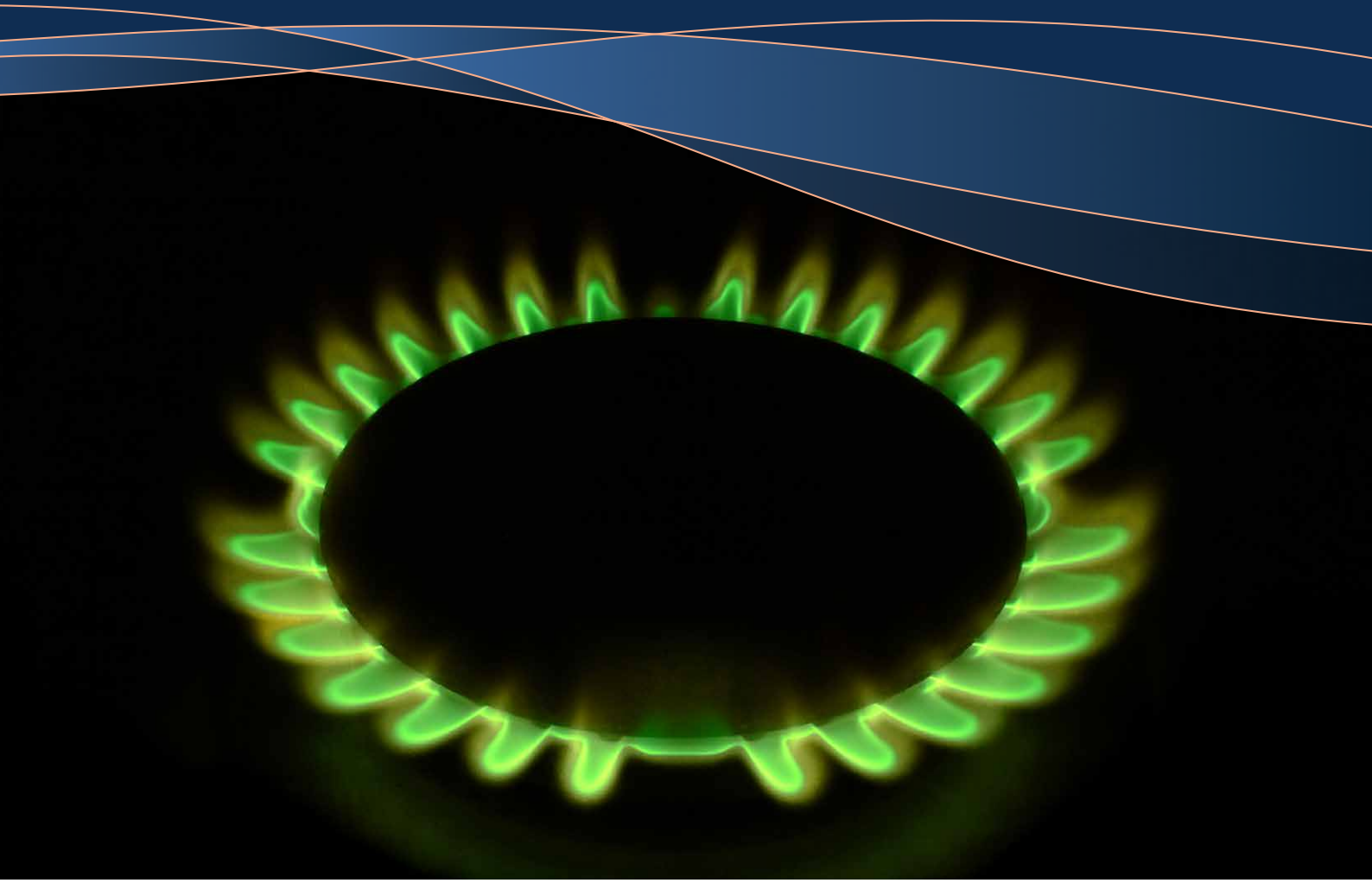
Gaffney Cline

Green Gas



Introduction

The war in Ukraine has increased the cost of natural gas and dramatically shaken up security of supply issues, especially for European countries. Some European countries, in their urgent need to secure energy supplies, began to reverse climate change related policies on fossil fuels with some countries even resorting to restarting their abandoned coal fired power stations.

