Just part of the energy mix?

Shale gas could replace some of the UK's oil and gas imports and, as a transition fuel, give the country time to develop the carbon-free fuels of the future, argues **Simon Talbot**

Recent exceptional winter storms, heavy rainfall and flooding are regularly cited as evidence of climate change. In April, the UK experienced one of its worst episodes of smog for many years and there is ever-increasing public concern about the effects of local, national and global pollution and greenhouse gas (GHG) emissions. The dilemma for politicians is how to address this while improving prosperity against the backdrop of a rising world population and increasingly internationalised markets.

The key commodity underpinning every aspect of human endeavour and prosperity is energy. It is such a fundamental factor that it is often overlooked. At best, only fragments of the total energy picture are identified and discussed. It is against this context that UK shale gas has emerged as a major topic for national debate.

The UK energy mix argument pitches renewables, identified as clean, against fossil fuels, identified as causing pollution and climate change. This simplification is unhelpful because the issues are complex. Although the success of its shale gas sector has transformed the US economy, the UK government has expended considerable thought and effort into the question of where shale gas should fit into the energy mix.

Supply and demand

The Department of Energy and Climate Change (DECC) 2012 Energy Flow Chart (see Figure 1) shows the full complexity of the UK energy market. On the left are primary energy inputs, with energy processing, transitions and losses in the middle and final consumption on the right.

The primary sources are coal, oil, gas, nuclear and renewable energy. On the consumption side, by far the largest sector is transport, consuming 36% of the total. This is closely followed by the domestic sector at 29%. The complicating factor is the proportion of primary energy converted into electricity before final consumption. Electric power often dominates the headlines, but it only accounts for 20% of the total energy consumption. Possibly as significant is the fact that a huge 59% of the primary input energy is lost in power stations during conversion to electricity.

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Figure 1 shows that of a total 214 million tonnes of oil equivalent (Mtoe) annual UK energy demand, 73.3 Mtoe of refined petroleum (34% of the total), 73.8 Mtoe of natural gas (34% of the total), and 41.9 Mtoe of coal (20% of the total) are consumed. Nuclear energy at 15.2 Mtoe represents 7% of the total, while renewable hydroelectric, wind farms and bioenergy collectively account for just 10.3 Mtoe, or 5% of the total.

So where could shale gas fit in to the UK energy flow? On the supply side, it could replace some coal and gas imports. In 2012, gas imports amounted to 47 Mtoe, some 55% of all gas supplied; much of it liquid natural gas from Qatar. On the consumption side, shale gas could be fed directly into the national grid for the domestic and industrial sectors. It could be used to replace some petrol and diesel vehicles in the transport sector.

In the global context, the International Energy Agency (IEA) predicts that world annual energy demand will rise from 13 billion tonnes oil equivalent (Btoe) in 2012 to 17 Btoe by 2035. However, after taking into account emerging government policies on climate change, the IEA also predicts that coal, oil and gas will still make up 70% of the world energy mix in 2035.

