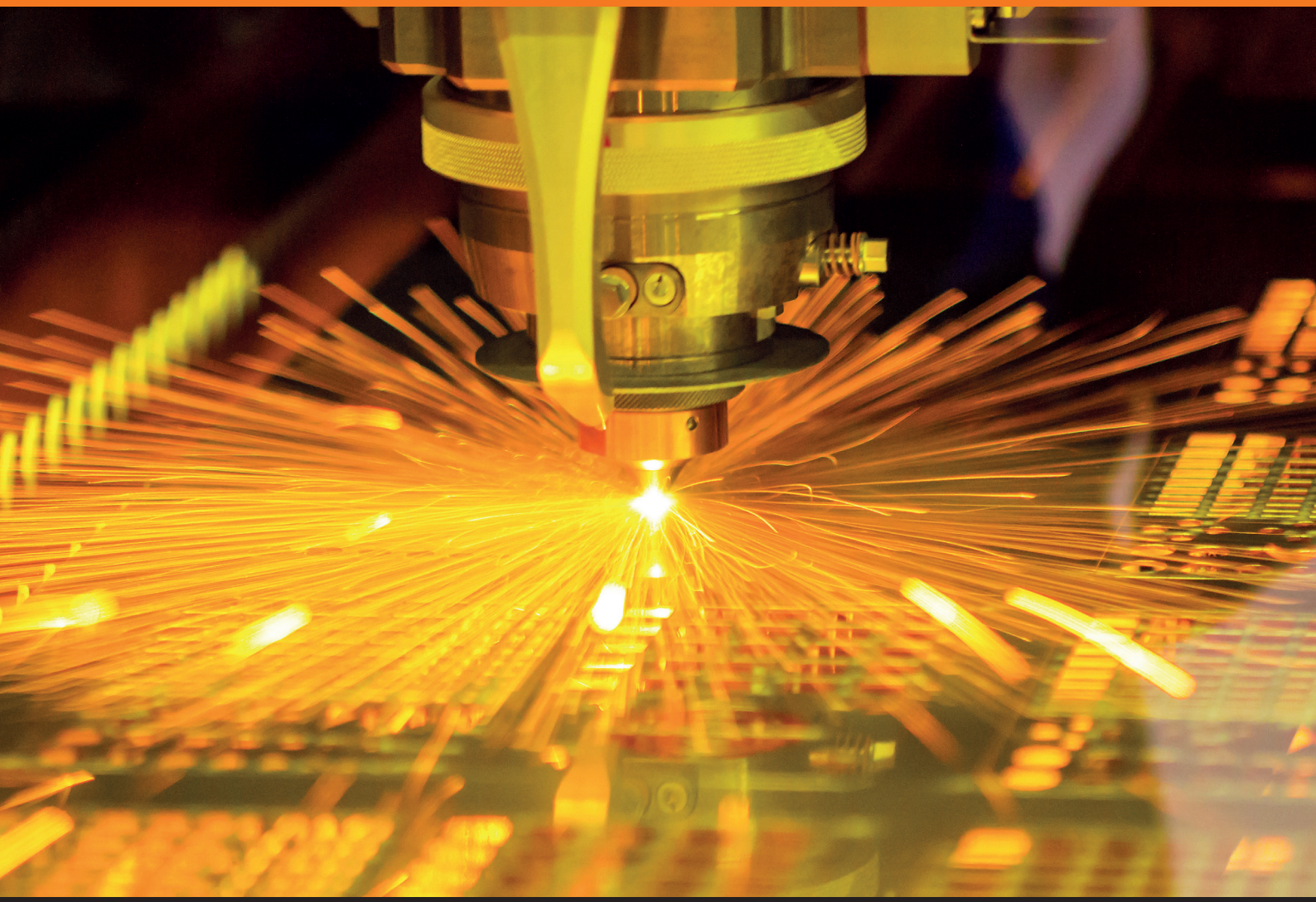
An Institute of Physics Report | **October 2017**

The role of physics in supporting economic growth and national productivity



IOP Institute of Physics

The **Institute of Physics** is a leading scientific membership society working to advance physics for the benefit of all.

We have a worldwide membership, from enthusiastic amateurs to those at the top of their fields in academia, business, education and government.

Our purpose is to gather, inspire, guide, represent and celebrate all who share a passion for physics. And, in our role as a charity, we're here to ensure that physics delivers on its exceptional potential to benefit society.

Alongside professional support for our members, we engage with policymakers and the public to increase awareness and understanding of the value that physics holds for all of us.

