Getting ready for UK shale gas

Supply chain and skills requirements and opportunities

April 2014

EY

Building a better working world

Foreword

This study was commissioned by the onshore oil and gas industry and part funded by the Department for Business, Innovation, and Skills (BIS). Over 40 interviews with suppliers of materials, equipment, services, facilities, infrastructure and labour for onshore activities have taken place from both the US and the UK.

We wanted to answer three important questions as part of this study. First what will it take to build a shale gas pad in the UK in terms of supply chain and skills; second what are our capabilities in the UK; and finally what do we need to do in order to fill those gaps and to stimulate the supply chain and skills we already have.

What we have found is a truly enormous opportunity for the UK with potentially £33bn spend in the next 15 or so years. The study shows that the shale industry will need to purchase 12,600km of underground steel casing enough to go from Land's End to John O'Groats some nine times and with a total spend of £2.3bn. In addition, we will need to purchase some 50 landward rigs and some workover rigs at a total cost of £1.6bn, 9m tonnes of sand and will require some £1.2bn of ancillary equipment and services.

The study traces and builds on the figures outlined in the Institute of Directors' (IoD) report *Getting shale gas working* from May 2013. Given the industry is in the very early stages of development, the primary focus for this study is on the upstream elements of the value chain where the majority of the activity will take place in the near term. Therefore the peak spend and jobs differ slightly but are consistent with those produced in the IoD report.

This report focuses on what is required to ramp-up for production; and build on existing industrial and regulatory resources already in place to support the exploration phase. It shows that in most sectors we have the capability to supply this industry. In some sectors such as rig manufacturing, we will need to bridge the gap between the industry being able to deliver a sustainable order book and the need for early capital commitment by the supply chain. In other sectors such as steel, we may need to help suppliers to open up new product lines. Whatever the requirement, the industry and the Government are committed to bridging those gaps so that potential UK opportunities are not lost to other countries.

This report outlines the need for some 64,500 jobs (direct, indirect, induced) at peak, there are however gaps. The UK has historically had a strong capability in highly skilled engineering and geosciences; there is now evidence of an ageing workforce and gaps, driven by the downturn and lower investment during the years of low oil prices in the 1990s.

We have seen in recent years an encouraging increase in graduates with degrees in chemicals, geology, process and engineering, this report shows that we need to encourage them to join our industry. But more immediately, we have a gap in blue collar roles in drilling and completions. Due to the early stage nature of the shale industry, these skills do not exist yet.

Again the industry and the Government will need to work together in order that these gaps are identified and filled. With this skills awareness will come many opportunities for a new breed of engineer and scientist to join the oil and gas industry.

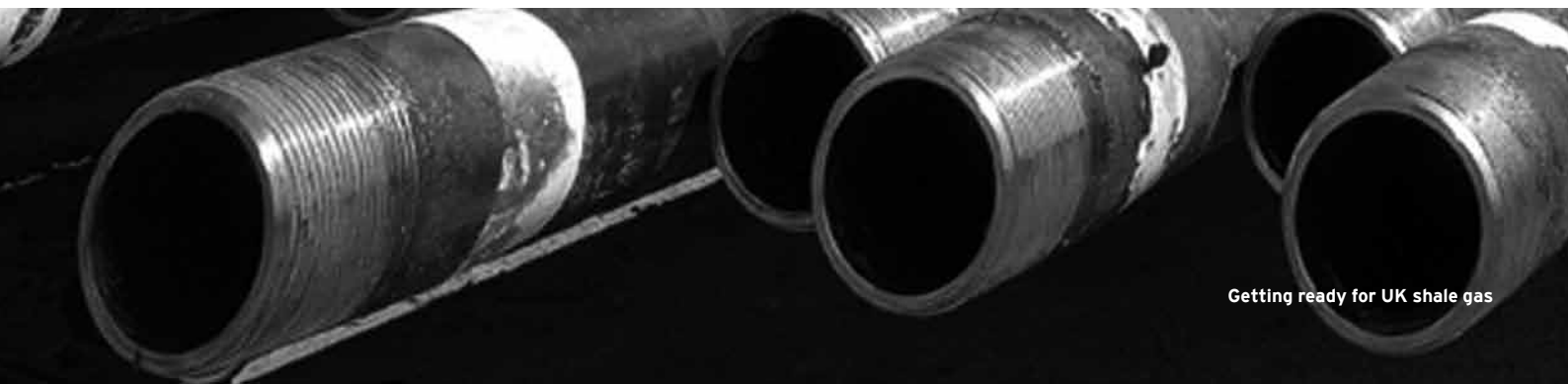
This report also highlights that the industry, in order to maximise the efficiency and potential economies of using a UK supply chain, must also provide information about a standardised approach to pad drilling and supply chain management. We will need to make a commitment to work together.

We have known for some time that the benefits to the UK in terms of energy security, tax revenues and the environment, were large. However, this report also underlines that other industries will significantly benefit too.

We have a lot of work to do in terms of working with the communities involved, understanding geology, flow rates and the cost base. Keeping the economic benefits in the UK of the supply chain is not a given, but the potential level of benefits as highlighted in this report should make it an economic imperative that we should make the best possible attempt.

Ken Cronin
Chief Executive

UKOOG United Kingdom Onshore Operators Group



Foreword

I welcome the findings of this industry-commissioned study which the Department for Business, Innovation and Skills was pleased to support. The report demonstrates the big prize that could be available to the UK in terms of jobs and manufacturing in the supply chain for our onshore oil and gas industry. Just as importantly, it makes clear what needs to be done to be ready to seize this opportunity.

The study is one of two reports on supply chains for our oil and gas industry. A parallel report maps the supply chain for the offshore industry, which started originally in the 1970s to meet the needs of the North Sea and has since grown to be a great British success story. The offshore mapping exercise shows that turnover from this existing supply chain increased from £24bn in 2008 to £35bn in 2012, creating 21,000 new jobs, whilst average salaries have increased to £47,000.

Moreover, exports now constitute 42% of total turnover, and have risen by £4.8bn since 2008. The positive benefits for the local economy around Aberdeen are well-known. What perhaps is less well recognised is that supply chain benefits are shared throughout the UK, and almost equally between Scotland and England. Well-paid, highly skilled jobs are supported throughout the UK, whether in Leeds, Glasgow, Belfast, Portsmouth, Bristol or Cumbria, and companies are exporting throughout the world.

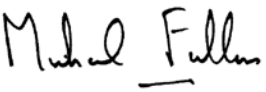
By comparison the onshore shale industry is still in its infancy in the UK. As we press on with exploration there is an opportunity for the supply chain, so that the benefits can be secured for the UK.

In his 2014 Budget the Chancellor made clear the Government's commitment to work with the industry to ensure the UK has the right skills and supply chain in place to benefit from the huge potential of the country's oil and gas resources.

The Oil and Gas Industry Council, consisting of Government and industry, will consider the recommendations, and come forward with specific proposals later in the year. In advance of that, I am pleased now to announce the launch of a £2m Technology Strategy Board competition designed to support innovation in key technologies to help the UK supply chain to serve the UK and global shale gas and oil markets. Additionally, the Government has recently committed a further £100m of investment to increase the global competitiveness of our manufacturing supply chains. This latest tranche of the Advanced Manufacturing Supply Chain Initiative opens for bids later this spring.

> "This report demonstrates the big prize that could be available to the UK in terms of jobs and manufacturing in the supply chain for our onshore oil and gas industry."

I want this report to be a call to action for the UK supply chain for small and large companies, whether in Lancashire or Lowestoft, whether in the steel industry, the chemical industry, or in other manufacturing and services. The message is to get ready for shale.



Michael Fallon
Minister of State for Business and Energy

Department for Business Innovation & Skills

Getting ready for UK shale gas

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Executive summary

The purpose of this report is to detail the supply chain and skills needed to develop Shale Gas reserves in the UK:

- This study was commissioned by the UK Onshore Operators Group (UKOOG) to identify any supply chain or skills blockages that will prevent the UK realising the economic potential of shale gas.

The report supports the numbers already published by the Institute of Directors in May 2013*. It identifies that over 2016–32 c.£33bn of spend could be required to bring up to 4,000 wells into production. At peak this equates to around £3.3bn of spend and some 64,500 jobs (6,100 of which are direct roles):

- The IoD published two scenarios in May 2013: a high case scenario (a single pad has 10 wells with 4 lateral sections each) and a low case scenario (a single pad has 10 wells with 1 lateral section each). The numbers reflected in this report are based on the IoD high case scenario of what a shale pad could look like.
- The focus is primarily on the upstream elements of the value chain where the majority of the activity will take place in the near term. Therefore the peak spend and jobs differ slightly but are consistent with those produced in the IoD report.

In 2014, the UK is at the start of onshore shale gas exploration:

- Cuadrilla has been active for some time in the Bowland-Hodder shale basin within Lancashire. The basin which stretches across the North of England from Lancashire to Yorkshire has been estimated by the British Geological Survey to have a most likely gas in place of 1,329 tcf.
- If safely and economically extracted, shale gas can develop a new onshore gas industry, which provides local employment and ensures a security of supply for the UK.
- In addition, Europe remains a significant – yet untapped – shale market; the UK has an opportunity to lead the development of that market and contribute specialised equipment and skills.

Key opportunities and requirements include:

- **Specialised equipment and skills for hydraulic fracturing totalling £17bn**

  This includes equipment such as pumps, trucks and blenders, which today are supplied to the industry by third parties and only partially from inside the UK. This sector provides a massive opportunity for UK-based oilfield service and manufacturing companies to get involved.

- **A £4.1bn waste, storage and transportation requirement**

  More work is required by industry, Government and regulators to understand what is possible with respect to localised and centralised services. In addition, investment will also be needed in order to bridge the gap as the industry grows.

- **A £2.3bn steel requirement in the UK**

  The industry will need over the next years some 12,600km of steel casing of specific diameter and quality. The report confirms that the UK has the ability to produce this amount at the right quality, but further research and development is required to make it a reality.

- **The potential for a new £1.6bn rig manufacturing industry**

  The industry will need up to 50 landward rigs at peak drilling activity and a number of workover rigs. Despite having the capability, UK fabricators are likely to need some initial support to bridge the gap between the current and the anticipated market requirement, in order that these rigs are ready in the right timescale and can be supplied from the UK.

- **A new market for existing UK businesses**

  The UK currently produces a number of the key components that will be vital for the UK shale industry including cement, sand, drilling fluids and transportation. Despite no theoretical supply constraints these companies will need to be kept informed and the shale industry will need to work on ensuring standardised practices and common infrastructure are planned and agreed.

- **A 64,500 jobs employment opportunity and a requirement to grow skills**

  64,500 jobs (direct, indirect, induced) will be needed at peak. These include highly-skilled direct site development roles with above-UK average salaries. The UK will need to standardise skill requirements and create a national institute of skills in order to address shortages and to provide the right opportunities for existing qualified personnel.