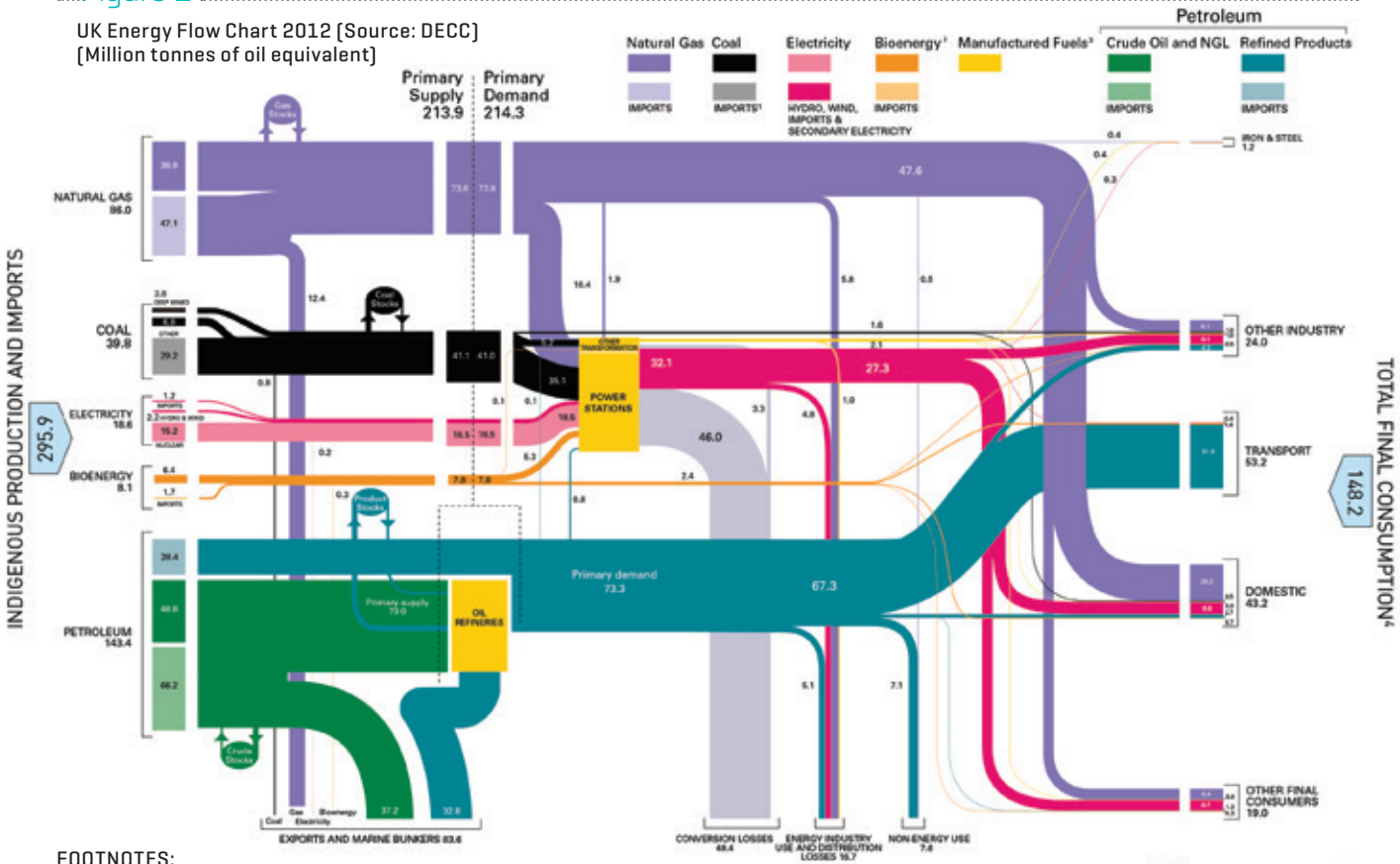
In other words, despite a significant drive to save energy, develop more efficient vehicles and greater home insulation in the developed nations, the growth in population and rising prosperity in the developing nations will result in an overall increase in use of fossil fuels.

Energy security

Energy security is another factor that should be considered in the context of the UK's energy mix. Figure 1 indicates 63.5% of the UK's primary energy supply comes from imports, with most of the UK's oil and gas coming from the Middle East.

Figure 1

UK Energy Flow Chart 2012 (Source: DECC)
(Million tonnes of oil equivalent)



FOOTNOTES:
1. Coal imports include imports of manufactured fuels, which accounted for 0.1 million tonnes of oil equivalent in 2012
2. Bioenergy is renewable energy made from material of recent biologicacl origin derived from plant or animal matter, known as biomass
3. Includes heat sold
4. Includes non-energy use
This flowchart uses the style of balance and figures in the 2013 Digest of UK Energy Statistics, Table 1.1.0.33.8

Department of Energy & Climate Change

Over the past 60 years, energy has been a key geo-political driver with much of European and US foreign policy focused on securing Middle Eastern oil and gas supply. This is now changing. If the US becomes self-sufficient in petroleum, the need to maintain its Fifth Fleet in the Arabian Gulf will be removed. Also, the recent Ukranian crisis and the threat to the Russian gas supply to Europe underlines the vulnerability of current energy supplies. It is not surprising, therefore, that the UK government and other countries are looking to their own natural resources to secure future energy supplies.

Moving to a low carbon economy

Notwithstanding the above, the need to move to a low carbon economy is clearly established by the Intergovernmental Panel on Climate Change (IPPC). In the Fifth Assessment Report, published on 31 March this year, the IPPC stated: "Human influence with the climate system is occurring."

The physical science contribution to the report also states that cumulative emissions of CO_2 will largely determine global mean surface warming by the late 21st century and beyond, and limiting climate change will require substantial and sustained reductions of greenhouse gas emissions.

Meeting this challenge will also involve significant societal adaptation and mitigation, including reduced energy use, improved energy efficiency and a move to cleaner energy sources. In this context, the worst offending fuel is coal, followed by oil, with gas the least damaging fossil fuel. Natural gas is mostly methane (CH_4) and it provides its energy by the combustion of four hydrogen atoms to every carbon atom. This means that it can produce half the CO_2 per unit of energy as coal.

However, CH_4 is 24 times more potent as a GHG than CO_2. Therefore, in addition to switching from coal to gas, it is essential that uncontrolled methane emissions are reduced to as low a level as possible.

Ultimately, government policies influence CO_2 emissions, but here is the rub: governments need to keep their economies globally competitive to maintain standards of living and health. To do that, they need to buy the cheapest fuels they can.

In the US, the shale gas boom has led to very low gas prices. As a consequence, much of the North American electricity production has been switched from coal-fired power stations to gas. In addition, gas is increasingly used in the transport sector and the US Energy Information Agency (EIA) reports that 2,790 million cubic feet of natural gas was used as vehicle fuel in January 2014 (*http://1.usa.gov/1hJ8CVZ*). The combined result is that US CO_2 emissions have been falling over the past eight years (*EIA Monthly Energy Review*, March 2014).

