WE

Western Energy®

The Official Publication of Western Energy Institute

Powering Ontario with Hydro One's Mark Poweska

Winds and Wildfires Put LADWP Crews on High Alert

ATCO Uses mCHP Technology for Smaller Applications

AI: Predictive Technology for a Safer Gas System

WEI 2020 ANNUAL PHOTO CONTEST NOW OPEN

PAGE 42

DOWNSIZING COMBINED HEAT AND POWER TECHNOLOGY FOR SMALLER APPLICATIONS

By Abbas Ali Beg and William Ren, ATCO

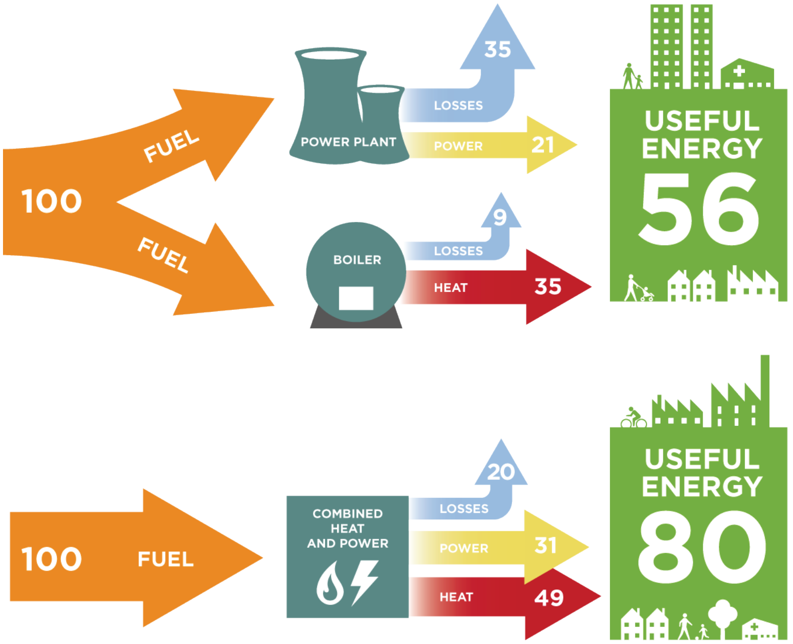
ABBAS ALI BEG

WILLIAM REN

Renewable and green energy generation is growing in popularity and more-efficient energy technologies are emerging to meet demand. One of these is micro combined heat and power (mCHP). This cogeneration technology generates both heat and electricity for smaller applications, such as residential and small commercial. The technology is similar to combined heat and power (CHP), but mCHP projects are sized not to exceed heating requirements.

In a topping cogeneration cycle, fuel is used to generate mechanical energy through an engine to produce electricity. The waste heat from this process is captured through a glycol loop and can be used for either space heating or domestic hot water demand within the facility. Recycling this would-be waste heat results in an astonishing efficiency of up to 90%.

Figure 1. Energy efficiency of conventional energy generation (top) as compared to Combined Heat and Power (CHP) technology (bottom).



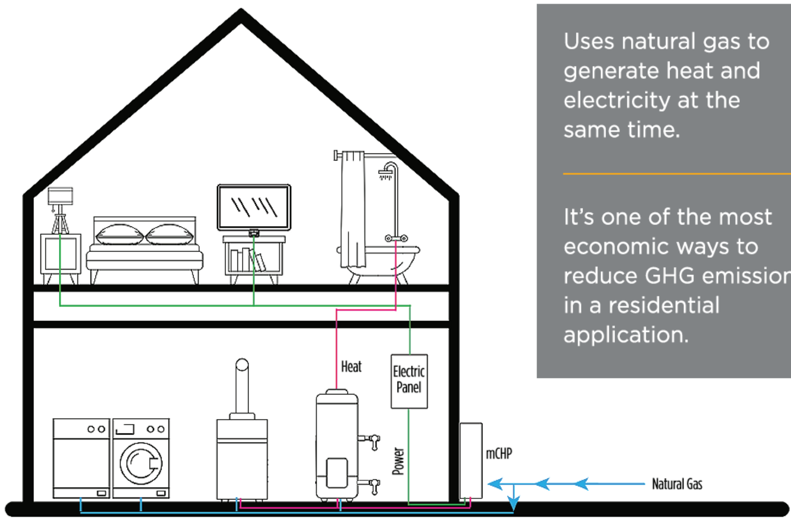
(Source: US EPA Study)

CHP technology is not new and has already been successfully implemented across Europe, Japan and North America in large-scale operations, including power plants, health facilities, educational facilities, and leisure centers. They benefit enormously from economic savings, as well as reduced greenhouse gas (GHG) emissions.

