Severn Estuary Commission

Socio Economics Workstream

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Executive Summary

Hardisty Jones Associates, in partnership with Oxford Economics and Arcadis was appointed by the Severn Estuary Commissioners and Western Gateway Partnership to understand the potential socio-economic effects of the development of tidal power in the Severn Estuary.

Four areas of focus were identified, to:

- Provide an updated summary report on the regional economy as it relates to the Severn Estuary area and the existing evidence base relevant to the potential effects and key considerations of tidal range energy generation in the Severn Estuary;
- Assess the potential economic impacts which could arise from investment in tidal range energy schemes within the Severn Estuary; with a focus on the potential for the development of the local supply chain and workforce and potential synergies or conflicts with other sectors;
- Assess the wider economic effects that could result on ports and other businesses; with consideration of how to minimise negative impacts and maximise economic opportunities; and
- Assess the potential impacts on communities around and related to the Severn Estuary.

In common with other research workstreams, six example tidal range projects were agreed as a means of narrowing research efforts. These were agreed with the Commissioners as illustrative of the wider range of options that have been previously proposed. The six example schemes are summarised in Table ES1 and illustrated in Figure ES1.

Table ES1: Selected Example Tidal Range Schemes

Option	Cardiff – Weston Barrage (P1)	Shoots (English Stones) Barrage (P2)	Swansea Bay Tidal Lagoon (P4)	Cardiff Tidal Lagoon (P5a)	West Somerset Tidal Lagoon (P6)	Stepping Stones Tidal Lagoon (P11)
Installed capacity (MW)	8,600	1,050	320	3,000	2,500	600
Capital cost (£m 2023)	33,407	6,830	1,779	12,365	9,775	2,278

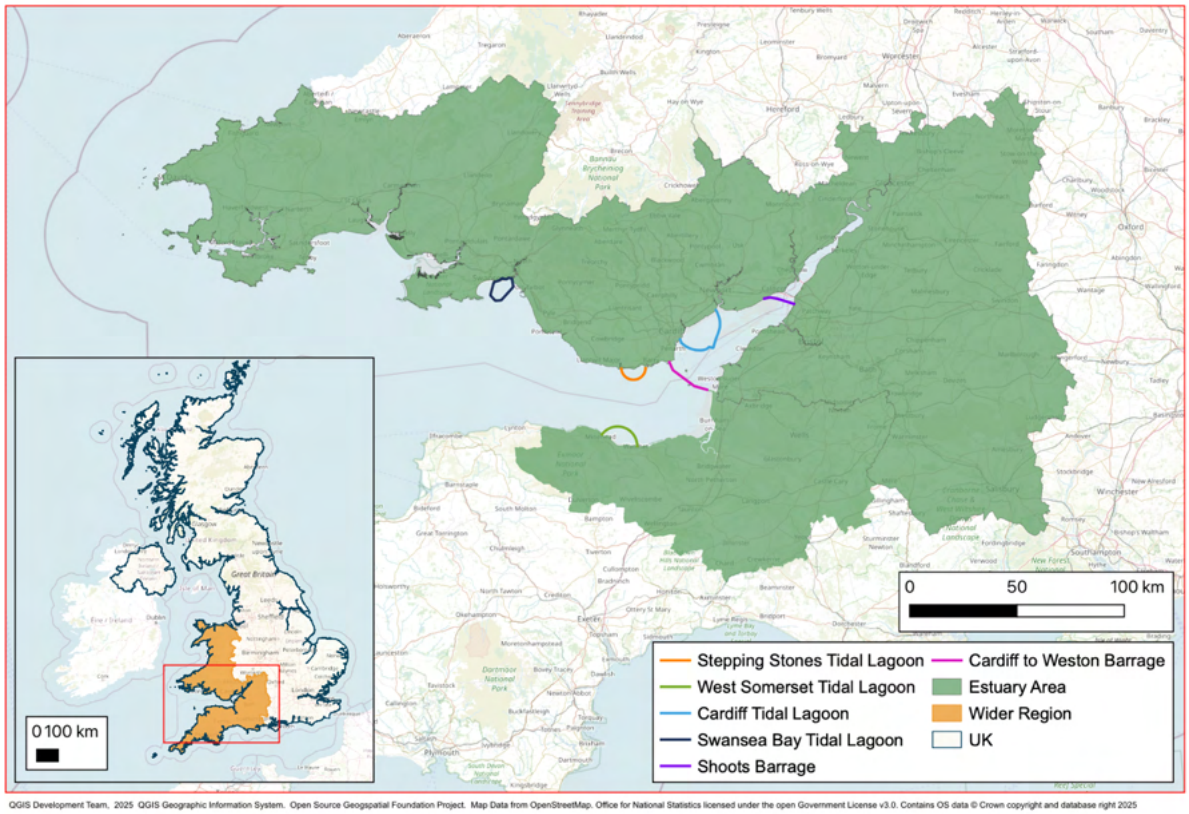
Source: Sustainable Energy in the Severn Estuary, Evidence Base and Framework (WSP)

For the purposes of assessing impacts, three geographic areas were agreed with the Commissioners:

- Severn Estuary area – comprising the Western Gateway Partnership area plus the county of Somerset;
- Wider region – comprising the entirety of the South West of England region and the nation of Wales; and
- National – comprising the UK.

The findings of this report are based on extensive documentary review, interviews with almost 40 stakeholders, and technical economic impact modelling and analysis.

Figure ES1: Map of Selected Example Tidal Range Options



Policy

Across national and regional policy there is an identified opportunity to support the development of renewable energy projects, with projected growth in marine renewables as a key opportunity, which would also facilitate employment and business opportunities.

In the wider region, there are recognised strengths in marine renewable technologies and a strong manufacturing base to support the delivery of such infrastructure. There is opportunity to build on the skills base and manufacturing expertise in the region's low carbon energy sector to attract more investment and deliver growth.

Across policy, tidal range power receives less focus and does not have such a prominent profile compared to other marine renewable technologies (such as offshore wind and tidal stream). However, ambitions to support skills development and supply chains in the marine renewable energy sector have the potential to support the delivery of all future marine energy projects including tidal range.

Previous Research

Whilst the potential to harness the energy of the tides in the Severn Estuary has been discussed for more than 175 years, the most significant studies in the last 20 years are the Sustainable Development Commission's *Turning the Tide* (2007); Department for Energy and Climate Change's *Severn Tidal Power Feasibility Study* (STPFS) published in 2010; and the Department for Business Energy & Industrial Strategy's *Hendry Review*, published in 2017. The STPFS was very extensive, considering a wide range of potential schemes, and with the resources to undertake a far deeper dive into issues than this current review. The

Hendry review had a narrower focus than the STPFS, on tidal lagoons, particularly the Swansea Bay option, and a geographic focus on Wales and the UK.

Overall, previous evidence reviews of tidal power infrastructure indicate that such development will bring economic opportunities to the wider region. Both the STPFS and Hendry Review note that tidal power projects would work to grow the offshore renewables sector and provide employment opportunities.

In particular, the delivery of tidal power infrastructure presents opportunity for investment within manufacturing and construction activities that will substantially strengthen UK and regional capabilities.

However, whilst there are economic opportunities with tidal power in the Severn Estuary, there are recognised challenges and negative impacts that would come about during the construction and operation phases. One of the biggest challenges identified in reviews was the shortage in capacity and capability to meet the demands for certain manufacturing activities.

Another potential substantial negative impact was disruption to ship and port activity. For large barrage options in particular, ship movements and ports further upstream in the Severn Estuary would face negative effects to their competitiveness and investment potential due to the risk of impeded ship movements.

Severn Estuary Area Socio-Economic Baseline

The Severn Estuary area, encompassing parts of England and Wales, is a large and diverse region, with a population of 5.5 million in 2024. It includes the major urban areas of Bristol, Newport, and Cardiff, and is characterised by a mix of dynamic cities and sparsely populated rural regions.

The employment rate in the area is slightly below the UK average, but unemployment remains lower than the national average. The workforce is relatively well-educated, with a significant proportion holding degree-level qualifications. However, there are notable disparities in employment and income levels, with pockets of deprivation in urban centres, the Welsh Valleys and coastal towns.

Economically, the Severn Estuary area is robust, with a total GVA of £144 billion in 2024, making it larger than either the Greater Manchester or West Midlands Combined Authorities. The region's economy is diverse, with significant contributions from human health and social work, wholesale and retail, manufacturing, and professional services. Manufacturing, particularly in aerospace and electronics, is a key sector, although the area also relies on traditional industries like steel production and oil refining, which face challenges from environmental targets and global competition.

Future growth projections for the region are positive, with an expected annual GVA growth rate of 1.7% until 2030, aligning with the UK average. High-value services, such as information and communication, and professional, scientific, and technical activities, are expected to drive this growth. However, the region faces challenges, including a forecast decline in manufacturing employment and a slower growing and ageing population, which could impact labour supply.

Specific to the area's ability to meet the demands of tidal range energy projects are the relative tightness of the labour market, its relatively large manufacturing sector – which is

projected to decline in terms of employment - potentially freeing up a skilled manufacturing workforce to meet new project demands, and a relatively small civil engineering sector that will likely need to scale.

Core Effects

Economic Impacts

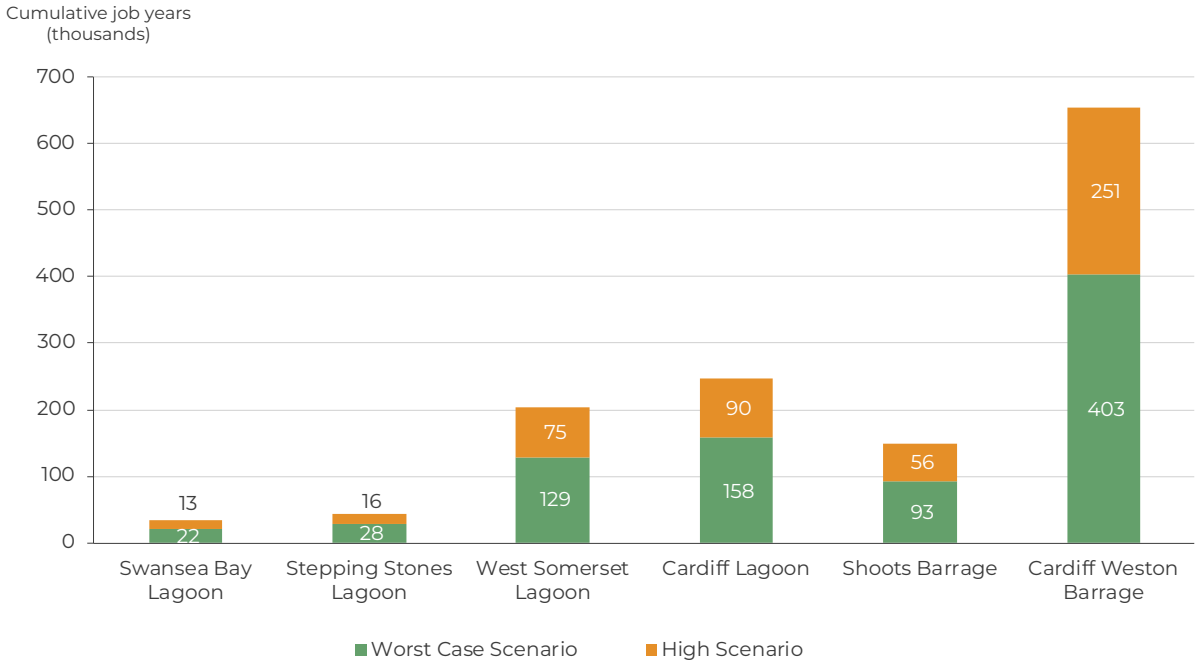
There are significant economic opportunities presented by the development of tidal range projects in the Severn Estuary. The most recent and suitable data has been used, but some of this is dated and not prepared specifically for the six example projects. However, the economic modelling, supported by stakeholder engagement, has provided valuable insights into the potential impacts.

The analysis indicates that whilst substantial supply-side development will be necessary to deliver any of these projects, this offers a huge opportunity for both the supply chain and the workforce.

The development and construction phases of the projects are expected to generate significant employment opportunities. The projects vary in scale, with the smaller projects like Swansea Bay and Stepping Stones lagoons supporting around 30,000 – 40,000 job years, whilst the Cardiff-Weston Barrage, a mega project, could support over 600,000 job years, making it comparable to some of the largest construction projects in Europe.

Figure ES2 shows the scale of employment opportunity under a worst case UK content scenario as well as the additional opportunity associated with a high UK content scenario. This illustrates the considerable benefit that can be secured with appropriate mechanisms and incentives to secure UK content.

Figure ES2: Economic Opportunity for the UK, Worst Case to High Impact, Cumulative Job Years, Development and Construction Phase



Source: Oxford Economics

The economic impact will be distributed across various sectors, with the greatest effects anticipated in manufacturing; construction; professional, scientific and technical services; and wholesale and retail trade.

The majority of the employment impact is expected to be concentrated in the Severn Estuary area, with additional impacts in the wider region and the rest of the UK. However, there is uncertainty about the exact location of manufacturing supply chain activities which could lead to a more distributed impact profile.

A multi-project approach could spread capital expenditure over a longer period, develop the supply chain, and offer longer-term career opportunities, although it also presents challenges in terms of sequencing.

Supply Chain Issues

The expansion of the renewable energy sector, particularly through tidal range projects, presents significant supply chain opportunities for the Severn Estuary area, wider region and UK. However, capitalising on these requires strategic action and coordination among stakeholders. The current supply chain is limited and needs substantial investment to scale-up, especially in marine civil engineering and turbine/electrical components. Stakeholders emphasise that whilst substantial activity will occur within the Severn Estuary area, supply chain development is a UK-wide issue, with a focus on scaling existing companies rather than developing new start-ups.

Securing UK and local content, to maximise economic benefits of investment, will largely rely on contractual requirements and incentives. Without specific requirements, cost will become the primary determinant, potentially reducing UK content. Confidence in a pipeline of further opportunities is also critical, as the failure of the Swansea Bay Tidal Lagoon project has led to cynicism within the supply chain. Clear signalling and commitment from the UK government is necessary to unlock the required supply chain investment.

The experience from Hinkley Point C (HPC) demonstrates that high levels of local, regional, and UK content can be achieved with concerted efforts to build local capability. This has led to significant growth in local businesses and substantial contracts awarded to companies in the region, and significant inward investment from outside the region.

Turbine manufacture and assembly present specific challenges, as there are limited manufacturers globally for turbines suitable for tidal range infrastructure. The number of turbines required for a Cardiff-Weston Barrage is a particular challenge. Establishing new manufacturing facilities in the UK would require a guaranteed pipeline of project demand and significant investment. Alternatively, establishing an assembly plant could be feasible, as proposed by the Swansea Bay Lagoon project. However, the UK has lost some of the capability identified in the Swansea project, and the market capacity to deliver large-scale projects remains a concern.

A multi project scenario potentially offers a more sustainable and deliverable socio-economic impact than a mega project such as the Cardiff- Weston Barrage. This provides the potential for a slower scaling of capability and capacity, reducing risk, and delivering beneficial impacts over an extended period.

Workforce Issues

The renewable energy sector is facing a significant skills shortage, which poses a major challenge to the successful implementation of future projects, including tidal range initiatives. Addressing this issue will require a concerted effort from both government and industry to increase the level of required skills across the board.

A major issue identified is the lack of coordination and scale in skills and workforce development at present. The speculative nature of many projects has lead to a reluctance to invest in workforce development in advance. However, if this can be overcome, with appropriate policy and other indications to give confidence, the range of major infrastructure projects across the Severn Estuary area and wider region presents an opportunity to train a workforce that can move from scheme to scheme. Effective coordination and sequencing of projects can ensure a steady pipeline of work and a skilled workforce ready to tackle new challenges.

The experience of HPC shows that positive skills and workforce outcomes can be achieved with coordinated efforts. This has included apprenticeship activity far exceeding expectations (at close to 5% of the workforce), awards for schools' engagement, and significant investment in skills and training infrastructure. However, early preparation and investment is crucial. Delays in the HPC project were cited as advantageous in this regard, but still the level of local workforce recruited to the project has fallen below target levels.

Sector Development Legacy

The longer-term opportunities arising from investment in tidal range energy activities within the Severn Estuary area and wider UK are expected to be concentrated in the development and export of knowledge and expertise rather than large-scale, ongoing production for a global market. They will also be limited by the global market for tidal range energy schemes, which is recognised to be somewhat limited due to the specific tidal conditions required, which are only present in a few locations worldwide. Additionally, the technical challenges and environmental conditions in these locations pose further barriers.

Despite these limitations, the expertise acquired through the development of tidal range infrastructure in the UK, particularly in the Severn Estuary area, has export potential. This expertise can drive local and regional economic development across various activities, including research, skills development, professional services, and engineering. The European Marine Energy Centre (EMEC) in Orkney serves as a relevant example, demonstrating how being at the forefront of a field can create an asset that stimulates wider economic growth.

Wider Effects

Port Related Impacts

The ports within the Severn Estuary are significant economic infrastructure assets performing a regional and national role, supporting a combined 40,000 jobs and £3bn per annum of GDP. They underpin a number of sectors and support a large number of jobs in the Severn Estuary area and wider Wales and South West economies.

Even if at a UK level any negative impacts lead to the displacement of activity to other UK ports, there is a clear negative risk to the wider regional economy which needs to be carefully considered.

The greatest risk is associated with the Cardiff-Weston Barrage. This is potentially at a scale where the overall appeal of the project could be called into question. The lowest risk is associated with the Swansea Bay lagoon. Further technical work will be required to develop a shared understanding of the impact of other lagoon options. Any projects that progress will need to ensure designs minimise any disruption to shipping and navigation.

There would also be positive opportunities for ports to support the development, construction, and operation of tidal range energy schemes in the estuary.

Commercial Fishing and Aggregates Industries

The commercial fishing industry within the estuary is relatively small but culturally significant. There is also recreational angling activity which has some economic value. Regulatory changes since previous socio-economic studies have further reduced the scale of commercial fishing activity in the estuary area to protect fish populations. The environmental issues associated with fish populations are therefore of more significance to any discussions of tidal range energy infrastructure in the estuary than the economic issues.

There is an active marine aggregates dredging industry in the Severn Estuary. However, no assessment of its economic value has been found. Previous studies have identified potential positive and negative impacts on the industry as a result of tidal range energy infrastructure. The Cardiff lagoon is the only project within the six examples considered in this research that would include direct development over a licensed aggregate dredging area. The key change since previous socio-economic studies were undertaken is evidence highlighting the significant increase in forecast need and demand for aggregates to support the construction and infrastructure industries, including nationally significant infrastructure projects. Activities which reduce the potential for aggregate extraction could have wider implications for the development of infrastructure in the Severn Estuary area and wider UK.

Tourism and Leisure Impacts

Analysis indicates uncertainty about the exact nature of tourism, leisure, and regeneration impacts arising from tidal range infrastructure, with both positive and negative effects likely. The location of schemes, and particularly the location of landfall will be a key factor in the potential opportunities for tourism, leisure, and regeneration benefits to be secured. It will also require additional investment beyond the barrages and lagoons themselves.

Previous analysis suggested that barrage schemes could attract 150,000-200,000 annual visitors given their visual prominence, supporting 10 – 130 jobs. However, there would also be the potential for offsetting impacts should there be reductions in the level of ornithological tourism as well as any adverse effects from the potential loss of the Severn Bore (which is not guaranteed[1]).

[1] The Severn Bore is unlikely to be significantly impacted unless one of the two barrage schemes is built. The bore itself is primarily influenced by a combination of the tidal flow, low barometric pressure and strong southwesterly winds. It begins forming above Sharpness, well upstream from either proposed barrage location.

La Rance tidal barrage in France attracts around 70,000 visitors per annum. The Sihwa Lake scheme in South Korea has a much greater number of visitors, at 1.5 million, reflecting the very large population in the catchment area and opportunities to interconnect with other tourism assets.

Lagoons have been identified as offering the opportunity for improved marine and other recreational facilities, as well as wider tourism regeneration. Previous research as part of the STPFS indicated that likely visitor numbers would be lower than for barrages, supporting approximately 10 jobs, but this has been contradicted by developer led claims of larger visitor numbers by factors of more than 10 times. The Hendry Review identified tidal lagoons as potential catalysts for wider tourism and leisure- based regeneration. Multiple schemes have proposed the inclusion of marinas and other water and land-based sports infrastructure.

Overall, the scale of impacts measured are in the region of 100 jobs.

Opportunities from Low Carbon Energy

The presence of an abundant supply of low carbon energy has the potential to support wider industrial development in the Severn Estuary area, particularly in energy intensive sectors. Case study reviews of Norway and Quebec have shown how a plentiful supply of energy, and early adoption of clean and renewable technologies have created economic opportunity. The development of tidal range as part of wider low carbon energy cluster in and around the Severn Estuary area can also play a role in redistributing UK low carbon power generation away from its current concentration to the east of the British Isles.

Capitalising on this opportunity would require regulatory adjustment. Exploration of this sits outside this workstream, but should be considered as part of efforts to maximise the economic potential of any future investment in tidal range energy.

Social and Community Effects

Flood and Coastal Erosion

Flooding and coastal erosion pose significant economic and social risks, including property damage, infrastructure repair costs, and mental health impacts. Tidal lagoons or barrages can mitigate some of these risks, however, the impacts differ between the impounded and non-impounded areas. Overall, benefits are varied across all options and depend upon location, scale and mode of operation. On the basis that any negative impacts are mitigated the net outcome is benefit and tidal range schemes could contribute to flood defence improvements and open up new land for development.

There remain gaps in the evidence base, particularly in respect of the use of ebb and flood turbine technologies. Much of the evidence which is available is now dated and neither aligns to the latest guidance nor takes into account more recent flood defence schemes. The primary finding of this review is the need for comprehensive research to create a robust understanding of the positive and negative effects for flood and coastal risk management.

Delivering Large Scale Infrastructure Projects

Large-scale infrastructure projects create numerous job and training opportunities, enhancing economic stability, improving quality of life, and fostering social cohesion. These projects also contribute to skills development, thus increasing future employment prospects. However, they can also lead to the temporary or permanent migration of workers into the local area, increasing demand for housing and services. Effective mitigation strategies are essential to manage these impacts.

Hinkley Point C (HPC) serves as a helpful case study, demonstrating how the social and community impacts of a large infrastructure project have been managed. HPC has created substantial job opportunities for local people and a significant skills legacy, helping to retain younger workers in the area. The project has also managed the increased demand for housing and services, with mitigations like accommodation campuses and on-site health centres proving effective. Transport infrastructure has faced pressure from the movement of workers and materials, though most issues have been managed well.

In conclusion, the importance of planning, coordination, and community engagement in managing social and community impacts cannot be overstated. Lessons from HPC should be applied to future projects, ensuring that appropriate mitigation strategies are developed for housing, transport, and services. Positive engagement with local communities is crucial for managing potential social impacts and building support for tidal range energy projects. The evidence suggests that local communities should not fear the development of tidal range energy infrastructure projects.

Maximising & Mitigating

Throughout this research a series of actions to maximise positive impacts and mitigate negatives have been identified. These include strategic actions at UK Government level as well as more tactical actions within the Severn Estuary area and wider region.

To capitalise on opportunities within the supply chain, and the associated employment opportunities for local residents, there is a need for clear signalling to provide confidence that tidal range energy projects will go ahead. Without this, the necessary investment will not come forward. A multi-project commitment to tidal range technologies would also help to increase supply chain commitment. In addition, contractual models need to be used to mandate, incentivise and de-risk the use of UK content. Coordinating approaches are also required to aid the sequencing and synergies of multiple large scale low carbon energy and other infrastructure projects within the Severn Estuary area and the wider region.

At a more tactical level there is a need for clear early warning signals to industry and wider stakeholders to encourage and enable investment in sector and skills readiness, given long lead times. This will include more detailed analysis, particularly around skills requirements, to ensure suitable provision is put in place.

When considering the mitigation of potential negative effects, the most significant economic focus should be on the ports sector. There is a need for further technical analysis of the hydrological impacts in the estuary, to better understand the potential implications for shipping and navigation. In addition, evidence shows that in terms of social and community impacts, effective mitigation from project development, closely monitored,

evaluated and adapted through implementation, can help to avoid substantial adverse effects. The lessons learned from HPC should be implemented wherever possible.

Conclusions

The current research confirms that tidal range energy schemes in the Severn Estuary present significant socio-economic opportunities, particularly during the development and construction phases. However, there are challenges, notably the need to manage potential negative impacts on ports within the estuary. The research highlights the complexity of developing tidal range projects and identifies evidence gaps that need addressing.

Significant economic opportunities exist at both the UK and Severn Estuary levels, even for smaller projects. However, the UK supply chain requires substantial scaling-up to deliver these projects, as the current capacity has declined since previous reviews. There is a need for strategic and tactical actions to realise these opportunities, alongside building confidence and certainty to unlock the necessary commercial investment.

A large barrage scheme, such as the Cardiff-Weston Barrage, poses substantial risks to major port operations within the estuary, despite its potential economic benefits. A multi-project scenario, involving multiple smaller projects, is seen as a more realistic and sustainable approach. This scenario allows for gradual scaling of the workforce and supply chain, offering a robust investment case and long-term career opportunities.

Effective coordination and early planning and investment are essential to ensure workforce and supply chain readiness. Clear messaging and collaboration among stakeholders, including sector bodies and other skills agencies and providers, will help realise the substantial economic opportunities while mitigating risks to costs and timescales. The research underscores the importance of strategic planning and coordination to maximise the benefits of tidal range energy projects.

1. Introduction

The Western Gateway Partnership comprises 28 Local Authorities, one Mayoral Combined Authority in England, and two Corporate Joint Committees in Wales, representing over 4.8 million people. The Severn Estuary sits at the heart of Western Gateway's geography and has long been recognised for its potential to generate renewable electricity.

The Partnership launched the Severn Estuary Commission to consider the feasibility of developing tidal range energy. Chaired by Dr Andrew Garrad CBE FREng, the Commission comprises experts in science, engineering, finance, sustainable development, and environmental disciplines.

Hardisty Jones Associates, in partnership with Oxford Economics and Arcadis was appointed by the Severn Estuary Commissioners and Western Gateway Partnership to understand the potential socio-economic effects of the development of tidal range energy in the Severn Estuary.

Severn Tidal Energy Opportunity

Consideration of how to harness the tidal energy within the Severn Estuary, due to the presence of the third highest tidal range in the world, has been a discussion point for more than 175 years with a barrage scheme proposed by Thomas Fulljames in 1849[2]. Large scale reviews of the issues have been commissioned periodically since that point with the Severn Barrage Committee established in 1925[3]. Further reviews took place in the 1970s and 1980s, and again in the 2000s and 2010s.

Whilst the potential for energy generation has been well understood, and the proposed Swansea Bay Tidal Lagoon progressed to the stage where it received planning consent, the complexities mean that nothing of substance has ever been constructed and installed. Indeed there are no tidal range energy projects installed in the UK and only two globally (in France and South Korea).

Over the decades a wide array of schemes have been proposed. The initial evidence base compiled to inform the current Commission identified 27 (twenty seven) different options that had been subject to previous consideration[4]. This included tidal barrage, tidal fence and tidal lagoon options.

Scope and Approach of the Socio Economic Workstream

Four areas of focus were identified for the socio-economics workstream, to:

1. Provide an updated summary of the regional economy as it relates to the Severn Estuary area and the existing evidence base relevant to the potential effects and key considerations of tidal range energy generation in the Severn Estuary;

[2] Great Western Power Barrage, 2025. History of Severn Barrage. Available at: https://www.greatwesternpowerbarrage.com/history-of-severn-barrage. Accessed January 2025.
[3] W.J. Langston, P.J.C. Jonas, G.E. Millward, 2010. The Severn Estuary and Bristol Channel: A 25-year critical review. Available at: https://www.sciencedirect.com/science/article/pii/S0025326X09005116#:~:text=Government%20interest%20in%20the%20possibility,outbreak%20of%20World%20War%20II. Accessed January 2025.
[4] WSP, 2023. Sustainable Energy in the Severn Estuary: Evidence Base and Framework. Available at: https://www.severncommission.co.uk/wp-content/uploads/2024/03/Severn-Estuary-Evidence-Base-and-Framework.pdf. Accessed January 2025.

2. Assess the potential economic impacts which could arise from investment in tidal range energy schemes within the Severn Estuary; with a focus on the potential for the development of the local supply chain and workforce and potential synergies or conflicts with other sectors;
3. Assess the wider economic effects that could result on ports and other businesses; with consideration of how to minimise negative impacts and maximise economic opportunities; and
4. Assess the potential impacts on communities around and related to the Severn Estuary.

This study has not considered the overall economic value of green and blue infrastructure, and the potential socio-economic implications of any changes to this. This is a potential area for future research.

Example Schemes

To progress this work, and in common with other research workstreams, six example tidal range projects were agreed as a means of narrowing research efforts. These were agreed with the Commissioners as illustrative of the wider range of options that have been previously proposed and potential schemes which may emerge in the future.

The six example schemes are summarised in

Table 1.1 and illustrated in Figure 1.1. The selection or non-selection of any scheme as an example does not imply any preference, support, assessment of deliverability or otherwise.

The selected examples include:

- Two barrage schemes and four tidal lagoon schemes;
- Both a large and small barrage;
- Tidal lagoon schemes of varying sizes; and
- Schemes located within different parts of the Severn Estuary.

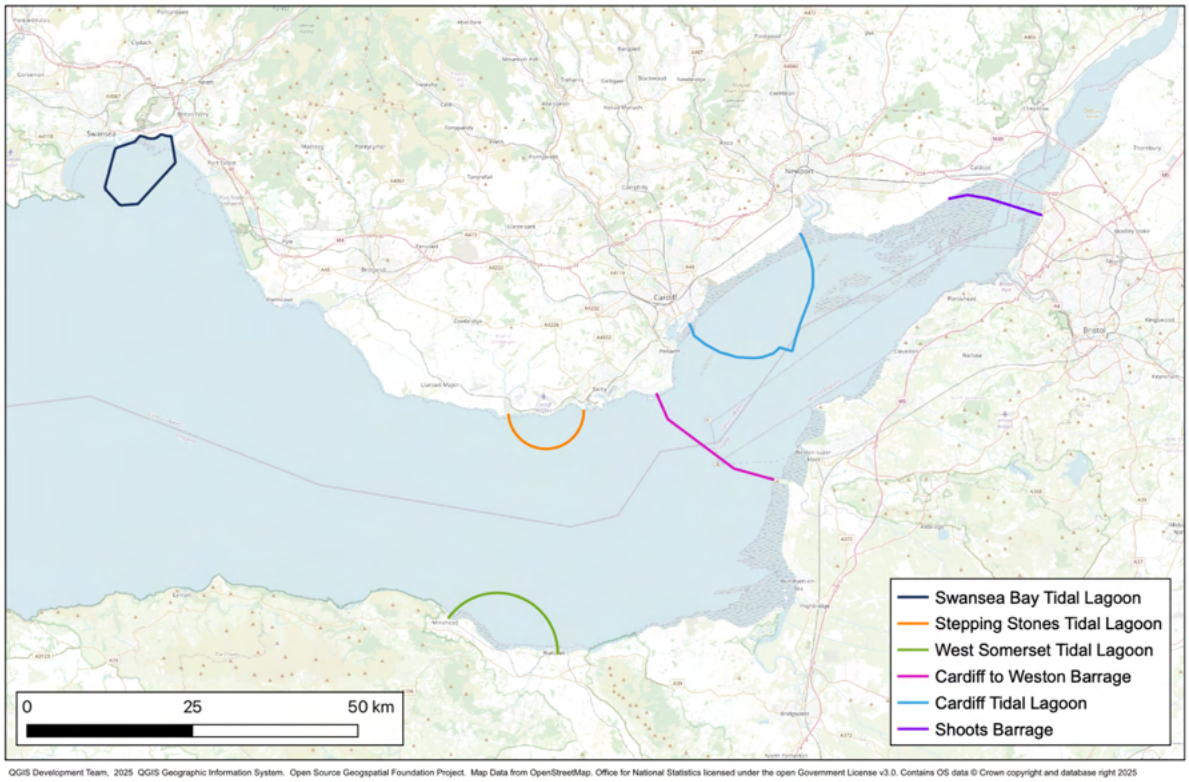
It was agreed with the Commissioners that this current study should not consider any road or rail connections on top of either barrage option nor any potential economic impacts associated with these.

Table 1.1 Selected Example Tidal Range Options

Option	Cardiff – Weston Barrage (P1)	Shoots (English Stones) Barrage (P2)	Swansea Bay Tidal Lagoon (P4)	Cardiff Tidal Lagoon (P5a)	West Somerset Tidal Lagoon (P6)	Stepping Stones Tidal Lagoon (P11)
Installed capacity (MW)	8,600	1,050	320	3,000	2,500	600
Capital cost (£m 2023)	33,407	6,830	1,779	12,365	9,775	2,278

Source: Summarised from Western Gateway Tidal Energy Evidence Base, WSP (2023)

Figure 1.1 Map of Selected Example Tidal Range Options



Study Area

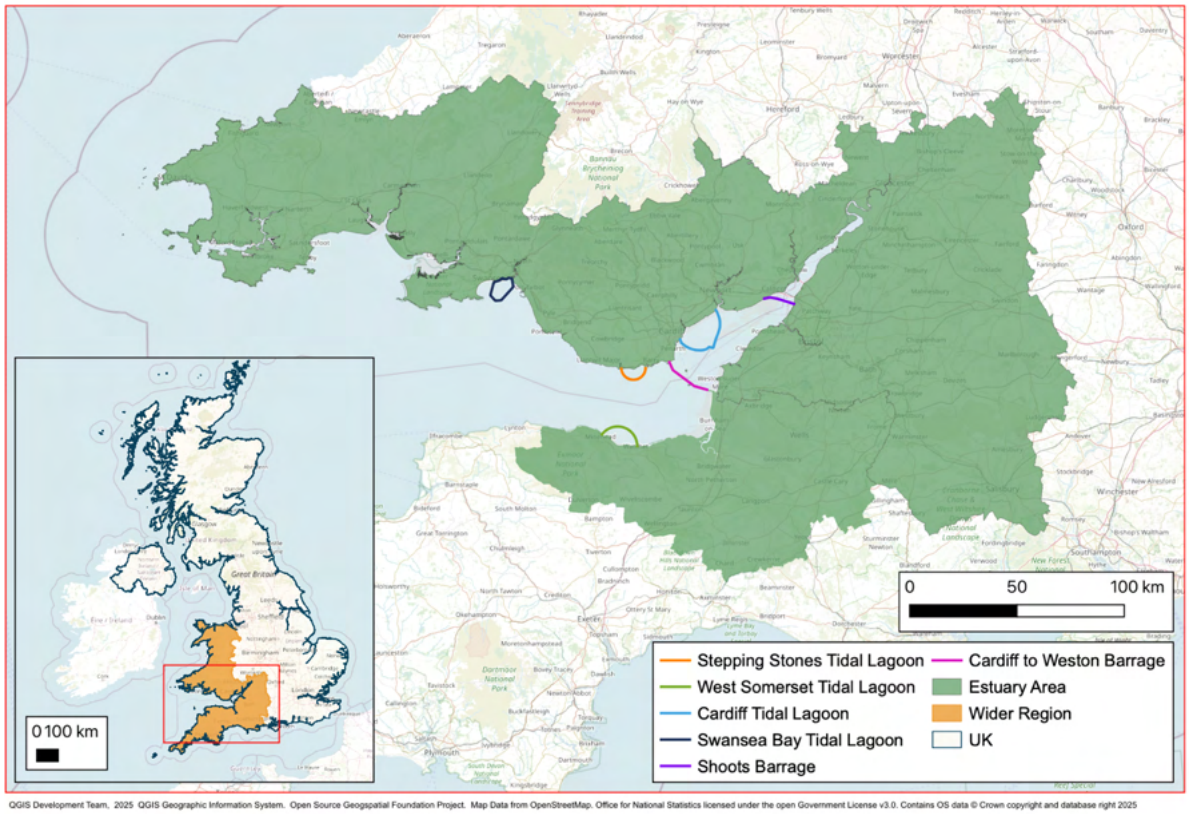
For the purposes of assessing impacts three geographic areas were agreed with the Commissioners:

- Severn Estuary area – comprising the Western Gateway Partnership area plus the county of Somerset;
- Wider region – comprising the entirety of the South West of England region and the nation of Wales; and
- National – comprising the UK.

