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THE ECONOMIC CONTRIBUTION OF THE UK DOWNSTREAM OIL SECTOR

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FOREWORD

Stephen Marcos Jones

Director General, UKPIA

The UK's downstream oil sector is going through a transformation. The long-term trends—shifting product demand, misalignment of supply and demand, and ensuring the UK remains an attractive place to do business—continue to challenge the UK Petroleum Industry Association (UKPIA) and our membership.

But there is change ahead for all elements of the sector, as the government rightly pursues its ambitions to reduce carbon emissions and those of other pollutants. We are firmly behind these goals, which benefit the communities in which we want to continue to work and prosper.

This is precisely why the sector is seeking the opportunities from among these challenges: playing its part now, adapting in the medium term, and planning for continued participation in a vibrant lower-carbon economy in the long term. Ours is a sector that adds considerable value and energy security to the wider economy today. We see this important role continuing in future, though we will change the *how* and *what* we deliver to provide new benefits to society.

For the first time, this analysis by Oxford Economics brings together a compelling account of the importance of the economic contribution of the downstream oil sector right across the UK, including through activity we enable elsewhere in the economy. While the sector contributed £8.6 billion directly to UK GDP in 2016 and provided more than 120,000 jobs, we also enabled all other key sectors of the economy (from chemicals and other manufacturing to almost all transport-related business) to grow. Given this importance for the whole of the UK, this study also looks at the role the sector must play in the transition to a low-carbon future.

This is the first of a series of analyses that are being delivered as part of UKPIA's Future Vision programme, which will be published during 2019. It shows a positive future for the downstream oil sector, with the sector playing a key part in the solution to environmental challenges faced by the UK, and the wider world.

Through greater investment, development of transformative technologies, new business models, and collaboration across the whole business landscape, we believe the UK's downstream oil sector—as a technologically advanced, responsive sector, skilled in the cost-effective manufacture of a wide variety of energy and other useful products—can be a central part of a cleaner UK economy. We will work hard to reach this goal.

WHAT IS THE UK DOWNSTREAM OIL SECTOR ...

- This sector encompasses a wide range of companies involved in the production, import, distribution and sale of refined oil products, from petrol and aviation fuel to heating oil and lubricants
- A combination of domestic production and global import networks enables the sector to provide the UK with a secure supply of fuels

Share of UK energy consumption met by petroleum products

6 major refineries
- refine crude oil and blend biomass into petroleum products

41 coastal and 20 inland terminals
- used to import, export, and store refined fuel
- receive fuel from UK refineries via pipeline, rail and sea

3,000 miles of pipeline
- transports a range of fuels around the country
- pipes jet fuel direct to some of UK's main airports

8,500 filling stations
- supplied from terminals by a fleet of road tankers

Main products supplied

- petrol
- diesel to fuel cars, HGVs, buses & trains
- aviation fuel
- marine fuel
- heating oil
- liquefied petroleum gas (LPG)
- bitumen & lubricants
- chemical feedstocks

... AND HOW ARE ITS PRODUCTS USED?

1. TRANSPORT

More than three-quarters of petroleum products consumed in the UK are used to fuel the transportation of people and goods (figures shown are for 2016).

Road

46 billion litres of oil products consumed

324 billion miles travelled on UK roads

1.9 billion tonnes of freight transported

Aviation

14 billion litres of oil products consumed

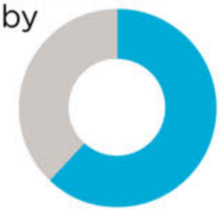
134 million passengers departed from UK airports

1.1 million tonnes of freight flown from UK airports

Rail and maritime

1.7 billion litres of oil products consumed

62% of rail energy needs met by petroleum products



103 million tonnes of domestic freight transported by water

2. PETROCHEMICALS

7.2 billion litres of oil products were used to manufacture petrochemicals. These are, in turn, used to produce a huge range of goods including:

- building components
- consumer electronics
- clothing
- cosmetics
- paints/fertilisers
- plastics/packaging
- pharmaceuticals
- vehicle components

3. HOME HEATING

2.6 billion litres of oil products were used for domestic heating in 2016

3.7 million homes in Great Britain are not connected to the mains gas network. Many rely on heating oil and LPG as the main source of heating

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EXECUTIVE SUMMARY

THE UK DOWNSTREAM OIL SECTOR

The UK's downstream oil sector incorporates a range of companies involved in the production, import, distribution and sale of refined oil products such as petrol, diesel, aviation fuel, heating oil, liquid petroleum gas, bitumen and lubricants. Companies in the sector use their network of infrastructure, which includes six major refineries, 61 terminals, 3,000 miles of pipeline and 8,500 filling stations to ensure that the UK has a constant and reliable supply of the fuels needed to ensure the smooth operation of the economy and enable people to go about their everyday lives. **In total, oil and oil products account for 38 percent of the UK's energy needs.**

In this report we explore the vital role that the downstream oil sector plays within the UK economy. We do this in three parts:

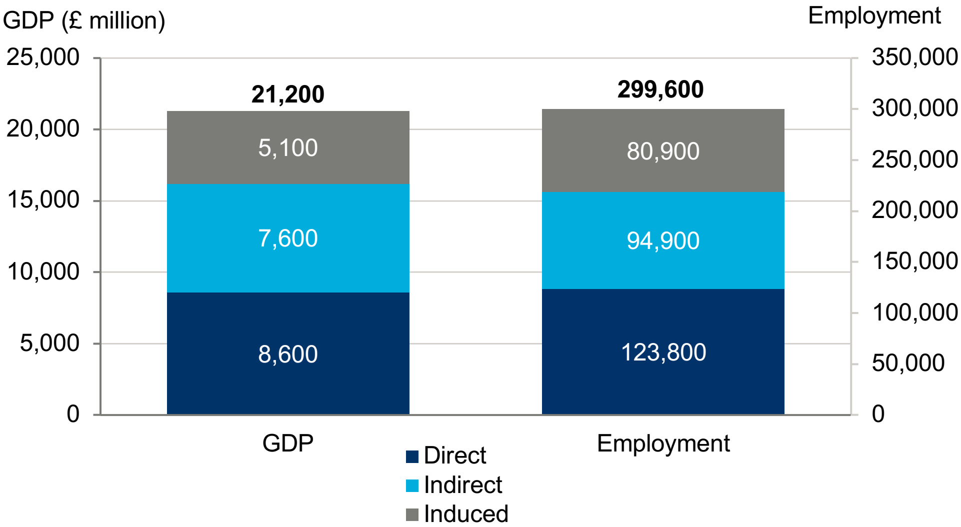
- Firstly, we estimate the contribution to UK GDP and employment the downstream oil sector supports, both directly through its own operations, and through "multiplier effects" supported in the sector's supply chain and as a result of workers' spending.
- Secondly, we look at how the downstream sector's products are used, and the ways in which they enable activity right across the economy.
- And finally, we look ahead to the future and explore the role that firms in the downstream sector are playing in supporting the UK's transition towards a low-carbon future.

THE ECONOMIC CONTRIBUTION OF THE UK DOWNSTREAM SECTOR

We estimate that the downstream oil sector directly provided 124,000 jobs in 2016. Almost 100,000 of these jobs were at the UK's 8,500 petrol filling stations, while 24,000 were in other parts of the sector.

Including multiplier effects, **the downstream oil sector supported a total GDP contribution of £21.2 billion.** This means that the sector has a multiplier of 2.5: for every £1 of GDP it contributed directly, a further £1.50 was supported elsewhere in the economy. Similarly, the total employment footprint of the sector in 2016 extended to almost 300,000 jobs. For each job in the downstream sector itself, a further 1.4 jobs were supported elsewhere in the economy.

Fig. 1. The total economic contribution of the UK downstream oil sector



Source: Oxford Economics

Productivity across the downstream oil sector, measured in terms of GVA per worker, is some 29 percent greater than the UK average. Productivity is substantially higher in some parts of the sector, reflecting the highly-skilled nature of many roles. High skills and productivity levels are also reflected in average wages: those working in refining earn almost 90 percent above the national average. Nonetheless, in common with other STEM-reliant activities, firms in the downstream sector can face challenges in recruiting the skilled workers they need. Downstream companies continue to address this through a range of initiatives to develop their workforces (for example through apprenticeships and other training schemes for young engineers), and to generate interest in STEM subjects amongst young people.

The downstream sector is also an important collector of tax revenues. It collected £36 billion in fuel duty and VAT in 2016-17, equivalent to five percent of UK tax revenues in that year.

ACTIVITY ENABLED BY THE DOWNSTREAM OIL SECTOR

While the downstream oil sector makes a substantial contribution to the UK economy in its own right, its economic importance extends far more widely because the sector is responsible for the supply of fuels which are essential to the operation of almost all other industries.

More than three-quarters of petroleum products consumed in the UK are used to fuel the transportation of people and goods. These fuels therefore underpin the smooth functioning of the UK economy and enable people to go about their daily lives. In 2016, 1.9 billion tonnes of freight were transported by road in the UK, covering a total of 11.9 billion miles, whether that be to bring food to shops, or to enable the nation's producers to obtain the inputs they need and move their products to market. 253 billion miles were travelled by car, the vast majority of them fuelled by petrol or diesel. The downstream sector also fuels aviation, enabling 134 million passengers to depart from UK airports in 2016 to travel 191 billion miles. Passengers travelled 40 billion miles by rail in 2016, and 62 percent of the energy needed to fuel these journeys came from oil. 138 million tonnes of freight were exported from UK sea ports, and 103 million tonnes were transported between UK ports.

The UK's transport industries generated a £35 billion contribution to GDP and supported 732,000 jobs in 2016. However, not all transport is provided by a dedicated provider: many companies across all sectors of the economy provide transport in-house using their own fleets of road vehicles. The average share of companies' costs relating to refined petroleum products is 2.2 percent, although this proportion is notably higher for the agriculture and transport and storage sectors.

The petrochemicals industry is another significant user of the downstream sector's outputs. In 2016, seven percent of petroleum products were used as feedstocks for the petrochemicals industry. The importance of refined products to petrochemicals production is also reflected in the fact that petrochemicals facilities are often located in close proximity to refineries, creating the potential to reduce transport costs and achieve synergies from shared utilities such as heat, steam and power.

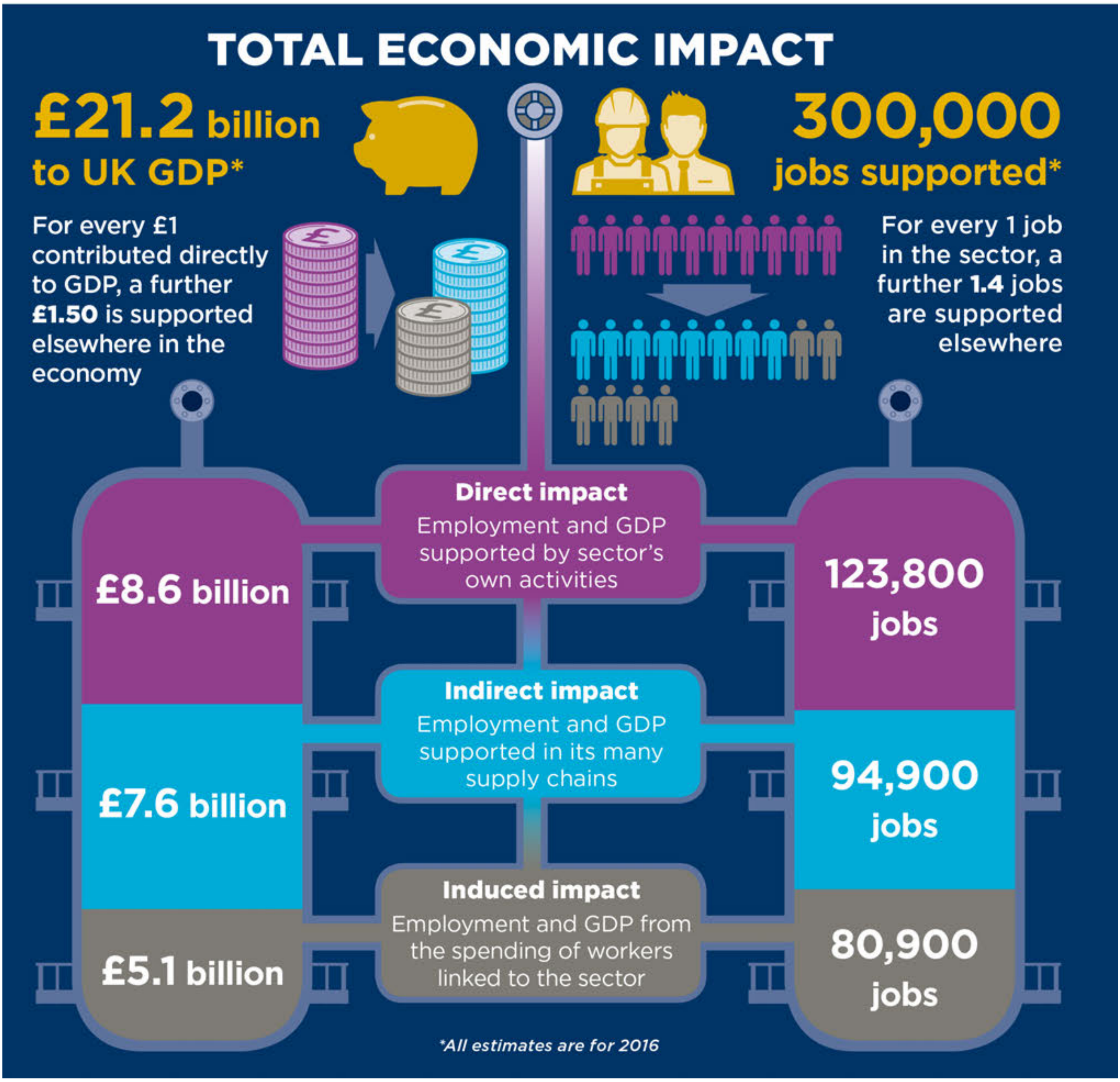
The chemicals industry uses refined oil products to produce a range of substances which are, in turn, used in products encountered in most aspects of day-to-day life. Just a few examples include building components, carpets, consumer electronics, clothing, cosmetics, detergents, fabrics, fertilisers, packaging, paints, pharmaceuticals, plastics, tyres, and other vehicle components. In 2016, the petrochemicals industry supported a £3.5 billion contribution to UK GDP, and directly employed almost 20,000 workers.

Refined petroleum products have a wide range of other uses. Heating oil and liquid petroleum gas (LPG) are used to heat homes which are not connected to the mains gas network. LPG is also used, amongst other things, as a cooking fuel in food trucks and caravans, and to power vehicles such as forklift trucks. Other refined petroleum products include bitumen, used to build roads and footpaths; lubricants used in a wide range of vehicles and machinery; and petroleum coke, used when smelting steel and aluminium.

Given the wide range of applications of refined petroleum products, it is vital that companies in the downstream oil sector have a high degree of resilience built into their processes and distribution networks so that they can ensure a consistent and secure supply of fuels to the UK market. This provides a strong rationale for the UK to sustain its own refining and production capabilities, which enable the country to retain a greater degree of resilience in the event of global disruptions. The UK's refineries are complemented by well-established import networks which allow the UK to source products from a range of overseas markets. Analysis by BEIS suggests that the UK sits within the top half of OECD countries for the security of supply of petrol and jet fuel, and just below half-way in the ranking for diesel.

TOTAL ECONOMIC IMPACT OF THE UK DOWNSTREAM OIL SECTOR

The sector makes a major contribution to the UK economy each year, in terms of the GDP it generates and the employment it supports



Skills and productivity

Productivity in the sector is **29%** above the national average

Oil refining offers a range of highly-skilled roles:

Oil refining education profile

- **35%** Degree or equivalent
- **23%** Completed/current apprenticeships

Reflecting these high skill levels, average pay in refining exceeds **£50,000 per year**, almost **90%** above the UK average

Tax revenues

The sector is an important collector of government revenues. In 2016/2017, it collected:

£28 billion in fuel duty

+ **£8 billion** in VAT from road fuels

= **5%** of UK's total tax receipts

The impact of filling stations

100,000 people were employed in UK filling stations in 2016

Each 100 workers employed generated **£1.1 million** for the wider economy, and supported **18 jobs** through their spending

THE ROLE OF DOWNSTREAM COMPANIES IN THE ENERGY TRANSITION

In line with its international commitments the UK government has set ambitious targets for reducing greenhouse gas emissions. These targets, in turn, imply that the UK will need to reduce its reliance on burning fossil fuels to meet its energy needs. Forecasts of the rate at which this change will occur are subject to a high degree of uncertainty, particularly over a time horizon spanning decades: it will depend, amongst other things, on changes in oil prices, government policies and the rate at which new technologies can be developed. Forecasts by the IEA suggest that between 2016 and 2040, European oil demand could fall by 20 percent based on current policies, or by 56 percent if governments introduced the sustainability policies needed to meet international objectives. Nonetheless, on a global basis the IEA's baseline scenario suggests that demand will continue to increase to 2040, driven by strong economic growth in other regions of the world.

While the take-up of electric and hybrid vehicles is steadily increasing (and the UK government has stated that the sale of new conventional petrol and diesel cars will end by 2040), their share of the overall *stock* of vehicles will increase only gradually. As of 2017, 98.5 percent of licensed cars were powered by petrol or diesel. What is more, known technologies are not yet sufficiently developed to permit a similar switch away from fossil fuels for HGVs and aircraft. There is also expected to be ongoing demand for refined petroleum products from the petrochemicals industry.

Downstream oil companies therefore have a vital role to play within the transition to a low carbon future, and are looking at a number of ways to contribute to the government's policy objectives.

1) *Increasing the operational efficiency of downstream activities*

UK oil refineries have steadily reduced their fuel usage over the last two decades. The competitive environment in which they operate, and the fact that energy can be the second highest cost after crude oil and other feedstocks, means that they have a strong incentive to continue to identify and implement measures to reduce energy usage. These can include the use of sophisticated control and monitoring systems; management initiatives to ensure that strategy and staff are focused on keeping energy costs down; the introduction of technologies to re-use waste heat; and closer integration with industries such as petrochemicals to share utilities and reduce transport costs.

UK refineries are far more efficient today than in the past. Five out of six major refineries have installed energy efficient "combined heat and power" (CHP) plants which re-use waste heat and reduce reliance on the main electricity grid (and potentially export surplus electricity back to the grid). The sixth refinery has committed to install CHP in 2019. Efforts to reduce energy usage are also underway in the filling station sector, where a number of outlets have installed solar panels on their roofs.

2) *Reducing the external environmental impact of downstream activities*

Refineries have already made significant progress in reducing their impact on the environment: between 2005 and 2016 they reduced sulphur dioxide emissions by 65 percent; nitrogen oxide emissions by 43 percent; and emissions of non-methane organic compounds by 48 percent.

Looking ahead, some refineries are exploring ways of exporting recovered waste heat for use by surrounding homes and businesses, for example within "district heating networks" which reduce the need for others to burn fossil fuels.

In the longer term downstream firms hope to be able to implement carbon capture and storage technology to prevent the carbon burnt during the refining process from entering the atmosphere. An extension of this technique is carbon capture and utilisation under which the carbon is re-used, for example to make construction materials.

3) Innovating new products

In addition to reducing the impact of their own operations, firms in the downstream sector are actively developing cleaner fuels which reduce carbon emissions when they are used. In line with legislation, the sector has already achieved progress in this area by removing sulphur from all petrol and diesel sold in the UK since the start of 2009.[1]

The downstream sector is also increasing the share of biofuel content in its products, as required by the government's Renewable Transport Fuel Obligation. Firms in the sector are engaged in a range of initiatives to develop renewable fuels from a variety of organic and waste products. One UK refinery has successfully trialled processing waste oil into renewable fuel, while other areas of global research include the develop of biofuel from algae, agricultural waste, and municipal waste. Biopropane was made available on the UK market in 2018 and has an identical chemical formulation to conventional LPG, meaning that it can be used in existing LPG infrastructure and equipment without modification. Synthetic "gas to liquid" fuel is a less polluting form of diesel which can be used in existing diesel engines, and was made available in the UK in 2017.

4) Diversifying into new products and services

Downstream companies are also supporting the take-up of zero tailpipe emission vehicles. For example, a UK refinery produces graphite coke which is used in electric vehicle and smartphone batteries. This is currently exported to China, but could potentially be incorporated into the UK electric vehicle supply chain. Other downstream companies are adapting their filling stations to accommodate and support the take-up of low emission vehicles, for example by installing electric vehicle charging infrastructure, and through the sale of hydrogen for use in hydrogen fuel cell vehicles.

[1] "Sulphur-free" is defined as less than 10ppm

KEY CONCLUSIONS

- The UK downstream oil sector incorporates a wide range of activities linked to the production and distribution of the fuels which the country needs to ensure the smooth functioning of the economy, and to enable citizens to go about their daily lives.
- The sector makes a substantial contribution to UK employment and GDP, both through its own activities, and those related to its supply chain and workers' spending. In total we estimate this "economic footprint" to support a £21.2 billion annual contribution to the UK's GDP, and almost 300,000 jobs.
- More than three-quarters of petroleum products consumed in the UK are used to fuel the transportation of people and goods. Downstream firms also provide vital inputs to, and sometimes share infrastructure with, the petrochemicals industry, as well as providing products for a range of other uses, such as fuel to heat homes away from the gas grid; the bitumen used to surface roads; and the lubricants applied to virtually all machinery and vehicles. Downstream companies therefore carry a large responsibility for ensuring the secure supply of their products to minimise the likelihood of costly disruptions.
- At the same time, firms in the sector are adapting for a low carbon future in which there is less reliance on burning fossil fuels to meet our energy needs. Important progress has already been made in making oil refineries cleaner and more fuel efficient. Now companies are exploring ways to further adapt, including by making better use of waste heat and carbon; developing low-carbon biofuels from a range of organic and waste products; and diversifying activities to support the switch to low-emission vehicles.

1. INTRODUCTION

1.1 WHAT IS THE DOWNSTREAM OIL SECTOR?

The downstream oil sector incorporates a wide range of companies involved in the production, distribution and sale of refined oil products, such as petrol, diesel, aviation fuel, heating oil, liquid petroleum gas (LPG), bitumen, lubricants and a range of other specialised oil-based products.

For this study, the downstream sector is defined to include the following types of company:

- **Refiners and manufacturers**, who convert crude oil and other inputs (or “feedstocks”) into liquid fuels and other refined petroleum products used by a range of industries and consumers.
- **Blenders,** who blend petroleum products, including fuels and lubricants.
- **Suppliers** involved in the bulk supply of petroleum products from a terminal and may also be refiner or company who imports petroleum products for bulk supply to the market.
- **Distributors** who purchase products from a supplier for sale to end users. Distributors are particularly important for the supply of products such as LPG, gas oil and heating oil to domestic and commercial customers.
- **Transporters** who specialise in the transportation of oil products by road, railway, pipeline or ship.
- **Storage companies** who store oil products in tanks.
- **Re-sellers** who purchase and re-sell petroleum products.
- **Traders** who buy and sell crude oil and petroleum products via financial markets.
- **Retail marketing**, which comprises companies which own and operate filling stations to sell petroleum products to consumers.
- **Commercial marketing** companies who sell petroleum products to commercial customers.
- **Specialities marketing** companies who sell products such as LPG, lubricants, coke, bitumen and aviation fuel.

Companies working in the downstream sector may be engaged in any one or some combination of these activities.[2] These companies own and manage a range of critical infrastructure, including six oil refineries; 41 coastal terminals to import, export and store fuel; 20 inland terminals; 3000 miles of pipeline; and almost 8,500 petrol filling stations.

[2] The downstream sector does not include activities related to the exploration, extraction and production of crude oil and gas, which are classed as the “upstream sector”.

1.2 AIMS OF THIS REPORT

The UK Petroleum Industry Association (UKPIA) has asked Oxford Economics to assess the economic contribution of the UK downstream oil sector. We do this in three parts.

In **Section 2** of the report we assess the "economic footprint" of the UK downstream oil sector. To do this, we start by estimating the value of GDP and employment supported by firms in the downstream sector. However, the sector's impact extends much more widely than this, notably through its supply chain purchases from other UK companies, and through activity supported as workers spend their wages. We analyse the extent of these direct, supply chain and worker spending impacts as part of our analysis.

