

# Activity Report.



Nuclear Industry Association

---

NUCLEAR ACTIVITY  
2016

---

DECEMBER 2017



155,000



CIVIL NUCLEAR SUPPORTS  
155,000 DIRECT AND  
INDIRECT JOBS

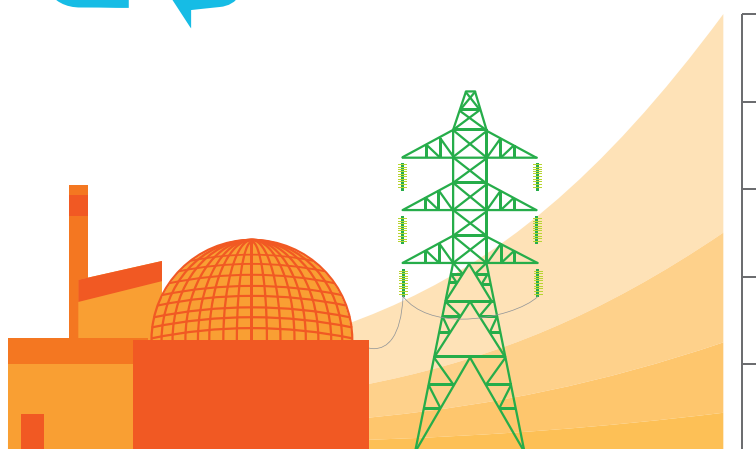
£16.7 MILLION, 33% OF LLWR'S  
EXPENDITURE WAS PLACED WITH SMALL  
TO MEDIUM-SIZED ENTERPRISE



MORE THAN £1.5 MILLION  
SAVED ACROSS MAGNOX  
FLEET BY REUSING  
EQUIPMENT ON SITE



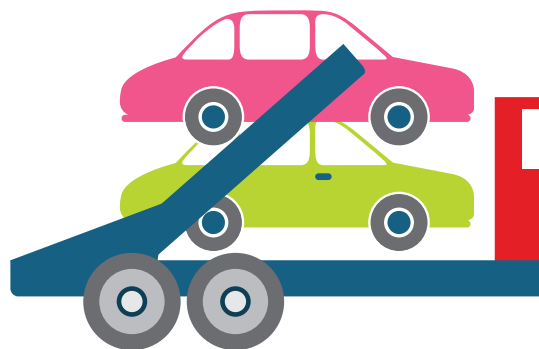
ALMOST £4.5 BILLION  
IN TAX REVENUES PAID  
TO THE EXCHEQUER



NUCLEAR GENERATED £6.4 BILLION  
IN GDP, AND £12.4 BILLION WHEN  
INDIRECT IMPACT IS INCLUDED



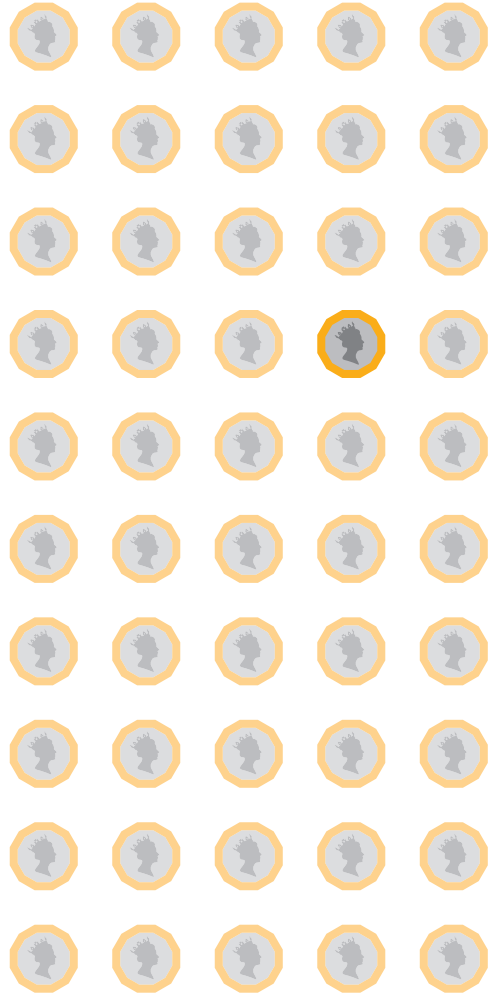
NUCLEAR POWER  
AVOIDED 22.7  
MILLION METRIC  
TONS OF CO<sub>2</sub> - THE  
SAME AS TAKING A  
THIRD OF ALL CARS  
OFF UK ROADS



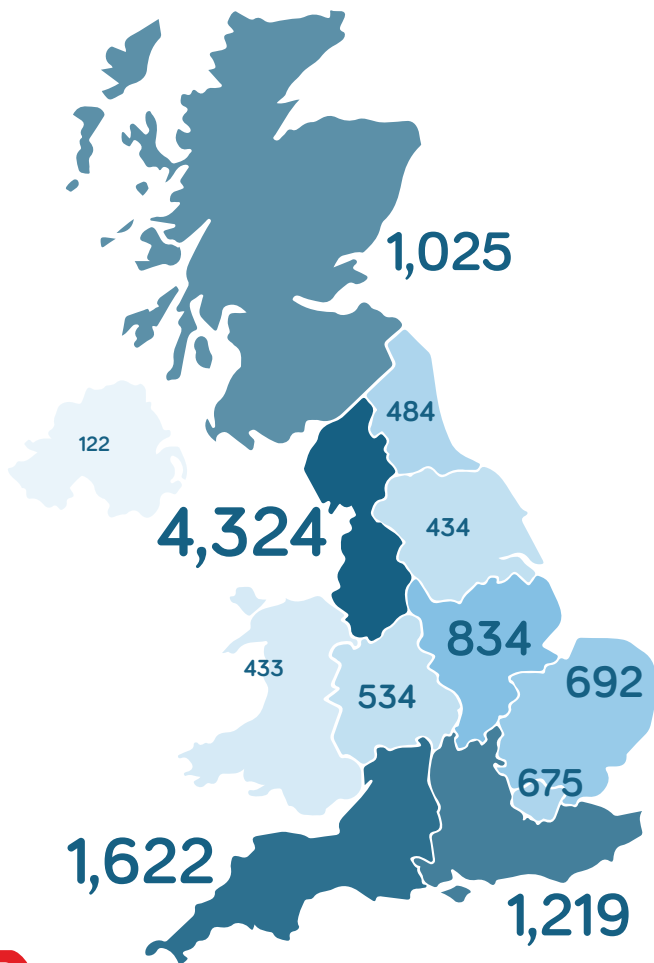


NUCLEAR SUPPORTS £1 IN EVERY £50  
OF ECONOMIC OUTPUT IN BOTH  
THE NORTH WEST AND SOUTH WEST

£1 in £50



IN 2016, EACH NUCLEAR WORKER  
CONTRIBUTED AN AVERAGE OF  
£96,600 IN GVA TO THE ECONOMY



LARGEST CIVIL NUCLEAR  
REGIONAL GVA IMPACT (£M)  
IN NORTH WEST



NDA R&D  
FRAMEWORK  
CONTRACTS  
WORTH UP TO  
£12 MILLION OVER  
FOUR YEARS  
AWARDED TO  
10 COSORTIA

# Foreword - Nuclear Industry Association

For 60 years, nuclear has been an integral part of the UK's electricity system, providing low carbon and reliable power to UK homes, public services and businesses.

This Activity Report presents a comprehensive study of the UK's civil nuclear industry. It assesses the progress made in the sector in 2016, and for the first time, we can accurately report the economic contribution the sector makes to the economy, thanks to independent analysis undertaken by Oxford Economics.

In 2016 the UK's civil nuclear sector generated £6.4 billion in GDP for the UK economy – the equivalent to the output of the aerospace manufacturing industry. When the indirect impact of the sector's activity is considered, this figure almost doubles to £12.4 billion.

The civil nuclear sector is a vital job creator; more than 65,000 people are directly employed and 155,000 jobs are reliant in some way on its activities. Furthermore, the sector supports one in every 64 jobs in the north west of England and around £1 in every £50 of economic output in both the north west and south west of England.

These figures alone show the vital economic contribution of the sector which reaches all parts of the country and the highly skilled advanced engineering which underpin the industry. As well as being an important contributor to the economy, nuclear remains an integral part of the electricity mix.

A fifth of total electricity produced in 2016 came from nuclear power and it remains the largest single source of low carbon electricity in the UK providing 46% of the low carbon electricity produced, with wind, solar, hydro and biomass providing the remainder.

However, with two thirds of all dispatchable power capacity retiring between 2010 and 2030, including all but one of our current nuclear stations, this will need to be replaced with a new fleet to continue providing the reliable, secure low carbon power the UK will need.

Beginning the construction of much anticipated and increasingly important new build programme and the continued progress being made across decommissioning has helped develop UK capability across its supply chains. There is also a significant opportunity for the sector in developing the first small modular reactors – a global market which could be worth up to £400 billion.

The nuclear industry will have a clear role to play in achieving the governments aims for a modern Industrial Strategy. We have made significant progress with government through the Nuclear Industry Council, towards agreeing an early Sector Deal which will maximise these opportunities and help improve productivity, foster innovation and reduce cost.

This report demonstrates the importance of the UK's civil nuclear sector and through continued investment in its people, plant and products it will be well placed to continue to develop its supply chains and opportunities for the long term.



**Lord Hutton of Furness**  
**Chairman,**  
**Nuclear Industry Association**

# Foreword - Oxford Economics

The UK's energy sector faces many challenges in the coming decades. In an effort to meet emissions targets under the UK's climate change agreements, the National Grid will see diminishing contributions from existing coal and gas power plants. And keeping the lights on while these sources taper off will require substantial new supplies of dependable and affordable low-carbon supply.

Today, nuclear technology meets one-fifth of the nation's electricity needs. In doing so, the civil nuclear sector is already generating extensive economic benefits throughout the country. These benefits, including sizeable GDP contributions and employment impacts, are particularly concentrated within the north west and south west of England, the homes of important civil nuclear clusters. Our analysis reveals that in these two regions, civil nuclear activity added almost £6 billion to regional output, and supported 75,000 jobs in 2016.

But all nations and regions of the UK enjoyed the economic fruits of the civil nuclear sector's activities. At a national level in 2016, the sector, its supply chains and workers contributed £12.4 billion to GDP and sustained 155,000 jobs. Beyond these headline impacts, civil nuclear organisations add further value in ways that are harder to quantify. For example, their research capabilities are driving innovation in many domains, including nuclear fusion. Such innovation can also yield broad economic payoffs, with new technologies and methods often 'spilling over' into new contexts, adding value to society in unexpected ways.

Our research, presented in this paper, provides a detailed assessment of the UK's civil nuclear sector's economic footprint. It demonstrates the importance of the sector in the UK, as well as its regional economies and labour markets. And as the requirement for low-carbon energy grows, the sector's activities—and its continuing investments in infrastructure and human capital—will prove increasingly important in meeting this challenge.



OXFORD  
ECONOMICS

**Ian Mulheirn**  
Director of Consulting,  
Oxford Economics

# Contents

## Economic Impact Report

<b>Executive Summary</b>	<b>P. 02</b>
--------------------------	--------------

<b>1 Introduction</b>	<b>P. 04</b>
-----------------------	--------------

- The UK's Energy Landscape
- The UK's Civil Nuclear Sector
- Scope of this Study

<b>2 Economic Impact of the UK's Civil Nuclear Sector</b>	<b>P. 08</b>
---	--------------

- Direct Impact
- Indirect Impact
- Induced Impact
- Total Impact

<b>3 Regional Contribution</b>	<b>P. 13</b>
--------------------------------	--------------

- Contribution to Regional GVA
- Contribution to Regional Employment

<b>4 Wider Impact of the Civil Nuclear Sector</b>	<b>P. 15</b>
---	--------------

- Skills, Training and Development
- R&D and Innovation

<b>5 Conclusion</b>	<b>P. 19</b>
---------------------	--------------

## Nuclear Sector Activity 2016

<b>6 Existing Generation</b>	<b>P. 21</b>
------------------------------	--------------

- 2016 Performance

<b>7 Nuclear New Build</b>	<b>P. 26</b>
----------------------------	--------------

- EDF Energy
- Horizon Nuclear Power
- NuGeneration Limited

<b>8 Decommissioning and Waste Management</b>	<b>P. 34</b>
---	--------------

- Magnox Decommissioning
- Low Level Waste Repository
- Dounreay
- Sellafield Ltd
- Decommissioning Progress

<b>9 Fuel Fabrication</b>	<b>P. 44</b>
---------------------------	--------------

<b>10 Supply Chain Activity</b>	<b>P. 46</b>
---------------------------------	--------------

- Opportunities for SMEs
- R&D

<b>Appendix</b>	<b>P. 51</b>
-----------------	--------------

A photograph of a worker in a factory setting, wearing a white hard hat, blue earmuffs, and a blue t-shirt. The worker is focused on a task, with their hands on a series of parallel metal rods. In the background, another worker is visible, also wearing a hard hat and earmuffs. The image is overlaid with a blue and orange diagonal graphic element.

# **Economic Impact Report**

Oxford Economics

# Executive Summary

**Nuclear power is an increasingly important energy source for the UK. Having met more than one-fifth (21%) of the country's entire electricity demand during 2016, it is the single largest source of low-carbon electricity in the UK's energy mix.** With national targets for emissions reduction becoming more ambitious in the coming years, and coal-fired stations set to be removed from the grid by 2025, the prominence of nuclear power in the generation portfolio is set to grow. It remains the leading technology that can provide reliable and predictable 'baseload' capacity, in a low-carbon fashion and at a nationally-significant scale.

**The operations of the civil nuclear sector enable a wide range of benefits that are derived from this energy supply.** The civil nuclear sector describes the collection of firms and organisations that operate power stations, produce nuclear fuel, manage decommissioning and waste processing activities, and drive nuclear research — as well as its supporting industries, that provide nuclear-specialised components, infrastructure and expertise.

**The sector is comprised of some 66,000 workers throughout the UK, who collectively generated an estimated £6.4 billion in GDP during 2016.** This scale of economic output, equivalent to the output of the UK's entire aerospace manufacturing industry, also supported an estimated £2.8 billion in tax revenues for the Exchequer during the same period. This so-called 'direct' impact was felt across the UK's nations and regions, but especially in the north west and south west of England, areas that feature important civil nuclear clusters, and the majority of the sector's workforce.

**But the civil nuclear sector's economic impact is not restricted to this direct contribution.** In its procurement of goods and services from domestic suppliers, it supports an 'indirect' impact that stretches along its extensive network of UK-based supply chains. Moreover, the £3.2 billion in gross salaries paid by the sector during 2016—in addition to the salaries paid by its supplier industries—support consumption expenditure by these workers, for example in retail and leisure outlets. This gives rise to a further, 'induced' consumption multiplier effect, that is also ultimately attributable to the operations of the civil nuclear sector.

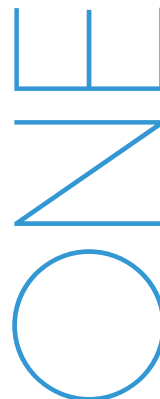
**Taking these indirect and induced channels of impact into account, the civil nuclear sector supported a total GDP contribution of £12.4 billion during 2016.** In addition, when counting these same multiplier mechanisms, around 155,000 jobs were supported across the UK by the sector, while tax revenues totalling almost £4.5 billion were contributed to the Exchequer. The spatial distribution of these wider impacts further underlines the importance of the sector to the economies of the north west and south west of England. During 2016 we estimate civil nuclear activities supported around £1 in every £50 of economic output in these regions.

**However, these quantifications alone would be an incomplete picture of the economic value that the civil nuclear sector delivers the UK.** The sector provides additional 'catalytic' benefits, that amount to enlargements of the supply-side of the economy, thereby improving the nation's future growth potential. One example of these catalytic impacts is the extent of the civil nuclear sector's investments in training and capabilities development. The primacy of specialist knowledge and expertise in the sector is evidenced by the very high productivity of its workers, and average salaries that are markedly above equivalent figures for the UK economy as a whole. But the sector also works to ensure a sustainable in-flow of workers with such specialist skills, not least through the provision of thousands of graduate roles and apprenticeships. Initiatives such as these provide opportunities for people of all ages to develop careers in the civil nuclear sector, and foster the stock of skills available in the UK's workforce, supporting future productivity and prosperity.

**The importance of research and innovation within the sector's activities also points towards further catalytic benefits for the UK economy.** We estimate that in 2016, around 2,700 people worked in research and development (R&D) roles within the civil nuclear sector. Innovations that emerge from such R&D activity invariably diffuse throughout the economy, in a 'spillover' effect that provides benefits stretching far wider than the sector itself, raising productivity across the economy.

**The sector's fusion research activities are an example of innovation objectives that could have profound economic implications.** Should the technology eventually realise its potential, the resultant low-carbon and practically limitless energy would provide benefits well beyond those for the power generation sector itself.

**In addition, the value of averted carbon emissions that nuclear power enables are not calculated in this Oxford Economics assessment,** the improved health, energy security and environmental benefits that stem from burning less hydrocarbon fuels undoubtedly have important economic benefits, despite being difficult to quantify. All of these wider, less tangible benefits can be considered additional to the sector's monetary and employment contribution to the UK, that are set out in this section of the report. However, some of this is considered by the Nuclear Industry Association in part two of this report.



---

## The UK's Energy Landscape

- 1.1 The UK is committed to reducing its greenhouse gas emissions by at least 80%, relative to its 1990 baseline level, by 2050.<sup>1</sup> The country has so far met its five-year targets toward this goal, with emissions in 2016 standing at 42% below the 1990 baseline. But meeting future targets will be more challenging, requiring the UK's emissions to fall by an average of 3% every year.
- 1.2 The complete replacement of coal-fired generation with low-carbon energy sources is a central component of the government's plans to meet these emission targets. Coal is the most carbon-intensive source of electricity generation, and is being phased out through the planned retirements of the UK's ageing coal plants. As such, coal generation has been on a downward trend over recent years, with the latest Digest of United Kingdom Energy Statistics (DUKES),<sup>2</sup> for 2016, showing UK coal production fell by almost two-thirds (60%) on 2015 levels, taking it to a record low.
- 1.3 Despite this progress, eliminating the fuel altogether will be a significant challenge. Increasing the share of low-carbon and renewable technologies within the UK's generation mix will imply increases in intermittency. The variable nature of power drawn from (for example) solar PV and wind can make it more difficult for network operators to supply power exactly on demand, and often requires backup capacity to be left on 'standby', should any shortages emerge.
- 1.4 In this context, nuclear power is a valuable asset in the UK's electricity mix. It can be generated continually, and in a predictable manner that can be scheduled weeks ahead of time, making it a reliable source of baseload electricity capacity. These characteristics will become increasingly important as fossil fuels continue their decline in the UK's energy mix, being replaced by greater proportions of low-carbon and renewable sources.

