IGas Energy plc and Peel Environmental Ltd

# Potential Economic Impacts of Shale Gas in the Ocean Gateway

## Final Report


June 2014

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# Executive summary

AMION Consulting was appointed by IGas Energy plc (IGas) and Peel Environmental Ltd to undertake an independent assessment of the potential economic impacts of extracting shale gas in the Ocean Gateway area, which covers Liverpool, Manchester, Cheshire and Warrington.

Shale gas is natural gas but is often termed 'unconventional' as it is located in geological formations that previously prevented extraction in a commercially viable way. The process has seen significant growth over the last decade, particularly in the US, through the combination of horizontal drilling and hydraulic fracturing techniques. More recently, shale gas extraction activity has started to occur in Canada, South America, Asia, Australasia and Europe.

There has been relatively little research on the potential economic impacts of extracting shale gas, apart from in the US where operations are most advanced. However, there is a growing body of research now emerging in the UK. The US and recent UK evidence has shown that the process of shale gas extraction requires at peak times large volumes of labour, specialist suppliers and expensive capital equipment.

This assessment of economic impact has considered the six main stages of activity involved in shale gas extraction:

- *'enabling'* - the preparation required to secure planning consents and other permissions alongside development planning for each site concerned;
- *'site preparation'* - including all site (or pad) design and civil engineering works;
- *'exploration and appraisal'* - preliminary drilling and flow testing of vertical wells;
- *'development and distribution'* - the drilling-out of vertical/lateral wells on a site (or pad) as well as connection to any network infrastructure;
- *'operation and maintenance'* - the activities necessary to ensure safe, efficient flow of gas; and
- *'decommissioning'* - all activities necessary to seal and abandon wells, remove all equipment and reinstate the site to its prior condition.

The additional costs relating to seismic testing were also included in the assessment.

The development scenario assessed for the Ocean Gateway area envisages the development of 30 shale gas production sites, each site comprising 10 vertical 'motherbore' production wells with 4 horizontal laterals (40 laterals per production site). Overall development costs to 2035 are estimated at £9.8 billion with a peak annual cost of £945 million and an average annual cost of £466m (see Table 1).

| Table 1: Development costs: 2015-2035 | |
|---|---|
| Developed production Wells | 300 |
| Maximum Annual Cost | £945.1m |
| Average Annual Cost | £466.4m |
| Cumulative Spend (to 2035) | £9.8bn |

The economic impact assessment model is based on a 'multiplier' structure that takes into account not only direct and first-tier supplier spending/employment but the subsistence and leisure spend of non-resident workers, subsequent supply-chain expenditure and the 'induced' spending of all those individuals that receive wages/salaries as part of this process.

In terms of peak year impact for the UK, the modelling suggests a potential for over 15,500 jobs. On the basis that some of the supplier base relocates to the Ocean Gateway area, local residents are equipped with the necessary skills and some skilled workers move in to the area, the projected Ocean Gateway peak year total is some 3,500 jobs (see Table 2).

| Table 2: Peak-Year Employment Projections | | |
|---|---|---|
| | **Ocean Gateway** | **UK** |
| Direct | 1,482 | 2,914 |
| Indirect | 1,792 | 6,444 |
| Induced | 230 | 6,184 |
| **Total** | **3,504** | **15,542** |

As well as the quantified economic impacts, the report highlights a number of wider economic effects that shale gas exploitation within Ocean Gateway will potentially generate, including:

- the potential for midstream and downstream economic effects arising from natural gas upgrading, the reduced cost of gas processing, the 'export' of surplus gas to other markets and capital investment in new infrastructure. While these benefits are likely to be less significant in the UK than the US – where they have been forecast to account for up to 15% of all job gains – cost reductions and capacity expansion will undoubtedly deliver economic benefit over and above that assessed in this exercise;
- possible improvements in business competitiveness and the relative attractiveness of the area as a business location arising from the use of gas in many manufacturing industries - including in particular petrochemicals. The latter is of particular relevance given the concentration of the chemicals industry in the Ocean Gateway area and the substantial competitive advantage in favour of the US petrochemical industry that is now emerging as a result of price differentials between domestically produced gas and alternative energy sources. Shale gas development in Ocean Gateway may serve to moderate these market pressures, protect existing jobs and limit downsizing of activity in the area and the UK - although the balance of outcomes remain unclear in the absence of specific research;

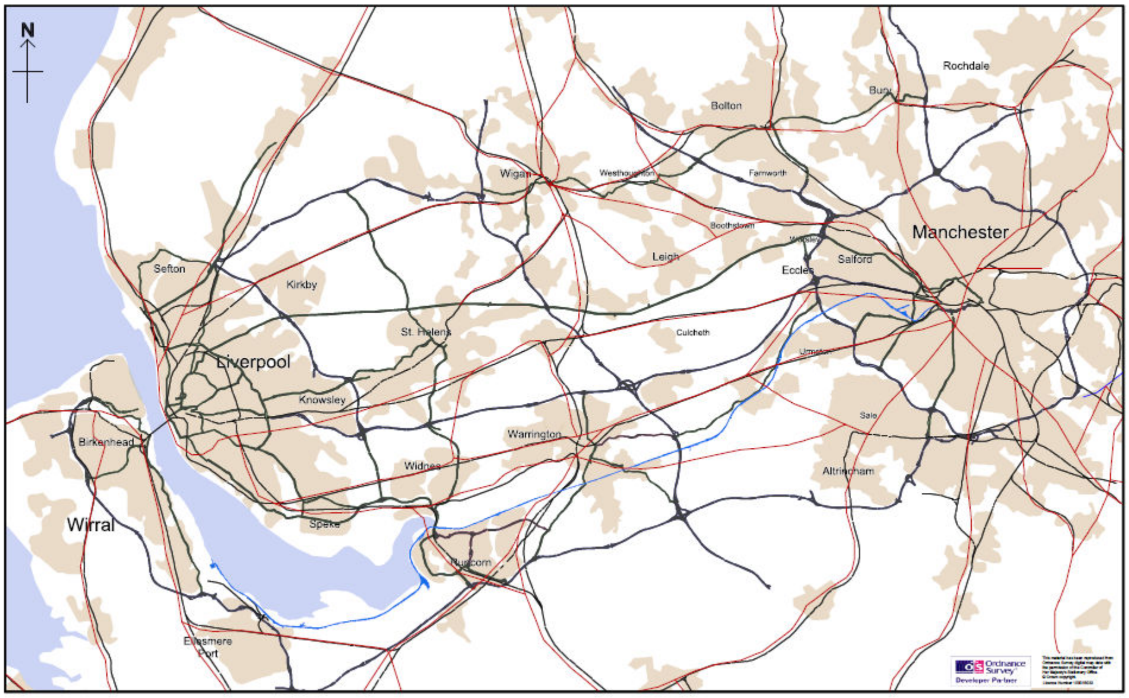
- impacts upon skills and training infrastructure. It is anticipated that the size of the local resident labour pool with appropriate skills will be limited in the first instance but that there will be opportunities to enhance the 'pool' through training with local colleges or perhaps the development of a dedicated training institution. It is unlikely that the issue of skills will be eradicated in the short-term, particularly if shale gas activity expands across the UK as a whole; and finally
- the exploitation of shale gas has the potential to generate significant tax revenues. These will relate not only to taxes on extraction/sales of gas but direct and indirect taxation generated through the employment and supply-chain structures that are envisaged over the course of the development period. However, the scale of such impacts is unclear given uncertainty about fiscal regimes and the nature of the future tax treatment of the sector.

On balance, the assessment has shown that shale gas extraction has the potential to generate significant economic impacts, including in terms of peak year employment and a range of other important, wider economic benefits that permeate throughout the economy.

# 1 Introduction

AMION Consulting was appointed by IGas Energy plc (IGas) and Peel Environmental Ltd to undertake an independent assessment of the potential economic impacts of extracting shale gas in the Ocean Gateway area[1] (see Figure 1.1). An economic impact model has been constructed and the results of the analysis are set out in this report.

**Figure 1.1: Ocean Gateway area**




Extraction typically requires a vertical well drilled into a hydrocarbon reservoir in which conventional oil and gas are trapped by an impermeable layer[2]. Shale gas is natural gas but is referenced as 'unconventional' in that it is located in geological formations that previously prevented extraction at viable commercial rates. Access often requires directional drilling alongside hydraulic fracture stimulation (fracking).