While the downstream oil sector supports substantial economic activity in its own right, it plays an arguably much more valuable role in providing essential fuels which enable the smooth functioning of activity in virtually all other sectors of the UK economy, whether that be diesel to fuel lorries which deliver food to supermarkets, aviation fuel for passenger flights, or heating fuel and LPG to heat households and businesses in outlying areas. We explore the activity enabled by the downstream sector in **Section 3** of the report.

The final part of our analysis in **Section 4** looks ahead to the future of the UK downstream oil sector. Our focus in this part of the report is to explore how firms in the downstream sector are innovating and adapting to smooth the transition to a low-carbon future.

1.3 RESEARCH APPROACH AND ACKNOWLEDGEMENTS

We have adopted a range of approaches to gathering and analysing the information which makes up this report. This has included a review of information provided by UKPIA, its members, and other stakeholders; consultations with UKPIA members and stakeholders; and our own quantitative analysis.

We would like to extend our thanks to the following organisations for participating in consultations and providing other inputs during the course of the project:

- UKPIA members: BP Oil UK, Essar Oil (UK), Esso Petroleum Company, Petroineos Manufacturing Scotland, Phillips 66, Shell UK, Total UK, Valero Energy UK.
- Cogent Skills
- Department for Business, Energy and Industrial Strategy
- Engineering Construction Industry Training Board
- Federation of Petrol Suppliers
- Greenergy Fuels
- Tank Storage Association
- UKLPG

2. WHAT IS THE ECONOMIC VALUE OF THE DOWNSTREAM OIL SECTOR AND ITS SUPPLY CHAIN?

2.1 OUR APPROACH TO ESTIMATING THE ECONOMIC IMPACT OF THE DOWNSTREAM SECTOR

2.1.1 Introduction to economic impact modelling

The economic impact of the downstream oil sector is assessed using a standard means of analysis called an economic impact assessment. This involves quantifying the sector's impact across three "core" channels:

- ***Direct impact,*** which relates to the downstream sector's own activities. It encompasses the economic activity and employment supported directly by firms in the downstream sector.
- ***Indirect impact,*** which encapsulates the economic activity and employment supported in the UK supply chain of the downstream sector, as a result of its procurement of goods and services from firms in other sectors. Our analysis estimates the impact of firms' capital investments, as well as that of their day-to-day purchases.
- ***Induced impact,*** which comprises the wider economic benefits that arise when employees within the downstream sector, and its supply chain (including that for capital purchases), spend their earnings— for example, in local retail and leisure establishments.

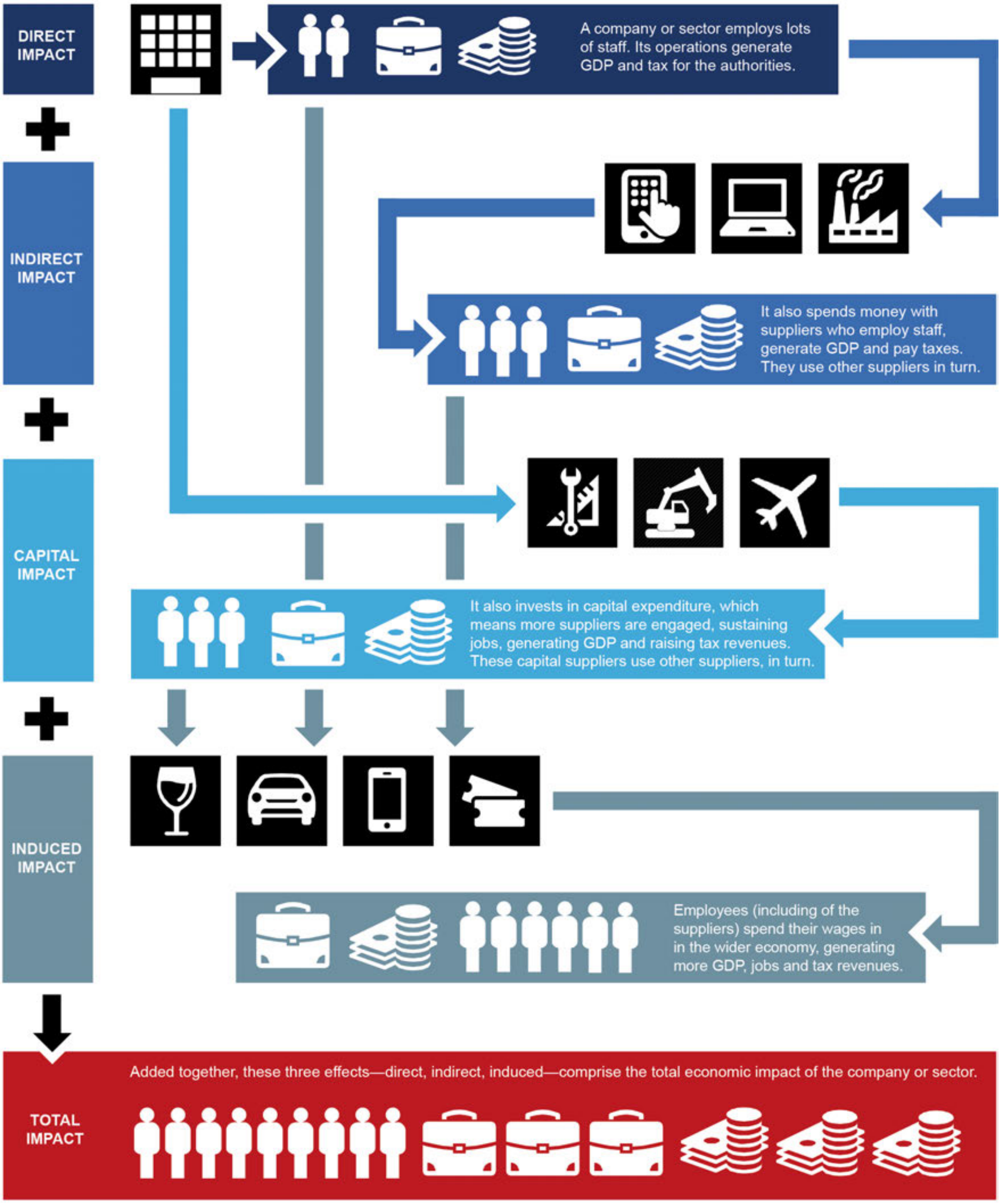
The sum of these channels makes up the downstream sector's total economic impact. Two main metrics are used to present a picture of the sector's economic contribution:

- ***GDP,*** or more specifically, the *gross value added (GVA)* contribution to GDP.[3] For brevity, we refer to the sector's "GDP contribution" throughout this report.
- ***Employment,*** measured on a headcount basis.

The modelling is conducted using an Input-Output (I-O) based model of the UK economy. This model was constructed by Oxford Economics, using data published by the ONS. Further detail about the economic impact methodology is included in Appendix 1.

[3] GVA measures the contribution to the economy of each individual producer, industry or sector. When aggregated across all industries, GVA approximates to GDP. The latter represents the total value of all goods and services produced in an economy and is the main measure of a country's total economic activity.

Fig. 2. How we measure the UK downstream oil sector's economic contribution



2.1.2 Defining the downstream sector for economic modelling

In Section 1 we outlined the wide range of activities which together comprise the downstream oil sector. Estimating the economic contribution of these activities using published statistics is challenging for two reasons. Firstly, downstream activities do not sit neatly within the standard industrial classifications used by the Office for National Statistics.[4] And secondly, many of the companies which make up the downstream oil sector also undertake related activities which we do not wish to count within our estimates, for example in relation to the extraction of crude oil, or the production of chemicals. As such, company accounts do not provide a suitable basis for estimating the value of downstream activity.

In light of these challenges, we have used a range of sources to estimate the value of economic activity within the downstream sector:

- Published statistics from the ONS Annual Business Survey.
- Financial information on more than 70 companies which stakeholders identified as being part of the downstream sector.[5] This group includes members of the Federation of Petroleum Suppliers, Tank Storage Association and UKLPG, amongst others.
- Information on logistics companies from Fuel Oil News.
- Information on downstream employment provided by UKPIA members.

Discussions with UKPIA suggest that our approach is likely to detect the majority of activity within the UK downstream oil sector. However, the reliance on published company accounts means that we are unable to incorporate the smallest firms into our analysis.[6]

We estimate the economic footprint of the downstream sector in 2016, the most recent year for which data relating to UKPIA members were available at the time of writing.

[4] This is a particular issue for activities related to transport, storage and distribution, which often do not allow us to isolate activities relating to oil products from those relating to other goods.

[5] Turnover and employment data from company accounts was gathered from www.duedil.com

[6] While our approach excludes the very smallest downstream companies, we cannot be certain that it results in an under-estimate of the size of the sector since we may be capturing aspects of non-downstream activity amongst firms which are included.

2.2 DIRECT ECONOMIC CONTRIBUTION

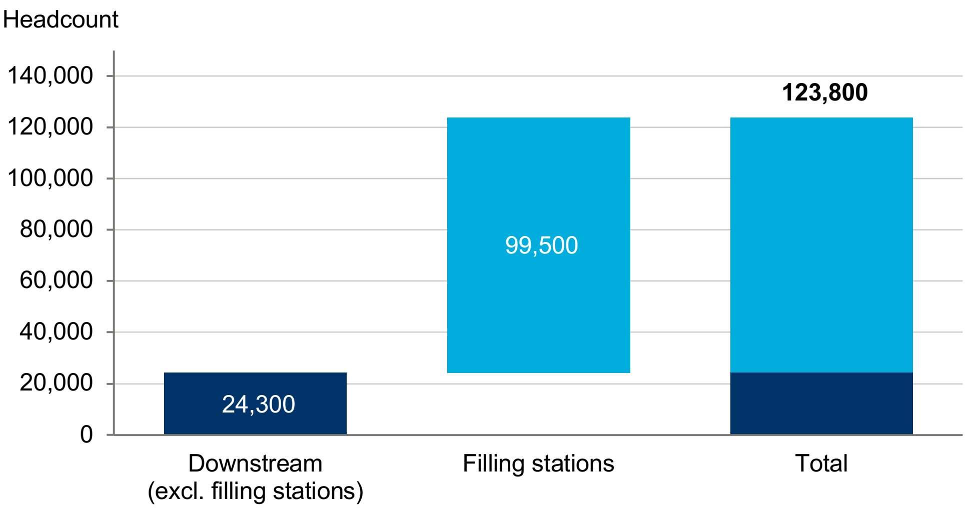
2.2.1 Employment

We estimate that 123,800 people were directly employed in the UK downstream oil sector in 2016. The vast majority of these workers were employed by the almost 8,500 filling stations located throughout the country.

It is estimated that almost 6,000 people were employed in downstream activities by the eight UKPIA member companies, excluding workers in the filling stations they own. The largest concentrations of downstream workers amongst UKPIA members are found at the UK's six major petroleum refineries. Each of these employs hundreds of people, split between operational staff and those in support functions, such as finance, HR or procurement.

In addition to the staff they employ directly, UKPIA members are estimated to employ more than 3,500 contractors at the refineries. While these staff are outsourced to third party companies, they predominantly work alongside colleagues employed by the refinery itself, and in most cases the refinery is their permanent place of work. They are therefore included in the direct employment estimates presented below. In contrast, short-term and temporary contract staff are not included in the numbers below, but are instead considered in our analysis of indirect impacts. The numbers of such staff can swell during the periodic shutdowns that refineries undergo in order to undertake maintenance.

Fig. 3. Direct employment in the downstream sector in 2016



Source: Oxford Economics

The Petroleum Driver Passport (PDP) scheme

The PDP is an industry initiative backed by government to ensure all petroleum tanker drivers in the UK are trained and assessed to a consistent, high standard. The scheme, set up in 2012, sets a benchmark in competency against which all road tanker drivers who are loading, transporting and offloading petroleum fuel products in road tankers in the UK are measured. All major terminals require drivers to be registered under the scheme if they are to access terminals.

At the time of writing, 11,300 individuals have an active PDP.[7] As the scheme is voluntary, it is likely to exclude tanker drivers employed by smaller home heating oil distributors, but it does include a number of agency drivers who are also employed on other haulage contracts which do not involve delivery of petroleum products.[8] Cogent Skills estimates that around 11,500 to 12,000 drivers are involved in supply of petroleum products as their main source of employment.

Relationship with Oxford Economics' estimates

Our estimates of employment in the downstream oil sector should include most of the tanker drivers employed in the downstream sector, although we cannot be certain of the extent to which this is the case. We have estimated employment (including drivers) at major logistics companies involved in the delivery of fuels, and our estimates of total employment at other downstream companies should also include tanker drivers employed by those firms. However, our methodology is not able to capture employment at the very smallest downstream companies, so to the extent that very small firms employ tanker drivers they will not be included in our estimates. If tanker drivers are employed by larger companies as sub-contractors, they would appear in the estimates of indirect employment presented below.

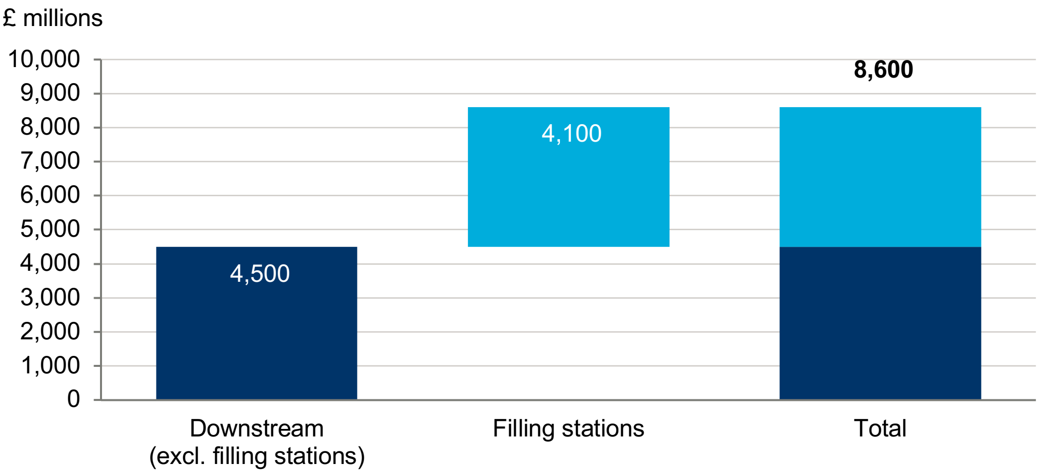
2.2.2 GDP

Using a combination of financial data on downstream oil sector firms and published statistics, we can estimate the sector's contribution to UK GDP. We estimate this to have been £8.6 billion in 2016, split between filling stations and other downstream companies.

[7] UKPIA/Cogent

[8] Figure also includes drivers from the Army who have been trained and registered under PDP to maintain a capability within the Armed Forces to make fuel deliveries in the event of a serious disruption to normal deliveries.

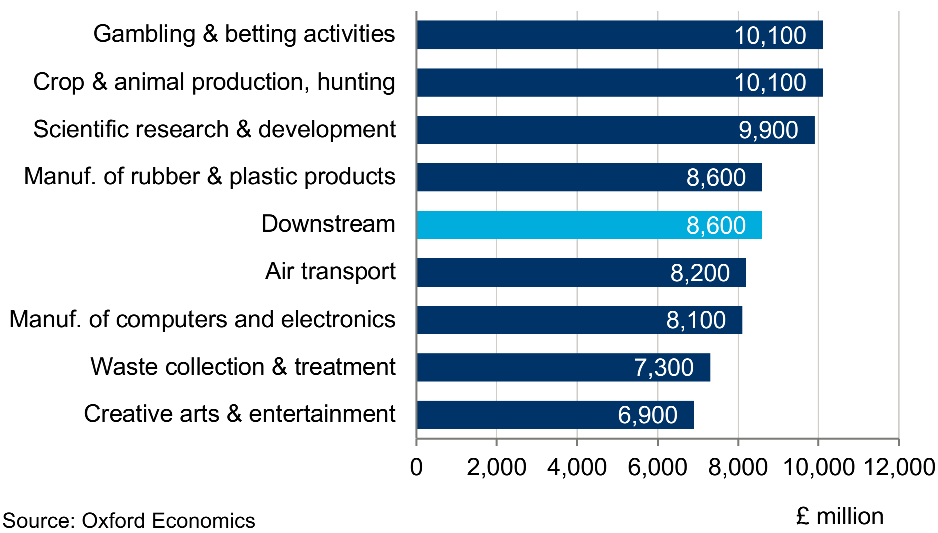
Fig. 4. Direct GDP contribution of the downstream sector in 2016



Source: Oxford Economics

We can compare this direct GDP contribution to that generated by other industries. The downstream oil sector's £8.6 billion direct contribution to UK GDP is slightly larger than that of the air transport sector and computer and electronics manufacturing. The downstream sector also makes a larger contribution than the arts and entertainment sector.

Fig. 5. Direct GDP contribution of the downstream sector and comparator industries in 2016

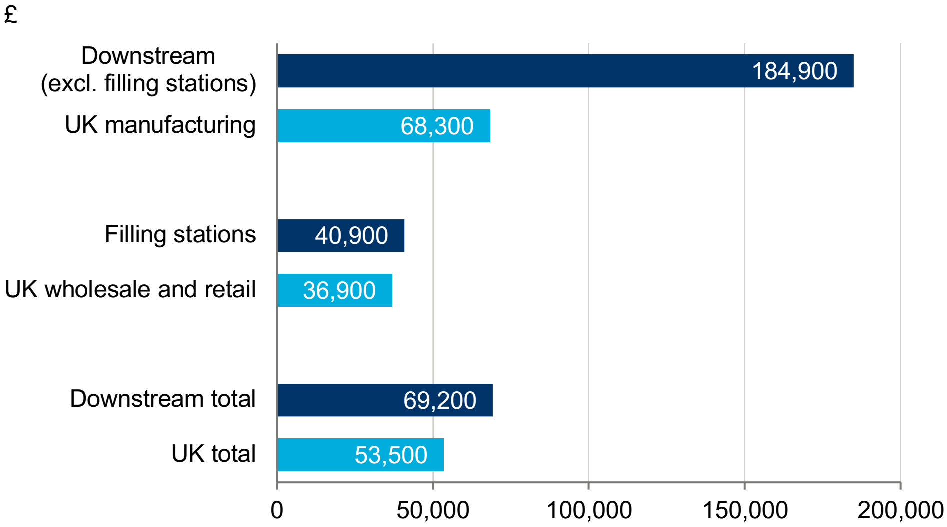


Source: Oxford Economics

By bringing together the estimates of employment and GVA, we can estimate GVA per worker, a measure of productivity. We estimate that each worker in the downstream oil sector contributed an average of £69,200 to UK GDP in 2016, which was 29 percent greater than the UK average.

There is considerable variation in productivity levels within the downstream oil sector, and productivity levels are extremely high in certain parts of the sector. Excluding filling stations, productivity is around £185,000 per worker, which is more than 2.5 times the average for manufacturing, and almost 3.5 times the UK average. In contrast, productivity levels are considerably lower in filling stations, although similar to the average for the UK wholesale and retail sector.

Fig. 6. GVA per worker in the downstream sector in 2016



Source: ONS, Oxford Economics

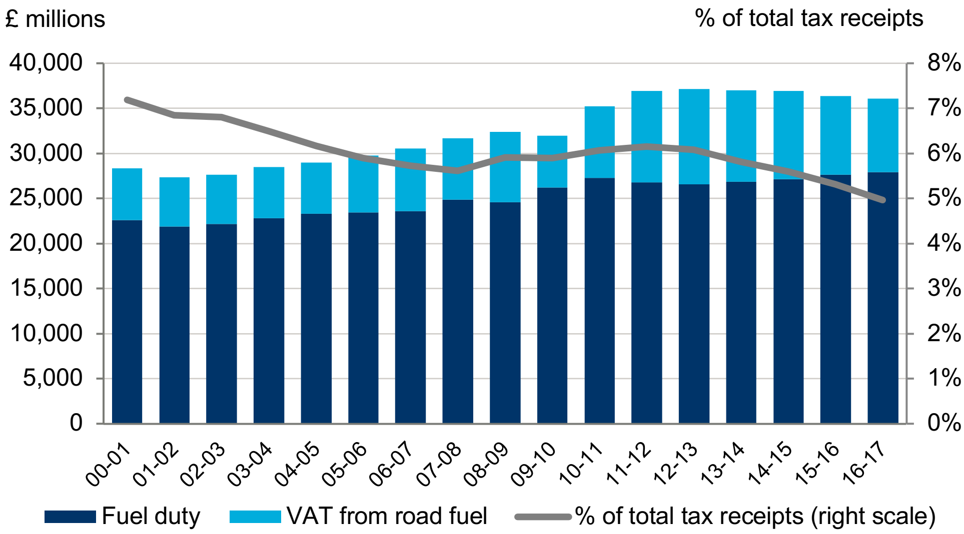
2.2.3 Fuel duty and VAT

Over and above its substantial contribution to employment and GDP, the downstream oil sector is an important collector of government revenues. In 2016-2017, the downstream sector collected £28 billion in fuel duty and a further £8 billion in VAT from road fuels. This is five percent of total tax receipts in that year,[9] and would be sufficient to cover one-quarter of spending on Health and Social Care, or almost 90 percent of government spending on defence.[10]

[9] Fuel duty and total tax receipts from the OBR website [accessed 13 December 2018]. VAT estimated using volumes data from DUKES table 3.13 and VAT per litre from DfT table ENV0105

[10] HM Treasury, Public Expenditure Statistical Analyses 2018 <https://www.gov.uk/government/statistics/public-expenditure-statistical-analyses-2018> [accessed November 2018]

Fig. 7. Duty and VAT from road fuels collected by HMRC, 2000 to 2017

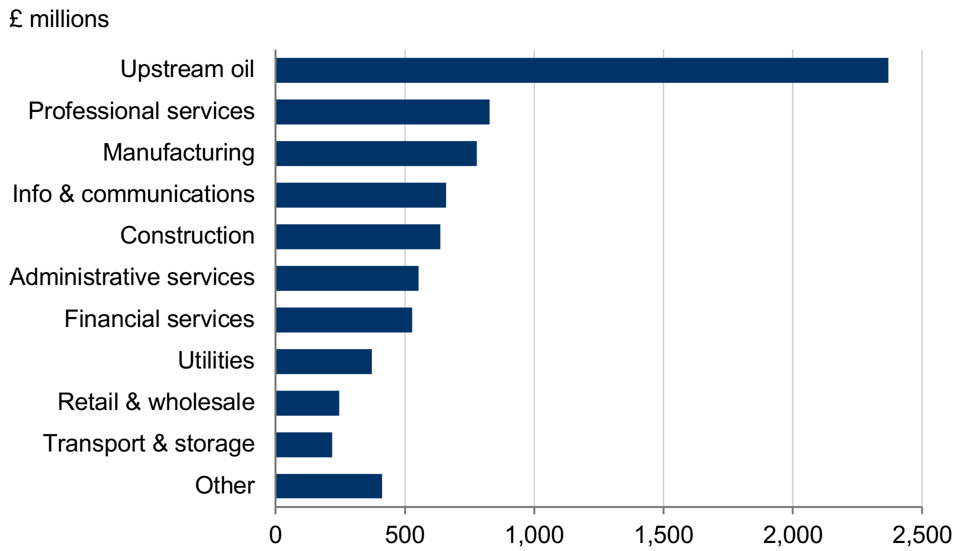


Source: OBR, BEIS

2.3 INDIRECT CONTRIBUTION

The economic contribution of the downstream sector extends far beyond the companies which make up the sector. Substantial further activity is supported within the sector's UK supply chain. Using data published by the ONS, Oxford Economics have developed an "input-output" model to estimate the value of this "indirect" contribution which arises as the downstream sector's purchases ripple down the supply chain. In total, we estimate that this indirect impact contributed £7.6 billion to UK GDP in 2016.

