March 14, 2022

Combined Heat and Power Alliance
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The Combined Heat and Power Alliance (CHP Alliance) appreciates the opportunity to comment on the Michigan Department of Environment, Great Lakes, and Energy (EGLE) and the Council on Climate Solutions' draft MI Healthy Climate Plan. The CHP Alliance applauds Michigan's commitment to achieve 100% economy-wide carbon neutrality by 2050 and the resources the state has dedicated to the task.

The draft plan includes many strategies to reduce emissions, however there are additional opportunities to realize emissions reductions, especially in the buildings and industrial sectors. Technologies such as combined heat and power (CHP) and waste heat to power (WHP) can help to increase energy efficiency and reduce emissions, especially in these sectors.

About the CHP Alliance

The CHP Alliance is a diverse coalition with more than 70 members including equipment manufacturers and distributors, engineers, utilities, labor, contractors, non-profit organizations, and educational institutions.[1] Our members come together with the common purpose to educate all Americans about CHP and WHP, and how CHP and WHP can make America's manufacturers and other businesses more competitive, reduce energy costs, enhance grid reliability, and reduce emissions.

[1] The Combined Heat and Power Alliance, "Who We Are," accessed February 28, 2022, https://chpalliance.org/about/.

The CHP Opportunity

As discussed further below, CHP systems are highly efficient, combusting less fuel to provide the same energy services, and reducing all types of emissions. CHP can also improve economic competitiveness by reducing facilities' energy costs while also helping companies and building owners achieve their environmental emissions reduction goals.

CHP is an integral component of both the electric grid of the future and a future greener gas system. CHP is a clean, reliable, and resilient energy resource that can help governments, utilities, businesses, institutions, and communities meet their energy system goals, including reducing emissions, saving money, maintain energy reliability, and improving resiliency in the face of a changing climate. CHP systems can be integrated with other clean resources, such as wind and solar, including as part of a net-zero energy facility.

In Michigan, CHP has the potential to reduce emissions in the buildings and industrial sectors, helping the state to achieve its goal of 100% economy-wide carbon neutrality by 2050.

About Combined Heat and Power

CHP is a proven and highly efficient technology that can reduce emissions using traditional fuels, and has the opportunity to reduce emissions even further using emerging renewable and lower-carbon fuel technologies. In almost all regions of the U.S., CHP units installed through 2035 and operating through 2050 using natural gas are expected to cause a net reduction in carbon emissions over their system life.[2] For all states in the continental U.S., fossil fuel generators are used as marginal electric grid resources to serve incremental loads. But, when CHP is installed, grid requirements for these marginal resources are reduced. The emissions from the marginal resources are avoided, even with the CHP unit operating on natural gas.

[2] In all regions except New York and California. "Combined Heat and Power Potential for Carbon Emission Reductions: National Assessment 2020-2050," ICF, July 2020, p. 4, http://consortia.myescenter.com/CHP/ESC_CHP_Emissions-Full_Study-ICF-071320.pdf.

CHP units are already deployed throughout the industrial sector and could transition to clean fuels in the near-term as these fuels become more accessible. Renewable and lower-carbon fuel technologies can serve as the primary fuel source for CHP systems and further reduce emissions across the industrial sector.

CHP 2.0

Historically, CHP units have run on traditional fuels, and many today use natural gas. This use of CHP can be thought of as "CHP 1.0," the first wave of CHP technologies that relied on fossil fuels. However, CHP units can be fueled by renewable and lower-carbon fuels, including biogas, renewable natural gas (RNG), hydrogen, and renewable propane, known as "CHP 2.0." Use of these fuels can allow CHP systems to reduce emissions even further than they do under CHP 1.0.