European countries are scrambling for new natural gas markets following the EU announcement earlier in 2022 of making Europe independent from Russian fossil fuels well before 2030. While Europe adapts to the to the new reality of reduced Russian piped gas, and prices are beginning to soften, analysts and commentators are predicting the market will continue to experience volatility in prices as Asia and Europe compete for LNG while legacy market flexibility in Europe declines. This means that energy bills are likely to remain high for European consumers for the foreseeable future.

There is a potential solution that may help in alleviating the natural gas constraints and that is the scaling up of biomethane and Green Gas.

What is Green Gas?

The UK's Green Gas Certification Scheme defines Green Gas as gas produced from a renewable source that has lower GHG (Green House Gas) emissions from its production and consumption than an equivalent fossil fuel product and meets the quality requirements of the Distribution Network into which it is being injected. The main Green Gases are:

- Biogas: a mixture of bio-produced methane, CO_2 and small quantities of other gases.
- Biomethane: near-pure source of manufactured methane.

Green Gas Production and Use

Biogas

As highlighted above, Biogas is a mixture of bio-produced methane (45% to 75% by volume), CO_2 and small quantities of other gases. The composition of methane in biogas is dependent on feedstock and production methodology. Biogas is formed through the anaerobic digestion of organic matter in an oxygen-free environment. Industrially, this occurs in one of three typical production methodologies:

- Use of Biodigesters: organic material is mixed with water and placed in airtight systems, and then broken down by naturally occurring micro-organisms. The contaminants and moisture are removed before the utilisation of the biogas.
- Landfill gas recovery systems: decomposition of municipal solid waste under anaerobic conditions at landfill sites produces biogas.
- Wastewater treatment plants: can be equipped to recover organic matter, solids, and nutrients such as nitrogen and phosphorus from sewage sludge. With further treatment, the sewage sludge can be used as an input to produce biogas in an anaerobic digester.

The produced biogas can then be used directly to produce electricity and heat or as an energy source for cooking.

Biomethane

Biomethane is a near-pure source of methane and is produced in one of two ways:

- Upgrading biogas: Biogas is 'upgraded' utilising various technologies such as water scrubbing and membrane separation. Upgrading biogas accounts for the majority of total biomethane produced worldwide today.
- Thermal gasification of solid biomass followed by methanation: This method typically utilises a woody biomass which is broken down at high temperatures (700-800°C) and high pressures in a low-oxygen environment. This produces a mixture of carbon monoxide, hydrogen and methane (syngas) which is then purified. The methanation process uses a catalyst to promote a reaction between hydrogen and carbon monoxide or CO_2 to produce methane. Any remaining CO_2 or water is removed at the end of this process.

The produced biomethane is indistinguishable from natural gas and can be used without the need for any changes in the transmission and distribution infrastructure or end-user equipment. In addition, the biomethane is fully compatible for use in natural gas vehicles.

Feedstock and Global Production

The feedstock for Green Gas production is organic matter that comes from many different sources including:

- Crop residues (from harvest of wheat, maize, rice etc.);
- Animal manure;
- Municipal solid waste (i.e. food and green waste, paper, cardboard etc.);
- Waste water treatment plants or Sewage works;
- Residue from processes such as cheese making; and
- Forestry residues for direct production of biomethane via gasification .