Fig. 8. Indirect GDP contribution of the downstream sector in 2016



Source: Oxford Economics

By far the most important input to the downstream oil sector is crude oil. The sector is estimated to have purchased 53 million tonnes of crude to be used within its refining process in 2016. This is estimated to have cost almost £15 billion, of which £3.25 billion is estimated to have been purchased from UK sources.[11] Based on these crude oil purchases, we estimate that the downstream sector supported a £2.4 billion GDP contribution in the UK upstream oil sector and related activities in 2016.[12]

The downstream sector also supports substantial activity in sectors such as manufacturing and construction, from which it purchases both inputs for the refining process (e.g. chemical catalysts) and machinery and other hardware related to the maintenance and upgrading of refineries and other infrastructure.

Other major expenses for refinery operators include purchases of professional services (such as consultancy, advertising, accountancy and legal services), IT services, administrative services and financial services. We estimate that the downstream sector supported an indirect GDP contribution of £2.6 billion in these activities.

THE DOWNSTREAM SECTOR AS A DRIVER OF INVESTMENT

UK downstream oil companies own and operate critical elements of the UK's energy infrastructure used for the processing, manufacturing and distribution of oil products. In the course of doing this companies make substantial capital injections into the UK economy to replace and upgrade elements of this infrastructure. Our modelling suggests that the downstream sector made capital purchases of £1.2 billion from UK suppliers in 2016.[13] The activity these investments support within the sector's supply chain, and through workers' spending, has been factored into our economic impact analysis.

A notable feature of the refining sector is the need to take refineries off line on a periodical basis for inspection and upgrades. Industry representatives reported that since new refineries cost billions of pounds, an approach of incrementally improving existing facilities is likely to be more cost effective than major new developments. Upgrades most commonly aim to improve efficiency and reliability, and reduce the environmental impact of refining. Such upgrades mean that oil refiners make regular large capital investments which support further employment and economic activity.

Examples of major recent and planned downstream sector investments include:

- **Essar** reports that it invested over £570 million in the Stanlow refinery between 2011 and 2018.[14] Its investments have focused on improving efficiency and throughput, reducing emissions, and enhancing safety.

[11] Oxford Economics calculations based on DUKES data

[12] Intra-industry purchases of refined products are an important feature of the downstream sector, for example as refiners sell fuel to distributors or retailers. But while many downstream companies make significant purchases of refined products, the activity supported by these transactions is already recorded in our estimate of the direct impact of the sector. We do not, therefore, consider it within the indirect analysis to avoid double counting. Further details of our approach are presented in Appendix 1.

[13] Estimated value based on industry average investment rates from the ONS Annual Business Survey.

[14] https://www.essaroil.co.uk/news/essar-oil-uk-delivers-robust-financial-performance-in-fy18-with-ebitda-of-us-300m-and-pat-of-us-161m/ (investment value converted to GBP using an average exchange rate of £1=$1.49)

- **Esso** is seeking to make a £500 million upgrade to its Fawley refinery. This would enable it to use a wider range of crude oil as inputs, reducing raw material costs, as well as increasing the supply of diesel to the UK market and enabling the production of cleaner fuels from a new “hydrotreater” refinery.[15] The company is also seeking to build a replacement pipeline from Southampton to Heathrow Airport to supply jet fuel.[16]
- **Petroineos** has, in line with other UK refineries, invested heavily in regulatory compliance to reduce the environmental impact of its Grangemouth refinery.[17] Its investments reduced sulphur dioxide emissions by 41 percent between 2002 and 2017. And investments during 2018 are expected to deliver a further eight percent reduction from the 2002 level.
- **Phillips 66** has undertaken £1.5 billion of capital and maintenance expenditures at its Humber refinery since 2005.[18]
- **Total** has allocated £33 million to upgrade its refinery under its “Future in Total” programme. It plans to spend £15 million of this sum in 2019/20 to enable it to increase its output of sulphur-free petrol and diesel, and to process crude oil from a wider range of regions.[19] This is in addition to the £20 million the refinery invests each year to adapt to industry demands and remain competitive.[20]
- Since coming to the UK in 2011, **Valero** has undertaken a range of investments to enhance its operating capabilities, with the additional benefit of increasing the UK’s energy resilience. For example, it has refurbished and reopened the Manchester oil terminal and the pipeline that connects it directly to the Pembroke refinery, and upgraded the Avonmouth terminal so that it can handle all grades of retail fuel.[21] The company is currently planning a £127m “cogeneration” plant at its Pembroke refinery. Running off natural gas this will provide all of the refinery’s electricity needs, freeing up capacity on the local electricity grid.[22]

By combining the indirect GDP results with labour productivity levels in each sector, we can estimate employment supported in the downstream sector’s supply chain. The largest concentration of jobs was in administrative services, which is likely to include many temporary contract staff employed through employment agencies. This category also includes outsourced services such as facilities management, security and rental and leasing. A further 16,400 jobs were in professional services, such as consultancy, legal, accounting and advertising, and 14,200 jobs were supported in manufacturing. While the indirect GDP contribution was dominated by the downstream sector’s purchases of crude from the upstream sector, extremely high productivity levels in that sector mean that relatively fewer jobs are supported.

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and http://www.essaroil.co.uk/news/2017/essar-oil-uk-plan-to-invest-250-million-in-capex-and-maintenance-at-stanlow/

15 https://www.bbc.co.uk/news/uk-england-hampshire-45496649

16 https://www.slpproject.co.uk/

17 https://www.sepa.org.uk/regulations/air/air-quality/petroineos-permit-derogation/

18 https://www.marketinghumber.com/media/3948/investing-humber-2018.pdf

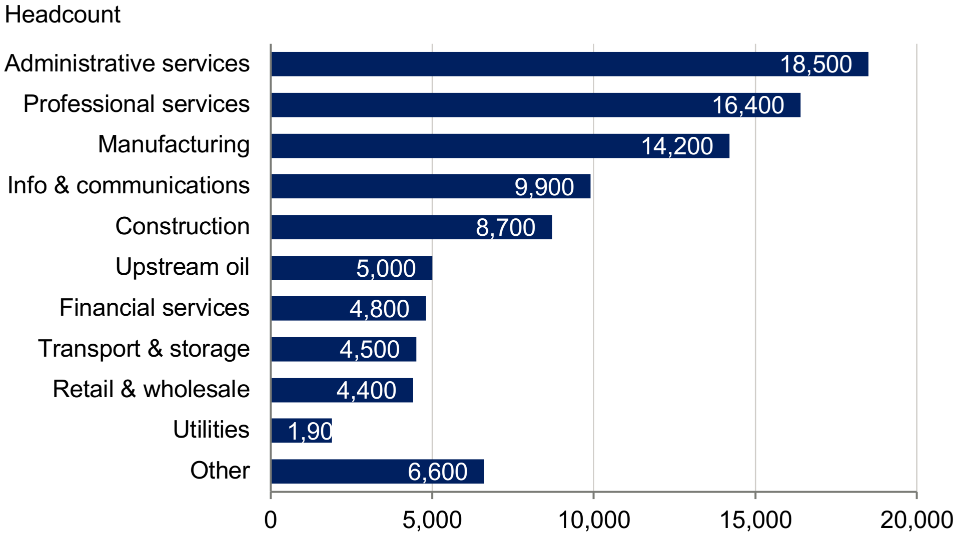
19 Total, "Affordable, Reliable and Clean Energy- How We do Business in the UK", 2016/17, p.14.

20 https://issuu.com/schofieldpublishingltd/docs/eog_163?e=7939731/66349549

21 https://fueloilnews.co.uk/2017/03/valeros-newly-expanded-avonmouth-terminal/

22 https://www.bbc.co.uk/news/uk-wales-43242768

Fig. 9. Indirect employment contribution of the downstream sector in 2016



Source: Oxford Economics

DEVELOPING CAPABILITY IN THE SUPPLY CHAIN [23]

As well as selling goods and services to firms in the downstream sector, suppliers can benefit from other types of support to help them develop the capabilities of their business.

Broham Forecourt Developments (BFD) is a construction and civil engineer firm which employs around 30 people. It specialises in the construction of petrol filling stations and retail outlets, and has been working with BP in that capacity for more than two decades. BP contracts account for a large share of BFD's turnover. The relationship with BP has also led to a number of other benefits for the firm.

BP encourages its construction-oriented contractors to build their skills through ongoing health and safety training, and attain certification under the "UKPIA Forecourt Contractor Safety Passport Scheme" which BFD is committed to. BP recognises the efforts of its contractors through various awards, of which Broham Forecourt developments has won several, including "Most proactive site manager" and "Most health and safety conscious principle contractor". BP also provides seminars for its contractors focusing on specific subjects (e.g. asbestos awareness), and shares bulletins summarising industry best-practices on health and safety.

Kevin Porter, owner of Broham Forecourt Developments explains that the support they have received from BP has "changed our approach," and helped to build, maintain and train the company's workforce. The processes the company has put in place, and BP's reputation for rigour in assessing and selecting contractors, means that Broham Forecourt Developments now finds it easier to win contracts from other companies.

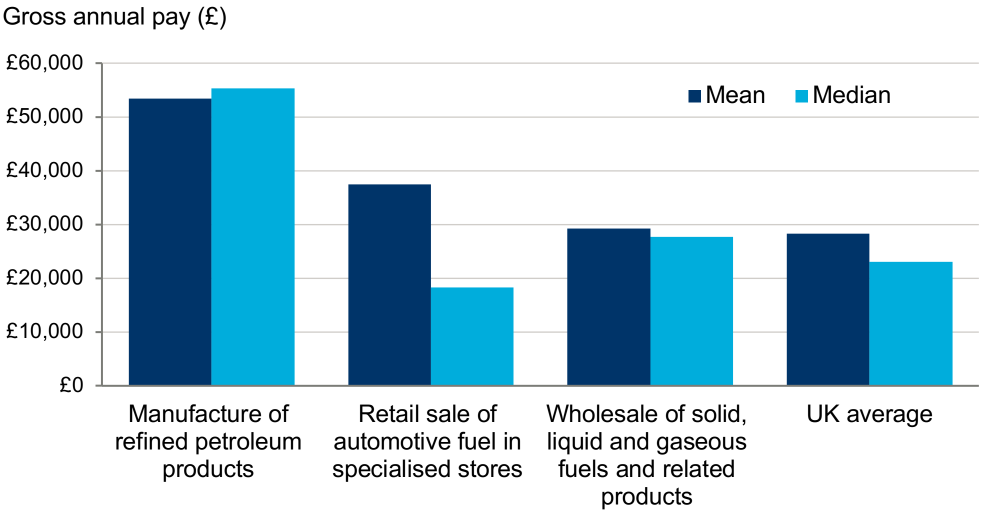
[23] Oxford Economics, "The impact of BP on the UK economy in 2014", report for BP, 2015

2.4 INDUCED CONTRIBUTION

Wages in some parts of the downstream sector are significantly above the UK average. As shown in the chart below, average pay in refining is in excess of £50,000 per year, or almost 90 percent greater than the UK average.[24] Wages in fuel wholesaling also tend to be slightly above the UK average.

While the average wage in petrol retailing is above the UK average, the estimated median wage is below average, and more similar to levels in other retail sectors. The large difference between the median and mean suggests that the latter may be distorted by a small number of workers earning very high wages.[25]

Fig. 10. Gross mean annual pay in downstream-related sectors, 2016



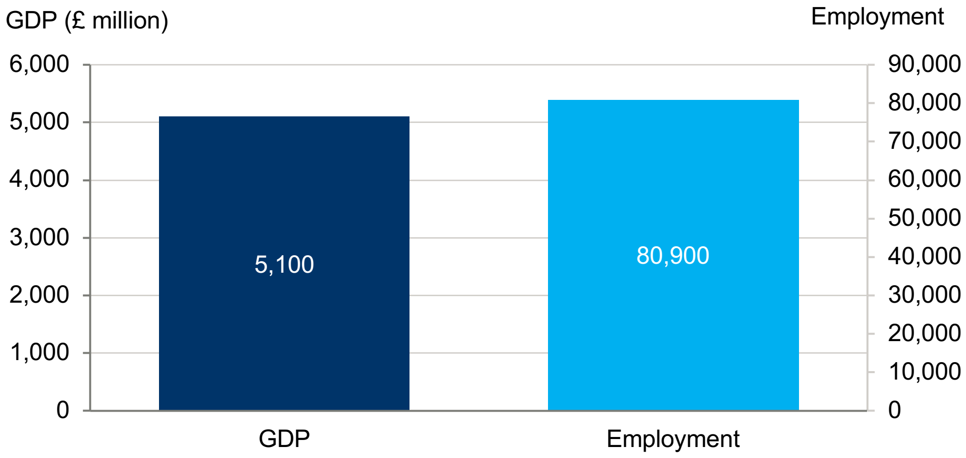
Source: Annual Survey of Household Earnings (ASHE), Office for National Statistics (ONS)

As workers in the sector spend their wages, they support a further round of multiplier effects. Along with spending by workers in the supply chain, this constitutes the induced impact of the downstream oil sector. Under the assumption that workers spend in line with average spending patterns, we estimate that this induced activity supported a further £5.1 billion contribution to GDP, and almost 81,000 jobs.

24 Downstream companies suggested in consultations that many of their roles also come with relatively attractive non-wage benefits, such as favourable pension arrangements.

25 No median wage for petrol retailing was reported by ONS in 2016, so it has been estimated based on the 2016 mean wage, and the ratio between mean and median in 2017.

Fig. 11. Induced contribution of the downstream sector in 2016



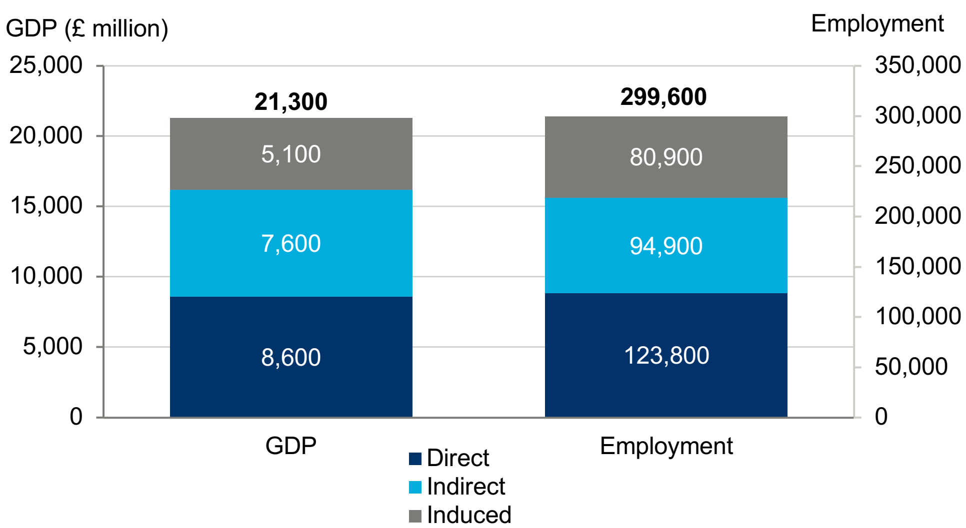
Source: Oxford Economics

2.5 TOTAL ECONOMIC CONTRIBUTION

By bringing together the direct, indirect and induced impacts, we can estimate the downstream sector's total economic contribution. On this basis, we estimate the sector supported a total GDP contribution of £21.2 billion, either directly, or through supply chain and worker spending multiplier effects. This means that the sector has a GDP "multiplier" of 2.5: for every pound of GDP the sector contributed directly, a further £1.50 was supported elsewhere in the economy.[26]

Similarly, the total employment footprint of the downstream sector in 2016 incorporated almost 300,000 jobs. The sector's employment multiplier was therefore 2.4: for each job in the sector itself, a further 1.4 were supported elsewhere in the economy.

Fig. 12. Total economic contribution of the UK downstream sector, 2016



Source: Oxford Economics

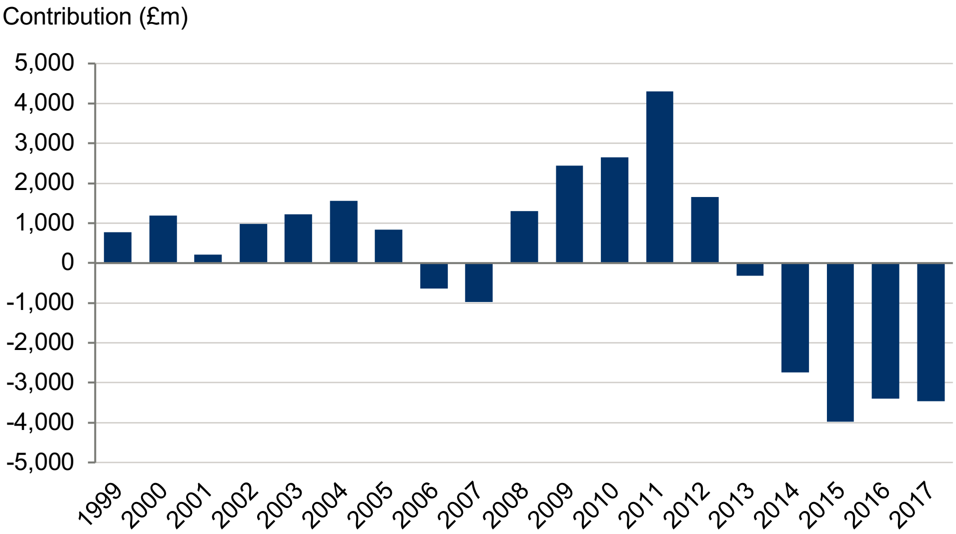
[26] The "Type II" multiplier is calculated as (Direct + Indirect + Induced) / Direct

2.6 CONTRIBUTION TO THE UK BALANCE OF PAYMENTS

The downstream oil sector plays an active role in the international market for petroleum products. It imports fuels to ensure that the UK's demand is met, and exports fuels produced in the UK to overseas markets. We analyse the sources of supply for different types of petroleum products in Section 3.1, but here we briefly consider the sector's contribution to the UK balance of payments.

Between 2000 and 2012, the oil refining sector tended to make a positive contribution to the UK balance of payments. That is, exports were greater than imports. However, this position changed in 2013, since when the UK has become a net importer of refined petroleum products. This change was driven by a combination of two refinery closures since 2012, and the growing demand for diesel and jet fuel, for which the UK has a greater reliance on overseas sources. In contrast, the UK remains a net exporter of petrol.

Fig. 13. Contribution to UK balance of payments from imports and exports of petroleum products



Source: BEIS DUKES Table G.3

2.7 REGIONAL DISTRIBUTION OF ACTIVITY WITHIN THE DOWNSTREAM SECTOR

The analysis above estimated the economic contribution of the downstream oil sector to the national economy. In this section, we consider how the employment supported by the sector is distributed across the UK. We focus on two elements of the sector's employment: firstly, we identify the areas where there are important concentrations of activity within refineries and other associated major infrastructure located in close proximity; and, secondly, we show how the filling station sector is an important source of employment across all regions of the country.

2.7.1 Employment at oil refineries and in related sectors

Oil refineries are important sources of employment, typically employing hundreds of workers directly, plus a similar number of contractors, many of whom work on site on a permanent basis. In many cases, as we discuss below, refineries are located in close proximity to other closely-related activities which may either supply a refinery, or make use of refinery outputs within their own production processes. In light of this, refineries can assume a great deal of importance within the local economies where they are located.

The spending of refining workers, in particular, can play an important role in supporting economic activity in the areas where they reside, particularly given the above-average wages available to refinery workers. We estimate that for each 100 workers employed in the downstream sector (excluding filling stations), £4.7 million of GVA and 76 jobs are supported as a result of their spending.

In the section below we present evidence to outline some of the ways in which the UK's six refineries support activity within their local areas.

The Humber "Energy Estuary"

> "More than one-third of the Grimsby and Immingham ports' total tonnage relates to crude oil, oil products, or liquefied gas."

Two oil refineries are located in close proximity on the banks of the Humber Estuary: the Lindsey Total UK refinery and the Phillips 66 refinery. The area has been named the "Energy Estuary", due to its concentration of refineries and related activities, power stations, and the emerging offshore wind sector.

The Phillips 66 refinery has 750 onsite workers plus 300 to 400 regular contractors[27] and has undertaken £1.5 billion of capital and maintenance expenditures since 2005.[28] The Lindsey refinery employs a further 400 workers, plus contractors, and has recently received £33 million of investment to enhance its energy efficiency.[29] This is in addition to the £20 million the refinery invests each year to adapt to industry demands and remain competitive.[30]

The refineries are an important customer of the nearby VPI Immingham power station, which provides steam and electricity to fuel to the refineries' operations.[31]

The port of Grimsby and Immingham also plays an important role in supporting the refineries' operations. Crude oil arrives at the port by tanker, and is transferred to the Total refinery by pipeline,[32] while the port is also used to export refined products.[33] In 2016, some 5.9 million tonnes of crude oil was imported through the port, and 12.3 million tonnes of oil products were also transported (of which 62 percent were exports). In total, more than one-third of the port's total tonnage related to crude oil, oil products or liquefied gas.[34]

27 https://www.raconteur.net/manufacturing/chemicals-prosperity-north

28 https://www.marketinghumber.com/media/3948/investing-humber-2018.pdf

29 https://www.raconteur.net/manufacturing/chemicals-prosperity-north

30 https://issuu.com/schofieldpublishingltd/docs/eog_163?e=7939731/66349549

31 https://www.theade.co.uk/members/industrial-chp/vpi-immingham-llp

32 http://www.ukpia.com/industry_information/refining-and-uk-refineries/total-lindsey-oil-refinery.aspx

33 https://www.phillips66.co.uk/EN/about/refining_ops/Pages/index.aspx

34 Oxford Economics calculations based on DfT Port Freight Statistics Table 0303

The Haven waterway

The Haven Waterway zone has a strong concentration of energy sector activity, much of it involving the downstream sector. This includes the Valero refinery. Valero report that more than 500 people are employed at the refinery, plus several hundred contractors.[35] Valero estimates that it is the largest private sector employer in its local area.

Other downstream activity located in the vicinity includes:[36]

- one of the UK's largest fuel storage facilities, which was acquired by Valero in 2018;[37]
- two Liquefied Natural Gas (LNG) import, storage and regasification plants, operated by Dragon LNG and South Hook LNG; and
- a storage facility operated by Puma Energy.[38]

> "Crude oil, oil products and liquefied gas represent more than 95 percent of total tonnage passing through the port of Milford Haven."

The energy sector is reliant on the port of Milford Haven, and vice-versa. In 2016, the port imported 10 million tonnes of crude oil, and handled 16 million tonnes of oil products (of which two-thirds were exports). In total, crude oil, oil products and liquefied gas accounted for more than 95 percent of the tonnage passing through the port that year.[39]

Grangemouth

The Petroineos refinery, close to the Firth of Forth, is the only petroleum refinery in Scotland. The North Sea Forties Pipeline system terminates at the refinery, and excess crude oil is exported via pipeline to a tanker loading terminal on the Forth. Crude oil also comes to the refinery via pipeline from the Finnart Ocean terminal.

The refinery has close links to the adjoining petrochemicals complex, and the combined petroleum and chemicals cluster is a major source of employment in the Grangemouth and Falkirk area. The chemicals plants, including the one owned by INEOS, use outputs from the refinery and are together estimated to have contributed around one-third of the Scottish chemical industry’s value added in 2015.[40]

The refinery directly employs 550 people, and seeks to use local contractors for large-scale operations, wherever possible.[41] ONS data suggest that 900 people were employed in the chemicals sector in the Falkirk district in 2016.[42]

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35 https://www.valero.com/en-us/Pages/Pembroke.aspx

36 https://businesswales.gov.wales/enterprisezones/zones/haven-waterway/business-environment-haven-waterway

37 https://globenewswire.com/news-release/2018/02/23/1386872/0/en/Valero-to-Purchase-SemLogistics-Milford-Haven-Fuel-Storage-Facility.html; https://globenewswire.com/news-release/2018/04/26/1487899/0/en/Valero-Energy-Reports-First-Quarter-2018-Results.html

38 https://www.pumaenergy.com/en/where-we-operate/europe/uk/

39 Oxford Economics calculations based on DfT Port Freight Statistics Table 0303

40 Peter Brett Associates, “Future Grangemouth vision 2025 evaluation of economic effects”; report for Scottish Enterprise and Chemical Sciences Scotland, 2017

41 http://www.energy-oil-gas.com/2018/07/17/petroineos-manufacturing-scotland-ltd/

42 ONS Business Register and Employment Survey <accessed 7 December 2018>

Fawley

The Esso refinery at Fawley on the west shore of Southampton Water is the largest in the UK, and the only refinery in the South of England. The refinery is closely integrated with the adjoining chemical manufacturing plant, with which it shares a site. As well as transport and heating fuels, the refinery produces petrochemical feedstocks which are used in the chemicals processing element of the facility to produce a range of products, including plastics, synthetic rubber, printer inks, solvents and other substances. Esso reports that colocation of the chemicals and refinery operations enables them to realise important synergies between the two operations, supporting the competitiveness of an important element of their manufacturing operations.

