



# Micro CHP in Multifamily Residential Building

## South Milwaukee, Wisconsin

### 4.4 kW CHP System

#### Background

In January 2022, a 4.4 kW micro CHP system was installed in a 32 unit, two-story multifamily residential building located in South Milwaukee, Wisconsin. The owner of the building selected the micro CHP system as the best option for reducing his overall energy costs, while providing increased reliability of utility service for the tenants.

The thermal energy recovered from the micro CHP system replaces the operation of a 210,000 Btu/hr natural gas fired boiler used to provide domestic hot water to the entire building. The existing boiler is now used as backup for increased reliability.

The onsite electricity generated by the micro CHP system is used to offset electricity normally provided from the local utility grid to meet the electrical demand in the common areas of the building (entrance, hallways, laundry room). Any excess electricity generated onsite is sold back to the local utility.

#### Quick Facts

**Location:** South Milwaukee, Wisconsin

**Market Sector:** Multifamily Residential

**Facility Size:** 32 unit, two-story building

**Prime Mover:** Single cylinder, 8 HP, liquid cooled, Marathon reciprocating engine (1,200 to 3,400 rpm)

**Engine Maintenance:** 4,000 hr intervals

**Fuel Type:** Natural gas

**Electric Output:** 1.2 to 4.4 kW

**Thermal Output:** 13,000 to 42,000 Btu/hr (160°F hot water)

**CHP Operation Began:** January 2022

**CHP System Efficiency:** Over 90%

#### Utility Billing

The electric and natural gas service is supplied by the local utility, WE Energies. It provides individual electric bills monthly to each apartment (paid by the occupant) and one monthly electric bill for electricity consumed in the common areas of the building (paid by the building owner). The natural gas consumed by the entire building (individual apartments plus common areas) is billed monthly by WE Energies under one bill paid by the building owner. Since the individual apartment occupant's monthly rent includes the use of natural gas, there is little incentive for the individual occupants to try to conserve energy when heating their apartment or consuming domestic hot water.

#### System Description



Axiom 4.4 kW Micro CHP System  
Source: Axiom Energy Group

The multifamily building has a central hot water system, consisting of three natural gas fueled boilers, two operating to supply space heating and one to provide domestic hot water throughout the building. With the installation of the micro CHP system, the domestic hot water is now delivered to each apartment from a single 120 gallon buffer tank that is connected directly to the thermal output of the micro CHP system. The recovered thermal energy from the micro CHP system provides the energy necessary to produce the hot water.

The buffer tank contains three sensors that monitor the temperatures and water levels within the tank. The data from these sensors is fed to a controller located in the micro CHP system and utilized to operate the system (start the CHP unit, modulate the unit to match the thermal load, and shut the unit down). Should the micro CHP system not be able to totally meet the thermal requirements, the existing 210,000 Btu/hr boiler is available for back up. During the first year of operation, the micro CHP system delivered 100% of the thermal requirements of the building's domestic hot water load, negating the need to operate the backup boiler.

The micro CHP system is connected electrically on the customer side of the utility meter servicing the common areas of the building. During the first year of operation, the micro CHP system achieved a 94% capacity factor, generating 36,106 kWh with 30,677 kWh utilized to meet the electric demand of the building's common areas and the excess 5,429 kWh net metered / sold back to the local utility.

