SGBI Opinion Article: Shale Gas

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Government perceives electric vehicles to be a panacea that will solve problems surrounding air quality and CO_2 emissions simultaneously. The EV has two main selling points: reduced CO_2 emissions and high efficiency. However, these are only valid at a superficial level and the argument disintegrates under any level of scrutiny.

In terms of CO_2 emissions, EVs replace 'average' cars to give a lower CO_2 output per km, although the scenario becomes more complex depending on the type of vehicle and fuel used. However, the major drawback of EVs is the initial production of the electricity used to charge the vehicle. In theory, the 'average' UK grid electricity used could be generated in a variety of ways, including renewable or alternative methods. However, the minimum electricity demand in summer night-time is approximately 25 GW but nuclear and wind energy will only produce a maximum output of 14 GW at any one time. This means that the electricity used to charge an EV will actually be generated by burning fossil fuels in coal or gas power stations. Therefore, EVs cannot realistically claim to reduce CO_2 emissions or improve air quality. Furthermore, the range of an EV is designed and limited to short journeys, making the use of a second vehicle necessary to travel greater distances. In contrast, a low emission diesel or petrol hybrid could be used for all journey types and emits just 100g of CO_2 per km.

Concerning efficiency, a gas combined cycle gas turbine (CCGT) generates at around 50 per cent, however if 10 per cent grid losses are assumed this gives a 45 per cent efficiency at the charging point. If the electric motor is about 80 per cent efficient, it gives an overall 36 per cent efficiency at converting fossil energy into the movement of a car. For a diesel car, this overall efficiency is around 25 per cent so an EV appears to be much better. However, there are a number of flaws with this argument. Firstly, if the ambient temperature is low, the EV uses a significant proportion of energy to heat the car: a feature that occurs naturally with diesel vehicles. Taking this into account, the efficiency of the EV drops to 32 per cent and the diesel vehicle increases to 28 per cent. A similar effect occurs in warmer temperatures due to air conditioning and the efficiencies of the EV and diesel vehicle become 31 per cent and 29 per cent, respectively. The other issue affecting efficiency is the vehicle weight. The Nissan Leaf is a very heavy car compared, for example, to the larger VW Passat due to the weight of batteries. Taking this into consideration, the efficiency of the EV is approximately the same as a diesel vehicle.

EVs have been around for 100 years and the new cars show potential. However, as yet EVs are not the best option in terms of CO_2 emissions in the UK. In time, EVs may become more viable but this is dependent on a large nuclear programme, offshore wind and coal/gas with CCS. The chance of this occurring hinges on an increase in the world carbon price to enable the UK to finance these projects. It also depends on natural gas prices, which are significantly linked to the cost of shale gas production.

Previously shale gas has been considered an uneconomic prospect due to difficult and expensive extraction. However, with the development of more reliable fracking techniques and horizontal drilling equipment the problem is no longer in whether the gas can be recovered, but if it can be done at 40p/therm.

If EVs can be discounted as a credible option and there is potential for a large increase in the availability of gas in the UK, the most logical option is for transportation to shift towards natural gas vehicles.

Natural Gas Vehicles (NGVs)

The use of oil in British industry was dramatically reduced in the period of 1970 to 1990 as the UK economy shifted to natural gas from the North Sea reserves. As a result, oil became predominately used for transport fuel.

In the early 1990s, British Gas became world leaders in the development of NGVs. However, the initiative failed due to several reasons. Firstly, the compressed natural gas (CNG) filling stations were located on gas-holder sites where the gas was 'wet' and corroded engines. In addition, the vehicles were conversions of petrol vehicles so were not reliable, had lower equivalent performance, and the CNG storage tanks occupied significant space and reduced payload.

However, overseas BG Group is making investment in relation to NGVs (Brazil, Argentina, India, and Kazakhstan) as the world sees huge growth in NGVs. When British Gas worked on it in 1992 there were around 10,000 vehicles in the world running on natural gas. By 2002 this had grown towards 1 million and by 2012 there is forecast to be 15 million. In the US, National Grid is also involved in the growing NGV market there. This is partly motivated by the political initiative to reduce reliance on oil but the key driver is the low price of natural gas caused by shale gas production. The German Government fixed CNG fuel duty in 2001 at the CEU minimum level (6 p/kg) for 20 years on the basis that the gas industry would build CNG filling stations and the car industry will develop CNG cars, a strategy that has been proved successful.