Our subsidiary company, IOP Publishing, is a world leader in scientific communications, publishing journals, ebooks, magazines and websites globally.

Find out about our strategy for success at **iop.org/strategy**

Cover image: *Shutterstock/Maurus Spescha*

FOREWORD

The UK has an excellent track record in physics research and innovation. It's a key part of international research collaborations, as well as being home to world-leading institutions and innovative, pioneering businesses. All of those will be crucial to securing the UK's economic future.

The UK government has committed to a modern industrial strategy, including a desire to increase productivity and drive growth across the country. Physics-based industries contribute to that productivity and growth. Our research provides a comprehensive analysis of the extent of those contributions, in terms of productivity, value added and employment.

Our data show the important role of physics in the economy of the whole of the UK, as well as in all of the regions of England and in Scotland, Wales and Northern Ireland. Physics-based businesses drive productivity and create growth and offer employment in all areas of the UK.

The government has shown its commitment to increasing science spending to 2.4% of GDP. This should be invested in all areas – investment in cutting-edge science, fundamental research and work applied to the real world. All kinds of physics research have the potential to have a huge impact: not only those directly and immediately applied to business, but also the curiosity-driven research that inspires and underpins the applications and technologies of the future.

As government pushes forward with its industrial strategy, physics-based industries will have a vital role in driving growth across the whole country. Some of the most important sectors highlighted by the government directly involve physics – from the life sciences, ultra-low-emission vehicles, industrial digitalisation, the nuclear industry and the creative industries. These will require physics-based businesses to advance the UK's standing in these sectors of the future.

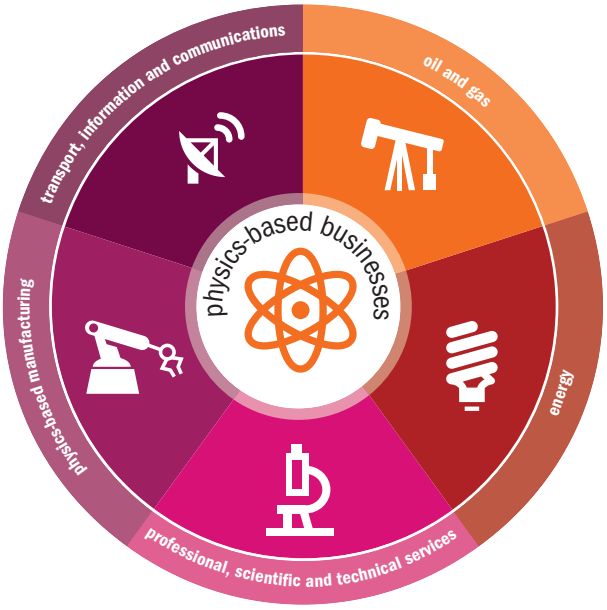
At the IOP, we're working to ensure that investment in physics continues and that businesses can continue to grow in a changing landscape. The analysis presented here will be pivotal to that drive.

Professor Dame Julia Higgins
IOP President

Physics-based businesses

Physics-based businesses play a crucial role in the UK's economy: enhancing productivity, boosting economic growth and increasing prosperity.

The IOP regularly gathers evidence about the role of physics in the economy, to ensure that physics is recognised for the contribution that it makes to society. The IOP has commissioned the Centre for Economics & Business Research (Cebr) to analyse the value of physics-based businesses to the economy. This research demonstrates that physics-based businesses are vitally important to the UK economy: driving increases in employment, productivity and prosperity.



Physics-based businesses are those in which the use of physics – in terms of both technology and expertise – is absolutely critical. This means that the industries considered are those in which workers with some training in physics would be expected to be employed, and in which the industrial activities themselves rely heavily on the theories and results of physics to achieve their commercial goals.

Physics-based businesses are broken down into five sub-categories, as shown in the figure above right.

Value of physics to the UK economy

This report is based on *The role of physics in driving UK economic growth and prosperity* produced by the Centre for Economic and Business Research.