---

## The UK's Civil Nuclear Sector

- 1.5 Nuclear power is a well-established low-carbon alternative to fossil fuels. The UK's first commercial nuclear plant opened in 1956, and nuclear has provided the country with electricity for 60 years. Today, the UK has 15 operating nuclear reactors.
- 1.6 The supply of nuclear electricity in the UK has recently increased, following a decline since the late 1990s. A 10% increase in generation between 2014 and 2015 saw nuclear's share of the UK's energy generating mix reach 21%, the largest contribution from any single low-carbon energy source.
- 1.7 But, all but one of the UK's currently active nuclear plants are set to retire by 2030. Along with the winding up of coal generation in the UK, this presents the risk of an electricity supply shortfall, if sufficient replacement capacity is not developed in time. While advances in demand management are continuing,<sup>3</sup> the retirement schedule of large power stations in the UK foreshadows an ongoing tightening of the 'cushion' between electricity demand and supply.

<sup>1</sup> Climate Change Act, (c.27), (2008).

<sup>2</sup> Digest of UK Energy Statistics (DUKES), June 2017 <https://www.gov.uk/government/collections/digest-of-uk-energy-statistics-dukes>.

<sup>3</sup> Examples of these include energy efficiency measures, smart metering, distributed generation and household energy storage.

- 1.8 Given these long-term trends, since 2006, there has been a renewed focus on developing new nuclear power capacity. In 2010, the UK government identified eight suitable sites for new nuclear power plants. The first of these, Hinkley Point C, received final approval in September 2016, and is set to be the first new nuclear site to open in the UK in over two decades.
- 1.9 The UK's civil nuclear sector today employs around 65,000 people, and this report estimates the contribution that it made to the UK economy during calendar year 2016.

---

## Scope of this Study

- 1.10 Our definition of the 'civil nuclear sector' rests upon the organisations that are members of the Nuclear Industry Association (NIA), and feature in its 2016 Jobs Map survey.<sup>4</sup> This encompasses firms directly involved in the generation of nuclear power, and those in its 'nuclear-specific' supply chain. This definition includes:
- ▶ Operators of the UK's nuclear power stations;
  - ▶ Developers of new nuclear power stations;
  - ▶ Firms that fabricate nuclear fuels, as well as those that work in the 'back-end' of the fuel cycle, such as waste processing and management;
  - ▶ Companies engaged in the decommissioning of nuclear power stations and reactors that are no longer active;
  - ▶ Those providing specialised components, infrastructure and expertise such as nuclear engineering, manufacturing, and consultancy firms; and,
  - ▶ Organisations conducting nuclear research, for example into reactors, fuel, waste and fusion research (but excluding defence research).
- 1.11 The Nuclear Decommissioning Authority (NDA) is excluded from our definition, as are any activities focussed on defence or military applications of nuclear technology. We also exclude the majority of the UK's academic nuclear researchers.<sup>5</sup>
- 1.12 The report draws upon data from the NIA, official statistics from the Office for National Statistics (ONS), HM Revenue & Customs (HMRC), and a bespoke survey of NIA members, conducted by Oxford Economics in May and June 2017.
- 1.13 Our study quantifies the contribution the civil nuclear industry makes to employment, GDP, and tax revenues. In addition to measuring the direct impact of the civil nuclear industry, we examine the wider economic 'footprint' that is supported by the industry's domestic supply chains, and the wage-financed consumption of its workers, and those within its supply chain.
- 1.14 But the civil nuclear sector's impact goes beyond this core economic contribution. The investments that nuclear organisations make in research and development (R&D) activities, as well as in staff training and skills development, boost the UK's productive capacity. As such these activities not only benefit the sector itself, but also have wider 'catalytic' impacts elsewhere in the economy. This report also assesses these contributions.

<sup>4</sup> Nuclear Industry Association Jobs Map <https://www.niauk.org/resources/jobs-map>.

<sup>5</sup> Some academic institutions are included in our study scope: these are the Reactor Centre at Imperial College London, the Dalton Nuclear Institute at the University of Manchester, and the South West Nuclear Hub at the University of Bristol.

# INTRODUCTION TO ECONOMIC IMPACT ANALYSIS

The economic benefits of the civil nuclear industry are assessed using a standard means of analysis, called an economic impact assessment. This involves quantifying the sector's impact across three 'core' channels, consisting of:

- ▶ **Direct impact**, which relates to the civil nuclear sector's own activities. It encompasses the economic activity and employment supported directly by firms in the civil nuclear sector, and the taxes it generates.
- ▶ **Indirect impact**, which encapsulates the economic activity and employment supported in the supply chain of the civil nuclear industry, as a result of its procurement of goods and services from firms in other sectors.
- ▶ **Induced impact**, which comprises the wider economic benefits that arise when employees within the civil nuclear industry, and its supply chain, spend their earnings, for example in local retail and leisure establishments.

The sum of these channels make up the civil nuclear industry's total economic impact. Three main metrics are used to present a picture of the industry's economic contribution:

- ▶ **GDP**, or more specifically, the gross value added (GVA) contribution to GDP.<sup>6</sup>
- ▶ **Employment**, measured on a headcount basis.
- ▶ **Tax revenues**, the estimated fiscal contribution resulting from transactions and employment sustained by the civil nuclear industry.

The modelling is conducted using an Input-Output (I-O) based model of the UK economy, and its constituent nations and regions. This model was constructed by Oxford Economics, using macroeconomic, employment and tax data published by the Office for National Statistics and Her Majesty's Revenue and Customs.

The report also examines the '**catalytic**' impacts the civil nuclear sector has on the UK economy. The catalytic impacts represent the wider benefits other industries, government, consumers, and society gain from the industry's productivity boosting activities. In this report, we examine two channels through which the industry generates these wider benefits:

- ▶ The civil nuclear industry's investment into skills, training, and education; and
- ▶ The impact of the civil nuclear industry's innovation and R&D activities, which lead to the development of new products and processes.

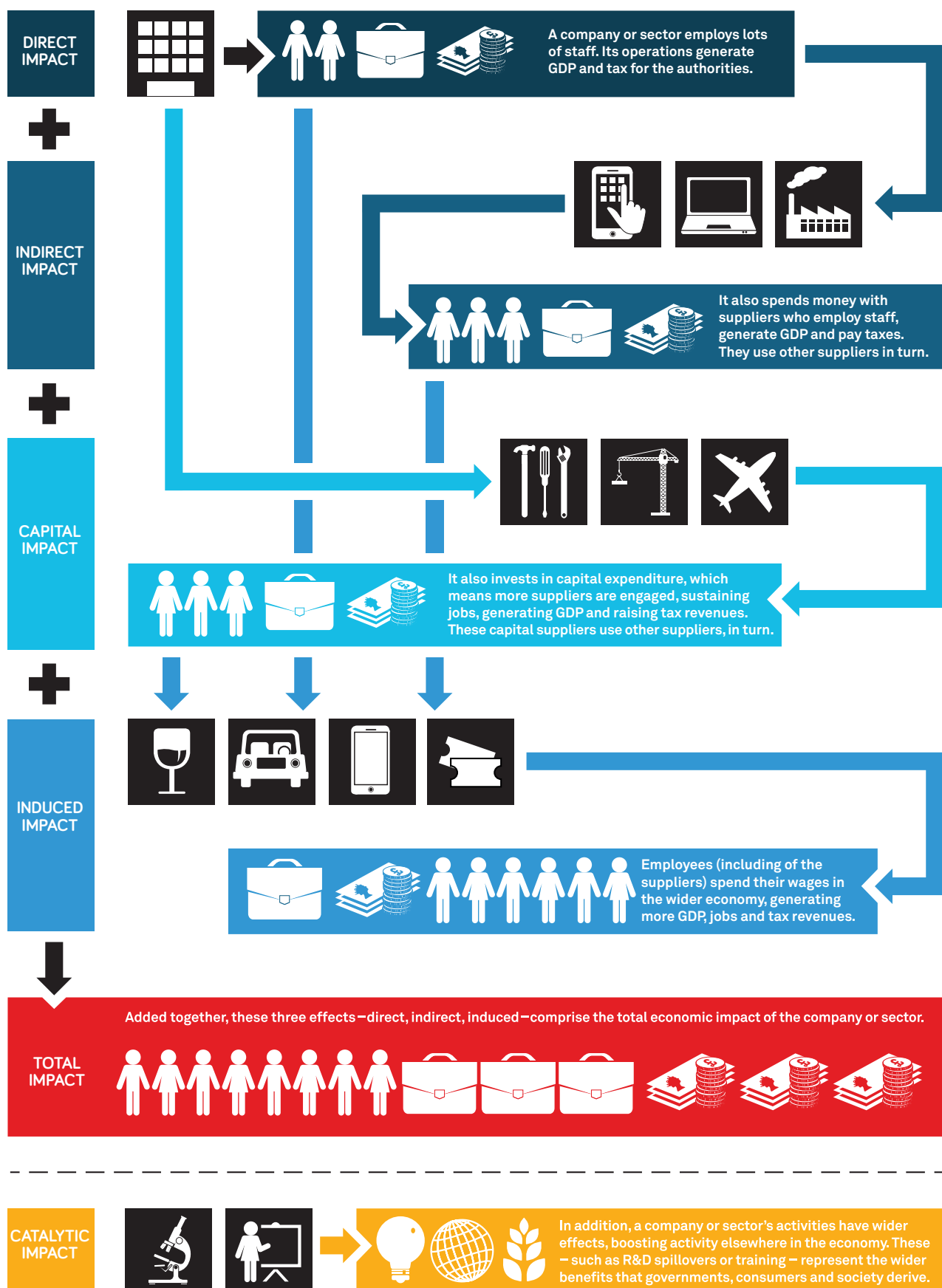
The analysis is underpinned by data from the Nuclear Industry Association (NIA), and a bespoke online survey of NIA members conducted during May and June 2017.

Fig. 1 on the following page sets out how the various channels of a standard economic impact study relate to one another.

Further detail about the economic impact methodology is included in Appendix 1.

<sup>6</sup> GDP, or Gross Domestic Product, is the total value of final goods and services produced in an economy over a given period. The contribution of an individual producer, industry or sector to GDP can be understood as either:

- (i) the value of output (goods or services) less the value of intermediate inputs used in the production process; or
- (ii) the sum of compensation of employees (gross wages) and gross operating surplus (profits).



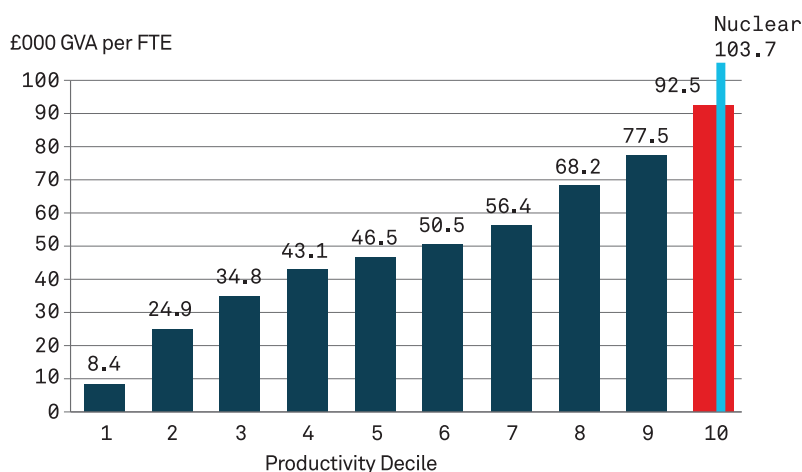
▲ Fig. 1 Channels of Impact

# Economic Impact of the UK's Civil Nuclear Sector

- 2.1 This chapter presents the findings of the Oxford Economics analysis of the core economic impact of the civil nuclear industry in the UK. The modelling underpinning this analysis is informed by the NIA's 2016 Jobs Map, and a bespoke survey of the NIA's members, which was used to ascertain the economic characteristics of their nuclear-related activities.

## Direct impact

- 2.2 The direct impact of the sector captures the civil nuclear sector's own employment and operations. This means it includes entities operating nuclear power plants, those working in decommissioning and waste management, and those engaged in nuclear-specific engineering, construction, manufacturing, consulting, research and other services.
- 2.3 **The sector created an estimated £6.4 billion gross value added (GVA) contribution to GDP during 2016.** This is calculated based on the mix of activities within the civil nuclear sector, and Oxford Economics' estimates for the typical output that is contributed by workers undertaking each type of activity.
- 2.4 **This means the civil nuclear sector directly generated around 0.3% of the UK's entire GDP during 2016.** This is broadly equivalent to the direct GDP contribution of the aerospace manufacturing sector in the same year; or almost two-thirds (64%) of the UK's oil and gas industry.
- 2.5 **This GDP was contributed by the 65,790 people working in the UK's civil nuclear industry.** To put this into context, this is the same as three-quarters of all employment within the aerospace manufacturing industry, or nearly double (185%) of the workforce of the UK's entire pharmaceuticals sector. Put another way, the civil nuclear sector directly employed one in every 525 people employed throughout the UK during 2016.



- 7] The value in Fig. 2 show the lower-bound of each decile, and can be interpreted as follows. If all the UK's workers were arranged in a line from least to most productive, the productivity of the first 10% of these would range between £8,400 and £24,900 (first decile). The productivity of the second 10% would range between £24,900 and £34,800 (second decile), and so on. The productivity of the top decile—the 10% most productive workers in the economy—would be above £92,500. This decile would include the civil nuclear workforce.

◀ Fig. 2 Distribution of productivity within the UK's workforce in 2016, by decile<sup>7</sup>

Source: ONS, Oxford Economics

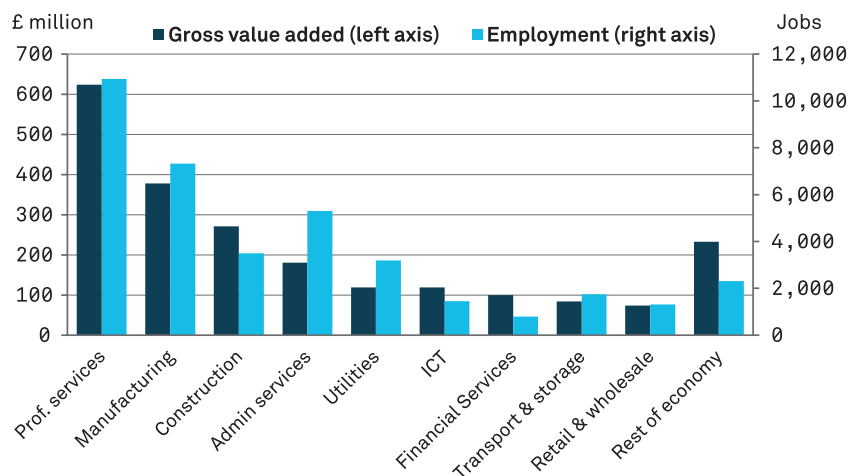
- 2.6 **Employees in the civil nuclear sector are highly productive. In 2016, each worker contributed an average of £96,600 in GVA to the economy.** This was almost three-quarters (73%) higher than the UK average of £56,200 per person in that year. This high productivity reflects both the highly-skilled nature of the civil nuclear workforce, and the intensive use of advanced technologies to add value.
- 2.7 When adjusting for the proportions of full and part-time working within the civil nuclear sector, its productivity reaches £103,700 of GVA per full-time equivalent (FTE) worker. This places the UK's civil nuclear workforce firmly within the most productive decile of economy, as shown in Fig. 2.
- 2.8 **The civil nuclear industry also generates substantial sums in taxes for the Exchequer.** Through generating electricity, procuring inputs, accruing profits and employing workers and paying wages, the sector is liable for many different forms of tax payments. These include VAT and other product taxes, business rates, Corporation Tax, and labour taxes, such as income tax and employees' and employers' National Insurance Contributions (NICs).
- 2.9 **We estimate the activities of the civil nuclear sector gave rise to around £2.8 billion in tax payments in 2016.** This is equivalent to the gross annual salaries of 71,000 police officers.

---

## Indirect impact

- 2.10 **The civil nuclear sector draws upon a vast and complex network of supply chains.** The nuclear-specific proportion of these supply chains—for example, the specialised activities of nuclear engineers, consultants and manufacturers—are captured within NIA's membership, and are thus encompassed in the direct impact described above.
- 2.11 **However, the civil nuclear sector also depends upon other, non-nuclear specific inputs.** This involves billions of pounds' worth of operational and capital expenditure with other industries in the UK, procurement spending that supports further GDP and employment contributions among its suppliers. In addition, these suppliers draw upon their own suppliers, and so on along the supply chain, extending across all sectors and regions of the UK economy.
- 2.12 **The civil nuclear sector spent an estimated £2.8 billion on inputs of goods and services from non-nuclear UK firms.** This estimate takes into account the extent of procurement with other civil nuclear industry firms (captured in the direct impact), as well as the extent of imports (that 'leak' out of the UK economy and are assumed to provide no further economic benefit).
- 2.13 **The procurement expenditure generated a further £2.2 billion in UK GDP during 2016.** This GDP contribution benefitted a range of industrial sectors across the UK. The largest beneficiary industry in terms of GVA was the professional services sector, which saw £624 million in GVA, accounting for almost a third (29%) of the total indirect impact. This reflects the importance of engineering and other technical services in the civil nuclear sector's supply chain, as well as other business services such as legal, accounting and advisory activities.
- 2.14 The manufacturing and construction sectors also generated a significant GDP contribution as a result of demands from the civil nuclear sector. The indirect GVA impacts in these sectors reached £650 million, accounting for another 30% of the total indirect impact.

2.15 **The civil nuclear sector's procurement of goods and services also supported an estimated 37,900 jobs in 2016.** The largest indirect employment impact was again among the professional services industry, in which around 10,900 jobs were supported by the procurement demands of the civil nuclear sector. Manufacturing, and administrative services such as facilities management and employment agencies, also enjoyed large shares of the total indirect jobs impact. Together, these sectors saw 12,600 jobs supported, equivalent to around 33% of the total indirect jobs impact.



◀ **Fig. 3 Indirect impact of the civil nuclear sector, 2016**

Source: NIA, ONS, Oxford Economics

2.16 **This economic activity generated £550 million in tax receipts in 2016.** This comprised of labour taxes, corporation taxes, and other taxes on products and production.

## Induced impact

2.17 The final channel of 'core' economic impact considered is the induced impact of the civil nuclear sector. This describes the GVA, employment, and tax revenues supported throughout the UK by the wage-financed consumption of workers in the civil nuclear sector, and by workers in its supply chain.

2.18 **An estimated £3.2 million in gross wages and salaries were paid to the civil nuclear sector's staff in 2016.** This is a substantial wage bill, reflecting high average salaries throughout the sector. Fig. 4 on the following page sets out the estimated distribution of salaries throughout civil nuclear organisations in the UK. Across the income scale, the civil nuclear sector's salaries far exceed UK averages, with a median salary fully twice as high as the equivalent figure for the UK economy as a whole. This disparity underlines the prevalence of highly-specialised skills among workers in the civil nuclear sector.

2.19 A portion of these wages are expended in the form of consumption spending: including spending at retail and dining outlets, on leisure activities, utilities, housing, and so on. Similarly, wage payments by companies throughout the civil nuclear sector's supply chain will also stimulate consumer spending.

2.20 **In total, this wage-financed consumer spending generated a further £3.9 billion contribution to UK GDP in 2016.** The real estate sector and retail/wholesale industry account for the largest shares of this impact, at £991 million (26%) and £600 million (16%), respectively.

