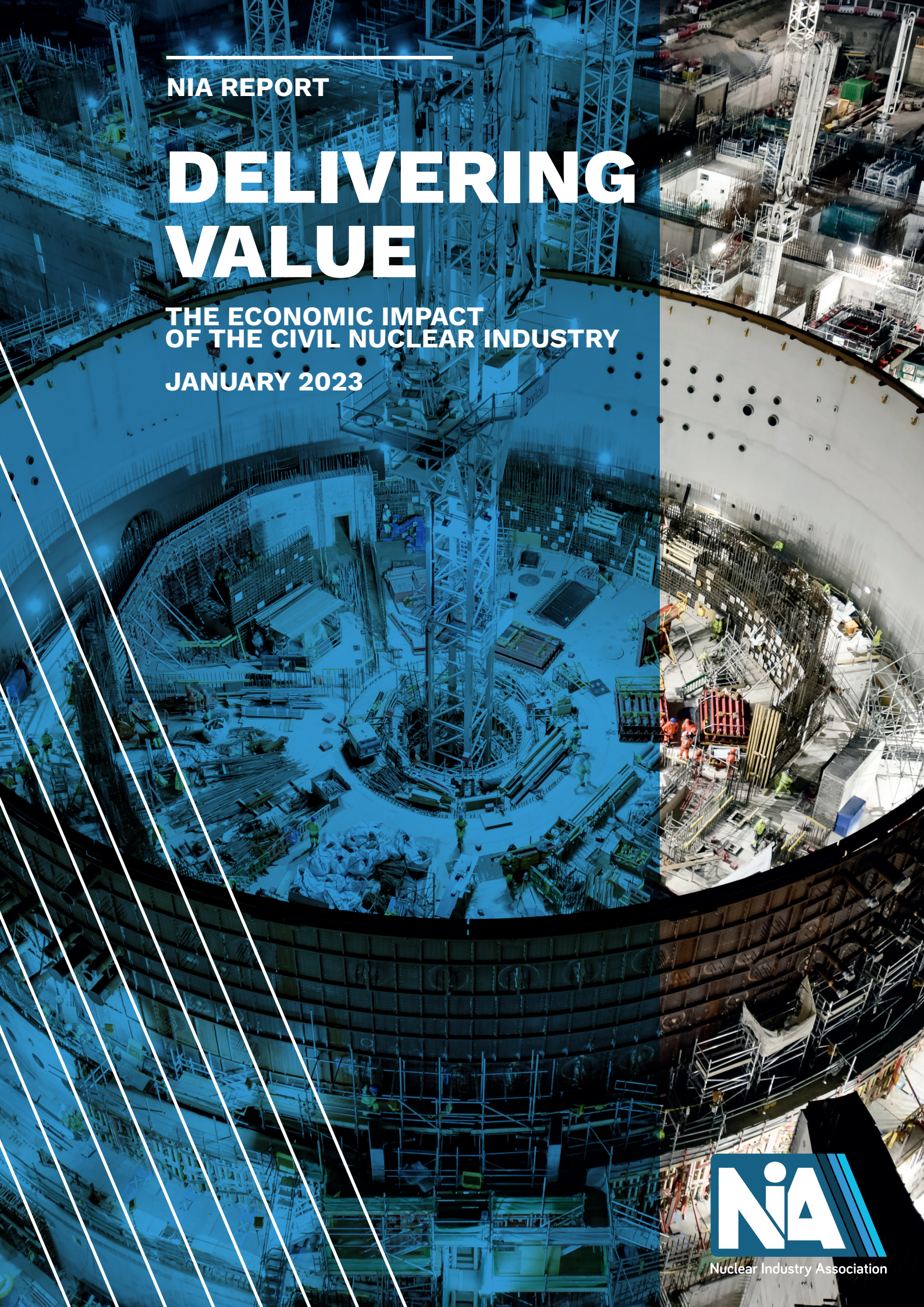


NIA REPORT

DELIVERING VALUE

THE ECONOMIC IMPACT OF THE CIVIL NUCLEAR INDUSTRY

JANUARY 2023

Nuclear Industry Association

ABOUT OXFORD ECONOMICS

Oxford Economics was founded in 1981 as a commercial venture with Oxford University's business college to provide economic forecasting and modelling to UK companies and financial institutions expanding abroad. Since then, we have become one of the world's foremost independent global advisory firms, providing reports, forecasts and analytical tools on more than 200 countries, 100 industrial sectors, and 8,000 cities and regions. Our best-of-class global economic and industry models and analytical tools give us an unparalleled ability to forecast external market trends and assess their economic, social and business impact.

Headquartered in Oxford, England, with regional centres in London, New York, and Singapore, Oxford Economics has offices across the globe in Belfast, Boston, Cape Town, Chicago, Dubai, Frankfurt, Hong Kong, Houston, Johannesburg, Los Angeles, Mexico City, Milan, Paris, Philadelphia, Sydney, Tokyo, and Toronto. We employ 450 full-time staff, including more than 300 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.

Oxford Economics is a key adviser to corporate, financial and government decision-makers and thought leaders. Our worldwide client base now comprises over 2,000 international organisations, including leading multinational companies and financial institutions; key government bodies and trade associations; and top universities, consultancies, and think tanks.

January 2023

OXFORD ECONOMICS

To discuss the report further please contact:

Andy Logan, Director of Industry Consulting, alogan@oxfordeconomics.com

Alexandra Hermann, Senior Economist, ahermann@oxfordeconomics.com

Emily Gladstone, Senior Economist, egladstone@oxfordeconomics.com

Oxford Economics, 4 Millbank, London, SW1P 3JA
Tel: +44 203 910 8000

FOREWORD

For 65 years, nuclear power 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 Delivering Value report presents, for the first time since 2017, a comprehensive study of the contribution the UK civil industry makes to our economy, thanks to independent analysis undertaken by Oxford Economics.

In 2021 the UK's civil nuclear sector generated £6.1 billion in GDP for the UK economy—around twice as much as the air transport industry. When the indirect impact of the sector's activity is considered, this figure more than doubles to £16.1 billion. The civil nuclear sector is a vital job creator: more than 64,000 people are directly employed and 211,000 jobs are reliant in some way on its activities. 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 underpins the industry. Nuclear remains a vital part of the electricity mix, but there is work to be done.

Around 15% of total electricity produced in Britain comes from nuclear power, down from around a fifth in 2016. It is the second largest source of low carbon electricity in the UK, providing a backbone of firm, clean power alongside renewables. However, with two thirds of all dispatchable power capacity retiring by 2030, including all but one of our current nuclear stations, this will need to the replaced and expanded with a new nuclear fleet to continue providing the reliable, low carbon power the UK will need if it is to keep the lights on and hit net zero.

There is much work to be done. The vision of Great British Nuclear, set out in the Government's Energy Security Strategy, could signal the start of a new atomic age for Britain and ensure we keep pace with other leading nuclear nations, but we need to act urgently so we can seize this generational opportunity to drive innovation, boost productivity, and cut costs.

New build projects bring unprecedented economic benefits and can revolutionise the life chances of people in nearby communities: Hinkley Point C alone has delivered more than £4 billion of investment into the South West, and more than 8,000 people are now working on site. Coupled with the progress being made in decommissioning, projects like this have helped develop UK industrial skills and capabilities across the supply chain. We also have a significant opportunity for the sector to be world leaders in the development of Small Modular Reactors, a global market which could be worth hundreds of billions of pounds.

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

DR TIM STONE CBE, CHAIR
NUCLEAR INDUSTRY ASSOCIATION

Nuclear energy is a crucial component in the UK's electricity mix, accounting for nearly 15% of all the electricity the UK generates and helping the country keep the lights on and meet its climate targets. It facilitates the use of renewables by providing predictable and reliable all-day generating capacity when the sun doesn't shine and wind doesn't blow. The UK's nuclear power stations also boost our energy security, by reducing our reliance on imported fossil fuels.

But the impact of the civil nuclear industry on the UK economy extends well beyond its core function of delivering a secure energy supply to businesses and consumers across the country. Our research investigates the impact the industry has on the economy as a whole, especially the jobs market and the UK's public finances. We find it supports an estimated £16.1 billion gross value added contribution to the economy, around 211,500 jobs, and around £7.1 billion in tax revenues. This impact is not spread evenly across the UK—24% occurs in the North West and 16% in the South West, where there are clusters of civil nuclear activities.

The study finds the nuclear sector is helping to address disparity in opportunities in the UK. Over half of the jobs within the civil nuclear sector are in largely rural areas. By providing highly-paid jobs in these areas, the civil nuclear industry helps to narrow the rural-urban wage gap. The industry's employment is also over-indexed in local authorities where labour market participation is currently low and employment growth is predicted to be slow over the next decade. In providing job opportunities where they are most needed, the industry is helping to reverse regional inequality.

The industry also boosts the productive potential of the economy. The high-technology nature of nuclear activities means that continual innovation and research and development (R&D) are essential to ensure competitiveness. The civil nuclear sector is also a significant investor in the UK's human capital, in the form of training and development opportunities for its workers.

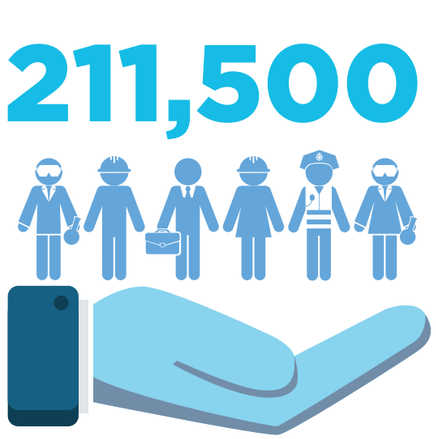
Our research clearly demonstrates the significant contribution that the civil nuclear industry makes to the UK economy. I hope you enjoy reading it.

