Physics and the Economy: Measuring the value of physics-based industries in Wales

A Cebr report for the Institute of Physics

November 2021

Authorship and acknowledgements

This report has been produced by Cebr, an independent economics and business research consultancy established in 1992. The views expressed herein are those of the authors only and are based upon independent research by them.

The report does not necessarily reflect the views of Institute of Physics.

London, November 2021

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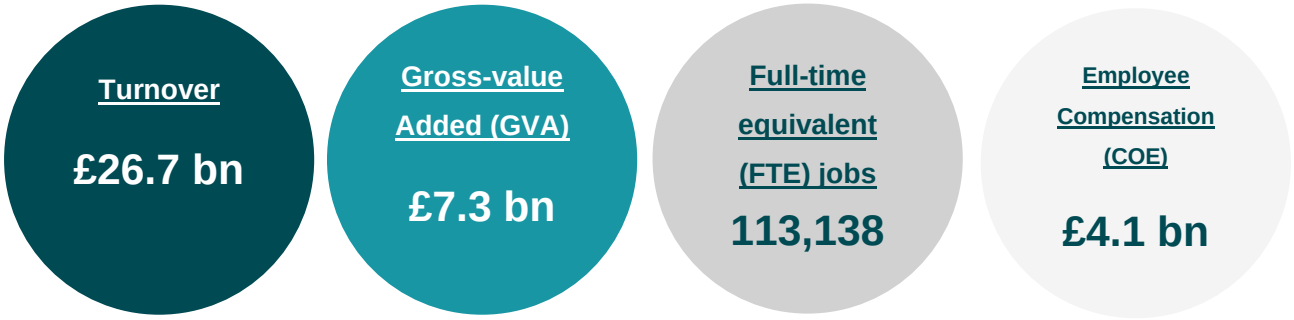
Headline findings

- This is a report by the Centre for Economics and Business Research (Cebr), on behalf of the Institute of Physics, detailing the **economic contribution of physics-based industries (PBIs) in Wales, to the Welsh economy.**
- In the graphic below, we present the economic impact of the PBIs in Wales in 2019, although our analysis also covers trends over the nine preceding years.
- In 2019, it is estimated that in Wales, PBIs directly contributed to the Welsh economy:



- There were 12,170 PBI enterprises operating in Wales in 2019. 92% of these were classified as micro enterprises with fewer than nine employees, which is a slightly higher share compared to the whole economy in the nation (89.3%).
- In 2019 Physics Science & Technology was the PBI sub-sector with the greatest number of enterprises, with 8,385 enterprises in Wales (68.9% of all PBI enterprises in the nation) in 2019.
- Overall, it is estimated that 9.5% of total Welsh GVA in 2019 was attributed to the PBIs.
- With regards to gross value added (GVA), the biggest PBI sub-sector was Physics Manufacturing, which contributed £3.4 billion in 2019, followed by Physics Science & Technology (£1.1 billion), Telecoms (£0.99 billion) and Energy Production, Transmission & Distribution (£0.96 billion).
- Throughout the decade, the turnover of PBIs increased by 36.1%, from £19.6 billion to £26.7 billion. The highest absolute growth was experienced by the Physics Manufacturing sub-sector, whose turnover increased from £10.3 billion to £15.5 billion, an increase of 51.3%, while the Space Transport and Air Transport Services sub-sector and the Physics Machine Sales sub-sector both more than doubled their initial 2010 turnover values - from £39 million to £80 million (104.0%) and from £96 million to £224 million (133.6%), respectively.
- Labour productivity for the PBI sector in Wales fluctuated over the decade but overall, it increased by 10.1% throughout the period, from £58,855 to £64,828.
- An estimated 113,138 full-time equivalent employees (FTEs) were employed in Wales in the PBIs in 2019, accounting for a 9.8% share of total employment in Wales. This is slightly

higher than the PBI sector's total 8.4% total share of UK employment. Average employee compensation in the PBIs stood at just over £36,000 in 2019.

1. Introduction

This report by the Centre for Economics and Business Research (Cebr), on behalf of the Institute of Physics (IOP), considers the contribution and importance of physics-based industries (PBIs) to the Welsh economy, an analysis that spans the period of 2010 to 2019. This report forms part of a series of six reports, which quantify the impact of the PBIs to the UK and Irish economies.

1.1 Background and general purpose of the study

According to the IOP's definition, PBIs are those where either:

- Ongoing research and development (R&D) in the industry consistently makes use of physics knowledge in a way that can be expected to affect the fortunes of businesses within the industry

Or

- The underlying technology supporting the industry requires significant physics knowledge for continued operation.

In other words, PBIs can be thought of as those industries in which the industrial and technical activities associated with the industry require physics knowledge.

This research provides up-to-date insights on the size and performance of the UK and Irish physics sectors, presenting a range of analyses which demonstrate different aspects of the economic value brought by the PBIs. The intention of this is to empower the IOP with a thorough and comprehensive knowledge and evidence base, such that they can support and advocate for the sector across the UK and Ireland.

An important task has been to develop an in-depth understanding of PBIs. To produce a robust study, it is necessary to analyse the available data to ensure that it captures the full range of activities that should be included in establishing the total economic 'footprint' of the industry. Following the collation of the necessary data capturing these activities, the values of key economic indicators were established to demonstrate the impact of the sector. The key macroeconomic indicators include:

- GVA[1] contributions to Wales and constituent regional GDP generated by the PBIs
- Full-time equivalent (FTE) jobs supported by the sector[2]
- The value of the PBIs' turnover

1 GVA, or gross value added, is a measure of the value of production in the national accounts. Conceptually, it can be considered the value of what is produced, less the value of intermediate goods and services used to produce it. GVA is distributed in three directions – to employees, to shareholders and to the government. It is often used as the proxy for the contribution of a sector or industry to GDP: strictly this relationship is GVA + taxes on products - subsidies on products = GDP.

2 The calculation of full-time equivalent (FTE) is an employee's scheduled hours divided by the employer's hours for a full-time workweek. When an employer has a 40-hour workweek, employees who are scheduled to work 40 hours per week are 1.0 FTEs. Employees scheduled to work 20 hours per week are 0.5 FTEs. We considered all part-time workers to work 20 hours per week. Lastly, we subtracted the number of employees from the number of employment in order to get the number of self-employed individuals.

- The value of employee compensation[3] generated by PBIs, representing the total remuneration of employees operating in the sector
- The productivity of the PBIs
- The number of PBI businesses operating in Wales.

In addition to the core modelling and analysis, we also undertake a range of comparisons to contextualise the findings, including:

- How the economic indicators vary over the period 2010-2019
- How the economic indicators vary across different categories or groupings of the PBIs
- How the economic indicators for the PBIs vary between the UK nations
- How the indicators for the PBIs compare with other important sectors of the Welsh economy.

Mapping Welsh PBIs

Here we set out how PBIs have been defined for the purposes of the study. The PBIs consist of over 120 four- and five-digit SIC codes, in which ongoing R&D in the industry consistently makes use of physics knowledge, or the underlying technology supporting the industry requires significant physics knowledge for continued operation. The full list of SIC codes used within this study can be found in Appendix I**: SIC-based definition of PBIs and sectoral alignment**.

For the purpose of this report, these SIC codes are then aggregated into 11 sectors.[4] These are:

- Oil & Gas Extraction
- Physics Manufacturing
- Physics Machine Services
- Energy Production, Transmission & Distribution
- Physics Waste & Recovery
- Physics Machine Sales
- Medical Equipment Sales
- Space Transport & Air Transport Services
- Telecoms
- Physics Science & Technology
- Defence

3 Compensation of employees (COE) or employee compensation, is the total remuneration, in cash or in kind, payable by an employer to an employee in return for work done by the latter. This consists of wages paid to employees; employers' actual social contributions (excluding apprentices); employers' imputed social contributions (excluding apprentices); and employers' social contributions for apprentices.

4 In order to visualise the data better, and avoid some volatility, we aggregated several of these smaller sub-sectors into an 'Other' category. 'Other' consists of: Oil & Gas Extraction; Physics Machine Services; Physics Waste & Recovery; Physics Machine Sales; Medical Equipment Sales; Space Transport and Air Transport Services; and Defence

1.2 Earlier research

The IOP previously commissioned Cebr in 2016 to produce studies focused on measuring the impact of the physics-based industries to the UK and to the Irish economies.

In this suite of six reports, we go beyond the 2016 project and present a range of new materials, including assessment of:

- How the full range of economic indicators for the PBIs vary across the UK nations and English regions, as well as the Republic of Ireland
- How the economic indicators for the PBIs vary between the UK and Ireland and other international comparable countries
- How the indicators for the PBIs compare with other important sectors in the UK and Ireland (such as Construction or Transportation and Storage), and how they are broken down by the UK's constituent nations and regions.

In addition, the definition of the PBIs has been updated since the 2016 research; therefore, figures between reports in the two series are not directly comparable.

This report focuses on Wales specifically.

2. Enterprises in the Welsh PBIs

This section provides an assessment of the importance of PBIs to Wales in terms of turnover and business demographics over the period 2010-2019.

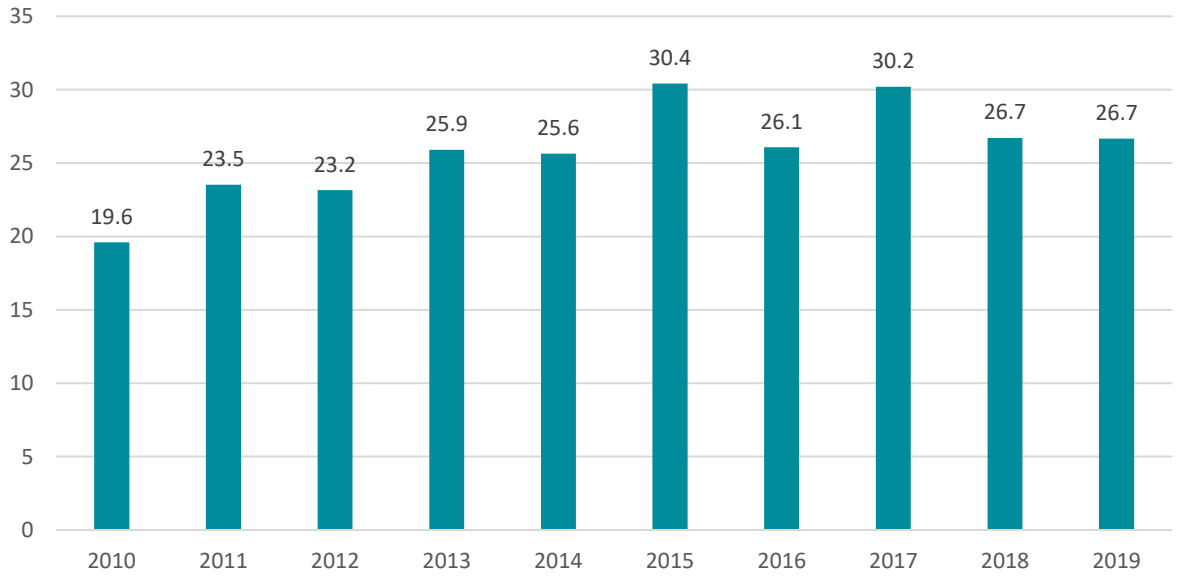
2.1 Turnover

We firstly present the contribution of PBIs to the Welsh economy in terms of the turnover generated by those industries. Figure 1 shows that physics-based industries in Wales generated £26.7 billion in turnover during 2019, an increase of 36.1% from £19.6 billion in 2010. This relatively was the fastest growing out of the four UK nations between 2010 and 2019, and therefore well above the UK average of 24.1%.

In 2011, 2015 and 2017, the total turnover generated by PBIs increased significantly, but these periods of growth were all followed by a decline in turnover (albeit in no year was this sustained). Overall total turnover generated peaked in 2015 with turnover reaching a high of more than £30.4 billion.

The physics sector in Wales had an average yearly increase of 3.5%, which is more than 1 percentage point higher than the average UK-wide PBI sector's yearly turnover rise of 2.4%. This difference is largely driven by strong growth in Wales's Physics Manufacturing sub-sector, which increased by more than 50%. Across the UK as a whole, this growth was 27.4%.