Where these terms are used they relate to these geographic areas unless otherwise specified.

Figure 1.2 illustrates the three impact areas in addition to the six example tidal range projects which are the focus of this research and analysis.

Figure 1.2 Map of Geographic Impact Areas



Research Methods

A wide range of data and documentary evidence has been reviewed as part of this workstream. References are cited throughout this report and its appendices.

In addition, a substantial programme of stakeholder engagement was undertaken to capture current knowledge and understanding, as well as identifying potential lines of further enquiry. Consultees were drawn from a range of organisations with interests relevant to the research topics. Appendix 1 to this report sets out a full list of stakeholder organisations consulted to inform this research.

Stakeholder engagement was primarily undertaken via video teleconferencing interviews on a one-to-one or one-to-few basis. Interviews used a semi structured topic guide, with discussions tailored to the relevant knowledge and expertise of the interviewees. Interviews had a particular focus on what has changed since previous major evidence reviews. The Severn Estuary Commissioners and the authors of this report are very grateful for the time and contributions made by all those that participated in the consultation programme.

Technical economic impact modelling was undertaken to appraise the six example schemes. This was informed by available data on the schemes under consideration, as well as testing with stakeholders.

Other Concurrent Research

In addition to multiple previous studies that included consideration of the socio-economic impacts of tidal energy generation in the Severn Estuary, there are other studies, with

different emphases being undertaken at the same time as the research set out in this study. This includes work under the umbrella of the Welsh Government's Tidal Lagoon Challenge[5] and TARGET (TidaAl Range schemes as configurable Grid-scale Energy sTorage facilities)[6]. The authors of this report have engaged with those progressing these other socio economic workstreams.

Report Structure

The remainder of this report is structured as follows:

Chapter 2 provides a high-level summary of relevant policy context;

Chapter 3 sets out a review of previous studies focused on the socio-economic impacts of tidal range energy in the Severn Estuary;

Chapter 4 provides a baseline summary of the economy surrounding the Severn Estuary;

Chapter 5 sets out the findings of quantitative economic impact modelling of the development, construction and operation of tidal range energy infrastructure within the estuary;

Chapter 6 sets out a discussion of the supply chain, workforce and legacy issues associated with the construction and operation of tidal range energy in the estuary;

Chapter 7 sets out a review of the wider economic effects, particularly on ports within the estuary;

Chapter 8 considers the social and community effects which might arise from the development of tidal range energy in the estuary;

Chapter 9 considers how positive impacts can be maximised and negative impacts mitigated; and

Chapter 10 sets out summary conclusions.

A series of appendices contain further detail and technical information.

[5] Further details can be found at: https://www.gov.wales/tidal-lagoon-challenge. Last accessed March 2025.
[6] Further details can be found at https://www.strath.ac.uk/humanities/centreforenergypolicy/ourprojects/target/#:~:text=Overview,grid%2Dscale%20energy%20storage%20facilities. Last accessed March 2025.

2. Policy Review

This chapter provides a high-level summary of policy and related supporting documentation at a national and regional level with relevance to the potential socio economic impacts of tidal range energy generation.

Chapter Headlines

- There is an identified need to address growing energy demand, facilitate a transition to clean energy, and enhance energy security.
- There are recognised business and employment opportunities arising from marine renewable energy development.
- There is opportunity to build on the skills base and manufacturing expertise in the Severn Estuary area and wider region's renewable energy sector to attract more investment and deliver growth.
- Across policy, tidal range power receives less focus and has a lower profile than other marine renewable technologies but there are ambitions to support skills development and supply chains in the marine renewable energy sector.

National Policy – UK

The **National Policy Statement (NPS) for Energy (overarching) (EN-1)**[7] sets out policy for energy infrastructure. The NPS EN-1 notes that tidal power can provide relatively predictable low carbon power and could play a role in future if costs can be reduced. However, it is also identified that capacity is limited for tidal power.

The NPS EN-1 sets out how energy infrastructure developments should be assessed, taking into consideration all relevant socio-economic impacts, which may include:

- The creation of jobs and training opportunities.
- The contribution to the development of low-carbon industries at the local and regional level as well as nationally.
- The provision of additional local services and improvements to local infrastructure, including the provision of educational and visitor facilities.
- Any indirect beneficial impacts for the region hosting the infrastructure, in particular in relation to use of local support services and supply chains.
- Effects (positive and negative) on tourism and other users of the area impacted
- The impact of a changing influx of workers during the different construction, operation and decommissioning phases of the energy infrastructure.
- Cumulative effects.

The **Marine Delivery Routemap** published by The Crown Estate[8] sets out to support a more coordinated plan on informing the future demand and management of the UK seabed and coastline, which will help enable the growth of important offshore industries, (such as renewable energy), protect the marine environment, and provide onshore benefits. The Routemap aims to understand future needs through setting out cross-sector spatial

[7] Department for Energy Security & Net Zero, 2024. Overarching National Policy Statement for Energy (NPS EN-1). Available at: https://www.gov.uk/government/collections/national-policy-statements-for-energy-infrastructure. Accessed January 2025.
[8] The Crown Estate, 2024. Marine Delivery Routemap. Available at: https://www.thecrownestate.co.uk/our-business/marine/Marine-Delivery-Routemap. Accessed January 2025.

pathways to 2050 which will give better visibility to infrastructure, supply chain, fabrication and manufacturing needs.

The **National Energy System Operator (NESO) – Clean Power 2030**[9] sets out pathways to a clean power system for Great Britain by 2030 which involves major investments to increase the electrification of heat, transport and industry whilst maintaining energy security.

The report recognises that the power system is a key enabler of sustainable economic growth and will provide opportunities for local growth and good jobs and presents investment opportunities for supply chains involved with clean energy. The report notes that there are supply chain and workforce challenges across almost all technologies required to reach clean power by 2030, including challenges with sourcing electrical components (e.g., cabling and transformers) that impact on the delivery of projects.

Whilst the pathways are focused on offshore wind and either hydrogen or carbon capture and storage developments, the report does recognise that other renewable technologies (including tidal range) could feasibly contribute to energy generation.

The **Clean Power 2030 Action Plan**[10] sets out plans for the UK to achieve clean power by 2030, tackling the need for a secure and affordable energy supply, the creation of essential new energy industries, supported by skilled workers, and the need to reduce greenhouse gas emissions. The Action Plan aims to take an approach of integrating energy and environmental needs.

Electricity demand is expected to double and therefore strong growth in power supply, from a diverse range of sources, is required. The Action Plan sets out a pathway towards deploying low carbon flexible capacity technologies such as carbon capture, usage and storage (CCUS), hydrogen to power, and nuclear generation to provide round-the-clock reliable power. Renewables such as offshore wind and tidal stream are considered an important part of the UK's future energy mix, however in this plan up to the year 2030 are expected to play a more limited role as their technology is still emerging.

There is an identified need to reform grid connections to support future energy supplies.

The Action Plan highlights that the movement towards clean power will create opportunities for new industries and employment. Lowering the barriers to investment into resilient supply chains and workforce development are key ambitions to help capture the economic benefits associated with clean energy. The government will support supply chains by:

- Giving developers greater route-to-market certainty.
- Rapidly convening a new supply chains and workforce industry forum for clean power 2030 sectors.
- Maximising domestic opportunities for clean energy supply chains.
- Driving an increase in capacity of domestic clean energy workforce to match scale of the deployment challenge.
- Boosting awareness of clean energy job opportunities.

[9] National Energy System Operator, 2024. Clean Power 2030. Available at: https://www.neso.energy/document/346651/download. Accessed January 2025.
[10] UK Government, 2024. Clean Power 2030 Action Plan: A new era of clean electricity. Available at: https://assets.publishing.service.gov.uk/media/675bfaa4cfbf84c3b2bcf986/clean-power-2030-action-plan.pdf. Accessed January 2025.

National Policy - England

The **National Planning Policy Framework (NPPF)**[11] sets out to ensure planning policy and decisions contribute to sustainable development. This includes an economic objective to build a strong responsive and competitive economy where businesses can invest, expand and adapt. The NPPF notes that significant weight should be placed on the need to support economic growth and productivity.

The NPPF also sets out the need to support the transition to a low carbon future, taking full account of flood risk and coastal change, supporting renewable and low carbon energy and associated infrastructure.

The **Marine Policy Statement**[12], **British Energy Security Strategy**[13], and **Powering up Britain: Net Zero Growth Plan**[14] identify economic growth opportunities associated with transitioning to a greener future and exploring renewable energy (including tidal range). This includes opportunities for creating well-paid and high-skilled local and national jobs and increasing competitiveness. The Marine Policy Statement also notes that greater inward investment into the manufacturing activities needed for the marine renewable energy could increase the UK's low carbon manufacturing capability.

The Net Zero Growth Plan notes that making the most of these opportunities will depend on having the right workforce with the right skills and capacity in the right locations across the UK. The Plan identifies challenges in the power and networks sector workforce which include issues with the future pipeline of people with the relevant skills in the sector and an aging workforce.

National Policy - Wales

The **Planning Policy Wales**[15], **Economic Mission**[16], and **Welsh National Marine Plan**[17] policy documents set out the Welsh Government's ambition to increase economic activity through investment into renewable and low carbon energy resources.

Aims set out in the Economic Mission document include:

- Realising Net Zero opportunities across Wales and supporting business growth and people to move towards a just transition.
- Enabling current and future development of a low carbon economy to increase opportunities for local businesses to create local jobs and stimulate new supply chains and investments.

[11] UK Government, 2023. National Planning Policy Framework. Available at: https://www.gov.uk/government/publications/national-planning-policy-framework--2. Accessed January 2025.
[12] Department for Environment, Food & Rural Affairs, 2011. Marine policy statement. Available at: https://www.gov.uk/government/publications/uk-marine-policy-statement. Accessed January 2025.
[13] UK Government, 2022. British Energy Security Strategy. Available at: https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy. Accessed January 2025.
[14] Department for Energy Security & Net Zero, 2023. Powering up Britain: The Net Zero Growth Plan. Available at: https://www.gov.uk/government/publications/powering-up-britain/powering-up-britain-net-zero-growth-plan. Accessed January 2025.
[15] Welsh Government, 2024. Planning Policy Wales, Edition 12. Available at: https://www.gov.wales/planning-policy-wales. Accessed January 2025.
[16] Welsh Government, 2023. Economic mission: priorities for a stronger economy. Available at: https://www.gov.wales/priorities-stronger-economy. Accessed January 2025.
[17] Welsh Government, 2019. Welsh National Marine Plan. Available at: https://www.gov.wales/sites/default/files/publications/2019-11/welsh-national-marine-plan-document_0.pdf. Accessed January 2025.

- Building on active labour markets and investment and business support policies to increase skills and employment opportunities.

The **Welsh National Marine Plan** sets out to support the opportunity to sustainably develop renewable marine energy resources with the right development in the right place, noting that renewable energy projects can present substantial opportunities for local economies to grow. The Plan sets out low carbon energy sector objectives which include:

- Supporting development of renewable energy projects.
- Developing a better understanding of the potential for tidal lagoon power technology.
- Developing Wales as an exemplar of marine renewable energy technology by developing the essential skill base, infrastructure and technical knowledge to support the development of the industry over the next 20 years.

The Welsh National Marine Plan sets out the aims to understand future opportunities for tidal range developments (policy ELC_04) and to encourage public and private sector collaboration to increase the understanding of constraints and opportunities for the sustainable use of the tidal range resource and the optimal sites that these developments could be situated.

The **Wellbeing of Future Generations (Wales) Act**[18] gives a legally binding common purpose for national government, local government, local health boards and other specified public bodies and sets out to improve the social, economic, environmental and cultural well-being of Wales.

The Act sets out for organisations to act in accordance with a sustainable development principle: seeking to ensure that the needs of the present are met without compromising the ability of future generations to meet their own needs. This should consider collaboration, integration, involvement of relevant bodies, and balancing short-term and long-term needs, and preventing future problems.

One of the goals set out in the Act aims to create a prosperous Wales, which includes building an innovative, productive and low carbon society that uses resources efficiently and developing a skilled and well-educated population who have access to employment opportunities.

Regional Policy and Research

The **Western Gateway Prospectus**[19] and updated **Independent Economic Review (IER)**[20] identify the Severn Estuary as a place that has the potential to contribute to the UK's energy need. One of the Western Gateway's missions is to generate renewable energy which will also provide new opportunities for local people.

The updated IER highlights the abundance of natural resources and renewable energy (which are mostly maritime based) and the strong manufacturing base in the region. The

[18] Welsh Government, 2015. Wellbeing of Future Generations (Wales) Act 2015. Available at: https://www.legislation.gov.uk/anaw/2015/2/contents. Accessed January 2025.
[19] Western Gateway, 2022. Western Gateway Prospectus. Available at: https://western-gateway.co.uk/sites/default/files/2022-04/Western_Gateway_Prospectus_V12_compressed.pdf. Accessed January 2025.
[20] Western Gateway, 2024. Updated IER: The UK's Future Economy. available at: https://western-gateway.co.uk/sites/default/files/2024-07/WG%20Stage%203%20final%20240520%20%281%29.pdf. Accessed January 2025.

updated IER identifies green energy and aerospace and other advanced manufacturing as two of its key sectors and suggests the region has potential for further future employment and business gains as it moves towards clean energy markets and supporting the green economy.

South and South West Wales regional policy and research taken into consideration in this review includes:

- **South West Wales Regional Economic Delivery Plan**[21]
- **CCR Regional Economic & Industrial Plan 2023-2028**[22]
- **Marine Energy Wales State of the Sector 2023**[23]

In South and South West Wales, policy ambitions aim to make the regions into leaders of renewable energy through building capacity and expertise in the sector, increasing resilience of the regions' manufacturing base, and ensuring there is engagement with local businesses and supply chains.

Ambitions also include securing investment and supporting development of renewable energy production infrastructure, with the Marine Energy Wales State of the Sector report projecting increased future spend across the Welsh marine energy sector.

The State of the Sector report identifies Pembrokeshire as an area that has a well-established supply chain cluster, comprising fabricators, engineers, environmental consultants, marine operators, technology developers, project developers, and other supporting organisations in which building on this capacity and capability can help grow the sector further. The report does however predict the smallest future spend increase in tidal range energy due to unclear market routes.

Key strategies and plans for West and South West England include:

- **West of England Strategic Economic Plan 2015-2030** [24]
- **Gloucestershire's County Economic Strategy (2024-2034)**[25]
- **Draft Gloucestershire Local Industrial Strategy**[26]
- **Swindon & Wiltshire Local Industrial Strategy 2020-2036**[27]

[21] Swansea Council, 2021. South West Wales Regional Economic Delivery Plan. Available at: https://www.swansea.gov.uk/article/15033/South-West-Wales-Regional-Economic-Delivery-Plan. Accessed January 2025.
[22] Cardiff Capital Region, 2023. Regional Economic & Industrial Plan. Available at: https://cardiffcapitalregion.wales/wp-content/uploads/2023/04/ccr-reip-2023-english.pdf. Accessed January 2025.
[23] Marine Energy Wales, 2023. State of the Sector. Available at: https://www.marineenergywales.co.uk/wp-content/uploads/2023/06/MEW-2023-State-Of-The-Sector-Report.pdf. Accessed January 2025.
[24] West of England Combined Authority, 2015. West of England Strategic Economic Plan 2015-2030. Available at: https://www.westofengland-ca.gov.uk/wp-content/uploads/2021/12/WEC063-LEP-Accessible_-FINAL.pdf. Accessed January 2025.
[25] Gloucestershire County Council, 2024. Gloucestershire's Economic Strategy (2024-2034). Available at: https://www.gloucestershire.gov.uk/council-and-democracy/grow-gloucestershire/gloucestershire-s-economic-strategy-2024-2034/#:~:text=Gloucestershire's%20Economic%20Strategy%20(2024%2D2034)%20covers%20the%20next%2010,contribute%20to%20and%20benefit%20from. Accessed January 2025.
[26] Gfirst LEP, 2019, Gloucestershire Local Industrial Strategy 2019. Available at: https://www.gfirstlep.com/downloads/2020/gloucestershire_draft_local-industrial-strategy_2019-updated.pdf. Accessed January 2025.
[27] Swindon & Wiltshire LEP, 2020. Swindon & Wiltshire Local Industrial Strategy 2020-2036. Available at: https://static.swlep.co.uk/swlep/docs/default-source/strategy/industrial-strategy/local-industrial-strategy.pdf. Accessed January 2025.

- **Somerset Economic Futures 2023**[28]
- **Heart of the South West Strategic Economic Plan 2014-2030**[29]
- **The Great South West: A Clean Energy Powerhouse**[30]
- **The Great South West Investment Brochure**[31]

Policy documents across west and South West England identify the low carbon sector as a key sector and ambitions are set out to increasingly develop and grow the sector, including local renewable energy production, so that local businesses and people can benefit.

Regional policies set out ambitions to attract investment in energy generation and build on the local green capabilities and advanced engineering clusters in the region to develop technology. This will deliver opportunities for local businesses to build strong supply chains and provide employment for local people.

The Great South West (GSW) Pan-regional Partnership identifies that the region already provides a hub of global companies, scalable supply chains, and research and innovation centres that are uniquely placed to drive clean energy generation in the UK. Documents published by the GSW Pan-regional Partnership highlight the range of renewable energy generation opportunities (such as offshore wind, tidal and wave) in the region, and sets out ambitions to keep investing in such technologies to support new jobs and the economy.

Summary

Overall, across national and regional policy there is an identified need to address growing energy demand, facilitate a transition to clean energy, and enhance energy security. These present an opportunity to support the development of renewable energy projects, with projected growth in marine renewables a key opportunity, which would also facilitate employment and business opportunities.

In Wales and South West England, there are recognised opportunities for marine renewable development and a strong marine and advanced manufacturing base to support the delivery of such infrastructure. There is opportunity to further build on the skills base and manufacturing expertise in the region's renewable energy sector to attract more investment and deliver growth.

Across policy, tidal range power receives less focus and has a lower profile than other marine renewable technologies (such as offshore wind and more recently tidal stream). However, ambitions to support skills development and supply chains in the marine renewable energy sector could work to support the delivery of all future marine energy projects.

[28] Somerset County Council, 2023. Somerset Economic Futures. Available at: https://www.somerset.gov.uk/business-economy-and-licences/county-wide-economic-strategies/. Accessed January 2025.
[29] Heart of the South West Local Enterprise Partnership, 2014. Strategic Economic Plan 2014-2030. Available at: https://heartofswlep.co.uk/wp-content/uploads/2016/09/SEP-Final-draft-31-03-14-website-1.pdf. Accessed January 2025.
[30] The Great South West, 2024. The Great South West: A Clean Energy Powerhouse. Available at: https://greatsouthwest.co.uk/wp-content/uploads/2024/11/GSW-Energy-Prospectus_2024_FINAL.pdf. Accessed January 2025.
[31] The Great South West, 2024. The Great South West Investment Brochure. Available at: https://greatsouthwest.co.uk/wp-content/uploads/2024/05/Great-South-West-Investment-Brochure-2024.pdf. Accessed January 2025.

3. Previous Evidence Review

In the last 20 years three major overarching reviews of tidal range power options within the Severn Estuary have been undertaken.

- The Sustainable Development Commission (SDC) published Turning the Tide, a strategic overview of tidal power in the UK, in 2007[32].
- The Severn Tidal Power Feasibility Study (STPFS)[33] published in 2010 was a two year cross government feasibility study exploring whether tidal energy schemes in the Estuary should be promoted.
- The Hendry Review published in 2017[34] provided an independent examination of the potential for tidal lagoons as an energy source for the UK.

Each of these studies considered socio economic issues. This chapter provides a high-level summary of each. Further detail, where appropriate, is also considered within subsequent chapters of the report.

Chapter Headlines

- Previous evidence reviews indicate tidal range energy development could bring economic opportunities to the South Wales and South West England areas.
- In particular investment in the manufacturing of components and construction activities would significantly boost UK and regional capability.
- There are also recognised challenges and negative impacts that could come about during the construction and operation phases.
- One of the biggest challenges identified is the shortage of capacity and capability to meet the demands for certain manufacturing activities associated with tidal range infrastructure.
- Another negative impact identified was the potential for ship and port activity disruption.

Turning the Tide (SDC, 2007)

The report presented a strategic overview of tidal power in the UK and set out the SDC's position and recommendations on tidal development proposals for the Severn barrage.

The report recognised the long-term potential for tidal technologies to contribute to the UK electricity supply and export potential. It set out both the advantages and disadvantages of tidal stream, tidal barrage, and tidal lagoon technologies.

In relation to the Severn Estuary, the report noted that a Severn barrage would help to provide clean energy and could help mitigate the risk of coastal flooding and rising sea levels. However, it also noted that if a Severn barrage was delivered it would involve major

[32] Sustainable development commission, 2007. Turning the Tide. Tidal Power in the UK. Available at: https://www.sd-commission.org.uk/data/files/publications/Tidal_Power_in_the_UK_Oct07.pdf. Accessed January 2025.
[33] https://www.gov.uk/government/collections/severn-tidal-power-feasibility-study-conclusions. Accessed January 2025.
[34] Hendry, C., 2017. The role of tidal lagoons. Available at: https://hendryreview.wordpress.com/. Accessed January 2025.

physical changes to water levels, geomorphology, and sedimentary processes and flood defences would still need to be maintained.

The report set out economic and social impacts that a Severn barrage could have at a regional level. This included:

- Ports and navigation – the Severn Estuary supported a number of ports, contributing to handling UK trade and supporting thousands of jobs. A Severn barrage would impact the navigation of ships with regard to changes in sedimentation levels, with dredging being identified as possible solution (however this would still have a potential carbon cost)
- Transport Links – many of the barrage proposals set out the potential for new transport links – either road or rail – running on top of the barrage, however there was a lack of information on how this would be engineered (e.g. to manage ship traffic).
- Coastal defence and flood protection – flood protection was viewed by many as a significant possible benefit of a Severn barrage, particularly for low-lying areas upstream as high tide would be lowered.
- Employment – a barrage would bring a substantial number of new jobs, most of which would be concentrated in the construction phase. There was likely to be a substantial net migration of labour into the region from the rest of the UK and internationally. The report noted provisions for accommodation and up-skilling should be made to ensure the participation of existing local businesses if a barrage is delivered.
- Aggregates - the Severn Estuary was home to a regionally important aggregates industry which could be impacted if a barrage was constructed (e.g. changes to quality of sand resources could impact the economic viability of extracting these aggregates). A potential benefit would be that aggregates for the construction of a barrage could be sourced locally or regionally.

Overall, the report noted both economic and social benefits and challenges should a tidal scheme be delivered. There are a number of potential benefits including flood protection, job creation, and opportunities to support local and regional businesses. The report noted there are also a number of issues that need further exploration including how sedimentary changes would impact on ship navigation and the aggregates industry, and potential impacts on port trade if a barrage is built.

Severn Tidal Power Feasibility Study (STPFS)

Phase 1 Regional Economic Impacts Study (DTZ, 2009) [35]

The overarching aim of this study was to *"undertake an initial assessment of the potential economic impact of the proposed Severn Tidal Power project on the regional economies of Wales and the South West of England."* This included consideration of ten different scenarios/options for tidal schemes at different locations within the Severn Estuary.

The report outlined potential economic benefits, including significant job creation during construction and operation, increased regional investment, and opportunities to develop a

[35] Department for Energy and Climate Change, DTZ, 2010. Severn Tidal Power Feasibility Study. Available at: https://www.gov.wales/sites/default/files/statistics-and-research/2018-12/090126-tidal-power-generation-severn-estuary-en.pdf. Accessed January 2025.

global export market for tidal technologies. It suggested substantial long-term economic gains if the estuary's power is harnessed effectively.

However, potential negative economic impacts are noted, such as high upfront costs, potential disruption to other industries including shipping/ports, fisheries and tourism, as well as uncertainty over funding models. There are also potential negative social impacts including pressure on local services and housing arising from temporary populations during construction.

The report highlighted the significant role of caisson and turbine manufacture in tidal range energy projects. It identified these components as key areas for securing economic benefits, given their large-scale production requirements and the potential for local supply chains. Manufacturing caissons and turbines could create numerous skilled jobs and boost industrial activity in the regional economies. However, the report noted that this depends on establishing robust manufacturing capabilities and ensuring competitive costs compared to international suppliers. Strategic planning would be necessary to maximise local economic benefits.

The report noted the need for workforce development and upskilling to meet potential demand in engineering, manufacturing, and project management. Local economies could benefit significantly, but ensuring sufficient training opportunities and aligning with existing industrial capabilities is essential for maximising employment benefits.

The report noted that tidal range projects in the Severn Estuary could leave significant legacy impacts, including infrastructure improvements, long-term employment opportunities, and the establishment of a local supply chain for marine energy technologies. There is also the potential for reduced flooding risk, however, there remained uncertainty as to the extent of this. It also highlighted the potential for skills development, fostering a highly trained workforce that could support other renewable energy sectors. However, concerns about environmental changes and possible disruption to existing industries are raised, suggesting a need for balanced planning to ensure positive, enduring outcomes.

In terms of transport, logistics and port activity, the report concluded that there is likely to be a negative impact, due to disruptions to shipping, should a tidal scheme be delivered. The study noted that should a large barrage be developed, ship movements would be impeded, reducing the overall competitiveness of key ports in the estuary. Bristol, Cardiff, Newport and Sharpness ports are identified as likely to be subject to direct negative impacts.

Phase 2[36]

The Phase two paper of the STPFS set out a re-working of the Phase one regional economic impact assessment, and included the following changes:

- Updated construction costs and more detailed leakage estimates to better reflect proportion of work likely to take place in the region
- Updated operational phase employment and expenditure figures

[36] Welsh Assembly Government, 2010. Severn Tidal Power Feasibility Study. Phase 2: Regional Economic Impacts Study. Available at: https://assets.publishing.service.gov.uk/media/5a795a76e5274a3864fd6467/7._Regional_Economic_Impacts_Study.pdf. Accessed January 2025.

- Updated baseline port employment and GVA data; and new ports baseline scenarios to take account of predicted expansion in port sector and possible major investment at Bristol Port
- Worst case scenario for ports allowing for the possibility of complete closure of upstream ports as a result of the largest barrage, Cardiff-Weston.

The phase two paper noted that there would be a net positive regional impact in terms of employment and GVA should the different tidal scheme options go ahead.

The revised port baseline took into account the additional factors of people employed at Bristol Port and an estimated number for induced jobs that occur in the region as a result of port activity. The revised figures showed an increase of employment and GVA at Bristol Port.

In the high impact case scenario (under the Cardiff-Weston option), should the closure of ports occur upstream on the Severn Estuary, then there would likely be a loss of employment and GVA.

The study noted that the main regional sectors that would be affected by STP are port and construction sectors. Impacts on other sectors are harder to estimate as they are relatively smaller. Sector comments included:

- Tourism: range of both positive and negative impacts in construction and operation but overall effect unclear. Potential to attract new tourists into the region
- Commercial fisheries: expected job losses
- Marine aggregates: Cardiff Weston Barrage and Welsh Grounds Lagoon would likely deliver negative impacts during construction.

Hendry Review

The focus of the review was on the general principles of tidal lagoons, looking at the cost and value of tidal lagoons as part of the UK's energy mix and at the how the technology might be developed and financed. The review focused on the proposal for a tidal lagoon in Swansea Bay (referred to as 'TLSB').

The TLSB could generate a range of employment opportunities within its construction and operation and in wider related services such as tourism, recruitment, and legal and financial services.

Manufacturing and assembly (of which a high proportion of the labour force would need to be high skilled), power plant operation and maintenance, and construction jobs will be important for the TLSB. There is a large opportunity for investment particularly in the manufacture of electromechanical equipment such as turbines and generators and in steel sector activities.

However, the Welsh Government identified notable shortages in Wales's capability and capacity to meet the demands for certain labour areas (particularly in steel casting and forging and in fabricated metal components).

Caissons used in tidal range developments would need to be imported unless there is investment to develop suitably sized facilities to manufacture them in UK, given their large size. The review noted that whilst there are challenges of using caissons, they could offer

the opportunity to widen the tidal lagoon supply chain very significantly and develop the UK's civil engineering capability.

The review noted that tidal range development could bring opportunities to become the location for developing, testing and improving technological innovations, which could impact the work of other leading sectors such as offshore renewables and high value manufacturing; particularly under multiple lagoon options. However, multi lagoon options also bring additional challenges and will require managing cumulative environmental effects, ensuring sufficient investment and coordination across multiple stakeholders and regions. This will require robust environmental and economic frameworks and clear strategic planning.

The review noted that other evidence has found that the TLSB could act as a catalyst for wider regeneration if flood risk is reduced as it could mean land could be unlocked for development.

Summary

Overall, previous evidence reviews of tidal range infrastructure indicate that such development could bring economic opportunities to the South Wales and South West England areas. Both the STPFS and Hendry Review note that tidal range projects would help to grow the offshore renewables sector and provide employment opportunities.

In particular, the delivery of tidal range infrastructure presents opportunity for investment in the manufacturing of components and construction activities that would significantly boost UK and regional capability.

Whilst there are opportunities for tidal range, there are recognised challenges and negative impacts that could come about during the construction and operation phases. One of the biggest challenges identified in the reviews was the shortage of capacity and capability to meet the demands for certain manufacturing activities associated with tidal range infrastructure.

Another negative impact identified was the potential for ship and port activity disruption. Should a barrage be developed, ship movements and ports further upstream in the Severn Estuary could lose competitiveness and investment potential due to impeded ship movements.

4. Severn Estuary Area Socio-Economic Baseline

This chapter sets out a summary socio economic baseline of the Severn Estuary study area (see Figure 1.2 highlighting key strengths and weaknesses, as well as future economic prospects for the area. A more detailed analysis is attached at Appendix 6 to this report.

Chapter Headlines

- The Severn Estuary area has a population of 5.5 million people that is growing more rapidly than the national average.
- The area has positive but variable labour market indicators; and includes pockets of deprivation in its cities, South Wales Valleys, and coastal towns.
- The area has annual GVA of £144bn, greater economic output than both the Manchester and West Midlands Combined Authority areas, fuelled by its cities and clusters. But lower productivity than national benchmarks is a challenge.
- There is evidence of a two speed economy with knowledge sectors thriving between the West of England and Cardiff alongside legacy industries facing challenges from environmental legislation and international competition.
- Energy generation is a growing part of the region's economy, with low carbon technologies offering significant economic opportunities.
- Baseline forecasts (excluding any potential tidal energy project(s)) from Oxford Economics indicate economic growth (GVA and employment) across the Severn Estuary area in line with the UK average and well above the UK average excluding London. By 2050 the area will be an economy of £210 billion and 3.2 million jobs.

The Severn Estuary Area

The Severn Estuary area is an extensive and diverse region, which covers 19,000 square kilometres and accounts for close to 8% of the UK's land area. The region is characterised by a diverse landscape, with dynamic urban centres and sparsely populated rural areas. It hosts leading research and innovation clusters alongside traditional industrial activities. It is also marked by significant inequalities, including both prosperous places and areas of high economic deprivation.

The estuary itself is at the core of the area, and also contributes in its own right to the economy of the region. It is a logistics corridor that leads to the ports of Bristol and Newport, a place for energy generation (in particular at Hinkley Point) and industry, as well as leisure and tourism.

Population and Labour Market

The Severn Estuary area has an estimated population of 5.5 million in 2024, accounting for 8% of the UK total. The region has experienced rapid population growth, especially since 2020, as growth accelerated and outpaced the national average. Some areas shouldered a significant share of the recent growth, including Cardiff, Somerset and Wiltshire.

Labour market conditions are broadly positive, although they tend to vary significantly throughout the Severn Estuary area. Overall, the employment rate is slightly below the UK average (58.5% compared to 59.2%), but it is significantly higher in some parts of the West of England (such as Cheltenham and Gloucester), and lower in more rural areas such as

Monmouthshire and the Forest of Dean. Similarly, the level of qualifications among the working-age population is slightly below the national average, but there are clear disparities between urban and rural areas. The unemployment rate has remained consistently below the national average.

Underlying these disparities are issues relating to employment and income deprivation. There are pockets of deprivation in the main urban centres (Bristol, Cardiff, and Newport) as well as in the Welsh Valleys. There are also some smaller pockets along the Severn Estuary, including in Weston-Super-Mare and in Somerset's coastal towns.

Recent Economic Performance

The Severn Estuary area benefits from a high level of economic activity, led by its main urban centres as well as smaller but equally dynamic clusters. In 2024, we estimate the area produced total GVA of £144 billion, making it a larger economy than both the Greater Manchester Combined Authority (£83 billion) and West Midlands Combined Authority (£70 billion). Employment growth broadly tracked the national average in the decade before the Covid-19 pandemic, and although the shock of lockdown measures was somewhat less pronounced than in the rest of the country, the recovery post-Covid has so far been slower.

Productivity in the Severn Estuary area has historically been lower than the UK average, even after excluding London. In 2024, productivity in the area is estimated at £51,000 per worker, compared to £55,300 across the UK and £51,500 after excluding London. Part of the lower level of productivity can be explained by the sectoral specialisation of the area. In addition, the data shows that productivity in most sectors is below its respective UK average. Despite strong R&D and innovation assets, there are frictions in the transition process from research to commercialisation, and difficulties fostering cooperation between industries that are security-sensitive such as cyber and aerospace, which could at least partly explain the productivity gap, along with specific skills shortages.

Sectoral Specialisation

The Severn Estuary area's sectoral specialisation shows a diverse but two-speed economy. Knowledge sectors such as advanced manufacturing, aviation and computer science, located between the West of England and Cardiff, are growing rapidly and strengthen the region's expertise in scientific research and development.

At the same time, there are pockets of legacy industry in Wales, such as in Neath Port Talbot, where highly-polluting steel production and oil refining activities are located. These industries are increasingly challenged by international competition and environmental policies, creating short term frictions in the labour market and facing transition to cleaner industrial processes.

The two largest economic sectors in employment terms across the Severn Estuary area are Human health & social work, and Wholesale & retail, which is not dissimilar to the UK average. Taken together, these two sectors account for almost 26% of all jobs in the Severn Estuary area. There is also a significant share of jobs in Professional, scientific & technical activities, Manufacturing, and Accommodation & food services.

The Estuary itself mainly generates logistics and port activity. In 2023, the Port of Bristol handled 8.5 million tonnes of cargo, making it the 14th largest port in the country. Energy

generation is a growing part of the region's economy, and low carbon technologies offer significant opportunities for the Estuary, such as nuclear power, hydrogen, and offshore wind turbines. Tourism is also important to the Severn Estuary area and the Estuary. Commercial fishing and aquaculture activity remains in the Estuary but only on a small scale, while recreational fishing is popular.

Additional Socio-Economic Considerations

The Severn Estuary is a natural environment possessing a wealth of natural capital, providing direct and indirect benefits that support production, wellbeing, and the quality of life in the region. It is an important nature conservation site for many species of birds and fish. The Estuary also plays an important historical, cultural and social role for local communities, providing recreation space to residents and visitors.

Environmental risks also impact activity in the Severn Estuary area, and with climate change may pose greater risks to the economy and ecosystem of the region in the future. The main risks for the Estuary relate to fluvial, coastal and tidal flooding and erosion, and changes to land use could themselves exacerbate or mitigate these risks.

Future Growth Projections

Oxford Economics' baseline forecasts for the Severn Estuary area are constructed using a set of assumptions about key economic variables and conditions. These do not account for specific policies and investments and do not include any tidal range energy projects.

On this basis, Oxford Economics expects the economy of the Severn Estuary area to continue to grow in the five-year period to 2030, at an average annual rate of 1.7%, in line with the UK average and one percentage point above the UK average after excluding London. High-value services will continue to drive growth in the economy, including in Information & communication activities (2.7% per year on average) and Professional, scientific & technical activities (2.3%). Growth is expected to continue in the longer term, and by 2050 it is expected that the economy of the Severn Estuary area will be worth over £210 billion. This suggests an overall long-term growth rate on a par with the UK average.

Employment growth will expand at a similar pace to the UK average during the period 2025-2030 (1.1%), and a slightly faster rate than the UK after excluding London. Oxford Economics expects an additional 183,200 jobs across the Severn Estuary area during that period, with the bulk of growth in Health & social care work, followed by Professional, scientific & technical activities, Administration & support services, and Wholesale & retail. Manufacturing is expected to shed a significant number of jobs by 2030. Employment will continue to grow over the longer term, broadly matching the UK average. Oxford Economics expects over 3.2 million jobs across the Severn Estuary area by 2050, 400,000 more than the current level of 2.8 million.

