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Economic Impact of Shale Gas Exploration & Production in Lancashire and the UK

A Final Report by Regeneris Consulting

Cuadrilla Resources

Economic Impact of Shale Gas Exploration & Production in Lancashire and the UK

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1. Introduction

1.1 Cuadrilla Resources Ltd are currently exploring the potential for commercial shale gas extraction in the Lancashire area via a series of test wells. Exploration commenced in mid 2010. If commercially exploitable reserves are identified then a far more substantive and longer lasting phase of gas extraction could commence by 2013, subject to the necessary national and more local licensing and planning approvals.

1.2 The exploration phase is already generating a significant volume of additional economic activity for Lancashire, both through the activities on-site at the test well locations and the accommodation and subsistence expenses of workers who are often resident elsewhere. A full commercial extraction phase would bring more extensive economic benefits, particularly as suppliers set up permanent operations in the Lancashire area.

1.3 Regeneris Consulting have been appointed to quantify the economic impact of both the current exploration phase and the likely economic impact of a subsequent and far more extensive phase of commercial extraction. We have modelled the impact for both the county of Lancashire[1] and the UK as a whole.

1.4 Regeneris Consulting is an independent economic development consultancy with offices in London and Manchester. We are grateful for the information provided by Cuadrilla Resources and their suppliers in enabling us to complete this assessment.

[1] This comprises the current administrative area of Lancashire County Council, plus the unitary authority areas of Blackburn-with-Darwen and Blackpool.

2. Background on Shale Gas & Cuadrilla

2.1 Shale gas is natural gas extracted from shale rock formations. It is one of a number of so-called unconventional sources of natural gas, with other unconventional sources of natural gas including coal-bed methane.

2.2 Whilst labelled as unconventional, shale gas exploration and extraction techniques, including directional drilling and hydraulic fracture stimulation (sometimes known as frac'ing) have been used across the oil and gas industry, including in the UK for many decades. More information on the drilling and hydraulic fracturing process required for shale gas extraction is provided in Section 3 of this report.

2.3 A significant growth in global shale gas extraction has been witnessed in the last decade, largely in the US, and as a result of technological advances in hydraulic fracturing techniques. Interest in shale gas has spread from the United States in recent years, with exploration now occurring in Canada, Europe, Asia, and Australia.

Shale gas in the US

2.4 Shale gas production in the US has grown dramatically in the last decade. In 2010, US shale gas production reached 4.87 Tcf (trillion cubic feet), equivalent to 23 percent of total US natural gas production. Production in 2000 stood at just 0.39 Tcf.

2.5 Rising production from shale gas resources in the US has been credited with both lower natural gas prices and declining dependence on imported natural gas. EIA's Annual Energy Outlook 2011[2] highlights the growing importance of shale gas. It projects that shale gas will account for about 46 percent of US natural gas production in 2035.

2.6 Production has historically been concentrated in the Barnett field in the Dallas-Fort Worth area of Texas where significant drilling activity began in the late 1990s. This is now one of the largest natural gas fields in the US. Production was measured in 2010 at 1.83 Tcf – approximately 36% of all shale gas production in the US.

2.7 Many of the same companies who developed the Barnett area have now also sought to exploit the Marcellus play, which is by far the largest of the known shale plays in the US (see Figure 1). The Marcellus lies under most of West Virginia, roughly 60 percent of Pennsylvania and well into the upper tier of New York State. The formation also extends into eastern Ohio, western Maryland and extreme western Virginia. The total area of the Marcellus play which is of productive use is roughly 95,000 square miles. In contrast, the productive use of the Barnett field is about 5,000 square miles. Engelder[3] (2009) estimates that 2,445 trillion cubic feet of reserves are in place within the Marcellus and that 489 trillion cubic feet could be recovered under existing technology.

2.8 Other smaller plays have been exploited in locations such as Fayetteville and Woodford.

[2] Energy Information Administration's (EIA) Annual Energy Outlook 2011 (AEO2011)

[3] Professor Terry Engelder - Department of Geosciences, The Pennsylvania State University.

Figure 2.1 : Shale Plays in the US

Source: Energy Information Administration based on data from various published studies.
Updated: March 10, 2010

Source: Reproduced from the Energy Information Administration – published March, 2010

The Bowland Reserve & Cuadrilla Resources

2.9 A recent report by DECC[4] identifies Bowland Shale as the most promising location for UK shale gas extraction. Cuadrilla Resources is an independent oil and gas company based at Lichfield in Staffordshire, formed in 2008 by a group of unconventional gas explorers from the US and the UK with the support of specialist energy investors. A UK Petroleum Exploration and Development Licence (PEDL) was granted to Cuadrilla in September 2008 which allows the company to pursue shale gas exploration activities in the Bowland Shale, subject to the necessary drilling/development consents and planning permissions.

2.10 The license area is shown in Figure 2.2 (over page). It covers an area of some 500 square miles, which is considerably smaller than the main US plays identified above. The license area covers the western side of Lancashire, predominantly to the west of the M6 motorway and including the towns of Blackpool, Preston and Southport. A small scale gas well is already in operation at Elswick, and has been since 1996. It produces gas from a low permeability sandstone reservoir at a depth of approximately 4000 ft and is used to generate power for supply to the local electricity grid.

2.11 Cuadrilla is also currently assembling a portfolio of shale gas sites in established hydrocarbon provinces located in several other European countries including Poland and The Netherlands. It is within Lancashire however that Cuadrilla's most advanced exploration activities are located.

[4] Department for Energy and Climate Change (2010) – The Unconventional Hydrocarbon Resources of Britain's Onshore Shale Gas Basins.

2.12 The first test well commenced in August 2010 at Preese Hall. A second test well commenced in late 2010 at Grange Hill Farm. In the region of four to 12 test wells will be required as part of the exploration phase, roughly proceeding at the pace of three test wells per annum. The precise location of the future test wells within the licence area has not yet been confirmed.

2.13 Should it be concluded that commercially exploitable reserves are available, and should Cuadrilla and its investment partners want to proceed to commercial extraction, then DECC permission for a full extraction license would be required. Planning permission for each new well location would also be required.

Figure 2.2 : Bowland Shale Exploration License Area

Note: 1: Preese Hall; 2: Grange Hill Farm. The blue boundary represents the Bowland Shale licence area. Source: Microsoft Bing Maps/Pitney Bowes Mapinfo.

3. The Process of Extracting Shale Gas

3.1 Shale gas extraction is a sophisticated process, involving a large volume of skilled and experienced labour, specialist suppliers and costly capital equipment.

3.2 This section of the report provides a very basic summary of the procedures and timelines involved in drilling, fracturing and then harvesting shale gas. The process will differ to some extent between an exploration well and full commercial extraction, although the basic principles remain the same. We comment on these differences below, which revolve primarily on the degree of testing and analysis that is required and amount of fracturing.

Preparation of the Pad

3.3 The area where a well is drilled is referred to as the well pad. A typical test well pad is approximately 7,000 sqm in size and provides enough space for the drilling rig equipment, piping and storage, and other site facilities such as mobile portacabins for offices and worker restrooms. A test well pad of this size could typically support up to 10 wells spaced out across the site area, although for the purposes of test well extraction a single well will be drilled from each pad.

3.4 The main works included in the process are the insertion of a impermeable membrane and surface drainage ponds (as a safety precaution for groundwater supplies in the unlikely event of a spillage on the surface of fracing fluid or seepage of hydrocarbons), hard standing, and other ground works including landscaping the site to reduce the visual impact of the pad.

3.5 The time taken to prepare a pad can range from 30-60 days as the works are very weather dependent. The task of securing planning permission, which includes the necessary ground condition surveys etc, would precede the pad preparation process.

Figure 3-1: Cuadrilla's First Lancashire Well Pad at Preese Hall

Source: Cuadrilla Resources

Drilling the Well

3.6 Prior to the main drilling rig arriving on site, water-well drilling techniques are used to remove the gravel deposits below the surface. Once the top soil and gravel deposits have been drilled, a cement collar is inserted. Following insertion of the cement collar, the main drilling rig is brought on-site and takes one week to assemble. Once assembled, the main drilling programme lasts for approximately eight weeks.

3.7 Key steps in the drilling process are as follows:

- A drill bit is mounted on the end of a drill pipe. As the bit grinds away a mixture of water and additives called 'mud' is poured into the hole to cool the bit and to flush the deposits cut to the surface. The mud also coats the walls of the well providing greater resilience to the well wall. Once at the required depth past the freshwater zone (aquifers) the drill pipe and bit are removed from the bore hole.

- Surface casing is then inserted into the well hole to isolate the freshwater zone the bore has passed through, and to act as a foundation for the blow out preventer (a safety device which connects the rig to the well bore). Cement is pumped down the casing and out through the bottom of the casing, and forced up between the casing and the bore hole sealing off the well from the freshwater zone preventing contamination of the water supplies.

- The piping and drill bit is reinserted into the bore hole and drills through the plug and cement to carry on drilling down to the required depth. Hi-tech drill bits are then utilised to develop the angled curve to allow the bore hole to stretch out from beneath the main pad area out in to the shale.

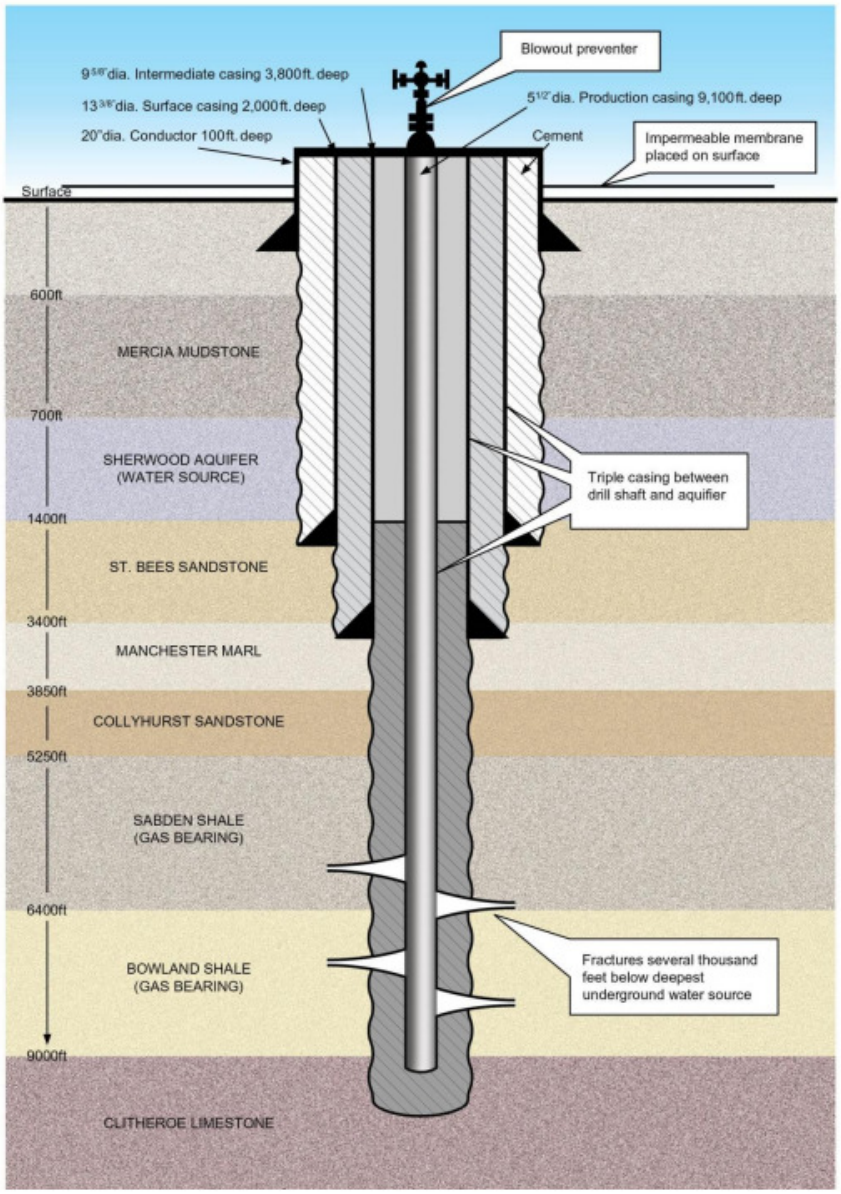
- Once the bore has reached the required distance, the drill pipe and bit are removed from the well. Production casing is then inserted in to the full length of the well. This process permanently secures the well bore, preventing hydrocarbons and other fluids from seeping out in to the geological formation. Testing is carried out at this stage to monitor the well and to ensure that it is safe.

3.8 The drilling rig is the most costly piece of capital equipment required for the drilling operations, and manned by a specialist crew. A range of specialist sub-contractors, providing items such as drilling fluids, tubular casings, drill bits etc are integral to the process.

3.9 Throughout the drilling process extensive daily deliveries and removals are required, providing essential bulk inputs (cement etc) and removing drilling debris from the site. Drill sites typically also require 24-hour security personnel.

3.10 A schematic of a Bowland Shale well is provided over page.

Figure 3-2: Bowland Shale Well Schematic



Source: Cuadrilla Resources.

Perforation, Fracturing & Testing

3.11 The next stage in the test well process is the perforation and hydraulic fracturing of the well to release the shale gas. This process typically starts about 3-4 weeks after drilling has been completed. It takes 2-3 weeks for a test well, longer for full commercial extraction wells. The key steps in this process are:

- A perforating gun is lowered in to the well to the targeted section. An electrical current is sent to the perforation gun, and sets of the charge which perforates the casing and cement, as well as a short distance out into the shale formation.
- The hole is then hydraulically fractured, or frac'd, by pumping a mixture of water, sand and additives (99.85% water) in to the well bore and casing under extremely

high pressure. The mixture is forced out of the perforations and into the surrounding rock; the pressure causes the shale to fracture. This process widens the fractures in the rock and makes these pathways wider for the gas to flow more easily from the rock to the well. The process of perforation and fracturing can be repeated several times to cover the distance of the well.

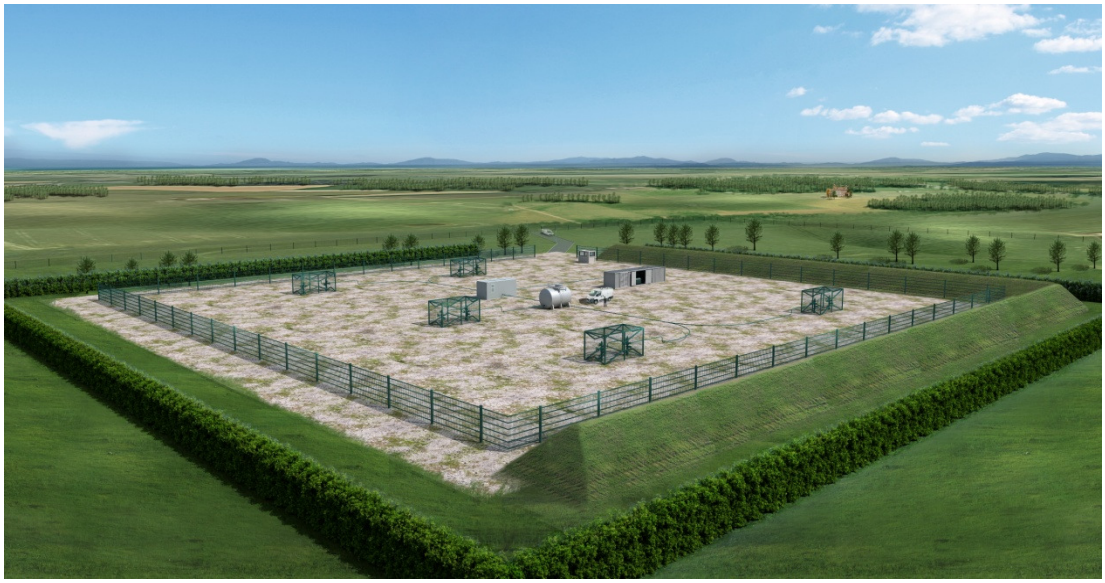
- Once fracturing has been completed a period of upto 8 weeks is typically taken to test and monitor the well. Plugs are inserted and gas levels are monitored, both for production levels but also for health and safety reasons. Once the main period of testing has been completed the plugs can be drilled out to allow the gas to flow up the well bore. A permanent well head is then installed and the test well is closed until production commences.