With mCHP implementation, the technology is more available to residential homeowners or small businesses who can then support the shift from grid electricity to a greener natural gas alternative. This can reduce their household emissions by approximately 30% in the Alberta grid mix. With the added benefit of being extremely quiet (approximately 45dB), homes that require a larger constant heat demand, or even small commercial facilities, can integrate multiple mCHP units to meet demands and minimize noise levels with long runtimes.

ATCO has partnered with Aisin Seiki Co. Ltd., a subsidiary of the Toyota Group, to introduce AISIN mCHP technology to the North American market. Over 5,000 COREMO units, the mCHP system designed by AISIN, have also been installed in Japan. A COREMO unit consumes up to 22,000 BTU/hr of natural gas to produce a maximum of 1.5kW of electricity and 12,600 BTU/hr of heat in the hydronic phase. These units are designed to be thermally led and electrically followed, meaning that

Figure 2. Simple mCHP integration into a home heating system.



Uses natural gas to generate heat and electricity at the same time.

It's one of the most economic ways to reduce GHG emissions in a residential application.

(Source: ATCO)

they are running as much as possible to best match and meet heat demand, while offsetting electricity demand from the grid. This results in a higher consumption of lower-cost natural gas instead of higher-priced electricity. Therefore, the more the unit is in use, the greater the savings.

Figure 3 represents a 1,950-square-foot single family residence in South Edmonton, Alberta. The mCHP unit delivered 3.5-4.0 tonnes of CO2 emissions reduction, which increased to 4.8 tonnes of CO2 reduction with a 1.6kW solar array. Table 1 shows the GHG emission intensity for Alberta. Note, the Alberta electrical and natural gas grid intensity is taken from the Open Government Program's Carbon Offset Emission Factors Handbook. A higher heating value is assumed for the mCHP intensity.

mCHP's use in Canada

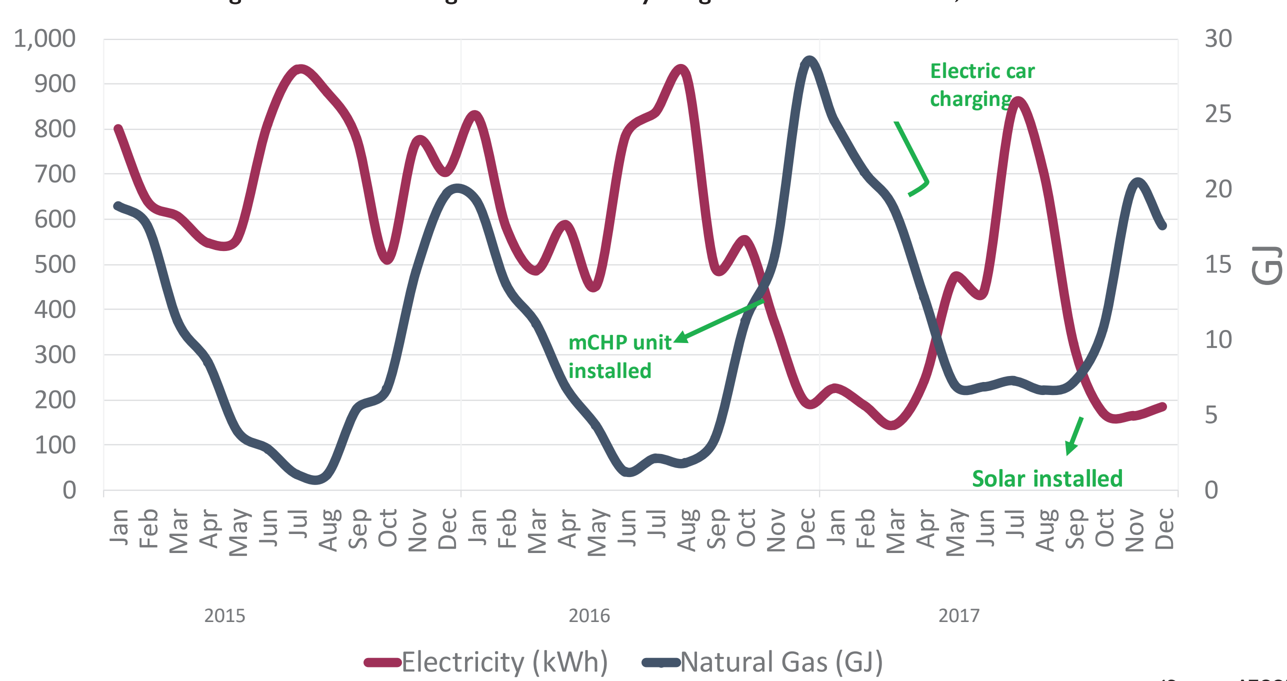
Alberta's Climate Leadership Plan, introduced in 2015, aims to shift 30% of electricity generation to renewables. In response, the Alberta government has partnered with Alberta Milk, a nonprofit organization representing Alberta's dairy producers, to provide a one-time grant to implement 24 mCHP COREMO units to dairy farms across the province.

