



A WPI Economics report for Heathrow

The value of off-site construction to UK productivity and growth

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Image on front page: Mechanical and electrical modules in place between steel towers for mechanical and electrical cores. Courtesy of Heathrow.

Summary

WPI Economics' 2017 report on the value of off-site construction suggested that increasing the proportion of UK construction undertaken off site could significantly boost UK productivity and growth.

Since that report, the Government has committed to the modernisation of the construction sector. It has announced that five key Government departments will use a presumption in favour of off-site construction in suitable capital projects from 2019 and has committed to investing to support the modernisation of the sector and development of critical skills.

These moves are welcome and support the wider transformation happening across the industry. The benefits that can come from off-site construction are wide-ranging, including faster, more reliable delivery; reduced costs; improved workplace safety and reduced environmental damage. Many of these benefits are already being realised, and this report provides case studies from the house building and infrastructure sectors that demonstrate how off-site construction can be effectively deployed.

The role of further innovation from the sector in delivering these benefits is clear. A prime example is Heathrow's commitment to use logistics hubs as a major part of its expansion plans. By creating four logistics hubs to source products from local supply chains it will boost productivity and increase sustainability. It also means that 60% of procurement spend will be outside of London, spreading the benefits of local investment regionally and nationally. Heathrow has just announced the next stage of the competition to host these sites, with each of the 65 long-listed sites being visited to begin the process of selecting the final locations.

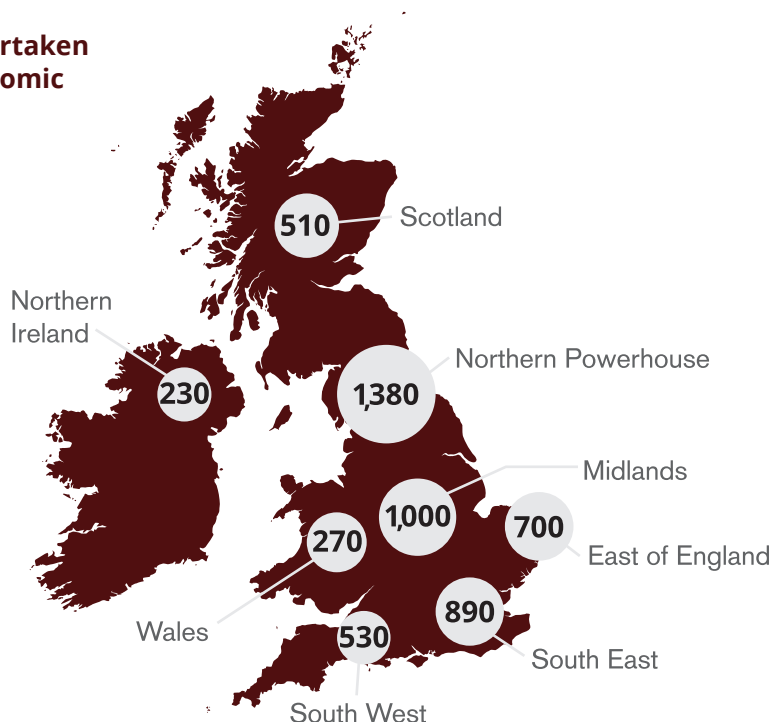
If other companies followed suit in accelerating their adoption of off-site construction, the aggregate benefits could be substantial. Updated modelling based on data only recently available from the ONS suggests that increasing off-site construction to account for 25% of all construction work undertaken, would be associated with an increase in GVA per job of 3.6% in the construction sector.

Given the geographic distribution of expertise in off-site construction, it is likely that the impacts will be concentrated outside of London. The central and conservative modelling case suggests that a move to off-site construction would lead to GVA in regions outside of the Capital being £5.5 billion higher than would have been the case without a move to increase off-site construction. In cumulative terms, this represents over a £30 billion spur to growth outside of London between 2018 and 2025.

Increasing the proportion of construction undertaken off site to 25% would provide a significant economic boost to all regions outside of London.

Increased GVA in 2025 (£million)

Source: WPI Economics Modelling.
Figure shows central case of 20% increase in productivity from off-site construction



To ensure this happens, the Government and sector need to push forward with the proposals already made and ensure that an effective measurement and monitoring process is set up, so that data on the contribution of off-site methods to UK construction are improved. The private sector also has a crucial role to play in leading innovation and modernisation. Together, this would mean that the UK's construction sector plays the full role it should in UK growth and prosperity.