Harvesting the Gas and Ongoing Maintenance

3.12 Once production commences infrastructure is required to feed the gas into the mainstream energy supply. The two main options are (i) additional pipelines to connect into the main UK gas pipeline network and (ii) on site electricity generation which is then connected into the national grid. Under either approach a substantial body of additional labour and equipment is required to put in place the necessary infrastructure, which will grow in scale as the number of wells in any one location increases. It may well be the case that in Lancashire a hybrid solution is put in place which combines gas pipelines at some wells and electricity generation at others.

3.13 An ongoing maintenance resource will be required to oversee the well field once it is in full production phase. This resource will carry out routine and scheduled maintenance on wells and also respond to any emerging issues. Figure 3-3 provides an image of what a well pad would look like after all drilling and fracturing has been completed.

Figure 3-3: Image of a Completed Well Pad with 10 wells (Computer Generated)

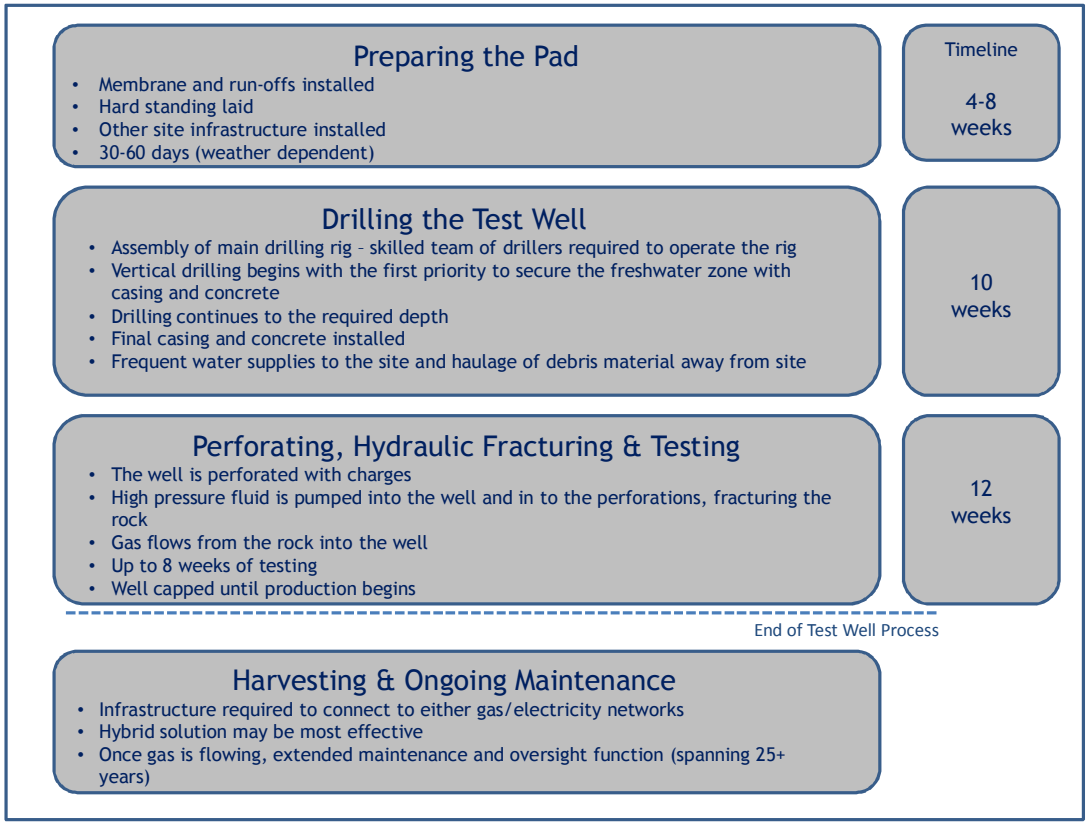


Source: Cuadrilla Resources.

Overview

3.14 A full cycle of test well pad preparation, drilling and fracturing can take up to half a year to complete (see Figure 3-4 over page). Drill kit will be freed up and available for other wells in the area part way through the process, allowing two test wells to proceed with just one drill rig. As and when full commercial extraction occurs certain elements of the process can be completed more quickly and efficiencies will emerge as a result of a greater critical mass of activity.

Figure 3-4: Overview of the Process



Source: Regeneris Consulting

4. Economic Impact Lessons from the US

4.1 To inform this assessment we have sought evidence from the US on the economic value of shale gas production. This has proved useful in both understanding the likely scale of job creation attached to each drill-well but also the nature of the supply chain effects and the locational decisions of key suppliers as production gears up. Before analysing the evidence, it is important to acknowledge some key differences between shale gas production in the US compared to that which is likely in the UK:

- *Scale of reserves*. Gas reserves within the US are significantly larger than those likely to be exploited in the UK. The sheer scale of the plays has persuaded a substantial array of specialist providers to locate operations near/within the plays and some international suppliers to base operations in the US. This attraction of the supply chain to individual plays might not be so extensive in the UK.

- *Geography*. The example of the Marcellus play in Pennsylvania highlights how gas extraction takes place over vast areas of rural and relatively sparsely populated locations. The US plays often dictate that suppliers require local bases, that regular commuting of staff from neighbouring regions is more difficult and the cost of connecting into established gas and electricity networks is more extensive. The economic geography of the UK is somewhat different.

- *Drilling Costs*. In the US, producers make extensive use of horizontal drilling techniques to maximise yield from any single well location. In the UK, due to the geological formations within the Bowland area, vertical and directional drilling is likely to be more common which will in turn lead to different timescales and costs attached to the drilling process.

- *Royalty payments*. The importance of royalty payments within the US is a major difference with the UK market. Royalty payments are typically paid to landowners in the US who also own the mineral rights to areas beneath their land, and as such is major source of additional local income. This is a key difference to the UK market where all mineral rights are the property of the Crown.

4.2 Despite the above, the evidence from the US provides some useful pointers on the labour requirement and supply chain impacts likely to materialise in the UK.

Marcellus Shale

4.3 Several studies have been undertaken in recent years on the Marcellus Shale area. The most authoritative of these have been authored by Timothy Considine from Penn State University in 2010. The studies he has authored include both an analysis of the Impact of Marcellus on Pennsylvania[5] and a wider assessment of the economic impacts of Marcellus on New York, Pennsylvania and West Virginia also in 2010[6].

[5] Considine, T. (May 2010). The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play

[6] Considine, T. (July 2010). The Economic Impacts of the Marcellus Shale for New York, Pennsylvania and West Virginia

Impacts of the Marcellus Shale in Pennsylvania

4.4 As part of Considine's 2010 research he assessed the economic impacts of drilling activity in Pennslyvania in 2009. In this year there were approximately 710 wells drilled across the state. The wells produced, on average, 550 mcf of gas per day by the end of 2009 (on average throughout 2009 this was 327mcf per day).

4.5 Drilling activities in Pennsylvania directly provided an economic contribution to the state economy of $3.77 billion in 2009. Once indirect and induced effects were also considered, the total gross output (i.e. economic contribution) from shale gas drilling rose to $7.17 billion. Indirect effects, which represent supply chain expenditure, are $1.56 billion and induced effects, which reflect expenditure by staff in the wider economy, are $1.84 billion. Considine estimated that for every $1 of direct drilling expenditure in Pennsylvania, $1.90 of total economic output was generated[7].

4.6 When just Value Added is considered (i.e. stripping out inter industry purchases) the total economic impact was almost $3.9 billion in 2009. GVA is essentially the components of Gross Output that are distributed as wage income, profits, interest, taxes and in the form of depreciation. GVA is used as a standard measure of wealth generation and represents Gross Output minus the costs of all bought in goods and services. Using a conversion rate of 1US$: £0.6, then shale gas production in the Pennsylvanian Marcellus Shale generates an equivalent GVA of some £2.3 billion.

4.7 Considine also estimated that approximately 20,400 direct FTE jobs were supported through drilling activities in Pennsylvania, with a further 20,900 jobs supported through indirect (8,200 FTE jobs) and induced (12,700 FTE jobs) effects. In total, shale drilling in Pennsylvania supported over 41,300 FTE jobs in 2009. Another way of looking at this is that for every 1 job supported directly through drilling activities in Pennsylvania, another 1 job is supported indirectly or through induced expenditure. One of the main drivers of this high multiplier effect is the role which lease bonuses and royalties, which are received by landowners, play in supporting induced employment as landowners spend some of their new found wealth within the economy.

Table 4-1: Pennsylvania Economic Impacts, 2009

	Direct	Indirect	Induced	Total	Total (direct & indirect only)
Gross Output ($m dollars)	3,769	1,557	1,844	7,170	5,326
Gross Value Added ($m dollars)	1,982	828	1,066	3,876	2,810
Employment (FTE jobs)	20,417	8,186	12,738	41,342	28,603
Gross Output (£m)	2,261	934	1,106	4,302	3,196
Gross Value Added (£m)	1,189	497	640	2,326	1,686
GVA (£) per FTE	58,246	60,689	50,212	56,253	58,945
FTE jobs per well	29	12	18	58	40

Note: Based on 710 new wells in year and an average over 2009 of 327mcf per day of gas production.
Source: Considine, T (2010)

[7] Considine found that this combined multiplier was higher than that estimated at other oil or gas locations in the US. Multipliers from other studies in Louisiana, New Mexico and Oklahoma were 1.34, 1.43 and 1.55.

4.8 Table 4.1 highlights the key economic impact indicators for production of shale gas in the state of Pennsylvania. With over 41,000 FTE jobs supported through this industry, this generated a GVA per FTE job of £56,000. Each well also supports an average 58 FTE jobs in Pennsylvania (if induced effects are not counted each well supports 40 FTE jobs).

4.9 The Pennsylvania study highlights the importance of the drilling industry to other sectors of the economy – these business to business transactions are important in stimulating various rounds of expenditure within the economy. Examples of this in Pennsylvania include:

- Real estate and legal services to deal with leasing
- Exploration crews who purchase supplies, stay in hotels and eat in local establishments
- Site preparation requires engineering studies, heavy equipment and aggregates
- Drilling requires trucking firms and support companies, who in turn purchase fuel, piping, and other goods and services.

4.10 The following table highlights how employment in sectors in Pennsylvania has been supported through drilling activities. While the construction sector, drilling and trade sectors account for 60% of all direct employment supported by gas extraction, when indirect employment is analysed other sectors rise to prominence.

4.11 Over a fifth of all indirect employment is within the professional scientific and technical services, while 15% of employment is in waste and administrative services and a further 8% in finance and insurance services. It is also clear from reviewing induced expenditure that this supports further employment within the medical and service sectors including retail, hotels and food providers, and the financial services sector.

4.12 What this demonstrates is that the scale of drilling activities in Pennsylvania currently supports significant levels of employment across a wider range of sectors – some sectors not always readily associated with drilling activities. While some of the jobs created and supported in Pennsylvania will require staff with high-level technical skills and qualifications, others will lead to the creation of a range of jobs which will require low to medium levels skills within the service sector.

4.13 In neighbouring Ohio there is evidence of further supply chain activity, with Vallourec & Mannesmann Holdings Inc. building a new $650 million steel plant in the once booming steel town of Youngstown to make the pipes used in hydraulic fracturing and shale gas drilling.

Figure 4-1 : Sectoral Breakdown of Impacts

Sector	Direct Share	Indirect Share	Induced Share	Total Share
Construction	22.9%	1.8%	0.9%	12.0%
Retail Trade	13.5%	2.6%	20.4%	13.5%
Mining	13.2%	0.6%	0.1%	6.7%
Wholesale Trade	10.4%	5.8%	3.1%	7.2%
Health & social services	9.1%	0.3%	21.6%	11.2%
Hotel & food services	6.3%	5.1%	10.3%	7.3%
Educational services	4.9%	0.3%	4.2%	3.8%
Other services	4.4%	4.9%	9.1%	6.0%
Professional-scientific & tech services	3.4%	22.2%	4.0%	7.3%
Transportation & Warehousing	2.8%	7.1%	2.2%	3.5%
Real Esate and rental	2.0%	6.7%	4.4%	3.7%
Arts-entertainment & recreation	1.8%	1.3%	3.0%	2.1%
Administrative & waste services	1.5%	15.3%	4.4%	5.1%
Manufacturing	1.1%	6.6%	1.6%	2.3%
Finance & Insurance	0.8%	8.0%	6.2%	3.9%
Government & Misc	0.7%	2.3%	1.3%	1.2%
Agri, forestry etc	0.5%	1.5%	0.6%	0.7%
Utilities	0.3%	0.5%	0.3%	0.4%
Information	0.3%	3.7%	1.8%	1.4%
Management of companies	0.0%	3.5%	0.5%	0.8%

Source : Considine, T (May 2010). The Economic Impacts of the Pennsylvania Marcellus Shale Natural Gas Play

Marcellus Shale in West Virginia

4.14 In 2010, Considine also estimated the current and future economic impacts of the wider Marcellus shale play which stretches beyond Pennsylvania and into West Virginia and parts of New York State (although New York State has a moratorium in place on drilling activity).

4.15 Considine's estimates of the 2009 impacts in West Virginia were as follows:

- Gross Value Added (GVA) from gas production in the state was £1.3 billion. With over 13,000 FTE jobs supported, this generated a GVA per FTE job of £42,500.
- Each well also supports an average 32 FTE jobs in West Virginia (if induced effects are not counted each well supports 26 FTE jobs).

4.16 In broad terms the labour requirement per new well was slightly less than the observed results for Pennsylvania, due in large part to the less well established local supply chain and more limited induced impacts.

Table 4-2: West Virginia Economic Impacts, 2009					
	Direct	Indirect	Induced	Total	Total (direct & indirect only)
Gross Output ($m dollars)	918	196	212	1,327	1,114
Gross Value Added ($m dollars)	632	138	169	939	770
Employment (FTE jobs)	8,436	2,052	2,762	13,249	10,488
Gross Output (£m)	551	118	127	796	668
Gross Value Added (£m)	379	83	101	563	462
GVA (£) per FTE	44,950	40,351	36,713	42,524	44,083
FTE jobs per well	21	5	7	32	26
Note: Based on 411 new wells in year. Source: Considine, T (2010)					

Barnett Shale

4.17 The Texas based economic and research consultancy, The Perryman Group, produced a report on the economic impact of drilling within the Barnett Shale region in Texas area. Their 2008 report, *Drilling for Dollars*, estimated that drilling activity in the Barnett Shale contributed approximately $8.2 billion in annual output to the Barnett Shale region in 2008. This accounted for just over 8% of the total economic output of the area. The drilling activity also supports over 83,000 FTE jobs within this region.

4.18 As well as these more local benefits, the State of Texas also benefits from the expansion of drilling activity. The State saw approximately $10.1 billion in annual output from this activity, while almost 98,000 jobs were supported across Texas. Currently the direct drilling operations account for $5.5billion of total economic output and over 48,800 FTE jobs.

4.19 As with the Marcellus Shale a significant proportion of the economic impacts measured by economic output and employment supported are derived from indirect and induced expenditure associated with the drilling activities and royalty payments. Taking all the impacts in to consideration, total FTE employment supported in the Barnett Shale area is 83,800 jobs, based on a production of 1.6 TCF of gas production.

4.20 Based on the number of wells developed in the period leading up-to and including 2008, the FTE job to well ratio in the Barnett area is an average 50 FTEs per well, or 36 FTEs per well if induced impacts are excluded.