For the full report, please visit **iop.org/publications**

Key statistics

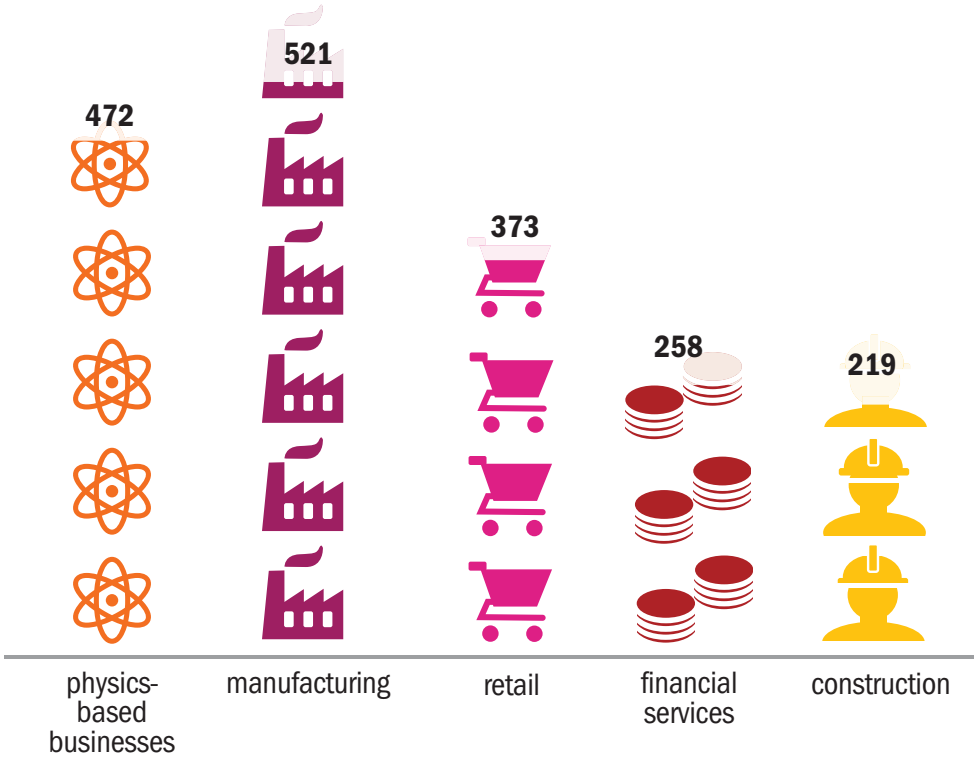
- **Gross value added:** physics-based businesses in the UK make a **£177bn GVA[1] contribution** – a **16.1%** share of the GVA generated by the entire UK business economy and almost **10%** of GDP.
- **Growth:** the GVA contributions of physics-based businesses have, on average, **grown 3% each year**.
- **Employment:** more than **two million people** are employed in physics-based businesses – this is a **6.7%** share of the total employment in the UK.
- **Productivity:** a person employed in physics-based businesses contributes an average of **£88,114 a year in value added**.

[1]Gross value added (GVA) is a measure of the economic output of a sector; that is, the value of what they produce or provide after subtracting the inputs of goods and services required to do so.

Turnover and productivity

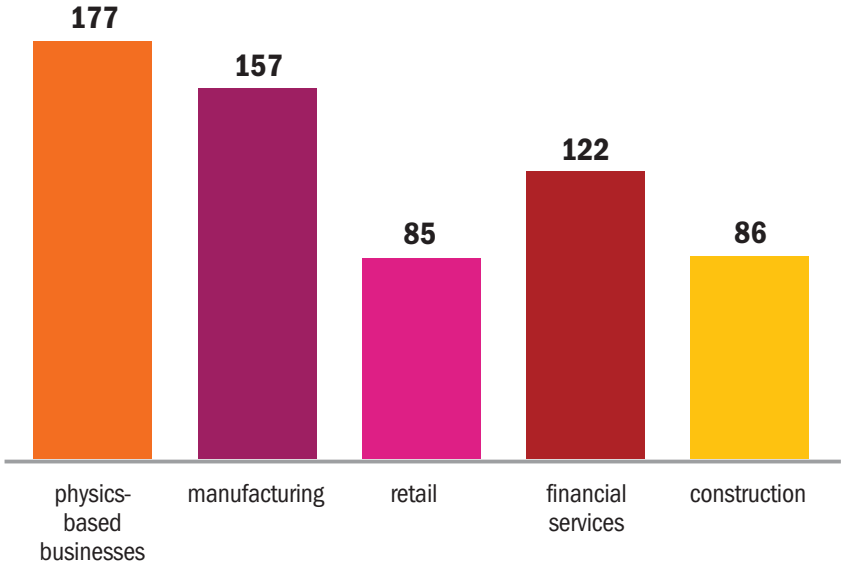
Physics-based businesses generated £472bn of turnover and made a £177bn GVA contribution to GDP in 2014.