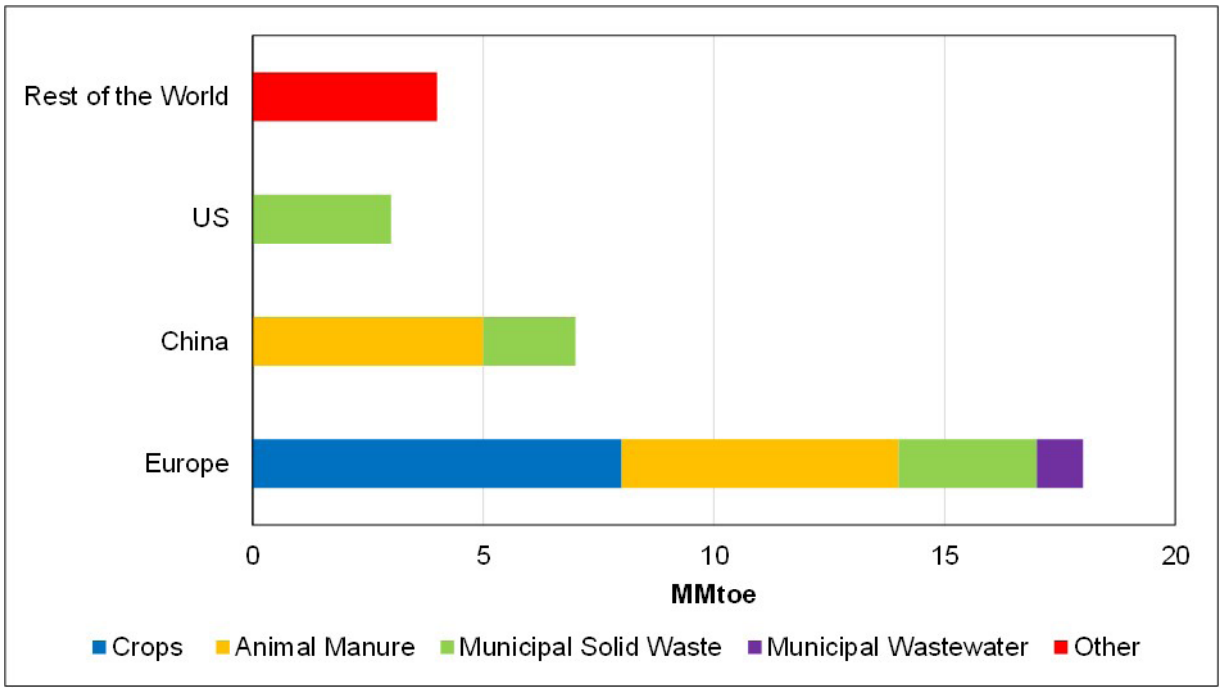
According to the IEA, global feedstock availability is plentiful for sustainable production of biogas and biomethane (approximately 730 MMtoe biomethane potential and 570 MMtoe of biogas potential) but only a fraction is produced today at approx. 35 MMtoe[1] . IEA analysis indicates that full utilisation of the sustainable potential could cover some 20% of today's worldwide gas demand.

Global Production

As Figure 1 highlights, the development of Green Gas has been uneven across the world. This is predominantly due to availability of feedstocks but also based on the policies of specific countries which incentivise biogas production and use.

Europe, China and the United States account for 90% of global production (Figure 1). Europe is the main biogas producer with just under 20 MMtoe with Germany being the largest market and responsible for two-thirds of Europe's biogas plant capacity. The feedstock utilised in Europe is predominantly crops and animal manure as well as the capture of methane from landfill sites.

