Domestic gas storage: The foundation for UK energy flexibility and security

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Contents

Introduction .....................................................................................................................................................4

Executive summary .......................................................................................................................................6

Part I: The potential economic impacts of InfraStrata’s Islandmagee gas storage project ...............................................................................................................................................8

Part II: The UK’s growing gas insecurity ................................................................................................13

Part III: How gas storage contributes to the ‘Net Zero’ objective ..................................................18

Conclusion ...................................................................................................................................................23

Appendix I ....................................................................................................................................................24

Appendix II ...................................................................................................................................................25

Appendix III ..................................................................................................................................................26
Introduction

This report provides an assessment of the long-term importance of domestic gas storage. It is divided into three main parts and a conclusion.

- **Part I** provides a high-level assessment of the potential economic impacts on Northern Ireland, the rest of the UK, and Ireland of InfraStrata’s Islandmagee gas storage project, focusing on three areas:
  - **Employment.** The number and type of jobs created by the Islandmagee project, both directly and indirectly in the development, design, construction and operational phases of the project.
  - **The ripple effect on the local economy.** The economic ripple effect on average income levels, local tax revenues, the development of local infrastructure, and the quality of local services, including a brief review of the impact of the development of other, related economic sectors.
  - **The Islandmagee Energy Community Fund (IMECF).** The vision, purpose and potential impact of InfraStrata’s £1-million fund.

- **Part II** sets out the broader context of the UK’s growing dependence on imported gas, the pre-existing insufficiency of current gas storage facilities and the need for a diverse range of supply flexibility options; storage in particular but also enhanced LNG import capacity.

- **Part III** examines the role of natural gas in the energy transition in terms of displacing coal and enabling a hydrogen economy, and the advantages of natural gas storage in general and the benefits of InfraStrata’s infrastructure projects specifically, in terms of supply flexibility, as well as energy security and competitiveness. This section also provides an overview of the dynamics of the natural gas market. The report concludes with highlighting the need for investment in critical infrastructure and government support.

- A **conclusion** highlights the need for investment in critical infrastructure and government support.

The UK currently has a robust system of gas import pipelines and LNG terminals, the total capacity of which exceeds annual demand by some margin. It boasts a successful and liquid gas trading hub in the National Balancing Point (NBP), although the Netherlands’ Title Transfer Facility (TTF) has outgrown the NBP in recent years to become the centre of the European gas market.

However, the UK gas system lacks the flexibility and infrastructure necessary to meet the demands of the future. It relies on a number of geographically concentrated large import assets, and, most notably, a very small amount of gas storage capacity. This lack of flexibility – the ability to cycle gas in and out of storage – limits suppliers’ and traders’ optionality and undermines the benefits that accrue from a competitive marketplace.

There is little doubt that in the coming years the UK’s security of gas supply will be increasingly challenged by falling domestic production and an increasing reliance on imported gas arriving along extended supply chains. The UK has offset this vulnerability through the expansion of its LNG import capacity, but needs to do so again, by making sure it has a sufficient number of LNG import points and, most importantly, the storage capacity to maximise the benefits of its gas import infrastructure.

The growth of variable renewable energy generation capacity in the power sector and the loss of baseload capacity (coal and nuclear), combined with a likely ‘whole system’ integration of these sectors as a result of the low-carbon energy transition and the UK’s net-zero carbon emission target means the power system will need more flexibility. If gas is to provide flexibility to the power system, it is vital that the gas system has sufficient flexibility itself.

Moreover, it is critical to make the distinction between natural gas as a fuel and gas infrastructure assets. Salt cavern gas storage facilities and LNG terminals are gas assets, not simply natural gas assets and therefore bear little or no risk of being stranded by the energy transition. Indeed, they will be critical elements of the low-carbon energy system in which hydrogen is expected to play a central role.
Figure 1. InfraStrata’s proposed gas storage projects in the UK

Source: Oxford Analytica
Executive summary

The UK suffers from diminished resilience in its natural gas system and limited ability to manage significant volatility and peaks in demand. With growing dependence on imported gas (a key enabler of the energy transition), comes vulnerability to fractious political relations with Russia and the EU in a post-Brexit world. The contribution of gas storage to the UK’s future security of supply, however, is not fully captured by markets and so there is a need for targeted investment support by the Government.

Economic benefits of the Islandmagee Gas Storage project

In addition to ensuring security and flexibility of the UK’s energy supplies, and supporting the transition to a net-zero economy, the Islandmagee gas storage project has the potential to create jobs and support investment into Northern Ireland.

- During construction, 400 direct jobs will be created, as well as between 800 and 1,200 indirect jobs (ie, among suppliers), expected to bring around £7 million into the local economy.
- During construction it is estimated that for every £1 million of capital expenditure, a further £2 million will be created in the economy; this means with 75% local content, the wider economy could benefit by around £400 million.
- During operations, 60 direct jobs will be created, expected to bring in around £1 million into the local economy and between 120 and 180 indirect which would bring in a further £2-3 million.
- Many of the jobs created will be skilled Science, Technology, Engineering and Mathematics (STEM) jobs as detailed in the Belfast Region City Deal.

The UK’s energy challenge

- The UK’s domestic natural gas production is in irreversible decline, having peaked 20 years ago at 113.5 billion cubic metres (bcm).
- The UK’s import dependency will increase. In 2035, 74% of natural gas consumed in the UK will be imported, compared with 48% today.
- The UK will become increasingly reliant on imports from Russia via the EU and become vulnerable to Russia’s often fractious political relations with transit countries.
- What is more, the UK’s future relationship with the EU is an unknown and it is possible that the UK will see threats to its energy supply as a result of Brexit.
- During the ‘Beast from the East’ weather phenomenon in February/March 2018, in order to meet energy demands, the UK had to resort to coal-fired power generation. The UK government has decided to phase out all coal-fired power generation, thus increasing reliance on gas power generation for system stability.
- Considering that severe weather events will become more common as a result of climate change, replacement capacity to help manage future shock events – and associated supply disruptions – is imperative.
- Until domestic gas storage capacity is increased, flexibility to meet these exacerbated peaks in demand is diminished.

The importance of Gas Storage Facilities

- Falling UK production means an increasing reliance on imported gas and limited ability to manage seasonal demand swings, periods of severe cold or supply disruptions.
• The Netherlands – a declining gas producer like the UK – has compensated for its loss of flexibility with gas storage. In terms of working capacity as a percentage of domestic demand, the UK has less than 2% (compared with the Netherlands’ 35%).

• By establishing sufficient gas storage facilities, the UK can continue to effectively manage any disruptions to supply, contributing significantly to energy security and flexibility.

• The location of the proposed Islandmagee Energy Limited facility in Northern Ireland is strategically and operationally significant as neither Northern Ireland nor Ireland have any underground gas storage capacity.

• The shift to a hydrogen-based economy will gather pace over the coming years and decades. The need for hydrogen storage will intensify, and gas storage facilities (such as the proposed salt caverns at Islandmagee) can be repurposed as hydrogen storage facilities.

• Salt cavern gas storage, such as the proposed Islandmagee gas storage facility, is by far the most appropriate technology to meet the UK’s growing flexibility requirements.

Investing in Gas Storage

• Commercial returns for gas storage projects or infrastructure investments do not currently fully reflect their contribution to security of gas supply, flexibility and smooth market functioning, nor the role they can play as an energy transition enabler.

• Government support and direction are essential to get the right infrastructure in place at the right time.

• It is crucial that targeted investment support distinguishes between natural gas as a fuel and gas infrastructure assets, such as gas storage (which are critical to long-term gas decarbonisation plans).

• Many of the EU’s largest economies have substantially increased their investments in gas storage.