The graphs in this section show the turnover and GVA contributions of physics-based businesses compared with other important sectors: manufacturing (beyond physics-based manufacturing), retail, financial services and construction. When compared with these large and well-known sectors, physics-based businesses generate the second-largest turnover and the largest GVA.



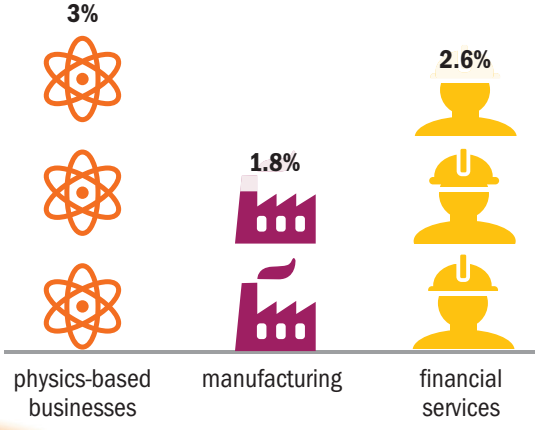
Turnover of physics-based businesses compared with other major sectors in 2014 (£ billion).

Physics-based businesses generated a greater GVA than comparable sectors in 2014 and accounted for nearly 10% of GDP in 2014.



GVA in selected UK sectors in 2014 (£ billions)

Physics-based businesses grew by an average of 3% between 2011 and 2014. This is a larger growth than observed in the manufacturing and financial services sectors, generating more than £100bn GVA.

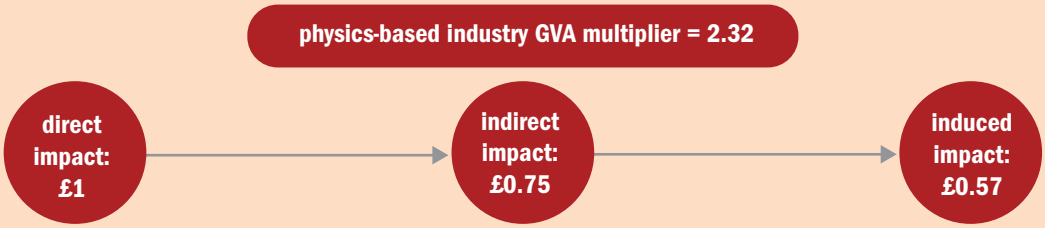


Average annual growth of selected UK sectors between 2011 and 2014.

Productivity and the wider economy

Using the estimate of indirect and induced multiplier impacts detailed below, every £1 of GVA generated by physics-based businesses will generate an additional £1.32 in the economy as a whole.

This means that in 2014 physics-based businesses in the UK produced an estimated **£411bn** aggregate GVA.



Expenditure on the physics-based sector triggers the physics industry's supply response. In providing its services, the physics industry generates additional value added. Assume sufficient expenditure to generate £1 of GVA. This £1 of GVA is the direct GVA impact of the relevant increment in expenditure on physics-based businesses.

To increase their supply, the physics-based businesses must increase their demands on their suppliers, who increase demands on their suppliers and so on down the supply chain. This generates the indirect impact, an increase in GVA throughout the supply chain of £0.75 for every additional £1 of GVA in physics-based businesses.

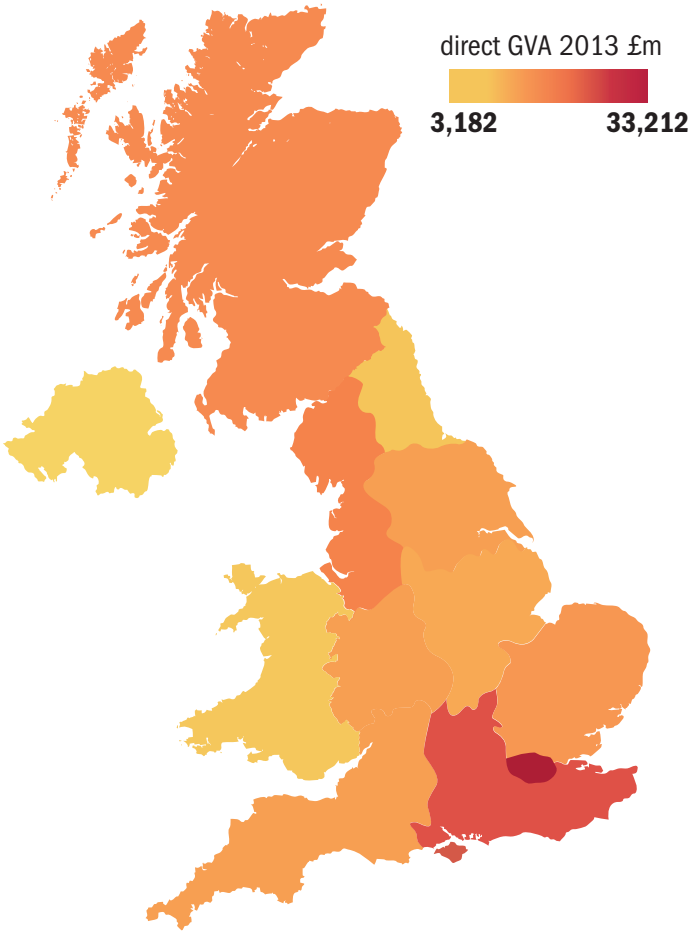
The combined direct and indirect impacts have an impact on household income throughout the economy, through increased employment, profits, etc. A proportion of this income will be re-spent on final goods and services, producing a supply response by the producers of these goods/services and further impacts through their supply chains. This produces the induced impact of £0.57 for every additional £1 of GVA in physics-based businesses.

