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A study to determine the construction labour and skills demand, supply and gaps associated with the creation of the Swansea Bay Tidal Lagoon

Sandra Lilley & Adam Evans, CITB
Malcolm Horner & Doug Forbes, Whole Life Consultants Ltd

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Glossary of Terms

A

Annual
Recruitment
Requirement
(ARR)

The annual recruitment requirement is a gross requirement that takes into account workforce flows into and out of construction, due to such factors as movements between industries, migration, sickness and retirement. However, these flows do not include movements into the industry from training, although robust data on training provision is being developed by CITB in partnership with public funding agencies, further education, higher education and employer representatives. Thus, the annual recruitment requirement provides an indication of the number of new employees that would need to be recruited into construction each year in order to realise forecast output.

Caveat

Readers should note that in relation to Swansea Bay Tidal Lagoon this data and related information must be viewed and used with caution and readers should be aware of the following caveat:

As with all projections and forecasts, the results presented in this report should be regarded as indicative and not precise measurements.

The forecasts are based on information known up to this point in time and are subject to changes in project timelines and refinements to build methodology.

The forecasts are based in part on information received from a Tier One contractor who has since left the Swansea Bay Tidal Lagoon project. It is not possible to quantify the effect of this change in contractor on the forecasts.

The commencement start year of construction was assumed to be 2016 when analysis for this report was undertaken and labour supply information was compiled. Readers should bear in mind that a start date has not yet been confirmed at the time of publication. This may again impact on the research findings presented.

The forecasts specifically relate to the construction plan and timetable of a tidal lagoon in Swansea Bay by Tidal Lagoon Swansea Bay Plc.

Summary

This research was commissioned by the Welsh Government to explore the impact of the construction of the Swansea Bay Tidal Lagoon (SBTL) on the labour and skills available. There were two questions to answer.

- Can Welsh Government be sure that there is overall capacity and capability within Wales to build a tidal lagoon in Swansea Bay?
- Can it ensure that people living in Wales and Welsh business benefits from the opportunity?

The 320MW SBTL is the first of a number of tidal lagoons proposed by Tidal Lagoon Power Ltd. in Wales and the rest of the UK. This research is unique since no publically available assessment has taken place of the construction labour and skills demand for the SBTL. As well as assessing the labour and skills impact of the SBTL we have developed within the commission a methodology that can be potentially adapted to assess future developments in tidal lagoon energy.

The report has been produced by the Construction Industry Training Board (CITB) and Whole Life Consultants Ltd (WLC Ltd) - a spin out company from the University of Dundee.

It focuses initially on the creation of a bespoke labour demand profile for the SBTL using data provided by Tidal Lagoon Swansea Bay Plc (TLSB Plc) and its preferred tier one contractors¹. A forecast of the labour demand for the SBTL on a month by month basis in each of the 28 occupational groups has been produced. Alongside the demand analysis is an assessment of the supply of labour across the next five years in Wales. This draws on research produced by CITB as part of its Construction Skills Network publications.

The demand and supply analyses have been compared to produce a 'gap analysis' at occupational level. Based on the results of the gap analysis we have proposed recommendations relating to skills and training interventions to ensure that the SBTL has the right workers in place with the right skills at the right time. This approach is the first step in ensuring that optimum opportunity can be leveraged from this very significant project.

Research in this report has focused on the direct construction jobs associated with the SBTL. A parallel study has been carried out by Miller Research and SEMTA entitled "*A study to forecast the manufacturing and assembly labour requirements for the Swansea Bay Tidal Lagoon Project*". The Miller Research and SEMTA study considers the supply chain requirements for turbine manufacture and fabrication associated with the SBTL. That study also considers the operation and maintenance jobs associated with the power generation work packages in the project.

¹ This research has been commissioned in 2015 and is based on the information provided by the preferred Tier One contractors for SBTL at that time. Any changes in the scope or timescales may have an impact on the labour demand.

The construction period is assumed to be from 2016 to 2022 and labour demand peaks in 2019 at slightly over 1,000 people. Any changes to the programme will have a knock on impact to the labour and skills demand. Five occupational groups account for over 60 per cent of the labour demand. These are plant operatives, specialist building operatives, wood trades and interior fit-out, labourers and maritime related occupations.

The report also highlights the buoyancy of a recovering construction market in Wales (employment growth is forecast to average 2.9% a year well above the 1.1% predicted across the UK as a whole). It also draws together the 'big picture' in terms of the other significant competing projects including High Speed 2, the Northern Line Extension, Wylfa Newydd, Hinkley Point C nuclear power station and the Thames Tideway Tunnel.

Significantly the report emphasises that although research suggests a stable demand for the construction workforce in Wales, the Labour Force Survey suggests around 18,000 workers will be eligible for retirement over the next ten years.

Furthermore, trends in further and higher education qualification numbers point to a reduction in the future supply of qualified workers at a time when workloads are recovering. There may be capacity within the employment base to absorb these demands in the short term. However, in the medium to long term the emergence of occupational pinch-points both in terms of numbers and skills is a real risk.

This report measures the opportunity in terms of supply and demand and produces as accurate a picture as possible given the data available, the number of variables and the known facts.

The report concludes that in the short term there is capacity in the market to enable the construction element of the SBTL. However, this is dependent upon a number of factors including the construction element of other large projects and the growth in the Welsh construction market.

Collaboration and forward planning for the skills agenda is critical, even in a market which can be swayed by economic factors and political uncertainty. The report makes six key recommendations regarding that planning process and highlights the need for collaborative working. This partnering approach should be led by Welsh Government and should involve employers, representatives from the higher and further education sector and Regional Skills Partnerships.

SBTL represents more than just the normal opportunities that a major project might present. The approach established in Swansea Bay could form the blueprint for the future delivery of tidal lagoons across the UK by creating a working model for development and delivery that maximises investment opportunity, gives a sound economic and social return on investment and emphasises the success of Wales in optimising the outcomes.

1 Introduction

Tidal Lagoon Swansea Bay Plc (TLSB Plc) is proposing to construct a tidal lagoon capable of generating 320MW of power in Swansea Bay. The Welsh Government wished to explore the impact of tidal lagoons on the construction labour market, with the Swansea Bay Tidal Lagoon as the first of a number proposed in Wales and the UK. It is proposed that Swansea Bay Tidal Lagoon is the first in a fleet of six lagoons where an additional three may be built in Wales. It would be possible in future research to apply a similar methodology to that detailed in this report for those future developments.

Welsh Government has engaged the Construction Industry Training Board (CITB) and Whole Life Consultants Ltd (WLC Ltd - a spin out company from the University of Dundee) to conduct a bespoke research study to understand the employment and skills opportunities created by the development of a tidal lagoon in Swansea Bay. The study will consider the labour demand arising from the construction in Swansea Bay and compare this with the supply of labour in the wider area of Wales and neighbouring parts of England. This demand, supply and gap analysis will allow opportunities to maximize the skills and employment opportunities for the area, including instigating training interventions where required. As part of this commission, we have presented to the Tidal Lagoon Industry Advisory Group; namely the Skills and Training Sub Group, who are keen to view the outcomes of the study.

The research in this report has focused on the direct construction jobs associated with the Swansea Bay Tidal Lagoon. There is a parallel study being carried out by Miller Research and SEMTA entitled “*A study to forecast the manufacturing and assembly labour requirements for the Swansea Bay Tidal Lagoon Project*”. The Miller Research and SEMTA study considers the supply chain requirement for the turbine manufacture and fabrication aspect of the Swansea Bay Tidal Lagoon. That study is also considering the operations and maintenance jobs associated with the power generation element of the project.

1.1 Background of the project

This research was initiated following a feasibility study carried out in late 2014. That study, carried out by CITB and WLC Ltd, determined that it was possible to produce a full, bespoke labour forecasting demand model for the tidal lagoon in Swansea Bay. In partnership with WLC Ltd, CITB have used its Labour Forecasting Tool (LFT) to create a ‘demand profile’ for each relevant occupation engaged in the construction of the Swansea Bay Tidal Lagoon.

CITB’s primary remit includes:

- assisting and directing the college offer to employers – improving the quality, relevance and impact of the most significant providers of initial training and up-skilling;
- sharing labour market intelligence – creating a ‘bespoke evidence base’ where required;

- improving employability with a focus on ensuring that young people aged 16-24 have the best opportunity to get a job locally and are work ready;
- supporting business-provider collaboration across supply chains.

1.2 Aims of this study

The aim of this project is to create a robust evidence base that will:

- analyse the demand arising from the Swansea Bay Tidal Lagoon to understand what construction employment opportunities are likely to be created, the current skills challenges and how employment and training opportunities can be maximised;
- analyse the wider demand pipeline to understand what additional projects will be taking place that will draw on the skills base;
- conduct analysis into current supply including the existing workforce, outputs from local colleges, technical and higher level skills development and retention and how new entrants feed into construction;
- consider inter-regional supply mobility and how this might impact on construction skills and employment in the area;
- evaluate existing construction training provision in the area, the extent to which it is fit for purpose and the potential viability of a range of flexible training options in the future;
- make recommendations regarding how stakeholders from industry, Welsh Government, skills bodies and training providers can work together to ensure a successful project is delivered that maximises employment and skills opportunities for Welsh people and feeds into the legacy of the next tidal lagoon project in Wales; and
- make suggestions about how the above evidence might be used to leverage investment funding.

1.3 Methodology

CITB and WLC Ltd have used the Labour Forecasting Tool to predict the labour required by occupation for the Swansea Bay Tidal Lagoon. The principal data required relates to the labour coefficients (number of person years per million pounds of construction output) for each of the relevant occupations. Details of the labour on a month-by-month basis during the project are also needed to define the labour profile during the course of the project.

The feasibility report suggested that suitable and sufficient data, including a detailed cost plan, can readily be made available to derive labour coefficients and profile curve parameters (the so-called 'S' curve) to calibrate the LFT. Thus, it is possible to model the 28 occupational groups already embedded in the LFT that will enable CITB to undertake a skills gap analysis.

The supply side analysis will collate the pertinent data for the supply of labour and skills, taking into account changes in the workforce including new entrants and leavers. This allows the development of a gap analysis and key recommendations on how to ensure that the right people with the right skills are in the right place at the right time to deliver successfully a tidal lagoon at Swansea Bay in the wider context of the Welsh Construction Industry.

1.4 Structure of the report

This report is structured in the following way:

- Section 2 considers the labour demand arising from the Swansea Bay Tidal Lagoon and describes the detailed modifications made to the LFT.
- Section 3 considers the supply of labour in Wales and factors which may affect the provision of suitably qualified people.
- Arising from the demand and supply analyses, Section 4 identifies potential skills gaps that may arise.
- Section 5 presents our conclusions and recommendations.

2 Labour demand analysis

The labour demand analysis produces an estimate of the amount of labour required to deliver the Swansea Bay Tidal Lagoon project. The demand analysis was carried out in consultation with Tidal Lagoon Power Ltd and TLSB Plc's preferred bidders for its tier one contracts. CITB's Labour Forecasting Tool (LFT) was used to undertake the labour demand analysis. The LFT is a powerful and unique award-winning tool, developed by WLC Ltd on behalf of CITB. It can predict the labour demand in each of the 28 occupational groups (based on the ONS Standard Occupational Classifications, SOCs) shown in Appendix 1, on a month-by-month basis given no more than the type of project, its value, and its start and finish dates. This capability exists for seven sub-sectors of the construction industry².

For projects, which are "typical" construction projects, we utilised the existing models within the Labour Forecasting Tool. We have also developed a number of bespoke instances including nuclear, onshore and offshore wind energy generators, and a more detailed disaggregation of the infrastructure sector.

Since the Swansea Bay Tidal Lagoon project is not typical, it has not been possible to model the main works using any of the existing models. We have therefore developed bespoke tidal lagoon models and used these to forecast the labour demand for this project.

An annex detailing the methodology is included in Appendix 2. This includes how the forecast has been produced, the assumptions made and the sources of data used.

2.1 Elements of the work

We have engaged directly and extensively with TLSB Plc to determine the nature and extent of work proposed to take place in Swansea Bay to allow us to model the project. In total there are nine work packages as outlined in Table 2.1. Not all of these work packages are relevant to construction and some are considered by the parallel study carried out by Miller Research and SEMTA which considers the manufacture and assembly requirements. The work packages which are relevant to construction are as follows:

- Sea Wall and Marine Works (C131)
- Turbine and Sluice Structures (C132)
- Ancillary Civil Works (C133)
- Buildings (C134)

We have modelled each of the work packages separately. This allows the effects of changes in the timing or value of any work package to be easily assessed.

² The seven sectors are: Housing, Public non-residential, private commercial, private industrial, infrastructure, housing repair and maintenance and non-housing repair and maintenance.

Table 2.1 Work packages

Work Package	Description	Included in manufacturing & assembly definition?	Included in construction definition?	Notes
C122 Turbines and Power Generation Plant	Includes the manufacture and assembly, and installation of: <ul style="list-style-type: none"> • Turbine & generator plant • Transformers • Sluice gates • Permanent cranes • Stoplog bulkheads • 275kV cable and connection to National Grid • Electrical Systems • Mechanical Systems 	Yes (except a small amount of construction installation)	No	The majority of this work package comprises the manufacture, assembly, installation and commissioning of turbine & generator plant, transformers, sluice gates, permanent cranes, stoplog bulkheads, 275kV cable, electrical systems and mechanical systems. However, there is a small amount of on-site construction installation which is not strictly manufacturing and assembly and so is not included in the calculations, however a stand-alone paragraph is included to describe the activity in the manufacturing and assembly report.
C131 Sea Wall and Marine Works	Includes the design and construction of bunds, public realm and other marine works.	No	Yes	
C132 Turbine and Sluice Structures	The manufacture, construction and assembly of the physical structures for the turbine housing and sluice gates.	Yes (manufacture and assembly of sheet piling, dividing structure, turbine house structure, sluice structure and wing walls)	Yes (construction of turbine & sluice housing blocks and construction installation)	The manufacturing and assembly elements include the manufacture of structural metal products, and concrete placement. There will be on-site construction installation that is not included in this report.
C133 Ancillary	Works to highways and parking, landscaping, marina works and	No	Yes	

Work Package	Description	Included in manufacturing & assembly definition?	Included in construction definition?	Notes
Civil works	other miscellaneous items.			
C134 Buildings	Construction of visitor centre, boating centre, and other tourist / visitor services.	No	Yes	
C135 Power Plant O&M³	Management and administration, operations, maintenance and other services of the power plant.	Yes (some maintenance, repair and replacement of parts)	No	
C150 Lagoon Maintenance	On-going scheduled and un-scheduled maintenance of the lagoon.	No	No	Although the maintenance packages will require some construction labour these are beyond the scope of the construction report which was limited to the construction stage.
C151 Infrastructure Maintenance	On-going scheduled and un-scheduled maintenance of the site infrastructure such as buildings, roads, etc.	No	No	
C152 Facilities Management	The on-going management of facilities.	No	No	

³ Operations and Maintenance

This study considers only the direct construction stage of the tidal lagoon and takes no account of the operations and maintenance of the asset⁴. Within the construction phase, consideration is only taken of the direct jobs and not any of the employment roles that are likely to be created from the supply of goods and services by the local economy. The workforce jobs presented are full time equivalent.