• Islandmagee Energy Limited’s pledged £1-million community fund (to be independently administered) will benefit the community of Islandmagee over the 40-year lifetime of the project.

Gas storage will support delivery of ‘Net Zero’ objectives

• Although electrification, powered by renewable energy sources, lies at the heart of the energy transition, energy will still have to be delivered in gaseous form to a significant degree.

• Gas storage facilities will become critical complimentary elements of the UK’s low-carbon energy transition.

• Hydrogen is expected to play a central role in supporting the UK’s energy transition. The EU and several European countries have formulated hydrogen strategies as part of their net-zero ambitions by 2050 targets.

• Hydrogen storage will be essential to support the required producers’ and end users’ flexibility.
Part I: The potential economic impacts of InfraStrata’s Islandmagee gas storage project

Employment

In terms of the overall number of jobs, the proposed Islandmagee gas storage project will create around 40 full-time equivalent (FTE) permanent jobs when operations commence. This will rise to approximately 60 FTE permanent jobs when all the caverns are fully operational, according to InfraStrata.

This boost to employment will be significant for Islandmagee, a sparsely populated rural town, part of Belfast City Region, and surrounding communities. The region has in recent years been unable to offer an adequate number of high-quality jobs in fields such as engineering, technology and construction.

Many of the jobs created by the Islandmagee project will be skilled Science, Technology, Engineering and Mathematics (STEM) jobs, in line with a push by Belfast Region City Deal (BRCD) to promote such employment opportunities. The BRCD aims to redouble efforts to develop more innovative approaches to nurture the regional STEM agenda to drive inclusive economic growth.

The permanent job figures are broadly in line with industry norms as highlighted in the table below. The table has been prepared to provide a high-level comparison of the Islandmagee manning levels with other similar projects.

For the purposes of this section in the report, unless stated otherwise the analysis undertaken is based on this final figure of 60 permanent jobs.

The table shows that the staff-cavern ratio for the Islandmagee project is expected to come down to approximately 3.0 if the number of caverns increases to a maximum of 20 under Phase 3. While the number of staff employed by the Islandmagee project seems quite high, the average cost per head is close to current data from other projects.

In terms of the number and type of employees employed by the project, the actual breakdown will largely depend on both the local contracting strategy in terms of how much work is outsourced, the nature of the engineering, procurement and construction (EPC) contract, and how closely it will need to be supervised.

However, based on data from similar gas infrastructure projects, staffing structure and numbers are expected to be similar to those shown by the organogram and summary table respectively (see next page). The key point to note is that the Construction department would be quite large during the construction phase but would reduce considerably when all major construction work on the project has finished.

Table 1. Comparison of Islandmagee operational phase staffing levels with other salt cavern projects in the UK

<table>
<thead>
<tr>
<th>Operator / Owner</th>
<th>Facility / Location</th>
<th>No. of caverns</th>
<th>No. of staff</th>
<th>Salary costs from latest accounts (£m)</th>
<th>Average number of staff per cavern</th>
</tr>
</thead>
<tbody>
<tr>
<td>EDF Energy</td>
<td>Hill Top Farm and Hole House Farm</td>
<td>14</td>
<td>22</td>
<td>£1.6</td>
<td>16</td>
</tr>
<tr>
<td>EON Energy</td>
<td>Holford Gas Storage</td>
<td>8</td>
<td>25</td>
<td>£21</td>
<td>31</td>
</tr>
<tr>
<td>SSE</td>
<td>Aldbrough and Hornsea</td>
<td>18</td>
<td>82</td>
<td>£5.7</td>
<td>4.6</td>
</tr>
<tr>
<td>Storengy (UK)</td>
<td>Stublach Gas Storage</td>
<td>20</td>
<td>48</td>
<td>£3.0</td>
<td>2.4</td>
</tr>
<tr>
<td><strong>Totals / Averages</strong></td>
<td></td>
<td><strong>62</strong></td>
<td><strong>177</strong></td>
<td><strong>£12.4</strong></td>
<td><strong>2.9</strong></td>
</tr>
<tr>
<td>InfraStrata</td>
<td>Islandmagee (Phase 1)</td>
<td>7</td>
<td>40</td>
<td>£2.8</td>
<td>5.7</td>
</tr>
<tr>
<td>InfraStrata</td>
<td>Islandmagee (Phases 1, 2, 3)</td>
<td>20</td>
<td>60</td>
<td>£4.2</td>
<td>3.0</td>
</tr>
</tbody>
</table>

Source: Project data; Oxford Analytica calculations. Notes: Data has been used from the most up to date accounts for each project, which were either 2018 or 2019, with no correction for inflation. Data for Islandmagee has been provided by InfraStrata.
Indirect employment and apprenticeships

In terms of additional employment brought to the region, the Islandmagee project could create between 120 and 180 indirect jobs. Similarly, during the construction phase of the project if 400 direct jobs are created by the project during this phase then the project will also create between 800 and 1,200 indirect jobs. This assessment is based on multipliers of 2.0 and 3.0. The quoted research in terms of employment multipliers varies considerably from around 1.8 to 3.75 (see Appendix II).

The best opportunity for developing apprenticeships will be during the construction of the caverns, as this phase will employ around 400 workers, according to InfraStrata’s calculations. Current UK government statistics suggest that between eight and ten opportunities for apprenticeships might arise during the construction phase and between two and four opportunities during the operational phase of the project. However, given the technical nature of this project, these estimates could be higher.

The ripple effect on the local economy

The ripple effect of an industry on the local economy can be split into three categories:

- **Direct effect.** If there is an increase in the final use of a particular industry output, it can be assumed that the industry will increase the output in response to the market.

- **Indirect effect.** An increase in industry output will lead to an increase in use of suppliers along the supply chain.

- **Induced effect.** Increased spending of the income by the employees will be spent on final products in the local area.

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Table 2. Typical breakdown of staffing levels

<table>
<thead>
<tr>
<th>Description of roles</th>
<th>Headcount at start of operations</th>
<th>Headcount at full operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive team</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Asset management team (overall management, planning and strategy)</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>Asset development team (strategy, planning, technical services)</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Construction team (initial and incremental construction)</td>
<td>15</td>
<td>3</td>
</tr>
<tr>
<td>Gas storage operations team (O&amp;M activities and daily operations, etc)</td>
<td>7</td>
<td>21</td>
</tr>
<tr>
<td>Commercial operations team (user services, regulation, billing)</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>Finance and shared services (wide range of administration support)</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td><strong>Total resources required</strong></td>
<td><strong>40</strong></td>
<td><strong>60</strong></td>
</tr>
</tbody>
</table>

Source: Oxford Analytica. Note: The headcount at full operation assumes all caverns that are going to be developed have been developed, although given the longevity of the project this figure is not guaranteed.
These effects can be estimated using type 1 and type 2 gross value added (GVA) multipliers. Type 1 multipliers sum together the direct and indirect effects, while type 2 multipliers include all three effects. The extra employment in the area will have the ripple effect of bringing more jobs and money into the area. The effect can be roughly estimated by using GVA multipliers relevant to the region to quantify the extra jobs and income that the project will bring to the area.

The ripple effect of construction

The Northern Ireland Statistics and Research Agency (NISRA) recently published figures for GVA and for type 1 GVA multipliers. These are experimental results and therefore some analyses of ripple effects still prefer to use the available Scottish figures. The type 1 GVA multiplier for the construction sector calculated by the NISRA is 1.8. The NISRA has not published a figure for the type 2 multiplier; however, the Scottish government has published the figure for the type 2 GVA multiplier for the construction sector in Scotland as 2.0.