Population growth will be a key challenge for the Severn Estuary area. Total population is expected to grow by an average 0.4% per year between 2025 and 2030, below the levels in the UK (0.6%), and the UK excluding London (0.5%). Although Oxford Economics expects over 400,000 additional residents by 2050 across the Study Area, growth is forecast to lag the national average over the longer term. This is largely a result of an ageing population which itself could impede growth in the labour supply.

5. Core Effects – Economic Impact Analysis

This chapter considers the economic impacts associated with the development, construction and operation of potential tidal range energy infrastructure within the Severn Estuary.

This chapter draws on economic impact modelling undertaken by Oxford Economics, with further details set out at Appendix 7.

Chapter Headlines

- There are significant economic opportunities presented by the development of tidal range projects in the Severn Estuary.
- Substantial supply side development will be necessary to deliver any of these projects, presenting an opportunity for the Severn Estuary area, wider region and UK economies.
- The six example projects illustrate a wide range of scale of project. But even the smaller projects will provide substantial economic benefits.
- Small projects will support 30,000 – 40,000 job years of employment in the UK in their development and construction phases.
- The Cardiff-Weston Barrage 'mega project' could support almost 600,000 job years, comparable to some of the largest construction projects in Europe.
- The majority of the employment impact is expected to be concentrated in the Severn Estuary area. However, the location of manufacturing activities is relatively uncertain and could lead to a more distributed impact across the UK.
- A multi project approach could offer a range of positive impacts to enable development of a UK supply chain and longer term economic opportunity measured in decades.

Data Inputs, Assumptions and Limitations

This is a strategic study, drawing on available data and evidence. Whilst six example projects are the subject of consideration within this research, many of them do not have active project developers. As a result, there is a relative lack of up-to-date, project specific data for many of the six example projects. Therefore, economic modelling has had to draw on data that is available, supplemented with stakeholder[37] testing to 'reality check' emerging findings. This testing process did not identify any substantive concerns with the modelling approach or outputs.

Stakeholder engagement was consistently clear there will need to be significant supply-side development to deliver any of the six example projects, and this presents a huge opportunity for both the supply chain and the workforce. For this reason, it is not possible to undertake a detailed analysis of existing capability to assess impact.

Scenario modelling has therefore been used to illustrate the potential scale of economic impacts associated with a 'worst case' scenario for UK content, alongside 'low', 'mid-point' and 'high' scenarios for UK content, drawing on project level data. These scenarios help to illustrate the potential opportunity beyond the 'worst case' scenario should the right conditions be in place to secure UK content.

[37] Including the Welsh Economy Research Unit, Offshore Renewable Energy Catapult and Tidal Range Alliance.

Key inputs and assumptions include:

- Project costs (development and construction) and construction periods have been sourced from the 2023 WSP evidence base report.
- Operational costs expenditure is based on academic analysis by Vanderkruyssen et al.
- The composition of spend across economic sectors is based on analysis developed for the West Somerset Lagoon and STPFS.
- Location of expenditure within the three study geographies is based on project data for the West Somerset Lagoon, Swansea Bay Tidal Lagoon, and analysis of ONS data.

Modelling was undertaken by Oxford Economics using its proprietary impact model to illustrate the direct, indirect, and induced effects of the example projects in terms of both Gross Value Added (GVA) – a measure of economic output - and employment.

Given the levels of uncertainty, it is important to understand the modelling results in context. In particular, the focus should be on the broad messages that can be drawn from the analysis, rather than focusing on the minutiae and specific figures as stated.

Appendix 7 provides a technical economic impact modelling report with further detail on the evidence, assumptions, and modelling approaches used, as well as the resulting findings.

Headline Results

Table 5.1 and Table 5.2 set out the UK level employment and GVA impacts during the development and construction phase for the six example projects. All are very large. The smallest project will support more than 20,000 job years[38] of employment under the worst-case scenario, with the largest supporting more than 400,000 job years under the worst-case scenario.

Table 5.1 Cumulative Employment Impact in the UK, Development and Construction Phase (Thousands of job years)

	Scenario				Range (Worst-High)
	Worst Case	Low	Midpoint	High	
Swansea Bay Lagoon	22	26	30	35	13
Stepping Stones Lagoon	28	34	39	45	16
West Somerset Lagoon	129	155	180	204	75
Cardiff Lagoon	158	189	219	248	90
Shoots Barrage	93	116	132	149	56
Cardiff Weston Barrage	403	511	582	654	251

Source: Oxford Economics

[38] Employment is measured in job years for temporary employment facilitated through the development and construction phase.

In GVA terms the worst-case scenario impacts range from a little over £1bn to more than £25bn at the UK level. The largest project, the Cardiff-Weston Barrage, generates job and GVA estimates equivalent to approximately 1% of UK GDP[39] and workforce job[40] estimates.

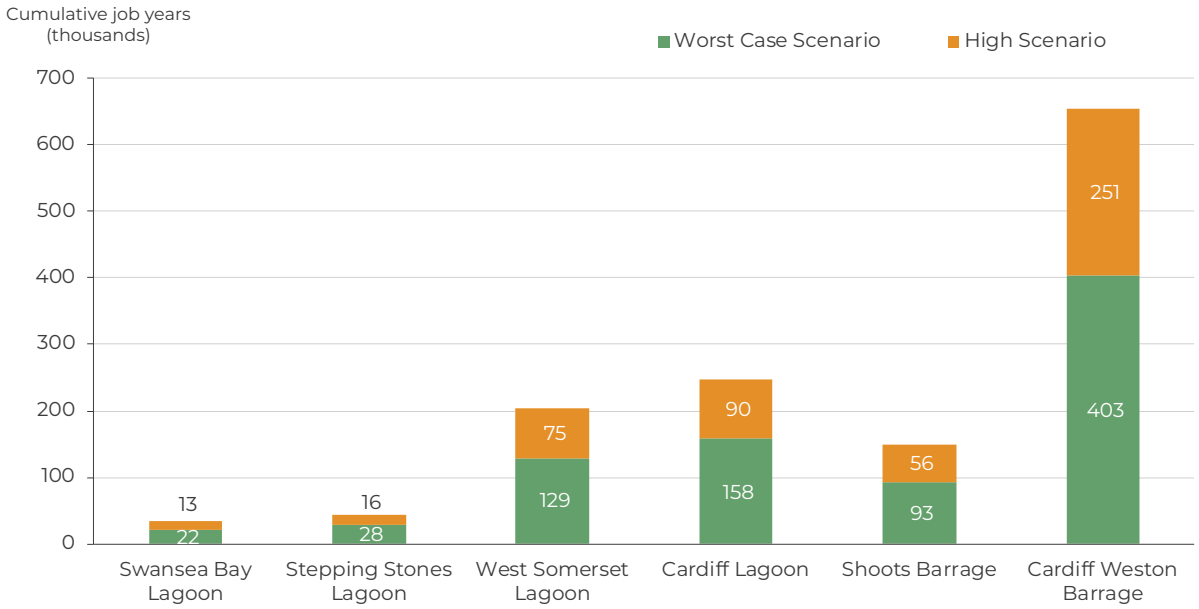
Table 5.2 Cumulative GVA Impact in the UK, Development and Construction Phase (£m, constant prices)

	Scenario				Range (Worst-High)
	Worst Case	Low	Midpoint	High	
Swansea Bay Lagoon	1,175	1,427.	1,632	1,839	664
Stepping Stones Lagoon	1,5067	1,831	2,094	2,360	854
West Somerset Lagoon	6,989	8,491	9,706	10,935	3,946
Cardiff Lagoon	8,865.	10,777	12,271	13,780	4,915
Shoots Barrage	5,600	7,054	7,932	8,819	3,219
Cardiff Weston Barrage	25,179	32,187	36,113	40,084	14,905

Source: Oxford Economics

The different scenarios illustrate the scale of economic opportunity that could be realised if the conditions to secure UK content can be put in place. Under the high scenario the project impacts increase by approximately 60%, equivalent to an additional 13,000 to 250,000 jobs years and £0.6bn to £14.9bn in GVA. Figure 5.1 illustrates the scale of additional opportunity in terms of cumulative job years at the UK level across the six example schemes.

Figure 5.1 Economic Opportunity for the UK, Worst Case to High Impact, Cumulative Job Years, Development and Construction Phase



Source: Oxford Economics Figures may not sum due to rounding.

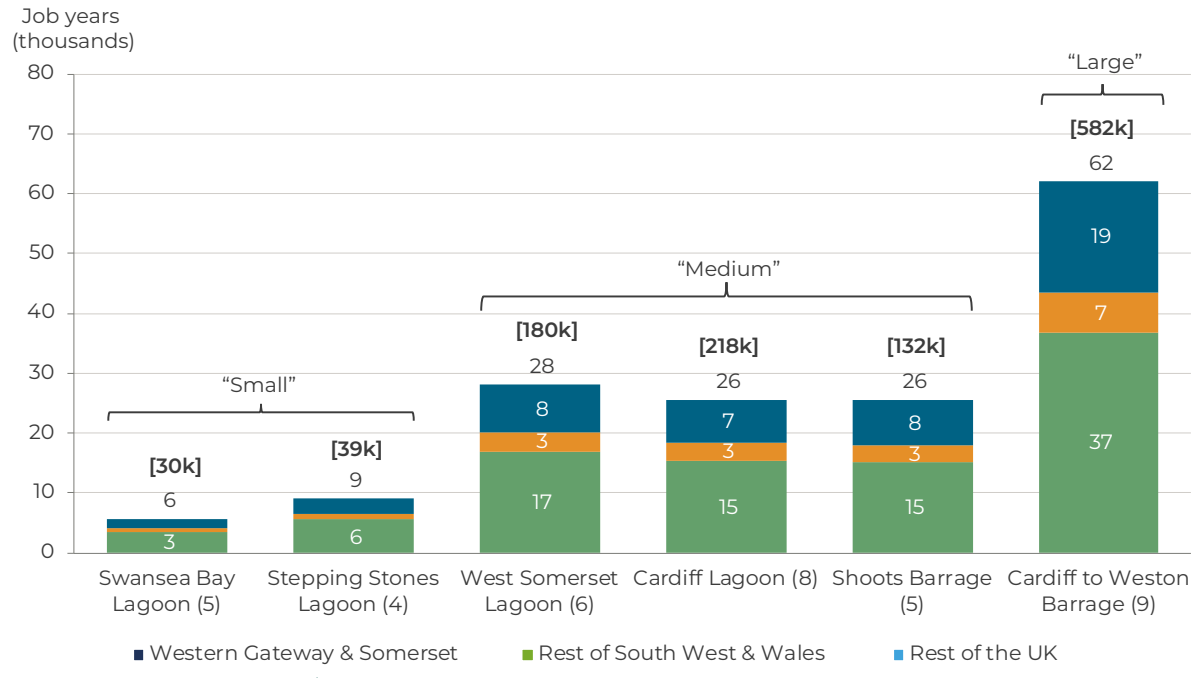
[39] ONS, 2024. Total economic output at the national level is reported as GDP. Below national level GVA is more commonly used. The key difference is that GDP includes the impact of taxes and subsidies.
[40] ONS, 2024

Whilst each example project shows a large positive economic impact, they vary considerably. Figure 5.2 illustrates this variation clearly. The six example projects can be broadly categorised into three groups:

- Small – the term is used advisedly given the overall scale of the projects at an estimated capital cost of £1.8bn - £2.3bn. The Swansea Bay and Stepping Stones lagoons fall into this category, supporting approximately 30,000 to 45,000 jobs years of employment. This is equivalent to around 5,000 to 10,000 annual job years of employment through the four to five year construction periods.
- Medium – this includes the Shoots Barrage, West Somerset Lagoon and Cardiff Lagoon, with cumulative job years estimated at approximately 90,000 to 250,000. This is equivalent to around 25,000 to 30,000 job years annually through the five to eight year construction periods. Total project costs are estimated at approximately £7 - £12 billion.
- Large – the Cardiff–Weston Barrage is in a category of its own. With current costs estimated at more than £33bn this is a mega project, almost three times the scale of the next largest example. This is similar in scale to the Hinkley Point C new nuclear build, described as one of the largest construction projects in Europe. Cumulative job years in the UK are estimated at 400,000 to 650,000, equivalent to almost 45,000 to 70,000 job years per annum across a nine-year construction period.

The Cardiff-Weston Barrage is approximately equal to the sum of the other five projects in terms of jobs, GVA and cost. Also of note is that significant analysis has been undertaken in respect of the Swansea Bay Tidal Lagoon, which is the smallest of the six example projects. This is potentially important when extrapolating from the Swansea Bay Lagoon to other projects.

Figure 5.2 Development and Construction Average Annual Job Years in the UK by Impact Area and Project, Mid Point Scenario.

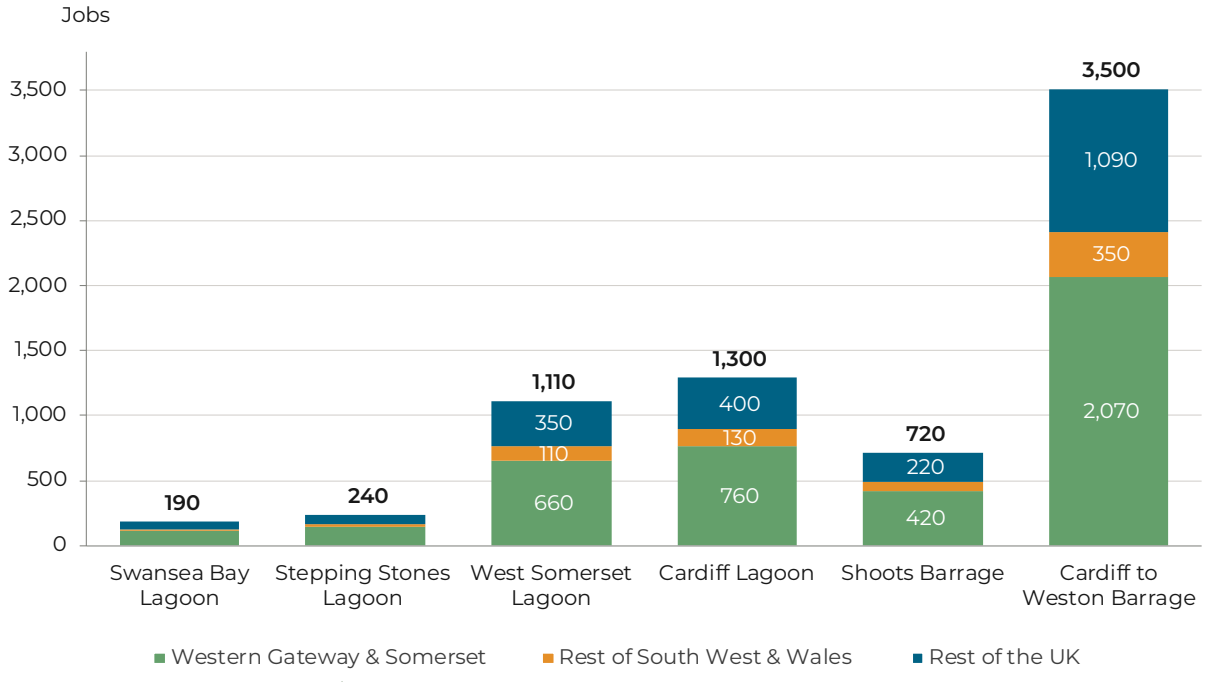


Source: Oxford Economics.

Figures in rounded brackets ( ) indicate number of construction years. Figures in square brackets [ ] indicate cumulative job years throughout development and construction phase.

Operational phase employment is much smaller in scale, as illustrated in Figure 5.3. The 'small' project examples will support approximately 200 jobs across the UK. The medium projects will support around 700 – 1,300 jobs. The large project, again a different order of magnitude, supports an estimated 3,500 jobs within the UK during the operational phase, roughly equivalent to the sum of the five other example projects.

Figure 5.3 Operational Phase Jobs, UK and Sub-areas



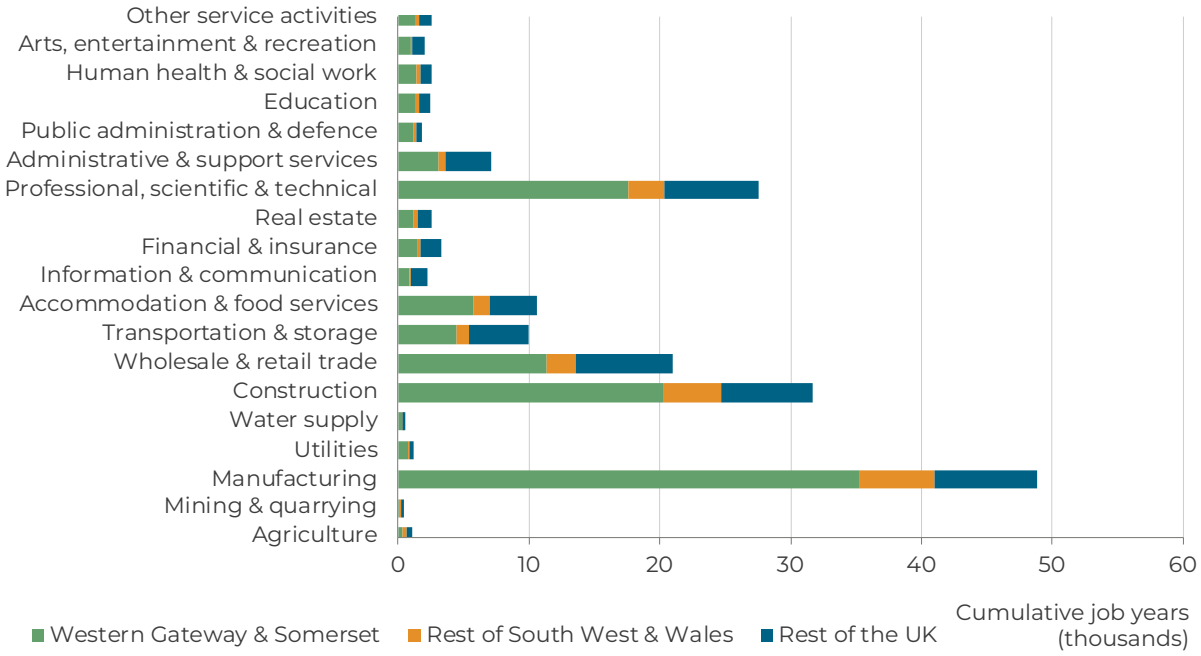
Source: Oxford Economics Figures may not sum due to rounding.

Sectoral Spread of Impact

The total cumulative impact will be spread across a wide range of sectors throughout the economy. Figure 5.4 highlights that the greatest anticipated impact will be within the Manufacturing; Construction; Professional, scientific & technical; and Wholesale & retail trade sectors. However, there are still substantial impacts in the Transport & storage; and Accommodation & food services sectors, supporting the development and construction phase. Almost all sectors in the economy will experience some positive impact as a result of either direct, indirect, or induced expenditure.

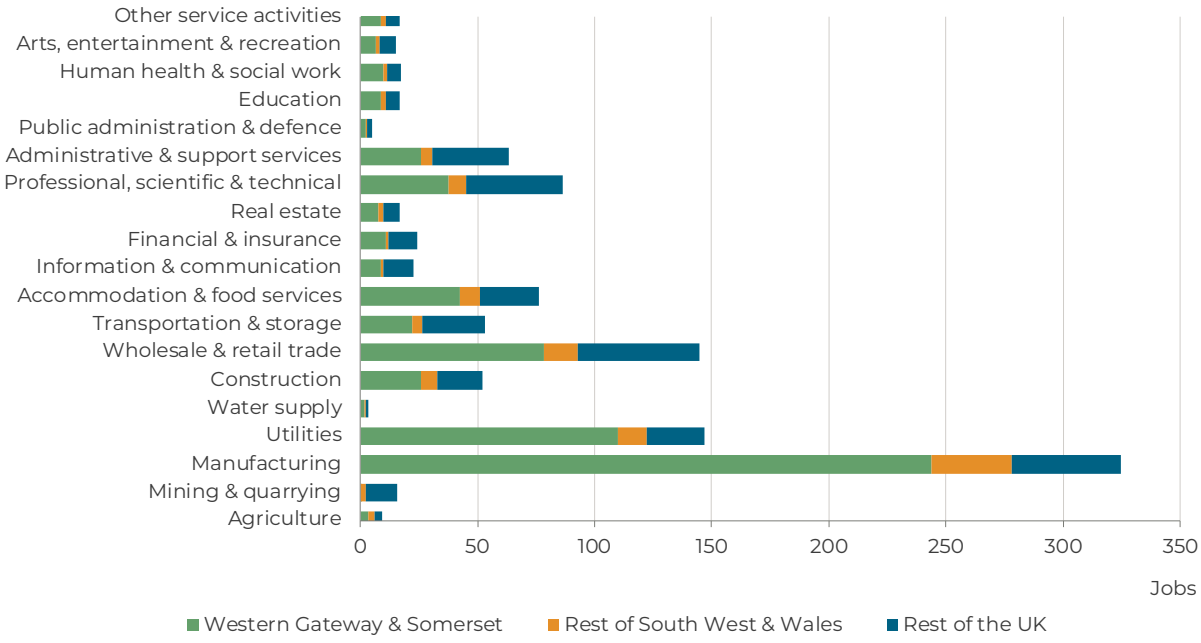
Operational phase jobs will also be spread across a range of sectors, reflecting the direct, indirect, and induced activities which will support employment opportunity. The Manufacturing sector is again the largest sector benefitting from operational activity. The Utilities, and Wholesale & retail sectors will also experience notable employment benefit. Figure 5.5 illustrates the spread of operational phase employment across sectors.

Figure 5.4 Development and Construction Phase, Sectoral Spread of Employment (West Somerset Lagoon is used as an example)



Source: Oxford Economics

Figure 5.5 Sectoral Mix of Operational Phase Employment (West Somerset Lagoon is used as an example)



Source: Oxford Economics

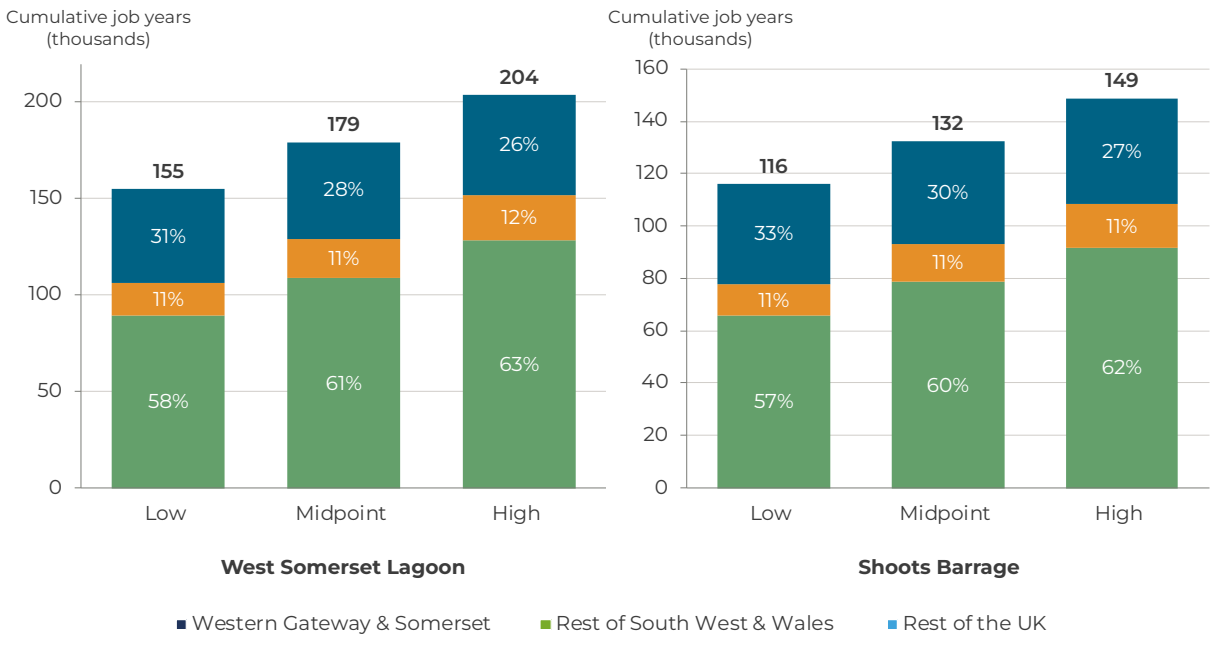
Geographic Spread of Construction Phase Impact

Figure 5.6 shows that the majority of employment impact during the construction phase is anticipated to accrue within the Severn Estuary area, with lower levels of impacts in the rest of the wider Wales and South West area and the rest of the UK. The economic impact analysis differs across lagoon and barrage scheme types, so Figure 5.6 includes an example of each to illustrate the marginal differences. Under the mid-point scenario approximately 60% of UK construction phase employment is anticipated within the Severn Estuary area, around 10% in the wider South West and Wales region, and 30% elsewhere in the UK.

However, there is significant uncertainty about the exact location of large proportions of the supply chain activity. Modelling has been based on data from the Swansea Bay and West Somerset lagoons, supplemented with ONS data and stakeholder consultation, including sector bodies and potential Tier 1 contractors. Large proportions of civil engineering construction activity will either need to be undertaken in close proximity to the site, or contractor preference is to utilise locations in close proximity wherever possible. Manufacturing activities could potentially be located in other parts of the UK, or outside the UK, depending on a range of factors including contractual requirements. As noted in Figure 5.4 a large proportion of employment impact is within the Manufacturing sector and so estimates should be treated with appropriate caution.

Subsequent industry stakeholder consultation has confirmed that the supply chain analysis undertaken to inform the Swansea Bay Lagoon approximately 10 years ago was thorough and robust at the time. However, stakeholders were also clear that the supply chain capability and capacity in both the Severn Estuary area and the wider UK have diminished since that time. Stakeholders agreed it will require significant effort to (re)develop the UK and Severn Estuary area supply chain capability to deliver the example projects.

Figure 5.6 Geographic Spread of Cumulative Job Impacts (West Somerset Lagoon and Shoots Barrage are used as example projects, Mid Point Scenario)

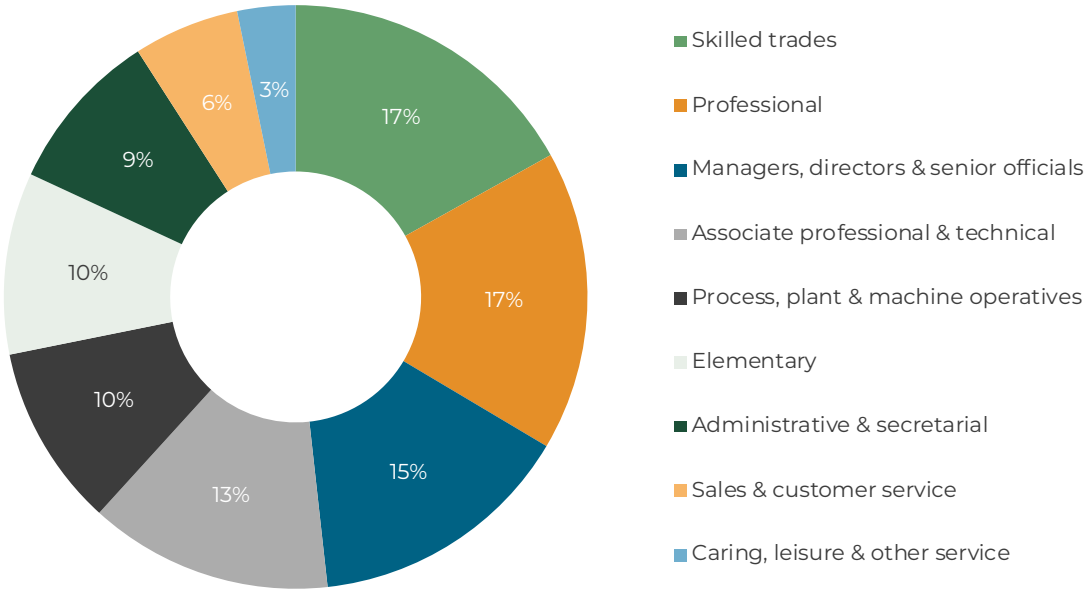


Source: Oxford Economics. *Figures may not sum due to rounding.*

Skills Impact

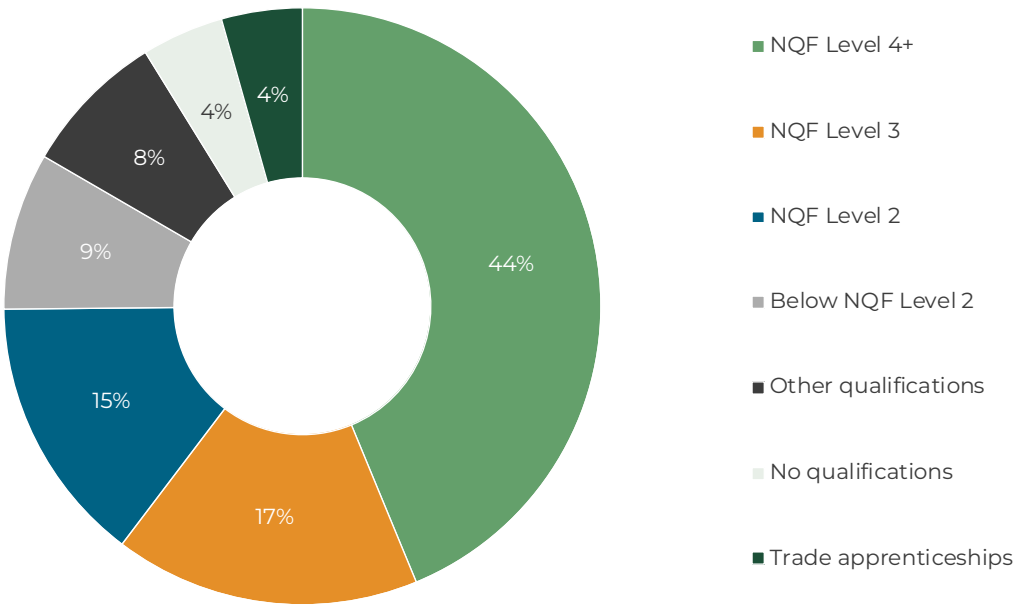
Figure 5.7 and Figure 5.8 illustrate the breakdown of occupations and qualification for job roles during the construction phase. The West Somerset lagoon example is used for illustrative purposes. The analysis draws on typical occupational and qualification profiles for the sectoral employment anticipated. These charts help to illustrate a number of key points. Firstly, there will be employment opportunity across all occupational groups and qualification levels, providing the potential for a wide range of the workforce to be engaged in supporting the project. Secondly, 44% of job roles are expected to require NQF Level 4+ qualifications, which include higher apprenticeship and certificates of higher education and above, indicating a relatively advanced level of learning and qualifications.

Figure 5.7 Development and Construction Phase Occupational Mix (West Somerset Lagoon used as an example)



Source: Oxford Economics

Figure 5.8 Development and Construction Phase Qualification Mix (West Somerset Lagoon used as an example)



Source: Oxford Economics

Multi Project Scenario

The analysis set out above considers the six example projects in isolation. Multiple stakeholders highlighted the potential economic opportunities afforded by a multi project scenario. This could include a series of lagoons developed over time (rather than simultaneously), with stakeholders advocating for early projects to be smaller in scale. It was generally agreed that any multi project scenario would not include the Cardiff Weston Barrage, given its scale, the hydrology, and wider potential impacts.

There are no current proposals for a multi project scenario, so any consideration in this report is purely illustrative. Tidal Lagoon Power was actively pursuing a multi lagoon model, to deliver greater energy generation potential and economic benefit.

A multi project scenario creates a number of potential socio-economic opportunities:

- The ability to spread total capital expenditure requirements over a longer period, and drive cost efficiencies for subsequent projects.
- The potential to develop a supply chain over time, with the opportunity for delivering efficiencies and learning from earlier projects.
- The ability to deliver greater cumulative economic impact than a single project, over a longer period with a lower peak.
- The ability to offer longer term career development opportunities to the workforce, rather than a single project, short-term job role.
- The potential to deliver better (or even sufficient) return on investment to supply chain companies needing to scale in order to deliver project components.

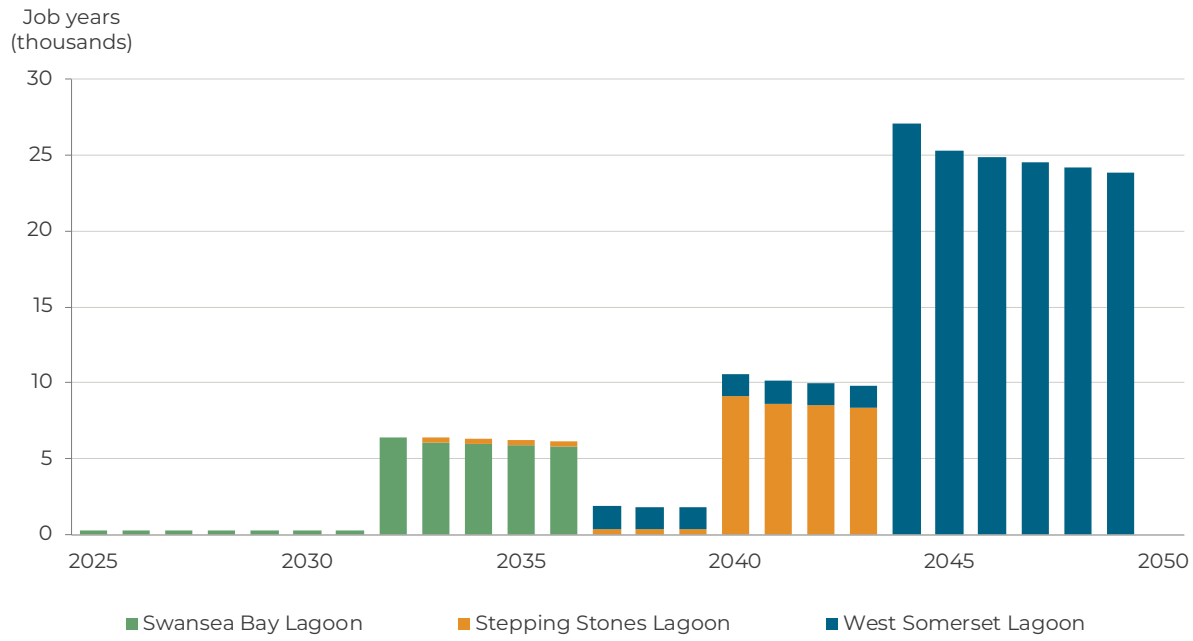
An illustrative multi project scenario has been modelled, incorporating the Swansea Bay, Stepping Stones, and West Somerset lagoons. The selection of projects is not intended to show any preference. In terms of implementation, a multi project scenario could

incorporate tidal range schemes outside the Severn Estuary, to support the development of a UK supply chain.

Figure 5.9 shows how a sequential multi project scenario could deliver impact over decades rather than years. As illustrated, this shows the development phase of subsequent projects overlapping with earlier schemes. No cost savings have been built into the modelling at this stage, this would require further technical analysis and is a potential area for further research. As illustrated the three scheme multi project scenario could deliver 179,000 cumulative job years during the development and construction phase across the UK under the worst case scenario, rising to 283,000 job years under the high scenario.

It should be noted there are potential supply chain complexities associated with a multi project scenario, particularly in terms of sequencing and timing, to keep production facilities and workforces efficiently utilised. Such challenges are exacerbated if the sequential approach is hoped to deliver design refinements, which will not be understood until earlier projects are operational.

Figure 5.9 Illustrative Sequential Lagoon Scenario, Annual Employment Impacts at UK Level



Source: Oxford Economics

Summary

There are significant economic opportunities presented by the development of tidal range projects in the Severn Estuary. Despite the lack of up-to-date, project-specific data for the six example projects, the economic modelling, supported by stakeholder engagement, has provided valuable insights into the scale of potential impacts.

The analysis indicates that whilst substantial supply-side development will be necessary to deliver any of these projects, this offers a huge opportunity for both the supply chain and the workforce.

The development and construction phases of the projects are expected to generate significant employment opportunities. The projects vary in scale, with the smaller projects like Swansea Bay and Stepping Stones lagoons supporting around 30,000 – 40,000 job years, while the Cardiff-Weston Barrage, a mega project, could support almost 600,000 job years, making it comparable to some of the largest construction projects in Europe.

