The drive for biogas autofuels

John Baldwin *of CNG Services looks as the prospects of biomethane for use as a road transport fuel.*

Natural gas vehicles are becoming increasingly available in the UK as a result of developments by OEMs (original equipment manufacturers), driven by the German NGV (natural gas vehicle) market which is growing at 50% annually, and by innovative UK companies making dual fuel (25% diesel, 75% natural gas) trucks that offer around a 25% reduction in carbon dioxide (CO_2) emissions compared to conventional diesel. In addition, NGVs are well placed to exploit the potential of new investments underway in anaerobic digestion of waste to produce biomethane.

These were the key messages that emerged from the one-day conference 'Naturally gas – production and use of methane in low carbon automotive applications' held at Loughborough on 1 May 2007. Attended by around 150 delegates from over 90 organisations, the event was hosted by Cenex, the UK's national centre of excellence in low carbon and fuel cell technologies, and the Low Carbon and Fuel Cell Technology Knowledge Transfer Network (LCFC KTN), in partnership with the Natural Gas Vehicle Association (NGVA) and the National Society for Clear Air (NSCA).

The conference opened with a presentation by Robert Evans, CEO of Cenex, who explained his organisation's strategy to broker technology demonstration projects, and to promote networking and knowledge transfer in key low carbon technology areas via the LCFC KTN (**www.lowcarbonfuelcellktn.org.uk**).

A buoyant worldwide picture of the uptake of NGVs in Germany, Italy, Sweden and other European countries was presented by session chair Mike Ellithorn of the NGVA. Globally, however, there are just 20,000 refuelling stations for over 6mn NGVs. This could become a major sticking point in the future as, according to one of the speakers, the number of new NGVs being introduced is rising by 20% annually.

Professor John Murlis of University College London (UCL) then presented a paper on policy drivers for the take-up of biomethane in the UK. He noted that while the primary policy driver that will affect the further growth of biomethane use is the global wish to alleviate climate change, other European and domestic policies on waste reduction, air quality management and noise reduction can also be used to promote the case for biomethane.

Trevor Fletcher of Hardstaff gave a presentation on the case for gas, borne of his company's own experience as a provider of NGV technology, refuelling infrastructure and as a road haulage operator. The company currently operates 86 NGVs and plans to increase to 100 vehicles by this summer. Using Hardstaff's OIGI dual-fuel technology, natural gas (NG) can substitute up to 90% of diesel in HGV operation, reportedly resulting in CO_2 savings of over 30 t/y for a 44-tonne truck.

Meanwhile, Christopher Maltin of Organic Power, which produces anaerobic digestion systems, asserted that the adoption of biomethane as a vehicle fuel must be preceded by the wide rollout of pipeline-fuelled NGVs. Posing the question as to why the worldwide experience with NG is not being mirrored by UK activity, he postulated that the UK had been an early adopter of NG vehicles, but suffered from adverse reaction as some of these vehicles experienced teething problems. He added that there was a pressing need for 'joined-up thinking' to take into account the obvious CO_2 and air quality benefits from biomethane vehicles. An obvious area to look at related to buses – UK buses currently receive a grant based on their consumption of diesel, which acts as an incentive that increases local air pollution and puts UK cities out of step with the likes of Paris, Rome and Madrid where most new buses ordered are now NG-powered.

Guy Hitchcock of Sustainable Transport Solutions concluded the session with analysis showing that biomethane could substitute between 8% and 10% of road fuel, or around 30% of heavy-duty fuel use. In looking at the environmental benefits of biomethane, he presented data that showed that biomethane generated from anaerobic digestion of liquid manure actually has negative well-to-wheels greenhouse gas emissions, since the process effectively

A brand new Mercedes truck running on natural gas awaiting its supermarket livery

captures methane that would otherwise be released into the atmosphere.

Renewable natural gas

The conference also saw the launch of the UK National Forum for Biomethane as a Road Transport Fuel. This forum intends to build on the outreach of the Knowledge Transfer Networks to establish a community to promote the use of biomethane as a fuel. One of its key objectives is to persuade government to create a level playing field for renewable natural gas compared to renewable electricity.

At present, a wind turbine operator in Scotland can sell its output for use to provide lighting for a building in central London. However, if a new anaerobic digester is built to make biomethane from domestic organic waste, and then this gas is put into the gas grid, it loses its renewable status. This manifests itself in large numbers of generally low-efficient (35% to 40% being the norm) electricity generation plants at landfill sites and sewage works, where there is often no use for all the waste heat.

