Better Buildings®
U.S. DEPARTMENT OF ENERGY

Combined Heat and Power Fact Sheet Series

CHP MARKET SECTOR: CORRECTIONAL FACILITIES

Correctional facilities can help ensure the safety of inmates, staff, and the public at large by making investments to improve their infrastructure. Onsite combined heat and power (CHP) systems, which produce efficient thermal energy and electricity, allow correctional facilities to reduce their energy consumption, freeing up funds to make vital upgrades. These facilities require energy at all times of the day and all year round. They consist of living and common spaces for inmates, as well as cafeterias, laundry facilities, infirmaries, and visitor spaces, which require reliable and resilient energy. As a result, correctional facilities are ideal candidates for CHP systems, which can provide power during times of utility grid outages.

The State Correctional Institution at Laurel Highlands, Pennsylvania, has implemented a 1.5 MW CHP system. It uses biogas from the Mostoller Landfill to generate electricity and steam.

Photo courtesy of the Pennsylvania Department of Corrections.

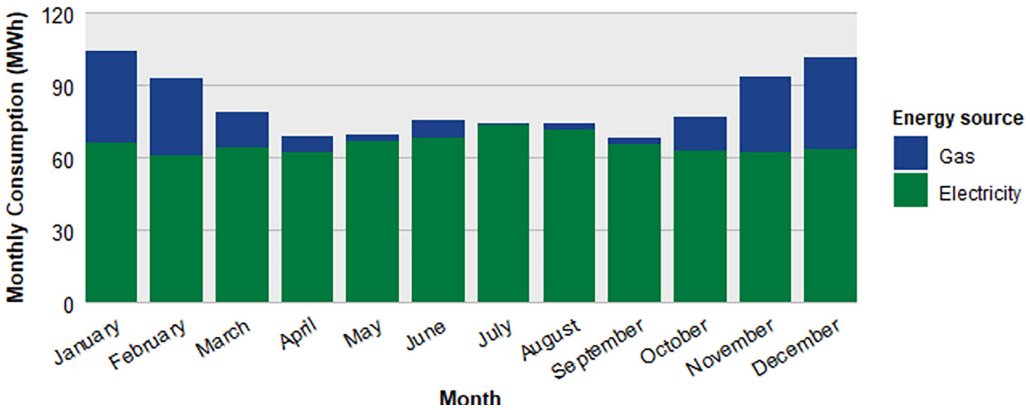
Characteristics of Energy Use at Correctional Facilities

Correctional facilities have significant electricity, hot water, and space heating/cooling requirements. The Watauga County, North Carolina, correctional facility provides an example of potential CHP benefits. A 2017 study performed empirical energy consumption estimations, using utility gas and electric bills to determine the monthly average energy consumption for this specific facility.[1] Figure 1 shows the facility's monthly electric and gas loads, which vary with the seasons. During the colder months, the use of gas increases to meet space heating requirements, comprising approximately one third of the facility's winter energy consumption. CHP could potentially be sized to meet the winter baseload thermal demand, allowing a large portion of thermal energy demand to be met year round while fully utilizing CHP electricity onsite.

CORRECTIONAL FACILITIES CHP QUICK FACTS

- Correctional facilities maintain steady **24/7 energy loads** and significant thermal requirements to meet space heating, cooling, and hot water needs.
- **CHP's reliability**, independent of the electric grid, makes it a good match for correctional facilities, which are considered **critical facilities** in the event of disasters and emergencies.
- The **average CHP system** at a correctional facility has a capacity of 2.4 MW.
- **Forty percent** of all CHP systems at correctional facilities have been installed since 2010.
- Opportunities exist for an additional **1.7 GW** of CHP at correctional facilities nationwide.

