COGENERATION

OVERVIEW OF A HIGH-IMPACT DRAWDOWN SOLUTION

Cogeneration involves the co-production of beneficial heat and electricity. It can involve capturing waste heat that is a byproduct of coal- and gas-fired power production, where the captured heat can be used to heat water or buildings, manufacture products, or create more electricity. It can also involve the capture of waste heat from an industrial or commercial process that is then used to generate electricity, as in the pulp and paper industry. Cogeneration reduces emissions by displacing the consumption of fossil fuels that would otherwise have been used.

TECHNOLOGY AND MARKET READINESS

Cogeneration technologies and markets are mature and market ready. Cogeneration systems – also called combined heat and power (CHP) – are able to be used in individual buildings, in a district heating network or in manufacturing and electricity generation systems. They have long been viewed as beneficial along a variety of dimensions including grid reliability, energy efficiency, water conservation, and pollution reduction. As a result, countries around the world have increased subsidies for CHP and are expecting rapid growth (from 33 GW in 2015 to 74 GW by 2024 worldwide) (Navigant Research, 2015). With the 2012 U.S. Executive Order establishing national goals for CHP by 2020, CHP has been growing in the United States, as well (Brown, 2017).

Numerous different types of cogeneration systems are possible, including combinations of (1) prime mover (e.g., microturbine, fuel cell), (2) renewable energy source (e.g., solar PV, wind turbine) and (3) energy storage (e.g., lithium-ion battery, compressed air energy storage). Most experience to date has been with natural gas-driven microturbines (EIA, 2020), but cogeneration with solar systems would appear to hold promise.

LOCAL EXPERIENCE AND DATA AVAILABILITY

In 2017, Georgia had 43 cogeneration facilities totaling 1.4 GW of capacity. Most of the largest facilities are industrial (e.g., pulp and paper), but some are commercial (such as the 3,000 KW system in the Bank of America Plaza in Atlanta). One cogeneration system run by Albany Green Energy is located at P&G's paper manufacturing facility; it provides 100% of the steam energy utilized in the manufacturing of Bounty paper towels and Charmin toilet paper. It also generates electricity for the local utility, Georgia Power, and powers an 8.5 MW electricity generator using steam at the Marine Corps Logistics Base in Albany (Holbrook, 2017). The plant can co-generate 394,000 MWh per year using wood waste from local forestry operations as fuel supply (CEO, 2017).

TECHNICALLY ACHIEVABLE CO2 POTENTIAL

Using NEMS, Brown, Cox and Baer (2013) estimated that industrial cogeneration had the technical potential to reduce CO2 emissions in the United States by 1.9% by 2035, meeting 18% of U.S. electricity requirements, up from 8.9% in 2012. Given the sizable and compatible industrial base in Georgia, a comparable level of penetration would seem achievable. Because of Georgia's amount of heavy industry, the opportunities for cogeneration should be greater in our state than elsewhere.

COST COMPETITIVENESS

Research has documented the cost competitiveness of district, industrial, and power generation CHP systems. The cost-effectiveness of commercial CHP depends on rate design and system ownership (Brown, 2017). Albany CHP LCOE is estimated to be $127-132 (in $2017)/MWh without including a value for the steam that is produced. A 35-year plant life brings the LCOE down to $123/MWh.

The cost competitiveness of CHP systems depends on whether they are customer or utility owned, and on the type of rate tariff that they operate under. Two possibilities that have been evaluated include a CHP system that is owned and operated by a customer, subject to a flat tariff, versus a CHP system that is owned and operated by a utility subject to time varying locational marginal prices. The latter was found to be more financially favorable (Brown, 2017).

BEYOND CARBON ATTRIBUTES

Environmental benefits mainly relate to air quality improvements from efficient and clean electricity and thermal energy generation [2]. However, cogeneration may lead to greater local pollution, depending on the system design and the primary energy source (Bo Yang, et al., 2019).

From an economic development perspective, research on The Job Generation Impacts of Expanding Industrial Cogeneration (Baer, et al., 2015) estimates: (for new CHP generation investments driven by a federal investment tax credit) first-order jobs of 0.08 full time equivalent (FTE)/GWh from construction and installation, and 0.09 FTE/GWh from operations and maintenance; second-order jobs of 0.33 job-years/GWh from household and commercial re-spending. These gains are partially offset by a loss of 0.45 job-years/GWh from centralized plant generation. In addition to overall net jobs benefits, as a decentralized energy resource, cogeneration can also lead to lower infrastructure requirements/costs (T&D) and improve grid resilience as a source of reliable, base load generation.

As a social benefit, cogeneration generally offers a competitive energy costing structure for its users (mainly commercial and industrial players) and reduces the wholesale electricity prices for the grid consumers [3].

References:

Baer, Paul, Marilyn A Brown, and Gyungwon Kim. "The Job Generation Impacts of Expanding Industrial Cogeneration." Ecological Economics 110 (2015): 141-53.

Bo Yang, Jiajun Gu, Tong Zhang, K. Max Zhang, 2019. Near-source air quality impact of a distributed natural gas combined heat and power facility, Environmental Pollution, Volume 246, https://doi.org/10.1016/j.envpol.2018.12.067.

Brown, M. A. (2017). Commercial cogeneration benefits depend on market rules, rates, and policies. Environmental Research Letters, 12(3), 031003.

Brown, M. A., Cox, M., & Baer, P. (2013). Reviving manufacturing with a federal cogeneration policy. Energy Policy, 52, 264-276. Engineering; (109) Part A, Pages 423-431.

CEO, A. (2017) Albany Green Energy Biomass Plant Showcased in ADEDC's. Retrieved from http://albanyceo.com/features/2017/11/albany-green-energy-biomass-plant-showcased-adedcs-madeinalbanyga/

DOE. (2019). Combined Heat and Power Basics. Retrieved from https://www.energy.gov/eere/amo/combined-heat-and-power-basics

Energy Information Administration (EIA). 2020. "Annual Energy Outlook 2020 with Projections to 2050," www.eia.govv/aeo.

Holbrook, E. (2017). From Scrap Wood to Steam: How Procter & Gamble is Using Renewable Energy to Make Toilet Paper. Retrieved from https://www.environmentalleader.com/2017/09/scrap-wood-steam-proctor-gamble-using-renewable-energy-make-toilet-paper/

Navigant 2015 Combined Heat and Power for Commercial Buildings (Boulder, CO: Navigant) https://doi.org/10.1016/j.ecolecon.2014.12.007.

Endnotes:

1. https://www.drawdown.org/solutions/electricity-generation/cogeneration
2. https://www.energy.gov/sites/prod/files/2013/11/f4/chp_clean_energy_solution.pdf
3. https://www.energy.gov/sites/prod/files/2017/11/f39/StateOfCHP-Georgia.pdf

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