Introduction

About this report

WPI Economics' 2017 report on off-site construction highlighted that, while the construction sector is vital for the UK economy, a long-term deficit in productivity had limited growth in the sector. The report went on to outline the opportunities that off-site construction could bring in terms of boosting productivity and growth across the UK. Since that report, significant action has been taken in this space. The Government has launched its industrial strategy, including a construction sector deal aimed at modernising the sector and increasing skills and productivity. The strategy and deal highlighted the key role that off-site construction could play and committed the Government to increasing its use of off-site construction in both house building and infrastructure development. There has also been action on the ground, with businesses such as Heathrow pushing to adopt new off-site technologies that will improve productivity, speed up delivery and deliver economic and social benefits across the UK.

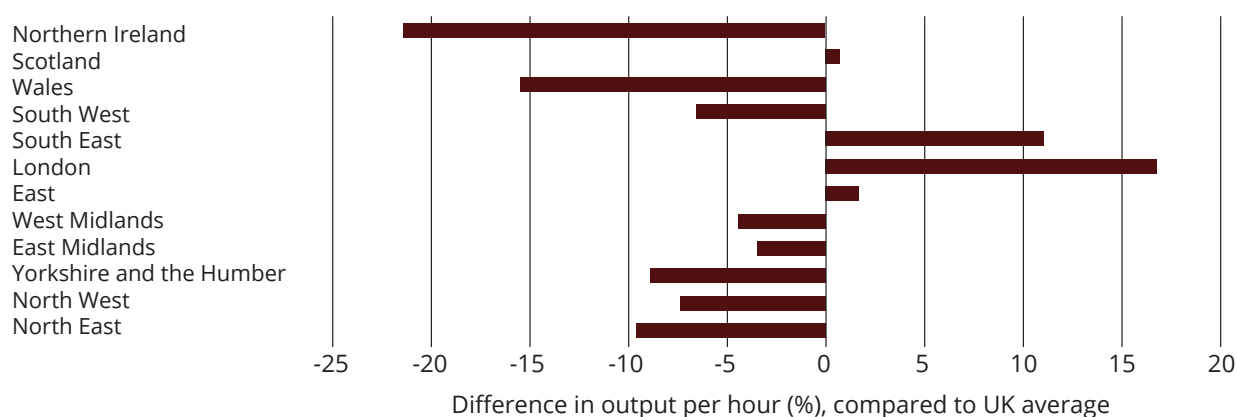
Based on this progress and the recent published data on sector-level productivity, this report updates findings from the 2017 report. It develops the modelling further, using newly-available data to demonstrate how increasing the speed of take up of off-site construction methods could deliver tangible benefits across the UK.

A deficit in construction sector productivity

The construction sector contributes close to £140 billion to the UK economy and employs nearly 10% of the total UK workforce.¹ However, despite recent high-profile success stories, including the 2012 Olympics and the construction of Terminals 2 and 5 at Heathrow, numerous reports have demonstrated that construction sector productivity is poor. WPI's 2017 report showed that, over the last 20 years, whole economy productivity in the UK has risen by over 30%, but productivity in the construction sector has increased by a little over 10%.²

Productivity in the construction sector also varies significantly across the UK. Recently-published data from the ONS shows that, over the last 10 years, London and the South East have enjoyed between a 10 and 15% productivity advantage compared to the rest of the UK. In contrast, regions in the Northern Powerhouse experienced a productivity deficit of between 7.5% and 10%. In Northern Ireland the productivity deficit was over 20% higher than the rest of the UK.

Variation in construction sector productivity (output per hour), by regions in the UK



Source: WPI Economics analysis of ONS - Notes: Seasonally adjusted

A 2016 survey also showed that just 68% of construction projects finished within budget and only 41% came in on time or better.³ With these facts in mind, it is no surprise that the Government's Construction Sector Deal committed to achieving four key objectives by 2025:⁴

- A 33% reduction in the cost of construction and the whole life cost of assets;
- A 50% reduction in the time taken from beginning-to-end of new build and refurbished assets;
- A 50% reduction in greenhouse gas emissions in the built environment; and
- A 50% reduction in the trade gap between total exports and total imports of construction products and materials.

