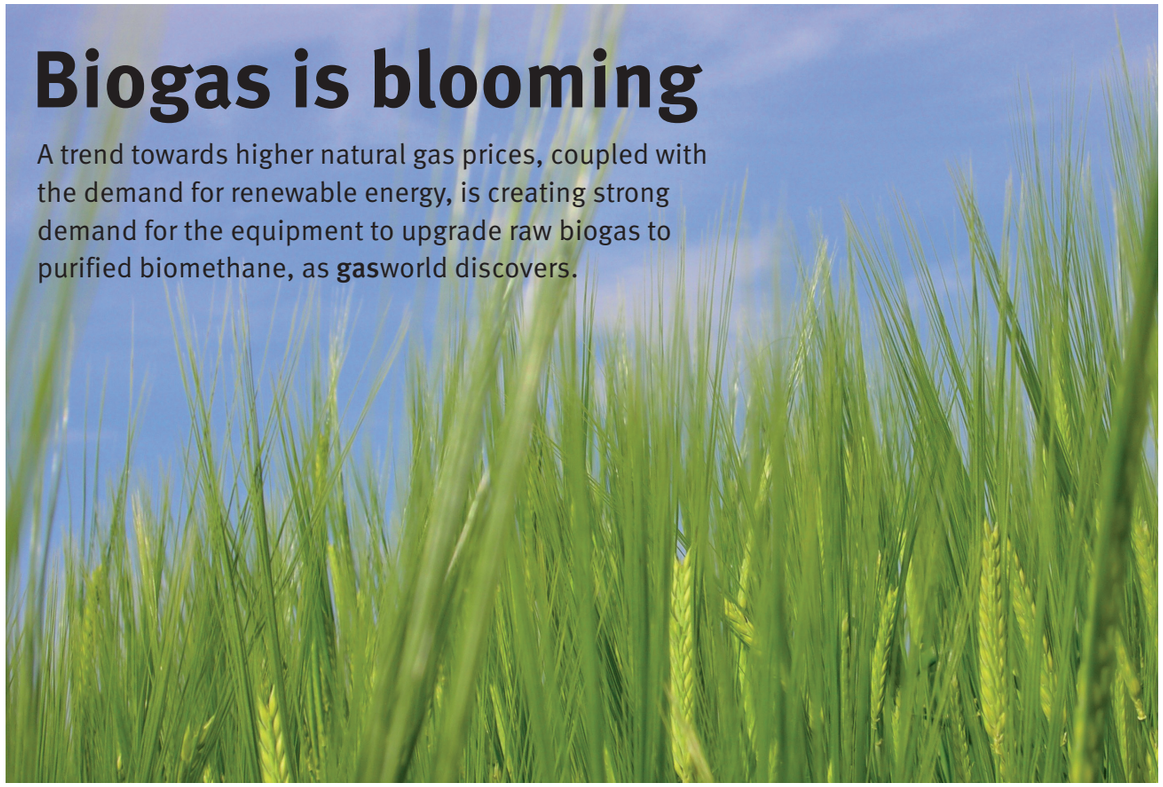

Biogas is blooming

A trend towards higher natural gas prices, coupled with the demand for renewable energy, is creating strong demand for the equipment to upgrade raw biogas to purified biomethane, as **gas**world discovers.

As the world strives for a more diversified energy mix, renewable energies like biofuels and biogas are coming to the fore. Sustainability is driving the utilisation of natural resources such as biomass, the products and potential of which is unlocked through anaerobic digestion (AD).

The process of anaerobic digestion is nothing new. There is evidence to suggest that AD was in use as an agent of energy as far back as the 16th century, while it has been used in the UK since the late 1800s according to the NNFCC, a specialist Bioeconomy consultancy based in the UK. But as the world's energy system appears set to go full circle and balance fossil fuels with greener, cleaner technologies based on natural resources, AD plants are firmly in demand.

AD is a natural process whereby plant and animal materials (biomass) are broken down by micro-organisms in the absence of oxygen. Many different forms of biomass exist and can be used, from food waste to manure and crops or crop residues in-between.

The process of AD, as explained by NNFCC, begins when biomass is put inside a sealed tank or digester, where naturally occurring micro-organisms digest the biomass and a methane-rich natural gas, or biogas, is released. This biogas can be used to generate renewable heat and power, gradually reducing both the use of fossil fuels and the release of greenhouse gas emissions. The remaining material, known as digestate, is rich in nutrients itself and can therefore be used as a fertiliser, creating a kind of closed cycle system of sustainability. Even the waste materials from wastewater treatment applications, for example, can be used as a means of generating biogas. And biogas is burgeoning, globally. Its use is rapidly growing around the world and especially in Europe, perhaps due to the versatility afforded by its make-up.

