AXIOM ENERGY GROUP

Clean Energy For Our World™

Iowa Energy Summit
Des Moines, Iowa
10 October 2024

mCHP - The Elegant Solution

A solution is regarded as ‘elegant’ when it is simple and effective in addressing an otherwise complex problem.

Clean energy solutions often are expensive and lack simplicity, efficiency, reliability, and effectiveness.

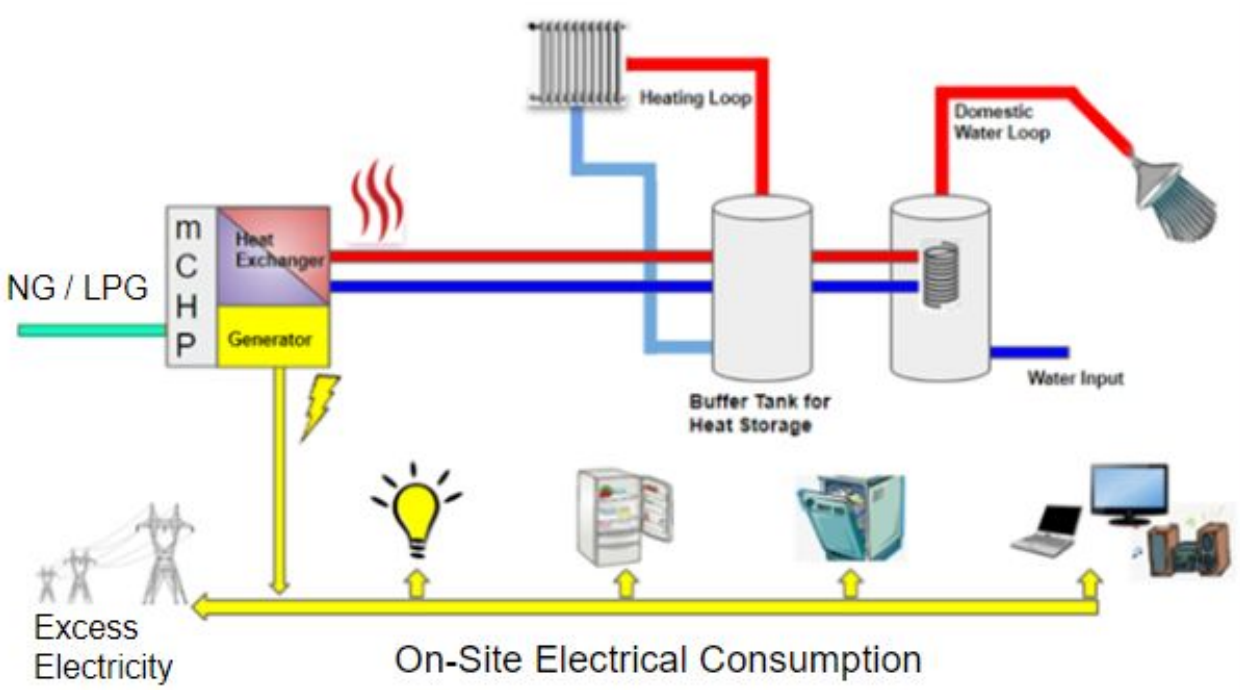
micro Combined Heat & Power (mCHP) provides a clean energy solution that is reliable, simple and effective while offering substantial financial savings.