The methods used in shale extraction have been available for a number of decades but improvements in techniques have allowed access to larger volumes of hydrocarbons in tight, low permeability formations and, as a result, have significantly enhanced commercial viability.

Shale gas extraction is most advanced in the United States with the proportion of total natural gas accounted for by shale gas increasing from around 2% in 2000 to some 37% in 2012[3]. This development has had a significant impact on the US energy sector enhancing energy security, reducing energy prices and making self-sustainability an achievable ambition. In the wake of such events, interest has extended to examining shale gas potential in other parts of the world.

1 The Liverpool City Region, Greater Manchester and Cheshire and Warrington Local Enterprise Partnership (LEP) areas
2 IHS (2012) "America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy".
3 IHS, ibid

The Department of Energy and Climate Change (DECC, 2012)[4] reports that "untested shale rock volume in the UK is very large" though testing is required to evaluate technical and economic viability. Likewise, it points to the fact that the US has relatively permissive environmental regulations, low population densities, tax incentives, existing infrastructure, well developed supply chains and access to technology.

The British Geological Survey (BGS), in association with DECC, completed an estimate of the shale gas resource in an area between Wrexham and Blackpool in the West and Nottingham and Scarborough in the East[5]. This includes the Ocean Gateway area. The estimate of gas in place ranged from a lower limit of 822 trillion cubic feet (tcf) and an upper limit of 2,281 tcf, with the central estimate being 1,329 tcf. Subsequently, the BGS, in association with the DECC, has identified significant shale oil resources in the Weald Basin in South East England.

The purpose of this study is to examine the economic impact of shale gas exploration and extraction in the Liverpool City Region, Greater Manchester and Cheshire and Warrington Local Enterprise Partnership (LEP) areas - the overall Ocean Gateway area.

Actual impacts are likely to be different from those shown in the assessment because events and circumstances frequently do not occur as expected and the differences may be material. Impact studies vary in terms of their assumptions and methodologies and, as such, significant care is required in drawing direct comparisons with other studies. The report should not be used for any other purposes beyond those set out in the report or be relied upon by any other party.

The report continues in four sections as follows:

- **Section 2** - sets the scene by reviewing existing evidence as to the economic impact of shale gas extraction across the US, UK and Europe;
- **Section 3** – describes the approach adopted to assessing the impact and presents the results of the assessment;
- **Section 4** - considers wider issues of significance to the development of the shale gas sector and its impact in the Ocean Gateway area; and
- **Section 5** – provides an overview and summary.

4 DECC (2012) "The Unconventional Hydrocarbon Resources of Britain's Onshore Basins – Shale Gas"
5 BGS and DECC (2013), The Carboniferous Bowland Shale Gas Study: Geology and Resource Estimation

# 2 Existing Evidence Base

## 2.1 Introduction

This section reviews existing evidence on the potential economic impact of shale gas extraction. Given the expansion of the shale gas industry in the US, much of the evidence base references US experience. Nevertheless, impact assessments in other geographies are emerging. The studies covered vary between straightforward economic impact assessments of specific areas and broader macroeconomic impact studies.

## 2.2 US Evidence

### *2.2.1 Pennsylvania Shale Gas*

The size of the Marcellus shale reserves in Pennsylvania inevitably made this area a focus for many early economic impact assessments. The series of studies led by Considine (which also extended to cover Marcellus shale in New York and West Virginia) provided one of the first set of studies attempting to examine the likely benefits of shale extraction[6] [7] [8].

Considine, Watson and Blumsack (2011) identify over 1,400 wells drilled during 2010 (710 in 2009) – 1,213 horizontal and 189 vertical. Grossing up survey data from 12 firms covering 55% of all wells, the report indicates total expenditure of $11.5bn, a notable increase on the 2008 figure ($3.2bn). The largest categories of spend relate to upstream drilling and completion ($7.4bn) and lease and bonus payments ($2.1bn), followed by midstream pipeline and processing ($1.3bn). On the basis of evidence from a 2009 survey, it is assumed that 95% of all such spending is directed at suppliers/supplies within Pennsylvania.

Modifying existing input-output accounts, using some benchmark data from the 2009 study and using the IMPLAN input-output model, the report indicates a direct gross output impact of $10.4bn, with a direct value added[9] of $5.3bn and 67,739 full-time equivalent (FTE) direct jobs (Table 2.1).

**Table 2.1: Pennsylvania Shale Gas Economic Impact**

| | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Gross Output ($m) | 10,407 | 4,319 | 5,742 | 20,467 |
| Value Added ($m) | 5,333 | 2,376 | 3,452 | 11,161 |
| Employment (FTE) | 67,739 | 26,234 | 45,916 | 139,889 |

Source: Considine et al (2011)

6 Considine, T.J., R. Watson, R. Entler, J. Sparks (2009) "An Emerging Giant: Prospects and Economic Impacts of Developing the Marcellus Shale Natural Gas Play," The Pennsylvania State University, Dept. of Energy and Mineral Engineering

7 Considine, T, Watson R, and Blumsack S (2010), "The Economic Impacts of the Marcellus Shale Natural Gas Play: An Update", The Pennsylvania State University, College of Earth and Mineral Sciences

8 Considine, T, Watson R, and Blumsack S (2011), "The Pennsylvania Marcellus Natural Gas Industry: Status, Economic Impact and Future Potential", The Pennsylvania State University, College of Earth and Mineral Sciences

9 Value added is the difference between gross output and the value of all intermediate (purchased) goods and services

As implied by the terminology, these direct values represent the immediate, visible activities associated with drilling and extraction. There also exist indirect impacts associated with the business-to-business supply chain supporting direct activities and what are known as induced effects which result from workers and households spending the incomes they earn from involvement in either direct or indirect activities.

Table 2.1 also details these additional impacts and indicates that the total economic impact of shale extraction in Pennsylvania during 2010 was $20.47bn of gross output, $11.16bn of value added and 139,889 jobs[10].

In terms of gross output/value added, the sectors that benefited most from shale gas extraction included mining, construction, real estate/rental, wholesale, professional and scientific and manufacturing. The sectors benefitting most in employment terms included retail, construction, health and social services, professional and scientific and hotel and food.

Unlike previous studies in the series, the 2011 Considine et al report considered the potential impacts of reductions in energy prices. Due to limited information, it was assumed that all benefits to commerce and industry were internalised within profits and had no secondary impacts. Reduction in household energy costs were modelled within the IMPLAN structure and generated additional value added of $170m and 2,200 jobs[11].

Looking forward to 2020, Considine et al pointed to the increasing role to be played by royalties as opposed to lease payments and estimated that value added would rise to $20.2bn by 2020 and employment to 212,000. The projection to 2020 is interesting in that it provides a fixed projection point in the future. The 2009 Considine et al report placed 2020 GVA and employment at $13.5bn and 174,700 jobs. The 2010 report increased these to $14.4bn and 211,909 jobs and the 2011 report adjusted upwards once more to $20.2bn and 256,420 respectively.

A retrospective review of the Marcellus shale experience, published in late 2013 by the Multi-State Shale Research Collaborative (MSSRC), contrasts actual employment growth with the projections of the Considine studies. It reports that 'with the passage of several years……….we now know that actual……..job growth has been much less than…..(initial)…..estimates'[12].

### 2.2.2 *Barnett Shale, Texas*

A further study – of the economic impact of drilling Barnett shale in Texas - is provided by The Perryman Group[13]. Drilling permits increased rapidly from around 1,000 per annum in the mid 2000's to over 4,000 in 2008, dropping by over 50% in the recession but recovering in 2010 with close to 15,000 wells in place and 70 rigs operating. The Perryman Group estimate that the total economic impact in 2011 (for Texas) was equivalent to $13.7bn of output and 119,216 jobs[14] (76,214 in exploration and drilling, 26,160 due to pipeline development and 16,841

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10 Figures for 2010 are close to three times the value of those reported in the 2010 report relating to 2009.
11 There is also passing reference to potential crowding out although no analysis of scale is provided.
12 Multi-State Shale Research Collaborative (2013), 'Exaggerating the Employment Impacts of Shale Drilling: How and Why'
13 The Perryman Group (2011) "A Decade of Drilling - The Impact of the Barnett Shale on Business Activity in the surrounding Region and Texas: An Assessment of the First Decade of Extensive Development"
14 Note: totals here and elsewhere in the report are as reported and may not sum due to rounding.

resulting from royalty and lease payments). Between 2001 and 2011, the cumulative benefits are defined as $80.7bn of output and 710,319 person years of employment[15].