Source: ONS, Cebr analysis

Value of physics-based businesses by region

The chart opposite shows the direct GVA contribution in the English regions and in Scotland, Wales and Northern Ireland.

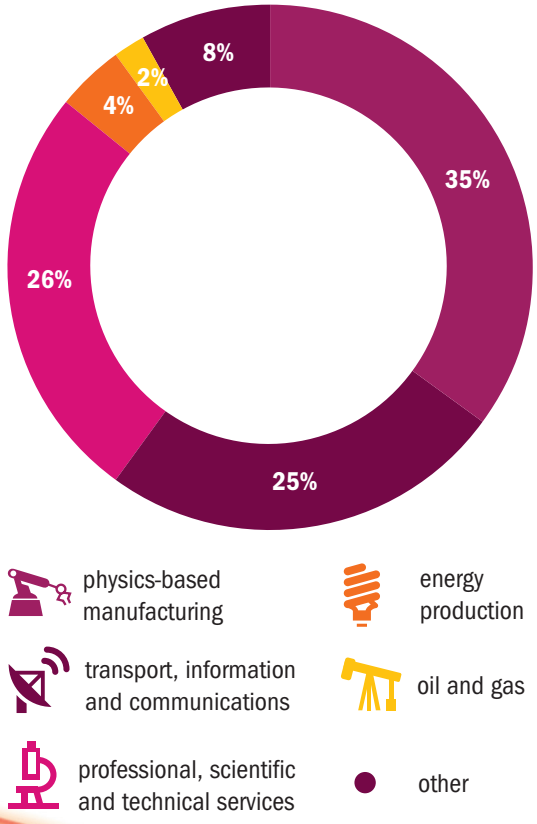
The £15bn GVA from physics-based businesses in Scotland represents 12.1% of the nation's economy. Physics-based businesses have a similar impact in the north east, where their GVA represents 11.8% of the region's economy.



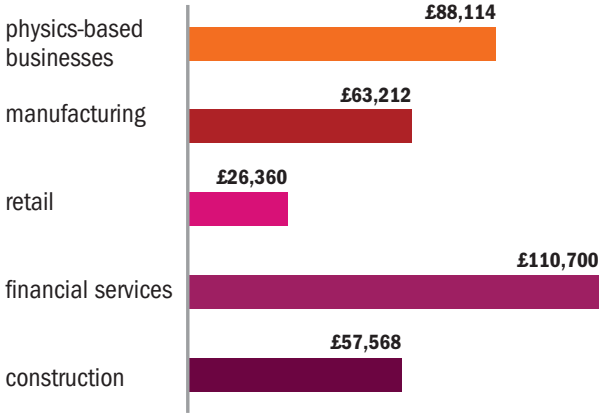
Employment

Physics-based businesses employed more than **two million people** in 2015. The majority of these (86%) are employed by businesses working in manufacturing, transport, information and communications or professional, scientific and technical services (see figure, below left). When compared to other sectors, manufacturing and retail both employ more people: approximately 2.5 million and 3 million in 2015, respectively. However, people working in physics-based businesses are on average more productive – in terms of average value added per person – than those working in all the other comparison sectors, with the exception of financial services (see figure, below right). The knowledge and technology-intensive nature of physics-based businesses produces greater productivity than is observed in many other sectors.

