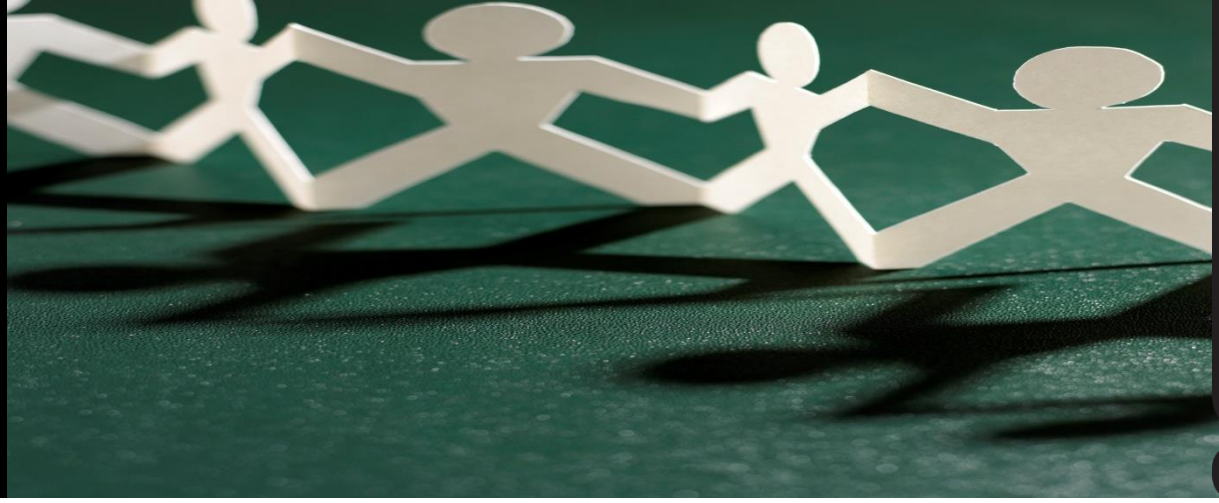

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A study to forecast the manufacturing & assembly labour requirements for the Swansea Bay Tidal Lagoon

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Date: July 2016

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Caveat

Readers should note that 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 February 2016 and are subject to changes in project timelines and refinements to build methodology.

The forecasts specifically relate to the manufacture and assembly of the main component parts required as part of the Swansea Bay Tidal Lagoon project by Tidal Lagoon Swansea Bay Plc.

Executive Summary

This report documents the findings of a study commissioned and funded by Welsh Government to understand the labour market requirements for the manufacturing and assembly elements of the proposed Swansea Bay Tidal Lagoon (SBTL) project[1].

SBTL is a £1.3 billion project that aims to harness the seven to nine metre tidal range in Swansea Bay through 16 specially designed and built turbines, to generate electricity. It is a first of a kind (FOAK) project and is intended as a relatively small scale pilot that will pave the way for future tidal lagoons. Around the coast of Wales four potential sites[2] have been identified with sufficient capacity for an average of 70 turbines at each site.

The study draws on the expertise and knowledge of the preferred contractors as well as the independent Tidal Lagoon Industry Advisory Group. Information is accurate up to the time of writing - February 2016.

The study estimates that the manufacturing and assembly of the main components required for the SBTL project will support around 1,197 FTEs[3] during a 5 year build period and an additional 28 FTEs supported per year continuing for the operation and maintenance of the power plant for the useful life of the lagoon (estimated to be a minimum of 120 years) – a total of 1,225 FTEs. The majority of this labour (92 per cent) will be required for the power generation components and of this, 83 per cent will be required for the manufacture of turbine sets and sluice gates / stop logs.

Around two thirds of the labour demand (63 per cent) is for technical / skilled occupations – the equivalent of Level 3 skills. Thus, the project is providing higher level job opportunities. The largest proportion of jobs (49 per cent) is for people working in the manufacture of fabricated metal industry. One fifth (20 per cent) of jobs require people working in steel casting, and eleven per cent for forging / stamping metals.