Table 4-3: Barnett Shale Region, Texas – Current (2008) Impacts					
	Direct	Indirect	Induced	Total	Total (direct & indirect only)
Gross Output ($m dollars)	5,465	897	1,845	8,207	6,362
Employment (FTE jobs)	48,811	11,383	23,629	83,823	60,194
Gross Output (£m)	3,279	538	1,107	4,924	3,817
FTE jobs per well	29	7	14	50	36
Note: Average number of new wells was 1,700 per annum (Texas Railroad Commission) Source: The Perryman Group					

4.21 The impact of the real estate market in the Fort Worth area is an issue which the Perryman report draws out in addition to the work Considine in the Marcellus play. The real estate effects can be considered for both residential and commercial space.

4.22 Evidence suggests that residential demand increased markedly within the Forth Worth area as a result of the increase in the flow of people moving in to the area, as well as existing residents who may have benefitted from royalty payments and are looking to invest some of this new wealth.

4.23 Commercial real estate changes within the Fort Worth area were driven by the need for drilling and drilling companies to establish regional offices and bases. As well as these companies requiring space, their service providers and other supply chain organisations looked to set up operational hubs in close proximity to their clients.

Overview

4.24 Various studies have researched the issue of employment and supply chain impacts in the US shale plays. The available evidence points to large scale employment creation based on the substantial US shale plays. The total number of full time equivalent jobs range from 13,000 across the state of West Virginia to 83,000 FTEs in Texas.

4.25 The number of wells drilled in any particular year is the primary factor determining the scale of impacts. The number of direct, indirect and induced FTE jobs per new well ranges from 32 FTEs (West Virginia) to 58 FTEs (Pennsylvania). The range, we suspect, is due in part to the differing degrees to which a local supplier base has been established.

4.26 The evidence suggests the construction, drilling and related trade sectors account for 60% of all direct employment supported by gas extraction in the US. Over a fifth of all indirect employment is within the professional scientific and technical services, while 15% of indirect employment is in waste and administrative services. Induced employment is heavily loaded towards the medical and service sectors including retail, hotels and leisure providers. While some of the jobs created and supported in the US require high-level technical skills and qualifications, others provide opportunities for those with less formal skills and working on a part-time basis.

5. Economic Impact Lessons from the UK

5.1 The scale and nature of employment impacts in the existing UK oil and gas extraction industry can offer some useful insights into the likely economic impacts of the Bowland Shale play.

5.2 Oil production in the UK in 2009 totalled 61,870,000 tonnes offshore and 1,168,000 tonnes onshore. Gas production totalled 62,800 million m^3 (2,218,000 million ft^3) offshore and just 93 million m^3 (3,300 million ft^3) onshore in 2009.

5.3 Offshore activity clearly dominates the sector. Over the last forty years, exploration and development of the UK's offshore oil and gas reserves has created a supply chain with an extensive range of products, services and expertise, particularly in Scotland and Aberdeen. East Anglia is another important location.

5.4 There are currently some 28 UK onshore oil fields and 10 onshore gas fields in production. Onshore production is a small fraction of offshore production, with onshore oil and gas representing around 2% and 0.4% of total UK production respectively. The Wessex Basin, with its large Wytch Farm oilfield in Dorset, dominates UK onshore oil production.

Headline Economic Value

5.5 According to Oil and Gas UK, the offshore industry association, some 440,000 jobs throughout the UK were supported by the servicing of offshore activity and in the export of oil and gas related goods and services in 2010. Some 32,000 are employed directly whilst another 207,000 are employed in the wider supply chain, 100,000 in jobs induced by the economic activity of employees. A further 100,000 individuals are employed across the country in jobs exporting goods and services not linked directly to UK production, a number of which spend extended periods overseas. Similar employment information for the onshore sector is not available.

5.6 According to the Mineral Planning Fact Sheet produced for CLG by the British Geological Society[8], the total value (or gross output) of producing oil and gas was £36.2 billion in 2008, a major proportion of which was from offshore fields. Onshore oil and gas is estimated to be worth £650 million in 2008, of which 90% was generated from oil.

5.7 Evidence from ACSEF[9] (Aberdeen City & Shire Economic Futures) quoting data from UK National Statistics quantifies the GVA of the total sector at £25 billion.

[8] Mineral Planning Fact Sheet Onshore Oil and Gas, CLG and British Geological Society NERC, 2010.

[9] ACSEF Importance of the Energy Sector 2010.

Table 5-1 : UK Onshore and Offshore Oil and Gas Production Employment Estimates		
	Offshore	Onshore
Oil/Liquids (tonnes) 2009**	61,871,000	1,167,000
Gas (million m^3) 2009**	63,000	93
Jobs (Total UK) 2010*	440,000 FTEs, comprising: - 32,000 direct - 207,000 indirect - 100,000 induced - 100,000 in the export supply chain, including working overseas	No definitive source available
Total Output 2008 (value of producing oil and gas)	£36bn (sourced from CLG/BGS and verified by Oil and Gas UK)	
Total GVA 2010***	£25bn (sourced from ACSEF)	
Source: *2011 Oil and Gas Activity Survey, Oil & Gas UK **Oil & Gas Statistics, DECC *** ACSEF 2010		

Characteristics of the Labour Force

5.8 The 2009 Annual Survey of Hours and Earnings (ASHE) shows that the highest earning UK industry was extraction of crude petroleum and natural gas, with average gross annual earnings of £89,800 per FTE. This compares to average gross annual earnings (mean) of £32,100 per FTE across all employee jobs in the UK. In the UK, the industry is characterised by an older and predominantly male workforce. Table 5-2 disaggregates the workforce into proportions by age, gender and occupation.

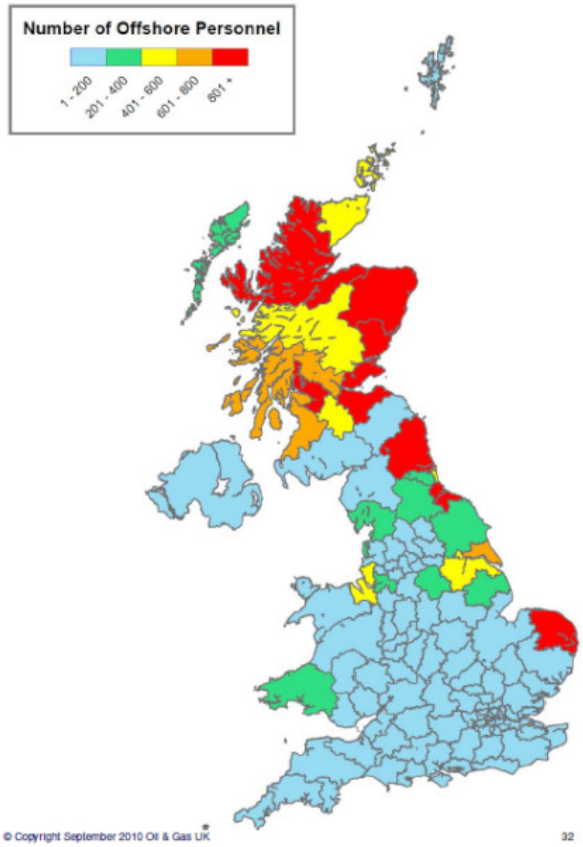
5.9 It is a relatively high-skilled profession with the majority of jobs within *professional* and *skilled trade* occupations.

5.10 Almost 50% of the UK oil and gas workforce is aged 45 or over. Oil and Gas UK note that the average age for offshore personnel is 41 years. Oil & Gas UK also note that the number of females employed in the industry has remained relatively low since 2008, the predominant job category for these being in the administrative and supporting catering sectors.

5.11 The distribution of offshore workers living in the UK shows that there are particularly high concentrations of offshore workers in Aberdeen, Inverness, Dundee, Kirkcaldy, Glasgow, Edinburgh, Newcastle upon Tyne, Sunderland, Teesside and Norwich.

Table 5-2 : UK Oil and Gas Extraction Industry Workforce Profile	
Age group (%)	
16-24	5
25-34	22
35-44	25
45-54	30
55+	18
Gender (%)	
Female	21
Male	79
Occupation Distribution (%)	
Managers and senior officials	16
Professional occupations	24
Associate professional and technical	19
Administrative and secretarial	13
Skilled Trades occupations	23
Sales and customer service occupations	1
Process, Plant and Machine operatives	11
Elementary occupations	1
Source: Cogent, Oil and Gas Industry Details Profile	

Figure 5-1 : Number of Offshore Personnel Living in the UK by postal region, 2010.



Source: Oil and Gas UK

5.12 Certain locations can provide some insights into the scale of labour involved and the how the supply chain responds.

Aberdeen

5.13 Aberdeen represents by far the biggest concentration of UK oil activity, with just four parliamentary constituencies in Aberdeenshire accounting for c. 40% of total employment supported by the offshore industry[10]. Oil and Gas UK estimate that Aberdeen City & Shire accounts for 23,500 direct jobs, rising to 137,000 when supply chain and induced employment is also included.

5.14 A disproportionately large number of Scotland's top companies are located in Aberdeen City and Shire; economic output per head is among the highest in Europe; and the area has become an important hub for exporting activity.

5.15 It is estimated there are around 1,000 energy related companies within the Aberdeen City and shire area. One third of the top 50 Scottish based companies are based in Aberdeen City and Shire and almost all of these are in the energy sector[11]. The supply chain of the industry is structured as shown in Figure 5-2.

Figure 5-2 : Sector Segmentation within the Aberdeen Oil and Gas Industry

Oil Producers/Operators
(e.g. Apache, BG International, Exxon Mobil, ConocoPhillips, Marathon, Total)
|
Specialist Tier 1 Service Providers
(e.g. Aker, Haliburton, KCADeutag, Petrofac, Prosafe, Technip, Schlumberger, Wood Group)
|
Managed Service Providers
(e.g. Craig International, Sodexi, Sparrows, RBG)
|
SMEs
(e.g. Consultants, Design Houses, Minor Works, Specialist Equipment and Services)

Source: The Chartered Institute of Purchasing and Supply (CPI)

5.16 Several important developments have been recorded over the past few years including: Haliburton's new headquarters in Dyce which houses 500 staff, BP's new £60 million headquarters in Dyce, the Technip expansion, the Subsea £30 million campus for 850 staff at Westhill, and Acergy's relocation of staff to a new 17 acre campus in Westhill.

5.17 Aberdeen airport has three terminals to support its commercial heliport, with 500,000 helicopter passengers in support of North Sea oil and gas. Passenger growth at the airport has exceeded growth at both Edinburgh and Glasgow (31%). Aberdeen harbour handles over 9,000 vessels a year and is Europe's main support centre for the offshore oil and gas industry. The harbour is estimated to sustain c. 11,000 FTEs.

[10] Oil and Gas UK, 2008 Economic Report.

[11] The Importance of the Energy Sector to Aberdeen City and Shire, Briefing Paper 2010/02, Aberdeen City Council

5.18 A range of wider economic benefits are also evident in the available research, including:

- Significant growth in the population of the Aberdeen City and Shire area, by over 15% over the past 30 years, while the overall Scottish population has remained largely unchanged.
- The strength of Aberdeen City and Shire's retail sector which is linked to the relatively high level of disposable incomes in the area; the sixth highest level of gross disposable income out of 37 areas in the UK. There have been major improvements to the infrastructure in terms of retail and leisure developments in recent years.
- The local hotel sector. Aberdeen's hotels generate some of the highest revenues outside of London. The average length of stay by business and conferencing visitors is 2.5-3.3 days and further accommodation is planned for or in development due to demand exceeding present supply.

5.19 Both universities in Aberdeen are responsive to the needs of the energy sector and have strong industry links: Aberdeen is recognised as a centre of excellence in petroleum geology research and training and offers a number of postgraduate courses targeting the energy sector. The Robert Gordon University Energy Centre is focused on developing/deploying accredited learning related to oil/gas/renewable sectors.

East Anglia

5.20 Great Yarmouth/Lowestoft area has been at the centre of operations for the Southern North Sea gas industry from 1965.

5.21 Since the Southern North Sea gas fields were amongst the first to be developed in the North Sea, and because Great Yarmouth and Lowestoft were closer to continental Europe than Aberdeen, the East of England region had a resource and locational advantage. There are now more than 200 gas installations and 1000+ wells, supported by c.400 companies.

5.22 Smaller and more agile firms have taken over fields from major operators and extended their lives through innovative use of technologies. Perenco employs c. 500 in its UK operation, with many of these in Great Yarmouth.

5.23 Eastern England is estimated to account for c.5% of all UK offshore oil and gas related employment according to research by industry association Oil and Gas UK. Current industry employment estimates, based on this share of all UK employment, show the region contributes c. 22,000 FTE jobs to total UK direct, indirect and induced offshore oil and gas employment as well as some export activity.

5.24 This corresponds with a more detailed assessment of the industry undertaken by the East of England Energy Group in 2002 which shows there were some 15,300 jobs in the region supported by direct, indirect and induced oil and gas industry employment in 2002. Direct jobs accounted for 2,000 of these, and this represented a 40% increase on 1999 levels. The breakdown of these jobs by industry reflects that at the UK level, although slightly more jobs are retained in engineering and computing services and fewer in other business services in the East of England.

Table 5-3: Employment by Industry Subsector, East of England, 2002.					
	Direct	Indirect (capital)	Indirect (operational)	Induced	Total
Oil & Gas Extraction	2,100	0	0	0	2,100
Other primary & utilities	0	0	100	100	200
Traditional metal manufacturer	0	1,000	700	100	1,800
Other manufacturing	0	0	300	200	600
Construction	0	900	1,200	0	2,100
Wholesale, retail	0	300	800	1,200	2,300
Personal services	0	0	300	800	1,100
Transport	0	400	600	100	1,100
Finance	0	0	400	100	500
Engineering & Computing services	0	800	600	0	1,400
Other Business Services	0	0	1,600	100	1,700
Education & Health	0	0	100	500	600
Total	2,100	3,300	6,800	3,100	15,300
Source: The Energy Sector in the East of England, Impact Study 2000 Review and Refresh (2003), OTM for EEEGR. Employment figures from PACEC.					

5.25 There has been a trend of major operators selling North Sea assets to small, independent operators, frequently newcomers to the North Sea, which could help to catalyse further rounds of investment in the area, as well as increase the lifespan of mature fields. There is evidence that the physical presence of an operator in the area instigates a team of contractors which require representation by senior management and consequently a greater regional profile.

5.26 Wider benefits which are a likely derivative from the development of the industry include transport infrastructure in the form of Norwich International Airport, which is home to possibly the second biggest heliport in the UK behind Aberdeen. The local retail and housing markets have also benefited from the presence of the oil and gas sector in the Great Yarmouth area.

Wytch Farm, Dorset

5.27 Wytch Farm is located in Dorset, an oil field which comprises three separate oil reservoirs under Pool Harbour and Bay. The site, Europe's largest onshore oilfield, was discovered in 1974 and has been developed by BP within an Area of Outstanding Natural Beauty (AONB). From initial commercial production to the intervention from a considerable number of energy companies, the development of the local industrial base has taken in the region of 30 years. Although production peaked at the BP field over a decade ago, it still produces in excess of 20,000 boe per day (15% of BP's production in the UK).

5.28 The requirement to minimise environmental impacts of the industry have been a driver in the development of new technology at Wytch Farm, and have been a particularly important factor in the decision to adopt extended reach drilling from land. Gas is used to fuel on-site generation and is exported via a 45 km pipeline to a local NGC site. Oil products are exported via a 90 km pipeline to Hamble tank farm and directly from site by road tanker. Oil is piped

from Wytch Farm to BP's Hamble terminal on the South Coast from where it can be exported or supplied to Esso's Fawley refinery.

5.29 Locally the industry provides an appreciable number of jobs (BP estimate that Wytch Farm employs c.230 people when in steady production). This figure was significantly higher when the scale of drilling work was more extensive.

5.30 BP strives to place contracts with local companies where possible, and estimates the local expenditure of the field between 1984-1998 at £250 million, with spending in 1997 of £6 million. Information on investment and employment is taken from BP's own records, where available online, and local reports.

Overview

5.31 The UK already has a mature oil and gas sector. Aberdeen is by far the most significant hub of activity with secondary nodes in East Anglia and at a number of other locations. Offshore extraction dominates with onshore oil and gas representing only around 2% and 0.4% of total UK production.