Dairy farms are an ideal match for mCHP applications because of their significant hot water usage for their washing and milking systems. The continuous demand for hot water means dairy farms can see significant savings in both energy operating costs and emissions. A prime example is a dairy farm in Taber, Alberta, whose two mCHP units have an impressive 90% utilization rate. This means the two units are almost always running, saving costs on utility bills and reducing the dairy's environmental footprint.

Cost savings

The cost of a home mCHP unit is about $11,000 Canadian dollars, with average install costs ranging from CA$2,000 to CA$5,000, depending on the complexity of the hydronic system. In terms of economic

Figure 3. Household gas and electricity usage in South Edmonton, Alberta.



(Source: ATCO)

Table 1: GHG Emissions Intensity for Alberta	
Energy Source	**GHG Emission Intensity**
Alberta Electrical Grid	570.0 g CO2e/kWh
Natural Gas Grid	186.1 g CO2e/kWh
AISIN mCHP	226.9 g CO2e/kWh

Two mCHP units installed at a dairy farm in Taber, Alberta. (ATCO)

mCHP integration into a home heating system (left) and a mCHP retrofit in an urban home (right). (ATCO)

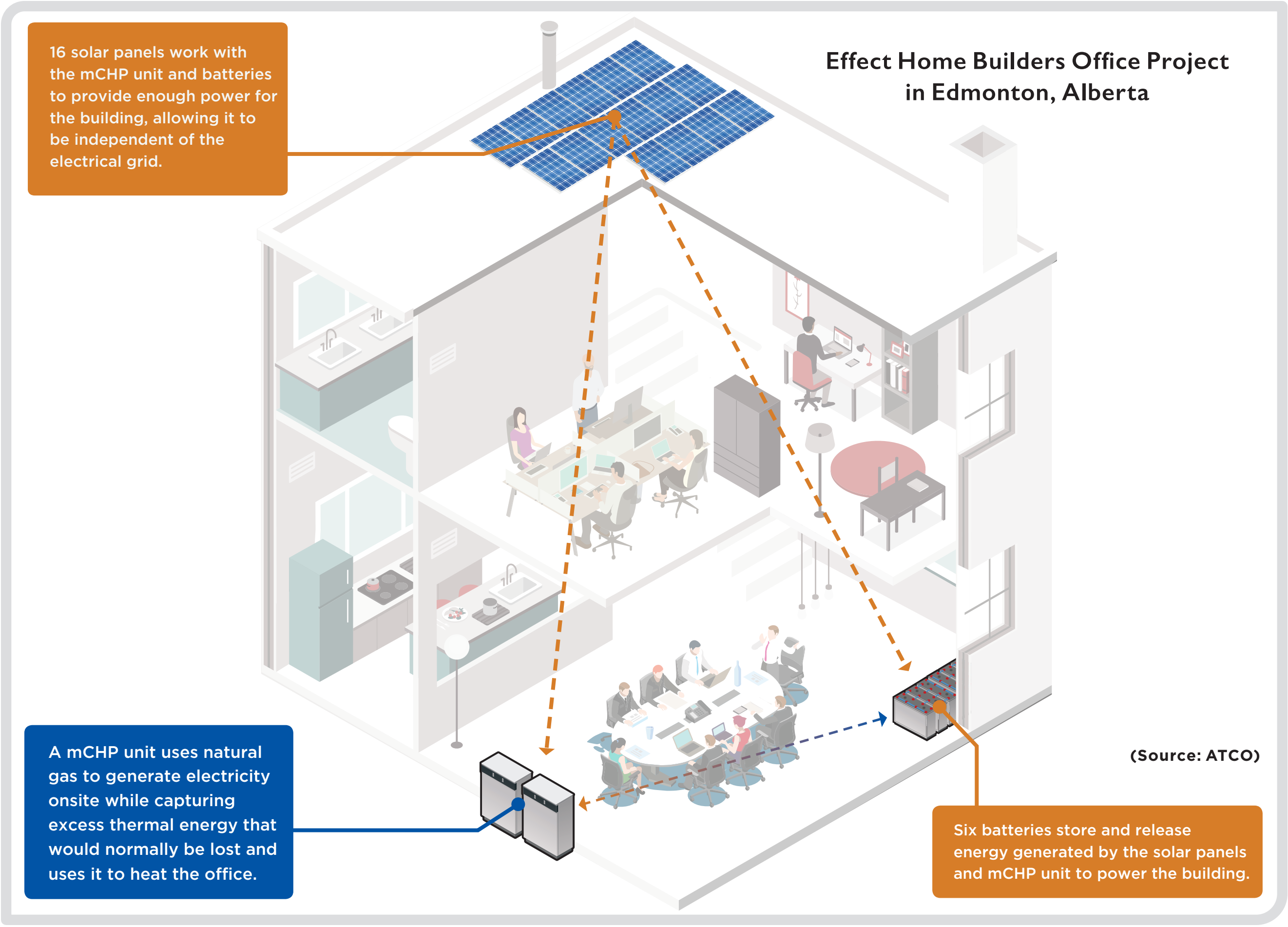
feasibility, mCHP units capitalize on utility bill savings by offsetting expensive household electricity consumption with lower-priced natural gas. In addition, there is the potential to sell unused electricity back to the grid, generating further deductions off a monthly utility bill.