2.2 Analysis of data from the preferred bidders

We have obtained from TLSB Plc the details of the month-by-month labour demand from their preferred Tier 1 contractors for the marine works, the turbine housing structure and the ancillary civils. Data is not available in this format for the building work for which a different approach has been adopted.

The labour demand provided by the contractors was broken down by a range of occupations. These occupations were specific to each contractor and we have engaged directly with TLSB Plc and their Tier 1 contractors to understand the exact role requirements of the job titles provided by the contractors. In total labour demand profiles were available for 212 occupations. Some of these 212 titles were very similar but used different terminology (for instance the same occupation working on the shore and on the off shore structures).

One of the challenges in undertaking a gap analysis is that both the demand and the supply of labour needs to be compared on a like for like basis. It is useful to see in some detail the individual occupations, which will be required to build a bespoke project like a tidal lagoon to allow appropriate interventions to be put in place to ensure the workforce has the correct skills. However, in conducting a skills gap analysis, sufficient robust data is not available for a comparison to be made at the minutest level of detail. For consistency with data that is available for the supply and gap analysis described in the later sections of this report, we have to consider the 212 occupational titles as one of the 28 occupational groups in Appendix 1. These 28 occupational groups have been developed over a number of years by CITB and include all occupations within the construction industry. The issue is common to numerous other bespoke projects on which we have been engaged. In each case, we sought to map each of the job roles to one of the 28 occupational aggregates, and a similar approach has been used in this commission. The mapping has been done through the knowledge and understanding gained from the engagement with TLSB Plc and their Tier 1 contractors and our understanding of the 28 aggregates and the 166 occupations (derived from the 212 occupational titles) which sit within those.

It has not been possible to map every job role. For the purposes of creating models for tidal lagoons, we have added three additional occupational groups to the standard 28:

⁴ There is a parallel study being carried out to consider the supply chain requirement for the power generation plant manufacture and production aspects of the Swansea Bay Tidal Lagoon project. This study is also considering the operations and maintenance jobs associated with the completed power plant.

- Out of scope: This includes those job roles that are beyond the scope of traditional construction skills.
- Marine works: Marine works are also out of scope from traditional construction, but these have been identified separately to allow an assessment of the magnitude of the skills demand in this area.
- Undefined: For a small number of roles the TLSB Tier 1 preferred bidders included an allocated number of people to undefined occupations. To avoid making any unnecessary assumptions regarding these roles they have been shown as a separate group.

For each of the work categories and each of the 31 occupational groups the LFT was used to derive the “s-curve” depicting how labour peaked during the project. This also incorporated offsets at the start and end of a category of work to reflect the fact that some trades are not required at the very start of the work and that others complete their work before the end of the project or work package.

Data was not available in the same format from TLSB Plc contractors for the onshore and offshore buildings as preferred bidders are not currently in place, but TLSB Plc made available to us the details of the estimated value of the construction work and the programme information. We have used the standard LFT model for public non-residential buildings to estimate the labour demand for these categories of work. By value the buildings are small in proportion to total costs of the main contracts.

Once the labour demand was produced for the buildings, it was aggregated with the data from the other three packages to provide an overall labour demand estimate.

At this stage, TLSB Plc reviewed the labour demand profile by occupation and identified that the contractors’ estimates did not take account of the labour demand from TLSB Plc’s own professionals at design and construction stage or logistics personnel during construction. Additional models were developed to take account of these roles and were aggregated with the demand from the four packages.

2.3 Including the models in the LFT

The LFT has the flexibility to be able to incorporate models specifically for tidal lagoon construction. We have adapted the LFT to embrace seven models representing the work packages shown in Figure 2.1. The 31 occupations (28 construction occupations plus out of scope, maritime and undefined) are shown in Figure 2.2.

Figure 2.1 Example of LFT showing tidal lagoon models

The screenshot shows the 'Add Forecast' window in the LFT software. It features a navigation bar with tabs: 'Details', 'Occupations', 'Start/End Dates', 'Curve', and 'Coefficients'. The 'Details' tab is selected. On the left, a tree view under 'Project Types' shows 'Swansea Bay Tidal Lagoon' expanded, listing sub-categories: Ancillary Civils, Marine Works, Turbine Structure, Power Generation, TLP Professionals, TLP Logistics, and Buildings. The right side of the window contains a form with the following fields: 'Title*' (text input), 'Description' (text area), 'Tags' (with an 'Add Tags' button), 'Location*' (dropdown menu), 'Input Value Type*' (dropdown menu), 'Price Index Date*' (dropdown menu), 'Start Date*' (text input), 'End Date*' (text input), and 'Duration (months)*' (text input with the value '0').

The integration of the tidal lagoon models into the LFT provides the flexibility to model changes in the programme as part of this analysis. It also allows the labour demand required for future potential developments of tidal lagoons to be estimated.

2.4 Programme adjustments

During the analysis, TLSB Plc advised us that as a result of the completion of a detailed integrated programme the planned individual programme dates for each work package had changed from that provided in the individual contractors' labour profiles. The revised programme resulted in a change to the phasing and duration (but not the value or scope) of the packages of work. Since each model had been built into the LFT, it was possible to change the start and end dates for each category of work to the revised dates provided by TLSB Plc. The LFT was then used to estimate the revised labour profile as shown in the next section.

It should be noted that the assumption underlying such an adjustment is that the total labour demand will be the same. The peak labour demand will also be the same and the inter-relationships between the packages of work will be the same despite the changes in phasing. Further investigation would be required to determine whether or not this is the case.

Figure 2.2 Example of LFT showing tidal lagoon construction occupations

Select / deselect all	Occupation
<input type="checkbox"/>	(SBTL01) Senior, executive and business process managers
<input type="checkbox"/>	(SBTL02) Construction managers
<input type="checkbox"/>	(SBTL03) Other construction process managers
<input type="checkbox"/>	(SBTL04) Non-construction professional, technical, IT, and other office-based staff (excl. managers)
<input type="checkbox"/>	(SBTL05) Construction trades supervisors
<input type="checkbox"/>	(SBTL06) Wood trades and interior fit-out
<input type="checkbox"/>	(SBTL07) Bricklayers
<input type="checkbox"/>	(SBTL08) Building envelope specialists
<input type="checkbox"/>	(SBTL09) Painters and decorators
<input type="checkbox"/>	(SBTL10) Plasterers
<input type="checkbox"/>	(SBTL11) Roofers
<input type="checkbox"/>	(SBTL12) Floorers
<input type="checkbox"/>	(SBTL13) Glaziers
<input type="checkbox"/>	(SBTL14) Specialist building operatives not elsewhere classified (nec)
<input type="checkbox"/>	(SBTL15) Scaffolders
<input type="checkbox"/>	(SBTL16) Plant operatives
<input type="checkbox"/>	(SBTL17) Plant mechanics/fitters
<input type="checkbox"/>	(SBTL18) Steel erectors/structural fabrication
<input type="checkbox"/>	(SBTL19) Labourers nec
<input type="checkbox"/>	(SBTL20) Electrical trades and installation
<input type="checkbox"/>	(SBTL21) Plumbing and heating, ventilation, and air conditioning trades
<input type="checkbox"/>	(SBTL22) Logistics
<input type="checkbox"/>	(SBTL23) Civil engineering operatives not elsewhere classified (nec)
<input type="checkbox"/>	(SBTL24) Non-construction operatives
<input type="checkbox"/>	(SBTL25) Civil engineers
<input type="checkbox"/>	(SBTL26) Other construction professionals and technical staff
<input type="checkbox"/>	(SBTL27) Architects
<input type="checkbox"/>	(SBTL28) Surveyors
<input type="checkbox"/>	(SBTL29) Maritime
<input type="checkbox"/>	(SBTL30) Other out of scope
<input type="checkbox"/>	(SBTL31) Undefined

2.5 Proposed labour demand profile

Following the analysis outlined in previous sections the total labour demand was estimated for the construction stage of Swansea Bay Tidal Lagoon. The results are shown in Figure 2.3 for all of the packages of work including the TLSB Plc professionals during design and construction and logistics during construction. The demand was produced on a month-by-month basis as shown in Figure 2.1. For the purposes of clarity, it has been calculated as an annual average. The annual average labour demand in each year by each occupation is given in Appendix 3, with a graphical representation in Figure 2.4. This figure shows the labour demand from 2016-2022 which peaks at just over 1,000 FTE people in 2019. There is a fairly constant ramp up of labour from 2016 to 2019 with a slight drop from the peak in 2020 and a reduction to

around 300-400 FTEs in 2021 and 2022. This has been based on the assumption that year 1 of the construction is 2016. If necessary, the LFT can provide a breakdown for each of the four (plus logistics and professionals) packages. A breakdown of the total labour demand by package is shown in Figure 2.5.

A start date of August 2016 has been assumed and the labour demand figures will need to be adjusted accordingly if that date changes.

Figure 2.3 Labour demand profile showing monthly labour demand

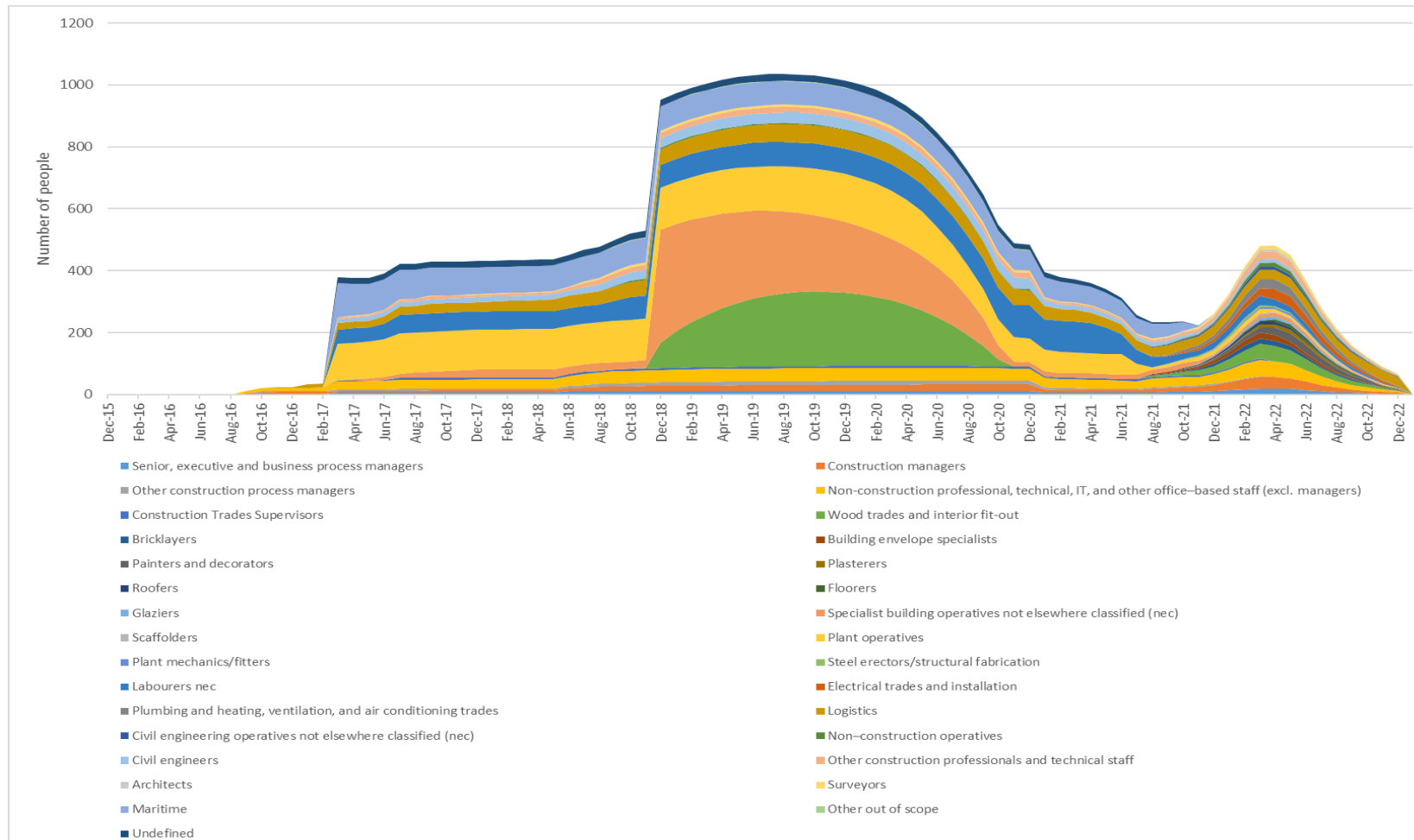
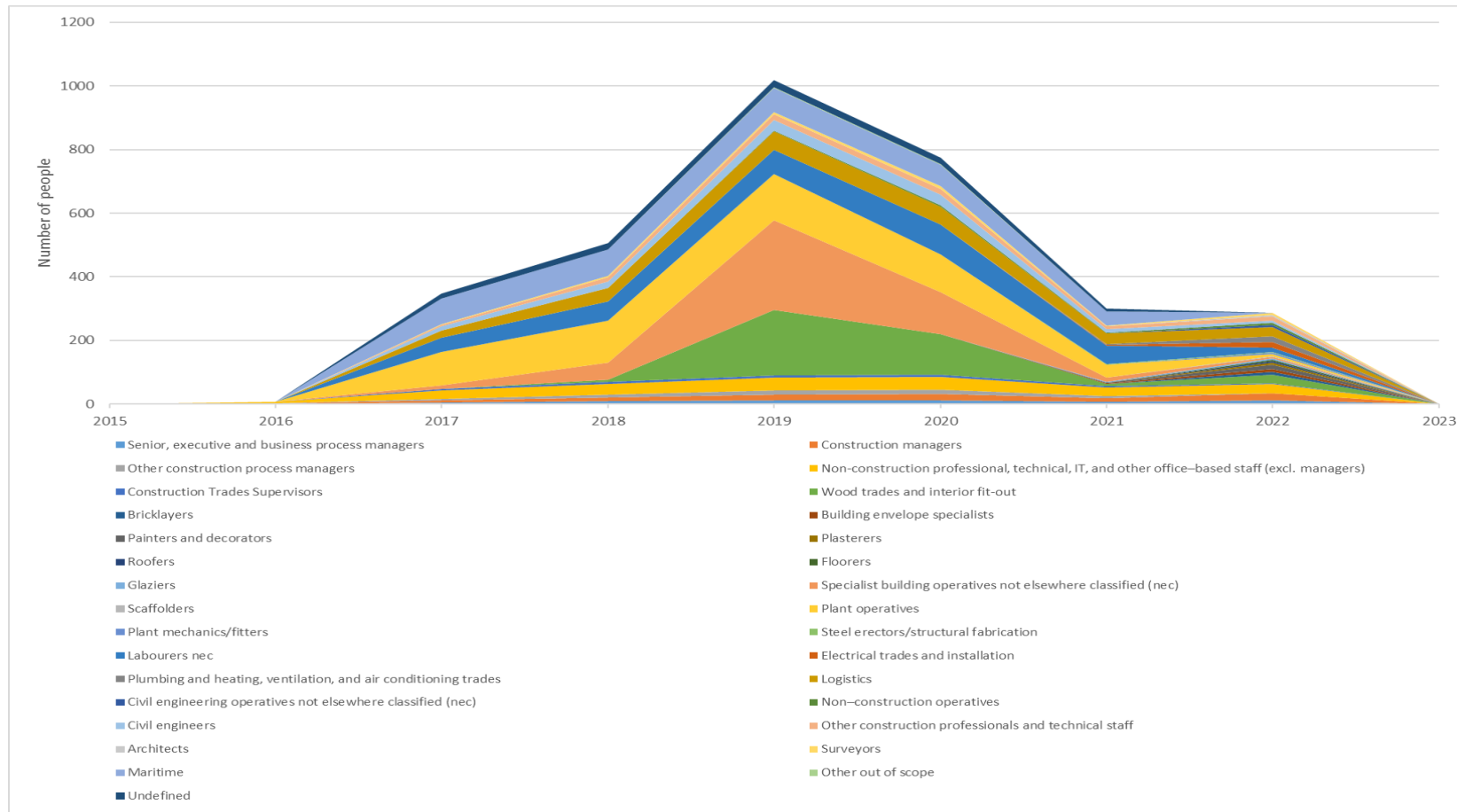