ONS data suggest that in 2016 some 1,000 people were employed in the refining sector in the New Forest district, in which the Fawley site is located.[43] The same data source suggests there were 800 people employed in chemicals manufacturing in the area.

Cheshire

The Essar refinery is located at Stanlow, on the south bank of the Mersey Estuary. It is closely integrated with the Shell Chemicals plant on the same site, to which it provides petrochemical feedstocks, although Shell has recently announced the closure of the chemicals units.[44] The refinery employs more than 900 staff, plus around 800 contractors.[45] There is also a large chemicals sector in the surrounding region: ONS data suggest that 2,000 people are employed in chemicals manufacturing in the Cheshire West and Chester district, within which Stanlow is situated.[46]

THE THAMES ESTUARY

While this section of the report focuses predominantly on areas with major refineries, downstream oil infrastructure, such as terminals and storage facilities, also plays an important role in other regions of the UK. For example, the Thames Estuary has a concentration of terminal and storage facilities which provide London and the South East of England with direct access to global fuel markets. In total, the area has more than 1.5 million cubic metres[47] of bulk storage facilities for liquid fuels, and major facilities include BP Isle of Grain, Esso Purfleet, InterTerminals, Navigator Terminals, NuStar Grays, Oikos Storage, Shell Haven, Stolthaven Dagenham, Thames Oilport, and CLH Pipeline System. Since 2014, more than £100 million of investments[48] have been undertaken or announced to refurbish and expand the import and distribution facilities in the area.

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[43] ONS Business Register and Employment Survey <accessed 7 December 2018>

[44] https://www.bbc.co.uk/news/uk-england-merseyside-46567614

[45] http://www.essaroil.co.uk/our-work/stanlow/

[46] ONS Business Register and Employment Survey <accessed 7 December 2018>

[47] http://portoflondonhandbook.com/fact-files/liquid-bulks and https://www.tankstorage.org.uk/tsa-members/type/full-members/ <accessed 4 February 2019>

[48] http://portoflondonhandbook.com/fact-files/liquid-bulks and https://www.trant.co.uk/news/fantastic-progress-on-fuel-tank-farm-upgrade-project <accessed 4 February 2019>

MAJOR DOWNSTREAM OIL INFRASTRUCTURE

For each 100 workers employed in the downstream sector (excluding filling stations), we estimate their spending contributes £4.7 million to the UK's annual GDP, and supports 76 jobs

Cheshire

Essar Stanlow

- Refinery employs more than 900 staff, plus 800 contractors.
- Essar invested more than £570 million between 2011 and 2018 to improve efficiency and throughput, reduce emissions, and enhance safety.

The Haven Waterway

Valero Pembroke

- More than 500 people are employed at the refinery, plus several hundred contractors.
- The refinery is situated within a cluster of other energy sector activity, which also includes major fuel storage facilities operated by Valero and Puma Energy.
- Crude oil, other oil products, and liquefied gas represented more than 95 percent of the total tonnage that passed through nearby Milford Haven port in 2016.

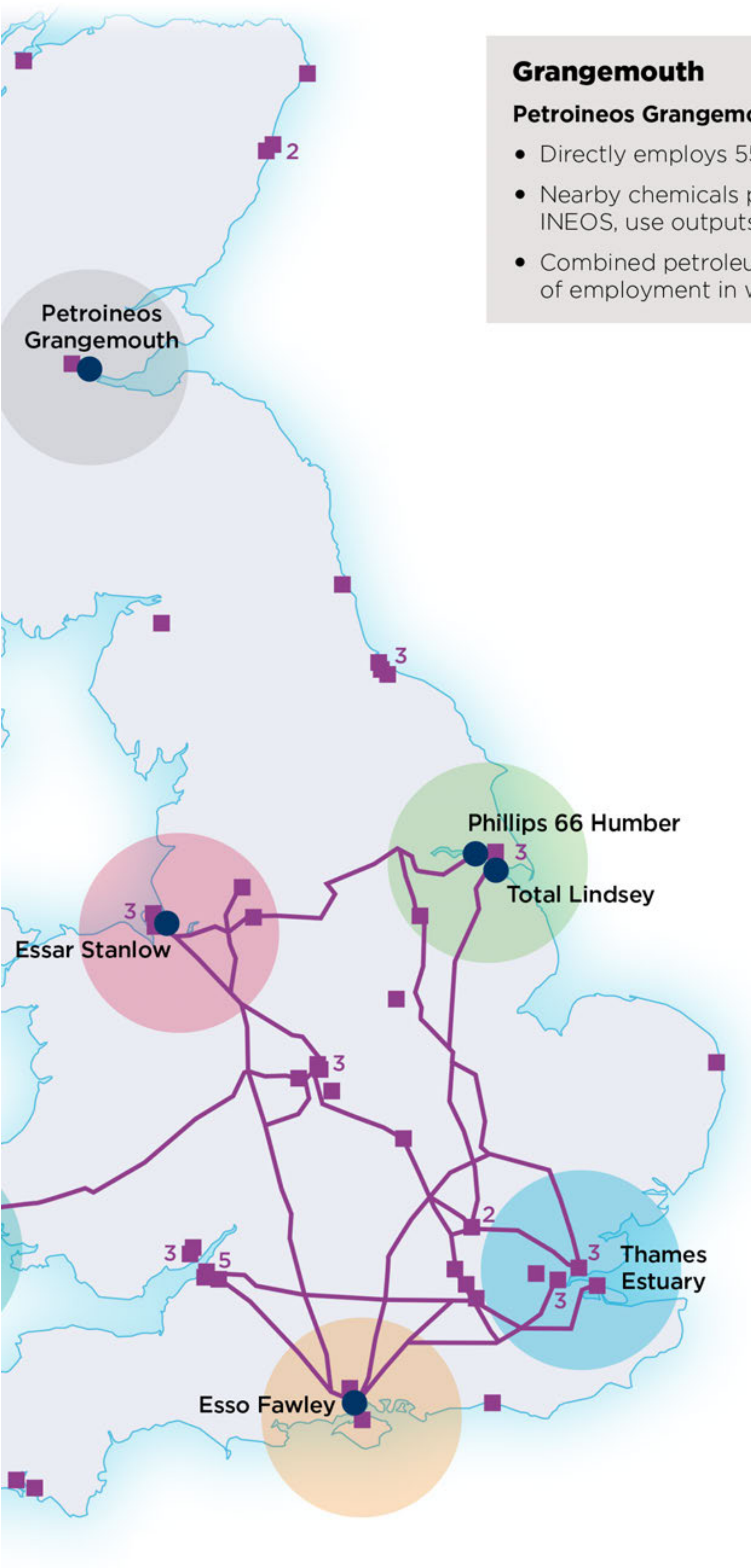
Key

- Refineries
- Pipelines
- Terminals (Numbers denote multiple terminals in close proximity)

Fawley

Esso Fawley

- Largest refinery in UK, and only one in South of England.
- Closely integrated with adjoining chemical manufacturing plant.
- In 2016, 1,000 people were employed in refining sector within New Forest district.
- A further 800 people were employed in chemicals manufacturing in the area.



Grangemouth

Petroineos Grangemouth

- Directly employs 550 people, plus contractors.
- Nearby chemicals plants, including the one owned by INEOS, use outputs from the refinery.
- Combined petroleum and chemicals cluster is major source of employment in wider Grangemouth and Falkirk area.

The Humber Energy Estuary

Phillips 66 Humber

- 1,100 onsite workers (including contractors).
- Has undertaken £1.5 billion of capital and maintenance expenditures since 2005.

Total Lindsey

- Employs a further 400 workers, plus contractors.
- £33 million of investment allocated to enhance efficiency, in addition to the £20 million that is invested every year to adapt to industry demands and remain competitive.
- More than one-third of Grimsby and Immingham ports' total tonnage related to crude oil, oil products, or liquefied gas in 2016.

Thames Estuary

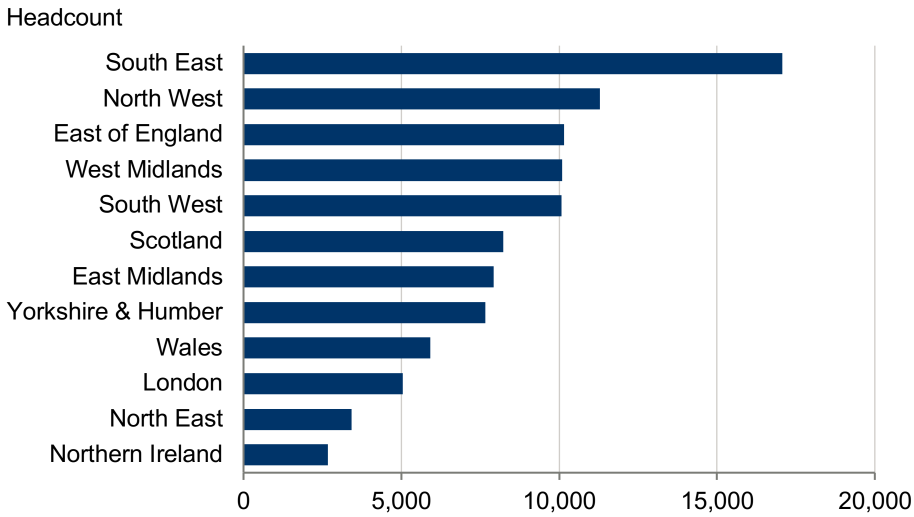
- Terminals and storage facilities that provide London and the South East with direct access to global fuel supply markets.
- More than 1.5 million cubic metres of bulk storage facilities for liquid fuels.
- Home to Shell Haven, BP Isle of Grain, Navigator Terminals and CLH Pipeline System.
- More than £100 million of investment undertaken or announced since 2014 for refurbishment and expansion.

2.7.2 Employment in filling stations

As shown above, the refining component of the downstream sector provides concentrations of employment at major facilities at specific locations within the UK. In contrast, the retail sale of road fuels at filling stations is distributed widely across all regions of the country.

In total, we estimate that almost 100,000 people were employed in filling stations in 2016. Based on the number of filling stations, and adjusting for productivity differences across regions, we can estimate the regional distribution of this employment. The largest concentration of employment was estimated to be in the South East, where filling stations employed an estimated 17,100 people.

Fig. 14. Estimated employment in filling stations, by region



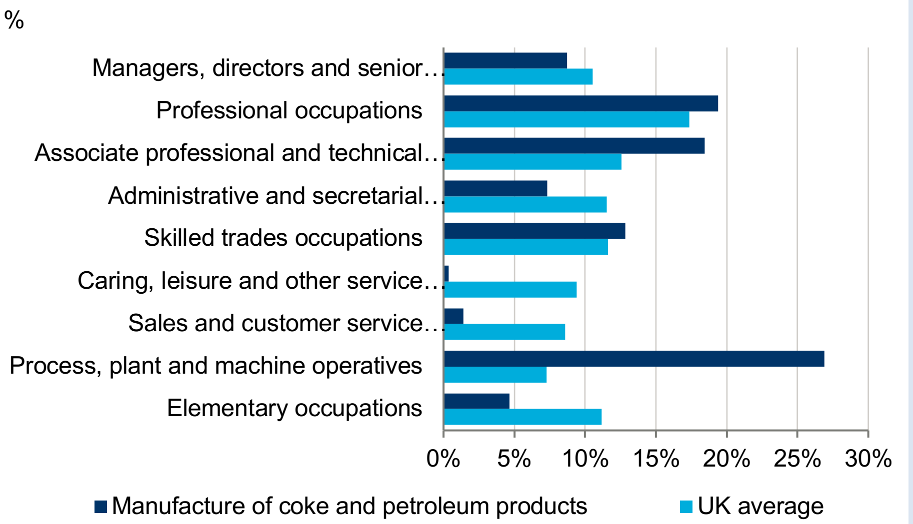
Source: Oxford Economics

Our modelling suggests that for each 100 workers employed at filling stations, £1.1 million of GVA and 18 jobs are supported as a result of their spending.

FOCUS: THE REFINING INDUSTRY WORKFORCE[49]

Refineries employ a diverse range of workers, including engineers, operations staff and maintenance operatives. These workers are supported by a large number of colleagues in support roles such as administration, HR, procurement and finance. Compared to the UK as a whole, the refining industry has a higher share of workers in high-skilled professional, associated professional and skilled trade roles. Around one-quarter of staff are employed in process plant and machine operative roles (Fig. 15).

Fig. 15. Share of workers in each occupational group, 2011

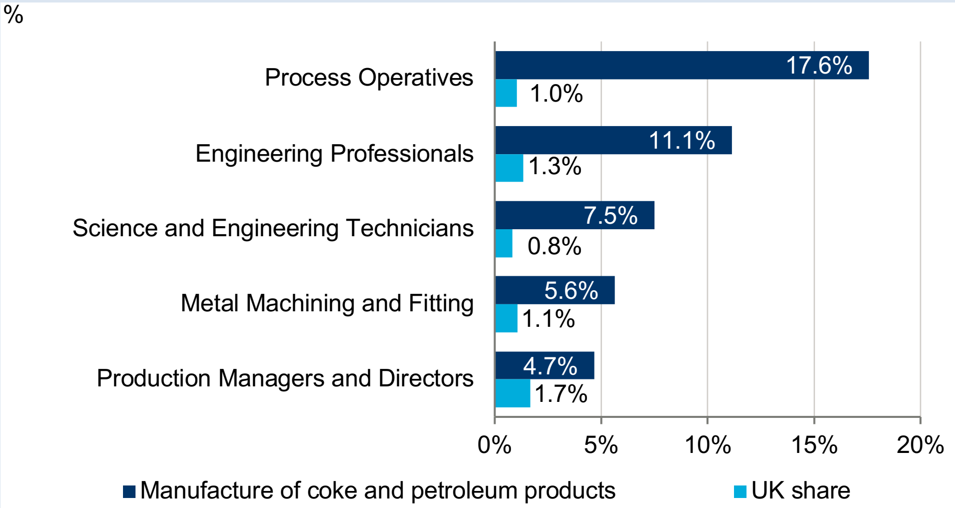


Source: ONS, 2011 Census

More detailed data suggest that more than 18 percent of the refining workforce comprises engineers or science and engineering technicians.

[49] The analysis in this box is only possible for aspects of the downstream sector that can be identified within standard ONS sector definitions. As such, our focus is on refining.

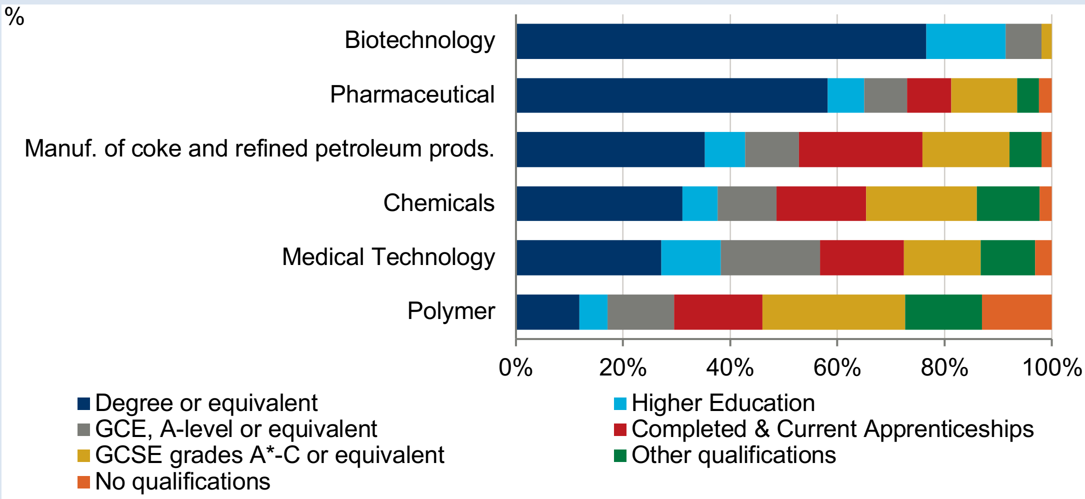
Fig. 16. Five most common occupations in the UK refining industry, 2011



Source: ONS, 2011 Census

The refining industry compares favourably to other science-intensive industries in terms of the qualifications of its workforce. Research by Cogent Skills identified that 35 percent of employees in refining were qualified to degree level. While this was a smaller proportion than in the biotechnology and pharmaceutical sectors, it was greater than in chemicals, medical technology or polymer sectors. Also notable in this analysis was that 23 percent of refining workers hold or are working towards apprenticeships, the highest proportion amongst all of the industries in the comparison.

Fig. 17. Highest qualification of workforce, 2014[50]



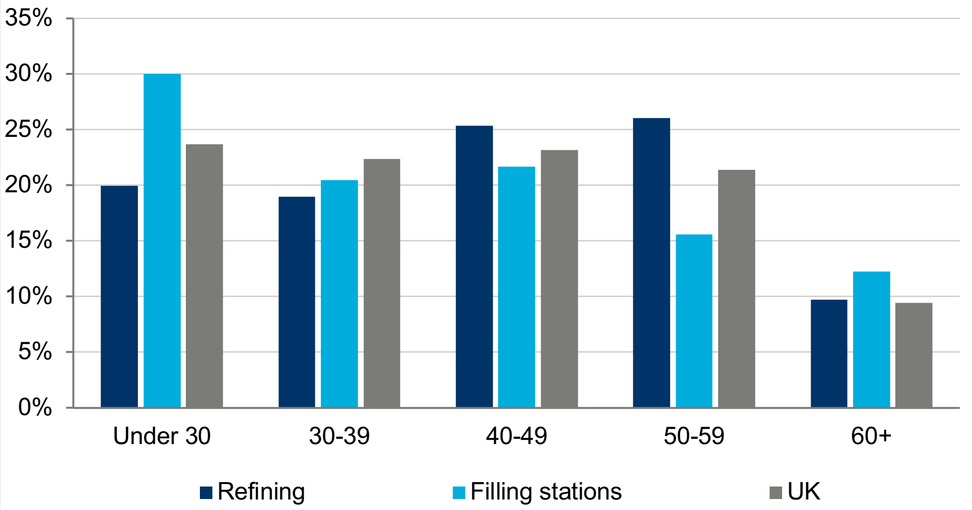
Source: Cogent Skills, based on ONS Labour Force Survey

Previous research has identified shortages of workers in roles such as control and instrumentation engineers, chemical engineers, petroleum product drivers and contractor staff.[51] The consultations for this study suggested a mixed picture across downstream companies. There tended to be agreement that it was harder to recruit engineering staff than those for commercial and marketing roles. But discussions with skills bodies suggested that this is reflective of the situation across different types of infrastructure, and was not necessarily unique to downstream.

Some stakeholders reported that it was becoming harder to find contractors when they were needed. Others suggested that the situation may be more nuanced, since it may be that the skills exist, but they are not available at the location and time required. There was also some uncertainty as to whether contractors from other EU countries may become less available as a result of the UK's departure from the EU. The Engineering Construction Industry Training Board is developing standardised tests based on industry standards to increase the transferability of skills across companies (and different engineering industries), with a view to increasing the mobility of the UK's engineering workforce.

Companies often reported good staff retention, with many staff having worked for the company for decades. The flip side of this, however, is that workforce ageing can become an issue. One company reported, for example, that it could lose one in five workers per over the next six years due to retirement, if all of its staff were to retire at their "official" retirement date. ONS Labour Force survey data confirm that compared to the economy as a whole, the refining sector tends to have a higher share of workers aged between 40 and 59, and a lower share of under-40s. In contrast, the petrol retailing sector has a relatively higher proportion of workers in the under 30 and 60-plus categories, potentially reflecting the opportunities for flexible and part-time working that it offers.

Fig. 18. Workforce age distribution in the downstream sector, 2016[52]



Source: ONS Labour Force Survey, Oxford Economics

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50 Science Industry Partnership, "The Demand for Skills in the UK Science Economy", 2016.

51 Unite the Union, "Wells to Wheels- Unite Strategy for the Oil Industry".

52 Based on Labour Force Survey data for January to December 2016. Refining is defined as SIC category 19, filling stations are defined as SIC category 4730. It is not possible to present results for other elements of the downstream sector which do not align with ONS SIC codes.

3. WHAT ACTIVITY DOES THE DOWNSTREAM OIL SECTOR ENABLE IN THE WIDER ECONOMY?

In the previous chapter we explored the economic value supported through the downstream sector's operations within the UK. The economic importance of the sector is, however, far greater than the value which stems from the sector's own activities. Companies within the downstream sector are responsible for the production and supply of fuels which are, today, essential to the operation of almost all sectors of the UK economy.

The most visible contribution of the downstream sector to other parts of the economy is its provision of transport fuels to power cars, HGVs, aircraft, ships and trains. However, the sector also makes a vital contribution in other areas, for example through its provision of heating fuels, construction materials, lubricants and the inputs used to create a range of chemicals, plastics, paints, solvents and other substances.

In this chapter we start by outlining how the sector's products are used in other sectors of the economy, and the economic importance of the industries which rely on them. We then consider the importance of a secure supply of fuels, and the potential consequences of disruption to these supplies.

3.1 WHAT ARE THE DOWNSTREAM SECTOR'S OUTPUTS AND HOW ARE THEY USED?

3.1.1 Overview of the UK's demand and supply for petroleum products

In 2016, oil and oil products accounted for 38 percent of the UK's energy needs.[53]

Firms in the downstream sector ensure the UK's fuel needs are met in two ways. Firstly, they produce refined petroleum products at oil refineries and other manufacturing facilities. Some of this production is sold on to the UK domestic market, and some of it is exported to overseas markets. Secondly, downstream companies import petroleum products from overseas, which are sold on the UK market alongside domestically-produced equivalents. The current combination of domestically produced and imported fuels enables downstream firms to supply road fuels to the UK market at amongst the lowest pre-tax prices in Europe.[54]

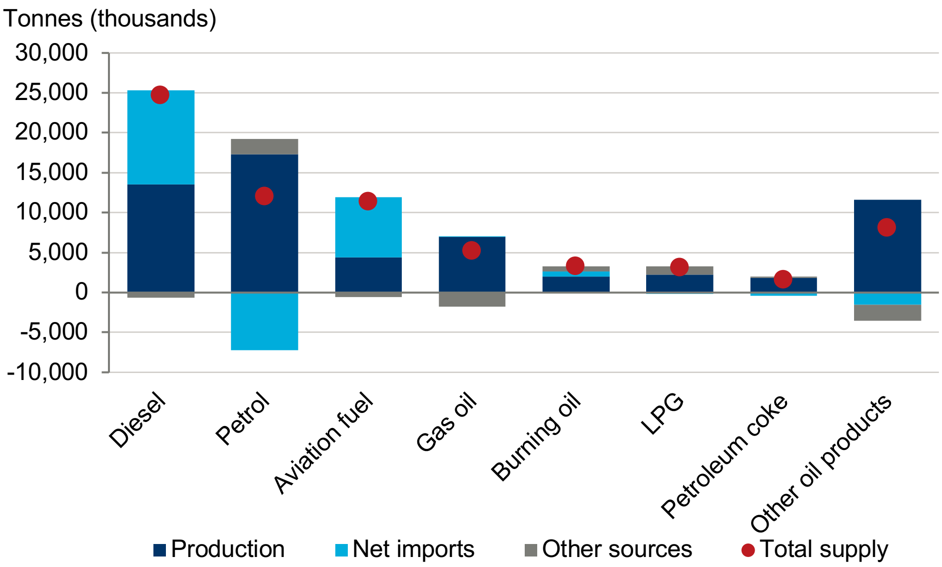
53 Share of oil and petroleum products in total primary energy demand in 2016, based on DUKES table 1.1

54 FuelsEurope, "Statistical report 2018", pages 38-39

Fig. 19 shows the main products produced and sold by the downstream sector, and the source of supply to the UK market. By far the most important product in volume terms is diesel fuel, of which the UK consumed almost 25 million tonnes in 2016. Nearly half of this demand was fulfilled through net imports (the difference between exports and imports). The UK used a similar quantity of petrol and aviation fuel—just over 11 million tonnes in each case. However, the UK has a strong reliance on imports for aviation fuel, but is a net exporter of petrol. This situation reflects that the UK's refineries were built primarily to meet demand for petrol, and have been less able to keep up with strong growth in demand for diesel and aviation fuel. Diesel demand has risen due to the increased popularity of more fuel-efficient diesel cars (although this now shows signs of reversing) and policy and tax incentives which have tended to favour diesel over petrol.[55] Strong growth in demand for aviation fuel is associated with the rapid expansion of the airline industry over the last two decades.