The study estimates that at present, Wales has the capability to provide around half (54 per cent) of the manufacturing and assembly of the main components requirements. With sufficient investment to fill the gaps in Welsh capability (most notably in securing the required machinery and facilities), the capacity in Wales could, in theory, be expanded to provide some 92 per cent of activities[4].

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[1] Readers should note that 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 February 2016 and are subject to changes in project timelines and refinements to build methodology.
The forecasts specifically relate to the manufacture and assembly of the main component parts required as part of the Swansea Bay Tidal Lagoon project by Tidal Lagoon Swansea Bay Plc.

[2] Including Swansea Bay. The others are Cardiff, Newport and Colwyn Bay.

[3] A full time equivalent job is estimated as one person being employed full time for 8 hours a day, for 5 days a week and for 48 weeks in a year – or 1,920 person hours.

[4] This only provides a potential indication – it does not suggest that Wales can or will supply this proportion of labour – many other externalities such as competition from other non-Welsh companies and other infrastructure sites, as well as the capability of the labour market, willingness of companies to participate and capacity to do so will impact on this.

There are notable shortages in Wales' capability to meet the demands for steel casting given the lack of such companies operating in Wales – but with investment, the necessary infrastructure could be re-located to Wales. There are also concerns over Wales' capability and capacity to meet the demands of the forging and fabricated metal aspects given that the SBTL project demands 64 per cent and 20 per cent of existing labour respectively.

Clearly, to meet the labour demands of the SBTL project, more people with the right skills are needed in Wales. Given training lead-in times, training should start as soon as possible to ensure that Welsh labour can meet the demand.

With the SBTL, there is an opportunity for Wales to be the first to develop a dedicated industry with a Wales based supply chain – that can support a global tidal lagoon industry. Wales could establish itself as the global leaders in this new industry. To capitalise on the SBTL opportunity, that of a future fleet of lagoons in Wales, and a potential global industry – immediate investment is essential. With the correct machinery, aspects of the manufacturing can be handled in Wales and this will further support job creation. Similarly, a suitable investment in developing the skills of the Welsh labour market through a strategic approach to up-skilling the existing workforce, and developing the number of new entrants into the industry is essential.

This report has focussed on the labour demand for the manufacturing and assembly elements of the SBTL. A parallel study entitled 'A study to determine the construction labour and skills demand, supply and gaps associated with the creation of the Swansea Bay Tidal Lagoon' has been carried out by the Construction Industry Training Board (CITB) and Whole Life Consultants Ltd (WLC Ltd). The CITB and WLC study considered the direct construction jobs associated with the SBTL. Their report estimates a peak labour demand of slightly more than 1,000 people (direct jobs only) with five occupational groups accounting for over 60 per cent of the labour demand.

The researchers would like to acknowledge and thank the independent Tidal Lagoon Industry Advisory Group and other industry experts that have provided the necessary insight to enable this report to be produced. Without their expertise and willingness to give their time, it would not have been possible to produce this report.

1 Introduction

This report documents the findings of a study commissioned and funded by Welsh Government to understand the labour market requirements for the manufacturing and assembly elements[5] of the proposed Swansea Bay Tidal Lagoon (SBTL) project[6]. A separate report[7] details the labour market requirements arising from the construction elements of the project.

The study draws on the expertise and knowledge of some of the preferred tier one[8] contractors as well as the independent Tidal Lagoon Industry Advisory Group to understand the manufacturing and assembly labour demand for the project. Information has been gathered from industry experts up to the end of February 2016 and is accurate at the time of writing – based on the project information that was available at the time. Then, using a range of research methods, this information is analysed and interpreted to understand the potential opportunities for companies based in Wales to meet the demand for expertise and labour in this specific area of the project.

The report is structured as follows:

- The remainder of the introductory chapter sets out in greater detail the aims and objectives of the research study and describes the proposals for the tidal lagoon;
- The second chapter describes the research methodology and defines the scope of the research;
- Chapter three details the expected demand for labour, whilst;
- Chapter four examines how well equipped the labour market in Wales is to meet demand, and
- The final chapter concludes the study, suggesting potential uses for the data and recommendations that could be considered by the Welsh Government to ensure Welsh businesses and individuals can capitalise on the opportunities provided by the project.