Fig.4 Distribution of gross annual salaries in the UK and civil nuclear sector, by percentile, 2016

Source: NIA, ONS, Oxford Economics

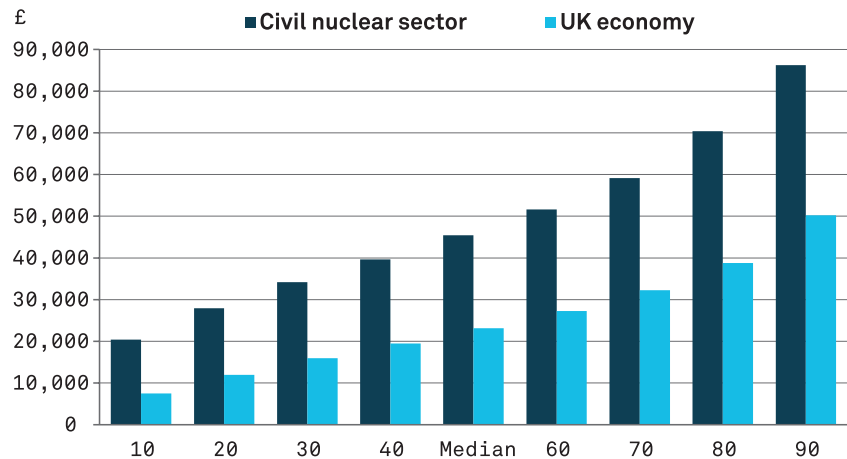
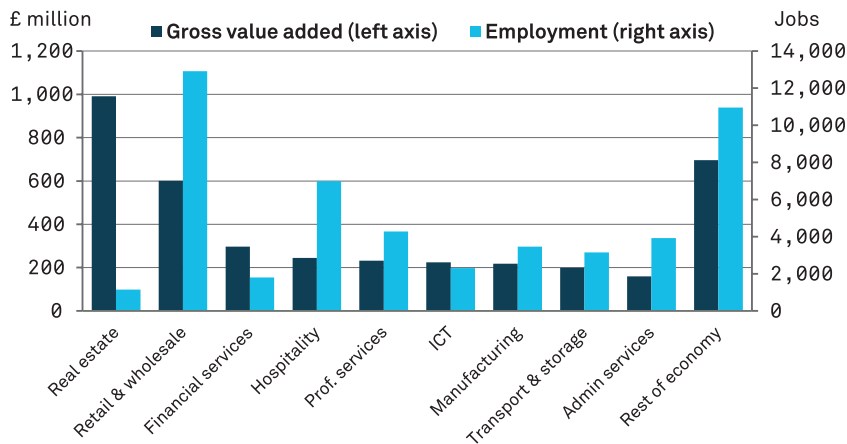


Fig.5 Induced impact of the civil nuclear sector, 2016

Source: NIA, ONS, Oxford Economics

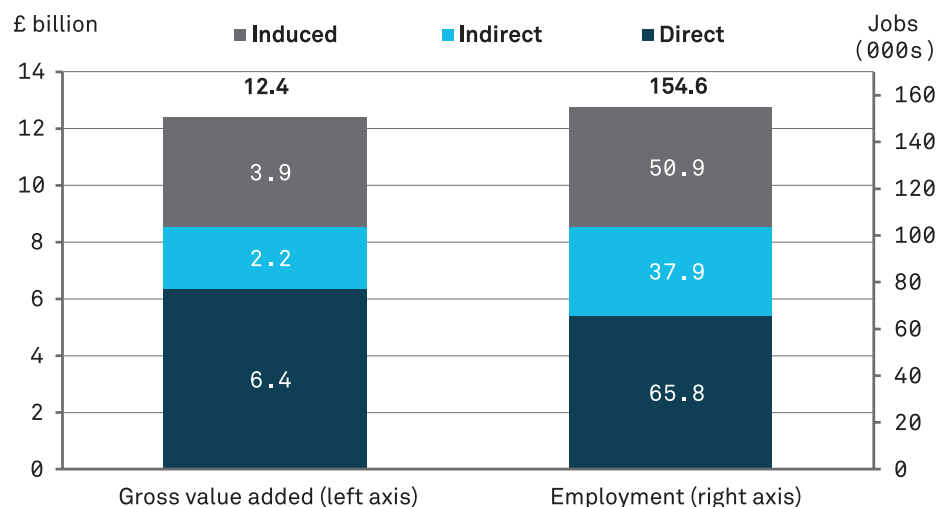


- 2.21 **This induced consumption, attributable to the civil nuclear sector, also supported almost 50,900 jobs in 2016.** The sector seeing the greatest number of jobs supported was the retail and wholesale industry, which saw around 12,900 jobs supported – a quarter of the total induced jobs impact. A further 7,000 jobs (14% of total) were supported in the hospitality sector, encompassing restaurants, cafes, bars and hotels. The small employment impact in the real estate sector (relative to its GVA impact), reflects the very capital-intensive nature of the industry.
- 2.22 **This induced activity also gives rise to additional revenues for the Exchequer.** The wage-financed spending of civil nuclear sector workers, and employees within its supply chains, incur VAT and other product taxes. Moreover, the firms meeting these consumer demands also pay taxes on their profits and salary payments. These induced tax contributions reached £1.1 billion in 2016.

Total impact

- 2.23 The total economic contribution the civil nuclear sector makes to the UK is the sum of the three channels of impact discussed in this chapter—direct, indirect, and induced.
- 2.24 **Through these three channels, the civil nuclear sector supported a £12.4 billion GVA contribution in 2016.** This amounts to 0.6% of the UK’s total GDP, or all

of the UK's economic output for more than two days. More than half (51%) of this contribution was made by civil nuclear organisations themselves, with the remainder supported through the sector's procurement spending and wage payment multiplier impacts.



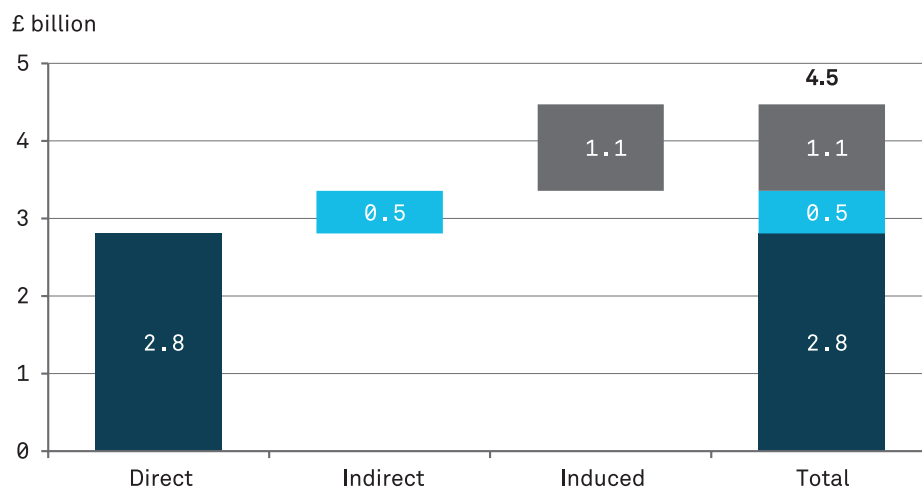
◀ Fig. 6 Total impact of the civil nuclear sector, 2016

Source: NIA, ONS, Oxford Economics

Totals may not sum due to rounding'

2.25 **Through these three channels, the civil nuclear sector sustained around 154,600 jobs in 2016.** This means that one in every 223 jobs in the UK was in some way supported by the civil nuclear sector's activities. Some 65,800 of these are employees working directly in the civil nuclear sector, making up 43% of the total. Another quarter (24%), some 37,900 jobs, were supported in the industry's non-nuclear supply chain. The remaining 50,900 jobs were sustained through its consumption multiplier impact.

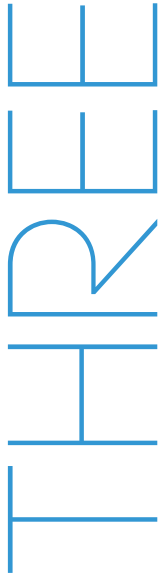
2.26 **The output and employment supported by the civil nuclear sector also generated an estimated £4.5 billion in tax receipts in 2016.** This includes Corporation Tax, income taxes and NICs, and other taxes on production and products. Almost two-thirds (63%) of this contribution to the Exchequer was attributable to the civil nuclear sector's own activities, with the remainder attributable to its wider multiplier impact.



◀ Fig. 7 Total tax impact of the civil nuclear industry, 2016

Source: NIA, ONS, Oxford Economics

# Regional Contribution



3.1 We also investigated the impact the civil nuclear sector has on each of the UK's constituent nations and regions. This chapter of the report sets out the results of this analysis.

## Contribution to Regional GVA

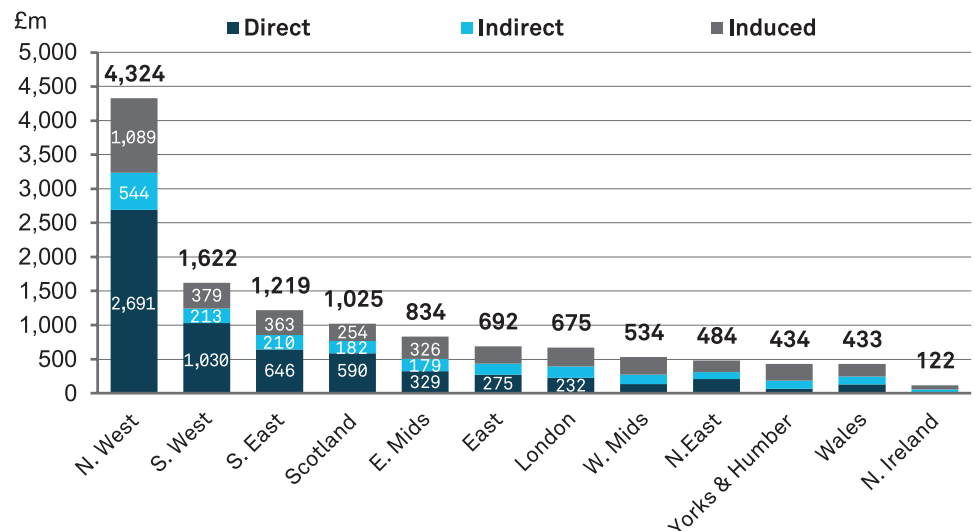
3.2 **The north west sees the civil nuclear sector's largest regional impact, in both absolute and relative terms.** Some £4.3 billion in GVA was contributed by the nuclear sector in 2016, equivalent to 2.7% of all regional output. The north west's prominence is unsurprising, given its status as the most extensive cluster of nuclear activities in the UK. This cluster includes Sellafield, housing decommissioning and waste processing activities, as well as the National Nuclear Laboratory's (NNL) flagship central facility. The north west also contains the Heysham reactors and multiple fuel production sites, further underlining the region's importance to the UK's civil nuclear sector.

3.3 **The south west saw the next-largest impact, totalling an estimated £1.6 billion in 2016.** The £1.0 billion direct GVA contribution was driven by the nuclear activities at Hinkley as well as the Berkeley, Oldbury and Winfrith decommissioning sites. Meanwhile, the local supply chains and consumption spending impacts supported a further £592 million worth of GVA in the region.

3.4 Much of the remainder of the civil nuclear sector's impact is concentrated in regions featuring other operational power stations or decommissioning sites, including the south east (housing Dungeness and Harwell, as well as the UK's first fusion energy research facility at Culham); Scotland (Hunterston, Torness, Chapelcross and Dounreay) and the east of England (Bradwell and Sizewell).

Fig.8 GVA impact of the civil nuclear sector, by UK nation / region, 2016

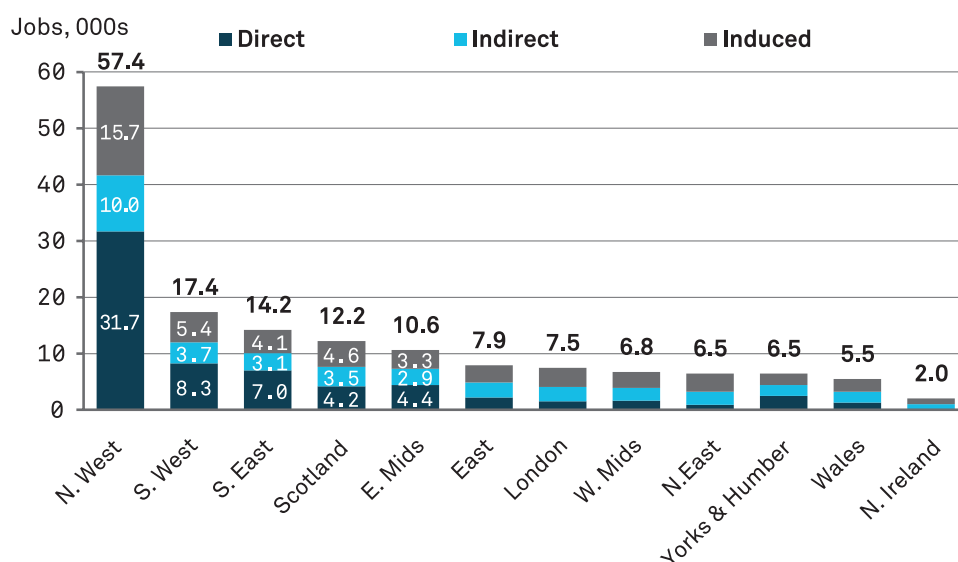
Source: NIA, ONS, Oxford Economics



## Contribution to Regional Employment

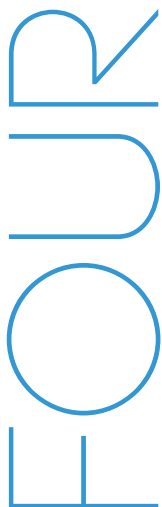
3.5 When examining the civil nuclear sector's employment impact across the UK's nations and regions, a similar distribution can be observed.

- 3.6 **The north west contains by far the largest number of jobs supported by the civil nuclear sector, at 57,400.** This impact encompasses the direct employees of the sector itself, as well as the jobs supported along local supply chains, and in the local consumer economy. The scale of this jobs impact reaches 1.6% of the entire regional workforce. Put another way, the civil nuclear sector supports one in every 63 jobs throughout the north west, a region that includes the cities of Manchester and Liverpool.
- 3.7 **Some 17,400 jobs were supported in the south west, amounting to around 0.6% of the region's total employment.** This proportion is only half as large as the sector's share of the region's output (1.2%). This relatively larger GVA footprint is due to the highly productive nature of the civil nuclear workers in the region, characterised by employees at the operational reactors and in their local supply chains.
- 3.8 The sector's indirect and induced jobs impact is spread more evenly across the UK than is the case for direct employment. While all of these jobs are attributable to the civil nuclear sector's activities, the supply chain and consumption spending 'ripples out' to form a wider footprint than the distribution of the UK's nuclear organisations themselves. This can be seen in the example of Northern Ireland, where around 2,000 jobs are estimated to be supported by the civil nuclear sector, despite the relatively scant presence of nuclear organisations there.



◀ Fig. 9 Employment impact of the civil nuclear sector, by UK nation/region, 2016

Source: NIA, ONS, Oxford Economics



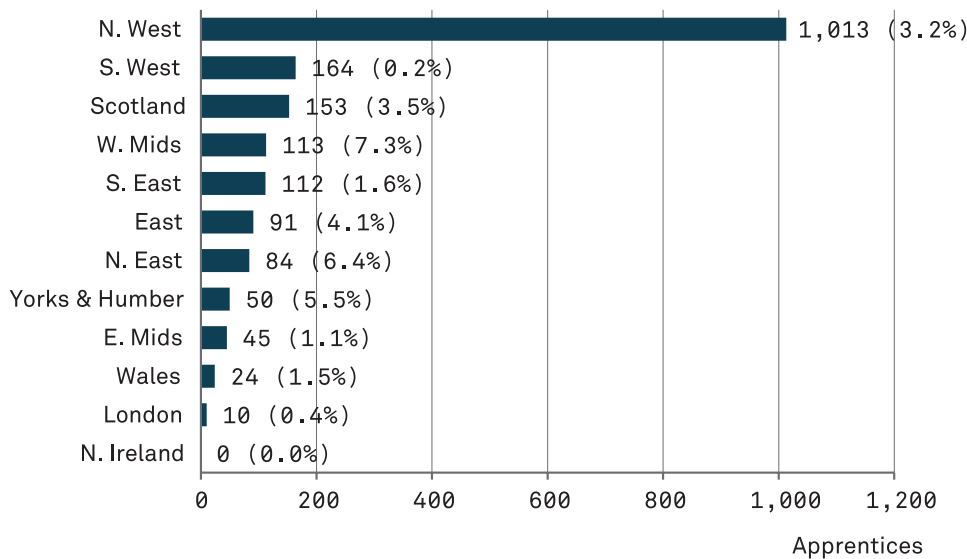
# Wider Impact of the Civil Nuclear Sector

- 4.1 Previous chapters focussed on the 'core' economic contribution of the civil nuclear sector to the UK economy. Through its activities, expenditures and wage payments, the industry supports tens of thousands of jobs and billions of pounds' worth of GDP. However, there are other, broader ways in which the civil nuclear sector contributes to the economy. This chapter of our study explores these wider facets of the sector's impact.
- 4.2 For example, through the recruitment and training of their workers, civil nuclear organisations impart skills and abilities that benefit individual employees in a narrow sense. But this training also provides benefits to the economy overall, as the higher wages upskilled workers can command then boost tax receipts, and support additional consumption spending too. The sector's R&D activity also has benefits for the economy. Some of the technological advances and innovations that emerge from its investment in R&D will affect other sectors of the economy, in a so-called 'spillover' process.
- 4.3 Both channels help improve the UK's productive capacity, by increasing the stock of human and knowledge capital, respectively. Developing these stocks of skills and knowledge supports future output, incomes, and prosperity. While the nature of these 'catalytic' impacts means their size is not always straightforward to quantify, they undoubtedly amount to meaningful economic contributions which benefit governments, consumers, other industries, and society.

---

## Skills, Training and Development

- 4.4 The number of people employed in the sector is not the only job-related metric that is of economic relevance. The efforts the sector makes in training and developing its workers are an important supply-side contribution to the UK economy, with a highly-skilled workforce being a key ingredient in improving nationwide productivity.
- 4.5 The industry not only recruits skilled employees, but also provides a range of training, from informal on-the-job training to apprenticeships and graduate schemes, thereby making an important contribution to the UK's productivity. Training, and apprenticeships in particular, help young employees acquire skills and experience which increase their life-long probability of being employed, while also lifting the wages they can expect to command in the job market.
- 4.6 **Organisations in the civil nuclear sector employed around 1,070 workers on graduate schemes during 2016, equivalent to 1.4% of its workforce.** Initiatives such as these provide formal, structured training and career progression opportunities to young workers, and help ensure a sustainable in-flow of qualified workers into the UK's civil nuclear workforce.
- 4.7 **In 2016, the sector also employed 1,940 apprentices throughout the UK, reaching 2.8% of all civil nuclear employment.** These apprenticeships allow staff to earn incomes and gain vital on-the-job experience, whilst studying for formal qualifications. Organisations in the sector offer these apprenticeships at different levels: from Level 2, which is equivalent to GCSEs; to Level 4 and above, equivalent to foundation or higher degrees.
- 4.8 Over 1,000 of these were within organisations based in the north west, further-highlighting the region's importance as a centre of nuclear training and development.