SAM MOORE, MANAGING DIRECTOR, ECONOMIC CONSULTANCY
OXFORD ECONOMICS

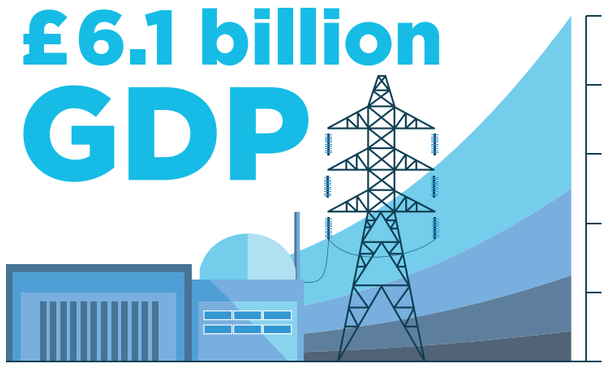
CONTENTS

Images courtesy of -

www.edfenergy.com/about/nuclear

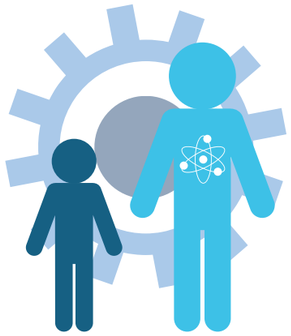


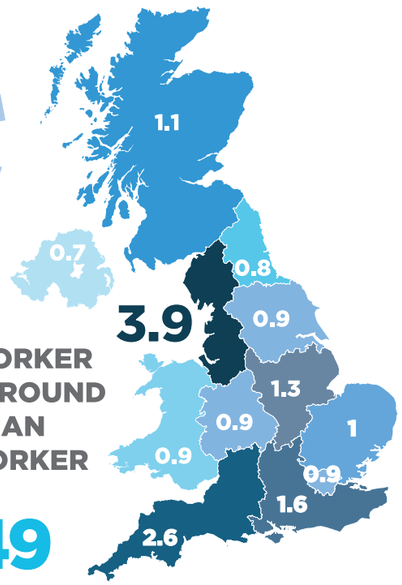
CIVIL NUCLEAR SUPPORTS AROUND 211,500 JOBS



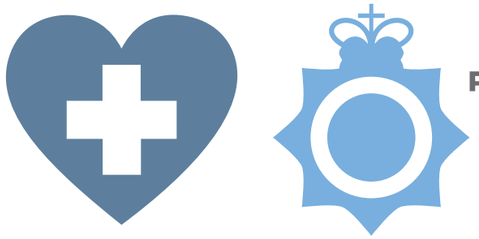
NUCLEAR GENERATED £6.1 BILLION IN GDP, AND £16.1 BILLION WITH INDIRECT IMPACT INCLUDED

£4.5 BILLION IN TAX REVENUES PAID TO THE EXCHEQUER

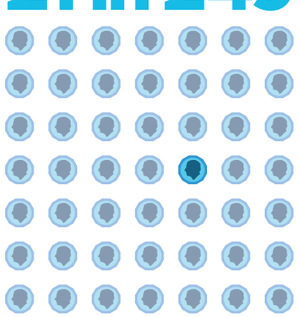




CIVIL NUCLEAR WORKER PRODUCTIVITY IS AROUND 50% HIGHER THAN THE AVERAGE WORKER

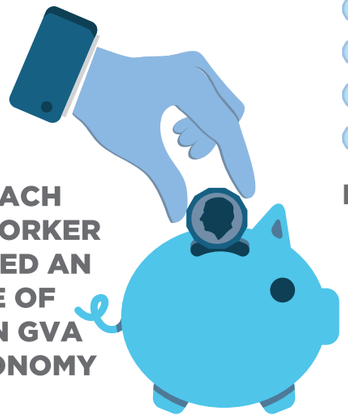


EQUIVALENT TO THE GROSS ANNUAL SALARIES OF OVER 145,000 NURSES OR ALMOST 110,000 POLICE OFFICERS



NUCLEAR SUPPORTS £1 IN EVERY £49 OF ECONOMIC OUTPUT IN BOTH THE NORTH WEST AND SOUTH WEST

THE LARGEST CIVIL NUCLEAR REGIONAL GVA IMPACT (£BN) IS IN THE NORTH WEST



IN 2021, EACH NUCLEAR WORKER CONTRIBUTED AN AVERAGE OF £102,300 IN GVA TO THE ECONOMY

£178 MILLION INVESTED IN CIVIL NUCLEAR R&D PROJECTS

EXECUTIVE SUMMARY

The UK's civil nuclear sector has a long history of delivering innovation and investment, creating high skilled jobs, and providing low carbon power across the UK. The sector includes not only the operators of nuclear power stations, but also fuel fabricators, decommissioning and waste processing organisations, engineers and construction specialists, project managers and consultants, and nuclear researchers.

Our analysis of the sector shows that it **contributes a range of benefits to the UK economy, from its provision of energy through to its investment in skills and innovation.** The value created by the sector delivers billions of pounds worth of economic output, supports tens of thousands of jobs, and generates a substantial stream of tax revenues for the UK Exchequer. Generating this value depends upon the coordinated efforts of a broad range of firms spanning numerous civil nuclear activities. This assessment considers several dimensions of the sector's contribution to the economy, to quantify the total size of its "economic footprint" in 2021.

We calculate that the UK's 64,100 strong civil nuclear workforce directly added about £6.1 billion to UK GDP in 2021. This amounts to around 0.3% of the UK's total economic output in that year, or around 48% the equivalent figure for the chemicals industry. Furthermore, through taxes levied on the sector's revenues, profits, wage payments, and properties, the civil nuclear industry also directly contributed £4.5 billion in revenues to the Exchequer––sufficient to cover the average annual salaries of over 145,000 nurses.[1]

This scale of output points towards the remarkable productivity of civil nuclear sector workers. The average civil nuclear worker generated £95,300 of GDP during 2021. Productivity reached £102,300 of GVA per full-time equivalent (FTE) worker—a rate almost twice as high as the UK median figure. This level of productivity puts employees of civil nuclear firms firmly within the second most productive 10% of the UK workforce.

Beyond this direct impact, our analysis also traces the wider economic footprint of the sector through its supply-chain and wage-consumption multiplier effects. The inputs required by the civil nuclear sector stimulate a broad and complex network of supply chains reaching all parts of the economy. The spending of wages by the sector's employees (and those within its supply chains) creates further economic activity in the consumer economy.

Taking all these channels of impact together, the sector's total contribution to GDP more than doubles, to an estimated £16.1 billion. This means it has a GVA multiplier of 2.6. In other words, for every £1 of value added by the nuclear sector, another £1.6 is generated across the wider UK economy. The total contribution is equivalent to 0.8% of the UK's total GDP in 2021, or nearly three days' worth of the total economic output that year. This contribution is associated with a total employment footprint of around 211,500 jobs, and around £7.1 billion in tax revenues raised.

While the impact is felt across the UK, its local and regional impacts are also important. Many of the jobs within the industry are in rural areas, where there are less high paying alternative job opportunities. Similarly, the industry is a significant provider of employment opportunities in deprived areas, helping to address regional inequality.

But the economic advantages provided by nuclear power do not end there. The technology is a crucial component in the UK's electricity mix, accounting for nearly 15% of its total electricity generation during 2021 and making it a key source of low-carbon energy for the UK. This has become even more important in the wake of Russia's decision to restrict the supply of gas to Europe in the wake of its illegal invasion of Ukraine, adding further upwards pressure on energy prices in the UK.

We also examine the sector's importance as an investor in the UK's future economic potential. The high-technology nature of nuclear activities means that continual innovation and research and development (R&D) are essential to ensure competitiveness. Breakthroughs emerging from such activity have important applications in other contexts, thereby enhancing the productivity and prosperity of disparate industries across the economy. One example of this is in fusion energy, a field in which the UK is an important partner in international research efforts as shown by the recent experiment that succeeded in producing more fusion energy than energy input into the experiment. Future breakthroughs in this field could have transformative consequences for all economic activity.

The civil nuclear sector is also a significant investor in the UK's human capital, in the form of training and development opportunities for its workers. At least 1,500 civil nuclear workers participate in structured graduate or apprentice training programmes, highlighting the industry's commitment to enhancing the pool of skills available in the UK's labour force. Such training boosts the productivity of the recipients and their colleagues, enhances the adoption of new technology and methods, and increases innovation in products and processes.

This is just some of the broader value that the civil nuclear sector delivers to the UK economy. Other benefits include the strategic advantages that result from reducing the UK's dependence on a steady stream of imported fossil fuels. While the full economic value of this cannot be straightforwardly quantified in monetary terms, it is certainly another important area when appraising the sector's full economic significance for the UK.

1] The average annual salary of a nurses in the UK was £30,728 in 2021. This is a weighted average salary of midwifery nurses, community nurses, specialist nurses, nurse practitioners, mental health nurses, children's nurses, and other nursing professionals (SOC20 codes 2231-2237), See Annual Survey of Hours and Earnings (Statistical bulletin), Office for National Statistics, 2021 https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2021

1. INTRODUCTION

The goal of meeting the UK's net zero target by 2050 relies crucially on a decarbonisation of the electricity system, which is a substantial contributor of UK emissions. The Government's plan to remove coal and other fossil fuels from Britain's energy generation and heating has already started to make a substantial impact. Between 1990 and 2021, carbon dioxide emissions from fossil fuels declined by over 43%.[2]

As this shift takes place, nuclear power has become a more important energy source for the UK. Predictably and reliably meeting all-day minimum energy requirements ("baseload" demand) has traditionally relied on large contributions from fossil fuels. The civil nuclear sector in the UK has helped to ensure that much of this baseload demand can be met with a low-carbon technology. In doing so, the nuclear sector directly displaces coal and gas production, while also providing resilience that permits greater proportions of wind and solar power onto the Grid.

The invasion of Ukraine by Russia in February 2022 and its subsequent restrictions on gas supply to Europe has intensified the focus of the UK Government to support development of alternatives to Russian fuel supply and strengthen UK energy security. In January 2023, the Department for Business, Energy and Industrial Strategy announced a £75 million Nuclear Fuel Fund to provide greater options for UK nuclear operators to use UK-produced fuel.[3]

It is against this backdrop that this report assesses the current economic impact of the civil nuclear sector in the UK. It builds upon a previous analysis, conducted by Oxford Economics for the Nuclear Industry Association (NIA) in 2017, that quantified the sector's economic characteristics for the year 2016. This report updates our evidence for the sector's scale and significance, drawing upon data from the NIA, statistics from the Office for National Statistics (ONS), HM Revenue & Customs (HMRC), and a bespoke survey of NIA members, conducted by Oxford Economics during autumn 2022.

The sector directly employs more than 64,100 people and contributes to the economy through several channels beyond the supply of energy. Our analysis captures the effect it has on other industries via its supply chain, as well as the wage-spending impact of its employees within the consumer economy. The report also considers the sector's role in expanding the supply side of the economy, through its investment in skills and innovation, as well as the economic significance of the greenhouse gas emissions that it helps the UK to avert.

Our definition of the "civil nuclear sector" rests upon the organisations that are members of the NIA and supplied data to their 2021-22 Job Map survey. 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;
- 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).

Any activities focussed on defence or military applications of nuclear technology are excluded from our definition. We also exclude the majority of the UK's academic nuclear researchers.[4]

2] 2021 UK greenhouse gas emissions, provisional figures, Department for Business, Energy & Industrial Strategy, 31 March 2022 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1064923/2021-provisional-emissions-statistics-report.pdf

3] Ministers bolster UK nuclear fuel capacity to squeeze out Russian influence, Department for Business, Energy & Industrial Strategy, 2 January 2023 https://www.gov.uk/government/news/ministers-bolster-uk-nuclear-fuel-capacity-to-squeeze-out-russian-influence

4] 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, the University of West of England, the University of Southampton, and the University of Plymouth.

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 generated 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 impact on the UK and local economies. 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.[5]
- **Employment,** measured on a headcount basis.
- **Tax revenues,** the estimated fiscal contribution resulting from transactions and employment sustained by the civil nuclear industry.

The results are presented on a gross basis. They therefore ignore any displacement of activity from other energy sources. Nor do they consider what the resources currently used by the civil nuclear industry or stimulated by its expenditure could alternatively produce in their second most productive usage.