The economy in Scotland can be considered similar enough to Northern Ireland to use the Scottish GVA multiplier to estimate the ripple effect of the Islandmagee gas storage project. This means that the effect on the economy could be reasonably estimated by assuming that for every £1 million of capital expenditure in the project, £2 million will be created in the local economy. Given the estimated expenditure of InfraStrata of £265 million, this leads to an estimated impact of £530 million.

The nature of the impact on the local Northern Ireland economy will depend on how much of the materials and skills are sought locally. InfraStrata is committed to ensuring high levels of local content but even if 25% of the work created will require specialist knowledge and skills, which cannot be sourced locally, resulting in a quarter of the investment going to contractors from outside the local economy, it still leaves around £400 million for the local economy.

During the construction phase of the Islandmagee gas storage project it is expected that InfraStrata will employ around 400 people. Supposing an average salary for the construction phase in this high-paying industry of £35,000, this gives a total net income after taxes and national insurance of approximately £10 million. Using an averaged multiplier of 2.0, this amounts to an impact of £20 million on the Northern Ireland economy due to the staff expenditure for each year of construction.

It could be argued that some of the money spent on taxes will also benefit the local economy in terms of council tax, etc, and so the impact may be higher than this figure.

How this will be distributed in the local area will depend on the nature of the jobs created. For example, nearby Harland & Wolff could be used to meet fabrication requirements for the Islandmagee project, resulting in a positive ripple effect in terms of jobs created at the shipyard. Staff moving to the area for work will bring an increase in population and local taxes for the duration of the construction, spending their wages locally and therefore contributing to the induced ripple effect. If this leads to an improvement of road and rail links this could have a further knock-on effect for the local economy. However, if there are not the appropriate increases in services to handle the increased population, this could also have a negative effect on the area. For example, in a review of the impacts of oil refinery and synthetic petrol production projects in New Zealand, as well as a stimulus to the local economy there were also negative repercussions as an absence of forward planning meant that stress was placed on local services.

The ripple effect during operations

As previously noted, the ongoing project is expected to lead to the creation of around 60 permanent jobs. The staff costs and pay will cause an ongoing ripple effect on the local economy. The type 1 GVA multiplier from the NISRA for gas distribution services is given as 2.2, and the multiplier for office administration and support services is 1.2. The type 2 multipliers from the Scottish study for the equivalent areas are 1.8 and 1.4. With ongoing staff costs of an estimated £1.5 million per year after tax and national insurance, this gives an impact of around £2 million per year to the local economy.
Analysis by the NISRA show that the average weekly earnings in Northern Ireland over the year to April 2019 increased in real terms to £535. This can be compared to the UK average of £585. The Office of National Statistics (ONS) publishes estimates for gross disposable household income (GDHI) within the UK broken down into regions. The current figures are shown in Appendix I. This GDHI per head in Northern Ireland is calculated as £17,340 which is the third lowest of the UK regions. An influx of 400 jobs in the construction phase of the project could then be expected to bring in £7 million in disposable income, assuming that the jobs have an average GDHI per head in line with the local average. In the longer term, if 60 permanent jobs are created this would give a figure of around £1 million per year in extra disposable income from the employees of the Islandmagee project.

As previously stated, assuming that the employment multiplier for the project is in the range of 2.0 to 3.0, as per the figures from the Scottish government, the project could create between 120 and 180 jobs in the local economy. This could lead to an extra £2-3 million of disposable income in the region. However, one of the more challenging questions for a project such as the Islandmagee facility is in terms of skills and local contractors: what proportion of these will be brought in to fill a skills gap, and what skills can be developed by the deployment of long-term strategies? A study of the economic impact of the related geoscience industry on the Northern Ireland economy has been performed by the Ulster University Economic Policy Centre. Their analysis of the productivity of different industry sectors relative to the Northern Ireland average showed that the mining, construction and geoscience industries (which are most closely related to the Islandmagee gas storage project) have a GVA per employee above the Northern Ireland average. This indicates that the Islandmagee gas storage project is likely to have a positive impact on the local economy, potentially leading to higher than average incomes in the area, which will have a knock-on effect for local taxes and spending (see Appendix III).

Another area where this project may add value to Northern Ireland’s economy in terms of jobs, investment and expertise is in the development of a ‘hydrogen ready’ storage project or a CCS project, or both. Activity in both these areas would allow Northern Ireland’s industry to lead in this area. Indeed, the Northern Ireland government has stated its intentions to develop a local hydrogen economy and aims for Northern Ireland to become a leading player in hydrogen energy technology. There is significant potential for adapting salt caverns at Islandmagee to store large quantities of hydrogen, which could be a cornerstone in realising the government’s vision.

While little hard data is currently available, in a study by the Centre for Energy Policy at the University of Strathclyde, the impact of the CCS industry in Scotland was investigated. This study attempted to bring together methods used in previous studies for the techno-economic impact, with extension studies and a fuller analysis of economic multipliers to capture the wider economic impact (see Appendix II). Their conclusion on the multiplier effect on jobs for broadly related sectors suggests that energy-related projects can have an employment multiplier or between 2 and 4. The UK government action plan on carbon capture, usage and storage (CCUS) came to similar conclusions, in that every direct job in capital intensive industries can support up to four jobs in indirect employment.

The local impact of the Islandmagee Energy Community Fund (IMECF)

The vision of the fund

As part of the legacy of this project, InfraStrata has pledged £1 million over a ten-year period, during the operational period of the gas storage caverns. The fund will be independent from the Company and administrated by an external body with relevant experience in managing community funds. The Community Foundation Northern Ireland is a good model for this.
Potential applications of the fund

The fund aims to support local projects and initiatives, with schools, groups and organisations all being able to benefit over the 40-year-lifetime of the project. While improving education, employability and enterprise are obvious targets, projects that strengthen community cohesion and build social capital are part of the InfraStrata vision. As Islandmagee itself is a very small town, applications will be accepted from the wider Mid and East Antrim Council area with particular attention being given to the area between Islandmagee, Whitehead and Larne due to proximity to the storage site.

In the current rapidly evolving circumstances and social climate, also to be considered is the social mobility involved in the application, the duration of funded applications – whether they have long-reaching goals, especially related to length of this project. Relevant applications to the project ie, energy related, or those promoting quality of life changes could also be of particular interest. Examples of other companies doing this are Greggs community fund, focusing on poverty, nutrition and inclusion.\textsuperscript{xvi}

It should be noted that most community funds come from government-enforced community infrastructure levies (CIL) where a charge on new developments is used for community projects.\textsuperscript{xxii}

Finally, it should be noted that several energy companies in Northern Ireland, which all award funding through the Community Foundation Northern Ireland, share the following list of priorities, which is an important starting point given the shared business sector.

- Projects that address marginalisation and help tackle rural isolation, particularly children and teenagers (including pre-school children).

- The provision of skills development of local people and arts and cultural activities. Activities and events designed to encourage greater community interaction and cohesion.

- Projects that improve the utilisation of existing community space, including community venues and outdoor spaces and programmes and projects designed to improve local environmental and conservation management are supported.

Impact on local economies

Community funds can have significant local benefits. For example, RenewableUK, the UK trade association for wind power, found that for each installed megawatt (MW) of onshore wind, around £100,000 stays in the community and surrounding areas during the lifetime of a project. Onshore wind industry community funds are some of the most established in the country.

However, there is little information on the long-reaching impact of community funds, both those originating from CIL or industrial sources. Both the financial investment and number of projects funded would usually be provided; however, this does not give a real impression of both the short- and long-term success of the funds. Due to the nature of the projects, often working towards quality rather than purely financial goals (such as job creation), makes it fundamentally difficult to quantify. For that reason, the stories from projects funded by this new fund are as important as easily available financial merits.
Part II: The UK’s growing gas insecurity

The UK has long relied on its domestic natural gas production not just as an energy source but as a source of flexibility. The ability to store gas and ramp output up and down have been essential tools in managing seasonal demand swings, periods of severe cold, or supply disruptions.