◀ Fig. 10 Apprentices in the civil nuclear sector, by region, 2016<sup>8</sup>

Source: NIA, ONS, Oxford Economics

4.9 There is well-developed academic literature that measures the economic benefits of gaining apprenticeships and other vocational qualifications. For the individual, the returns to such training are an increased likelihood of being employed, and receiving higher wages on average.

4.10 For example, BIS research found that those completing a Level 2 apprenticeship can command a 16% wage premium, rising to around 18% for Level 3 apprentices (relative to those with a Level 1 qualification or below). It also found apprenticeships are estimated to increase the lifetime probability of being employed, by 2.7% for a Level 2 apprentice and 3.8% for a Level 3 apprentice (again compared to an individual with Level 1 qualification or below).<sup>9</sup> This paper, and other analyses, also identify significant wage and employment benefits for apprentices, relative to those with equivalent qualifications but no apprenticeship. This points towards the additional value that is delivered by the practical, applicable knowledge obtained through apprenticeship programmes.

4.11 The wage premium and higher employment likelihood both point towards benefits for employers also. Given that wages align with the productivity of a worker over the long-term, these significant and persistent effects are evidence of apprenticeships imparting additional capabilities to employees, enhancing their effectiveness. They support higher profits or increased competitiveness for their firm — since better-trained employees are more efficient, can undertake more complex tasks, and also tend to diffuse their knowledge throughout the organisation.

4.12 However, some of the external benefits go beyond the firm investing in training. The role of education and skills in driving productivity and economic growth have long been recognised in academic and government policy.<sup>10</sup> Workers moving jobs deliver these benefits into new contexts and to new firms, spreading the benefits throughout the economy. Higher average skill levels also support greater technological innovation and adoption, increasing the returns to investment in R&D.

<sup>8</sup> The percentage values in brackets indicate the proportion of the civil nuclear sector workforce that is made up of apprentices.

<sup>9</sup> Department for Business, Innovation and Skills (now the Department for Business, Energy and Industrial Strategy), Measuring the economic impact of further education (Research Paper Number 38, 2011).

<sup>10</sup> For a discussion of the literature on the role of education and skills in productivity growth, see BIS, UK skills and productivity in an international context (Research Paper No. 262, 2015).

- 4.13 Finally, a better qualified worker is also good news for the Exchequer. BIS also found that vocational qualifications are associated with significantly higher tax receipts. The lifetime returns to the Exchequer are found to be between £31,000 and £48,000 for a Level 2 apprenticeship, and between £56,000 and £81,000 for a Level 3 apprenticeship.<sup>11</sup>

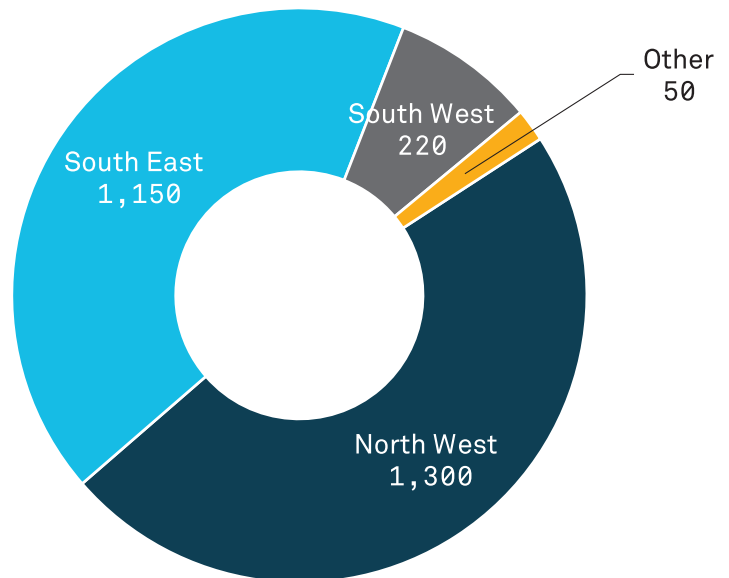
## R&D and Innovation

- 4.14 Given the complex technology involved in the construction and operation of nuclear power plants, the civil nuclear industry undertakes continual innovation. Innovation and R&D activity is important for delivering improved products and processes to businesses, government, and consumers. It is also a key component of productivity growth, which is a fundamental driver of a country's long-term prosperity.
- 4.13 **We estimate that the UK's civil nuclear sector includes over 2,700 people who work in nuclear research facilities.** Fig. 11 shows how this workforce breaks out across the UK's regions. It can be seen that the civil nuclear research workforce is predominantly concentrated in the north west (home to Sellafield and the NNL's Central Laboratory), and the south east (where the Culham Centre for Fusion Energy is located).

**Fig. 11 Distribution of the UK's civil nuclear sector R&D workforce, 2016**

Source: NIA, NIRAB, Oxford Economics

Persons

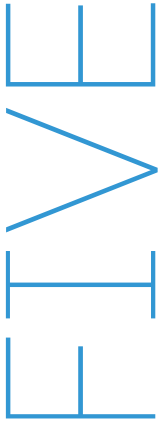


- 4.14 **The UK's nuclear research primarily focusses on developing innovations in waste management and decommissioning, as well as in fusion research.** This reflects the landscape of the UK's civil nuclear sector: with many decommissioning sites and extensive waste disposal activities, the potential gains from new techniques and breakthroughs could be huge.

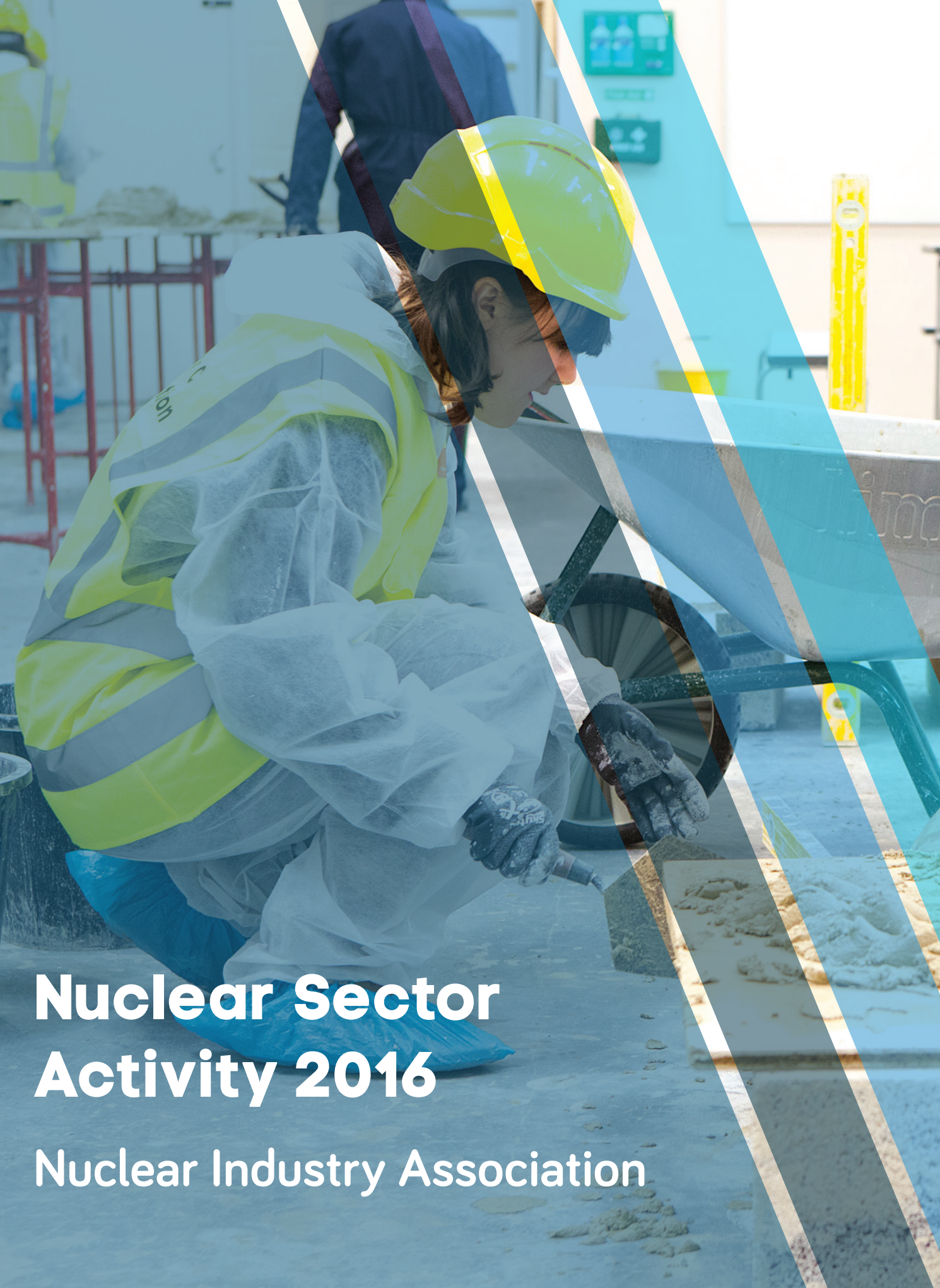
<sup>11</sup> Department for Business, Innovation and Skills (now the Department for Business, Energy and Industrial Strategy), Returns to Intermediate and Low Level Vocational Qualifications (Research Paper No. 53, 2011).

- 4.15 **The process of developing and operating new and innovative technologies can deliver private benefits (to the organisation performing the R&D), in the form of higher revenues and profits.** But it also gives rise to wider benefits, as advances are disseminated throughout other businesses, academia, government, and wider society. These ‘spillovers’ are a recognised positive externality of R&D activity, providing continual and long-term benefits to the UK economy.
- 4.16 **There are many ways that such innovation can spillover into the wider economy.** Patents and licensing fees are a one formal channel for the dissemination of advances, with the practical value of the new knowledge often greater than the cost of licensing it. But informal channels can be equally important for knowledge and technology transfers. Technical aspects of development can be shared across a firm’s supply chains, as suppliers to the innovating firm are exposed to new products or process improvements, that they can then apply to their own operations. Knowledge transfer among professional networks also facilitates the spillover of innovations (this is particularly prevalent among knowledge-intensive activities) and well-connected industries with established trade bodies.
- 4.17 **These mechanisms describe how knowledge can diffuse across an economy – thereby raising productivity for parties that did not undertake the initial R&D.** These mechanisms are mostly relevant in the context of ‘incremental’ or even ‘disruptive’ innovations: for example, in the civil nuclear sector, these might be advances in component or reactor design, fuel fabrication or disposal techniques, engineering approaches, or safety procedures.
- 4.18 **But the domain of nuclear research, and in particular fusion research, holds the promise of even more dramatic outcomes.** Research into fusion energy is an investment which could eventually have a significant future payoff, with world-changing economic implications: an effectively limitless and low-carbon electricity source. While it is not possible to predict when or how these benefits would materialise, the UK’s civil nuclear sector is an important contributing partner in the ambitious international effort in nuclear fusion.

# Conclusion



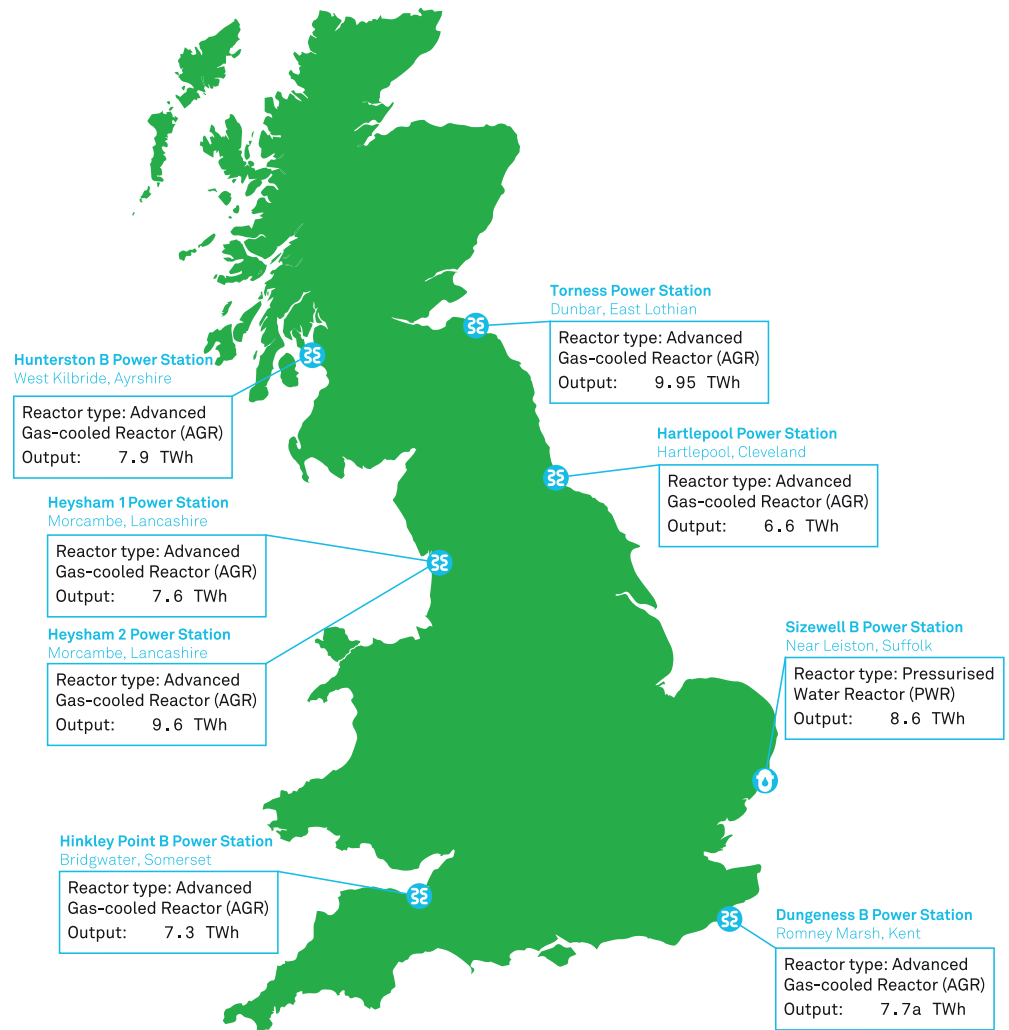
- 5.1 **Nuclear power is an essential component of the UK's energy mix, with 15 operational reactors across the country meeting over one-fifth of national electricity demand during 2016.** In the context of efforts to decarbonise the UK's power generation, the importance of nuclear energy is even more pronounced. It is the single largest source of low-carbon power in the UK, contributing more than half of the UK's low-carbon electricity supply.
- 5.2 **By enabling the provision of this power, the civil nuclear sector plays a critical role in the UK's energy landscape.** Power station operators, fuel fabricators, infrastructure providers and decommissioning companies all work in concert to deliver this low-carbon energy in a safe and efficient manner. In addition, UK organisations are also engaged in continual efforts to develop new techniques and innovations to improve nuclear power, including the cutting-edge domain of fusion research.
- 5.3 **This report has outlined how these important civil nuclear activities leave a sizeable 'footprint' on the UK economy.** During 2016, the civil nuclear sector's 65,790 workers directly generated some £6.4 billion in GDP. These contributions were enabled by nuclear activities in every region and nation of the UK, but the importance of the sector is more pronounced in certain areas. Well over half (59%) of the total direct GDP impact was contributed by the important civil nuclear clusters in the north west and south west of England; regions that house three-fifths (61%) of the sector's workforce.
- 5.4 **But the civil nuclear sector's economic 'footprint' extends well beyond the scale of its own activities.** By procuring inputs from UK-based supply chains, and supporting consumer spending through its payment of wages, its total impact reaches an estimated £12.4 billion. This output was associated with the employment of almost 155,000 people across the UK.
- 5.5 **In addition to this core impact, 'catalytic' economic benefits are also delivered by the operations of the civil nuclear sector.** Organisations in the sector invest heavily in the training and development of their employees, including through the provision of thousands of apprenticeships and graduate roles. These are contributions to human capital which enhance the stock of skills in the UK workforce, boosting its future productive potential. Moreover, the research-intensive nature of the sector gives rise to new developments and innovations, that diffuse throughout other sectors and industries, further-enhancing the UK's productive capacity.
- 5.6 **This section of the report also does not attempt to quantify the value of averted carbon emissions enabled by nuclear power,** compared to the 'baseline' situation of coal and gas generation. But the resultant economic impacts of improved air quality and energy security are undoubtedly enormous – pointing to yet another channel through which the civil nuclear sector supports the UK economy. While the full economic value of this array of additional benefits cannot be straightforwardly quantified in monetary terms, they are of great relevance when appraising the sector's economic importance.



# Nuclear Sector Activity 2016

Nuclear Industry Association

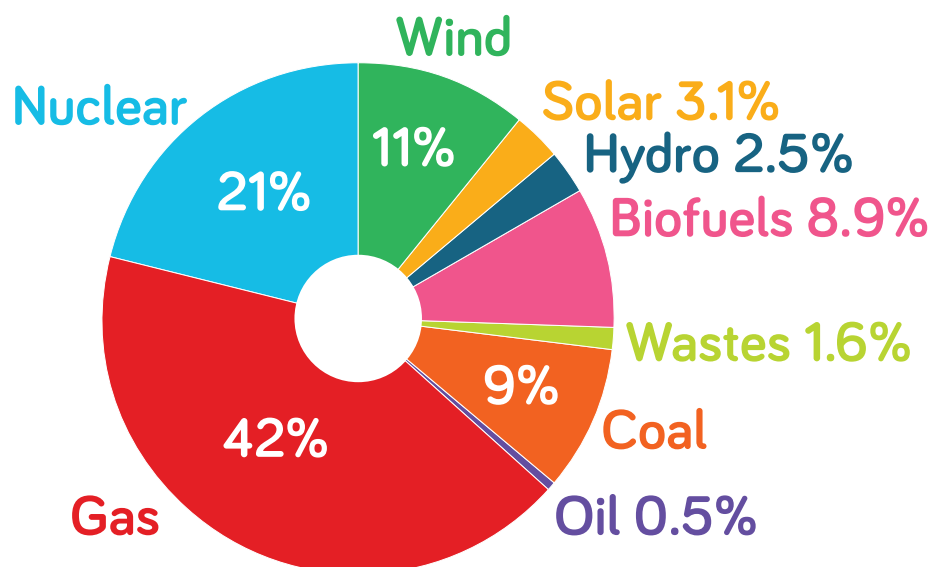
# Existing Generation



- 6.1 The UK has 15 nuclear reactors across eight sites which provide a constant source of always available, low carbon power for UK homes, businesses and public services.
- 6.2 Nuclear power remains the largest single source of low carbon electricity generation in the UK and the second largest energy source, following gas.

**Fig. 12 Shares of UK electricity generation 2016**

Source: BEIS, Digest of UK Energy Statistics July 2017



6.3 EDF Energy run the UK's nuclear fleet. In 2016 total output reached 65.1TWh, an increase of 4.5TWh on the previous year and the highest achieved since 2003 (Fig. 13).

6.4 This is a fifth of the UK's total electricity production and enough to power 16.3 million homes or 60% of all homes in the UK.