The key difference in these examples is that the new cars and vans have been designed from first principles to run on CNG. Therefore, the vehicles have none of the drawbacks experienced by British Gas 20 years ago. For example, the VW Passat Ecofuel has a 1.4 litre engine with twin supercharger and turbocharger. It can go 0 to 60 mph in 9.5 seconds but has CO_2/km of less than 120 g/km. It can also run on petrol and has a combined range of around 700 miles.

As of 2002 there were around 20 CNG filling stations operational in the UK but no grid connected public access stations that are capable of 'fast filling' a vehicle. There are estimated to be around 50 vehicles running on CNG and 200 running on natural gas stored on board as LNG (liquid natural gas) with fuel mostly provided at a small number of depot-based filling stations. There is no case for large-scale investment to install CNG at filling stations as although CNG emissions are lower than a normal petrol they are comparable to many diesel and hybrids. Furthermore, there are not believed to be any investors looking at

the UK car market for natural gas and with the development of electric vehicles this situation is unlikely to change. It is therefore reasonable to assume that CNG will not be made available at petrol stations in the UK.

The sector of interest for natural gas is the commercial vehicle sector. There are around 700,000 vans, rigid trucks and tractors operating in the UK and a large proportion of these operate from depots. As such, they are well suited to running on natural gas as the gas grid is invariably close by. The most significant technological development is in relation to the engine and fuel combination.

If air quality is the driver (nitrous oxides and particulates) then having an engine that runs on 100 per cent natural gas gives exceptional performance. This is why most Los Angeles buses (9,000), and all 670 refuse trucks in Madrid run on CNG. CNG is the fuel of choice where air quality is a major issue but whilst air quality is an issue in the UK, the driver for change is now reduction in CO_2.

The development of dual-fuel diesel-natural gas engines in transformational. The vehicle starts on 100 per cent diesel, but after 30 seconds it becomes 80 per cent natural gas, 20 per cent diesel. This gives the advantage of lower CO_2 from burning methane instead of the C9 and C12 chain hydrocarbons found in diesel but without reducing vehicle efficiency. Evidence from Volvo and Mercedes-Benz diesel-natural gas trucks suggests the reduction in CO_2 is around 20 per cent as opposed to 100 per cent for diesel.

Of the three world leaders of dual fuel truck technology, two are based in the UK in Leyland (Clean Air Power, CAP) and Nottingham (Hardstaff). It is encouraging for the UK manufacturing industry that British companies still hold such gravitas, with CAP providing dual fuel technology to the likes of Volvo and Hardstaff to Mercedes Benz. Hardstaff also hold the patents for a revolutionary new system that allows CNG storage to be on the trailer with an umbilical connection to the tractor unit; a system UK logistics company Tenens Environment are already using.

In terms of fuel, there have been 'Well to Wheel' studies that have looked at natural gas they have used data from the 1990's gas industry. The assumption has been that the gas is taken out of the low pressure grid. Firstly, it requires 30 per cent more electricity to drive a compressor using gas at 0.5 bar than if the gas was at 4 bar. Going forward, CNG should be taken out of the grid at pressures from 4 to 50 bar, giving up to a 75 per cent reduction in electricity consumption. Secondly, a substantial part of the gas pipeline grid was developed in the period 1890 to 1930 when towns' gas (made from coal) was the fuel. These pipelines were made from cast iron and have leaking joints, around 0.5 per cent of the gas leaks out of the low pressure tiers. Even though around £1 billion a year is invested replacing these pipelines it will take until 2030 until the grid is substantially leakage free. Hence, if gas it taken for CNG at these low pressures, it was assumed that around 0.5 per cent of it would have leaked out. With the global warming effect of methane around 20 times more efficient than CO_2, this 0.5 per cent

translates to around 10 per cent CO_2. By taking gas out of high-pressure grids (4 bar and above) there is negligible leakage and hence there is a further 10 per cent benefit.