### 2.2.3 *Arkansas Fayette Shale*

The Center for Business and Economic Research (CBER) provided an overview of natural gas activity in the Arkansas Fayette Shale area[16]. Drilling permits were first issued in 2004 and increased from 30 in that year to 1,080 in 2008 after which they declined in the wake of recession and reductions in natural gas prices. In the spring of 2012 there were 27 rigs operating in the field with eleven oil and gas companies actively involved in extraction and several additional companies involved in transmission pipelines.

Expenditures by extraction and production companies increased from some $2.8bn in 2008 to $3.6bn in 2012 with leasing and royalty payments rising from $244m to $346m. Table 2.2 reports the impact estimates (using IMPLAN) and shows cumulative effects of $18.5bn in output, $12.4bn in value added and 22,499 FTE jobs in 2011.

**Table 2.2: Fayetteville Shale Gas Economic Impact (2008-2011)**

| | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| Gross Output 2008/11 ($m) | 12,770 | 1,798 | 3,965 | 18,534 |
| Value Added 2008/11 ($m) | 9,109 | 950 | 2,378 | 12,438 |
| Employment 2011 (FTE) | 7,544 | 3,674 | 11,282 | 22,499 |

Source: CBER (2012)

Compared to the Considine studies, the CBER output multiplier is smaller and the employment multiplier considerably larger. Looking at the impact estimates it is evident that the relationship between the impact components is very different between the two models. The ratios of indirect/induced to direct values are much lower for the Lafayette model than the Pennsylvania model whereas the ratios for employment are higher.

### 2.2.4 *Studies of impact on the overall US economy*

On a broader front, a number of reports focus on impacts across the US economy as a whole:

(i) PWC (2011) suggest manufacturing employment might increase by 1m workers over the period 2025 to 2035 in a high shale recovery scenario although the only technical detail provided is reference to a 'regression model'[17].

(ii) Citi GPS (2012) projects direct Gross Domestic Product (GDP) growth of $274bn between 2012 and 2020 (1.4% of GDP), a total cumulative effect of $370bn to $624bn (2% to 3% of GDP and 3.6m new jobs)[18]. The latter arise from 550,000 jobs in the oil and gas extraction sector, 2.3m jobs from downstream activity with 785,000 jobs from lower price effects.

[15] The report does not define the profile of direct, indirect and induced benefits.
[16] CBER (2012), "Revisiting the Economic Impact of the Natural Gas Activity in the Fayetteville Shale: 2008-2012", University of Arkansas.
[17] PWC (2011), "Shale Gas: A Renaissance in US Manufacturing?"
[18] Citi GPS (2012) "Energy 2020: North America, the New Middle East?"

Reference is made to an internal US macroeconomic model and an alternative produced by macroeconomic advisers.

(iii) IHS (2012) also provides a projection of the economic impacts to 2035 across the US as a whole[19]. While the overall analysis considers seven tight oil plays, nine shale gas plays and four tight gas plays, shale extraction (in the lower 48 states) is envisaged as expanding from 23.8 to 54.17 billion cubic feet (bcf) per day between 2012 and 2035[20].

Annual capital expenditure on drilling is projected to increase from $14.5bn to $72bn while that for completion is likewise projected to rise from $25.9bn to $120.2bn over the same period. Alongside other spend for facilities and gathering systems, total upstream capital spend is projected to be nearly $3tn between 2012 and 2035[21].

Economic impacts are generated through an IMPLAN model framework and defined as increasing value added from $80.9bn in 2012 to $195bn in 2035 and increasing an estimated 605,384 shale related jobs in 2012 to 1.4m such jobs in 2035. Direct, indirect and induced profiles are provided but for total unconventional gas which includes tight gas as well as shale gas (see Table 2.3).

**Table 2.3: US Total Unconventional Gas Impacts 2012-2035**

| | Direct | Indirect | Induced | Total |
|---|---|---|---|---|
| 2012 Value Added ($m) | 49,096 | 34,608 | 37,967 | 121,670 |
| 2035 Value Added ($m) | 117,272 | 80,806 | 89,049 | 287,127 |
| 2012 Employment (FTE) | 187,360 | 277,888 | 437,427 | 902,675 |
| 2035 Employment (FTE) | 436,773 | 645,696 | 1,026,012 | 2,108,481 |

Source: IHS (2012)

IHS has also extended this analysis in a 2013 report to cover midstream and downstream economic impacts (including the energy related chemicals sector)[22]. The report references total unconventional activity rather than gas and extends to 2025 rather than 2035, nevertheless it attributes value added of $39bn and 323,000 jobs to mid/downstream activity with energy and chemicals adding another $6.7bn and 53,000 jobs in 2012. The projections for 2025 are that mid/downstream value added declines to $6.9bn while that for energy related chemicals increases to $51bn. Employment projections operate in the same way with mid/downstream levels falling to 57,000 and energy related jobs increasing to 319,000[23].

19 IHS (2012) "America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy Volume 1: National Economic Contributions"
20 Bcf: Billions of cubic Feet
21 Lease acquisition costs are treated as a sunk cost
22 IHS (2012) "America's New Energy Future: The Unconventional Oil and Gas Revolution and the US Economy, Volume 3: A Manufacturing Renaissance".
23 These figures sit alongside a projected output increase of $132.4bn and jobs increase of 412,000 produced by the American Chemicals Council in the lights of an assumed 25% growth in ethane production: American Chemistry Council (2011), "Shale Gas and New Petrochemicals Investment: Benefits for the Economy, Jobs and Manufacturing.

(iv) The summer 2013 IMF US country report points out that while the energy boom has had positive direct effects on the U.S. economy, all mining contributed only 0.1 percentage point to real GDP growth in 2012, consistent with the small share of oil- and gas-related sectors in the economy (around 1½ percent of GDP). Likewise, although employment in the oil and gas sectors increased by around 50,000 employees in both 2011 and 2012 this represents a relatively small share of net (2.2m) jobs created.

Looking forward, macroeconomic impacts are assessed using the IMF Global Economy Model (GEM). The baseline modelling position assumes that higher energy production and efficiency improvements reduce the net energy trade deficit effects by 0.9 percentage points of GDP during 2012–2025 before any second-round effects. It is also assumed that this improvement in the energy balance is attained linearly over the next 12 years, and is evenly split between production and efficiency drivers.

Various simulations are assessed reflecting different scenarios with regard to forward-looking behavior among households and firms, the degree of initial economic capacity, short-run monetary policy response, private-sector saving behavior and the technological feasibility of energy exports.

The simulation results suggest that macroeconomic benefits for the United States are positive, but may be modest. In a scenario with production gains and no efficiency improvements, real GDP increases by some 0.3 percent over the next 10 years. With both production increases and efficiency gains, GDP increases by 0.5 to 1 percent during the next decade. The short-run impact on GDP is largest when the boom in energy production and efficiency are fully anticipated and the economy has capacity so that monetary policy is not required to dampen aggregate demand in the economy.

On the other hand, the real exchange rate tends to appreciate, energy prices fall in all scenarios and the U.S. current account balance as a share of GDP deteriorates slightly in the medium term. The adjustment path is, however, highly sensitive to assumptions about expectations and private saving behavior.