Burning oil (used mainly for heating) and gas oil (which includes fuel used to power boats and off-road machinery) together accounted for 12 percent of the total volume of oil products supplied to the UK market. A range of other products, including liquid petroleum gas (LPG), petroleum coke, bitumen, and various gases accounted for a further 18 percent of the products supplied.

Fig. 19. UK supply of petroleum products by source, 2016[56]



Source: Digest of UK Energy Statistics (DUKES table 3.3)

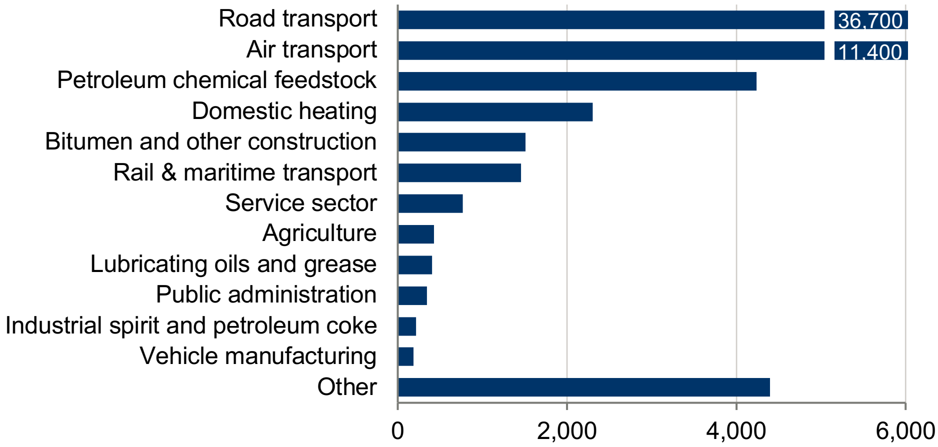
[55] Nick Vandervell, "Readdressing the balance between petrol and diesel demand", The RAC Foundation, 2015.

[56] "Other oil products" includes bitumen, fuel oils, lubricants, white spirit and SBP, aviation spirit, ethane, other gases, naptha and other products. "Other sources" includes sources of supply that do not represent "new" supply, e.g. recycled products or recovered fuels, plus marine bunkers, stock changes and transfers. The original source of these quantities will have been reported in an earlier accounting period or elsewhere in the current period. "Transfers" have two components: the reclassification of products within the refining process and the receipt of backflows of products from petrochemical plants that are often very closely integrated with refineries.

We can gain further insights into how the downstream oil sector's products are used from data on the sector of consumption (Fig. 20). This shows that more than three-quarters of fuels were used for transport purposes (road, air, rail and maritime). However, it also highlights the role of the downstream sector in other areas. For example, the third most important use of petroleum products is as petroleum chemical feedstocks, which accounted for seven percent of petroleum product usage in 2016. And four percent of petroleum products were used for domestic heating.

Fig. 20. Consumption of oil products by sector, 2016

Tonnes (thousands)



Source: Digest of UK Energy Statistics (DUKES 3.3)

In the following section, we outline the important role that oil products play in fuelling key sectors of the UK economy.

3.1.2 Transportation fuels

As shown above, the market for petroleum products is dominated by transport fuels. Transport is a crucial enabler of economic activity, and everyday life. For example, it enables manufacturers to obtain the components they need. It enables the distribution of products to retailers and consumers. It enables workers to travel to their place of work. It enables business people to travel to meetings, either within the UK or internationally. And it enables journeys for travel and leisure.

Statistics from the Department for Transport and other sources indicate the scale of transport usage in the UK in 2016:[57]

- A total of 324 billion miles were travelled by motor vehicles on the UK's roads, of which 253 billion were by car.[58]
- 1.89 billion tonnes of freight were moved by road, covering a total of 11.9 billion miles. The three most important commodities transported by road were food (17 percent of the total volume of goods moved), metal ore and mining and quarrying products (17 percent), and waste products (14 percent).[59]
- 134 million passengers[60] departed from UK airports on 1.1 million departing flights,[61] travelling an estimated total of 191 billion miles.[62] In addition, 1.1 million tonnes of freight were moved on aircraft departing from UK airports (including on domestic trips).[63]
- 138 million tonnes of freight were exported from UK ports, and 103 million tonnes were transported between UK ports.[64]
- There were 1.7 billion passenger journeys on the National Rail network, and those passengers travelled 40 billion miles.[65] Around 62 percent of energy consumption by the rail transport sector was met by petroleum products.[66]

Placing a value on all of these journeys is complex—we would expect any trip to be worth at least as much as the cost of that trip for the individual or business undertaking it, but we have no way of estimating by how much the value obtained may be greater than the costs incurred.

Nonetheless, we can gain insights into the importance of transport from published statistics. The chart below shows the contribution of transport-related sectors to GDP and employment. Together these sectors generated £35 billion of gross value added (GVA) and sustained 732,000 jobs in 2016. This is equivalent to 1.8 percent of total UK GVA and 2.1 percent of employment in that year.

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57 Department for Transport, "Transport Statistics Great Britain", 2017 Edition

58 Department for Transport, "Transport Statistics Great Britain", 2017 Edition

59 Department for Transport, "Transport Statistics Great Britain", 2017 Edition

60 Source: Oxford Economics calculations based on CAA data

61 Source: Oxford Economics analysis of DIIO data

62 Source: Oxford Economics calculations based on DIIO data

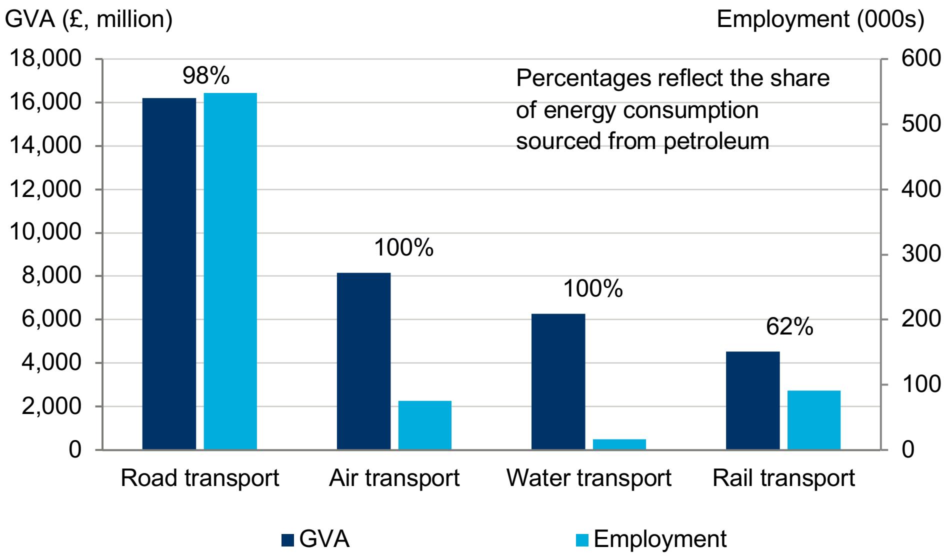
63 CAA Airport Data 2016 <https://www.caa.co.uk/Data-and-analysis/UK-aviation-market/Airports/Datasets/UK-Airport-data/Airport-data-2016/>Table 13 and Table 14. [Accessed 07 Nov 2018]

64 Department for Transport, "Transport Statistics Great Britain", 2017 Edition

65 Department for Transport Rail usage, infrastructure and performance statistics Table TSGB0601 (RAI0101). Figures relate to 2015-16

66 DUKES table 1.1.5

Fig. 21. The economic contribution of transport-related industries, 2016[67]



Source: Oxford Economics, ONS and ABS

> All business sectors rely to some degree on refined petroleum products, likely reflecting that road transport is of vital importance to almost all economic activity.

While transport-related sectors account for substantial amounts of economic activity in their own right, the GVA and employment contribution of these sectors does not fully reflect the importance of transport to businesses across the economy. This is because activity in the sectors shown only reflects transport provided by a dedicated provider. This may be a reasonably accurate guide to the economy's spending on aviation and rail, for example, but it does not reflect spending on transport that firms in other sectors provide in-house using their own fleets of vehicles.

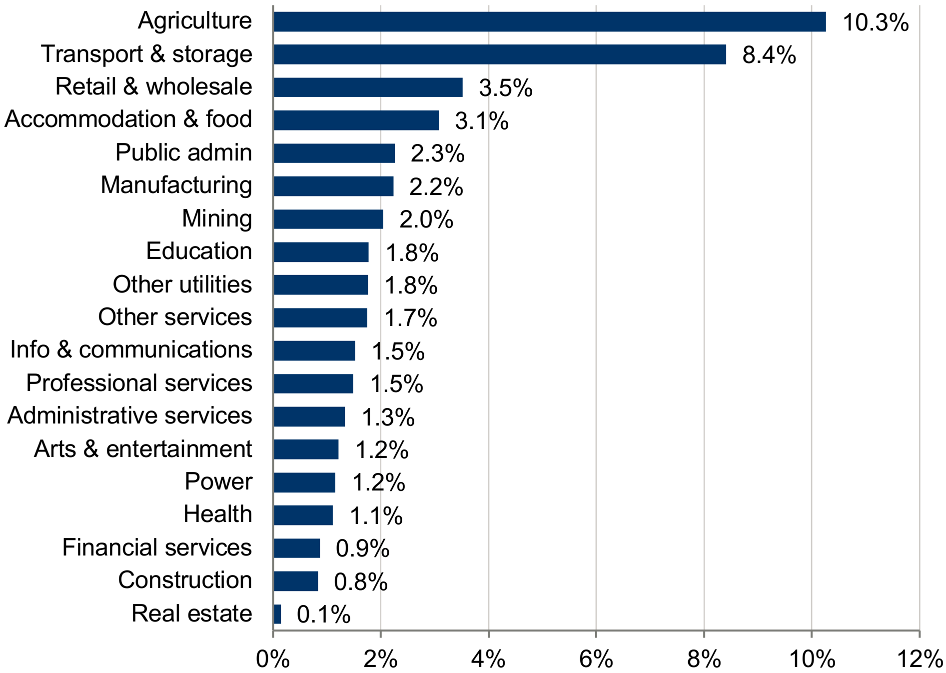
We can get some sense of this by referring to UK "supply-use" tables, which indicate how much businesses in different sectors of the economy spend on different types of inputs, including refined petroleum products.[68] This suggests that spending on refined petroleum products accounts for an average of 2.2 percent of input costs. However, this proportion is notably higher for the agriculture and transport and storage.

Perhaps the most striking feature of this analysis, however, is the extent to which all business sectors have some degree of reliance on refined petroleum products, likely reflecting that road transport is of vital importance to almost all economic activity.

[67] The share of energy consumption sourced from petroleum, bioenergy and waste is 100% for road transport. GVA and employment for road transport include SIC categories 49.4 (freight transport by road and removal), 49.32 (taxi operation) and 49.39 (other passenger land transport).

[68] It is not possible to identify purchases of different types of refined petroleum products within input-output tables. Our intention here is to demonstrate that all sectors have some degree of reliance on oil-based fuels. In most cases it would seem reasonable to assume that this is likely to reflect transport-related uses.

Fig. 22. Proportion of input costs relating to coke and refined petroleum products, 2016[69]



Source: ONS Supply-use tables

3.1.3 Petrochemicals

The chemicals sector is a high-value manufacturing industry with a strong reliance on the outputs of the downstream oil sector. The chemicals industry produces a wide range of materials which are used in a whole host of products. Just a few examples include building components, carpets, consumer electronics, clothing, cosmetics, detergents, fabrics, fertilisers, packaging, paint, pharmaceuticals, plastics, toys, tyres, and other vehicle components.

Seven percent, or 4.2 million tonnes, of oil products consumed in the UK are used as inputs (or “feedstocks”) in petrochemicals plants.[70] Many of these feedstocks are produced in conjunction with the production of transport and other fuels.[71] Chemicals plants are often located close to oil refineries, co-located on the same site or connected to them by pipeline. In consultations stakeholders suggested that the direct linkages between refineries and chemicals plants represent a source of competitive advantage for the UK chemicals industry, since they reduce transport costs and create the potential for sharing utilities such as heat, steam and power.

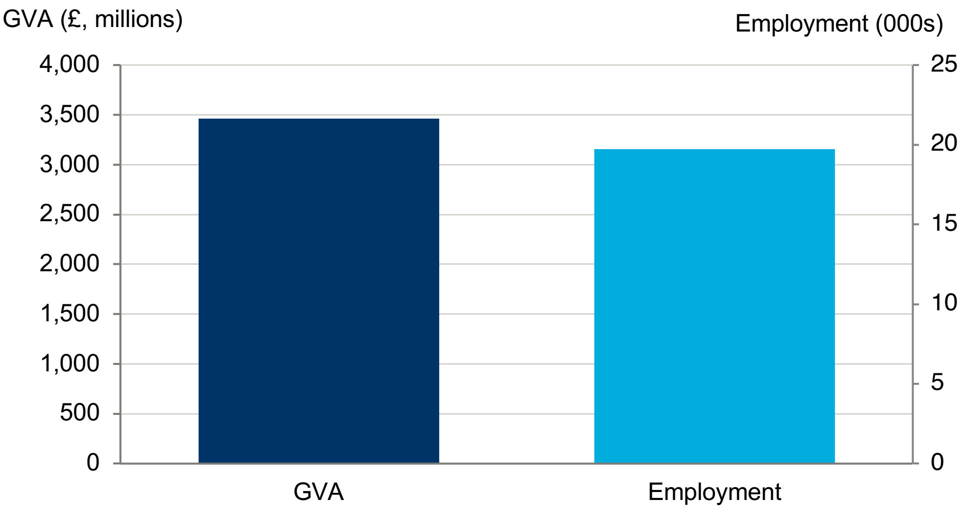
In 2016, the petrochemicals industry directly supported a GDP contribution of almost £3.5 billion, and employed 19,700 workers (see Fig. 23). Most of these workers were employed in activities relating to the manufacture of organic basic chemicals and plastics in primary forms.

[69] The manufacture of chemicals is included in manufacturing.

[70] Source: DUKES table 3.3

[71] OECD/IEA, “The future of petrochemicals: towards more sustainable plastics and fertilisers”, 2018, page 37

Fig. 23. The economic contribution of the petrochemicals industry, 2016[72]



Source: Oxford Economics, ONS and BRES

THE ROLE OF PLASTICS IN SUSTAINABILITY

The feedstocks produced by the downstream oil sector enable petrochemicals companies to produce a range of substances which are, in turn, used in goods which are ubiquitous in everyday life. There is, however, increasing awareness of the environmental impacts of the products produced by the petrochemicals industry. These impacts include the contribution to urban air pollution of substances such as adhesives, paints and pesticides; the greenhouse gas emissions associated with chemicals production and the use of fertilisers; and issues related to the processing and disposal of waste plastic products.

Nonetheless, as highlighted by the IEA, plastics have an important role to play in supporting energy efficiency and sustainability across a range of contexts.[73] These include:

- Plastic-based materials can enable the production of longer and more durable blades for **wind turbines**, in turn enabling the more efficient generation of electricity. Plastics are also used to produce **solar panels**.
- Most synthetic **insulation materials** used in buildings are based on plastics. Plastics can also be used to produce **reflective roof coatings** which help cool buildings in warm climates.
- Plastic-based products, as well as high-strength steel and aluminium, are increasingly used to **reduce vehicle weight** and increase fuel economy. The US Department of Energy estimates that a 10 percent reduction in vehicle weight can improve fuel economy by six to eight percent.[74] The need to reduce weight is particularly important in the context of electric vehicles, in order to increase driving range. The IEA suggests that increasing take up of electric vehicles could lead to greater use of plastics and plastic-based materials in the years ahead.

[72] Consistent with the approach taken by ONS, the petrochemicals sector is defined to include the manufacture of other organic basic chemicals, plastics in primary forms, synthetic rubber in primary forms and man-made fibres.
[73] OECD/IEA, "The future of petrochemicals: towards more sustainable plastics and fertilisers", 2018, Chapter 3
[74] https://www.energy.gov/eere/vehicles/lightweight-materials-cars-and-trucks [accessed 14 December 2018]

The importance of plastic components in cars[75]

PlasticsEurope suggest that plastics account for 12 to 15 percent of the materials used in a modern car weighing 1,500 kg. More than 2,000 individual parts may be made from plastic. Just a few examples include:

Air intake manifold	Cupholders	Headrests
Airbags	Dashboard	Mirror frames
Ashtray	Door covers	Seat belts
Bumper	Door handles	Seats
Buttons	Engine components	Tyres
Child seats	Fuel tank	Wash fluid tank
Clips	Headlamps	Windscreen

3.1.4 Home heating and LPG

BEIS estimates that in 2016, around 3.7 million homes in Great Britain were not connected to the mains gas network (14 percent of households).[76] In Northern Ireland, the proportion of homes not connected to mains gas is considerably greater, reflecting that mains gas networks were developed relatively recently.[77]

Many off-grid households rely on heating oil and liquid petroleum gas (LPG) as their primary source of heating.[78] Other types of buildings can also rely on these sources of fuel, such as pubs, hotels, schools and care homes.

LPG also has a range of other uses, including as an alternative automotive fuel, in the catering industry to fuel mobile kitchens and food trucks, and in the leisure sector to power cooking devices in caravans, motorhomes, boats, and so on. It is also increasingly used for "non-road mobile machinery" such as forklift trucks. LPG on the market in the UK is either produced at UK oil refineries or imported. The UK has three major LPG storage facilities to ensure a secure supply and support peak demand during the winter months.

[75] Based on information presented by PlasticsEurope in "Automotive—The world moves with plastics", 2013. Share of plastics materials based on data from Association Française de Mécanique (AFM)

[76] BEIS, "Sub-national estimates of households not connected to the gas network 2016"

[77]Office of Fair Trading, "Off-Grid Energy, An OFT market study" 2011, p.14.

[78] The government has recently run a consultation to explore how to reduce the reliance on high carbon fuels for heating buildings away from the gas grid— https://www.gov.uk/government/consultations/a-future-framework-for-heat-in-buildings-call-for-evidence . Amongst the alternative energy sources considered are biofuels, which are discussed in Section 4 of this report.

3.1.5 Other downstream products

Besides oil products in transportation and inputs to the chemicals industry, the downstream sector's outputs fulfil a wide range of other important uses.

DUKES data published by BEIS suggest that the UK downstream oil sector produces 350,000 tonnes of lubricants each year, of which 320,000 tonnes are exported. A further 395,000 tonnes are imported and used in a wide range of machinery and vehicles domestically. However, the DUKES figures do not include production by up to 100 independent lubricant manufacturers. Separate analysis by the Union of the European Lubricants Industry (UEIL), who represent independent lubricant companies, suggest that more than 550,000 tonnes of lubricants were sold on the UK market in 2016.[79] Of this total, UEIL estimates that around half of products were used in automotive engines and half for industrial uses.

Other key petroleum products produced by the downstream oil sector include:

- Bitumen, which is used in the construction industry as a binder in the asphalt used to surface roads and footpaths. It also has good waterproofing qualities, making it suitable for use in roofing, as well as sealing and insulating.
- Petroleum coke, which is used as an electrode when smelting steel and aluminium.[80]

3.2 REGIONAL RELIANCE ON THE DOWNSTREAM SECTOR

As we saw in Section 3.1.2, just under two percent of firms input costs relate to purchases of coke and refined petroleum products, although the proportion can be much greater in certain transport-intensive sectors.

We can use similar underlying data sets to explore the extent to which the regional economies of the UK may be dependent on refined petroleum products. To do this we start by looking at the industrial sectors which make up the economy of each region. Under the assumption that each sector has a similar degree of reliance on refined petroleum products, wherever it is in the UK, we can estimate the value of refined petroleum products purchased as intermediate inputs by the businesses in each region.[81]

As indicated by the lighter blue markers in Fig. 24, this analysis suggests a fairly consistent degree of reliance on refined petroleum products across regions, ranging from 2.0 percent in London to 2.7 percent in Yorkshire and the Humber. So once again, we observe a consistent reliance on refined petroleum products across all regions of the UK.

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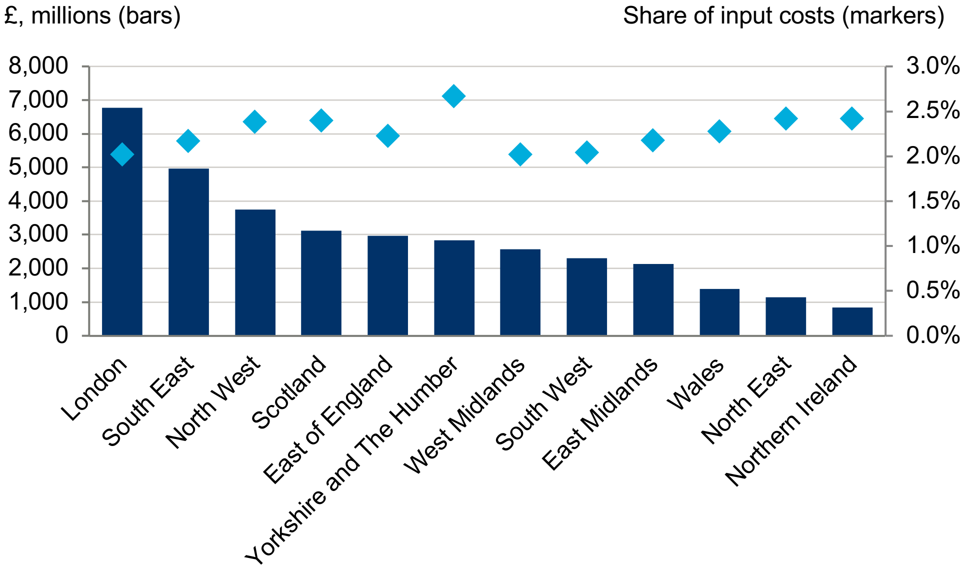
79 UEIL Industry Statistics

80 https://www.phillips66.co.uk/EN/about/refining_ops/Pages/index.aspx

81 We estimated a weighted average of the share of refined petroleum products in each region's intermediate purchases, using SIC2 GVA as weights.

We can also apply these proportions to the total value of business input costs in each region to obtain an estimate of the value of refined petroleum product purchases by region (shown by the bars in Fig. 24). This suggests that while refined petroleum is a smaller share of costs for firms in London, this effect is more than outweighed by the fact that the London economy is much larger than those elsewhere in the UK. Based on the ONS supply-use tables, we estimate that businesses in London purchased £6.8 billion of refined petroleum products in 2016. In contrast, firms in Northern Ireland are estimated to have spent £850 million on refined petroleum products.

Fig. 24. Estimated proportion of input costs relating to coke and refined petroleum products, by region, 2016



Source: Oxford Economics analysis of ONS Supply-Use Tables

3.3 THE BALANCE BETWEEN DOMESTIC PRODUCTION AND IMPORTS

The discussion above highlighted the vital role that refined petroleum products play in a wide range of contexts to enable people to go about their daily lives and to support the smooth functioning of the economy. In light of this an important function of downstream companies is to not only produce and distribute oil products, but to also *ensure the security of supply*. This means that a high degree of resilience needs to be built into the downstream companies' processes and distribution networks so that they can continue to supply fuels, even during times of disruption.