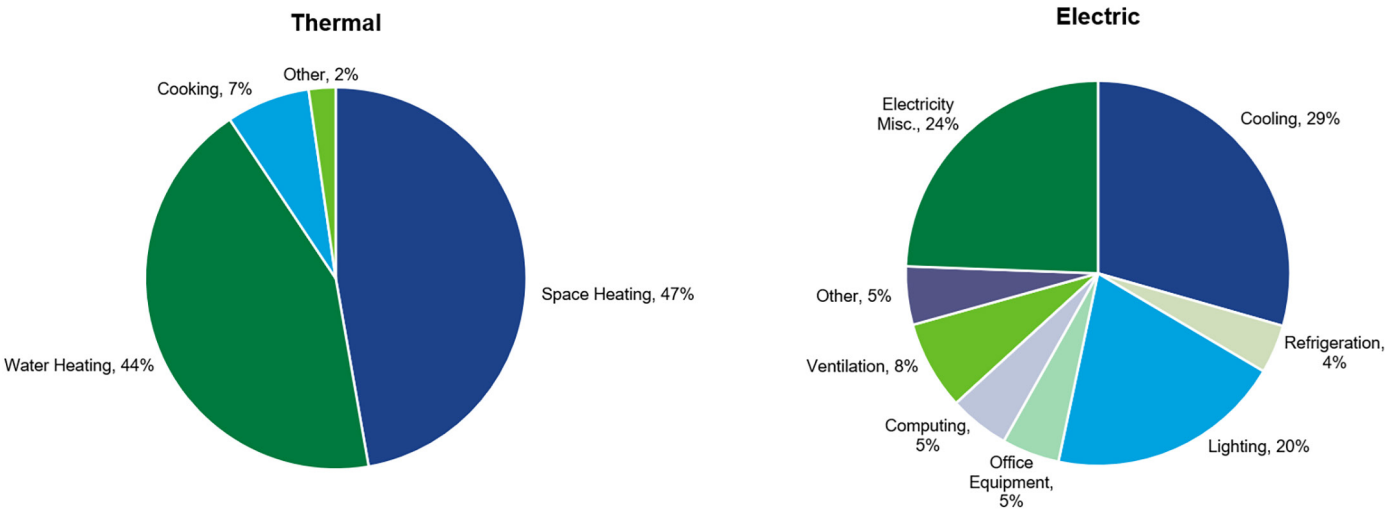
Figure 1. Monthly Electric and Gas Consumption at the Watauga County Correctional Facility



1 Alexandra Bostwick Lowrie. Energy Modeling of Jails: A Case Study of Watauga County Detention Facility. Dissertation. Appalachian State University, 2017. https://www.semanticscholar.org/paper/Energy-Modeling-Of-Jails%3A-A-Case-Study-Of-Watauga-Lowrie/b5dbc7437481775d2e0e159b67e8e044cdd9a666.

Figure 2 shows breakouts for average energy end uses in the correctional facilities sector in the United States.[2] End uses are split between loads that can be covered by a CHP system's thermal and electric outputs. Correctional facilities have steady year-round lighting, computing, office equipment, and ventilation requirements that account for upwards of 38% of total electricity consumption. Cooling needs represent approximately 30% of total electricity consumption. When paired with an absorption chiller, thermal output from CHP can also be applied to cooling and refrigeration end uses. Thermal energy requirements are split primarily between water heating and space heating loads. CHP systems at correctional facilities can be sized to efficiently cover year-round electric loads, water heating loads, and potentially space heating and/or cooling loads, depending on the facility's climate region.

Figure 2. Average Correctional Facility Thermal and Electric Consumption by End Use



PROJECT SNAPSHOT: CHP Keeps the Lights On

After a 2012 derecho that knocked out power across Montgomery County, Maryland, the county correctional facility installed a microgrid with 220 kW of CHP and 2.8 MW of solar. The system uses its thermal generation for space heating and hot water and can operate separately from the grid when there is an outage.

Photo courtesy of Montgomery County.

DOE Packaged CHP eCatalog

The eCatalog is a voluntary public/private partnership designed to increase deployment of efficient CHP systems in a wide range of applications, including manufacturing plants, commercial buildings, institutional facilities, and multifamily housing. The eCatalog is a searchable web-based system that hosts commercially available DOE-reviewed packaged CHP systems with comparable performance data from DOE-recognized CHP suppliers. End users, consulting engineers, utilities, state energy offices, federal agencies, and project developers can benefit from the data available in the eCatalog. In addition to an extensive database of packaged CHP products, the eCatalog provides information on CHP benefits, project financing considerations, and current events and news. Visit the DOE CHP eCatalog here.