Figure 2.4 Labour demand profile showing annual average employment⁵



⁵ A table showing the annual average labour demand in each year by each occupation is given in Appendix 3.

Figure 2.5 Labour demand profile by work package

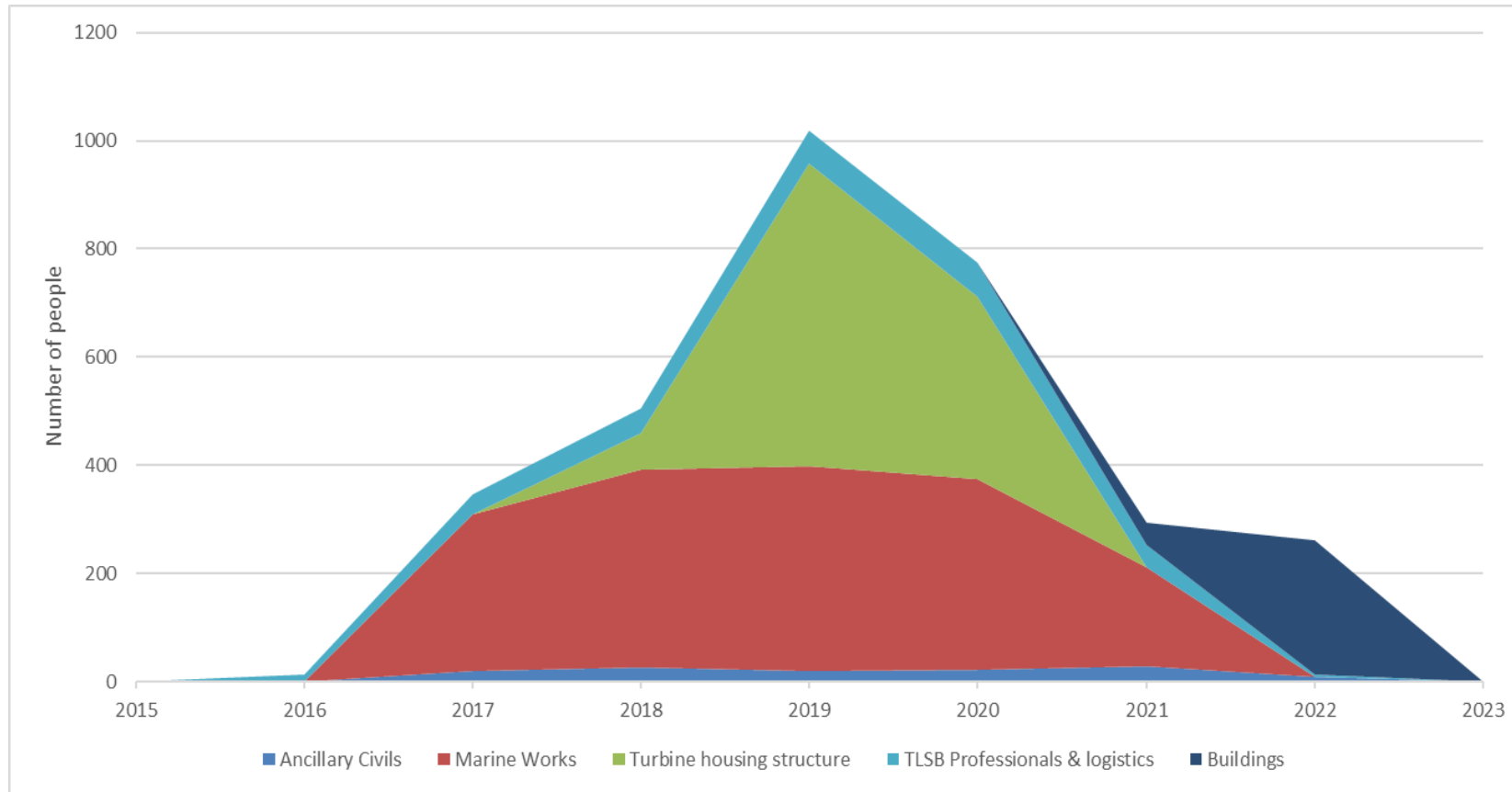


Table 2.2 shows the labour demand in each of the 31 occupational groups presented as a proportion of the total labour demand over the entire duration of the project.

The five occupations with more than 10 per cent of the total labour demand account for around 62 per cent of the total labour demand. Between them, the two largest occupations account for almost a third of the total labour demand. The occupation with the highest labour demand is plant operatives⁶ with 16 per cent of the labour demand. Specialist building operatives not elsewhere classified are the second highest with 15 per cent. Specialist building operatives are a wide-ranging category, which includes steelfixers and concrete finishers, which are in high demand on this project. Wood trades and labourers are the remaining two construction occupations with a high labour demand. The fifth largest occupation is maritime roles, which account for around 10 per cent of the labour demand on the project. This is not unexpected given the marine works element of the construction. Although this is not within CITB's footprint, it has been considered in the supply and gap analysis reported in sections 3 and 4.

Table 2.2 Labour demand by occupation

Occupations	Total Person-Year⁷	Per cent of total labour demand⁸
Plant operatives	550	17
Specialist building operatives not elsewhere classified (nec)	500	15
Wood trades and interior fit-out	370	11
Labourers nec	350	11
Maritime	350	11
Logistics	240	7
Non-construction professional, technical, IT, and other office-based staff (excl. managers)	200	6
Construction managers	90	3
Undefined	90	3
Other construction professionals and technical staff	80	2
Senior, executive and business process managers	60	2

⁶ It should be noted that the plant mechanics/fitters group is very low due to there being no plant fitters or mechanics listed in the contractors' profiles. Given the large amount of plant this is unexpected and we can only assume that this is considered to be a service that is supplied with the plant and is therefore not included in the labour profiles. We would suggest that further investigation of the labour demand in this occupation is considered.

⁷ One person-year is equivalent to one person employed for 12 months or two employed for six months etc. Person years are rounded to the nearest 10.

⁸ Percentages are based on unrounded figures.

Occupations	Total Person-Year⁷	Per cent of total labour demand⁸
Other construction process managers	50	1
Surveyors	30	1
Construction Trades Supervisors	30	1
Plumbing and heating, ventilation, and air conditioning trades	20	1
Electrical trades and installation	20	1
Non–construction operatives	20	1
Painters and decorators	<20	0
Building envelope specialists	<15	0
Bricklayers	<15	0
Civil engineering operatives not elsewhere classified (nec)	<10	0
Plasterers	<10	0
Roofers	<10	0
Glaziers	<10	0
Architects	<10	0
Floorers	<10	0
Other out of scope	<10	0
Plant mechanics/fitters	<10	0
Steel erectors/structural fabrication	<10	0
Scaffolders	<10	0

* indicates those occupations which are not in traditional construction.

2.6 Demand summary

The labour demand analysis is based on data provided by TLSB Plc. It has provided an estimate of the labour demand arising from the project, measured by 28 occupational groups common to construction projects plus three additional occupation groups covering the labour demand for occupations beyond the traditional construction footprint. The following observations relate to the labour demand forecast.

- The construction period is from 2016 to 2022. Labour demand peaks in 2019 at slightly over 1,000 people.
- Five occupational groups account for over 60 per cent of the labour demand. These five groups are:
 - Plant operatives
 - Specialist building operatives not elsewhere classified (nec)
 - Wood trades and interior fit-out
 - Labourers nec
 - Maritime

3 Supply-Side Analysis

The supply side analysis section collates pertinent data for the supply of labour and skills, taking into account changes in the workforce including new entrants and leavers. It considers these in the wider context of the Welsh Construction Industry.

3.1 Demand arising from competing projects

There are a number of other large construction projects occurring at a similar time to the tidal lagoon project. These projects are ‘competitors’ and could generate increasing demand for labour and skills within the supply chain, drawing on a similar occupational footprint.

Table 3.1 provides details of major construction projects with estimates of start and finish years.

Table 3.1 Details of major construction projects

Project	Estimated Start	Estimated End
Network Rail electrification (CP5)	ongoing	2021
SHARP Flintshire	ongoing	2020
Cardiff new homes	ongoing	2018
A465 dualling	ongoing	2017
Wheelabrator	ongoing	2017
Northern Line Extension	ongoing	2020
Thames Tideway Tunnel	ongoing	2025
Cwmbran critical care centre	ongoing	2019
Anglesey Biomass	2017	2018
Swansea redevelopment	2017	2020
Central Square, Cardiff	2017	2020
High Speed 2	2017	2025
M4 Upgrade	2018	2022
Wylfa Newydd	2019	2025
Crossrail 2	2022	2033
Other nuclear including Sizewell C, Moorside, Oldbury	tbc	2030+

Note: Updated 31st May 2016, project details are indicative and dependent upon financing.

The most significant key competing projects for the tidal lagoon project include High Speed 2, the Northern Line Extension, Wylfa Newydd, Hinkley Point C nuclear and the Thames Tideway Tunnel.

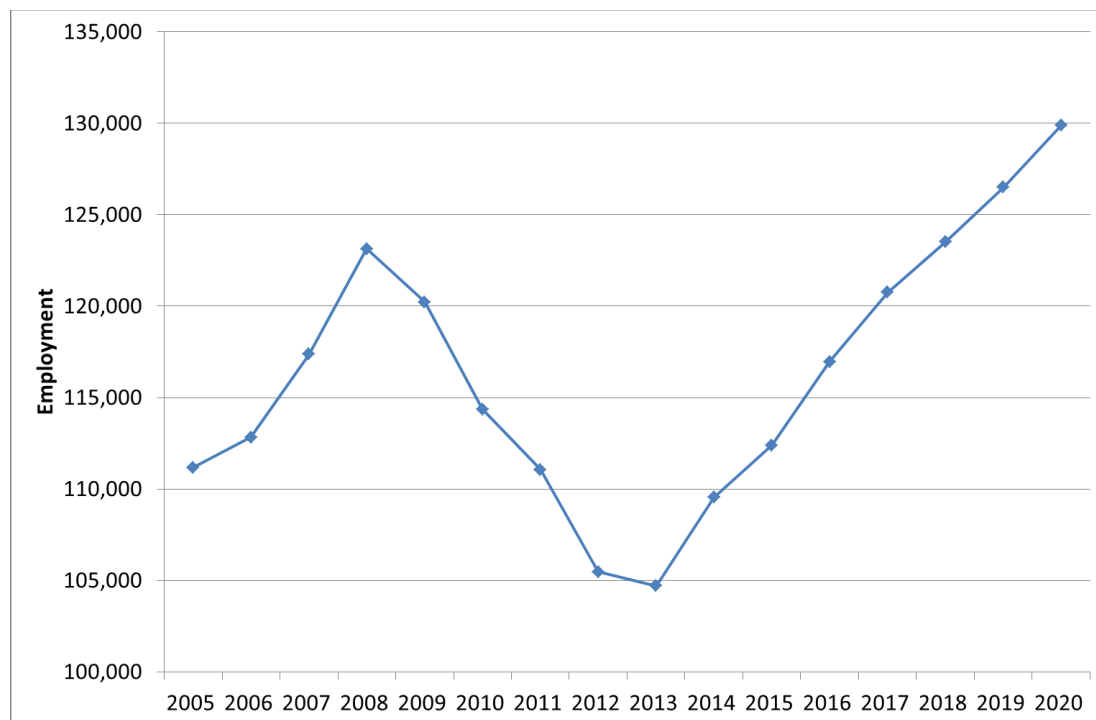
Based on the level of publicly available information in relation to specific projects, it is not possible to create a detailed demand forecast for each project.