If these ambitious targets are to be met, the construction sector will need to change.⁵ In particular, it will have to embrace and take up new technology and modern methods of construction at a far quicker pace than has been the case historically. A key part of this will be the use of off-site construction.

The role of off-site construction

Off-site construction is a catch-all phrase used to describe a range of construction activities that involve bringing together construction processes, components, elements or modules in a factory before installation into their final location. The method is already used successfully in a wide range of countries in a number of settings, but most notably in house building and infrastructure development.

Existing research and practical examples demonstrate some significant advantages over more traditional on-site construction methods. These include:⁶



More reliable delivery: On-site methods are impacted by weather, and site and access conditions. With off-site methods, these factors are controlled within a factory environment, providing greater certainty and allowing improved delivery. A clear example here is Portakabin Group, who delivered nearly 100% performance in delivering off-site projects on budget and on time over a 12-year period. The industry average over the same period across all construction projects was 40% for timeliness and 30.7% for budget accuracy.



Greater efficiency: These same factors also lead to off-site construction being associated with speedier project completion. The NAO previously demonstrated that off-site construction methods could reduce on-site build time for housing by over 50% and more recent work at the BRE innovation site has shown that a house can be built in just one day. Industry case studies suggest that overall this means that homes constructed off site can be built 30% more quickly with 25% lower costs.



Improved and more consistent quality: These benefits arise because using a factory environment facilitates tighter controls and more consistent and standardised processes. As well as the benefits of improved quality, this reduces the need (and associated cost) of re-design and re-work. It is estimated that off-site methods are associated with a 50% reduction in the project costs of dealing with “snagging”.



Improved safety and workforce satisfaction: An average of 2.2 million working days were lost to work-related injuries and ill health in the construction sector each year between 2013/4 and 2015/16. The costs of workplace injury and work-related illness in the sector is around £1.2 billion a year. Off-site construction has the potential to significantly reduce the risk of accidents and ill health. The HSE list a range of potential reasons for this, including that it provides a controlled, clean and warm environment, uses production line techniques and standards, reduces the need to work at height or below ground and reduces exposure to UV.



Reduced environmental impact: By reducing traffic flows to and from the construction site, there are significant benefits in terms of congestion and, by implication, pollution in the local area. Recent research based on case studies has suggested that projects using off-site construction can deliver a reduction of between 20% and 60% in metric tons of CO₂ associated with project transport. Substantial benefits in terms of waste are also possible. Traditional methods are associated with 10%-20% raw material wastage, however with more advanced techniques, for example the use of CAD / CAM, off-site construction can produce the same assets with just half the waste. The energy use associated with the completed assets can also be lower. Estimates suggest these savings could be as high as 25% over the asset life.



Increased support from local residents: The vast majority of the UK population support the development of critical infrastructure and housing. However, the challenges with gaining support from both residents near construction sites and planners are apparent in the UK's long history of slow development. Concerns about the construction process itself are often important in explaining this. For example, responding to qualitative research for a recent report one local authority Director of Planning argued that “...they [local residents] don't actually object to the new houses... It's the lorries, the diggers and all that sort of stuff.” In the same report, a London Councillor suggested that: “...people are sick and tired of living on the construction site, because it never ends. There is always something going on: trucks going up and down...”. Off-site construction can significantly ease the concerns of local residents. By reducing time, headcount and the range of activities that need to be completed on site compared to traditional on-site methods, it leads to projects that are completed more quickly with less noise, less local air pollution and less traffic disruption.



Picture: Precast concrete beams for multi-storey car park ramp. Source: Heathrow.

Case study: Lynch Hill Enterprise Academy

Lynch Hill is a 1,140-place academy free school specialising in science, technology, engineering and maths. It is one of the largest schools in the UK to have been built using modular construction. Work was completed on the school in only 53 weeks, some 17 weeks ahead of schedule, and approximately six months quicker than site-based construction of an equivalently sized school. To achieve this, around 65% of the building was manufactured off site at The McAvoy Group's production centre in Northern Ireland.

New innovations in modular technology developed for the Lynch Hill project included larger 15.6m long modules and a new lifting system to reduce time, transportation, and installation costs. These were used to build facilities including science laboratories, an ICT suite, a kitchen and restaurant area, and studios for music, drama and art.

