilities across the state.[15]

CHP research focuses on improving small (<1 MW) and microscale (<50 kilowatt [kW]) systems. These systems are typically less efficient and more expensive and produce more emissions when compared to the larger counterparts. Technological advancements are required to improve the performance and increase the economic attractiveness of CHP and CCHP (combined cooling, heat, and power) systems for prospective buyers and installers. CHP research also focuses on enabling technologies such as thermally driven cooling and thermal energy storage. Due to the high cost of electricity when compared to natural gas, avoided air-conditioning and refrigeration costs can sometimes make cooling CHP and CCHP systems economical where traditional (heating) CHP systems are not. By developing these cooling CHP and CCHP systems, more can be installed in California. Similarly, thermal energy storage systems can substantially increase the flexibility of a CHP system, allowing such systems to meet the needs of applications where electric and thermal loads do not peak at the same time.

Current Trends

Despite policy, program, and research efforts to support CHP, recent years have seen a decline in capacity and output from existing resources that significantly outpaces the addition of new facilities. From 2010 to 2017, California's CHP fleet has decreased 8 percent in nameplate capacity and 25 percent in annual electrical generation. Figure 1 shows the annual percentage changes to CHP capacity and generation relative to 2010.

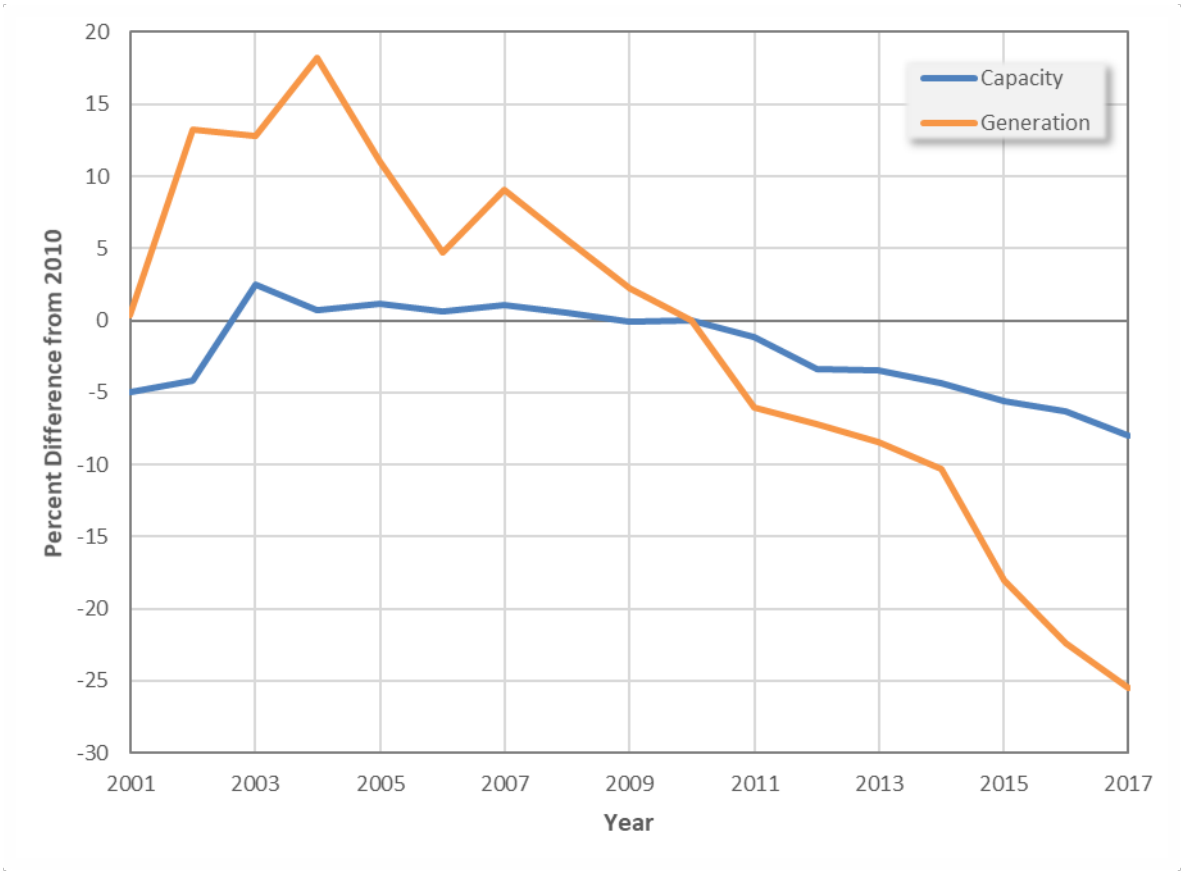
As discussed in the *2017 Integrated Energy Policy Report*,[16] the rapid shift in consumers away from IOUs to Community Choice Aggregators[17] – along with increases in behind-the-meter solar and energy efficiency – have contributed to IOUs being long on supply and not entering long-term contracts. Also, the primary need in the electricity sector is for flexible resources that can help integrate variable wind and solar energy (see the Tracking Progress on Resource Flexibility), but CHP has limited ramping capability. Despite the programmatic support for the technology as described above, capacity may continue to decline.

15 http://www.energy.ca.gov/research/renewable/chp.html.

16 California Energy Commission staff. 2017. *2017 Integrated Energy Policy Report*. California Energy Commission. Publication Number: CEC-100-2017-001-CMF.

17 Community Choice Aggregation (or CCA) lets local jurisdictions aggregate their electricity load to purchase power on behalf of their residents. In California, CCAs are legally defined by state law as electric service providers and work together with the region's existing utility, which continues to provide customer services (for example, grid maintenance and power delivery).(For more information see http://www.leanenergyus.org/what-is-cca/ and/or http://newsroom.ucla.edu/releases/community-choice-is-transforming-the-california-energy-industry.)

Figure 1: Historical Capacity and Generation Relative to 2010



Source: California Energy Commission staff

The disparate rates of capacity and generation decline shown in **Figure 1** suggest that, beyond plant additions and retirements, change in operation at existing facilities may be an important consideration in developing reliable demand forecasts and accurately assessing California's progress toward policy goals. The Energy Commission is examining scenarios in which California's CHP capacity may continue to decline in the near future as facilities unable to secure export contracts either shut down or significantly scale back production.

Additional References:

For information about the CPUC QF Settlement Agreement, terms sheet, semiannual reports, and GHG reductions please visit http://www.cpuc.ca.gov/General.aspx?id=5432.

For additional CHP-related information and events at the Energy Commission, please visit the Commission's CHP website at http://www.energy.ca.gov/chp.

For information on the technical potential of CHP nationally and by state, a report published by the United States Department of Energy is available at http://energy.gov/sites/prod/files/2016/04/f30/CHP%20Technical%20Potential%20Study%203-31-2016%20Final.pdf.

Contact:

Bryan Neff (Bryan.Neff@energy.ca.gov)

Next Update:

October 2019 with updates provided annually.