	2009	2010	2011	2012	2013	2014	2015	2016
Output (TWh)	55.1	48.3	55.7	60.0	60.5	56.3	60.6	65.1

◀ Fig. 13 Total output from EDF Energy Nuclear Generation fleet by calendar year

Source: EDF Energy

6.5 Nuclear power avoided the emission of 22.7 million metric tons of carbon dioxide (MtCO<sub>2</sub>e) in 2016, which is the equivalent to taking 10 million cars off the road<sup>12</sup> - or around a third of all cars on UK roads.

6.6 This performance has been made possible through the operators continued investment in the UK's nuclear power stations valued at £529 million in 2016, including lifetime extension, maintenance and performance improvements.

6.7 Since EDF Energy acquired the fleet in 2009, it has invested over £4 billion, improved safety performance by 51% and increased output by 50%.

Station	Reactor type	Date Commissioned	Scheduled Decommissioning
Hunterston B	AGR	1976	2023
Hinkley Point B	AGR	1976	2023
Hartlepool	AGR	1983	2024
Heysham 1	AGR	1983	2024
Dungeness B	AGR	1983	2028
Heysham 2	AGR	1988	2030
Torness	AGR	1988	2030
Sizewell B	PWR	1995	2035

◀ Fig. 14 Lifetime of EDF Energy Nuclear Generation fleet

Source: EDF Energy

6.8 The most recent nuclear power station to be built in the UK, Sizewell B in Suffolk, was connected to the grid in 1995 and is currently scheduled to close in 2035, however EDF Energy expects to be able to make the case to extend its running lifetime for up to a further 20 years.

6.9 In 2016 EDF Energy announced a series of life extensions to the fleet and operation of each of the Advanced Gas-cooled Reactors (AGR) has been extended by an average of eight years since 2009. However, all seven AGRs are currently due to cease operation by the end of 2030 (Fig. 14), highlighting the importance of the current nuclear new build plans.

6.10 Fleet-wide contracts were awarded to companies across the UK's supply chain.

<sup>12</sup> CCGT is likely to provide the majority of the UK's fossil fuel generation in the short to medium term, therefore in the absence of nuclear generation, the CO<sub>2</sub> comparison has been made with this source based on 0.349kg CO<sub>2</sub> per kWh.

- 6.11 Amec Foster Wheeler<sup>13</sup> secured a new agreement, worth £125 million to provide long-term support to EDF Energy Nuclear Generation. The five-year agreement, with an option to extend for a further five years, follows its 50-year partnership with EDF Energy under two similar frameworks - TSA1 and TSA2.
- 6.12 Costain is leading a project to create an infrared camera which uses augmented reality to assess radioactive pipelines which will change the way boiler tubes are inspected for defects. This has the potential to save millions of pounds as all pipes are currently exchanged regardless of their condition.
- 6.13 James Fisher Nuclear was awarded a contract to produce inspection tools, using its innovative eddy current technology, to assess the condition of the graphite cores across the fleet to a level that has not previously been possible.

---

## 2016 performance

### *Hunterston B*

- 6.14 Hunterston B in Scotland produced 7.9 TWh of electricity in 2016 – enough to power two million homes. It avoided 2.8 MtCO<sub>2</sub>e – the equivalent of taking 1.2 million cars off Scottish roads.<sup>14</sup>
- 6.15 EDF Energy's extensive graphite research programme has allowed it to develop a model of how reactor cores will age. Each reactor outage allows it to add to this research and clarify the reactors are ageing as expected.
- 6.16 Planned maintenance took place in May 2016, and as part of the routine inspections, engineers looked at the reactor's graphite core. The inspection identified two further cracks as a result of keyway root cracking, which is in line with EDF Energy's expectations at this stage of the reactor life, and is within the limits allowed by the safety assessment.
- 6.17 It is recognised by the UK's independent regulator, the Office for Nuclear Regulation (ONR) that during the life of a nuclear reactor, the core will lose some of its mass and cracks will appear in some of its bricks, as part of the ageing process.

### *Hinkley Point B*

- 6.18 Hinkley Point B station in the south west of England produced 7.3 TWh of electricity in 2016 – enough to power 1.8 million homes. It avoided 2.5 MtCO<sub>2</sub>e – the equivalent of taking 1.1 million cars off the road.
- 6.19 Unit 1 at the site was shut down between January and March 2016 for a statutory maintenance outage. During an outage, EDF Energy generally spend £20-£40 million with the supply chain, including significant spend within the local supply chain.

<sup>13</sup> Wood Group acquired Amec Foster Wheeler on 9 October 2017. The organisation is now known as Wood. <https://www.woodplc.com/news/press-releases/2017/wood-group-completes-acquisition-of-amec-foster-wheeler>.

<sup>14</sup> There were 2.9 million cars registered in Scotland at the end of December 2016: [https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/608374/vehicle-licensing-statistics-2016.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/608374/vehicle-licensing-statistics-2016.pdf).

## Hartlepool

- 6.20 Hartlepool station in the north east of England produced 6.6 TWh of electricity in 2016 – enough to power 1.6 million homes. It helped avoid 2.3 MtCO<sub>2</sub>e.
- 6.21 This performance is despite Unit 1 being closed for an extended outage from February to mid-April 2016 for boiler and gas circulator maintenance and a statutory outage was conducted on Unit 2 from June to September.
- 6.22 UK firm, CRA Risk Analysis supported the third Periodic Safety Review for both the Hartlepool and Heysham 1 Advanced Gas-cooled Reactors.

## Heysham

- 6.23 Four reactors operate at the Heysham site in the north west of England – two each at Heysham 1 and Heysham 2.
- 6.24 Heysham 1 produced 7.6 TWh electricity during 2016 – enough to power 1.9 million homes and avoided 2.6 MtCO<sub>2</sub>e – the equivalent of taking 1.2 million cars off the road.
- 6.25 This is despite only six of eight boilers operating until April 2016, following a defect discovered in 2014. Modifications took place in 2016 which allowed seven of the eight boilers to operate.
- 6.26 Heysham 2 produced 9.6 TWh electricity during 2016 – enough to power 2.4 million homes and avoided 3.3 MtCO<sub>2</sub>e – the equivalent of taking 1.5 million cars off the road.
- 6.27 The station also broke the world record for the continuous operation of a commercial nuclear power reactor, running continuously for 941 days, when it was taken offline for scheduled maintenance in September 2016. It surpassed Ontario Power Generation's Pickering 7's 894-day continuous run, a record that had lasted for 22 years.

## Dungeness B

- 6.28 Dungeness B on the south east coast of England produced 7.7 TWh electricity during 2016 – enough to power 1.9 million homes and avoided 2.7 MtCO<sub>2</sub>e – the equivalent of taking 1.2 million cars off the road.
- 6.29 L3 MAPPS won a contract to perform upgrade work on the operator training simulator at the site. The two-phase project, which began in early 2017, is expected to be completed in the fourth quarter of 2019.

## Torness

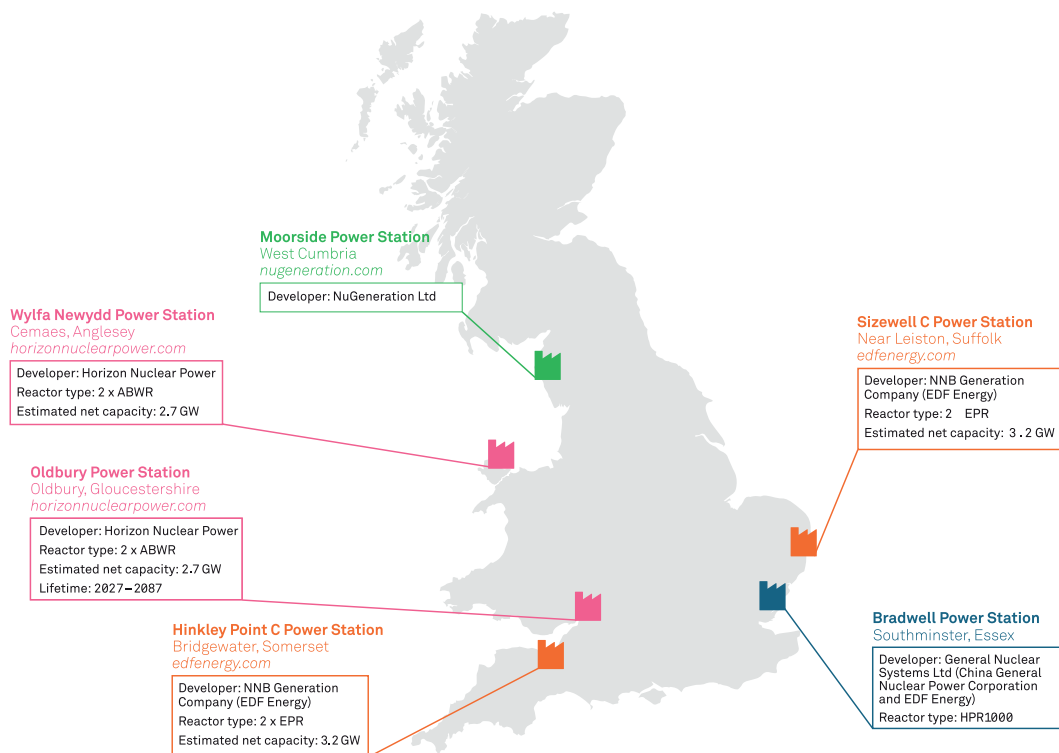
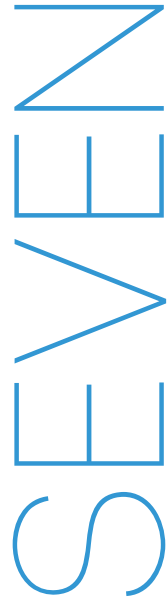
- 6.30 Torness station in Scotland produced 9.95 TWh electricity during 2016 – the highest output of all EDF Energy's nuclear power stations. This is enough power for 2.5 million homes and helped avoid 3.5 MtCO<sub>2</sub>e – the equivalent of taking 1.6 million cars off the road. The combined carbon saved at Torness and Hunterston in 2016 is the equivalent to taking almost all of the cars in Scotland off the road.

## Sizewell B

- 6.31 Sizewell B on the Suffolk coast produced 8.6 TWh electricity during 2016 – enough power for 2.2 million homes and help to avoid 3.0 MtCO<sub>2</sub>e – the equivalent of taking 1.3 million cars off the road.
- 6.32 A statutory outage and refuelling was completed between April and June 2016. A third of the fuel was replaced in the reactor and thousands of maintenance jobs were completed.
- 6.33 An additional 1,500 specialist workers joined the station's 550 employees to complete the work which included major projects such as replacing the low-pressure rotor on a turbine generator.
- 6.34 Inside the Sizewell dome the 10-year routine inspection of the reactor pressure vessel was completed and all four steam generators examined. Specialist robotic equipment controlled by skilled engineers was used to complete this work.
- 6.35 Contracts were awarded to dozens of UK firms, many of them local to the site.
- 6.36 A further contract was awarded to CRA Risk Analysis to perform a technical review of a reliability analysis developed for upgrades to the Process Control and Distributed Computer Systems.

# Nuclear New Build

- 7.1 A programme of nuclear new build will be vital to ensuring the UK's energy security and achievement of its decarbonisation targets in the coming decades. By 2030, more than two-thirds of the UK's 2010 generating capacity will have been retired, including all but one of our current fleet of nuclear power stations.
- 7.2 The UK has an ambitious plan to build 18GW of new nuclear capacity to replace the stations which will close. Plans are at varying stages of development for each project and three consortia are developing plans across sites in England and Wales, which are scheduled to be completed in the 2020s.
- 7.3 The UK's independent nuclear regulator, the ONR, is internationally regarded as among the best in the world. All nuclear operators in the UK must work within a strict regulatory framework, and all reactor designs must satisfy the safety, security and environmental requirements of the Generic Design Assessment (GDA), undertaken by the ONR and Environment Agency (EA).
- 7.4 Two reactor designs have completed the GDA process and are approved for use in the UK – the Areva European Pressurised Reactor (EPR) and the Westinghouse AP1000.
- 7.5 Hitachi GE Nuclear Power Europe is progressing through the GDA process for its Advanced Boiling Water Reactor (ABWR) and is scheduled for completion before the end of 2017.
- 7.6 China General Nuclear (CGN) in partnership with EDF Energy began the GDA process for the HPR1000 reactor it plans to use at its Bradwell site in Essex.



◀ Fig. 15 Proposed new build sites

## 2016 HIGHLIGHTS

- ▶ In 2016 a Final Investment Decision was made by EDF Energy and the UK government for Hinkley Point C – the first new nuclear station to be built in a generation.
- ▶ EDF Energy also continued public consultation on its plans to develop Sizewell C in Suffolk. EDF Energy's investment in new nuclear totalled £860 million in 2016.
- ▶ Horizon Nuclear Power appointed its development partner, Menter Newydd – a joint venture between Hitachi Nuclear Energy Europe, Bechtel Management Company and JGC Corporation (UK) – to further its plans to develop the site.

### EDF Energy

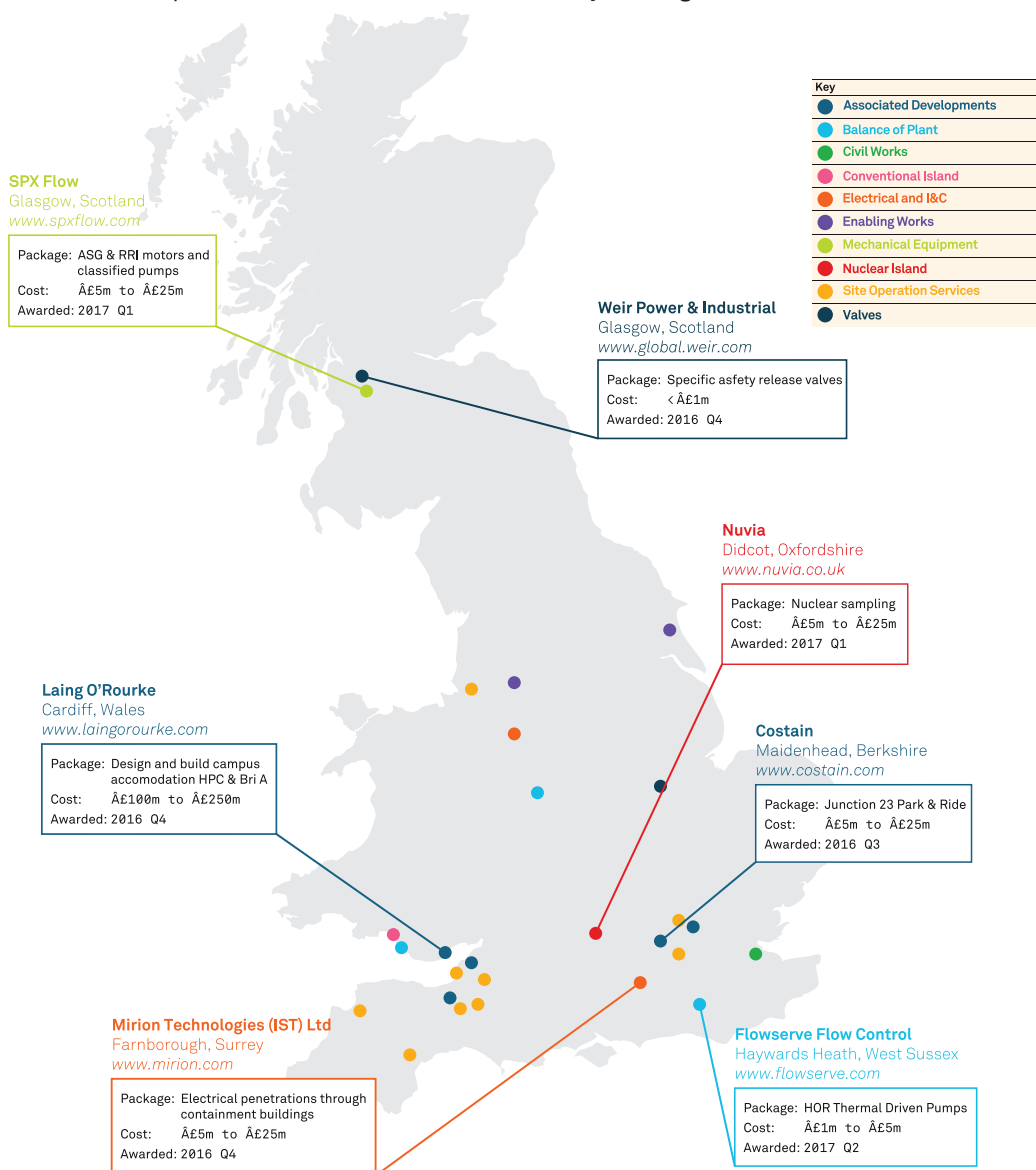
- 7.7 EDF Energy has plans to build two new nuclear power stations at sites across the south of England – Hinkley Point C, which is under construction in Somerset and Sizewell C in Suffolk.
- 7.8 It is also involved in the new build development at Bradwell, alongside CGN, with whom it has worked with for the past 30 years. CGN will take the lead in developing Bradwell B in Essex.<sup>15</sup>

### Hinkley Point C

- 7.9 September 2016 saw the final approval given for construction to begin at Hinkley Point C.
- 7.10 Two EPR reactors will be built at the site, generating 3.2GW of electricity when operating. Around 25,000 job opportunities will be created throughout construction and approximately 900 full time jobs will be needed to operate the power station.
- 7.11 EDF Energy confirmed 64% of the construction value of the project will go to UK companies, and more than £225 million has been spent with south west companies. Around 2,000 workers are on site each day.
- 7.12 Early progress at the site includes:
- ▶ Start of construction of a 500-metre temporary jetty in the Bristol Channel allowing 80% of the aggregate to be brought in by sea rather than by road. The jetty is due for completion in 2018 and each shipload of materials will take the equivalent of 250 lorry-loads off local roads.
  - ▶ Excavation of four million cubic metres of soil and rock to prepare the ground for the power station buildings. Almost six million cubic metres will be excavated in total.
  - ▶ Construction of the first two tower cranes. The larger of the two cranes is 40 metres high with a 60-metre jib and has a lifting capacity of 16 tonnes. More than 50 tower cranes will be on site once building work reaches its peak.
  - ▶ The first nuclear safety concrete pour of the technical galleries has been completed.

<sup>15</sup> Share of the project - Hinkley Point C: EDF Energy 66.5%, CGN 33.5%; Sizewell C: EDF Energy 80%, CGN 20%; Bradwell B: EDF Energy 33.5%, CGN 66.5%.

- 7.13 Work to build 15 on-site accommodation buildings for more than 500 workers has begun. Caledonian Modular in Newark, Nottinghamshire has completed the production of the first accommodation modules.
- 7.14 The company competed with an international supply chain to win the contract with Laing O'Rourke valued at £50 million. It has doubled its workforce and re-launched its apprenticeship scheme to complete the project.
- 7.15 Construction is underway on the sea wall which will provide a barrier between the power station and the coastline. Over 10,000 tonnes of rock armour has been delivered by ship from Pembroke for the 13.5m high, reinforced concrete wall.
- 7.16 In early 2016, work was completed on a new bypass to route traffic around the village of Cannington as part of a £16 million package of road improvements paid for by EDF Energy.
- 7.17 This work is one of many schemes completed ahead of the main works at Hinkley Point C to relieve pressures on the local road network. Further projects include new roundabouts on the A39 at Washford Cross and at Sandford Corner and road improvements at Taunton Road/Broadway in Bridgwater.