Figure 1: Global Green Gas Production



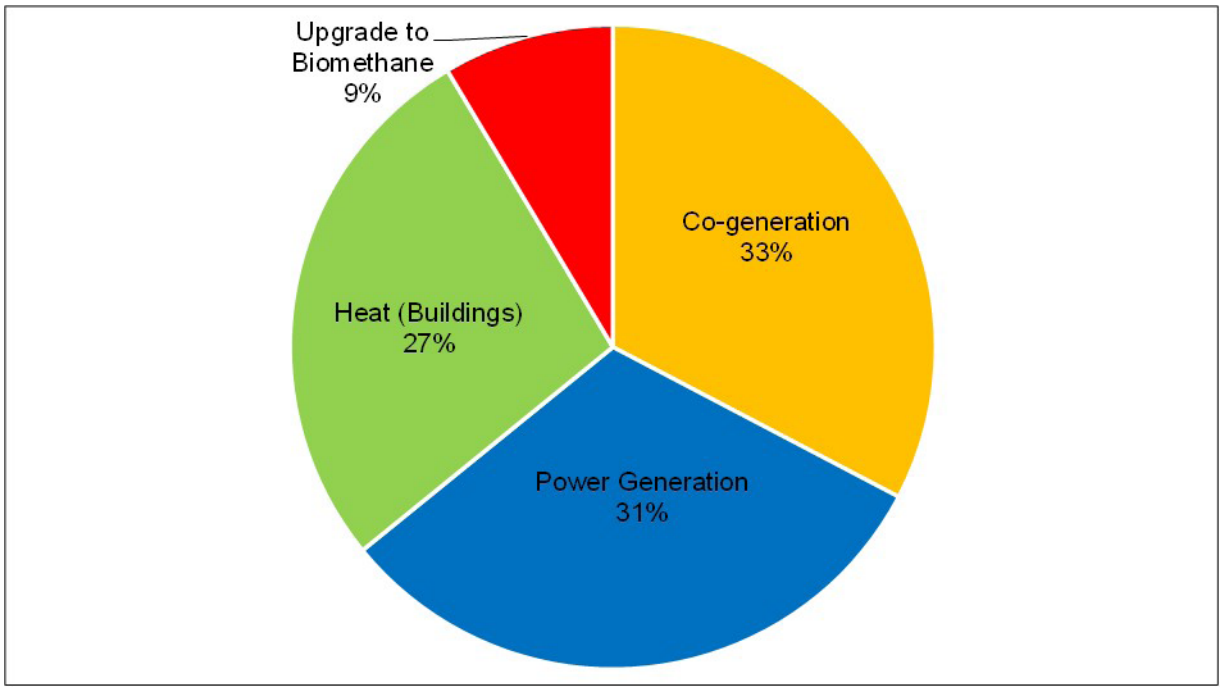
Source: IEA data, GaffneyCline analysis

[1] IEA (2020), Outlook for biogas and biomethane: Prospects for organic growth, IEA, Paris
https://www.iea.org/reports/outlook-for-biogas-and-biomethane-prospects-for-organic-growth

Consumption and Generation

The main global use of Green Gas is in the generation of electricity and heat, with an approximately equal split between electricity-only facilities and co-generation facilities (Figure 2). Just under 30% of Green Gas was utilised for heating in buildings. Only a small proportion of global biogas production, approximately 9%, is upgraded to biomethane which is then blended into the gas networks or used as a transport fuel.

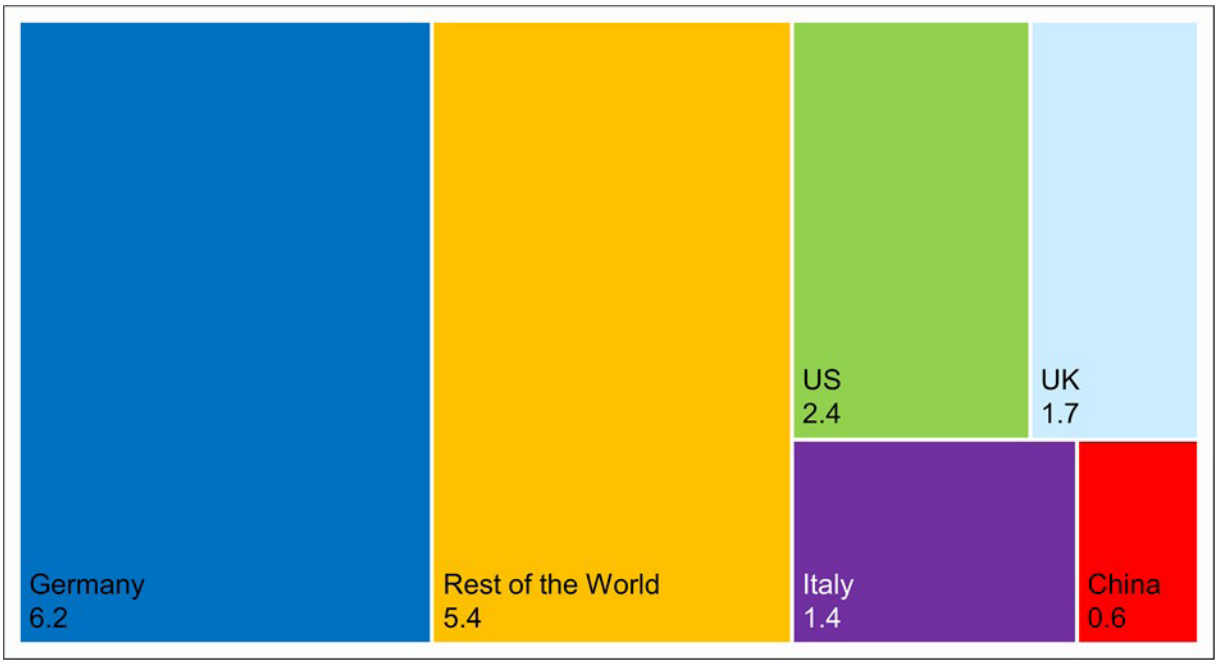
Figure 2: Global Green Gas Consumption by Sector



Source: IEA data, GaffneyCline analysis

In terms of global Green Gas installed power generation capacity, there is currently just under 20 GW most of which is in Germany (Figure 3). This low amount is also reflected in the utilisation of bioenergy globally, where it comprises only around 10% of the world's primary energy demand today with solid biomass being the main utilised form of bioenergy (around 90%). Biogas and biomethane today account for less than 3% of total bioenergy demand.