Employment in selected physics-based businesses, 2015



Productivity across sectors (in GVA per year per employee) averaged over 2011–14



Key statistics

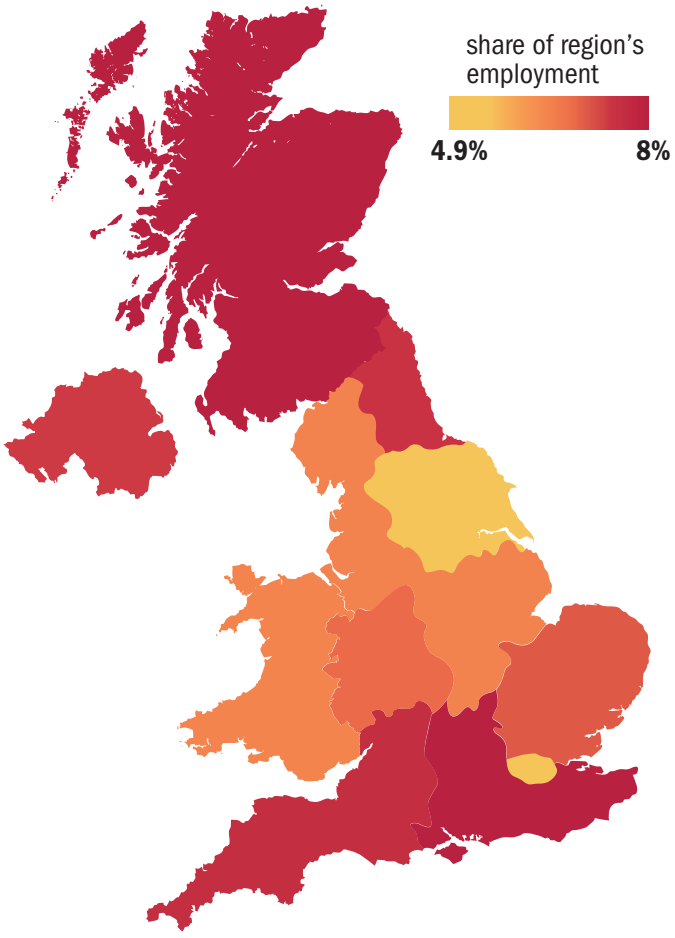
Employees in physics-based businesses are more than twice as productive as the UK average – which was under £40,000 GVA per person per year over this period – and are substantially more productive than employees in the manufacturing and construction sectors.

Employment by region

Physics-based businesses are important employers across every nation and region of the UK. This map shows the impact of physics across the UK in terms of the share of the region's employment.

Physics-based businesses in the south east employ the most people (more than 333,000), and more than 210,000 people are employed by these businesses in both London and the north west.

While London has the second-largest number of people employed in physics-based businesses in absolute terms, this actually represents the smallest percentage of the workforce across all the nations and regions. This view is particularly important for highlighting the importance of physics-based businesses for employment in Northern Ireland, the north east, the east of England and the south west – where, in every case, more than 7% of the workforce are employed by physics-based businesses.



Employment and the wider economy

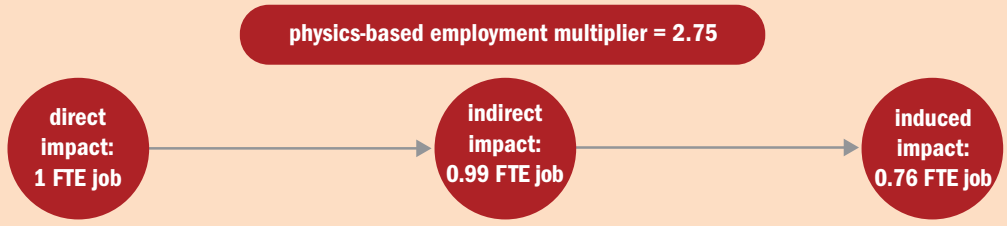
Across the UK, physics-based businesses boost both employment and productivity.

The activities of the physics-based industries also support jobs in the wider economy. This "ripple" or "multiplier" effect is created when the physics-based industries purchase intermediate inputs from other sectors of the economy – the activity thus supporting indirect jobs in their supply chain – and when the direct and indirect employees of the physics-based industries spend their earnings in the wider economy – thus supporting induced jobs in the sectors that supply final goods and services to households.

The indirect and induced multiplier values produce an employment multiplier of 2.75. This suggests that an additional 2.6 million jobs can be attributed to the indirect and induced employment impacts of the physics-based industries. This combines to make an aggregate contribution to UK employment amounting to 4.6 million in 2015.

