Future UK Gas Security: Midstream Infrastructure

Michael Bradshaw[1],
Professor of Global Energy,
Warwick Business School

About the UK Gas Security Forum

This briefing reports the findings of the second UK Gas Security Forum, which brought together a range of stakeholders from government, business, think-tanks and academia to consider the impact of Brexit on the UK gas industry. The aim of the Forum is to inform the Brexit negotiations and the formulation of a Post-Brexit UK Gas Security Strategy. The Forum builds on previous research funded by UKERC on: *The UK's Global Gas Challenge* (Bradshaw et al. 2014) and *The Future role of natural gas in the UK* (McGlade et al. 2016). The approach adopted combines a supply chain analysis of energy security with a whole system approach, that places gas security within the wider context of the decarbonisation of the UK energy system. It is assumed that a future UK gas strategy must deliver secure, affordable and sustainable energy services to end users.

A Supply Chain Approach to Gas Security

The literature on energy security has tended to be overly focused on upstream security of supply—which was the focus of the first briefing (Bradshaw 2017). A supply chain approach was adopted in our previous research to provide a more holistic analysis of gas security, as well as a link to wider energy system issues. The aim of the Forum is to aid in the updating of our earlier analysis which was aimed at assessing the challenges and opportunities further complicated by Brexit, as well as the requirements for a post-Brexit UK Gas Security Strategy.

The first Forum meeting focused on Upstream Security of Supply, the second considered critical infrastructures in the Midstream, and third focused on the Downstream and future security of demand. A daylong conference, in February 2018, will consider the impact of Brexit and the key challenges that should be addressed in a future UK Gas Security Strategy (a final report will be published soon after).

Midstream Security Challenges

This briefing considers the critical infrastructures—both hard and soft—that are necessary to link gas suppliers to end users. The hard infrastructures include: the gas pipeline systems (both offshore and onshore), the three LNG terminals, the various gas storage facilities and the three interconnectors (two to Continental Europe and one to Ireland). The soft infrastructures include: the National Balancing Point (NBP)—the virtual trading hub for the sale, purchase and exchange of natural gas in the UK—and the gas governance infrastructure that includes the UK regulator (Ofgem) and the EU organisations (ACER, CEER and ENTSOG) that regulate and enable the UK's participation in the internal energy market. In many ways, this is the most complex, least studied and most important element of the UK's gas supply chain. This briefing describes the various elements of the Midstream, assesses their current status, considers the potential impact of Brexit, and, the challenges they pose in relation to future UK gas security.

The key challenge that the Midstream has to manage is the strong seasonality of UK gas demand, which is driven largely by winter demand for domestic heating. However, in recent years the growth of low-carbon generation (wind and solar) has introduced the additional complexity of intermittency, which is resulting in swings in gas demand on a much shorter time-frame. This is a challenge that is only going to increase in the future as coal-fired generation closes (by 2025) and intermittent low-carbon generation continues to grow.

Figure 1 demonstrates the roles played by the different elements of the Midstream in meeting UK gas demand. As explained in the first briefing, the system is underpinned by domestic production from the UKCS and from the NCS, both supplied by offshore pipelines. A combination of storage, LNG terminals and interconnection supplies the balance and provides most of the short-term flexibility.