3.2 Construction Skills Network (CSN) data

From 2016 through to the end of 2020 the Construction Skills Network (CSN) forecasts that construction employment in Wales will increase at an annual average rate of 2.9 per cent per year, substantially higher than the 1.1 per cent average rate for the UK⁹. This will mean an overall increase in construction industry employment in Wales of 12,900 from 116,950 to 129,900 over the period.

As Figure 3.1 shows, employment levels fell sharply during the recession, down by 18,430 between 2008 and 2013, and it will take until 2018 for employment to exceed the previous peak levels. The drop in employment from 2008 was clearly in response to the banking crisis and recessionary effects in the UK economy that impacted upon construction work.

Figure 3.1: Construction Employment Wales, 2005-2020

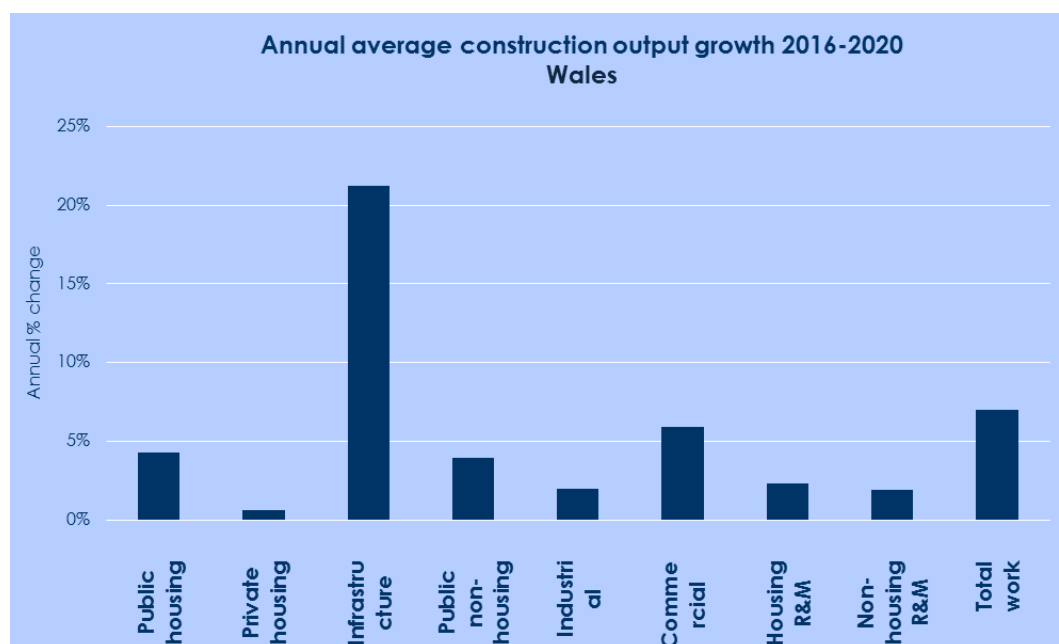


(Source: CITB)

Figure 3.2 shows the CSN construction output forecasts for Wales by sector over the period 2016-2020.

⁹ CITB (2016) *Construction Skills Network Wales 2016-2020*
http://www.citb.co.uk/documents/research/csn%202016-2020/csn_wales_2016.pdf
[accessed 16 February 2016]

Figure 3.2: Wales Construction Output Forecasts, 2016-2020



(Source: CITB)

The five-year output forecasts from 2016 to 2020 are a very robust 7.1 per cent a year on average, driven to no small extent by infrastructure growth in excess of 21 per cent a year as work commences on the Wylfa project from 2019. However, all sectors are expected to see some level of expansion, and even if Wylfa were excluded, an annual average rise of 3.7 per cent is forecast, in part due to the success of the Welsh Government in attracting funding from other sources through innovative mechanisms.

The five-year forecast for the infrastructure sector is dominated by the start of work on nuclear new build at Wylfa in 2019. However, it is not the only large project due to start in the second half of the forecast period. Work on the new M4 corridor around Newport is expected to start in 2018, while in the rail sub-sector, there is over £2bn of electrification and renewals work to be delivered in Wales in Network Rail’s Control Period 5 (CP5).

There are also significant housing programmes in the pipeline that should generate growth in public housing output in the medium term. Cardiff Council has plans to deliver 1,000 new homes across the city over the next decade, and Flintshire County Council is intending to deliver a £500m regeneration programme for the next five to seven years, which will include a large housing element.

To try and give a view on potential issues for future employment demand, the work of the Construction Skills Network produces figures on the Annual Recruitment Requirement (ARR) for occupational groups. The ARR is a gross requirement that takes into account workforce flows into and out of construction, due to such factors as movements between industries, migration, sickness and retirement. However, these flows do not include movements into the industry from training, although robust data on training

provision is being developed by CITB in partnership with public funding agencies, further education, higher education and employer representatives. Thus, the annual recruitment requirement provides an indication of the number of new employees that would need to be recruited into construction each year in order to realise forecast output.

The current ARR¹⁰ is for the construction sector in Wales to need an additional 5,440 workers per year, over the next five years to meet expected demand, which represents 4.7 per cent of base employment, well above the UK with 1.7 per cent of base employment.

In terms of occupations, the recovery in the housing and commercial sectors does mean there will be increasing demand for occupations such as bricklaying, roofing, wood trades, painting and decorating and the like. However, there is also set to be increasing demand for civil engineers, architects and construction trades supervisors.

3.3 Mobility and Demographic Analysis

These shifts in prospects by sector raise the question about the possible movement or mobility of workers between sectors and regions. The recent Workforce Mobility report¹¹ highlights several important points, which suggest that the Welsh construction workforce is comparatively stable, compared to the UK:

- Around a third of all construction workers in Wales have worked in the industry for at least 20 years (34 per cent), which compares with a lower UK average (31 per cent). A total of 55 per cent have done so for 10+ years, almost identical to UK average of 56 per cent.
- Most construction workers in Wales were interviewed in the same location in which they were living in when they started their construction career (94 per cent). This compares with the lowest proportion in London (50 per cent) and highest in Northern Ireland (97 per cent). The UK average is 75 per cent.
- In Wales the average (mean) distance from workers' current residence (note the average distance from current residence to work includes temporary accommodation as this was viewed as the current residence for the purpose of the analysis) to their current site was 16 miles, which is less than in 2012 when workers travelled an average of 26 miles, and less than the UK average of 22 miles, in 2012 the UK average was 28 miles.
- Around 7 in 10 construction workers in Wales are confident that when they finish this job they will get a job that allows them to travel from their permanent home to work on a daily basis (71 per cent compared

¹⁰ CITB (2016) *Construction Skills Network Wales 2016-2020*
http://www.citb.co.uk/documents/research/csn%202016-2020/csn_wales_2016.pdf
[accessed 16 February 2016]

¹¹ CITB (2015) *Workforce Mobility and Skills in the UK Construction Sector – 2015* [online], available:
<http://www.citb.co.uk/Documents/research/Workforce%20Mobility%202015/Wales%20Mobility%20Report%202015.pdf> [accessed 7 January 2016]

to 74 per cent in 2012). This proportion is very similar to the UK average where 75 per cent compared to 69 per cent in 2012 are confident that when they finish this job they will get a job that allows them to travel from their permanent home to work on a daily basis.

- Overall nearly two thirds of all construction workers in Wales have only worked on one project type (63 per cent), this compares to just under half across the UK (48 per cent).
- Within Wales, 3 in 10 construction workers say they definitely will (30 per cent); and a further 51 per cent think it is very or quite likely that they will still want to work in construction in 5 years time. These figures are similar to UK where 4 in 10 construction workers say they definitely will (40 per cent); and a further 42 per cent think it is very or quite likely that that they will still want to work in construction in 5 years time.

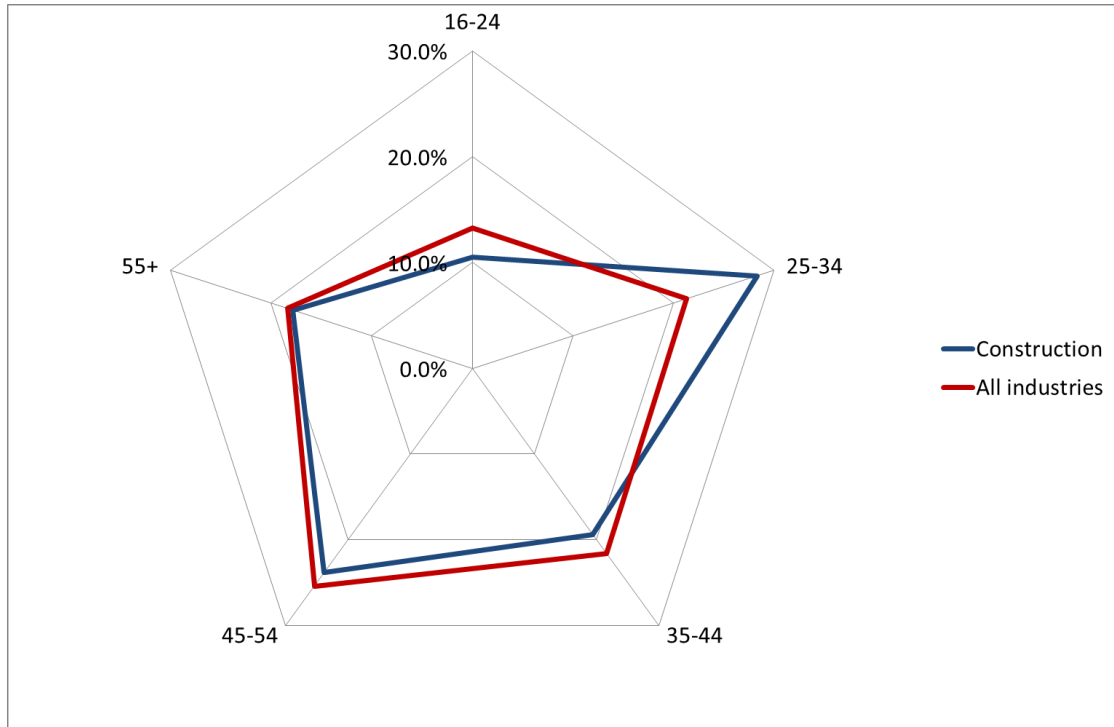
The UK construction sector workforce is generally considered to be quite flexible and mobile with workers willing to move from project to project. The survey data indicates that the Welsh construction workforce travels slightly less on average in comparison to the UK average. It is likely though that, as has been seen in London, workers may be willing to travel further to work on high profile projects that may offer higher wages. All of this means that the construction sector overall has a flexible workforce that can adapt to the different types of work being carried out across the UK and draw from a substantial pool of labour.

The availability of labour will also be affected by demographic pressures although as Figure 3.3 shows, the pressures facing the construction sector are very similar to those of the general workforce with almost 1 in 5 workers becoming eligible for retirement over the next 10 years. Due to the physical nature of work in the construction sector some workers often report that they wish to move into less physically demanding perhaps office based roles as they get older and it may be that some are forced to retire through associated health problems.

The Construction sector in Wales has a higher share of workers in the 25-34 year old age group, however, it is noticeable that in recent years the sector has struggled to attract younger people with a pronounced drop in the level for the 16-24 year old group, which is almost three percentage points lower than the all industry figure.

Over the next ten years, with almost 18,000 construction workers in Wales becoming eligible for retirement (18 per cent of construction workers in Wales), and when taking into account the employment growth forecast, it highlights that the sector will have to recruit a significant amount of new entrants if demand is to be met in the coming years.

Figure 3.3: Age profile of Construction Sector and All-Industries in Wales, 2015



(Source: Labour Force Survey, 2015). All industries sample size approximately 8,000 interviews, Construction sample size approximately 600 interviews.

While the details so far have focused on employment numbers, it is useful to consider existing levels of qualification and training covering both further and higher education.

3.4 Qualification Analysis

The overall qualification profile for the construction workforce in Wales is detailed shown in Table 3.2.

The construction sector has tended to be slightly lower in its share of higher-level qualifications when compared to all industries; however, it has always been higher in trade apprenticeships. To some extent this will be influenced by the numbers employed across the sector, which for construction is biased towards workers who would be classed as being in skilled trades.

Table 3.2: Equivalent qualification level for Construction and All Industries, Wales

Equivalent Qualification Level	Construction Per cent	All Industries Per cent
NVQ Level 4 and above (including First degree)	33	39
NVQ level 3	21	19
Trade Apprenticeships*	14	4
NVQ level 2	11	16
Below NVQ level 2	10	10
Other qualifications**	5	6
No qualifications	6	6

Source: Labour Force Survey (2015). All industries sample size approximately 8,000 interviews, Construction sample size approximately 600 interviews.