Large sections of the building were manufactured and then shipped, resulting in faster on-site construction and the need for fewer deliveries to site, increased productivity, and a highly predictable construction process. The Education and Skills Funding Agency, the funder of the school, noted that "the main driver for off-site construction for this project was speed," and that this method allowed a severe shortfall of local school places to be quickly addressed. This demonstrates both the flexibility, and the unique benefits that off-site construction can bring to critical projects.

Source and Image credit: The McAvoy Group



Case study: The use of off-site construction in large-scale infrastructure projects

WPI's 2017 report highlighted the use of off-site construction methods to assist with the construction of Heathrow's Terminal 2 and Terminal 5. In both cases, to expedite construction and join local supply chains with the national project, components were constructed off site before being shipped semi-finished or pre-fabricated to the construction site.

Heathrow will also use four logistics hubs for its future expansion. These will source products from local supply chains, and either combine them into efficient shipments, or to pre-fabricate whole modules of the buildings or component that will be used for the expansion project. The result of approaching the whole project like this is that some 60% of the procurement spend will be outside of London, spreading the benefits of local investment regionally and nationally. This is reflected in the wider job creation figures for the Heathrow expansion project, which are forecast as around 108,000 in total outside of London and the South East.

The planned logistics hubs will also continue to exist after expansion, providing a vital focus for regional skills and growth strategies by either serving other projects, or helping local supply chains export their products to other areas of the UK, or abroad.

The approach is also used more broadly across large-scale infrastructure projects. For example, it was used during the redevelopment of Birmingham New Street station, including in delivering a new Combined Heat and Power (CHP) link to meet the increase in energy demands of the new station. This was manufactured externally by NG Bailey Offsite Manufacture and installed with no disruption to daily operations. By delivering off site, the project was completed in nine months, reduced the number of on-site operatives by 75% and was delivered with no reportable accidents or incidents.

Source: Heathrow, <http://www.offsitehub.co.uk> and NG Bailey

Progress on the use of off-site construction

Following the 2017 WPI report, the Government has taken action in this area. For example, it has invested £170 million in a Transforming Construction programme to support innovation and skills in the sector.⁷ It is also using its status as a significant funder of construction projects to increase the adoption of modern methods of construction. A key part of this is the commitment of the Department for Transport, the Department of Health, the Department for Education, the Ministry of Justice and the Ministry of Defence to adopt a presumption in favour of off-site construction on suitable capital programmes by 2019.⁸

The Industrial Strategy White Paper also highlighted the work that industry is already undertaking across the sector. This includes a commitment to invest £250 million alongside the Government to boost innovation and skills and clear areas where innovation is already taking place. For example, the White Paper highlighted Heathrow's innovative approach to the use of logistics hubs to deliver its third runway.

As suggested in WPI's first report, the sector is seeing the Government's commitment to off-site methods as a reason to increase their use. For example, following the Autumn Budget announcements on the presumption in favour of off-site construction, Legal and General announced an acceleration in their housebuilding efforts, with the first of their factory-built modular homes due to be erected on site in the second quarter of 2018. It has invested some £55 million in a 580,000 sq ft factory, which has the capacity to build 3,000 houses or 4,500 flats a year. Other house-builders are following this lead, with Berkeley recently acquiring a new off-site factory.⁹