1 Michael.Bradshaw@wbs.ac.uk

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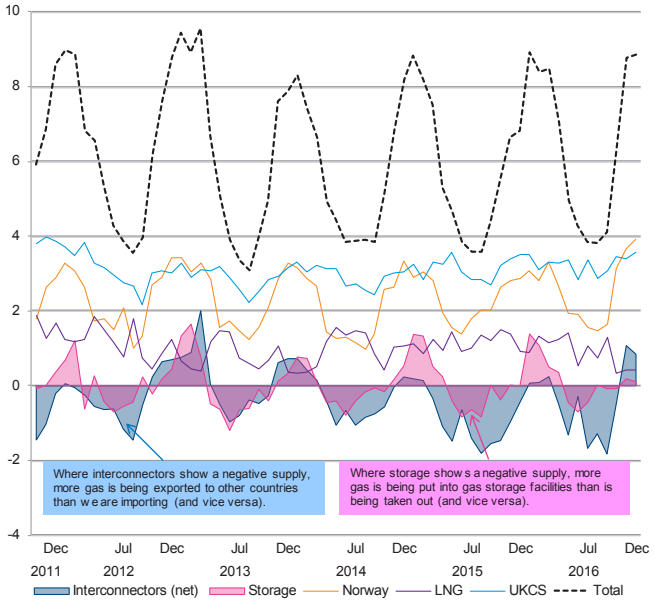

Figure 1: Monthly GB gas supply 2011 to 2016 (billion cubic metres) (Source: National Grid 2017a, based on BEIS Energy Trends data)

Pipelines

The UK's pipeline infrastructure can be divided into three elements: first, the pipelines that bring gas onshore from producing fields in the UKCS and NCS (what National Grid calls beach supplies); second, the pipelines that move gas around the UK—the 7,600 km of the high pressure National Transmission System (NTS); and third, the 280,000 km of high, medium and low-pressure pipes that comprise the Gas Distribution Network (GDN). The interconnectors are dealt with later, once LNG and storage have been discussed.

It is noteworthy that the UK Government's assessment of gas security only focuses on those elements of the infrastructure that deliver imports. Thus, the UKCS and the onshore pipelines are not considered. However, the recent problems with the INEOS-owned Forties pipeline (previously owned by BP) serves to highlight the importance of the integrity of the domestic pipeline system to UK gas security. On 11th December 2017 the pipeline system was shut-down following the discovery of a small hairline crack in the pipeline at Red Moss near Netherley, south of Aberdeen. The pipeline carries almost 40 per cent of UK North Sea oil and gas production. The shutdown impacted on the Brent Crude oil price and the NBP, both showing short-term peaks. INEOS announced that the pipeline was back in operation on 30th December 2017. However, there was another short disruption on 7th February 2018. It is also worth noting that some production from the NCS is reliant upon access to pipelines on the UKCS.

These episodes suggest that any assessment of UK gas security must consider the integrity and future resilience of the domestic pipeline system (both onshore and offshore). The Wood Review (2014, 44) recommended: "...the Regulator [now the Oil & Gas Authority] to identify critical infrastructure, monitor its capacity, track current throughput and potential volumes within its catchment area, and be cognisant of the commercial drivers needed to sustain such infrastructure." The latter point is particularly important as all the midstream is in private ownership and falling levels of both domestic production and demand could threaten its future commercial viability.

Onshore the NTS and associated GDN are a significant asset. According to a study by the then DECC (2014,6), between 2000 and 2014 around £300 million was invested to ensure the safety and reliability of the NTS, supporting around 4,000 jobs a year and over the same period £3.8 billion was invested in the GDN, supporting 11,500 jobs. These figures highlight the significant investment required to maintain the system. The same DECC report identified three challenges for the networks: 1. Increasing imports as domestic resources decline; 2. Increasing variability for gas with renewable generation; and 3. An aging structure, that is less safe and reliant. The NTS, that distributes gas directly to the GDNs, larger power stations and industrial users is owned and operated by National Grid as the system operator (TSO), while the GDN is divided between four companies: Cadent Gas Ltd.; Northern Gas Networks Ltd; Wales and West Utilities; and SGN.

Because the gas network and distribution systems operate as national and regional monopolies they are regulated by Ofgem, which in turn must follow EU regulations (Network Codes) in relation to gas market operations. This begs the question, what will be the nature of the regulatory system that governs the UK's gas networks post Brexit? On day one after Brexit the UK system will still be 100% compliant with the EU regulations, but thereafter the degree of 'regulatory alignment' will depend on the nature of the UK's relationship with the EU's single energy market and its underlying regulations and institutions (more on this below). The current uncertainty around future regulations presents a major challenge to both Ofgem and the companies that own the UK's pipeline assets.