◀ Fig. 16 Companies awarded contracts in the Hinkley Point C supply chain (2016/17)

Source: <https://www.edfenergy.com/content/supply-chain-information>

Visit for full information of all awarded contracts

## HINKLEY POINT C CONTRACTS AWARDED

- ▶ Harris Pye UK Ltd has been awarded a contract by GE Steam Power Systems for engineering design work on two tank sets, including all required services, for the turbine halls.
- ▶ Gleeds will provide NEC contract management services and anticipates that its Bristol and Gloucester offices will double in size over the next three years as a direct result, creating up to 100 new jobs.
- ▶ Express Reinforcements, a steel reinforcement specialist, based in Neath, South Wales, won a contract from Tier 1 suppliers, Bouygues Laing O'Rourke (BYLOR) to provide 200,000 tonnes of steel to be used at Hinkley Point C. The contract is estimated to be worth around £100 million.
- ▶ Reinforced steel will be supplied from the firm's Neath and Newport manufacturing centres using rod supplied by Celsa Steel in Cardiff.

### *Sizewell C*

- 7.18 Following approval to construct Hinkley Point C, EDF Energy undertook the second stage public consultation for its next new build project at Sizewell C in Suffolk. Sizewell C will also house two EPR reactors with 3.2 GW capacity, and will replicate the Hinkley Point C design as far as possible.
- 7.19 The consultation period began in November 2016 and included 23 exhibitions across east Suffolk where the public could meet the Sizewell C project team and discuss the proposals.
- 7.20 Following feedback from the Stage 1 consultation, as well as ongoing technical and environmental studies, EDF Energy has refined some elements of the proposals at Stage 2. This included changes to the main development site for the power station, revised proposals for road improvements and refinements to the arrangements for housing construction workers and materials logistics.
- 7.21 Engineering studies also continue so that the Sizewell C project can follow on from Hinkley Point C in a timely way, subject to securing suitable financing arrangements.

### *Bradwell B*

- 7.22 CGN will lead the Bradwell B project, alongside EDF Energy and together they have applied to the regulatory authorities to begin the GDA process to build a UK version of the HPR1000, CGN technology which is being constructed in China. They moved to the second stage of the process in November 2017.
- 7.23 The reference plant for the design is CGN's Fangchenggang Plant Unit 3 in China which is under construction and on schedule.
- 7.24 The GDA process will take several years to complete. There are many different consents and permissions to be achieved before a nuclear power station can be constructed. As well as successful completion of the GDA process, other requirements include development consent, site licensing and environmental permits.

- 7.25 The proposed Bradwell project is at an early pre-planning stage, which will involve extensive investigative works and public consultations before detailed proposals are produced enabling a detailed planning application to be made and considered.

## WHAT IS GDA?

GDA was developed by the Office for Nuclear Regulation (ONR) and the Environment Agency (EA). It is unique to the UK and is recognised globally as a robust, independent process to assess new nuclear reactor designs before they are built. The process is not a legal requirement; however it is an essential step to deliver safe, secure and environmentally acceptable nuclear new build in the UK.

Justification is the first step in the regulatory process for new reactor designs. It is required by EU law and can be undertaken in parallel with the GDA process.

The government must assess whether the social, economic or other benefits outweigh the health detriment of ionizing radiation. The Secretary of State for Business, Energy and Industrial Strategy is the sole Justifying Authority and any decision will be UK-wide.

GDA is a step-wise process consisting of four stages to assess the generic design of a specific reactor type.

At each step the ONR undertakes an increasingly detailed assessment of the safety and security aspects for the reactor design. GDA is not a legal requirement but it aims to give a clear indication of whether the design would meet UK regulatory requirements. The GDA process takes around four years to complete.

The ONR assesses the reactor design and operator in three steps, after an initial preparation step. The EA's process consists of a preliminary and detailed assessment followed by a consultation. ONR and EA publish end of step reports with any issues identified.

At the end of the GDA process ONR will grant a Design Acceptance Confirmation and the EA will grant a Statement of Design Acceptability if the design and operators meet the high safety and security standards.

## Horizon Nuclear Power

- 7.26 Horizon Nuclear Power, a subsidiary of Hitachi Ltd, is developing the Advanced Boiling Water Reactor at sites on Anglesey and at Oldbury. It plans to provide at least 5,400 MW of new power station capacity to the UK, enough to power around 10 million homes.
- 7.27 Each project will require a construction workforce of around 4,000 people for the majority of the time, with up to 8,500 workers needed at the peak of construction. This investment will boost the country's low carbon power supplies and help develop local skills and new prospects for British suppliers.
- 7.28 2016 saw Horizon Nuclear Power appoint its Engineering, Procurement and Construction contractor, Menter Newydd to the project. Menter Newydd, a joint venture between Hitachi Nuclear Energy Europe, Bechtel Management Company and JGC Corporation (UK) Ltd, will be responsible for the construction of Wylfa Newydd, overseen by Horizon Nuclear Power.

- 7.29 Throughout the year, Menter Newydd's activities to develop construction plans and build supply chain relationships, supported Horizon in making progress with the project.
- 7.30 Horizon was issued with a Licensee Certificate, meaning its internal arrangements are suitable for procuring long lead items to ensure they meet the correct technical specification and that adequate documentation is available to justify the safety of those items.
- 7.31 These are items which are required early in the construction phase, but have a long manufacturing time, meaning they need to be ordered in advance. The first items due to be procured are the materials for the hydraulic control units which form part of the reactor's primary shutdown systems, the reactor pressure vessel and the reinforced concrete containment vessel liner.
- 7.32 To work towards becoming a nuclear operator, several partnerships were announced throughout 2016. The partners have been selected to enhance Horizon's nuclear expertise in a number of key areas including; operations and maintenance, boiling water reactor experience, UK licensing, and training.
- 7.33 Working alongside key North Wales-based training organisations, the partners will help ensure the transfer of global excellence in nuclear operator skills to Horizon's growing team on Anglesey and at its Gloucester HQ.
- 7.34 These partnerships include, Exelon Nuclear Power who will provide guidance on operations and maintenance of nuclear power plants and the Japan Atomic Power Company who provide experience in working with the boiling water reactor technology, focusing on design, construction, operation and maintenance.
- 7.35 Horizon's commitment to building a strong local workforce was highlighted through the year with £1 million funding for Grŵp Llandrillo Menai.
- 7.36 The funding will help to facilitate the design, construction and associated infrastructure of a brand new purpose-built, state of the art Engineering Centre adjacent to the existing Energy Centre at its Llangefni Campus on Anglesey.
- 7.37 Horizon will also provide technical support and advice to Coleg Menai, as the facility will cater for the technical training of Horizon's apprentices. Initially Horizon's first cohort of apprentices who joined the company in September 2016, will start their technical training at existing facilities in Coleg Menai's Bangor Campus, and will relocate to Llangefni once the new facility is complete.
- 7.38 The 21-strong team of apprentices with 10 recruited in 2016, were recruited from the local area. They form part of the wider Horizon team and will spend the next four years learning what it means to work on a nuclear new build project.
- 7.39 In the first year they'll work towards achieving a Level 2 NVQ in Performing Engineering Operations, along with a basic skills and knowledge introduction to the nuclear industry, before moving on to a BTEC Level 3 in the second year. Year three will broaden their practical experience further with specific and extensive on-the-job learning experience and qualifications chosen to match their specific technical route.
- 7.40 In addition to its activities to build a strong workforce, consultations with local communities took place to hear their views on plans for the site. The views from the Stage 2 Consultation in 2016 resulted in changes to the plans which went back to the community for a further consultation stage.

- 7.41 The company is presenting a more compact power station design. It is also suggesting where and how it can best manage the impacts from construction and bring long term benefits to the community.
- 7.42 Key project updates and changes described in the consultation include:
- ▶ Reduction in the area taken up by the main power station, with more buildings and facilities shared between the twin reactors.
  - ▶ A single, carefully managed, temporary workers accommodation campus at the construction site.
  - ▶ Appointing a Welsh Language and Culture Co-ordinator to ensure protection and enhancement of language and culture remains at the heart of Horizon's development.
  - ▶ Support for the development of an Employment and Skills Service to signpost people from across the region to jobs available at Wylfa Newydd.
  - ▶ Support for a capital investment programme for all five secondary schools on the island to improve science and technology facilities and help promote the take up of Science, Technology, Engineering and Maths subjects.
  - ▶ Funding to support a capital investment programme for the provision of new build affordable housing, initially focusing on increasing housing stock around the power station and in nearby Amlwch.
  - ▶ Establishing a tourism fund to support marketing initiatives and skills and training for those in the tourist sector.
- 7.43 Plans which will directly benefit the local communities also include improvements to local roads. Horizon first asked local people for their views in 2016 on its plans to widen, reconstruct and add a new surface layer to parts of the A5025 between Valley and the Wylfa Newydd site. There are also new plans for drainage, refinement of cycle and pedestrian crossings and increased sections of replacement hedges, walls and tree planting.

---

## NuGeneration Ltd

- 7.44 NuGeneration has plans to build at least 3GW of new nuclear power at Moorside in Cumbria. The company expects to create up to 21,000 jobs over the lifetime of the project, and around 1,000 during operation.
- 7.45 During 2016-17 NuGen's focus was on progressing the Development Consent Order (DCO) process and communicating that work to the people of Cumbria. The DCO covered aspects of transport infrastructure, housing solutions, the impact of construction and the legacy benefits for the region.
- 7.46 More than 3,000 people visited 34 public exhibition events over an 11-week period resulting in around 1,200 pieces of feedback during the Stage 2 public consultation. This was a significant package of work co-ordinated by NuGen from its base in Manchester and from its satellite sites in Cumbria.
- 7.47 During 2016 Toshiba, NuGen's parent company, experienced financial difficulties and Westinghouse entered the Chapter 11 bankruptcy protection process. As a result, Toshiba is in the process of selling its stake in NuGeneration.
- 7.48 Work on the site has been paused while NuGen undertakes a Strategic Review to ensure the company is in a position to move forward with its plans to deliver the next generation of low carbon power at the site.

- 7.49 This review includes looking at a range of options which could include new investors, technology and financing solutions to ensure Moorside is delivered.
- 7.50 NuGen remains a key player within the UK nuclear industry, has a vital role to play within the UK Industrial Strategy, and the Moorside project remains a key infrastructure project focused on creating employment and economic prosperity in Cumbria and across the north.

# Decommissioning and Waste Management

800

Hectares  
of nuclear  
licensed land

17

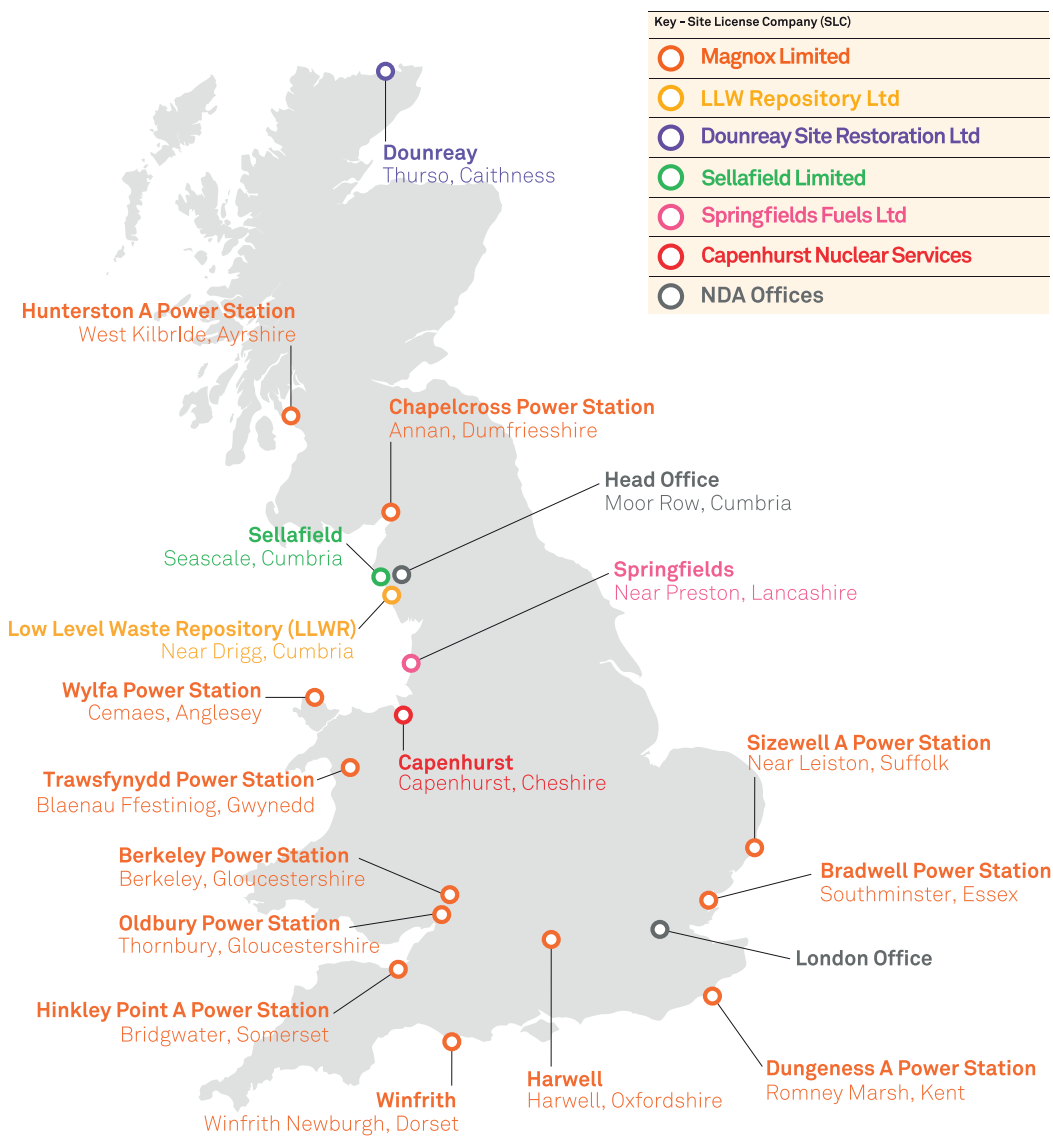
## Sites across the UK

# 18,500

## Employees across the estate

## 7 Subsidiaries (inc. Sellafield Ltd)

## 4 SLCs funded directly by the NDA



◀ Fig. 17 The NDA Estate

- 8.1 The Nuclear Decommissioning Authority is the strategic body responsible for establishing the overall approach to decommissioning across its 17 sites. It allocates budgets, set targets and monitors progress.
- 8.2 It does not have a hands-on role in cleaning up its facilities. Instead, it delivers its mission through others, primarily Site Licence Companies (SLCs).
- 8.3 The total NDA spend was £3.2 billion in 2016-17. It invests more than £85 million in R&D annually, and last year jointly invested £3 million for new technologies.
- 8.4 £2.2 billion came from government and £1 billion through commercial revenue. The cost of running the NDA itself remains below £40 million, or approximately 1.2% of the overall budget.
- 8.5 60% of spend was at its largest, most complex site, Sellafield in Cumbria. The NDA's decision to make Sellafield Ltd an NDA subsidiary has helped the site focus on providing better value for money. Over £200 million in savings were generated in 2016-17. The change is also enabling work to be prioritised on clean-up rather than commercial incentives.

---

## Magnox decommissioning

- 8.6 Magnox, is a nuclear decommissioning site licence company controlled by the Cavendish Fluor Partnership, responsible for decommissioning 12 nuclear sites on behalf of the NDA.
- 8.7 The NDA spent £502 million cleaning-up the Magnox sites in 2016, split between decommissioning, waste management and asset management. Of this, £265 million was spent with supply chain companies and 29% of that with SMEs.
- 8.8 Innovative techniques and approaches have saved money and maximised decommissioning delivery. These include using a 'lead and learn' approach to test new techniques comprehensively at one site before implementing at others, taking advantage of the learning acquired.
- 8.9 The Advanced Vacuum Drying System for intermediate level waste is now being installed at a third site after being trialled at Berkeley, while divers who worked in the spent fuel ponds at Dungeness are now being deployed at Sizewell.
- 8.10 In addition, more than £1.5 million has been saved across the Magnox fleet by reusing equipment between sites, for example, remotely controlled excavators, fuel skips, a fork lift truck, van, air compressor, some cameras and hydraulic shears were all sent to Winfrith in Dorset from Bradwell in Essex. Turbines have also been recycled for use in other industrial sectors.
- 8.11 Adelard LLP was awarded a contract for to deliver its ASCE Software, which will allow Magnox to deliver a common approach to safety case design across all its sites. With the 12 sites all at different stages of decommissioning the ability to create standard safety case templates for each phase of the lifecycle brings productivity gains through re-use.
- 8.12 Kurion's UK subsidiary, Nuclear Solutions, will deploy effluent treatment systems at four Magnox sites. Under the agreement the company will design, build and install the new systems at the four sites, enabling the removal of contaminated

waste from the sites' active effluent water treatment, ponds water filtration, and cesium removal plants.

- 8.13 NSG Environmental Ltd has been awarded a multi-million pound contract to design and supply cement and polymer encapsulation plants for three Magnox sites: Berkeley, Hinkley Point A and Chapelcross.
- 8.14 R&D framework contracts worth up to £12 million were awarded to 10 consortia to provide innovative solutions to technical challenges in decommissioning, part of the NDA's Direct Research Portfolio.
- 8.15 The value of this work, involving more than 70 organisations, is likely to exceed £12 million over a four-year period and will provide support for R&D across radioactive waste management, site decommissioning and restoration.
- 8.16 Among the organisations involved are UK universities, global corporations and around 20 SMEs.<sup>16</sup>
- 8.17 2016 saw significant steps forward in safely decommissioning the sites, taking a lessons learned approach to each of the sites.

## Berkeley

- 8.18 More than 61 tonnes of fuel element debris has been removed. Through operational experience, better levelling and packaging techniques have been developed which could reduce the number of containers used by around 20, saving almost £3 million for the UK taxpayer over the project lifetime.

## Bradwell

- 8.19 The site ceased operation in 2002 and is following an accelerated decommissioning programme. It is now more than halfway through a programme of work which should see it become the first reactor site in the UK to enter care and maintenance by 2019.
- 8.20 A project, which began in 2012, to build a new aluminium structure to protect the two reactor structures, was largely completed last year. Magnox, working with its contract partner Vinci Construction, employed more than 900 people, who worked over 98,000 hours since the project began in 2012.
- 8.21 All underground waste storage vaults have been emptied in preparation for the care and maintenance phase. Waste, including metal, sand and sludge, was stored in 18 different vaults during the site's 40-year operational phase. This has been recovered and characterised, ready for long-term storage.
- 8.22 More than 10,000m<sup>2</sup> of walls, floors and ceilings in the site's ponds complex have also been decontaminated and partially demolished.
- 8.23 During the project more than 2.5km of pipework was removed and more than 120 tonnes of metal waste was recovered and appropriately disposed of. A new weather-proof over-structure is being constructed that will maintain the building's integrity during the care and maintenance period.

<sup>16</sup> <https://www.gov.uk/government/news/12-million-contracts-support-nuclear-decommissioning-research>.