Figure 1: Turnover in physics-based industries in Wales, £ billion, 2010 - 2019



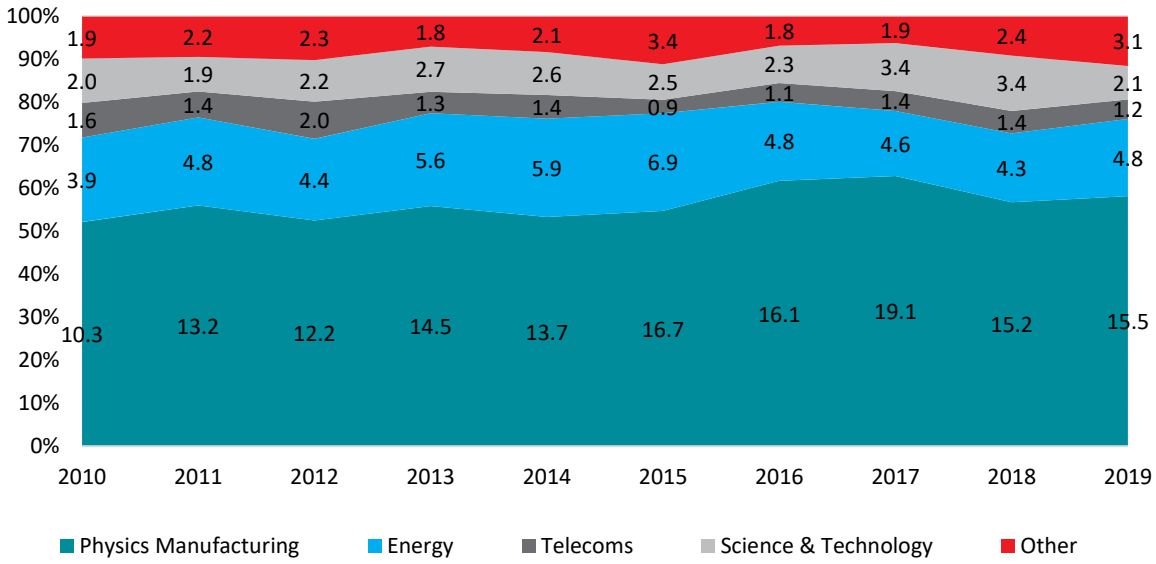
Source: ABS, Cebr analysis

Figure 2 presents a breakdown of the turnover generated by Welsh PBIs by sub-sector.[5] Their composition has remained reasonably constant throughout the 2010-2019 period. Those PBIs

5 See Table 9 in Appendix II: Supplementary figures and tables for a full breakdown of the contribution to total turnover by Welsh PBIs, disaggregated by all industries.

that are engaged in manufacturing accounted for the largest share, averaging 57% across the period, followed by those engaged in energy activities, accounting for approximately 19%.

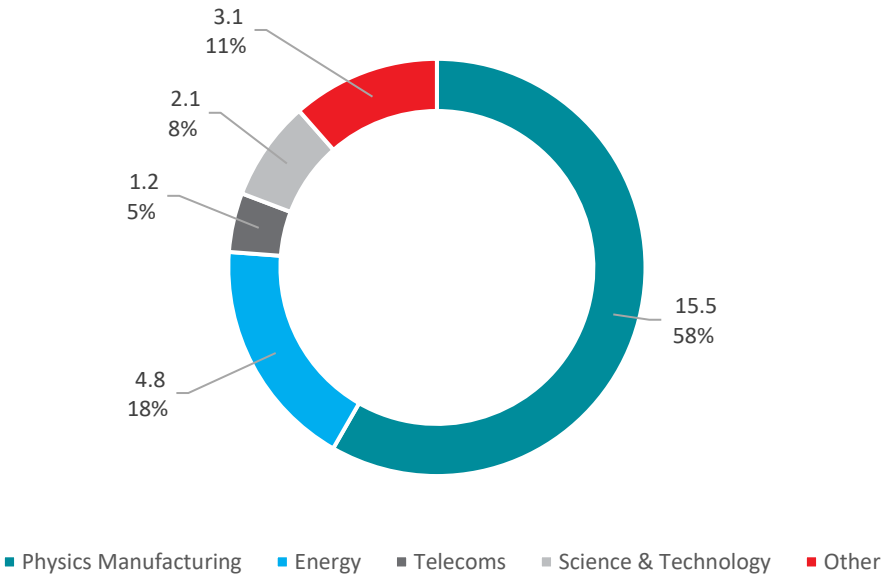
Figure 2: Turnover in the different sub-sectors of the physics-based industries, % of PBI total (LHS axis) and monetary value (£bn, label), 2010-2019



Source: ABS, Cebr analysis

Figure 3 below visualises the breakdown of turnover in 2019.

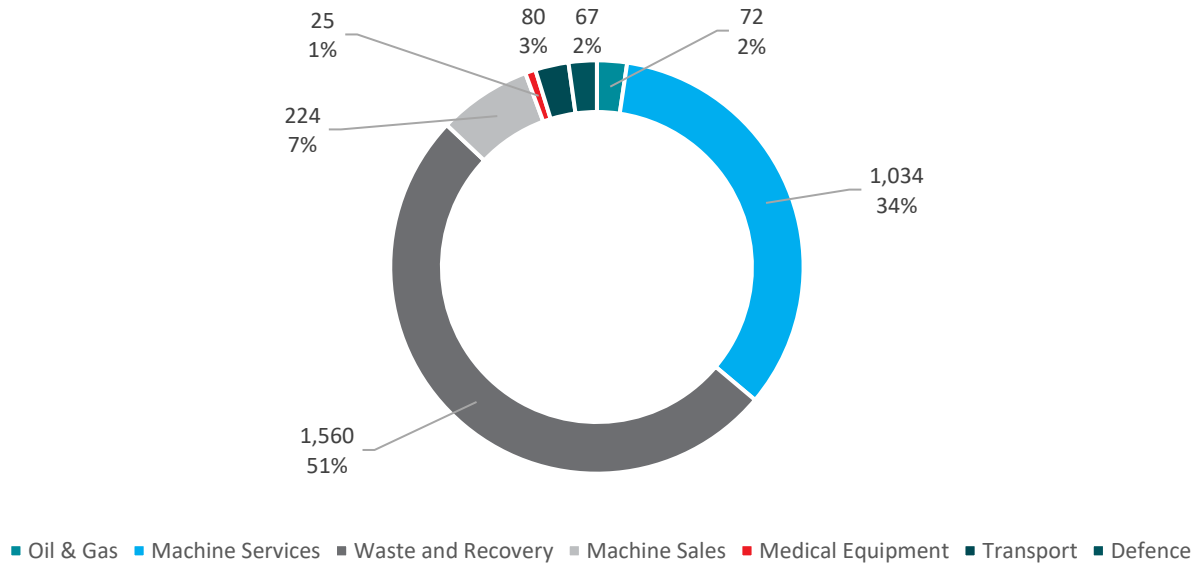
Figure 3: Turnover in the different categories of PBIs in Wales, £ billions, 2019



Source: ABS, Cebr analysis

Figure 4 below shows the full breakdown of the industries included within the 'Other' category.

Figure 4: Breakdown by turnover of industries included within 'Other', £ millions, 2019

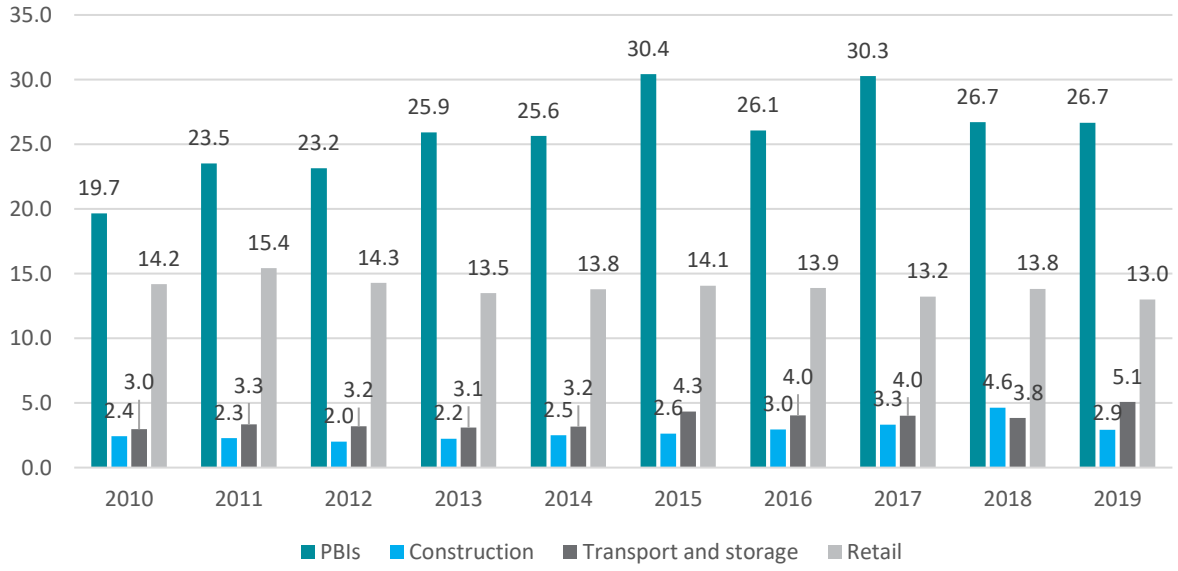


Source: ABS, Cebr analysis

Industry comparison

Figure 5 compares the turnover generated by the Welsh PBI sector with a selection of other sectors across 2010 to 2019. This data highlights the importance of PBIs to the Welsh economy, with PBI-generated turnover outstripping the sum of turnover in Construction, Retail and Transport & Storage, in every year of the sample. Of these three sectors, Retail generated the greatest turnover in Wales in all years, averaging £13.9 billion compared to £2.8 billion and £3.7 billion in Construction and Transport & Storage, respectively. In 2019, the Welsh PBI sector generated £26.7 billion in turnover, compared to £21 billion in Construction, Transport & Storage, and Retail combined.

Figure 5: Turnover comparison for selected sectors of the Welsh economy, £ billions, 2010-2019



Source: ABS, BRES, Cebr analysis

When compared to the UK as a whole, the Welsh PBI sector is a bigger contributor in relative terms to the Welsh economy than these three other sectors. This was true across the 2010-2019 period. The ratio of turnover generated in Wales by PBIs to the sum of the three other

sectors is 1.26 on average during the period, compared to 0.76 for the UK as a whole. This means that for every £1 these three sectors produce combined, PBIs produce £1.26 in Wales, compared to £0.76 across the UK.

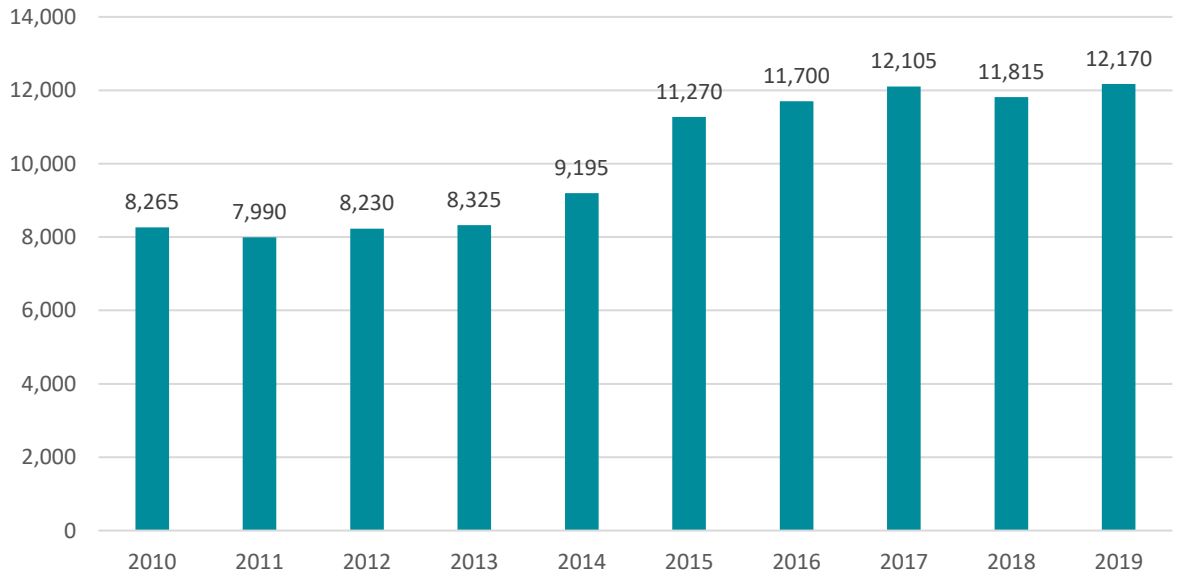
2.2 Business demography[6]

Business count

From 2010 to 2019, PBIs experienced a steady upward trend in terms of the number of enterprises operating in relevant fields. In 2010, there had been an estimated 8,265 enterprises counted, which grew to nearly 12,200 by 2019, which equals to 11.5% of all Welsh enterprises. The greatest change was seen in 2015, when the number increased from 9,195 to 11,270 (22.6% increase).

