Summary

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Valorisation of biowaste in the United States

Distributed biogas upgrading to Renewable Natural Gas (RNG) using biomethanation

IEA Task 36 Case Study

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SUMMARY

Include a link to the report.

Renewable natural gas deployments in the United States have increased significantly in recent years. As of 3/31/2020, there are 119 operational projects with a further 88 under construction[1]. Renewable natural gas is a mature technology that upgrades biogas into high purity methane. Historically, amine, membrane, or pressure-swing adsorption technologies have been used to perform this gas upgrading through the separation of carbon dioxide. Biomethanation instead converts this carbon dioxide into additional methane through the addition of hydrogen.

In addition to increased yields of methane compared to incumbent separations approaches, biomethanation offers potential as a grid scale storage technology by utilizing curtailed electricity to produce the hydrogen needed. Being a biological process, the hydrogen and carbon dioxide conversion process is quickly ‘rampable’. There have been several pilot- and demonstration-scale installations of the technology and this case study explores some of the economic and environmental considerations of doing so.

TECHNOLOGY SUMMARY

As opposed to traditional biogas upgrading technologies such as the use of amine scrubbing or membranes, biomethanation converts the carbon dioxide in biogas to additional methane. By converting the carbon dioxide found in biogas, the overall yield of biomethane is increased by 60-70% compared to upgrading technologies that separate carbon dioxide. This is accomplished through the use of a non-GMO microorganism that converts this carbon dioxide and hydrogen to methane. The hydrogen is supplied to the system by a polymer electrolyte membrane electrolyzer.

[1] https://www.anl.gov/es/reference/renewable-natural-gas-database

The biological organism utilized, a methanogen, is quite robust and demonstrates quick responsiveness to start/stop cycles and tolerance to other impurities found in biogas including hydrogen sulfide. This represents an additional advantage over catalytic methanation processes which often operate at high temperature and sometimes requires conditioning of these species to avoid catalyst deactivation/poisoning. The electrolyzer and organism can both ramp very quickly which offers opportunities for grid-scale energy storage solutions. With increasing deployment of solar and wind power generation in the United States, there has also been a rise in wind and solar energy curtailments. Without grid-scale storage solutions, this will ultimately prevent deeper renewables penetration. Biomethanation effectively can serve as a load peaking service to store excess electricity in the form of methane.

Depending on the source, the carbon intensity of renewable natural gas can be very low and often is negative. This negative carbon intensity score is due to the fact that the 'business-as-usual' practices can result in fugitive methane emissions. Since methane is more than 25 times more potent in terms of global warming potential, use of the methane in stationary or transportation applications is far preferable to venting or flaring.

There are several policies that have supported the development of this technology in the United States. Landfill organics bans are causing municipalities to explore new solutions to managing food waste, municipal sludge, and other waste streams. Simultaneously, incentive policies such as the Renewable Fuels Standard and Low-Carbon Fuels Standard are offering credits for renewable natural gas. The Low-Carbon Fuel Standard in particular offers lucrative incentives based on the carbon intensity reduction achieved and is driving significant growth in biogas to renewable natural gas projects.

Conclusions

Biomethanation is demonstrating itself as a scalable and robust technology for producing renewable natural gas while simultaneously increasing the methane yield from a given biogas source. By utilizing a biological organism to perform this carbon dioxide conversion, the technology operates at more benign temperatures and is resistant to impurities and toxic compounds found in biogas. The technology has also demonstrated its ability to provide ancillary services to the grid in terms of load peaking. This enables greater penetration of other renewable generation technologies. Worldwide, several thousand hours of continuous operations have been demonstrated at a small number of plants. As the process continues to demonstrate performance and robustness, this will improve investor confidence in this technology and encourage further deployments.