(v) Mckinsey Global Institute (2013) also provides a number of potential development scenarios for the US economy to 2020 in the light of shale gas and tight oil production[24]. They suggest that increased shale production might increase GDP through four channels:

- higher domestic oil and gas production directly generating jobs and GDP within the energy sector, as well as reducing oil imports and raising exports;
    - projection: increase of $115bn (to $225bn) in the annual GDP of the oil and gas production sector alone (both shale gas/tight oil) with associated employment gain of between 110,000 and 215,000 jobs;
- downstream energy-intensive manufacturing industries that use natural gas as a fuel or feedstock could increase production:
    - projection: $55bn to $85bn increase in annual GDP with 165,000 to 270,000 jobs added;

[24] McKinsey Global Institute (2013) “Game Changers: Five Opportunities for US Growth and Renewal”

- Indirect gains in services, construction, trade, and related sectors that emerge to support higher output in the energy and manufacturing sectors:
  - projection: $130bn to $235bn increase in annual GDP and 250,000 to 450,000 jobs added
- Higher employment and wages leading to induced gains throughout the economy:
  - projection: $80bn to $145bn increase in annual GDP and 385,000 to 725,000 jobs added

These impacts constitute an additional 2 to 4 percent (roughly $380 bn to $690 bn) in annual GDP by 2020 with 1m to 1.7m jobs generated – the lower end estimate is of the same order of magnitude as the US automobile manufacturing sector.

This set of projections contains a caveat in that realising the economic benefits will require substantial infrastructure development, mitigation of environmental risks and potential skills shortages. They are also substantially larger than the IMF projections.

(vi) In contrast to other assessments, the Energy Modelling Forum at Stanford University (2013) is cautious about the scale of shale gas impacts stating that claims about a resurging US economy appear 'speculative without further research'[25]. The primary issue is that while potential gains appear large, they are concentrated in a small part of the total economy. Using 2011 data, it points out that the oil and gas industry (allowing for support industries) accounted for 0.23 percent of total U.S. employment and 1.44 percent of total U.S. value added while the principal industry to benefit from less expensive natural gas is chemical products, which accounted for 0.57 percent of total employment and 1.68 percent of total value added in the same year.

(vii) In a similar vein, The Economist (2013) cites a Goldman Sachs report that refers to shale gas providing only a modest boost to the US economy for similar reasons – the small size of the energy sector - as well as the limited pace of innovation and doubts about the extent to which cheap energy will encourage other industries to increase investment[26]. Indeed, the same article speculates whether the decline in gas prices makes investment in shale gas wells less attractive or shifts emphasis to wells that primarily deliver oil and have gas as a by-product. It does, however, offer a balancing view that some companies arrived late in the market, paid highly for drilling rights, targeted less productive sites and that it may be too soon for wider economic benefits relating to reshoring, exporting and gas powered vehicles to work through the economy.

(viii) Another assessment of impact on the US economy by the Institut du development durable et des relations Internationales (2014), suggests 'a minimal impact' equivalent to 0.84% of total US GDP between 2012 and 2035 with most primary manufacturing impacts confined to gas-intensive sectors[27].

[25] Energy Modelling Forum (2013) "Changing The Game: Emissions and Market Implications of New Natural Gas Supplies", Stanford University
[26] The Economist, November 16th 2013 "From Subset to New Dawn"
[27] Institut du development durable et des relations Internationales (2014) 'Unconventional Wisdom: an economic analysis of US shale gas and Implications for the EU'

## 2.3 Other non-US Evidence

### *2.3.1 Cuadrilla, Lancashire*

One of the first UK shale-based studies was the 2011 Regeneris Consulting report on the potential impact of shale gas in Lancashire[28]. This covered the Cuadrilla PEDL licence, covering a 500 square mile area primarily to the west of the M6 motorway. In common with many US studies, the methodology adopted was to establish the cost of operations at an existing site (Preese Hall) and to use this as a basis for wider exploitation.

Estimated single well completion costs (including depreciation) are assessed at £10.5m composed of £0.59m for site preparation, £4.34m for drilling and related costs and £5.52m for all fracturing/related costs and testing. These costs are alternatively disaggregated to indicate that bought-in goods and services and depreciation account for £4.7m, labour for £2.83m, subsistence for £0.51m, overheads of £1.15m and profit of £1.25m. The latter detail is provided by a supplier survey with responses from just short of 50% of the supplier base.

A Supplier Survey is also used as the basis for the allocation of expenditure/cost across different geographies. Table 2.4 indicates the attribution that is employed in the analysis. Overall, around a third of expenditure is assumed to leak from the UK, ranging from a low of 10% in terms of subsistence spend to 44.8% of bought-in goods and services. Likewise, some 16.6% of spend is assumed to take place in Lancashire with a range between 75% of subsistence spend and some 10% of labour, overheads and profits. Finally, over two thirds of expenditure on labour is assumed to go to workers resident outside Lancashire (but in the UK) with a similar profile for overheads and profits.

**Table 2.4: Distribution of Single Well Expenditure/Costs (%)**

| | Lancashire | Rest of UK | Overseas | All UK |
|---|---|---|---|---|
| Labour | 10.7 | 69.9 | 19.3 | 80.6 |
| Subsistence | 75.0 | 15.0 | 10.0 | 90.0 |
| Bought-in Goods/Services | 17.0 | 38.2 | 44.8 | 55.2 |
| Overheads | 9.9 | 60.0 | 29.9 | 69.9 |
| Profits | 9.9 | 60.0 | 29.9 | 69.9 |
| **Total** | **16.6** | **50.7** | **32.8** | **67.3** |

Source: Regeneris Consulting (2011)

Job estimates are calculated using a series of ratios for each type of spend in Table 2.4 – thus jobs associated with Cuadrilla or first-tier suppliers are constructed by dividing the level of wage-related spend for these groups by £55,000 with other job numbers constructed in a similar way. On this basis, a single test well is projected to create 19 Lancashire based jobs within Cuadrilla or first round suppliers, 19 jobs due to subsistence expenditure, 4 jobs within the rest of the supply chain and 3 jobs due to induced effects, or 43 jobs in total. It is estimated that 207 jobs are created in the rest of the UK.

Initial test well costs are further modified to reflect potential production, rather than testing, conditions. These include: (i) a general 15% efficiency gain in moving towards commercial

[28] Regeneris Consulting Ltd (2011) "Economic Impact of Shale Gas Exploration & Production in Lancashire and the UK"

operations reducing well costs to some £8.97m; (ii) low, mid and high scenarios involving 190, 400 and 810 wells; (iii) uplifting drilling and fracturing costs by 15% to allow for the costs of connecting gas to pipeline networks with 50% of workers/suppliers assumed to come from Lancashire; (iv) low, mid and high scenarios with regard to movement of labour and the supply chain to Lancashire from elsewhere; and (v) an ongoing maintenance requirement.

Projections for a central case scenario, involving 400 wells, over a 20 year period suggest the creation of 1,700 (FTE) jobs in Lancashire at the peak of production with 5,600 jobs within the UK as a whole[29]. Of the peak UK jobs, 4,610 (including pipeline connection) would be created either directly or indirectly through the supply chain[30]. Estimates for different scenarios regarding the balance of labour origins and the supply chain between Lancashire and elsewhere, suggest a range of between 3,400 to 6,550 (peak) FTE jobs for the UK and 560 to 2,500 (peak) FTE jobs for Lancashire[31].

### *2.3.2 Bowland Basin*

DeLoitte has also published a report investigating the economic and fiscal impacts of shale development in Lancashire[32]. The report estimates potential peak employment of between 6,900 and 23,600 jobs related to the Bowland Basin although the figures are generated 'using a range of employment multipliers drawn from US shale experience'.

### *2.3.3 UK economy*

The Institute of Directors (IoD) has released two shale-gas related studies. The first, 'Britain's Gas Potential', defines an 'optimistic' estimate of UK unconventional gas reserves at 300tcf onshore and up to 1,000tcf offshore[33]. With 2011 UK gas consumption of 2.9 tcf, an onshore recovery rate of 10% would extract 30 tcf, sufficient for 10.3 years of gas supply or 10% of UK gas demand for 103 years. Since 10% of UK gas demand is equivalent to 8m tonnes of oil, and the oil and gas sector employ 444,000 people, the IoD computes potential new jobs as 8% of 440,000, some 35,000 jobs.

The second IoD study adopts a more developed methodology[34]. It builds capital and operating expenditure profiles for 10 well pads associated with either 10 or 40 lateral wells with each well costing £6m, facility costs ranging between £15m and £30m, abandonment costs ranging between £10m and £40m, variable operating expenditure of £0.5m per bcf and fixed operating costs equivalent to 2.5% of annual cumulative capital expenditure. A fixed ratio of 20 (direct, indirect and induced) jobs per £1m of expenditure (£50,000 per job) provides the basis for job calculations.