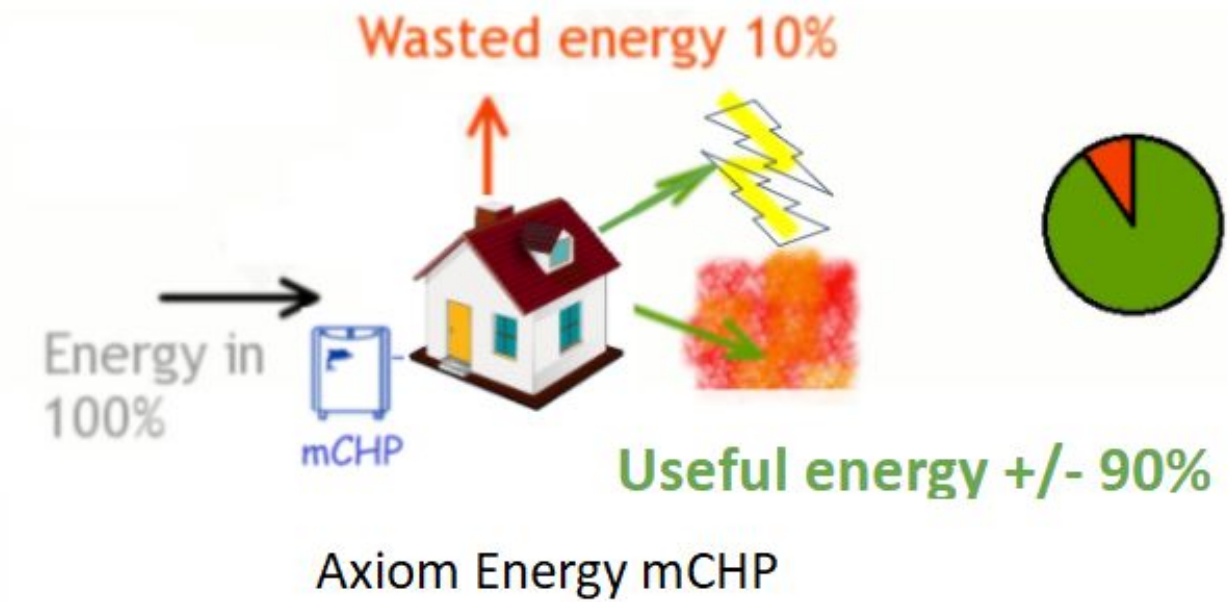
While there is no regulatory definition of what distinguishes a combined heat and power (CHP) system from a ***micro*** combined heat and power system (mCHP), it is generally accepted that any co-generation system that produces under 50kW is considered “micro.”

mCHP Advantages

- mCHP is typically >85% efficient, which is higher than standard CHP systems
- Some mCHP systems can be connected to operate in parallel, allowing for more flexibility where heat loads fluctuate to fall below the threshold necessary to activate larger CHP systems
- mCHP can address a niche energy market that cannot be adequately serviced by larger CHP systems
- mCHP systems can be adaptable to mobile applications
- mCHP can make the power grid more resilient
- mCHP does not expire into toxic waste, is not impacted by weather or time of day, and significantly limits any impact on wildlife and the environment

mCHP - Innovative Technology





Axiom Energy mCHP

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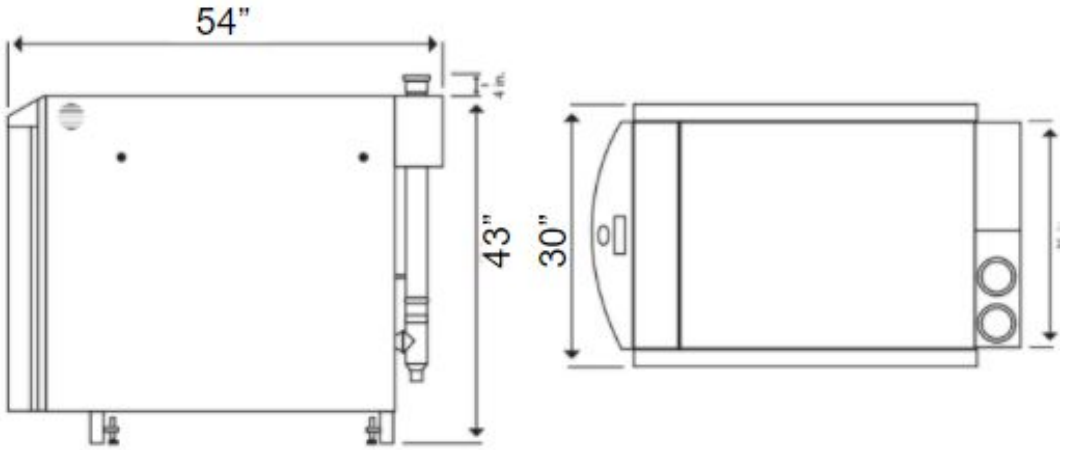
Axiom Energy mCHP System Overview