The oil and gas industry needs to act now to prevent shale gas supply chain and skills constraints. Our report recommends that industry groups, developers and government work together to:

- **Define an investment case to develop required skills at pace.**
- **Define common pad and hydraulic fracturing standards, setting detailed specifications for UK suppliers.**
- **Encourage investment for UK-based capabilities in specialised areas like steel, rigs, hydraulic fracturing equipment as well as shared infrastructure for water treatment, waste disposal and gas processing.**

* Getting Shale Gas Working', institute of Directors, May 2013

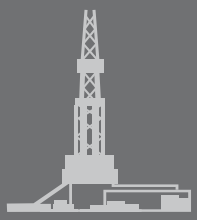
Getting ready for UK shale gas

Supply chain, skills requirements and opportunities

20m homes*

Potential number of UK homes heated by UK shale gas production at peak times

Estimated spend to bring UK shale wells into production between 2016 and 2032



4,000

Estimated number of horizontal wells to be drilled onshore for UK shale by 2032

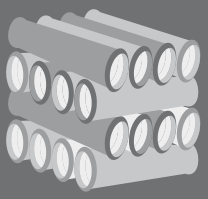
£20.5bn

Estimated spend on hydraulic fracturing between 2016 and 2032

50

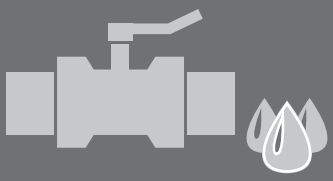
High-tonnage drilling rigs required for peak years

Estimated cost to build 50 high-tonnage rigs and required workover rigs



£2.3bn

Estimated spend on steel casing and heads between 2016 and 2032



£4.1bn

Estimated spend on drilling fluid and water waste management, including storage and transportation between 2016 and 2032

In the last four years, UK universities have seen:

41.1%

Increase in number of students graduates with a Chemicals, Process, and Engineering degree

21.7%

Increase in number of graduates with a geology degree

Workforce opportunities created by UK shale:

6,100

Site development (direct) jobs at peak

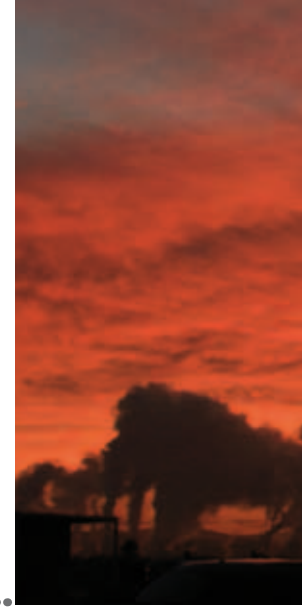
Up to six times the national average

£36,000 to £160,000

Typical salary ranges for direct site development jobs

* Getting Shale Gas Working', IoD, 2013

1 UK shale gas in context



- If the UK is to deliver 400 lateral wells per year at peak, then a new supply chain will be required, representing a significant opportunity to create new jobs.
- In this scenario, shale gas production could represent over a third of total UK annual consumption in the 2020s.
- The US experience indicates that the development of shale gas can help improve security of supply, and increase employment and investment that cascade into other sectors (e.g., manufacturing)

UK shale role in the future energy mix

The UK needs to secure its future energy mix and offset declining North Sea production. Whilst doing this, it must also reduce carbon emissions from reliance on coal power and ensure an affordable future energy supply for consumers.

Gas is vital to the UK. It heats more than 80% of homes and flows through a well-developed transmissions network.[1]

Shale gas will also impact continental Europe. Currently, 89% of Europe's annual gas demand is imported. Estimates suggest shale could reduce European import dependency by up to 27% by 2035.[2]

'UK shale provides us with a **long-term option** to buy energy locally rather than through imports'

UK chemical supplier

1 Developing Onshore Shale Gas and Oil – Facts about 'Fracking', DECC, December 2013
2 Macroeconomic effects of European Shale Gas Production, Poyry November 2013

UK shale potential

Recent estimates from the British Geological Survey (BGS) indicate that the gas in place in the Bowland-Hodder shale basin totals more than 1,300t cubic feet (tcf) (Figure 1). This compares to total UK annual gas consumption of around 3tcf.

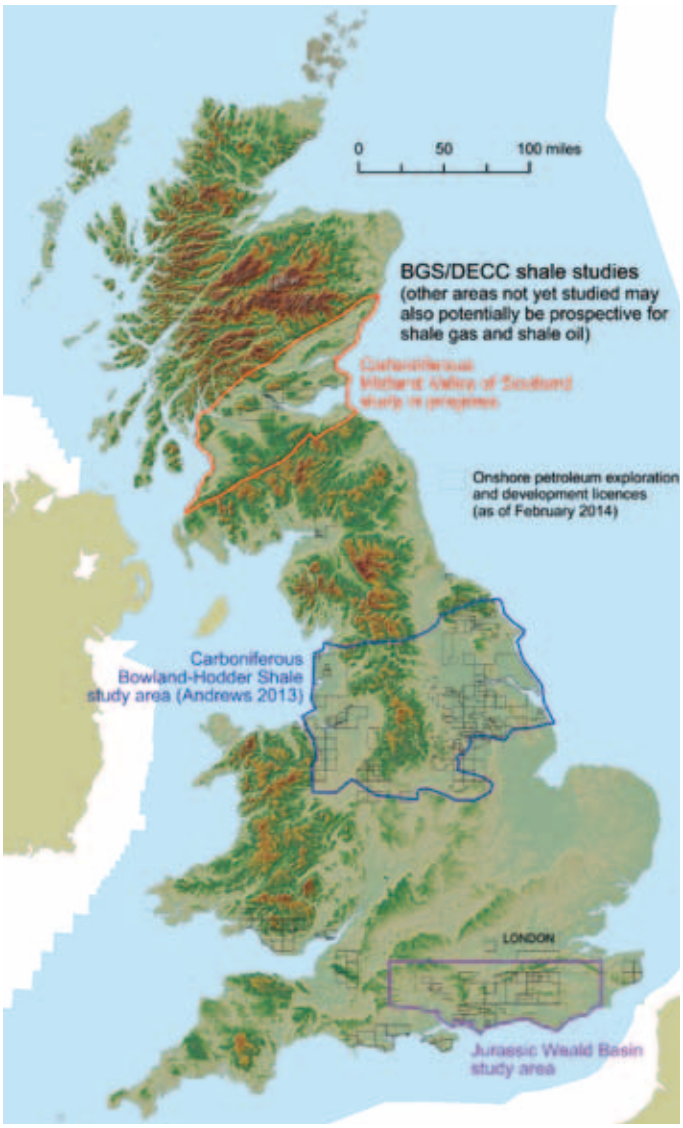
It is not yet possible to make any forecast of potential recovery rates, but there is clearly the potential for shale gas production to contribute a significant proportion of the UK's gas requirements. In its highest scenario, the IoD assessed that production could reach a level of more than 1 tcf in the 2020s.

'Equivalent to heating over 20m homes'[3]

What UK shale gas production levels could achieve at peak time

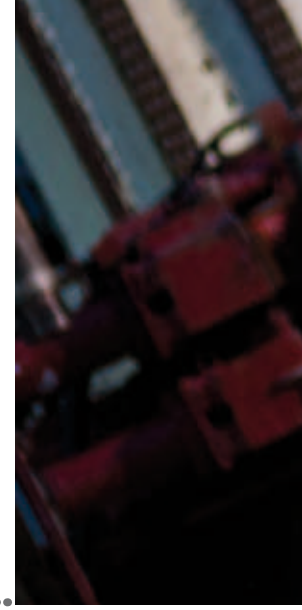
3 Getting Shale Gas Working', IoD, 2013

Figure 1: Bowland-Hodder Shale Basin study



Source: *DECC 2014*

2 Supply chain and skills requirements for shale gas



- £33bn could be required to bring up to 4,000 horizontal wells into production by 2032.
- Shale development requires a mix of existing onshore drilling expertise, as well as specialist equipment, services and skills.
- Critical roles for establishing the shale sector over the next 10 years include petroleum engineers, geoscientists, drillers, hydraulic fracturing personnel, planners, and health, safety and environmental experts.

2.1. Supply chain

The demand opportunity for the UK shale supply chain

In its high case scenario, the IoD report estimates that 4,000 lateral wells will be drilled over the period 2016-32.

In this period, total spend could reach £33bn. Figures 2 and 3 illustrate the five main categories of supply chain spend. These are hydraulic fracturing, drilling and completions, waste management, storage and transportation, and other, which includes spend on items related to pad preparation, construction equipment, security services, environmental impact assessments, etc.

Figure 2: Category breakdown of total spend based on IoD high-case scenario (%)

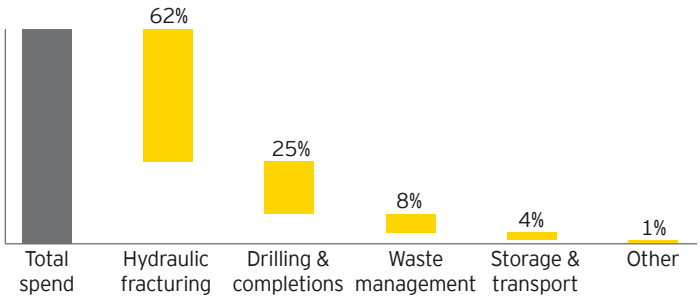
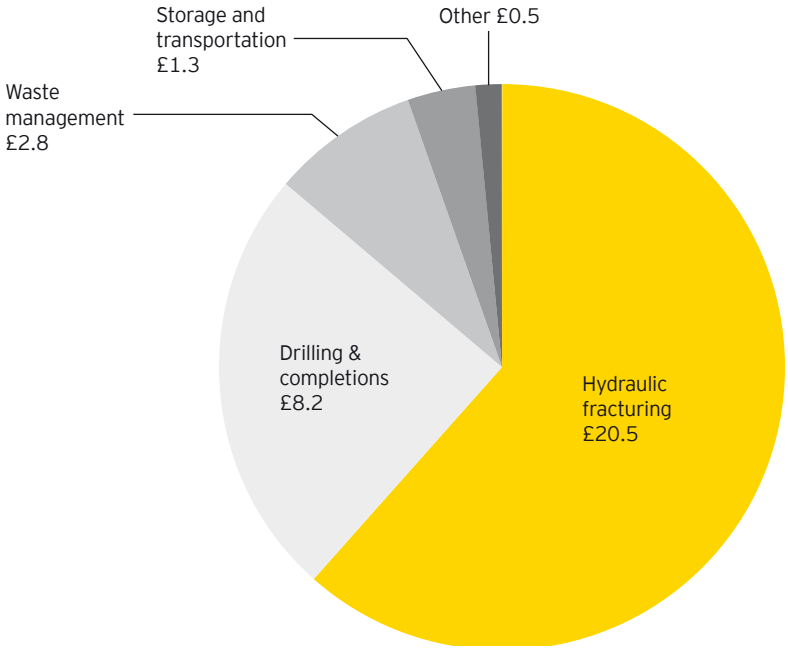


Figure 3: Category breakdown of total spend over 2016-32 (£bn)