The share of UK PBI enterprises operating in Wales was 3.4% in 2019. Since the turnover share was 4.2%, this means that Wales had a disproportionately large impact on a per-firm basis compared to the UK average, thus Welsh PBI enterprises produce more turnover on average than the rest of the UK.

Figure 6: Number of physics-based enterprises in Wales, 2010-2019



Source: Nomis, Cebr analysis

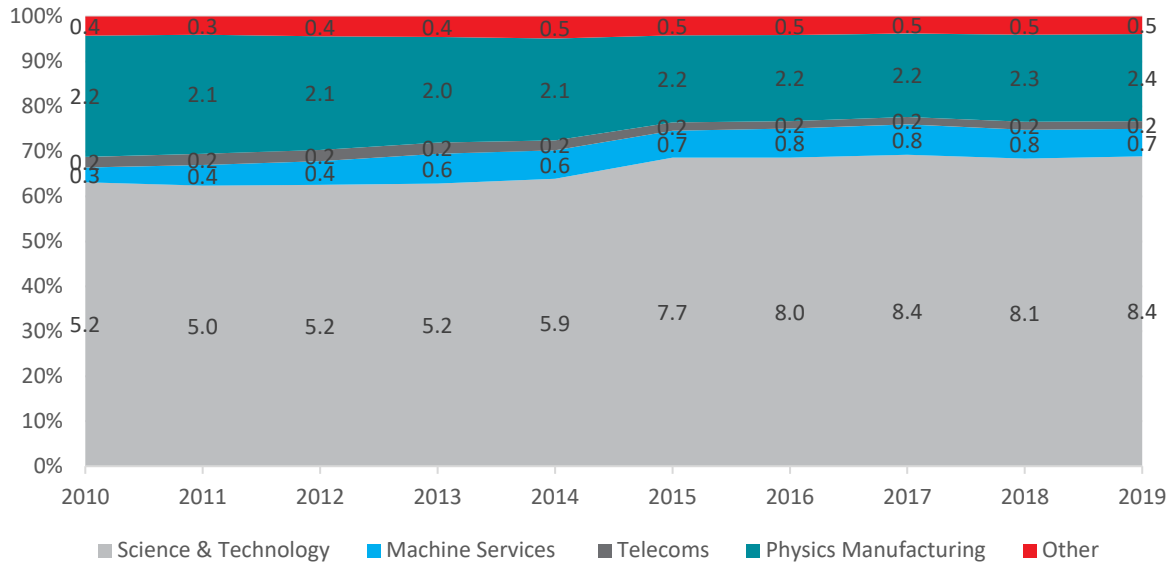
Figure 7[7] below shows the composition of the number of PBI enterprises in Wales from 2010 to 2019. It is clear that the Physics Science & Technology sub-sector was heavily dominating the sector, especially during the second half of the period. On average, this sub-sector contributed 65.9% of all physics-related enterprises, and this ratio peaked in 2017 with 69.3%. In 2015, there were 2,945 more firms operating in PBIs in Wales, compared to 2013. 85% of these additional firms were in the Physics Science & Technology sub-sector, while only 8% of the growth in these years is attributable to firms in the Physics Manufacturing sub-sector.

6 Due to the lack of data, we didn't include the Defence sub-sector in the business demography analysis. SIC 84.22 is dominated by a few very large companies, therefore omitting it doesn't alter the data on a significant level.

7 Here, we included the Energy sector in the 'Other' category, as it had few enterprises present.

The largest sub-sector in terms of turnover and GVA – Physics Manufacturing – accounts for the second largest number of enterprises with an average of 22.0%. However, this share declined from 27% to 19.5% across the period. The other nine industries make up the remaining 12.1% when observing the 2010 to 2019 average.

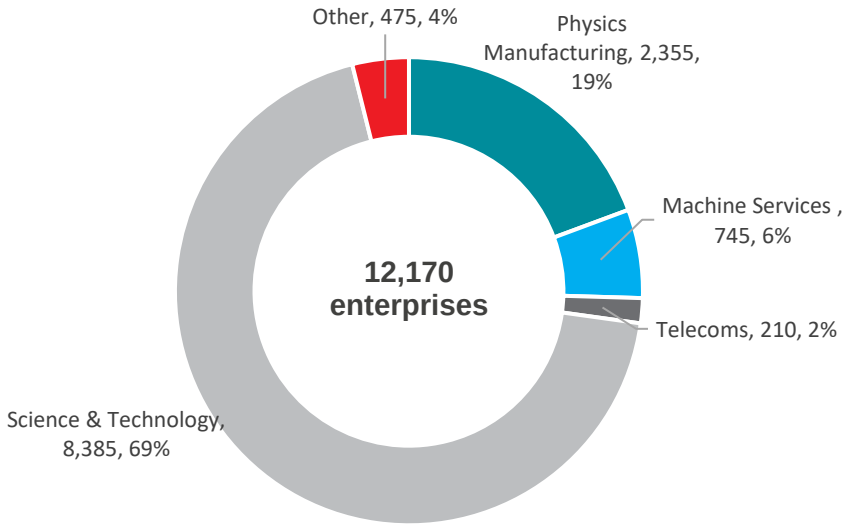
Figure 7: Number of enterprises in selected PBIs in Wales, % of PBI total (LHS axis) and value (000s, label), 2010-2019



Source: Nomis, Cebr analysis

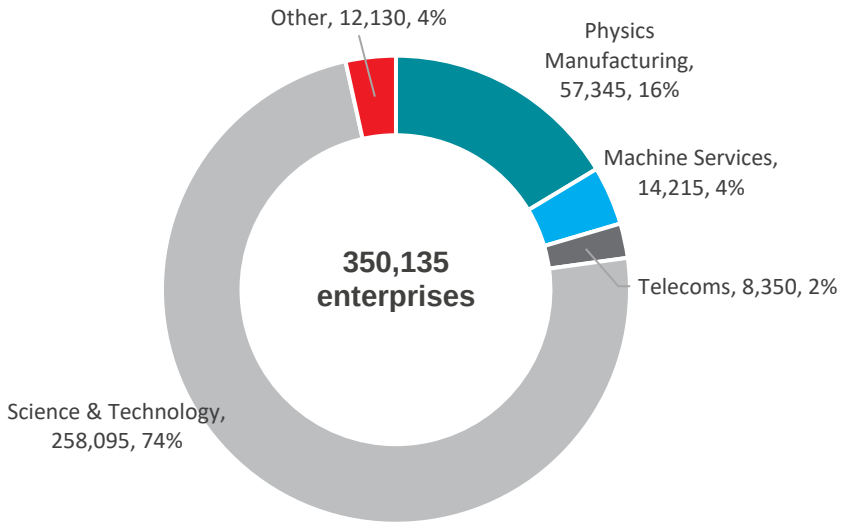
Compared to the sectoral distribution of the UK PBIs, the trends in the Welsh PBI business demographics are relatively similar. For example, Figure 8 visualises the division of the sub-sectors for 2019 in Wales, while Figure 9 visualises the division of the sectors for 2019 across the whole of the UK; for both, Physics Science & Technology is the dominant sub-sector across the decade. In 2019, however, this industry was marginally underrepresented in Wales compared to the rest of the UK (69% compared to 74%), while the share of Physics Manufacturing enterprises out of all PBI firms in Wales was higher than in the UK (19% compared to 16%). This supports the earlier identified trend, that business turnover growth in Wales over the last decade was largely driven by growth in Physics Manufacturing turnover, above and beyond the growth rate observed in the same sub-sector in the UK.

Figure 8: Division of enterprises in PBIs in Wales, 2019



Source: Nomis, Cebr analysis

Figure 9: Division of enterprises across all UK PBIs, 2019

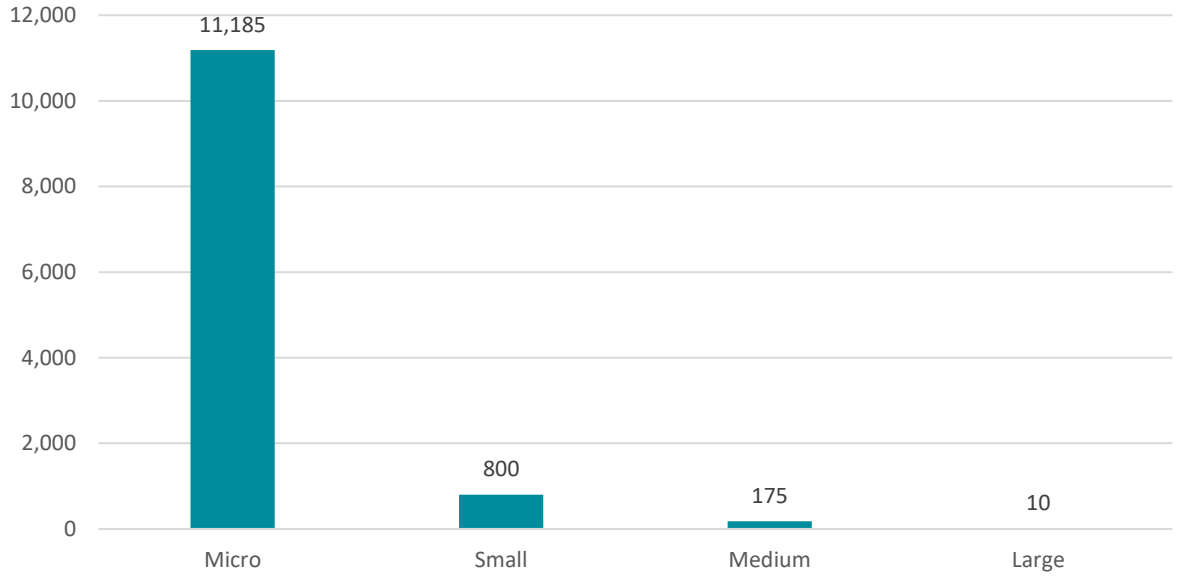


Source: Nomis, Cebr analysis

Size of enterprises

Micro companies are considered as enterprises which employ a maximum of nine people. In 2019, PBIs in Wales were dominated by these micro enterprises, where 92% (11,185) of all PBIs fell into this category, which is similar to the other UK nations. Of the remainder, 6.6% (800) of enterprises were defined as small (10-49 employees), with the remaining 1.5% (180) medium (50-249 employees) or large (250+). By comparison, in the wider Welsh economy, 89.3% of firms were micro enterprises in 2019, 9.1% small and the remaining medium or large. Figure 10 shows the composition of enterprises by size in the PBIs in Wales, for 2019.

Figure 10: Number of enterprises in PBIs in Wales, distinguished by size, 2019



Source: Nomis, Cebr analysis

Table 1 presents the division of enterprises in Wales for selected PBIs, distinguished by size for 2019. The sub-sector with the least micro enterprises was Physics Waste & Recovery, at 76%. For the 800 'small' physics-based enterprises in Wales for 2019, Physics Science & Technology accounted for 375 of them (47%). In 2019, there were 175 'medium' sized enterprises in Welsh PBIs, of which the Physics Manufacturing sub-sector accounted for the greatest share (66%). Physics Manufacturing and Physics Machine Services equally shared the only ten 'large' physics-based enterprises in Wales for 2019.[8]

Table 1: Division of enterprises in Wales for selected PBIs, distinguished by size, 2019[9]

Sub-sector	Micro	Small	Medium	Large
Physics Manufacturing	1,920	315	115	5
Physics Machine Services	690	40	10	5
Telecoms	190	20	-	-
Physics Science & Technology	7,965	375	45	-
Other	420	50	5	-
Total	**11,185**	**800**	**175**	**10**

Source: Nomis, Cebr analysis

8 Note that Nomis data on business demography is rounded to the nearest five enterprises. Therefore, there is a chance that other sectors in Wales could have up to two large enterprises, with this not being captured here.

9 "-" means that the raw data showed zero. The raw data from Nomis used to estimate these were rounded to the nearest five; this means it is possible that there are one or two enterprises present in the industry.

