Decarbonizing natural gas

Reducing carbon concentration in natural gas and blending hydrogen with natural gas lowers carbon emissions while allowing users to maintain existing equipment and processes.

By Tonya McMurray

In its efforts to further reduce greenhouse gas emissions, the natural gas industry is marshalling new technologies that offer a more cost-effective way to reduce emissions.

Many commercial and industrial operations rely on natural gas. Switching to electricity or alternative fuels to reduce emissions would require significant reworking of their systems, said Mothusi Pahl, vice president of business development and government affairs at Modern Hydrogen Inc.

"Converting to electricity will cost on the scale of millions of dollars per factory," he said. "Plus, they would have to shut down their factory to convert and will be subject to power outages, which impacts profits."

More efficient solutions include removing carbon from natural gas and using hydrogen-enhanced natural gas (HENG) to reduce carbon in the fuel stream. Both technologies create an environmentally friendly fuel source that works with existing systems and equipment.

> "This is a full cycle process. It gets the carbon out of natural gas and the carbon goes into roads to make them more cost-effective to build."
>
> — Mothusi Pahl, vice president, business development and government affairs, Modern Hydrogen Inc.

PRE-COMBUSTION CARBON CAPTURE

Modern Hydrogen strips carbon from natural gas, preventing those molecules from becoming carbon dioxide. Called "pre-combustion carbon capture," this technology can be paired with existing gas networks to decarbonize them at stages upstream during gas transmissions, at utility gate stations or directly at an operator's point of use.

The largest component of natural gas is methane, composed of one carbon atom and four hydrogen atoms. Stripping carbon atoms from natural gas leaves pure hydrogen, which can be used alone or blended back with natural gas for use in heat, steam, power generation and other applications.

The process also leaves industrial-grade solid carbon and eliminates the production of carbon dioxide (CO_2). The solid carbon can then be sold to asphalt and concrete manufacturers for use in building roads.

"This is a full cycle process," Pahl said. "It gets the carbon out of natural gas and the carbon goes into roads to make them more cost-effective to build."

Modern Hydrogen has entered a strategic partnership with leading industrial boiler manufacturer Miura Co. Ltd. to use its technology to develop new solutions for industrial heating systems. Modern Hydrogen has field trials planned for this year.

Miura produces hydrogen-fueled boilers that emit no carbon dioxide during operation. The partnership between Miura and Modern Hydrogen will combine Miura's hydrogen technologies with Modern Hydrogen's decarbonization technique.

HENG DEMONSTRATION SUCCESS

A strategic effort between three Buffalo, New York-based companies successfully demonstrated that blending hydrogen with natural gas can create a clean fuel source without disrupting existing operations.

Wheatfield Gardens, an agricultural company which grows high-quality produce and cannabis for local distribution, has a strategic focus on new technologies that improve the energy efficiency of

PHOTO COURTESY OF MODERN HYDROGEN

Modern Hydrogen Inc.'s carbon capture technology removes carbon atoms from natural gas, leaving pure hydrogen which can be blended back with natural gas or used alone to fuel a variety of applications.

indoor growing operations. The greenhouse already uses many energy-saving technologies, including a combined heat and power system for on-site electrical and thermal needs and a system to capture CO_2 for use as crop fertilizer.

Knowing the company's interest in energy technology, Kenneth Lawton, senior technical energy consultant for the energy services department at National Fuel Gas Distribution Corp., the area's natural gas utility, invited Wheatfield Gardens to participate in a HENG demonstration with the utility and Linde PLC, a global industrial gases and engineering company. Paal Elfstrum, CEO of Wheatfield Gardens, agreed.

Energy is the second-largest cost in indoor agriculture, exceeded only by labor costs, Elfstrum said. Reducing energy use benefits both the environment and the company's bottom line.

"Wheatfield Gardens is committed to greener agriculture," he said. "This seemed like a good way to broaden our efforts and help New York reach its decarbonization goals, but we wanted to make sure we'd still be able to capture carbon for use in our production."

Wheatfield Gardens installed a skid-mounted blending unit provided by Linde next to its primary boiler to enable blending hydrogen into the natural gas immediately before the gas entered the boiler. On-site operational expertise and support was provided by Linde to ensure the blending unit incrementally increased the amount of hydrogen blended to three levels, 5%, 10% and 15%. The data collected was used to determine the impact on carbon dioxide and other emissions, boiler performance and the greenhouse's ability to capture CO_2 for fertilizer.

.PHOTO COURTESY OF NATIONAL FUEL GAS DISTRIBUTION CORP.

Wheatfield Gardens installed a skid-mounted hydrogen blending unit from Linde PLC next to its primary boiler to enable blending of hydrogen into natural gas, resulting in reduced carbon emissions without any impact to the greenhouse's operations.

Using the Wobbe Index, the impact of CO_2 emissions reduction potential with the supplementation of hydrogen into natural gas can be seen in the table below.

At all three blending levels, the greenhouse was able to reduce carbon emissions without any impact on operations, Lawton said.

"This demonstration was an opportunity to learn by doing," he said. "All parties benefited from the demonstration occurring in the field at a host site that was actively pursuing their normal course of business as opposed to testing in a controlled laboratory environment."

Elfstrum said the demonstration proved the greenhouse could capture enough carbon for fertilization of plants while still decarbonizing some of the natural gas it uses. He believes these types of incremental approaches will likely be the most successful for industries like his that rely heavily on natural gas.

"Cold climates need the reliability of natural gas," he said. "A greenhouse runs 24 hours a day, seven days a week, and we need energy for that entire time. Plants don't understand if the power goes out. If they don't have what they need, they'll die. Electrifying all our equipment is not an approach that will work but this incremental decrease is a way we can work toward decarbonization goals."

Reduction of CO_2 emissions as it relates to hydrogen content in a natural gas stream:	
Hydrogen Content (by Vol.)	Relative CO_2 Emission Reduction (by Vol.)
0%	0%
5%	1.62%
10%	3.36%
15%	5.24%

For more information, visit:

Modern Hydrogen Inc.:
modernhydrogen.com

Miura Co. Ltd.:
www.miuraz.co.jp/en

Linde PLC:
linde.com

This is carbon.

Carbon that used to be in natural gas.

Modern Hydrogen

Instead of becoming CO2, Modern Hydrogen's distributed pyrolysis product ripped this carbon out of natural gas, leaving only clean hydrogen fuel behind and reducing emissions from use to nearly zero.

Don't wait for new pipelines, trucked-in fuel deliveries, or renewable power to achieve your net-zero goals. Decarbonize your natural gas where you use it, and check that problem off the list.

Contact us to learn more: ModernHydrogen.com