Total spend for 2016-32 is c. £33bn

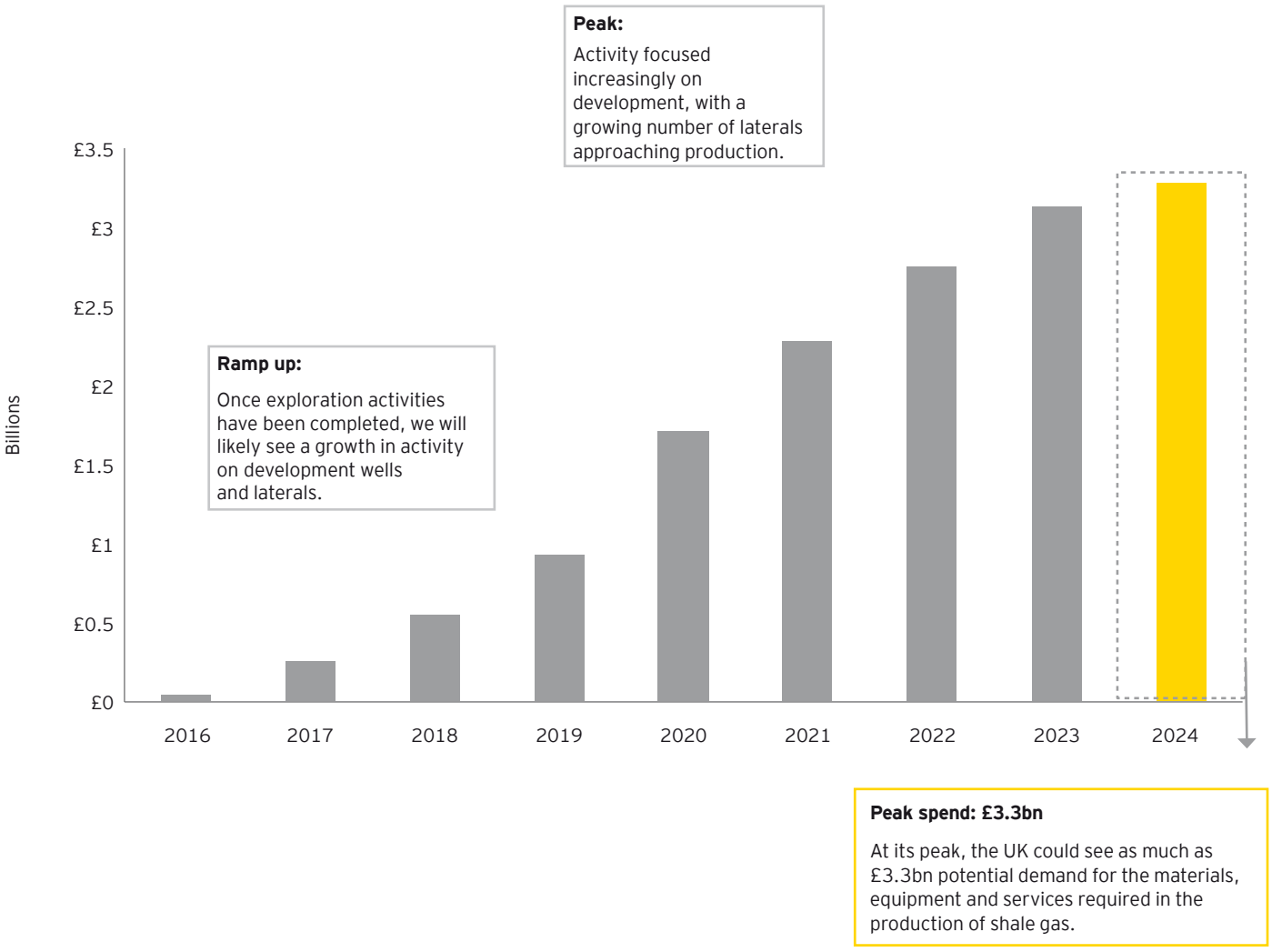
Understanding supply chain spend over time

We estimate that it will take six years to complete the exploration and development stages to bring a single pad with 40 lateral wells into production.

This means that annual spend would reach its peak levels around 2024 as shown in Figure 4.

Demand will change over time. The geological characteristics of the pad will be better understood with each new well development. The drilling days will gradually reduce over time as the number of wells drilled increases due to anticipated enhancement in efficiency.

Figure 4: Evolution of spend from exploration to development



Defining the supply chain for shale gas

Our approach to mapping out the shale supply chain builds on EY's global Oil and Gas Process Framework (Figure 5), which details the processes within a standard oil and gas value chain (upstream, midstream and downstream).

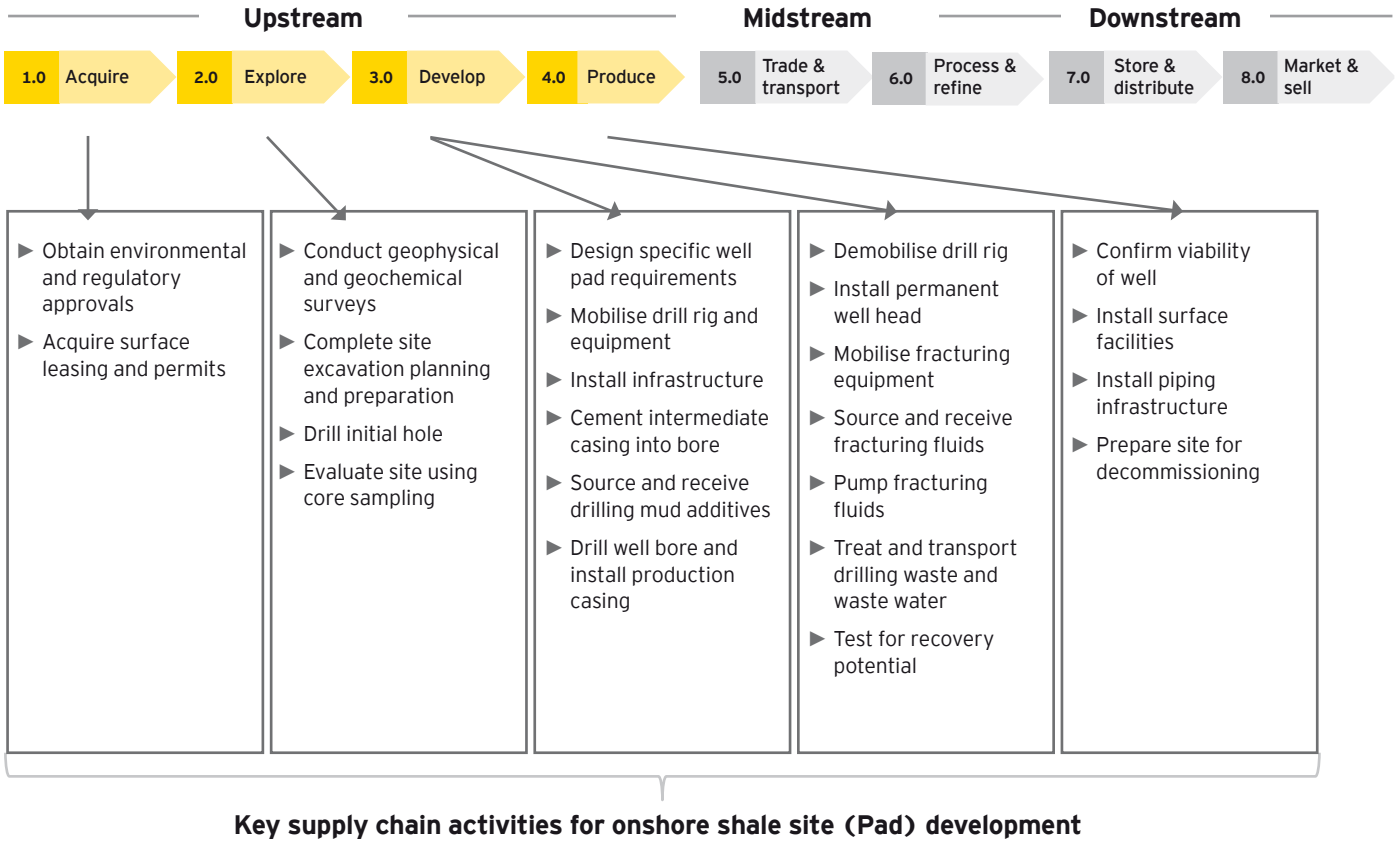
Given the industry is in the very early stages of development, the primary focus for this study is on the upstream elements of the value chain where the majority of the activity will take place in the near term.

These elements primarily consist of drilling and completions, hydraulic fracturing, waste management and storage and transportation activities.

Longer term, once production is in full flow, midstream and downstream activities (e.g., processing, transmission and distribution) are likely be supported, for the most part, by existing infrastructure.

The supply chain and skills model that underpins this study builds on the IoD high case scenario and uses a single shale gas pad with 40 lateral wells as a starting point. It looks at spend per pad per year and takes into account the fact that it will take up to 6 years to get a pad from exploration to production; and that at peak, different wells will be at different stages of development within one pad.

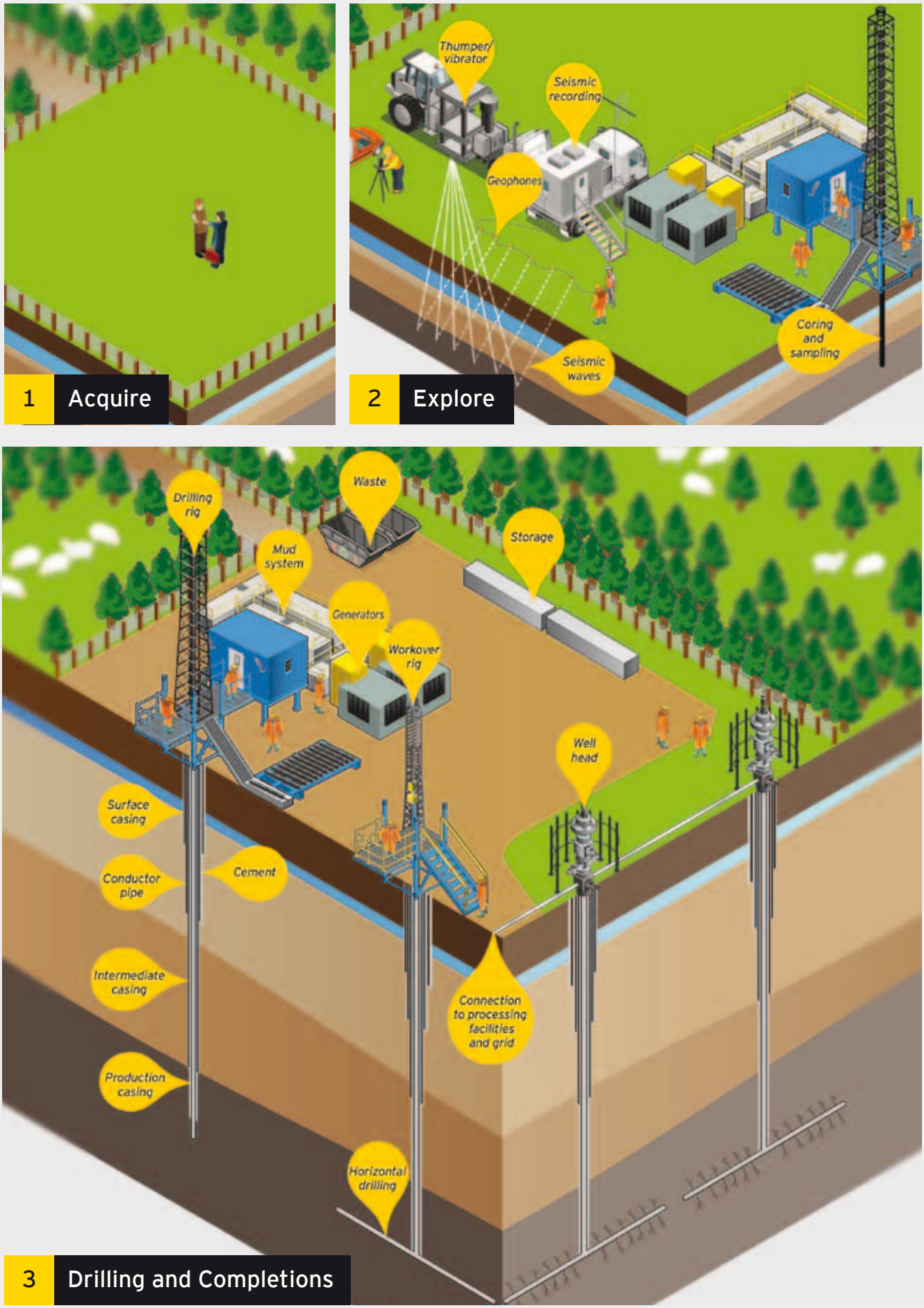
Figure 5: The onshore shale gas value chain and supply chain

