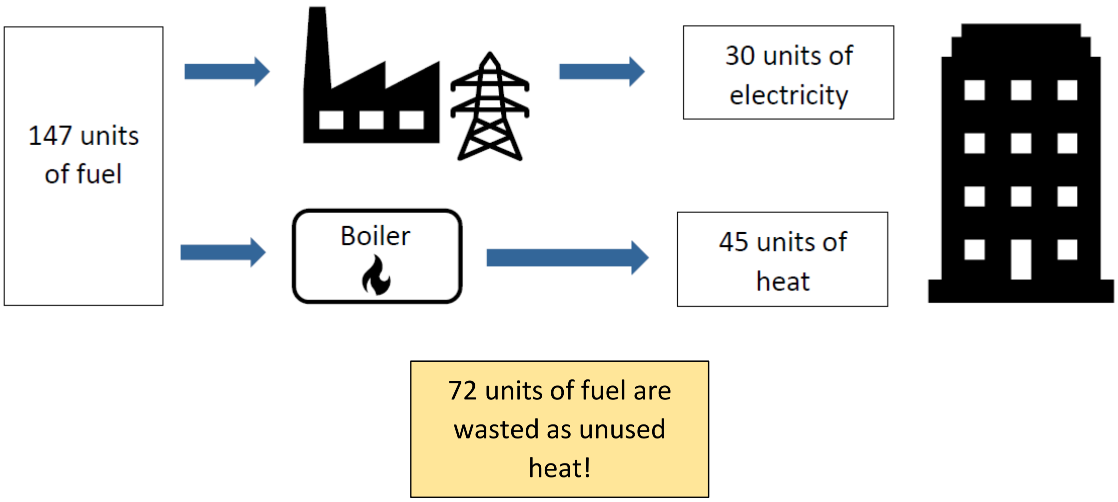
Combined Heat and Power (CHP)
Resource Guide

Updated January 11, 2023

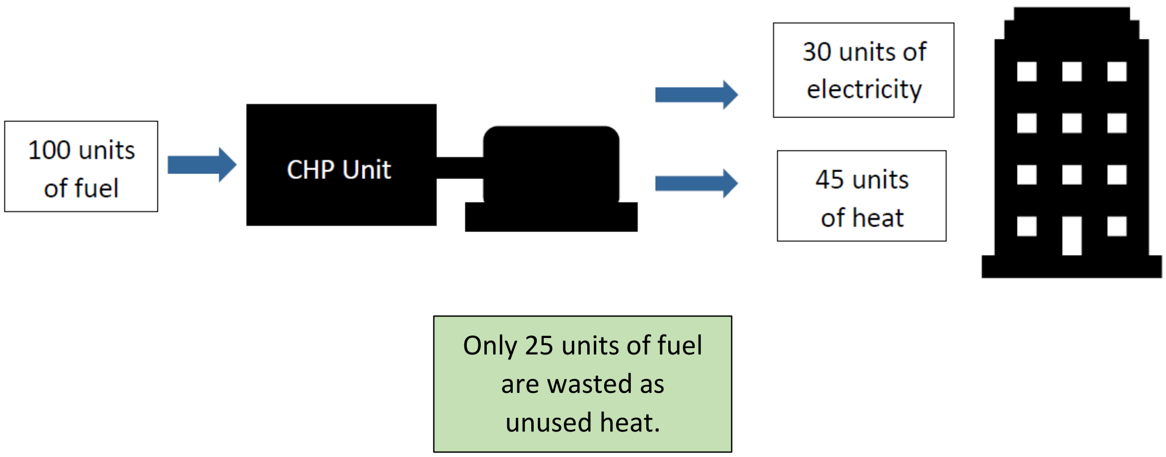
CHP Basics

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 cost reduction and management. CHP systems 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 comes from the electric utility, and thermal energy comes from the combustion of fuel in boilers, furnaces, or other technologies. However, this process is 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).



Less electricity is needed from the grid to meet a site's total electricity need because the CHP produces electricity onsite. The cost of fuel for a CHP system (typically natural gas) compared to grid-supplied electricity is usually cheaper, and that means that an organization can lower its overall energy costs through reduced utility expenses.

CHP systems are often designed to operate when electricity grid power is unavailable, through a process known as "black start and islanding." This added energy resilience attribute is one of the main reasons that organizations choose to install CHP systems. This is because CHP helps safeguard them against catastrophic product losses, costly operational downtime, threats to life and safety, and other adverse impacts from the loss of electricity. Essential energy loads can continue to receive power and heat indefinitely as long as the fuel for the CHP system remains available.