Case study: Heathrow's logistics hubs

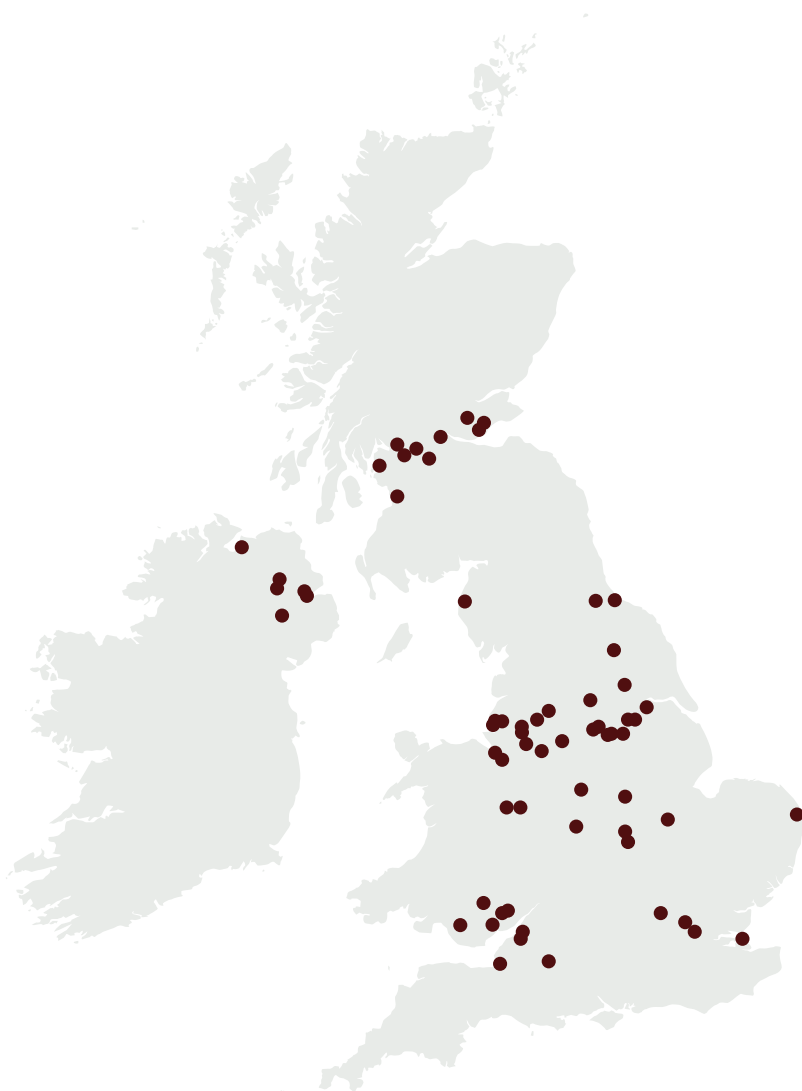
Location of long-listed hub sites

Since inviting communities to apply to host one of its four logistics hubs, Heathrow has long-listed 65 potential sites from regions across the UK. Each site will now be visited individually, and four locations will eventually be selected to pre-assemble components of the expanded airport before transporting them in consolidated loads to Heathrow.

The approach will ensure that people across the UK benefit from the expansion of the airport. By inviting other major infrastructure clients into the process there is the potential for them to benefit, and together offer long-term custom through a succession of projects, supporting investment in off-site manufacturing facilities and employment around the country. By considering its procurement strategy at the earliest stage, Heathrow has shown how it can both affordably and sustainably spread the potential benefits of expansion across the UK whilst securing the capacity required to deliver the programme.

Source: Industrial Strategy White Paper (BEIS, 2017).

Map showing the 65 long-listed locations for Heathrow's logistics hubs.



Estimating the benefits of increased use of off-site construction

The benefits of the UK increasing the use of off-site construction are wide ranging. There are many routes through which these could be realised:

- Improved working practices, skills and efficiency could help boost productivity in the construction sector and wider economy;
- Speedier and more cost-effective upgrading of the UK's critical infrastructure could bring significant benefits across the economy;
- Off-site construction centres can form a lasting body of construction expertise, providing a long-lasting economic boost to the area in which they are located;
- These centres can also provide a focus for skills and investment policy - facilitating the growth of a high-skilled economy from which agglomeration benefits can be enjoyed;
- By creating a lasting economic centre - small businesses can be supported to contribute to national and international supply chains, driving growth in this important demographic of businesses; and
- Economic activity related to construction could be more effectively spread around the country rather than being concentrated in the areas in which the construction is ultimately benefiting, meaning that it can play a strong role in ensuring that regions all across the UK benefit from economic growth, increased skills and productivity and higher living standards.

While estimates of the impact of increased take up can never be definitive, WPI's 2017 report outlined the potential contribution of increasing off-site construction to boosting economic growth in each region of the UK. It provided a range of scenarios to help the reader understand the potential scale and nature of benefits that might be felt. This report updates these estimates based on the most recently available data and adapts the approach to account for new data issued by the ONS.