2 U.S. Energy Information Administration, CEBCS, 2020. https://www.eia.gov/consumption/commercial/.

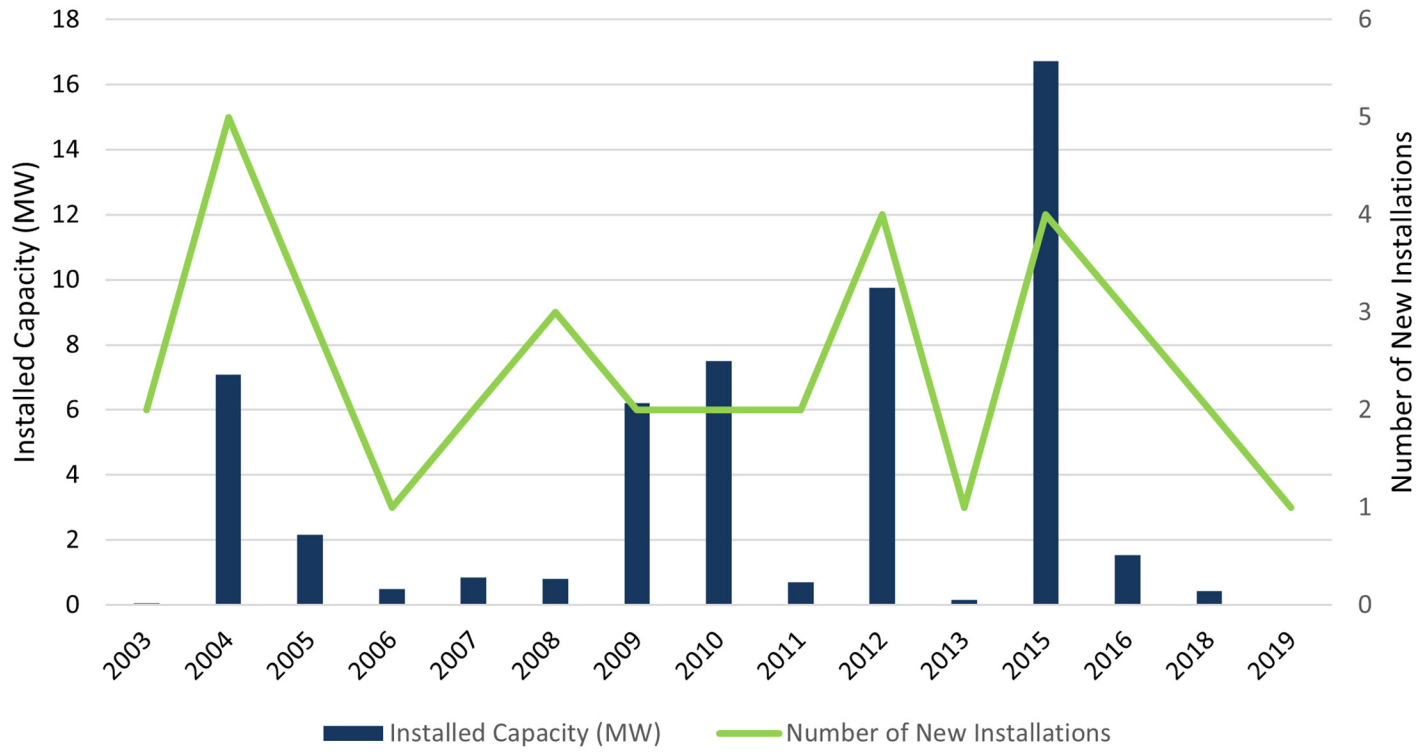
Current Correctional Facility CHP Installations

The U.S. Department of Energy (DOE) CHP Installation Database identifies 44 correctional facilities with CHP, totaling 124 MW of installed electric capacity.[3] CHP systems in this sector range from small engines supporting portions of the facility to large turbines providing most of the facility's energy needs. Thermal energy requirements can vary widely at correctional facilities, depending on climate, building design, and facility operations.

CHP systems at correctional facilities are typically sized to thermal loads. In hot climates, CHP tends to be sized for hot water, while cold climate sizing can include space heating loads. Some correctional facilities include manufacturing operations that can use thermal energy from CHP. CHP systems may be configured to supply electricity and thermal energy to the entire correctional facility campus, or only to specific buildings or loads. They can also be configured as part of microgrids, providing resilient onsite heat and power during utility grid outages in combination with other distributed energy resources.