The economic impact will be distributed across various sectors, with the greatest effects anticipated in Manufacturing, Construction, Professional, scientific & technical services, and Wholesale & retail trade.

The majority of the employment impact is expected to be concentrated in the Severn Estuary area, with additional impacts in the rest of the wider Wales and South West region, and the rest of the UK. However, the location of manufacturing employment is relatively uncertain, which may contribute to a more distributed impact across the UK.

A multi-project approach could present a range of positive impacts including spreading capital expenditure over a longer period, enabling development of the UK supply chain, and offering longer-term career opportunities. However, it also presents challenges in terms of timing and sequencing if lessons from earlier schemes are to influence those that follow.

6. Core Effects – Supply Chain, Workforce & Legacy

This chapter includes a discussion of supply chain and labour force considerations, as well as consideration of the potential longer-term economic legacy.

This chapter draws on a substantial programme of stakeholder consultation with a wide range of relevant consultees, supplemented with additional desk top analysis[41].

Chapter Headlines

- There are significant **supply chain** development opportunities for the Severn Estuary area, wider region and UK.
- To capitalise on these opportunities will require strategic and coordinated action, including very clear signalling from UK Government.
- Securing UK and local content, to maximise the economic benefits of investment, will also require appropriate contractual models and incentives.
- There is a degree of cynicism within the supply chain following previous tidal range schemes which did not move forward. However, industry consultees are confident that industry will step up to the challenge.
- A multi project scenario offers a more attractive investment proposition for supply chain companies to scale and establish within the UK.
- The significant **employment opportunity** associated with the development and construction of tidal range energy will be across a wide range of sectors, occupations and skill levels.
- The renewable energy sector is already facing a significant skills shortage. A concerted effort will be required to meet the workforce demands.
- The lack of coordination and scale in skills and workforce development activity is highlighted as a challenge that needs to be overcome.
- The experience of Hinkley Point C is a positive example of how supply chain and workforce development can be catalysed to capture benefit within the region.
- Longer term economic opportunity is expected to be concentrated in the export of knowledge and expertise.

Supply Chain Issues

Expanding the renewable energy sector, particularly to support the development of tidal range projects, presents significant supply chain opportunities within the UK. Figure 5.1 set out the potential opportunity associated with securing increased UK content within the supply chain. The high scenario delivers around 60% greater employment and GVA impact compared to the worst-case scenario. However, capitalising on these opportunities will require strategic action and coordination among stakeholders.

The current supply chain for tidal range projects is recognised by stakeholders to be limited (both globally and within the UK), and will require significant investment to scale-up and

[41] Sources include: various academic and research publications – journals and research papers provide case studies, environmental impact assessments, and technology discussions for tidal lagoons in areas such as the Bay of Fundy, South Korea's Sihwa Lake, and France's Rance Tidal Power Station. Various National and Regional Renewable Energy Agencies – Localised research and feasibility studies from countries with significant tidal resources (e.g., Natural Resources Canada, South Korea's Ministry of Trade, Industry and Energy) offer region-specific data on tidal energy potential and ongoing projects.

adapt to deliver any of the example projects. This includes both the capability and capacity to deliver large-scale marine civil engineering and turbine/electrical components. Within the UK this would require a range of supply chain development support. Stakeholders indicated that whilst there would be substantial activity within the Severn Estuary area to develop and construct any of the example projects, supply chain development would be a UK-wide issue, particularly as the key focus will need to be scaling-up existing companies that possess the right capabilities, rather than developing new start-ups[42].

Some stakeholders suggested that close to 85% of supply chain expenditure could be captured within the UK. Others were more circumspect, but noted that as a large civil engineering project, a lot of economic activity would be, and could be, undertaken locally. It was also highlighted that the lack of a significant, established global supply chain for tidal range energy infrastructure means there is an opportunity to develop the required capability within the UK, and the Severn Estuary area within that (unlike, for example, the offshore wind supply chains which were already well established in countries such as Denmark and Germany).

Two critical elements within the construction phase that will have material impact on the level of UK content secured are turbine production (including related electrical components) and caisson construction. Each of these key components is considered separately, alongside a general supply chain discussion below.

Securing UK and Local Content

The degree to which the UK and, within that, the Severn Estuary area economies can capture supply chain activity is reliant on a number of key factors.

Contractual requirements and incentives were cited by a wide range of stakeholders as the primary determining factor. It was repeatedly noted that *"industry will find a way"* to meet the specification as outlined, including levels of UK and local content. However, it was stressed that this will have cost (and possibly timetable) implications in comparison to a more flexible approach to where component manufacture and assembly takes place. Without contractual requirements to deliver particular levels of UK and local content, i.e. left to the market alone, it was clearly indicated that cost would become the primary determinant, coupled with existing supply chain arrangements. This would likely deliver substantially less UK content, particularly in terms of component manufacture and assembly (e.g. for turbines, where none of the major turbine manufacturers have UK production facilities or established supply chains at present).

Related to contractual requirements, many stakeholders indicated that mechanisms such as Contracts for Difference (CfDs) would likely deliver lower levels of UK content than desired due to a significant focus on price, as well as wider challenges related to project risk. A wider discussion of contractual and financing models is a separate workstream under the Commission and is not explored in great detail here.

Confidence and certainty in a pipeline of opportunities was also highlighted as critical. The impact of the Swansea Bay Tidal Lagoon project failing to progress after significant investment by a number of key supply chain companies has led to a loss of confidence

[42] The scale, capability and quality assurance requirements within the supply chain were indicated to be a significant barrier to start-ups and be far better suited to organisations with existing expertise and capability that can be scaled to meet the requirements of a tidal range energy project.

regarding tidal range project developments progressing in the UK. Almost all stakeholders highlighted the need for very clear signalling from UK Government to unlock the required supply chain investment. At present the National Energy System Operator (NESO) has identified 3-5GW of tidal range and stream energy generation in the UK by 2050[43], which is not viewed as offering the level of commitment to tidal range energy at a scale required to unlock the level of investment required. Stakeholders noted that as a result of historic changes of attitude and policy within government, industry will continue to have reservations, knowing that for such a long-term project, changes in the party of government, or other changes in policy drivers create substantial investment risk.

In addition to confidence in the UK's commitment to tidal range energy, suppliers indicated that a **pipeline of projects** would be clearly advantageous to the business case for investing in new capability and capacity within the UK. Some consultees had significant reservations about whether the required return-on-investment could be achieved for a single tidal range project. One consultee noted *"we have to build a few lagoons for this to make sense; these cannot be looked at as isolated projects"*. As noted previously, the proposed sequence of lagoons by Tidal Lagoon Power underpinned the UK content assumptions and investment proposals associated with the Swansea Bay Lagoon. Without clarity and confidence, there will be both risks to the level of UK content that can be realistically achieved, and/or implications for project timescales as a result of insufficient preparatory investment.

Related to this, supply chains for critical and complex infrastructure are underpinned by **trusted relationships** that are developed over time. In many cases prime contractors already have established supply chains, albeit these would likely need to scale-up to deliver any of the example projects. Trust is particularly important for bespoke, sophisticated requirements that will be deployed in hostile marine environments. Building trust with new partners would require a range of actions including relevant accreditations and quality assurance. It was noted that a multi project scenario which allows capacity and capability within supply chains to be developed and scaled-up over time would create enhanced opportunities to achieve higher proportions of UK and Severn Estuary area content.

Certain **construction methodologies** increase the potential for non-UK content (e.g. caisson rather than embankment construction methodologies for sea walls could enable higher levels of overseas content).

Stakeholders flagged potential supply chain risks and opportunities related to the **coordination** of tidal range and other major infrastructure such as FLOW[44,45]. Without effective coordination it is feared that competition for resources will lead to sub-optimal outcomes and higher costs. The opportunity to deliver infrastructure in a more collaborative and coordinated way was promoted by stakeholders. However, this was recognised as complex, and no single, obvious coordinating body was proposed.

[43] NESO, 2024. Future Energy Scenarios: ESO Pathways to Net Zero. Available at: https://www.neso.energy/document/321041/download. Accessed January 2025.
[44] Other examples of billion pound infrastructure schemes included the tail end of the HPC project, TATA regeneration at Port Talbot, investments in Sustainable Aviation Fuel, Port Talbot port development, Milford Haven Carbon Capture and Storage investment, Small Modular Reactors and others.
[45] Port capacity, with a requirement for significant laydown areas for construction and marshalling of components, is clearly recognised as a key issue to enable marine renewables construction projects. There are already proposals for FLOW supporting infrastructure development at Port Talbot and Bristol ports. Key port operators do not currently have active plans to support tidal range development given the lack of certainty.

It was widely recognised that the level of current preparatory investment and activity, for the wider renewables and infrastructure sector as a whole, let alone tidal range, is insufficient. As one stakeholder stated, infrastructure development is *"putting a big strain on supply chains with low anticipatory investment"*. Adding to this risk, it was noted that the decarbonisation and energy transition agenda is international. As a result, there is a global competition for components, production capacity and parts. This is framed as both an opportunity (to develop domestic capability) and a threat (e.g. driving costs up, impacting construction timescales and hindering access to migrant workers).

Hinkley Point C Supply Chain Outcomes

The experience from Hinkley Point C (HPC), within the Severn Estuary area, has shown that high levels of local, regional and UK content can be achieved. A detailed case study of the socio-economic impacts of the HPC construction to-date is attached at Appendix 2. Specific to supply chain development, a concerted effort to build local capability has been undertaken. This has led to very positive outcomes, with EDF indicating that participating businesses will be able to participate in future major nuclear infrastructure projects such as Sizewell C. Key highlights from the latest impact report include:

- Significant (10x) growth in medium sized businesses and double the employment growth in Sedgemoor (closest local authority area) when compared to the South West regional average.[46]
- Significant growth in large companies setting up, expanding and moving to Somerset.[46]
- Local and regional supplier registrations and the number and value of contracts awarded to companies in the region exceeded or were on target to exceed the targets set.[46]
- The total value of contracts placed with businesses in the South West region is estimated to reach a total of £7.3bn by the end of the construction period (£5.3bn to date), far exceeding the £1.5bn target.[47]
- It is estimated that 64% of the value of HPC supply chain contracts will go to British companies. There are currently 3,800 British businesses in the HPC supply chain, and the project will support 71,000 jobs across Britain by the end of construction.[48]
- Supply chain expenditure has been recorded in every region of the UK, illustrating how large infrastructure projects can have impact across the whole nation.

Turbine Manufacture and Assembly

There is currently a limited number of manufacturers globally which are active in the market for the type of turbines suitable for tidal range infrastructure. Two of the key manufacturers (GE Vernova and Andritz) have been consulted as part of this research.

[46] EDF, 2024, New Skills, Better Jobs: Socio-Economic Impact Report 2024. Available at: https://www.edfenergy.com/media-centre/new-skills-better-jobs-report-reveals-positive-impact-hinkley-point-c Accessed January 2025.
[47] Oxford Brookes University, 2024. Hinkley Point C Peak Construction: Impacts Monitoring and Auditing Study (2023-24). Available at: https://www.suffolk.gov.uk/asset-library/Final-Report-HPC-Peak-Construction-Nov-2024.pdf. Accessed January 2025.
[48] EDF, 2024, New Skills, Better Jobs: Socio-Economic Impact Report 2024. Available at: https://www.edfenergy.com/media-centre/new-skills-better-jobs-report-reveals-positive-impact-hinkley-point-c Accessed January 2025.

Current Production Approaches

The turbines used in large hydropower projects such as tidal range energy schemes are large, complex machines that require a high level of skilled and bespoke engineering. These are not quickly acquired skills and capabilities, which makes scaling-up of production capacity a complex, time consuming and expensive process. Because the turbines have to be trusted to operate in a hostile marine environment for a long project life, manufacturers want to work with established and trusted supply chain partners.

At present none of the key manufacturers are producing turbines in the UK. GE Vernova have a primary manufacturing plant in Brazil, with Andritz utilising workshops in Germany and Austria. It was noted that their existing, trusted supply chains are largely outside the UK.

Establishing New Facilities

It was noted that whilst new manufacturing facilities could be developed in the UK, the workshop requirements to produce 8 metre turbines would require a massive investment and would need a guaranteed, financed pipeline of work to justify and de-risk (i.e. multiple projects). Another key question is around the availability of the required skills in the labour force at a reasonable cost. This would require significant due diligence work and long lead times. Costs of production in the UK were recognised to be much greater than for non-UK options.

Rather than establishing turbine manufacturing plants within the UK, there may be potential to establish an assembly plant (predicated on a sequence of lagoons). This was the proposed approach developed for the TLP proposed Swansea Bay Lagoon[49] [50]. The complete turbine and housing mechanisms are large and complex, with potential for UK production of some components as well as assembly.

For Swansea Bay, around 50% of the turbine content was identified to be delivered by UK based suppliers, alongside 100% of the generators. However, it was noted that the due diligence work was undertaken 10 years ago. Whilst assumptions were robust at that time, this would need to be revisited. Multiple stakeholders indicated that the UK had lost some of the capability identified for the Swansea project.

Market Capacity

As noted earlier in this chapter, the example projects are very different scales. This also applies to the number of turbines anticipated. Figure 6.1 illustrates the number of turbines stated within the designs for each of the examples, as well as for the two existing tidal range schemes, at Sihwa Lake and La Rance, and the proposed Mersey Tidal Barrage. The Swansea Bay Lagoon, Shoots Barrage, and Stepping Stones Lagoon (estimated) each require up to 30 turbines. The larger lagoon proposals at Cardiff and West Somerset require approximately 110-130 turbines, and the Cardiff -Weston Barrage would require 260

[49] CITB and Whole Life Consultants Ltd, 2016, commissioned by the Welsh Government. 'A study to determine the construction labour and skills demand, supply and gaps associated with the creation of the Swansea Bay Tidal Lagoon'. Available at: https://www.citb.co.uk/media/fjrheftn/swansea-bay-tidal-lagoon-jul16.pdf. Accessed January 2025.

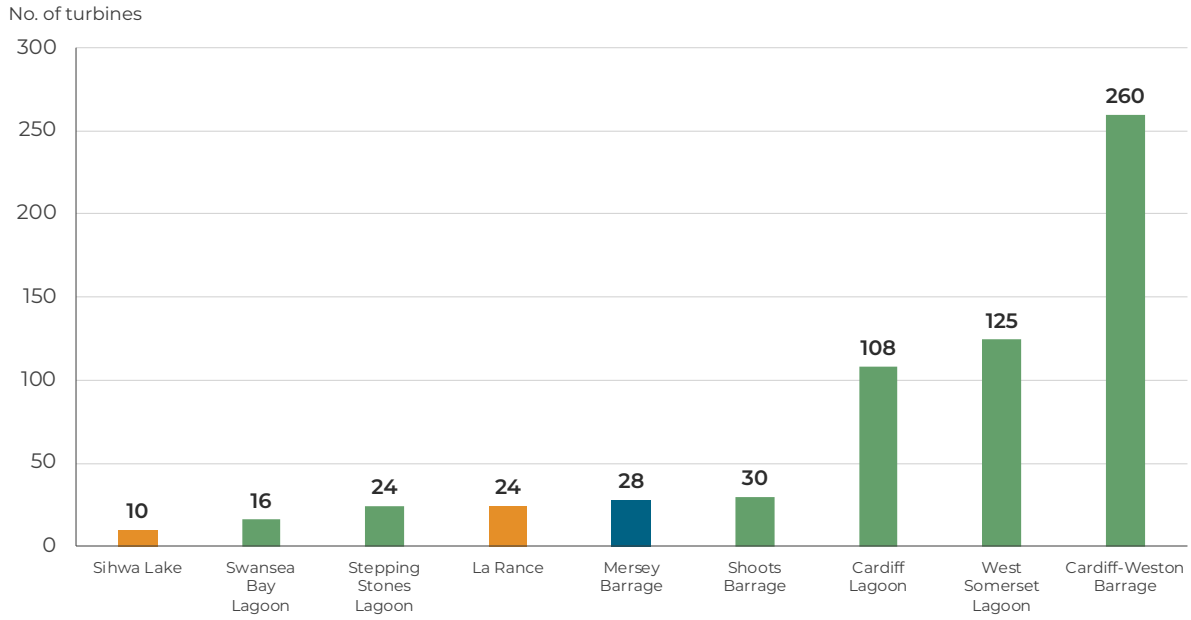
[50] Miller Research and Semta, 2016, commissioned by the Welsh Government. 'A study to forecast the manufacturing and labour requirements for the Swansea Bay Tidal Lagoon'. Available at https://businesswales.gov.wales/skillsgateway/sites/skillsgateway/files/documents/sq_-_sbtl_manufacturing_study.pdf. Accessed January 2025.

turbines. These figures should be considered in the context of around 400-450 turbines of this style installed globally across a range of hydro power schemes.

Even the smaller schemes were described by consultees as "large" projects for individual producers, and are considerably larger than Sihwa Lake and La Rance. Beyond 20-30 turbines, it was noted that it would require the prime manufacturers working in consortia with each other to mitigate risk and meet the scale of requirement. Whilst the large lagoon schemes were not discussed explicitly, schemes requiring above 100 turbines will fall into a category requiring all the major global manufacturers, and may require additional global manufacturing capacity.

When discussed with the turbine manufacturers, both consultees struggled to comprehend how the market could respond to a requirement as large as the Cardiff-Weston Barrage. The scale, risk, and complexity are all considered very large. There was agreement that a scheme of this size would require new suppliers, and in reality, involvement from Chinese manufacturers. This raises a series of issues 1) this would negatively impact the overall proportion of UK content[51], 2) China is currently not engaged in export activity into the global hydro turbine market due to a domestic focus, so a change in approach would be required and there is no certainty this would be forthcoming; and 3) there are political questions over UK Government openness to Chinese involvement in UK energy infrastructure projects. In combination, there are some significant delivery risks associated with the scale of turbine requirements for the Cardiff-Weston Barrage.

Figure 6.1 Number of Turbines Required in Tidal Range Projects



Source: HJA based on publicly available documentation and WSP Evidence Base.

Capacity to deliver for tidal range schemes will also be dependent on order books. Failure to secure sufficient capacity in a timely manner will have potential implications for project timescales. Consultees reported that Pumped Storage Hydro (PSH) schemes are currently struggling to secure interest from turbine manufacturers, let alone secure orders. This was confirmed by the manufacturers. However, there is some evidence that the domestic

[51] This has been factored in to the assumptions used within the economic modelling for this study.

Chinese demand may be reducing and hence some Chinese capacity may become available.

It was noted that the schemes of up to 30 turbines are serious projects, but not large enough to propose reworking the entire supply chain and production approach. The example of PSH was given, where projects totalling 5-6GW have not been deemed sufficient to change production schemes or needing to add capacity. In effect, this scale of demand could be delivered by the existing market. Consultees did not clarify what scale of pipeline demand might be required to build industrial production within the UK.

A significant question arising from this research is the likely availability of workshop/production capacity to deliver anything but the smaller schemes in a timely manner[52]. Even where capacity does exist, there is no guarantee that UK tidal range schemes would be able to secure all of it. This can be considered as either a challenge (to project delivery) or an opportunity (for establishing new UK capability).

Notwithstanding the issues set out above, consultees were confident that industry would find a way to respond to confirmed, financed proposals, in line with the contractual specifications. The key balancing factors to achieve both scale and UK content would likely be cost and timescale.

Caisson Production and Civil Engineering

In common with turbine manufacturers, industry consultees related to the civil engineering elements of delivering a tidal range project in the Severn Estuary were confident that the market would respond to the scale and nature of any contractual requirement, although it would require a scaling-up of existing capacity and capability in order to deliver it. In keeping with wider supply chain issues, the need for clarity, certainty, and sufficient lead times to ensure sector readiness was stressed as a critical factor.

In line with previous supply chain studies, the challenges around port capacity and the scale of caissons required were acknowledged, but not deemed insurmountable challenges. Two Tier 1 civil engineering contractors (Kier and Tarmac[53]) indicated a preference to produce caissons as close to any project(s) as possible. The potential to develop temporary fabrication facilities on floating quaysides was proposed if there are limitations on the capacity or availability of port infrastructure within the estuary. This was indicated as a proven feasible approach.

The experience of Hinkley Point C, delivering large concrete structures for marine use, was cited as evidence of the capability to undertake similar work within the Severn Estuary area. Whilst it was acknowledged it could be possible for caissons to be manufactured elsewhere in the UK or overseas and floated into position, this was clearly viewed as a sub-optimal approach, particularly in anticipation of contractual requirements incentivising local content.

[52] Department of Energy & Climate Change, South West RDA & Welsh Assembly Government, 2010. Severn Tidal Power Project Supply Chain Survey. Available at: https://assets.publishing.service.gov.uk/media/5a79c35bed915d042206adb1/20._Supply_Chain_Survey_Report.pdf. Accessed January 2025.

[53] Tarmac were consulted as part of supply chain research being undertaken by the Offshore Renewable Energy Catapult.

The potential competition for resource (labour, ports, equipment) with other major infrastructure projects was explored with consultees. The desire to see coordination that fosters collaboration rather than competition was universal. Notwithstanding, there was recognition that the UK has delivered a range of large projects such as HPC and Crossrail, and the civil engineering sector has been able to source the required workforce, showing resilience in the face of challenges such as Brexit which reduced the number of EU workers in the sector within the UK.

A multi lagoon scenario, delivering a pipeline of opportunities was identified as a helpful way to secure efficiencies and the return-on-investment that would be required to prepare the sector for projects of this nature.

Appendix 3 to this report sets out a summary of supply chain development activities currently being delivered to support the offshore renewables sector more generally. Stakeholders were typically of the view that this activity was helpful but too piecemeal in nature. A specific focus for tidal range, drawing on similar principles would be required to meet the needs of even the small projects if the UK is to realise the full potential of capturing supply chain content.

Employment and Skills

Scale of Workforce Demand

The economic impact analysis in the previous chapter set out the potential for significant employment opportunity associated with tidal range energy development within the Severn Estuary area and across the UK. The need to develop the supply chain, and the significant proportion of employment within the Manufacturing sector is such that the exact scale and location of employment opportunity is uncertain.

Under the worst-case scenario, and the smallest project (Swansea Bay Lagoon), it is estimated that during the development and construction phase there will be 12,600 job years of employment in the Severn Estuary area, with a further 9,200 elsewhere in the UK. These figures increase to 21,700 and 12,800 under the high UK content scenario. The average annual job years in the Severn Estuary area is around 4,300 job years for the high scenario. This equates to around 0.2% of the current estimate of total jobs in the Severn Estuary area.

For the largest project (Cardiff to Weston Barrage) the scale of workforce requirement is vast, with 227,400 job years in the Severn Estuary area, and a further 175,500 job years elsewhere in the UK under the worst case scenario; rising to 401,300 and 252,300 under the high UK content scenario. The average annual job years in the Severn Estuary area is around 45,000 for the high scenario. This equates to around 1.6% of the current estimate of total jobs in the Severn Estuary area.

The most significantly impacted sectors are anticipated to be Manufacturing and Construction.

As set out in the baseline chapter, the Manufacturing sector in the Severn Estuary area is relatively large with around 230,000 workers, accounting for 8% of employment. The sector is forecast to decline in employment terms over the next five years with a potential reduction of 16,500 jobs. Tidal range energy would present a significant driver of manufacturing demand, which would present an opportunity for those working in the

sector to be supported into new roles. The 'small' projects are estimated to support around 1,600 manufacturing job years per annum under the mid-point scenario; the medium sized projects 5,000 to 6,000 job years per annum; and the Cardiff-Weston Barrage mega project 13,000 manufacturing job years per annum.

The Construction sector employs an estimated 180,000 workers in the Severn Estuary area, or 6.4% of the workforce. However, the civil engineering sub-sector is relatively under-represented in the area. Oxford Economics forecasts growth of 17,700 jobs over the next five years for the sector, without taking into account any tidal range energy infrastructure development. The 'small' projects are estimated to support around 500 to 1,000 construction job years per annum under the mid-point scenario; the medium sized projects 2,500 to 3,500 job years per annum; and the Cardiff-Weston Barrage mega project 6,000 construction job years per annum in the Severn Estuary area. The smaller projects are relatively modest in scale in comparison to the existing sector and forecast job growth, but the medium and large projects are of a more substantial scale.

Wider Renewable Energy Workforce Demand

The evidence, including the consistently reported views of stakeholders, indicates that the renewable energy sector is facing a significant challenge in terms of a massive skills shortage that threatens the successful implementation of future projects. This goes beyond tidal range, but is highly relevant context. As one stakeholder stated *"(we are) staring down the barrel of massive skills shortages across the renewable energy sector. Not enough is being done to increase the level of required skills across the board!"* another indicated that *"we don't have nearly enough capacity and not enough is being done to encourage young people to become Civil Engineers. We don't have the workforce"* and went further to note that *"the scale at which we are encouraging people is so miniscule compared to what needs to happen. I cannot see how any of these projects are going to be enabled. A lot more coordination is needed."*

The current workforce is clearly insufficient to meet the demands of pipeline projects across the sector, and stakeholders consistently reported that not enough is being done to encourage young people to pursue careers in civil engineering and related fields. To address this, a concerted effort from both government and industry is required to increase the level of required skills across the board. Appendix 4 to this report sets out a more detailed analysis and discussion of the issues around current workforce and skills shortages.

Supporting Workforce Growth and Development

A major issue identified by stakeholders is the lack of coordination in skills and workforce development. The speculative nature of many projects is leading to a reluctance to invest in workforce development. However, the range of major infrastructure projects across Wales, the South West, and the Severn Estuary area in particular, presents an opportunity to train a workforce that can move from scheme to scheme. Utilising this workforce effectively and efficiently will require careful coordination.

It is also clear that stakeholders are keen to be involved to support tidal range projects, and have a range of good practice to draw on from other large projects in the Severn Estuary area. This would involve upskilling existing workforces, supporting worker transition from other related sectors, and attracting and equipping new entrants to engineering and construction related activities. Stakeholders were encouraging of efforts to boost

coordination of skills and training interventions across the Wales-England border to maximise impact across the Severn Estuary area.

Effective coordination and sequencing of projects can ensure a steady pipeline of work and a skilled workforce ready to tackle new challenges. This also presents real career opportunities for new entrants to the sector, which was flagged by stakeholders as a key element of the pitch to younger people, who want to see a longer-term future and not just a short -erm job. It was also noted that the potential to be engaged in tackling climate change is also an important driver for attracting younger people into the sector. Consultees also indicated a multi lagoon project, providing clear long term career development as potentially helpful. With the right communication (including active engagement of careers guidance professionals), and with activity at the right scale, there is an opportunity to grow a workforce within the Severn Estuary area that can support the full range of future projects.

The other element required to enable the skills and training sector to respond is clarity over the exact skills requirements that will be needed. This will require further research as any potential project(s) progress.

The UK education and skills landscape was criticised by stakeholders for its academic focus and low priority on apprenticeships and vocational skills. Addressing this requirement will need a shift in how education and training are approached, with a greater emphasis on skilled trades. This is a strategic issue well beyond the scope of tidal range infrastructure alone.

With regards to meeting the specific needs of tidal range infrastructure development, it was highlighted that in many cases the skills requirements could be met through adaptation of existing courses, e.g. by adding specific modules to marine construction, rather than wholesale changes. The UK and regional strengths in maritime training were highlighted as a key asset in this regard, if the right coordination can be achieved.

Notwithstanding, industry stakeholders, including Tier 1 contractors, were confident that solutions would be found to meet workforce demands for tidal range projects, and the wider renewable energy and other infrastructure projects. It was noted that the construction sector has shown resilience in meeting labour demands and delivering major infrastructure in the face of various challenges, not least Brexit. This is borne out by the data from the ONS Vacancy Survey showing the levels of reported vacancies in manufacturing, construction, electricity, gas, steam and air condition supply sectors all well below peak levels in the last 20 years. Consultees were unable to identify any major schemes that had not progressed because of workforce shortages.

Hinkley Point C (HPC) was flagged as a good example, with the required workforce sourced, even with peak construction exceeding expected levels.[54] However, it should be noted that HPC has utilised a lower proportion of local resident workers than initially expected. A range of potential reasons for this have been cited including lack of awareness and cost pressures. The potential to utilise the legacy workforce from HPC was also highlighted as an asset to the Severn Estuary area, with skilled workforces from other relevant infrastructure projects such as Pump Storage Hydro also an opportunity.

[54] Oxford Brookes University, 2024. Hinkley Point C Peak Construction: Impacts Monitoring and Auditing Study (2023-24). Available at: https://www.suffolk.gov.uk/asset-library/Final-Report-HPC-Peak-Construction-Nov-2024.pdf Accessed January 2025.

The experience from HPC shows the importance of early warning and planning to maximise local impact. It was reported by stakeholders that delays at the outset of the HPC project were fortuitous for skills development, as without them the workforce would have been unprepared. It was also noted that EDF, as the developer of HPC took a strong lead in coordinating and investing in the skills and training infrastructure. The HPC case study at Appendix 2 highlights the positive skills outcomes that have been delivered, with apprenticeships a highlight, far exceeding targets and expectations. EDF has also won a series of awards for its schools engagement work, and other workforce related interventions. The project is also leaving a lasting legacy in terms provider capacity, and workforce development. Development of tidal range projects in the estuary will support training providers in the region becoming real centres of excellence in this field.

In keeping with supply chain issues, early warning and confidence are clear requirements of stakeholders. This is relevant to both engagement of future workers and generating provider readiness. At the population level it takes time to change hearts and minds. At the sector and provider level, early warning can ensure that the opportunities arising from tidal range energy projects are fed into sector skills plans and the like. An infrastructure sector skills plan is currently under development in response to the lessons from HPC, where industry was not sufficiently aware in a timely manner. These clear markers of intent will be the triggers for the skills and training sector as well as the construction and civil engineering industry to prepare itself for the opportunities.

While the focus is often on job creation, there is also potential for technological advancements to play a role in addressing skills shortages. The use of autonomous survey vessels and new generations of AI and technologies throughout the supply chain can drive productivity gains and innovation. This aspect of technological change is crucial for the future of the renewable energy sector.

Sector Development Legacy

It will be important to capture a supply chain, skills and expertise legacy beyond the construction and installation phase. The general view of stakeholders, supported by the wider evidence, is that future opportunities will be concentrated in the development and export of knowledge and expertise, rather than large scale, ongoing production.

Both documentary evidence and stakeholder opinion suggests the global market for tidal range energy schemes is limited[55,56,57,58]. Whilst tidal range energy is able to deliver a predictable and reliable energy source, and climate goals and the desire for energy security are changing the context, there are relatively few locations globally that have the required tidal conditions (e.g. UK, Canada, France, South Korea and parts of China)[59]. In addition, the technical challenges and environmental conditions in such locations become a further

[55] Marine Energy Wales, 2023. State of the Sector. Available at: https://www.marineenergywales.co.uk/wp-content/uploads/2023/06/MEW-2023-State-Of-The-Sector-Report.pdf. Accessed January 2025.
[56] International Renewable Energy Agency, 2025. Ocean Energy Reports. Available at: https://www.irena.org/Publications. Accessed January 2025.
[57] World Energy Council, 2025. Various sources. Available at: https://www.worldenergy.org/publications . Accessed January 2025.
[58] UK Department for Business, Energy & Industrial Strategy (BEIS), 2025. Various sources and case studies related to tidal lagoon projects.
[59] It is acknowledged that technical innovations could increase the number of areas where tidal lagoons could be feasible.

barrier, evidenced by the presence of only two operational tidal range schemes of significance at the current time.

The same issues of cost competitiveness, and a desire to utilise major infrastructure investment to support local, regional and national economic growth will also be at play in other countries as it is in the UK. The relatively high cost of manufacturing within the UK therefore reduces the potential for a substantive ongoing production role within global supply chains.

However, the expertise acquired through the development of tidal range infrastructure within the UK, and particularly the Severn Estuary area has both export potential, and the opportunity to become a driver of wider local and regional economic development. This will apply across a wide range of activities including research, skills development, professional services, engineering, and other commercial activities.

The European Marine Energy Centre (EMEC) in Orkney was highlighted as a relevant example in this regard. Whilst not focused on tidal range technologies, the experience of EMEC demonstrates how being at the cutting edge of a relevant field can create an asset that drives wider economic development. Further details are set out below.

European Marine Energy Centre (EMEC)– Orkney

Background

The EMEC is a leading test centre for marine energy which began operating in 2003, with £30 million of funding[60], offering purpose-built, open-sea testing facilities for prototype technologies, helping to facilitate the development of new wave and tidal industries. To date, around £42 million of public investment has been made in EMEC[61].

The EMEC operate two open sea, grid-connected, accredited test sites for testing larger marine energy prototypes:

- Billia Croo wave test site (near Stromness)
- Fall of Warness tidal test site (off the island of Eday)

Two smaller scale non-grid-connected test sites are in operation to test smaller scale devices or devices at an earlier stage in their development:

- Scapa Flow wave test site (adjacent to the Orkney mainland, south of Kirkwall)
- Shapinsay sound tidal test site ((adjacent to the Orkney mainland, north-east of Kirkwall)

Whilst the EMEC focuses on wave and tidal stream energy in the UK, the centre has undertaken other research and demonstrations on green hydrogen, storage solutions, smart local energy systems, transport and heat.

EMEC also has a number of offices and data acquisition facilities, including areas dedicated to specific developers in Stromness. Highlands and Islands Enterprise (HIE) have also built six industrial units for developers testing at EMEC sites, offering workshop, storage and office accommodation and a logistics base.

[60] Funding provided from the Scottish Government, Highlands and Islands Enterprise, the Carbon Trust, the UK Government, Scottish Enterprise, the European Union and Orkney Islands Council.
[61] European Marine Energy Centre, 2023/2024. Website – various pages. Available at: https://www.emec.org.uk/. Accessed January 2025.

More marine energy devices have been tested at EMEC than at any other single site in the world. By 2019, EMEC had hosted 20 wave and tidal energy clients (with 31 marine energy devices) spanning 11 countries.

Economic Impact

An economic impact assessment which examined the EMEC's activities from 2003 to 2023 found that the creation of the EMEC, and the subsequent activities have delivered £370 million of gross value add (GVA) to the UK economy. £130 million of this was accrued in the Orkney Islands where the EMEC is headquartered62.

The EMEC is one of the top 20 employers in Orkney. In 2023, EMEC employed around 85 members of staff, and it is estimated that over the 20-year period, EMEC has supported 224 jobs in Orkney, 406 jobs across Scotland, and 540 in the UK as a whole.

The employment generated by the EMEC comprises high skilled and high value jobs, with average earnings of EMEC staff being higher than the Orkney average.

A highly skilled local supply chain has also built up around EMEC. It is also a core tenant of the Orkney Research and Innovation Campus, and its collaborative research and development activity has forged many international partnerships.

An earlier 2019 impact study63 also reported that between 2003 and 2017 visits to Orkney to see EMEC's facilities and the support services available in Orkney have totalled around 5,250 visitor nights.

Wider impacts that have also been linked to the EMEC facilities and services and associated marine energy development include:

- Population growth related to the employment growth, sustaining services in Orkney's rural communities.
- An increase in average earnings, encouraging young people to stay in Orkney or return.
- Benefits to other users from harbour developments and to other renewable energy producers from grid upgrades.
- A raised profile for the University of the Highlands and Islands in Orkney and Heriot-Watt's International Centre for Island Technology campus.

Future developments

The UK Government is providing £3 million to fund and support EMEC's growth plans over a two-year period. The funding will support EMEC to contribute to meeting the UK's net zero ambitions and increase innovation and investment in research and development.

The EMEC growth plans include expanding test facilities to support various tidal energy arrays, as well as developing other decarbonisation projects such as green hydrogen, storage, and offshore wind.

The EMEC has been exploring options for developing a national floating offshore wind (FLOW) test site to the west of Orkney. This would offer FLOW developers an opportunity to

[62] European Marine Energy Centre, 2023. 20 years of EMEC instigates UK wide economic impact. Available at: https://www.emec.org.uk/20-years-of-emec-instigates-uk-wide-economic-impact/. Accessed January 2025.
[63] European Marine Energy Centre, 2019. EMEC Socio-Economic Report. Available at: https://marine.gov.scot/sites/default/files/8._emec_socio-economic_report_rep659.pdf. Accessed January 2025.

test their technologies that would be implemented in Scotwind, the Celtic Sea, and future leasing rounds.