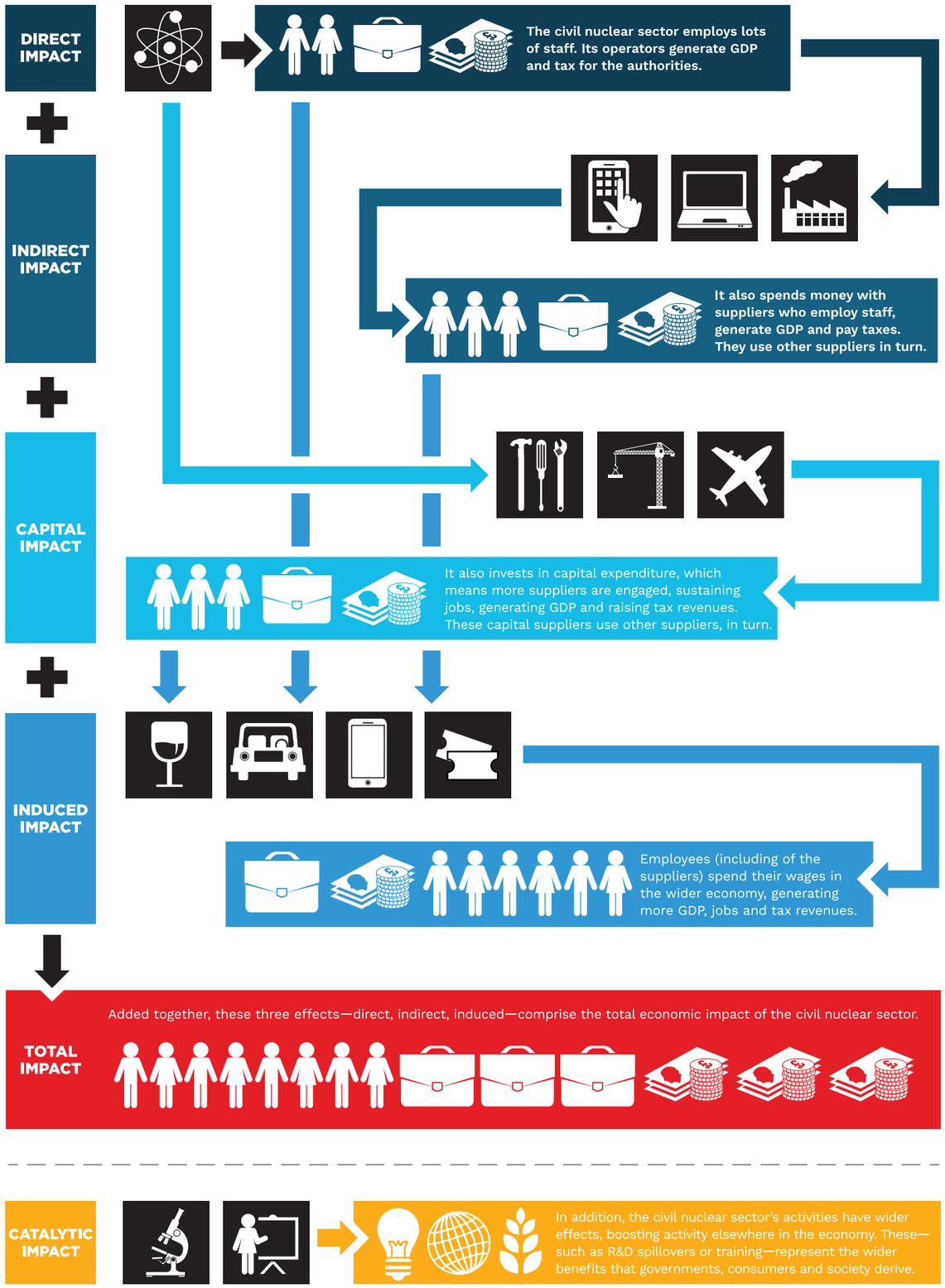
The report also examines the **"catalytic"** impacts the civil nuclear sector has on the UK economy. The catalytic impacts represent the wider benefits other industries, government, consumers, and society gain from the industry's productivity boosting activities. In this report, we examine two channels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

Fig. 1 overleaf 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 the Appendix to this document.

5] 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 is easiest thought of as the value of output (goods or services) less the value of intermediate inputs used up in their production.

Figure 1 ***Channels of impact***



2. CORE IMPACT OF THE UK'S CIVIL NUCLEAR SECTOR

This chapter presents our estimates of how the civil nuclear industry contributed to UK GDP, employment, and tax revenues in 2021.

This analysis draws upon the NIA's Jobs Map data, an annual research programme across its membership that estimates the scale and distribution of civil nuclear sector employment in the UK. It also utilises data from a survey of the NIA's members, which informed our updated modelling of their nuclear-related activities.

2.1 Direct impact

The direct impact of the sector captures the economic contribution made by the civil nuclear sector's own employment and operations. This encompasses businesses and 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.

The sector's employment amounted to 64,105 people in 2021. This means that the sector's employment was larger (by around 9%) than the UK's entire rail sector,[6] or around 87% that of the aerospace manufacturing industry.[7] This figure, which amounts to a small reduction (of 2.6%) when compared to 2017, includes workers across all manner of occupations, and within firms undertaking many combinations of the nuclear-specific activities listed above.

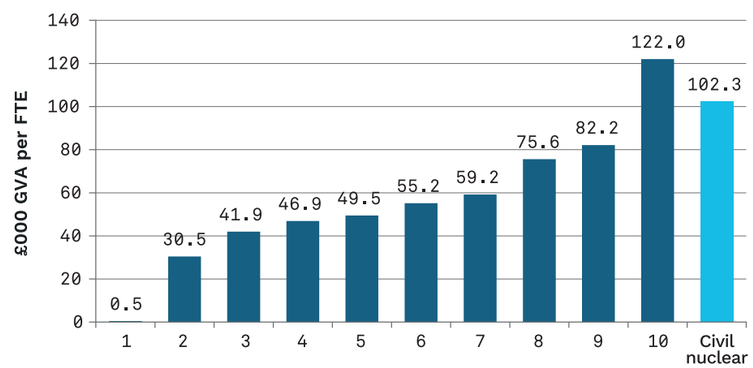
The activities of these civil nuclear sector workers generated a £6.1 billion gross value added (GVA) contribution to GDP during 2021. This is calculated based on the mix of activities taking place within the civil nuclear sector and estimates for the average level of output associated with workers undertaking each type of activity.

This scale of activity among civil nuclear firms means that they directly accounted for 0.3% of the UK's entire GDP during 2021. This is broadly equivalent to 44% of the direct GDP contribution of the pharmaceuticals industry in the same year; or around twice as much as the UK's air transport sector in 2021.

Employees in the civil nuclear sector are highly productive. In 2021, each worker contributed an average of £95,300 in GVA to the economy. Adjusting for the proportions of full- and part-time working within the civil nuclear sector, productivity reaches £102,300 of GVA per full-time equivalent (FTE) worker—a rate almost twice as high as the UK median figure. This places the UK's civil nuclear workforce firmly within the most productive decile of economy, as shown in Fig. 2. This high productivity reflects both the highly skilled nature of the civil nuclear workforce, and the intensive use of advanced technologies to add value.

The industry having high productivity workers is important as it can enhance its price competitiveness or boosts its profit margin. Both potentially add to GDP and raise living standards in the UK.

Figure 2 ***Distribution of productivity within the UK's workforce by decile***[8]



6] Employment in the rail transport sector (SIC codes 49.1 and 49.2) amounted to 59,000 in 2021. See Business Register and Employment Survey, Office for National Statistics https://www.ons.gov.uk/surveys/informationforbusinesses/businesssurveys/businessregisteranddemploymentsurvey

7] Employment in the aerospace manufacturing industry (SIC code 30.3) amounted to 74,000 in 2021. As above.

8] The productivity distribution of the UK workforce is as of 2020. The values 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 £500 and £30,500 (first decile). The productivity of the second 10% would range between £30,500 and £41,000 (second decile), and so on. The productivity of the ninth decile–the second group of most productive workers in the economy–would be between £82,200 and £122,000. This decile would include the civil nuclear workforce.

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).

We estimate that the activities of the civil nuclear sector gave rise to around £4.5 billion in tax payments in 2021. This is equivalent to the gross annual salaries of over 145,000 nurses, or almost 110,000 police officers.[9]

2.2 Indirect impact

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 the NIA's membership and are thus encompassed in the direct impact described above.

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 firms draw upon their own suppliers, and so on along the supply chain, extending across all sectors and regions of the UK economy.

The civil nuclear sector spent an estimated £5.7 billion on inputs of goods and services from non-nuclear UK firms. This estimate adjusts for the extent of procurement with other civil nuclear industry firms (this spending, and its resultant economic activity, is captured in the sector's direct impact).[10] It also adjusts for the extent of imports, which 'leak' out of the UK economy and are assumed to provide no further economic benefit.

The procurement expenditure generated a further £5.0 billion in UK GDP during 2021. 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 almost £1.3 billion in GVA, accounting for 25% 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 management advisory.

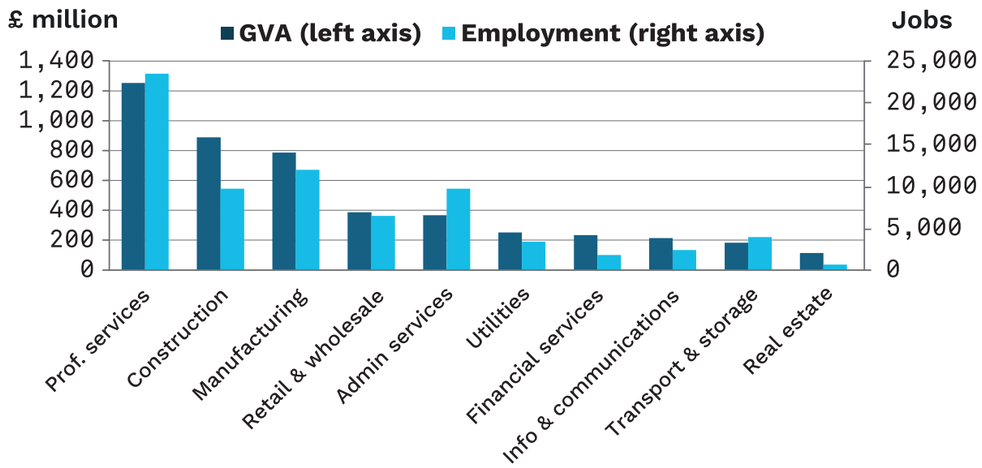
A significant indirect GDP contribution was also seen within the construction and manufacturing sectors. Demands for advanced equipment, components, infrastructure, and maintenance by all parts of the civil nuclear sector help to drive this impact, supporting £888 million and £786 million, respectively, in indirect GVA. This amounts to one third of the nuclear sector's total indirect impact.

The procurement activity supported an estimated 77,500 jobs in 2021, across the length of the supply chains providing goods and services to the civil nuclear sector. The largest indirect employment impact was again among the professional services industry, in which close to 23,500 jobs were supported by the procurement demands of the civil nuclear sector. Manufacturing, construction, and administrative services such as facilities management and employment agencies, also enjoyed large shares of the total indirect jobs impact. Together, these sectors saw 31,400 jobs supported.