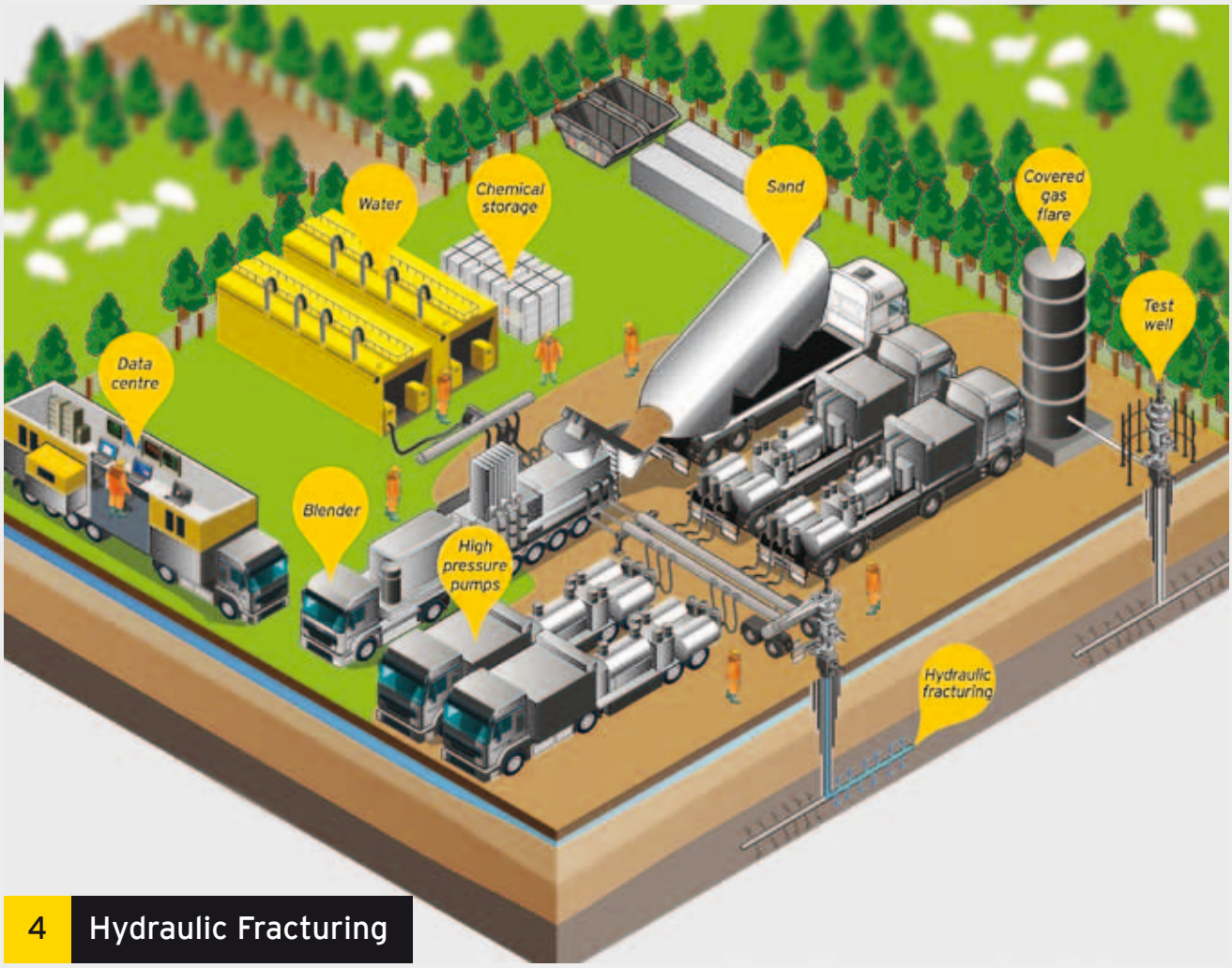


Understanding the core components and activities of the UK shale gas supply chain

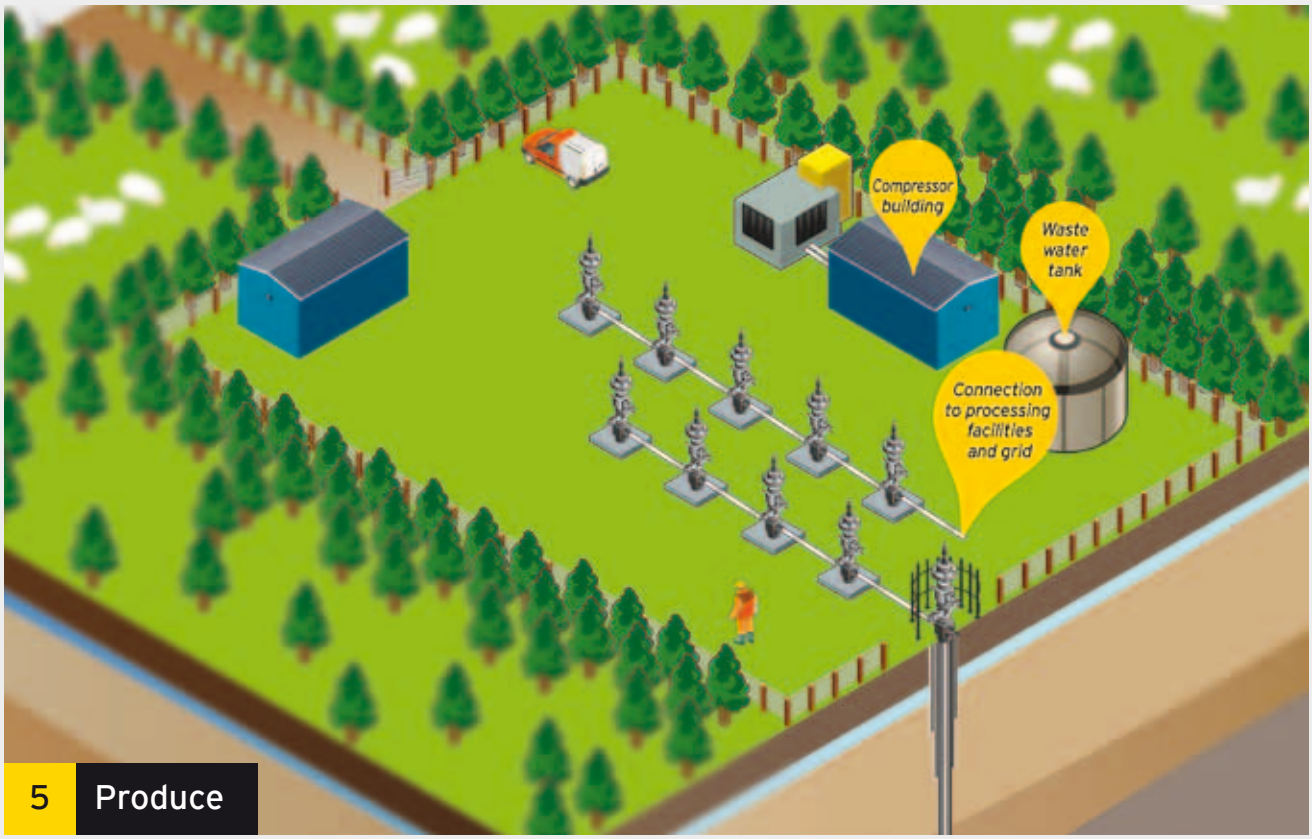
A pad will evolve over the stages, requiring different services and skills at each stage, as shown in this graphic.

Note: This graphic is for illustrative purposes only and is not fully to scale





4 Hydraulic Fracturing



5 Produce

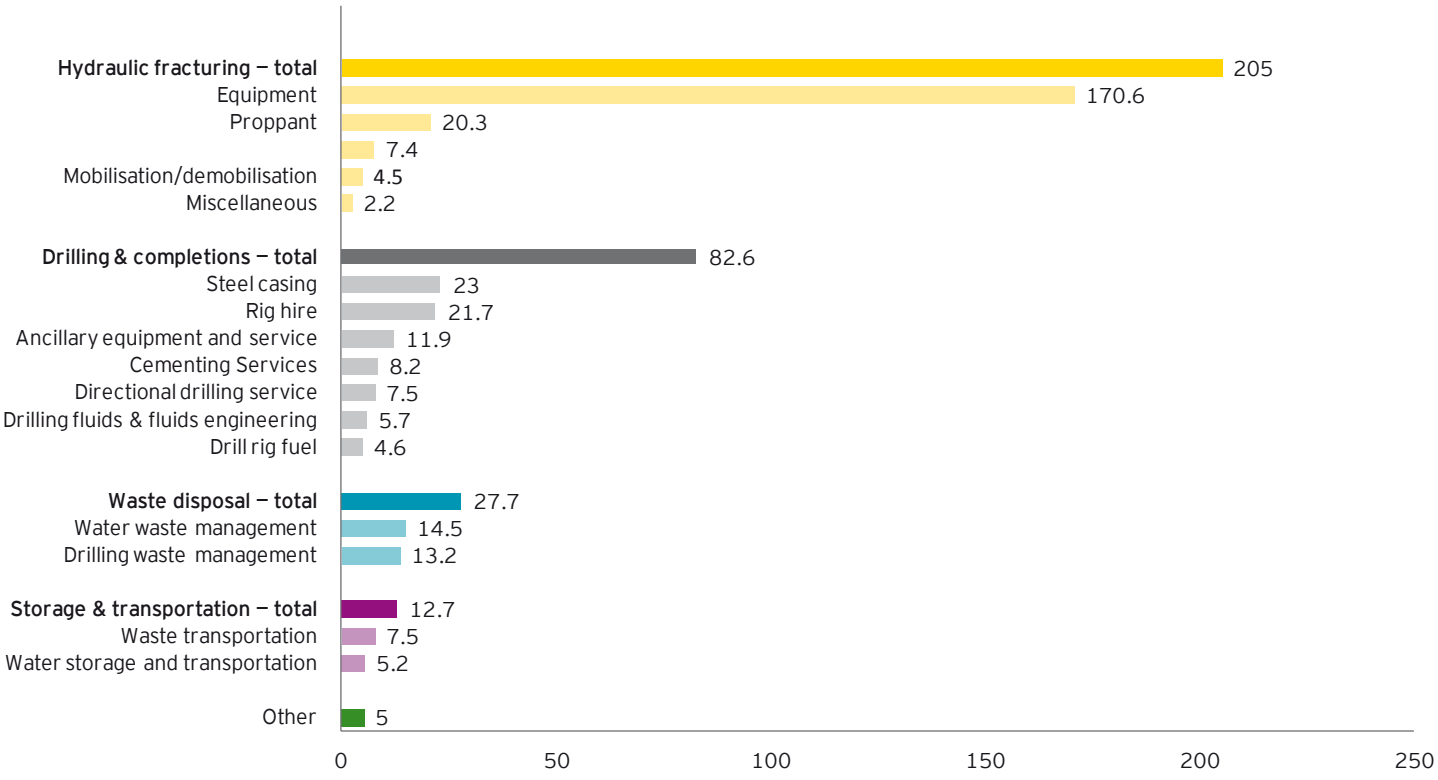
Breaking down a pad into its key supply chain components

In order to better understand the key components of each spend category, we have developed a view of spend required to bring a single pad on-stream.

Figure 6 outlines the breakdown of spend categories for a single pad with 10 vertical wells and 40 lateral wells, and illustrates the range of key materials, equipment and services required to bring these wells into production.

In this high case scenario, the spend split between hydraulic fracturing and drilling & completions is 2.5:1. In the lower case scenario (10 wells, 10 laterals) that ratio would likely be closer to 1.2:1.

Figure 6: Breakdown of spend £m categories for a single pad (10 vertical wells; 40 lateral wells)



To bring a single pad on-stream will require £333m

Note

The *Other* spend category includes components such as pad preparation, construction equipment and security services, which average about £380,000 per pad.

2 Supply chain and skills requirements for shale gas

2.2. Shared infrastructure

In terms of the infrastructure needed to support the industry in its development, there are four main areas:

1. Waste water management
2. Drilling waste management
3. Storage and transportation of materials and equipment to and from sites
4. Gathering and gas processing

Waste water management

After the hydraulic fracturing process has been completed, a proportion of that fluid will flow back up the well and will most likely require some treatment. This could be for bacteria or chemicals present in the original fluid mix, and, in some cases, for small amounts of naturally occurring radioactive materials (NORM).

The bulk of flow back volumes occurs in the first three months after completing the hydraulic fracturing process, with minimal amounts continuing to trickle up over the remaining life-cycle of the well. Consequently, there will be different treatment needs between the exploration, development and production phases.

Operators are keen to explore a mix of on-site water treatment technologies to help reduce traffic to and from sites and to improve operational efficiency, in particular for costs related to storage and off-site treatment.