The proposed test site will initially comprise four grid-connected berths for floating offshore wind turbines up to 20 MW and is designed for developers to de-risk their technologies by putting FLOW infrastructure in an energetic offshore environment. The proposed test site would help catalyse FLOW research and development and innovation, supporting future job creation and supply chain development. The proposed test site has the potential to generate £690 million GVA to the UK economy and create over 4,000 new jobs in the UK during its expected 25-year lifetime.

Summary

Supply Chain Issues

The expansion of the renewable energy sector, particularly through tidal range projects, presents significant supply chain opportunities for the Severn Estuary area, wider region and UK. However, capitalising on these requires strategic action and coordination among stakeholders. The current supply chain is limited and needs substantial investment to scale-up, especially in marine civil engineering and turbine/electrical components. Stakeholders emphasise that whilst substantial activity will occur within the Severn Estuary area, supply chain development is a UK-wide issue, with a focus on scaling existing companies rather than developing new start-ups.

Securing UK and local content, in order to maximise economic benefits of investment, will largely rely on contractual requirements and incentives. Without specific requirements, cost will become the primary determinant, potentially reducing UK content. Confidence in a pipeline of further opportunities is also critical, as the failure of the Swansea Bay Tidal Lagoon project has led to cynicism within the supply chain. Clear signalling and commitment from the UK Government is necessary to unlock the required supply chain investment.

The experience from Hinkley Point C demonstrates that high levels of local, regional, and UK content can be achieved with concerted efforts to build local capability. This has led to significant growth in local businesses and substantial contracts awarded to companies in the region and significant inward investment from outside the region.

Turbine manufacture and assembly present specific challenges, as there are limited manufacturers globally for turbines suitable for tidal range infrastructure. Establishing new manufacturing facilities in the UK would require a guaranteed pipeline of project demand and significant investment. Alternatively, establishing an assembly plant could be feasible, as proposed by the Swansea Bay Lagoon project. However, the UK has lost some of the capability identified in the Swansea project, and the market capacity to deliver large-scale projects remains a concern.

A multi project scenario potentially offers a more sustainable and deliverable socio-economic impact than a mega project such as the Cardiff- Weston Barrage. This provides the potential for a slower scaling of capability and capacity, reducing risk, and delivering beneficial impacts over an extended period.

Workforce Issues

The development of tidal range energy infrastructure within the Severn Estuary will support substantial employment activity across a wide range of sectors, occupational groupings and skill levels.

The renewable energy sector is facing a significant skills shortage, which poses a major challenge to the successful implementation of future projects, including tidal range initiatives. Addressing this issue will require a concerted effort from both government and industry to increase the level of required skills across the board.

A major issue identified is the lack of coordination and scale in skills and workforce development at present. The speculative nature of many projects leads to reluctance to invest in workforce development. However, if this can be overcome, with appropriate policy and other indications to give confidence, the range of major infrastructure projects across the Severn Estuary area and wider region presents an opportunity to train a workforce that can move from scheme to scheme. Effective coordination and sequencing of projects can ensure a steady pipeline of work and a skilled workforce ready to tackle new challenges.

The experience of Hinkley Point C shows that positive skills and workforce outcomes can be achieved with coordinated efforts. This has included apprenticeship levels far exceeding expectations (at close to 5% of the workforce), awards for schools' engagement, and significant investment in skills and training infrastructure. However, early preparation and investment is crucial. Delays in the HPC project were advantageous in this regard, but still the level of local workforce recruited to the project has fallen below target levels.

Sector Development Legacy

The longer-term opportunities arising from investment in tidal range energy activities within the Severn Estuary area and wider UK are expected to be concentrated in the development and export of knowledge and expertise rather than large-scale, ongoing production for a global market[64]. They will also be limited by the global market for tidal range energy schemes, which is recognised to be somewhat limited due to the specific tidal conditions required, which are only present in a few locations worldwide. Additionally, the technical challenges and environmental conditions in these locations pose further barriers.

Despite these limitations, the expertise acquired through the development of tidal range infrastructure in the UK, particularly in the Severn Estuary area, has export potential. This expertise can drive local and regional economic development across various activities, including research, skills development, professional services, and engineering. The European Marine Energy Centre (EMEC) in Orkney serves as a relevant example, demonstrating how being at the forefront of a field can create an asset that stimulates wider economic growth.

[64] Hendry, C., 2017. The role of tidal lagoons. Available at: https://hendryreview.wordpress.com/. Accessed January 2025.

7. Wider Effects

This chapter of the report considers the wider potential economic effects associated with the development of tidal range energy infrastructure in the Severn Estuary. This includes:

- Ports – considering the potential implications arising from impacts on shipping and navigation within the estuary, as well as opportunities to support the construction and maintenance of tidal range energy infrastructure.
- Aggregates and Commercial Fishing – considering other economic activities within the estuary.
- Tourism and leisure – considering the potential for new tourism and leisure development as well as potential negative impacts to existing tourism and leisure activities.
- Proximity to power generation – considering the potential economic effects of new power generation capability in the estuary to support economic development.

Chapter Headlines

- The **ports** within the Severn Estuary are significant economic infrastructure assets performing a regional and national role, supporting a combined 40,000 jobs and £3bn per annum of GDP.
- Whilst any disruption to port activities would likely be displaced at a UK level, there would be clear negative risks to the Severn Estuary area and wider regional economies.
- The greatest risk to ports is associated with the Cardiff-Weston Barrage. The lowest risk is associated with the Swansea Bay lagoon.
- Further technical work is required to assess the potential impact of other lagoon options, with divergence between the main port operators regarding their potential acceptability.
- There are potential positive commercial opportunities for ports in supporting the construction and operation of tidal range energy infrastructure.
- The **commercial fishing** industry in the estuary is relatively small but culturally significant. Environmental issues associated with fish populations are likely to be of more significance than the economic issues.
- There is an active **marine aggregates dredging** industry in the estuary. There is limited evidence of its economic value. Tidal range energy could have both positive and negative impacts.
- The Cardiff lagoon is the only example project that would include direct development over a licensed aggregate dredging area.
- There is evidence of increasing demand for aggregates to support the scale of infrastructure development planned across the UK.
- There are potential **tourism and leisure** opportunities arising from tidal lagoons and barrages. However, the scale of economic impact associated with this is relatively muted.
- The **abundant supply of low carbon energy** has the potential to support wider economic opportunities in the Severn Estuary area, particularly in energy intensive sectors. Further exploration of this opportunity is required.

Ports

The Severn Estuary is a significant shipping channel. There are a number of ports operating in the estuary which will potentially be impacted by tidal range energy infrastructure. There could be both negative and positive effects, for example through impacts on shipping, and opportunities to support the construction and operation of tidal range energy installations.

The most notable ports which have formed the focus of this research are:

- Bristol (operated by The Bristol Port Company).
- Newport, Cardiff, Barry, Port Talbot and Swansea (all operated by ABP).
- Sharpness Dock (operated by the Victoria Group).

This research has not included any new technical analysis of shipping, navigation, and hydrodynamics within the estuary. Shipping and navigation were considered in detail as part of the 2010 STPFS.

Previous Research

STPFS Navigation

The STPFS considered the potential effects of a broader array of tidal power projects on shipping and navigation. The analysis recognised the critical economic role of ports within the Estuary.

The assessment highlighted a range of potential risks including changes to tidal patterns, increased siltation and sedimentation, increased journey times, the need for route alterations and navigational hazards, but also potential opportunities for infrastructure development that would support maritime industries.

The assessment did not identify insurmountable risks for shipping and navigation, but acknowledged significant challenges. Tidal barrages were identified as likely to have more significant effects, particularly on transit times due to the need for vessels to navigate locks. Tidal lagoons were noted as less intrusive, providing greater flexibility for preserving existing shipping routes, although may create more localised impacts.

The need for comprehensive mitigation measures was emphasised, regardless of option. Identified mitigations could include enhanced navigational aids, careful project design, more frequent dredging and detailed stakeholder engagement. It was highlighted that comprehensive impact assessments should be undertaken to ensure challenges are addressed.

Hendry Review on Navigation

The Hendry Review also notes that tidal lagoons could impact shipping, navigation and ports. Primarily this would be through changes in tidal flows and potential obstruction to maritime routes. This includes changes to sediment patterns which could affect port access. Similar to the STPFS, the review highlights the need for thorough planning and detailed environmental assessments to minimise disruption, including consultation with port authorities and shipping operators. It also recognises that tidal lagoons might offer some opportunities for port infrastructure improvements.

Current Port Related Economic Activity

The identified ports handled a combined 19,400 tonnes of freight in 2023, 4.5% of all UK shipping freight. Timeseries data shows that these ports have accounted for ~4-5% of UK shipping freight for the last 20+ years. Stakeholders indicated that since the 2010 STPFS study freight volumes had not substantially changed, but there had been a gradual shift to larger vessels, but with fewer total vessel movements. Data from the Department for Transport suggests there has been slight decline in freight volumes, which is in keeping with the UK overall position. However, there can be quite significant year on year volatility in freight volumes[65].

Table 7.1 sets out summary statistics on vessel movements (arrivals) for Bristol, Cardiff, and Newport ports. The largest vessel category recorded by the Department for Transport (DfT) is 100,000+ deadweight tonnage (DWT[66]). There were no arrivals within this size category to any of the three major ports upstream of a Cardiff-Weston Barrage in 2023. There has been one recorded arrival of a vessel in this size category in the period 2017-23 which draws on the current statistical measurement. Over the longer time period of 2009-23 there have been 22 arrivals within this category. This includes 11 arrivals at Bristol Port in 2013 and eight arrivals at Cardiff Port in 2015. Whilst the statistics show there are occasional vessel arrivals in this largest category, they are not typical.

The 20,000 – 99,999 DWT category is relatively widely defined. In 2023 there were a total of 275 vessel arrivals within this category. 88% of these arrivals were into Bristol Port which shows a clear difference with the size of vessels arriving. Overall, 15% of Bristol vessel arrivals are in this category, compared to 7% at Newport and 0% at Cardiff. The total number of vessel arrivals within this category at Bristol Port has fluctuated over time. Over the 2009-2023 period which broadly aligns to the period since the STPFS was undertaken, arrival numbers have ranged from 202 to 412. The peak of 412 (in 2012) was a notable outlier. Over the narrower period of 2017-2023 using the latest statistical methodology, the number of arrivals ranges from 202 to 334, with a mean average of 268. Data on average gross tonnage in this category indicates average ship size of 44GT (Gross Tonnage)[67] in 2023, which is a fall of 5.1GT from 2017.

Whilst data on individual vessels is not available publicly, the summary data indicates larger vessel arrivals (above 20 DWT) occur less than once per day.

Figure 7.1 illustrates the pattern of all marine vessel movements in the Severn Estuary during 2023. The red coloured areas show high densities of movements. This shows hot spots of activity around the key ports and along the primary shipping channels within the estuary.

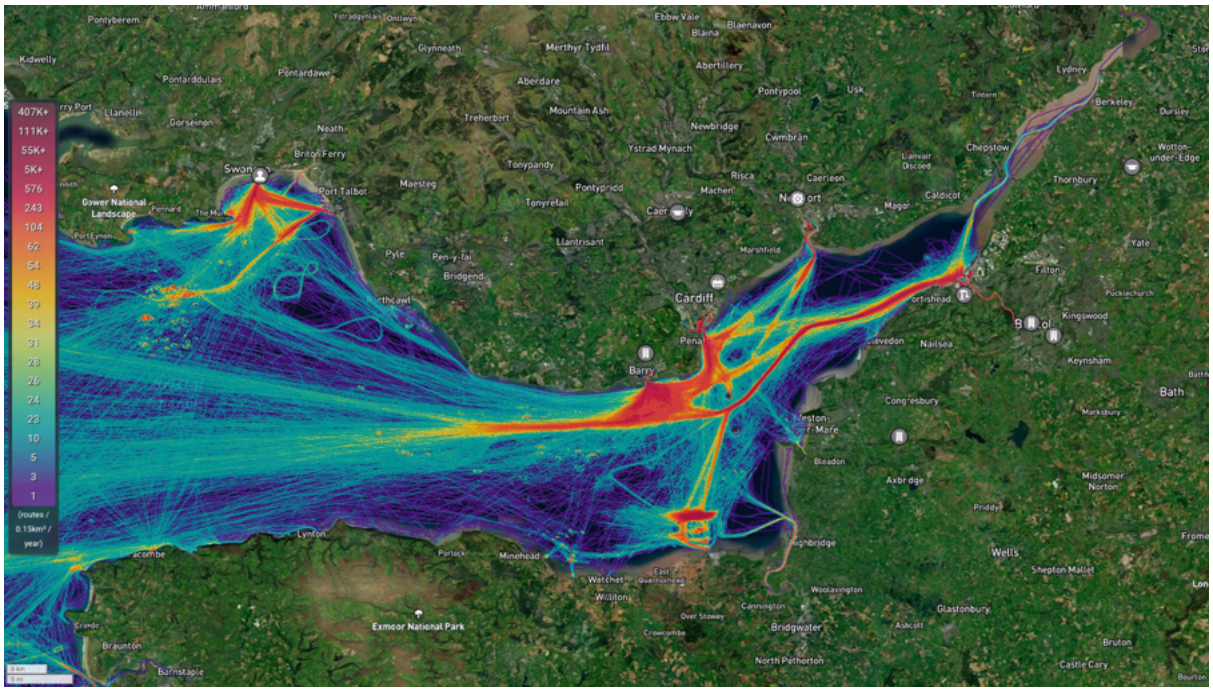
[65] A three-year rolling average was used to aid data interpretation.
[66] Deadweight Tonnage represents the total carrying capacity of a vessel.
[67] Gross Tonnage measures the overall size of vessels by internal volume, expressed in cubic metres.

Table 7.1 Summary Vessel Movement Statistics (size categories measured in deadweight tonnage)

Port	Number of Vessel Movements (arrivals) 2023	Change 2017-2023	Average Vessel Movements (arrivals) per day	Average Gross Tonnage per vessel (2023)	Change in Average Gross Tonnage per vessel 2017-2023
Bristol					
All sizes	1,659	-121	4.5	18.9	-1.0
1 to 4,999	664	-48	1.8	2.4	0.0
5,000 to 19,999	752	69	2.1	25.4	0.1
20,000 to 99,999	242	-92	0.7	44.0	-5.1
100,000+	0	0	0	-	-
Unknown	1	-50	0	0.5	0.4
Cardiff					
All sizes	283	-166	0.8	4.3	-0.2
1 to 4,999	197	-74	0.5	2.1	0.2
5,000 to 19,999	85	-92	0.2	9.3	0.8
20,000 to 99,999	1	1	0	15.5	-
100,000+	0	0	0	-	-
Unknown	1	-1	0	-	-
Newport					
All sizes	460	-458	1.3	4.6	0.9
1 to 4,999	340	-415	0.9	2.4	0.5
5,000 to 19,999	88	1	0.2	7.1	1.6
20,000 to 99,999	32	-42	0.1	21.5	1.4
100,000+	0	0	0	-	-
Unknown	0	-2	0	-	-
Combined					
All sizes	2,402	-745	6.6	14.4	1.5
1 to 4,999	1,201	-537	3.3	2.3	0.2
5,000 to 19,999	925	-22	2.5	22.2	1.9
20,000 to 99,999	275	-133	0.8	41.2	-2.6
100,000+	0	0	0	-	-
Unknown	1	-53	0	LOW	0.2

Source: DfT Maritime and Shipping Statistics (Table PORT0601), July 2024. The 2017-2023 period is used to align to a change in the method of statistical collection.

Figure 7.1 2023 Marine Traffic Density Maps



Source: Marine Traffic Density Maps[68] © Mapbox © OpenStreetMap

Ports are critical economic infrastructure, supporting a wide range of economic activity regionally and nationally and acting as hubs for manufacturing and logistics. Both ABP and The Bristol Port Company have commissioned economic impact studies of their operations which highlight the scale and reach of their operations[69]. The key findings of these studies are summarised in Table 7.2 below.

Through supporting import and export activities across a range of sectors, ports are a key facilitator of supply chains. The economic impact evidence demonstrates the high wage and high productivity nature of ports and their related activities.

The economic impact study of Bristol Port and its estate articulates the hub role that ports can play. Whilst The Bristol Port Company employs around 600 – 700 people directly, there are more than 6,000 jobs on its estate in Portbury and Avonmouth. 60% of these jobs are related to port and shipping operations, with the remaining 40% relating primarily to imported goods.

[68] Available at https://www.marinetraffic.com/en/ais/home/centerx:-3.3/centery:51.4/zoom:10. Last Accessed March 2025. Used with permission.
[69] The authors are not aware of and have not had access to equivalent research in respect of Sharpness Docks.

Table 7.2: Headline Economic Impact of Severn Estuary Ports

Port Operator	Key sectors of activity	Total employment supported	Total GVA/GDP[70] supported
Bristol Port	• Motor vehicles • Aviation fuel • Animal feed • Dry bulk	• 22,000 jobs in UK economy • 13,000 jobs in South West economy	• £1.4bn to UK economy • £0.8bn to South West economy
ABP South Wales (Newport, Cardiff, Barry, Port Talbot and Swansea)	• Steel • Agriculture and Forestry • Recycling • Construction • Industrial including Chemicals • Ship Repair • Energy Generation • Food & Drink • Automotive	• 21,000 jobs in UK economy, • 15,000 jobs in Wales.	• £1.4bn to UK economy. • £1bn to Wales economy.
Sharpness	• Shipyards • Aggregates • Agriculture • Leisure	• No data	• No data

Source: Oxford Economics/TBPC[71], Arup/ABP[72], stakeholder consultation

Future Proposals

Alongside continued enhancement of shipping and logistics operations, the port operators have developed a range of future development proposals, with a particular focus on supporting the UK energy transition and decarbonisation agenda. In particular:

- ABP is progressing the transformation of Port Talbot port into a major hub for floating offshore wind (FLOW) and green energy development (including sustainable aviation fuel [SAF])[73]. The port has been identified as one of only two locations to be advanced to the primary list phase of the UK Government's Floating Offshore Wind Manufacturing Investment Scheme (FLOWMIS). The port is also part of the Celtic Freeport, alongside Milford Haven, which includes plans for a cluster of low carbon industries. The Freeport is setting out to deliver 11,500 new jobs and add £8.1bn in economic value[74]. Across ABPs South Wales' ports there are wider decarbonisation plans including hydrogen development and carbon capture and storage (CCS).
- The Bristol Port Company (TBPC) is also positioning Bristol Port to be at the heart of decarbonisation and energy transition. This includes proposals for the Bristol Wind Terminal to support FLOW developments in the Celtic Sea, hydrogen development, CCS, and SAF, as well as continued support to the development of Hinkley Point C and

[70] Analysis of Bristol Port quotes GDP and analysis of ABP quotes GVA.
[71] Oxford Economics (2020) The economic contribution of The Bristol Port Company and firms on the port estate
[72] ABP South Wales (undated) Delivering jobs and driving growth
[73] ABP, 2024. Future ports: Port Talbot. Available at: https://www.abports.co.uk/future-ports-port-talbot/. Accessed January 2025.
[74] Celtic Freeport, 2024. Homepage. Available at: https://www.celticfreeport.wales/. Accessed January 2025.

Sizewell C new nuclear plants, the development of small modular reactors and development of the Agratas battery plant at Gravity (Somerset)[75,76]. The port and its estate are also at the heart of the West of England Local Industrial Decarbonisation Plan (LIDP). It was noted that the general trend is towards larger vessel sizes, and project such as CCS are seeking to utilise larger vessels for efficiency. This has implications for ensuring the navigability of the estuary to support these initiatives as well as ongoing port operations.

Views on Tidal Range Energy Development within the Estuary

Stakeholder interviews were undertaken with ABP, TBPC, Gloucester Harbour Authority and the Canal & River Trust. Each organisation has previously engaged with studies considering the implications of tidal range energy infrastructure in the Severn Estuary. The focus of interviews was therefore to understand current thinking and identify new evidence or plans for the future which may be pertinent to tidal range energy development.

Areas of broad agreement and commonality

All the port operators are agreed on the need for energy transition, and are keen to play substantial roles in supporting the decarbonisation and net zero agenda, as outlined above.

Issues relating to impacts on shipping and navigation within the estuary are of primary concern to port operators and related parties. The large tidal range which creates significant potential for energy generation also has implications for shipping and navigation as well as the hydrodynamics of the estuary. In particular, the tidal pattern of the estuary leads to constrained timing windows for large vessel movements. There are very significant concerns in respect of any infrastructure that would further limit these windows or slow the passage of vessels to and from ports.

Both ABP and TBPC re-confirmed their firm opposition to a Cardiff-Weston Barrage. A full estuary barrage downstream of the ports is noted to have significant detrimental impact on the primary functions of the ports of Bristol, Cardiff and Newport. As concluded in previous studies, the presence of locks within such a barrage would enable passage but would have implications for journey times, even if the full operational costs of lock operation were borne by the operator. The ports stressed the highly competitive nature of the ports sector, and the negative economic effects of any additional costs and restrictions on their operations. Operators also have concerns over the potential for major disruption during any construction phase of such a barrage which could lead to a loss of commercial activity.

There are also significant concerns among stakeholders relating to the potential for siltation and sedimentation behind a large barrage, which could have further impacts on ship navigation and create additional dredging and pumping costs. Stakeholders in the Sharpness and Gloucester Docks area also highlighted the significance of this risk, given existing high demand for pumping and dredging activities to ensure waterways were navigable. It was stressed that the costs of this activity are already presenting commercial challenges to the Canal & River Trust, and further costs could risk the charity's viability.

[75] The Bristol Port Company, 2024. Bristol Wind Terminal. Available at: https://bristolenergytransitionhub.com/#BWT-Pop-Up. Accessed January 2025.
[76] The Bristol Port Company, 2024. The Bristol Port Company Today. Available at: https://www.bristolport.co.uk/about-us/bristol-port-company-today. Accessed January 2025.

There is broad acceptance of a tidal lagoon in Swansea Bay across all the stakeholders interviewed for this research. This is viewed as sufficiently downstream to reduce the potential negative impacts on TPBC and Sharpness/Gloucester. ABP which operates ports in much closer proximity to a Swansea Bay lagoon, stressed its previous engagement with Tidal Lagoon Power - which led to a change in its position from opposition to support through securing appropriate design mitigations.

There is recognition of the economic opportunities that lagoon development could offer the port industry across stakeholders.

Areas of divergence

ABP now holds a broadly supportive view of tidal lagoons, including potential openness to a multi lagoon scenario within the estuary. As noted above, this position was developed through previous close working with Tidal Lagoon Power. This position remains subject to appropriate design mitigations to ensure any lagoons are compatible with port operations, but at a strategic level it is recognised that such a position can be achieved. This includes lagoons that are in relatively close proximity to ABP ports. ABP now mentions tidal lagoons within its own visioning documentation and is welcoming of the economic and commercial opportunities that could arise from supporting the development, construction and operation of tidal lagoon infrastructure.

TBPC retains significant concerns about the majority of lagoon schemes other than at Swansea Bay. The most significant concern relates to the hydrodynamic changes that could be created as a result of taking energy out of the estuary. The potential siltation and sedimentation changes that could ensue are viewed as a substantial risk to shipping and navigation which could have material commercial and operational impacts on Bristol Port. TBPC indicated that significant further technical work would be required to demonstrate other lagoon options could be achieved without detrimental impacts.

Impact Assessment

It is challenging to quantify the potential impacts on port operations given the level of uncertainties and divergence of opinions over the impact on ports.

The potential adverse risks associated with the Cardiff-Weston Barrage are the most significant challenge to shipping and navigation, and the agreement of key port operators in this regard (as opposed to their divergent position on lagoons) is potentially instructive. However, whilst overall journey times are likely to increase due to the need to navigate locks, the tidal windows for some vessels to navigate the estuary could increase rather than decrease in some instances. The overall scale of journey time increases should also be considered in the context of overall journey times and other factors which can impact overall journey times[77]. Potential changes in sedimentation would also only impact in areas where water depth was critical to transit, which could potentially be mitigated through increased dredging activity, albeit with additional costs. There is also a dynamic future baseline with substantial shifts in sediment at present as well as potential sea level rise. Further research is required to test this against both current activity and a future baseline if vessel sizes continue to increase, or the frequency of larger vessel movements increases.

[77] Notwithstanding, adding lock navigation will increase journey times as opposed to other factors which may only impact adversely under certain conditions (e.g. adverse weather routing or delays).

At the UK level any reduction in port activity within the Severn Estuary would be expected to be displaced to other ports. However, the economic significance of TBPC and ABPs operations to the local and regional economies is so large that even modest reductions in activity levels could have substantial negative economic impacts within the Severn Estuary area and across Wales and the South West. Mitigating such adverse economic effects should therefore be considered a high priority.

The in-principle agreement of stakeholders to a Swansea Bay lagoon indicates this example project could be achieved without a major detrimental impact to ports in the Estuary.

When considering the Stepping Stones, Cardiff, and West Somerset lagoons there is a lot less clarity, with opposing views about the possible impacts on ports from the port operators. The hydrodynamic matters that are raised as significant objections have not been tested as part of this workstream, and would require further investigation to retain the engagement of stakeholders. Based on the evidence available, it is not possible to draw clear conclusions about the potential impact on ports of these other lagoons or a multi lagoon scenario within the estuary, save to say there are clear risks and opportunities that need further investigation. Any potential changes to the tidal regime will also need to be considered in the context of other environmental changes in the estuary, which may be more significant.

The analysis undertaken as part of the STPFS noted that the impact on vessel movements and timing windows is dependent on the size of the vessels and the mitigation measures which are put in place. The very largest vessels are likely to be impacted, but the total number of vessel movements, after mitigation, are likely to be relatively few. Sea level rise may also mitigate some of these impacts. Further research is required to identify appropriate mitigation for very large vessels.

Summary Conclusions

The ports within the Severn Estuary are significant economic infrastructure assets performing a regional and national role, supporting a combined 40,000 jobs and £3bn per annum in GDP. They underpin a number of sectors and support a large number of jobs in the Severn Estuary area and wider Wales and South West economies.

Even if at a UK level any negative impacts are displaced to other UK ports, there would be clear negative risks to the Wales and South West regional economies which need to be carefully considered.

The greatest risk is associated with the Cardiff-Weston Barrage. This is potentially at a scale where the overall appeal of the project could be called into question. The lowest risk is associated with the Swansea Bay lagoon. Further technical work will be required to develop a shared understanding of the impact of other lagoon options. Any projects that progress will need to ensure designs minimise any disruption to shipping and navigation.

There would undoubtedly be positive impacts to ports in supporting the development, construction and operation of tidal range energy schemes in the estuary.

Fisheries and Commercial Fishing

The Severn Estuary waters are some of the richest and most diverse in the UK, with around 111 fish species recorded. The Severn Estuary is an important conservation area, partly because of the presence of migratory species, such as salmon and other protected species. As a result, the estuary is both a Site of Special Scientific Interest (SSSI) and a Special Area of Conservation (SAC). It has also been given the international designation of Wetland of International Importance (Ramsar Site)[78].

The high tidal range and strong currents within the Severn Estuary mean fishing in its waters has always been difficult. Commercial fisheries are therefore relatively small, compared to other parts of the UK. However, recreational fishing is popular within the Severn Estuary with people fishing from the shore or from charter boats[79].

Further, in 2021, new byelaws were introduced placing restrictions on salmon fishing on the River Severn and Severn Estuary in response to the decline in migratory salmon stocks and include the following[80]:

- Requiring all salmon caught on rod and line on the River Severn to be released alive with minimum injury and delay.
- Closing the operation of parts of the Severn Estuary commercial net fisheries such as Putcher ranks and Draft nets.
- Allowing a maximum of 22 Lave net licenses to allow catch and release for cultural purposes without impacting the fish stocks.

The STPFS valued commercial fishing activity within the estuary at around £1 million per annum. With regard to tidal infrastructure, the STPFS noted that the main impacts a tidal scheme could have on the fishing sector included:

- Potential disruptions to fish stocks and the impact on commercial fishing activity.
- Potential disruption to fish stocks and the impact on recreational fishing activity.

The STPFS noted that a tidal range scheme could potentially cause a change in habitat (e.g., through changes in water levels and currents), potentially impacting spawning and nursery grounds. However, it recognised that effects of the various tidal range schemes on commercial fishing within the study area are uncertain as it was not yet known how fish populations will be affected by the presence of a tidal range scheme in the Severn Estuary.

Overall, commercial fishing was identified to be a small and declining industry in the STPFS, whereas recreational fishing contributes more to the local economies (e.g., through angling clubs and operating charter vessels) in South Wales and South West England. The study noted there could be a potentially positive impact from barrage schemes on recreational angling of some species, as a result of longer periods of high water, reduced water turbidity, and improved water quality and access.

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[78] Living Levels, 2021. Fishing in the Severn Estuary. Available at: https://www.livinglevels.org.uk/stories/2021/7/21/fishing-in-the-severn-estuary. Accessed January 2025.
[79] Severn Estuary Partnership, 2025. Fish webpage. Available at: https://severnestuarypartnership.org.uk/the-estuary/physical-natural-environment/fish/#:~:text=Commercial%20fishing%20within%20the%20Estuary,are%20commonly%20found%20during%20winter. Accessed January 2025.
[80] Environment Agency, 2021. New byelaws to be introduced in the Severn Estuary and River Severn. Available at: https://www.gov.uk/government/news/new-byelaws-to-be-introduced-in-the-severn-estuary-and-river-severn. Accessed January 2025.

Since the STPFS, regulatory changes have further reduced the level of fishing activity within the estuary. In economic terms the industry is relatively small, but it retains cultural significance.

Aggregates and Dredging

The Crown Estate notes that Britain has one of the world's most developed marine aggregate industries and extracts around 15 to 20 million tonnes annually[81]. Marine aggregate dredging affects considerably less than one percent of the UK's marine area, yet provides around 20 percent of the sand and gravel needed in England and Wales. Around 90% of all aggregates are used within the construction industry.

A total of 403 million tonnes of marine sand and gravel was dredged from all of The Crown Estate licence areas between 1998 and 2017[82]. However, the annual area of seabed dredged over the 20 years has reduced by 60% from 223km^2 in 1998 to 91km^2 in 2017.

It is anticipated that demand for aggregates will increase, particularly given increasing needs to support nationally significant infrastructure projects (NSIPs), alongside baseload demands for construction materials. A report looking into the future demand and supply of aggregates in Great Britain noted that approximately 3.8 billion and 4.1 billion tonnes of aggregates will be required between 2022 and 2035[83].

Whilst future demand and supply of aggregates is forecasted to rise, a number of challenges have been identified such as:

- Ongoing decline in permitted reserves, indicating a potential need for growing supply from other sources.
- Potential supply shortages, particularly given level of demand to support NSIPs alongside baseload demand for construction materials. The pressures for offshore development are increasing. Major proposals for offshore windfarms, tidal barrages, tidal-driven generating stations, oil and gas development, and infrastructure projects such as airport developments may arise.
- Growing concern around future availability of skilled workers to support the industry, with attracting workers with the relevant technical skills being considered a major challenge by aggregates and mineral product producers.

The Severn Estuary

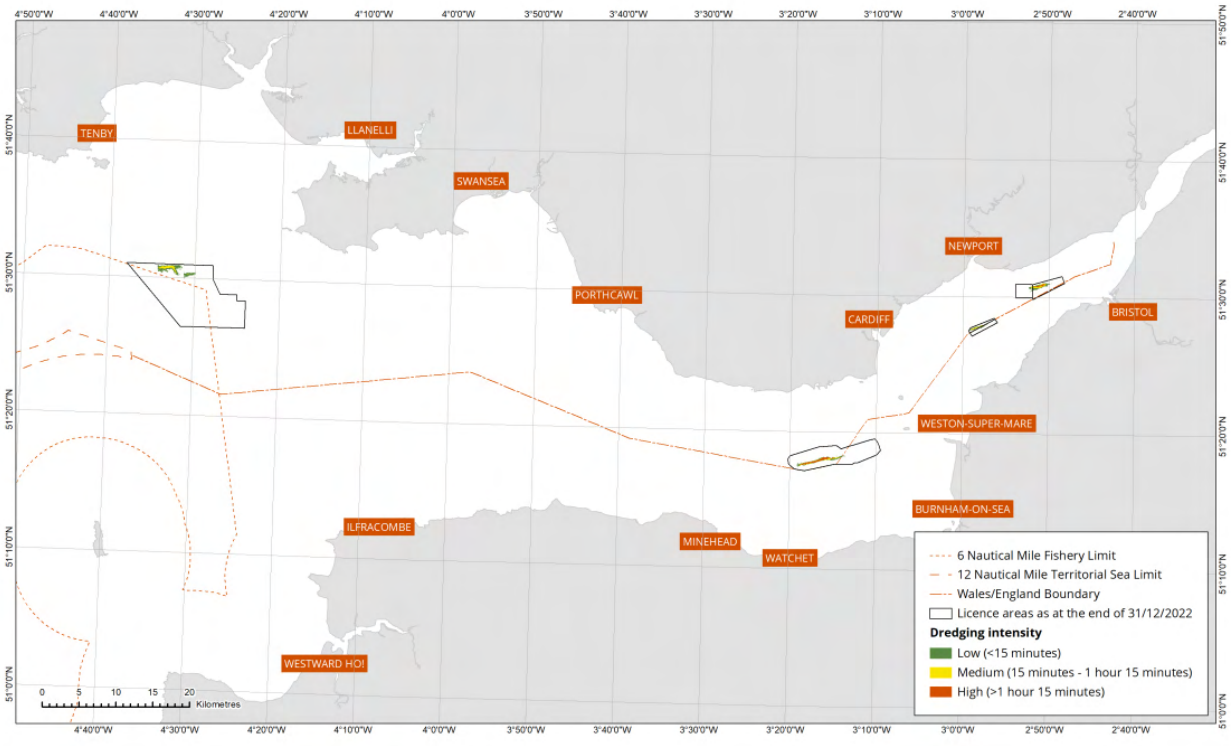
The South West region, which includes the Severn Estuary, currently has nine licensed dredging areas. All the areas for extracting marine aggregates are held under both commercial and legal production agreements issued by the Crown Estate, and environmental-based marine licences which are issued by either the Marine Management Organisation (English waters), or Natural Resources Wales (Welsh waters).

[81] The Crown Estate, 2023. Marine Aggregates – Annual review. Available at: https://www.thecrownestate.co.uk/media/4505/marine-aggregates-annual-review-2023.pdf. Accessed January 2025.
[82] The Crown Estate, 2018. Marine aggregate dredging 1998 – 2017. Available at: https://www.datocms-assets.com/136653/1720791538-marine-aggregate-dredging-1998-2017-a-twenty-year-review.pdf. Accessed January 2025.
[83] Mpa, 2022. Aggregates demand and supply in Great Britain. Available at: https://mineralproducts.org/MPA/media/root/Publications/2022/Aggregates_demand_and_supply_in_GB_Scenarios_for_2035.pdf. Accessed January 2025.

Aggregates in the South West region mainly consist of fine, medium, and coarse sand which are principally used for the construction industry. Between 1998 and 2017, the South West contributed to 7% of total UK dredge tonnage. In 2022, material extraction from the region was mainly delivered to the South West (English wharves – 51%, Welsh wharves 49%)[84]. Over the period 1998-2017 a net additional 38km^2 of seabed was licensed, however, the area actively dredged decreased by 9km^2.

Figure 7.2 (sourced from the Marine Aggregate Extraction report[85]) shows the key areas for dredging in the Severn Estuary.

Figure 7.2 Key Areas for Dredging in the Severn Estuary



Source: Crown Estate and the British Marine Aggregate Producers Association

The Severn Estuary contains extensive areas of sandbanks. The marine aggregate resources in the Severn Estuary are of significant commercial interest as the sand dredged is of high quality. There are also significant manufacturing and production benefits, further supplemented by the industry's ability to land large tonnages by sea, close to urban areas.

No evidence of the value of the economic contribution of aggregates dredging in the Severn Estuary has been identified.

The Sustainable Development Commission's *Turning the Tide* report (2007) noted that the Severn Estuary is home to a regionally-important aggregates industry which supports both direct and indirect jobs in aggregate dredging activities. The report highlighted that if a barrage was built in the Severn Estuary there would be a number of potential impacts on the aggregates industry such as:

[84] The Crown Estate, 2023. Marine Aggregates – Annual review.
[85] The Crown Estate, 2022. Marine aggregate extraction report.