3. Economic contribution of PBIs to the Welsh economy

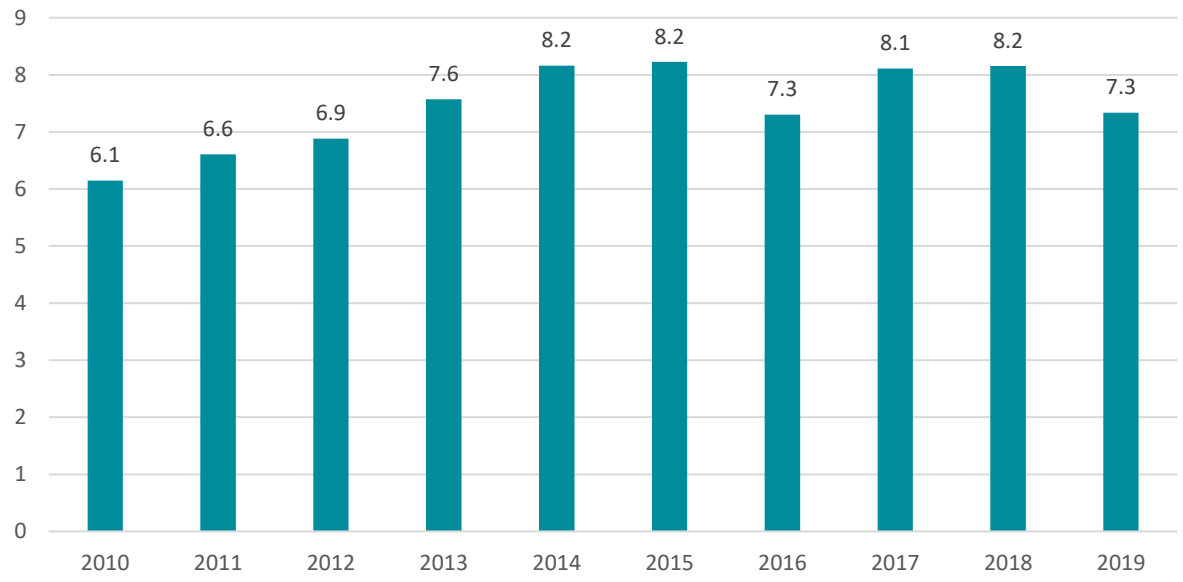
This section provides an assessment of the importance of PBIs to Wales in terms of turnover, gross value added, employment, compensation of employees, and business demographics over the period 2010-2019.

3.1 Gross value added (GVA)

We now focus on the economic contribution of the PBIs to the Welsh economy in terms of their GVA contributions to GDP. We present our estimates of the Welsh PBIs' GVA contributions to GDP in Figure 11. The latest data suggests a £7.3 billion GVA contribution in 2019. Regarding the share of Welsh GDP that is attributable to PBIs, we estimate that this sector accounts for approximately 9.5% of output. Wales was also the third biggest contributor to UK GVA by the PBIs in 2019, behind England and Scotland (England was at 82.9%, Scotland was at 12.4%, compared to 3.2% and 1.5% for Wales and Northern Ireland, respectively).

Annual nominal growth averaged 2.3% between 2010 and 2019 but was strongest in 2017 at 11.1%. The weakest year in terms of growth was 2016, when GVA reduced by 11.2% compared to the year before. The causes of this 2016 decline was significant drops in employee compensation for the Energy Production, Transmission & Distribution and Physics Machine Services sub-sectors (£441 million and £158 million declines, respectively) that did not recover in the following years. Physics Manufacturing also displayed a GVA drop of £312 million in 2016, but it recovered to a large extent in 2017, increasing by £197 million in that year.

Figure 11: GVA in PBIs in Wales, £ billions, 2010-2019

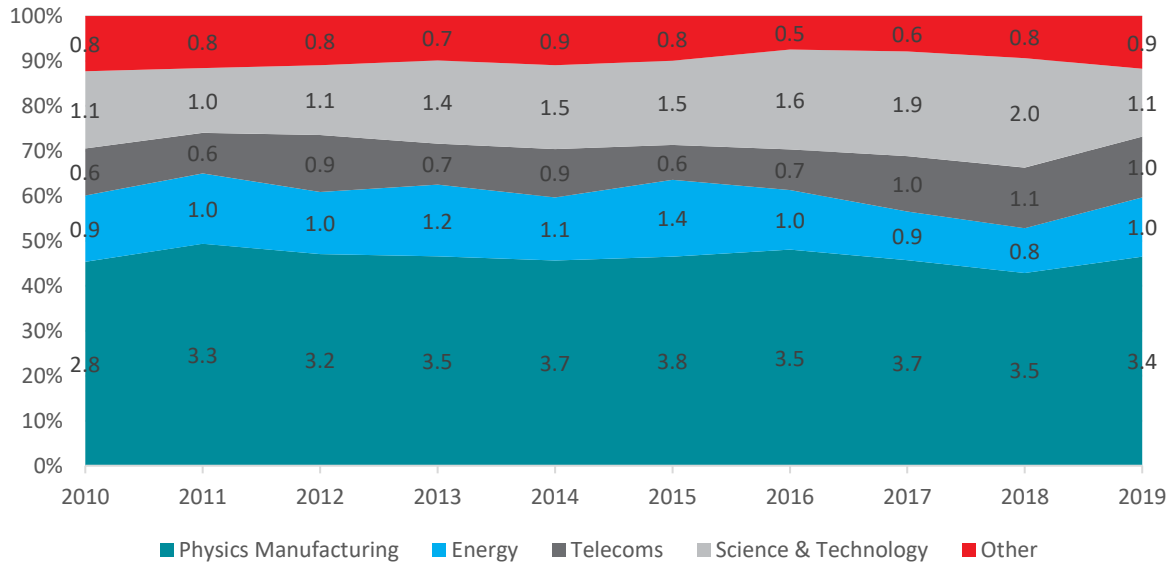


Source: ABS, Cebr analysis

Physics Manufacturing again accounted for the largest share of Welsh PBIs' GVA contribution, as illustrated in Figure 12, contributing on average 46.4% over the period 2010-2019. The next largest contributor is the Physics Science & Technology sub-sector, which also contributed a significant share of Welsh PBI employment (approximately 18.8% of the total physics sector

employment). For a detailed breakdown of the industry GVA contributions, please see Appendix II: Supplementary figures and tables.

Figure 12: GVA in selected PBIs in Wales, % of PBI total (LHS axis) and monetary value (£bn, label), 2010-2019



Source: ABS, Cebr analysis

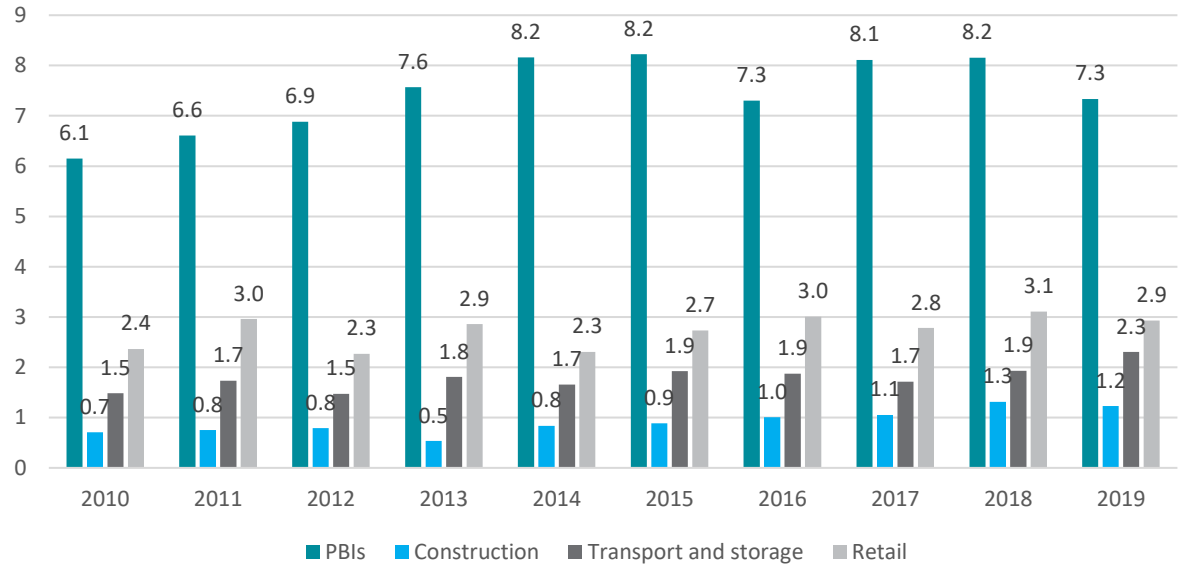
We note the significantly smaller range in the GVA contributions of these categories of PBIs than was observed for turnover. Using figures taken for 2019, this is driven by a relatively low rate of GVA generated per pound of turnover in the large Physics Manufacturing sub-sector (£0.22), compared to the overall average of £0.28 of GVA generated per pound of turnover. The industry with the highest GVA contribution per pound of turnover was Telecoms, at £0.82.

Industry comparison

In line with the previous comparisons between the PBI sector and other major sectors in Wales regarding turnover, PBIs contributed more to annual GVA than the Construction, Transport & Storage, and Retail sectors combined (see Figure 13). In 2019, the PBI sector contributed £7.3 billion in GVA to the Welsh economy, compared to £2.9 billion from Retail, £1.2 billion from Construction, and £2.3 billion from Transport & Storage.

However, in terms of the rate of GVA contributed per pound of turnover, PBIs did not perform as well as some of the other comparators. The average rate of GVA contributed per pound of turnover was £0.29 between 2010-2019 for PBIs. This was higher than in Retail (£0.20), but both the Construction and Transport & Storage sectors display higher rates of GVA per pound of turnover than PBIs, averaging £0.33 and £0.49 across the period, respectively.

Figure 13: GVA comparison for selected sectors of the Welsh economy, £ billions, 2010-2019



Source: ABS, Cebr analysis

3.2 Employment

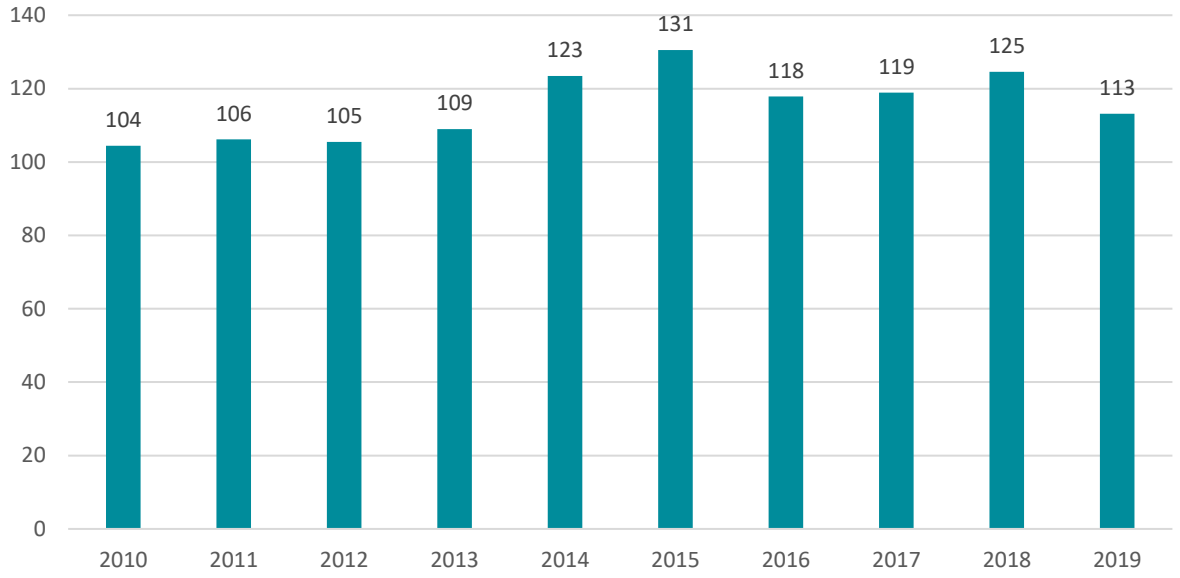
Cebr's estimates suggest that full-time equivalent (FTE) employment in the PBIs in the UK topped more than 2.7 million in 2019 and amounted to a 10.0% share of total UK employment. For Wales specifically, there were an estimated 113,138 FTE employees in 2019, accounting for a 9.8% share of total employment in Wales.

Compared to the rest of the UK and the other three home nations, the PBIs in Wales accounted for a similar share of national FTE employment (10.0%) as in Scotland (9.8%), England (10.1%) and the UK as a whole (10.0%), but a higher share than in Northern Ireland (6.8%).

The increase of PBI FTE employment in the UK was 13.2% over the period, slightly higher than Wales' 8.3%. However, the nation's share of UK PBI employment remained similar, as it was 4.2% in 2019 and 4.3% in 2010.

Employment growth in Welsh PBIs was positive for the first half of the decade, with an average year-on-year growth rate of 4.8% between 2010 and 2015. However, over the latter half of the decade, the trend displays a slight decline from the 2015 peak of 130,522 FTE jobs to 113,138 in 2019: an average year-on-year decline of 1.5%. The cause of the recent diminishing trend is predominantly declining employment in the Physics Science & Technology, Physics Manufacturing and Energy Production, Transmission & Distribution sub-sectors, with each showing net decreases of approximately 8,500, 6,900, and 2,700 respectively, between 2015 and 2019.