LNG Import Terminals

In the early 2000s, in anticipation of the decline in production from the UKCS, the private sector built three LNG terminals, plus the much smaller 'GasPort' facility on Teeside that was the world's first dockside floating regasification facility (it ceased operation in 2015 but may soon return to operation under new ownership). The first terminal to start was the Isle of Grain on the River Medway Estuary in Kent, which opened in 2005 and is owned by National Grid. It now has an annual send-out capacity of 19.5 bcm a year and a maximum flow rate of 56 million m3 a day. In 2009, two further terminals opened at Milford Haven in Wales. The South Hook Terminal, which is owned by Qatar Petroleum International (67.5%), Exxon-Mobil (24.15%) and Total (8.35%) and has an annual send-out capacity of 21 bcm a year and a maximum flow rate of 58 million m3 a day. The Dragon LNG terminal is currently owned by Petronas (50%) and Shell (50%) and has a send-out capacity of 7.6 bcm a year and a maximum flow rate of 21 million m3 a day.

Each of the terminals operates on a different business model. National Grid owns the Grain Terminal, but it does not buy or sell LNG, rather it has sold terminal capacity to a number of companies on a take or pay basis on long-term contracts. This means that until the mid-to-late-2020s their investment has a guaranteed income stream regardless of whether or not LNG is delivered. The terminal capacity holders also have the option to sell their capacity to third parties. South Hook, by comparison, is

part of an integrated LNG supply chain that delivers Qatari LNG to the UK. The terminal is run by the South Hook LNG Terminal Company and the LNG is supplied from the Qatar II Project at Ras Laffan, but it is marketed by ExxonMobil Gas Marketing Europe. Whether or not cargoes are sent to the UK is determined by Qatar Petroleum's optimisation team back in Doha and the decision is subject to global considerations and the desire to maximise total income to the Qatari State. Dragon LNG is a standalone business jointly financed by two industry shareholders, Shell and Petronas. Shell only recently acquired its share as a result of the purchase of BG. Again, the operations at the terminal reflect the corporate strategies and interests of the owners. The key point here is that whether or not there is LNG in the various terminals and whether or not that LNG is released onto the market is determined by a complex network of companies all with their own business interests.

As we saw in the briefing on upstream security of supply, LNG supply to the UK is highly variable and difficult to predict. At present, it is counter-cyclical with more deliveries in the summer. It is also the case that even when the market conditions in the UK suggest that gas should flow from the terminals, it often fails to do so because of specific corporate considerations. Finally, the ability to flow LNG to Europe via IUK is a vital consideration for terminal and capacity owners.

The total send-out capacity of the three LNG terminals is 48.1 bcm a year, which is significant when you consider that total gas consumption in the UK in 2016 was 76.7 bcm. However, according to BP (2017), total LNG imports into the UK in 2016 were only 10.5 bcm, which is only 21.8% of total terminal send-out capacity and 13.7% of total UK gas consumption. Thus, the LNG terminals are significantly underutilised. This has important implications for the assessment of UK gas security as BEIS and Ofgem use the terminal capacity and maximum flow rates in their security assessments. This is problematic as the LNG terminals have to retain cushion gas for technical reasons and they are often at 25% of capacity, thus the amount of gas available to address a medium to long-term gas emergency is probably far less than assumed. Furthermore, the maximum flow of the Milford Haven terminals is determined by the capacity of the South Wales Gas Pipeline (Felindre) that moves LNG from Milford Haven into the Midlands. Equally, maximum flows from the Grain terminal might be constrained by congestion on the NTS if the interconnectors were also looking to flow at maximum rates. This highlights the close interrelationship between the integrity of the NTS and the ability to import natural gas. A final consideration is the response time of LNG to a UK gas security emergency. It takes 2 weeks for an LNG carrier to reach the UK from Qatar, thus, short term emergencies must be addressed by the gas that is in the tanks or by redirecting nearby LNG cargoes towards the UK by offering a higher price, which has happened in the past.