29 Peak production lasts for four years in the central case with virtually all impact in the first ten years of the impact horizon. Job numbers are negligible for the last ten years and all impacts of well development are assumed to take place within a twelve month period.

30 No direct, indirect, induced breakdown is provided for Lancashire.

31 Poyry, "How will Lancashire Shale Gas impact the GB Energy Market", (2012) suggested that impact on the domestic energy market would become evident in the early 2020's when extraction was set to climb to a significant proportion of gas from the Continental Shelf and with reduction in prices of some 2% to 4%. Poyry , "UK Shale Gas – where are we now?", (2014) reports that the slow pace of development will delay such benefits.

32 Deloitte (2013) " Potential Bowland Basin shale gas development"

33 Institute of Directors (2012), "Britain's Shale Gas Potential"

34 Institute of Directors (2013) Getting Shale Gas Working".

The study defines an impact scenario involving 100, 10 well pads of 40 lateral wells (4,000 wells) with staggered development so that no more than 10 new pads can be developed each year. Drilling is assumed to occur over 12 years with peak annual well development (400 wells) between years 9 and 13 of the 16 year drill horizon (2016 – 2032). Capital/operating expenditure and job creation profiles extend to 37 years with annual expenditure peaking at £3.7bn and translating to 74,000 jobs (£3.7bn at £50,000 per job).

A recent study, produced by AMEC on behalf of DECC, considers both low and high activity development scenarios within Great Britain relating to the next onshore licence round[35]. The scenarios essentially constitute between 50 and 150 licences, 20 and 240 test boreholes and 30 to 120 pads - each containing between 6 and 24 wells. The profile of wells runs from 48 in year 1 to a maximum of 360 between years 6 and 9, falling to 0 in year 13 and sums to 2,880 (24 wells across 120 pads). Economic impact is assessed by applying the values contained in the Cuadrilla/Regeneris 2011 study discussed above. This produces a potential (peak) employment range of between 16,000 and 32,000 jobs, at the peak impact level.

The most recent study containing estimates of UK employment impact is the April 2014 Ernst and Young Study 'Getting ready for UK shale Gas'. With a time horizon between 2016 and 2032, the analysis adopts the IoD profile of 4,000 lateral wells and assesses the total spend required to bring the wells into production at £33bn. Peak employment impacts are defined as 6,092 direct jobs, 39,405 indirect jobs and 19,036 induced jobs, making a total of 64,533 jobs[36].

### *2.3.4 Other studies*

Beyond the UK, other studies are slowly emerging for geographies outside the US. One of the more recent analyses is that by Poyry and Cambridge Econometrics (2013) which considers the macroeconomic effects of European shale gas production by analysing three EU development scenarios – no shale, some shale and shale boom[37].

EIA estimates, supplemented by national geological surveys where available, provide a base estimate of a EU28 'risked' resource of some 54tcm[38]. The some shale scenario assumes 15% of risked resources are technically recoverable while the shale boom scenario raises this figure to 20%. The latter is projected to require between 33,500 and 67,000 wells (depending on well productivity) to be drilled over the period to 2050. With an assumed peak around 2035, the estimated requirement is for between 148 and 295 rigs[39].

Modelling of energy markets suggests an average reduction in wholesale gas prices of some 6% in the some shale scenario and 14% in the shale boom scenario resulting in average annual savings of €12bn and €28bn respectively (peaking at €36bn and €50bn). Likewise, there is an average reduction in wholesale electricity prices of 3% in the some shale scenario and 8% in the

[35] DECC (2013) "Strategic Environmental Assessment for Further Onshore Oil and Gas Licensing".
[36] The employment estimates exclude jobs related to midstream activities (processing, connection to the Grid) and downstream activities (product sales and decommissioning)
[37] Poyry and Cambridge Econometrics (2013), "Macroeconomic Effects of European Shale Gas Production: A Report to the International Association of Oil and Gas Producers (OGP)"
[38] Risked resource is used to reference resource that accounts for shale play success probability (high enough flow rates) and prospective area success (geological complications that reduce availability).
[39] It is assumed that the EU has a rig manufacturing capability of 12-18 rigs per year.

shale boom scenario resulting in average annual savings of €12bn and €27bn respectively (peaking at €28bn and €42bn). Cumulative (2020 to 2050) wholesale energy savings are €765bn and €1.7tn. Household spending on energy is projected to reduce by up to 8% and 11% in the two scenarios while gas import dependency reduces and generates trade balance benefits of between €484bn and €1.1tn.

Macroeconomic impacts are generated via the Cambridge Econometrics E3ME input-output model of the European economy and energy system. The some shale scenario generates a €57bn (0.3%) increase in EU28 GDP by 2035 rising to €138bn (0.6%) by 2050. The respective shale boom profile is €145bn (0.8%) rising to €235bn (1%)[40]. In cumulative terms, it is estimated that EU28 GDP (2020 to 2050) increases by €1.7tn in the some shale scenario and €3.8tn in the boom scenario. Net employment (some shale) is projected to increase by 0.4m by 2035 and 0.6m by 2050. The shale boom profile is 0.8m jobs by 2035 and 1.1m jobs by 2050. In common with other studies it is assumed that investment in shale gas does not displace other forms of investment in the EU although simulations suggest that results are not sensitive to this assumption.

## 2.4 Summary

There is a body of evidence emerging in relation to the economic impact of unconventional gas extraction. Much of the early evidence is based on specific US shale formations which are some way removed from the potential scale of operations in the UK, but imply significant job and other economic gains. The results of the assessments do though vary.

[40] The total mining and quarrying sector in the EU28 is reported as generating around 1% of total EU28 value added.

# 3 Impact Assessment

## 3.1 Introduction

This section describes the nature of the development process that underlies our analysis, the profile of expenditure that drives overall impact and the set of assumptions that underpin our evaluation of the impact in both the UK and the Ocean Gateway area. Finally, it sets out the results of the impact analysis.

## 3.2 Development Activity

Impact is assessed using an overlapping cohort model of development that reflects six stages of activity involved in the shale gas extraction process set over a twenty year time horizon. These are

- **'enabling'** - the range of preparatory actions required to achieve consents and permissions alongside development planning for each potential site. A time horizon of twelve months is allowed for these actions at a cost of £0.45m;
- **'site preparation'** - including all front-end design and civil engineering inputs necessary to prepare each site for drilling. It is assumed that this activity occurs in year 2 of operations at each site and incurs a cost of £0.5m per site;
- **'exploration and appraisal' -** preliminary drilling and flow testing of vertical wells. All such activity is taken to occur in year 2 and entails a cost of between £10m and £15m depending on whether a well proceeds to the testing phase;
- **'development and distribution' -** the drilling-out of vertical/lateral wells on a site (or pad) as well as connection to any network infrastructure. It is assumed that a single pad sustains a maximum of 10 'motherbore' or 'production' wells with a maximum of 4 laterals drilled per well, at a total cost of £330m per pad. Distribution infrastructure is costed at £5m (per pad) with all work completed so that full production can start in year 4 of operations at a specific site;
- **'operation and maintenance'** - the activities necessary to ensure safe, efficient flow of gas. With a projected site cost of £0.5m per annum, it is assumed that operations average 15 years per well/site;
- **'decommissioning'** - all activities necessary to seal and abandon wells in a safe and compliant manner, remove all equipment and reinstate the site to its prior condition. It is assumed that this is completed within twelve months of flow cessation and at a cost of £11m per site.

Outside this profile, there are additional costs relating to seismic testing across the licence area. It is assumed that the Ocean Gateway geography contains five 'blocks' each of which requires 3D seismic testing and that activity (costed at £20m in total) is carried out over the first five years of operation.

Finally, it is assumed that a subsistence payment (equivalent to 10% of annual wage) is made to workers that are non-local but are required to live in the vicinity of operations for their contract period and that this group of workers spend 10% of their wages/salaries on leisure activities.

## 3.3 Development Scenario

The development scenario assessed for Ocean Gateway envisages the development of 30 shale gas production sites, each site comprising 10 vertical 'motherbore' production wells with 4 horizontal laterals (40 laterals per production site). The overall 30 site development therefore consists of a total 300 vertical 'motherbore' production wells and 1,200 laterals. As outlined in Table 3.1, production peaks with some six rigs adding 30 wells per annum over the period 2026 to 2030.