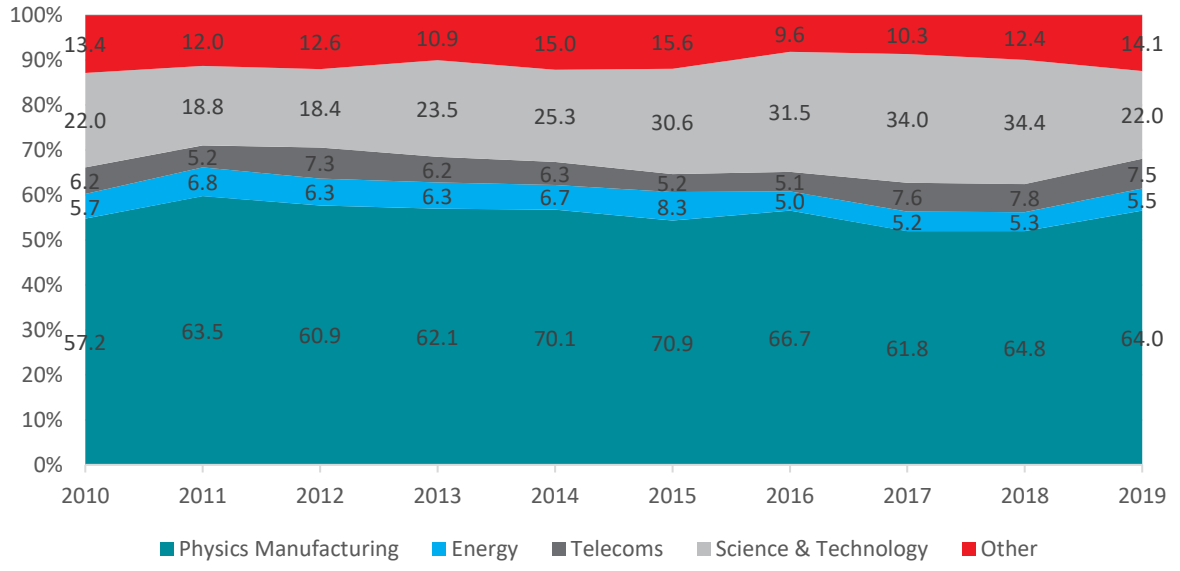
Figure 14: Physics-based employment in Wales, thousands, 2010-19



Source: BRES, Cebr analysis

Large shares of employment in the PBIs are accounted for by Physics Manufacturing and Physics Science & Technology (56.5% and 19.5% respectively, recorded in 2019). In 2019, no other industry accounted for more than 6.6% of FTE jobs for PBIs in Wales.

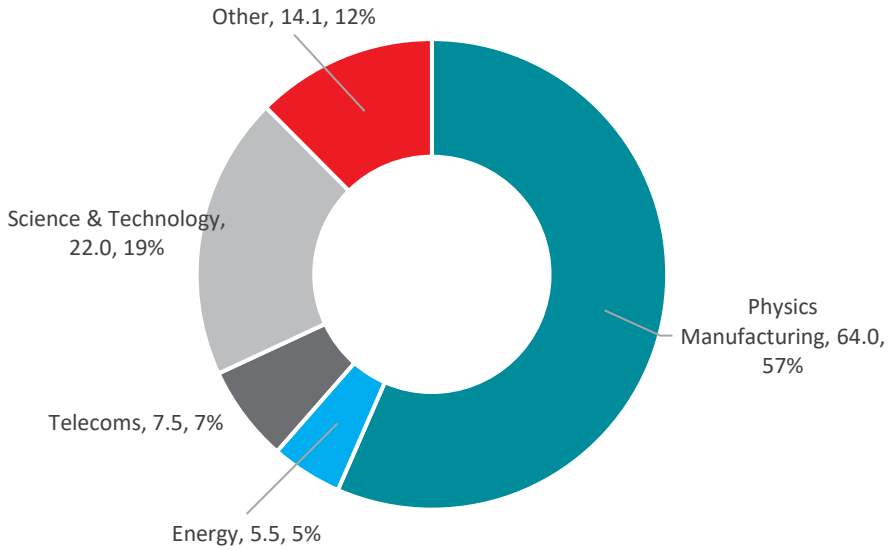
Figure 15: FTE employment in selected PBIs in Wales, % of PBI total (LHS axis) and value (000s, label), 2010-2019



Source: BRES, Cebr analysis

Figure 16 shows the number and share of FTE employment across the most prominent sub-sectors for Welsh PBIs in 2019. See Table 13 in Appendix II: Supplementary figures and tables for a full breakdown of FTE employment estimates for all industries.

Figure 16: FTE employment across Welsh PBIs, FTE jobs and %, 2019

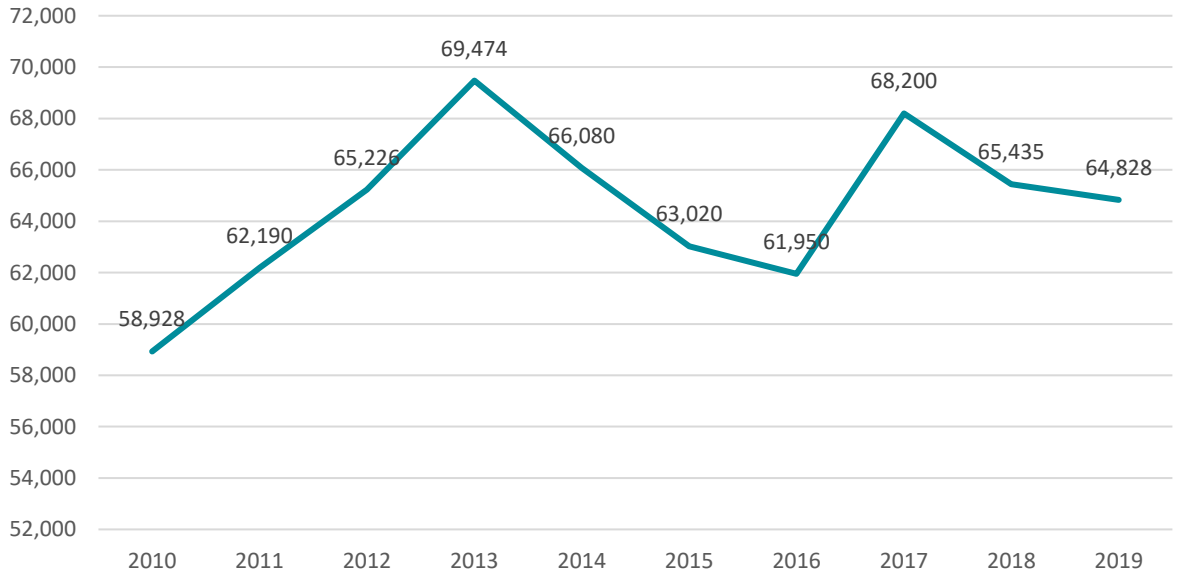


Source: BRES, Cebr analysis

Labour productivity

Labour productivity is defined as annual GVA over the number of full-time equivalent workers in the same year, or output per worker per year. For Welsh PBIs, Figure 17 shows the evolution of this metric over the period. It is a fluctuating trend, but across 2010-2019, labour productivity increased by 10.1%, from £58,855 to £64,828. There were temporary peaks in 2013 and 2017, at £69,474 and £68,200 of output per worker, respectively.

Figure 17: Overall labour productivity for PBIs in Wales, £, 2010-2019



Source: ABS, BRES, Cebr analysis

Table 2 presents a comparison between the share of total FTE employment in Welsh PBIs for each sub-sector, and the share of the total GVA contributed by that sub-sector. In 2019, these shares were broadly proportional, with the exception of four sub-sectors: Physics

Manufacturing, Energy Production, Transmission & Distribution, Telecoms, and Physics Science & Technology. For the Physics Manufacturing and Physics Science & Technology sub-sectors, employment shares were more pronounced than their GVA contributions, while in the Energy Production, Transmission & Distribution and Telecoms sub-sectors, their contributions to the total GVA generated by Welsh PBIs was greater than their respective shares of FTE employment. This suggests that labour productivity – defined as GVA per FTE employee – was higher in the Energy Production, Transmission & Distribution and Telecoms sub-sectors than in the Physics Manufacturing and Physics Science & Technology sub-sectors.

Table 2: Comparison between the shares of GVA and FTE employment by Welsh PBIs, 2019

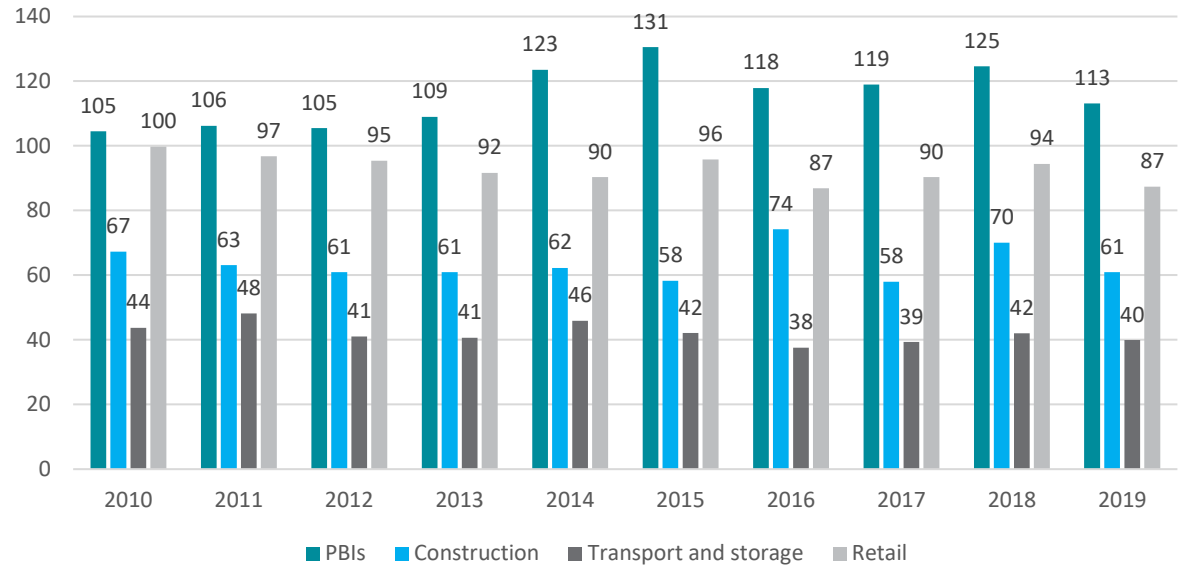
Sub-sector	Share of 2019 GVA	Share of 2019 FTE employment
Oil & Gas Extraction	0.7%	0.04%
Physics Manufacturing	46.5%	56.5%
Physics Machine Services	4.5%	5.6%
Energy Production, Transmission & Distribution	13.1%	4.9%
Physics Waste & Recovery	3.9%	4.2%
Physics Machine Sales	1.3%	1.0%
Medical Equipment Sales	0.2%	0.3%
Space Transport and Air Transport Services	0.7%	0.4%
Telecoms	13.5%	6.6%
Physics Science & Technology	15.1%	19.5%
Defence	0.5%	0.8%

Source: ABS, BRES, Cebr analysis

Industry comparison

When comparing the turnover and GVA contributions of the Welsh PBI sector with other sectors of the Welsh economy, the PBI sector drastically outperforms the other highlighted sectors. However, to provide some context to these results, Figure 18 shows a comparison of FTE employment in each of the sectors. The data exemplifies the strength of labour productivity in the PBIs in Wales, as the FTE employment levels are significantly closer across all four sectors.

Figure 18: FTE employment comparison for selected sectors of the Welsh economy, thousands, 2010-2019



Source: BRES, Cebr analysis

In 2019, the PBI sector generated 2.1 times more turnover and 2.5 times more GVA than the Retail sector, with only 1.3 times more FTE employees. Therefore, labour productivity (GVA per FTE) in the PBIs was much higher than in the Retail sector, as illustrated by Table 3.

On average over the period, GVA per FTE employee was £64,530 in the PBIs, compared to £29,518 in Retail, £14,358 in Construction, and £42,911 in Transport & Storage.