9] The average annual salary of police officers was £41,077 in 2021. See Annual Survey of Hours and Earnings (Statistical bulletin), Office for National Statistics, 2021 https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2021

10] This figure has risen strongly since our assessment in 2017, from £2.8 billion to £5.7 billion. This shift is driven by new evidence from this year's survey of NIA members, that suggests civil nuclear firms procure more from outside the sector than was previously estimated. This means that our estimate of the sector's indirect impact is higher, reflecting the broader economic 'footprint' that extends along its non-nuclear specific supply chains.

Figure 3 ***Indirect impact of the civil nuclear sector 2021: Top 10 supported industries***



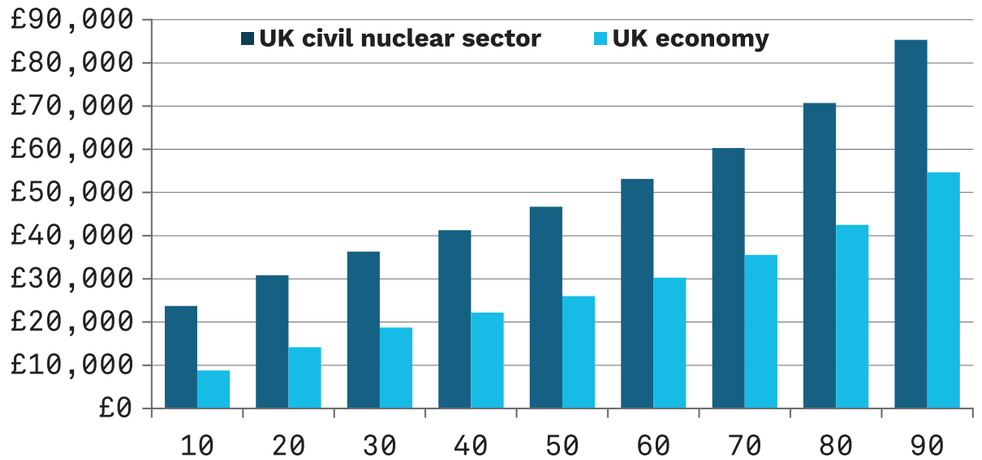
This economic activity generated £1.2 billion in tax receipts in 2021. This comprised of labour taxes, corporation taxes, and other taxes on products and production.

2.3 Induced impact

The final channel of 'core' economic impact that we consider 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.

An estimated £3.5 billion in gross wages and salaries were paid to the civil nuclear sector's staff in 2021. This is a considerable wage bill and is reflective of the high average salaries throughout the sector. Fig. 4 below 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 1.8 times as high as the equivalent figure for the UK economy as a whole.[11] This disparity underlines the prevalence of highly specialised skills among workers in the civil nuclear sector. Having highly paid workers living in the local community has beneficial impacts for the survival of local businesses (such as retail outlets on the high street).

Figure 4 ***Distribution of gross annual salaries in the UK and civil nuclear sector by percentile 2021***

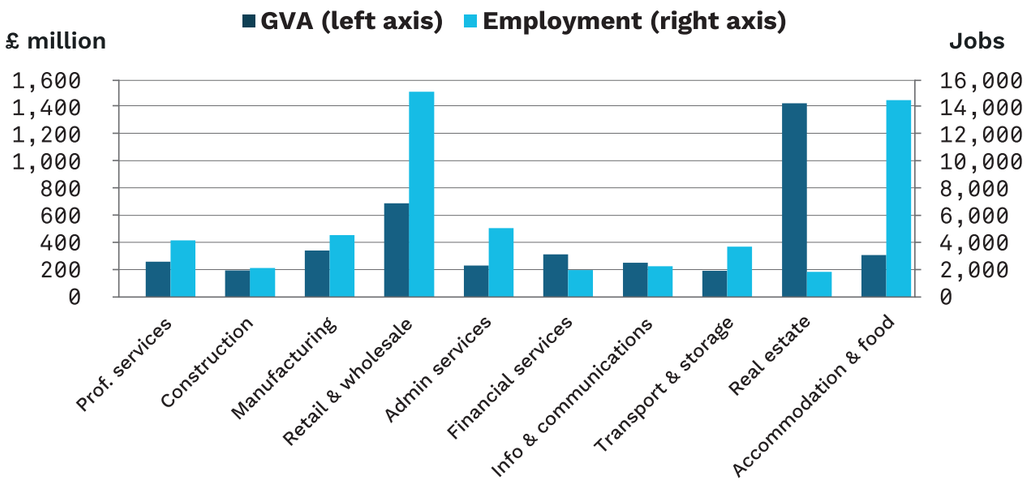


11] The median salary was £25,990 for all employee jobs in the UK in 2021 while that in the civil nuclear industry amounted to £46,704. See Annual Survey of Hours and Earnings (Statistical bulletin), Office for National Statistics, 2021 https://www.ons.gov.uk/employmentandlabourmarket/peopleinwork/earningsandworkinghours/bulletins/annualsurveyofhoursandearnings/2021

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.

In total, this wage-financed consumer spending generated a further £5.9 billion contribution to UK GDP in 2021. The real estate sector and retail/wholesale industry account for the largest shares of this impact, at £1.4 billion (29%) and £694 million (14%), respectively.

Figure 5 *Induced impact of the civil nuclear sector 2021: Top 10 supported industries*



This induced consumption, attributable to the civil nuclear sector, also supported almost 70,000 jobs in 2021. The sector seeing the greatest number of jobs supported was the retail and wholesale industry, which saw around 15,200 jobs supported—22% of the total induced jobs impact. A further 14,600 jobs (21% of total) were supported in the hospitality sector, encompassing restaurants, cafes, bars and hotels. The small employment impact of 1,900 in the real estate sector (relative to its GVA impact), reflects the very capital-intensive nature of the industry.

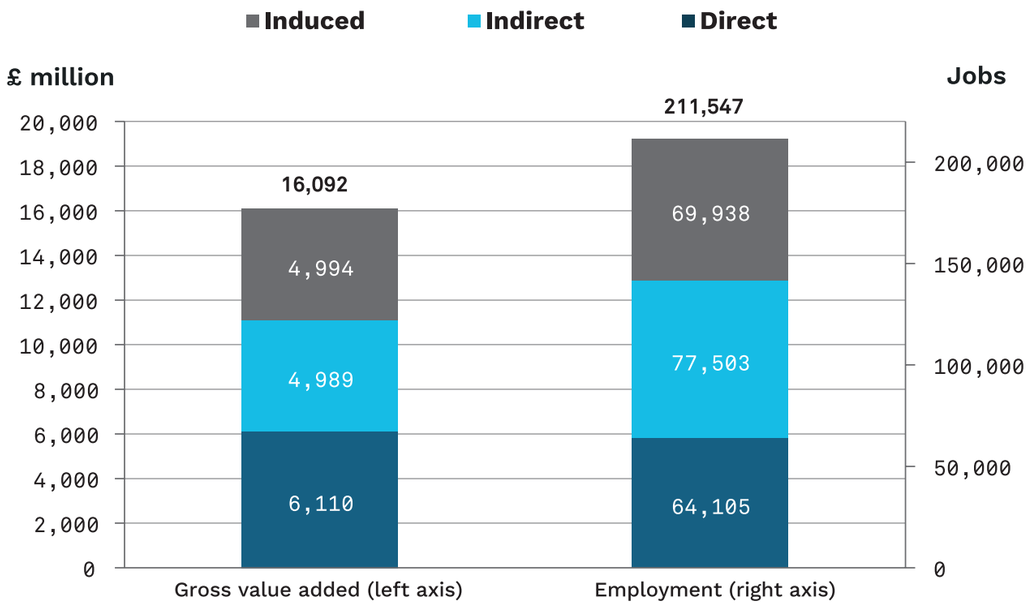
This induced activity also gives rise to additional revenues for the Exchequer. The wage-financed spending of civil nuclear sector workers, and employees within its supply chains, incur VAT and other product taxes. Moreover, the firms meeting these consumer demands also pay taxes on their profits and salary payments. These induced tax contributions reached £1.4 billion in 2021.

2.4 Total impact

The total economic contribution that 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.

Through these three channels, the civil nuclear sector supported a £16.1 billion GVA contribution in 2021. This amounts to 0.8% of the UK's total GDP, and is equivalent to all of Aberdeen's GDP in that year. Of the total contribution, 38% was made by civil nuclear organisations themselves, with the remainder supported through the sector's procurement spending and wage payment impacts. The sector is therefore estimated to have a GVA multiplier of 2.6. So for every £1 million it directly contributed to UK GDP, it supported another £1.6 million elsewhere in the economy through its expenditure.

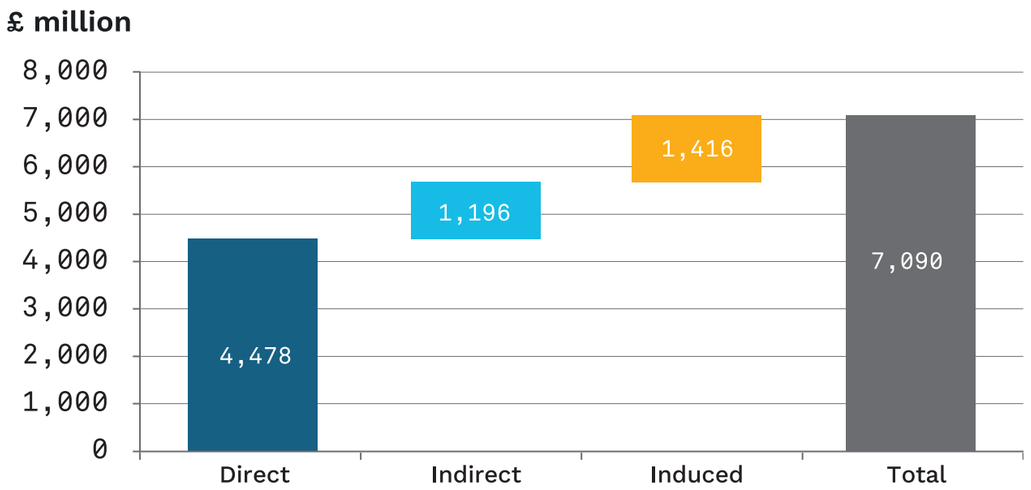
Figure 6 *Total impact of the civil nuclear sector 2021*



Through these three channels, the civil nuclear sector sustained around 211,500 jobs in 2021. This means that one in every 148 jobs in the UK was in some way supported by the civil nuclear sector's activities.[12] Some 64,100 of these are employees working directly in the civil nuclear sector, making up 30% of the total. Another 37%, some 77,500 jobs, were supported in the industry's non-nuclear supply chain. The remaining 69,900 jobs (33%) were sustained through wage consumption impacts. This implies that the sector had an employment multiplier of 3.3. So for every one job in the nuclear sector, it supported another 2.3 jobs in the rest of the economy.

The output and employment supported by the civil nuclear sector also supported an estimated £7.1 billion in tax receipts in 2021. This includes Corporation Tax, income taxes and NICs, and other taxes on production and products. Well over half (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.