Compact & Modular

- Marathon Engine
- Heat Exchanger
- Power Inverter
- System Controller
- Engine Controller
- Control Interface



MADE in WISCONSIN
From U.S. and Foreign Parts

1.2 - 4.4 kWh of electricity
15,000 - 47,000 btu/hr of heat - Propane
13,000 - 42,500 btu/hr of heat - NG
Exhaust Gas Temperature 180^0 F
Overall efficiency = 93%
55dB

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Axiom Energy's Marathon® Engine

4,000 hour maintenance interval
- Equivalent to 160,000 miles

Rated for 40,000 hours
- Equivalent to 1.6 million miles
- Tested in excess of *100,000* hours
- Components can be replaced or reconditioned

Specifications
- 8 HP, single cylinder, water cooled, 4 cycle, no belts
- 272cc
- 12.8/1 compression
- Modulating 1200 - 3400 rpm
- 11 litre sump

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Resiliency

Matrix of DER Vulnerability to Weather Events

Natural Disaster or Storm Events	Flooding	High Winds	Earthquakes	Wildfires	Snow/Ice	Extreme Temperature
Battery Storage	Semi-Resilient	Resilient	Semi-Resilient	Not Resilient	Resilient	Semi-Resilient
Biomass/Biogas CHP	Semi-Resilient	Semi-Resilient	Semi-Resilient	Not Resilient	Resilient	Resilient
Distributed Solar	Resilient	Semi-Resilient	Semi-Resilient	Not Resilient	Semi-Resilient	Semi-Resilient
Distributed Wind	Resilient	Semi-Resilient	Semi-Resilient	Semi-Resilient	Semi-Resilient	Semi-Resilient
LPG / NG CHP	Resilient	Resilient	Semi-Resilient	Semi-Resilient	Resilient	Resilient
Standby Generators	Semi-Resilient	Resilient	Semi-Resilient	Not Resilient	Semi-Resilient	Resilient

Not Resilient

Semi-Resilient

Resilient

US Department of Energy 2018

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Typical Applications

Residential

Commercial

Fitness Centers

Multifamily

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mCHP - Myths and Misconceptions

1. mCHP effectiveness in colder climates during colder months
2. mCHP in applications that have large energy demands
3. mCHP consumption of fuel
4. mCHP compatibility with other clean energy options

Any Climate, Any Region, Any Time of Year

The primary function of mCHP is to produce hot water, which is needed at all times for cleaning and sanitation functions such as laundry, hot showers, dishwashing, etc. The use of hot water for these functions is consistent regardless of the outdoor weather and temperature. A load of laundry does not require less hot water and a dishwashing cycle does not shorten because of weather. The amount of hot water used in these situations remains constant regardless of outdoor temperature, cold or hot. Electric generation is essentially a by product from the production of hot water. Therefore, in applications that require high volumes of hot water, mCHP will always offer a clean energy solution, regardless of climate, region, or time of year.