The model created for this research is based on varying two key assumptions:

1. The extent to which off-site construction leads to increased per-job productivity compared to standard onsite construction methods. We have modelled the following cases:

Low (10% more productive) / **Mid** (20% more productive) **High** (30% more productive)

Our central case is the "mid" value. Given the increases in speed, safety and quality that off-site construction can bring highlighted above, we believe this to be a conservative estimate.

2. The increase in proportion of work in the construction sector that is undertaken off site. We have modelled the following cases against the baseline of current 7% coverage:

Short-term (25% coverage) / **Aspiration** (50% coverage)

Our central case is chosen to be the low, short-term coverage figure. Whilst some industry experts believe that it will be possible to undertake up to 70% of all construction activity off site, we believe the 25% figure is deliverable over 5-10 years, whilst the 50% coverage should represent a longer-term aspiration for the sector.

It has also been assumed that, compared to the existing UKCES baseline of jobs growth, a move to off-site construction results in more significant growth of construction jobs over the next ten years (in line with the proportionate increase in off-site coverage) outside of London.

Findings

Results from our central but conservative case suggest that, if the construction industry were able to increase the use of off-site construction so that 25% of all work is undertaken off site, it would be associated with an increase in GVA per job of 3.6%.

Combined with growth in construction sector jobs modelled by the UKCES, this suggests construction sector GVA increasing in all regions of the UK.¹⁰ However, given the existing (and likely future) distribution of expertise in off-site construction, our model suggests that employment growth will be concentrated outside of London. As such, GVA in regions outside of London would be £5.5 billion higher in 2025 as a result of the shift to off-site methods.

This is driven by:

1. Off-site construction methods improving productivity across the sector; and
2. Off-site construction methods leading to a redistribution of construction jobs growth outside of the Capital.

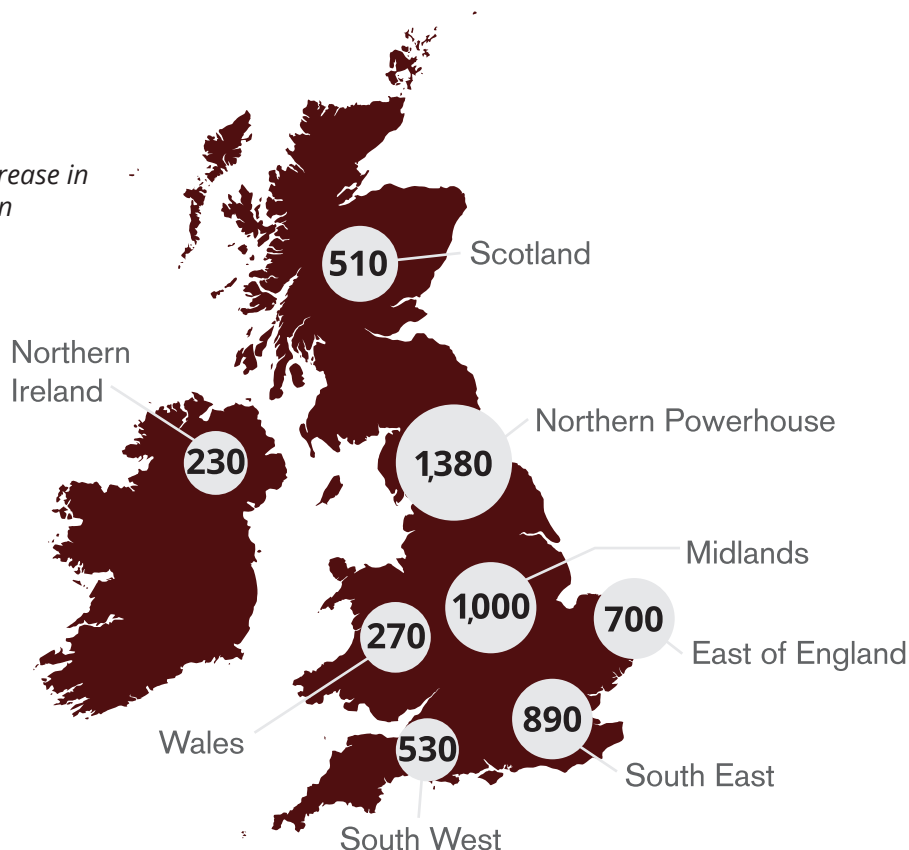
Looking in isolation at the impact of the increased use of off-site construction, we see that, in our central case, GVA in the Northern Powerhouse and Midlands in 2025 would be £1.38 billion and £1 billion higher respectively, than would have been the case without a move to increase off-site construction. These figures are slightly above our 2017 estimates, as we are modelling the changes over a longer period, and using updated data from ONS allows us to be more accurate.