5.32 Some 32,000 FTE jobs are employed directly in offshore activity whilst another 207,000 are employed in the wider supply chain. It is estimated there are a further 100,000 in jobs induced by the economic activity of employees.

5.33 The total value (or gross output) of producing oil and gas was £36.2 billion in 2008, the majority of which was from offshore fields. Evidence from ACSEF quoting data from UK National Statistics quantifies the GVA of the sector at £25 billion.

5.34 Case study evidence from Aberdeen, East Anglia and the largest onshore field in Dorset confirms the degree to which supply chains can cluster in individual locations and the wider local economic benefits in terms of retail, leisure and housing markets.

6. Lancashire's Economic Context

6.1 The economic benefits from commercial shale gas extraction at the Bowland play will be felt across the UK, but it is in Lancashire where proportionately the greatest share of economic impacts will materialise. Lancashire is a polycentric economic area comprising a number of discrete nodes of population and economic activity spread across 14 local authority districts. The five main recognised components of the sub-regional economy are:

- Lancaster, to the north of the sub-region, which has experienced some recent GVA and employment growth. Education is a sizeable employer in Lancaster, focused around the University of Lancaster which now employs over 2,000 staff and teaches over 17,000 students.

- The Fylde Coast, of which Blackpool is the largest settlement. This sub area has a strong tourism focus with some advanced manufacturing activity including the BAE Systems site in Warton. Significant employment is generated by the lower value, services industry, in particular the accommodation and food services sector in Blackpool and other smaller resort locations on the coast.

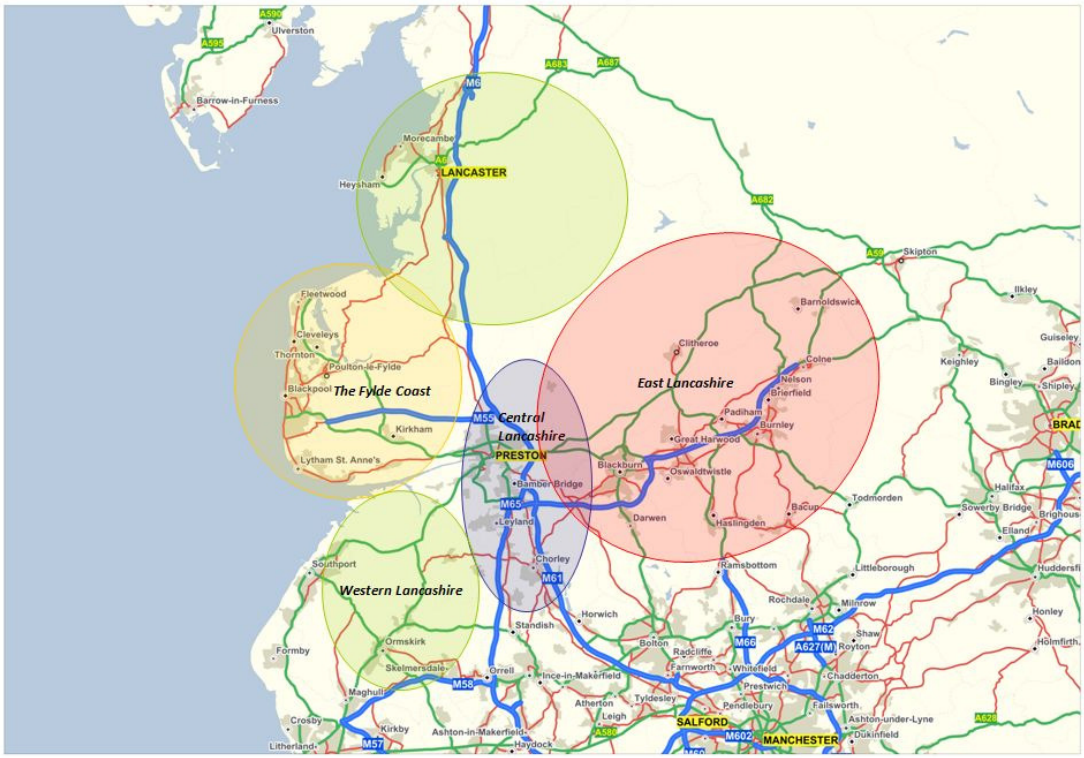
- Central Lancashire which has also experienced recent employment and GVA growth, in excess of regional and national averages, with the city of Preston driving growth. A few sectors account for a large proportion of employment in Preston, including health and social work, real estate, renting and business activities and wholesale and retail trade. Manufacturing also plays a considerable role in the area's employment base. Construction appears to be a significant sector in parts of the area.

- East Lancashire (sometimes referred to as Pennine Lancashire) which is characterised by a strong manufacturing legacy which includes some advanced manufacturing activity but also contains areas of extensive deprivation and a shrinking economic base.

- West Lancashire which is an overwhelmingly rural area, whose economy has a heavy concentration of manufacturing employment together with a significant, though weakening agricultural sector. There is evidence of some higher value manufacturing, although more generally there is limited predisposition towards growth-oriented sectors.

6.2 This report focuses on the socio-economic profile of the Lancashire area as a whole, followed by an assessment of prevailing economic trends in the Fylde Coast area – an area which broadly corresponds to the likely concentrations of drilling activity.

Figure 6-1 : Lancashire Sub-Areas



Source: Regeneris Consulting

Lancashire Economic Headlines

6.3 Total GVA in Lancashire (including Blackpool and Blackburn with Darwen) sits ahead of that in both Cheshire (£22.2bn) and Merseyside (£19.8bn), at £23.4 billion in 2008. Lancashire has however exhibited lower rates of GVA growth than experienced regionally (2.8%) and nationally (3.1%) since 2000. The data points to the inability of key urban areas of Lancashire to keep pace with areas such as Manchester and Liverpool elsewhere in the North West. GVA growth rates are lower in Lancashire than in all other North West NUTS3[12] areas except some parts of Cumbria, Manchester North and Sefton.

6.4 GVA per head of £16,200 (2008) in the county lags behind Cheshire (£22,100) and Greater Manchester's (£18,500). GVA per job gives the higher figure of £38,500, which is also lower than the regional average of £40,800[13].

6.5 Employee jobs in the Lancashire area totalled 606,500 in 2008, with the five single largest subsectors; education, retail trade, human health activities, public administration and food and beverage service activities accounting for 247,500 (41%) of this total.

[12] NUTS3 - the Nomenclature of Territorial Units for Statistics (NUTS) is a geo-code standard for referencing the subdivisions of countries for statistical purposes. NUTS3 is the lowest level for which GVA data is available in the UK.

[13] GVA per job calculated using GVA 2008 (ONS) divided by ABI employee job data (workplace analysis) 2008, ONS Crown Copyright Reserved.

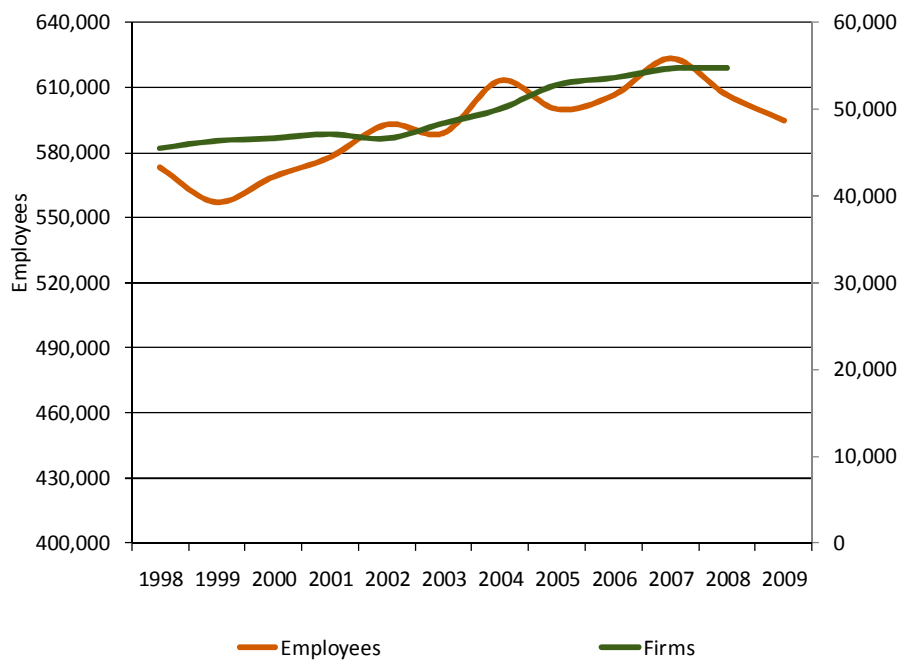
6.6 Employee jobs have shown a steady increase to 2007 in Lancashire, with a peak of 623,500 dropping by 3% to 606,500 in 2008 to just below 2006 levels. Comparing ABI and Business Register and Employment Survey employment totals shows a decline of 2% between 2008 and 2009, although there are some issues associated with linking the two datasets.

6.7 Over the longer term, an employment increase between 1998 and 2008 of 6% has been driven by substantial increases in real estate and other business activities (+65%), education (+52%) and construction (+45%). Manufacturing, whilst remaining a key employer across the county (94,000 jobs), has experienced the most significant rate of decline in employment over the period (-32%).

6.8 Overall job increases in Lancashire between 1998 and 2008 has reflected the national and GB growth rates of just over 9%, with some sectors showing similar trends to that nationally and others more isolated in their activity:

- A decline in manufacturing employment experienced in Lancashire is indicative of the national trend, which has experienced a decrease of a similar magnitude (-33%).
- Education employment has grown at a rate much higher than that nationally (+52% compared to +33%)
- Construction in Lancashire has provided more of a drive for growth than in England overall (+16%)
- Financial intermediation employment, which has decreased by a considerable -13% compared to small increases of 2% at the England level.

Figure 6-2 : Employees and Firms Year on Year 1998-2008 for Lancashire (including Blackpool and Blackburn)



Source: Annual Business Inquiry, workplace analysis and Business Register and Employment Survey 1998-2009 dataset, accessed Nomis, 2011.Note : 2009 data not directly comparable to earlier years.

Strategies & Action Plans

6.9 The recent approval of a pan-Lancashire Local Enterprise Partnership marks a new chapter in the approach to coordinating economic development across the area, and new priorities are likely to emerge in the coming months.

6.10 The current Lancashire Economic Strategy (LES) and Action Plan (2006) provides a focus on raising the value of the sectoral, business and employment base across Lancashire, which translates specifically into supporting the ventures of high value, growth potential businesses, and increasing business support for the advanced manufacturing sector. Lancashire's strengths in the advanced manufacturing sector and strategic investment focus on energy and environmental technologies are noted in the 2006 Strategy.

6.11 The LES Strategy identifies a number of sectors which, in 2006, were key forecast growth sectors for the county. Whilst the recession is likely to have stalled or slowed the rate of this growth, it is likely the same sectors will experience some expansion over the next 5 to 10 years.

Table 6-1 : Key Forecast Growth Sectors (2015)

GVA Growth	*Employment Growth*
• Manufacture of Fuels	• Other Transport Equipment
• Pharmaceuticals	• Retailing
• Electronics	• Hotels and Catering
• Other Transport Equipment	• Air Transport
• Electricity	• Communications
• Air Transport	• Insurance
• Communications	• Computing Services
• Banking & Finance	• Professional Services
• Insurance	• Other Business Services
• Computing Services	• Health and Social Work
• Professional Services	• Miscellaneous Services
• Public Administration & Defence	
• Health and Social Work	

Source: Lancashire Economic Strategy and Action Plan. April 2006, GVA Grimley, KPMG.

6.12 The Supporting the Continued Success of Manufacturing in Lancashire (2008) document notes that the Lancashire manufacturing base accounts for nearly a quarter of local GVA. Sustaining this position is conditional on providing the right conditions for competitive advantage for knowledge based companies. Flexibility in operating across industries and supply chains is also key. The strategy notes an opportunity to develop towards world class in other sectors including automotive and energy, which would fit well with the development of gas extraction. There is a call for support for local industries as well as the alignment of foreign direct investment activity with the development of local manufacturing.

Blackpool and the Fylde Coast

6.13 The Blackpool and wider Fylde Coast area is a key part of the Lancashire economy but one which faces significant challenges. GVA in the Blackpool NUTS3 area totalled £1.7bn in 2008, 7.4% of sub-regional GVA. Growth has been minimal relative to other NUTS 3 areas over the period 2000 to 2008 (17.6% compared to 50% nationally). More recently, growth has outstripped that of only Sefton in a North West context.

6.14 Official GVA data is not available for the Fylde and Wyre areas, although the Multi Area Agreement for the Fylde Coast (2008-11) indicates a declining GVA contribution over the past two decades and an economy characterised by low skilled, low pay occupations employing a lower proportion of people in managerial and other professional occupations than other sub-regions of Lancashire.

6.15 Employment in the combined Blackpool, Fylde and Wyre area totalled 131,000 in 2009, with wholesale and retail and manufacturing sectors representing the largest single shares of employment (15.5% each). Health and social work activities is another significant sector, accounting for 17,200 employees and a share of 13%.

6.16 The Fylde Coast area experiences profound labour market challenges, particularly in Blackpool. Employment rates are typically significantly lower in Blackpool, while unemployment rates are typically higher (and subject to seasonal fluctuation). The employment rate in Blackpool declined by 7 percentage points from 2002 to 2007 compared to growth of 5.7 percentage points across Lancashire and by 3.5 percentage points nationally, although employment appeared to recover somewhat in the period to June 2009.

6.17 Low employment rates are reflected in data on claimants of out-of-work benefits. In August 2008, 15% of the working age population were claiming Job Seekers Allowance (JSA) and Incapacity Benefit (IB) compared to 9% in Lancashire and 8% nationally. The vast majority of these are on IB. Educational attainment is generally relatively low among residents - 18% of residents have NVQ Level 4 qualifications compared to 25% in the North West and 28% in England. The town also struggles to attract and retain graduates. Only 10% of the working age population were educated to degree level in 2007, less than half the national figure (20%) and well below the regional average (17%).

6.18 Data from NWDA shows that in 2009 there were 31,000 IB/JSA beneficiaries in Blackpool claiming in excess of £2.2m per week.

6.19 Many of the challenges facing Blackpool are linked to the high levels of deprivation found in the town. Deprivation levels in the borough have worsened in recent years. In 2004 Blackpool was ranked 24th most deprived local authority area out of 354 across England. By 2007 this position had worsened to the 12th most deprived area. Closer analysis of the data shows that Blackpool was ranked the 3rd worst district in terms of the *concentrations* of deprivation[14]. This clearly indicates that deprivation is a highly localised problem within the Borough, affecting a few severely deprived areas.

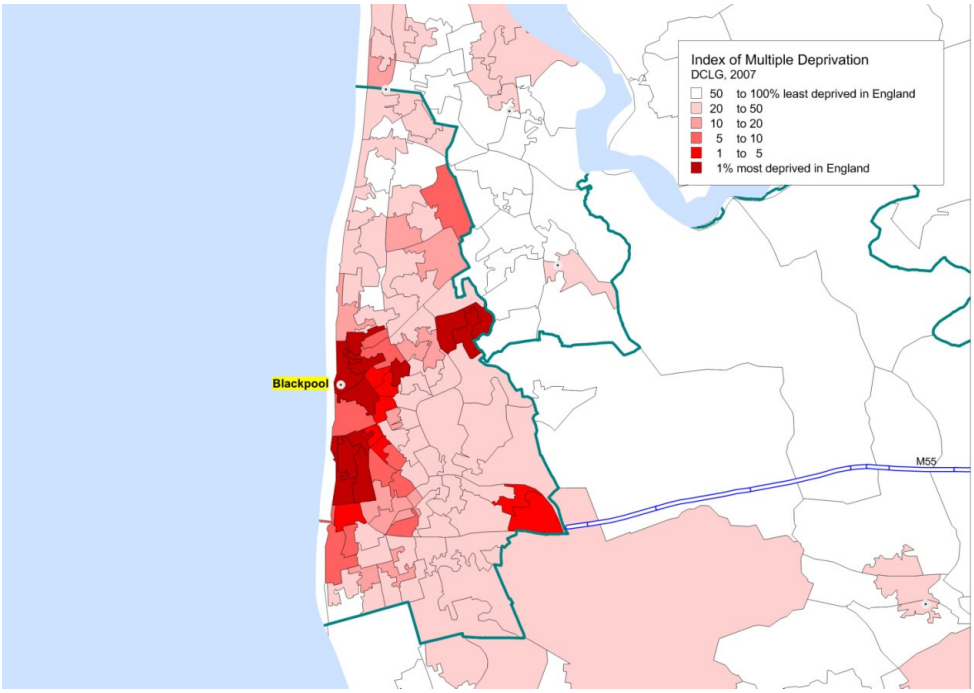
[14] *Local Concentration* is the population weighted average of the ranks of a district's most deprived LSOAs that contain exactly 10% of the local authority district's population. *Extent* is the proportion of a local authority district's population living in the most deprived LSOAs in the country.