There are also non-water based solutions currently being trialled in the US, which could be considered within a wider approach to reducing waste water volumes.

£5.9m

Portion of the £14.5m waste water disposal spend that covers costs for transporting 100% of waste water to an off-site treatment facility

Drilling waste management

During the drilling process, drilling fluids 'muds' are extracted from the wellbore and enter the mud tank system for processing. The muds circulate through the system so that drill cuttings and fine solids can be captured and removed from the recovered drilling fluids that are used in the drilling process.

In the US, it is common practice for these solids to be stored in a reserve pit next to the drilling rig. UK regulations would not permit this, instead requiring that such wastes are treated at an appropriate facility.

These treatment facilities employ a number of techniques to clean drilling waste by removing oil, potentially hazardous substances and waste water. There are then a number of disposal routes including, for example, recycling (e.g., composting, wetlands restoration) and landfill.

'If recycling technologies can be used on-site to treat drilling waste, you could see a **reduction of 70%** in the number of trucks required to transport solid waste offsite'

(waste management specialist)

2 Supply chain and skills requirements for shale gas

£1.1m

Average cost of storing water on-site over the drilling period of a single 40-lateral well pad

Storage and transportation of materials and equipment to and from sites

Finding the right balance between storage and transportation of materials and equipment will be key to addressing public concerns with traffic volumes and operational efficiency. Costs are associated with longer lead times to access sites because of road weight, height and width restrictions in the UK.

In addition, storage and transportation needs are intrinsically linked to the use of mobile on-site treatment facilities for water and drilling waste. If more treatment can be done on-site, this will reduce the volume of waste that will need to be transported off-site for treatment.

Possible solutions that would combine the on-site storage of liquid materials, such as water, chemicals or fuel, with a reduction in associated traffic could include temporary collapsible 'bladder' tanks, which are used by a number of industries, including the military, aid or agriculture. Operators could also consider sharing the costs associated with building centralised material and equipment warehouses.

£1.5m–£2m

Indicative charge for construction works for a new minimum offtake connection (MOC) at a National Grid greenfield site[4]

Gathering and gas processing

To monetise shale gas resources, operators will require access to the infrastructure that will deliver natural gas to consumers. In shale-producing regions in the US, production field wellheads deliver gas via gathering pipelines, either directly to interconnectors/market hubs or indirectly through a processing plant if the gas is 'wet' and requires treatment to comply with transmission tolerances.

The UK is expected to follow a largely similar process, which has been tried and tested in the biomethane sector, and would require shale gas to meet calorific value and gas quality standards. To do this, key steps would include enclosed flaring to establish commercial flow by providing sufficient volumes for sample testing of gas quality; and processing to clean and dry the gas if needed. Flaring is only used in early exploration wells.

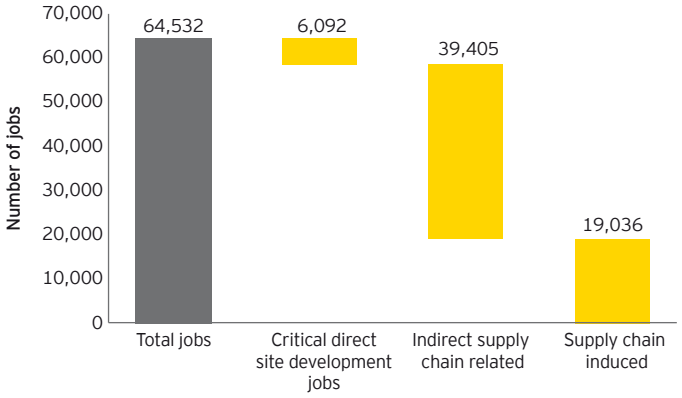
Connecting the processed gas to the National Transmission System (NTS) would be completed through a Network Entry Agreement (NEA) with National Grid. The requirement is for one NEA per entry point. The number of NEAs required will vary depending on whether operators choose to build individual connection points for each individual pad, or a single connection point from a shared processing plant covering multiple pads.

4 The Statement for Gas Transmission Connection Charging, http://www.nationalgrid.com/NR/rdonlyres/D2FD2718-68B8-47CE-ABC5-9BDC1881DF33/54531/Gas_Charging_Statement_June_2012V20.pdf

2.3. Skills

At peak, 64,500 jobs will be created. These jobs represent direct, indirect and induced roles involved in developing a shale pad from exploration to production – i.e., upstream activities. Similarly to the offshore oil and gas industry, the bulk of development activities is delivered by the wider supply chain, which support a smaller number of direct critical roles.

Figure 7: Direct, indirect, and induced jobs generated at peak



Note: These numbers do not include jobs related to midstream activities (e.g., processing, connection to Grid) or downstream (e.g., product sales and marketing, decommissioning)

For the purpose of this study, we have chosen to focus on direct roles and services considered critical to developing a shale pad. The categories for these roles include: drilling and completions; hydraulic fracturing; petroleum engineering and geosciences; planning approvals and permitting issuance, health, safety and environmental monitoring. Providing enabling services are roles and suppliers within operations management, construction, and office support categories. By unlocking the shale reserves, these roles are critical to opening up the wider supply chain opportunities (e.g., steel, rigs, ancillary equipment, cement, proppant, chemicals).

Figure 8: Overview of critical direct FTE roles

Skills category	Functions and services	Roles
Drilling and completions	▶ Drilling services ▶ Casing and cement services ▶ Drilling waste disposal ▶ Logistics management	▶ Crews (drilling, casing and cement and coiled tubing) including engineering services, front line supervisors and project management, derrick and equipment operators, apprentices and labourers (roustabouts) ▶ Mud loggers, geologists or geotechnical engineers ▶ Drill cutting and waste disposal vehicle drivers
Hydraulic fracturing	▶ Pressure pumping equipment and perforation set-up and operations ▶ Chemical and proppant supply ▶ Mixing and pumping fracturing fluid ▶ Waste management ▶ Micro seismic service	▶ Fracturing and perforating crews including engineering services, front line supervisors and project management, high pressure pump operators, perforating charge operators, blender operators, apprentices and labourers (roustabouts) ▶ Waste water treatment and disposal vehicle drivers ▶ Crane and tower operators
Petroleum engineering and geosciences (including environmental consultants)	▶ Evaluation and monitoring of field performance ▶ 2D and 3D seismic modelling ▶ Coring and field lab sample analysis	▶ Petroleum engineers ▶ Geologists and geophysicists ▶ Lab technicians ▶ Seismic crews (supervisors, equipment operators, observers and apprentices)
Planning approvals and permitting issuance, health, safety and environmental monitoring	▶ Review of planning applications from operators to permit the surface operations required to explore for and extract shale gas ▶ Monitoring of compliance with safety risk management requirements (e.g., well integrity) ▶ Advising local authorities on the scope of an Environmental Impact Assessment	▶ Local Planning Authorities ▶ HSE Well Examiners ▶ Environmental risk and impact assessment advisors

Figure 9: Overview of supporting FTE roles

Skills category	Functions and services	Roles
Operations management	▶ Site and facilities management ▶ Security services ▶ Fuel ▶ Waste disposal/cleaning ▶ Equipment inspections and maintenance	▶ Operations and maintenance technicians ▶ Security guards ▶ Fuel truck drivers ▶ Waste disposal vehicle drivers ▶ Trades services and apprentices (carpenter, electrician, plumber), construction labourers
Construction	▶ Pad site grading ▶ Construction of gathering facilities and pipelines ▶ Transport of construction materials	▶ Excavation heavy equipment operators ▶ Engineering (civil, mechanical, chemical, electrical) ▶ Project management ▶ Trades services and apprentices (carpenter, electrician, plumber), construction labourers
Office support	▶ Field services support including drilling, well completions, geology, health and safety, environmental monitoring, permitting, production planning, procurement, community relations, finance and administrative	▶ Field services support: drilling engineering, well completions, geological support, health and safety, approvals and permits, production and site planning, procurement and PR and community relations ▶ Finance and administrative professionals ▶ Marketing and sales professionals

'There is a huge wealth of expertise in this country, but very few have onshore expertise; shale provides an **opportunity to upskill** an existing talent pool'

(Environmental geologist)

Estimates of direct jobs have been prepared based on the IoD high case scenario whereby 100 pads will be developed over 2016–32. Each pad will contain 40 wells (10 vertical wells and 4 lateral sections) and take 6 years to get from exploration to production.

At the single pad level, throughout the six-year development lifecycle there is an average of 102 direct jobs required per year on each pad, with a spike in year 2 at 145 accounting for an initial ramp-up in drilling activity.

Using this pad profile, and the IoD case scenario activity schedule, the total number of site development (direct) jobs reached in 2024, and sustained until 2026, will be around 6,100 per year (Figure 10). Drilling and completions is the largest job category making up almost two-thirds (Figure 11).

Figure 10: Site development (direct) jobs annual ramp up profile to peak years (2024-26)

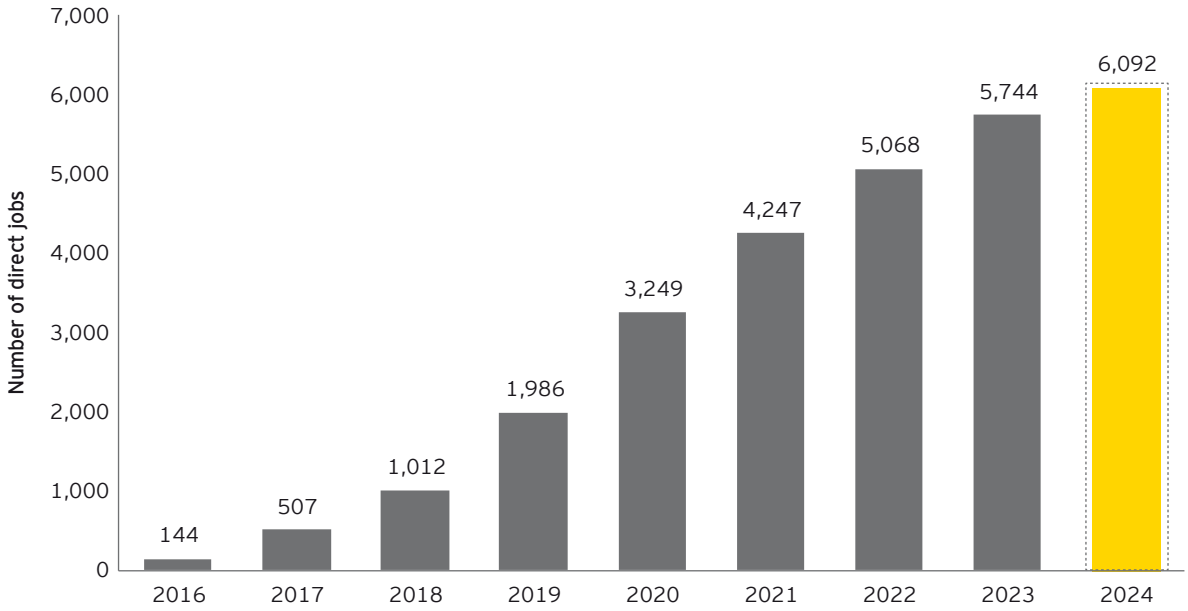
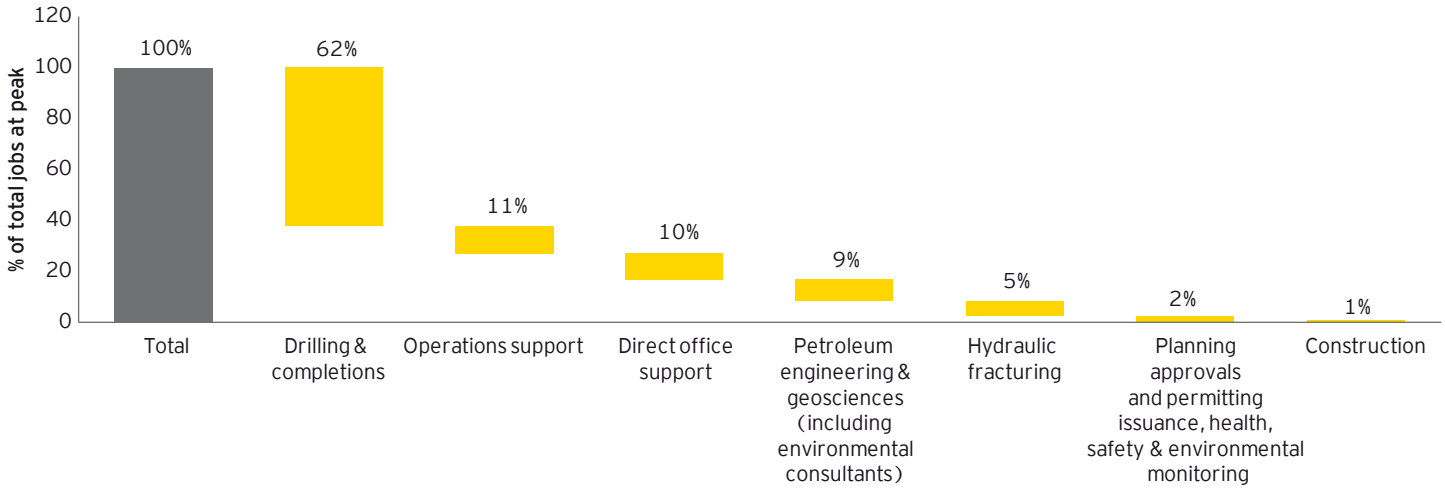