**Table 3.1: Development Scenario (2015-2035)**

| Year | Operating Rigs | Producing Wells | Cumulative total Wells |
|---|---|---|---|
| 2015 | 1 | 0 | 0 |
| 2016 | 1 | 0 | 0 |
| 2017 | 1 | 3 | 3 |
| 2018 | 1 | 3 | 6 |
| 2019 | 1 | 4 | 10 |
| 2020 | 2 | 10 | 20 |
| 2021 | 3 | 15 | 35 |
| 2022 | 4 | 20 | 55 |
| 2023 | 5 | 25 | 80 |
| 2024 | 5 | 25 | 105 |
| 2025 | 5 | 25 | 130 |
| 2026 | 6 | 30 | 160 |
| 2027 | 6 | 30 | 190 |
| 2028 | 6 | 30 | 220 |
| 2029 | 6 | 30 | 250 |
| 2030 | 6 | 30 | 280 |
| 2031 | 4 | 20 | 300 |

Assuming an operating life of fifteen years means that wells operate until 2046 with additional costs incurred until 2047. Table 3.2 shows that overall development costs to 2035 are placed at £9.8bn with a peak annual cost of £945m and an average annual cost of £466m[41].

| Table 3.2: Development Summary: 2015-2035 | |
|---|---|
| Developed Production Wells | 300 |
| Maximum Annual Cost | £945.1m |
| Average Annual Cost | £466.4m |
| Cumulative Spend (to 2035) | £9.8bn |

## 3.4 Expenditure Profiling

The core of the impact study lies in tracking the way in which expenditure profiles are likely to flow through the geographies of interest and the extent to which they are 'retained', providing profit and employment opportunities for businesses and residents. The first stage in this process involves disaggregating expenditure streams into their primary labour, capital and intermediate components.

We have been guided in this task by industry representatives who have provided a detailed breakdown of the activities and supply infrastructure necessary to sustain the operations under consideration in this assessment. This enables us to directly integrate the associated expenditure profile with the UK Supply and Use Tables (SUTs) and to use the latter as the basis for assessing the nature and level of inputs. The SUTs provide the basis on which expenditure is allocated between labour and intermediate inputs.

As far as labour is concerned, we use industry specific wage costs as the basis for calculating employment numbers[42]. The data is sourced from the Office of National Statistics (ONS) 2011 Annual Business Inquiry with 2011 chosen as the base date to be consistent with the 2011 SUTs. This means that estimates of employment numbers not only reflect variation in spend across industry sectors but also variation in the costs of employment across industry sectors.

This approach defines total peak year direct employment opportunities at just over 2,900 jobs. Overall employment impact, however, has to be supplemented by associated supply-chain spending, spend on other items such as subsistence and the induced spending by those who gain employment from each of these activities. This overall impact reflects a variety of factors to which we turn in the next section.

## 3.5 Impacts Methodology

The impact model is based on a 'multiplier' structure that takes into account not only direct and 'first-tier supplier' spending/employment but the subsistence and leisure spend of non-resident workers, subsequent supply-chain spend and the 'induced' spending of all those individuals that receive wages/salaries as part of this process.

[41] Prices are held constant over the assessment period.
[42] With an appropriate adjustment for employer on-costs.

There are a number of ways to report the outcomes of the modelling exercise. In the first instance, we report estimates of potential impact for the UK as a whole. The perspective taken is of a 'gross' nature whereby the assessment reports the number of jobs that would be sustained in the peak year were the supply-chain to be 'internalised' within the UK[43]. This provides a 'ceiling' estimate of impact.

We also provide an impact estimate for the Ocean Gateway area. Here, the critical issues are the extent to which

- available jobs are taken by local residents;
- supply-chain expenditure is won by local businesses; and
- spending by those local resident/businesses that do benefit from development activity is retained within the local area as opposed to 'leaking' elsewhere in the UK or abroad.

Since peak-year activity occurs well into the development schedule, it is assumed that many local residents will have acquired relevant skills and skilled workers will have relocated to the area such that at least 40% of direct jobs are taken by residents. Likewise we assume that first-tier suppliers locate up to 35% of their operations in the Ocean Gateway area with subsequent tier operators also co-locating 15% of their supply base. All subsistence spending is assumed to take place within the Ocean Gateway geography with 80% of leisure spending also located in the same area.

To these elements must be added the induced spending of workers and businesses. The structure employed to calculate these latter effects does not impose, assume, or 'borrow' multipliers; it constructs them as a natural outcome of the modelling process, reflecting the specific set of circumstances under review.

Workers in each supply sector are subjected to a disposable income assessment calculated using information on average sector wages/salaries and on the tax and national insurance regimes in place, having taken account of personal allowances in the calculation of tax burdens. For modelling purposes, the regime adopted is that in place for fiscal year 2013/2014.

Salaries are matched against profiles in the ONS Living Costs and Food survey (LCF) to estimate spend across consumption categories with the latter subsequently aggregated to match the consumer spend classifications contained in the UK National Accounts and SUTs[44]. Leakage from the local area is based on consideration of local presence and relative concentration of employment in each supply sector[45].

This process establishes the parameters required to model 'first round' effects. A series of subsequent rounds are also modelled in much the same way except that parameters reflect 'average' local profiles instead of those directly associated with the shale gas industry.

43 That is, all supply-chain activity is undertaken by UK-based suppliers.
44 Taking LCF figures for tax and insurance deductions allows us to estimate average propensities to consume (APC) out of disposable income. The APCs are taken to be estimates of marginal propensities to consume and vary with lower paid workers displaying higher propensities to consume and vice-versa.
45 Sourced through BRES.

## 3.6 Assessment of impact

Employment impacts are assessed via the methodological process outlined above and Table 3.3 details the peak-year impacts for both the Ocean Gateway area and the UK. In terms of the latter, peak year modelling projections add a potential 6,444 indirect and 6,184 induced jobs to the 2,914 direct jobs reported in Section 3.4.

The Ocean Gateway peak-year projections identify 1,482 direct jobs, 1,792 indirect jobs and 230 induced jobs. The low induced jobs figure reflects the fact that a large proportion of induced spending will be serviced by organisations located outside the Ocean Gateway area.

**Table 3.3: Peak-Year Employment Projections**

| | Ocean Gateway | UK |
|---|---|---|
| Direct | 1,482 | 2,914 |
| Indirect | 1,792 | 6,444 |
| Induced | 230 | 6,184 |
| **Total** | **3,504** | **15,542** |

## 3.7 Summary

This section provides the heart of the impact study. It details the range of assumptions that are used to examine the potential impact of shale gas extraction in the Ocean Gateway economy based upon a six-stage development process for each site/pad.

The overlapping nature of the model used means that the precise mix of development activity varies from year-to-year as the number of wells expands and each individual site reaches a different point in the development horizon. That said, overall development spend between 2015 and 2035 is projected to be £9.8bn with a peak-year spend of £945m.

Potential peak-year employment estimates for the UK are defined at 15,542 jobs though this reflects an assumption that supply-chain jobs are sourced within the UK and relaxing this assumption would lower the scale of this estimate. Ocean Gateway impacts allow for both direct and indirect jobs to be sourced outside the Gateway area but assume that a base of local residents/migrants have acquired the skills required by the shale-gas industry and that some supplier activity is located locally. The assumptions made indicate a potential for some 3,504 peak-year jobs to be generated in the Ocean Gateway area.

# 4 Wider Impact Considerations

## 4.1 Introduction

The content of previous sections has concentrated exclusively on the upstream economic impacts of shale gas extraction within Ocean Gateway. It is clear, on the other hand, that any extensive extraction activity within the Ocean Gateway area (and the wider UK) will have potential midstream, downstream and energy-related chemical impacts.

Likewise, the expansion of unconventional capacity is likely to require the expansion of appropriate skills among the workforce close to development sites if the pace of expansion is not to be constrained or is to be increased in the context of significant upward pressure on employment costs in skill shortage occupations. Finally, there is the issue of potential tax benefits likely to accrue to the exchequer and local authorities from development activity.

This section makes reference to each of these elements in drawing together a wider picture of shale gas development impact.