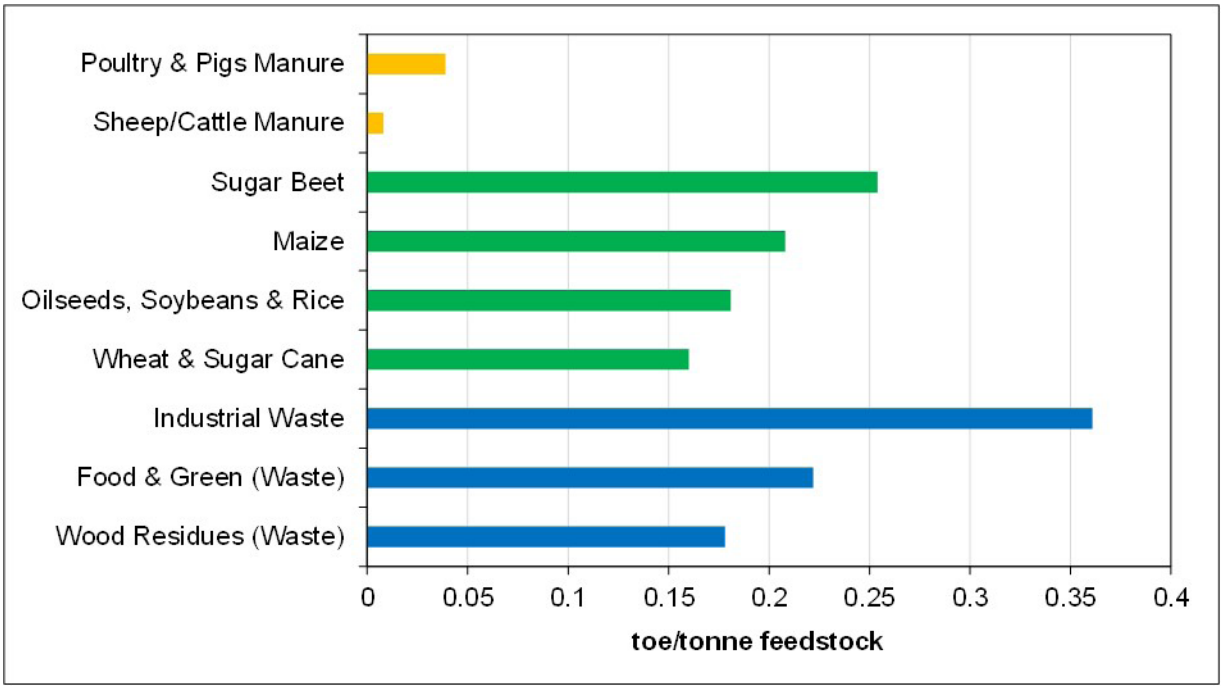
Figure 3: Global Green Gas Power Generation Capacity (GW)



Source: IEA data, GaffneyCline analysis

As Figure 4 highlights, different feedstocks will yield differing quantities of biogas. Industrial waste yields the largest volume of biogas while animal manure yields the lowest volumes. Crop residues also yield greater volumes of biogas than animal manure.