6.20 Figure 6-3 shows that 12 of Blackpool's 94 lower level Super Output Areas (LSOAs) are ranked within England's top 1% most deprived, including England's fourth most deprived LSOA out of 32,482, located towards the North East of the town centre. All the most severely deprived areas are located in the immediate area surrounding the town centre, with a further concentration on the eastern side of the district around Carleton.

6.21 Figure 6-4 (over page) shows deprivation in a wider Fylde coast context. The concentrations of deprivation in Blackpool are clearly evident, as are a number of other nodes in Fleetwood, inner Preston and to the south of the licence area in parts of Southport.

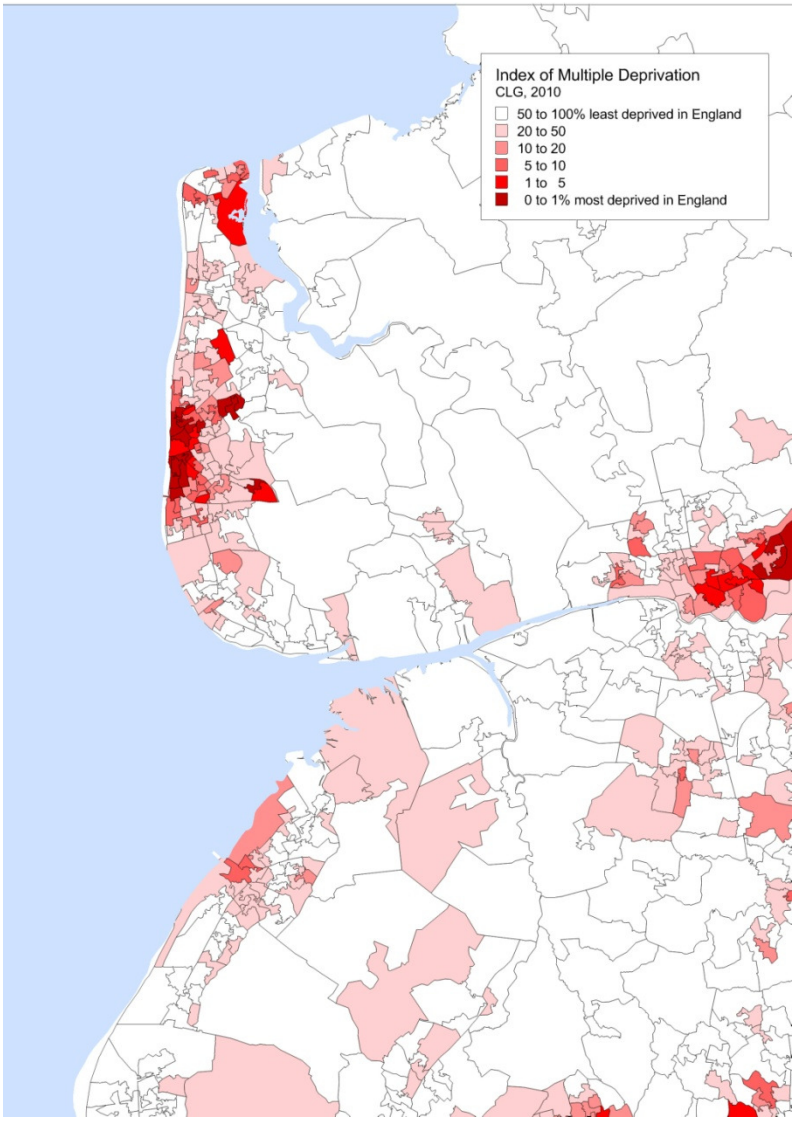
6.22 The Action Plan for Sustainable Growth (Report for the Blackpool Task Force, 2007) notes a lack of diversification in the Blackpool, Fylde and Wyre economic area and emphasises the negative impact of a declining resort economy which has long supported seasonal employment and a low proportion of higher order occupations. A lower quality visitor offer, combined with an increasingly outdated infrastructure and housing market imbalance puts pressure on the area to attract private sector investment.

Figure 6-3 : Concentrations of Deprivation within and around Blackpool



Source : DCLG, 2007.

Figure 6-4 : Concentrations of Deprivation in the wider licence area



Source : DCLG, 2007.

6.23 The Fylde Coast Multi-Area Agreement notes that economic growth is low and slow in comparison with other sub-areas of Lancashire, with an over-reliance on low value manufacturing and the service sector. Promoting the growth of new sectors such as sustainable forms of energy production, renewable technologies (including the development of a supply chain for this) and support for digital and media companies is a priority for supporting diversification. Being positioned on the North West 'Energy' Coast brings in significant links with a wider energy infrastructure and supply chain.

Overview

6.24 Lancashire represents a large and complex economic area spanning urban areas exhibiting strong economic growth, towns with very weak historic performance and a substantial rural economy.

6.25 Total GVA in Lancashire stood at £23.4 billion in 2008. GVA per head of £16,200 in the county lags behind Cheshire (£22,100) and Greater Manchester's (£18,500). GVA growth rates are lower in Lancashire than in all other North West areas except select parts of Cumbria, Manchester North and Merseyside. Employment in the Lancashire area totalled 606,000 in 2008, but growth in the last decade (+6%) has failed to keep pace with regional and national trends.

6.26 Economic strategies for the county call for considerable diversification away from declining and lower value sectors, and prioritise actions that will attract higher value industries with strong growth potential.

6.27 In the Fylde Coast sub-region – an area within which future drilling activity will be concentrated – the challenges and diversification needs are even more acute. GVA growth has been minimal, the second lowest of all areas across the North West, and there is considerable reliance on a visitor economy that has been in long term decline. Blackpool, the main town within the Fylde Coast is the 3rd most deprived local authority in England.

7. Economic Impact of Test Well Operations

Methodology & Terminology

7.1 As outlined in Section 2 of this report, the Preese Hall test well site is the most advanced of Cuadrilla's test well operations in Lancashire. Other test wells developed by Cuadrilla in Lancashire will be broadly comparable in terms of both the time taken to complete the full test cycle and the expenditure incurred by Cuadrilla.

7.2 Our approach has sought to establish the total cost of the Preese Hall operation and use this as a basis for estimating the total cost of the full suite of test well sites. As shown in Figure 7.1, the total cost of the Preese Hall test well comprises:

- A proportion of Cuadrilla HQ staff time devoted to the operation. This includes management team time, geology services and a proportion of internal accounting resource.
- The costs incurred by two internal service companies. Cuadrilla has established two internal service companies, one to deliver the majority of the drilling work (Cuadrillco) and one to deliver the majority of the fracturing works and associated processes (Cuadrilla Well Services). In practice the operations of these two service companies, largely comprise a range of sub-contracted functions provided by third party suppliers.
- Expenditure in other first tier third party suppliers. Across the Preese Hall site, Cuadrilla has a large number of suppliers, approaching 100, for the provision of both equipment and services. These supplier contracts involve a wide range of functions and include the preparation of the initial site, site security, waste removal, sample analysis etc. Some of Cuadrilla's suppliers spend a substantive amount of time on-site and will account for a large proportion of staff on site at any point in time. Other suppliers will rarely or indeed never visit the site.
- Depreciation. Cuadrilla incurred a substantial capital outlay to purchase the main drill rig and equipment necessary for the fracturing process. This capital investment will last several years and be utilised on all the test well locations in Lancashire, and indeed in subsequent locations. An element of depreciation on this capital outlay is included in the total cost of the Preese Hall operation.

7.3 For all the main supplier contracts we have sought to identify, via a bespoke survey questionnaire, the proportion of the contract value that is accounted for by:

- Labour costs. This includes wage income inclusive of bonuses, overtime and National Insurance costs. It also included the cost of any contract staff.
- Labour related costs, particularly in the form of subsistence costs where workers spend time on site and away from their usual place of residence. This has been a relatively common trend on the test well operations.
- Bought in equipment, supplies and raw materials.

- Office overheads
- Profit, inclusive of any corporation tax to be paid on this.

7.4 Not every Cuadrilla supplier was surveyed as part of this work. The allocation of costs across the categories above for each of the main contracts was taken as illustrative for other smaller scale suppliers providing similar services. We surveyed suppliers who collectively accounted for about 75% of total supplier spend for the Preese Hall well. Responses were received from 60% of those who were surveyed.

7.5 The total cost of the Preese Hall test well can be thought of as additional Gross Output some which will leak out of the UK into international economies (see below). From the breakdown of costs it is also possible to generate an estimate of Gross Value Added (GVA) and also the proportion deployed in the form of wage income. In estimating the full economic impact of Cuadrilla's test well activities it is also necessary to include:

- The value of the goods and services that are bought in by Tier 1 suppliers in servicing their Cuadrilla contract. These are not included in the Gross Output/GVA estimates based on first round impacts but provide an additional injection into the UK economy, and to some extent that of Lancashire. To model these impacts we have made use of the government's UK input-output analytical tables. More specifically we have studied supply chain expenditure and found that a relatively high share of all bought in goods and services is in the form of additives, aggregates, various forms of components and equipment, fluids and plant hire. The input-output analysis shows that for every £1 spent in the UK economy, the total effect is an increase in output in the UK economy of £1.70 on average across the sectors most closely aligned with the goods and services listed above[15]. This figure is for the UK economy. An estimate is provided for the Lancashire level by looking at the share of all UK suppliers based locally. The percentage of these second round effects assumed to flow into Lancashire is a very modest (5%) this is based on the fact that Lancashire accounts for 3% of all firms in the UK[16].

- The economic effect of the purchases made by employees within Tier 1 suppliers, also known as the induced effect. To measure this we have identified both (i) the propensity for Lancashire based workers to spend elements of their disposable income in the Lancashire economy and the wider UK economy and (ii) the propensity for workers based in the rest of the UK to do likewise.

Table 7.1 : Induced Employment Assumptions

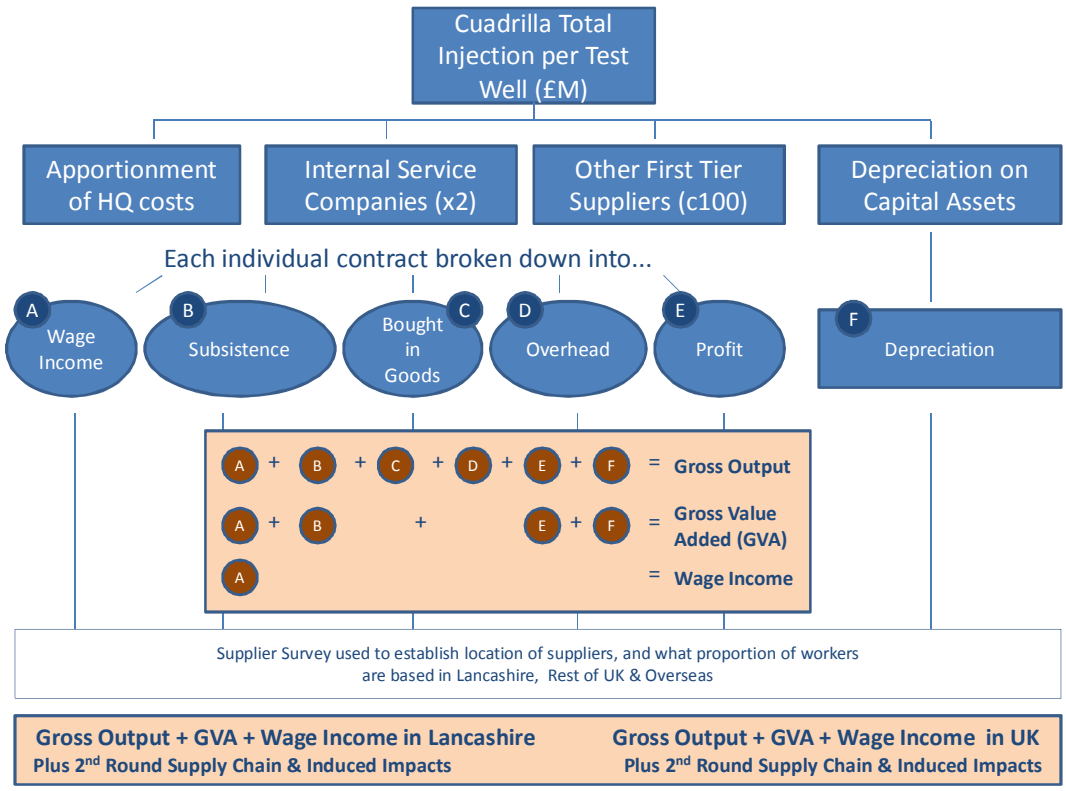
	% of wage income available after effects of taxes and savings*	% spent in Lancashire	% spent in rest of UK
Lancashire Workers	65%	40%	50%
UK Workers	65%	5%	85%

Source : Regeneris Consulting. UK average tax rates vary across areas. An average tax rate of 30% is assumed, and an average savings ratio of 5%. Propensity to spend locally in Lancashire derived from local retail surveys etc.

[15] The selected sectors were Oil & Gas Extraction, Iron & Steel, Special Purpose Machinery, Construction & Renting of Machinery. Sourced from 1995 UK Analytical Input-Output Tables.

[16] Source : . UK Business - Activity, Size and Location, 2008, IBDR/ONS.

Figure 7.1 : Impact Methodology



Source : Regeneris Consulting

Converting Gross Output/Wage Income to Jobs

7.6 The measures of Gross Output and Wage Income generated above represent that which will materialise via a typical test well process. Our modelling assumes that Cuadrilla will be able to complete three full test well procedures in a calendar year. As such the estimates have been trebled to provide an assessment of the total Gross Output/Wage Income generated by test well activities in a full year.

7.7 Jobs are then calculated in a number of ways:

- For all Wage Income within Cuadrilla and Tier 1 suppliers we utilise the average FTE salary for the oil and gas sector (£89,800 – see Section 5 of this report), dampened down to account for the fact that some employment will be in less well paid sectors/occupations. We therefore utilise a figure of £55,000 per FTE, roughly mid-point between the all sector UK average FTE salary in 2009 (£32,100) and that for the oil and gas sector. Evidence from our supplier survey suggested that the average salary within respondent firms was £53,000 per FTE.

- For subsistence expenditure we use a figure for gross output per (FTE) head in the hospitality sector of £60,000. Studies on the economic impact of the tourism and

leisure sector provide a wide range of turnover per job estimates. The range extends from £51,000 per FTE in the North East to £65,000 per FTE in the North West. Our analysis of Annual Business Inquiry (ABI) data for the tourism and leisure sectors provides an estimate of turnover per workforce job (i.e. not per FTE) of £54,000.

- For all induced expenditure we utilise an all sector, gross output per (FTE) head figure of £133,000. This is sourced from 2008 Annual Business Inquiry (ABI) data on both total turnover and employment for Great Britain.

- For all Tier 2 supply chain expenditure we utilise a blended gross output per (FTE) head figure of £185,000. This is sourced from 2008 Annual Business Inquiry (ABI) data on both total turnover and employment for Great Britain for those sectors most closely aligned to the nature of bought in goods and services amongst the suppliers we surveyed (see Para 7.5).