Table 3: Comparison between GVA per FTE for selected sectors of the Welsh economy, £, 2010 - 2019

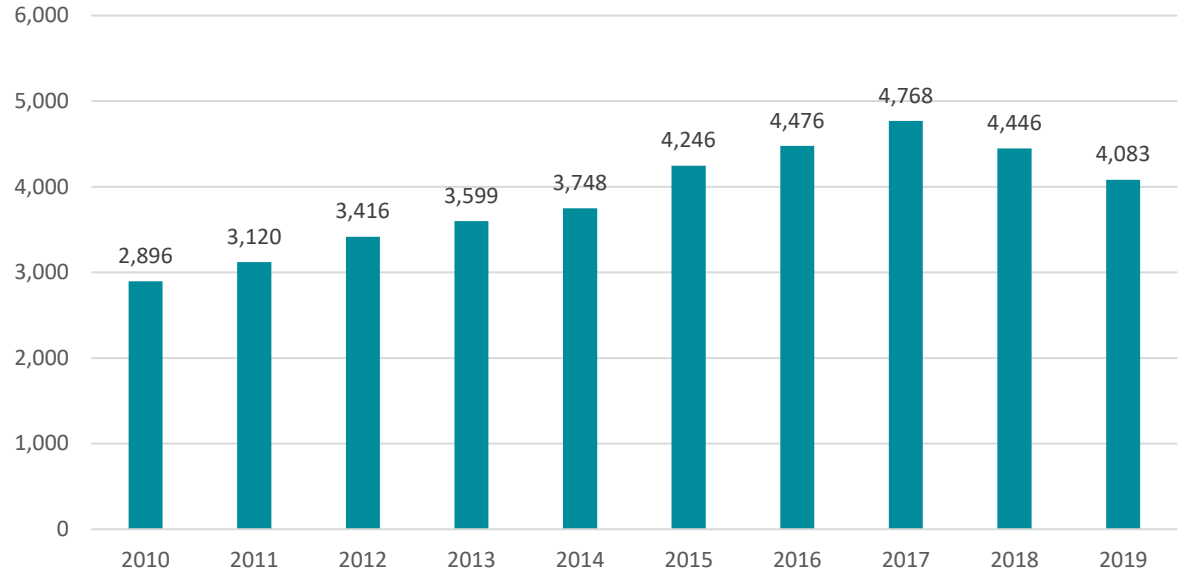
Year	PBIs	Construction	Transport and Storage	Retail
2010	58,855	10,567	34,024	23,698
2011	62,190	11,906	36,012	30,566
2012	65,226	12,971	35,892	23,763
2013	69,474	8,764	44,492	31,227
2014	66,080	13,410	36,114	25,547
2015	63,020	15,215	45,660	28,541
2016	61,950	13,615	49,819	34,596
2017	68,200	18,183	43,513	30,775
2018	65,435	18,799	45,911	32,922
2019	64,828	20,148	57,671	33,546

Source: ABS, BRES, Cebr analysis

3.3 Compensation of employees (COE)

Total compensation of employees (COE) across Welsh PBIs was £4.1 billion in 2019. This value meant a 3.6% share of the total UK COE for PBIs, which is 0.3 percentage points higher than in 2010. As will be seen, this is driven by increasing employee compensation per worker in the Welsh PBIs. Figure 19 presents the evolution of COE for the Welsh PBIs over the period, with a peak in 2017, at £4.8 billion.

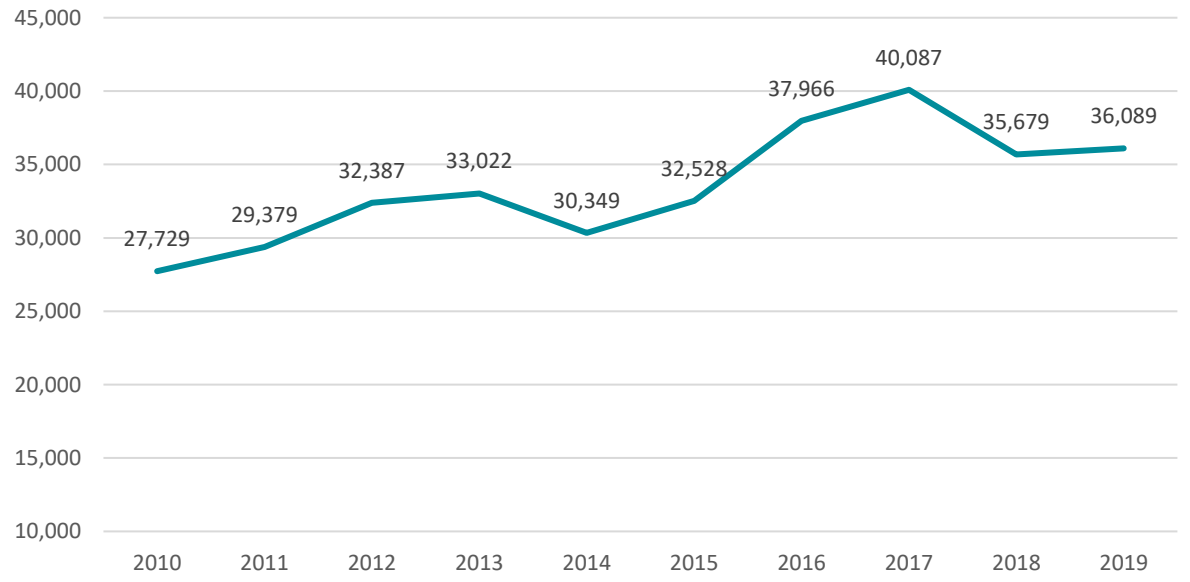
Figure 19: Physics-based COE in Wales, £ millions, 2010-19



Source: ABS, BRES, Cebr analysis

Regarding the overall COE/FTE ratio for Welsh PBIs, there was a broadly increasing trend over the period, from £27,711 in 2010 to £36,089 in 2019. Again, COE is equivalent to the total remuneration of employees operating in the sector. In terms of sub-sector specifics, COE/FTE in Physics Manufacturing rose to £37,371 in 2019 from £26,460 in 2010, compared to COE/FTE in Physics Science & Technology, which fell from £33,854 to £27,328 over the same period.

Figure 20: COE to FTE ratio for PBIs in Wales, £, 2010 - 2019.

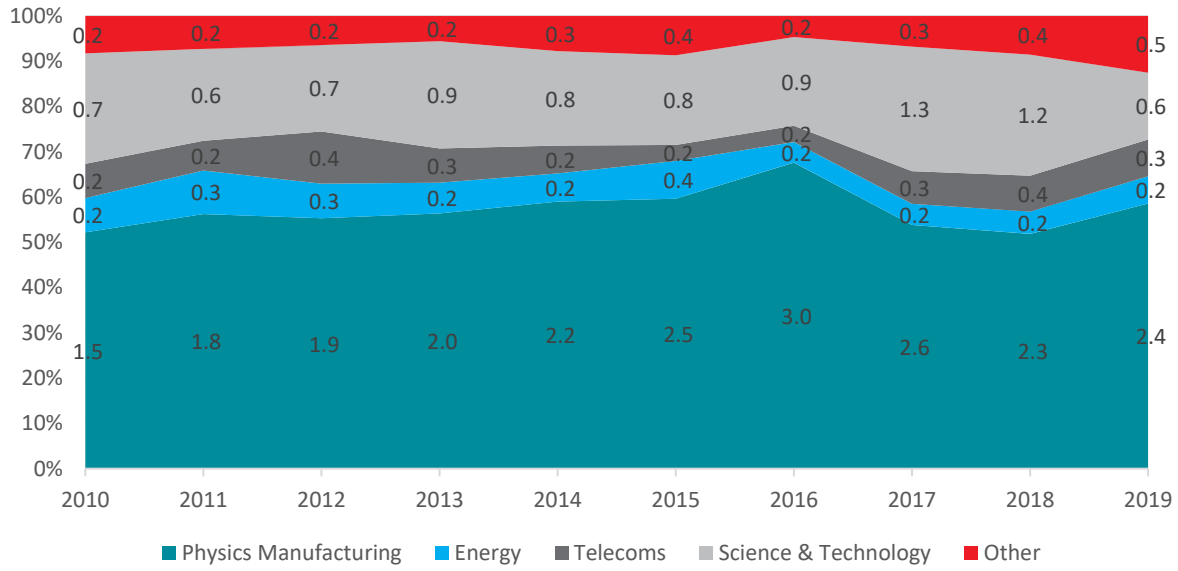


Source: ABS, BRES, Cebr analysis

In line with the other metrics, Physics Manufacturing accounted for the largest share of the total Welsh PBI employee compensation, with 58.6% contributed by this sub-sector in 2019 (£2.4 billion). The Physics Science & Technology sub-sector was the second largest, with a 14.7% share (£602 million), although this was down from a peak, both relatively and absolutely,

in 2017 of 27.5% (£1.3 billion). See Table 14 in Appendix II: Supplementary figures and tables for a full breakdown of employee compensation across Welsh PBIs.

Figure 21: Employee compensation in selected PBIs in Wales, % of PBI total (LHS axis) and monetary value (£bn, label), 2010-19

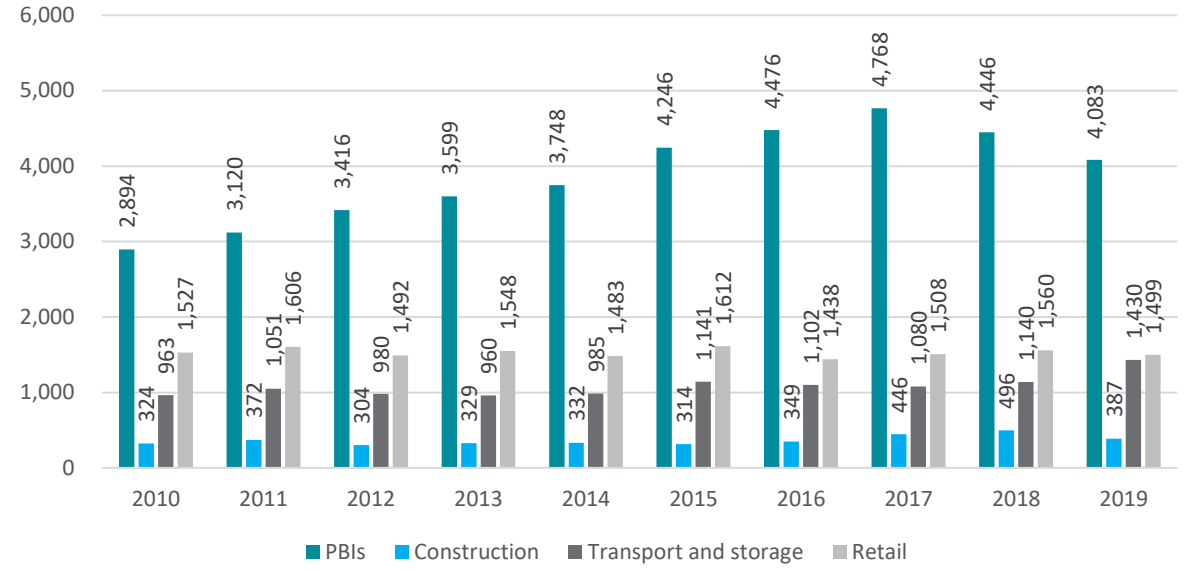


Source: ABS, BRES, Cebr analysis

Industry Comparison

Figure 22 shows the COE of the PBIs and the comparator sectors. Unsurprisingly, the trend is very similar to that seen for GVA. While the number of employees was also greater in the PBI sector, the difference was not as big. This suggests that the average COE/employment ratio is much higher compared to the other three sectors. PBIs also had the second highest yearly average growth with 3.9%, compared to Constructions' 2.0% and Retail shrink of 0.2%. The Transport & Storage sector had the highest annual growth with 4.5%.