Case Study - Electric Production - Milwaukee, WI

Sample Temperatures 2022
- June 21 = 100^{O}
- June 14 = 99^{O}
- June 15 = 95^{O}
- June 20 = 94^{O}
- June 30 = 94^{O}

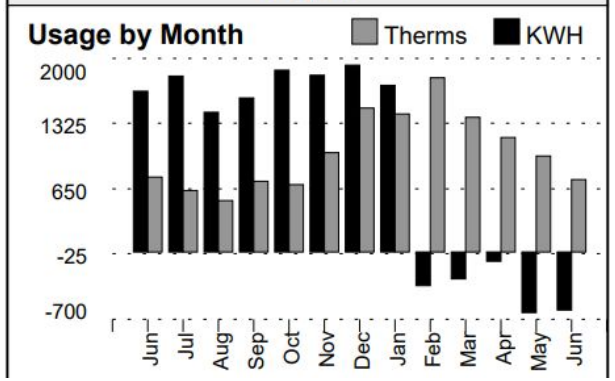
NOTE:

The highest electrical production was during the *warmer* months because there were vacancies in the cooler months. Once full occupancy was reached, more hot water was being consumed, therefore the mCHP operated more hours.

Account Summary
Bill Period: 05/12/2022 to 06/14/2022

	Jun 2022	May 2022	Jun 2021
Billing Days	34	30	30
Avg Temp	62°F	47°F	63°F
Heating Deg Days	131	474	169
Cooling Deg Days	83	5	120
KWH Used	-599	-629	1668
Avg KWH / Day	-17.6	-21	55.6
Therms Used	746.2	991.1	777
Avg Therms / Day	21.9	33	25.9
Utility Gas Cost	$0.35	$0.35	$0.35

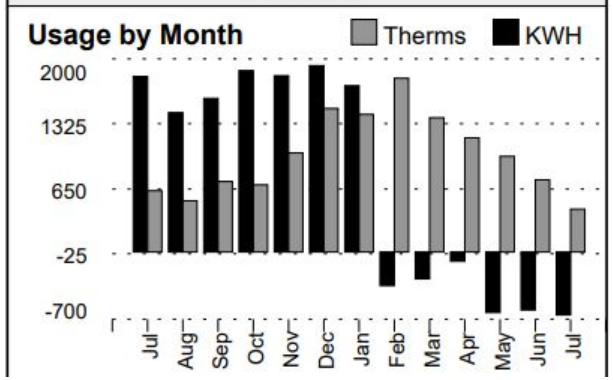
Graphs



Account Summary
Bill Period: 06/14/2022 to 07/14/2022

	Jul 2022	Jul 2021
Billing Days	31	35
Avg Temp	72°F	72°F
Heating Deg Days	4	4
Cooling Deg Days	293	247
KWH Used	-656	1821
Avg KWH / Day	-21.2	52
Therms Used	445.4	633.1
Avg Therms / Day	14.4	18.1
Utility Gas Cost	$0.35	$0.35

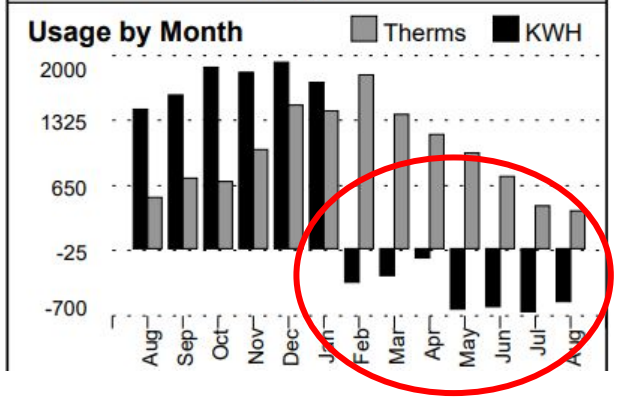
Graphs



Account Summary
Bill Period: 07/14/2022 to 08/12/2022

	Aug 2022	Aug 2021
Billing Days	30	28
Avg Temp	73°F	74°F
Heating Deg Days	0	0
Cooling Deg Days	294	266
KWH Used	-550	1449
Avg KWH / Day	-18.3	51.8
Therms Used	390.8	533.2
Avg Therms / Day	13	19
Utility Gas Cost	$0.35	$0.35

Graphs



Over 50% of the days June - August had high temperatures between 80^{O} - 100^{O} F