Geographical Analysis

7.8 Our approach is designed to establish the economic value of test well activities in terms of gross output, GVA and jobs per annum at the level of the UK and for Lancashire. To do this we needed to establish via our supplier survey:

- For all labour costs, the broad pattern of where workers are permanently resident particularly the proportion that are resident in Lancashire.

- The recipients for subsistence payments, a large proportion of whom are likely to be based locally in Lancashire

- For bought in goods and services, the address of suppliers

- The main HQ office for suppliers for the purposes of modelling where both profits and overheads are likely to materialise.

Information Sources

7.9 Financial information has been provided by Cuadrilla based on the actual/predicted costs of the whole Preece Hall process. Actual expenditure data was provided for the period to March 2011 at which time the scheme was largely completed. An element of the estimated cost was based on a prediction from Cuadrilla of the expenditure required to complete the test well post March 2011. All costs were provided in US dollars and converted on the basis of 1 US$ = 0.6 £.

7.10 Invoicing details were provided on all third party suppliers. We surveyed around 20 of the biggest suppliers (assessed on the basis of scale of invoicing). This allowed us to formulate estimates on the geographical spread of impacts and ask a series of questions that would assist in the quantification of impacts under various commercial extraction scenarios (see next section).

7.11 From these results we extrapolated percentage shares to other providers.

Results

A Single Test Well Cost

7.12 It is estimated that a single test well costs in the region of £10.5 million to complete, inclusive of depreciation costs. The derivation of this figure is shown in Table 7-2.

Table 7.2 : Costs of Test Well Operations

Category	Cost (£)	Comments
Site Preparation Works	590,000	Includes all the preparatory works required to secure planning consent for the test well location. Also includes all initial earth works, laying membrane etc
All Drilling and Related Costs	4,338,000	Includes: • Payments made third party suppliers. • Drill fluids etc. • All costs incurred by internal drill service company. • Allowance for depreciation on drill rig. • Provision of casing and tubes etc.
All Fracturing & Related Costs, and Testing	5,517,800	Includes: • All costs incurred by internal frac' company. • Allowance for depreciation on main fracturing equipment. • Payments made third party suppliers. • Technical testing throughout process – some on-site, some off-site.
TOTAL COST (£)	10,446,000	

Source : Cuadrilla Resources & Regeneris Consulting
Note : the above total also includes an apportionment of Cuadrilla HQ time to test well activities of £300K per test well.

7.13 Table 7.3 provides a breakdown of these costs using material obtained from the supplier survey. It shows:

- Some 17% of expenditure is shown to be deployed on Lancashire workers/suppliers, with a third going overseas. The relatively high leakage overseas is due to the fact that the main drilling and fracturing equipment is sourced from overseas suppliers and often utilises specialist overseas labour when operational.

- Of all UK expenditure (circa £7 million per test well), a third is deployed on labour costs, with 7% being utilised for subsistence expenditure of workers most of which flows to Lancashire businesses. Bought in goods and services account for 37% of the total.

Table 7.3 : Disaggregation of Test Well Costs					
	Workers & Suppliers based in....				
	Lancashire	Rest of UK	Overseas	Total	*All of UK*
Labour	303,000	1,983,000	547,000	2,833,000 (27%)	*2,285,000 (33%)*
Subsistence	385,000	77,000	51,000	513,000 (5%)	*462,000 (7%)*
Bought in Goods & Services (inc depreciation)	801,000	1,793,000	2,102,000	4,696,000 (45%)	*2,594,000 (37%)*
Overheads	115,000	691,000	345,000	1,151,000 (11%)	*806,000 (11%)*
Profits	125,000	752,000	376,000	1,254,000 (12%)	*877,000 (12%)*
TOTAL	1,729,000	5,296,000	3,422,000	10,446,000	*7,024,000*
	17%	50%	33%		
Source : Cuadrilla Resources & Regeneris Consulting					

Jobs in a Single Year of Activity

7.14 The expenditure data above provides the basis for estimating the one-off turnover injection associated with test well activity over a 12 month period. The process requires an adjustment to:

- Omit overseas expenditure, which has no direct impact on the UK economy
- Add in the turnover associated with the 2nd and subsequent rounds of supply chain effects.
- Add in the turnover associated with the induced impacts
- Recognise the fact there will be on average three test wells completed within a 12 month period.

7.15 Using the various assumptions listed at Paragraph 7.7 we estimate the test well activity will support some 250 FTE jobs over a 12 month period across the UK. Half of the jobs will occur within Cuadrilla and its extensive range of 1st tier suppliers. Over a tenth of the jobs result from the expenditure patterns of employees across the wider UK economy.

7.16 Just over 15% of the jobs (circa 40) are estimated to be taken by Lancashire residents, a figure which rises to 83% in relation to the positions created via subsistence expenditure and reduces to 10% in respect of the induced jobs.

Table 7.5 : Bowland Shale FTE jobs generated by three test wells			
	Lancashire	Rest of UK	All of UK total
Jobs within Cuadrilla/1st Round Suppliers	17	108	125
Jobs due to subsistence expenditure	19	4	23
Jobs within the rest of the Supply Chain	4	68	72
Jobs from Induced Impacts	3	27	30
TOTAL	43	207	250
Implied Jobs per Well			83
Source : Regeneris Consulting			

Overview

7.17 A single test well operation, in 2011 prices, costs in the region of £10.5 million, made up of Cuadrilla's own costs, that of its two internal service companies and expenditure on a range of first tier suppliers.

7.18 Some 18% of expenditure is shown to be deployed on Lancashire workers/suppliers, with a third going overseas. Of all UK expenditure (circa £7 million per test well), a third is deployed on labour costs, with 7% being utilised for subsistence expenditure of workers most of which flows to Lancashire businesses.

7.19 We estimate the test well activity will support some 250 FTE jobs across the UK over a 12 month period. Half of the jobs will occur within Cuadrilla and its extensive range of 1st tier suppliers.

7.20 Some 15% of the jobs (circa 40) are estimated to be taken by Lancashire residents. These result from a number of the more localised contracts (pad preparation, security, some haulage activities etc) and the extensive hotel and related expenditure of visiting workers. At this stage very few of the specialist supply chain contractors make extensive use of local labour although this would change under a full commercial extraction scenario.

8. Factors Affecting Future Economic Impacts

8.1 Whilst the test well operations provide a good guide to the likely scale of labour required per well under future commercial extraction scenarios, certain adjustments need to be made to reflect the realities of a larger scale commercial operation. These adjustment factors are summarised in this section of the report.

Efficiency Gains

8.2 In many respects the full drilling/fracturing works for a commercial extraction process will be broadly similar to the test well operations. There are however a number of efficiency related adjustments needed for the purposes of a robust economic impact model, as follows:

- An assumed re-use of some test well pads for the commercial phase i.e. a slightly reduced scope for the site preparation works required per well.
- Less analysis and testing required, and as such a quicker drilling and fracturing process. To counterbalance these adjustments, the scope of the fracturing process could be slightly more extensive for each commercial well to maximise future gas flows.
- Efficiency gains from having suppliers and workers based more locally and the reductions in associated travel times (this is discussed in more length below).

8.3 Having examined the costs of commercial extraction in the US and reviewed with Cuadrilla in detail we have applied a percentage change to various items in the test well purchase ledger to arrive at a more reasonable assessment of the likely cost of each commercial well in 2011 prices. These are shown below. In total the adjustments serve to reduce the overall cost of a typical commercial extraction well by about 15% from £10.446 million to £8.97 million.

Table 8.1 : Cost Adjustments

	Adjustment Factor (%)	General Efficiency Factor (%)
Planning	-80	-15
Site Preparation Work	-80	-15
Third Party Drilling Costs	0	-15
Cuadrillco Drlling Costs	0	-15
Tubulars	0	-15
Cuadrilla Well Services (CWS) Costs	+15	-15
Third Party Fracturing & Related Costs	+15	-15
Third Party Post Fracturing Costs	+15	-15
Other Costs	0	-15
Logging & Analysis Services	-15	-15
Cudrilla Internal HQ apportionment	0	-15

Source : Regeneris Consulting

Scale & Pace of Roll Out

8.4 The scale (in terms of completed wells) and speed of any commercial exploitation scenario will be primary factors shaping the extent and profile of employment impacts. Our understanding is that it would be possible to drill six commercial extraction wells per year per drill rig, and that it would be Cuadrilla's preference to do the exploitation quickly and introduce up-to 10 drill rigs across any agreed commercial extraction licence area. This in theory could yield 60 completed wells per year.

8.5 The total number of wells to be drilled will only become clearer as and when the results of the exploration phase are available and investment decisions made, and will be subject to the necessary planning approvals. In the absence of this information we, with the assistance of Cuadrilla, have made certain assumption about the possible scale and phasing of commercial exploitation.

8.6 We have investigated three scenarios. In all scenarios there is a build up of activity in the initial years as the number of drill rigs and fracturing kit increases, with some slowing down at the conclusion of the process as equipment is gradually redeployed to other locations. The lower end scenario sees 190 wells drilled at 20 pads over a period of 6 years. The higher end scenario sees just over 800 wells drilled at 80 pads over a period of 16 years.

8.7 Under all scenarios an assumed start date of the beginning of 2013 is used.

Table 8.2 : Scale Scenarios

Pads	20 (low)	40 (medium)	80 (max)
Number of years of drilling if all at peak rate	3.3 Say 3.5	6.7 Say 6.5	13.3 Say 13.5
Adjust drilling years to account for build up	Year 1 – 20 Year 2 – 30 Year 3,4,5 – 40 Year 6 – 20 *So 6 years = 190 wells*	Year 1 – 20 Year 2 – 30 Year 3 – 40 Year 4-7 – 60 Year 8 – 40 Year 9 – 30 *So 9 years = 400 wells*	Year 1 – 20 Year 2 – 30 Year 3 – 40 Year 4-14 – 60 Year 15 – 40 Year 16 – 20 *So 16 years = 810 wells*

Source : Regeneris Consulting/Cuadrilla
Note : The impact model assumes 10 wells per pad.

Method of Conversion

8.8 The costs and associated labour requirement in the previous section of this report relate solely to the stage where a well has been completed in terms of drilling and fra'cing activity. The earlier analysis makes no allowance for the costs of establishing an infrastructure through which gas (or electricity from gas) flows into national networks.

8.9 As outlined in Section 3 of this document, the two main options for this infrastructure are (i) additional pipelines to connect into the main UK gas pipeline network and (ii) on site electricity generation which is then connected into the national grid. Under either approach a substantial body of additional labour and equipment is required to put in place the necessary infrastructure, which will grow in scale as the number of wells in any one location increases.

8.10 It is likely that in Lancashire a hybrid solution is put in place which combines gas pipelines at some wells and electricity generation at others.

8.11 We have spoken with Cuadrilla on this issue and sought to gather information from US drilling companies. Our best estimate is that we need to inflate the total average cost of the drilling and fracturing process (see Paragraph 8.3) by 15% to cover the costs of producing, supplying and installing the conversion infrastructure. The works involved include the provision of steel products, compression and gas measuring equipment, supply and installation of pipelines etc.

8.12 The model assumes that 50% of workers and suppliers for this activity are located in Lancashire in all scenarios. The additional employment that results from supplying and installing the conversion infrastructure also results in additional induced employment (assumed at a further 10% at the Lancashire level and 40% at the UK level).

Attraction of Industry and Staff to Area

8.13 The evidence from the test well process is that relatively few, if any, specialist suppliers and their staff have relocated to Lancashire as part of their work for Cuadrilla so far. This is to be expected given the relatively small scale of operations to date and their exploratory nature.

8.14 Material from our case study research of existing UK oil and gas locations (Aberdeen and East Anglia in particular) and US shale plays is that a local and extensive specialist supplier base can be expected to build up over time as the volume of work increases.

8.15 Predicting the scale of any shift in the supplier base – both from overseas to the UK and from existing UK bases to Lancashire – is extremely difficult. For this reason our economic impact modelling assumes three separate scenarios. These are:

- Low Range – here the geographical profile of workers and suppliers within Cuadrilla and the first tier supply chain is assumed to largely resemble that observed under the test well operations. This scenario is very unlikely.
- Mid Range – where there is some reasonably significant migration of workers and supplier to Lancashire (and to the UK from overseas).
- High End – whereby a more substantive shift occurs and more workers and suppliers base themselves in Lancashire.

8.16 The evidence from the supplier survey was that approximately 50% of first tier suppliers would be likely to relocate to Lancashire if a commercial extraction scenario materialised. With this in mind, Table 8.1 identifies the scale of the estimated change under each of the three scenarios listed above.

8.17 Under each scenario there is also an assumed shift in the location of round two and subsequent tier suppliers. In using information from the UK input-output model we assume Lancashire accounts for 5% of all second round effects in Low Range scenario, 7.5% in the Mid Range scenario and 10% in the High End scenario. We also assume that the relative share of subsistence costs in total expenditure becomes slightly less in the Mid Range scenario and High End scenario as more workers located full-time in Lancashire.

Table 8.1 : Assumed Shift in Geographical Spread of Workers/Suppliers : Labour & Subsistence First tier suppliers only									
	Low Range (same as Test Well Assumptions)			Mid Range			High End		
	% Lancs	% Rest of UK	% Overseas	% Lancs	% Rest of UK	% Overseas	% Lancs	% Rest of UK	% Overseas
	Labour								
Planning & Site Prep	30	70	0	60	40	0	80	20	0
All Other	10	70	20	35	50	15	55	40	5
	Subsistence								
All	75	15	10	80	15	5	85	10	5
Source : Regeneris Consulting									

Lifetime Maintenance Requirement

8.18 An ongoing maintenance resource will be required to oversee the well field once it is in full production phase. This resource will carry out routine and scheduled maintenance on wells and also respond to any emerging issues.

8.19 For the purposes of this assessment we have assumed a flat rate labour requirement of 2 FTEs for every five wells drilled for ongoing maintenance which commences as soon as the well is complete. This has been agreed with Cuadrilla as being a reasonable assumption.

8.20 The operational lifetime of the well in Lancashire could easily be 40-50 years, although we have modelled the lifetime maintenance impact for a twenty year period. Given the nature of these works it is highly likely that all maintenance functions will be provided by staff based in Lancashire.

9. Economic Impacts of Commercial Extraction

Summary of Scenarios

9.1 As outlined in Section 8 of this report there are a range of considerations which will determine the scale and nature of employment impacts from commercial shale extraction in Lancashire, not least the volume of wells drilled and the pace at which the drilling proceeds.

9.2 Three scenarios have been selected and modelled as part of this assessment, as shown in Table 9.1. The detail on each of these can be found the preceding section of the report.

9.3 In each scenario all future costs are expressed in current (2011) values. We have modelled over a twenty year period from 2013 onwards.

Table 9-1 : Commercial Extraction Scenarios

	Lower End	**Central Case**	Higher End
Efficiency Gains	As predicted at Table 8.1 Average cost reduction of c15% against test well costs	**As predicted at Table 8.1** **Average cost reduction of c15% against test well costs**	As predicted at Table 8.1 Average cost reduction of c15% against test well costs
Scale and Pace	Lower 190 wells over 6 years	**Central** **400 wells over 9 years**	High 810 wells over 16 years
Cost of Conversion	15% uplift, attached to Lower end scenario Implemented at same pace as roll out	**15% uplift, attached to central case scenario** **Implemented at same pace as roll out**	15% uplift, attached to higher end scenario Implemented at same pace as roll out
Attraction of Industry*	Lower Range Scenario	**Mid Range Scenario**	High End Scenario
Lifetime Maintenance Costs	Standard assumption across each scenario	**Standard assumption across each scenario**	Standard assumption across each scenario

* Note : the attraction of industry variable has its greatest impacts on the observed levels of employment impact at a Lancashire level.