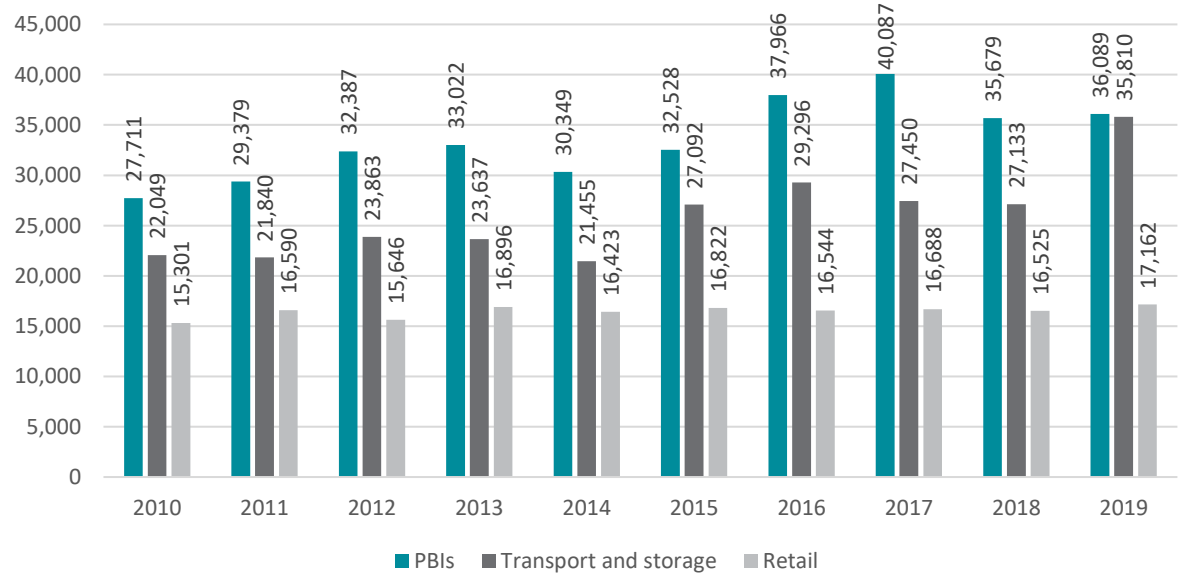
Figure 22: COE in selected Welsh sectors, £ millions, 2010-19



Source: ABS, Cebr analysis

As with labour productivity, the PBI sector had a higher average COE per FTE worker than the comparator sectors, with slightly more than £36,000 in 2019. Interestingly, while the Transport sector had very big increase in COE per FTE worker (especially due to the high jump in 2019), the Retail sector only had a small growth. Figure 23 shows that while their initial rate was much closer to each other, by 2019 the Transport sector was on the level of the PBIs, and provided twice as much COE per FTE than Retail.

Figure 23: Compensation per FTE in selected Welsh sectors, 2010-2019



Source: ABS, BRES, Cebr analysis

4. National comparisons

This section provides an assessment of the importance of PBIs in Wales compared to the other UK nations, in terms of turnover, GVA, employment, COE, and business demographics over the period 2010-2019.

4.1 Turnover

Table 4 provides a national breakdown of the PBIs' turnover on a yearly basis, by nation. Over the period, the PBIs in Wales gained a higher rate of share regarding their contribution to total PBI turnover in the UK, growing to 4.2% in 2019 (£26.7 billion out of £633.7 billion) from 3.8% in 2010 (£19.6 billion out of £510.6 billion). This relatively was the fastest growing nation out of the four between 2010 and 2019, with Welsh turnover increasing by 36.1%, relative to the UK average of 24.1%, highlighting the strength of the industry in Wales.

Table 4: Turnover in UK PBIs, distinguished between nations, £ billions, 2010-2019

Nation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
England	417.1	442.1	452.3	462.9	463.2	459.3	482.9	517.1	530.2	533.2
Scotland	65.9	70.8	58.1	64.0	62.8	59.5	60.8	58.4	60.4	63.8
Wales	**19.6**	**23.5**	**23.2**	**25.9**	**25.6**	**30.4**	**26.1**	**30.2**	**26.7**	**26.7**
Northern Ireland	8.0	8.9	9.1	9.4	11.5	11.1	9.6	9.7	9.6	10.1

Source: ABS, BRES, Cebr analysis

4.2 GVA

We now focus on the economic contribution of the PBIs to the UK national economy, in terms of their GVA contributions to GDP. In terms of the share of UK GVA generated by PBIs, Welsh contribution peaked in 2015 (at 3.9%, £8.2 billion out of £210.7 billion), but this declined back to its 2010 proportion (3.2%, £7.3 billion out of £229.5 billion) by 2019. The share of GVA contributed by the PBIs to Wales' own economy was 9.6% in 2019 (£7.3 billion out of £76 billion), which is broadly similar to the UK average of 10.6% in the same year. In other words, the PBIs were approximately as important to the Welsh economy as the wider UK economy.

In 2019, in line with the concentration of PBI businesses (see Section 4.5), 80% of the GVA generated by UK PBIs was attributable to England.

Table 5: GVA in UK PBIs, distinguished between nations, £ billions, 2010-2019

Nation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
England	153.9	164.1	166.9	176.5	181.1	176.8	181.1	187.8	190.1	190.2
Scotland	27.2	27.7	24.1	24.9	25.0	22.2	21.4	25.9	26.6	28.4
Wales	**6.1**	**6.6**	**6.9**	**7.6**	**8.2**	**8.2**	**7.3**	**8.1**	**8.2**	**7.3**
Northern Ireland	2.4	2.7	2.7	3.2	3.0	3.4	3.1	2.9	3.3	3.5

Source: ABS, BRES, Cebr analysis

4.3 Employment

Wales' share of UK PBI employment was 4.2% in 2019 (113,000 out of 2.7 million), which was similar to its 2010 value of 4.3% (104,000 out of 2.4 million). There is also a roughly inverted U-shaped trend in this metric, with total employment in Welsh PBIs peaking in 2015 at 131,000. Wales' share of UK PBI employment also peaked in this year, at 5.1%. By 2019, all nations, however, increased from their 2010 employment levels. Relative to the UK average increase

of 13.2%, Wales fell slightly below this at 8.3%. As a share of total FTE employees in Wales, FTE employees in the Welsh PBIs was 9.8%, in line with the UK average of 10.0%.

Table 6: Employment in UK PBIs, distinguished between nations, thousands, 2010-2019

Nation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
England	2,055	2,037	1,971	1,991	2,075	2,187	2,211	2,237	2,257	2,338
Scotland	203	197	193	196	217	211	207	218	220	220
Wales	**104**	**106**	**105**	**109**	**123**	**131**	**118**	**119**	**125**	**113**
Northern Ireland	40	44	41	44	43	52	44	41	48	49

Source: ABS, BRES, Cebr analysis

4.4 Compensation of employees

Wales contributed 3.6% of the total UK employee compensation for PBIs in the UK in 2019 (£4.1 billion out of £114.3 billion), 0.3% more than in 2010. As identified in Section 3.3, COE across Welsh PBIs experienced a 41.1% increase compared to 2010, outstripping the UK average increase of 31.4% over the same period.

Table 7: Employment compensation in UK PBIs, distinguished between nations, £ billions, 2010-2019

Nation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
England	74.2	76.5	78.5	80.6	82.5	84.5	88.8	89.8	92.5	98.2
Scotland	8.8	8.7	8.4	9.1	10.0	9.7	9.7	10.0	10.0	10.4
Wales	**2.9**	**3.1**	**3.4**	**3.6**	**3.7**	**4.2**	**4.5**	**4.8**	**4.4**	**4.1**
Northern Ireland	1.2	1.3	1.3	1.3	1.5	1.7	1.5	1.7	1.7	1.7

Source: ABS, BRES, Cebr analysis

4.5 Business demography

In terms of the number of enterprises operating in PBIs, the national disaggregation can be found below, displaying the number in Wales relative to the rest of the UK.

Table 8: Division of enterprises in UK PBIs, distinguished between nations, thousands, 2010-2019

Nation	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
England	210.1	204.6	216.2	221.5	239.8	282.7	299.4	320.1	302.9	305.4
Scotland	16.9	17.5	19.4	20.6	22.8	26.1	26.8	27.1	26.8	27.2
Wales	**8.3**	**8.0**	**8.2**	**8.3**	**9.2**	**11.3**	**11.7**	**12.1**	**11.8**	**12.2**
Northern Ireland	3.8	3.7	3.7	3.8	3.9	4.1	4.4	4.8	5.1	5.3

Source: Nomis, Cebr analysis

An interesting point to note is that the share of UK PBIs operating in Wales was only 3.4% (12,170 out of 350,135) in 2019. Across the other economic impact metrics, Wales accounted for closer to, and above, 4%. Therefore, for a smaller number of enterprises in the PBI sector, Wales had a disproportionately large impact on a per-firm basis compared to the national average.

The explanation for this is not necessarily a smaller average business size: in 2019, PBIs in Wales were dominated by these micro enterprises (0 – 9 employees), where 92% (11,185) of all firms in Welsh PBIs fell into this category, which is a trend that is reflected across all UK nations. A possible explanation might be the slight underrepresentation of the Physics Science & Technology sub-sector in Wales (69% of all PBI enterprises) compared to the UK (74%).

Since across the UK, this sub-sector generally produces less turnover per enterprise, having proportionally fewer Science & Technology enterprises, raises the average turnover per enterprise slightly in the PBIs in Wales.

Appendix I: SIC-based definition of PBIs and sectoral alignment

Code	Description	Code	Description
Oil & Gas Extraction			
06.1	Extraction of crude petroleum	06.2	Extraction of natural gas
Physics Manufacturing			
13.95	Manufacture of non-wovens and articles made from non-wovens, except apparel	26.511	Manufacture of electronic instruments and appliances for measuring, testing, and navigation, except industrial process control equipment
13.96	Manufacture of other technical and industrial textiles	26.512	Manufacture of electronic industrial process control equipment
13.99	Manufacture of other textiles nec[10]	26.513	Manufacture of non-electronic instruments and appliances for measuring, testing and navigation, except industrial process control equipment
18.129	Printing (other than printing of newspapers and printing on labels and tags) nec	26.514	Manufacture of non-electronic industrial process control equipment
20.12	Manufacture of dyes and pigments	26.52	Manufacture of watches and clocks
20.13	Manufacture of other inorganic basic chemicals	26.6	Manufacture of irradiation, electromedical and electrotherapeutic equipment
20.17	Manufacture of synthetic rubber in primary forms	26.701	Manufacture of optical precision instruments
20.301	Manufacture of paints, varnishes and similar coatings, mastics and sealants	26.702	Manufacture of photographic and cinematographic equipment
20.302	Manufacture of printing ink	26.8	Manufacture of magnetic and optical media
20.51	Manufacture of explosives	27.11	Manufacture of electric motors, generators and transformers
20.59	Manufacture of other chemical products nec	27.12	Manufacture of electricity distribution and control apparatus
23.11	Manufacture of flat glass	27.2	Manufacture of batteries and accumulators
23.12	Shaping and processing of flat glass	27.31	Manufacture of fibre optic cables
23.13	Manufacture of hollow glass	27.32	Manufacture of other electronic and electric wires and cables
23.14	Manufacture of glass fibres	27.33	Manufacture of wiring devices
23.19	Manufacture and processing of other glass, including technical glassware	27.4	Manufacture of electric lighting equipment
23.2	Manufacture of refractory products	27.51	Manufacture of electric domestic appliances
23.31	Manufacture of ceramic tiles and flags	27.9	Manufacture of other electrical equipment
23.43	Manufacture of ceramic insulators and insulating fittings	28.11	Manufacture of engines and turbines, except aircraft, vehicle and cycle engines
23.44	Manufacture of other technical ceramic products	28.21	Manufacture of ovens, furnaces and furnace burners
23.49	Manufacture of other ceramic products	28.23	Manufacture of office machinery and equipment (except computers and peripheral equipment)
24.1	Manufacture of basic iron and steel and of ferro-alloys	28.25	Manufacture of non-domestic cooling and ventilation equipment

10 'Nec' means not elsewhere classified.