How Thermal (Heat) Energy of the CHP is Used

Thermal (heat) energy produced by a CHP unit can used for many different purposes. Thermal energy recovery methods vary based on the type of CHP system. In engine and turbine systems (discussed in more detail in the next section), heat is captured from the engines and from the exhaust streams. This thermal energy is then 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)

A site is likely a good candidate for CHP as long as it can use the majority of the heat produced annually by a CHP system, and it has adequate access to the fuel needed to run the 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 (the total number of hours the CHP is on and operating in a year) 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 $1,433 - $2,900 / kW Maintenance Cost $0.018 / kWh	Equipment & Install $1,250 - $3,300 / kW Maintenance Cost $0.01 / kWh	Equipment & Install $2,500 - $4,300 / kW Maintenance Cost $0.012 / kWh	Equipment & Install $4,600 - $10,000/ kW Maintenance Cost $0.05 / kWh

These are average figures and specific costs will vary by technology type, the specifics of the facility where the CHP unit is installed, prevailing fuel prices, and other factors. Organizations pursuing CHP installations should discuss their options with CHP providers in

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

detail to determine the most cost-effective, technically feasible, and efficient system setups which provide the greatest value and meet the organization's goals for pursuing CHP.

There are also different ways that a CHP system can be owned and maintained. These typically include two categories: (1) purchasing the system and maintaining it, and (2) various forms of third-party ownership. If an organization decides to purchase a CHP system, it will own it outright and be responsible for its operation and maintenance. However, the organization may also not want this responsibility if it does not have these resources, or for a number of other reasons including but not limited to financial, convenience, etc. When this happens, an organization will enter into a third-party agreement with a CHP developer, solution provider, energy service company, etc. Examples of these agreements include power purchase agreements, energy service and energy performance contracts, leases, etc. The CHP system is still installed on the customer's site as it would be in a purchase situation, but it is owned, operated, and maintained by the third party for a fee. This fee is usually included in the rate that the customer pays the third party for the energy the CHP system produces. Organizations pursuing CHP under third party ownership should carefully review the options and their associated terms and conditions and discuss them with the CHP providers they are considering. Rates and fees vary based on provider and contract type.

Payback on CHP Systems

Payback periods on CHP systems are determined by a few primary factors: system uptime, how much energy produced by the CHP is used by the facility, the difference between fuel price and electricity price (what is known as the "spark spread" – the larger, the better), and proper system upkeep and maintenance. When CHP systems are sized and configured to maximize economics and efficiency, and take advantage of incentives, simple paybacks usually average five (5) to seven (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 life. Even without incentives it is possible for CHP systems to achieve paybacks under 10 years when properly designed, installed, and financed.

CHP Grants & Incentives

CHP systems can be powerful tools for states, jurisdictions and utilities to meet energy efficiency and greenhouse gas reduction targets. Because of this, many of these entities provide customers with grants and other low-cost incentives to help offset the cost of the system. The Maryland Energy Administration (MEA) provides several grants and a low-cost loan program to help customers with the planning, design, equipment, and installation costs associated with CHP systems*.

- CHP Grant Program[2]: Provides funds for the equipment and installation costs of qualified CHP systems. Grants are calculated on a dollar per kW of installed capacity basis as well as the inclusion or exclusion of black start and islanding technologies as well as sustainable fuel sources.

- Resilient Maryland Program[3]: Provides feasibility analysis, design, other preconstruction planning grants, as well as equipment and installation grants, 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.

- Jane E. Lawton Conservation Loan Program[4]: Provides low-cost financing for energy efficiency and CHP projects (interest rate does not exceed 1%). The payback term is based on the simple payback of the project, with a maximum possible loan term of 13 years.

- Maryland's five (5) EmPOWER Utilities[5] also offer CHP incentives, which can be stacked with MEA incentives. 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 project stakeholders (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:

[2] https://energy.maryland.gov/business/pages/meachp.aspx
[3] https://energy.maryland.gov/business/Pages/ResilientMaryland.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://homeenergysavings.pepco.com/md/business/chp
[9] https://www.smeco.coop/save-energy-and-money/business-solutions/combined-heat-power
[10] https://homeenergysavings.delmarva.com/md/business/chp

- U.S. Department of Energy (DOE) Combined Heat and Power Basics[11]
- Energy Solutions Center's Understanding CHP Website[12]
- U.S. Department of Energy CHP Mid-Atlantic Technical Assistance Partnership[13]
- U.S. DOE CHP eCatalog[14]: This tool was developed by the U.S. Department of Energy's CHP Technical Assistance Partnerships to catalog many different CHP systems available to organizations considering them. Systems in the eCatalog have had their data technically-vetted by the U.S. DOE. The eCatalog's search feature is highly-customizable based upon site characteristics; CHP system types, fuel sources, and heat exchange methods; sizes; and many additional filters that help identify systems that best meet the organization's requirements. MEA encourages the use of this tool when pursuing CHP.

For questions or additional information about CHP technology or the incentives provided by MEA, please contact Brandon Bowser, 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.

[11] https://www.energy.gov/eere/amo/combined-heat-and-power-basics
[12] https://understandingchp.com/
[13] https://betterbuildingssolutioncenter.energy.gov/chp/mid-atlantic-chp-technical-assistance-partnership
[14] https://chp.ecatalog.lbl.gov/