## 4.2 Midstream/Downstream Benefits

IHS (2013), in the context of the US, pointed to potential midstream and downstream benefits arising from natural gas upgrading (processing of rich gas into higher value added refined and intermediate products), cost reductions for gas processing, exporting surplus gas as a liquefied 'feedstock' into markets that command a price premium and capital investment[46].

The combined economic impact of these developments is anticipated to account for 15% of the total projected job gain from unconventional gas expansion in the US (compared to 82% from upstream activity) at the start of the period but is expected to decline to just 1.5% of the total by 2025.

This front-loading primarily reflects an assumption about the pipeline infrastructure necessary to connect the resource base with end-users and which is expected to be built-out in early years. However, the relative contribution of all the underlying elements noted (such as upgrading and cost reductions) is not specified and remains unclear.

It is unlikely that infrastructure development in the UK, even allowing for scale, will be at a similar level of intensity as in the US and the presumption must be that benefits are more likely to arise from other drivers such as cost reductions and potential capacity expansion. While such benefits do not form part of this impact exercise, it must also be recognised that connectivity with the National Grid will be more straightforward in the UK than it has been in the US and there is an added potential for private, dedicated supply infrastructure.

It is clear that large scale unconventional gas development has transformed the US natural gas market. As late as 2008, the US had constructed a dozen Liquid Natural Gas (LNG) import facilities to supplement declining national gas production. The emergence of unconventional

[46] Referenced in Section 2.

gas, on a large scale, has reversed this position with the result that plants originally constructed for import (over 20 by 2012) are now being retrofitted for export.

Such is the emerging growth in US LNG capacity and such is the differential in gas prices between the US and Europe, there is not an insignificant risk that it may prove cost effective for overseas plants to 'reshore' to the US and export to Europe rather than maintain a European or UK presence. Nevertheless, the potential for direct and secure supply of gas to major users (of which there are a number in the Ocean Gateway area) and the potential to bypass transmission costs may serve to offset such considerations to a degree.

## 4.3 Energy-Related Chemicals

Natural gas is a key cost element in many manufacturing activities and a primary input into a range of petrochemical products including agriculture, vehicles, construction, pharmaceuticals, transport and textiles.

Ethylene (Olefin) is a major output of the petrochemical industry and is a raw material for a range of polymers and chemicals such as polyethylene (PE), polyvinyl chloride (PVC) and polyethylene terephthalate (PET) which are used in packaging, transportation, electronics, textiles, construction materials, coatings and adhesives. Manufactured in large 'steam cracker' plants, feedstock derived from oil and gas is broken down at high temperatures to produce the smaller molecules required.

More generally, IHS (2013) referenced nine specific chemical value chains where energy from natural gas and natural gas liquids constitute a high proportion of costs – acrylics, aromatics, nitrogen fertilisers, chlor-alkali, olefins, polyolefins, vinyls, glycols and methanol. It is projected that production volumes of these chemicals will expand by a factor of nearly 10 between 2014 and 2025 as a result of shale gas with employment impacts set to rise from 2.5% of total unconventional-related gain to 8% by 2035.

As with midstream and downstream activity, it is evident that the price differentials now emerging between domestically produced gas and alternative energy sources is generating a substantial competitive advantage in favour of the US petrochemical industry. It is already clear that capacity is expanding due to construction of new plants as well as the reopening of previously closed plants and that export of derivatives will play a major role in regenerating the industry.

Once again, the balance of outcomes for the UK and Ocean Gateway remain unclear in the absence of specific research and while the extent of energy-related chemical impacts remains outside the scope of this study, it is clear that shale gas development may serve to moderate market pressures, protect existing jobs and limit downsizing of activity in the UK. Moreover, since the Ocean Gateway has a particular concentration of chemicals industry activity, the effect locally may be more significant. Companies such as INEOS, which have a major facility in Runcorn (INEOS ChlorVinyls Limited) have identified the potential business and economic benefits of shale gas.

## 4.4 Skills

The Offshore Petroleum Industry Training Organisation (OPITO) is the focal point of skills, learning and workforce development for the offshore oil and gas industry and works with employers and trade unions to manage the industry's training and safety programmes. OPITO not only provides a link between employers and training providers to ensure that skill development meets the specific needs of the industry but also sets training standards and approves providers that deliver training in accordance with these standards.

No such organisation currently exists for the UK shale gas industry. Furthermore, recent surveys[47] have concluded that one of the main barriers to the growth of the industry is a lack of suitably skilled personnel in the UK. This view is reiterated in the 2013 IOD report, where the lack of an onshore drilling services industry is considered to be a constraint on the development of UK shale gas at scale[48]. The IOD also acknowledges the skill problems that exist in the oil and gas industry more generally, noting that 'current demand for experienced engineers and geoscientists in the UK (and globally) outstrips supply.' Particular recruitment difficulties appear to exist in the sourcing of geoscience professionals; senior engineers; reservoir, development, process, sub-sea and mechanical engineers[49]. Age is also considered to be a significant problem, as almost half of the UK oil and gas extraction industry workforce is aged 45 or over, with just over a quarter aged 34 or younger[50].

Since the unconventional gas sector is at an early stage of development in the UK, it is highly likely that outside expertise will initially be needed to assist capacity expansion. The ability to import 'appropriate' skills is never straightforward in a highly competitive global marketplace and it is evident that the sector is increasingly aware of the need to develop skills within the UK.

The Energy and Climate Change Select Committee (HC785) recently commented that 'The UK already has extensive drilling experience from the conventional gas industry in the North Sea, some of which could be transferable to the onshore industry' [51]. It concluded that, in the case of Lancashire, that government should 'encourage partnerships such as the one between Cuadrilla and the University of Central Lancashire to ensure the skills required to develop the shale gas industry are available. Government should make an assessment of the need for skills development and should work with industry and the relevant sector skills council to develop a skills action plan for shale gas similar to the Nuclear Supply Chain Action Plan which the Government has recently published.'

Whilst agreeing with the Select Committee's recommendations on skills development within the UK, the IOD has recommended that a similar body to OPITO should be encouraged, together with developing a UK shale gas education, skills and training directory similar to the one currently available for the UK nuclear industry[52].

47 Oil and Gas People (February 2014).
48 IOD (2013) *Infrastructure for Business: Getting shale gas working*
49 The University of Strathclyde and the Aberdeen and Grampian Chamber of Commerce, Oil and Gas Survey: 15th Survey, November 2012.
50 Regeneris Consulting, Economic Impact of Shale Gas Exploration and Production in Lancashire and the UK, September 2011
51 Energy and Climate Change Select Committee, Seventh Report, *The Impact of Shale Gas on Energy Markets* (HC 785) para 92.
52 IOD (2013) *Infrastructure for Business: Getting shale gas working*

The IOD notes that although it will be challenging to attract the most highly skilled personnel for shale gas production, the onshore nature of the work should help attract those dissuaded by the offshore lifestyle typified by working in remote areas for several weeks at a time. It is predicted that there is an immediate and growing need throughout the UK for:

- geologists and geophysicists with subsurface reservoir characterisation skills;
- reservoir and petroleum engineers able to pinpoint optimal drilling sites and maximise shale gas recovery; and
- drilling specialists with the horizontal drilling skills and experience required to exploit shale gas reservoirs.

There will also be requirements for the surveyors, architects and civil engineers needed to build and maintain drilling sites and the infrastructure required to service them.

Although there are a currently only a limited number of skills training courses specifically designed for personnel operating in the UK shale gas industry, it is likely that existing providers may be able to offer such courses in the event that sufficient demand emerges.

## 4.5 Tax

The extraction of shale gas has the potential to generate significant tax revenues. Any scaling up of capacity and extraction will bring with it additional tax streams. These will relate not only to taxes on extraction/sales of gas but direct and indirect taxation generated through the employment and supply-chain structures that are envisaged over the course of the development period.

Profits from shale gas production are currently subject to the 'ring fence' tax for oil and gas. This regime covers the exploration and production of oil and gas in the UK and Continental Shelf (UKCS) and impose a number of taxes including:

- Ring Fence Corporation Tax (RFCT):
  - calculated in the same way as mainstream corporation tax but with a ring fence that prevents taxable profits being reduced by losses from other activities or by 'excessive' interest payments and 100% first year allowances for most forms of capital expenditure. The tax rate is 30%;
- Supplementary Charges (SC):
  - an additional charge on a company's adjusted ring-fence profits of 32%.