Figure 7 *Total tax impact of the civil nuclear industry 2021*



12] Total employment was 31.4 million in 2021. See Business Register and Employment Survey, Office for National Statistics https://www.ons.gov.uk/surveys/informationforbusinesses/businesssurveys/businessregisterandemploymentsurvey

3. REGIONAL CONTRIBUTION

This section investigates the impact that the civil nuclear sector has on each of the UK's constituent nations and regions. We also examine how the presence of a civil nuclear industry works to provide opportunities for those in "left behind" areas, helping to reduce regional disparities.

The UK has larger geographical differences than many other developed countries as reflected in income, education, or health outcomes.

Studies have shown that countries with larger regional disparities experience lower long-term economic growth.[13] This is because regional disparities can lead to economic inefficiencies, with opportunities for those stuck in "left behind" areas limited, so labour and other resources are underutilised.[14] Meanwhile scarcity of resources in overheated areas leads to the bidding up of prices and people working longer hours than optimal, so they become less productive.

Regional disparities also raise equity concerns. They contribute to overall within-country inequality as well as inequality of opportunity.

In 2021, nearly half (46%) of employment in the civil nuclear industry was in local authority districts deemed by government as in highest need of investment.[15] By providing both jobs and opportunities in left behind regions (typically those regions outside of London and the South-East) the civil nuclear sector can contribute to reducing regional disparities. This may also have the added benefit of boosting overall economic growth.

3.1 Contribution to regional GVA

The civil nuclear sector has the largest economic impact on the North West of England. The industry supported around 2.1% of all regional output in 2021, nearly three times its share of total UK output at 0.8% (Fig. 8). It supported a £3.9 billion contribution to the North West's GVA. The region's civil nuclear activities are largely dominated by the decommissioning and waste management processes that continue at Sellafield, as well as the Heysham plants, multiple fuel fabrication facilities, the Low Level Waste Repository, and four of the National Nuclear Laboratory's (NNL) six UK sites. Many other businesses have clustered around these centres, meaning that the North West houses an extensive civil nuclear skills base, encompassing engineering and construction, operations support, and supply chain services.

The South West region saw the next-largest impact from the civil nuclear sector, totalling an estimated £2.6 billion in 2021. This output was linked mainly to the nuclear activities at Hinkley, as well as the Berkeley, Oldbury, and Winfrith decommissioning sites. The region's civil nuclear sector has also formed a significant array of engineering and project management expertise. Altogether, civil nuclear activities accounted for 1.9% of the regional economy in 2021.

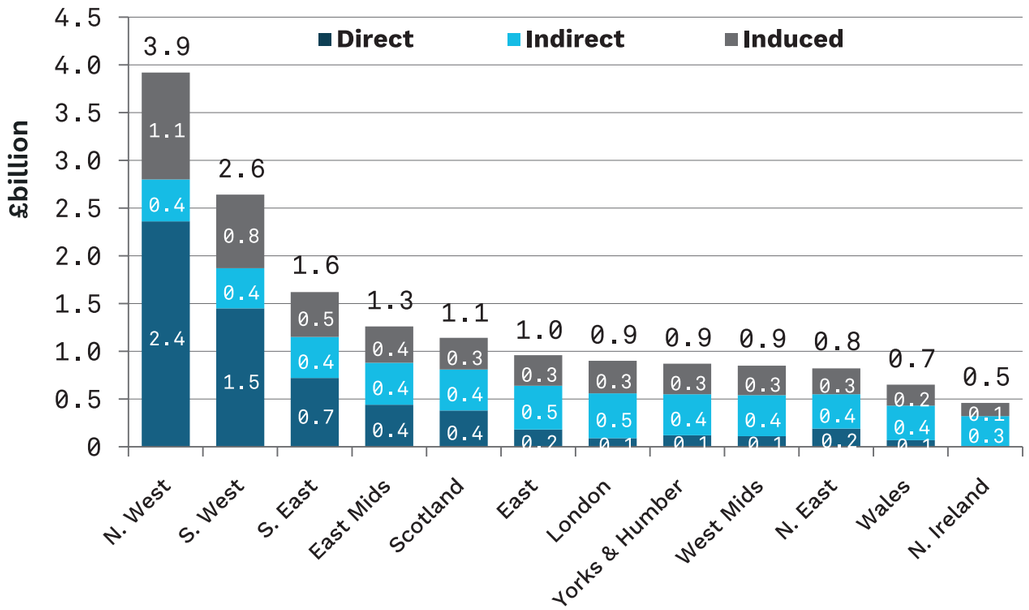
Outside of these two principal clusters, the civil nuclear sector's impact is felt mainly in regions featuring active or decommissioned reactors. The South East, home of the Dungeness and Harwell sites as well as the UK Atomic Energy Authority and the Civil Nuclear Constabulary, sees the third largest impact (£1.6 billion in 2021, equivalent to 0.6% of the regional economy). The impact in the East Midlands, amounting to £1.3 billion (1.1% of the regional economy) is predominantly driven by the presence of Rolls Royce in the region.

13] Structural reforms and Regional Convergence, IMF Working Paper 12/106, Natasha Che and Antonio Spilimbergo, April 2012 https://www.elibrary.imf.org/view/journals/001/2012/106/001.2012.issue-106-en.xml

14] Regional Disparities Growth and Inclusiveness, IMF Working Paper 21/38, Holger Floerkemeier, Nikola Spatafora, and Anthony Venables, February 2021 https://www.imf.org/en/Publications/WP/Issues/2021/02/13/Regional-Disparities-Growth-and-Inclusiveness-50076

15] Local Authority districts under "Category 1". Categories were determined by the Department for Levelling Up Communities (DLUC) in order to assess eligibility for the Levelling Up Fund. See Levelling Up Fund Round 2: prospectus, Department for Levelling Up, Housing & Communities, 15 July 2022 https://www.gov.uk/government/publications/levelling-up-fund-round-2-prospectus/levelling-up-fund-round-2-prospectus

Figure 8 ***GVA impact of the civil nuclear sector, by UK nation/region 2021***

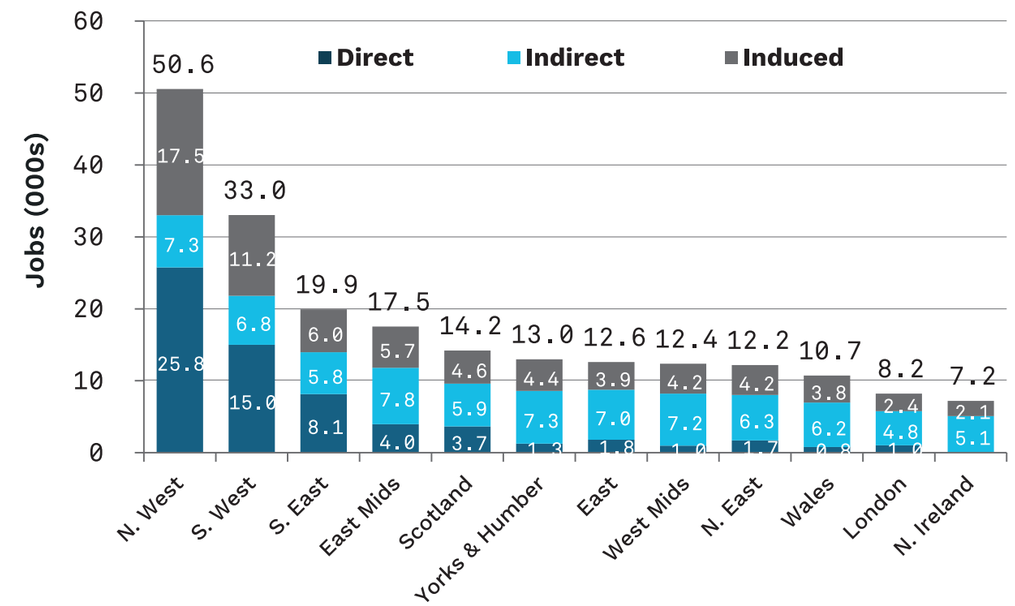


3.2 Contribution to regional employment

The regional profile of the employment supported by the civil nuclear industry is very similar to its contribution to GVA. It supported the most jobs in the North West, South West, and South East of England (Fig. 9).

Our modelling suggests that in comparison to direct jobs, indirect and induced jobs supported by civil nuclear activities are spread more widely across the UK. While all of these jobs are linked to the sector itself, the supply chain and consumption spending "ripples out" to form a wider footprint than the UK's nuclear organisations themselves. This is illustrated in the case of Northern Ireland, where around 7,200 jobs are estimated to be supported by the civil nuclear sector (virtually all in the supply chain and consumer economy), despite the relatively scant presence of civil nuclear organisations there.

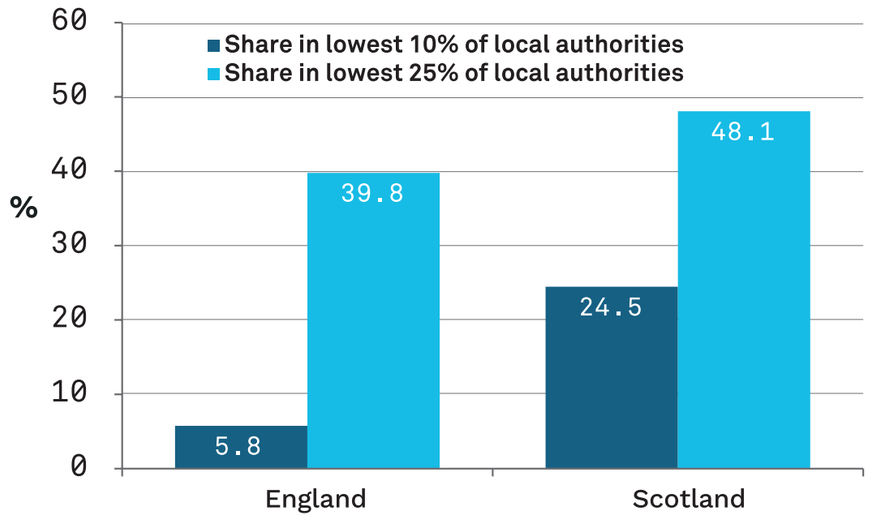
Figure 9 ***Employment impact of the civil nuclear sector, by UK nation/region 2021***



3.3 Contribution to areas with low levels of opportunity

A significant proportion of employment in the civil nuclear sector is located in deprived areas. **In England, almost 40% of direct employment in the civil nuclear sector occurs in the most deprived 25% of local authorities (Fig. 10).**[16] The figure for Scotland is 48%. (Northern Ireland and Wales are omitted as the civil nuclear sector directly employs a limited number of people in these regions.)