There is also a new advantage of CNG that is aligned with wind generation. It makes sense to run compressors at times when renewable electricity is in surplus. In this way, the CNG will further reduce its carbon footprint. There are also positive developments in relation to the energy footprint of bringing natural gas to the UK. At the Isle of Grain, National Grid uses waste heat from an EON CCGT to warm the LNG and make it into natural gas for injection into the gas grid. This is estimated to give around a 5 per cent CO_2 benefit, which is also significant.

It is important to note that aside from CNG there is also LNG. The Hardstaff and CAP technology uses gas in gaseous form at low pressure. Whether the gas is stored on the truck in compressed form (CNG) or liquid form (LNG) is not important, however the supply chain advantages differ.

The UK now has major LNG importation facilities at Isle of Grain and Milford Haven. It is low cost and technically straightforward to load 20 tonne road tankers with LNG at these facilities by installing an LNG road tanker loading bay (cost around £3 million). If LNG is made in, for example, Qatar, transported by ship to UK, loaded into an LNG road tanker, transported to a depot LNG storage tank, then decanted into the LNG storage on board a truck, there are very low CO_2 emissions in that supply chain. The LNG stored on board uses waste engine heat to become gas again. There would be an estimated 10 per cent saving in CO_2 from this. Therefore, LNG in dual fuel trucks may be able to deliver a 30 per cent reduction in CO_2, with a similar saving for CNG.

In terms of climate change, the reduction from dual fuel trucks is material within that sector and material overall and is worthy of independent analysis. It would be beneficial if The Committee on Climate Change reviewed the data and gave an opinion.

Separately, the reason British Industry switched from oil to gas was that gas cost around half price in energy terms. It is around half price again today so the logic of switching haulage from diesel to (part) gas is a sound one. It is estimated that UK balance of payments would take a hit of around £40 billion a year compared to 2010 as a result of importing oil. If the UK reduces oil imports by 15 per cent as a result of dual fuel then it could save up to £6 billion of oil at a cost of £3 billion gas.

For a 44 tonne truck to run on electricity, it has been estimated that around 50 tonnes of batteries would be required. So there is clearly not going to be a material electricity option for trucks. Additionally, if the shale gas reserves are as extensive as the promoters say, and if they can be developed economically, then the logical response for the UK is to switch haulage to natural gas-diesel dual fuel.

Government

If the manufacturers, vehicles and fuel are in place, the only question that remains is what the Government can do. Government could

ask the Technology Strategy Board to support Hardstaff and CAP in developing their dual-fuel diesel-natural gas technologies. The Government can also support cities like Sheffield that are taking significant steps to move along the LA and Madrid paths by introducing natural gas for refuse trucks and other commercial vehicles as the best way to improve air quality.

Crucially, however, the Government can also support investment in infrastructure and vehicle development by giving a longer period of confidence on natural gas fuel duty, which is currently only fixed relative to diesel for 3 years. The regimes to promote investment in offshore wind or ground source heat pumps or anaerobic digesters rely on a long term guarantee of income support. An equivalent level of confidence in duty level is required if we are to capture the CO_2 reduction prize offered by dual fuel. This will also offer a duty reduction to hauliers who are prepared to invest in the natural gas refuelling infrastructure and vehicles. Once the depot based filling stations are built and depreciated, the Government can look forward to increasing duty on natural gas without it killing the market, but this is 15 years away.

Finally, the Government is preparing to announce the level of the Renewable Heat Incentive which includes the renewable premium paid to biomethane (renewable natural gas made from organic material). If set at an appropriate level this will encourage waste to be converted into biomethane, injected into the gas grid and taken out at existing truck depots. In this way, the dual fuel CNG-diesel development is aligned with the move towards a fossil free economy. National Grid forecast in January 2009, that biomethane could supply around 50% of the gas used by domestic gas consumers. The same resource would supply much more than the 80% of gas required to move haulage to dual fuel.