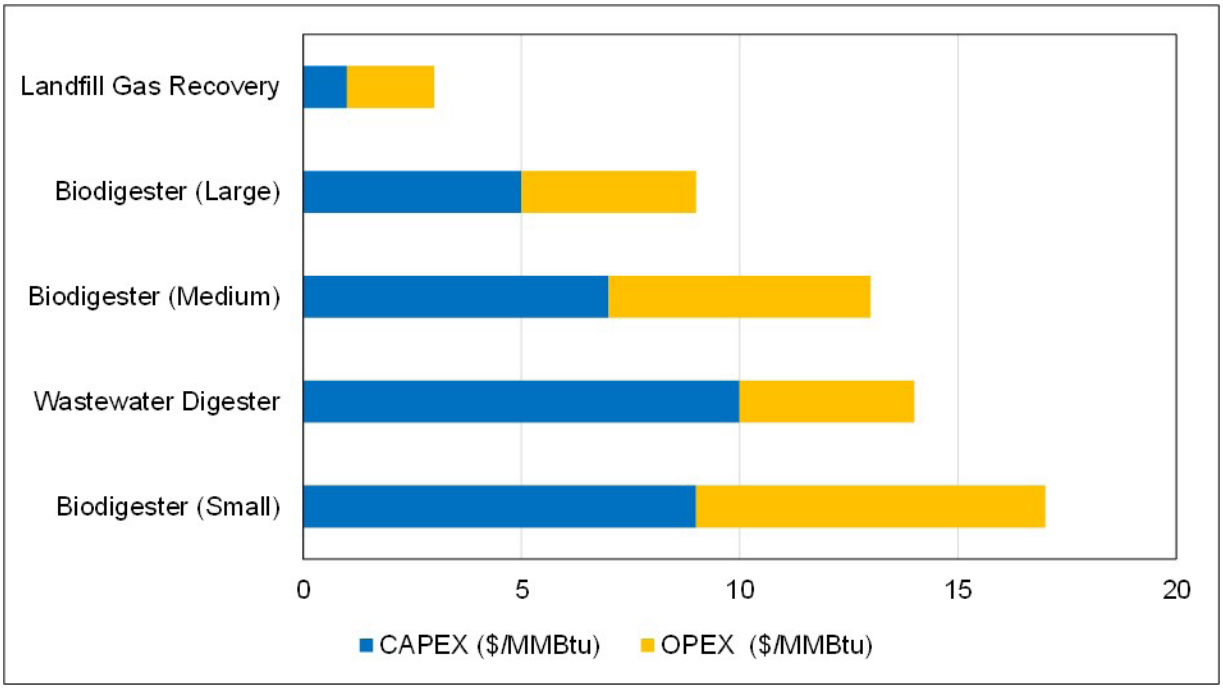
Figure 4: Average Biogas Production Yield by Feedstock



Source: IEA data, GaffneyCline analysis

The costs for biogas production also vary depending on the technology utilised and also the effort required to collect the feedstock (Figure 5). The small biodigester, which typically yields less than 100 m^3 of biogas per hour, is the most expensive per US dollar/MMBtu when taking into account both capital and operating expenditure. The medium biodigester has a capacity of 250 m^3 per hour while the large biodigester has an output rate of 750 m^3 per hour. The wastewater treatment plants are less expensive than the small biodigester and have an output flow rate of approximately 1,000 m^3 per hour. The Landfill gas recovery systems (to recover biogas produced from closed landfill sites) are the cheapest, relative to the other technologies and have an output flow rate of 2,000 m^3 per hour.

Figure 5: Biogas Production Costs



Source: IEA data, GaffneyCline analysis

Outlook

The current utilisation of Green Gas (biogas and biomethane) is relatively low, however it has the potential to gain a firmer foothold in the future due to several factors. The predominant driver is that biogas and biomethane can provide the same thermal benefits as achieveable from natural gas but without the net carbon emissions; as the decarbonisation agenda becomes more prominent, this becomes a crucial attribute. The GHG reduction benefit is amplified by the collection and utilisation of biomethane, a potent GHG, that could otherwise be released directly to the atmosphere from the decomposition of organic byproducts and waste. Green Gas also displaces the need to import natural gas in the energy mix, and therefore helps in security of supply issues. Unlike wind and solar PV, Green Gas plants can operate in a more flexible manner and so provide balancing services to the electricity network.

Certain industrial subsectors, such as the food and drink as well as chemicals produce wet waste with a high organic content, which is a suitable feedstock for anaerobic digestion. In such industries, Green Gas production can also have the co-benefit of providing environmental treatment for waste while also supplying on-site heat and electricity. In addition, Green Gas can provide a sustainable supply of heat and power that can serve communities seeking local, decentralised sources of energy, as well as a valuable cooking fuel in developing countries.

Currently, a relatively small but growing share of the biogas produced worldwide is upgraded to biomethane. This area has significant potential for further growth although this is heavily contingent on the strength and design of policies aimed at decarbonising gas supply in different parts of the World.

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