Key statistics

The data for 2015 suggest that physics-based businesses accounted for just over two million jobs in the UK, which represents a 6.7% share of total UK employment. Add in indirect effects and the number of overall jobs rises to 4.6 million.



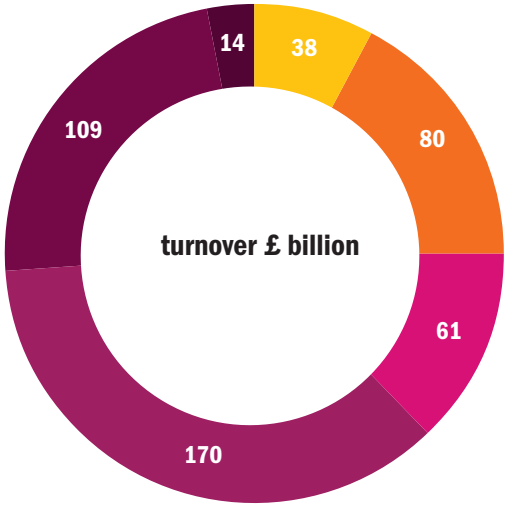
Expenditure on the physics-based sector supply response. In providing its services, the physics-based business hires additional staff. Assume sufficient expenditure to generate one additional FTE job. This FTE job is the direct employment impact of the relevant increment in expenditure on the physics-based sector.

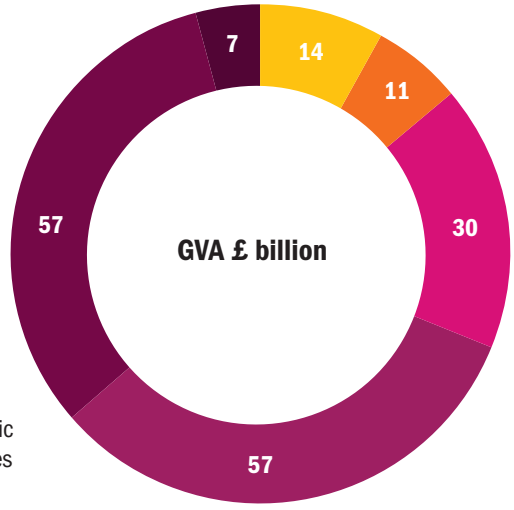
To increase its supply, the physics-based businesses must increase its demands on its suppliers, who increase demands on their suppliers and so on down the supply chain. This generates the indirect impact, an increase in employment throughout the supply chain of 0.99 of a FTE job for every additional FTE job in the physics-based sector.

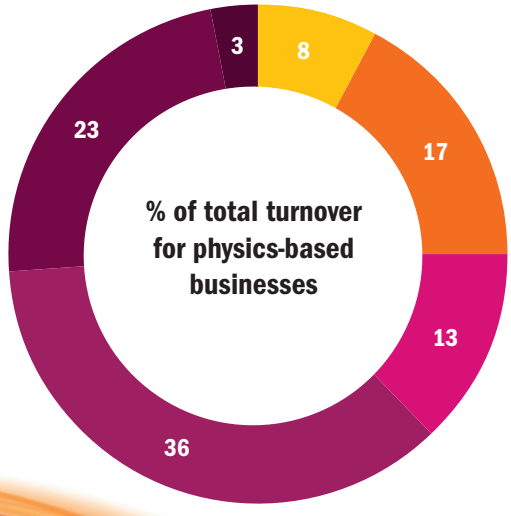
The combined direct and indirect impacts have an impact on household income throughout the economy, through increased employment, profits, etc. A proportion of this income will be re-spent on final goods and services, producing a supply response by the producers of these goods/services and further impacts through their supply chains. This produces the induced impact of 0.76 of a FTE job for every additional FTE job in the physics-based sector.

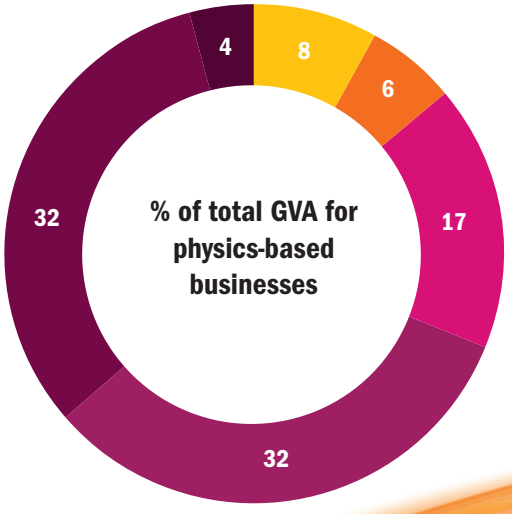
Value of the physics-based businesses by category

Considering the physics-based businesses, we see that physics-based manufacturing generates the largest turnover on its own – approximately £170bn. Physics-based businesses providing professional, scientific and technical services, and specialising in transport, information and communications provide a greater percentage contribution to GVA than turnover.









oil and gas

energy

professional, scientific and technical services

physics-based manufacturing

transport, information and communications

other

(due to rounding, the percentages do not add to 100%)

Appendix

Table of physics-based businesses

Definitions of physics-based businesses used in this report are given below, alongside their standard industrial classification code.