- Changes in the sedimentary regime from tidal infrastructure, which could impact on the quality of sand resources, and therefore on the economic viability of extraction of such aggregates.
- A requirement for a very large quantity of aggregates for fill and concrete to support barrage construction. There are benefits of being able to source these locally or regionally.

The STPFS noted similar potential impacts where a tidal scheme would be beneficial in creating jobs as aggregate demand would rise and some of the aggregates could be sourced locally. However, the study noted that it is unlikely that aggregates dredged from the Severn Estuary would be used to supply all the aggregate requirements of the tidal range options, and considerable resources would need to be imported into the local area.

Since the completion of previous studies, the primary change in context is the forecast for significant aggregates demand and a reduction in the area of seabed being dredged at both a UK and South West regional level. Whilst disruption to this industry could have direct impacts on those employed in dredging companies – with both positive and negative potential impacts identified – there could also be wider implications on the supply of marine aggregates into the construction and infrastructure industries.

Of the six example schemes considered as part of this analysis, only the Cardiff lagoon, as drawn, would be at risk of directly developing on a licensed and actively dredged area. Other schemes may have implications if changes in hydrodynamic conditions have an effect. No further technical work on this has been undertaken as part of this research.

Tourism & Leisure (including Regeneration)

Tidal Barrages

The Severn Tidal Power Feasibility Study (STPFS, 2009) considered the potential tourism and leisure related economic impacts associated with both the Cardiff-Weston Barrage and Shoots Barrage. Estimates of 200,000 and 150,000 annual visitors were included for the schemes respectively. The scale and visual significance of the Cardiff-Weston Barrage was highlighted as a particular driver of visitors.

On the basis of developing visitor centres, and the quoted visitor numbers, estimated employment impacts range from 20-130 jobs for the Cardiff-Weston Barrage and 10-80 jobs for the Shoots Barrage.

The potential impact on marine sports and leisure was considered to be mixed, with both positive and negative impacts. However, changes in hydrodynamics in some locations could have implications for pursuits such as surfing.

Stakeholder consultation as part of this current study has indicated that leisure boating activities out of locations such as Sharpness may have some degree of positive impact with barrage schemes that increase water levels at low tides.

Potential negative impacts, associated with the possible loss of the Severn Bore[86] and ornithological tourism were noted. These were anticipated to be relatively small in absolute economic terms. However, they may have greater social and cultural significance.

Tidal Lagoons

Various tidal lagoon proposals have been highlighted as having regeneration, tourism, and leisure opportunities. Evidence on the extent to which tidal lagoons could provide these opportunities vary between tidal lagoon projects and is limited. The impact tidal lagoons could have on tourism and leisure is mixed and highly dependent on each project and the project's location.

The STPFS states that lagoons, in comparison to other tidal range generation options such as barrages, would create less opportunity for tourism, as they are 'not as visually impressive'. However, it is mentioned that they could provide the opportunity for increased marine activity within their walls, although this would require a significant amount of additional investment.

The STPFS assesses the tourism impacts of tidal lagoons together with tidal fence and tidal reef options, since they attribute these three options to have less visual impact and as a result similar, lower direct tourism impacts.[87] The study quantified the direct tourism impacts from a visitor centre, based on the assumption that the projects would attract 40,000 visitors per year. It estimated that the schemes could create up to 10 FTE jobs and £3m GVA (annually).

The study also highlights the possibility for a decrease in ornithological tourism due to habitat loss and no additional benefit from increased marine tourism. However, it states that although there would be a loss of habitat, in comparison to barrages, the assessed schemes would contribute to less habitat loss and that the impacts on ornithological tourism could be negligible.

The Phase 2 Feasibility Study (2010) estimated the same number of jobs and GVA as the previous study but was looking specifically at impacts from a visitor centre for the Welsh Grounds and Bridgwater Bay Lagoons.

It has also been highlighted by Natural Resources Wales (2022)[88] that tidal lagoons could negatively impact angling tourism, but the Phase 2 Feasibility Study highlights that this could be counteracted by tidal infrastructure increasing tourism numbers on their own, and even possibly leading to net additional benefits.

The Hendry Review highlights the possibility for tidal lagoons to have other benefits apart from generating reliable clean energy. It states that place based economic regeneration, enhanced recreational facilities and flood protection can be additional benefits from these projects. Tidal lagoons that offer benefits in addition to energy production, such as the

[86] The Severn Bore is unlikely to be significantly impacted unless one of the two barrage schemes is built. If these schemes operate as ebb-only projects they will have similar high-water levels funnelling into the upper estuary with all the incoming flows being in the upper half of the tidal prism. The bore itself is primarily influenced by a combination of the tidal flow, low barometric pressure and strong southwesterly winds. It begins forming above Sharpness, well upstream from either proposed barrage location.
[87] The study only explored the potential direct tourism impacts of tidal power options, *excluding the additional possible tourism impacts from ancillary investment*.
[88] Natural Resources Wales, 2022. Information to support Environmental Assessment of tidal lagoon developments in Wales. Available at: https://naturalresources.wales/media/696812/gn60-information-to-support-environmental-assessments-of-tidal-lagoon-development-in-wales-zm0523.pdf. Accessed January 2025.

proposal for the Tidal Lagoon Swansea Bay (TLSB) by Tidal Lagoon Power, are described in The Review as 'hybrid' infrastructure projects due to the projects being able to provide more than renewable energy.

The Review states that "it is beyond question that, in the case of Swansea Bay, local economic regeneration would follow a tidal lagoon" (p. 36) and concludes that lagoons are likely to bring wider benefits, but they are dependent on location and that the benefits can be difficult to quantify.

Tidal Lagoon Power, the developers for TLSB, highlighted various opportunities in community leisure and tourism that would come from the construction of a lagoon in Swansea Bay. Notably, opportunities for "sports, recreation, education and culture, including use for local, national and international sports, such as cycling, walking and running around the lagoon wall, in addition to sea angling, open water swimming, canoeing, rowing and sailing within the lagoon" (p.18) [89]. They have described lagoons as 'multi-functional assets' that can provide future benefits to the local community and local businesses.

The TLSB was promoted as a project able to re-connect the local community with Swansea Bay through offering the opportunity for various water-based activities, including a sailing centre and a beach. It was claimed that it would become a 'major iconic tourist attraction' with an offshore visitor centre (an architecturally significant building named 'The Oyster') proposed to attract approximately 500,000 visitors in the first year of operation.[89]

The Blue Eden project, the newest proposal for a tidal lagoon in Swansea Bay, emphasises that the project will promote education, communication, and recreation, specifically with a floating dome structure that will become a cultural and scientific centre as well as a visitor centre.[90] The scheme will also include the creation of a battery farm, giga factory, floating solar, and a data centre as well as residential developments. The project is seen as a major opportunity to boost both the local and regional economies and foster regeneration in Swansea, but no specific estimates have been produced for the potential tourism and leisure impacts of the scheme.

The proposal for a West Somerset Lagoon (WSL) includes an offering of new business and community uses and increased opportunities for local leisure and tourism at one of the tidal lagoon connections, in Minehead. Plans for the lagoon include a new 300 berth marina, harbour, promenade, arts and visitor centres and ferry terminal.[91]

West Somerset Lagoon Ltd state that the lagoon will enhance the area's leisure offerings and will foster increased tourism. The WSL project proposes to create an opportunity for sailing, boating, active tourism and maritime recreation. The plans also include open-air heated leisure baths accompanied by sun decks, changing spaces, a café and saunas. It is estimated that the lagoon could create over 200 local jobs in and around the new promenade.[91]

[89] Tidal Lagoon Power, 2020. Unleashing the Potential of our Tides: An opportunity for our times – and for the United Kingdom.
[90] Swansea Labour, 2022. £1.87 billion Blue Eden project is "game-changer" for city says Swansea Labour. Available at: https://www.swansealabour.org/news/blue-eden-project Accessed January 2025.
[91] West Somerset Lagoon, 2024. Local Benefits. Available at: https://www.westsomersetlagoon.com/local-benefits Accessed January 2025.

Stakeholder consultation as part of the current study has indicated that the location of lagoon projects, particularly landfall, is critical to whether meaningful regeneration benefits will be secured. It was perceived that landfall close to existing urban areas would be far better suited to delivering wider regeneration. This will require additional investment.

Tourism and Leisure at Operational Tidal Barrages

The two operational tidal barrages in the world, at La Rance, Brittany (France) and Sihwa Lake (South Korea) have attracted high levels of tourism. La Rance welcomes approximately 70,000 visitors per year[92] and Sihwa Lake welcomes an estimated 1.5 million visitors per year.[93]

Sihwa Lake tidal power station and barrage has become a local landmark and a popular location for visitors, not only for its 75-metre high observatory tower, but for its sport and leisure opportunities along its 12.7 km embankment. Additionally, the location of the tidal barrage offers opportunities for eco-tourism focused on bird observation, the surrounding ecosystem and landscapes.

The Hendry Review highlights that the reason for Sihwa Lake's high visitor numbers is in part due to the additional tourism and leisure offerings nearby, including the development of Sihwa Lakes's Eco-Park Areas. Additionally, the tidal barrage is located in the city of Ansan and is connected to Daebudo Island, an already popular destination due to its scenic beaches. It is also located near South Korea's largest city and capital, Seoul, and it's third largest city Incheon, which makes it accessible to a very large number of residents and visitors[94]. An opportunity to create a 'tourism belt' in the area surrounding Sihwa Lake barrage and power station has been highlighted as a possibility due to the high visitor numbers. It was highlighted that there were plans for a 3.8 trillion won (approximately 2 billion GBP) investment from the Korean government to develop the surrounding areas.[95]

Opportunities from Low Cost Energy

Multiple stakeholders identified the economic opportunities that arise to regional economies from the presence of an abundant energy supply, particularly where direct offtake agreements could be secured. Examples cited included South Wales following the discovery of coal, and in modern times, Norway and Quebec. The potential for an abundance of clean renewable energy was highlighted as a potential opportunity to power the industrial future of the Severn Estuary area.

Related to this, stakeholders highlighted the opportunity to rebalance the UK's geographic spread of renewable energy generation capability, with a current dominance on the east of the country. In tandem with other wind, hydrogen and nuclear energy related

[92] EDF, 2012. The Rance Power Station. Available at: https://www.edf.fr/sites/groupe/files/2024-12/memoguide-la-rance-en.pdf. Accessed January 2025.
[93] International Hydropower Association, 2016. Technological Case Study: Sihwa Lake Power Station. Available at: https://www.hydropower.org/blog/technology-case-study-sihwa-lake-tidal-power-station. Accessed January 2025.
[94] The Seoul Metropolitan Area, which includes Seoul, Incheon and Gyeonggi Province has a population of approximately 26 million people as of 2024. This makes it one of the largest metropolitan areas in the world. (www.kostat.go.kr sourced via Wikipedia). The cities of Seoul and Incheon alone have a combined population of approximately 13 million people.
[95] Park and Lee, 2021. The rebirth and eco-friendly energy production of an artificial lake: A case study on the tidal power in South Korea. Available at: https://www.sciencedirect.com/science/article/pii/S2352484721004698 Accessed January 2025.

developments across the Severn Estuary area, there are a mix of technologies which can support industrial and economic activity in power hungry uses, as well as the development of a range of expertise in renewables.

Full case studies of both Quebec and Norway are attached at Appendix 5 to this report, with summaries of the key findings below. These highlight the economic success, across a range of indicators, that have been delivered through both a plentiful supply of energy, and early adoption of clean and renewable technologies.

Stakeholders have highlighted potential regulatory challenges that would need to be overcome to fully realise the economic benefits. These include current challenges related to dedicated offtake agreements and the requirements/obligations of DNOs (Distribution Network Operators) to ensure the same power could be made available through the grid in the case of gaps in generation from any tidal scheme. It was also noted that some early work has been undertaken by Regen on the issue of collaborative PPAs (power purchase agreements). Exploring such regulatory challenges and opportunities is outside the scope of this research but would need further examination to identify whether the benefits of a proximate abundant renewable energy supply could be maximised.

Abundant Energy Supply and Economic Growth – Case Studies

Norway

Norway's energy sector, built on **hydropower, oil, gas, and wind energy**, has played a pivotal role in its economic growth. The **early development of hydropower** in the 1900s facilitated industrialisation, with the government ensuring national benefit through state ownership of key energy assets[96]. Today, **hydropower supplies around 90% of Norway's electricity**, making energy costs relatively low for consumers and businesses.

This **abundant, low-cost, and renewable energy supply** has supported economic growth in several ways:

1. **Industrial Development** – Norway's cheap and reliable electricity has attracted energy-intensive industries like **aluminium production** (e.g., Norsk Hydro) and **data centres**, which require vast amounts of power[97].
2. **Green Innovation & Clean Energy Leadership** – Norway is investing in **offshore wind, hydrogen production, and carbon capture and storage (CCS)**, strengthening its position in global clean energy markets[98].

[96] Government of Norway, 2016. The history of Norwegian Hydropower in 5 Minutes. Available at: https://www.regjeringen.no/en/topics/energy/renewable-energy/the-history-of-norwegian-hydropower-in-5-minutes/id2346106/. Accessed January 2025.
[97] Norwegian Government, 2024. Norwegian data centres - sustainable, digital powerhouses. Available at: https://www.regjeringen.no/en/dokumenter/norwegian-data-centres-sustainable-digital-powerhouses/id2867155/?ch=4. Accessed January 2025.
[98] Chambers and Partners, 2024. Power Generation, Transmission & Distribution 2024: Norway. Available at: https://practiceguides.chambers.com/practice-guides/power-generation-transmission-distribution-2024/norway/trends-and-developments. Accessed January 2025.

3. **Electrification & Transport** – The widespread availability of renewable energy has enabled **high electric vehicle (EV) adoption**, with Norway leading globally in EV ownership and infrastructure[99].
4. **Energy Exports & Economic Stability** – While Norway's domestic electricity comes mainly from renewables, **oil and gas exports** to Europe remain a major economic driver, especially after the shift in European energy dynamics following Russia's invasion of Ukraine[100].
5. **Interconnection & "Europe's Green Battery"** – Norway's flexible hydropower system allows it to **balance intermittent renewable energy sources** in European grids via electricity interconnectors to the UK, Germany, and Denmark.

By leveraging its natural energy abundance, Norway has built a **stable, high-income economy**, attracting investment, fostering innovation, and securing its role as a key player in the global energy transition.

Quebec

Quebec's vast **hydropower resources** have played a central role in its economic development, providing **cheap, renewable, and reliable electricity**. Hydropower accounts for **94% of Quebec's electricity generation[101]**, primarily through Hydro-Québec, a state-owned utility. This energy abundance has fostered industrial growth, innovation, and international investment.

Economic Benefits of Abundant Energy

1. Competitive Advantage for Industry – Quebec has the lowest electricity prices in North America[102], benefiting energy-intensive industries such as aluminium production, pulp-and-paper, and chemicals. Companies like Rio Tinto and Alcoa have established large operations in Quebec due to affordable energy, strengthening global competitiveness.
2. Emerging Sectors & Foreign Investment – Cheap and clean electricity has attracted global tech firms like Google, Amazon, and Microsoft to build data centres[103], a growing industry reliant on sustainable power. The increasing demand for AI-driven data processing presents further economic opportunities.
3. Green Innovation & Clean Energy Leadership – Quebec is investing in hydrogen production and carbon reduction technologies. Projects like Hy2gen's green hydrogen

[99] McKinsey & Company, 2023. What Norway's experience reveals about the EV charging market. Available at: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/what-norways-experience-reveals-about-the-ev-charging-market. Accessed January 2025.
[100] DNV, 2022. Energy Transition Norway 2022. Available at: https://www.norskindustri.no/siteassets/dokumenter/rapporter-og-brosjyrer/energy-transition-norway/2022/energy-transition-norway-2022_web.pdf. Accessed January 2025.
[101] Canada Energy Regulator, 2024. Provincial and Territorial Energy Profiles – Quebec. Available at: https://www.cer-rec.gc.ca/en/data-analysis/energy-markets/provincial-territorial-energy-profiles/provincial-territorial-energy-profiles-quebec.html Accessed January 2025.
[102] Hydro-Québec, 2023. Comparison of Electricity Prices in Major North American Cities. Available at: https://www.hydroquebec.com/data/documents-donnees/pdf/comparison-electricity-prices.pdf Accessed January 2025.
[103] Hydro-Québec, 2021. Future data center in Beauharnois. Available at: http://news.hydroquebec.com/en/press-releases/1712/future-data-center-in-beauharnois/ Accessed January 2025.

and ammonia facility showcase how low-cost renewable energy supports next-generation industries[104].

4. Electrification & Transportation – Quebec leads Canada in electric vehicle (EV) adoption[105], with one in four new cars being electric[106]. Its extensive hydropower infrastructure provides a stable foundation for EV charging networks and clean transportation solutions.
5. Energy Exports & Trade – Quebec's hydropower surplus allows it to export electricity to the U.S. and other Canadian provinces, generating revenue while enhancing North America's energy security[107].

Through low-cost, renewable energy, Quebec has established a thriving industrial base, attracted international investment, and positioned itself as a leader in clean energy innovation, driving long-term economic prosperity.

Summary

Port Related Impacts

The ports within the Severn Estuary are significant economic infrastructure assets performing a regional and national role, supporting a combined 40,000 jobs and £3bn per annum of GDP. They underpin a number of sectors and support a large number of jobs in the Severn Estuary area and wider Wales and South West economies.

Even if at a UK level any negative impacts lead to the displacement of activity to other UK ports, there is a clear negative risk to the wider regional economy which needs to be carefully considered.

The greatest risk is associated with the Cardiff-Weston Barrage. The lowest risk is associated with the Swansea Bay lagoon. Further technical work will be required to develop a shared understanding of the impact of other lagoon options. Any projects that progress will need to ensure designs minimise any disruption to shipping and navigation.

There would undoubtedly be positive impacts to ports in supporting the development, construction, and operation of tidal range energy schemes in the estuary.

Commercial Fishing and Aggregates Industries

The commercial fishing industry within the estuary is relatively small but culturally significant. There is also recreational angling activity which has some economic value. Regulatory changes since previous socio-economic studies have further reduced the scale of commercial fishing activity in the estuary area in order to protect fish populations. The

[104] Hy2gen, 2024. Hy2gen Is Awarded Renewable Electricity Supply. Available at: https://www.hy2gen.com/press-releases/project-courant-in-baie-comeau-quebec. Accessed January 2025.
[105] Banks, Brian. 2024. Quebec ZEV Registrations hold steady in Q1, but drops in Ontario and B.C. pull down national ZEV market share to 11,3 per cent: StatsCan. Available at: https://electricautonomy.ca/data-trackers/2024-06-13/q1-zev-registrations-statscan-canada/. Accessed January 2025.
[106] Kyriazis, Joanna. 2024. Capturing Canada's Electric Vehicle Opportunity. Available at: https://cleanenergycanada.org/capturing-canadas-electric-vehicle-opportunity/. Accessed January 2025.
[107] Hydro-Québec, 2024. Power generation. Available at: https://www.hydroquebec.com/generation/#:~:text=Our%20facilities&text=Its%20hydropower%20facilities%20also%20include,dams%20and%2091%20control%20structures. Accessed January 2025. Accessed January 2025.

environmental issues associated with fish populations are therefore of more significance to any discussions of tidal range energy infrastructure in the estuary than the economic issues.

There is an active marine aggregates dredging industry in the Severn Estuary. However, no evidence of its economic value has been identified. Previous studies have identified potential positive and negative impacts on the industry as a result of tidal range energy infrastructure. The Cardiff lagoon is the only project within the six examples considered in this research that would include direct development over a licensed aggregate dredging area. The key change since previous socio-economic studies were undertaken is evidence highlighting the significant increase in forecast need and demand for aggregates to support the construction and infrastructure industries, including nationally significant infrastructure projects. Activities which reduce the potential for aggregate extraction could have wider implications for the development of infrastructure in the Severn Estuary area and wider UK.

Tourism and Leisure Impacts

Analysis indicates uncertainty about the exact nature of tourism, leisure, and regeneration impacts arising from tidal range infrastructure, with both positive and negative effects likely. The location of schemes, and particularly the location of landfall will be a key factor in the potential opportunities for tourism, leisure, and regeneration benefits to be secured. It will also require additional investment beyond the barrages and lagoons themselves.

Previous analysis suggested that barrage schemes could attract 150,000-200,000 annual visitors given their visual prominence, supporting 10 – 130 jobs. However, there would also be the potential for offsetting impacts should there be reductions in the level of ornithological tourism as well as adverse effects in the event of loss of the Severn Bore.

La Rance tidal barrage in France attracts around 70,000 visitors per annum[108]. The Sihwa Lake scheme in South Korea has a much greater number of visitors, at 1.5 million[109], reflecting the very large population in the catchment area and opportunities to interconnect with other tourism assets.

Lagoons have been identified as offering the opportunity for improved marine and other recreational facilities, as well as wider tourism regeneration. Previous research as part of the STPFS indicated that likely visitor numbers would be lower than for barrages, supporting approximately 10 jobs, but this has been contradicted by developer led claims of larger visitor numbers by factors of more than 10 times. The Hendry Review identified tidal lagoons as potential catalysts for wider tourism and leisure-based regeneration. Multiple schemes have proposed the inclusion of marinas and other water and land-based sports infrastructure.

Overall, the scale of impacts measured are in the region of 100 jobs.

[108] EDF, 2012. The Rance Power Station. Available at: https://www.edf.fr/sites/groupe/files/2024-12/memoguide-la-rance-en.pdf Accessed January 2025.
[109] International Hydropower Association, 2016. Technological Case Study: Sihwa Lake Power Station. Available at: https://www.hydropower.org/blog/technology-case-study-sihwa-lake-tidal-power-station Accessed January 2025.

Opportunities from Low Carbon Energy

The presence of an abundant supply of low carbon energy has the potential to support wider industrial development in the Severn Estuary area, particularly in energy intensive sectors. Case study reviews of Norway and Quebec have shown how a plentiful supply of energy, and early adoption of clean and renewable technologies have created economic opportunity. The development of tidal range as part of wider low carbon energy cluster in and around the Severn Estuary area can also play a role in redistributing UK low carbon power generation away from its current concentration to the east of the nation.

Capitalising on this opportunity would require regulatory adjustment. Exploration of this sits outside this workstream, but should be considered as part of efforts to maximise the economic potential of any future investment in tidal range energy.

8. Social and Community Effects

This chapter considers the potential for social and community level effects to arise from the development of tidal range energy infrastructure within the Severn Estuary area. In particular, this chapter considers:

- The potential social and economic implications associated with changes to flood and coastal erosion risks that may arise.
- The potential social and community implications that may arise from one or more large scale infrastructure development projects.

Chapter Headlines

- **Flooding and coastal erosion** pose significant economic and social risks.
- Both barrages and lagoons can mitigate some of these risks, with the impacts differing between impounded and non-impounded areas.
- Overall benefits are variable, depending on location, scale and mode of operation.
- There are gaps in the evidence base, and the evidence which is available is largely dated and is not aligned to the current context or technical guidance.
- **Large scale infrastructure projects** can create both positive and negative social and community impacts.
- The example of Hinkley Point C provides a helpful case study and demonstrates that positive impacts can be delivered, with potential negative effects mitigated through careful planning and ongoing management.
- The evidence shows local communities should not fear the development of tidal range energy infrastructure projects in their communities. But planning, coordination and community engagement should be prioritised to deliver positive outcomes.

Changes to Flood and Coastal Erosion Risk

A review of the existing evidence on the potential changes to flood and coastal erosion risk arising from the development of tidal range energy infrastructure in the Severn Estuary is available at Appendix 8 to this report. A summary is set out here.

Nature of Socio-Economic Impacts Associated with Flood and Coastal Erosion

The scale of the socio economic impact of flooding and coastal erosion is significant. Impacts include damage to residential and commercial properties, vehicles, public and private infrastructure (e.g. schools, hospitals, power, water and telecommunications utilities, transportation networks, etc). Impact during a flood also include the costs of evacuation, emergency services, disruption to transport and commercial business. Such impacts can occur significant distances outside the flooded area, for example where power or water supplies are disrupted.

Post-flood impacts include the cost of temporary accommodation for displaced residents and businesses, and disposal of damaged goods and building materials. Social impacts predominantly are the risk to life during a flood event and mental health impacts (stress, anxiety, depression, etc) incurred in the months or years after a flood.

Over the longer-term, repeated flooding of the same location can also lead to the depreciation of local property values and investor confidence, otherwise known as "flood blight". Respective national planning policies in England and Wales steer development proposals away from areas of highest flood risk, restricting potential for future development and investment, or requiring increased mitigation measures (with associated costs) to secure planning permissions.

Severn Estuary and Tidal Range Energy Context

There are extensive areas at flood risk in the Severn Estuary along both the English and Welsh coasts. These include areas with existing residential and commercial development and areas with development potential that are currently constrained by flood risk. Climate change is predicted to increase the number of properties and infrastructure at risk of flooding over the coming century, which will increase the socio-economic costs of floods. A tidal lagoon or barrage therefore has the potential to provide a reduction in flood risk to one or multiple areas, which could yield socio-economic benefits at a regional or national scale.

The barrage and lagoons options will both positively and negatively impact the different sources of flood and erosion risk. The impacts will differ across the impounded and non-impounded areas, with generally positive impacts on the impounded area and negative impacts on the non-impounded area.

The positives (benefits) and negatives (disbenefits) have been summarised in Table 8.1.

Table 8.1 Benefits and Disbenefits Associated with Tidal Range Energy Options

Positive		**Negative**	
Outcomes	**Benefits**	**Outcomes**	**Disbenefits**
Protection from Impounding Structure	**Applies to the impounded area for both Lagoons and Barrages** • Reduction in storm surges • Reduction of peak tides • Reduced sea level rise effects • Reduced tidal locking over high tide	**Increased low tide water levels**	**Lagoons** • Impedance of natural drainage from rivers and drainage networks, mitigated through outfall redesign, and applies to a smaller impounded area **Barrages** • Impedance of natural drainage from drainage networks, mitigated through outfall redesign though applies over a larger area • Impedance of peak flood discharges from large rivers, mitigated through management of impounded water level

Positive		Negative	
Outcomes	**Benefits**	**Outcomes**	**Disbenefits**
		Increased mid-high tide period	**Lagoons** • No significant impact **Barrages** • Whilst any impact would be resolved in the design a barrage would impound a larger area
Combined reduced tides levels and reduced wave action within the impounded area	**Lagoons** • Reduced coastal erosion • Removes the need for new/existing flood defences upstream • Reduced coastal squeeze and loss of intertidal habitat **Barrages** • Reduced coastal erosion • Removes the need for new/existing flood defences upstream • Reduced coastal squeeze and loss of intertidal habitat	**Increased water levels in the Severn Estuary in the non-impounded area**	**Lagoons** • No significant impact **Barrages** • Minor increase on the seaward side for larger barrages.
Reduced wave action from swell in the impounded area	**Lagoons** • Reduction of wave heights Barrages • Reduction of wave heights	**Changes to coastal processes**	**Lagoons** • Some changes in erosion or accretion, managed as part of operation. **Barrages** • Depending on the size of the barrage, some changes in erosion or accretion patterns will occur.
		Increased wave heights and exposure in non-impounded areas	**Lagoons** • No significant impact due to size of lagoons **Barrages** • Increased wave action from reflection off large scale barrage.

Defence Designation

Following the introduction of the Flood and Water Management Act in 2010 there is specific provision in Schedule 1 of the Act for designating privately maintained or owned structures or features which perform a flood or coastal erosion risk management function as a flood risk management asset. This could enable a tidal range asset to be classified as a designated flood defence structure. Guidance on the designation process was published in 2012[110] but to-date designation of assets has been very limited across England and Wales.

If a tidal barrage or lagoon is built to a design that meets or exceeds the coastal flood Standard of Protection plus allowances, and the regulatory authorities have confidence in its maintenance being resourced (e.g. for power generation purposes), there may be increased likelihood it could be a factor in enabling landward development.

A tidal barrage or lagoon could also operate as an active flood and coastal defence asset (vs. a passive one such as a sea wall). By closing the lagoon/barrage sluices and turbines prior to a high tide, or by pumping sea water out of the lagoon/barrier, a low tide level in the impounded area can be maintained. This practice could therefore reduce the risk of tidal locking[111] due to a barrage or lagoon and the associated fluvial flooding. However, during these periods no power would be generated and so the scheme's owner may want to receive commercial compensation for providing a flood risk management service to one or several of the statutory flood and coastal risk management authorities.

Securing Benefits

A barrage or lagoon could offer flood and erosion risk improvements that unlocks development opportunities across parts of the Severn Estuary area that are currently hindered by flood and erosion risk. A possible proxy for the areas that may benefit from 'unlocking development' are those currently defined as Coastal Change Management Areas (CCMA's). The development of a barrage or lagoon that reduces overall flood and erosion risk may remove the requirement for a CCMA and enable more development in these zones. Further research is needed to compile all the potential CCMA opportunity areas covered by the options considered in this report.

A challenge In claiming these 'unlocking development' benefits, Is that If no barrage or lagoon was constructed then these benefits would potentially be transferred elsewhere (displacement), e.g. into other coastal towns on the Estuary, which are at lower flood and erosion risk, and leaving the national/regional picture neutral in terms of benefits. The likelihood of the benefits transferring to other areas will depend largely on the uniqueness of the area affected, the ability of businesses to relocate, and the availability of less flood prone sites. A greater understanding of the risk factors and the local business sentiment along the estuary is required to understand these potential socio-economic benefits.

Another benefit that is easier to apply is preventing a reduction in property values due to flooding, as this is relative to the individual property. This could be undertaken through a land value uplift calculation comparing the prices of locally non-flooded properties to those

110 Defra / Welsh Government, 2012, Designation of structures and features for flood and coastal erosion risk management purposes: information note

111 Tidal locking occurs where the tidally raised sea level prevents flood water draining from rivers, causing flooding inland back up the river's course.

which are flooded and unlocking potential benefits. This is likely to significantly increase the benefits compared to flood damages alone.

Scheme Configuration

Flood and coastal protection is affected by the mode of operation and the type and design of the structure (e.g. ebb only, ebb and flood, with or without sluicing and/or pumping). The mode of operation changes the natural water levels impounded by the structure, reducing the upper elevation and increasing the lower tidal level. More detailed discussion of the technical issues is set out at Appendix 8.

Example Options Summary Review

A high-level review of the available evidence for each of the example options has been undertaken.

Cardiff-Weston Barrage

A Cardiff-Weston barrage is the most researched option, in terms of flood and coastal erosion risks, of the six examples considered in this research, however all previous research focuses on ebb-only operation; which will likely provide lower net flood and erosion risk benefits compared with the currently favoured flood-ebb generation. Nevertheless Cardiff-Weston Barrage would provide the greatest potential for flood and erosion risk benefit of the options considered. The option may improve protection in key towns and cities such as Western-super-Mare, Cardiff, Newport and Severnside. The socio-economic benefits were quantified in the SETP report, which yielded £194m to £330m of benefits. It should however be noted that since 2010 some of these areas have gained flood defences, which will reduce the potential benefits as properties that are already protected will not yield additional flood risk benefits.

The Cardiff-Weston Barrage also produces also produces tidal locking and raises tide levels in the wider Severn and Irish Sea. The cost to mitigate the tidal locking effect was costed at £273m in the SETP. The cost of increased tide levels in the non-impounded Severn were calculated in the SETP as £44m. This does not account for the more recent modelling which shows impacts in the Irish Sea, which would significantly increase this figure. The combined disbenefits from tidal locking and increased tide level determined by the SETP total £317m, this would, based on the SETP analysis, wipe out most if not all the positive flood risk benefits for the option. This would imply therefore that there are no net flood or erosion risk benefits associated with an ebb-only Cardiff Weston Barrage. At the time not all the financial benefits were considered as part of the study and therefore further analysis would be required to confirm the cost impact.

Shoots Barrage

Whilst the SETP report did not identify any flood or erosion risk benefit, the structure does provide protection from future sea level rise. The cost of approximately £210M to mitigate against increased tidal locking and increased tide levels in the Severn were included in the overall project costs to ensure the project had no negative impacts. Additionally, certain barrage operation models, such as closing the sluices of the barrage during a flood event, could yield some limited benefits to areas upstream.

Swansea Bay Lagoon

The Swansea Bay Lagoon provides limited economic benefits from flood and erosion risk mitigation, as it covers only a short section of coastal frontage, encompassing the Swansea Bay University Campus and Swansea Dock. Both of these facilities would still be at risk of flooding from the surrounding low-lying area. Where the option may provide more benefits is the prevention of tidal locking of the local drainage network at Crymlyn Burrows, however, this is likely to be limited in the context of the overall scheme as again these properties are likely to still be subject to coastal flooding from the east of the lagoon.

Stepping Stones Lagoon

The Stepping Stones lagoon covers a shoreline that predominantly consists of cliffs with limited flood risk present. The key potential socio-economic benefit for this option is from a potential reduction in cliff erosion rates, which would benefit several holiday parks and other shoreline features. Additionally, the lagoon would also only reduce the rate of erosion and not permanently protect these areas further reducing the potential benefits.

West Somerset Lagoon

The West Somerset Lagoon could offer moderate flood and erosion risk benefits protecting Minehead, Blue Anchor, Watchet, Butlins Resort and the West Somerset Railway. No study has been undertaken into the socio-economic benefits that this option could provide however Minehead, which is the most populated area at risk, is currently in part protected by a coastal defence scheme that was undertaken in the 1990s which may reduce potential benefits. As with other locations there may be some tidal locking of river and drainage networks that also needs to be considered, which may further negate some of the benefit.

Cardiff Lagoon

The Cardiff Lagoon may offer moderate economic flood risk benefits to the area as it impounds an area of coastline with key urban areas and infrastructure (the South Wales Mainline), however no assessment has been made to date. The project includes the potential for locking of the drainage network and River Rhymey. The costs to mitigate this tidal locking were included in the overall project costs however further study is be required to fully gauge the scale of this requirement.

Summary Conclusions

Of the six locations considered the most researched in terms of flood and coastal risk is Cardiff Weston Barrage, followed by Shoots Barrage and Swansea Bay Lagoon. Stepping Stones Lagoon, Cardiff Lagoon, and West Somerset Lagoon have limited research available. The 2010 Severn Estuary Topic Paper (SETP) Flood Risk and Drainage is the only source of costed flood and erosion impacts.

In principle there is nothing to prevent a privately owned or maintained barrage or lagoon operating as a flood defence asset. If the structure was to deliver that flood risk management role in an active manner, i.e. pumping water in or out, it is highly likely that the statutory flood and coastal risk management authorities would require adherence to comprehensive, formalised operating procedures.

If the barrage or lagoon designs met or exceeded flood and coastal design standards of protection it may unlock the potential for enabling landward development in the areas protected.

Economic benefits resulting from a flood and coastal risk management scheme can normally only be claimed once, so a barrage or lagoon is unlikely to be able to take account of properties already benefitting from an extant flood or coastal defence scheme, of which several have been or are being built in the estuary. However, such benefits could potentially be claimed where a barrage/lagoon would remove the need for an existing defence to be improved or replaced in the future.

There is potential for a wider range of social, economic and environmental benefits using the modern benefits management approach the UK Government expects major projects to use. This could offer an opportunity to identify more quantifiable and intangible benefits to help strengthen a tidal scheme's business case and demonstrate its wider value for money to society. Tidal schemes located and designed such that they are able to deliver meaningful, claimable benefits would therefore have an advantage through fulfilling a dual purpose and deliver wider socio-economic outcomes to enhance the cost benefit assessment.

The benefits associated with any lagoon or barrage differ between the impounded area and the non-impounded wider estuary, the positive impacts are all associated with the impounded area. Positive flood and erosion benefits are associated with reduced peak tide levels, reducing flooding through lower high tides, reduced storm surges, as well as mitigating the impacts of sea level rise. These will also reduce rates of coastal erosion and the loss of habitat from coastal squeeze.

The Cardiff-Weston barrage could potentially raise sea levels along the coast of Somerset, Devon, Wales, eastern Ireland and southwest Scotland; this might trigger the need for new or enhanced existing coastal defences to maintain the present-day risk levels. The financial costs of this were assessed by SETP however this assessment did not assess the full extent of the impact and is now outdated against current construction pricing and climate change information.