24.2	Manufacture of tubes, pipes, hollow profiles and related fittings, of steel	28.41	Manufacture of metal forming machinery
24.31	Cold drawing of bars	28.49	Manufacture of other machine tools
24.32	Cold rolling of narrow strip	28.91	Manufacture of machinery for metallurgy
24.33	Cold forming or folding	28.922	Manufacture of earthmoving equipment
24.34	Cold drawing of wire	28.94	Manufacture of machinery for textile, apparel and leather production
24.41	Precious metals production	28.95	Manufacture of machinery for paper and paperboard production
24.46	Processing of nuclear fuel	28.96	Manufacture of plastics and rubber machinery
25.11	Manufacture of metal structures and parts of structures	28.99	Manufacture of other special-purpose machinery nec
25.12	Manufacture of doors and windows of metal	29.1	Manufacture of motor vehicles
25.21	Manufacture of central heating radiators and boilers	29.31	Manufacture of electrical and electronic equipment for motor vehicles
25.29	Manufacture of other tanks, reservoirs and containers of metal	29.32	Manufacture of other parts and accessories for motor vehicles
25.3	Manufacture of steam generators, except central heating hot water boilers	30.11	Building of ships and floating structures
25.4	Manufacture of weapons and ammunition	30.12	Building of pleasure and sporting boats
25.5	Forging, pressing, stamping and roll-forming of metal; powder metallurgy	30.2	Manufacture of railway locomotives and rolling stock
25.61	Treatment and coating of metals	30.3	Manufacture of air and spacecraft and related machinery
25.62	Machining	30.4	Manufacture of military fighting vehicles
26.11	Manufacture of electronic components	30.91	Manufacture of motorcycles
26.12	Manufacture of loaded electronic boards	30.92	Manufacture of bicycles and invalid carriages
26.2	Manufacture of computers and peripheral equipment	30.99	Manufacture of other transport equipment nec
26.301	Manufacture of telegraph and telephone apparatus and equipment	32.5	Manufacture of medical and dental instruments and supplies
26.309	Manufacture of communication equipment (other than telegraph and telephone apparatus and equipment)	32.99	Other manufacturing nec
26.4	Manufacture of consumer electronics	33.16	Repair and maintenance of aircraft and spacecraft
Physics Machine Services			
33.11	Repair of fabricated metal products	33.17	Repair and maintenance of other transport equipment
33.12	Repair of machinery	33.19	Repair of other equipment
33.13	Repair of electronic and optical equipment	33.2	Installation of industrial machinery and equipment
33.14	Repair of electrical equipment	33.15	Repair and maintenance of ships and boats
Energy Production, Transmission & Distribution			
35.11	Production of electricity	35.13	Distribution of electricity
35.12	Transmission of electricity	35.22	Distribution of gaseous fuels through mains
Physics Waste & Recovery			
38.12	Collection of hazardous waste	38.32	Recovery of sorted materials
38.22	Treatment and disposal of hazardous waste	39	Remediation activities and other waste management services
38.31	Dismantling of wrecks		
Physics Machine Sales			
46.14	Agents involved in the sale of machinery, industrial equipment, ships and aircraft		

Medical Equipment Sales			
47.741	Retail sale of hearing aids in specialised stores	47.749	Retail sale of medical and orthopaedic goods (other than hearing aids) nec, in specialised stores
Space Transport & Air Transport Services			
51.22	Space transport	52.23	Service activities incidental to air transportation
Telecoms			
61.1	Wired telecommunications activities	61.3	Satellite telecommunications activities
61.2	Wireless telecommunications activities	61.9	Other telecommunications activities
Physics Science & Technology			
71.121	Engineering design activities for industrial process and production	72.19	Other research and experimental development on natural sciences and engineering
71.122	Engineering related scientific and technical consulting activities	74.1	Specialised design activities
71.129	Other engineering activities (not including engineering design for industrial process and production or engineering related scientific and technical consulting activities)	74.9	Other professional, scientific and technical activities nec
71.2	Technical testing and analysis	82.99	Other business support service activities nec
72.11	Research and experimental development on biotechnology		
Defence			
84.22	Defence activities		

Appendix II: Supplementary figures and tables

Table 9: Turnover in the different sub-sectors of PBIs in Wales, £ billions, 2010-2019

Sub-sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oil & Gas Extraction	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1
Physics Manufacturing	10.3	13.2	12.2	14.5	13.7	16.7	16.1	19.1	15.2	15.5
Physics Machine Services	0.6	0.9	0.7	0.8	1.2	2.2	1.1	1.1	1.1	1.0
Energy Production, Transmission & Distribution	3.8	4.8	4.4	5.6	5.9	6.9	4.8	4.5	4.3	4.8
Physics Waste & Recovery	0.9	1.1	1.3	0.8	0.7	0.9	0.4	0.5	1.0	1.6
Physics Machine Sales	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
Medical Equipment Sales	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Space Transport & Air Transport Services	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.1
Telecoms	1.6	1.4	2.0	1.3	1.4	0.9	1.1	1.4	1.4	1.2
Physics Science & Technology	2.0	1.9	2.2	2.7	2.6	2.5	2.3	3.4	3.4	2.1
Defence	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Overall	19.6	23.5	23.2	25.9	25.6	30.4	26.1	30.2	26.7	26.7

Source: ABS, BRES, Cebr analysis

Table 10: Number of enterprises in the different sub-sectors of PBIs in Wales, 2010-2019

Sub-sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oil & Gas Extraction	0	0	0	0	0	0	0	0	0	5
Physics Manufacturing	2,230	2,115	2,075	1,955	2,080	2,180	2,235	2,245	2,285	2,355
Physics Machine Services	270	365	435	550	585	680	755	815	760	745
Energy Production, Transmission & Distribution	30	25	60	65	105	130	150	160	175	170
Physics Waste & Recovery	130	125	145	150	180	170	175	150	150	145
Physics Machine Sales	120	110	105	100	100	110	100	95	90	90
Medical Equipment Sales	45	40	35	35	35	40	40	35	35	35
Space Transport & Air Transport Services	25	25	20	30	30	25	20	20	30	30
Telecoms	195	200	205	205	205	205	195	200	210	210
Physics Science & Technology	5,220	4,985	5,150	5,235	5,875	7,730	8,030	8,385	8,080	8,385
Overall	8,265	7,990	8,230	8,325	9,195	11,270	11,700	12,105	11,815	12,170

Source: Nomis, Cebr analysis

Table 11: Division of businesses in PBIs in Wales, distinguished by size, 2019

Sub-sector	Micro	Small	Medium	Large
Oil & Gas Extraction	5	-	-	-
Physics Manufacturing	1,920	315	115	5
Physics Machine Services	690	40	10	5
Energy Production, Transmission & Distribution	165	5	-	-
Physics Waste & Recovery	110	30	5	-
Physics Machine Sales	80	10	-	-
Medical Equipment Sales	35	-	-	-
Space Transport & Air Transport Services	25	5	-	-
Telecoms	190	20	-	-
Physics Science & Technology	7,965	375	45	-
Total	**11,185**	**800**	**175**	**10**

Source: Nomis, Cebr analysis

Table 12: GVA contributed by the different sub-sectors of PBIs in Wales, £ billions, 2010-2019

Sub-sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oil & Gas Extraction	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Physics Manufacturing	2.8	3.3	3.2	3.5	3.7	3.8	3.5	3.7	3.5	3.4
Physics Machine Services	0.4	0.4	0.4	0.5	0.6	0.5	0.3	0.3	0.4	0.3
Energy Production, Transmission & Distribution	0.9	1.0	1.0	1.2	1.1	1.4	1.0	0.9	0.8	1.0
Physics Waste & Recovery	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.2	0.2	0.3
Physics Machine Sales	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
Medical Equipment Sales	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Space Transport & Air Transport Services	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0
Telecoms	0.6	0.6	0.9	0.7	0.9	0.6	0.7	1.0	1.1	1.0
Physics Science & Technology	1.1	1.0	1.1	1.4	1.5	1.5	1.6	1.9	2.0	1.1
Defence	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.0
Overall	6.1	6.6	6.9	7.6	8.2	8.2	7.3	8.1	8.2	7.3

Source: ABS, BRES, Cebr analysis

Table 13: Employment in the different PBIs in Wales, thousands, 2010-2019

Sub-sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oil & Gas Extraction	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0
Physics Manufacturing	57.2	63.5	60.9	62.1	70.1	70.9	66.7	61.8	64.8	64.0
Physics Machine Services	8.2	7.2	6.4	6.5	9.8	8.0	5.6	6.0	6.9	6.4
Energy Production, Transmission & Distribution	5.7	6.8	6.3	6.3	6.7	8.3	5.0	5.2	5.3	5.5
Physics Waste & Recovery	2.7	2.8	4.3	2.8	3.0	5.4	1.7	2.2	3.1	4.8
Physics Machine Sales	0.3	0.2	0.2	0.0	0.4	0.3	0.2	0.1	0.1	1.2
Medical Equipment Sales	0.3	0.3	0.3	0.2	0.4	0.4	0.3	0.4	0.5	0.3
Space Transport & Air Transport Services	0.4	0.5	0.3	0.3	0.6	0.4	0.3	0.3	0.6	0.5
Telecoms	6.2	5.2	7.3	6.2	6.3	5.2	5.1	7.6	7.8	7.5
Physics Science & Technology	22.0	18.8	18.4	23.5	25.3	30.6	31.5	34.0	34.4	22.0
Defence	1.4	1.0	1.1	1.0	0.9	1.2	1.4	1.2	1.2	0.9
Overall	104.4	106.2	105.5	109.0	123.5	130.5	117.9	118.9	124.6	113.1

Source: BRES, Cebr analysis

Table 14: Employee compensation attributable to the different PBIs in Wales, £ billions, 2010-2019

Sub-sector	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Oil & Gas Extraction	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.01	0.01
Physics Manufacturing	1.51	1.76	1.89	2.03	2.21	2.53	3.03	2.57	2.31	2.39
Physics Machine Services	0.07	0.10	0.07	0.07	0.12	0.20	0.08	0.19	0.20	0.18
Energy Production, Transmission & Distribution	0.22	0.30	0.26	0.24	0.23	0.35	0.20	0.22	0.22	0.25
Physics Waste & Recovery	0.06	0.07	0.08	0.09	0.09	0.10	0.06	0.07	0.09	0.24
Physics Machine Sales	0.04	0.01	0.01	0.00	0.02	0.01	0.00	0.00	0.00	0.04
Medical Equipment Sales	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.01	0.01
Space Transport & Air Transport Services	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.02
Telecoms	0.22	0.21	0.39	0.27	0.23	0.15	0.16	0.34	0.35	0.33
Physics Science & Technology	0.71	0.63	0.65	0.85	0.78	0.84	0.88	1.31	1.19	0.60
Defence	0.04	0.02	0.03	0.03	0.02	0.03	0.04	0.04	0.04	0.03
Overall	2.89	3.12	3.42	3.60	3.75	4.25	4.48	4.77	4.45	4.08

Source: ABS, BRES, Cebr analysis

Appendix II: Methodology

The following section lays out our methodology, broken down by our approach to the overall impacts and the national impacts. In order to estimate the impact of the PBIs in Wales, we first needed to estimate the impact of the sector across the UK as a whole. The methodology for both stages can be found in this section.

Economic impact of the PBIs in the UK as a whole

In order to provide a well-rounded summary of the PBIs in the UK (including a disaggregation across the four nations that make up Great Britain and Northern Ireland), we worked with the turnover, GVA, total full-time employees and COE, as well as with the number of enterprises. For these, we used the Annual Business Survey (ABS) from the Office of National Statistics (ONS), the Business Register and Employment Survey from Nomis (which also comes from ONS), and the UK business counts from Nomis.

ABS provides a very detailed database on a UK level; however, there have been cases when some of the values were missing. When this occurred, we estimated the data we needed in order to provide a more exact summary and not omit anything. If employment data was missing, we used the average of the employment in the industry one year earlier and one year later. In cases where the turnover, GVA or COE was not written, the turnover-FTE, the GVA-FTE or the COE-FTE ratio for the previous year where we had the full data was used. Whenever we encountered a SIC 5-digit level industry, where ABS had no data, we used the 3- or 4-digit level values and the ratio of the 5- and 3-digit level BRES FTE values in order to estimate the specific data on these:

$$5\ digit\ GVA_i = 3\ digit\ GVA_i \times \frac{5\ digit\ FTE_i}{3\ digit\ FTE_i}$$

Here, again, GVA_i is the gross value added in year *i,* and $FTE_i$is the number of full-time employees in year *i.*

Once we had all the data, we aggregated the PBI industry into 11 sub-sectors. These are: Oil & Gas Extraction; Physics Manufacturing; Physics Machine Services; Energy Production, Transmission & Distribution; Physics Waste & Recovery; Physics Machine Sales; Medical Equipment Sales; Space Transport & Air Transport Services; Telecoms; Physics Science & Technology; and lastly, Defence. Appendix I shows which industries belong to which sub-sector.

Economic impact of the PBIs in Wales

After finishing the gathering and modelling of data on the UK impacts, we were able to estimate the International Territorial Levels Level 1 (ITL1) regional values, including those for Wales. First, we used BRES again to estimate the share of FTEs in each of the UK nations and nine English ITL1 regions in a given industry, thus getting the implied number of full-time employees. We modelled the GVA by using the UK industrial GVE/FTE ratio, multiplying it by the regional productivity differential (from ONS) and the implied number of employees in the region. In order to estimate the compensation of employees and the turnover, we used the ABS 2-digit SIC code level regional data to find the COE-GVA and the GVA-turnover ratio in a given year. After that, we were able to estimate both from the GVA and the relevant ratio. Since we already had the overall direct impacts, we scaled back to that in order to avoid any differences between that and the regional values.

In some cases, ABS was missing one of the regional values we needed to calculate the ratios. If there was only one or two years of data missing, we averaged the earlier and later years to

estimate the value of the missing year. If the lack of data was more frequent, we used the UK-level ratios to estimate the regional values. In a few cases, we had the ABS values, but they provided a great volatility in the COE-GVE ratios, for example, going from 15% in a region to 80%, or even higher. In order to control for this, we have adjusted the methodology in such cases and used the COE/GVA ratio across the UK to estimate the regional COE. For most industries, using the bespoke regional ratio is more accurate as it adjusts for regional differences in industry/firm structure, but sometimes the regional volatility is so significant that the trade-off is no longer worth it.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