## Chapelcross

- 8.24 Scotland's first commercial nuclear reactor. Chapelcross ceased operation in 2004 and recently completed defuelling ahead of schedule and is progressing decommissioning for entry into care and maintenance.
- 8.25 The asbestos removal project at Chapelcross is the largest asbestos strip programme in Europe. More than 2,200 tonnes has already been removed.
- 8.26 Work is underway to strip all 16, 100-foot-tall heat exchangers of their external steelwork. Teams at the site from principal contractor for the project, Hertel, and its sub-contractor Mammoet Cranes are on track to complete the project by January 2018.

## Dungeness A

- 8.27 Dungeness A stopped generating at the end of 2006 and in July 2012 transitioned from the defuelling to the decommissioning phase. The site is now preparing for care and maintenance.
- 8.28 Part of the decommissioning work involved using divers to cut up pond skips, once used to store nuclear fuel. This innovative technique will also be passed on to other Magnox sites, where similar work will be carried out, changing the way pond decommissioning will be carried out in the future.

## Harwell

- 8.29 Hazard reduction in one of the previously active handling facilities on site has led to cost savings of £30,000 per year, as a post operation clean out campaign means ventilation to the facility could be reduced.
- 8.30 Decommissioning progress and cost reduction was also evident as work to decommission the Old Main Active Drain (OMAD) was completed on time and 14% under budget. The project involved the removal of 4,000 metres of drain and 95 manholes.
- 8.31 Some of the areas traversed by OMAD have been subsequently de-licensed, demonstrating that the project achieved a fully clean end state.
- 8.32 Much of the infrastructure which has been in operation for 60 years at the site has been cleared. The office and welfare accommodation has been demolished; the pump houses removed and the medium-level treatment plant has been decontaminated and demolished.

## Hinkley A

- 8.33 The Ponds Programme at Hinkley has hit a major operational milestone with the drain and stabilisation of the reactor one pond, meaning that both sites' cooling ponds are now empty.
- 8.34 Both ponds have had up to 10m<sup>3</sup> of highly active sludge removed, several tonnes of underwater pond furniture removed, 5,540m<sup>3</sup> of water drained and the surfaces stabilised.

## Hunterston A

- 8.35 Above ground storage facilities used to house intermediate level waste are in the process of being decommissioned, with the second bunker (of five) being successfully cleared in 2016.
- 8.36 The project, which was completed six weeks ahead of schedule, used remotely operated vehicles to lift more than 650 tonnes of radioactive graphite and metallic waste before it was packed into specially engineered stainless-steel boxes.
- 8.37 Learning lessons from the earlier experience, improvements in the packing efficiently meant that 274 boxes were used to clear the bunker – 23 fewer than the original projection – providing a cost saving.

## Oldbury

- 8.38 Oldbury has been officially declared fuel free, confirming that 99% of the radioactive inventory has been removed from the site.
- 8.39 This allowed the site to move into the decommissioning phase. All low level waste pond skips have been removed and transferred for temporary storage, work which was completed four months ahead of schedule.
- 8.40 UK company, Radwise will provide Radiological Protection services in support of ponds decommissioning activities at the station.

## Winfrith

- 8.41 Work to remove 1.5 km of stainless steel pipework is underway at the site's Steam Generating Heavy Water Reactor to allow access to remove the reactor core.
- 8.42 The removal of the steam risers and feeders represent the culmination of many years of pre-cursor work, leading to the eventual safe removal of the reactor core and demolition of the reactor complex.
- 8.43 UK firm, James Fisher Nuclear has been appointed to work on this challenging project. Its work will include the detailed design and build of an intermediate level waste processing facility and a fully robotic core segmentation system, which will enable the reactor core to be safely dismantled and prepared for disposal
- 8.44 Work to demolish storage tanks and its associated structures has also been completed in the year, meaning work is on track at the site to return the land to heathland.

## Wylfa

- 8.45 Wylfa is located on the north coast of Anglesey. Commissioned in 1971, it was the last and biggest of the Magnox stations to be built. After nearly 45 years of successful and safe operations, on 30 December 2015, Wylfa nuclear power station closed, marking the conclusion of Magnox reactor generation in the UK.
- 8.46 During its generating life, Wylfa produced 232 TWh of electricity.

- 8.47 Costain successfully completed construction of a pipeline – the Active Effluent Discharge Line – which enabled the site to proceed with defueling and decommissioning.
- 8.48 The site is now in the defuelling phase; it is 45% defueled and more than 64,000 fuel elements have been removed from both reactors.

## Sizewell A

- 8.49 As part of Sizewell A's decommissioning, Magnox Ltd has appointed Actavo Industrial Solutions to deliver a £400,000 contract for an access and egress, waste-handling building which will be used to remove radioactive debris from the ponds as part of the ponds decommissioning programme.
- 8.50 Work started in August 2016 and the building was handed over in January 2017.
- 8.51 Actavo Industrial Solutions was also awarded two further contracts as part of the ponds decommissioning programme, supporting the installation of a new vent plant system to the ponds building and new, covered, walkway gantries.
- 8.52 Radwise won a contract to supply Radiation Protection Services in support of the pond decommissioning programme.

## Trawsfynydd

- 8.53 Demolition work has begun at the site as the stores complex, associated workshops and the three-story administration block have all been removed, with 1,200 tonnes of material sent off site.
- 8.54 Fuel element debris is being retrieved again, following a pause in the work. Following five years preparation, the first concrete plug weighing two tonnes was removed from the north vault, allowing access. More than 2,500 tonnes of waste has been retrieved so far. The process will be repeated to access the remaining vaults.

---

## Low Level Waste Repository

- 8.55 The LLW Repository Ltd manages the national Low Level Waste Repository (LLWR) in west Cumbria on behalf of the NDA and oversees a National LLW Programme to ensure that lower activity waste is managed effectively across the UK.
- 8.56 Some 3,858 tonnes of metals were diverted in 2016, which was more than double the previous year's total of 1,505. In addition, 3,100m<sup>3</sup> of waste went down the combustible route compared to 2,216m<sup>3</sup> in 2015, and the volume of very low level waste diverted also increased from 5,311m<sup>3</sup> to 6,509m<sup>3</sup> last year. This activity has extended the expected lifetime of the repository to 2130.
- 8.57 A third (33%) of its overall direct and indirect expenditure in 2016 was placed with small to medium-sized enterprises, working with more than 125 companies, compared to a government target of 23.5-25% and equates to £16.7 million.
- 8.58 LLWR has developed Dynamic Purchasing System (DPS) called the Business Services Marketplace which allows a more flexible engagement with suppliers. As of September 2017, 19 further competitions had been awarded using this

commercial vehicle with more in the pipeline. Other SLCs can also utilise the DPS expanding their potential buyer community for suppliers who join.

- 8.59 Cooper Handling Group was awarded a new five-year contract to maintain mobile site equipment at the site.
- 8.60 LLW Repository Ltd and partner GRAHAM Construction signed the second half of their major four-year Engineering, Design and Construction Framework contract.
- 8.61 Cumbria County Council planners have given the go-ahead to an application to enable the phased construction of two new low level radioactive waste vaults and an extension to a third, for the disposal of waste in specially-grouted containers, on the site, near Drigg. It will create around 120 construction jobs, secure existing posts and ensure the future of the LLW Repository site in Cumbria.
- 8.62 Brand new high-precision containers were used successfully for the first time to deliver radioactive waste from Harwell to Sellafield. Cumbrian firm Bendalls Engineering of Carlisle won the £multi-million contract to produce six pairs of Novapaks, all of which will be completed and in service by mid-2018. They will replace an existing fleet of LLWR containers for Intermediate Level Waste (ILW).

---

## Dounreay

- 8.63 Dounreay Site Restoration Limited (DSRL) is a wholly-owned subsidiary of the Cavendish Dounreay Partnership Ltd, a consortium of Cavendish Nuclear, CH2M and AECOM. It is funded by the NDA to deliver the site closure programme.
- 8.64 Today, Dounreay is a site of construction, demolition and waste management, all of it designed to return the site to an interim end state. The experimental nature of many of its redundant facilities means the clean-up and demolition requires innovation as well as great care.
- 8.65 Work is currently under way to retrieve the last remaining radioactive fuel elements that have been stuck for decades inside the iconic Dounreay Fast Reactor (DFR).
- 8.66 The experimental dome-shaped nuclear reactor once led the world in fast breeder technology and after it closed in 1977 most of the core fuel was removed. But work to remove elements from the breeder zone came to a halt when some were found to be swollen and jammed.
- 8.67 After many years of designing and testing remotely-operated equipment, a decommissioning team has started to recover the remaining elements. It is expected to take around three years to remove them all, after which work can begin on the final dismantling of the landmark reactor.
- 8.68 In 2016, £110 million worth of contracts were placed with the supply chain, with 26% of supply chain spend with SMEs, out-performing the government target.
- 8.69 Project delivery has been dominated by work to remove exotics material from the site and the supply chain has supported this priority programme with a range of services. Companies such as Nuvia, GDES, JGC Engineering and DXC continue to be among the biggest suppliers to the company.

- 8.70 Work is also ongoing to create framework contracts for decommissioning contracts that will take place once the exotics work has been completed.
- 8.71 Amec Foster Wheeler won a contract to design and build a new effluent treatment plant to support the shaft and silo clean-up, valued at up to £7 million.
- 8.72 Arcadis has been appointed to support nuclear safety review the site.
- 8.73 Croft Associates delivered a number of related contracts for the supply, manufacture, testing and re-licensing of the Croft 2816 J Safkeg. The containers, used for material arising from decommissioning and closure work, were delivered ahead of schedule.

---

## Sellafield Ltd

- 8.74 Sellafield is one of the oldest and the most complex sites in the NDA estate. It led the development of the UK's civil nuclear industry and was home to the first commercial nuclear power station, Calder Hall, which opened in 1956 and ran for 50 years.
- 8.75 Over the last seven decades, Sellafield has evolved into a large and complex nuclear site playing a pivotal role in the industry since the 1940s when the site, then known as Windscale, produced plutonium for the UK nuclear deterrent.
- 8.76 Through the production of civil nuclear power, the development of commercial spent fuel reprocessing and the creation of a complex network of facilities to manage nuclear materials and wastes, the site and its workforce continue to support the UK's energy requirements.
- 8.77 Today, the site is moving into another phase of its life. The priority to improve the storage of legacy wastes in modern facilities and the closeout of reprocessing operations, all bring fresh challenges to long-term waste and spent fuel management.
- 8.78 More than 10,000 people work across the site, deploying innovative techniques to make real progress in reducing the hazard.
- 8.79 Early 2016 saw a new framework arrangement to deliver decommissioning and site work. The Decommissioning Delivery Partnership (DDP) is a 10-year framework and will provide opportunities for SMEs in delivering work.
- 8.80 Work is split into Lots and a number of partner organisations have been appointed.
- 8.81 Lot 1 includes site remediation work across a broad range of facilities at the site including the Pile Fuel Cladding Silo, Pile Fuel Storage Pond and Calder Hall, among other areas of work. Between £10-£14 million was spent on work during 2016.
- 8.82 There are four delivery partners who have been identified to undertake the work:
  - ▶ The AREVA-Doosan-Atkins joint venture
  - ▶ Integrated Decommissioning Solutions – Atkins, Hertel, North West Projects and Westlakes Engineering
  - ▶ Nexus
  - ▶ The Cumbria Nuclear Solutions Ltd joint venture comprising Jacobs Engineering Group, James Fisher Nuclear Ltd, Westinghouse Electric Company, Shepley Engineers Ltd, WYG and REACT Engineering Ltd.

- 8.83 Lot 2 focuses on the First Generation Magnox Storage Pond. The Decommissioning Alliance (Jacobs, Atkins, Westinghouse Electric Company) has been appointed delivery partner on the project. Work has been awarded and a £9 million project in 2016-17 looked at a asset care, restoration and commissioning.
- 8.84 Lot 3, the Magnox Swarf Storage Silo project was awarded to Amec Foster Wheeler, Hertel and Shepley Engineers. Work will cover a wide range of activities including replacing the building's roof, installation of steel work among other areas and will be worth between £6-8 million across 2016-17.
- 8.85 Elsewhere on the site, Carr's Engineering won a 10-year £48 million framework for high integrity in-cell tanks and vessels project. It will work with Copeland based Prima Uno and Amec Foster Wheeler to deliver the project.
- 8.86 Dudley based Exova won a two-year contract to provide a range of testing services to support the 3m<sup>3</sup> box project, a key programme to support hazard reduction and clean-up.
- 8.87 NIS Ltd successfully secured a 10 years framework contract from valued up to £25 million, to manufacture and supply of Personal Access Doors.
- 8.88 Capula is to deliver a fully integrated control solution to Sellafield Ltd. The Box Encapsulation Plant Delivery Team, responsible for this project comprise joint venture partners Balfour Beatty, Jacobs Engineering Group and Amec Foster Wheeler.

---

## Decommissioning progress

- 8.89 At the **First Generation Magnox Storage Pond**, bulk quantities of waste have been removed after new equipment was able to begin operation 10 months ahead of schedule.
- 8.90 The six-metre deep pond holds spent fuel from the Magnox power stations and other miscellaneous materials. Over time, sludge has accumulated, up to one-metre thick in places, and must be removed with great care, making sure the water remains in place as a radioactive shield for the remaining contents.
- 8.91 First sludge removals began on a small scale in 2015. The new Bulk Sludge Retrieval Tool was commissioned during 2016, helping to increase the rate of retrievals.
- 8.92 The first skip of solid fuel was lifted out in April 2016 and more than 50 tonnes of solid fuel have now been removed, around 10% of the total. Work is expected to be completed by 2033, massively reducing the pond's risks and hazards.
- 8.93 Westinghouse UK was awarded a contract for design and manufacture of 247 Self Shielded Boxes that will be used at Sellafield for the interim storage of decommissioning material from the First Generation Magnox Storage Pond.
- 8.94 Unique rolling scaffolding has been also been used at the pond saving £300,000 for the UK taxpayer, as it reduces the amount of equipment needed and is quicker to assemble than traditional scaffold.
- 8.95 Created in collaboration with Kaefer, the scaffolding uses a state-of-the-art rail track system which creates one easily-moveable structure that can shift side to side as sections of work are complete along the external pond wall.

- 8.96 Sellafield is also home to the world's largest and oldest spent fuel storage pond. The **Pile Fuel Storage Pond** is 100 metres long and was built to take spent fuel from the UK nuclear weapons programme.
- 8.97 Bulk stocks of fuel have already been removed, leaving the sludge in the pond as the biggest remaining radioactive hazard. The work means radioactivity levels have now been cut by 70% at the pond, vastly reducing the risk it poses.
- 8.98 For the first time, sludge has been pumped out of the pond to a purpose-built treatment plant, it will then be transferred in a 500-litre drum to the Waste Encapsulation Plant, where drums are grouted and processed into a storage state ready for final disposal in a UK Geological Disposal Facility. It will take several years to remove all pond sludge.
- 8.99 The programme is 10 years ahead of schedule outlined in the 2010 baseline. De-watering of the pond is the next stage. It is due to start in 2019 and expected to take 10 years.
- 8.100 Another high hazard area where progress is being made is the **Magnox Swarf Storage Silo**. It was built to hold metallic debris 'swarf' from the outer cladding of Magnox fuel, before it was reprocessed.
- 8.101 The swarf is stored under water in 22 compartments, and the first of three huge purpose-built specialist machines has been installed to start removing waste.
- 8.102 This was the culmination of over a year's effort, involving 100-plus separate crane lifts to install the 22 modules that make up the 360-tonne machine.
- 8.103 The other two machines are now being tested off-site prior to installation. When complete the three machines are expected to operate for many years to remove the waste.
- 8.104 The **Pile Fuel Cladding Silo** holds fuel cladding removed from the Windscale Pile that helped to create the UK's nuclear deterrent, along with cladding from Magnox fuel.
- 8.105 The air inside the silos was replaced by inert argon gas in 2001 to reduce the fire risk. Although non-toxic, argon cannot be breathed so all work must be carried out remotely and the atmosphere maintained during retrievals.
- 8.106 Two significant steps forward have been taken. The last of six huge stainless steel doors, each seven metres tall by four metres wide and as heavy as 150 adults, are now in place. Holes are being cut behind the doors, enabling remote controlled grabs to reach in, drop down and pull out the waste. These should be in place to allow the start of retrievals in 2020.
- 8.107 Meanwhile, engineers are using an innovative water jet to remove six large plates of steel while maintaining the inert atmosphere.
- 8.108 The deflector plates, each about the size of a small car, were used to guide waste into the chambers when it was put into the silo. Each plate has now been cut into approximately 150 pieces, using water and finely ground stone blasted at the speed of sound to prevent sparks.
- 8.109 The pieces fall into the chambers and will be removed along with the cladding when waste retrievals begin.

# Fuel Fabrication

- 9.1 The UK's nuclear sector covers the full lifecycle from fuel fabrication through to decommissioning.
- 9.2 Activity in the UK is undertaken by URENCO at its Capenhurst facility and Westinghouse through Springfields. Fuel fabricated in the UK is exported to nuclear stations across the world.

---

## URENCO

- 9.3 URENCO operates plants in Germany, the Netherlands, the UK and the USA, using URENCO's centrifuge technology to enrich uranium for the use as a nuclear fuel for civil power generation.
- 9.4 At its Capenhurst enrichment facility, URENCO employs more than 300 people and provides the local community with long-term employment in a technical environment, as well as opportunities for young people to pursue engineering and scientific careers.
- 9.5 The largest of Capenhurst's three plants houses more than 80% of the site's enrichment capacity. It began operation in 1997, and has continued to expand ever since. At the end of 2016, Capenhurst provided a production capacity of 4,700 tSW/a.<sup>17</sup>
- 9.6 URENCO makes a valuable contribution to the low carbon economy, supplying more than 50 customers in 19 countries with a reliable source of enrichment services and uranium to support the optimal operation of their reactors.
- 9.7 In 2016 it was announced that DBD Limited will support URENCO to develop the Continued Operations Safety and Environment Reports for two facilities at the Capenhurst site. DBD Limited is a UK based international company specialising in safety, engineering, technical and environmental work throughout the nuclear sector.

---

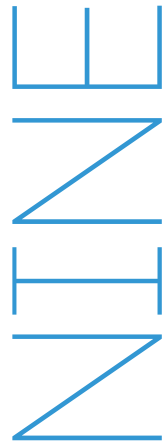
## Springfields

### *Westinghouse Electric Company*

- 9.8 Westinghouse Electric Company is a global leader in nuclear energy, supplying nuclear plant products and technologies to utilities worldwide.
- 9.9 Westinghouse is at the forefront of the UK nuclear sector in fuel manufacture, plant services, decontamination, decommissioning, remediation and waste management, and new build.

<sup>17</sup> SWU: Separative Work (SW) stands for the effort necessary to separate U235 and U238. It is measured in kilograms of separative work (kg SW). tSW is one metric ton of separative work.

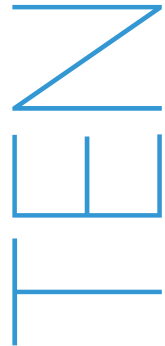
A large nuclear power station with a net electrical capacity of 1,300 MW requires annually about 25 tonnes of enriched uranium with a concentration of 3.75% U235. This quantity is produced from about 210 tonnes of natural uranium using about 120 tonnes separative work. An enrichment plant with a capacity of 1,000 tSW/a is, therefore, able to enrich the uranium needed to fuel about eight large nuclear power stations.