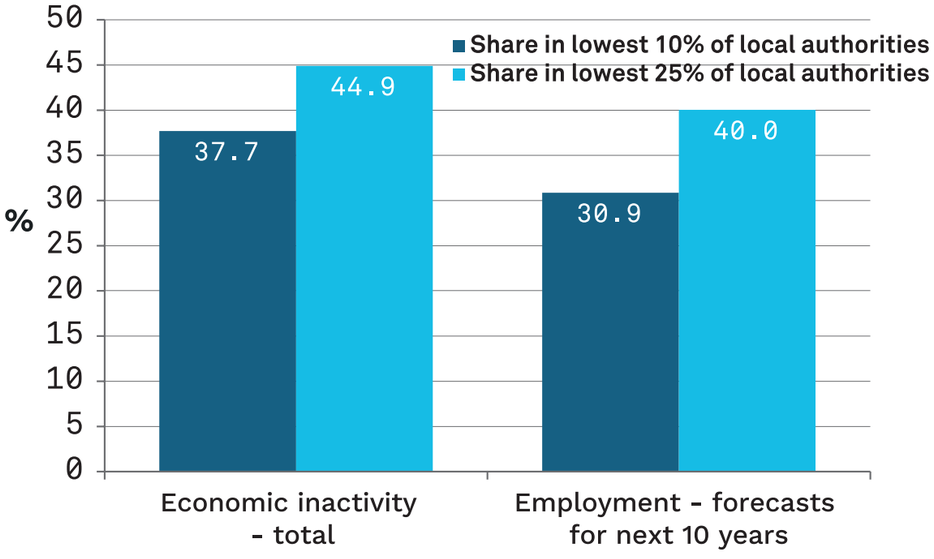
Figure 10 *Share of civil nuclear industry employment in local authorities with highest levels of deprivation*



Similarly, employment in the civil nuclear sector is disproportionately located in geographical areas with low employment levels. **Some 38% of civil nuclear employment is in the lowest 10% of local authorities for economic inactivity levels (Fig. 11 below).**

Civil nuclear employment is also disproportionately located in the local authority districts forecast to experience the lowest growth in employment. **Some 31% of civil nuclear employment is located in the 10% of local authorities predicted to have the slowest growth in employment over the next decade (Fig. 11 below).**

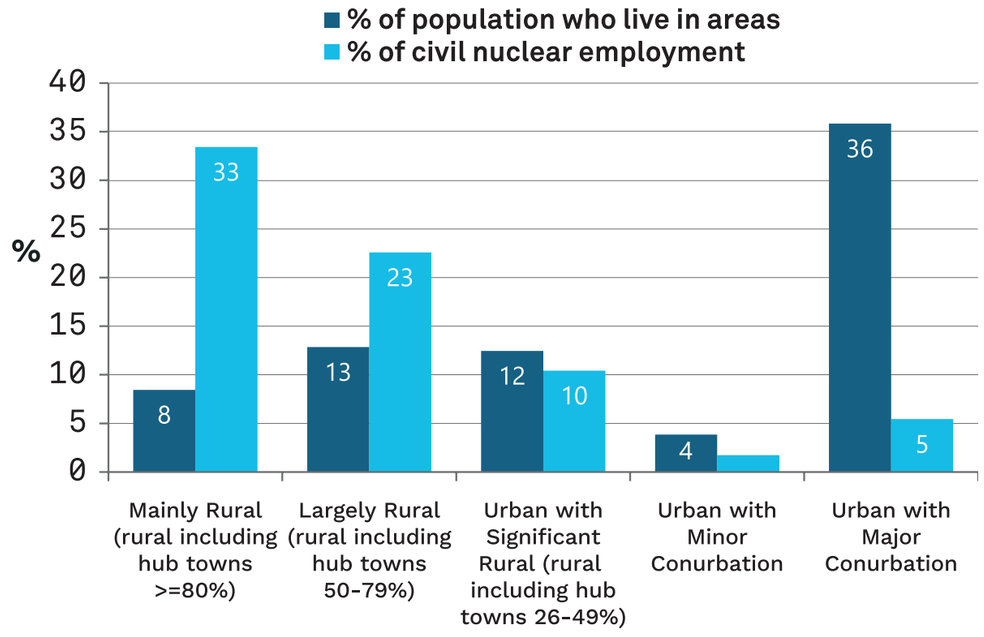
Figure 11 *Share of civil nuclear industry employment in local authorities with lowest current/future employment outcomes*



16] As defined by the Index of Multiple Deprivation (IMD).

Lastly, jobs in the civil nuclear are disproportionately located in rural areas. As illustrated in Fig. 12 below, whilst 21% of the population of England live in largely or mainly rural areas, 56% of civil nuclear employment occurs in these areas. This is largely driven by nuclear activities at Sellafield and Hinkley, both of which are located in rural areas.

Figure 12 *Civil nuclear industry employment in rural-urban types and % of population who live in these areas*



By providing highly paid jobs in rural areas, the presence of the civil nuclear industry helps to narrow the rural-urban wage gap. In 2020, median workplace-based earnings in predominantly urban areas (excluding London) were £25,400 while predominantly rural areas were lower at £22,900.[17] The presence of the civil nuclear industry in rural areas also offers employees training opportunities. This is particularly important as those living in rural areas will typically have higher barriers to accessing these opportunities.

17] Rural earnings, Department for Environment Food & Rural Affairs 26 August 2021 https://www.gov.uk/government/statistics/rural-earnings/rural-earnings#:~:text=In%202020%2C%20median%20workplace%2Dbased,were%20lower%20at%20%C2%A322%2C900

4. WIDER IMPACTS OF THE CIVIL NUCLEAR SECTOR

The previous two chapters of this report summarise our analysis of the "demand-side" impacts the UK's civil nuclear sector. They describe how the industry's expenditure (on its own operations, procurement, and payment of wages) supports jobs and GDP throughout all regions of the UK. But the sector's economic impact does not end there. There are many other dimensions through which the civil nuclear industry provides economic value: several of these are considered in this chapter of our report.

First, we examine some of the "supply side" contributions that the sector makes to the UK economy. This encompasses the investments that civil nuclear firms make in improving the productive capacity of the UK economy, through its investments in people (i.e., training and development of its employees), as well as investments in innovative technologies and research and development (R&D). These boost the stock of human and knowledge capital, respectively—in other words, improving the ingredients that are needed to support future output, incomes, and prosperity. While it is tricky to quantify these supply-side contributions, we discuss them since they undoubtedly provide meaningful economic benefits to households, industry, governments, and society more broadly.

Second, we examine the unique advantages that nuclear power provides for the UK's energy portfolio. This will outline some strategic and technical advantages that are provided by nuclear power in a decarbonising electricity mix. Furthermore, we explain that the UK's civil nuclear industry brings about security of supply benefits by being a dispatchable resource—one that can be counted on when needed—that is able to generate power during periods of system stress when demand is close to exceeding available supply.

Finally, we consider the contributions made to the economy through civil nuclear exports. This will explore the current and potential future scale of such exporting activity, in the context of existing capabilities and expertise, and the prevailing plans for nuclear power development across the globe.

4.1 Skills, training, and development

The civil nuclear industry boosts the productive potential of the UK economy through its investment in staff training and the passing on of new knowledge and competencies. Some of this new knowledge may also be transferred to colleagues, as the recipient of the training will likely share some of their new skills with their co-workers. The civil nuclear industry's training increases its workforce's skills and competencies, making them more productive.

Investment in training may bring firms other benefits.[18] In particular, a more highly skilled workforce is an asset that makes it easier for companies to innovate. The skills learned on a training course may help firms develop new products and services or adapt more rapidly to the introduction of new technology or changes in work processes.

There may also be knowledge spillovers from the civil nuclear industry's training its own staff to other firms in the local economy. These can occur through knowledge sharing through trade bodies, external courses, or informal interactions with other firms' staff. Alternatively, it may happen when people leave the company to take jobs elsewhere.

Organisations in the civil nuclear sector that were surveyed in autumn 2022 employed 1,523 workers on apprenticeship training schemes or vocational training positions and traineeships during 2021.[19] This figure represents a lower bound for the total number of people on graduate or other training schemes that the civil nuclear sector employed. The true number is likely to be substantially higher as only organisations representing around 50% of the civil nuclear workforce responded to the survey.

Moreover, these organisations spent over £39 million, or on average £1,265 per employee, on training and development for staff in civil nuclear roles. This result is not only driven by large players. In fact, organisations across the entire spectrum of profits made substantial investments in training their staff, ranging from £100 to £3,700 per employee.

18] The impact of vocational education and training on company performance, Research Paper No. 19, European Centre for the Development of Vocational Training (Cedefop), 2011 https://www.cedefop.europa.eu/files/5519_en.pdf

19] This figure is made up of 1,171 apprentices and 352 people on other traineeships.

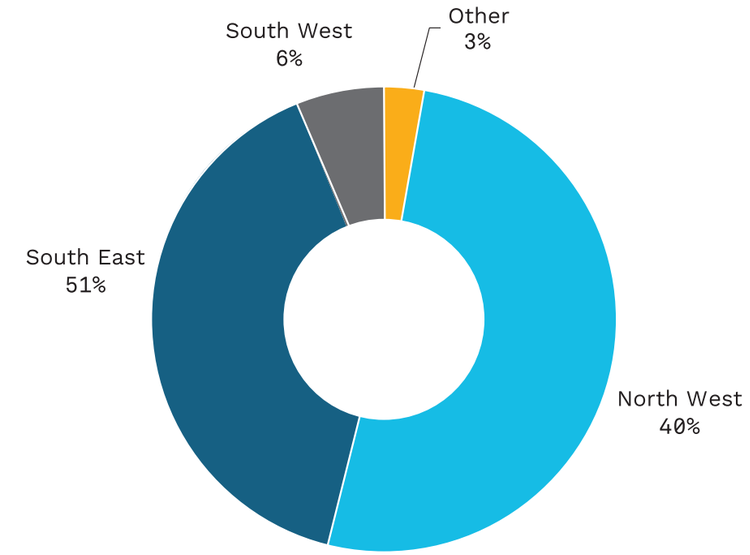
4.2 R&D and innovation

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.

The sector's R&D activity has benefits not only for the firms that conduct this innovation, but also the wider economy. These benefits are transmitted through more than one channel: first, continual innovation will be a key component of future growth, helping to ensure products and technologies that will ensure the sector's participation in nuclear investment around the world. Secondly, the technological advances and breakthroughs that emerge from its investment in R&D will affect other parts of the economy and society, in a so-called "spillover" process. Over the longer term, some of the sector's potential future advancements (notably in the domain of fusion energy) could have truly transformative economic spillovers.

We estimate that the UK's civil nuclear sector includes over 4,500 people who work in nuclear research. Fig. 13 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 South East (where the Culham Centre for Fusion Energy is located) and the North West (home to the civil nuclear cluster around the Sellafield site, as well as several NNL facilities).

Figure 13 ***Distribution of the UK's civil nuclear sector R&D workforce***[20]



Moreover, organisations in the civil nuclear sector that were surveyed in autumn 2022 reported investments of over £178 million in R&D in civil nuclear activities. As above, the true number is likely to be substantially higher as only organisations representing around 50% of the civil nuclear workforce responded to the survey.

The current focus of the UK's nuclear research efforts are in the areas of waste management and decommissioning, as well as in fusion energy. These priorities point towards the prominence of decommissioning and waste disposal within the UK's civil nuclear activities. It also reflects the long-standing and broad-based commitment to progressing and commercialising nuclear fusion, exemplified in the purpose-build Culham Centre for Fusion Energy.