Correctional facilities have used a range of system configurations and technologies; reciprocating engines, used at 52% of sites, are the most common. Over 70% of correctional facility CHP sites are fueled by natural gas, while the others are fueled by biomass, coal, or steam.[4] To the extent that zero-carbon fuels like renewable natural gas and hydrogen become more economic and available in the future, the ability of CHP systems to adapt and be modified would enable them to increasingly use these fuels and further reduce greenhouse gas emissions from correctional facilities. Figure 3 shows the number and capacity of new CHP installations at correctional facilities.

Figure 3. New Correctional Facility CHP Installations by Year and Capacity



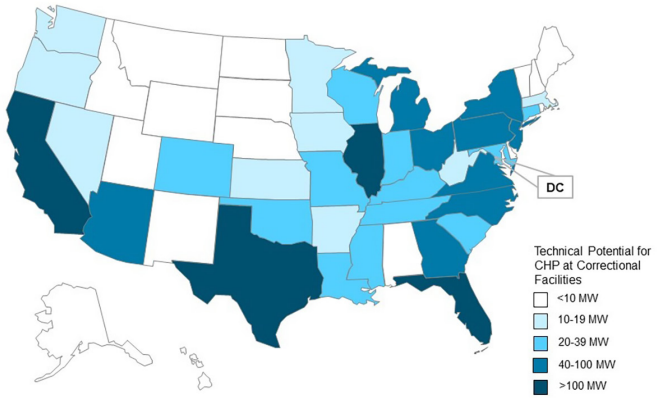
3 U.S. Department of Energy CHP Installation Database (U.S. installations as of December 31, 2020). https://doe.icfwebservices.com/chp.

4 Ibid.

Potential for New CHP Installations at Correctional Facilities

In 2016, DOE conducted a study of CHP's technical potential in the United States, estimating CHP market size in a sector based on existing facilities (i.e., not considering anticipated new construction), with that potential constrained only by technological limits (not economic or market factors). This study identified more than 1.7 GW of additional technical potential for CHP in over 1,500 correctional facilities across the United States, with opportunities for CHP development concentrated in states with large populations (see Figure 4).[5] Technical assistance paired with policies designed to overcome market barriers could help CHP installations expand to capture more of their technical potential. As with the current fleet of CHP systems, this potential includes a mix of configurations and sizes.

Figure 4. CHP Technical Potential at Correctional Facilities by State



Source: U.S. Department of Energy, Combined Heat and Power (CHP) Technical Potential in the United States, March 2016.

PROJECT SNAPSHOT: Anchoring a Microgrid with CHP

Administrators of the Santa Rita Jail in Dublin, California, first sought to develop a microgrid in response to California's energy crisis in 2001. That year, the jail installed a 1.2 MW solar photovoltaic system on the roof, and in 2005, a 1 MW CHP fuel cell was added. The fuel cell provides both base load electricity and waste heat, which is used to preheat the facility's hot water. In 2016, instead of replacing the stack of the original 1 MW fuel cell, a new 1.4 MW fuel cell was installed. In addition to solar and CHP, the facility has five small wind turbines and a 2 MW battery energy storage system. This combination of energy assets enables the facility to island itself from the grid for an extended time following a grid outage.

Photo courtesy of ENGIE Services.

For More Information

For more information about CHP at correctional facilities, visit DOE's CHP Project Profiles Database, a collection of more than 200 descriptions of installations in various market sectors compiled by DOE CHP Technical Assistance Partnerships (CHP TAPs). The database contains profiles of CHP systems installed at public safety facilities across the country, including details about equipment, project economics, environmental benefits, and more. The CHP TAPs can also assist facility owners and stakeholders with opportunity screenings and technical analyses for proposed CHP installations. Contact your regional CHP TAP for additional details.

5 DOE, "Combined Heat and Power (CHP) Technical Potential in the United States," March 2016. https://betterbuildingssolutioncenter.energy.gov/resources/combined-heat-and-power-chp-technical-potential-united-states.