Late last year, the aforementioned problems with the Forties pipeline happened at the same time as an explosion at the Baumgarten gas facility in Austria, technical problems with the Norwegian Troll field and flow constraints imposed by the System Operator on the UK interconnectors. This is the kind of 'perfect storm' that is the stuff of gas security assessments and it challenged the ability of the NTS to move gas to consumers, triggering demand reduction responses. The media got particularly excited when it seemed that the first LNG cargo to leave Russia's Novatek Yamal LNG project above the Arctic Circle in West Siberia, which is subject to western sanctions, might come to the rescue. The Christophe de Margerie did dock at the Grain LNG terminal to offload its cargo, but it was purchased by the French Company Engie and its LNG tanker Gasleys that first headed for Spain, and then the east coast of the US, where it eventually offloaded its cargo at the Everett terminal in the Boston area. The globe-trotting of this LNG cargo simply serves to highlight the interconnected nature of the LNG market where traders chase the highest price. This suggests that if there was a prolonged gas security emergency in the UK, customers might have to pay emergency prices to attract LNG, much like Japan had to post-Fukushima.

Gas Storage

If increased reliance on LNG is not a solution, then the UK is not helped by the fact that compared to most large gas consuming countries available storage capacity is considerably lower. Until recently, total storage in the UK covered 6% of annual demand compared to Germany, France and Italy where it covers about 20% of annual demand. This low coverage was for historical reasons as it was previously possible for the UK to surge production from the UKCS to provide flexibility. This flexibility is now long gone, although some flexibility remains in the NCS. The traditional business model for long-range storage relies on there being a spread in the price between summer (low) and winter (high) prices enabling storage facilities to fill in the summer and sell in the winter. The problem is that the summer-winter differential is no longer sufficient to support investment in new long-range storage capacity. The summer-winter differential at the NBP has fallen significantly in recent years (Ofgem 2018). Over the years there has been considerable debate as to whether the UK Government should incentivise new storage, but the current position is to leave it to the market. The net result being that very little new storage capacity has been built.

Historically, the UK's storage capacity has been comprised of one large, long-range storage facility, the depleted gas field of Rough (offshore the Yorkshire coast) and eight medium-range storage facilities (that are mainly onshore salt caverns). The total capacity was 4.5 bcm (5.9% of total consumption in 2016) and the maximum output from storage has been 162 mcm/d. However, in June 2017, following: "an assessment of both the economics of seasonal storage today, and the costs of refurbishment or rebuilding the facility and replacing the wells", Rough's owners, Centrica Storage, announced that they would be closing the facility. The facility is no longer receiving gas and is recovering the remaining cushion gas. When fully operational, the Rough facility was able to supply the NTS for 90 days and was an important source of additional gas in the winter months. Without Rough, the UK only has 1.4 bcm of storage capacity (1.8% of 2016 consumption) with a maximum output of 117 mcm/d. The medium-range storage facilities offer a different service to the system and run on a different business model as they will empty and re-fill many times in a winter period to exploit short-term volatility, providing flexibility. But daily price volatility has

also fallen, thereby undermining the case for investment in new medium-range capacity.

National Grid (2017b) reports that in the winter of 2016/17 storage only supplied 6% of gas demand and the average daily flow was 5 mcm/d, with a maximum of 23 mc/d, which was half that of the previous year. However, National Grid (2017b, 50) also notes that there is no precedent for the low level of gas that will be available from Rough in the 2017/18 winter. It is too early to tell what the long-term consequences of the loss of Rough will be, but for the moment the market must rely on other sources of flexible supply, which is principally the two interconnectors that can access surplus storage capacity in continental Europe.