Another key negative impact is the increase of inland flood risk from tidal locking within the impounded area, which prevents rivers and the drainage network from flowing into the sea. The SETP identified that the Cardiff Weston Barrage could negatively impact 372 km^2 of land containing 50,473 properties. This however was based on ebb only generation and the assessment also predates several key studies which may alter this conclusion, further research on this topic is required.

Overall benefits are varied across all options. A review using an ebb/flood model plus up to date socio-economic flood benefit calculations would be expected to improve the understand of this situation.

The experience of interviewees from previous barrage or lagoon proposals highlighted the risks of leaving an evidence and messaging vacuum that a scheme's opponents could fill. Across all the six schemes the current evidence base is relatively poor or outdated and comprehensive research is recommended to create a robust understanding of positive and negative effects for flood and coastal risk management.

Large Scale Infrastructure Development

Large scale infrastructure development has the potential to create a range of social and community level impacts, both real and perceived[112] [113] [114]. These can include:

- Creation of employment and training opportunities for local residents.
- The temporary or permanent migration of workers, and family members, into existing communities.
- The associated demands on housing and other services from such increases in local populations.
- Changes to community attitudes associated with noise, congestion and anti-social behaviour or crime or other disruptions.

The ongoing development of the Hinkley Point C (HPC) new nuclear power station within the Severn Estuary area is a very useful case study, and on current evidence is a very good example and potential template for how to effectively manage the potential social and community level impacts of large-scale infrastructure development.

A case study of the HPC project is attached at Appendix 2 to this report with key findings relevant to social and community impacts included within this chapter.

Workforce and Skills

Chapters 5 and 6 considered the potential economic impacts as well as the supply chain and workforce opportunities associated with the development, construction, and operation of tidal range energy infrastructure in the Severn Estuary area. Under any of the example options there will be a substantial number of job opportunities within the Estuary area. These are spread across a range of sectors and skill levels. Whilst there would likely be a concentration of activity in close proximity to any scheme, the presence of a wide variety of supply chain activity and further induced jobs will lead to opportunities across a much wider geography.

There are wider benefits to the individual and the community from increased employment opportunities. Employment can provide individuals with a sense of purpose and connection within their community, thereby reducing feelings of social isolation and providing benefits in terms of self-esteem and mental wellbeing. Similarly, employment can provide individuals and households with economic stability, improving people's ability to meet essential needs such as food, housing, utilities and healthcare (The Health Foundation, 2024)[115]. These should be considered beneficial social and community impacts,

[112] Government Office for Science, 2017. Future of Skills & Lifelong Learning. Available at: https://assets.publishing.service.gov.uk/media/601980f2e90e07128a353aa3/Skills_for_jobs_lifelong_learning_for_opportunity_and_growth__web_version_.pdf. Accessed February 2025.
[113] UK Parliament, 2024. Importance of skills: Economic and social benefits. Available at: https://lordslibrary.parliament.uk/the-importance-of-skills-economic-and-social-benefits/. Accessed February 2025.
[114] Institute of Employment Studies, 2021. A Better Future: Transforming jobs and skills for young people post-pandemic. Available at: https://www.employment-studies.co.uk/system/files/resources/files/A%20Better%20Future%20-%20Transforming%20jobs%20and%20skills%20for%20young%20people%20post-pandemic_1.pdf. Accessed February 2025.
[115] The Health Foundation, 2024. Relationship between employment and health. Available: https://www.health.org.uk/evidence-hub/work/employment-and-unemployment/relationship-between-employment-and-health#:~:text=There%20is%20a%20bidirectional%20relationship,standards%2C%20and%20better%20mental%20health. Accessed February 2025.

with their scale varying in line with the volume of employment opportunities created by the example options.

More broadly, with increased economic growth governments can generate higher tax revenues facilitating increased investment in public services such as healthcare, education and infrastructure, all of which can further improve quality of life for the population. Increased employment and reduced unemployment can also reduce public spending via the welfare system (IFS, 2023)[116].

The legacy of enhanced skills also creates a lasting benefit with an increased likelihood of future employment and higher earnings in response to the acquisition of skills and qualifications. Analysis of the HPC project has identified that 4.4% of the workforce engaged in an apprenticeship, a level of participation that has far exceeded expectations. This shows the potential for major infrastructure development to a deliver significant skills legacy, within the workforce as well as the increased capability and capacity within the skills and training provider network.

For many of the less urbanised parts of the Severn Estuary area there is a trend of younger persons (aged 15-29) migrating to other areas with greater economic and educational opportunity[117]. This can lead to pressures on local services as local populations have greater proportions of older residents. The evidence from HPC indicates the presence of a large infrastructure project helping to counter that trend, with evidence that younger workers are able to *"stay and thrive"*.

To ensure longer term positive impact there is a requirement for future work opportunities. As previously discussed, the role of coordinating infrastructure development to effectively utilise the workforce of the Severn Estuary area, as well as considering how a series of tidal range schemes might deliver a longer-term economic opportunity, have the potential to offer meaningful careers in the field of construction and renewable energy, as opposed to short to medium term job opportunities.

Housing, Transport and Local Services

Not all jobs are filled by local residents. The construction phase of large-scale infrastructure developments will frequently require a large labour force that is beyond the capacity of the immediate site catchment. Whilst some workers will be able to commute to site (which can have transport implications) others will need to temporarily or permanently relocate within a commutable distance. This will require appropriate mitigation strategies to be developed and actioned.

Analysis of the HPC workforce indicates that around 25% of the construction workforce was already resident within the local area (i.e. the county of Somerset), a further 10% commute from their normal residence outside Somerset to the construction site for work. 55% have

[116] Institute of Fiscal Studies, 2023. How have government revenues changed over time?. Available: https://ifs.org.uk/taxlab/taxlab-key-questions/how-have-government-revenues-changed-over-time#:~:text=spreadsheet%2C%20available%20here.-,Tax%20revenue%20forecast%20to%20reach%20historical%20highs,historically%20high%20but%20not%20unprecedented. Accessed February 2025.
[117] Based on analysis of ONS Mid Year Population Estimates 2013-2022.

temporarily moved to Somerset whilst working on the project, and the final 10% have relocated permanently to the local area.[118]

During the stakeholder consultations for this research, it was noted that areas with more limited urban capacity could face greater challenges in accommodating both temporary and permanent relocated workers, especially where there is already constrained housing supply and pressure on services. The HPC case study is therefore helpful given the characteristics of the county of Somerset, with no major city. The largest town in the county within easy commutable distance to the site is Bridgwater (population c.40,000), with evidence showing the majority of temporary migrant workers wanting to live in this area. The construction site itself is relatively isolated.

The 10% of the workforce that has permanently relocated into the county has led to further associated migration, in terms of other family members. Early monitoring and evaluation have shown this level of permanent relocation to be higher than anticipated at the time of consenting[119]. This migration creates a long-term demand for housing and other services (e.g. health, education, leisure etc).

The 55% of the workforce that has relocated temporarily (which equates to thousands of people) creates temporary demand for accommodation and other services. The experience of HPC indicates workers in temporary accommodation are choosing to live close to the site wherever possible – in both provided accommodation and within the local private rented sector. This has led to an increase in HMOs (Houses in Multiple Occupation).[119] Key mitigations included the development of accommodation campuses for workers, as well as the provision of an on-site health centre to ensure pressure on existing services was minimised, and this has proved very effective. Community engagement activities have also been valuable in addressing fears around community cohesion, crime and anti-social behaviour.

The movement of a significant number of workers to and from site, either locally or from further afield, as well as the movement of materials and equipment also have the potential to put pressure on both strategic and local transport infrastructure. Current evidence suggests mitigations, including transport upgrades and worker park and ride facilities, have been largely effective in this regard. However, the one area that has led to notable levels of complaints from residents is 'fly parking'.[120] This is identified as the main unexpected effect.

Overall, the level of negative impact is reported to be very low. Fears of potential negative impacts on the tourism sector, as a result of accommodation being filled by temporary workers, have not been identified in the evidence. The monitoring and evaluation work has also found no major social issues (e.g. community cohesion, crime and anti-social behaviour) and indicates that potential negative impacts have been well managed.[121]

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[118] Turquoise Thinking, 2024. Hinkley Point C Workforce Survey: Summary – Summer 2024. Available at: https://www.somerset.gov.uk/business-economy-and-licences/major-developments/monitoring-the-project/socio-economic-advisory-group/ Accessed January 2025.
[119] Oxford Brookes University, 2019. Study on the Impacts of the Early Stage Construction of the Hinkley Point C (HPC) Nuclear Power Station. Available at: https://radar.brookes.ac.uk/radar/file/ae6facec-8a5d-4df6-ac0f-15fd6ae7fa1d/1/HinkleyPointCReport.pdf Accessed January 2025.
[120] Oxford Brookes University, 2019. Study on the Impacts of the Early Stage Construction of the Hinkley Point C (HPC) Nuclear Power Station. Available at: https://radar.brookes.ac.uk/radar/file/ae6facec-8a5d-4df6-ac0f-15fd6ae7fa1d/1/HinkleyPointCReport.pdf Accessed January 2025.
[121] Glasson et al., 2020. Monitoring and auditing the local socio-economic and environmental impacts of the early stage construction of Hinkley Point C Nuclear Power Station, UK. Available at: https://www.tandfonline.com/doi/full/10.1080/14615517.2020.1838237 Accessed January 2025.

Contractors consulted as part of this research have indicated that communication efforts with local communities in respect of HPC have been very good, and have significantly helped the process of managing potential social impacts. This corresponds with stakeholder opinions relating to the Swansea Bay Tidal Lagoon shared as part of the consultation process. It was noted that due to positive engagement with communities there was actually disappointment that the project did not proceed, particularly in terms of the loss of the economic benefits to the local area that had been anticipated.

Addressing these potential impacts requires forethought and planning across a range of topic areas to ensure the correct supporting infrastructure is put in place. It also requires ongoing monitoring and adaptation. This has been shown as particularly necessary at HPC due to the peak construction workforce exceeding expectations at the time of the consenting process[122], and the active management of mitigations as a result.

With regard to developing tidal range energy infrastructure in the Severn Estuary area, the majority of example options are smaller in scale than the HPC construction. A Cardiff-Weston Barrage is potentially of comparative scale. On this basis, the overall scale of social impacts would be smaller, and with appropriate mitigations should be effectively managed. Based on the lessons from HPC even a mega project such as the Cardiff Weston Barrage could be effectively managed. The expertise within the Severn Estuary area from the HPC scheme should be harnessed wherever possible.

The location of the West Somerset Lagoon is probably the farthest from large scale population centres – Minehead has a population of approximately 12,000 – and has limited existing transport connectivity. This would require careful consideration.

Attention to the cumulative impact with other major infrastructure would also be required, particularly if any tidal range scheme was in close proximity to other hub locations for major projects. With good coordination there may be opportunities to develop shared or common mitigation actions such as temporary accommodation campuses.

On the basis of the HPC evidence, communities in close proximity to potential tidal range energy projects should not unduly fear the development of major projects.

Summary

This chapter has explored the potential social and community-level impacts of developing tidal range energy infrastructure in the Severn Estuary area. Key areas of focus included changes to flood and coastal erosion risks, the implications of large-scale infrastructure projects, and other social, cultural, and community effects.

Flooding and coastal erosion pose significant economic and social risks, including property damage, infrastructure repair costs, and mental health impacts. Tidal lagoons or barrages can mitigate some of these risks, however, the impacts differ between the impounded and non-impounded areas. Overall, benefits are varied across all options and depend upon location, scale and mode of operation. On the basis that any negative impacts are mitigated the net outcome is benefit and tidal range schemes could contribute to flood defence improvements and open up new land for development.

[122] Oxford Brookes University, 2024. Hinkley Point C Peak Construction: Impacts Monitoring and Auditing Study (2023-24). Available at: https://www.suffolk.gov.uk/asset-library/Final-Report-HPC-Peak-Construction-Nov-2024.pdf Accessed January 2025.

There remain gaps in the evidence base, particularly in respect of the use of ebb and flood turbine technologies. Much of the evidence which is available is now dated and neither aligns to the latest guidance nor takes into account more recent flood defence schemes. The primary finding of this review is the need for comprehensive research to create a robust understanding of the positive and negative effects for flood and coastal risk management.

Large-scale infrastructure projects create numerous job and training opportunities, enhancing economic stability, improving quality of life, and fostering social cohesion. These projects also contribute to skills development, increasing future employment prospects. However, they can also lead to temporary or permanent migration of workers, increasing demand for housing and services. Effective mitigation strategies are essential to manage these impacts.

The Hinkley Point C (HPC) nuclear power station serves as a helpful case study, demonstrating how to manage the social and community impacts of large infrastructure projects. HPC has created substantial job opportunities and a significant skills legacy, helping to retain younger workers in the area. The project has also put in place mitigations to alleviate damaging demand for housing and services, with mitigations like accommodation campuses and on-site health centres proving effective. Transport infrastructure has faced pressure from the movement of workers and materials, though most issues have been managed well.

In conclusion, the importance of planning, coordination, and community engagement in managing social and community impacts cannot be overstated. Lessons from HPC should be applied to future projects, ensuring that appropriate mitigation strategies are developed for housing, transport, and services. Positive engagement with local communities is crucial for managing potential social impacts and building support for tidal range energy projects. The evidence suggests local communities should not fear the development of tidal range energy infrastructure projects in their communities if projects are well managed.

9. Maximising and Mitigating Effects

This chapter draws together the range of potential actions, both strategic and tactical, which will support the maximising of positive socio-economic effects and the mitigation or minimising of adverse socio-economic impacts. This also identifies areas for further research to fill existing evidence and knowledge gaps.

Chapter Headlines

- To maximise the potential positive impacts arising from tidal energy infrastructure there is a need for clear signalling of a commitment to tidal range energy from UK Government in order to build confidence across industry.
- There is a need for clarity on whether multiple projects will be supported to unlock supply chain and skills investment.
- Contractual models need to require and incentivise UK content.
- Coordination is needed to enable joined up responses from stakeholders across infrastructure projects.
- Early warning is required to allow industry and other stakeholders to put in place the necessary planning and investment.
- Further research is required, particularly around the issues of hydrodynamic impacts in the estuary and changes to flood risk.

Strategic Level Action

There is a clearly identified need for development of the supply chain and workforce to deliver tidal range energy infrastructure within the Severn Estuary. Under the worst case scenario there are expected to be substantial benefits to the UK and Severn Estuary area economies, but with appropriate action and support these can be substantially uplifted.

The initial strategic requirement is for very **clear signalling** from UK Government of its **commitment** to tidal range energy within the Severn Estuary. Without this commitment the necessary investment in the supply chain and skills development will not come forward. Stakeholders are clear that current levels of activity are insufficient, and the lack of any **confidence** in tidal range projects making progress means there is little to no preparation activity underway. Historic failure to progress projects has led to very low levels of confidence across industry, which needs to be addressed to close the credibility gap. Industry is looking for clear, consistent and joined-up policy and action at UK Government level in order to trigger investment. This will also require appropriate references to tidal range projects within NESO Regional Energy Strategic Plans.

Part of providing a clear policy steer should be clarity on whether a **multi project scenario**, either within the Severn Estuary or across the UK, is to be pursued. This will enable industry to understand whether it should prepare for a single project or a pipeline of schemes. There is a recognition among stakeholders, illustrated by the economic impact analysis, that a series of projects has the potential to deliver economic benefit over decades, creating more attractive conditions for industry to invest in UK capability and capacity which will increase the level of economic benefit and return on investment. Further engagement with industry is required to understand how any multi project scenario can be phased to meet the investment requirements of government and industry.

Related to the above issues, there is a need to **coordinate** not only potential tidal range energy projects, but also wider infrastructure development, particularly across the energy and net zero sector and within the Severn Estuary area and wider region. Stakeholders have been critical that current approaches are too project driven and siloed. Better coordination will help industry allocate resources appropriately to support the full range of projects, and support collaboration rather than competition. The risks of uncoordinated action include cost premiums through competition for resources, time delays due to a lack of available resources, or unviable projects where one or both factors impact. Stakeholders are unclear on who is best placed to provide a strategic coordination role, and potential suggestions include the National Infrastructure and Service Transformation Authority (NISTA), GB Energy, and Mission Control at the Department for Energy Security and Net Zero (DESNZ).

Associated with the coordination point, the need for **early warning** is also noted by stakeholders from a range of backgrounds. This is vital to enable preparatory investment and collaboration to take place. It was noted that too often large-scale infrastructure projects are commissioned with insufficient lead times to prepare the local workforce or supply chain to capitalise on the opportunities. With the scale of supply chain preparation needed for a tidal range project this is even more relevant.

Largely outside the remit of the socio-economics workstream, the issue of **contractual models** has been highlighted by stakeholders as relevant to securing socio-economic benefits and maximising UK content through the supply chain and workforce. In particular stakeholders advise adopting contractual approaches that de-risk investment (particularly early stage costs), and recognise the value of capturing socio-economic benefit, rather than focusing primarily on cost and price. Related to this, the need for government to see tidal range as multi-faceted cross-department projects covering energy, flood risk, transport, education, labour market, and business, rather than solely an energy project have been highlighted. This applies to both valuing and appraising projects as well as ensuring appropriate action to maximise positive impact is taken. Stakeholders shared the view that Contract for Difference (CfD) approaches do not enable coordination or collaboration particularly well, and a Regulated Asset Base (RAB) approach is more suitable. The approach of Crown Estate to licensing, in addition to UK Government approaches were also flagged as valuable in driving UK content.

Tactical Action

Maximising Positive Impacts

The section above focused primarily on UK Government level action to create the conditions for socio economic benefit to be realised. There will also be a range of supporting activity 'on the ground' in order to facilitate this. These will need a particular focus in and around the Severn Estuary area, but given the nature of the supply chain requirements, will also include a UK level response. In addition, there are a number of preparatory activities and studies required to help mitigate potential negative effects.

As noted above, early warning is critical to enable supply chain and workforce readiness. This is a lesson learned from the Hinkley Point C project within the Severn Estuary area. If one or more tidal range energy projects are moved forward, there will be a need for rapid **stakeholder engagement** to ensure a coordinated response. Stakeholders highlighted the need for a pan-regional **England and Wales response** where possible, avoiding the

limitations of past approaches which have often been piecemeal and uncoordinated. The Hinkley Point C response has provided a range of learning within the Severn Estuary area which should be capitalised upon.

Coordination at the Severn Estuary area level with and across other infrastructure projects such as FLOW should also be a priority. The issues of workforce development in particular have significant commonality, and there is an opportunity for an integrated and coordinated response, rather than highly localised and disjointed activities. Further research to analyse the skills and workforce needs will be required to inform this activity.

Mitigating Negative Impacts

Throughout the consenting process for any tidal range projects, and beyond, there should be a focus on **mitigating potential adverse social impacts**, learning from the experience of Hinkley Point C. There are potential opportunities to **develop integrated responses** with other major infrastructure projects, particularly for issues such as worker accommodation where geographic proximity allows. Ensuring community level engagement should be central to this.

Further research is needed in respect of **hydrodynamic impacts** of tidal range energy projects in the Severn Estuary, and the potential implications on shipping and navigation. This is critical to any potential multi project scenario. In addition, any scheme design should be undertaken with engagement of the port operators to secure mitigation by design wherever possible.

Further research is also needed in respect of **changes to flood risk**. Much of the existing evidence was compiled on the basis of ebb-only turbines. Consideration of ebb and flood technologies will enable a more robust analysis of potential impacts, and may help to evidence reduced disbenefits associated with a number of the example schemes. In addition, research to compile a database of all the potential Coastal Change Management Areas (CCMAs) which could be enabled for development will help with understanding whether there are greater positive land use benefits which can deliver socio-economic benefit.

10. Conclusions

In broad terms, the current research has confirmed the conclusions of previous large-scale reviews. There are significant socio-economic opportunities from tidal range energy projects, particularly during the development and construction phases, arising from installation of a tidal range energy scheme within the Severn Estuary. There are also potential challenges, with the most significant being the need to manage and mitigate any potential negative impacts on shipping and ports within the estuary.

In a number of key areas there remain evidence gaps. Whilst this research has focused on six example projects of varying sizes, typologies, and locations, this only highlights the level of complexity associated with developing tidal range energy projects.

To draw meaningful conclusions, this research has focused at the strategic level, seeking to identify substantive changes since previous reviews were undertaken. On this basis, the following conclusions have been reached:

Significant Economic Opportunity

The example projects vary substantially in scale. However, even the "small" projects represent a significant economic opportunity at both the UK and Severn Estuary area level.

Whilst there will undoubtedly be significant levels of economic activity within the Severn Estuary area if any tidal range project progresses to construction and operation, the scale and complexity of even the small projects should be considered as a UK level opportunity.

Undeveloped Supply Chain

There is a need for significant scaling-up of the supply chain needed to deliver tidal range projects. All the examples considered within this research are much larger than the two existing schemes in operation globally.

It is widely recognised that the UK supply chain potential has declined since previous reviews, and if the economic opportunities are to be realised at a UK, regional, and local level, there will need to be a range of strategic and tactical actions.

Insufficient Investment and Preparation

The UK is not currently preparing for the level of investment and activity that will be required, and a significant level of confidence and certainty will need to be built to unlock the commercial investment required.

This is set against a backdrop of concerns of insufficient investment and coordinated action to prepare the economy for other renewable energy and infrastructure projects which are further ahead in the planning process than tidal range energy.

Industry Confidence in Ability to Respond

Engagement with industry bodies and Tier 1 contractors has consistently found an expectation that both the manufacturing and civil engineering sectors will respond positively to the commercial challenges and opportunities presented by tidal range energy projects.

However, this will require appropriate contractual models, and a wider policy environment that builds confidence to secure UK content. The key risks relate to project cost and timescales, as the balancing factors.

Cardiff-Weston Barrage Challenges

A large barrage scheme, such as the Cardiff-Weston Barrage, is at a significantly larger scale to any of the other project examples considered. The scale, broadly equivalent to the sum of the other five options considered, is more akin to the Hinkley Point C new nuclear build, regarded as one of the largest construction projects in Europe.

The Cardiff-Weston Barrage option, as considered within this research, creates the most significant risks to major port operations within the Severn Estuary. Therefore, whilst in purely quantitative terms it may appear to bring the greatest economic opportunity it also brings by far the greatest economic risks and challenges.

In addition, whilst this research has considered supply chain matters at a high level, it has identified significant delivery challenges associated with the number of turbines required for a full estuary span barrage. Further technical work would be required to consider this matter in detail.

It is the widely held view across the stakeholder community that a large barrage is not the most suitable socio-economic option.

Multi Project Scenarios

A multi project scenario is generally recognised as offering more realistic and sustainable socio-economic opportunity. The focus of this research has been on the Severn Estuary, and an illustrative multi lagoon scenario has been considered. However, a multi project scenario at a UK level would not necessarily need to incorporate multiple projects within the Severn Estuary.

A multi project scenario creates the opportunity for a more gradual scaling of the workforce and supply chain, creating an industrial opportunity measured in decades rather than years. The cumulative employment and GVA impacts will likely remain smaller in scale than the large barrage project but this approach can offer a more robust and sustainable investment case within the supply chain, and offer career progression opportunities to local people in the workforce.

A multi project scenario is not without challenges, particularly related to balancing the commercial need to maintain activity within production facilities and the workforce against the opportunities that arise from wanting to learn from previous projects to deliver efficiencies and design enhancements.

Port Impacts

The potential impact on port operators within the Severn Estuary has been identified in previous studies as the most significant economic risk. That remains the case, given the ports' role as critical economic infrastructure underpinning the local, regional and national economies.

Port operators on both sides of the estuary are consistent in their opposition to a large Cardiff-Weston Barrage, citing the negative impact on commercial shipping operations at a level that puts the entire operation of port functions at Cardiff, Newport and Bristol at risk.

Whilst at a UK level an argument could be made that shipping activities could be displaced to other ports, the local and regional economic role of the ports is such that their overall operation should not be jeopardised.

There is divergent opinion about the impact one or more tidal lagoons might have on port operations. Whilst there is broad support for a lagoon in the Swansea Bay area, there is significant concern from The Bristol Port Company about the impact on hydrodynamics, water and sediment levels with lagoons further into the Estuary, and particularly under any multi lagoon scenario. Further hydrological research is certainly required to understand whether the presence of lagoons will adversely affect shipping routes. ABP has indicated a differing view, based on previous close engagement with Tidal Lagoon Power. In consultation discussions it recognised that with suitable design mitigation there is a potential multi lagoon scenario that could be achieved. It is recognised that this will not be without some impact on shipping and navigation, but can be more than offset by the commercial and economic opportunity to ports from supporting tidal range project construction and operation.

Other Economic Impacts

Other economic impacts, such as the impact on tourism, leisure and regeneration are much smaller in scale and include both positive and negative impacts. The nature of any impacts will vary on a project-by-project basis, related to the proposed landfall locations.

Flood and Coastal Erosion Protections

Existing evidence finds that there are both positive and negative socio economic impacts associated with changes to flood and coastal erosion risks arising from the example tidal range projects. In broad terms these appear to offset, with neither significant residual positive or negative socio economic impacts associated with any of the example schemes.

However, there are substantial gaps in the evidence base, particularly with regard to the impact of ebb/flood turbine technology which may reduce some of the disbenefits previously considered.

Further research is advised in this area, particularly as there are opportunities for flood and coastal erosion protections to support the economic case for a tidal range project under the right circumstances.

Social and Community Impact

There are a series of positive social and community impacts arising from the creation of employment, skills development, and enhanced economic vitality.

The lesson of Hinkley Point C, within the Severn Estuary area, is that a larg- scale infrastructure project can be well managed to mitigate concerns around negative social and community impacts, such as on housing and local services. This requires good communication, careful planning in advance, as well as active monitoring and evaluation throughout delivery, to put in place and adapt suitable mitigation measures.

The Need for Coordination and Advance Warning

A consistent message from stakeholders is the need for coordination of major infrastructure projects in and around the Severn Estuary. Whilst there are clearly a range of opportunities, there is an array of other major infrastructure projects in the wider area, not least the development of FLOW in the Celtic Sea, which could potentially be competing for the same resources (e.g. workforce, supply chain, materials, and port capacity).

Coordination to enable synergies to be achieved would be highly advantageous. The alternative is likely to be risks to costs and timescales. Identification of the most appropriate body to lead on coordination is less clear among stakeholders.

In addition, early warning is the consistent message, to enable planning and investment in workforce and supply chain readiness. Clear messaging in good time will allow stakeholders to collaborate and coordinate to put in place the right programmes to help realise the substantial economic opportunities.

Appendix 1: Stakeholder Consultees

The Severn Estuary Commissioners and the Hardisty Jones Associates, Oxford Economics and Arcadis team are grateful to the following consultees who offered their time and contributions to inform this research.

Organisation
Andritz Hydro
Associated British Ports
British Hydropower Association (BHA)
Canal & River Trust
Cardiff Business School
Cardiff University
Civil Engineering Contractors Association (CECA)
Construction Excellence Wales
Construction Industry Training Board (CITB)
GE Vernova
Harbour Master, Gloucester Harbour Trustees
Institution of Civil Engineers
Jacobs
Kier Group
Make UK
Make UK (Wales)
Marine Energy Council
Marine Energy Wales
Offshore Renewable Energy Catapult
Regen
South Wales Industrial Cluster
South West Infrastructure Partnership
TARGET
The Bristol Port Company
Tidal Lagoon Challenge
Tidal Range Alliance

Appendix 2: Hinkley Point C Case Study

Hinkley Point C (HPC) is a 3.2 GW nuclear power station under construction near Bridgwater in Somerset. It is the first nuclear power station to be built in Britain since 1995, and it will comprise two nuclear reactors able to generate approximately 7% of Great Britain's electricity requirements.

The project was approved in 2016 and was estimated to create 25,000 employment opportunities throughout the project and cost £18 billion. It had an anticipatory completion date of 2027 and will provide 900 permanent jobs upon completion for the next 60 years.[123] HPC was initially funded by Électricité de France (EDF) and a joint venture between two Chinese companies.

Following various delays (in part due to Covid and Brexit) and to rising inflation, HPC remains under construction. It is estimated that the project could now cost up to £46 billion and HPC's completion date has now been revised and can be expected sometime between 2029 and 2031.[124]

Due to the project being the first nuclear power station being built since the mid-1990s, EDF set out to 'restart the nuclear construction industry' by focusing on UK skills, creating jobs, building an effective supply chain, blending international expertise and local talent and securing the UK's future energy supply.[125]

The construction of HPC increased the confidence of key nuclear developers and Tier 1 suppliers to invest in the UK and Wales.[126] Some examples of local investment because of HPC include:

- In 2016, Express Reinforcements, a steel reinforcement company from South Wales, was named the preferred bidder for HPC with a deal to supply steel for the project. The following year, it was reported that four companies, Code Serve, Dyfed Steels, Celsa Steel and Express Reinforcements invested significantly in steel production in Wales. This investment created 90 jobs and saved 477 jobs across the country.127 Cole Serve expanded and relocated its production facility to accommodate for the increase in steel production for major infrastructure projects across the UK production.
- Efinor, a French engineering firm, expanded its UK operations by opened a manufacturing and technology centre in Bristol, creating 60 highly skilled jobs.128 In 2024, Laing O'Rourke opened a new factory at Bristol Port to produce steel reinforcement cages needed for HPC.

123 Department for Business, Energy & Industrial Strategy, 2018. Hinkley Point C wider benefits realisation plan.
124 Jack, Simon, 2024. Hinkley C: UK nuclear plant price tag could rocket by a third.
125 EDF, 2015. Blog: How we are restarting the UK nuclear industry.
126 Welsh Government, 2016. "Hinkley should be built with UK Steel", says Economy Secretary.
127 Kelsey, Chris, 2017. More than 550 steel jobs saved as companies invest in Wales.
128 Nuclear South West, 2021. Efinor expands West of England operation with opening of a new Avonmouth Manufacturing and Technology Centre.

Investment in Employment, Skills and Training

To develop the skills required for HPC, three Centres of Excellence (specialising in welding, electrical and mechanical), the Construction Skills & Innovation Centre and the Energy Skills Centre at Bridgwater & Taunton College were established to provide training and education at various levels.

To maximize the amount of HPC job opportunities going to local people, the HPC job service was launched by EDF, Jobcentre Plus and the Somerset Council, where candidates on the portal were given priority access (for a 48h period) to new job adverts before they were advertised elsewhere.

The HPC New Skills, Better Jobs: Socio-Economic Impact Report (2024) highlights that from 2022 to 2024, HPC's Centres of Excellence trained 8,000 people. Various 'routes into training' were set up for HPC for people with varying levels of skills and experience, including traineeships, apprenticeships, work experience, industrial placements, graduate programmes, reactor operator programmes and occupational traineeships. So far, 1,320 apprentices have been trained, exceeding EDF's original target of 1,000. The report states that overall, EDF invested £24 million into education, skills and employment to develop the workforce needed to build HPC.

The report highlighted that as a result of HPC, the productivity level in Bridgwater is 10% higher than the surrounding areas and in Sedgemoor there has been a 25% growth in younger age groups (25-39) since HPC construction began. It was estimated by EDF that HPC would create over 25,000 jobs and the report states that since the beginning of the project, 23,500 jobs have been created on the construction site.

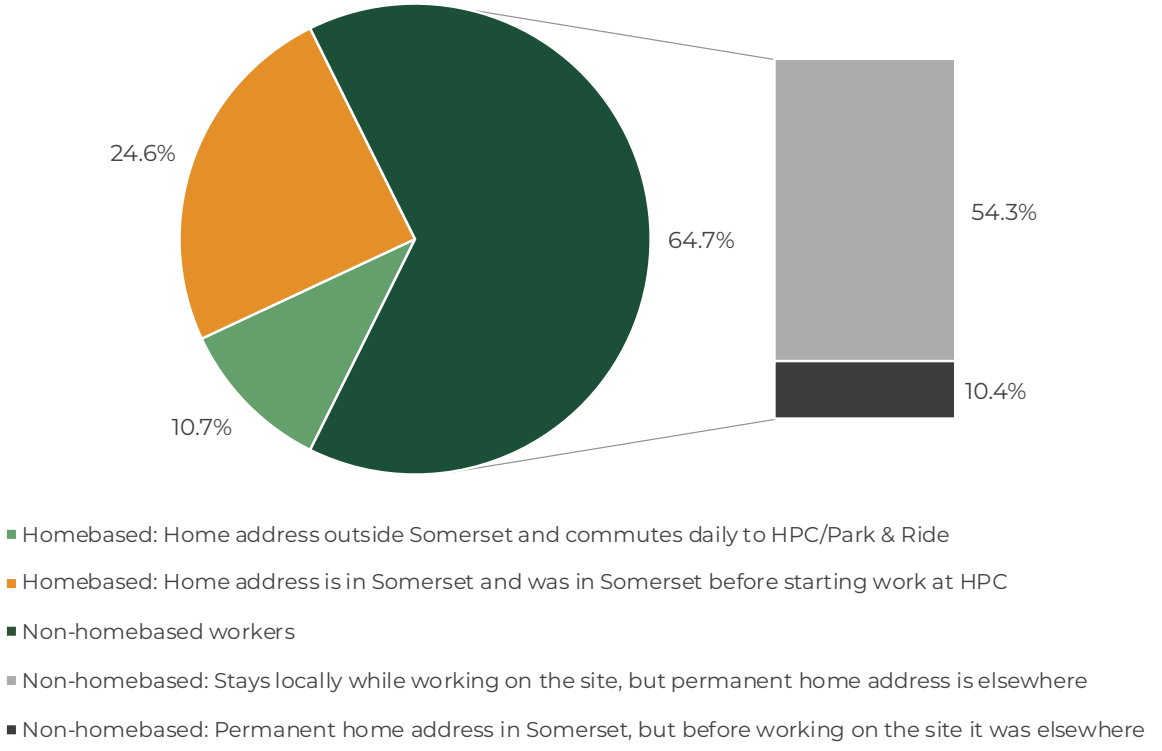
The most recent EDF Workforce Survey (2024)[129] found that there were 10,262 on-site workers and that 66% of the total workforce had worked on the project for over twelve months. However, an Impact Study conducted in the early stages of construction (2019)[130] highlights that although many jobs were awarded to people from Somerset, but that due to the available data not being disaggregated, it was not possible to distinguish the type and level of the jobs offered to local people.

The Workforce Survey found that 62% of the current on-site workers live in the Sedgemoor district with a further 11% and 10% in Taunton Dean and West Somerset, respectively. It found that of the total workforce, approximately 35% of the workers were home-based and 65% were non-homebased.

Figure A4.1 below shows the distribution of workers at HPC as reported in the Workforce Survey. Most homebased workers (24.6%) currently reside in Somerset and were based in Somerset prior to starting work at HPC. The remaining homebased workers (10.7%) have a permanent address outside Somerset and commute to the site daily. For the non-homebased workers, 54% of the workers are staying locally, but have a permanent home address elsewhere and 10% of workers have a permanent home address in Somerset, but their permanent address was elsewhere prior to starting work at HPC.

[129] Turquoise Thinking Ltd, 2024. Hinkley Point C Workforce Survey: Summary Summer 2024.
130 Oxford Brookes University, 2019. Study on the Impacts of the Early Stage Construction of the Hinkley Point C (HPC) Nuclear Power Station.

Figure A4.1 HPC Workforce Summary: Homebased and Non-homebased Workers[131]



Source: Turquoise Thinking

A monitoring and auditing study by conducted in 2020132 looked at the impacts of HPC in the first two years of construction, prior to the peak construction phase. It found that for economic development, the project was performing well against the set Key Performance Indicators (KPIs). Notably, the project performed well in terms of local employment, training and education, apprenticeships and job brokerage. Various training and educational initiatives were provided, the level of apprenticeships exceeded the initial target, and the overall workforce level was near or above the 2012 employment level predictions. However, the study found that the recruitment of unemployed people was significantly below the 8% target, at 1%.

A more recent Impacts Monitoring and Auditing Study (2024)[133] assessed HPC at peak construction level (from 2023 to 2024) and found good economic development performance overall, particularly in EDF's delivery of local training and skills development, the development of new and relevant pipelines from education to employment and high levels of training and education take up.