Figure 11: Percentage category breakdown of site development (direct) jobs at peak years (2024-26)



Based on the Hays Oil & Gas Global Salary Guide 2013, average salary ranges for key exploration and development roles demonstrate that most of the direct jobs critical to developing a shale gas pad command above-UK average salaries, as detailed below (Figure 12). Some of these roles could be worth up to six times the national average salary, and represent a significant opportunity for further development of those critical skills in the UK.

Figure 12: Salary ranges within site development job categories

Job categories	Salary ranges
Drilling	£52,156-£125,743
Geoscience	£40,573-£159,520
Health, Safety and Environment (HSE)	£38,146-£102,994
Reservoir/Petroleum Engineering	£35,926-£106,323
Process (Chemical)	£38,076-£115,201

Source: http://hays.clikpages.co.uk/Oil_and_Gas_Salary_Guide_2013/

3 UK opportunity assessment

- Shale gas production in the UK will require the development of a new onshore supply chain for equipment, services and skills, as well as reusing some of the offshore experience.
- Typically operators maintain in-house activities related to acquiring new licenses, geosciences, and engineering. The oil and gas industry purchases the majority of services from suppliers, demonstrating a large supply chain opportunity for shale gas.
- The UK should build modular, conversion courses specific to shale and offer international secondment opportunities to accelerate skills transfer.

Capability assessment of existing UK supply chain for shale gas

The UK has a long history of offshore and onshore oil and gas developments, including proven experience of hydraulic fracturing.

The UK has been drilling wells onshore since 1919 and since that date more than 2,000 wells have been drilled, about 10% of which have required hydraulic fracturing.

In addition, the UK began developing unconventional plays, such as coal-bed methane, in the 1990s. Due to these initial developments the supply chain for UK shale is not starting from square one.

In this section, we review the UK's ability to source the materials, equipment, infrastructure and labour required for each of the main categories of spend.

To understand where the strategic growth opportunities are for the UK supply chain, we have mapped key components of the shale supply chain against anticipated level of spend. Figure 13 illustrates supply chain category availability by size of spend opportunity.

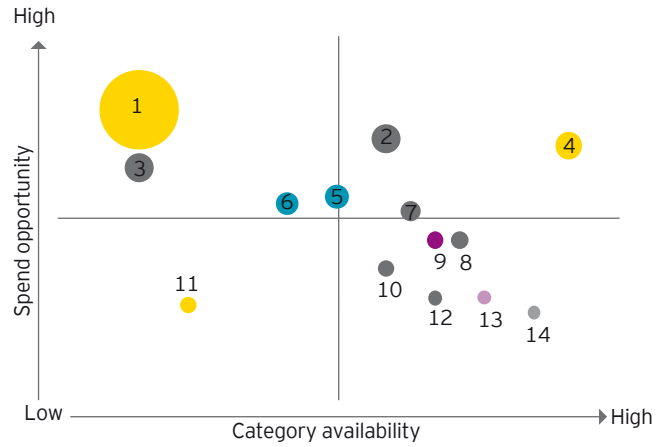
Assessing UK supply chain opportunities

The development of the UK shale gas industry will bring with it opportunities to establish a presence in new markets, such as the manufacturing of high-tonnage drill rigs.

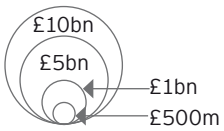
There will also be an opportunity for suppliers and service providers to supply existing materials, equipment and services to a new industry in the UK.

The following pages assess the spend opportunity for individual supply chain components, and identify current gaps and opportunities for capturing that spend within the UK.

Figure 13: Supply chain category availability by size of spend opportunity



Key: Size of bubble = Total estimated spend



- – Hydraulic Fracturing
- – Drilling and Completions
- – Waste management
- – Storage and transportation

1. Hydraulic fracturing equipment and personnel
2. Steel casing
3. Rig hire
4. Proppant
5. Waste water management
6. Drilling waste management
7. Ancillary equipment and services
8. Cementing Services
9. Waste transportation
10. Directional drilling service
11. Chemicals
12. Drilling fluids and fluids engineering
13. Water storage and transportation
14. Drill rig fuel

£20.5bn
Estimated total spend

Key: UK supply chain opportunity categorisation

- Existing market/no anticipated supply constraints
- Existing market requiring additional funding to ramp-up
- Significant investment required/new market

3.1. Hydraulic fracturing

Category overview

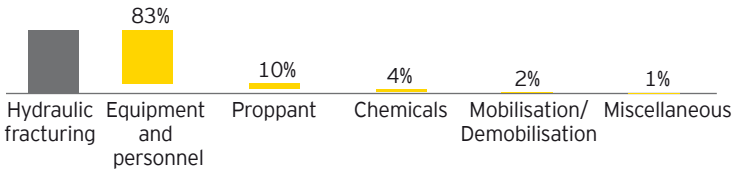
Hydraulic fracturing is typically purchased as a service provided by a third party.

Once a well is drilled it is fractured in order to release the gas. This means pumping fluids into the well at high pressures in order to fracture the shale rock.

A propping agent, such as silica sand is then used to allow fractures to remain open.

The spend in this category is highly dependent on the number of stages within a 'frac job'. Based on our high case defined with Oilfield Service companies and operators, there could be a total spend of £20.5bn through demand for specialised equipment and services, as well as key materials and skills.

Figure 14: Percentage split between key hydraulic fracturing components



Component	Estimated total spend opportunity	Strategic growth opportunity for the UK?	Capability assessment
Specialised equipment (including high-pressure pumps, trucks, and blenders) and personnel	£17bn	●	▶ The majority of basic pump units are currently manufactured outside of the UK. Yet assembly often happens in the UK if the unit is destined for a buyer in the EU region. And pipework and valves tend to be sourced from the UK where this subsector is strong. ▶ With intense activity comes the need to replace equipment more frequently – opportunities for the hydraulic fracturing equipment market include support services for using the equipment and parts replacement.[5]
Proppant	£2bn	◐	▶ According to the BGS, silica sand resources for shale will come from 20 existing UK foundry sand quarries, and there will be no availability issues.
Chemicals	£748m	◔	▶ There are no anticipated shortages in supply. Total volumes of chemicals required for shale are in fact relatively low – even at peak – which at this time makes the economic case for building production capability in the UK unlikely.

Recommended next steps

Hydraulic fracturing represents 62% of total spend over 2016–32: this is a significant opportunity for UK-based oilfield services companies, as well as UK manufacturing:

- The UK Onshore Operators Group (UKOOG), with the support of the Government, and supply chain companies should build an investment case for developing UK-based capabilities in specialised equipment and personnel for hydraulic fracturing. The investment case should include recommendations on bridging finance options to allow the supply chain to invest early enough to deliver on time.

5 "Shale holds much promise for equipment makers," http://processengineering.theengineer.co.uk/oil-and-gas/shale-holds-much-promise-for-equipment-makers/1011731.article, 15 February 2012.

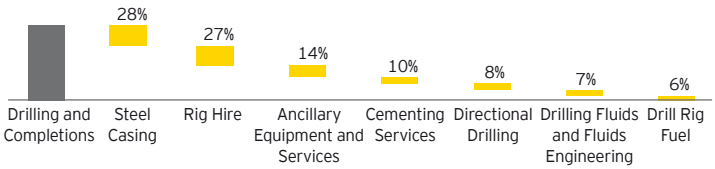
£8.2bn
Estimated total spend

3.2. Drilling and completions

Category overview

Drilling and completion refers to the drilling of vertical wells and subsequent horizontal lateral wells, and securing multiple layers of steel well casing using cement. Whilst the drilling and casing account for a large percentage of demand in this process, there are a number of additional materials, equipment and services that are required for the drilling and completion of shale gas wells, as shown below.

Figure 15: Percentage split between key drilling and completion components



Component	Estimated total spend opportunity	Strategic growth opportunity for the UK?	Capability assessment
Steel casing	£2.3bn		▶ There are two UK-based steel manufacturers that supply the UK offshore market. We understand that product development opportunities to meet the UK shale development requirements are being considered.
Rig hire	£2.2bn		▶ Many of the components of a drilling rig currently tend to come from North America, with some of the drilling equipment being supplied from Europe. Drilling crews follow the market; as the market for shale is not yet established in the UK, there is a shortage of drilling crews. ▶ Whilst it may be difficult for the UK to supply the core components of a drilling rig in the short run, many of the surrounding components could be sourced from the UK. ▶ An investment of c.£1.65bn would be required to deliver the workover rigs and 50 landward rigs needed for peak drilling activity.
Ancillary equipment and services	£1.2bn		▶ Whilst the UK has limited existing capability in the manufacturing of high-tonnage drill rigs, a number of companies currently focus on adding value by upgrading to the UK standards and through the provision and design of other ancillary equipment.
Cementing services	£819m		▶ There are four major cement manufacturers based in the UK, with operations across 11 sites. There are no anticipated shortages of cement supplies for the UK shale industry. Shale operators will tend to purchase a cementing service, which is generally performed by an international Oilfield Services company with established operations in the UK.
Directional drilling services	£747m		▶ Directional drilling is considered a highly specialised skill, which is usually purchased by shale operators from an oilfield services company. Once the market for shale is established in the UK, incentive for UK Small Medium Enterprises (SME) to develop this high-value competency further will increase.
Drilling fluids and fluids engineering	£571m		▶ Water- or oil-based drilling fluids are used to aid the drilling process. ▶ The supply of drilling fluids and associated fluids engineering services is not currently a constraint, but could become an issue as levels of drilling activity accelerate in the UK.
Drill rig fuel	£457m		▶ No supply shortages anticipated.

Recommended next steps

Steel, rigs and ancillary equipment and services represent a significant opportunity for UK investment, especially as some of the capability exists today. UKOOG, with the support of the Government, research councils, higher education institutions, and Oilfield Services companies should:

- Work with supply chain providers to gain a common understanding of pad and hydraulic fracturing standards, and R&D requirements.
- Expand the Fabricators' Directory to include detailed specifications ('nuts and bolts') of components required; and promote UK-based suppliers (including Small and medium Enterprises) with the capability to deliver to those specifications.

In addition, UKOOG, and supply chain companies should build an investment case, including finance options, for developing UK-based steel and rigs required to support UK shale development.