The Interconnectors

The NTS is connected to three interconnectors, two of which—IUK and BBL—connect to continental Europe. The third pipeline—the Moffat Interconnector—links the NTS to the Isle of Man, Northern Ireland and the Republic of Ireland. This brief focuses on IUK and BBL, but the issue of the island of Ireland is discussed in a future report.

The IUK dates back to the early 1990s, a time when the UK had plentiful supplies of gas from the UKCS and was looking at ways to monetise that gas. In 1994, an independent UK-based company, Interconnector UK Limited, was created to finance, build and operate the pipeline. It began operations in 1998 and provides physical bi-directional flow that links the UK and Belgian markets via a 235-km pipeline that runs from Bacton to Zeebrugge. It has a capacity of 20 bcma in GB export mode and its initial GB import capacity was 8.5 bcma, which has since been expanded to 25.5 bcma. The project was innovative as it linked two gas markets and operated on a merchant licence allowing it to set the prices (in Sterling) for services provided, which differs from most pipelines that operate on the basis of a regulated price. However, to mitigate risk, both interconnectors have historically operated with long-term contracts that provide a guaranteed income. Over time, the ownership structure has changed and today the Belgium TSO Fluxys is the dominant shareholder in IUK.

The BBL pipeline was built in 2006, after the UK market had become a net importer of gas, and it provides a connection between the Dutch TTF market and the NBP. The BBL Company operates a 235-km pipeline that links Balgzand in the Netherlands with Bacton. The company was formed in 2004 and the majority shareholder is the Dutch Company Gasunie. It is a Dutch Company with offices in Groningen and operates in Euros. For the time being, BBL only provides physical services to import gas into the UK and has a capacity of 15.7 bcma. The BBL pipeline has the advantage of connecting to the TTF market that is far more liquid that the Belgian Zeebrugge (ZEE) trading hub (Heather and Petrovich 2017).

But both pipelines are being challenged by market trends, augmented by EU reforms, that are bringing to an end their ability to rely on long-term contracts. The future market will involve these merchant interconnectors having to rely much more on unpredictable and volatile short term capacity revenue. The BBL pipeline now faces additional complications posed by problems at the Groningen field in the Netherlands where the Dutch Government has told producers that, due to seismic issues, production must stop within four years. The UK does not import Groningen gas, but the Dutch market will have to compensate for this loss of production, which might impact on the operation of BBL. A further problem for the interconnector business model is that the convergence of gas prices across NWE hubs, something that is aided by the presence of the interconnectors, is reducing price volatility and the spread between markets, resulting in a loss of the arbitrage opportunities that are an essential source of income for the shippers who pay for interconnector access.

The regulation and economics of the interconnectors is a complex matter that cannot be dealt with in detail here, but it is sufficient to note that even without Brexit, a combination of restrictive regulations and market conditions are challenging the fundamentals of the business model. Brexit adds yet another layer of complexity as the two interconnectors currently link two market areas within the single European Gas market. Post-Brexit that status will change. The owners of BBL have reacted by extending the TTF market area to Bacton, making clear its status as a Dutch asset that links to the UK. The IUK is a registered UK company and is hopeful that Brexit might allow the UK Government to introduce regulations that are more supportive of its merchant status. In written evidence to a recent House of Lords enquiry into Brexit and Energy Security IUK warned that given the current regulatory framework: "... IUK's future economic viability cannot be taken for granted and partial or full closure is an option." In the context of reduced domestic storage, and given the current limited role played by LNG, the future of both interconnectors is a crucial matter for UK security and the Brexit negotiations.