Booming

Although the exact composition of biogas depends on the type of feedstock it is derived from, it generally comprises around 60% methane and 40% carbon dioxide (CO_2), as well as traces of other contaminant gases. This structure enables biogas to be used for two means of energy generation; it can either be combusted to provide heat and/or electricity, or can be upgraded to biomethane (pure methane) through the removal of other gases. The purified product can then be injected into the mains gas grid or used as a road fuel.

Such two-fold utility is clearly paying off in Europe. According to the European Biogas Association's (EBA) Biogas Report of December 2013, there are already more than 13,800 biogas plants in Europe – a number that is still growing. Bulgaria and Serbia opened their first installations in 2012, while the industry is currently 'booming' in France, UK, Slovakia and Italy in particular, which doubled its number of installations from 521 up to 1264 within one year [2012].

A significant increase in biogas production has also been seen in the Czech Republic, although until 2020 no additional capacity will be added due changes in the Feed-in Tariffs for new installations. Similarly, a slowdown of biogas development is underway in Germany; 340 new plants were commissioned by the end of 2012, compared to the construction of 1,270 plants in 2011. Those new to the biogas business, however, might still express surprise at such statistics – numbers that just keep coming.

June (2013) saw UK-based company Tamar Energy unveil ambitious plans to build a network of more than 40 new biogas plants by 2018, with Denmark's market leading supplier of AD technology, Xergi, signed up to supply two of its first biogas plants. Tamar Energy's aim is for a network of more than 40 biogas plants across the UK, with a total capacity of 100 MW and producing enough energy to power more than 200,000 homes.

The latter figures provide an interesting talking point; it is not just the proliferation of biogas plants throughout Europe that is so significant, but what this could potentially mean to the wider challenge of energy security. It is thought that the current electricity generation from biogas in Europe could replace up to seven nuclear reactors in Belgium or produce almost as much power as coal power plants in the Czech Republic.

Uptake is growing beyond Europe too. In July (2013), the first biogas-fuelled micro-turbine generator was installed in a local sewage treatment plant in Hong Kong, completing a project started in mid-2012 and effectively reducing greenhouse gas emissions in this application. While AD is an established technology in Europe and Asia for the treatment of biodegradable wastes and for the production of renewable power, there are few examples of large commercial AD facilities in Africa. But another was added last year when Tropical Power, a developer of biogas and solar plants in Africa, announced in June that it had signed a deal with Clarke Energy to supply the first two containerised Jenbacher biogas engines in Sub-Saharan Africa.

The units are to be supplied to an agricultural biogas plant at a farm in Kenya, where the AD facility will produce biogas from the digestion of food processing wastes of surrounding farms – demonstrating the ability of this technology to provide continuous reliable and sustainable power on the African continent.

Synergy

At this point, we can observe a number of similarities between the rise of the distributive LNG sector and the growth of the biogas business, and what they could both mean for the industrial gas and equipment industry.

Like the escalation in LNG, the utilisation of AD systems for biogas production will only increase as energy security becomes more apparent. Further, as time goes on it is expected that technological crossovers will become more commonplace between the industrial gases industry and the biogas sector – just as there are currently vast synergies between the cryogenic technologies required in LNG and those developed in the gases industry.

> "...there are already more than 13,800 biogas plants in Europe – a number that is still growing"

Arguably the biggest current example is in upgrading biogas. **gas**world understands the growing trend towards higher natural gas prices and an exigency for renewable energy has created strong demand for the equipment necessary to upgrade raw biogas to purified biomethane. As described earlier, biomethane is a purified form of renewable biogas that meets pipeline natural gas quality specifications and can be distributed and sold by injection into existing pipeline gas utility pipelines. It can also be used as a carbon-neutral compressed natural gas (CNG) vehicle fuel for vehicles including refuse trucks, heavy duty transportation trucks, transit buses and passenger cars.

To meet these pipeline specifications, biogas must be put through a process whereby the methane present is separated from the CO_2 and hydrogen sulfate that makes up the bulk of biogas – leaving behind an almost pure biomethane gas. This is largely achieved through biogas upgraders that process biogas and concentrate it to the same standards of fossil natural gas, removing CO_2, water, hydrogen sulfide and other particulates.

