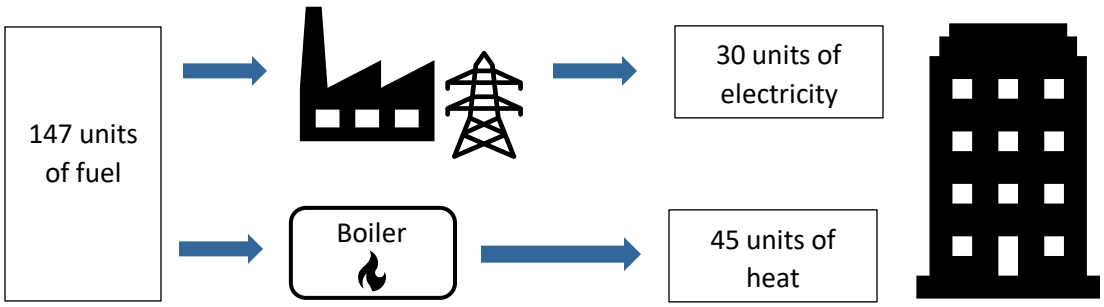
# Combined Heat & Power (CHP)

## Resource Guide

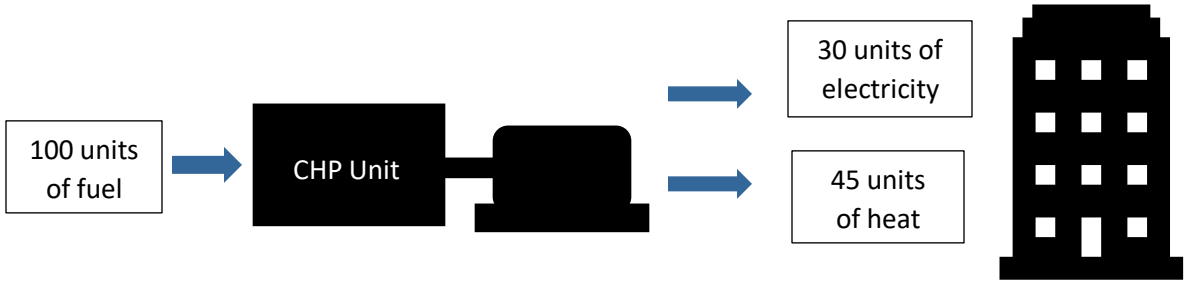
### CHP Basics

Combined Heat and Power (CHP) is a technology that provides continuous electricity and thermal energy from a single fuel source to power a facility's operations. CHP systems provide a clean, efficient, affordable and resilient energy solution to an organization that has a high annual energy demand and seeks to improve its sustainability, energy efficiency, and operational efficiency through utility expense reduction. CHP technologies come in many different forms, sizes, and setups, designed to meet the unique energy needs and applications of the facilities where they are installed.

Traditionally, electricity and thermal energy are supplied to a facility separately. The electricity is delivered by the electric utility, and thermal energy is sourced from the combustion of fuel in boilers, furnaces, or other technologies. However, this process is typically not very efficient—even in the best cases, total energy efficiency for utility electricity and thermal energy at a facility reaches about 51%.




This means that a significant amount of energy from the fuel used to create utility electricity is wasted–about 67% of it. CHP technology makes it possible, however, to capture the heat from generating electricity and use it to meet the thermal energy needs of a facility. This reduces, and can in some cases can virtually eliminate the need for separate fuel purchased to fire boilers, furnaces, etc. A CHP system can achieve total energy efficiency for a facility at approximately 75% (though efficiencies can go higher if more heat is used).




Because electricity is being produced onsite from the combustion of the fuel that is purchased, electricity purchased from the grid can be significantly reduced to only what is needed in addition to what the CHP unit can provide. Given the often-cheaper price of CHP fuel (most commonly natural gas) compared to electricity, this means that an organization has a lower overall expense for its total energy need.