National Balancing Point (NBP)

The UK has a privatised and liberalised gas market that relies on gas-on-gas competition to link suppliers and consumers to discover a daily gas price, in pence per therm, which is known as the National Balancing Point or NBP. The NBP originated in the 1990s and is the longest standing, most developed, and until recently, the most liquid gas hub in Europe. Because

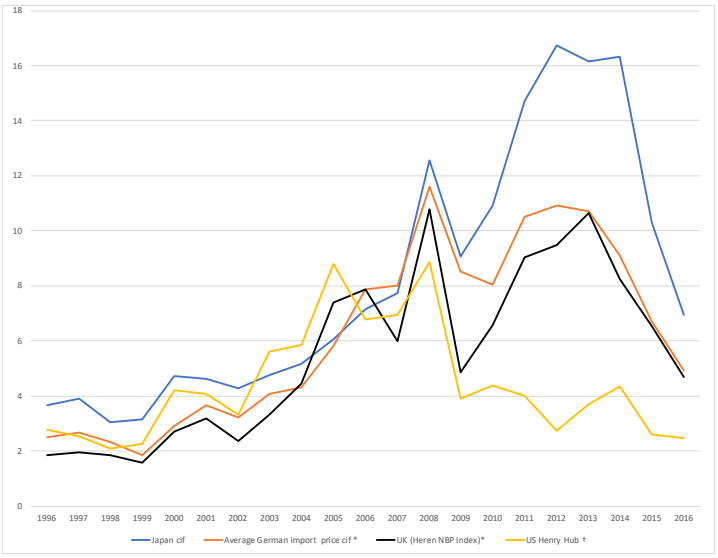

Figure 2: Natural Gas Prices ($ mmbu)
Source: BP 2017.

of its history and liquidity the NBP has also served as a benchmark price for European gas. Figure 2 shows the relationship between NBP and other benchmarks. It shows the great divergence in prices that occurred after the Fukushima disaster and as a consequence of the shale gas revolution in North America. These two factors resulted in a very high oil-indexed LNG price in Japan and a very low domestic price in the US. The NBP and German prices were somewhere between, with the German price reflecting the influence of oil-indexed Russian gas supplied on long-term contracts. However, partly in response to the actions of the European Commission against Gazprom, more and more European gas is traded across hubs, which, as noted above is resulting in convergence.

	ACER	CEER	ENTSOG
EU Member State (e.g. France)	Membership possible	Membership possible	Membership possible
EEA (e.g. Norway)	Associate membership theoretically possible with EU agreement*	Membership possible	Associate membership possible with EU agreement*
Energy Community (e.g. Ukraine)	Associate membership theoretically possible with EU agreement*	Associate membership possible **	Associate membership possible with EU agreement*
Bilateral Treaty (e.g. Switzerland)	Associate membership theoretically possible with EU agreement*	Associate membership possible **	Associate membership possible with EU agreement*
WTO (e.g. Morocco)	Associate membership theoretically possible with EU agreement*	Associate membership possible **	Associate membership possible with EU agreement*

Table 1: Participation in EU regulatory bodies
Source: DG for Internal Policies (2017, 51)

The resilience of the NBP is crucial for the UK's gas security. The latest BEIS/Ofgem (2017,3) *Statutory Security of Supply Report 2017* states at the onset: "Retaining a well-functioning competitive and resilient energy system after leaving the EU is a priority." It then goes on to state: "The UK is seeking a deep and special future partnership with the EU on energy. A well-functioning energy market is of vital importance for the European economy and the well-being of citizens. The UK will work to ensure that our future relationship is successful at ensuring efficiency of trade." A recent analysis by Heather and Petrovich (2017) affirms the maturity of NBP as a gas hub, but recently it has been surpassed by TTF as Europe's most liquid hub. The TTF price, which is denominated in Euros, is now seen as the European benchmark. Should a hard Brexit result in increased friction of trade between the UK and EU gas markets, this may further erode the status of NBP. Bros (2017) has suggested that NBP may need to trade at a premium to attract gas imports. This might mean that UK consumers have to pay more for their gas than at present, a conclusion supported by the recent House of Lords (2018) Report, but so would consumers in Ireland. A higher NBP price would certainly make the UK a more attractive destination for LNG deliveries to supply the domestic market. It would also stimulate imports via IUK and BBL, but it could undermine the export business of IUK. Thus, much depends on the nature of future market relations between the UK and continental Europe.

