Consider Fracking Your Backyard

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Fracking or hydraulic fracture stimulation is a very recognisable, very divisive topic. It is common to have a strong opinion about fracking, be it for or against. "Fracking. No. Not in my backyard." Indeed, for most, fracking is something for others to solve. But while we empathise with the impact of such industrial development, we seldom suggest fracking in our backyard.

The North Sea dominates the United Kingdom's (UK) energy supply. However, with North Sea oil and gas fields in decline, controversial fracking technology may be the best option to fill the gap in domestic energy demand. Exploration sites earmarked for hydraulic fracture stimulation are in relatively rural areas of the North West, Yorkshire and East Midlands, but shale oil and gas development should be considered in more urban areas. London and the South East overlie the prospective Weald and Wessex sedimentary basins and development here would be close to consumers in an area with a strong history of monitoring, industrial brownfields sites and existing road and power infrastructure. Perhaps it is time to consider fracking in our London backyard.

The UK remains the second largest producer of petroleum liquids in European OECD countries, with almost all the UK's oil and gas production from offshore fields in the North Sea. The declining production of these fields has led the UK to become a net importer of natural gas in 2004, crude oil in 2005 and all petroleum products by 2013. While the use of renewables increased to almost 20% of all electricity generated in 2016, petroleum and natural gas still make up 76% of total primary energy consumption, with natural gas providing 46% of electricity generation. The UK consumes approximately 2.5 trillion cubic feet (TCF) of natural gas a year and natural gas imports currently supply 40% of this domestic demand [1].

The UK principally imports crude oil from Norway with the balance from West Africa, the Middle East, Russia and North America. Crude oil can be transported in tankers or pipelines, however, while natural gas can also be transported in pipelines, tanker shipping requires conversion to liquefied natural gas (LNG) and then regasification at the destination. The UK gas grid is connected to mainland Europe through two major pipelines and via pipelines from the Norwegian sector of the North Sea. In 2016, 77% of imported gas came through these pipelines, principally from Norway [1]. However, Europe faces similar issues of production decline and Russian imports are increasingly part of the energy mix of continental Europe [2]. Imports of LNG ceased in the UK during the 1980s following development of the North Sea but resumed in 2005; the import amount now varies in response to global market conditions. For example, LNG imports significantly decreased following the 2011 Fukushima disaster as demand for LNG in Japan tightened the global market [1]. Companies such as Centrica are trying to

secure gas supply through long term LNG import contracts [3], while National Grid and Ineos already import shale gas converted to LNG from North America [4,5].

The development of shale oil and gas in the UK could make a significant contribution to meeting the increasing domestic energy shortfall and help secure gas supplies as the North Sea declines. At present, the UK has no shale oil and gas developments and only limited shale oil and gas exploration has been attempted. Without significant exploration effort, the estimated volumes are very uncertain, however, suggested recoverable shale gas could be 5-40 TCF [6].

Exploration and development of shale oil and gas, and other unconventionals such as tight gas, coalbed methane, mine vent gas and gas storage come under the *Petroleum Act 1998* and onshore licensing in the form of a UK Petroleum Exploration and Development Licence (PEDL). The statutory regulations to allow drilling and well testing within a PEDL involves several government regulators. These regulators vary according to the jurisdictions of England, Scotland and Wales. Shale gas exploration came to a sudden halt in the UK following fracture stimulation of the Preece Hall site near Blackpool in 2011 [7]. Two minor earthquakes are thought to have been triggered during the operations [8]. Following this incident the UK government imposed a moratorium on hydraulic fracturing, but lifted it a year later following the review of scientific and engineering evidence by the Royal Society and Royal Academy of Engineering [9]. The review introduced new requirements and oversight for fracking operations [6] and additional regulation around hydraulic fracture stimulation was enacted in the *Infrastructure Act 2015*. These requirements mean fracture stimulation operations need to adhere to the traffic light seismic monitoring system. This system is designed to mitigate the risk of seismic activity and operators are required to monitor seismic activity in real time around the hydraulic fracture site using a Richter scale rating. Depending on the measured response they will continue (green), monitor (amber) or stop (red) [10].

In addition to induced seismicity, shale oil and gas development in the UK raises concerns around water contamination and handling. The Energy and Climate Change Select Committee's report on shale gas concluded that hydraulic fracturing itself does not pose a direct risk to water aquifers, provided that the well casing is intact [11]. Current regulation should ensure well integrity; however, there is criticism of how robustly this legislation can be enforced [6]. Baseline monitoring of air, land and water is critical and while the *Infrastructure Act 2015* requires 12 months of methane monitoring in groundwater prior to fracture stimulation and air quality monitoring following stimulation – a longer history of monitoring is desirable. A key recommendation of the Royal Society and Royal Academy of Engineering report was to carry out comprehensive baseline surveys [9]. Air quality can show seasonal variation, weekend variation due to road traffic and there can be episodes of winter or summer smog from Europe [12]. It will be important to distinguish these 'normal' levels from shale oil and gas activities and this will require a record of levels before stimulation. The British Geological Survey (BGS) is currently undertaking a National Baseline Methane Survey in groundwaters across the UK. Findings from this survey show that where sites were sampled a number of times variations were generally minor but some areas show larger changes [13]. Without greater understanding of this variation, it is not clear if the mandatory 12 month monitoring will adequately capture longer term baseline variation in groundwater methane concentrations.