However, the UK’s domestic natural gas production is in irreversible decline, having peaked 20 years ago in 2000 at 113.5 billion cubic metres (bcm). The government’s ban on fracking in England, introduced in November 2019 on the grounds that it was not possible to predict the probability of seismic activity, combined with the maturity of the UK’s offshore gas resources, suggest little likelihood of a revival in UK gas output. According to forecasts made by the Oil and Gas Authority (OGA), UK gas production will amount to just 15.6 bcm by 2035, 55% lower than the 34.9 bcm forecast for this year. Michael Bradshaw, Professor of Global Energy at Warwick Business School, warned in 2018: “Historically, flexible supply came from simply producing more from the North Sea, but that option has gone.”

Import dependency

Although UK gas demand is expected to decline modestly over the period to 2035, natural gas will remain a critical part of the UK’s electricity and heat supply. The reduction in UK gas output will thus have a dramatic impact on the country’s gas import dependency. The OGA expects gas imports to rise from 32 bcm per year in 2020 to 44.1 bcm in 2035. At this point, 73.8% of natural gas consumed in the UK will be imported, compared with 47.8% today.

Figure 3. UK projected gas demand and production (bcm)

Source: UK Oil and Gas Authority

National Grid ESO’s 2020 Future Energy Scenarios (FES 2020) show a wider range of possibilities depending on the speed and nature of the low-carbon energy transition. Gas imports in 2030 range from 33.1 bcm (Leading the Way scenario – LW) to 51.6 bcm (Steady Progression scenario – SP), and in 2050 from 0 bcm (LW) to 67.7 bcm (System Transformation scenario – ST). Gas imports in the Consumer Transformation (CT) scenario are 42.2 bcm in 2030 and 6 bcm in 2050.

The UK’s rising reliance on imports is compounded by the import dependency of the markets through which its imported piped gas flows, including the Netherlands. According to the International Energy Agency’s World Energy Outlook 2019 (Stated Policies Scenario), Europe’s gas import dependency ratio will rise from 52.7% in 2017 to 67.0% in 2035.

Ireland’s situation is even more extreme. With the closure of the Kinsale gas field in July 2020, Ireland has only one producing domestic gas field, Corrib, which supplies about two-thirds of Ireland’s gas requirements. The field is expected to be depleted within about ten years and as a result its flow rate is already diminishing, leaving the country entirely dependent on flows from the UK via two interconnectors originating at a single supply point in Moffat, Scotland. Dublin’s intention to stop issuing any new exploration licences in its waters reduces significantly the prospect of any new discoveries.

Figure 4. Summary of natural gas supply across all FES 2020 scenarios

Source: Future Energy Scenarios, National Grid ESO, July 2020
Note: UKCS stands for UK Continental Shelf. Green gas refers to both biomethane and bioSNG (i.e. biomethane which is created by larger, more industrial processes)
The UK’s gas import pipelines are a key element in providing security of gas supply and facilitating trade between the NBP and TTF, two of the largest gas markets in the world, but they are only as secure as the supply sources to which they are connected. The UK’s gas security is thus intimately linked with upstream production in Norway and the Netherlands, and, increasingly, supply sources much further afield.

Norway remains the leading country for UK gas imports. Although there have been disruptions due to maintenance issues, Norway’s gas production is projected to be steady if not growing until 2035. However, some of the UK’s other sources of supply are riskier.

**The Beast from the East**

A lack of gas storage meant the UK survived the Beast from the East only by resorting to coal-fired power generation, an option already much reduced and no longer available after October 2024 owing to the phase-out of all coal-fired generation – an essential part of the UK’s effort to combat climate change.

The ‘Beast from the East’ was a freezing Siberian weather system, which hit the UK and much of Northern Europe in late February and early March 2018, and resulted in wholesale electricity prices rising to five times the average for the quarter. Despite this, on two of the coldest days, 28th February and 1st March, the 2 gigawatt (GW) Interconnexion France Angleterre (IFA) interconnector flowed electricity from the UK to France, owing to even higher prices in the French market. In the UK, the rise in gas demand caused the National Grid to issue its first deficit warning since it introduced the system in 2012.

Supply disruptions exposed the weaknesses of the UK’s gas system as three major gas infrastructure assets were affected simultaneously. The event also prompted industry leaders to speak out against the UK government’s decision to operate its network with minimal storage capacity, including Marco Alvera, CEO of Snam, the owner and operator of Italy’s natural-gas distribution network. “I would hope the UK would rethink and reverse its decisions — it’s important for the whole continent”, Alvera said. “As the UK moves from being a significant exporter of gas to a major importer, there could be a significant gas supply issue in the near future.”

While a gas deficit was avoided, consumers paid for the incident through sky-high electricity and gas prices. Gas prices for within-day gas delivery hit a record high of 350p/th, while next-day delivery gas reached 230p/th. Reflecting on the government’s choice to let the market determine whether it makes sense to invest in new gas storage, Clive Moffatt of consultancy Moffat Associates said in March 2018: “There is still a level of complacency in the government that despite recent events the best course of action is to just accept these price shocks.”

Following the closure of the Rough gas storage facility in 2017, the UK had insufficient gas in storage to supply both increased heating demand and demand for gas for power generation (the UK’s high level of gas use for home heating means in the event of cold weather, heat and electricity generation both draw on the same resource). This led to an increase in coal-fired generation, an option that not only raised greenhouse gas (GHG) emissions, but is now only available in much reduced form up until October 2024 due to the closure or conversion of the UK’s remaining coal-fired power stations.
The accelerated reduction in gas output from the giant Groningen gas field in the Netherlands, owing to seismic activity, means the BBL pipeline, which connects the UK with the Netherlands, will in effect become a conduit primarily for Russian origin gas coming into the UK, as will the bidirectional IUK pipeline, which connects the UK with Belgium, the latter having no gas production of its own.

These extended supply chains, through Ukraine, Belarus and under the Baltic Sea, carry substantial geopolitical, physical and market risk. The Ukraine-Russia gas crises, Poland’s and the Baltic States’ desire to end Russian gas imports altogether, US sanctions placed on the completion of the Nord Stream 2 pipeline and an antagonistic EU-Russian energy relationship all highlight the geopolitical risk to which these links are subject. The fact that Nord Stream 2 arrives in the EU may also become a complication for the UK post-Brexit.

These tensions, or a natural or other disaster, such as the explosion at the Baumgarten gas hub in December 2017, could result in physical supply disruptions, but they also represent significant market risk. In the event of extreme cold, the UK will have to pay a high price to ensure gas continues to flow through the pipelines rather than be consumed on route by other increasingly gas import-dependent European countries. Moreover, extended supply chains are slower to respond to price signals in distant markets, which has the effect of increasing price volatility and the need for gas storage to mitigate that volatility.

Russia supplies about 37% of the European gas market, with European states’ dependency on Russian gas highest in Eastern and Central Europe. Russian gas accounted for 9.9% (7.8 bcm) of UK gas demand last year, according to BP’s data.

Groningen: the loss of a flexible asset – lessons for the UK?

The loss of Groningen represents not just a large reduction in domestic European gas supply but a major loss of supply flexibility for the Continental European gas market. The Netherlands – which became a net importer of gas in 2018 – has compensated for the loss of flexibility with gas storage.

Groningen was discovered in 1959 with reserves of 2.8 trillion cubic metres, making it the tenth largest gas field in the world. In 1974, Dutch gas policy required the operator to buy gas from smaller fields to preserve Groningen as a flexible asset.