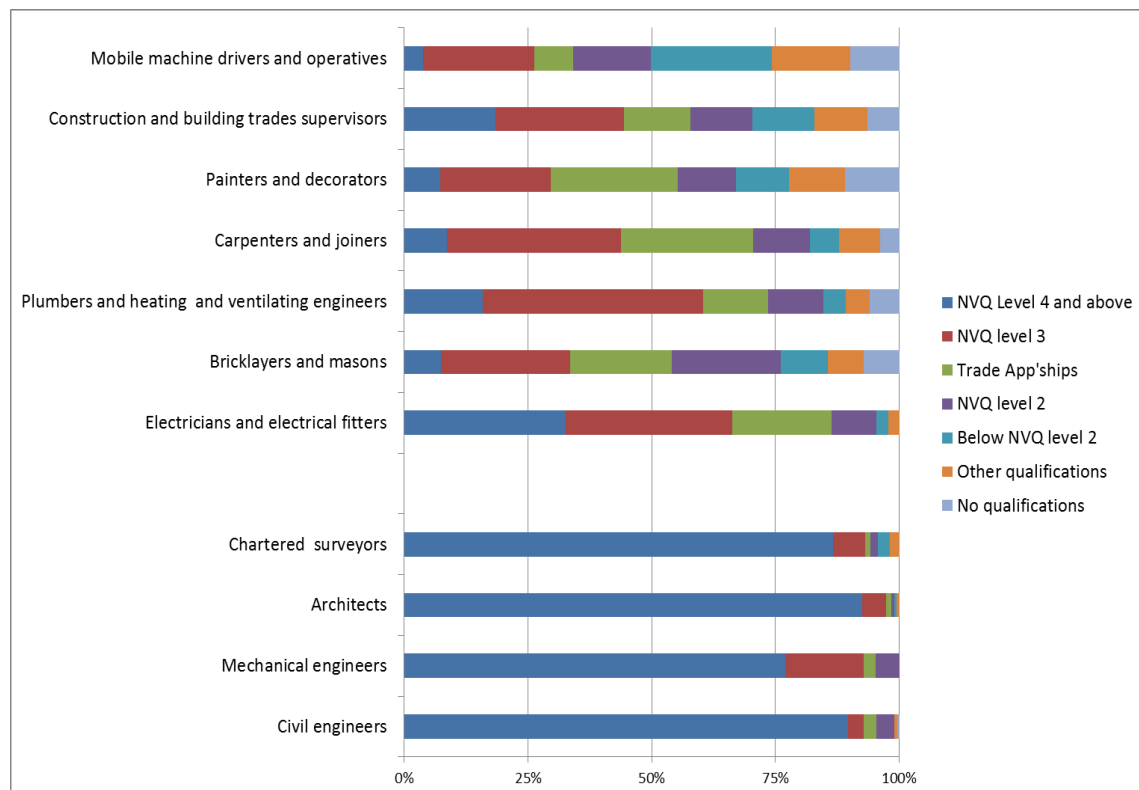
Notes: * Trade Apprenticeships can cover Level 2 and Level 3 qualifications

** Other qualifications covers non-UK qualifications

As Figure 3.4 (data only available at the UK level) shows, the distribution of qualifications does vary by occupation. Occupations such as Civil Engineer and Architect are mainly qualified to Level 4 and above, whereas for the skilled trades the majority either have a trade apprenticeship and/or qualification at Level 2 or Level 3. However, there are also occupations where there are significant portions of the workforce, which have qualifications below Level 2.

Typically workers on construction sites will have qualifications at Level 2 or above although labourers can have a Level 1 qualification. Workers on domestic projects who may be self-employed may have no formal qualifications which may explain the distribution illustrated in Figure 3.4.

Figure 3.4: UK Qualification Profile for Selected Construction Occupations, 2015



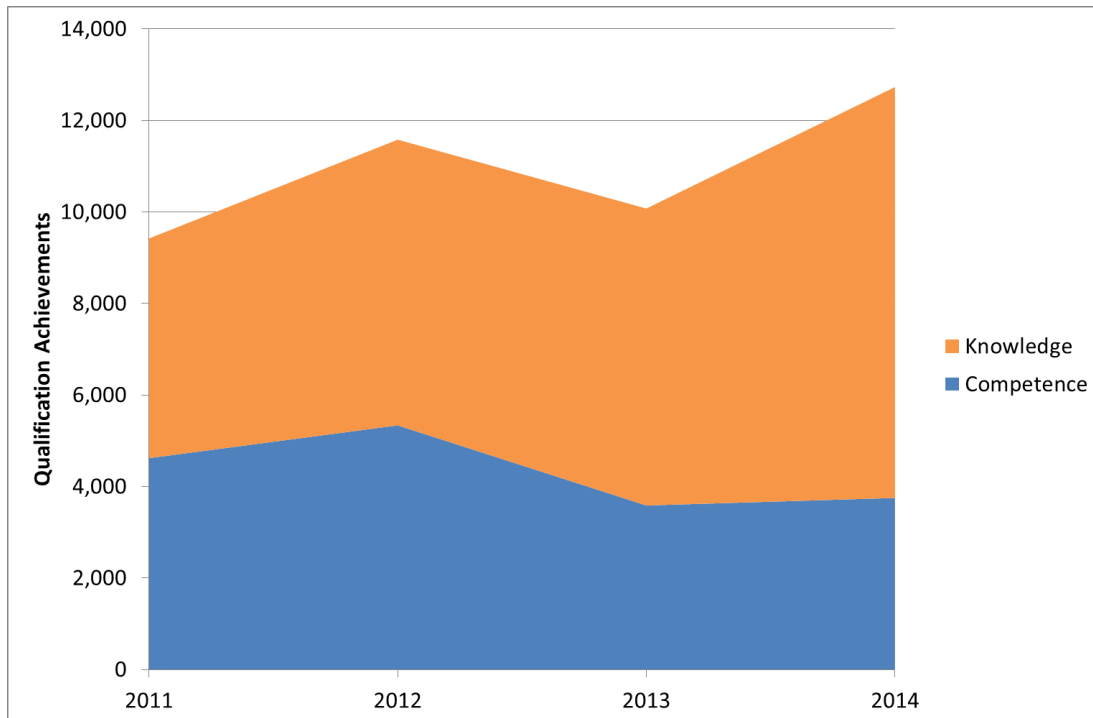
(Source: Labour Force Survey, 2015). Sample size approximately 13,500 interviews.

Further Education (FE) and private training providers are the main source for Level 2 and Level 3 skills (although higher level skills are increasingly being delivered through FE), while those at degree level will mainly be delivered through Higher Education (HE).

Figure 3.5 shows the recent trends for vocational qualification achievement in Wales with FE split into Competence and Knowledge based qualifications. This distinction is important as it is the competence based qualifications (QCF-NVQ's) that are closely recognised by the construction sector as being benchmarks for competence as they assess practical application of learning within the workplace, together with underpinning theory and knowledge and it is these qualifications that are usually closely linked to industry card schemes such as the Construction Skills Certification Scheme (CSCS) and Construction Plant Competence Scheme (CPCS).

Knowledge based qualifications are those that impart the underpinning theory or knowledge and are typically taken by learners entering full-time further education. Colleges will provide some practical competence based experience including work experience and students may have the opportunity to achieve CSCS or CPCS cards to enter the industry through that route.

Figure 3.5: Construction Vocational Qualification Achievements in Wales, 2011-2014

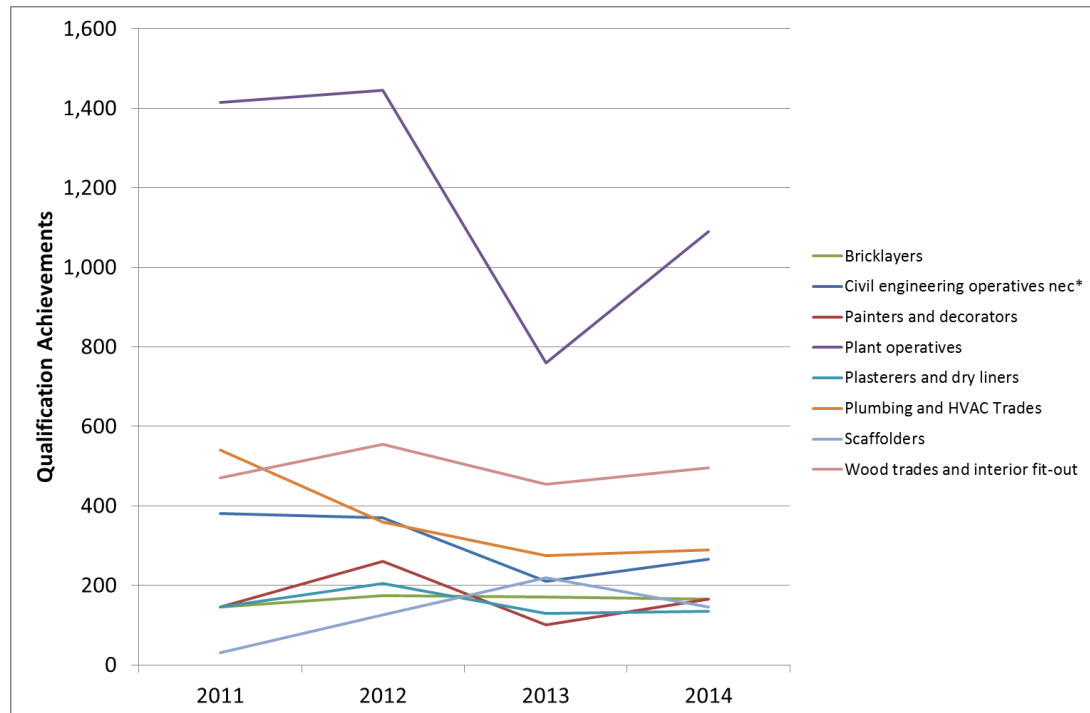


(Source: Ofqual/CITB)

The overall view is fairly static with the total number of qualification achievements around 10,000 per year. However, there is an underlying trend of decreasing numbers of Competence based qualification achievements and increasing numbers of Knowledge based achievements.

The Competence based achievements can be linked to occupations and a breakdown is shown in Figure 3.6 for Level 2 achievements.

Figure 3.6: Level 2 Competence Qualification Achievements in Wales, Construction occupations, 2011-2014



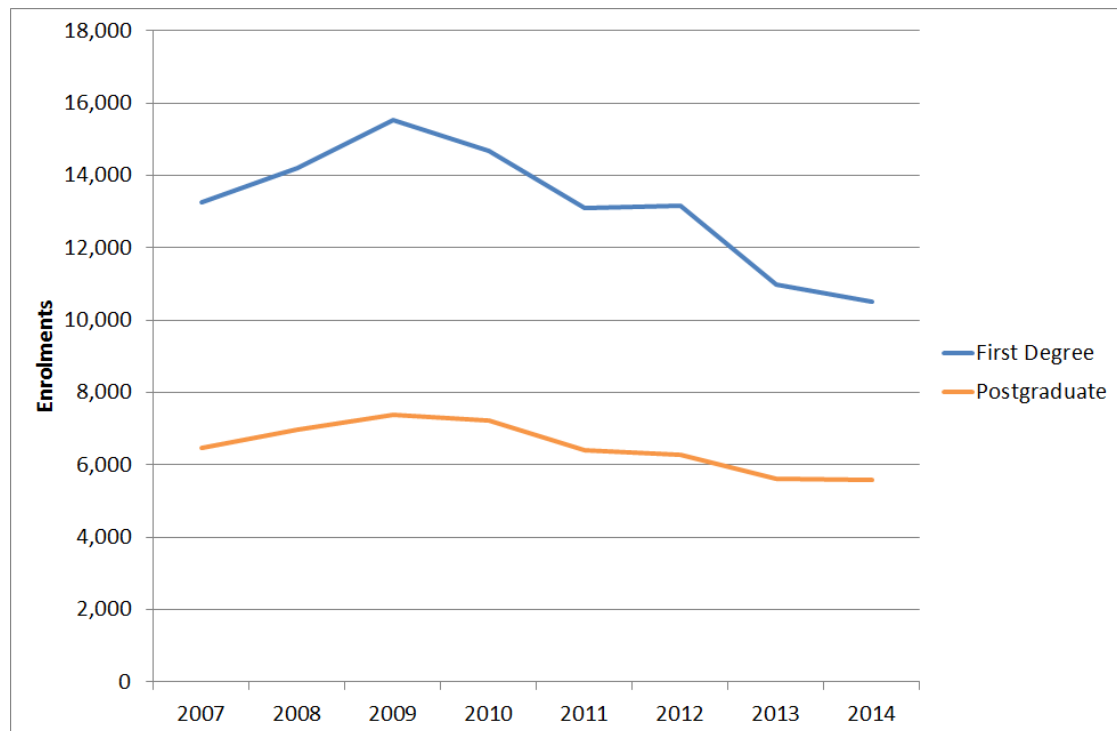
(Source: Ofqual/CITB)

From 2012 there has been an overall slight decreasing trend of competence achievements across most occupational groups which would have been influenced by general industry conditions and reductions particularly in employer funded training levels. A similar trend of decreasing qualification achievement is also shown for Level 3 vocational competence qualifications.

3.5 Higher Education Analysis

HE provision data is provided by the Higher Education Statistics Authority (HESA) for both enrolments and qualifiers (Appendix 4 details the relevant codes for Construction and Built Environment related subjects). It makes sense to look first at overall numbers for the UK as this population tends to be mobile - people are often willing to relocate to study and then once qualified to obtain professional work. In addition, it is important to note that learners may study other subject areas before obtaining work in the Construction and Built Environment sector. Figure 3.7 shows total UK domiciled first degree and postgraduate degree enrolments 2007-2014.

Figure 3.7: Construction, First Degree and Postgraduate Enrolments: UK domicile, 2007 - 2014



(Source: HESA, CITB)

The chart shows that overall Construction and Built Environment related subjects student numbers increased from 2007 to 2009 but have decreased from 2009 onwards – this trend is similar to all subject enrolments and associated with the recession and tuition fees. In 2014 there were 21 per cent fewer enrolments for construction related first degree subjects when compared to 2007 – a decline of over 2,700 students across the UK.