To ensure a secure supply of fuels the UK both sustains its own refining and production capabilities and imports products from the global market. The UK's ability to produce oil products domestically means that the country can have better control in the event of global shortages or disruptions. The government has also identified a number of other advantages of having a UK refining industry to support the UK's supply resilience.[82] For example, the UK's oil infrastructure enables it to import either crude oil or finished products, giving it the flexibility to respond to shortages of different products if supplies are disrupted, while the storage facilities located at refineries gives the UK the ability to hold greater stocks of oil products for use if they are needed. Producing refined oil products in the UK means that supply chains are short and simpler, reducing the risk that the UK will be impacted by events which occur elsewhere in a complex global supply chain.

The importance of UK refining capacity to security of supply was highlighted in work by Deloitte for DECC, which investigated the resilience of UK fuel supplies to "black swan" disruptions.[83] This found that the supply of fuels to the UK was not likely to be disrupted by significant international disruptions, providing that international trade in crude oil and petroleum products was not disrupted. If international trade were disrupted, on the other hand, then there would be a risk of disruption to UK fuel supplies. In such cases, it may be possible to divert domestic production that would previously have been exported to serve the UK market. Deloitte's analysis suggested that reductions in the UK's refining capacity could reduce the UK's ability to respond in this way, and thereby increase the extent of disruption to UK fuel supplies.

For these kinds of reasons, few large countries choose to entirely rely on imports to meet their demand for oil products. Industry stakeholders also suggested in consultations that imported fuels can be more expensive due to transportation costs, or may have been produced in countries with less stringent quality control or environmental standards. Moreover, if the UK did not produce certain types of fuel itself, it could find itself reliant on supplies from regions of the world which may be subject to geopolitical disruptions. For example, increasing the UK's share of imported diesel could result in an increased reliance on Russia and the Middle East for supplies.

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[82] Department of Energy and Climate Change, "Review of the refining and fuel import sectors in the UK", 2014

[83] Deloitte LLP, "Assessing the impact of reduced UK refining capacity on the resilience of UK fuel supplies to 'black swan' disruptions", report for DECC, 2015

Nonetheless, imports do constitute an important source of supply for the UK market, particularly for diesel and jet fuel. Imports enable UK suppliers to respond rapidly to domestic disruptions; to tie up less capital in production infrastructure; and to source products from a range of overseas markets.[84]

BEIS presents analysis based on IEA data which assesses the security of supply of oil products across OECD countries. This shows that the UK has a high degree of self-sufficiency for crude oil and petrol, but is far more reliant on imports for diesel and jet fuel. Nonetheless, the UK has taken steps to diversify its sources of import supply, and seeks to import from politically stable countries where possible. As such, it achieves very high rankings for the diversity and political stability of supply in the BEIS analysis. In the case of jet fuel, the UK achieved the highest ranking amongst OECD countries for import diversity and stability, while it was also in the top five for petrol and diesel.

The combination of self-sufficiency and diversity/political stability of supply provides an overall security of supply score. This suggests that the UK has a high security of supply of crude oil and ranks within the top half of OECD countries for petrol and jet fuel. For diesel the UK falls just below half way in the ranking.

Fig. 25. UK security of supply, 2016[85]

Indicator	Crude oil	Petrol	Diesel	Jet fuel
Self-sufficient (% of demand that could be met through indigenous production)	83	138	54	39
Self-sufficiency rank (number of OECD countries reported)	5 (30)	14 (35)	22 (34)	24 (35)
Diversity and political stability rank (number of OECD countries reported)	16 (29)	2 (31)	4 (33)	1 (28)
Security of supply rank (number of OECD countries reported)	6 (30)	12 (34)	18 (34)	10 (34)

Source: BEIS analysis, based on IEA data

3.4 THE CONSEQUENCES OF DISRUPTION

One way of considering the importance of a reliable supply of oil products is to look at the consequences of disruption. For example, if there were a disruption to liquid fuel supplies, food could not be delivered to supermarkets; parts and raw materials could not be distributed to manufacturers; and individuals may not be able to travel to work. In the case of heating oil and LPG, supply disruptions could have even more severe consequences if they were to prevent people from heating their homes during colder months of the year.

Disruption is always a possibility, however, and can come from a number of sources. For example, both imports and domestic production can be affected by adverse weather, operational issues or industrial action, while imports might

84 Department of Energy and Climate Change, "Review of the refining and fuel import sectors in the UK", 2014

85 BEIS, "Diversity of supply for oil products in OECD countries in 2016"

also be affected by geopolitical factors. Accidents or cyber-attacks also pose a risk to the efficient operation of the sector.

> If there were a disruption to liquid fuel supplies, food could not be delivered, parts and raw materials could not be distributed, and people could not travel to work.

Relatively little work has been undertaken to estimate the economy-wide costs of disruption. However, the government has recently analysed this as part of its work on fuel resilience measures.[86] This study assessed the impact of disruption to a refinery or large terminal, and to a smaller terminal or jetty. There is inevitably a high degree of uncertainty within such analysis, and it relies on a large number of assumptions. Nonetheless, based on an analysis of the oil intensity of economic output, and assuming that this cannot be adjusted in the very short term, the analysis estimates that a three-day disruption to a refinery could cost the economy between £100 million and £500 million. This rises to £350 million to £1.6 billion for a 10-day disruption.

Industry representatives point out that these estimates reflect the costs were supply to stop entirely, and that they have measures in place to prevent such disruption from arising in the event of a major piece of infrastructure falling out of operation. The government's indicative analysis does, nonetheless, provide a sense of the extent of economic activities which could be impacted in the event of serious disruption.

Fig. 26. Government estimates of the economic impact of supply disruption, £m in 2015 prices

(£M)	3 day disruption	6 day disruption	10 day disruption
Refinery or large terminal	100-500	200-950	350-1600
Smaller terminal or jetty	50-200	100-450	150-750

Source: BEIS

[86] BEIS, "Government Response to Consultation on Fuel Resilience Measures", 2018

4. THE ROLE OF DOWNSTREAM COMPANIES IN THE ENERGY TRANSITION

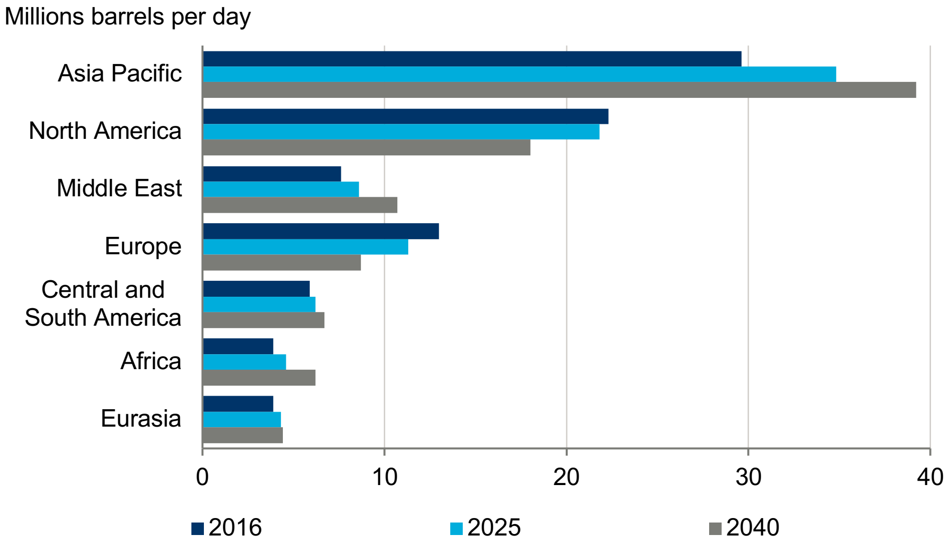
4.1 THE DECARBONISATION CHALLENGE

4.1.1 Ambitions and challenges

In 2015 195 countries signed up to the Paris Agreement committing them to take action to reduce emissions, with the aim of keeping the global average temperature rise to well below two degrees, and to take steps to aim to limit rises to no more than 1.5 degrees. It also included a goal of net zero greenhouse gas emissions in the second half of this century.

To achieve these goals, countries have recognised the need to shift energy production away from fossil fuels and towards low carbon energy sources, such as natural gas and renewables. Nonetheless, the International Energy Agency expects global oil demand to rise by nine percent from 2016 to 2040 (see Fig. 27), largely as a result of demand from faster growing economies in Asia Pacific. In contrast, oil demand is expected to fall in North America and Europe.

Fig. 27. World oil demand by region under the IEA "New Policies" scenario[87]



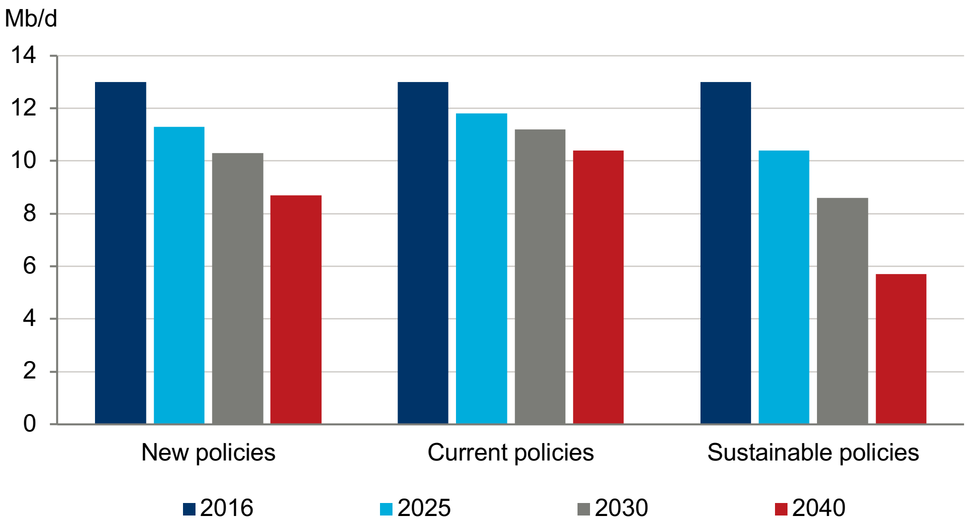
Source: IEA World Energy Outlook 2017

[87] The "New Policies" scenario is the IEA's baseline scenario. It incorporates policies already in place and those officially announced to be implemented in the future.

There is inevitably a high degree of uncertainty when forecasting over such a long time period. In addition to the uncertain evolution of oil prices, the pace of decarbonisation will be influenced by the speed at which new technologies can be developed and rolled out, and on government policies to encourage the use of low carbon technologies and develop supporting infrastructure.

Fig. 28, below, shows the IEA's forecasts for oil demand in Europe under alternative scenarios. These forecasts suggest that oil demand will fall between 2016 and 2040 under all three scenarios, but the rate of reduction ranges from 20 percent in the "current policies" scenario (which is based only on those policies which are already in place) to 56 percent in the "sustainable policies" scenario (which models the impact of introducing the sustainability policies needed to meet international objectives).

Fig. 28. Oil demand across Europe 2016-2040 under different policy scenarios



Source: IEA, World Energy Outlook 2017

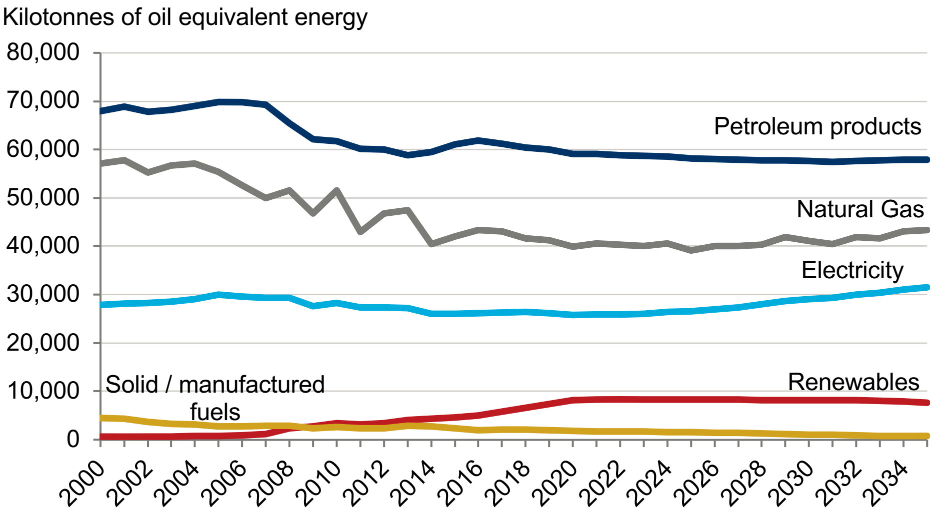
The UK is seeking to fulfil its obligations under the Paris Agreement through the UK Climate Change Act, which aims for an 80 percent reduction in greenhouse gas emissions by 2050, compared to 1990 levels.

In 2017 the government published its "Clean Growth Strategy" which sets out proposals for decarbonising the economy through the 2020s whilst also maintaining economic growth.[88] And in 2018 the government set out its ambitions for a cleaner road transport sector in its Road to Zero strategy.[89] Amongst other measures, this document confirms that the sale of all new conventional petrol and diesel cars and vans will end by 2040, and sets an ambition to remove most petrol and diesel cars from UK roads by 2050.

[88] HM Government, "The clean growth strategy, leading the way to a low carbon future", 2017
[89] Department for Transport, "The road to zero", 2018

Nonetheless, achieving carbon reduction objectives is likely to be challenging. The UK government's projections[90] suggest that up to 2035, petroleum products will remain the largest source of final energy consumption, providing 58 million tonnes of oil equivalent energy in 2035 (see Fig. 29).[91] This represents a decline of 4.1 percent compared to 2018. Within this overall trend, consumption of petroleum products used for road transport are projected to decline by 13 percent, but the impact of this will be significantly offset by a 23 percent increase in consumption of aviation fuel.

Fig. 29. Final energy consumption by source, 2000 to 2035



Source: BEIS, Energy and emissions projections 2017 (Reference Scenario)

The same projections predict a gradual increase in the economy's reliance on electricity, but this will remain less than the consumption of natural gas, and substantially below that for petroleum products.

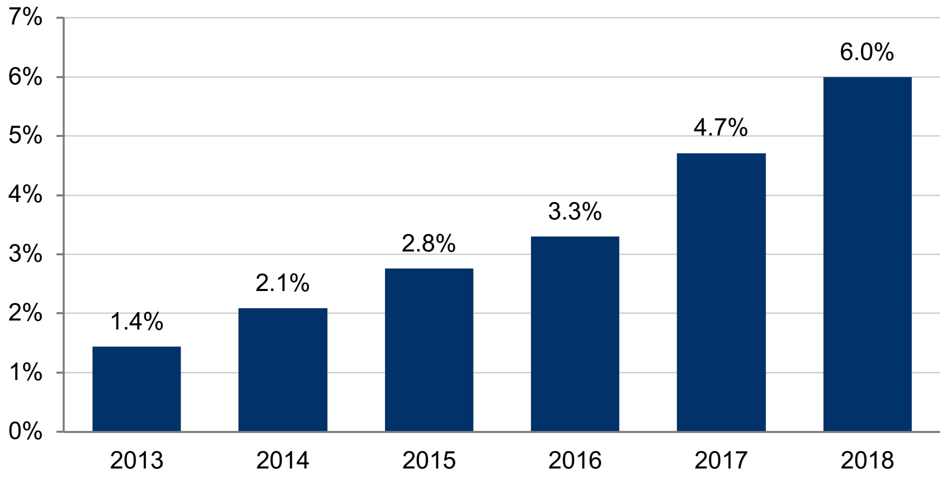
The flow of new electric and hybrid vehicles registered in the UK has increased from 1.3 percent in 2013 to six percent in 2018 (see Fig. 30). This was supported by the Plug-In Car Grant, in place between 2011 and 2018, which provided financial assistance to purchasers of electric and plug-in hybrid vehicles.

[90] Projection reflects BEIS' "Reference scenario". This is based on central estimates of economic growth and fossil fuel prices. It contains all agreed policies where decisions on policy design are sufficiently advanced to allow robust estimates of impact (i.e. it includes "planned" policies).

[91] Last year of forecast.

Fig. 30. New electric and hybrid vehicle registrations[92]

Proportion of new vehicle registrations that are for electric/hybrid vehicles



Source: Society of Motor Manufacturers and Traders (SMMT)

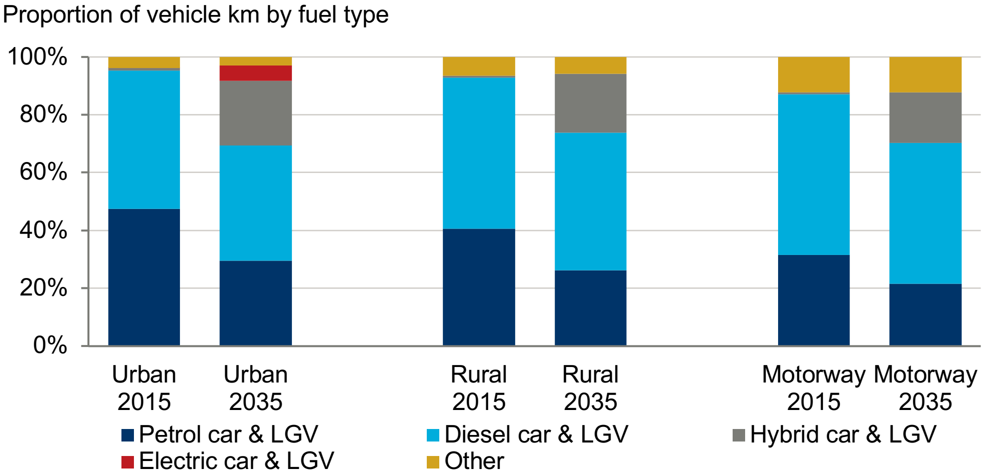
Yet while interest in electric and hybrid vehicles is increasing steadily, they remain a relatively small proportion of new car sales, and the overall *stock* of low-emission vehicles will change only gradually. In 2017, 98.5 percent of licensed cars were still powered by petrol or diesel.[93]

As such, forecasts produced for BEIS predict that that by 2035 only five percent of the distance travelled on urban roads (excluding London) could be in electrically-powered vehicles (see Fig. 31). Hybrid vehicles are, nonetheless, expected to account for between 18 and 22 percent of the distance travelled, depending on the type of road.

92 2018 data covers the period January - September

93 https://www.gov.uk/government/statistical-data-sets/veh02-licensed-cars, table VEH0203 <accessed 7 December 2018>

Fig. 31. Distance travelled by vehicles by fuel type in England (excluding London)



Note: diesel car & LGV includes diesel LGV hybrids
Source: NAEI UK Fleet Composition Projections, December 2017

A further factor which is likely to sustain demand for oil products is that current and expected future technologies do not permit heavier vehicles, such as HGVs, to be powered by electricity. Indeed, analysis by Fuels Europe suggests that battery technology will need to achieve a weight reduction of at least 10 fold to become a viable source of power in vehicles larger than passenger cars and light commercial vehicles.[94] Reducing the reliance of aviation and maritime transport on oil-based fuels also presents significant challenges.

Away from transport, the petrochemicals industry will continue to rely on refined oil products for use as inputs. The IEA suggests that strong growth in demand for chemical products could see oil demand for use as chemical feedstocks increase by approximately 50 percent between 2017 and 2050, to reach almost 18 million barrels per day. The IEA estimates this to be almost half of all growth in oil demand over this period, and raises feedstock's share of global oil demand from 12 percent in 2017 to 16 percent in 2050.[95] This trend is expected to be driven by the Middle East and China. In contrast, petrochemical feedstock demand is expected to fall in advanced European and Asian economies, although less quickly than demand from other oil consuming sectors, such that chemical feedstocks could account for 21 percent of oil demand in the EU in 2050, up from approximately 15 percent in 2017. Forecasts from BP and ExxonMobil also suggest that the global demand for petroleum products for use as chemical feedstocks will grow strongly over the coming decades.[96]

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[94] FuelsEurope, "Vision 2050- A pathway for the Evolution of the Refining Industry and Liquid Fuels", 2018, p.6.
[95] OECD / IEA, "The future of petrochemicals: towards more sustainable plastics and fertilisers", 2018, p.79-81. These results are based on the "Reference Technology Scenario", which projects forward the current trajectory based on existing and announced policies. It is effectively the baseline scenario used in this report.
[96] ExxonMobil, "2018 outlook for energy: a view to 2040"; BP, "Energy outlook 2018 edition".

4.1.2 The role of downstream companies in the energy transition

The challenges outlined above mean that the UK downstream oil sector's products are likely to continue to play a significant role in fuelling the UK economy for the foreseeable future. Downstream companies therefore have a vital role to play within the energy transition. They have already taken a number of actions to contribute to this process and they continue to seek new and innovative ways of reducing carbon emissions. These actions fall within four categories:

(1) Making operations more efficient
(2) Reducing environmental impacts
(3) Developing new, cleaner fuels
(4) Diversifying into new products and services.

In the following sections we explore what downstream companies are doing in each of these areas, drawing on examples from both the UK and overseas.

4.2 MAKING OPERATIONS MORE EFFICIENT

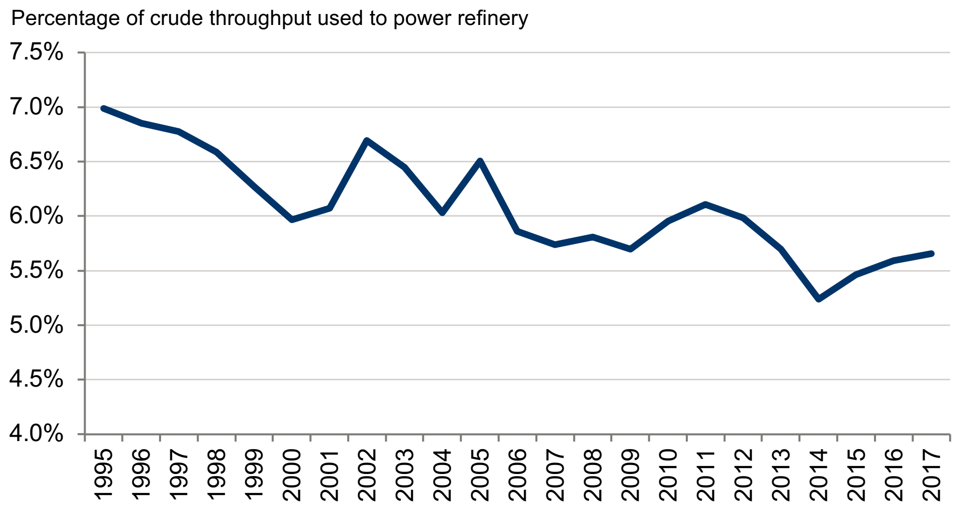
The first element of downstream companies' evolution towards a low carbon future revolves around the efficiency of their own activities.

4.2.1 Progress to date

Refineries operate in a competitive global market and typically face low margins. Given that energy can be one of a refinery's largest operating costs (aside from crude oil), there is a compelling economic case for refineries to reduce their energy consumption to reduce their running costs and maintain competitiveness.

A headline measure of the efficiency of oil refineries can be estimated as the fuel needed to power the refinery, as a share of total crude oil throughput. This ratio declined from around seven percent in 1995 to 5.7 percent in 2017, equivalent to a 19 percent increase in refinery energy efficiency.

Fig. 32. Refinery energy efficiency, 1995 to 2017



Source: DUKES table 3.12

4.2.2 Current and future initiatives

Refineries continue to seek ways of making their operations as efficient as possible. FuelsEurope notes that refineries may implement formal "Energy Management Systems" which comprise equipment to more effectively measure and control energy use, and management initiatives to embed energy efficiency into strategic planning and organisational culture to support the identification of future energy efficiency upgrades.[97]

Five out of the six major UK refineries have installed energy efficient "combined heat and power" plants, which re-use waste heat and reduce reliance on the main electricity grid (and sometimes export surplus electricity back to the grid). The sixth refinery has committed to install CHP in 2019.