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mCHP offers agile solutions in large applications

mCHP benefits any application that has large thermal and electrical requirements. mCHP is designed for 24/7/365 operation to provide the most financial and environmental benefits. Therefore, an application with thermal demands that exceed the capacity of the mCHP system will ensure that it remains in constant operational mode. Where appropriate, several mCHP systems can be connected to operate in parallel to meet the thermal demands of the application. Scaling up this way offers significant agility and flexibility in the application since it allows for some systems to slow down or shut down without shutting the entire system off. In comparison to one single large CHP system which is either on or off, this can offer significant advantages.

Case Study - YMCA - Mukwonago, WI

YMCA Sports & Fitness Center
Two mCHP systems provide heat for two pools: an 80,391 gallon lap pool and a 105,995 gallon recreational pool.

Electrical Output
While creating the thermal energy to keep those two pools at a specific temperature, each unit is capable of generating 4.4 kWh of electricity, for a total combined production of ***6,424 kW per month***

Benefits
Natural gas that would have otherwise been directed through a traditional pool heater is instead run through the mCHP systems first, producing heat for the pools and generating electricity that is used on site. This reduces the amount of electricity purchased from the utility, saving the YMCA several thousands of dollars each year while ***reducing its annual carbon footprint by over 40 metric tons***

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Case Study - Electric Production - Milwaukee, WI

110 Unit Apartment Building

Account Summary
Bill Period: 12/29/2022 to 01/26/2023

	Jan 2023	Jan 2022
Billing Days	29	29
Avg Temp	36°F	22°F
Heating Deg Days	849	1239
Cooling Deg Days	0	0
KWH Used	2000	4840
Avg KWH / Day	69	166.9
Utility Gas Cost	$0.50	$0.35

Account Summary
Bill Period: 01/27/2023 to 02/23/2023

	Feb 2023	Feb 2022
Billing Days	28	29
Avg Temp	29°F	25°F
Heating Deg Days	996	1172
Cooling Deg Days	0	0
KWH Used	1920	4880
Avg KWH / Day	68.6	168.3
Utility Gas Cost	$0.50	$0.35

Account Summary
Bill Period: 02/24/2023 to 03/26/2023

	Mar 2023	Mar 2022
Billing Days	31	32
Avg Temp	35°F	35°F
Heating Deg Days	920	951
Cooling Deg Days	0	0
KWH Used	2160	5160
Avg KWH / Day	69.7	161.2
Utility Gas Cost	$0.50	$0.35

60% Reduction in Electric Consumption
Approximately 3,000kW per month avoided

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mCHP can reduce gas consumption

In some applications, mCHP can reduce the consumption of gas because of its efficiency in producing hot water. A typical central hot water heater or boiler system cycles on and off several times during the day, often times operating for only a few minutes at a time, while the mCHP system will provide a steady supply of heat. This results in a more efficient supply of hot water with less consumption of gas.

Case Study - Gas Consumption - Milwaukee, WI

Account Summary
Bill Period: 05/12/2022 to 06/14/2022

	Jun 2022	Jun 2021
Billing Days	34	30
Avg Temp	62°F	63°F
Heating Deg Days	131	169
Cooling Deg Days	83	120
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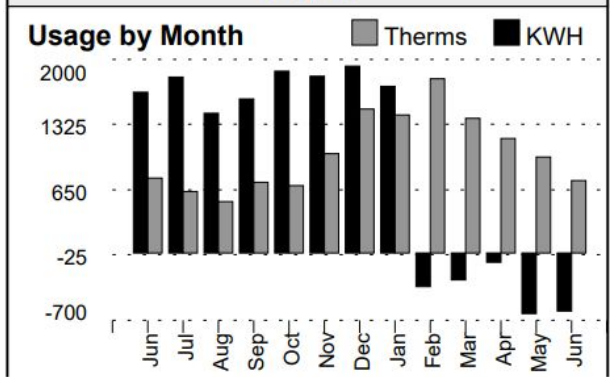