£4.1bn
Estimated total spend

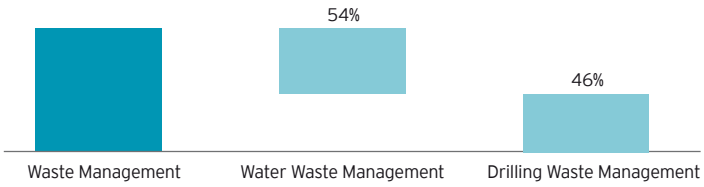
3.3. Waste management and storage and transportation

Waste management: £2.8bn

Category overview

The processes used to drill and hydraulically fracture a well create quantities of waste that must be treated.

Figure 16: Percentage split between key waste disposal components



Component	Estimated total spend opportunity	Strategic growth opportunity for the UK?	Capability assessment
Water treatment	£1.5bn		▶ UK has NORM water treatment facilities and capability to remove bacteria using UV technology which is a proven capability from UK suppliers. ▶ On-site water treatment technologies already exist, with some manufactured and/or distributed by UK-based suppliers. The use of such on-site treatment technologies and the type of on-site treatment authorised for re-injection should be discussed with the Environment Agency.
Drilling waste management	£1.3bn		▶ There are a number of drilling waste disposal facilities already established, which are mostly concentrated in the north of the UK. Feedback from interviews suggests that these facilities may not all have the required permits to treat NORM waste, and that increased capacity would be required to support the treatment and disposal of waste volumes that would be generated at peak. ▶ Mobile technologies exist to dewater drilling waste. If this process could be performed on-site, this water could then be added to the recycled volumes from the fracturing fluids. It would also decrease the volume of drilling waste needed to be transported off-site. Again, the use of such on-site treatment technologies should be discussed with the Environment Agency.

> 'On-site water treatment technologies: we excel at this and it's transferable to other sectors such as Nuclear, Construction, Offshore'
> (UK Petroleum Engineer)

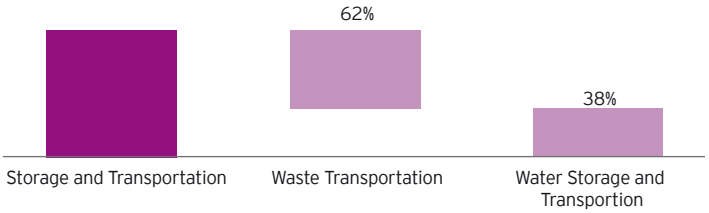
Storage and transportation – £1.3bn

Category Overview

In order to prevent bottlenecks in operations, storage and transportation of materials play a key role in the shale gas supply chain.

Water and waste are two supply chain elements that are likely to require more than £1bn of spend between 2016 and 2032 in transportation and storage costs.

Figure 17: Percentage split between key storage transportation components



Component	Estimated total spend opportunity	Strategic growth opportunity for the UK?	Capability assessment
Water storage and transportation	£523m		▶ The level of storage and transportation infrastructure required will vary depending on the proportion of treatment processes that can be conducted on-site. ▶ It will also vary depending on whether operators wish to collaborate on building shared infrastructure, such as material and equipment depots, where it is economically viable. ▶ There are no anticipated supply constraint for water storage and transportation facilities.
Waste transportation	£754m		▶ There is a large, existing waste transportation industry in the UK. ▶ Companies offering specialised waste transportation services for unconventional wells are already established, and do not foresee a supply constraint when expanding operations during the ramp-up phase.

Recommended next steps

Waste management, storage and transportation are categories of spend with significant interdependencies. Storage and transportation costs can be reduced if a proportion of water and drilling waste is treated on-site; or if facilities are located close to sites. Mobile waste water and drilling waste treatment technologies exist in the UK already:

- ▶ UKOOG, with the support of the Government, and supply chain companies should build an investment case, including finance options, for developing UK-based capabilities in shared infrastructure (e.g., water treatment, waste disposal facilities) required to effectively support UK shale development.
- ▶ UKOOG should engage with the Environment Agency on the types of treatment that would be authorised for re-injection and used to recycle waste water.

3.4. Other infrastructure: gathering and gas processing

Category overview

The processes used to drill and hydraulically fracture a well create quantities of waste which must be treated and disposed of.

There is an opportunity to learn from industries such as telecommunications, where they share mobile tower infrastructure.

Opportunities for shared infrastructure for UK shale include:

- **Gathering facilities:** a shared gathering facility could be built regionally to connect pads from different operators before being processed.
- **Gas processing plants:** dependant on the requirement to build processing plants, smaller plants could be shared on a regional level.

With the estimated ramp-up profile, these will not be needed for several years, providing an opportunity to use the time to plan and build in the concept of shared infrastructure into future business cases and development plans.

The connections process is well established, and coal-bed methane sites have provided a good template for this.

Connecting to the National Transmission System and UK gas distribution networks should be relatively straightforward, especially if the shale site is situated close to an existing entry point and/or entry points are minimised through the use of shared, centralised processing plants.

Situations in which sites are located further away from existing pipeline infrastructure would require additional pipelines to be built.

Recommended next steps

- UKOOG, with the support of the Government, and supply chain companies should build an investment case, including finance options, for developing UK-based capabilities in shared gathering and gas processing infrastructure required to effectively support UK shale development.

3.5. Skills

Category overview

For many of the skills required, there is a strong degree of commonality with offshore oil and gas, and with the chemicals industry. However, these related industries are already experiencing skills shortages of their own.

Given the significant lead times for training, unless early action is taken, there is a risk that the opportunity to maximise job opportunities for local people is missed and new demand makes existing skill shortages worse. Forward planning poses challenges whilst uncertainty still exists about the speed at which the shale industry will develop, but this should be possible to manage provided a partnership approach is adopted and the skills developed are easily transferable to related industries.

Partnerships between industry, education institutions and Government have been shown to reap rewards. In Aberdeen, for example, universities, such as Robert Gordon are working with operators and service companies to tailor courses to meet the industry needs. Similarly, in the US shale sector, state legislatures are investing in training centres alongside industry funding.

The UK Government has recently set out its ambition to develop a new generation of elite vocational institutions[6]. The first of these will support major, long term investments in Nuclear and HS2. They are industry-led. Their training is directly tied to the needs of employers in strategic, high-value industries, and they are financed by government and employers working in partnership. Their aim is to develop a world-renowned training regime.

A case could be considered for an elite vocational institution to meet the future skill needs of the shale industry, particularly if looked at in conjunction with offshore oil and gas and chemicals. This would not necessarily need to be based in a single location but could operate on a hub and spoke model, perhaps making use of some of the excellent facilities that are already available in higher education institutions.

UK Research Councils

Research Councils in the UK would also have an important role to play, particularly in supporting skills development and innovative technologies for onshore shale.

In its 2013 Impact report,[7] Research Councils UK (RCUK) highlights that 'combined grants from RCUK and the Technology Strategy Board in excess of £6m have contributed to the success of Marine Current Turbines (MCT).' Funding was used to develop, prove and build new turbine technology.

The Natural Environmental Research Council (NERC) now has an increased focus on oil and gas. This includes a new Centre for Doctoral Training, which through a consortium of leading HE institutions working with oil and gas companies is increasing PhD funding and establishing training academies that focus on critical issues such as improving the production effectiveness of unconventional hydrocarbon resources.

> 'We have an opportunity to build a brand for the UK and deliver a platform for academic excellence'
>
> (UK education institution)

6 https://www.gov.uk/government/speeches/the-skills-summit-importance-of-technical-and-vocational-training

7 http://www.rcuk.ac.uk/RCUK-prod/assets/documents/publications/2013Impactreport.pdf

Roles and skills assessment

In terms of role categories for management, commercial, legal and other professional services, semi-skilled blue collar and administrative, supply constraints are not anticipated. In addition, the UK has a very well established construction industry and as a result provides a strong supply of construction workers.

Critical role categories	Is this a strategic development opportunity for the UK?	Capability assessment
Petroleum engineering and geosciences (including environmental consultants)		▶ The UK has historically had a strong capability in highly skilled engineering and geosciences but this resource pool has suffered from the economic downturn and is showing evidence of an aging workforce. ▶ 2% of all graduates and 3% of non-graduates in 2013 were employed in the job category covering the energy sector.[8] There are encouraging numbers of new graduates with relevant qualifications coming through in the last four years from UK universities[9], such as 41.1% increase in the number of graduates with a chemicals, process and engineering or 21.7% increase in the number of graduates with a geology degree. ▶ There is an opportunity to build on recent positive trends and offer geology, and chemicals, process and engineering graduates modular courses and international secondment opportunities to develop the expertise required to support shale pad developments.
Drilling and completions		▶ Currently, the UK is likely to encounter difficulties staffing skilled blue collar roles involved in drilling and completions, and in particular those requiring directional drilling expertise, using local resources. The infancy of shale in the UK creates demand uncertainty, which in turn is delaying investment in hiring and training of drilling and completions crews. The gap is also a result of favourable remuneration and stability of working contracts in the offshore industry. ▶ Setting up international secondments of UK drillers to North America would help accelerate the development of practical skills required for shale.
Hydraulic fracturing		▶ It is difficult to attract experts in the hydraulic fracturing of shale to the UK as the market has not yet been developed and the UK is competing with other international markets for those skills. ▶ The opportunity for the UK lies in developing hydraulic fracturing engineers with expertise of local shale geology and a rigorous understanding of the EU/UK planning process.
Planning approvals and permitting issuance, health, safety and environmental monitoring		▶ Planning permission is required for both exploration and production stages. We expect more resources will be required to develop and process applications. ▶ Onshore oil and gas operators are required to hold the relevant environmental permits from the Environment Agency (EA) before they start operations. The regulatory work performed by the EA is self-funding through fees charged for environmental permits; current assessments suggest that the EA has sufficient technical resources and can scale up as and when the industry does. ▶ With regard to the Health and Safety Executive (HSE), it is noted on their website that 'HSE has sufficient wells expertise to cope with the current exploratory phase of shale gas but would need to reassess the situation if it moved into large scale production.'[9]

Recommended next steps

There is existing capability in the UK today for petroleum engineering and geosciences, drilling and completions, and planning approvals and permitting issuance, health, safety and environmental monitoring – however it is constrained and will require investment to meet the industry's needs during ramp-up.

There is currently limited capability in the UK for hydraulic fracturing engineers. Lead time to develop a hydraulic fracturing engineer with the right level of experience could be as long as five years and developing a new training programme could take up to four years.

In addition, there are already shortages in related offshore and chemical industries, and therefore a risk that these are further exacerbated by the take-off of shale.

To accelerate skills development and address existing constraints and gaps, UKOOG, with the support of the Government, research councils, higher and further education institutions, and Oilfield Services companies should:

- ▶ Define a set of standard skills, qualifications and/or accreditations required by operators for staff to work on shale projects.
- ▶ Define a plan and the investment case to develop required skills at pace (e.g., modular apprenticeships and courses, gold standard accreditations, establishment of a 'National Skills Institute for Shale' or Technical Centres of Excellence/Hubs in the UK, exchange programmes with other countries).

8 Source: http://www.hesa.ac.uk/index.php/content/view/1973/239/
9 http://www.hse.gov.uk/shale-gas/about.htm

3 UK opportunity assessment

4 Getting ready for UK shale gas

- We are at the start of the development cycle with limited exploration results. So the pace and scale of shale growth is uncertain.
- The economic impact of shale for the UK could be significant – the Government and the industry are addressing existing challenges such as social acceptance and streamlining regulation whilst ensuring it remains robust.
- The oil and gas industry needs to act now to prevent supply chain and skills constraints.