Fuels such as biogas and RNG are already being used in CHP systems, and additional existing systems could run on these fuels, providing a near-term solution for further emissions reductions. RNG, also known as biomethane, is most commonly produced from biogas that has been cleaned by removing CO2 and other trace gases. RNG can also be generated from the direct gasification or pyrolysis of biomass. The high methane content of RNG allows for full compatibility within natural gas appliances and pipeline systems. CHP fleets that run on natural gas require minimal upgrades to be fueled by RNG and would produce immediate emissions reductions by transitioning. According to an ICF study, RNG deployment could achieve as much as 235 MMT of GHG emissions reductions by 2040.[3]

Hydrogen fuel can serve as the primary fuel source for CHP systems and further reduce emissions across the industrial sector. CHP equipment manufacturers are working to make new units that can operate on 100% hydrogen fuel, and work is being done to increase the volume of hydrogen fuel that can be used in existing CHP systems. For example, gas turbine manufacturers are looking to provide equipment that can accommodate higher percentages of lower-carbon fuels: various companies in the U.S. and abroad are deploying or working on hydrogen-ready technology, and in 2019, a

[3] "Renewable Sources of Natural Gas: Supply and Emissions Reduction Assessment," An American Gas Foundation Study Prepared by ICF, December 2019, https://gasfoundation.org/wp-content/uploads/2019/12/AGF-2019-RNG-Study-Full-Report-FINAL-12-18-19.pdf.

number of European companies committed to provide gas turbines that can handle 20% hydrogen content in fuel by 2020, and 100% by 2030.[4]

Hydrogen fuel is commonly produced through a thermal process known as natural gas reforming, or through electrolysis using domestic resources like nuclear power, biomass, solar, and wind.[5] There are different types of hydrogen that distinguish how it is produced, which has impacts on its overall emissions:

- Grey hydrogen is produced industrially from natural gas, generating significant carbon emissions;
- Blue hydrogen is also produced from natural gas, but its carbon emissions are captured and stored or reused; and
- Green hydrogen is generated though electrolysis of water by using renewable energy sources that do not produce carbon emissions.[6]

In a 2020 report, the Hydrogen Council estimated that hydrogen has the potential to achieve 18% of global end energy demand by 2050.[7] The amount of emissions reductions that can be achieved by this increase in hydrogen use will depend on the source of the hydrogen fuel, as described above. Currently, 99% of global hydrogen is produced using fossil fuel sources, accounting for 830 Mt CO2/year, more than the entire country of Germany.[8] As the hydrogen economy grows, a switch towards lower-carbon hydrogen production options for both existing and added production could result in significant emissions reductions.

Renewable propane is chemically identical to conventional propane, and is produced from biomass-based feedstocks, including used cooking oil, animal fats, or 20% dimethyl ether.[9]

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[4] Sonal Patel, "High-Volume Hydrogen Gas Turbines Take Share," *POWER*, May 1, 2019, https://www.powermag.com/high-volume-hydrogen-gas-turbines-take-shape/.
[5] "Hydrogen Fuel Basics," U.S. Department of Energy Office of Energy Efficiency & Renewable Energy, Hydrogen and Fuel Cell Technologies Office, last accessed September 12, 2021, https://www.energy.gov/eere/fuelcells/hydrogen-fuel-basics.
[6] Noé van Hulst, "The clean hydrogen future has already begun," International Energy Agency, April 23, 2019, https://www.iea.org/commentaries/the-clean-hydrogen-future-has-already-begun.
[7] "Path to hydrogen competitiveness: A cost perspective," Hydrogen Council, January 20, 2020, https://hydrogencouncil.com/wp-content/uploads/2020/01/Path-to-Hydrogen-Competitiveness_Full-Study-1.pdf.
[8] "The future for green hydrogen," Wood Mackenzie, October 25, 2019, https://www.woodmac.com/news/editorial/the-future-for-green-hydrogen/.
[9] "Propane Production and Distribution," U.S. Department of Energy Office of Energy Efficiency & Renewable Energy, accessed February 28, 2022, https://afdc.energy.gov/fuels/propane_production.html.