Potential set ups

Adopting mCHP technology to an existing home energy system can vary from changing the existing furnace to a hydronic forced air furnace, using the heat for domestic hot water, or using another form of hydronic heating. This will provide space and/or water heating for the home and can potentially save the homeowner more money by offsetting any electricity consumption for either application.

If the homeowner is interested in additional emission reductions, the mCHP can easily integrate with photovoltaic (PV) solar panels to further reduce electric grid reliance. The system will provide the cheapest and cleanest energy for the home. In the daytime, solar will be providing electricity, as long as electric demand doesn't increase the solar PV capacity and, in the evenings or during times of less-optimal solar electricity production, the mCHP will be able to provide the required heat and electricity.

Another option ATCO is investigating is an off-grid mCHP package. Essentially, the mCHP will be equipped with a battery/inverter setup that allows it to run seamlessly in a feedback loop. In this application, the mCHP charges the battery with any extra power produced so it can power itself later when necessary. An added solar array to the off-grid mCHP package would also eliminate electric utility costs altogether, as well as minimize emissions, creating the most significant reduction in environmental impact.



The Effect Home Builders Office in Edmonton, Alberta is the first office building in the city to be disconnected from the electrical grid. The building uses a solar PV system, mCHP units, battery storage and an advanced HP+ wall system. (ATCO, Effect Home Builders and NGIF)

Effect Home Builders Office

The applications for mCHP are not limited to new facilities; a great example is the Effect Home Builders Office in Edmonton, Alberta. In 2018, the building underwent a deep energy retrofit from a 1,867-square-foot, 1940s-era, two-story residential home into a commercial space. The office is disconnected from the local electrical grid, using an upgraded building envelope, 4.8kW PV solar panels, six lithium ion smart batteries (6.6kWh each) and two AISIN mCHP units. An off-grid home stresses the importance of reliable energy generation. Using mCHP technology ensures that a reliable, green, natural gas alternative is fed through the home to provide heat. The mCHP unit provides domestic hot water and space heating using a hi-velocity hydronic forced air furnace. Overall, there is an expected 80% GHG reduction from the original home.

Brookfield Residential's Low Carbon Discovery Home with mCHP integration into the home heating system. (Top photo: Edmonton Journal; Bottom photo: ATCO)

Brookfield Low Carbon Discovery Home

mCHP is one of the prime technologies featured in the Brookfield Low Carbon Discovery home in Edmonton, Alberta, a partnership project by ATCO, Brookfield Residential and SAIT. The project's partners worked to create an affordable, low-carbon home able to produce all the electricity required. The Edmonton home is a new, detached, energy-efficient residence with an upgraded building envelope and reduced energy use. The home features 1.5kW PV solar panels with a 1.5kW mCHP unit tied to a 100Ga indirect water tank and an air handler. The mCHP unit provides the heating requirements through a hi-velocity, hydronic forced-air furnace and supplies domestic hot water. Both the heating and domestic water have electric backups.

ABBAS ALI BEG is a senior engineer in ATCO's growth and initiatives group. He has worked in the utility industry since 2011 as an EIT and senior engineer in a number of different engineering, construction and operations groups. Abbas is passionate about energy and energy-related technological solutions that are fiscally and environmentally responsible.

WILLIAM REN is a student working as an engineering intern in ATCO's growth and initiatives group. He has interests in the improvement and development of energy-efficient technologies for environmental growth and sustainability.