The process of pioneering new technologies can unlock higher revenues and profits to the innovator. But there are also many ways that such innovation can spill over and diffuse into the wider economy, into other firms, academia, government, and wider society. This occurs through (for example) the formal licensing of new technology, as well as knowledge transfers via supplier-customer relationships, throughout professional networks, through corporate spin-outs and joint ventures, or via employee turnover (with expertise and innovative ideas being transferred between firms). These processes are very pronounced among knowledge-intensive sectors, as well as highly interconnected industries with established trade bodies.

20] The figure draws on results from the NIA survey conducted in the autumn of 2022 as well as The UK Civil Nuclear R&D Landscape Survey by the Nuclear Innovation and Research Advisory Board (NIRAB) conducted during the 2018/19 financial year.

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. But the domain of nuclear research holds the promise of even more dramatic advancements.

Research into fusion energy is an investment that could eventually yield a 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 to establish and commercialise nuclear fusion. One example is the recent experiment that succeeded in producing more fusion energy than energy input into the experiment.[21]

4.3 Nuclear energy and the National Grid

The civil nuclear sector also delivers economic benefits through its important role in the UK's electricity portfolio. The characteristics of nuclear energy mean that it is a crucial enabler of the UK's strategic energy goals: to ensure supply of dependable, decarbonised, and cost-effective electricity.[22] By providing stable, predictable low-carbon "baseload" capacity, it enables greater penetration of variable renewable sources (such as wind and solar). It also does this with vastly reduced emissions compared to fossil fuels generation, which would be the only other practical source of baseload energy. Furthermore, in light of recent geopolitical events such as Russia's illegal invasion of Ukraine and its curbs on gas supply to Europe, domestically produced nuclear energy allows a reduction in the reliance on fossil fuel imports (natural gas in particular, but also nuclear related inputs) from abroad and the associated risk of energy shortages.

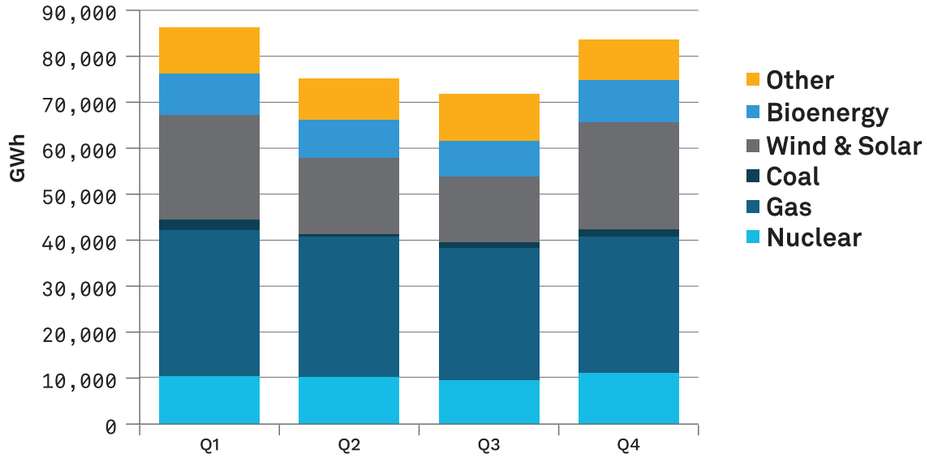
To meet demand for electricity in the UK, many different generation technologies work in concert. The profile of electricity demand varies greatly across days, weeks, and months: short-term fluctuations lead to "spikes" at times of high demand (e.g., during mornings and evenings) and "lulls" during the night. Meanwhile, longer-term seasonal patterns see structurally higher demand in winter compared to summer.

This means that different combinations of generators are appropriate at different times. When demand is peaking, fast-reacting gas generators are incentivised to boost their output. At times of strong wind or intense sunshine, "conventional" generators reduce their output, as the electricity supplied by renewable sources takes a greater prominence. At all times, the Grid's dynamic auction systems ensure that sufficient power is available to meet demand.

Within this system, nuclear power has a unique role as a provider of "baseload" energy. Since nuclear generators supply predictable and unvarying production, they are ideally suited to cover minimum electricity demands, that persist throughout all hours and all months. More variable technologies are then deployed on top of this, to react to peaks and troughs in demand.

To illustrate how nuclear power supports the UK's energy priorities, we ask the question: what would happen in its absence? This is necessarily a thought experiment since the UK's energy sector has evolved over decades alongside the presence of nuclear reactors. But this analysis attempts to identify the implications for other generation sources, and the UK's energy priorities—specifically, its decarbonisation objectives.

Figure 14 *Total UK electricity production by source 2021*



21] UK contributes to a breakthrough in nuclear fusion energy, UK Research and Innovation, 16 December 2022 https://www.ukri.org/news/uk-contributes-to-a-breakthrough-in-nuclear-fusion-energy/

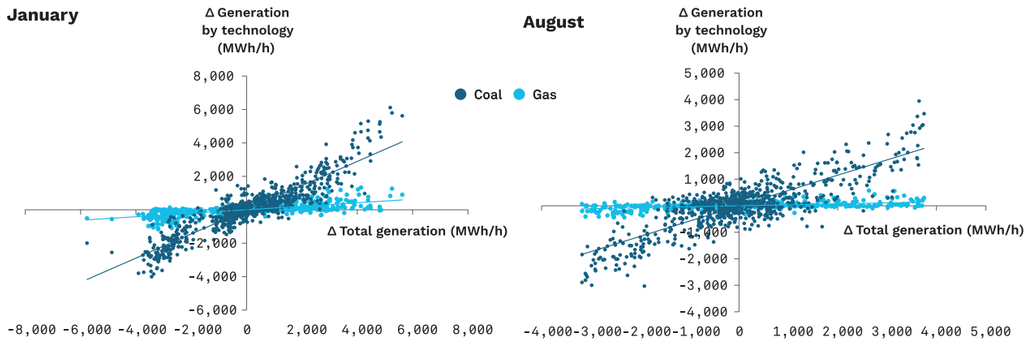
22] British energy security strategy, Department for Business, Energy, Industrial Strategy, , 7 April 2022 https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy

Fig. 14 above shows that nuclear power contributed nearly 15% of all UK electricity in 2021. In its absence, increased production would be required to cover the resultant shortfall. It is not appropriate to assume that the resultant energy shortfall would simply be met with the average mix of remaining generation sources. This is because the substitute energy source would need to play the same role as nuclear power plants in the UK's energy mix, as a baseload supplier. This would rule out renewable technologies such as solar and wind since their power output is more unpredictable and variable.

To identify the likely substitute generation sources, we examine Gridwatch figures that record live National Grid data on UK electricity demand and supply. Gridwatch collates this information in a database that measures both electricity demand and supply (by type of technology) for each five-minute interval throughout the year. These data allowed us to estimate how responsive each generation technology is to demand, or what is the UK's marginal fuel source for a given change in energy demand. This fuel source would vary at different times of day, across days of the week, and at different times of the year.

We find that gas and coal generation are the major sources of marginal fuel production in the UK. This means that when demand rises (or supply falls—as in our counterfactual of withdrawing nuclear supply), they are likely to be the fuel sources that meet this demand (or supply shortfall). Fig. 15 below illustrates that in both winter and summer, gas production is very responsive to changes in electricity demand. Meanwhile, coal production responds to a lesser extent in winter, and almost not at all in summer.[23] We also examine biomass as a substitute but do not find a discernible response.

Figure 15 *Identifying marginal fuel sources for electricity generation in the UK, January and August 2021*



What would have been the implication for emissions, had the nation's energy needs been met in this fashion? A recent literature review conducted by the National Renewable Energy Laboratory that collated estimates of the median "life-cycle" emissions of different electricity generation technologies. According to the different sources reviewed, the average estimates were (all measured in grams of CO_2 equivalent per kWh of energy):

- 486 grams of CO_2e/kWh for natural gas;
- 1,001 grams of CO_2e/kWh for coal-fired plants; and
- 13 grams of CO_2e/kWh for nuclear power.[24]

This implies that a hypothetical reconfigured Grid would have been responsible for substantially increased greenhouse gas emissions. A reduction in coal and gas generation delivers local benefits in terms of improved air quality and energy security, while also contributing to curbing global emissions and combatting climate change. These reductions are another aspect of the nuclear sector's economic value that is undoubtedly significant.

Looking forward, innovation means that nuclear power has the potential to become a more flexible energy source. Technologies such as Small Modular Reactors (SMRs)[25] could enable nuclear reactors to vary their output of electricity more readily. This will enable greater shares of variable wind and solar energy sources to be integrated into the grid, helping to reduce CO_2 emissions.

23] This is due to the prevailing prices at auction in summer months. During a season of lesser demand, and greater production from solar generators, lower wholesale energy prices make it less profitable for coal plant—that face expensive fuel and carbon costs—to supply electricity to the Grid. In our counterfactual situation (of no nuclear power generation), it is feasible that constrained supply would drive up wholesale prices even in summer, meaning that coal production would be economical and would take a larger role in "filling the gap". Hence, our calculation is likely a conservative estimate of the volume of emissions that nuclear power helps to avert.

24] Life Cycle Greenhouse Gas Emissions from Electricity Generation: Update, National Renewable Energy Laboratory, September 2021 https://www.nrel.gov/docs/fy21osti/80580.pdf

25] Nuclear Power and Secure Energy Transitions, International Energy Agency, June 2022 https://iea.blob.core.windows.net/assets/016228e1-42bd-4ca7-bad9-a227c4a40b04/NuclearPowerandSecureEnergyTransitions.pdf

4.4 Current and future exports

Exporting offers the civil nuclear industry the opportunity to sell to a wider range of customers, with larger collective budgets, rather than being reliant on just domestic customers. This enables the sector to earn more revenue, creating more employment, and contributing more to UK GDP and in taxes. But it is also important in reducing risk. By diversifying its customer base, nuclear firms are less reliant on the budget constraints faced by domestic customers. Diversification should lower the volatility of firms' incomes, as different customers' spending patterns are not necessarily correlated.

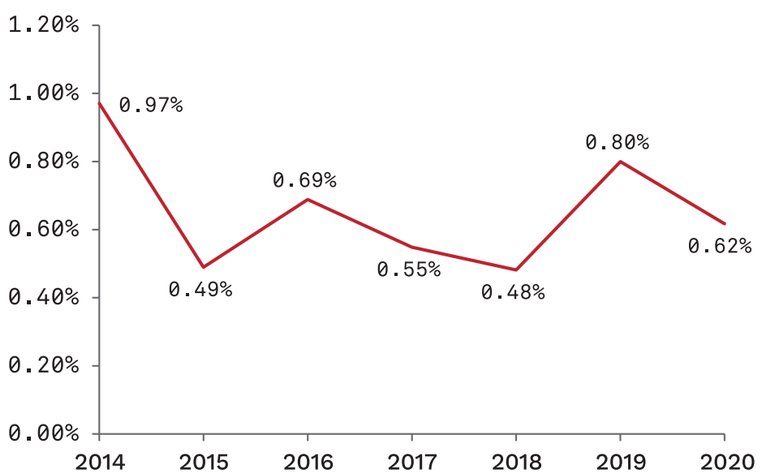
Overseas customers also have different needs to domestic customers. Exporting allows the industry to expand the range of products and services it offers. A more diversified portfolio of products and services lowers the company's dependence on any individual product or service, which may become outmoded by technological change or other developments in the marketplace.