## Key Characteristics of the Micro CHP System

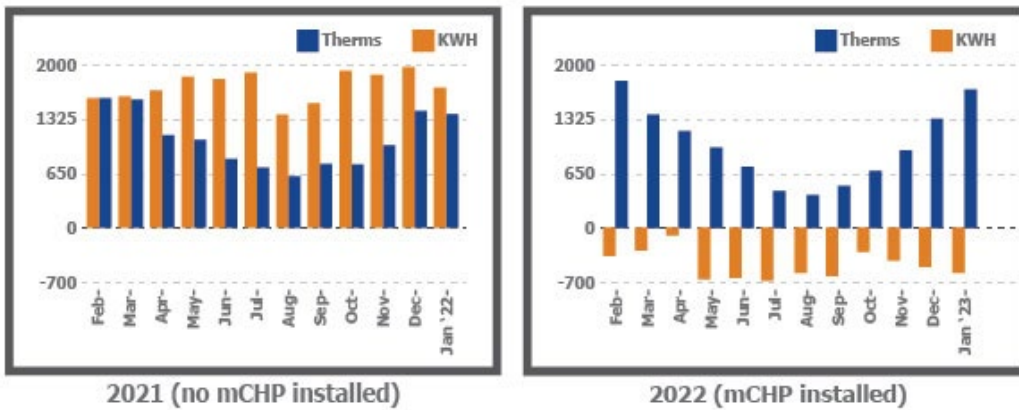


Figure 1: WE Energies Utility Bills, 2021 & 2022

The information in Figure 1 is copied directly from the monthly bills issued by WE Energies. It compares the monthly consumption procured from the local utility in 2021 (no CHP installed) to 2022 (CHP installed and operating). The orange bars show that in 2022, the micro CHP system generated enough onsite electric power each month to not only negate the cost of any power purchased from the grid for the common areas of the building, but enough to sell excess power each month back to the utility.

The blue bars show the total natural gas (therms) consumed in 2021 by the three boilers and in 2022 by the micro CHP system plus the boilers, providing both the space heating and domestic hot water to the entire building. Although the utility bills do not separate the gas usage between the individual components (each boiler and the micro CHP system), Axiom Energy Group (the CHP system manufacturer and installer) was able to make several observations from the data. For those months where there were either zero heating degree days or the same number of heating degree days in both years, the gas consumption was considerably lower (average of 27% lower) in 2022 when the micro CHP system was providing the thermal energy for the domestic hot water. Also, the total number of heating degree days was greater in 2022, yet the average therms/day consumed for both space heating and domestic hot water heating was lower in 2022 (32.4 therms/day versus 34.3 therms/day).

The ability to reduce the total gas consumption in 2022 was due to the fact that the engine driven micro CHP system is capable of self-modulating its thermal output. The system is operated in the thermal load following mode, varying the thermal output to follow the building's domestic hot water load. By varying the engine speed, the micro CHP system can provide a range of 13,000 Btus/hr to 42,000 Btus/hr of thermal energy while simultaneously generating between 1.2 kW and 4.4 kW of electric power. Operating the fully modulating system in the thermal load following mode results in maximum operating time for the micro CHP system (avoiding the system cycling of conventional boilers). This provides higher overall performance efficiencies, which translates to lower natural gas consumption.

*"The performance of the micro CHP system has met all my expectations; no resident complaints, faster delivery of hot water and lower utility bills, while providing more reliable energy service."*

*-Mikko Erkamaa, Building Owner*

After a detailed analysis of the WE Energies' monthly electric and gas bills combined with the operational data from the first year of operation of the micro CHP system, Axiom Energy Group estimated the first years savings from the micro CHP system to be approximately \$6,400. This was based on the sell back of excess electricity at \$0.04/kWh, avoided natural gas costs at \$0.86/therm, and avoided electricity costs at \$0.13/kWh.

## Lessons Learned

- It became apparent early in the project that local building inspectors, utility engineers, and local electricians necessary for the CHP installation were not familiar with CHP technology. Contacting these entities early in the process and educating them on CHP technology will avoid installation issues, delays and unexpected costs.
- Domestic hot water usage in multifamily residential applications remains relatively constant throughout the year, providing a good steady thermal load. The economic success of a micro CHP system (<5kW) is the ability to fully modulate the thermal output.

## For More Information

U.S. DOE Midwest CHP Technical Assistance Partnership (CHP TAP)  
[www.mwchptap.org](http://www.mwchptap.org)

Katie Slaski, Business Development Specialist, Axiom Energy Group  
Phone: (262) 642-6436 [Katie.Slaski@axiom-energy.com](mailto:Katie.Slaski@axiom-energy.com)