1.1 Research Aims and Objectives

The primary aim of the project study was to carry out a labour market information (LMI) analysis for the manufacture and assembly aspects of the proposed Swansea Bay Tidal Lagoon project.

To achieve this aim, a number of objectives were established. They were:

[5] See definition in Research Scope, Section 3.1.
[6] The analysis in this report applies to Swansea Bay Tidal Lagoon only, as a pathfinder project, paving the way for future projects. The potential demand for future lagoons is beyond the scope of the research, although commentary is provided where the numbers quoted in this document could, in theory, be applied to similar lagoons of varying size.
[7] Also commissioned by the Welsh Government.
[8] Tier one is a term used to describe supply chain tiers – a tier one supplier has direct contact with the ultimate client. Tier two suppliers will have a sub-contract with tier one contractors and so on down the supply chain.

1. To define the scope of the research including a Standard Industrial Classification (SIC) / Standard Occupational Classification (SOC) code definition of the proposed footprint:
2. To collate primary and secondary data, regarding the demand for skills and the associated skills requirements / needs to deliver the project, from:
    a. Tidal Lagoon Swansea Bay PLC. (TLSB)
    b. The consortium formed between General Electric and Andritz Hydro (GEAH); appointed as the preferred bidder for delivering the turbines and power generation TLSB work package
    c. The independent Tidal Lagoon Industry Advisory Group (ITLIAG)
3. To analyse the collated data to establish:
    a. A forecast of **direct labour demand** and the **potential contribution from the Welsh supply chain** for the main components required for the turbine manufacture and assembly aspect of the Swansea Bay Tidal Lagoon project.
    b. A forecast of the number of people required, analysed by the skills[9], occupation, industry and level of qualification they will need.
4. To produce a report which sets out the findings from the analysis undertaken to consider;
    a. Demand for manufacturing and assembly labour (project forecast)
    b. Skills requirements analysis (current and projected); the estimated number of companies and the people employed with the potential to deliver the project.
    c. A demand side analysis to inform future research focus related to:
        - Skills gaps and shortages
        - The potential supply of labour

1.2 About the Swansea Bay Tidal Lagoon Project

The Swansea Bay Tidal Lagoon (SBTL) is a £1.3 billion project that aims to harness the seven to nine metre tidal range in Swansea Bay to generate electricity. The plans include a specially constructed 9.5km causeway, forming a lagoon with sixteen turbine houses that allow the water to pass through four times a day (twice on the flood and twice on the ebb tides) – the tidal head differential creating water pressure turning the turbines to generate 320MW of predictable (14 hours a day) electricity; enough power for over 155,000 homes for 120 years[10]. Backed by equity funders Prudential and Infra Red, the project is being developed by Tidal Lagoon (Swansea Bay) Plc, a special purpose vehicle (SPV) company established specifically for the development of this

[9] The project aimed to establish the demand for Welsh language skills and the topic was raised with those interviewed however insufficient information was available to draw any meaningful outcomes. It is suggested that further research into Welsh language skills is carried out as the project develops and more information regarding the supply of labour is known.

[10] http://www.tidallagoonswanseabay.com/the-project/proposal-overview-and-vision/51/

project. The approach to deliver and manage the project will be through the appointment of tier one contractors (currently defined as preferred bidders), coordinated and project managed by a Swansea Bay Tidal Lagoon Team.

Table 1 provides a list of companies that have agreed contract terms to become a preferred bidder for the project[11].

Table 1 Preferred Tier One Bidders for Manufacturing and Assembly as of February 2016.