- 9.10 The Springfields nuclear fuel manufacturing facility in Lancashire, has a proud 70-year history and was the world's first to produce fuel for commercial nuclear power stations. Today it has the technology to produce fuel for all major reactor designs. It has a the most modern nuclear fuel manufacturing plant in the world and produces most of the fuel requirements for the UK's nuclear power stations.
- 9.11 Springfields main activities include:
- ▶ Manufacture of nuclear fuel for Advanced Gas-cooled Reactors and Light Water Reactors, as well as intermediate fuel products in the form of powder and granules
  - ▶ Uranium recovery services and sale of surplus uranium
  - ▶ Decommissioning and demolition of redundant plants and buildings
  - ▶ Transport services
- 9.12 A socio-economic impact review report published in February 2016 shows the contribution Westinghouse and its employees make in the local areas.
- 9.13 Employing more than 1,000 people at its Springfields site, it pays £56 million in wages each year. Its research shows the direct disposable income retained within the local economy is £20 million per year – or around £18,500 per employee per year.
- 9.14 It has more than 800 suppliers, spending more than £100 million annually with them.
- 9.15 The induced impact of Westinghouse UK's supply and salary chain creates 904 extra jobs throughout the UK, with more than two-thirds (69%) of these in the north west of England, where the company is based.
- 9.16 Recently, Westinghouse secured a new contract with EDF for the provision of uranium hexafluoride cylinder maintenance services covering transport, storage, washing, inspection and certification in support of the EDF fleet of cylinders which is used in the fuel cycle operations of EDF in France and EDF Energy in UK.
- 9.17 The company also reached an agreement with the NDA for the work on their legacy materials to be performed at Springfields in the financial year to 31 March 2018.
- 9.18 This confirmed extension of the work processing NDA's uranium residues for a further 12 months and retains operation of unique facilities into this period.

# Supply Chain Activity

- 10.1 The UK has industrial capability across the whole nuclear lifecycle. This is evidenced in the number of and types of contracts UK companies win work in.
- 10.2 Much of the UK's supply chain has more than 50 years' experience and have worked in civil nuclear since construction of the first plants. This means our experience is in demand from across the world.
- 10.3 In 2016, UK firms won contracts on nuclear projects across the world. These include:
- ▶ ALE, the heavy lifting operator, completing the final installation for the Embalse Nuclear Power Plant Life Extension Project in Argentina, providing the transportation, lift and final positioning of two feedwater preheaters within the turbine building of the plant.
  - ▶ Rolls-Royce completed the modernisation of Neutron Instrumentation Systems at two units of Ling Ao nuclear power plant in Shenzhen, China, replacing an existing analogue system, originally supplied by Rolls-Royce in the early 2000s, with a new digital system using its Spinline technology.
- 10.4 UK firms also signed co-operation agreements to work in partnership with counterparts in international markets.
- 10.5 ALE signed a strategic co-operation agreement with KFNE, the Shanghai Kangfu Nuclear Energy Machinery Co. Ltd, which will allow it to move into the Chinese nuclear power market.
- 10.6 Amec Foster Wheeler signed a collaboration agreement with Tecnatom SA, to enhance services provided to reactor operators, nuclear new build and advanced research. The agreement covers equipment and materials qualification, non-destructive testing, remote handling, and training services.
- 10.7 Amec Foster Wheeler also signed a wide-ranging agreement with nuclear power plant constructor China Nuclear Engineering & Construction (Group) Corporation covering potential collaboration in the nuclear industry. It is the first time CNEC has agreed to collaborate with a global engineering consultancy on the deployment of high-temperature reactors in the UK and internationally.



## CASE STUDIES

With our extensive decommissioning knowledge, UK expertise is highly regarded and UK-firms are playing a key role in decommissioning the Fukushima-Daiichi plant in Japan.

Amec Foster Wheeler's innovative proprietary technology is being used in a research and development programme at Fukushima, in Japan, to make radioactive waste safer.

The work, carried out in partnership with Fuji Electric on behalf of the Japan Atomic Energy Agency, will centre on the SIAL® matrix, a specialised geopolymer technique for encapsulating various radioactive waste streams.

Oxford Technologies has been awarded a further contract by Mitsubishi Heavy Industries (MHI) to bring its remote handling expertise to assist in the fuel debris removal project.

James Fisher Nuclear is also working with MHI to develop technology to sample radioactive debris sitting below reactor cores.

---

## Opportunities for SMEs

- 10.8 The industry is encouraging a new generation of companies to get involved in the nuclear sector and benefit from the new build, existing generation and decommissioning work.
- 10.9 The Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC) based in Sheffield runs Fit For Nuclear (F4N), a programme to help get UK manufacturing businesses ready to bid for and win work in the nuclear sector. To date 630 organisations have taken the initial assessment, several hundred more are in the process and more than 130 have completed the programme.
- 10.10 Nuclear AMRC also facilitates Civil Nuclear Sharing in Growth programme, which aims to develop the UK manufacturing supply chain for civil nuclear new build, operation and decommissioning. To date, the participating companies have reported it has helped secure £507 million of orders, creating or safeguarding 6,040 jobs, and have committed an additional £51.6 million private investment.

## CASE STUDIES

### *Heatric*

Poole-based Heatric is a specialist manufacturer of advanced heat exchangers, specialising in printed circuit heat exchangers (PCHEs) for demanding applications.

The technology was embraced by the oil and gas sector, but the company realised it needed to expand into other markets.

After carrying out some research on nuclear opportunities, Heatric completed the online F4N assessment and found it was very much aligned to the levels of compliance for oil and gas. The main area it needed to improve on was health and safety reporting.

While it held an exemplary record, it wasn't emphasising the safety culture in a way nuclear customers would expect. To close the gap, several additional nuclear quality standards were introduced for specific product types.

Heatric sees the biggest opportunities in the decommissioning market, including waste treatment systems and waste containers. It is also looking at pressure vessels and HVAC systems for new build as well as investigating the potential to supply heat exchangers for the proposed new generation of small modular reactors.

### *Outokumpu*

Part of the global Outokumpu group, Sheffield-based Outokumpu Stainless Distribution (OSD) is the UK's service centre for stainless steel plate, sheet and coil products. It currently provides a wide range of performance steel products for engineering sectors such as automotive and oil and gas.

OSD supplied the nuclear decommissioning sector and has recently provided steel for Sellafield's pile fuel cladding silo doors as well as for intermediate level waste containers.

This means the company is used to working with the high levels of control needed to prove traceability and integrity of the steels they produce. It is now looking at the nuclear new build market.

F4N has identified the company needed more refinement around project management and OSD has developed new project management capabilities, piloting them on real orders. They also delivered nuclear safety training to the 100-strong workforce and helps workshop staff understand the relevance of their work.

## *Hayward Tyler*

Luton-based Hayward Tyler manufactures high integrity specialist pumps and has facilities in Scotland, China, India and the US.

The company is 200 years old and provided the first pumps to Calder Hall, the UK's first civil nuclear power station, and it recently won civil nuclear contracts in South Korea and Sweden.

It generates around 15% of its revenues from nuclear, but sees significant scope for growth both in the UK and globally. It is being supported by the Civil Nuclear Sharing in Growth programme and recently completed the F4N programme.

Sharing in Growth helped the company understand how to design and implement a nuclear-compliant facility as well as train its workforce to nuclear standards.

Alongside Sharing in Growth, the company expanded and upgraded its Luton factory, supported by a £3.5 million Regional Growth Fund grant. The redevelopment, which was completed in 2016 extended the workshop by more than 40% and created five zones with a focus on lean manufacturing methods.

---

## R&D

- 10.11 The nuclear industry is always innovating – from use of advanced robotics to aid decommissioning activity to the development of efficient reactor technology.
- 10.12 Robotics for instance reduce human exposure to harmful radiation and speed up programmes of work, ultimately saving money. In the UK, small and medium sized companies across the industry have embraced the technological opportunities across the UK's decommissioning mission.
- 10.13 The National Nuclear Laboratory (NNL) carries out research across the whole fuel cycle – from advanced fuels and reactor technology to waste management techniques and even developing new power sources for space probes from nuclear waste. NNL also has facilities able to handle the most radioactive nuclear materials on the planet.
- 10.14 The Nuclear AMRC works specifically with companies to come up with innovative new methods to compete on cost, quality and delivery. Its core research and development capabilities cover machining, welding and cladding, metrology and inspection and visualisation.
- 10.15 Merseyside engineering company Cammell Laird has partnered with the Nuclear AMRC to open a new development centre to focus on developing modular manufacturing methods for new reactors of all sizes, drawing on Cammell Laird's

expertise in modular shipbuilding and a host of innovative technologies to significantly reduce costs and lead times for nuclear new build.

- 10.16 The companies will research a wide range of areas to support the assembly, commissioning and transportation of modules of up to 5,000 tonnes, where Cammell Laird benefits from its coastal location.

---

## Small Modular Reactors

- 10.17 Nuclear companies are working to develop small modular reactors (SMRs). These are smaller nuclear power stations which can be built in a factory and deployed quickly around the country to supply heat and power. Estimates put the potential of the global SMR market at £250-£400 billion by 2035.
- 10.18 SMRs could put the UK at the forefront of global nuclear research and development, bringing important commercial and industrial benefits, including assisting economic and industrial growth in the UK, and real export potential.
- 10.20 With UK intellectual property and building capacity within the supply chain, high value jobs and a strong manufacturing legacy could result.
- 10.21 In 2015 the Government allocated funding of £250 million for nuclear research and development, including SMR technology and said it would issue a roadmap for SMR development by the end of 2016 and begin a competition to determine the UK potential. An announcement is now expected before the end of 2017 on a new way forward.

---

## Fusion Research

- 10.22 The UK is at the forefront of fusion research with UK supply chain companies involved with the ITER fusion project in France.
- 10.23 Culham Centre for Fusion Energy (CCFE) is the UK's national laboratory for fusion research. CCFE is based at Culham Science Centre in Oxfordshire, and is owned and operated by the United Kingdom Atomic Energy Authority.
- 10.24 The UK fusion programme at Culham is centred on the innovative Mega Amp Spherical Tokamak (MAST) experiment and employs around 150 people.
- 10.25 The programme is funded by the Engineering and Physical Sciences Research Council and the European Union under the EURATOM treaty. MAST is currently undergoing a major upgrade – the new MAST Upgrade device will be operational in late 2017.
- 10.26 In addition, CCFE hosts the world's largest magnetic fusion experiment, Joint European Torus (JET) on behalf of its European partners. The JET facilities are collectively used by European fusion scientists, co-ordinated by a programme management unit at Culham. JET is situated next to the UK fusion laboratory. Around 500 people are employed at the JET facilities, with around 350 European scientists visiting each year to conduct research, and many more from outside Europe.

## CASE STUDIES

The UK's research and development expertise is being put to good use at the ITER fusion project in France.

The MOMENTUM joint venture, led by Amec Foster Wheeler in partnership with Assystem and KEPCO Engineering and Construction Company has the 10 year, €174 million construction management contract to build the world's largest nuclear fusion reactor – ITER – at Cadarache in France. There is an option for a three-year extension.

Amec Foster Wheeler is also carrying out design development work on an integrated plant simulator, drawing up technical specifications and implementation plans alongside the UK Atomic Energy Authority (UKAEA), Fortum, and VTT Technical Research Centre of Finland Ltd.

This contract adds to Amec Foster Wheeler's existing work at ITER, which includes, remote handling and robotics for the neutral beam, conceptual design and engineering for a remotely operated cutting and packaging system to reduce the volume of waste, design of a remotely operated rail and trolley system for maintenance and inspection of the cryostat, a part of the ITER machine that will contain key components including the vacuum vessel and tokamak, and studies into decommissioning and decontamination.

The study into dismantling ITER, which will take about 12 months, involves a concept-level study of the duration, sequencing and cost for dismantling the ITER machine, once it comes to the end of its life in 2042, within a context of recently updated French nuclear regulatory requirements.

Amec Foster Wheeler, with EAI Ingénierie and NUKEM Technologies Engineering Services, will apply their international nuclear decommissioning experience to the design of the facility.

In addition to the above, Fusion for Energy, which manages Europe's contribution to ITER, has appointed Amec Foster Wheeler to a new single source multi-year framework contract to provide technical specifications, contract follow-up and acceptance work on nuclear safety electronic controls and instrumentation systems.

Fusion for Energy, has also signed a multi-million-pound deal with Airbus Safran launchers, Nuvia and Cegelec CEM to develop robotics equipment for ITER.

Worth nearly €100 million, the deal will see state-of-the-art remote handling equipment become designed and supplied to the project. The high-tech remote handling systems will support the maintenance and repair of the ITER fusion experiment, where space is extremely limited and the exposure of some of the components to radioactivity prohibits any manual intervention inside the vacuum vessel.

# Methodology for Economic Impact Assessment

## Direct Impact

The direct employment impact of the civil nuclear sector is derived from the NIA's Jobs Map survey. These numbers, provided on a headcount basis, are based on surveys of the NIA's membership. As these numbers include employment at firms in the nuclear supply chain, our estimate of direct impact includes some of what would traditionally be termed the indirect impact. For more detail on the scope of the sector that is included in the direct impact, refer to Chapter 1.3.

The components of direct GVA, namely gross staff costs and gross profits, were estimated using findings from Oxford Economics' bespoke survey of the NIA's membership, conducted during May and June 2017. The distribution of average wages across the incomes scale was derived from sector-specific data from the ONS' Annual Survey of Hours and Earnings (ASHE).<sup>18</sup>

The incidence of corporation tax, business rates, and VAT were similarly estimated using findings from the survey, and validated using HM Revenue & Customs (HMRC) data. Labour taxes, encompassing income tax and National Insurance Contributions (NICs), were inferred from gross staff costs, using HMRC data on tax bands, thresholds and receipts in 2016.

## Indirect Impact

In this report, the indirect impact captures the economic activity of the non-nuclear components of the civil nuclear sector's supply chain. This includes services such as administration and business services, utilities, manufacture and supply of non-nuclear specific equipment and infrastructure, transportation, marketing and recruitment.

The sector's supply chain was estimated using procurement data gathered from the survey of NIA members, including the amount spent and the type of goods and services purchased. Firms were asked to identify what proportion of their inputs are sourced from other members of the NIA. This spending was removed from the indirect calculations to avoid double counting, as the resultant economic benefits are captured in the direct impact.

The modelling for this study was based on the national UK Input-Output (I-O) tables, as published by the ONS.<sup>19</sup> They 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 firms abroad). Similarly, they provide detail on the spending pattern of UK households, and indicate whether this demand is met by UK production, or imported products. In essence, the I-O table shows who buys what from whom, for the time period in question. Using the detail on these linkages provided by the I-O tables, Oxford Economics constructed a bespoke UK and regional impact model, which traces the supply chain impacts attributable to the civil nuclear industry.

Oxford Economics' impact model then quantifies all rounds of subsequent purchases along the supply chain. These transactions are translated into GDP contributions, using UK-specific ratios of value-added to gross output, sourced from the UK I-O table.

<sup>18</sup> Office for National Statistics, Annual Survey of Hours and Earnings: 2016 provisional results, (2016).

<sup>19</sup> Office for National Statistics, Input-output supply and use tables 2013, (2016).

Taxes were estimated using HMRC data on tax bands and receipts, along with official statistics on average profitability of each UK sector, the average wage rates seen in these sectors, and the indirect employment supported within them.

---

## Induced GVA, Employment and Tax Impact

The induced impact is modelled using a similar method. Using employment figures provided by the NIA and wage data calculated as part of the direct impact, Oxford Economics used household spending data to model the typical consumption spending of UK resident households, making allowing for 'leakages' in the form of imports and savings.

For workers within the civil nuclear industry's supply chains, we used industry-specific ratios of employee compensation per unit of output, in order to quantify how much household wages are supported among the suppliers' workers. Both of these spending streams were then fed into our I-O model for the UK, to calculate the total impact of this spending. Taxes were calculated using the same methodology as for the indirect impact.

---

## Regional Impacts

The direct regional impacts have been calculated using location data for each of the NIA's member firms, derived from the Jobs Map.

Oxford Economics developed a bespoke model of the UK economy that estimates employment and gross value added impacts across the country's 12 nations and regions. The model is built on techniques developed in academia, using distance-adjusted 'location quotients' to determine regional multiplier impacts. Location quotients express the intensity of a particular industry's economic activity in a particular region, relative to the nation as a whole.<sup>18</sup>

This procedure allows for better estimates of the spatial distribution of gross value added supported in the indirect and induced channels. Geographies with higher concentrations of industries that receive procurement or household expenditure will tend to experience greater impacts. In addition, by dividing gross value added by region-specific productivity data (where productivity is gross value added per employee per year), the employment estimates are refined.

# 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 200 countries, 100 industrial sectors and over 3,000 cities. 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.

Headquartered in Oxford, England, with regional centres in London, New York, and Singapore, Oxford Economics has offices across the globe in Belfast, Chicago, Dubai, Miami, Milan, Paris, Philadelphia, San Francisco, and Washington DC. We employ over 300 full-time people, including more than 200 professional economists, industry experts and business editors—one of the largest teams of macroeconomists and thought leadership specialists. Our global team is highly skilled in a full range of research techniques and thought leadership capabilities, from econometric modelling, scenario framing, and economic impact analysis to market surveys, case studies, expert panels, and web analytics. Underpinning our in-house expertise is a contributor network of over 500 economists, analysts and journalists around the world.

Oxford Economics is a key adviser to corporate, financial and government decision-makers and thought leaders. Our worldwide client base now comprises over 1,000 international organisations, including leading multinational companies and financial institutions; key government bodies and trade associations; and top universities, consultancies, and think tanks.

## December 2017

All data shown in tables and charts are Oxford Economics' own data, except where otherwise stated and cited in footnotes, and are copyright © Oxford Economics Ltd.

This report is confidential to the Nuclear Industry Association, and may not be published or distributed without their prior written permission.

The modelling and results presented here are based on information provided by third parties, upon which Oxford Economics has relied in producing its report and forecasts in good faith. Any subsequent revision or update of those data will affect the assessments and projections shown.

To discuss the report further please contact:

Osman Ismail, Senior Economist, [oismail@oxfordeconomics.com](mailto:oismail@oxfordeconomics.com)  
Kathryn Inglis, Economist, [kinglis@oxfordeconomics.com](mailto:kinglis@oxfordeconomics.com)

Oxford Economics, Broadwall House, 21 Broadwall, London, SE1 9PL, UK  
Tel: ± 44 203 910 8000

**The Nuclear Industry Association (NIA) is the trade association for the civil nuclear industry in the UK, representing more than 250 companies across the supply chain. The diversity of NIA membership expertise in new build, management and decommissioning enables effective and constructive industry-wide interaction.**

**Nuclear Industry Association  
is a company limited by guarantee  
registered in England No. 2804518**

Registered Office:  
5<sup>th</sup> Floor, Tower House  
10 Southampton Street  
London WC2E 7HA  
TEL +44(0)20 7766 6640  
EMAIL [info@niauk.org](mailto:info@niauk.org)

**NIAUK.ORG**

Follow us: [@NIAUK](https://twitter.com/NIAUK)