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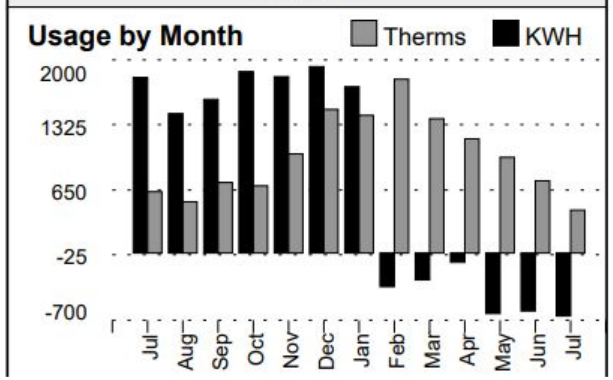

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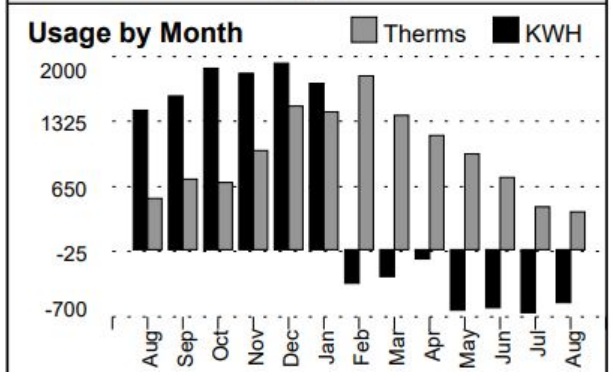
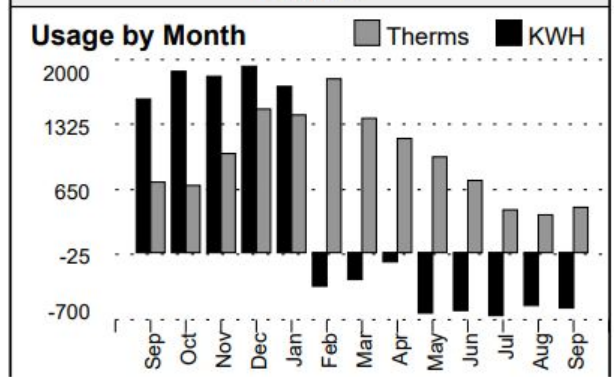


Account Summary
Bill Period: 08/12/2022 to 09/13/2022

	Sep 2022	Sep 2021
Billing Days	33	30
Avg Temp	69°F	74°F
Heating Deg Days	5	0
Cooling Deg Days	214	284
KWH Used	-572	1594
Avg KWH / Day	-17.3	53.1
Therms Used	472.8	731.1
Avg Therms / Day	14.3	24.4
Utility Gas Cost	$0.35	$0.35

Graphs



Average Gas Consumption Reduced ***27.21%***

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Case Study - Financial Benefits - Milwaukee, WI