Seismic shift

On 16 August 2012, an earthquake registering 3.6 on the Richter scale occurred near the Dutch village of Huizinge, resulting in numerous complaints of damage to homes. Almost 30 earthquakes of 1.5 or over were registered in 2013, suggesting assessments of the previously known link between gas extraction and seismic activity in the Netherlands had underestimated the likely impacts. As a consequence, production of gas from Groningen will now end in 2022, eight years earlier than expected only a year ago. The field will be kept operational until 2026 to meet high demand for gas on very cold days.

Storage becomes critical

Groningen’s loss has been replaced in large part by gas storage. Groningen’s monthly production has declined from almost 7 bcm in January 2011 to less than 2 bcm a month in 2018. In winter, Dutch daily net withdrawals from storage have risen from a high of about 60 mcm per day in 2011 to over 120 mcm per day in 2015 to a peak of 170 mcm per day in winter 2017.

Despite Dutch domestic gas demand being less than half that of the UK, the country has 12.4 bcm of working gas storage capacity in contrast to the UK’s 1.3 bcm. xxx
Implications of Brexit

The ability of the UK to import from the rest of the EU, and the terms on which such transactions are made, will be affected by Brexit. Although thought unlikely, it is at least theoretically possible that gas imports to the UK could be subject to tariffs, particularly in future years as the EU’s own gas import dependency rises. As Thierry Bros, senior research fellow at the Oxford Institute for Energy Studies, put it: “If there remains frictionless trade with the EU via the interconnectors following Brexit then it diminishes the case for domestic storage, but this isn’t certain.”

More immediately, post-Brexit, EU countries may have no obligation to supply the UK in the event of a major supply disruption or extreme demand event, such as the Beast from the East. Moreover, the EU’s revised Security of Gas Supply Regulation introduced the ‘solidarity principle’ for EU member states. This means they are obliged to help neighbouring EU states first.

Post-Brexit, Ireland will have no direct gas connection with any other EU state (and neither Ireland nor Northern Ireland has existing gas storage facilities). Stress in the UK system will almost certainly have implications for gas supply across Ireland and Northern Ireland.

Storage deficit

The UK’s growing gas import dependency and extended gas supply chains throw into sharp relief its inadequate number of gas storage facilities.

The UK currently depends on seven storage facilities, the largest of which, Aldbrough, represents just over a quarter of send out capacity and would be exhausted in six days at maximum withdrawal rates. At 14 days, 64% of UK overall send out capacity would be exhausted. The UK’s eighth and smallest gas storage facility, Holehouse Farm, has not returned to operation and is in the process of closing. Its send out capacity is listed by the UK government as zero. The closure of the Rough gas storage facility in 2017 was of major importance for the resilience of the UK’s gas system. It was the country’s only long-term gas storage facility, accounting for 70% of the country’s total gas storage capacity and 25% of storage deliverability.

There is no generally agreed method of specifying how much storage a given gas system should have because there are many different means of supply flexibility, which vary in terms of volume, duration and quality. However, by any common measure and by comparison with its European neighbours, the UK’s lack of gas storage capacity, particularly

Table 3. Operational gas storage sites in the UK at 1 November 2019

<table>
<thead>
<tr>
<th>Owner</th>
<th>Site</th>
<th>Location</th>
<th>Space (billion m³)</th>
<th>Approximate maximum delivery (million m³/day)</th>
<th>Type</th>
<th>Status*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scottish and Southern Energy &amp; Equinor (formerly Statoil)</td>
<td>Aldbrough</td>
<td>East Yorkshire</td>
<td>0.20</td>
<td>31</td>
<td>Salt cavern</td>
<td>Medium</td>
</tr>
<tr>
<td>Uniper</td>
<td>Holford</td>
<td>Cheshire</td>
<td>0.20</td>
<td>22</td>
<td>Salt cavern</td>
<td>Medium</td>
</tr>
<tr>
<td>Scottish and Southern Energy</td>
<td>Hornsea</td>
<td>East Yorkshire</td>
<td>0.24</td>
<td>12</td>
<td>Salt cavern</td>
<td>Medium</td>
</tr>
<tr>
<td>EDF Trading</td>
<td>Holehouse Farm</td>
<td>Cheshire</td>
<td>0.02</td>
<td>0</td>
<td>Salt cavern</td>
<td>Medium</td>
</tr>
<tr>
<td>Humbly Grove Energy</td>
<td>Humbley Grove</td>
<td>Hampshire</td>
<td>0.30</td>
<td>7</td>
<td>Depleted field</td>
<td>Medium</td>
</tr>
<tr>
<td>Scottish Power</td>
<td>Hatfield Moor</td>
<td>South Yorkshire</td>
<td>0.07</td>
<td>2</td>
<td>Depleted field</td>
<td>Medium</td>
</tr>
<tr>
<td>EDF Energy</td>
<td>Hill Top Farm</td>
<td>Cheshire</td>
<td>0.06</td>
<td>14</td>
<td>Salt cavern</td>
<td>Medium</td>
</tr>
<tr>
<td>Storengy</td>
<td>Stublach**</td>
<td>Cheshire</td>
<td>0.22</td>
<td>18</td>
<td>Salt cavern</td>
<td>Medium</td>
</tr>
</tbody>
</table>

Source: Gas Ten Year Statement 2019, National Grid. *Long-range, medium-range or short-range storage. Status is determined both by capacity size and injection, deliverability and storage re-cycling rates. **The space at Stublach increased to 0.4 bcm by January 2020.
medium- to long-range capacity, is extremely low. As 85% of home heating in the UK depends on gas, in addition to its use in power generation (41%) and the fact that natural gas remains a crucial fuel in many manufacturing sectors, comparing gas deliverability from storage as a percentage of average or peak winter demand shows not that the UK simply lags other markets, but that it is in a risk league of its own (see Table 4. Gas storage comparison).

### LNG import facilities

LNG has proven to be an important alternative source of gas imports for the UK and Northern Europe. The number of countries producing LNG has grown steadily over the last two decades, with the US, in particular, emerging as a major LNG exporter. This growth in produced volumes and the number of producers have created a much more secure market for LNG buyers, as well as pushing prices down, even before COVID-19, in what has become a very competitive market environment delivering cheap fuel to UK consumers. Even so, fierce international competition poses a constant risk to UK security of supply: traders will move cargo even if it is already in transit to the UK to get a better price, so storage capacity is critical.

The UK has three large LNG import terminals with total import capacity of just over 51 bcm per year. South Hook and Dragon LNG are both located at Milford Haven in South Wales and share a single distribution pipeline inland. This constitutes the UK’s largest single import asset, which National Grid ESO uses in its N-1 resiliency calculation. Grain LNG is in the Southeast of England.

LNG import terminals play a key role in providing an alternative to pipeline imports in the UK. In Ireland, the government is keen to move towards carbon neutrality. In this context, gas storage is likely to play a greater role than LNG import terminals. xxxiv

### Changes in the electricity sector

The UK’s challenges arising from lack of storage and increased import dependency are compounded by fundamental changes in the UK’s electricity system. Coal-fired power generation has been reduced to close to zero, while nuclear generation is falling, owing to plant retirements and a lack of new building. At the same time, the amount of variable renewable energy capacity is rising and will continue to do so in pursuit of the UK government’s 2050 net-zero carbon emissions target, as evidenced by the commitment to build 40 GW of offshore wind capacity by 2030, almost four times current capacity.

Electrification in transport and heating will also place greater demands on the electricity system, which will rely on gas-fired generation to mitigate the variability of renewable energy supply on the one hand, and the growing flexibility required from the coupling of the gas and power sectors on the other.