Selling more products and services to a greater number of customers enables companies within the civil nuclear sector to benefit from economies of scope and scale. This allows it to spread its fixed costs over a wider range and number of good and services, reducing its per-unit costs and making it more price competitive. This safeguards jobs in the UK, both in the industry itself, in its domestic supply chains and through wage-consumption impacts.

Finally, sales to prestigious foreign clients boost firms within the industry's brand name in the marketplace. This helps boost future business, by differentiating companies from their competition and building trust with potential customers.

Since 2014, the ONS has produced "experimental" estimates of the nuclear sector's exports, using data drawn from its Low Carbon and Renewable Energy Survey. These suggest that between 2014 and 2020, exports have been between 0.48% and 0.97% of the civil nuclear sectors turnover (Fig. 16). There is no clear upward or downward trend discernible over time. However, it should be noted that these numbers reflect a narrower definition of the civil nuclear sector than that which is used in our report, notably excluding the decommissioning and waste management activities of the sector. Moreover, the relevant ONS bulletin notes that there is a large degree of uncertainty around these estimates, and so should be treated with caution (they are designated as experimental statistics for this reason).

Figure 16 *Nuclear exports as a share of turnover*

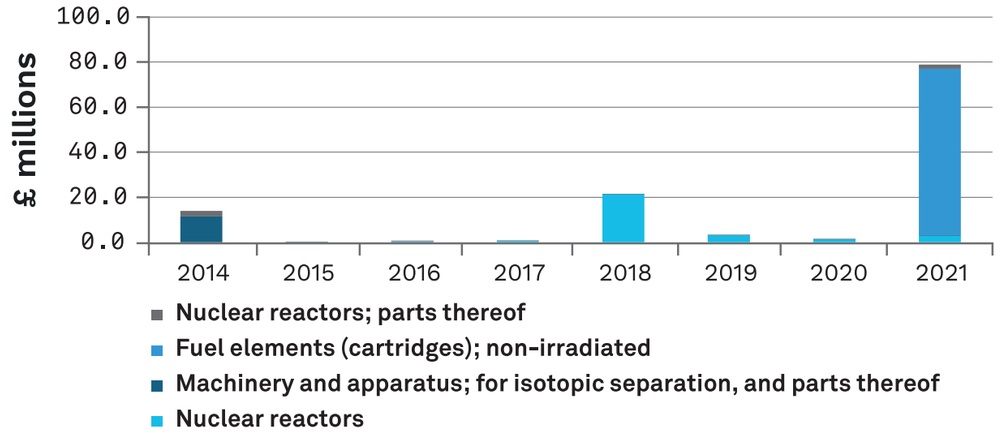


Responses from our survey of NIA members suggests that around 24% of turnover is accounted for by exports. However, we note our reservations regarding this figure also, both due to the quality of survey responses in this area (many firms do not collate or could not provide this information), and the potential for our survey being biased towards larger businesses within the sector.

Using the United Nations Comtrade database, it is possible to identify nuclear-related manufactured goods exports.[26] Fig. 17 below shows UK exports of nuclear components between 2014 and 2021. There is significant variation in the value and composition of exports across years. Between 2017 and 2021, the UK's exports of these goods were predominantly to the United States (55%) and France (19%). A further £74 million worth of fuel elements were exported to France in 2021. Other countries to which the UK exported nuclear goods to during 2014-2021 include Norway, China, Turkey, Canada, Brazil, France, Saudi Arabia, and Australia.

26] The following HS codes related to the nuclear industry have been identified: HS840110: Nuclear Reactor; HS830120: Machinery and apparatus; for isotopic separation and parts thereof; HS830130: Fuel elements (cartridges) non-irradiated; HS840140: Nuclear reactors parts thereof.

Figure 17 *UK exports of nuclear good*



In the coming years, many new reactors (predominantly in non-OECD countries) will come online whilst several ageing reactors (predominantly in OECD countries) will be retired. The International Atomic Energy Agency estimates that at the end of 2021, there were 437 nuclear power reactors operating globally.[27] In a baseline scenario, the World Nuclear Association estimated that 321 new reactors would come online between 2019 and 2040. Of these, 82 are projected to be built in the OECD countries, 134 in China, 25 in Eastern Europe and Central Asia, and 42 in India.[28] There is more uncertainty about the pace of retirements for existing reactors as their lifetime is dependent on investment decisions necessary for extending their operations.[29]

The UK has extensive capabilities in the vital aspect of nuclear decommissioning and clean-up, among others. The industry has developed unique technical solutions to complex problems in the decommissioning sphere, as well as stakeholder management, and the resolution of socio-economic issues surrounding new builds. The oversight and supervision of the Nuclear Decommissioning Authority (NDA) is a regulatory mechanism that helps to continually sharpen this capability. Given its significant expertise in the area, the UK is particularly well placed to capitalise on decommissioning projects which the World Nuclear Association estimates could total US$150 billion by 2040.[30]

The current capabilities within the UK's civil nuclear sector point to a strong potential for exports delivery. The sector has developed a broad and deep pool of nuclear expertise, ranging from enrichment, fuel fabrication, to operating nuclear power stations, and decommissioning and waste processing.

27] Nuclear Power Reactors in the World, 2022 Edition, Reference Data Series No. 2, International Atomic Energy Agency, 2022 https://www-pub.iaea.org/MTCD/Publications/PDF/RDS-2-42_web.pdf

28] The World Nuclear Supply Chain Report Outlook 2040, World Nuclear Association, September 2020 https://www.world-nuclear.org/press/press-statements/launch-of-the-world-nuclear-supply-chain-outlook-2.aspx#:~:text=Under%20the%20reference%20scenario%2C%20revenues,OECD%20area%2C%20including%20China

29] World Energy Outlook 2021, International Energy Agency, December 2021 https://iea.blob.core.windows.net/assets/4ed140c1-c3f3-4fd9-acae-789a4e14a23c/WorldEnergyOutlook2021.pdf

30] The World Nuclear Supply Chain Report Outlook 2040, World Nuclear Association, September 2020 https://www.world-nuclear.org/press/press-statements/launch-of-the-world-nuclear-supply-chain-outlook-2.aspx#:~:text=Under%20the%20reference%20scenario%2C%20revenues,OECD%20area%2C%20including%20China

5. CONCLUSION

The provision of nuclear power is key to the UK's manifold energy strategy. On the one hand, its dependable baseload output enables greater provision of low-carbon energy elsewhere on the Grid and averts the environmental damage associated with substantial gas- and coal-fired generation. On the other hand, it helps to reduce the UK's dependence on imported coal and gas fuel—a dependence which has pushed household energy bills to record levels in recent months.[31]

Nuclear generation accounted for around 15% of the UK's electricity generation in 2021. The civil nuclear industry, encompassing power station operators, fuel fabricators, infrastructure providers, project managers and decommissioning companies, all combine to contribute to delivering this low-carbon and secure form of energy.

The provision of nuclear power in the UK drives a large economic impact that extends through several channels. Through its production and supply of electricity, its procurement of inputs along a broad and complex supply chain, and the wage consumption impact of its workers, the civil nuclear industry contributed to headline economic variables such as GDP, employment, and tax revenues. The total output impact of the sector, incorporating its multiplier effects, reaches some £16.1 billion, while the industry's jobs footprint is estimated at 211,500 jobs.

While the impact is felt across the UK, its local and regional impacts are also important. Many of the jobs within the industry are in rural areas, where there are less high paying alternative job opportunities. Similarly, the industry is a significant provider of employment opportunities in deprived areas, helping to address regional inequality.

There are also important supply-side contributions made by civil nuclear activities, that increase the future productive potential of the UK. Civil nuclear firms are engaged in continual efforts to develop new techniques and innovations to improve nuclear power and continue their leadership in fusion research. Graduate trainees and apprentices work throughout the sector, reflecting some of the industry's continual investment in skills and human capital.

Despite these advantages, the volume of nuclear electricity supplied in the UK has been declining for several years. This reflects the retirement of several reactors in recent years while the finalisation of new reactors has repeatedly been delayed. Nine reactors across five stations are currently in operation in the UK, with two further reactors under construction.

Still, nuclear energy plays an important role in the UK government's plans for future electricity generation. According to its energy security strategy, the government aims to achieve up to one quarter of electricity demand being met by nuclear energy in 2050. For this, it invests billions of pounds in new nuclear plants and technology as well as works on improving further the institutional framework which fosters additional private investment.[32] Among others, this includes the establishment of the new "Great British Nuclear" body which supports nuclear projects throughout the development process.[33] More recently, it has announced a further £75 million investment boost to reduce the reliance on Russia.[34] While uncertainty remains regarding the details of new nuclear projects, the urgent need to minimise the use of fossil fuels and to cut the dependence on foreign energy sources means that further contributions from the nuclear sector will be key.

With market leaders in their specialist fields, and building on its 60 years of accumulated experience, the UK is well placed to capitalise on global developments in the civil nuclear industry. The UK was a pioneer in nuclear energy and has been safely operating nuclear plant since 1957. Today, many firms within the UK's civil nuclear sector have developed into market leaders within their specialist fields, operating throughout the life cycle of nuclear facilities.

31] British energy security strategy, Department for Business, Energy & Industrial Strategy, April 2022 https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy

32] British energy security strategy, Department for Business, Energy & Industrial Strategy, April 2022 https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy

33] About Us, Department for Business, Energy & Industrial Strategy, 29 November 2022 https://www.gov.uk/government/organisations/great-british-nuclear

34] Ministers bolster UK nuclear fuel capacity to squeeze out Russian influence, Department for Business, Energy & Industrial Strategy, 2 January 2023 https://www.gov.uk/government/news/ministers-bolster-uk-nuclear-fuel-capacity-to-squeeze-out-russian-influence#:~:text=Nuclear%20fuel%20production%20in%20the,announced%20today%20(2%20January)

APPENDIX: METHODOLOGY

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.

The components of direct GVA, namely employee compensation and gross profits, were estimated using findings from Oxford Economics' bespoke survey of the NIA's membership, conducted during autumn 2022.

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 2021.

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.[35] 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.

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 allowance 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.[36]

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.

35] United Kingdom Input-Output Analytical Tables, 2018, Office for National Statistics, April 2022 https://www.ons.gov.uk/economy/nationalaccounts/supplyandusetables/datasets/ukinputoutputanalyticaltablesdetailed

36] Regional Size, Regional Specialization, and the FLQ Formula, Regional Studies. Vol. 34.6 2000, pp. 563-9, Anthony Flegg and C. Webber

The NIA is the trade association for the civil nuclear industry in the UK. The NIA represents more than 250 companies across the supply chain. The diversity of NIA membership enables effective and constructive industry-wide interaction.

#NetZeroNeedsNuclear

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

Registered Office - 5th Floor, Tower House,
10 Southampton Street, London WC2E 7HA
TEL +44(0)20 7766 6640
EMAIL info@niauk.org

NIAUK.ORG MEMBERSHIP@NIAUK.ORG @NIAUK