32 Unit Apartment Building

Annual Savings

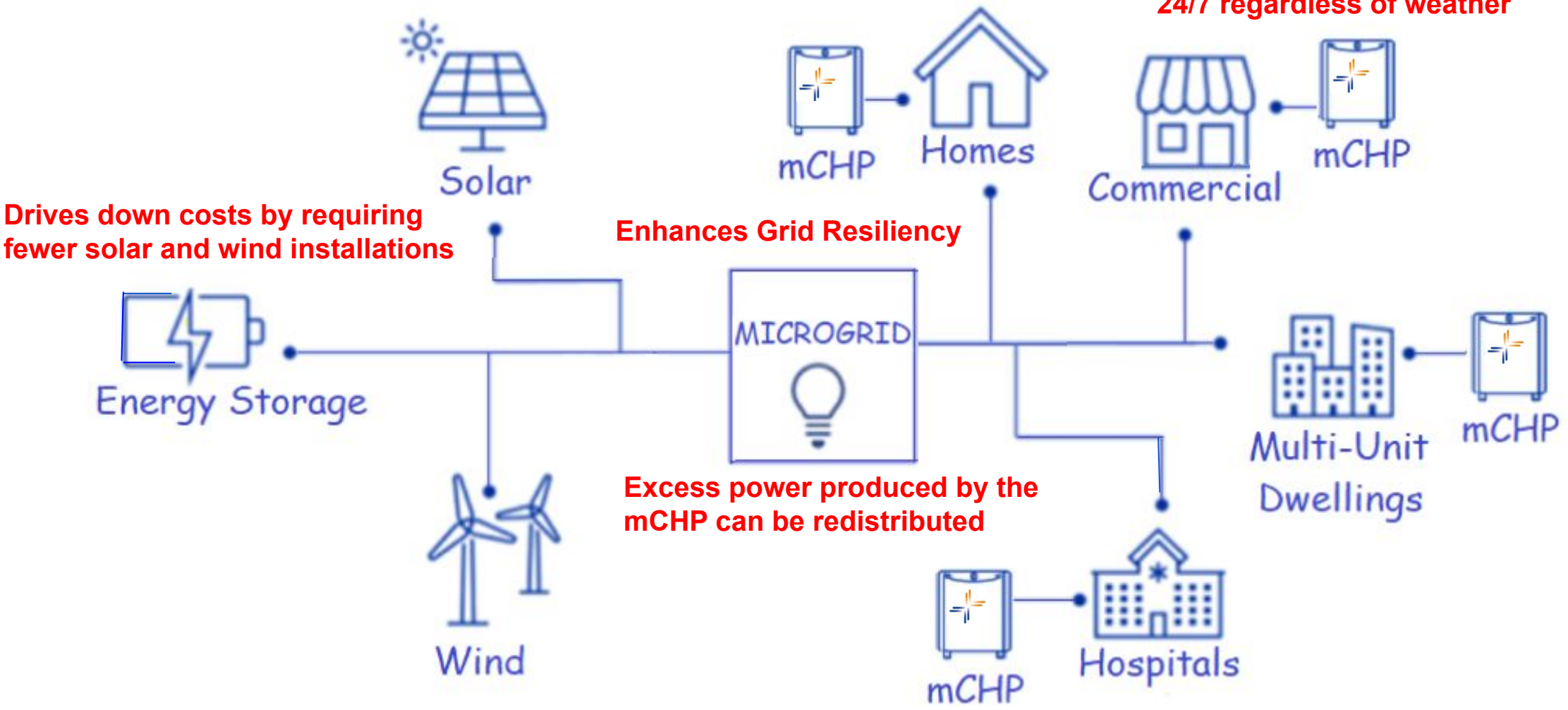
Electric	=	36,572kW	=	$5,851.52
Gas	=	2,190 Therms	=	$1,883.40
Total Savings				**$7,734.92**
Increased Property Value				**$154,700**

mCHP can be Integrated with Other Solutions

The agility of mCHP allows it to be integrated with other technologies to offer a more holistic approach to clean energy. mCHP can be paired with solar and wind to offer consistent electric generation when other options are not functioning, and when thermal loads are not enough to keep mCHP in operation, stored electricity supplied from solar and wind can fill the gap. Use of mCHP with opter options also can reduce the size and cost of projects by reducing the amount of solar or wind infrastructure needed.

mCHP with Microgrids

Reliability - Power is always available 24/7 regardless of weather



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The (Very Near) Future - Renewable Biogas