Refineries can also seek integration with other industries such as petrochemicals. This can create opportunities for further efficiencies through a reduced need to transport refined petroleum products to their point of use in the petrochemical manufacturing process, and through the development of shared utilities to make more efficient use of heat, steam and power.[98]

Within the UK, Esso's Fawley site generates its own power from natural gas using two energy-efficient combined heat and power (CHP) plants.[99] This arrangement enables surplus heat to be used in the production process, and the company is also able to export surplus electricity to the grid. Fawley is also an example of an oil refinery which is closely integrated with an adjoining petrochemicals facility, which the company suggests enables it to realise efficiencies in its operations. Valero is planning to develop a £127 million combined heat and power (CHP) plant at its Pembroke refinery.[100] This is expected to increase the efficiency of the refinery, and reduce its reliance on electricity from the national grid.

Initiatives to reduce energy usage are also underway elsewhere in the downstream sector. For example, BP worked with U Energy Solar to install solar panels on the roofs of filling stations in North West England.[101] The large roof area of filling stations and their day-long need for electricity mean that they can be well-suited to solar energy. U Energy Solar report that installations across three filling of the filling stations fitted with solar panels have a payback period of four-to-five years. Total has also been building solar panels on to the roofs of its service stations and industrial plants around the world since 2016.[102]

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97 FuelsEurope, "Vision 2050- A pathway for the Evolution of the Refining Industry and Liquid Fuels", 2018, p.32.

98 Fuels Europe, "Vision 2050- A pathway for the Evolution of the Refining Industry and Liquid Fuels", 2018, p.32.

99 https://www.exxonmobil.co.uk/en-gb/company/uk-operations/refining-and-marketing/fawley-refinery

100 https://www.bbc.co.uk/news/uk-wales-43242768, http://www.pembroke-refinery-cogen.co.uk/

101 http://www.uenergysolar.co.uk/

102 https://www.solar.total.com/en/our-success-stories/rooftops-and-facades

INITIATIVES TO DEVELOP THE SECTOR'S SKILLS BASE[103]

As discussed in Section 2, downstream companies can face challenges in recruiting the workers they need. This has led major downstream firms to engage in a range of initiatives to train their workforces, and to increase young people's interest in Science Technology Engineering and Maths (STEM) subjects. In this section, we present a number of examples of steps firms in the downstream sector are taking in this area.

Apprenticeships

Many downstream employers have developed apprenticeship programmes to build the skills and knowledge of younger workers joining the sector, particularly in roles at refineries and storage facilities. Certain companies also encourage contractors to hire apprentices, further leveraging their impact on the local workforce.

Valero Pembroke Refinery's apprenticeship programme has been in operation since 2005, offering apprenticeships in operations and maintenance.[104] Valero currently has 52 apprentice employees, all following a nationally recognised qualification route, and a total of 164 apprentices have been recruited since 2005. Valero provides equipment, support and opportunities to develop skills whilst working on refinery equipment. Valero works in tandem with contractor apprenticeship schemes, giving contractor apprentices identical opportunities to Valero apprentices.

The Phillips 66 Humber refinery has recruited eight apprentices per year since 2009. Participants are typically 16-18 year-old school leavers and there are currently 25 apprentices involved in the company's four-year programme. 95 percent of apprentices follow the scheme through to completion. The company reports that the apprenticeship scheme has generated benefits for its business: 65 percent of apprentices were subsequently employed, accounting for 40 percent of total hiring amongst "craft" trades. Other apprentices have gone on to work with local contractors, suggesting that Phillips 66 is contributing to the development of the wider local skills pool.

Training for undergraduates and graduates

Graduate training programmes within the downstream sector have a particular focus on engineering disciplines.

Esso has a graduate training scheme to develop chartered engineers. It typically recruits around 10 graduates per year in chemical engineering, and five in mechanical engineering. The latter work across the refining and chemicals elements of the business, providing opportunities to work in different business areas.

Petroineos takes on up to four engineering graduates per year who are trained in the specific skills needed in the refinery environment.

Valero operates a bursary scheme aimed at Pembrokeshire students who intend to study chemical or mechanical engineering at university. The company typically recruits two students for each discipline each year, who benefit from financial support, summer work, and a year in industry placement at the refinery.

[103] The information in this box was provided to the study team by UKPIA members during the consultations for this project and in subsequent communications.
[104] This paragraph is based on information provided by Valero.

Schools outreach

A number of downstream companies run schools outreach programmes to encourage interest in STEM subjects amongst younger students.

Both Phillips 66 and Valero arrange site visits for local schools to give pupils insight into the working environment at the refinery. Valero have also organised after-school clubs in conjunction with local colleges and the Welsh government. More than 40 children were in engaged in the initiative, which culminated in an end-of-term competition. In 2018, 20 students participated in the company's work experience programme, enabling them to gain an overview of technical career opportunities at the refinery.

Esso run outreach programmes with local schools and colleges to support recruitment and provide an opportunity to engage with the local community. These include a STEM Challenge for 14 and 15 year-old students, which includes an activity hosted at the Fawley refinery. It also runs a "STEM Roadshow" to stimulate interest across various age groups, as well as careers days, events and site tours for local school pupils.

BP is a founding supporter of Project ENTHUSE at the National STEM Learning Centre and Network which provides bursaries for high quality continuing professional development (CPD) training for teachers in STEM subjects. An evaluation of project ENTHUSE found that it has had a positive impact on young people's engagement with and attainment in STEM subjects.[105] Research by the Wellcome Trust and Education Datalab has found that engaging in ENTHUSE CPD increases the retention of teachers by 160 percent.[106]

BP also runs the "Schools Link" programme for its employees to volunteer in schools to inspire interest in STEM subjects and business. The company supports around 100 primary and secondary schools close to its major sites. It offers approximately 250 work experience placements and provides mentors for individual students and groups. At a national level, the BP Educational Service provides teaching resources for STEM teachers in primary and secondary schools. Over 50 percent of secondary schools and 25 percent of primary schools have downloaded resources in the last year – around 9,000 schools in total.[107]

Diversity

As well as seeking to increase interest in STEM subjects in general, some downstream companies are working to increase employment amongst groups who have previously been under-represented within their workforces.

Phillips 66 has active partnerships with local colleges and universities to support STEM subjects. It has seen a seven-fold increase in applications from women, and the refinery employs double the national average of female engineers.

Valero's Women in Industry committee has been working with the Engineering Construction Industry Training Board (ECITB) to promote downstream and engineering opportunities to females. A pilot programme called "Tackling Gender Inequality" saw Valero and ECITB partner with Pembrokeshire College and Scarlets Rugby. The two-day event saw up to 50 female pupils take part in rugby sessions, a pipeline construction challenge, science experiments, STEM demonstrations from female Valero engineers and a tour of Pembroke Refinery.

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[105] National Audit Office, "Delivering STEM (science, technology, engineering and mathematics) skills for the economy", 2018

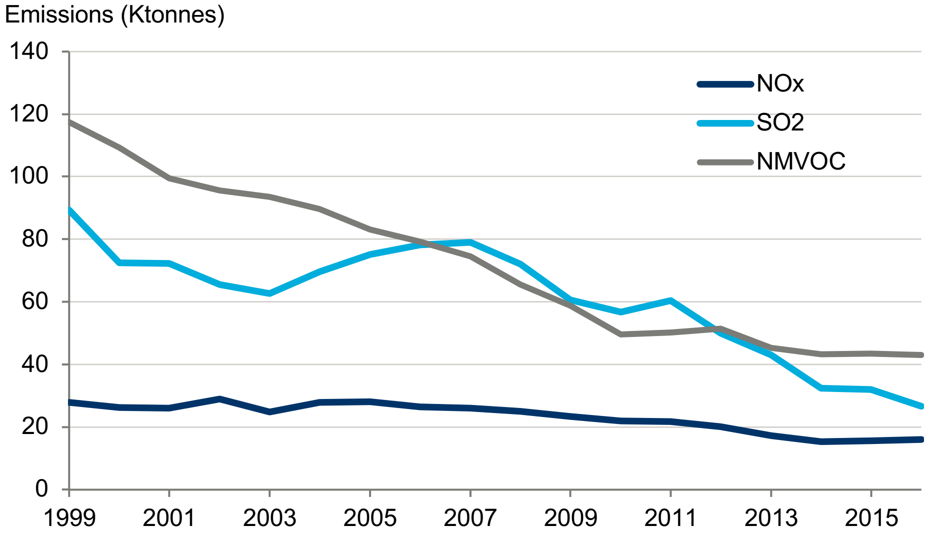
4.3 REDUCING ENVIRONMENTAL IMPACTS

4.3.1 Progress to date

As well as increasing efficiency through enhanced internal processes, downstream companies have taken steps to reduce the emissions that they release into the atmosphere (Fig. 33). Refineries produce sulphur dioxide from process units and the burning of fuels. This type of emissions was reduced by 65 percent between 2005 and 2016, as a result of a reduction in the UK's refining capacity; switching from heavy fuel oil to gas; investment in gas-powered combined heat and power generating plants; and sulphur recovery measures.[108]

Similar factors, as well as the introduction of low NOx burners enabled a 43 percent reduction in nitrogen oxide emissions. Refineries have also taken steps to reduce emissions of the non-methane volatile organic compounds which are produced from the evaporation of oil products. This has been achieved through improved sealing and vapour recovery equipment at storage and loading facilities, and at major filling stations.[109]

Fig. 33. Refinery emissions, 1999 to 2016



Source: NAEI

[106] https://wellcome.ac.uk/press-release/cpd-improves-science-teacher-retention

[107] Source: BP

[108] UKPIA Statistical Review 2018

[109] UKPIA Statistical Review 2018

4.3.2 Current and future initiatives

In addition to their efforts to reduce emissions, downstream companies are seeking to reduce their wider environmental impact in two main ways.

The first way involves contributing to carbon reduction in surrounding local communities by exporting waste heat and gasses for use in nearby homes and businesses.

For example, on the Humber Estuary, the VPI Immingham combined heat and power (CHP) plant generates electricity and steam used by nearby refineries. This is one of the largest CHP plants in Europe and is capable of generating 2.5 percent of UK peak electricity demand. In addition to natural gas (and liquid fuel as a back-up), the plant can be fuelled by surplus refinery gas.[110]

Other downstream companies are considering projects to use waste heat from the refining process to drive other nearby businesses, or to heat homes through "district heating networks". For example, Falkirk Council is assessing an "Energy Project", involving collaboration between INEOS, BP, Calachem, other major companies and the public sector. The scheme would involve a district heat network to use waste heat from the industrial processes, as well as from CHP facilities, and renewable sources to heat schools, healthcare facilities and homes.[111]

Esso is exploring the feasibility of using surplus heat from the Fawley refinery to provide heating and hot water to 1,500 homes on a proposed residential development on land adjoining the refinery site.[112]

Along similar lines, Shell has announced plans to heat 16,000 homes in Rotterdam using excess heat from its Pernis refinery. To do so, pipes were installed to transfer heat from Pernis to the city's existing heat network.[113]

A second way in which downstream companies may be able to reduce their environmental impact in the longer term is through carbon capture and storage. This involves collecting the carbon emitted during the refining process and transporting it for storage underground. The government estimates that this technology could make the greatest contribution to carbon reduction amongst the eight most energy intensive sectors.[114]

A variation on this is carbon capture and utilisation under which the carbon is re-used in some way, for example to make construction materials. ExxonMobil injects captured and compressed carbon dioxide into depleted oil wells to make

110 https://www.vitol.com/what-we-do/power-generation/

111 Peter Brett Associates, "Future Grangemouth vision 2025 evaluation of economic effects", report for Scottish Enterprise and Chemical Sciences Scotland, 2017.

112 Source: Esso.

113 https://www.shell.co.uk/media/2018-media-releases/residual-heat-from-shells-pernis-refinery-helps-heat-dutch-homes.html

114 Department for Business Energy & Industrial Strategy and UKPIA, "Oil Refining, Joint Industry - Government Industrial Decarbonisation and Energy Efficiency Roadmap Action Plan", 2017.

them more productive.[115] The advantage of such approaches is that they can generate a revenue stream to offset the cost of carbon capture.

Another approach to carbon capture involves incorporating equipment to capture carbon into the vehicles where fuels are used.[116] This process is even more complex than incorporating carbon capture into refineries or power stations since it requires the miniaturisation of the process. However, it offers the potential to capture carbon used in heavy goods vehicles and ships.

4.4 DEVELOPING NEW, CLEANER FUELS

The discussion above has focused on the efficiency and emissions of the refining process. Over and above this, some downstream companies are contributing to the energy transition through the innovation of new and improved products which have reduced environmental impacts.

4.4.1 Progress to date

Since the early 1990s, and in line with legislation, downstream companies have been taking steps to remove sulphur from petrol and diesel. By the start of 2009 all UK petrol and diesel has been sulphur free.[117]

A number of downstream companies are focusing on increasing the share of biofuel content in their products. Biofuels are made from materials of a biological origin and have the advantage that carbon dioxide is removed from the atmosphere when the crops upon which they are based are grown, and this is released back into the atmosphere when the fuel is burnt. As such, the overall carbon footprint of biofuels can be significantly lower than traditional hydrocarbon-based fuels.

So-called “first generation” biofuels were produced from food crops, and their environmental credentials were therefore open to challenge since crops for fuel competed for land with those grown for food. In contrast, “second generation” biofuels are made from materials that are not suitable for human consumption, unless they have already fulfilled their food purpose (e.g. used vegetable oil). “Third generation” biofuels are made from algae, which offers several advantages over other feedstocks, as discussed below. Other researchers are seeking to make fuel from other types of waste, including captured carbon dioxide.

The most common types of biofuel currently used in the UK are biodiesel, which is most frequently made from used cooking oil, and bioethanol which is produced from feedstocks including wheat, corn and sugar beet.[118]

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115 https://www.exxonmobil.co.uk/en-gb/current-issues/climate/driving-innovation/energy-developing-new-technologies-to-reduce-ghg#/section/2-potential-game-changing-tech-carbon-capture

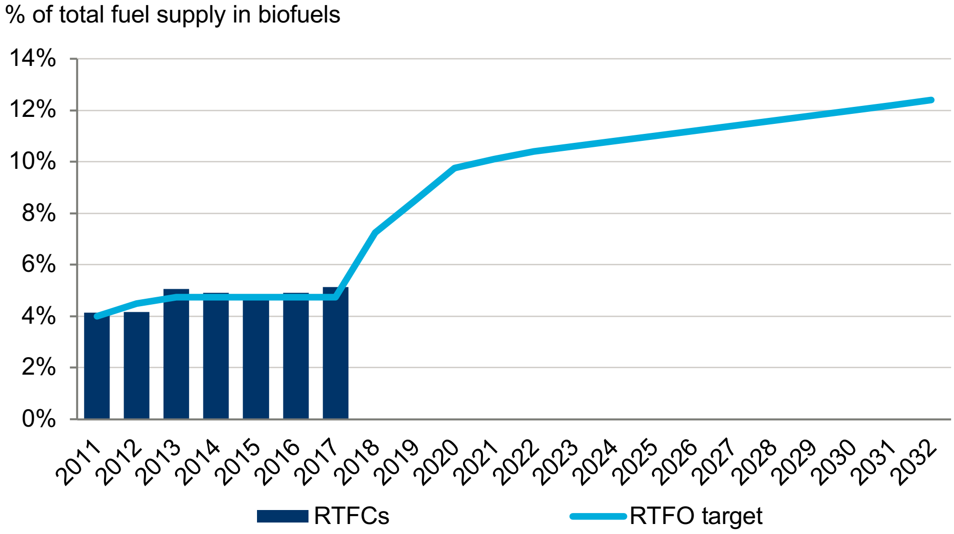
116 Fuels Europe, "Vision 2050- A pathway for the Evolution of the Refining Industry and Liquid Fuels", 2018, p.89.

117 UKPIA Statistical Review 2018. “Sulphur-free” is defined as less than 10ppm.

118 Department for Transport, “Renewable Transport Fuel Obligation statistics: period 10 (2017/18), report 4”

Between April and December 2018, the UK government's "Renewable Transport Fuel Obligation" (RTFO) requires 7.25 percent biofuel content (by volume) in road fuels. This share gradually increases to 12.4 percent in 2032. Progress against the government's target can be assessed by comparing the volume of "Renewable Transport Fuel Certificates" (RTFCs) issued to the total volume of fuel sold. One RTFC is issued per litre or kg of liquid biofuel derived from crop based feedstocks, while biofuels from other feedstocks receive two RTFCs to reflect that fuels from non-crop sources are less likely to divert land away from food production.[119]

Fig. 34. UK performance relative to RTFO targets[120]



Source: Department for Transport, Biofuel Statistics

4.4.2 New and emerging products

Biofuels

Companies in the downstream oil sector are researching new ways to produce biofuels based on a wide range of feedstocks. Low-carbon products can be produced from a combination of conventional and low-carbon feedstocks in current refineries, with or without specialist units. This could result in renewable hydrocarbon products which are interchangeable with conventional road fuels for use in existing engines. FuelsEurope suggests that in future it may also become possible to process various types of waste, including even plastics, as a feedstock for use in the refining process.[121]

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119 Department for Transport, "Renewable Transport Fuel Obligation statistics: Notes and definitions", 2018

120 While the chart shows that RTFCs were above the target level in 2017, this does not necessarily imply "over-compliance" since RTFCs can be carried over into subsequent years.

121 FuelsEurope, "Vision 2050- A pathway for the Evolution of the Refining Industry and Liquid Fuels", 2018

EXAMPLES OF INITIATIVES TO DEVELOP BIOFUELS

In the UK, the Phillips 66 Humber Refinery has, with support from DfT and the help of the Environment Agency, successfully trialled co-processing waste oil into renewable fuels in the refinery. The company is investing in pre-treatment to be able to process waste oils into renewable fuels on an ongoing basis.[122] In the US, Phillips 66 has undertaken research with partners to transform waste wood into petrol which delivers the same performance as conventional petrol, but with substantially reduced greenhouse gas emissions.[123]

ExxonMobil is leading research into the production of diesel fuel from algae.[124] Algae has the advantages of being energy rich, and emits much lower levels of greenhouse gases than most existing transport fuels. What is more, algae consumes carbon dioxide while it is growing; can be grown in wastewater, purifying it in the process; and can be harvested all year round. A further advantage is that diesel made from algae can be used in existing engines without the need for major changes to either car engines or supply infrastructure. Research efforts are focused on moving towards large scale production, and the company is aiming to produced 10,000 barrels of algae biofuel per day by 2025.[125] In addition to algae, ExxonMobil is working with the Renewable Energy Group, Inc. to investigate the production of biodiesel from sources such as agricultural waste.[126]

Shell is working with SBI Bioenergy to explore the commercialisation of a process for converting a range of waste fats and oils into biofuel that can be used in existing petrol or diesel engines. They have set up a pilot refinery in Canada to make biodiesel, but this needs to be blended with petroleum-based fuel for use in most vehicles. SBI is therefore seeking to convert biodiesel into renewable petrol and diesel which are chemically indistinguishable from petroleum-based fuels, and which can therefore be used in existing engines.[127]

In India, Shell is building a pilot plant to convert household waste into petrol, diesel and jet fuel. The same process works with forestry and agricultural waste, but can also use sorted municipal waste after glass, metal and rubber have been removed. The process can cope with up to 15 percent of plastic content within the waste.[128]

BP is working in partnership with Fulcrum BioEnergy to produce jet fuel from municipal waste.[129] The company is building its first "waste-to-fuel" plant in North America, and this could be expanded to other parts of the region later on. The process involves producing a synthetic crude oil substitute from waste, which is then converted into jet fuel using BP's expertise in refining and blending. BP suggest the carbon footprint of the resulting fuel is just 20 percent of the conventional equivalent.[130]

Biogas

There are two forms of biogas—biogas produced from anaerobic digestion of materials such as agricultural waste, manure, municipal waste, plant material,

[122] https://www.humberbusiness.com/news/waste-oils-addition-to-further-refinerys/story-10049-detail/story
[123] https://www.phillips66.com/newsroom/wood-biomass
[124] https://corporate.exxonmobil.com/research-and-technology/advanced-biofuels/Advanced-biofuels-and-algae-research
[125] https://news.exxonmobil.com/press-release/exxonmobil-and-synthetic-genomics-algae-biofuels-program-targets-10000-barrels-day-202

sewage, green waste or food waste, and biopropane, which is produced during hydrogenation of vegetable oils and animal fats to produce biodiesel.[131]

Biopropane has the same chemical make-up of conventional LPG and so can be used in place of LPG in existing equipment. As with conventional LPG, biopropane produces lower levels of nitrogen oxide and particulate matter when burned, and produces lower greenhouse gas emissions than alternatives such as fuel oil.[132]

In 2018, a UK company started importing biogas into the UK from Neste's Rotterdam refinery. Another source of biopropane is being developed by another company, in conjunction with the Institute of Biotechnology at Manchester University. This production method builds on UK government funded research which demonstrates that biopropane can be produced from fermentation processes using a variety of feedstocks (including multiple waste streams). The fermentation process emits little extra carbon into the environment meaning that production is effectively carbon neutral.[133]

Gas to liquid fuel

Shell has developed "GTL", a direct diesel replacement "gas to liquid" fuel.[134] Synthetically manufactured from natural gas, GTL fuel is less polluting than standard diesel and, importantly, can be used in any existing diesel engine without a need for modifications. This means that it could potentially play an important role in reducing emissions from larger vehicles which cannot easily be switched to other power sources, such as trains, ships and construction machinery. The fuel is produced at a large scale plant in Qatar, and was made available for sale in the UK in 2017.

4.5 DIVERSIFYING INTO NEW PRODUCTS AND SERVICES

As well as adapting their existing products, some downstream firms are diversifying into new areas. A number of these are focused on supporting the transition to zero tailpipe or low emission vehicles.

Graphite coke

Phillips 66 Humber is the only refinery in Europe which produces high grade graphite coke.[135] When oil is refined, a heavy residue is left over, which has traditionally been used as bunker fuel for ships or used in power stations.

126 https://energyfactor.exxonmobil.com/perspectives/focus-technology-advanced-biofuels/

127 https://www.shell.com/inside-energy/turning-fats-into-fuel.html

128 https://www.shell.com/inside-energy/back-to-the-future.html

129 Fuels Europe, "Vision 2050- A pathway for the Evolution of the Refining Industry and Liquid Fuels", 2018, p.83.

130 BP, "Advancing the energy transition", 2018.

131 https://www.neste.com/latest-addition-list-renewable-fuels-%E2%80%93-biopropane-%E2%80%93-will-soon-be-available

132 UKLPG, "UKLPG response to a Future Framework for Heat in Buildings- Call for Evidence" (2018)

133 UKLPG, "UKLPG response to a Future Framework for Heat in Buildings- Call for Evidence" (2018)

134 https://www.shell.co.uk/about-us/latest-news-and-features/2016-news-and-features/shell-gtl-fuel-help-customers-address-uk-air-quality.html

135 https://www.humberbusiness.com/news/refinerys-role-in-the-electric-vehicle/story-10031-detail/story

Phillips 66 instead put this residue through a “coker” to produce petrol, and also enabling them to produce “petroleum coke” and “graphite coke”. Certain formulations of these substances can be used in the lithium ion batteries used in smartphones and electric vehicles. Phillips 66 report that the resulting batteries are less susceptible to catching fire than other battery designs. Graphite coke is currently exported to China for use in electric vehicle batteries, but the company is exploring the potential to work with the UK government to incorporate its products into the UK electric vehicle supply chain.

Powering alternative fuel vehicles

To enable growth in the take-up of electric vehicles, it will be necessary to significantly expand the UK’s charging infrastructure. Major filling station owners are expanding into this space, enabling them to serve vehicles powered by different types of fuel.