Employment Impacts of Commercial Extraction - Central Case

9.4 Impacts have been assessed at both the UK level and Lancashire (see Figure 9-1 and 9-2 over page).

9.5 There are a number of categories of employment impact that comprise the total:

- Direct and Indirect jobs within Cuadrilla (or activities of an eventual lead producer) and those in both first and second tier suppliers.
- Direct and Indirect jobs associated with the installation of the conversion infrastructure.
- Direct and Indirect jobs associated with the long term maintenance works.

- Induced jobs that result from the expenditure of all those staff identified in the previous three categories.

9.6 At the UK Level, the FTE employment impact peaks at some 5,600 FTE jobs in the period 2016 through to 2019 with a build up in the years from 2013 onwards.

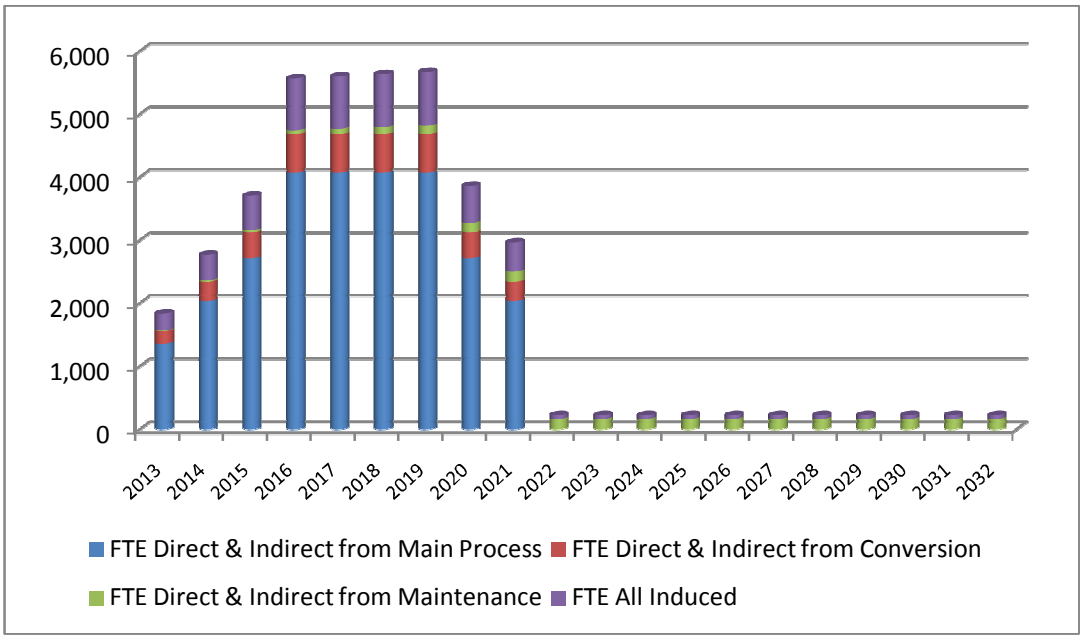
9.7 At the peak some 4,000 jobs are directly within the eventual lead producer and within both first and subsequent tier suppliers. 610 FTE jobs (direct and indirect) are required for the installation of the conversion infrastructure. Induced jobs resulting from the expenditure of staff account for 850 FTEs nationally.

9.8 At a Lancashire level, the FTE employment impact peaks at 1,700 FTE jobs in the period 2016 through to 2019. This represents 30% of the UK total up from 15% under the test well operations.

9.9 At the peak the implied FTE per well ratio stands at 95 FTEs per well at the UK level, reducing to 30 FTEs per well at the Lancashire level. Evidence from the US, measured at the State level, puts the FTE per well ratio at between 32 to 58 FTEs per well.

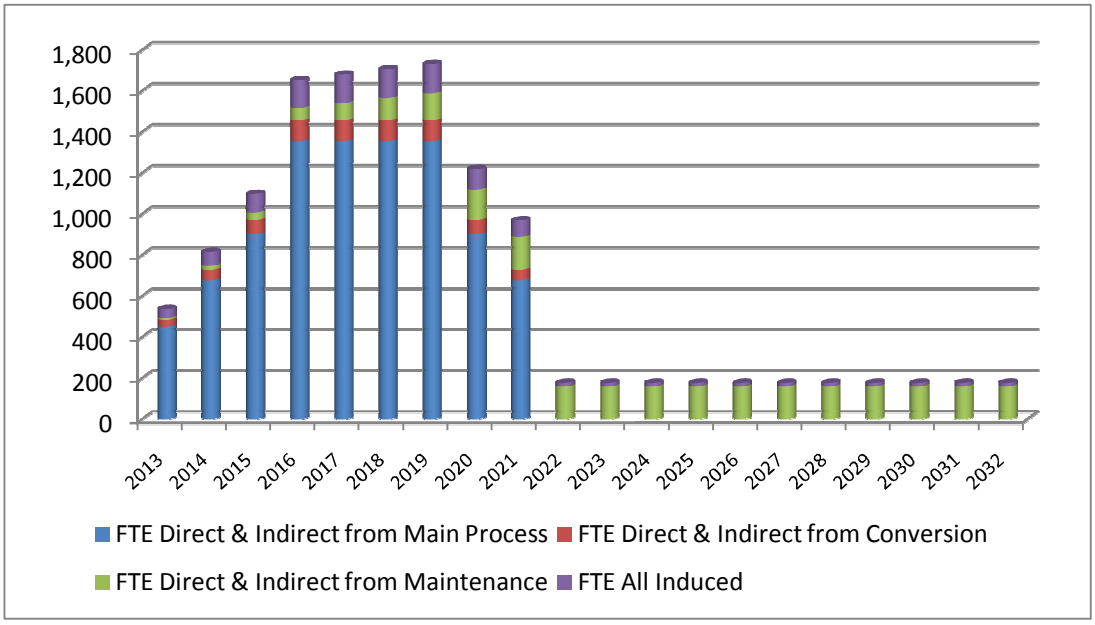
9.10 The scale of these operations will lead to substantial new clustering of a supplier base in Lancashire and some attraction of specialist overseas suppliers to other UK locations.

Figure 9-1 : Bowland Shale Central Case Extraction Scenario – FTEs at UK level



Source : Regeneris Consulting

Figure 9-2 : Bowland Shale Central Case Extraction Scenario – FTEs at Lancashire level



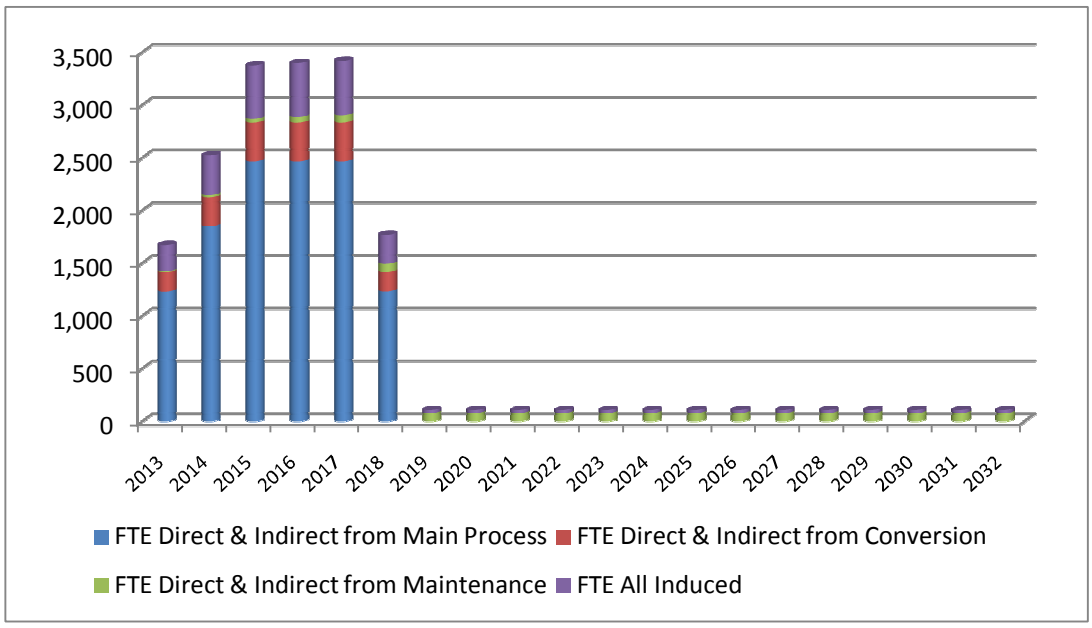
Source : Regeneris Consulting

Employment Impacts – Lower End Scenario

9.11 The total peak UK employment reduces compared to the Central Case scenario (3,400 FTEs per annum, versus 5,600 FTEs). This is largely due to the assumption that only 40 wells are completed per annum under the Lower End scenario, but remains a significant quantum of job creation. The jobs are maintained over a six year drill programme.

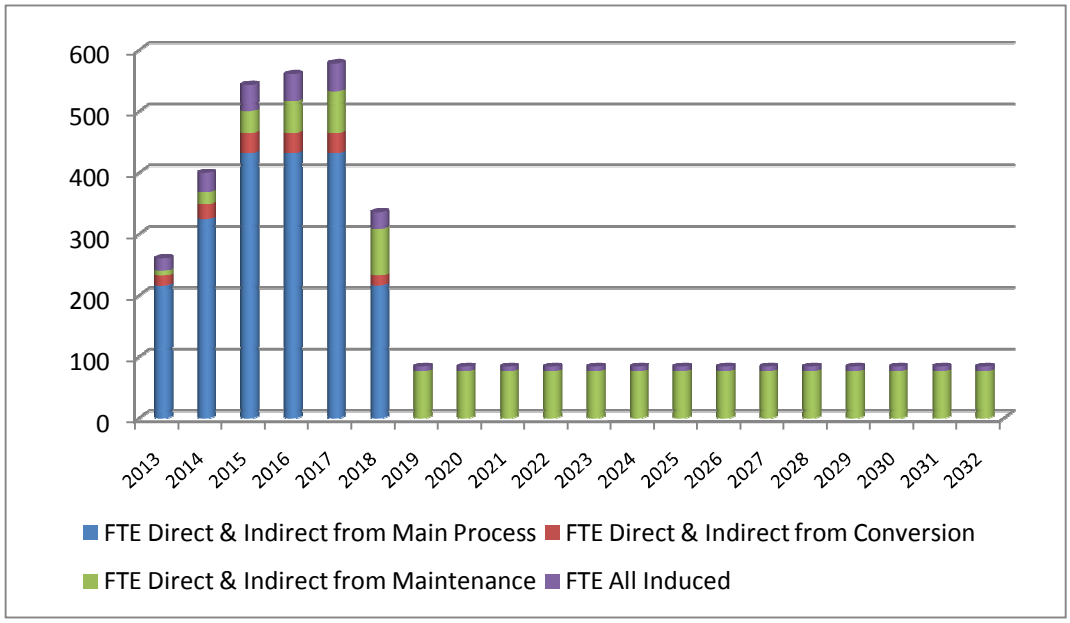
9.12 At a Lancashire level the peak employment impact also reduces (a peak average of 560 versus 1,700 under the Central Case). This is both due to (i) the lower volume of well completions per annum and (ii) the assumption that the location of the supply chain remains largely unchanged from that observed under test well operations.

Figure 9-3 : Bowland Shale Lower End Extraction Scenario – FTEs at UK level



Source : Regeneris Consulting

Figure 9-4 : Bowland Shale Lower End Extraction Scenario – FTEs at Lancashire level



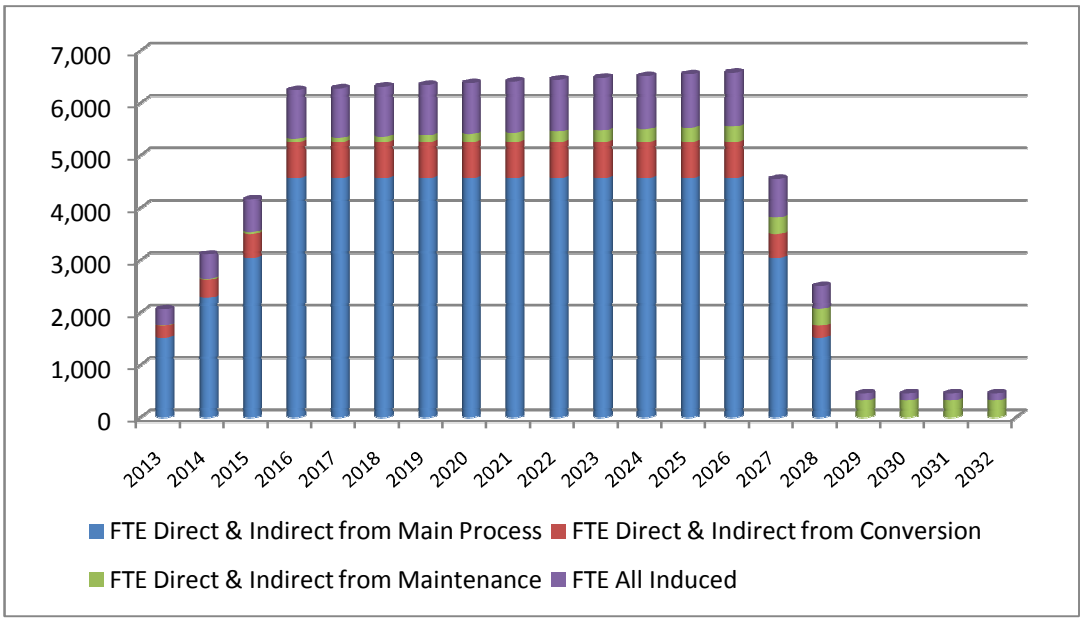
Source : Regeneris Consulting

Employment Impacts – Higher End Scenario

9.13 The total peak UK employment impacts are a little higher than in the Central Case (6,550 FTEs per annum, versus 5,600 FTEs). The impacts are clearly sustained over a longer period with this quantum of per-annum jobs maintained over an 11 year period from 2016 to 2026 inclusive.

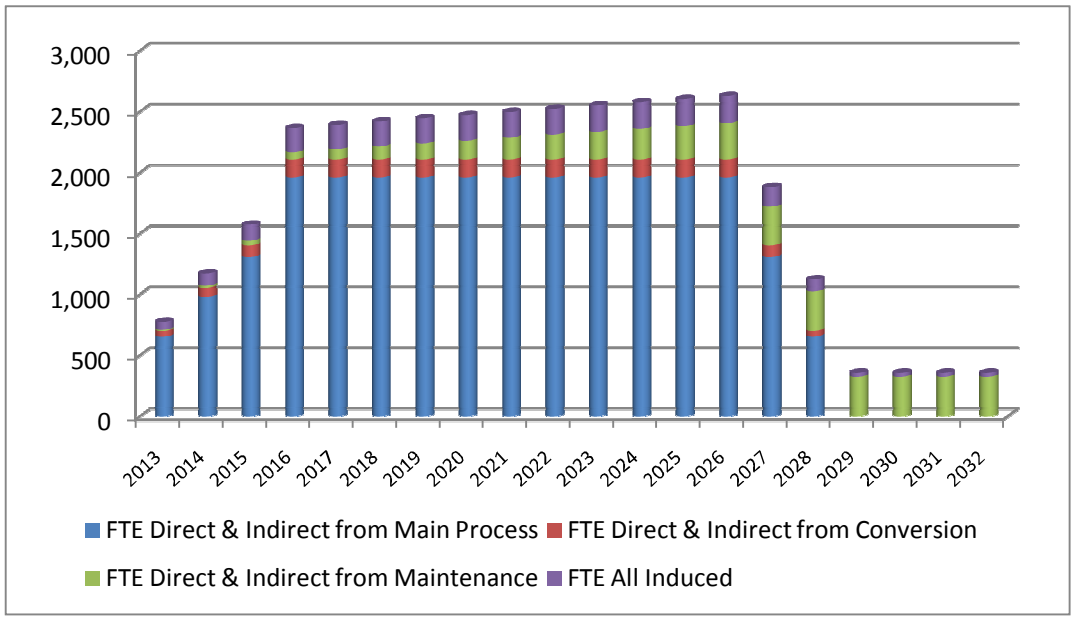
9.14 At a Lancashire level the peak employment impact is somewhat higher than the Central Case (a peak average of 2,500, versus 1,700 – or plus 50%). This is, in part, because of the assumptions that are built into the model on Lancashire gaining a higher relative share of supply chain activity as suppliers relocate. As with the UK impacts, these jobs are also sustained over a longer period.