How it works

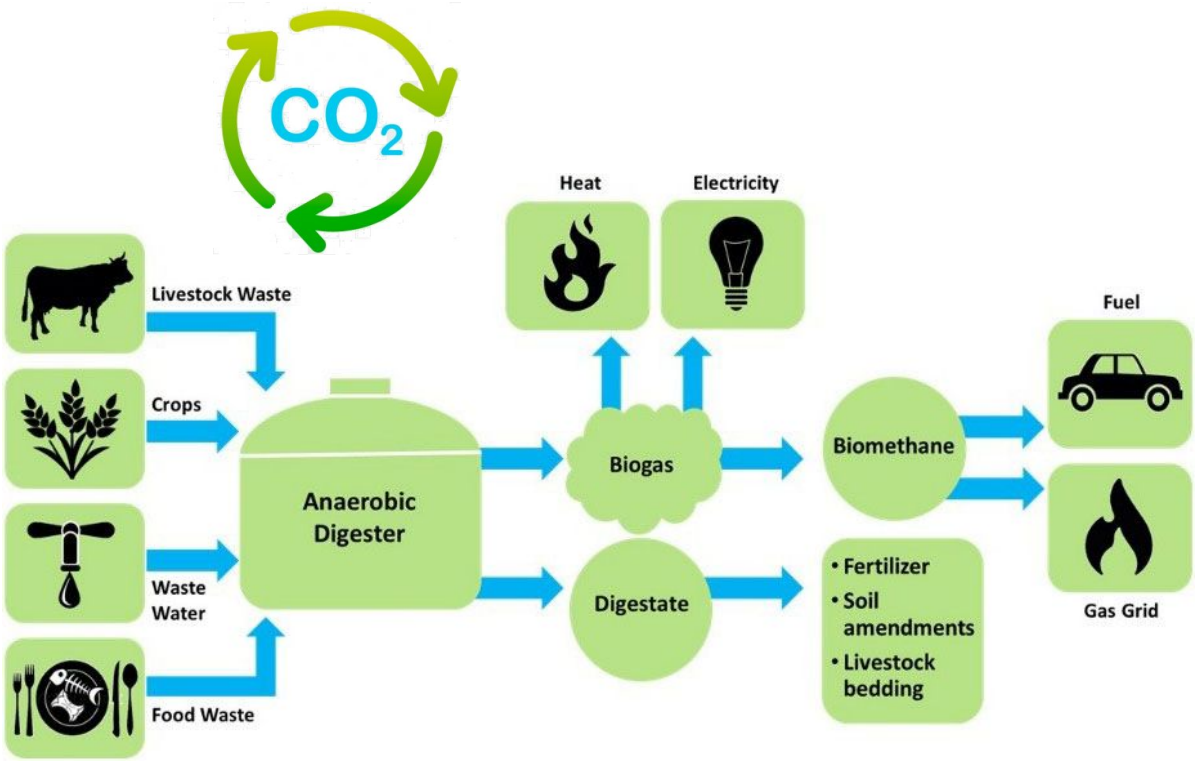
Renewable Biogas allows mCHP systems to operate on a carbon neutral basis, essentially taking CO_2 from the atmosphere and converting it to a gas to power the systems. Any CO_2 that is released from the combustion of renewable biogas is simply recaptured and recycled into fuel.

How it is produced

Waste from agricultural activity (animal manure), or from human activity (landfills, discarded food, wastewater treatment facilities) or from harvested plants (switchgrass) is collected into digesters and converted into propane and methane. The gas is then distributed through the existing pipeline (methane) or distribution (propane) infrastructure.

How it will make an impact

All waste material from human and agricultural activity can be converted into clean energy, benefiting the environment by reducing the waste and instead capturing the gas that would otherwise be released into the atmosphere. Further, harvesting switchgrass has multiple benefits - (1) the roots remain in the soil to prevent soil erosion; (2) it can be grown on land that is otherwise unsuitable for any other purpose; (3) it can be harvested twice per growing season; (4) one acre of switchgrass can produce more energy than an acre of solar panels; (5) switchgrass does not destroy the habitat; (6) growing switchgrass generates constant residual economic and commercial activity.



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