The gas and digester industries want biomethane to be given the same status as renewable electricity so that customers can decide what to use it for. If British Gas, for example, wants to sell 'carbon free' natural gas to be used for domestic heating and cooking then it can. If customers want to run a CNG car fuelled at home, direct from the grid with biomethane, then they can. The 'premium' paid for zero carbon homes and zero carbon motoring can be used to fund more anaerobic digester plants, capturing large volumes of methane that would otherwise pass into the atmosphere causing a global warming impact of 21 times that of CO_2.

The vision is for UK consumers to be able to use biomethane to heat their homes and fuel their cars so that, wherever they live, their homes and transport can become zero carbon. They should not have to take out new, efficient condensing boilers to do this. Given that the UK has a comprehensive natural gas grid, it can be used to bring second-generation biofuels to customers, putting the cost in one place (as in Sweden) and leaving the undoubted efficiencies of natural gas at the network (unit cost to move energy) and appliance level. If we did not have a nationwide gas grid this would not make sense, but the UK has invested £30bn on its gas distribution network and so the incremental investment of making 'renewable' biomethane is immaterial. This has to make the most sense for the UK economy and environment.

In Sweden there are a total of 35 anaerobic digester plants (spread over some 20 municipalities) delivering biomethane for use in vehicles. Biomethane is delivered into the NG grid in three locations and then withdrawn for use in vehicles at other locations. At all other biomethane production facilities the gas is delivered via local low-pressure pipelines to biomethane refuelling sites for use in buses, trucks and light duty vehicles. The total Swedish NGV fleet is now approaching 13,000 vehicles, including some 800 city buses and some 300 heavy-duty trucks, passenger cars and vans.

Last year, more than half of all methane used in Swedish vehicles consisted of biomethane (and less than half of natural gas, which is only available in the south-west part of Sweden). All other municipalities, including the capital city of Stockholm, solely rely on biomethane.

Unlike the UK, Sweden does not subsidise electricity generation based on the burning of biogas because of its inherent thermal inefficiency. This means that the biogas producers earn more money when upgrading the gas and supplying pure biomethane for use in vehicles than if just using partially cleaned (sulphur removed) biogas for electricity generation.

Sweden is continuing to invest in new plants for production of pure biomethane, including a large plant (80mn cm/y) for production of bio-methane based upon gasification of forest industry waste, scheduled to be ready in 2011/2012. This represents a second-generation biofuel, moving the industry away from the debate about fuel versus food.

For more information on the conference, visit
www.lowcarbonfuelcellktn.org.uk

Biogas fact file

Biogas, or renewable natural gas, is the name given to the mixture of methane and carbon dioxide (CO_2) gases that is formed whenever organic materials decompose in the absence of air. This process is known as anaerobic digestion and, when it occurs in nature, the gases escape to atmosphere. However, this natural process can be managed in an industrial plant. To make it more efficient, the industrial process requires warmth, air to be excluded, and the organic material is usually prepared before being fed into tanks which allow the gases to be captured and used. Modern industrial processes can make renewable natural gas in a matter of days rather than the thousands of years that were taken to produce natural gas.

Renewable natural gas is by far the most environmentally friendly fuel in the world when compared with other fuels currently available. Capturing the methane which would otherwise be emitted from decomposing organic materials, and preventing this from becoming a greenhouse gas that is 21 times worse than CO_2 in terms of climate change, is actually improving the environment rather than just being 'less bad' by merely replacing fossil fuels with renewable fuels.

Nearly all countries now have a mission to work out schedules for sustainable development, and powering vehicles from fuel made from wastes is a very obvious and direct example.

Manufacturing process

Biogas can be manufactured from just about any organic material. Historically, it has been produced from sewage sludge and animal slurries, but more recently the focus has been on producing gas from energy crops such as grass or maize, and wastes such as those that arise from food manufacturing, brewing, and household rubbish. On average, some 60% of the contents of a household dustbin are organic and can be used to make gas.

The biogas produced by natural processes contains about 65% methane, 35% CO_2 and some trace gases including hydrogen sulphide (HS). This raw biogas is mainly used in stationary engines that generate electricity. At sewage works it is used to power the machinery on site, and at landfill sites it is fed into the national electricity grid.

Biogas as a vehicle fuel

To use biogas as a vehicle fuel the CO_2 needs to be removed so that the methane content is similar to that in natural gas. If the CO_2 is allowed to remain in the biogas mixture the operating range of the vehicle is compromised as CO_2 does not burn. Hydrogen sulphide also needs to be removed as this is corrosive. Treated biogas for automotive applications is referred to as biomethane.

Environmental option

In a report from the Swedish Committee of Alternative Fuel, biogas was acknowledged as the best alternative fuel available today with regards to climate, environment and health – due to its low emissions and no net contribution to the greenhouse effect.