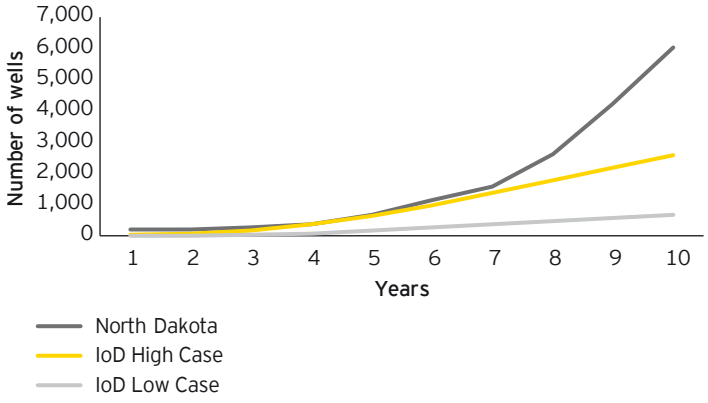
4.1 Pace of growth of the UK shale industry

The US has shown a rapid development path. The UK, however, has more challenges to overcome, so we expect a more gradual growth – at least in the near term.

The pace of growth in the US is highlighted in Figure 18 below which shows the rate of growth for the Bakken region situated in North Dakota compared to the High Case (4,000 wells drilled by 2032) and Low Case (1,000 wells drilled by 2032) scenarios published by the IoD.

A regular review of progress against the broader challenges through the development of options similar to the UK power market ('Slow Growth', 'Gone Green', and 'Accelerated Growth') scenarios would give the supply chain confidence to sustain investment.

Figure 18: Scenarios for growth in the number of shale-producing wells in the UK compared to North Dakota



Source: IoD Getting shale gas working, North Dakota Department of Mineral Resources Drilling and Production Statistics

Small to mid-size independent operators are the main industry players currently active in the UK onshore oil and gas sector. Typically, they do not have the balance sheet strength or financial flexibility of the majors. The uncertainty around the potential and pace of development makes access to funds needed to train crews and purchase equipment difficult.

To minimise investor risk, a number of operating models designed to increase the flexibility of those players are emerging. These include joint ventures and/or strategic partnerships between:

- International oil and gas companies (e.g., Total, GDF Suez, and Centrica) and smaller shale operators
- Shale operators and suppliers
- Suppliers with complementary skills and service offerings who, by pooling their resources, are positioning themselves to compete against the larger international players
- UK-based international oilfield services and manufacturing companies to plug gaps in British industrial capability, particularly around rig manufacturing

How the UK North Sea industry started:

- After the discovery of oil in the North Sea in the 1970s, one point of coordination was created by the Government (the Offshore Supplies Office) to ensure efforts were made early on to build domestic capacity for oil and gas extraction.
- It also had a role to play in connecting international oil companies with potential British suppliers and supporting the latter's marketing efforts at home and abroad.
- This led to the UK achieving and maintaining in excess of 70% domestic content in UK North Sea expenditure.
- Moving forward, onshore shale in the UK will form part of the remit of the Oil & Gas Industrial Council.

How the US shale industry started

In addition to a favourable mineral rights ownership framework, the US shale sector benefited from a number of critical enablers:

- **Early investments and access to capital.** The preparedness of the financiers, primarily private equity firms, who were offered appropriate incentives to fund the exploratory drilling and completion programmes.
- **A well-established conventional onshore oil and gas supply chain.** Operations were located in regions where there was a history of conventional onshore oil and gas exploration. Shale operators were able to exploit existing capabilities and knowledge.
- **Local business innovation by small, independent operators and suppliers.** Smaller independent companies dominated the shale industry in the US. These companies pioneered the development of techniques for hydraulic fracturing and horizontal drilling and were able to respond more quickly to the opportunity than their larger peers and competitors.

Key considerations for UK shale as it prepares to ramp-up

Whilst still in its infancy, there are a number of factors that will influence the pace of development in the sector:

- **Forecast growth in natural gas demand:** UK Continental Shelf (UKCS) oil and gas projections forecast that UK demand for gas will grow by 8.3% between 2013–30[10].
- **Established conventional onshore and offshore oil and gas supply chain:** the UK has a long history of conventional hydrocarbon exploration, development and production, both onshore and offshore. The offshore supply chain – which includes reservoirs, wells, facilities, marine and subsea and support services – represents an experienced £35bn industry with over 1,500 companies and 200,000 employees. This has led to the development of significant capability in many aspects of the supply chain[11].
- **Most well-established liquid spot gas trading hub in Europe, and presence of private equity players:** both factors mean shale gas is worth considering as part of a wider energy mix for the UK.
- **Export potential:** by investing in specialised equipment and skills, the UK can take a leadership position in shale gas; for instance, a recent study[12] suggests the UK is in a strong position to innovate in environmental management technologies such as fluid management, seismic monitoring and emissions monitoring and control. Combined with a strong regulatory regime, these disruptive technologies could establish a sustainable competitive advantage for the UK in Europe.
- **Positive political will:** the UK Government recognises the potential of shale gas to provide the UK with greater energy security, growth and jobs, and is encouraging the safe and environmentally sound development of the industry to go ahead as quickly as possible.
- **Demand uncertainty:** private sector exploration firms are cautious about commitment due to geological uncertainty and resource estimates potentially subject to large revisions. In turn, demand uncertainty means there are currently limited incentives for capital markets to provide affordable financing.
- **Equipment availability:** expensive and lengthy modifications are required for existing equipment to become compliant with EU regulations and the UK Town and Country Planning Act.
- **Local community benefits:** unlike the US, ownership of hydrocarbons sits with the state, not individual land owners. To address this, the UK Onshore Operators Group (UKOOG) now require 1% of production revenues to benefit local communities.
- **Social acceptance:** unfavourable public perception related to potential environmental concerns and messaging around the disruption to local communities are starting to be addressed through the engagement activities led by the Office of Unconventional Gas and Oil.
- **Permitting process:** permitting and planning processes, especially at local level, are being streamlined – currently bespoke permits from the EA are issued within 13 weeks, and from Summer 2014 standard rules permits could start reducing this timeline to two weeks (subject to consultation).

> 'For a new basin, we would expect to have 40 local suppliers (within 50km of the pad) in the first year, and then doubling each year thereafter. If there is drilling going on in the area for more than one year, over time we would expect two crews to be based within 50km of the well site.'
>
> (UK onshore operator)

Recommended next steps

- Make implementation of the recommendations in this report a priority for the Oil and Gas Industry Council to oversee over the next 12 months.
- The Technology Strategy Board should identify where there are opportunities to develop and deploy new technologies and align support through its innovation programme.
- Government should review existing early stage financing options, including inward investment, building on relevant research by the Business Bank.

10 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/287001/production_projections.pdf
11 UK upstream oil and gas supply chain: Economic Contribution, April 2014
12 OTM Consulting Limited, UK business opportunities for innovation in the extraction and utilisation of shale gas

4.2. Recommendations

Given the opportunities and requirements identified in this report, central and local Government, regulators, industry groups and operators need to act to prevent supply chain and skills constraints. To drive this forward, the Oil and Gas Industry Council should oversee the implementation of the following recommendations.

Skills development

Summary of gap:

- There is existing capability in the UK today for petroleum engineering and geosciences, drilling and completions, and planning approvals and permitting issuance, health, safety and environmental monitoring – however it is constrained and will require investment to meet the industry's needs during ramp-up.
- There is currently limited capability in the UK for hydraulic fracturing engineers. Lead time to develop a hydraulic fracturing engineer with the right level of experience could be as long as five years and developing a new training programme could take up to four years. In addition, there are already shortages in related offshore and chemical industries, and therefore a risk that these are further exacerbated by the take-off of shale.

Recommendations:

The UK Onshore Operators Group (UKOOG), with the support of the Government, research councils, higher and further education institutions, and Oilfield Services companies to:

1. Define a set of standard skills, qualifications and/or accreditations required by operators for staff to work on shale projects.
2. Define a plan and the investment case to develop required skills at pace.

Existing supply chain

Summary of gap:

- There are significant supply chain opportunities for existing businesses in the UK, e.g., steel and cement providers but not enough is understood about specific requirements of the shale industry.

Recommendations:

UKOOG, with the support of the Government, research councils, higher education institutions, and Oilfield Services companies to:

3. Work with Supply chain providers to gain a common understanding of requirements identifying in particular R&D needs.
4. Define common pad and hydraulic fracturing standards.
5. Expand the Fabricators' Directory to include detailed specifications ('nuts and bolts') of components required for onshore shale development; and work with the Government to promote – domestically and abroad – UK-based suppliers with the capability to deliver to those specifications.
6. Work with the existing Government schemes, e.g., the Manufacturing Advisory Service (MAS) to raise awareness of the supply chain opportunities for existing businesses, particularly Small and Medium Enterprises (SMEs).

New opportunities

Summary of gap:

- Rigs, ancillary equipment and services, waste disposal represents a significant opportunity for UK investment, especially as some of the capability exists today.
- However gaps exist especially in rig and fracturing equipment manufacture and in new technology requirements around waste water treatment and other environmental considerations.
- Gaps are exacerbated by the need for capital to bridge the gap between the start-up phase and the need to be ready for full production.

Recommendations:

UKOOG, with the support of the Government, and supply chain companies to:

7. Build an investment case for developing UK-based capabilities in specialised materials and equipment (in particular steel, rigs, hydraulic fracturing equipment) and shared infrastructure (e.g., water treatment, waste disposal, gathering and gas processing facilities) required to effectively support UK shale development. Investment case should include recommendations on bridging finance options to allow supply chain to invest early enough to deliver on time.

UKOOG to:

8. Engage with the Environment Agency on the types of treatment that would be authorised for re-injection and used to recycle waste water.

The Technology Strategy Board to:

9. Identify where there are opportunities to develop and deploy new technologies and align support through its innovation programme.

The Government to:

10. Review existing early stage financing options, including inward investment, building on relevant research by the Business Bank.

Glossary

Shale	An impermeable rock which can be rich in oil and gas
Pad	A section of land within a license area, upon which multiple wells are drilled.
Well	A vertical or horizontal bore hole drilled through the Earth's surface in order to access reserves.
Lateral	A well which has been drilled horizontally outwards from the vertical section. A well may consist of a vertical section with multiple laterals.
Hydraulic Fracturing	Once a well is drilled it is fractured in order to release the shale gas. This means pumping fluids into the well at high pressures in order to fracture the shale rock. A propping agent, such as silica sand is then used to allow fractures to remain open.
Acquisition	Upstream activities that relate to obtaining environmental and regulatory approvals; and acquiring surface leasing and permits.
Exploration	Upstream activities that relate to conducting geophysical and geochemical surveys; completing site excavation planning and preparation; drilling initial test wells; and evaluating reserves using core sampling.
Development	Upstream activities that relate to bringing a shale pad on-stream, i.e., into production. Activities in this stage include the preparation of a pad, the design of well requirements, the drilling and completions of wells, the hydraulic fracturing of lateral sections, waste management, and installation of permanent well heads. This stage is where the greatest volume of activity occurs.
Production	Upstream activities that relate to confirming the viability of wells; and installing surface facilities and pipeline infrastructure to connect to processing facilities and the distribution system
Peak	Refers to the period of activity during which supply chain spend is expected to be greatest. We estimate spend to peak at £3.3bn per year from 2024 through to 2026.

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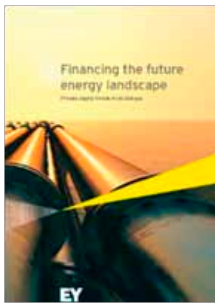

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This report, commissioned by Energy UK, considers the energy sectors economic contribution to the UK Economy considering investment in the industry, job creation and the empowering of energy consumers.

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Commissioned by Oil & Gas UK with support from Department for Business Innovation and skills, the Department for Energy and Climate Change and the Scottish Government, we've created two reports that consider the UK offshore supply chain, the value it creates for the economy and the value of its exports globally. The reports are split into two parts – Economic contribution and Market intelligence.

The UK upstream oil and gas supply chain: Economic Contribution

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UKOOG commissioned EY to produce 'Getting ready for UK shale gas', providing a common view of the supply chain for UK shale with the aim of helping parties to prepare and avoid blockages that might slow progress.

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