Company	Work Area
Andritz Hydro / General Electric consortium	Power generation plant
Laing O'Rourke	Turbine and sluice structures
Alun Griffiths Civil Engineering	Ancillary Civil Works

Source: Tidal Lagoon Swansea Bay

Granted a Development Consent Order in June 2015, Swansea Bay Tidal Lagoon will be the world's first, man-made tidal hydropower lagoon[12], and is also the first in a series of proposed lagoons which Tidal Lagoon Swansea Bay Plc. will be pursuing to develop in the UK. As a low carbon form of electricity generation, the Swansea Bay Tidal Lagoon is expected to save over 236,000 tonnes of CO_2 each year (compared with existing forms of energy generation). This is particularly pertinent in today's political landscape with the UK government having signed up to a commitment to delivery 15 per cent of its energy from renewable sources by 2020. In 2014 around 7 per cent of the UK's energy mix came from renewable sources[13] and so the Swansea Bay Tidal Lagoon could be an important aspect in achieving this target – which, as a first of a kind (FOAK) project will also lead the way for other tidal lagoon hydropower sites around the Welsh coast (and other areas of the UK), where tidal ranges are among the biggest across Europe and the rest of the world.

As a FOAK project, this lagoon promises to break new ground and could position Wales at the heart of the next generation of low carbon energy generation. With it there comes a significant level of direct and indirect employment and value creation for the Welsh economy. This research follows studies completed by Cardiff Business School and the Centre for Economic Business Research[14] and aims to further demonstrate direct employment impact that the project will have on the Welsh labour market.

As well as the immediate economic benefits, the project will also create community and tourism opportunities in sports, recreation, education, arts and culture, as well as

[11] At the time of writing, no contractors have executed contracts to deliver the whole of the work associated with any work area.

[12] There are other power stations that use tidal power such as the Sihwa Lake Tidal power station in South Korea but this will be the first man-made tidal lagoon power station.

[13] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/450298/DUKES_2015_Chapter_6.pdf

[14] http://business.cardiff.ac.uk/news/academics-predict-swansea-bay-tidal-lagoon-will-generate-%C2%A3300-million-wales

programmes to develop understanding and monitor key aspects of conservation, restocking, biodiversity, and coastal flooding protection.

The project will utilise proven hydropower technology, adapted for this specific marine environment. The turbines will be Kaplan bulb turbines, manufactured by joint venture between Andritz Hydro and General Electric, world leaders in hydropower plant manufacture and power conversion plant respectively. The type of turbines proposed for the Swansea Bay Tidal Lagoon are currently used on other hydro plants around the world, but will be tailored for this project capturing both the ebb and flood tides. To do so, they will have to also work in reverse and will therefore be bi-directional. To make the most of the tidal range – the optimum difference between the upstream and downstream (inlet and tailwater) water levels needs to be achieved. This will be achieved through controlling the difference in water level between the sea and lagoon via the turbine, generator and sluice gates.

The turbines will be encased in fully submerged concrete turbine housing structures. Each turbine can be dewatered to allow maintenance access. Although the provision of the turbines for TLSB will be the responsibility of a consortium based outside of Wales, Tidal Lagoon Power has identified a desire to maximise the elements of the work that can be carried out in Wales, either through existing capabilities, or as a result of future investment on the back of this and planned successor projects.

Construction is expected to begin in 2017[15] and will take approximately five years. Operations and maintenance (O&M) will commence after commissioning and will continue throughout the lagoon's useful life expectancy (which is a minimum of 120 years). An outline schedule of the work programme for the manufacturing & assembly activities associated with the power generation plant aspects is shown in Table 2.

It shows that the main manufacturing elements of the power generation work package – the manufacture of turbine components and sluice gates etc. will take place mid-way through the scheduled five-year delivery timeline and that most of the activity will take place during a 30-month period.

The O&M activity will largely comprise scheduled maintenance activity. The major components have a design working life ranging from 40 to 100 years but during this time, some elements of the components will require major maintenance, refurbishment, upgrading or replacement. Also – there will be an unknown element of unscheduled repair / maintenance in response to unplanned events or fault conditions resulting in plant damage requiring repair.

[15] At the time of writing. Dates are subject to change.