CHP systems are also often designed to operate when electricity grid power is unavailable, through a process known as black starting and islanding. This added energy resilience component is often one of the most-cited reasons for CHP adoption, as it helps secure organizations against the operational losses and threats experienced by utility outages. Essential energy loads can continue to receive power and heat indefinitely as long as the fuel for the CHP system remains available.

## Ideal CHP Candidates

CHP technologies are best suited for organizations which have consistent high energy demands; particularly for thermal energy (this is because two thirds of the energy a CHP unit produces is thermal). Some examples include the following:

- hospitals and other critical infrastructure
- wastewater treatment
- manufacturers
- multifamily housing
- industrial entities
- food processors & greenhouse operations
- colleges & universities
- hotels & hospitality industry

## How Thermal Energy of the CHP is Used

Thermal energy produced by a CHP unit can be applied to satisfy many different types of heat energy needs. The energy is often recovered through the engine block and through exhaust and sent to a heat exchanger where it's used for applications such as:

- space heating
- domestic hot water production

- steam production
- fed to an absorption chiller to create chilled water (for domestic purposes or space cooling)
- process-specific applications (such as in an industrial or manufacturing process)

As long as the majority of the heat produced annually by a CHP system can be effectively used by the facility and it has adequate access to the fuel needed to power the system, the site is likely a good candidate for CHP.

## Types of CHP Systems and Costs

CHP systems come in various types and configurations. The type of CHP system, its electrical capacity (the total number of kilowatts (kW) of electricity it can produce) and the technical complexity are what primarily determine its initial cost, and ongoing maintenance costs are typically determined by system uptime and regularly-scheduled servicing. The most common CHP types are as follows:

- reciprocating engines
- turbines
- biogas/biomass-fueled systems
- microturbines
- micro-CHP (< 60 kW)
- fuel cells

Below are figures reported by the Energy Solutions Center[1] on average cost per kW of capacity based on technology type as well as typical maintenance costs by kilowatt-hours (kWh) produced.

| Reciprocating Engines (1.5 – 10,000 kW) | Turbines (1,000 – 50,000 kW) | Microturbines (30 – 200 kW) | Fuel Cells (200 – 2,000 kW) |
|---|---|---|---|
| Equipment & Install<br>$1,433 - $2,900 / kW<br><br>Maintenance Cost<br>$0.018 / kWh | Equipment & Install<br>$1,250 - $3,300 / kW<br><br>Maintenance Cost<br>$0.01 / kWh | Equipment & Install<br>$2,500 - $4,300 / kW<br><br>Maintenance Cost<br>$0.012 / kWh | Equipment & Install<br>$4,600 - $10,000 / kW<br><br>Maintenance Cost<br>$0.05 / kWh |

These are average figures and ultimate costs will vary by technology type and the specifics of the facility where the CHP unit is installed. Organizations pursuing CHP installations should discuss their options with CHP providers in detail to determine the most cost-effective, technically feasible, and efficient system setups which provide the greatest value and meet the organization's ultimate goals for pursuing CHP.

[1] https://understandingchp.com/blog/understanding-chp-and-the-cost-of-installation/

An organization may also not wish to own its CHP system, but instead purchase the power and heat the system produces from the CHP provider. In these situations, the CHP is still installed at the facility as it would be if the customer chose to own it, but the provider retains ownership of the system and is responsible for its maintenance, upkeep, and associated expenses. The customer is instead charged an all-in price for electricity, heat, and associated administrative charges. These prices vary by provider and should be thoroughly discussed and understood before consideration.

## Payback on CHP Systems

Payback periods on CHP systems are driven by a few primary factors: system uptime, how much energy produced by the CHP is used by the facility, the spread between fuel price and electricity price (what is known as the "spark spread" – the larger, the better), and proper system upkeep and maintenance. When units are strategically installed to maximize economics and efficiency, and take advantage of incentives, simple paybacks average five to 7 years. The expected useful life of a CHP system is typically about 20 years, meaning that it can become cash positive very quickly, saving a customer hundreds of thousands or as much as millions of dollars over its expected useful lives. Even without incentives, CHP systems, when installed properly, can still achieve paybacks under 10 years.