CHP's Efficiency

Properly designed CHP systems typically operate with an overall efficiency of 65-85%, with some approaching 90%.[10] CHP achieves these high efficiencies by recovering the waste heat byproduct of electricity generation as useful thermal energy for heating and cooling, a process that is particularly beneficial for energy-intensive industrial sectors. Because they operate efficiently, CHP systems combust less fuel to provide the same energy services, reducing all types of emissions including greenhouse gasses such as carbon, criteria pollutants, and hazardous air pollutants.

CHP systems will also use clean fuels efficiently, requiring less fuel inputs for the same energy outputs compared to other generation units. Given the potentially higher costs of less abundant or newly-developed cleaner fuels, using these fuels efficiently in CHP systems can help to lower costs while enabling emissions reductions.

CHP Deployment

Today, there is nearly 66 gigawatts (GW) of installed CHP at more than 1,200 industrial facilities across the country, which equates to 13% of U.S. industrial electric generating capacity.[11] Using cleaner fuels such as RNG and clean hydrogen in these generation units can help industrial facilities reduce their emissions. Existing CHP systems, including ones installed today, can convert to 100% hydrogen at reasonable cost and with minimal downtime because these conversions can occur during scheduled overhauls.[12]

Historically, the top market sectors for CHP capacity include chemicals, petroleum refining, pulp and paper, and food processing. Within the last four years, the pulp and paper and chemical sectors led the way in new CHP capacity brought online, with over 5 GW and 3.5 GW installed respectively. All in all, existing CHP systems avoid over 210

[10] "Combined Heat and Power (CHP) Technical Potential in the United States," U.S. Department of Energy, March 2016, p. 3, www.energy.gov/sites/prod/files/2016/04/f30/CHP%20Technical%20Potential%20Study%203-31-2016%20Final.pdf ; "CHP Benefits," U.S. Environmental Protection Agency Combined Heat and Power Partnership, last accessed February 2022, https://www.epa.gov/chp/chpbenefits.
[11] The Combined Heat and Power Alliance, "Factsheet: CHP and American Manufacturing," October 2020, https://chpalliance.org/resources/combined-heat-and-power-chp-and-american-manufacturing/.
[12] A CHP system overhaul typically occur every 8-10 years for a unit that runs continuously.

million tons of CO_2 compared to separate production of heat and power.[13] Looking to the future, the Department of Energy has identified over 4,987 MW of remaining CHP (including WHP) total technical potential capacity at over 10,300 sites in Michigan, as described in the table below.

CHP Technical Potential in Michigan (Including WHP)[14]

Industrial		**Buildings**	
Transportation Equipment	618 MW	Commercial Office Buildings	718 MW
Chemicals	576 MW	Colleges and Universities	315 MW
Primary Metals	323 MW	Hospitals	193 MW
Paper	212 MW	Retail	129 MW
Food	188 MW		
Lumber and Wood	95 MW		

WHP

Waste heat to power (WHP), also known as "bottoming-cycle CHP," uses waste heat from industrial processes to generate electricity with no additional fuel and no incremental emissions. In a WHP system, fuel is used to produce useful thermal energy for an industrial process. The heat not used for that process, the "waste heat," is then utilized to produce electricity. No additional fuel is used to produce the electricity, meaning that there are no incremental emissions associated with the electricity production. As of 2016, there were 469 megawatts (MW) of existing WHP capacity at 75 sites across the U.S., mostly used in primary metals and refining applications.[15] In addition, as of 2016, WHP's technical potential is estimated to be 7.6 GW across all facility types, with petroleum, metal, and non-metallic mineral markets having the highest amount of technical potential.[16]

[13] David Jones, ICF. "CHP State of the Market." National Summit on CHP, State of the Market panel, September 13, 2021.
[14] "Combined Heat and Power (CHP) Technical Potential in the United States," U.S. Department of Energy, p. D-45-D-46..
[15] Combined Heat and Power (CHP) Technical Potential in the United States," U.S. Department of Energy, p. 18.
[16] Combined Heat and Power (CHP) Technical Potential in the United States," U.S. Department of Energy, p. 28.