If more ambitious targets for increasing off-site construction could be met, these figures could rise significantly. Equally, if the boost to productivity driven by off-site construction were larger, these impacts would again rise (see annex for results of scenario with higher productivity rise). In short, the benefits are there to be realised, and depend primarily on how bold Government and the sector want to be in adopting and making the best use of emerging technologies.

Increasing the proportion of construction undertaken off site to 25% would provide a significant economic boost to all regions outside of London.

Increased GVA in 2025 (£million)

Source: WPI Economics Modelling.
Figure shows central case of 20% increase in productivity from off-site construction



Conclusion

This report has demonstrated the clear importance of UK construction in securing productivity, growth and international competitiveness for the UK economy. However, it has also shown that, to ensure that the construction sector plays the role that it should, it will need to take steps to evolve and modernise.

The updated modelling in this report has re-confirmed the role that off-site construction could play in this modernisation. Increased adoption of these methods would boost productivity, improve reliability and safety and drive growth in the construction sector and the UK economy more broadly. Perhaps most importantly, off-site construction provides a vital opportunity to deliver shared growth across all of the UK regions and develop a foothold in a major global construction market.



It is encouraging that, following WPI's 2017 report, the Government has recognised the role that off-site construction can play. However, more action is needed to cement the progress made to date. In particular, the Government and the construction sector need to work together to ensure that the steps taken so far result in a tangible increase in the proportion of UK construction that is undertaken off site.

Attempts to do this are currently frustrated by the fact that data on the proportion of total UK construction that is undertaken off site is hard to come by. To tackle this:

- The Government should report yearly (from 2019) on the proportion of Government-funded construction that is undertaken off site; and
- This should be complemented by work across the whole construction sector to ensure that the coverage of off-site construction is measured. Given their role in driving the needed skills across the sector, CITB could be an appropriate body to take this work forward.

Ensuring that this measurement takes place will ensure that the Government and sector can be held to account in delivering both the presumption in favour of off-site construction and the training and skills development needed to support a move to off-site construction.

Annex: Results of different modelling scenarios

25% off site coverage	Low (10% increase) productivity case		Mid productivity case (20% increase)		High productivity case (30% increase)	
	Total	of which move to off site	Total	of which move to off site	Total	of which move to off site
Northern Powerhouse	2,392	956	2,691	1,382	2,991	1,808
Midlands	2,090	676	2,316	995	2,543	1,315
East of England	2,191	449	2,377	708	2,564	968
London	-498	-2,090	-303	-1,794	-107	-1,498
South East	2,644	544	2,890	889	3,138	1,234
South West	1,604	346	1,734	526	1,864	706
Wales	357	208	402	272	448	337
Scotland	276	351	383	509	491	667
Northern Ireland	289	189	318	230	347	271
UK Total	11,345	1,629	12,809	3,719	14,279	5,808

50% off-site coverage	Low (10% increase) productivity case		Mid productivity case (20% increase)		High productivity case (30% increase)	
	Total	of which move to off site	Total	of which move to off site	Total	of which move to off site
Northern Powerhouse	3,301	2,119	4,044	3,159	4,795	4,200
Midlands	2,735	1,503	3,295	2,282	3,861	3,062
East of England	2,626	1,013	3,083	1,641	3,545	2,270
London	-2,446	-4,246	-2,075	-3,644	-1,699	-3,043
South East	3,172	1,238	3,774	2,071	4,382	2,904
South West	1,939	774	2,259	1,212	2,582	1,649
Wales	553	451	669	612	785	773
Scotland	605	779	872	1,164	1,142	1,549
Northern Ireland	466	405	543	510	621	615
UK Total	12,952	4,036	16,464	9,007	20,014	13,978

Source: WPI Economics modelling using ONS & UKCES data

Endnotes

1. See <https://www.gov.uk/government/news/government-and-industry-cement-deal-to-give-uk-construction-the-edge> Accessed 20/01/2018.
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