## CHP Grants & Incentives

CHP systems can easily assist states, jurisdictions and utilities in meeting energy efficiency and greenhouse gas reduction targets. As such, many of these entities provide customers with grants and other low-cost incentives to help offset the capital cost of the system. The Maryland Energy Administration (MEA) provides two grants and a low-cost loan program to help customers with the planning, design, equipment, and installation costs associated with CHP systems*.

- Resilient Maryland Program[2]: Provides feasibility analysis, planning, engineering, and design funds for distributed energy resource projects (like microgrids and CHP systems) to entities considering these technologies. Grants are calculated based upon scope and complexity of the project from $10,000 to $100,000.

*MEA offers its incentive programs on a Fiscal Year basis. Programs are subject to funding availability.*

[2] https://energy.maryland.gov/business/Pages/ResilientMaryland.aspx

- **CHP Grant Program**[3]**:** Provides funds for the equipment and installation costs of qualified CHP systems. Grants are calculated on a dollar per kW of installed capacity basis, from $575 / kW for small systems, stepping down as systems grow larger to $425 / kW for the largest systems (this is done to leverage economies of scale). Grants can be as large as $500,000 total.

- **Jane E. Lawton Conservation Loan Program**[4]**:** Provides low-cost financing for energy efficiency and CHP projects (APR does not exceed 1.0%). The payback term is based upon the simple payback of the project, with a maximum possible loan term of 13 years.

Maryland's five EmPOWER Utilities[5] also offer CHP incentives, which can be stacked with MEA incentives and can be as much as $2.5 million. This stackability allows customers to minimize their out-of-pocket cost for CHP systems, which both helps mitigate risk and secure buy-in from critical organization decision makers (like CEOs and CFOs) as well as private capital providers. Links to each utility's CHP program webpage are provided below:

- BGE[6]
- Potomac-Edison[7]
- PEPCO[8]
- SMECO[9]
- Delmarva Power & Light[10]

## Additional Resources and Contact Information

For additional information on CHP technology, including technical basics and cost information, visit the following resources:

- U.S. Department of Energy Combined Heat and Power Basics[11]
- Energy Solutions Center's Understanding CHP Website[12]

U.S. DOE CHP eCatalog

[3] https://energy.maryland.gov/business/Pages/MEACHP.aspx
[4] https://energy.maryland.gov/Govt/pages/janeelawton.aspx
[5] https://energy.maryland.gov/Pages/Facts/empower.aspx
[6] https://www.bgesmartenergy.com/business/business-programs/chp
[7] http://energysavemd-business.com/combined-heating-and-power
[8] https://cienergyefficiency.pepco.com/combinedHeat.aspx
[9] https://www.smeco.coop/save-energy-and-money/business-solutions/combined-heat-power
[10] https://www.delmarva.com/SmartEnergy/MyGreenPowerConnection/Pages/CombinedHeatPower.aspx
[11] https://www.energy.gov/eere/amo/combined-heat-and-power-basics
[12] https://understandingchp.com/

The U.S. Department of Energy has developed an online catalog of technically-vetted CHP systems which organizations considering CHP can utilize to identify and compare different options based upon the unique energy needs and attributes of their facilities and operations, known as the CHP eCatalog[13]. The eCatalog provides a highly-customizable search function to locate not only CHP systems, but also CHP solution providers and customer engagement partners that can respectively provide comprehensive CHP solution packages (including design, build, and ongoing management and maintenance services) and CHP incentives like those described in this factsheet. MEA highly encourages entities seeking CHP systems to utilize the eCatalog in their research.

For questions or additional information about CHP technology or the incentives provided by MEA, please contact **Mr. Brandon Bowser, CHP & Energy Resilience Program Manager.** He can be reached via email at BrandonW.Bowser@Maryland.gov or via phone at (443) 306-0304.

For more information about MEA and its various incentive programs and resources, visit us online at Energy.Maryland.gov.

Maryland Energy Administration

[13] https://chp.ecatalog.lbl.gov/