The study highlights that the level of employment of the previously unemployed was 2.8%, remaining lower than the anticipated 8%. However, it mentions that there is an additional 3% of the workforce that comes directly from education. Additionally, the workforce size

[131] Source: Turquoise Thinking Ltd, 2024. Hinkley Point C Workforce Survey: Summary Summer 2024, p. 8.
[132] Glasson et al., 2020. Monitoring and auditing the local socio-economic and environmental impacts of the early stage construction of Hinkley Point C Nuclear Power Station, UK.
[133] Oxford Brookes University, 2024. Hinkley Point C Peak Construction: Impacts Monitoring and Auditing Study (2023-24).

was found to be 25% above prediction and was identified as an area of 'inaccurate prediction/limited compliance' in relation to original predictions.

It is highlighted in the 2024 impacts study that the EDF-produced Workforce Survey does not disaggregate their local employment figures by skill level and therefore "it is not possible to assess whether local people are gaining some of the most skilled jobs, and whether local training initiatives are opening up opportunities to such jobs" (p. 15), a finding that was previously highlighted in the 2019 report.

Overall, EDF was successful in supporting workforce and skills development in Somerset for HPC through various initiatives and investment in local skills and education provision. The project created jobs, increased employment levels and attracted and retained young people in the area. Nevertheless, the number of skilled jobs going to local people is uncertain, the project did not hire as many unemployed people as intended and over half of the workforce does not have a permanent address in Somerset.

Supply Chain Development

To develop the local and regional supply chain for HPC, EDF and the Somerset Chamber of Commerce worked together to ensure the local area would benefit from the project. Their collaboration began in 2010 and aimed to maximize the number of local businesses in the HPC supply chain by providing information to local businesses on HPC contractor and supplier requirements.

The Hinkley Supply Chain Team was commissioned by EDF to help manage the South West supply chain. It is overseen by the Somerset Chamber of Commerce and received investments from the Heart of the South West LEP, the West of England LEP and the Welsh Government.

By registering their interest with the team, local and regional businesses could access support, information and advice on becoming a competitive supplier for HPC and be matched with contractor opportunities, either with EDF directly or with its Tier 1 and Tier 2 contractors.

From March 2017 to February 2023, the South West Manufacturing Advisory Service (SWMAS) led the Hinkley Supply Chain Programme that supported over 1,300 companies and resulted in £180m of contracts with HPC[134]. It improved the visibility of Tier 1 and 2 contractors and matched their requirements with local business skills and expertise.

EDF highlights that through developing the skills and the supply chain necessary to build HPC, the people and businesses involved in the project will be able to participate in building future major nuclear infrastructure projects (such as the Sizewell C nuclear power station in Sussex) or creates opportunities for export[135].

Glasson et al. (2020) found that local and regional supplier registrations and the number and value of contracts awarded to companies in the South West exceeded or were on their way to exceed the targets set by EDF. The recent impacts study (2024) highlights that the number and value of contracts awarded to companies in Somerset and the wider South West region is estimated to reach a value of £7.3bn by the end of construction, far exceeding

[134] Covill, Rachel, 2023. £180m of nuclear opportunities for the South West generated.
[135] EDF, 2024. New Skills, Better Jobs: Socio-economic Impact Report 2024.

the anticipated the £1.5bn target. However, the study mentions that although total contract value figures are available, there is limited publicly available information on local contracts.

There are currently approximately 150 Tier 1 contractors and 3,800 British businesses in the HPC supply chain. It is estimated by EDF that approximately 64% of the value of HPC contracts is going to British companies and that the project will be supporting 71,000 jobs across Britain by the end of construction.

It was highlighted by EDF that the Sedgemoor district has seen 10 times more growth in medium-sized businesses in comparison to the rest of the South West and that local employment is double what is seen across the South West. Additionally, there has been evidence that there has been "significant growth in large companies setting up, expanding or moving to Somerset" (p. 31).

EDF has spent £5.3billion with 1,357 businesses across the South West so far, exceeding the £1.5 billion target. Table A4.1 below depicts the total spent by EDF for HPC so far.

The table indicates that EDF spending has been spread across the UK. The South West is the region with the second most direct spend from HPC, after the South East (excluding London), and the spending in the South West has been spread across over more than 1,000 business, the greatest number of businesses in comparison to all other regions.

Table A4.1 Estimated UK Spend by EDF for HPC[136]

Country/Region	Number of Businesses	Amount spent	Percentage of Spend
Scotland	123	£287m	1.7%
Northern Ireland	19	£12.8m	0.1%
Wales	179	£165m	1.0%
Yorkshire and the Humber	219	£172m	1.0%
North East	70	£395m	2.4%
North West	336	£1.4b	8.4%
East Midlands	213	£298m	1.8%
West Midlands	330	£427m	2.6%
East of England	261	£1.2b	7.2%
London	263	£1.3b	7.8%
South East (excl. London)	440	£5.7b	34.2%
South West	1,357	£5.3b	31.8%
Total	**3,810**	**£16.7b**	**100%**

Source: EDF

[136] Source: EDF, 2024, New Skills, Better Jobs: Socio-Economic Impact Report 2024, p. 29.

Overall, EDF has implemented mechanisms to develop the supply chain for HPC, with the support of the Somerset Chambre of Commerce, and a great majority of the value of HPC contracts have gone to British companies and to the South West directly. EDF's supply chain development has been found to be successful in terms of set KPIs both in the early and the peak construction phases.

Social and Community Impact

For HPC, EDF submitted a variety of documents as part of the Development Consent Order. The documents included a Community and Safety Management Plan, a Health Action Plan and an Accommodation Strategy. A few external studies have assessed how successful these strategies have been.

In their early stage construction impacts study, Glasson et al. (2020) highlights the overall good performance of the project in terms of social and community impacts, notably the early provision of a medical centre on site allowing the workforce to have convenient access to medical treatments and advice, which took some pressure off the local NHS. EDF also implemented a Worker's Code of Conduct, setting expectations for workers' behaviours and have played a proactive role in ensuing community safety by providing additional resources for community liaison, policing and emergency services. The other two impacts studies (2019 and 2024) have drawn similar conclusions, and the most recent study conducted at peak construction (2024) highlighted that the measures undertaken by HPC alleviated pressures from the NHS and GP surgeries and created an additional 20-35 FTE jobs on the site between 2018 and 2023.

The studies highlighted that EDF significantly invested in the community with its £20m Community Impact Mitigation fund, which is now three quarters allocated to projects responding to 'local wellbeing issues' targeting all age groups.

The 2019 impacts study stated that HPC had limited impacts on the local tourism industry in part due to the mitigation measures implemented (promotion and funding support). The study found that local tourism industry confidence was high and that HPC itself has become an attraction for visitors. The subsequent 2024 impacts study found that 90% of tourism was unaffected by HPC.

The two impacts studies (2019 and 2024) found that there were more school aged children in the local area than originally anticipated and that the EDF funding and mitigation measures for school-aged and pre-school children may not be adequate, since they were based on lower projections. A key community issue highlighted in both studies is the growing issues with fly-parking, where workers do not use the park and ride facilities they have been assigned. However, since 2019, HPC has implemented mitigation measures with a patrol team and a 'three strikes' rule to disincentivise its workforce from fly-parking.[137]

The 2019 report found that HPC could have an impact on local firm recruitment of local labour and that some of the work being done at the site could impact public right of way in some areas, although it was highlighted that there was limited data available to investigate these potential impacts further.

In terms of accommodation provision, some issues were found in terms of housing non-homebased workers in the area. The earlier monitoring studies conducted in 2019 and 2020

[137] EDF, 2019. Positive steps to prevent fly-parking.

noted that the immigrant workers were more concentrated in Bridgwater than initially anticipated and that there was a greater proportion of workers staying in private rented accommodation than expected. Additionally, it was highlighted that there were less workers living in 'owner occupied' accommodations than predicted. In the 2019 impacts study, it was found that only 1% of workers owned the property they lived in, in comparison to the expected 14%.

Most new non-homebased workers stayed in the HPC accommodation campuses. In the 2024 study, it was found that, in line with peak construction predictions, the majority of workers lived in the Sedgemoor district, the location of the Bridgwater campus completed in 2020. Although the percentage of workers living in campus or tourist accommodation was below the predicted level in summer 2023, the newly completed Bran Sands Campus has significantly increased the proportion of workers living on HPC campuses and it was found that the level of immigrant workers in tourist accommodation was near EDF's original predictions.

Additionally, it was found that between 2012 and 2019 there was an increase in the percentage of people living in homes of multiple occupations (HMOs), but that this is below the South West and England levels.[138]

There has been a significant re-location of staff and companies to Somerset. As mentioned above, in 2024 there were 54% of non-homebased workers staying in Somerset but having their permanent home address elsewhere and there has been evidence that some companies have decided to relocate to Somerset due to HPC.[139] This indicates that some potential displacement has occurred and that other areas may have lost out on investment and employment due to HPC. However, none of the studies explicitly looked at the potential impacts of resources being drawn out from other areas.

Overall, EDF has been successful in implementing mitigation measures to limit negative social and community impacts and there has been continuous monitoring, either by EDF, or by external auditors, to measure HPC's overall impact on the local area. Although the geographical and proportional distribution of workers in different accommodation tenure types have been different than anticipated, EDF has been successful in implementing housing support initiatives such as creating accommodation (through its campuses), increasing private renting sector capacity and implementing a housing delivery fund.[138] EDF has also been proactive in implementing health and safety mitigation measures with their on-site site health centre and implementing community safety measures.

[138] Oxford Brookes University, 2024. Hinkley Point C Peak Construction: Impacts Monitoring and Auditing Study (2023-24).
[139] Turquoise Thinking Ltd, 2024. Hinkley Point C Workforce Survey: Summary Summer 2024

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Appendix 3: Offshore Renewables Supply Chain Development Activities

The Offshore Wind Growth Partnership

The Offshore Wind Growth Partnership (OWGP) is a long-term business transformation programme established as part of the UK Offshore Wind Sector Deal. It is set to deliver £100m of grant funding and business transformation programmes.[140]

Since its launch in 2019, it has introduced various programmes aimed not only at supporting companies already in the offshore renewables sector, but those wanting to enter or transition into the sector. Through its programmes, the OWGP aims to develop the UK offshore wind supply chain by improving competitiveness, building capacity, and encouraging new entrants.

The OWGP offers three programmes which are delivered by the Offshore Renewables Energy (ORE) Catapult: The Wind Expert Support Toolkit (WEST), the Fit for Offshore Renewable (F4OR) and the Sharing in Growth (SiG) Offshore Wind programmes.

WEST

WEST is the lowest intensity programme offered by the OWGP. It is a short term (3-4 months) programme that aims to help organisations of any size and level of experience gain a greater understanding of the offshore renewable sector and become more competitive by providing 'specialist advice, market intelligence and strategic insight into the sector'[141].

The programme offers targeted and bespoke advice and support and be provided in the form of workshops, training or other collaborative activities.

It focuses on addressing the company's specific needs by addressing a minimum of two key 'needs' identified by the companies prior to taking part in the programme. Throughout the programme, the companies develop a plan addressing their needs and next steps with the help of the WEST consultants.

The WEST programme feeds back to the OWGP to increase its understanding of supply chain needs and to inform future interventions[142].

F4OR

F4OR is a medium intensity program that has been modelled after the successful Fit for Nuclear (F4N) program introduced for the nuclear sector in 2011. The F4OR programme has operated in cohorts at the regional level (in North East Scotland, Orkney, Caithness & Sutherland, North East England, East Anglia and Wales) and at the national level (with a UK-wide cohort).

The programme takes place over a 12 to 18-month period and is open to companies with more than 10 full time employees and a minimum of £1 million yearly turnover.

[140] OWGP, 2022. WEST Programme Briefing Webinar.
[141] ORE Catapult, 2024. Fit 4 Offshore Renewables Programme: F4OR.
[142] OWGP, 2024. Wind Expert Support Toolkit (WEST) Programme – Scope and Guidance Document.

It was designed in collaboration with senior industry representatives to "facilitate business improvements and sector specific capability development" for the participating companies, with a focus on 'inter-company learning' by organising various educational sessions and workshops for each cohort while the programme is active and after the programme has ended (p.1).[143]

Participants are guided by expert advisors with a focus on assessing companies' operations against industry standards and help them acquire skills and sector specific knowledge to getting ready to bid for work in the offshore renewable sector.

F4OR provides the opportunity for companies to achieve their 'Granted' status upon the completion of the programme. By receiving this status, OWGP ensures that the companies are "operating at a standard that aligns with the expectations of contact issuers" (p.1).

So far, F4OR has supported 110 businesses, and 64 companies reached 'Granted' status.[144]

SiG

SIG is a high intensity programme providing an intervention of approximately £150m to companies that are already established in the offshore renewable sector supply chain. It requires strong ambition and time investment from the participating companies and applicants must have a site turnover of between £5m and £100m per year.

The programme aims to "support growth of offshore wind supply chain companies through specialist training, embedding proven business improvement approaches and driving overall organisational improvement" over a 6-9 month period (p.6).[145]

The programme is catered to each company's individual needs and aims to increase turnover, jobs and exports of UK supply chain companies. The interventions can include the creation of a 'business transformation roadmap' outlining key areas of focus.

Hutchinson Engineering a SME specialising in the design, manufacture, coating, fit-out, assembly, and servicing of steel structures took part in the SiG programme in 2021. SiG helped the organisation create a roadmap after a 100-day diagnostic of their operations. Their bespoke business transformation roadmap addressed specific areas needing improvement for the company be able to grow and become a more competitive player in the offshore steelwork market.[146]

The areas needing improvement were addressed by strategic planning workshop with SiG team leaders to set aggressive targets to increase turnover and reduce costs. These targets were addressed through interventions, including a leadership and employee development framework to cultivate a 'culture of performance' required to meet the set targets and a supply chain analysis was conducted, and flow and cellular manufacturing was introduced to reduce costs and waste.

Two years after taking part in SiG, Hutchinson Engineering increased their turnover by £9.2m, their profits by 23% and hired 33 new employees.

[143] Saaei, Davood, 2024. Fit 4 Offshore Renewables: Our Impact in 2023.
[144] ORE Catapult, 2024. Fit 4 Offshore Renewables Programme: F4OR.
[145] OWGP, 2020. Sharing in Growth Offshore Wind: Pilot Programme 2020.
[146] Sharing in Growth, 2024. Sharing in Growth Transform Hutchinson Engineering for Offshore Markets.

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Appendix 4: Offshore Renewables Skills Shortages

In general, renewable sector jobs are increasingly in demand. The International Renewable Energy Agency estimate that with the efforts to triple installed renewables capacity under the 1.5°C Scenario, renewable energy sector jobs globally will also triple from 2021 levels to about 40 million by 2050[147].

A report by the National Grid estimates that by 2050, 400,000 roles will need to be filled in order to build the Net Zero energy workforce required to meet the increased demands for renewable energy production in the UK. The report estimates that around 260,000 of these jobs will be additional roles and the remaining 140,000 roles to be filled will be needed to replace people who have left the workforce[148].

With many offshore renewable projects in development, there is continual ambition to target skills development across the UK to support the delivery of offshore renewable infrastructure now and in the future.

Whilst a large amount of more recent research looking at the skills supply for renewable energy infrastructure is focused on floating offshore wind (FLOW), many of the skills and roles needed for FLOW also apply to other renewable energy technologies (e.g., in the construction of cables, electrical components, steel fabrication etc.).

Offshore Renewable Skills Shortages

Studies examining the skills pipeline and demand across the renewable energy sectors note that skills gaps and shortages exist for a variety of roles: from electrical engineers and technicians to project managers. It is identified that not enough people with the appropriate technical skills are entering the market to support the future demands of the sector.

Additionally, with multiple renewable projects planned and lined up for delivery, there is significant competition for many of these roles, such as engineers, across developers, suppliers and the international market operating in renewable energy developments.

South Wales/South West

There is a high abundance for marine and offshore renewable energy resource off the South Wales coast, including tidal range, tidal stream, wave, and wind resource.

The process of large-scale creation, deployment, and maintenance of such renewable energy infrastructure will have large economic benefits in terms of employment and supply chain opportunities for the offshore renewables industry.

The manufacture and assembly of marine energy, port, and grid infrastructure requires large amounts of materials and resources that can have the potential to be produced within South Wales with the right level of support towards the supply chain. Investment in upskilling and expanding capabilities and capacities will be required across the supply chain to meet the needs of delivering offshore renewables.

[147] International Renewable Energy Agency, 2024. Key Enablers to Triple Renewables by 2030: Skills and Capacities
[148] National Grid, 2025. Building the Net Zero Energy Workforce Report.

For the planned FLOW developments in the Celtic Sea, South Wales and South West England already has strong existing skill bases in high-skilled welding and concrete structure production (stemming from significant investment into Hinkley Point C). There is also a strong steel providers and fabricators. The existing skills base in South Wales and South West England provides the opportunity for greater capacity and a bigger local supply chain to be generated with further investment.

The south of Wales and South West England have several established onshore and offshore wind project developers with transferable skills to floating wind, such as Cornwall Light and Power, REG wind power, RES and Vattenfall which all have a base in these areas. This increases the likelihood of locally based employment and services being used. There are also a strong number of surveying companies which could play a significant role in wind farm projects, (i.e., through surveying the construction and operation of offshore wind sites)[149].

Offshore Wind and FLOW

The Offshore Wind Industry Council's (OWIC) Offshore Wind Skills Intelligence Report[150] notes there are several skills gaps and shortages that need to be addressed across the offshore wind industry in the UK including:

- High level electrical skills, including Senior Authorised Persons
- Digital skills e.g., data analysts/scientists etc and engineers
- Consenting skills
- Marine & Port orientated skills.

The report anticipates skills shortages that could arise over the longer-term:

- Electrical technical and engineering skills (particularly substations, HV and cables). The need for these skills is anticipated to be even greater due to the upgrading of the power network and the introduction of other renewables and battery storage sites.
- Project Management and the ability to manage significant sized projects and multiple contractors.
- High level digital specialisms including data analytics, artificial intelligence, robotics, digital engineering/science, machine learning, and software development.
- On and offshore logistics.
- Construction resource for floating wind projects, which are anticipated to require high numbers of people in fabrication and welding.

Offshore renewable skills and tidal wave supply chain

Research into the renewable energy supply chain shows the UK is strong in development services, blade manufacture, cables, electrical (design, control, monitoring and protection), offshore services.

Previous tidal studies have found that the UK has some capacity to support the tidal range supply chain (i.e., through strengths in manufacturing, fabrication, and assembly of components and metals). Opportunities to expand this workforce have been highlighted, whereby investment into training provisions and the relevant machinery and infrastructure

[149] ORE Catapult, 2020
[150] OWIC, 2023. Offshore Wind Skills Intelligence Report

could boost the proportions of the tidal workforce that could come from local populations rather than internationally.

Previous tidal studies note that as components for tidal technologies are similar to other offshore renewable infrastructure components, there could potentially be gaps and shortages in skills and labour within the UK to support the future pipeline of projects.

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Appendix 5: Norway and Quebec Case Studies

Norway's Energy Mix

Norway has vast natural resources, with many rivers and lakes, which has allowed for the establishment of significant renewable energy and non-renewable energy supplies.

Hydropower

The industrialisation of the country from the early 1900s was founded on the development of hydropower. The industrial potential of hydropower was also identified politically which initiated long-term political effort to place the Norwegian state in a role to support the ongoing electrification of the country and ensure that the hydropower resources would benefit the nation as a whole. The expansion of hydropower production, as well as developments of onshore and offshore wind, has meant that the country's electricity production is almost entirely based on renewable energy.

Hydropower accounts for approximately 90% of overall electricity production in Norway and mainly works to supply domestic energy to consumers and households within the Country[151].

A key aspect of Norwegian hydropower is that it is generally a flexible production method; more than 75% is flexible through the use of reservoirs which represents half of Europe's total reservoir storage capacity[152]. This flexibility helps to mitigate the risk of energy imbalances and helps to backup energy fluctuations that occur from non-flexible renewables such as wind and solar.

The vast majority of large hydropower plants are owned by Statkraft, a state-owned electricity producer, or by regional power companies such as Hafslund, Å Energi and Lyse, which are owned by municipalities.

Wind Energy

Wind power is identified as a prime source to fill the gap between increasing demand and available supply of energy within Norway.

Currently onshore wind accounts for approximately 8% of annual electricity production with Offshore wind infrastructure being increasingly developed. Deployment of wind power has dramatically increased within the last few years (mainly onshore wind) and the Norwegian government have set out ambitions to facilitate more offshore wind developments[153].

In 2023, Norway opened the Hywind Tampen which is the world's first floating offshore wind farm constructed to specifically supply and power oil and gas installations in the North Sea. This wind farm will help deliver electricity to oil and gas platforms as well as acting as a test bed for further developments in floating offshore wind technology.

[151] Chambers and Partners, 2024. Renewable Energy 2024
[152] Chambers and Partners, 2024. Power Generation, Transmission & Distribution 2024: Norway
[153] Chambers and Partners, 2024. Renewable Energy 2024

Oil and Gas

Norway has a large oil and gas export industry that has been developed since the discovery of oil and gas reserves on the Norwegian Continental Shelf in the late 1960s

Norway is one of the largest natural gas producers in the world and is also a significant oil producer. The majority of this is exported and plays a key role in meeting European energy demands. It is anticipated that Norway will continue to be a significant net exporter of energy over the next 30 years, with added pressure to increase such exports due to Russia's invasion of Ukraine.

Other Renewable energy

Norway's abundant and clean energy supply is facilitating further developments in its renewable energy sector.

Norway has two large-scale carbon capture and storage (CCS) projects operating, another large CCS project undergoing development, and several CCS pilot project. A number of companies with CCS expertise have based themselves within the Country, allowing Norway to establish itself as a leading country for CCS deployment.

Norway is also leading in the development of clean hydrogen. The country is developing blue hydrogen power, where coupled with CCS, could provide a steady flow of hydrogen using existing natural gas resources. Green hydrogen generated from renewable energy sources (such as offshore wind) is also being developed. Existing and future pipelines to the UK and mainland Europe will enable hydrogen transport from Norway to Europe, helping to meet climate goals and create new economic opportunities.

Impacts on the local, national, and international economies of Norway's Energy Sector

With greater global focus on transitions to clean renewable energy, Norway has significant opportunity to benefit from and play a strong part in this. The Country's availability of natural resources and suitable wind conditions alongside its capabilities and technologies from the offshore industries that use them, provides a strong foundation for future growth and investments.

The country will continue to need significant investments in new generation sources and grid expansions as electricity consumption grows.

Impact of Norway's energy mix on consumers and households

Norway's consumers and households benefit from reduced energy prices compared to other nations. Reasons for this include:

- The abundant availability of renewable hydropower in Norway means the country is self-sufficient in energy which has reduced their need for expensive imports of energy. This means the country is shielded from fluctuating costs of natural gas, oil, and coal that has been a cause of increased energy prices in other nations.
- Large portions of the energy infrastructure are state-owned (i.e., by Statkraft and Statnett) which prioritises public welfare alongside profitability.

- Norway's hydropower infrastructure not only generates a flexible energy source, but they also have low operational and maintenance costs. – compared to fossil fuels or nuclear for example

Within Norway, there are regional differences in energy prices with the south generally experiencing higher prices due to low rainfall in the past, a low transmission capacity going from the north to the south of the country, and congested transmission networks as new cables are established (to export energy to other nations like the UK and Germany).

National growth

Norway has an abundance of energy supply stemming from strong, well-established hydropower infrastructure, existing and new developments in onshore and offshore wind, and oil and gas reserves. With continual research and investments into developing other clean energy infrastructure, such as clean hydrogen, floating offshore wind, and carbon capture and storage, Norway has great potential in leveraging its clean electricity to decarbonise their economy and facilitate growth.

The abundance of energy has enabled a high level of electrification of homes and businesses within Norway. This is strongly supported by ample interconnection capacity and a well organised energy system led by state-owned transmission system operators. Norway has one of the highest electricity consumptions per inhabitant in the world due to factors such as:

- High electrification of road and marine transportation;
- High electricity uses in heating of residential and commercial buildings;
- Electricity-intensive industries (e.g., aluminium production); and
- High electricity uses in oil and gas extraction industries.

Norway's ample clean energy supply is fostering continual development of green industries. Norway is a strong leader in developing green hydrogen and carbon capture and storage technologies, aiming to contribute to climate goals alongside creating new economic opportunities.

A key green industry within Norway is electric vehicles and its associated technology and infrastructure. Norway has one of the highest rates of electric vehicle (EV) adoption in the world, with low-cost, renewable energy supplies playing a pivotal role in the transition electrified transport. In 2022, more than 80% of new cars purchased in the country were electric and 20% of all passenger vehicles were EV[154].

This high level of EV use, supported by economic and social incentives and a reliable and clean energy grid, has created a market for EV-related industries and infrastructure development. Whilst Norway is at the forefront in EV adoption, the challenge is scaling EV charging infrastructure to keep pace with such demand. This means Norway has drawn in a number of companies into the EV charging infrastructure industry, especially as EV charging is likely to remain profitable.

[154] McKinsey & Company, 2023. What Norway's experience reveals about the EV charging market

Wider international impacts

Norway's existing and forthcoming interconnectors between other countries such as UK, Denmark and Germany, allows for electricity exports, which generates revenue but strengthens energy security.

Norway has played a stabilising role in delivering global oil and gas supplies, especially to Europe. As domestic energy is mainly derived from renewable hydropower, the country is able to export large amounts of energy elsewhere.

Given Norway's structural position in supplying energy to a number of other countries, it has been proposed that Norway can act as "Europe's green battery". European power markets are undergoing transitions away from fossil fuels towards renewables, however renewable sources are largely inflexible. As Norway's hydropower system is highly flexible, the country can benefit from greater security and will remain a key player in the wider international energy supply chain.

Norway's expertise on energy infrastructure has also laid the groundwork for establishing and working on clean energy infrastructure. The high-tech value chain with world-leading expertise in gas and oil production and hydropower, and highly qualified skilled workers and researchers will help drive new green industries within the country and globally.

Norway's abundance of affordable energy (particularly from hydropower) has also enabled economic growth through drawing in developments of energy-intensive industries. One key industry that has established itself in Norway is aluminium production, which requires large amounts of electricity. Companies like Norsk Hydro (a global aluminium producer) have established major production facilities within the country due to low-cost energy availability.

Another market that Norway are aiming to attract, and grow, is the data centre market. Data centres require large amounts of energy and Norway has a renewable supply to power them. Alongside this, the country has space for large data centre developments and has a cold climate (which would reduce costs of cooling) making the country a highly attractive place for such infrastructure.

Quebec Case Study

Quebec is one of the ten provinces in Canada with a population of 9 million people. It is the second most populated province, after the province of Ontario and is home to the second most populated city in Canada, Montréal.

Quebec is the largest geographical province in Canada making up approximately one sixth of its total land area. It is rich in many natural resources, including forests, water, minerals, agricultural land, rivers, lakes, fish and wildlife. This means that Quebec is able to benefit from producing a significant amount of renewable and non-renewable energy domestically.

Quebec's Energy Landscape

Electricity

Today, the majority of Quebec's electricity is produced by Hydro-Québec and 99% of the electricity produced is renewable[155].

The majority of Quebec's electricity comes from hydropower facilities. In 2021, 94% of all electricity produced in Quebec is hydroelectricity that came from the 61 hydroelectric plants[156], the majority being within Quebec's border and one hydroelectric power station in Labrador157.

Quebec has a long history of hydroelectricity production. The first hydroelectricity power stations in Quebec were built by private investors at the end of the 19th century. In response to public outcry of poor service and high rates, due to the development of regional monopolies, the Quebec government created a new public electricity corporation, Hydro-Québec, in 1944.

In 1963, Hydro-Québec purchased the remaining private electricity producers and became a publicly owned electricity monopoly offering lower electricity rates to consumers and creating an advantage for energy-dependent industries such as aluminium, pulp-and-paper and chemical companies.

Quebec has an electricity transmission and distribution system with province-wide coverage consisting of 151,086 km of lines[158]. Being Canada's top energy producer, Quebec generated 212.9 terawatt-hours (TWh) of electricity in 2021[156]. This is equivalent to approximately one third of total Canadian electricity generation. As of 2021, it had an estimated capacity to generate 47,078 megawatts (MW)[159].

Wind power is the second largest source of electricity produced in Quebec, contributing to approximately 5% of total electricity generation. Quebec is home to the two largest wind farms in Canada and had an estimated wind capacity of 4,363 MW[160].

[155] Hydro-Québec, 2024. Setting up in Québec has its benefits.
[156] Canada Energy Regulator, 2024. Provincial and Territorial Energy Profiles – Québec.
[157] Quebec has an agreement with the province of Newfoundland and Labrador where Hydro-Québec has access to almost all output from one of their hydroelectric power plants until 2041
[158] Hydro-Québec, 2024. Setting up in Québec has its benefits.
[159] Canada Energy Regulator, 2024. Provincial and Territorial Energy Profiles – Canada.
[160] Hydro-Québec, 2024. Setting up in Québec has its benefits.

Currently, Hydro-Québec purchases all the output from 39 wind farms operated by independent power producers (equivalent to 3,508 MW) [161]. In July 2024, they announced a C$9B wind power project estimated to start in 2028 that could generate up to 3,000 MW of power[162].

The rest of Quebec's electricity is generated from bioenergy, diesel (for remote communities), natural gas (mainly for peak demand), and solar[163].

Hydroelectricity in Canada

Canada is a global energy leader in terms of its energy production. 70% of Canada's electricity comes from renewable sources and 82% from non-greenhouse gas emitting sources (solar, hydro, wind and nuclear)[164].

62% of Canada's electricity is generated by hydroelectricity and the country was the third largest generator of hydroelectricity in the world in 2023[165]. The majority of its major hydroelectricity capacity facilities are located in Quebec.

Other Energy Sources

Quebec also produces Refined Petroleum Products (RPPs) and Renewable Natural Gas (RNG), but it does not produce any crude oil. It does not produce Natural Gas/Natural Gas Liquids (NGLs), since the Quebec government's ban on hydraulic fracturing in 2018, but it does produce minimal amounts of propane and butane from its oil refineries[166].

Two large refineries operate in Quebec with crude oil from Western Canada and the U.S and has a production capacity of 402 thousand barrels per day (Mb/d). Quebec accounts for 21% of Canada's refining capacity, second only to the province of Alberta.

There are currently 4 biomethanisation plants in Quebec contributing to their target of 10% RNG in their natural gas system by 2030.

Impact of Quebec's Energy Mix

Given the increasing global focus on the shift the decarbonisation, Quebec's position and capability to create green energy presents a significant advantage and opportunity. Given its abundance of natural resources, notably water and minerals, Quebec is in a strong position for future innovation, investment and growth.

Competitive Advantage

Due to its abundance of electricity, primarily due to hydroelectric power capacity, Quebec has access to the cheapest energy within Canada[167] and has the lowest electricity prices for both residential and large power industrial consumers in North America[168].

[161] Hydro-Québec, 2024. Generating Stations.
[162] CBC, 2024. Hydro-Québec announces $9B wind power project, one of the largest in North America.
[163] Canada Energy Regulator, 2024. Provincial and Territorial Energy Profiles – Québec.
[164] Government of Canada, 2024. Energy Fact Book, 2024-2025: Clean Power and Low Carbon Fuels.
[165] Government of Canada, 2024. Hydroelectric energy.
[166] Canada Energy Regulator, 2024. Provincial and Territorial Energy Profiles – Québec.
[167] Prices in Quebec are C$0.0759 per kWh, compared with Ontario (C$0.1417 per kWh) and with Canada's national rate (C$0.192 per kWh).
[168] Hydro-Québec, 2023. Comparison of Electricity Prices in Major North American Cities.

In Quebec, households and businesses can benefit from low electricity prices that result from:

- the majority of the province's power coming from low carbon hydro power (that has low maintenance and operating costs). Hydropower systems can last for 40 to 50 years, have low maintenance and operating costs and operate 24/7.
- the fact that Quebec's electricity supply is publicly owned,
- and the ability to control power supply by operating reservoir systems.

Low energy prices and reliable electrical access create a competitive advantage for businesses, particularly in high-energy use industries since lower electricity costs contributes to overall lower operational costs. Additionally, due to the nature of Quebec's energy mix being almost exclusively produced from renewable resources, there is an additional incentive for companies and investors who want to reduce their emissions to meet global emission reduction targets.

Quebec has a history of high energy use industry (aluminium, pulp-and-paper and chemical companies). Today, strong aluminium, mining, IT and aerospace (AéroMontréal)[169] clusters exist and continue to drive Quebec's economic growth.

Due to the rise in digital technology, there has been a global increase in demand for data processing and storage from Data Centres. Data Centres require massive inputs in energy to run and create a challenge since the majority of electricity today is derived from fossil fuels. Hence, as a response to international mandates to decrease emissions, major international corporations including Google, Amazon and Microsoft have built (or are in the process of building) Data Centres in Quebec in recent years. This is due to having access to reliable, affordable and clean energy and there are currently 44 Data Centres in Quebec[170].

The increased in AI technology could increase demand for Data Centres by 160%, providing an opportunity for growth for Quebec[171].

Innovation and Investment

Access to cheap, efficient and clean electricity has led to greater innovation and investment in Quebec.

HY2GEN recently announced a new renewable ammonia project, Courrant.[172] The project will produce green hydrogen and green ammonia at its production plant in Baie-Comeau, Quebec. HY2GEN has entered into an agreement with Hydro-Québec to receive a block of hydroelectricity to power their operations. The province's renewable energy from hydropower and its abundant supply influenced the firm's decision in choosing the location of the energy intensive plant.

Clean energy provides a pathway for companies in carbon cost industries (e.g. mining, smelting and steel manufacturing) to capture benefits of electrification and invest in low-carbon process innovations[173]. For example, companies such as Rio Tinto and Alcos (aluminium production), ArcelorMittal (aerospace), Agnico Eagle (mining) and Air Liquide

[169] AéroMontréal, 2024. Quebec's Aerospace Cluster.
[170] DataCenters, 2024. Quebec Data Centres: Providers Map in Quebce, Canada.
[171] Goldman Sachs, 2024. AI Is Poised to Drive 160% Increase in Data Center Power Demand.
[172] HY2GEN, 2024. HY2GEN is awarded renewable electricity supply.
[173] Canadian Climate Institute, 2022. Clean energy is a must-have for business – and for Canada's economic prosperity.

(green hydrogen) have made significant investments towards carbon reduction technology at their Quebec operation locations.

Additionally, even the production of hydroelectricity itself has led to innovation and technological developments. To maintain and inspect its extensive infrastructure, Hydro-Quebec has invested in various robotic technologies over the past 25 years. This has led to technological advancements that are now being used globally including technology to gather strategic data and performing live-line maintenance task[174].

Quebec's history of hydroelectricity enabled the technological innovation of its EV system[175] and it now highest amount of Zero Emissions Vehicles (ZEVs) in Canada[176]. Approximately one in 4 new cars sold in Quebec are electric.

Increased Energy Efficiency

Quebec has 15 interconnections linking it to other Canadian provinces[177] and the North East of the United States[178]. Its energy landscape gives the province the opportunity to trade in energy markets in the US since it is able to export hydroelectric energy to meet part of the region's demand.

Some of Quebec's hydropower plants have a water reservoir in place and this provides a great advantage to Quebec and its neighbouring regions in North America. By having access to accumulated water, via its 28 reservoirs, they are able to adjust the supply of electricity based on the electricity demand at any point in time.[179] This provides a sizable advantage in comparison to other electricity producers, since they are able to optimize electricity production and usage.

The ability to export energy to neighbouring US states, decreases overall emissions and facilitates the integration of variable renewable electricity sources such as wind and solar, since wind and sun may not always be available to meet peak demand[180]. Conversely, when the NE US states have surplus energy, they send their surplus to Quebec, resulting in a more efficient use of energy.

[174] Beaudry et al., 2022. The benefits of robotics.
[175] Haley, Brendan, 2015. Low-carbon innovation from a hydroelectric base: The case of electric vehicles in Québec.
[176] Banks, Brian. 2024. Quebec ZEV Registrations hold steady in Q1, but drops in Ontario and B.C. pull down national ZEV market share to 11,3 per cent: StatsCan.
[177] The interconnections are with the province of Ontario and the Maritime Provinces (New Brunswick, Nova Scotia and Prince Edward Island).
[178] Primarily New England and New York.
[179] Hydro-Québec, 2024. Power generation.
[180] Hydro-Québec, 2024. Québec Hydropower: Clean, Renewable and Low in GHG Emissions.

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Appendix 6: Regional Economy Baseline

See separate volume.

Appendix 7: Core Effects Impact Modelling

See separate volume.

Appendix 8: Flood Risk and Coastal Erosion Topic Paper

See separate volume

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