Future Gas Governance

The EU's gas market strategy is largely based on the UK's experience and UK stakeholders have been influential in shaping and maintaining the current emphasis on creating a fully-functioning Internal Energy Market (IEM) for electricity and gas. However, membership of that market is linked to EU' Customs Union and the jurisdiction of the European Court of Justice (ECJ). The current position of UK's Conservative Government suggests that post-Brexit the UK will not be part of the Customs Union and will not be subject to the ECJ, and this suggests that it cannot be part of the IEM. Furthermore, the claim that Brexit is about reclaiming sovereignty suggests that the UK will have its own set of gas market regulations. This raises questions about future gas governance that have serious implications for Ogfem, as the regulator, and for the owners of gas infrastructure.

At present, Ofgem is a member of the Agency for the Cooperation of Energy Regulators (ACER) that was created by the Third Energy Package to further the progress of the single energy market. It ensures that market integration and the harmonisation of regulatory frameworks are achieved within the framework of the EU's energy policy objectives. The second institution is the Council of European Energy Regulators (CEER) that is a private association of European regulators which seeks to promote the interests of national regulators. The third institution is the European Network of Transmission System Operators for Gas (ENTSOG) whose role is to facilitate and enhance cooperation between national gas transmission system operators (TSOs) across Europe in order to ensure the development of a pan-European transmission system in line with European Union energy goals. At present, the UK members of ENTSOG are: Gas Networks Ireland (UK Limited), Interconnector UK, National Grid and Premier Transmission Limited (Northern Ireland). The BBL Company is a Dutch member and Norway has observer status. The role of ENTSOG is to develop the network codes that set out the rules for gas market integration and system operation and development, covering subjects such as capacity allocation, network connection and operational security. Thus, membership of both ACER and ENTSOG is critical in terms of shaping how the single gas market operates and evolves. The key question is what will happen to the status of the UK regulator and asset owners post-Brexit? Table 1 lays out the different ways in which countries can participate in EU regulatory bodies.

The UK Government's current negotiating position that it will not remain part of the EU's Customs Union or re-join the EFTA, but will seek a new trading relationship, creates significant uncertainty in terms of its ability to influence the future development of the IEM. A reading of Table 1 suggests that it would require an unprecedented level of agreement on the part of the EU to grant the UK anything other than observer status. Thus, the best that

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the UK can hope for is 'access without influence,' being a 'rule taker', rather than a 'rule maker.' The UK has been a strong influence in favour of market liberalisation, but it is possible that without that influence future EU energy policy may move away from market based solutions. The introduction of the notion of 'energy solidarity' is evidence of such a trend. The EU's position is that Brexit does not present a threat to the remaining Member States' energy security, but the same cannot be said for the UK.

Brexit and Midstream Infrastructure

As noted at the onset, even without Brexit the UK's Midstream infrastructure faces significant challenges that result from rising import dependence, the consequences of the low carbon energy transition and the aging of assets. However, there can be no doubt that the uncertainty created by Brexit introduces a new set of concerns and complications. It is widely accepted that the UK's membership of the EU's IEM has enhanced energy security and benefitted consumers. This analysis suggests that the following issues must be considered during the Brexit negotiations and addressed in a future UK Gas security strategy:

- The need for a more holistic assessment of energy security that considers the integrity of the offshore infrastructure on the UKCS and the onshore NTS and GDNs.
- The implications of greater reliance on LNG as a source of flexible supply to UK customers.
- The adequacy of the UK's gas storage capacity after the closure of Rough.
- The future status and viability of IUK and BBL as critical sources of flexibility and, in the case of IUK, an export channel to the continental European market.
- The future status of NBP relative to other European gas hubs, particularly TTF.
- The future governance of the UK's gas system and its relationship with the EU's IEM.

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