The downside is that the coal that would otherwise have been burnt in the USA has come onto the world market and prices have fallen. The irony is that much of this coal is now being purchased by European companies. In 2013, some 60 million tonnes of US coal was imported into the EU, with the UK being the largest importer (13.5 million tonnes), followed by the Netherlands (12.7 million tonnes), Italy (6.6 million tonnes) and Germany (5.5 million tonnes),

according to the *EIA Quarterly Coal Report* October-December 2013.

Locally produced shale gas could replace coal for electricity generation and be used for powering vehicles, substantially reducing particulate and nitrous oxide air pollution in UK towns and cities and leading to an overall reduction in CO_2 emissions, as seen in the USA.

However, it is equally important to increase renewable electricity, energy efficiency and building insulation. In the medium term, the UK should also develop carbon capture and storage technologies and, in the long term, entirely replace carbon-based fuels for the transport, domestic and industrial sectors. Currently, these technologies do not exist.

Shale gas resources and reserves

The British Geological Survey (BGS) has been working on estimating the UK shale gas resources and in 2013 identified a central estimate figure of 1,329 trillion cubic feet (tcf) of gas-in-place (not to be confused with technically recoverable gas) for the Bowland Hodder shales. The BGS is also working on estimates for southern England and the Midland Valley of Scotland and it is expected that significant shale gas resources will also be identified in these areas.

Onshore petroleum is not new. Over the past 60 years, the UK has drilled around 2,000 conventional wells. Many of these are producing oil and gas, in some cases for decades. Wytch Farm in Dorset was the largest onshore oil field in western Europe, producing 110,000 barrels a day at its peak in 1997. In respect of new onshore exploration, the DECC has let approximately 160 petroleum exploration and development licences (PEDL; see Figure 2). At the time of writing, the government's announcement on the 14th onshore licensing round, in the areas labelled Strategic Environmental Assessment, was imminent.

While the BGS gas-in-place figures are substantial, the more important statistics are the reserves of gas that can be extracted, where there is a distinction between what can be technically and commercially recovered. The EIA estimates that technically recoverable gas represents between 15% and 35% of gas-in-place. Commercially recoverable gas will be significantly less again. To date, Cuadrilla's Preese Hall well in Lancashire is the only one that has been drilled, hydraulically fractured and flow tested. How much commercially available shale gas is present in the UK is currently unknown.

A transition fuel

All the main UK political parties have energy policies that support the development of a shale gas industry, provided it can be done safely. The benefits of security of supply, improving the national balance of payments, creating local jobs and reducing air pollution and CO_2 emissions all count in its favour.

The questions are: can shale gas be exploited commercially, and can it be done safely in an environmentally responsible manner? The answer to the first will not be known until many more exploration wells are drilled and tested. The answer to the second is 'yes'. While environmental monitoring may not have been carried out to modern standards on the 2,000 onshore petroleum wells drilled in the past, no significant pollution incidents have been reported.

A good example of a well-managed onshore oil field is Wytch Farm, which is located in a world heritage site and several sites of special scientific interest, areas of outstanding natural beauty and nature reserves.

Three elements ensure that the UK onshore operations are safe: operators are required to work to best practice, the industry is regulated under the tightest system in the world and operations are subject to independent environmental monitoring.

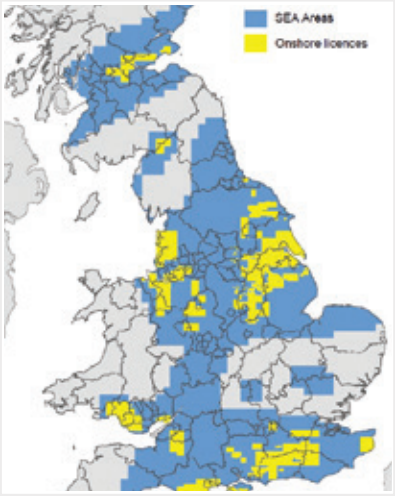
Ground-Gas Solutions has been at the forefront of developing independent continuous environmental monitoring systems for the emerging shale gas sector. Its services provide information that exceed regulatory requirements, giving confidence to the local communities that operator's environmental management systems are working effectively.

In respect of energy costs, the greater the proportion of UK sourced energy, the less the impact of world energy price fluctuations. As a transition fuel, shale gas could give the country the time needed to develop the carbon-free fuels of the future.

Conversely, if shale gas is left in the ground, the UK will remain heavily reliant on fossil fuel imports from other countries. Significantly, these may be from countries with weak environmental regulation and control. In terms of climate change, it does not matter where the greenhouse gas emissions occur. The earth has only one atmosphere.

Figure 2

Current PEDL area and consultation area for the 14th Licencing Round (Source: DECC)



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