With this objective in mind, BP has recently acquired Chargemaster, the UK’s largest operator of electric vehicle charging points.[136] The company has 6,500 charging points across the UK, and BP is seeking to roll out fast charging points to its filling station network. The company is planning to prioritise fast and ultra-fast charging points which can add up to 600 miles of range per hour of charging time. The company has been trialling the use of Freewire mobile rapid charging units at one of its London sites.[137]

BP is also investigating how batteries themselves may be improved: it has invested in StoreDot to investigate a new type of car battery that could be charged in five minutes or less.[138]

In 2017 Shell purchased NewMotion, one of Europe’s largest electric vehicle charging providers, which operates more than 30,000 charging points for homes and businesses in the UK, France, Germany and the Netherlands. It also operates more than 50,000 public charging points across 25 European countries.[139]

In October 2018, Shell opened its first high-powered charging station in France, in partnership with IONITY. These chargers take up to 10 minutes to charge next-generation electric vehicles, which Shell suggest is up to three times faster than other chargers. Shell plans to install high-powered chargers at 80 of its filling stations across Europe.[140]

Shell has started to sell hydrogen at three of its UK filling stations for motorists operating hydrogen fuel cell vehicles.[141] The first of these was opened at the

136 https://www.theguardian.com/business/2018/jun/28/bp-buys-uks-biggest-electric-car-charger-network-for-130m

137 https://www.bp.com/en_gb/united-kingdom/home/news/press-releases/bp-trials-freewire-ev-charging-system-in-hammersmith.html

138 https://www.store-dot.com/single-post/2018/05/22/StoreDot-Ltd-Announces-Strategic-Investment-From-BP

139 https://www.shell.co.uk/media/2017-media-releases/electric-vehicle-charging-offer.html

140 https://www.shell.co.uk/media/2018-media-releases/european-service-station.html

141 https://www.shell.co.uk/media/2017-media-releases/shell-launches-its-first-hydrogen-refuelling-station-in-the-uk.html

Cobham service station on the M25 in 2017. Hydrogen fuel cell vehicles convert hydrogen into electricity, and emit only water vapour when driven. Unlike electric vehicles, refuelling takes just a few minutes, and vehicles can have a range of up to 700km.

Total is also developing a dense network of electric vehicle charging points across Western Europe. The company's Saft subsidiary is undertaking an R&D programme with Solvay, Manz and Siemens to develop the "battery of the future", which it hopes to deploy across all transport sectors, as well as in other industries.[142]

Other initiatives to reduce carbon emissions from the transport fleet

BP has invested in a number of firms around the world which are seeking to reduce the carbon emissions from transport through the innovation of new products and services.[143] For example:

- Drover provides a platform for leasing vehicles to drivers wishing to work on ride sharing platforms. It provides short-term flexible contracts, which include insurance and maintenance.[144]
- Peloton is developing autonomous technologies to enable trucks to travel in "platoons". By connecting the braking and acceleration of trucks to others in the platoon, vehicles can safely travel together at close distances, improving aerodynamics, and thereby enhancing fuel efficiency.[145]
- Lightning Systems has developed a hydraulic system for commercial vehicles to recover energy from braking for use in propulsion. Fuels fitted with the system use less fuel and create less pollution.[146]

ExxonMobil has invested in the development of an on-board system that converts conventional petrol or diesel into hydrogen, to be used in the vehicle's fuel cell. This approach reduces the pollution associated with producing and distributing hydrogen. ExxonMobil suggests this system could be up to 80 percent more fuel efficient, and emit 45 percent less carbon dioxide, than an internal combustion engine on a "well-to-wheels" basis.[147]

142 https://www.total.com/en/energy-expertise/transformation-development/total-present-across-entire-low-carbon-electricity-value-chain

143 https://www.bp.com/en/global/ventures/our-portfolio.html

144 https://www.joindrover.com/

145 https://peloton-tech.com/how-it-works/

146 https://lightningsystems.com/lightninghybrid

147 https://www.exxonmobil.co.uk/en-gb/current-issues/climate/promoting-efficiency/encouraging-ghg-reductions

BARRIERS AND ENABLERS TO THE ENERGY TRANSITION

In the sections above, we have outlined some of the ways downstream companies are adapting to support the energy transition. A number of internal and external factors will influence their ability to deliver this transition. Some of these factors will act as "barriers" to progress, while others will play the role of "enablers". Previous research for the government by WSP, Parsons Brinckerhoff and DNV.GL has investigated these issues in some detail, and we summarise the findings below.[148]

Top barriers

(1) **Unfavourable market conditions, demand destruction, negative cashflow and uncertainty**—the fact that demand for oil products is expected to fall in the years ahead, the associated uncertainty, and competitive market conditions limit the ability and willingness of refineries to make investments with long payback periods.
(2) **Short-term management approach, less focus on decarbonisation due to companies' structure**—refineries are often part of large multi-national companies and must compete with the company's operations in other countries for investment. In some cases a lack of emphasis on decarbonisation can be a barrier.
(3) **Regulatory compliance**—this can increase the costs of operating in the UK. Research by Purvin and Gertz estimated that between 2013 and 2030 UK refineries will need to invest more than £5.5 billion to meet regulatory requirements. While some of the costs could be passed on to consumers, the authors estimated that around £900 million would likely be unrecoverable.[149]
(4) **Higher and increasing energy costs**—certain sources identified this as placing further pressure on margins, although the study authors note that UK electricity prices were similar to the EU average.
(5) **High competition levels preventing collaboration on decarbonisation projects.**
(6) **Long payback periods for advanced technologies**—investors and managers may favour incremental improvements over more substantial changes which take longer to yield returns.
(7) **Staff shortages**—refineries face an ageing workforce and may find it difficult to recruit suitably skilled staff, which may hinder their ability to adopt low carbon technologies.
(8) **CCS has a number of barriers**, including the additional operational complexities it could introduce; large and uncertain costs; the absence of supporting infrastructure; and the fact that the technology is unproven at scale.
(9) **Long lifespan of refineries**—a lack of new-build refineries in the UK may limit the technologies that can be introduced.[150]
(10) **Risk of production disruption**—market conditions mean that refiners may not wish to risk costly production disruptions which could arise when introducing new technologies.
(11) **Disruptive tested and reliable technologies not available**—it can be difficult for suppliers to obtain access to suitable facilities for testing new technologies.

[148] WSP, Parsons Brinckerhoff, DNV.GL, "Industrial decarbonisation and energy efficiency roadmaps to 2050: oil refining", 2015
[149] Purvin & Gertz (IHS) "The role and future of the UK refining sector in the supply of petroleum products and its value to the UK economy", report for UKPIA, 2013
[150] This point was questioned in discussion with certain UKPIA members, who felt that refinery lifespan was not necessarily a barrier to the uptake of new technologies.

Top enablers

(1) **Cost savings from energy savings**—energy is one of the largest costs for refiners, so there is a strong incentive to identify efficiencies.
(2) **Government actions to encourage decarbonisation**—there may be scope for more supportive government policy, for example by providing a stable policy, legislative and fiscal environment, and measures to reduce regulatory costs and encourage investment in low carbon technologies.
(3) **Management focus, long-term energy strategies and the willingness of top management to prioritise climate change**—this was also identified as a barrier. But there was some evidence of a culture of driving continuous improvements in energy efficiency.
(4) **Regulatory compliance**—this was also identified as a barrier, but can act as a driver of change, for example by encouraging more efficient use of fuel.
(5) **Increased energy efficiency through improved energy monitoring and process control systems**—these systems are already in place in many refineries.
(6) **Government recognition of the importance of the oil refining sector**, to reduce uncertainty for operators.
(7) **Enhanced collaboration between industry, government and academia** could reduce the costs of developing and deploying technologies.

Source: Adapted from WSP, Parsons Brinckerhoff, DNV.GL, "Industrial decarbonisation and energy efficiency roadmaps to 2050: oil refining", 2015

5. CONCLUSIONS

The UK downstream oil sector incorporates a wide range of activities linked to the production and distribution of the fuels that the country needs to ensure the smooth functioning of the economy and to enable citizens to go about their daily lives.

The sector makes a substantial contribution through the employment and GDP supported in its own activities, in its supply chain, and as a result of workers' spending. In total we estimate this "economic footprint" to support a £21.2 billion contribution to the UK's GDP and almost 300,000 jobs.

More than three-quarters of petroleum products consumed in the UK are used to fuel the transportation of people and goods, enabling food to reach the shops; producers to obtain inputs and get their products to market; and individuals to travel to work or for leisure. Downstream companies also provide vital inputs to, and sometimes shares infrastructure with, the petrochemicals industry, as well as providing products for a range of other uses, such as fuel to heat homes away from the gas grid; the bitumen used to surface roads; and the lubricants applied to virtually all machinery and vehicles. In doing so, downstream companies carry a large responsibility for ensuring the secure supply of their products to minimise the likelihood of costly disruptions.

Downstream companies are, nonetheless, adapting for a future in which there is less reliance on the burning of fossil fuels to meet our energy needs. This transition will take time, and during this period companies must play a dual role of both continuing to supply their existing products, while also innovating new products and processes to reduce their own carbon footprint and that of those using its fuels. Important progress has already been made in making oil refineries cleaner and more fuel efficient, but there is still a long way to go. Companies in the sector are exploring a range of ways to further adapt, whether that be by securing further efficiency gains in their internal processes; making better use of waste heat; capturing (and potentially using) the carbon they emit; developing low-carbon biofuels from a range of organic and waste products; or diversifying activities to support the switch to low emission vehicles.

APPENDIX 1: APPROACH TO ESTIMATING THE ECONOMIC IMPACT OF THE DOWNSTREAM SECTOR

DIRECT CONTRIBUTION

Since the definition of the UK downstream oil sector does not align with standard ONS classifications it was necessary to adopt a number of approaches to estimate the sector's direct contribution to employment and GDP. The estimation techniques applied for various groups of activity are outlined below.

UKPIA members

Direct employment in downstream activities was based on information provided by UKPIA members on their levels of employment in downstream activities. Oxford Economics applied an adjustment to these data to exclude filling station employees and contractors, who are counted elsewhere in our analysis.

Oxford Economics estimated the GVA contribution to GDP of UKPIA members based on published annual accounts for 2016 for the following businesses:

- BP Oil UK Ltd
- Essar Oil UK Ltd
- Esso Petroleum Company Ltd
- Petroineos Manufacturing Scotland Ltd
- Phillips 66 Ltd
- Shell UK Ltd
- Total Lindsey Oil Refinery Ltd
- Valero Energy Ltd
- Valero Logistics UK Ltd
- Valero Pembrokeshire Oil Terminal Ltd

GVA was estimated according to the income approach by summing estimated earnings before interest, tax, depreciation and amortisation (EBITDA) and compensation of employees for each of the companies. We divided the resulting GVA estimate by the number of employees reported in the annual accounts to obtain an estimate of GVA per employee.

We could not use the resulting value of GVA directly because it is likely to include some activity which either falls outside of the downstream sector or is counted elsewhere in our analysis (e.g. at company-owned filling stations). We therefore multiplied our estimate of GVA per employee by the downstream employment estimate from UKPIA to obtain our final direct GVA figure for UKPIA members. As with the employment estimate, this excludes the GVA generated by filling stations owned by UKPIA members.

Filling stations

GVA and employment at filling stations was based on information from the ONS Annual Business Survey (ABS) for SIC 47.3 (retail sale of fuel in specialised stores). This dataset does not, however, include all filling station activity. Most notably it excludes the value of fuel sales at supermarket petrol stations. We therefore upscaled the values in category 47.3 to include the value of automotive fuel sold by "non-specialised stores". This was taken from detailed ABS retail commodity tables showing the value of goods sold by different types of retailer.

In addition to the adjustment to incorporate supermarket fuel sales, we also added an estimate of the value of non-fuel goods sold on supermarket petrol station forecourts. This was based on the ratio of fuel to non-fuel sales within SIC 47.3.

To estimate the regional distribution of employment:

- We estimated the regional share of fuel station revenues using information on regional fuel volumes and shop sales from the 2017 Fuel Market Review (we assumed the distribution remained relatively unchanged between 2016 and 2017).[151]
- We estimated the employment in each region based on average UK turnover per worker in the "retail sale of automotive fuel in specialised stores" sector from the ONS ABS. We adjusted these results to reflect productivity differences across regions. To do this we estimated a regional productivity adjustment factor using GVA and employment data from ONS (via NOMIS) for the retail sector. We then re-scaled our results to align with our estimate of total UK employment in filling stations.

Hauliers and logistics companies

We gathered turnover and employment information from company accounts through www.duedil.com for the top 10 logistics companies as identified by Fuel Oil News. The number of tankers for each company was taken from https://fueloilnews.co.uk/top-fuel-oil-distributors/

We estimated average turnover and revenue per tanker for four companies which are assumed to primarily specialise in the distribution of petroleum products: Hoyer Petrolog UK Ltd, J.W. Suckling Transport Ltd, Greenergy Flexigrid, and Reynolds Logistics.

Based on those ratios and the number of tankers, we estimated the downstream-related turnover and employment for six further companies: Clugston Distribution, DHL, Montgomery Transport Services, Turners (Soham), Wincanton, and XPO Logistics.

We assigned each company to an industry based on its SIC code. The direct gross value added contribution to GDP was then calculated based on industry average ratios of GVA to turnover from the ONS Annual Business Survey.

Other companies

A list of companies was identified through consultation with UKPIA and other stakeholders, and industry association membership lists. These companies were selected on the basis that the majority of their operations relate to activity that falls within our definition of the downstream sector, and that their accounts are available online. Turnover and employment information for each company was taken from company accounts, gathered through www.duedil.com.

We assigned each company to an industry based on its SIC code. For most of these companies the direct gross value added contribution to GDP was calculated based on industry average ratios of GVA to turnover from the ONS ABS, although in a small number of cases we estimated this directly from more detailed company accounts.

[151] Experian data presented in Forecourttrader, "Fuel Market Review 2017".

The following companies are included in our definition of the downstream sector:

- Afton Chemical Ltd
- AH Fuel Oils
- Associated Petroleum Terminals (Immingham) Ltd.
- Avanti Gas Ltd
- Aztec Oils Ltd
- Bangor Fuels
- Barton Petroleum
- British Pipeline Agency (BPA)
- BWOC (wholly owned subsidiary)
- Calor Gas Ltd
- Certas Energy
- CLH-PS
- Eastham Refinery Ltd
- Exol Lubricants (Rotherham) Ltd
- Exol Lubricants Ltd
- Flogas Britain Ltd
- Ford Fuel Oils
- Fuchs Lubricants (UK) PLC
- Fuel Oils Holdings
- Gleaner Oil & Gas Ltd
- Gleaner Oils
- Granville Oil & Chemicals Ltd
- Greenergy Biofuels Ltd.
- Greenergy Biofuels Teesside Ltd.
- Greenergy Fuels Ltd.
- Greenergy Terminals Ltd.
- H&R Chempharm (UK) Ltd
- Haltermann Carless UK Ltd
- Harvest Energy Aviation Ltd
- Heltor
- Highland Fuels
- Infineum UK Ltd
- Inter-terminals
- Inver Energy (UK) Ltd
- Ironsides Lubricants Ltd (The)
- J Gas Ltd
- Jet-Lube (UK) Ltd
- Johnston Oils
- Kuwait Petroleum International Aviation Company (UK) Ltd
- Kuwait Petroleum International Aviation Company Ltd
- Kuwait Petroleum International Lubricants (UK) Ltd
- LCC Oil
- Local Fuel PLC
- Lubrizol Adibis (UK) Ltd
- Lubrizol Ltd
- Mabanaft Ltd. UK
- Mainline Pipelines Ltd
- Millers Oils Ltd
- Mitchell & Webber
- Nustar Grangemouth Ltd
- Nustar Terminals Ltd
- NWF Fuels
- Nynas Naphthenics Ltd
- Oikos Storage
- Oil 4 Wales
- Oil NRG
- Oilfast
- Prax Petroleum Ltd
- Puma Energy UK
- R.S.Clare & Co.,Ltd
- Rix Petroleum (East Anglia) Ltd
- Rix Petroleum (Hull) Ltd
- Rix Petroleum (Mercia) Ltd
- Rix Petroleum (Midlands) Ltd
- Rix Petroleum (Scotland) Ltd
- Rix Petroleum (Spalding) Ltd
- Sabic Innovative Plastics Ltd
- SIP Ltd (lubricants)
- Stolthaven Dagenham
- Thompson Fuels
- Topaz Energy (NI)
- WFL (UK)
- World Fuel Services Aviation Ltd
- World Fuel Services Europe, LTD.
- WP Group

Refinery contractors

UK oil refineries typically employ a large number of contract staff. Such workers may be based at a refinery on a permanent basis, work closely alongside colleagues directly employed by the refinery, and can account for around half of a refinery's workforce. However, they would not typically be included in a company's own employment figures and their wages will be paid out of intermediate consumption expenditure. As such, within our modelling approach such workers would show up within the estimates of indirect employment and GVA.

Given the central role that refinery contractors play within the downstream sector, it was decided that refinery contractors should be counted as part of the direct contribution for this study. To make this adjustment we estimated the number of refinery contractors based on insights from consultations with UKPIA members. This number of workers was removed from the engineering services sector of the indirect impact, and moved into the direct employment estimate. The estimated value of GVA associated with these workers was also moved from the indirect to direct categories.

ESTIMATED VALUE OF SUPPLY CHAIN SPENDING

For each of the groups of companies described above, we estimated the total value of supply chain spending, and the split of this spending by industry.

Our estimates of supply chain spending include both current and capital purchases.

UKPIA members

We estimated the total value of current purchases based on the ratio of intermediate consumption to GVA from the ONS ABS for SIC division 19 (manufacture of coke and refined petroleum products).

DUKES table 3.1 states that the UK used 53 million tonnes of crude oil in 2016. We estimated this to have a value of £14.7 billion based on a price of $36 per barrel. Of this, 22 percent came from domestic sources, giving value of domestic crude purchases of £3.25 billion.

Spending was allocated across other sectors was allocated based on 2016 Supply-Use tables from ONS, and the share of imported purchases was removed using 2014 Input-Output tables, again from the ONS.

A second round of adjustments was then applied to remove expenditures from wholesale, rail and other land transport services, and storage companies under the assumption that such purchases would be made from oil storage and transportation companies already included in the direct estimates.

Other companies

We estimated the value of procurement expenditure based on the ratio of intermediate consumption to turnover within the relevant SIC category, taken from the ABS. Many of these companies are involved in the resale and distribution of petroleum products and the value of their petroleum product purchases is already reflected in the direct impact estimates. As such we excluded the cost of goods for re-sale from the estimated supply chain expenditure to avoid double counting. The remaining expenditures should therefore reflect purchases of non-petroleum related goods and services.

Expenditures were allocated to sectors based on 2016 ONS Supply-Use tables. We adjusted the share going to each industry to exclude purchases of refined products and purchases from wholesalers (since our adjustment to remove the cost of goods sold should already have excluded spending in these categories). The share of imported purchases was removed from each sector using 2014 ONS Input-Output tables.

A second round of adjustments was applied to remove expenditures from wholesale, land transport and storage companies under the assumption that such purchases would be made from oil storage and transportation companies already included in the direct estimates.

Capital expenditure

For UKPIA members we obtained an estimate of capital expenditures based on the ratio of capital expenditure to GVA from the ABS for SIC category 19.

Similarly, for other companies we estimated capital expenditure based on the ratio of capital expenditure to turnover from the ABS for the respective SIC category for each company.

The value was allocated to sectors based on ONS Input-Output tables.

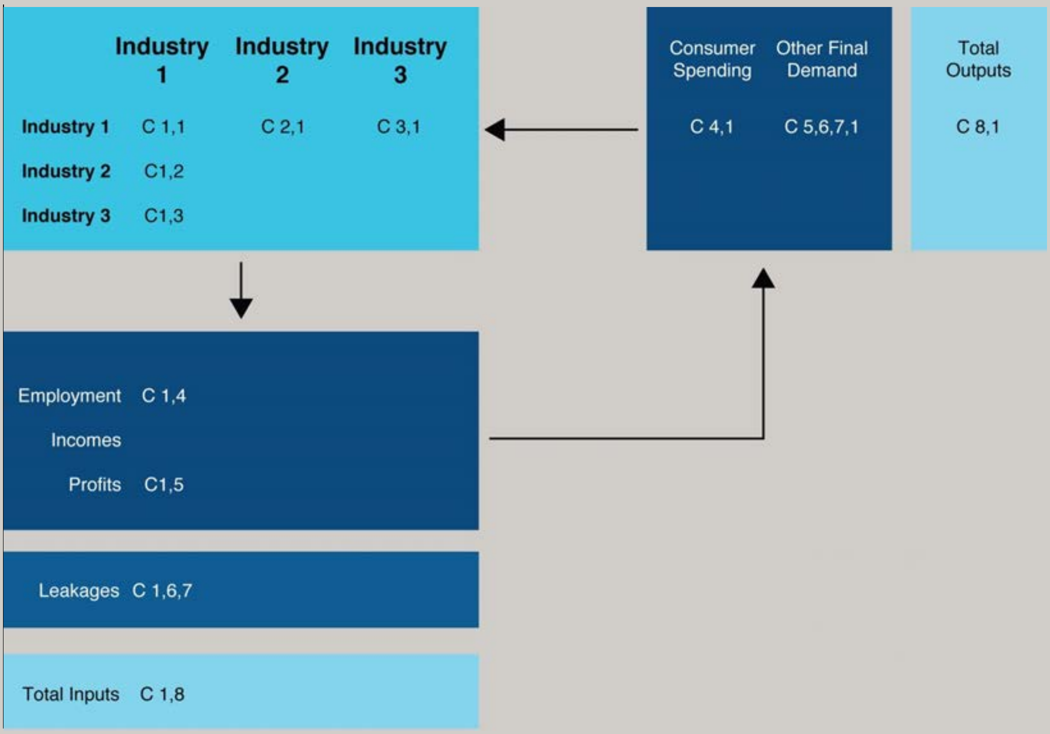
INDIRECT (SUPPLY CHAIN) AND INDUCED (WORKER SPENDING) CONTRIBUTIONS

Indirect impact

Above we outlined our approach to estimating the value of supply chain expenditures by the companies included within our definition of the downstream oil sector. To estimate the impact of these expenditures on the economy we input them into an "input-output" model based on UK input-output tables published by the ONS. These tables set out the goods and services that UK industries purchase from one another in order to produce their output (as well as their purchases from abroad). These tables also provide detail on the spending patterns of UK households, and indicate whether this demand is met by UK production, or imported products. In essence, the tables show who buys what from whom. Using details of these linkages from the input-output tables, Oxford Economics constructed a bespoke UK impact model to trace out the intermediate consumption and capital good consumption impacts attributable to the downstream oil sector (this is known as the Leontief manipulation).

Oxford Economics' impact model quantifies all rounds of subsequent purchases along the supply chain. These transactions are translated into GDP contributions, using UK-specific ratios of GVA to gross output, sourced from the UK input-output table. Once we have obtained results for output and GVA, we estimate employment using productivity estimates. Second and later round effects on the refining sector are excluded from our results to avoid double counting activity incorporated within the direct estimates.

Fig. 35. A stylised Input-Output table structure



Induced impact

The induced impact is modelled using a similar method to the indirect impact. Using employment and wage data calculated as part of the direct impact, Oxford Economics used household spending data to model the typical consumption patterns of UK households, making an allowance for "leakages" in the form of imports and savings.

For workers within the downstream sector's supply chain, we used industry-specific ratios of employee compensation per unit of output to estimate the value of household wages supported among the suppliers' workers.

Both of these spending streams were then fed into our input-output model, to calculate the total impact of this spending on GDP. As with the indirect impact, employment impacts were derived using productivity estimates for each sector of the economy.

Specifically for this project, we adjust the household spending calculations to remove the impact of household spending on petroleum products, since this has already been measured within the direct impact. We also exclude latter-round effects on the refining sector from our estimates.

About Oxford Economics

Oxford Economics was founded in 1981 as a commercial venture with Oxford University's business college to provide economic forecasting and modelling to UK companies and financial institutions expanding abroad. Since then, we have become one of the world's foremost independent global advisory firms, providing reports, forecasts and analytical tools on more than 200 countries, 250 industrial sectors, and 7,000 cities and regions. Our best-of-class global economic and industry models and analytical tools give us an unparalleled ability to forecast external market trends and assess their economic, social and business impact.

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