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**Table 4. Gas storage comparison**

<table>
<thead>
<tr>
<th>Source: BP, Cedigaz, Entsog, Oxford Analytica calculations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working capacity as a % of domestic demand</td>
</tr>
<tr>
<td>---------------------------------------------</td>
</tr>
<tr>
<td>France</td>
</tr>
<tr>
<td>Germany</td>
</tr>
<tr>
<td>Italy</td>
</tr>
<tr>
<td>Netherlands</td>
</tr>
<tr>
<td>United Kingdom</td>
</tr>
</tbody>
</table>
Part III: How gas storage contributes to the ‘Net Zero’ objective

Enabling the energy transition

In June 2019, the UK government passed into law a target to reduce its net carbon emissions to zero by 2050. Achieving this target will require fundamental change to the UK’s energy system and significant integration of the transport, gas and power systems.

Although electrification, powered by low-carbon energy sources, lies at the heart of the energy transition, energy will still have to be delivered in gaseous form to a significant degree. Whether or not natural gas proves a ‘destination’ fuel, combined with carbon capture and storage (CCS), it will play a critical role, particularly in the 2020-2040 period, as:

- a flexible and efficient power generation fuel to smooth and moderate the increasing flows of variable power from renewable energy sources;
- baseload back-up generation in the event of insufficient renewable generation;
- a source of ‘blue’ hydrogen when coupled with CCS;
- a low-carbon transport fuel allowing early GHG emissions reductions in long-haul freight transport both on land and by sea until other non-fossil fuel technologies become technically and commercially viable;
- a source of lower carbon petrochemical feedstock than oil, and
- public transport fuel, for example where policy targets both early reductions in GHG emissions and improved urban air quality – switching to LNG in transport reduces GHG emissions, but also significantly reduces nitrogen oxide emissions and virtually eliminates sulphur and particulates emissions.

Hydrogen strategies

France, Germany, the Netherlands and the EU have formulated hydrogen strategies as part of their net-zero by 2050 targets. Several countries, including the United States, France and Italy are also already building hydrogen storage. (At present, the UK only has minimal hydrogen storage capacity, on Teesside.)

These plans all assume a degree of blue hydrogen production until the costs of ‘green’ hydrogen – hydrogen made via electrolysis using low carbon electricity – become competitive and there is sufficient renewable energy capacity to meet the demands of the power sector and increased power demand from transport and heat. Moreover, decarbonised gas appears to be the only way of mitigating GHG emissions in hard to decarbonise areas of industry, such as high temperature heat provision, and long-distance transport.

Hydrogen production and use implies much greater integration between transport and gas markets on the one hand, as Compressed Natural Gas (CNG), LNG and hydrogen are used more as transport fuels, and between power generation and gas on the other, as green hydrogen will be produced at times of excess power generation and then used to generate electricity during high demand periods.

This integration of energy consuming and producing sectors implies that flexibility will be at a premium. Aurora Energy Research, in its study Hydrogen for a net zero GB: an integrated energy market perspective, published in June 2020, noted: “hydrogen storage will be essential to provide flexibility and to shift intermittent green hydrogen generation to peak demand periods.”

National Grid ESO commented in its FES 2020: “hydrogen plays an important and complementary role in a highly-electrified world by enabling storage of the large volume of energy required for seasonal flexibility.”

Existing infrastructure

One of the key advantages of hydrogen is that it can be stored, distributed and consumed using the vast majority of the existing natural gas network, a huge saving in terms of investment. Although there will be variations in the geology of different facilities, a study by Marcogaz, the technical association of the European gas industry, conducted in 2019, found that salt cavern gas storage facilities were unlikely to experience any problems with different blends of natural gas and hydrogen, up to 100% hydrogen.
Hydrogen adoption may in fact mean that larger storage capacities will be required because hydrogen is less energy dense than natural gas. Gas is often stored in the pipeline network itself using compression to meet daily variations in demand. Hydrogen’s lower energy density means this capacity will be lower than for natural gas. An increase in storage capacity, by providing greater flexibility, would make the use of existing assets easier. Methane reformation and CCS processes also work best at high load factors, which suggests additional storage will be needed to balance supply with demand in these areas.

Gas storage benefits

Gas storage is physically closer to UK demand centres than any other source of gas. It is not exposed to the same risks that affect other sources of supply. Gas storage can respond fast and without risk of diversion to higher-priced markets. It is an essential tool in the face of extreme and unexpected events.

Natural gas storage can also help enable the UK’s energy strategy driven by offshore wind – a key part of the government’s plan to achieve net zero – by backing up intermittent generation and ensuring security of supply.

Moreover, gas storage has other attributes that benefit consumers, the gas system as a whole and how the gas market operates. For example, the lack of gas storage this summer has limited UK suppliers’ ability to absorb excess volumes of gas through the summer months and store it for the winter. If the UK cannot take full advantage of low prices because of lack of storage, consumers will ultimately lose out. On the supply side, storage allows the industry to produce gas at a steadier rate throughout the year, reducing the need to add production capacity. It also avoids investment in excess import capacity and the associated network infrastructure this would require. Consequently, gas storage reduces overall sector investment costs, which feeds through into lower average costs for consumers. Moreover, as gas is typically stored when prices are low and withdrawn when prices are high, it has the effect of reducing the average cost of gas.\textsuperscript{41}

Gas storage, particularly from fast-cycle salt caverns, also provides short-term flexibility. The ability to cycle gas in and out of storage contributes to market liquidity and creates robust price signals, which, in turn, provides confidence for a wider range of actors to participate. Fast-fill storage will often see withdrawals and injections on the same day even in winter, which reflects trade optimisation, but also end of day balancing if pipeline imports, domestic production and LNG flow deliver more or less than actual, rather than forecast, daily demand.

A gas storage position thus allows suppliers to meet their contractual obligations if production is lower than expected, or to store gas, if output exceeds demand. It allows companies to optimise their trading operations, providing them with stability and consumers with a more competitive market.

Importantly, this short-term flexibility reduces price volatility and guards against price spikes, which aids price stability and confidence in the gas market. Moreover, by avoiding shortages, gas storage can prevent large potential costs to industry, resulting from contract interruptions or voluntary disconnections, as a result of high prices, or, in extreme situations, involuntary disconnections.

InfraStrata’s proposed storage projects

InfraStrata’s proposed gas storage projects will both help to address the UK’s current lack of flexibility and, when completed, will contribute to strengthening domestic energy security and facilitate the low-carbon transition.

The Islandmagee gas storage project

Salt cavern gas storage, such as InfraStrata’s proposed Islandmagee gas storage facility, is the most appropriate technology to meet the UK’s growing flexibility requirements. Unlike depleted gas fields or aquifers, salt caverns are multi-cycle and provide delivery rates more than three times greater than depleted gas fields and four times higher than aquifer storage. Salt caverns use only 20% of their total capacity for cushion gas, compared with 45% for depleted fields and 55% for aquifers. They can also be brought on-stream as phased developments.\textsuperscript{41}
The location of the proposed Islandmagee facility in Northern Ireland is strategically and operationally significant as neither Northern Ireland nor Ireland have any gas storage capacity. Given the island of Ireland’s relative isolation (and potential total isolation after Brexit) from the Continental European gas market and lack of LNG import facilities or storage capacity, a facility at Islandmagee would provide significant security in the event of a problem with the single supply point interconnectors to the UK.

With no import diversification on the horizon, and a large build out of offshore wind planned, access to gas storage will play a critical role in providing system flexibility and the infrastructure necessary for gas decarbonisation, which is likely to depend heavily on biogas and hydrogen production. The ability to store hydrogen will be necessary both to optimise the functioning of Ireland’s nascent offshore wind sector, thereby avoiding costly curtailment payments, and securely meet the difference in summer and winter energy demand.