Chesterfield BioGas (CBG) and Xebec Adsorption Inc. are just two examples of industrial and specialty gas-related companies already involved in this field. Canada-based Xebec is a developer and supplier of proprietary and conventional gas purification systems for several large international markets, including biogas production, natural gas processing, oil refining and specialty gases. When it comes to biogas, its BGX solutions are used to purify biogas streams into biomethane compliant with the stringent quality specifications for pipeline natural gas and vehicle fuel.

For biogas streams such as landfill gas and digester gas, Xebec's fast-cycle PSA systems are designed to operate reliably with low minimal maintenance – technology based on the company's hydrogen product platform, but modified to remove CO_2 from low quality methane streams. These solutions combine patented Xebec rotary valve technology with conventional beaded adsorbents, and operate with approximately one-minute cycles compared to around three-to-five minutes per cycle for conventional PSA systems.

For UK-based CBG, a sister company of Chesterfield Special Cylinders and part of the Pressure Technologies group, the biogas-to-grid business just continues to grow. October 2010 saw biogas injected into the UK gas grid for the first time, a project which CBG was instrumental in; raw biogas (originated from a wastewater treatment plant) was processed with a 'Manuka Plus' upgrading unit developed by Chesterfield Biogas, providing an output of 99% pure biomethane. Much

DIVERTING WASTE

Anaerobic digestion can be used to treat the waste produced by homes, farms, supermarkets and industries across the UK, helping to divert waste away from controversial landfill. Woody biomass is one of few resources that cannot be used, as micro-organisms cannot break down the lignin compound that gives wood its strength.

progress has been made since then. CBG announced two orders for upgrader units in August 2013 and as recently as January (2014) was selected to build the UK's largest biomethane-to-grid project. The groundbreaking UK renewable energy project will not only be the first of its kind when commissioned late this year, but will also be the largest of any biogas-to-grid project so far announced or operating in the UK.

CBG will be supplying the gas-scrubbing water-wash upgraders and ancillary equipment for the project. Such is the anticipated raw biogas input from the AD, the upgrading units will need to be coupled in parallel to optimise an output of up to 5,000 cubic metres per hour of 98% pure biomethane. The model being supplied is the Totara+, the largest in the Greenlane® range of water-wash processors that are proven in operation over the last 20 years and require no heat or chemicals.

When the project is completed in late 2014, CBG will have six similar systems of various capacities installed in the UK – more than all other types of biogas upgrading units operational in the country put together, and more than any other single supplier. Managing Director of CBG, Stephen McCulloch, said, "We believe that the order stream we are now experiencing, with diverse customers in different sectors, validates our outlook that creating a successful and sustainable business requires more than financial acumen. Our company places great importance not only on what we do, but how we do it."

Pentair Haffmans, part of the global diversified group Pentair, is another company engaged in the biogas upgrading business. September 2012 saw the company awarded a contract to supply a biogas upgrading system to Springhill Farms in Worcestershire, UK. The unit, commissioned in first quarter 2013, produces 1,630,000 m^3 of biomethane per year, which is enough to supply 1,000 households with their annual natural gas consumption. In addition, 4,200 tons of CO_2 are recovered. The system was the first in the UK to feed biomethane into the natural gas grid and at the same time recover the CO_2 by-product. The recovered CO_2 is stored in a buffer tank and used as natural fertiliser for tomato cultivation in the farms' greenhouses, while the system configuration allows for precise dosing of the CO_2 according to a set timetable that assures optimal plant growth.

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With renewable biogas energy on the rise, it is not just upgrader solutions that present opportunities for the gases industry. Global instrument manufacturer Sierra Instruments is another example of a company with biogas business of its own. Precise mass flow measurement of landfill gas (LFG) or digester gas is required to produce optimal heating value from the process and as biogas composition changes over time with the changing conditions in the landfill or digester tank, accurate measurement technology is essential.

Sierra's four-sensor QuadraTherm technology provides end-users with an optimal solution for accurately measuring and managing biogas, even with its changing gas composition, to produce higher energy yields.

Potential

The biogas business is clearly blooming. Moreover, as public awareness on green issues heightens, political moves are made by food suppliers to ensure waste produce goes to sustainable programmes, and governments channel funding to a rapidly expanding industry, the dynamics build for future growth.

As CBG points out, each biogas upgrade project will have different parameters, operating conditions and constraints. So while the range of upgraders is essentially modular or plug-and-play, variables in raw biogas source, expected gas throughput, compression requirements and other challenges will all require a closer understanding of these specific needs and expertise in gas processing equipment.

Upgrader units, biogas energy flow measurement, and diaphragm compression are all potential areas of opportunity for the gases industry, with companies such as CBG, Xebec, Sierra Instruments and more all positioned to capitalise on this wave of growth. gw