Code	Description
06.10	Extraction of crude petroleum
06.20	Extraction of natural gas
09.10	Support activities for petroleum and natural gas extraction
20.13	Manufacture of other inorganic basic chemicals
21.20	Manufacture of pharmaceutical preparations
23.44	Manufacture of other technical ceramic products
24.46	Processing of nuclear fuel
25.40	Manufacture of weapons and ammunition
25.99	Manufacture of other fabricated metal products n.e.c.
26.11	Manufacture of electronic components
26.12	Manufacture of loaded electronic boards
26.20	Manufacture of computers and peripheral equipment
26.30	Manufacture of communication equipment
26.40	Manufacture of consumer electronics
26.51	Manufacture of instruments and appliances for measuring, testing and navigation
26.60	Manufacture of irradiation, electro-medical and electrotherapeutic equipment
26.70	Manufacture of optical instruments and photographic equipment
26.80	Manufacture of magnetic and optical media
27.11	Manufacture of electric motors, generators and transformers
27.12	Manufacture of electricity distribution and control apparatus
27.20	Manufacture of batteries and accumulators
27.31	Manufacture of fibre-optic cables
27.32	Manufacture of other electronic and electric wires and cables
27.33	Manufacture of wiring devices
27.40	Manufacture of electric lighting equipment
27.51	Manufacture of electric domestic appliances
27.90	Manufacture of other electrical equipment
28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
28.21	Manufacture of ovens, furnaces and furnace burners
28.23	Manufacture of office machinery and equipment (except computers and peripheral equipment)
28.25	Manufacture of non-domestic cooling and ventilation equipment
28.29	Manufacture of other general-purpose machinery n.e.c.
28.49	Manufacture of other machine tools
28.99	Manufacture of other special-purpose machinery n.e.c.
29.10	Manufacture of motor vehicles
29.31	Manufacture of electrical and electronic equipment for motor vehicles
30.11	Building of ships and floating structures
30.20	Manufacture of railway locomotives and rolling stock
30.30	Manufacture of air and spacecraft and related machinery
30.40	Manufacture of military fighting vehicles
30.91	Manufacture of motorcycles
32.50	Manufacture of medical and dental instruments and supplies
33.11	Repair of fabricated metal products
33.12	Repair of machinery
33.13	Repair of electronic and optical equipment
33.14	Repair of electrical equipment
33.15	Repair and maintenance of ships and boats
33.17	Repair and maintenance of other transport equipment
33.20	Installation of industrial machinery and equipment
35.11	Production of electricity
35.12	Transmission of electricity
35.13	Distribution of electricity
38.12	Collection of hazardous waste
38.22	Treatment and disposal of hazardous waste
43.22	Plumbing, heat and air-conditioning installation
51.22	Space transport
52.21	Service activities incidental to land transportation
52.22	Service activities incidental to water transportation
52.23	Service activities incidental to air transportation
60.1	Radio broadcasting
61.1	Wired telecommunications activities
61.2	Wireless telecommunications activities
61.3	Satellite telecommunications activities
61.9	Other telecommunications activities
62.09	Other information technology and computer service activities
71.11	Architectural activities
71.12	Engineering activities and related technical consultancy
71.2	Technical testing and analysis
72.11	Research and experimental development on biotechnology
72.19	Other research and experimental development on natural sciences and engineering
74. 2	Photographic activities
74.9	Other professional, scientific and technical activities n.e.c.
84.22	Defence services
95.12	Repair of communication equipment

This report is based on *The role of physics in driving UK economic growth and prosperity* produced by the Centre for Economic and Business Research.
For the full report, please visit **iop.org/publications**

For further information contact:

Institute of Physics
76 Portland Place, London W1B 1NT
Tel +44 (0)20 7470 4800
Email **policy@iop.org**

www.iop.org/policy

Registered charity number 293851 (England & Wales) and SC040092 (Scotland)