The surface disturbance and surface footprint of shale oil and gas is important,

particularly as shale gas developments require the drilling of many wells. A major issue with regard to surface impacts is that areas of land and wildlife habitat can become fragmented. Land often needs to be cleared to allow access to the well site including construction of roads and pipelines [14]. This can change the look of the land and have implications for local wildlife populations which may need to be mitigated. The initial drilling and hydraulic fracturing process requires construction of a wellpad: a flat 2–3 hectare area. A drilling rig and equipment is then mobilised onsite to drill the well and carry out the hydraulic fracturing operation. During this stage there is often heavy vehicle traffic to the site and noise from the 24 hour operations. Following this stage, the site consists of a wellhead, perhaps with additional production equipment. The area of the wellpad may periodically be used again during workovers or restimulation. When the well is no longer economically viable, cement plugs are installed, and the land above can be reused [15, 16]. This plugging and abandonment of wells is commonplace in the UK for conventional oil and gas and is no different for shale oil and gas wells. However there are no precedents for large scale decommissioning of shale oil and gas fields. The technology behind shale oil and gas was only developed and implemented in the late 1990s and fields from this era are still producing [6]. While current regulations appear adequate, it will be important to follow the progress of these first shale oil and gas fields and regulation may need to be revisited based on their decommissioning experience.

No shale oil and gas fracture stimulation has been completed in the UK since the Preece Hall site in 2011. Now, in 2018, four companies are proposing to fracture stimulate wells in the North West, Yorkshire and East Midlands [17]. These proposed sites for future fracture stimulation are in rural areas; however, shale gas exploration and development can take place in urban areas. For example, shale gas wells have been drilled across the Dallas–Fort Worth–Arlington metropolitan area in North Texas, USA. Almost 2000 producing wells are located within the city limits of Fort Worth which is home to over 800,000 people [18]. Drilling in populated areas has also occurred in the UK; conventional oilfields underlie the villages of Gainsborough (the wells are on the golf course) and Wareham [7].

Urban exploration and development in London and the South East could investigate the shale oil and gas prospectivity of the Wessex and Weald Basins. These Basins already have a history of conventional (non-shale) oil and gas exploration and there are 13 producing fields within the Weald Basin alone. The source of the oil in these fields is from Jurassic aged shales; the Lias formation made famous by the Black Ven mudslides and fossils at Lyme Regis and the Kimmeridge Clay which seeps oil from the cliffs around Kimmeridge Bay. These formations would be the target for shale oil and gas exploration. It is not entirely clear how far these rocks extend beneath the surface but it is predicted that they go north as far as Croydon [7].

Shale oil and gas in London and the South East may be a better alternative than development in more rural areas. The energy is produced closer to the consumers, infrastructure is already present, and there is already a strong history of environmental monitoring within the city (for example, square mile air quality monitoring [12] and sampling and associated studies of methane in groundwater prior to the National Baseline Methane Survey [13]). The *Town and County Planning Register Act 2017* requires local authorities to prepare and maintain registers of brownfield (previously developed) land that is suitable for residential development. Croydon Borough lists 12 sites over 2 hectares and the 2012 National Land Use Database of Previously Developed Land also listed several locations south of London

over 2 hectares including old brickworks. These and other similar sites might be suitable for activities such shale gas development particularly locations such as old gas works, sewage works or brickworks. Redevelopment of these sites is often complicated by possible contamination and costly clean-up may be needed before any sort of reuse. This could be an opportunity for developing government incentives to link shale oil and gas development with clean-up of these types of brownfields sites.

While regulation is critical in the development of shale oil and gas in the UK, the current major roadblock is public opinion [6]. It will be important to educate and consult the wider community on choices within the greater energy landscape. In the absence of more creative solutions, the UK has three main alternatives. We can look to Europe, and increasingly Russia, for our domestic gas supplies. Alternatively, we can secure LNG imports; which requires additional energy input for liquification, regasification and transport and almost certainly will include shale gas. Our third option would be to develop our own domestic shale oil and gas. While the UK has an informed regulatory framework, any development will involve significant construction of surface infrastructure and needs to have extensive baseline monitoring of the land. These concerns would be eased if developments were in the more urban areas of London and the South East. Developments would be close to consumers in an area with industrial brownfields sites, existing infrastructure and a history of monitoring.

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