In the course of 2013, the UK Government introduced a series of measures designed to support the development of shale gas. These included streamlining the permit process, new planning guidance and working with operators to seek (at least) a £100,000 community donation per fracked well during exploration and a community revenue stream of (no less than) 1% of revenues during production. Subsequently, the Government has announced that the full business rates income will be retained locally. The 2013 budget also announced that changes were being considered to the fiscal regime in order to incentivise investment:

- as allowances are dependent on clearly delineated fields, which do not exist in the case of unconventional reserves, a 'pad allowance' may be introduced operating similar to existing field allowances, exempting a part of production income from the supplementary charge and reducing effective tax on that part to 30%; and
- extending the number of accounting periods under the RFES from six to ten for shale gas projects.

As the tax regimes for unconventional gas are only slowly emerging, the issue of fiscal impact is generally less well covered in impact studies outside the US. One of the few studies that attempts to assess the tax implications of shale gas production is the 2013 Deloitte report which seeks to assess fiscal impact of the Bowland Basin development based on the Regeneris (2011) impact study.[53]

The study points to considerable uncertainty in terms of fiscal impact estimates given the absence of any large scale extraction facility in the UK. Likewise, the analysis is based on the existing tax rates applicable to oil and gas production from the UK Continental Shelf (UKCS) in the absence of an alternative tax regime for shale gas.

In this context, the Deloitte analysis suggests that Bowland Basin shale gas production could generate tax revenues of around £580 million per annum by 2020 based on Cuadrilla cost and volume assumptions for shale gas production and DECC central wholesale price assumptions. Figures for 2030 vary from around £1.5bn to £0.5bn per annum depending on assumptions about well flow rates and It is clear from simulations that the level of tax generated varies materially across scenarios given variations in assumptions on wholesale gas prices and the cost of production, which together drive project profitability.

It is worth bearing in mind that the Deloitte study focusses solely on the fiscal impacts from production and sale of shale gas. It does not allow for the potential community donations noted earlier and excludes any direct or indirect taxation streams from the development activity covered in earlier sections of this report.

## 4.6 Summary

Attempting to assess the economic impacts of new or recently developing sectors is complex. There is the challenge of forming a coherent picture of the way in which activity and production will be structured in the presence of very limited information and there is limited evidence as to the wider effects of development.

This section reviews some of the broader aspects of shale gas expansion within Ocean Gateway. It notes the evidence that there may be potential for midstream and downstream economic effects as well as upstream effects and the scope for energy-related chemical impacts. The latter is of particular relevance given the concentration of the chemicals industry in the Ocean Gateway area and the inevitable competitive pressures that may mean active consideration of whether expanding US chemical facilities at the expense of those in the UK can be offset by access to a secure more cost-effective local source.

[53] Both are reviewed in Section 2.3.

Concerns about skills are a feature of the offshore and onshore oil and gas industry. It is anticipated that the size of the local resident labour pool with appropriate skills will be somewhat limited in the first instance but that there will be opportunities to enhance the 'pool' through training with local colleges or perhaps the development of a dedicated training institution. It is unlikely that the issue of skills will be eradicated in the short-term, particularly if shale gas activity expands across the UK as a whole.

Finally, knowledge about the potential tax streams associated with shale gas expansion is minimal. Amongst other things, this reflects the uncertainty about fiscal regimes and the nature of the future tax treatment of the sector. It is clear that the issue will require further assessment once the Government has decided the nature of tax arrangements but that attention should also be given to the tax streams associated with the development activity considered in earlier sections of the study.

# 5 Conclusion

This report has provided an assessment of the potential economic impact associated with the exploitation of shale gas reserves in the Ocean Gateway area.

The existing evidence base is relatively limited and much of it is based on specific US shale formations which are significantly different from the potential scale of operations in the UK. However, more recently, various studies have also been produced in the UK.

Our own assessment of the potential impact of extraction in the Ocean Gateway area has involved development of a detailed overlapping cohort model. This reflects the six stages of activity involved in shale gas extraction:–

- ‘enabling’ - preparatory actions required to achieve consents and permissions alongside development planning for each potential site;
- ‘site preparation’ - including all front-end design and civil engineering;
- ‘exploration and appraisal’ - preliminary drilling and flow testing of vertical wells;
- ‘development and distribution’ - the drilling-out of vertical/lateral wells on a site (or pad) as well as connection to any network infrastructure;
- ‘operation and maintenance’ - the activities necessary to ensure safe, efficient flow of gas; and
- ‘decommissioning’ - all activities necessary to seal and abandon wells, remove all equipment and reinstate the site to its prior condition.

Additional costs relating to seismic testing have also been included in the assessment.

The development scenario assessed envisages a total of 30 shale gas production sites over the period 2015 to 2031, with each site comprising 10 vertical ‘motherbore’ production wells and 40 horizontal lateral wells. Overall development costs to 2035 are estimated at £9.8bn with a peak annual cost of £945m and an average annual cost of £466m

The impact model is based on a ‘multiplier’ structure that takes into account not only direct and first-tier supplier spending/employment but the subsistence and leisure spend of non-resident workers, subsequent supply-chain spend and the ‘induced’ spending of all those individuals that receive wages/salaries as part of this process.

UK impacts are reported in ‘gross’ terms, estimating the number of jobs that would be sustained in the peak year if the supply-chain was to be ‘internalised’ within the UK and providing a ‘ceiling’ estimate of UK impact. A different approach is taken for the Ocean Gateway assessment which differentiates between the impacts retained within the area and those that accrue elsewhere. It is informed however by assumptions concerning the extent to which by the point of peak impact, the current ‘baseline’ position will have changed in terms of more local residents having acquired relevant skills and skilled workers and some of the supplier base having re-located to the Ocean Gateway area.

In terms of peak year impacts for the UK, the modelling suggests potential for 15,542 jobs on the basis that all supply-chain jobs are sustained. Relaxing this assumption would reduce indirect and induced employment estimates. The Ocean Gateway peak-year projections suggest a total of 3,504 jobs (see Table 5.1).

**Table 5.1: Peak-Year Employment Projections**

| | Ocean Gateway | UK |
|---|---|---|
| Direct | 1,482 | 2,914 |
| Indirect | 1,792 | 6,444 |
| Induced | 230 | 6,184 |
| **Total** | **3,504** | **15,542** |

As well as the quantified economic impacts, the report highlights a number of wider economic effects that shale gas exploitation within the Ocean Gateway area will potentially generate, including:

- the potential for midstream and downstream economic effects arising from natural gas upgrading, the reduced cost of gas processing, the 'export' of surplus gas to other markets and capital investment in new infrastructure. While these benefits are likely to be less significant in the UK than the US – where thay have been forecast to account for up to 15% of all job gains – cost reductions and capacity expansion will undoubtedly deliver economic benefit over and above that assessed in this exercise;
- possible improvements in business competitiveness and the relative attractiveness of the area as a business location arising from the use of gas in many manufacturing industries - including in particular petrochemicals. The latter is of particular relevance given the concentration of the chemicals industry in the Ocean Gateway area and the substantial competitive advantage in favour of the US petrochemical industry that is now emerging as a result of price differentials between domestically produced gas and alternative energy sources. Shale gas development in Ocean Gateway may serve to moderate these market pressures, protect existing jobs and limit downsizing of activity in the area and the UK - although the balance of outcomes remain unclear in the absence of specific research;
- impacts upon skills and training infrastructure. It is anticipated that the size of the local resident labour pool with appropriate skills will be somewhat limited in the first instance but that there will be opportunities to enhance the 'pool' through training with local colleges or perhaps the development of a dedicated training institution. It is unlikely that the issue of skills will be eradicated in the short-term, particularly if shale gas activity expands across the UK as a whole; and finally
- the exploitation of shale gas has the potential to generate significant tax revenues. These will relate not only to taxes on extraction/sales of gas but direct and indirect taxation generated through the employment and supply-chain structures that are envisaged over the course of the development period. However, the scale of such impacts is unclear given uncertainty about fiscal regimes and the nature of the future tax treatment of the sector.