Figure 9-5 : Bowland Shale Higher End Extraction Scenario – FTEs at UK level



Source : Regeneris Consulting

Figure 9-6 : Bowland Shale Higher End Extraction Scenario – FTEs at Lancashire level



Source : Regeneris Consulting

10. Summary & Conclusions

10.1 Shale gas extraction is a highly sophisticated process, involving large volumes of skilled labour, specialist suppliers and costly capital equipment. It has become a major industry in the US where a number of substantial shale plays have been exploited in the last decade.

10.2 The Bowland Shale in Lancashire is the most advanced opportunity for the first significant shale extraction field in the UK. It is currently being explored by Cuadrilla Resources, an independent oil and gas company based in Staffordshire. A UK Petroleum Exploration and Development Licence (PEDL) was granted to Cuadrilla in September 2008 which allows the company to pursue shale gas exploration activities in the Bowland Shale.

10.3 The licence area covers some 500 square miles, and comprises the western side of Lancashire, predominantly to the west of the M6 motorway and includes the towns of Blackpool, Preston and Southport.

10.4 The first test well commenced in August 2010. In the region of four to 12 test wells will be required as part of the exploration phase, roughly proceeding at the pace of three test wells per annum. Should it be concluded that commercially exploitable reserves are available then Cuadrilla would be in a position to proceed to a significantly more extensive commercial extraction phase by 2013, subject to the necessary consents.

Lancashire Economic Context

10.5 The economic benefits from commercial shale gas extraction at the Bowland play will be felt across the UK, but it is in Lancashire where proportionately the greatest share of economic impacts will materialise.

10.6 Lancashire represents a large and complex economic area spanning urban areas exhibiting strong economic growth, towns with very weak historic performance and a substantial rural economy. Total GVA in Lancashire stood at £23.4 billion in 2008. GVA per head of £16,200[17] in the county lags behind Cheshire (£22,100) and Greater Manchester's (£18,500). GVA growth rates are lower in Lancashire than in all other North West areas except select parts of Cumbria, Manchester North and Merseyside. Employment in the Lancashire area totalled 606,000 in 2008, but growth in the last decade (+6%) has failed to keep pace with regional and national trends.

10.7 Economic strategies for the county advocate diversification away from declining and lower value sectors, and prioritise actions that will attract higher value industries with strong growth potential.

10.8 In the Fylde Coast sub-region – an area where there is likely to be a particular concentration of any future drilling activity – the challenges and diversification needs are even more acute. GVA growth has been minimal, the second lowest of all areas across the North West, and there is considerable reliance on a visitor economy that has been in long term decline.

[17] Gross Value Added (GVA) is essentially the components of Gross Output that are distributed as wage income, profits, interest, taxes and in the form of depreciation. GVA, and the related measure of GVA per head, is used as a standard measure of wealth generation in local economies.

Impacts of US Shale Extraction

10.9 US shale production has historically been concentrated in the Barnett field in the Dallas-Fort Worth area of Texas but more recently supplemented with substantial activity in the Marcellus play in West Virginia and Pennsylvania.

10.10 Various studies have researched the issue of employment and supply chain impacts in the US shale plays. Timothy Considine of Penn State University has researched the Pennsylvania and West Virginia fields in some detail whilst the Perryman Group have quantified the economic value of shale extraction in Texas.

10.11 The available evidence points to large scale employment creation based on the substantial US shale plays[18]. The total number of full time equivalent jobs range from 13,000 across the state of West Virginia to 83,000 FTEs in Texas. FTE jobs in Pennsylvania is estimated at 41,000.

10.12 The jobs estimates includes those directly employed within drilling/production companies, indirect jobs in the immediate supply chain and those which are induced via the expenditure of staff employed by the lead producers and their suppliers. All impacts are measured at the state level.

10.13 The number of wells drilled in any particular year is the primary factor determining the scale of impacts. The implied number of direct, indirect and induced FTE jobs per new well ranges from 32 FTEs (West Virginia) to 58 FTEs (Pennsylvania).

10.14 The evidence suggests the construction, drilling and related trade sectors account for 60% of all direct employment supported by gas extraction in the US. Over a fifth of all indirect employment is within the professional scientific and technical services, while 15% of indirect employment is in waste and administrative services. Induced employment is heavily loaded towards the medical and service sectors including retail, hotels and leisure providers. While some of the jobs created and supported in the US require high-level technical skills and qualifications, others provide opportunities for those with less formal skills and working on a part-time basis.

10.15 Shale extraction has also been shown to stimulate large scale plant development with Vallourec & Mannesmann Holdings building a new $650 million steel plant in the once booming steel town of Youngstown, Ohio to make the pipes used in the drilling and hydraulic fracturing process.

The Existing UK Oil & Gas Sector

10.16 The UK already has a mature oil and gas sector. Aberdeen is by far the most significant hub of activity with secondary nodes in East Anglia and at a number of other locations. Offshore extraction dominates with onshore oil and gas representing only around 2% and 0.5% of total UK production respectively.

[18] The total area of the Barnett field is about 5,000 square miles, 10 times larger than the UK Bowland license area. The productive area of the Marcellus play, only a fraction of which has been exploited to date, is estimated at some 95,000 square miles.

10.17 Some 32,000 FTE jobs are employed directly in offshore activity whilst another 207,000 are employed in the wider supply chain at a UK level. It is estimated there are a further 100,000 jobs nationally induced by the expenditure of employees. In total some 340,000 jobs are supported. Robust estimates for the onshore sector are not available.

10.18 The total value (or gross output) of producing oil and gas was £36.2 billion in 2008, the majority of which was from offshore fields. Evidence from ACSEF quoting data from UK National Statistics quantifies the GVA of the sector at £25 billion.

10.19 Case study evidence from Aberdeen, East Anglia and the largest onshore field in Dorset confirms the degree to which supply chains can cluster in individual locations and the wider local economic benefits in terms of retail, leisure and housing markets.

10.20 The UK Oil & Gas sector is a relatively high-skilled sector with the majority of jobs within the *professional* and *skilled trade* occupational groupings. The 2009 Annual Survey of Hours and Earnings (ASHE) shows that the highest earning UK industry was extraction of crude petroleum and natural gas, with average gross annual earnings of £89,800 for a FTE position. This compares to average gross annual earnings (mean) of £32,100 across all employee jobs in the UK. The sector also sustains a large number of lower value support jobs, in occupations such as catering, security, HGV operatives and basic construction works.

Economic Impacts of Bowland Shale Extraction

Exploration Phase

10.21 Cuadrilla Resources has supplied extensive purchasing information on its existing test well operations in Lancashire. Regeneris Consulting has supplemented this material with a detailed survey of around 20 of the largest first tier suppliers. We estimate these 20 suppliers account for 75% of first tier supply chain expenditure. Responses were received from 12 of the 20 suppliers (60% response rate).

10.22 A single test well operation, in 2011 prices, costs in the region of £10.5 million, made up of Cuadrilla's own costs, that of its two internal service companies and expenditure on a range of first tier suppliers. The figure is comprehensive and includes an allowance for depreciation on the major capital purchases on the drill rig and fracturing equipment (most of which is sourced from overseas suppliers).

10.23 Some 17% of expenditure is shown to be deployed on Lancashire workers/suppliers, with a third going overseas. The relatively high leakage overseas is due to the fact that the main drilling and fracturing equipment is sourced from overseas suppliers and often utilises specialist overseas labour when operational. Of all UK expenditure, a third is deployed on labour costs, with 7% being utilised for subsistence expenditure of workers most of which flows to Lancashire businesses.

10.24 We estimate total test well activity will support some 250 FTE jobs per annum across the UK. This is based on the assumption that *three* test wells will be completed per annum. Half of the jobs will occur within Cuadrilla and its extensive range of 1st tier suppliers. Over a tenth of the jobs result from the expenditure patterns of employees across the wider UK economy.

10.25 Some 15% of the total test well jobs (circa 40 FTEs) are estimated to be taken by Lancashire residents. These result from a number of the more localised contracts (pad preparation, security, some haulage activities etc) and the extensive hotel and related expenditure on visiting workers. At this stage very few of the specialist supply chain contractors make extensive use of local labour although this would change under a full commercial extraction scenario – see below.

10.26 Viewed in isolation, the test well employment impacts will be relatively short lived. If six test wells are drilled the positions will be sustained for two years, rising to three years under a nine test well scenario.

Commercial Extraction Scenarios

10.27 In many respects the full drilling and fracturing process for commercial extraction will be broadly similar to the test well operations. There are however a number of adjustments we need to make for the purposes of a robust economic impact model of commercial extraction. These are:

- An allowance for efficiency savings. Based on the available evidence we assume a circa 15% average reduction in the cost of preparing a commercial well compared to test well operations.

- The labour required to put in place the conversion infrastructure. Our analysis of test well operations provides no allowance for the costs of establishing an infrastructure through which gas (or electricity from gas) flows into national networks. Based on evidence from Cuadrilla and information from US drilling companies, our best estimate is that we need to inflate the total average cost of the commercial drilling and fracturing process by 15% to cover the costs of producing, supplying and installing the conversion infrastructure. The works involved include the provision of steel products, compression and gas measuring equipment, supply and installation of pipelines etc.

- An ongoing maintenance resource will be required to oversee the well field once it is in full production phase. This resource will carry out routine and scheduled maintenance on wells and also respond to any emerging issues. For the purposes of this assessment we have assumed a flat rate labour requirement of 2 FTEs for every five wells drilled for ongoing maintenance which commences as soon as the well is complete.

10.28 The overall number of wells and the speed with which they are prepared will be primary factors shaping the extent and profile of employment impacts. The total number of wells to be drilled will only become evident as and when the results of the exploration phase become clearer. In the absence of this information we, with the assistance of Cuadrilla, have investigated three possible outcomes. In all of these there is a build up of activity in the initial years as the number of drill rigs and fracturing kit increases, with some slowing down at the conclusion of the process as equipment is gradually redeployed to other locations. The lower end scenario sees nearly 200 wells drilled over a period of 6 years. The higher end scenario sees just over 800 wells drilled over a period of 16 years.

10.29 The evidence from the test well process is that relatively few, if any, specialist suppliers and their staff have relocated to Lancashire as part of their work for Cuadrilla. This is to be expected given the exploratory nature of activities. However, material from our case study research of existing UK oil and gas locations and US shale plays is that an extensive specialist supplier base can be expected to build up locally over time as the volume of work increases.

10.30 Predicting the scale of any shift in the supplier base – both from overseas to the UK and from existing UK bases to Lancashire – is extremely difficult. For this reason our economic impact modelling assumes a number of separate scenarios. The low range assumes the geographical profile of workers and suppliers within Cuadrilla and the first tier supply chain largely resembles that observed under the test well operations. At the upper end of the range a more radical shift is assumed to occur and more workers and suppliers base themselves in Lancashire.

10.31 Overall three scenarios have been selected and modelled as part of this assessment, as shown in Table 10.1. In each scenario we have modelled impacts over a twenty year period from 2013 onwards.

Table 10-1 : Commercial Extraction Scenarios

	Lower End	**Central Case**	Higher End
Efficiency Gains	Average cost reduction of c15% against test well costs	**Average cost reduction of c15% against test well costs**	Average cost reduction of c15% against test well costs
Scale and Pace	Lower 190 wells over 6 years	**Central** **400 wells over 9 years**	High 810 wells over 16 years
Cost of Conversion	15% uplift, attached to Lower end scenario Implemented at same pace as roll out	**15% uplift, attached to central case scenario Implemented at same pace as roll out**	15% uplift, attached to higher end scenario Implemented at same pace as roll out
Attraction of Industry	Lower Range Scenario	**Mid Range Scenario**	High End Scenario
Lifetime Maintenance Costs	Standard assumption across each scenario	**Standard assumption across each scenario**	Standard assumption across each scenario

Commercial Extraction Impacts – Central Case

10.32 At the UK Level, the FTE employment impact peaks at some **5,600 FTE jobs** in the period 2016 through to 2019 with a build up in the years from 2013 onwards.

10.33 At the peak some 4,000 jobs are directly within the eventual lead producer and within both first and subsequent tier suppliers. 610 FTE jobs (direct and indirect) are required for the installation of the conversion infrastructure. Induced jobs resulting from the expenditure of staff account for 850 FTEs nationally.

10.34 At a Lancashire level, the FTE employment impact peaks at **1,700 FTE jobs** in the period 2016 through to 2019. This represents 30% of the UK total up from 15% under the test well operations.

10.35 At the peak the implied FTE per well ratio stands at 95 FTEs per well at the UK level, reducing to 30 FTEs per well at the Lancashire level. Evidence from the US, measured at the State level, puts the FTE per well ratio at between 32 to 58 FTEs per well.

10.36 The scale of these operations will lead to substantial new clustering of a supplier base in Lancashire and attract some specialist overseas suppliers to other UK locations. Based on the experience at a number of other oil and gas locations, we would also expect Lancashire to serve as a long term base for UK shale expertise with firms securing overseas and other UK contracts in subsequent waves of shale production whilst retaining a Lancashire base.

10.37 Our survey of Cuadrilla and its suppliers indicates average wage levels of around **£55,000 per FTE per annum**, reflecting the higher than average skills levels that are required throughout what is a sophisticated drilling and hydraulic fracturing process both on site and in supply chains. The small number of induced jobs will carry a lower salary range. Average wage levels across Lancashire currently stand at £27,500 according the latest (2009) Annual Survey of Hours & Earnings, and we would anticipate the average salaries on offer as a result of shale gas activities will be broadly **twice that** currently on offer on average across Lancashire. If the job creation was expressed on the basis of average Lancashire salaries, then the estimated figure would be substantially larger.

10.38 Lancashire county has expanded, in net terms, by around 20,000 jobs in the last decade. The additional employment generated as a result of shale gas extraction on the Fylde Coast would make a significant contribution to the growth aspirations of the next decade and would address head on the demands from many local authorities for more higher quality and higher skilled jobs locally. Commercial shale gas extraction would, in our opinion, represent the single largest job creation project across Lancashire in the next 10 years. The jobs would be created in close proximity to areas of economic disadvantage. Data from NWDA shows that in 2009 there were 31,000 IB/JSA beneficiaries in Blackpool claiming in excess of £2.2m in benefits per week. Other government data suggests Blackpool was ranked the 3rd worst district in terms of the concentration of deprivation across England.

Commercial Extraction Impacts – Lower End

10.39 The total peak UK employment reduces compared to the Central Case scenario (**3,400 FTEs** per annum, versus 5,600 FTEs). This is largely due to the assumption that only 40 wells are completed per annum under the Lower End scenario, but remains a significant quantum of job creation. The jobs are maintained over a six year drill programme.

10.40 At a Lancashire level the peak employment impact also reduces (a peak average of **560 FTEs** versus 1,700 FTEs under the Central Case). This is both due to (i) the lower volume of well completions per annum and (ii) the assumption that the location of the supply chain remains largely unchanged from that observed under test well operations.

Commercial Extraction Impacts – Higher End

10.41 The total peak UK employment impacts are a little higher than in the Central Case (**6,550 FTEs per annum**, versus 5,600 FTEs). The impacts are sustained over a longer period with this quantum of per-annum jobs maintained over an 11 year period from 2016 to 2026 inclusive. At a Lancashire level the peak employment impact is considerably higher than the Central Case (a peak average of 2,500 FTEs, versus 1,700 FTEs – or plus 50%). This is, in part, due to the assumptions made on Lancashire gaining a higher relative share of supply chain activity as suppliers relocate. It is also due to the higher cumulative well count, which drives a requirement for additional well maintenance labour. As with the UK impacts, these jobs are also sustained over a longer period relative to the Central Case.

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