In terms of subject area, enrolments on Civil engineering first degree courses have held up better than other areas and account for 30 per cent of construction enrolments in 2014. This is an increase of 3 per cent when compared to 2007, although still a reduction of 22 per cent when compared to peak enrolments in 2009.

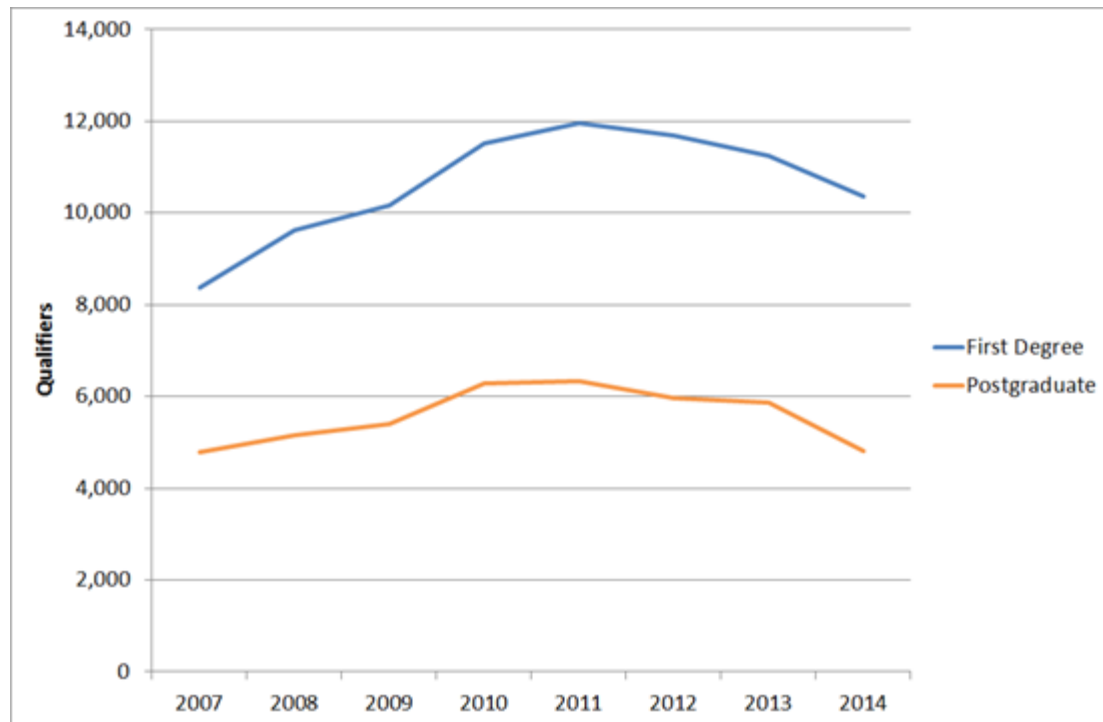
For all other first degree subject areas, enrolments in 2014 are lower than both 2007 and 2009, with Planning and the wider Building subject areas showing decreased enrolments of around 62 per cent when compared to 2009.

For postgraduate enrolments, the picture is slightly different in that it is Architecture that has grown, up by 49 per cent in 2014 when compared to 2007 enrolments and by 26 per cent when compared to 2009. For all the other main subject areas (Building, Civil Engineering and Planning) enrolment numbers are down in 2014 when compared to either 2007 or 2009, with Planning again being particularly hard hit with 52 per cent reductions.

Typical first degree full-time courses tend to be 3-4 years in length so the picture for qualifiers is slightly different as it takes a while for the differences in enrolments to feed through.

Figure 3.8 shows total UK domiciled first degree and postgraduate degree qualifiers 2007-2014.

Figure 3.8: Construction, First Degree and Postgraduate Qualifiers: UK domicile, 2007 - 2013



(Source: HESA, CITB)

Between 2007 and 2011 there has been an increase in qualifiers for construction related UK based first degree and postgraduate students, however, from 2011 numbers have started to decline.

When looked at by main subject area, in 2014, 31 per cent of qualifiers were from Civil engineering related first degrees, which is an increase from 23 per cent in 2007. However, qualifiers from Planning have shown a decrease in numbers from first degrees (down from 13 per cent in 2007 to 9 per cent in 2014) and more noticeably in postgraduate numbers (down from 39 per cent in 2007 to 22 per cent in 2014).

Looking at the overall picture of HE for the sector there appear to be largely comparable levels of UK domiciled people studying Civil Engineering and Architecture subjects in 2014 compared to 2007 although there are declines both for Building and Planning (Planning particularly has declined at postgraduate level). Although numbers are comparable, it is important that the sector markets itself well in order to attract the best possible graduates.

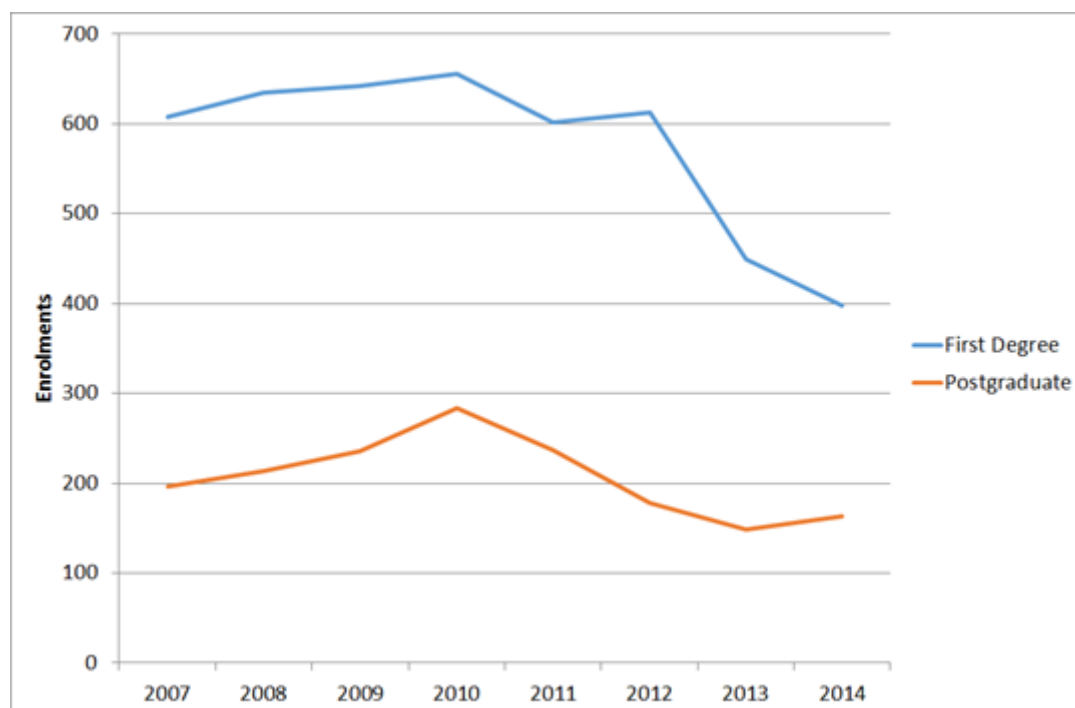
Charts for Higher Education provision in Wales show similar trends.

Figure 3.9 shows enrolments over the period 2007-2014 which increased from 2007 to 2010 before declining from 2010 onwards, apart from Postgraduate enrolments which increased in 2014.

In terms of subject area at first degree level there are declines across all subject areas in 2014 compared to 2007 with declines greatest for Architecture 50 per cent, Building 38 per cent, Planning 25 per cent and Civil Engineering 19 per cent.

At postgraduate level course numbers are broadly similar in 2014 compared to 2007 with the exception of Planning which has fallen by 53 per cent. Provision in other subject areas including Civil Engineering and Architecture has increased over the same period by 44 per cent and 23 per cent respectively. Building has also increased from a low base of 4 postgraduate enrolments in 2007 to 33 in 2014.

Figure 3.9: Construction, First Degree and Postgraduate Enrolments in Wales: UK domicile, 2007 - 2014



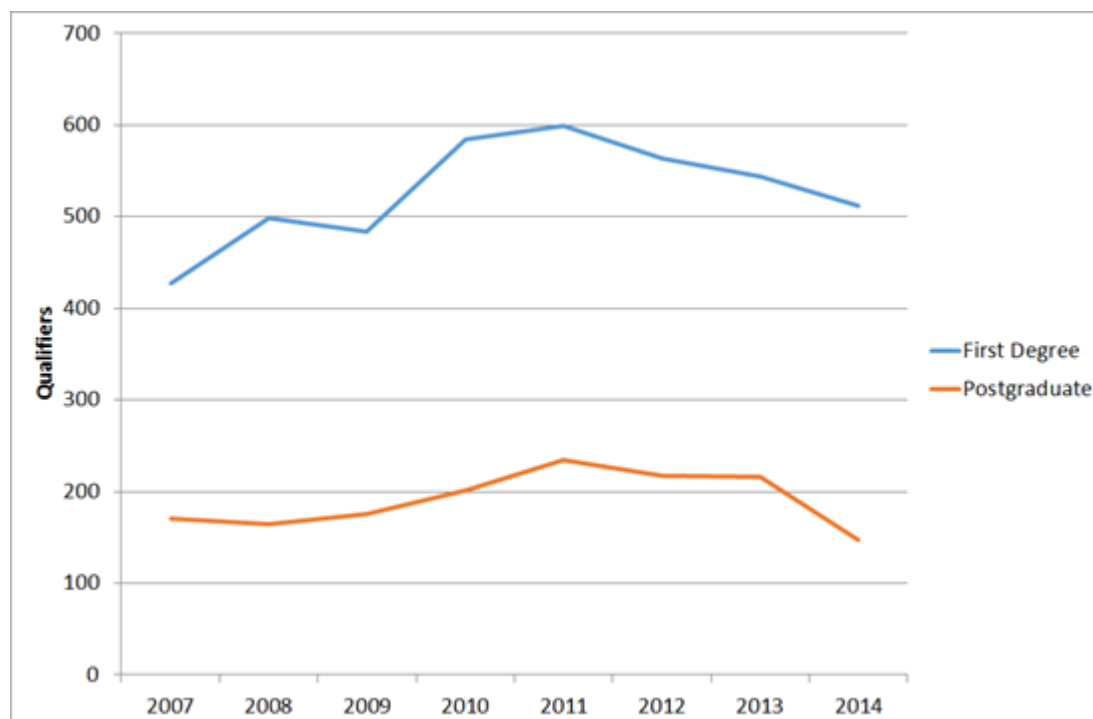
(Source: HESA, CITB)

Figure 3.10 shows qualifiers in Wales over the period 2007-2014. Overall, the number of qualifiers increased from 2007-2011 before declining slightly from 2011-2014. At first degree level the number of qualifiers has increased across all subjects except Architecture, which is broadly similar compared to 2007. In 2014 compared to 2013 qualifier numbers have increased for Civil Engineering by 10 per cent (18 graduates) and Planning by 6 per cent (6 graduates) whilst decreasing for Building by 23 per cent (30 graduates) and Architecture by 13 per cent (17 graduates).

At postgraduate level qualifiers have increased across all subjects compared to 2007 except for Planning which is 54 per cent down in 2014 compared to 2007. Qualifiers in Civil Engineering in particular have increased from 2007 (threefold increase). As enrolments (with the possible exception of building)

have declined in Wales from 2010-2014 it is anticipated that qualifiers will continue a broad trend of decline for the next 3-4 years as reduced entrant levels continue to feed through to qualifier numbers.

Figure 3.10: Construction, First Degree and Postgraduate Qualifiers in Wales: UK domicile, 2007 - 2014



(Source: HESA, CITB)

These trends in FE and HE qualification numbers point to a reduction in the future supply of qualified workers at a time when workloads are beginning to recover. While there may be capacity within the employment base to absorb these demands in the short term, in the medium to long term the emergence of occupational pinch-points both in terms of numbers and skills looks to be a possibility.

3.6 Supply-Side Summary

- Tidal lagoon construction work is forecast between September 2016 and December 2022¹².
- Other significant competing projects for the tidal lagoon project include High Speed 2, the Northern Line Extension, Wylfa nuclear, Hinkley Point C nuclear and the Thames Tideway Tunnel.
- Construction employment growth in Wales is forecast to average 2.9 per cent a year in Wales between 2016 and 2020, well above the UK rate of 1.1 per cent.

¹² Construction work dates are likely to change and this forecast is the assumption at the time of finalising the report May 2016.

- The CSN annual recruitment requirement in Wales, at 5,440, represents 4.7 per cent of base 2016 employment; also well above the UK rate of 1.7 per cent.
- The mobility research points to a stable, construction workforce in Wales although the Labour Force Survey suggests around 18,000 current workers will be eligible for retirement over the next 10 years (18 per cent of construction workers in Wales).
- Further Education - the overall view is fairly static with the total number of qualification achievements around 10,000 per year in Wales although there is a trend of decreasing competence based qualifications (NVQ) compared to knowledge based (VQ).
- Higher Education – decline in enrolments (2012-2014) across Built Environment subjects at first degree level although postgraduate levels broadly similar in 2014 compared to 2007.
- These trends in Further and Higher Education qualification numbers point to a reduction in the future supply of qualified workers at a time when workloads are recovering. While there may be capacity within the employment base to absorb these demands in the short term, in the medium to long term the emergence of occupational pinch-points both in terms of numbers and skills looks to be a possibility.
- The following chapter identifies potential pinch-point occupations for the Swansea Bay Tidal Lagoon project.

4 Identifying pinch-point occupations

The UK Construction Skills Network (CSN) forecasting model 2016-2020 provides estimates of employment by occupation. In order to identify potential pinch-point occupations it is possible to compare the peak forecast employment for the Swansea Bay Tidal Lagoon project in Table 4.1 to CSN employment figures.