**The FSRU at Barrow-in-Furness**

The decline of UK domestic gas production unbalances the geography of the UK’s gas supply. New LNG import capacity located in the northwest of England, such as InfraStrata’s proposed Floating Storage and Regasification Unit (FSRU) project in Barrow-in-Furness, would directly address a number of weaknesses in the UK’s gas security.

It would increase the number of import points and provide better geographical spread in terms of gas inputs into the grid. It would also offset the loss of domestic gas supplies using existing grid infrastructure for distribution once the gas is onshore – in this case, the National Transmission System interconnection at Barrow-in-Furness as gas production from the Morecambe Bay gas fields in the East Irish Sea declines. Moreover, it would provide additional peak shaving system support and add import capacity as domestic gas production declines.

FSRUs typically represent only 50-60% of the cost of an onshore LNG terminal, and can be delivered in half of the time, if not quicker, owing to FSRU developers’ willingness to build units on a speculative basis or the possibility of redeployment of an existing unit. An FSRU conversion typically takes about 1.5 years and a newbuild 2.5-3 years, with project lead time largely driven by construction of the FSRU’s onshore facilities.

Although FSRUs have higher operating costs than onshore terminals, they also have multiple uses – as a regasification terminal with storage, as a floating storage facility or as a conventional LNG vessel. The option to redeploy the FSRU also reduces risk for the operator should market conditions prove adverse.

The growing use of LNG in hard to decarbonise areas of the economy such as long-distance transport on road or by sea needs LNG supplies. LNG terminals act as a break bulk point for the supply of LNG to LNG refuelling stations for trucks and for ship bunkering. For road transport, long distances between LNG import points and refuelling stations raises costs just as it does with refinery deliveries of oil fuels. A northwest location would thus complement the UK’s existing LNG terminals in South Wales and the Southeast of England, aiding the expansion of the UK’s emergent LNG refuelling network for heavy-duty vehicles.

A FSRU at Barrow-in-Furness would be substantially closer to the northern cities of Manchester, Liverpool, Leeds and Newcastle, as well as Scotland than any of the UK’s other LNG terminals. It could also provide a UK point for LNG ship bunkering to complement the growing network of LNG ship refuelling facilities within the North and Baltic Seas Emission Control Areas.

Elsewhere in Europe, countries are developing FSRUs (for example, the LNG terminal in Wilhelmshaven, Germany, and the FSRU in the Gulf of Gdansk, Poland), as countries face similar increases in demand for imported natural gas over the coming years.

**Market dynamics**

Gas storage is necessary for the basic reason that demand for gas is much more variable than production. Storage operators maximise value by taking advantage of predictable price variations (seasonality) and unpredictable price variations (volatility). Seasonality generally provides the main source of income and is often referred to as intrinsic value. However, a gas storage facility’s short-term flexibility also has significant value. This is referred to as extrinsic value.

Revenue from seasonal spreads is a product of working gas volume, the seasonal price spread and the churn rate – ie, the gas storage facility’s ability to cycle gas in and out. Demand for gas varies on a daily and seasonal basis with a sharp peak in UK demand between 5am and 8am, weekday
demand higher than weekends, and winter demand much higher than in summer. Ahead of any given day, the system operator must forecast expected demand, but, for a variety of factors, for example operational problems or weather different from forecast, actual supply and demand will be different. This creates within-day and next-day price volatility from which gas storage operations can benefit.

Storage margins

The need for additional storage was reflected in the recovery of storage margins in 2017 and 2018, following a period of low returns from 2011-2016, according to modelling of the storage capture margin by risk analysts Timera Energy.

In the 2017 storage year (April 2017 – March 2018), the recovery in margins largely reflected the impact of the ‘Beast from the East’. Such shock events tend to occur every three to five years. However, bodies such as the International Panel on Climate Change have warned that global warming is likely to result in more frequent extreme weather events. In addition, the likelihood of the occurrence of shock events on the supply side rises as supply chains become more extended.

However, in 2018, margins were higher not because of a shock event but because of an increase in underlying volatility, reflecting the structural drivers impacting the UK’s gas and power markets – the loss of gas storage capacity, increasing import dependency, a greater need for flexibility in the power generation sector and a previous lack of investment in aging infrastructure in the UK and Continental Europe.

Outlook and market signals

While there is a clear upward trend in seasonal spreads since 2015, they have yet to return to the levels of 2008/2009, while volatility remains low following the spike caused by the Beast from the East.

The reason for this has been fairly flat demand for natural gas and surplus supply, owing to the rapid expansion of LNG export capacity in Australia and more latterly the US. Combined with the economic impact of COVID-19, market signals for additional storage capacity have thus been weak in 2020. This suggests that sufficient flexibility exists...
within the UK gas system while demand is low and supplies plentiful.

However, market signals do not capture the system-wide benefits of storage in terms of lower prices, less price volatility, less investment in production and import capacity and greater trading optionality to support smooth market functioning. Nor are they sufficiently forward looking in terms of the growing dependence on imported gas and the need for greater system flexibility, which will be brought about by the acceleration of the energy transition towards net-zero carbon in 2050.
Conclusion

Need for government support

Meeting the net-zero carbon target by 2050 is a huge challenge, requiring the development of new technologies such as CCS. This is needed not just for decarbonised hydrogen production, but for negative emissions technologies such as BECCs – bioenergy with carbon capture and storage – since it may not be possible to reduce GHG emissions to zero in every area of the economy. Moreover, increasingly, bodies such as National Grid ESO, are advocating a whole system approach, reflecting the increasing integration of the transport, gas and power sectors.

As a result, government support and direction are essential to get the right infrastructure in place at the right time. This will deliver early GHG emissions reductions and support the transition to low-carbon gases on a whole system basis.

In providing targeted investment support, it is essential to again make the distinction between natural gas as a fuel, which has the capacity to deliver early GHG reductions by displacing oil products in transport and coal-fired generation, and gas infrastructure assets, such as the Islandmagee gas storage project and InfraStrata’s proposed FSRU, which are critical not only to ensure flexibility and greater energy security but also to the long-term roll out of gas decarbonisation plans and will be a permanent feature of the future low-carbon economy.

There is widespread recognition that hydrogen and other energy transition technologies will require government support to become commercially viable, with the government’s auction-based Contracts for Difference (CfD) scheme the front runner in terms of mechanisms to provide this, where applicable.

The focus is understandably on the pre-commercial technologies seen as necessary for the next phase of the energy transition, while more mature technologies’ expansion or contraction are left to the price signals delivered by the market. To date, the government’s approach to gas storage has been to leave decisions on closures or new capacity up to operators’ own commercial decisions, in effect relying purely on market signals.

However, markets do not always fully capture externalities, such as the system benefits of infrastructure, their contribution to security of supply, market functioning and the environment. The need for carbon pricing is the most obvious recent example of this form of market failure.

It is in practice unrealistic to expect the market today to price in the costs and benefits of the energy transition over the next 30 years. Mature technologies, like gas storage, risk falling through the cracks as they are neither pre-commercial nor fully remunerated by market mechanisms as energy transition enablers. Yet, as mature technologies, they are a safer bet because they do not carry the technology risk of pre-commercial ventures.
Appendix I

Gross disposable income, UK and constituent countries and regions

As highlighted in the text, the analysis by the NISRA shows that the average weekly earnings in Northern Ireland over the year to April 2019 increased in real terms to £535\text{\textpounds}, compared to the UK average of £585. The following table reproduced from the Office of National Statistics (ONS) highlights estimates for GDHI within the UK by regions. The GDHI per head in Northern Ireland is calculated as £17,340, which is the third lowest of the UK regions.