Table 4.1 provides a comparison of CSN employment figures to peak Swansea Bay Tidal Lagoon project requirement. A traffic light indicator has been used to identify potential pinch-point occupations by comparing the ratio of peak employment to CSN employment in Wales. The colour red is used to indicate over 5 per cent requirement of employment compared to base employment, amber is between 2.2 per cent and 5 per cent requirement and green less than 2.2 per cent. The occupations with amber and red traffic light indicators are identified as occupations of potential skills gaps for the Swansea Bay Tidal Lagoon project.

Overall, the Swansea Bay Tidal Lagoon project at peak construction is forecast to generate 0.9 per cent of the total Welsh Construction demand for employment and so the total is labelled green using the traffic light indicator. It is anticipated that the Welsh Construction workforce will be able to meet the requirements of tidal lagoon for most occupations, although the table identifies potential occupational skills gaps.

Table 4.1: CSN Employment, peak project requirement

	Wales CSN 2016 employment	Swansea Bay Tidal Lagoon peak project requirement	Traffic light indicator
Senior, executive, and business process managers	4,110	20	Green
Construction project managers	1,410	40	Amber
Other construction process managers	8,120	5	Green
Non-construction professional, technical, IT, and other office-based staff	11,530	55	Green
Construction trades supervisors	2,250	5	Green
Wood trades and interior fit-out	14,650	240	Green
Bricklayers	7,120	20	Green
Building envelope specialists	4,410	20	Green
Painters and decorators	5,710	30	Green
Plasterers	4,760	10	Green
Roofers	1,460	10	Green
Floorers	140	10*	Green
Glaziers	590	10	Green

	Wales CSN 2016 employ ment	Swansea Bay Tidal Lagoon peak project requirement	Traffic light indicator
Specialist building operatives nec	4,220	365	Red
Scaffolders	840	10	Green
Plant operatives	1,780	155	Red
Plant mechanics/fitters	1,490	5	Green
Steel erectors/structural fabrication	1,250	5	Green
Labourers nec	6,010	110	Green
Electrical trades and installation	7,110	35	Green
Plumbing and HVAC Trades	10,480	35	Green
Logistics	750	60	Red
Civil engineering operatives nec	1,420	10	Green
Non-Construction Operatives	1,290	15	Green
Civil engineers	2,350	40	Green
Other construction professionals and technical staff	5,660	30	Green
Architects	1,280	10	Green
Surveyors	4,750	5	Green
Total	116,940	1,035	Green

Note figures are rounded to nearest 10 with calculations based on unrounded figures.

*Traffic light indicator downgraded from amber to green as ≤ 10 people required at peak

Note that maritime occupations is not included within the table as it is not within the scope of the Construction Skills Network data. At peak construction 109 maritime workers will be needed. This occupational group is considered in the next section.

4.1 Potential skills gaps

Table 4.2 presents the potential skills gaps identified by occupation and makes suggestions as to how they could be addressed. It may be that potential occupational skills gaps can be filled by training and recruitment either for new entrants, upskilling the existing workforce, recruitment from other sectors or regions of the UK, or in the short-term from overseas.

Table 4.2: Potential skills gaps

Demand Occupation	Gap identified (Yes/No)	How skills gap could best be addressed?		
		Short Term Training (up to 6 months)	Longer term training (6 months and over)	Additional demand met from other sectors, rest of UK or international workers
Construction project managers	Y		✓	✓
Specialist building operatives nec	Y	✓	✓	✓
Plant operatives	Y	✓	✓	✓
Logistics	Y	✓	✓	✓
Maritime	Y	Potentially	Potentially	Potentially

4.1.1 Construction project managers

Construction project managers undertake management of construction projects. This occupation typically includes skilled professionals that may come from an initial graduate or trade background.

In addition to relevant site experience there are a number of specific site management NVQ qualifications available. Training data from Welsh Government¹³ indicates Level 4 qualification provision in Wales at Coleg Menai, Deeside College, Yale College and Coleg Llandrillo.

Although it takes time to train graduates or upskill workers to a suitable level it should be possible to recruit sufficient project managers from within Wales for this project, although it should be noted that there may be competing demand for workers from other large construction projects taking place. Due to competing demand it may be necessary to recruit some workers from other sectors, other regions of the UK or to use international workers in the short-term.

Discussion with sub-contractors would be useful to determine if there is likely to be difficulty in recruiting suitable workers for this profession.

4.1.2 Specialist building operatives not elsewhere classified

Specialist building operatives covers a range of occupations which have specialised and niche skills predominately used for repair and refurbishment. This type of work tends to be more labour intensive and consequently they are in high demand during the peak construction period.

¹³ Welsh Government (2015) *Lifelong Learning Wales Record (LLWR) 2012/13*, [accessed 7 January 2016]

Demand data indicates that the main occupations needed for this project include steel fixers and, concrete finishers. Training data from Welsh Government does not include training details for steel fixing or concrete finishing. Training for other skilled workers could include specialist niche courses or skills that are developed informally whilst working. Further discussions with the CITB Welsh team confirm that there is no training provision for steel fixers or concrete finisher occupations available in Wales.

There are courses available for both steel fixing and concrete finishing elsewhere in the UK, with one of the main providers being the CITB National Construction College which offers an Apprenticeship in steel fixing at Bircham Newton in Norfolk with other Level 2 provision on offer from other providers elsewhere. There are various concrete finishing qualifications on offer elsewhere in the UK. For both occupations it is also possible to learn on the job with accreditation either via On Site Assessment and Training (OSAT) or the Experienced Worker Practical Assessment (EWPA) for experienced operatives.

As training provision courses are not readily available in Wales there may be a necessity to recruit workers from other sectors, regions of the UK or to use international workers in the short-term. Further discussion with sub-contractors would be useful to determine the specialisms required and specific training needed to meet demand.

4.1.3 Plant operatives

The data in table 4.1 indicates a considerable number of plant operatives will be required at peak construction.

Demand data indicates that the main occupations needed for this project include excavator operators, flatbed trailer drivers and dump truck operators. Training data from Welsh Government¹⁴ indicates a range of plant related training is available at level 2 or higher in Wales with courses at Deeside College, Cardiff and Vale College, Grwp Llandillo Menai, NPTC Grwp, Yale College and other training providers. In addition, experienced plant operatives may move readily between construction and other sectors such as manufacturing and wholesale/distribution.

It should be possible to recruit sufficient plant operatives from within Wales, other sectors or if necessary other regions of the UK, although again there may be competing demand for workers from other large construction projects taking place.

Discussion with sub-contractors would be useful to determine if there is likely to be difficulty in recruiting suitable workers for this profession.

¹⁴ Welsh Government (2015) *Lifelong Learning Wales Record (LLWR) 2012/13*, [accessed 7 January 2016]

4.1.4 Logistics

Logistics includes large goods vehicle drivers, van drivers, elementary storage occupations, buyers/purchasing officers and associated administrative support workers.

Demand data indicates that the main occupations needed for this project include mix truck drivers, lorry drivers, materials controllers, banksman/slinger and related occupations. As with plant operatives workers may move readily between construction and other sectors such as manufacturing and wholesale/distribution. The main centre for logistics training is within Carmarthenshire.

It should be possible to recruit sufficient staff for this occupation from within Wales, other sectors or if necessary other regions of the UK, although again there may be competing demand for workers from other large construction projects taking place.

Discussion with sub-contractors would be useful to determine if there is likely to be difficulty in recruiting suitable workers for this profession.

4.1.5 Maritime Occupations

Occupations within this group include sailors, divers, vessel engineers and dredging managers.

Training data from Welsh Government¹⁵ indicates limited formal training provision for maritime occupations although Grwp Llandillo Menai offers a NVQ Level 2 certificate in maritime studies (certificates include specialisms relating to Able Seafarer, Boatmaster and Engine Room). Pembrokeshire College is also a main provider of Marine qualifications with courses from NVQ Level 1 to Level 3 including Marine Engineering offered. Internet searches indicate that apprenticeships in maritime occupations are available in Wales although details of numbers in training are not available online.

In the absence of detailed employment or training information regarding this occupational group more investigation is needed to determine the extent of this potential skills gap. As the occupational group includes specialist occupations it may be that sub-contractors are best placed to advise if there is likely to be difficulty in recruiting suitable workers for group.

¹⁵ Welsh Government (2015) *Lifelong Learning Wales Record (LLWR) 2012/13*, [accessed 7 January 2016]

5 Conclusions and Recommendations

5.1 Conclusions

In summary

- The labour demand analysis is based on data provided by TLSB Plc and its preferred tier one contractors and it provides an estimate of the labour demand arising from the project, measured by 28 occupation groups common to construction projects plus three additional occupation groups covering the labour demand for occupations outside the traditional construction footprint.
- The construction period is from 2016 to 2022 ¹⁶and labour demand peaks in 2019 at slightly over 1,000 people. Five occupational groups account for over 60 per cent of the labour demand. These five groups are:
 - Plant operatives
 - Specialist building operatives not elsewhere classified (nec)
 - Wood trades and interior fit-out
 - Labourers nec
 - Maritime
- Other significant competing projects for the Swansea Bay Tidal Lagoon project include High Speed 2, the Northern Line Extension, Wylfa Newydd, Hinkley Point C nuclear and the Thames Tideway Tunnel.
- Construction employment growth in Wales is forecast to average 2.9 per cent a year on average in Wales between 2016 and 2020, well above the UK rate of 1.1 per cent.
- The CSN annual recruitment requirement in Wales, at 5,440, represents 4.7 per cent of base 2016 employment; also well above the UK rate of 1.7 per cent.
- The mobility research points to a stable construction workforce in Wales although the Labour Force Survey suggests around 18,000 workers will be eligible for retirement over the next 10 years (18 per cent of construction workers in Wales).
- Further Education - the overall view is fairly static with the total number of qualification achievements in construction around 10,000 per year in Wales although there is a trend of decreasing competence based qualifications (NVQ) compared to knowledge based (VQ).

¹⁶ Construction work dates are likely to change and this forecast is the assumption at the time of finalising the report May 2016.

- Higher Education – decline in enrolments (2012-2014) across Built Environment subjects at first degree level although postgraduate levels broadly similar in 2014 compared to 2007 (with a peak in 2010).
- These trends in Further and Higher Education qualification numbers point to a reduction in the future supply of qualified workers at a time when workloads are recovering. While there may be capacity within the employment base to absorb these demands in the short term, in the medium to long term the emergence of occupational pinch-points both in terms of numbers and skills looks to be a possibility.
- In terms of skills shortages and gaps the occupations of Construction Project Managers, Specialist Building Operatives, Plant Operatives, Logistics related occupations and Maritime Occupations were noted as a concern and recommendations addressing this are included in the next section.

5.2 Recommendations

The key question that the research should look to answer is:

‘Taking all variables into account, overall is there capacity to build a tidal lagoon at Swansea Bay in Wales?’

The response is yes; in the short term, there is capacity in the market to enable the construction element of a tidal lagoon at Swansea Bay. However, this is dependent upon a number of factors; particularly timing as the majority of large competing construction projects are scheduled to happen later than the tidal lagoon and in particular the nuclear new build projects may experience further delay.

In the medium to longer term the project will be competing with other areas of growth in the construction sector in Wales, including key infrastructure activity in roads, rail and housing developments and the occupations highlighted in Chapter 4 are at risk of skills gaps and shortages.

In order to achieve optimum benefit for the people of Wales in terms of job creation and investment in skills, early planning is vital. Projects tend to always be built but if the Welsh Government and its stakeholders want to mitigate against the cost of labour rising or over utilisation of imported labour it is important to consider the recommendations below.

The six recommendations suggested below should form the basis of discussions that include all stakeholders who have the ability to bring impact and influence to the future development of Swansea Bay Tidal Lagoon and future lagoons in Wales. This group should include Welsh Government, clients (TLSB Plc), providers at Higher Education and Further Education levels, skills bodies (such as CITB), funders and wider industry representation; including contractors at all levels both directly relating to the provision of construction and across the wider supply chain. The key recommendations are:

1. Tidal Lagoon Power should continue to inform Welsh Government and Regional Skills Partnerships (RSPs) of the emerging skills needs of the potential Swansea Bay Tidal Lagoon project. Given the scale of the project all three RSPs need to be aware of skills requirements as there will be regionally specific skills needs as well as potential displacement effects across other regions. The South West and Central Regional Learning and Skills Partnership is the RSP for this geographical area. The partnership aims to be demand-led with direct industry engagement and works with the City Region and Enterprise Zones to prioritise skills delivery in response to economic need.

The RSP has a key role to:

- reflect the skills needs of infrastructure projects within its regional employment and skills plan
- encourage feedback from sub-contractors in the supply chain
- to understand what immediate solutions can be activated in the short term to address skills gaps and shortages.

The Swansea Bay Tidal Lagoon specific Labour Market Intelligence (LMI) will be considered in a regional context and shared with Welsh Government and key stakeholders to provide an evidence base for a response from partners.

Action Owner: Tidal Lagoon Power and Welsh Government working in partnership with RSPs.

2. Working with education providers is critical. Sharing labour market intelligence, such as this report, and highlighting areas of specialist training and skills needs is essential to address the risk of skills gaps and shortages that will fuel a rise in project costs and over-runs. Evidence will be shared with the RSPs who will assess the project requirements in a regional context. Providers should work together to develop solutions based on RSP recommendations, and employers and other key stakeholders need to support, invest in training and drive the process, aligned with the Welsh Government Co-investment Framework.

Action Owner: This should be instigated by Welsh Government but led by the Provider Network in Wales.

3. Construction growth forecast in Wales is one of the highest compared to other locations in the UK, driven by significant projects and programmes of work, particularly relating to infrastructure. All projects will draw on the same labour pool creating further gaps and shortages in key occupations. Welsh Government is discussing a more detailed approach to analysis and skills planning relating to infrastructure drawing upon the evidence base presented in Regional Employment and Skills Plans. Realising the skills

needs and capitalising on the opportunities this infrastructure project presents is imperative.

Action Owner: CITB and ECITB, Welsh Government working with RSPs.

4. This report references maritime occupations and skills but is primarily focused on construction activity. Further understanding of occupations that sit outside the construction footprint, but are still key to the process, is required. These skills may need to be sourced from outside of Wales in the short term. However, all avenues that exist to develop a training opportunity to up-skill in maritime occupations in Wales as part of current and future tidal lagoon plans should be explored. In part, this need will be assessed via the annual Regional Employment and Skills Plans produced by the RSPs.

Action Owner: Tidal Lagoon Power, CITB and ECITB to discuss further with RSPs.

5. Welsh Government should consider bringing together clients and contractors working on all major projects and programmes in Wales where possible. This will enable an environment for partnership, where commercial and competitive issues can be acknowledged but a wider economic and social agenda established to address the employment and skills opportunities that support Welsh investment and people.

Action Owner: Welsh Government.

6. A pro-active stance should be encouraged to consider this study in the wider context of other associated studies relating to current and future tidal lagoon projects. This provides a key opportunity to share intelligence. Forecasting demand and supply is a critical part of the process in order to create an evidence base that can inform and support future decision-making. Welsh Government should encourage those delivering future tidal lagoons to undertake appropriate labour demand and supply analyses and also encourage RSPs to consider these analyses as part of their annual Regional Employment and Skills Plans.

Action Owner: Tidal Lagoon Power and Welsh Government in partnership with RSPs.

Appendix 1 –Occupations included in each occupational aggregate

Occupations included within construction occupational aggregates (Four-digit codes refer to Office for National Statistics Standard Occupational Classification Codes).	
1 Senior, executive, and business process managers)	
	(1115) Chief executives and senior officials (1131) Financial managers and directors (1132) Marketing and sales directors (1133) Purchasing managers and directors (1135) Human resource managers and directors (1251) Property, housing and estate managers (1136) Information technology and telecommunications directors (2150) Research and development managers (1162) Managers and directors in storage and warehousing (1259) Managers and proprietors in other services nec (1139) Functional managers and directors nec (2133) IT specialist managers (2134) IT project and programme managers (3538) Financial accounts managers (3545) Sales accounts and business development managers
2 Construction project managers	
	(2436) Construction project managers and related professionals
3 Other construction process managers	
	(1121) Production managers and directors in manufacturing (1122) Production managers and directors in construction (1161) Managers and directors in transport and distribution (1255) Waste disposal and environmental services managers (3567) Health and safety officers (3550) Conservation and environmental associate professionals
4 Non-construction professional, technical, IT, and other office–based staff (excl. managers)	
	(3131) IT operations technicians (3132) IT user support technicians (3534) Finance and investment analysts and advisers (3535) Taxation experts (3537) Financial and accounting technicians (3563) Vocational and industrial trainers and instructors (3539) Business and related associate professionals nec (3520) Legal associate professionals (3565) Inspectors of standards and regulations (2136) Programmers and software development professionals (2139) Information technology and telecommunications professionals nec (3544) Estate agents and auctioneers (2413) Solicitors (2419) Legal professionals nec (2421) Chartered and certified accountants (2424) Business and financial project management professionals

Occupations included within construction occupational aggregates (Four-digit codes refer to Office for National Statistics Standard Occupational Classification Codes).

	<p>(2423) Management consultants and business analysts (4216) Receptionists (4217) Typists and related keyboard occupations (3542) Business sales executives (4122) Book-keepers, payroll managers and wages clerks (4131) Records clerks and assistants (4133) Stock control clerks and assistants (7213) Telephonists (7214) Communication operators (4215) Personal assistants and other secretaries (7111) Sales and retail assistants (7113) Telephone salespersons (3541) Buyers and procurement officers (3562) Human resources and industrial relations officers (4121) Credit controllers (4214) Company secretaries (7129) Sales related occupations nec (7211) Call and contact centre occupations (7219) Customer service occupations nec (9219) Elementary administration occupations nec (2111) Chemical scientists (2112) Biological scientists and biochemists (2113) Physical scientists (3111) Laboratory technicians (3421) Graphic designers (2463) Environmental health professionals (2135) IT business analysts, architects and systems designers (2141) Conservation professionals (2142) Environment professionals (2425) Actuaries, economists and statisticians (2426) Business and related research professionals (4124) Finance officers (4129) Financial administrative occupations nec (4138) Human resources administrative occupations (4151) Sales administrators (4159) Other administrative occupations nec (4162) Office supervisors (7130) Sales supervisors (7220) Customer service managers and supervisors (4161) Office managers</p>
	5 Construction Trades Supervisors
	<p>(5250) Skilled metal, electrical and electronic trades supervisors (5330) Construction and building trades supervisors</p>
	6 Wood trades and interior fit-out
	<p>(5315) Carpenters and joiners (8121) Paper and wood machine operatives (5442) Furniture makers and other craft woodworkers</p>

Occupations included within construction occupational aggregates (Four-digit codes refer to Office for National Statistics Standard Occupational Classification Codes).	
	(5319) Construction and building trades nec (25 per cent ¹⁷)
7 Bricklayers	
	(5312) Bricklayers and masons
8 Building envelope specialists	
	(5319) Construction and building trades nec (50 per cent)
9 Painters and decorators	
	(5323) Painters and decorators (5319) Construction and building trades nec (5 per cent)
10 Plasterers	
	(5321) Plasterers
11 Roofers	
	(5313) Roofers, roof tilers and slaters
12 Floorers	
	(5322) Floorers and wall tillers
13 Glaziers	
	(5316) Glaziers, window fabricators and fitters (5319) Construction and building trades nec (5 per cent)
14 Specialist building operatives not elsewhere classified (nec)	
	(8149) Construction operatives nec (100 per cent) (5319) Construction and building trades nec (5 per cent) (9132) Industrial cleaning process occupations (5449) Other skilled trades nec
15 Scaffolders	
	(8141) Scaffolders, staggers and riggers
16 Plant operatives	
	(8221) Crane drivers (8129) Plant and machine operatives nec (8222) Fork-lift truck drivers (8229) Mobile machine drivers and operatives nec
17 Plant mechanics/fitters	
	(5223) Metal working production and maintenance fitters (5224) Precision instrument makers and repairers (5231) Vehicle technicians, mechanics and electricians (9139) Elementary process plant occupations nec (5222) Tool makers, tool fitters and markers-out (5232) Vehicle body builders and repairers
18 Steel erectors/structural fabrication	
	(5311) Steel erectors (5215) Welding trades (5214) Metal plate workers, and riveters (5319) Construction and building trades nec (5 per cent) (5211) Smiths and forge workers

¹⁷ Where reference is made to a percentage beside an occupation this refers to the percentage of the number of that occupation who are working in construction that are assigned to that occupational aggregate. For instance, in this case 25 per cent of Construction and building trades nec (SOC5319) are allocated to the occupational aggregate which is wood trades and interior fit out.

Occupations included within construction occupational aggregates (Four-digit codes refer to Office for National Statistics Standard Occupational Classification Codes).	
	(5221) Metal machining setters and setter-operators
19 Labourers nec	
	(9120) Elementary construction occupations (100 per cent)
20 Electrical trades and installation	
	(5241) Electricians and electrical fitters (5249) Electrical and electronic trades nec (5242) Telecommunications engineers
21 Plumbing and heating, ventilation, and air conditioning trades	
	(5314) Plumbers and heating and ventilating engineers (5216) Pipe fitters (5319) Construction and building trades nec (5 per cent) (5225) Air-conditioning and refrigeration engineers
22 Logistics	
	(8211) Large goods vehicle drivers (8212) Van drivers (9260) Elementary storage occupations (3541) Buyers and purchasing officers (50 per cent) 3541 (4134) Transport and distribution clerks and assistants
23 Civil engineering operatives not elsewhere classified (nec)	
	(8142) Road construction operatives (8143) Rail construction and maintenance operatives (8123) Quarry workers and related operatives
24 Non-construction operatives	
	(8117) Metal making and treating process operatives (8119) Process operatives nec (8125) Metal working machine operatives (8126) Water and sewerage plant operatives (8132) Assemblers (vehicles and metal goods) (8133) Routine inspectors and testers (8139) Assemblers and routine operatives nec (9249) Elementary security occupations nec (9233) Cleaners and domestics (9232) Street cleaners (5113) Gardeners and landscape gardeners (6232) Caretakers (9241) Security guards and related occupations (3319) Protective service associate professionals nec
25 Civil engineers	
	(2121) Civil engineers
26 Other construction professionals and technical staff	
	(2122) Mechanical engineers (2123) Electrical engineers (2126) Design and development engineers (2127) Production and process engineers (2461) Quality control and planning engineers (2129) Engineering professionals nec

Occupations included within construction occupational aggregates (Four-digit codes refer to Office for National Statistics Standard Occupational Classification Codes).

	(3112) Electrical and electronics technicians (3113) Engineering technicians (3114) Building and civil engineering technicians (3119) Science, engineering and production technicians nec (3121) Architectural and town planning technicians (3122) Draughtspersons (3115) Quality assurance technicians (2432) Town planning officers (2124) Electronics engineers (2435) Chartered architectural technologists (3531) Estimators, valuers and assessors (3116) Planning, process and production technicians
27 Architects	
	(2431) Architects
28 Surveyors	
	(2433) Quantity surveyors (2434) Chartered surveyors

Appendix 2 – Labour Forecasting Methodology

About the Labour Forecasting Tool (LFT)

The demand side models for SBTL have been generated using CITB's Labour Forecasting Tool (LFT). The tool is a web-based system which allows users to change the input parameters of the underlying models to allow the impact on the labour demand to be observed. In its most basic form, the Labour Forecasting Tool predicts the labour required in each of 28 occupations on a month-by-month basis given no more than the values of a project, its location, and its start and end dates. The principal data required relates to the labour coefficients (number of person years per million pounds of construction output) for each of the relevant occupations. The labour coefficients are different for each occupation. We also require details of the labour on a month-by-month basis during the project to allow the "s-curve" to be defined. The "s-curve" is used to define the flow of labour during a project and when the peak arises. Using a unique algorithm to integrate the s-curve, the tool can forecast the labour requirements month-by-month and occupation-by-occupation.

The tool allows a labour profile to be created showing both the peak workforce and the monthly average workforce during a project. Generally, and where the available data allows, a separate model is created for work involving similar types of activities. The workforce profiles can be aggregated at any level that is required – for instance by type of work (eg off shore) by combining individual forecasts (or work packages in the case of SBTL).

The tool has been specifically calibrated for the Swansea Bay Tidal Lagoon as part of this commission. Work packages (eg buildings, marine works, power generation etc) specific to SBTL have been produced. Bespoke coefficients for each occupation and s-curve profiles have been derived as part of this process. Details of the occupational aggregates produced by the tool are shown in Appendix 1. For construction there are 28 occupational aggregates supplemented with three additional non-construction occupations.

Sources of data

The main source of data for the modelling has been from TLSB Plc and their preferred contractors. They have provided us with data relating to the labour demand estimates on a month-by-month and occupation-by-occupation basis. This data has been used to derive the labour coefficients and s-curve parameters detailed above. Programme information has also been provided by TLSB Plc.

The only additional source of data for the modelling has been in relation to buildings where we have used a standard CITB model within the LFT for public non-residential buildings. The construction value has been used to generate the labour profile and this value has been provided by TLSB Plc.

It is important to note that following the provision of data from TLSB Plc, we were advised that there were changes to the programme (but not the scope of the work). We have therefore used the LFT to change the start and end dates

of each of the work packages. This has the inherent assumption that the total labour demand will be the same and that the labour profile (the s-curve) will be the same across the new programme of the work package. It is not clear at this stage, without access to further data, to be able to test that assumption.

Appendix 3 – Labour demand by occupation and year

Number of people	2015	2016	2017	2018	2019	2020	2021	2022
Senior, executive and business process managers	0	0	5	10	10	10	10	10
Construction managers	0	0	5	10	20	20	10	20
Other construction process managers	0	0	5	10	15	15	5	0
Non-construction professional, technical, IT, and other office-based staff (excl. managers)	0	5	25	35	40	40	30	30
Construction Trades Supervisors	0	0	5	5	5	5	5	0
Wood trades and interior fit-out	0	0	0	5	205	125	5	25
Bricklayers	0	0	0	0	0	0	0	10
Building envelope specialists	0	0	0	0	0	0	0	10
Painters and decorators	0	0	0	0	0	0	0	15
Plasterers	0	0	0	0	0	0	0	5
Roofers	0	0	0	0	0	0	0	5
Floorers	0	0	0	0	0	0	0	5
Glaziers	0	0	0	0	0	0	0	5
Specialist building operatives not elsewhere classified (nec)	0	0	10	55	280	130	15	5
Scaffolders	0	0	0	0	0	0	0	0
Plant operatives	0	0	105	130	145	120	40	5
Plant mechanics/fitters	0	0	0	0	0	0	0	5
Steel erectors/structural fabrication	0	0	0	0	0	0	0	5
Labourers nec	0	0	45	60	75	95	60	15
Electrical trades and installation	0	0	0	0	0	0	0	20
Plumbing and heating, ventilation, and air conditioning trades	0	0	0	0	0	0	5	15
Logistics	0	0	25	40	55	55	35	30

Number of people	2015	2016	2017	2018	2019	2020	2021	2022
Civil engineering operatives not elsewhere classified (nec)	0	0	0	0	0	0	0	5
Non–construction operatives	0	0	0	0	5	5	0	5
Civil engineers	0	0	10	20	35	35	15	5
Other construction professionals and technical staff	0	0	5	10	20	20	10	15
Architects	0	0	0	0	0	0	0	5
Surveyors	0	0	0	5	5	10	5	5
Maritime	0	0	80	80	75	70	45	0
Other out of scope	0	0	0	0	0	0	0	0
Undefined	0	0	15	20	20	20	10	0
Total	0	5	340	495	1010	900	385	285

Appendix 4 – Higher Education Subject Codes

Construction and Built Environment related subjects include the following Joint Academic Coding System (JACS) subject areas:

JACS 3.0 Subject Code
(H2) Civil engineering
(K1) Architecture
(K2) Building
(K4) Planning (urban, rural & regional)
(K9) Others in architecture, building & planning

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