Table 5. Gross disposable household income, UK and constituent countries and regions, 2018

<table>
<thead>
<tr>
<th>Countries &amp; regions of the UK</th>
<th>Population</th>
<th>GDHI per head (£)</th>
<th>GDHI per head growth on 2017 (%)</th>
<th>GDHI per head index (UK=100)</th>
<th>Total GDHI (£ million)</th>
<th>Total GDHI growth on 2017 (%)</th>
<th>Share of UK pop. (%)</th>
<th>Share of UK total GDHI (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UK</td>
<td>66,435,550</td>
<td>21,019</td>
<td>4.6</td>
<td>106.0</td>
<td>1,402,367</td>
<td>5.3</td>
<td>100.0</td>
<td>100.0</td>
</tr>
<tr>
<td>England</td>
<td>55,977,178</td>
<td>21,609</td>
<td>4.6</td>
<td>102.4</td>
<td>1,209,637</td>
<td>5.3</td>
<td>84.3</td>
<td>86.3</td>
</tr>
<tr>
<td>North East</td>
<td>2,657,909</td>
<td>16,995</td>
<td>3.9</td>
<td>80.5</td>
<td>45,171</td>
<td>4.4</td>
<td>4.0</td>
<td>3.2</td>
</tr>
<tr>
<td>North West</td>
<td>7,292,093</td>
<td>18,362</td>
<td>4.4</td>
<td>87.0</td>
<td>133,897</td>
<td>4.9</td>
<td>11.0</td>
<td>9.5</td>
</tr>
<tr>
<td>Yorkshire and The Humber</td>
<td>5,479,615</td>
<td>17,665</td>
<td>4.5</td>
<td>83.7</td>
<td>96,796</td>
<td>5.0</td>
<td>8.2</td>
<td>6.9</td>
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<tr>
<td>East Midlands</td>
<td>4,804,149</td>
<td>18,277</td>
<td>3.6</td>
<td>86.6</td>
<td>87,804</td>
<td>4.3</td>
<td>7.2</td>
<td>6.3</td>
</tr>
<tr>
<td>West Midlands</td>
<td>5,900,757</td>
<td>18,222</td>
<td>4.7</td>
<td>86.3</td>
<td>107,526</td>
<td>5.4</td>
<td>8.9</td>
<td>7.7</td>
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<td>East of England</td>
<td>6,201,214</td>
<td>22,205</td>
<td>4.9</td>
<td>105.2</td>
<td>137,698</td>
<td>5.5</td>
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<td>9.8</td>
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<td>London</td>
<td>8,908,081</td>
<td>29,362</td>
<td>5.2</td>
<td>139.1</td>
<td>261,562</td>
<td>6.1</td>
<td>13.4</td>
<td>18.7</td>
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<tr>
<td>South East</td>
<td>9,333,625</td>
<td>24,318</td>
<td>4.1</td>
<td>115.2</td>
<td>222,113</td>
<td>4.7</td>
<td>13.7</td>
<td>15.8</td>
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<tr>
<td>South West</td>
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<td>20,907</td>
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<td>99.0</td>
<td>117,071</td>
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<td>8.3</td>
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<td>Wales</td>
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<td>4.4</td>
<td>81.0</td>
<td>53,669</td>
<td>4.8</td>
<td>4.7</td>
<td>3.8</td>
</tr>
<tr>
<td>Scotland</td>
<td>5,438,100</td>
<td>19,572</td>
<td>5.1</td>
<td>92.7</td>
<td>106,433</td>
<td>5.4</td>
<td>8.2</td>
<td>7.6</td>
</tr>
<tr>
<td>Northern Ireland</td>
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<td>17,340</td>
<td>4.7</td>
<td>82.1</td>
<td>32,627</td>
<td>5.3</td>
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<td>2.3</td>
</tr>
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</table>

Source: Office for National Statistics – Regional gross disposable household income. Notes: Figures may not sum to totals as a result of rounding; per head (£) figures are rounded to the nearest pound sterling. 2018 estimates are provisional. Population estimates are sourced from the Population estimates for the UK.
Appendix II

Review of employment multipliers by the University of Strathclyde

In a study by the Centre for Energy Policy at the University of Strathclyde, the impact of the CCS industry in Scotland was investigated. This study attempted to bring together methods used in previous studies for the techo-economic impact, with extension studies and a fuller analysis of economic multipliers to capture the wider economic impact. The conclusion on the multiplier effect on jobs for various broadly related sectors is summarised below, where energy-related projects can have an employment multiplier or between 2 and 4.

Figure 9. Key Scottish employment multipliers: Full-time equivalent (FTE) indirect and induced supply chain jobs grouped under four broad industry areas per direct industry FTE job

Source: The Centre for Energy Policy at the University of Strathclyde
Appendix III

Analysis of the productivity of different industry sectors relative to Northern Ireland average

The following chart, which is a summary of sectoral productivity (GVA per employee) relative to the Northern Ireland average in 2015, is from a research study of the economic impact of the related geoscience industry on the Northern Ireland economy undertaken by the Ulster University Economic Policy Centre. It analysed the productivity of different industry sectors relative to the Northern Ireland average.

The chart shows that the mining, construction and geoscience industries (which are most closely related to the Islandmagee gas storage project) have a GVA per employee above the Northern Ireland average. This indicates that the Islandmagee gas storage project is likely to lead to higher than average incomes in the area, which will have a knock-on effect for local taxes and spending.

Figure 10. Sectoral productivity (GVA per employee) relative to the Northern Ireland average, 2015

Source: NI Annual Business Inquiry, ONS regional accounts, Business Register and Employment Survey (BRES) & UUEPC analysis. Note: GVA uses results from the ‘balanced’ approach. Geoscience is a bespoke sector and as such a GVA is used for analysis whereas the other sectors refer to GVA sourced from national accounts.
Endnotes


ii. The breakdown compares with a high-level breakdown of the staffing at the commencement of the project provided by InfraStrata to Oxford Analytica as follows: Operations (13 persons); Maintenance (12 persons); Security (5 persons) and Administrative staff (Unknown). We have assumed a total of 10 administrative staff, taking the total to 40 persons.


viii. For the purposes of this assessment, we have used a slightly higher average of £35,000 per annum to reflect the technical and professional nature of potential employees at the Islandmagee storage site. In addition, taxes and national insurance payments have been assumed to sum to 30%.

ix. While we have assumed that 25% of the EPC benefits might leave the region, we have assumed that the majority of the 400 employed contractors will reside in Northern Ireland during the course of the construction phase of the project and make a contribution to the local economy.


xii. This is based on the OPEX costs provided by InfraStrata of £2.8 million reduced by around 45% to take account of tax, employers and employees National Insurance.

xiii. Annual Survey of Hours and Earnings, NSIRA.


xvii. Dodds: Northern Ireland can lead the way in hydrogen energy, Chris Cocklin & Brendan Kelly, Science Direct, February 2020.

xviii. Reforming the value case for carbon capture and storage, Turner et al., Centre for Energy Policy, University of Strathclyde, March 2019.


xx. The Community Foundation Northern Ireland.

xxi. Local Community Projects Fund, Greggs Foundation.

xxii. Examples of infrastructure community funds include: The National Lottery (the largest non-CIL community fund); Power to change (an independent charitable trust that supports and develops community businesses in England); and BlackCraig Community Fund (an energy-related community fund).


xxiv. Not enough UK gas storage, warns professor, Chartered Institute of Procurement & Supply, 1 March 2018.

xxv. FES 2020 documents, National Grid.


xxvii. UK urged to ‘rethink and reverse’ gas storage plans, Financial Times, 7 November 2018.


xxxix. Reframing the value case for carbon capture and storage, Turner et al., Centre for Energy Policy, University of Strathclyde, March 2019.