Table 2 Swansea Bay Tidal Lagoon Schedule of Works for Power Generation Plant

	Build																				Operational			
	Year 1				Year 2				Year 3				Year 4				Year 5				Years			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	1 to 20	21 to 35	36 to 60	61 to 120
C122 Power Generation																								
Procurement of turbine components																								
Procurement of generator components																								
Procurement of mechanical & electrical balance of plant																								
Procurement of modular enclosures																								
Turbine components manufacturing in factory and transport to Swansea																								
Generator components manufacturing in factory and transport to Swansea																								
Mechanical & electrical BoP manufacturing in factory and transport to storage location																								
Modular enclosures manufacturing in factory and transport to storage location																								
Installation of machine and tools																								
Machining of turbine components																								
Assembly of various turbine components																								
Assembly of various generator components																								
Sluice gate structure construction and sluice gate installation																								
Powerhouse – installation of turbine draft tubes and turbine housings																								
Powerhouse – installation of turbine & generator and associated plant																								
Powerhouse – installation of mechanical & electrical balance of plant																								
C132 Turbine Structure	M&A				Setup on foreshore				Main Works												n/a			
C135 Power Plant O&M	n/a																				O&M & Parts Replaced			
C150 Lagoon Maintenance	n/a																				O&M & Parts Replaced			
C151 Infrastructure Maintenance	n/a																				O&M & Parts Replaced			
C152 Facilities Management	n/a																				O&M & Parts Replaced			

Source: Data provided by Tidal Lagoon Power and presented by Miller Research.

Key: M&A = manufacture and assembly, O&M = operation and maintenance, BoP = Balance of Plant.

2 Approach

The approach to the study comprised the following activities:

- **Defining the Sector**

A definition of the footprint for the study was established, using national datasets including Standard Industrial Classification (SIC) / Standard Occupational Classification (SOC) codes (see Section 2.1).

- **Scoping Interviews with Key Stakeholders**

A series of scoping interviews with key stakeholders were undertaken to aid the scoping element of the research. Fundamental to this task were discussions around the type and nature of manufacturing and component production required for the project as well as discussion to establish data collection protocols with key industry contacts. Representatives from the following organisations were engaged with during this task:

a. Tidal Lagoon (Swansea Bay) Plc. (TLSB)

b. General Electric and Andritz Hydro (GEAH);

c. Welsh Government

d. Tidal Lagoon Industry Advisory Group (ITLIAG)

- **Mapping the Work Packages**

Using the information obtained in the scoping interviews (the list of job occupations and skills needed to deliver the manufacturing and assembly elements of the Swansea Bay Tidal Lagoon project) it was possible to estimate how many businesses there are in Wales and how many people are employed within SIC / SOC codes relevant to the opportunity. To do this, the work packages were matched to SIC / SOC codes to provide a profile which was then compared with national datasets such as the Annual Business Survey (ABS) and the Business Register and Employment Survey (BRES) to calculate the number of companies in Wales with the potential to deliver the project and the people employed by them.

- **Forecast of Skills Needs**

The purpose of this task was to establish an understanding of the potential skills demand for the manufacture and assembly elements of the proposed Swansea Bay Tidal Lagoon project. Using the data provided to establish the demand for labour, a skills matrix was developed that sets out the skills required for each occupation required to deliver the project. This provided a figure for total labour demand (number of full time equivalent[16] positions (FTEs)), by skills needs.

[16] An FTE is the equivalent of one person working full time for 8 hours a day, 5 days a week, 48 weeks of the year or 1,920 hours per year.

2.1 Research Scope

The scope of the research encompassed an analysis of the key manufacturing and assembly labour requirements of the proposed Swansea Bay Tidal Lagoon project. The project comprises a number of major work packages. Within each work package there are several activities / components. Some of the work activities fall within the scope of manufacturing and assembly adopted in this study, the others fall within the definition adopted in the separate study which is concerned with construction activities[17]. A small amount of overlap exists where the work package contains some elements which are manufacturing and assembly, and some which are construction activities. Table 4 describes the full range of work packages for the SBTL project and indicates where there are elements included in the manufacturing & assembly definition and where there are elements that fit within the construction definition[18]. Where overlap exists, an explanation is provided in the notes section.

The definition of work activities included in this report and defined as manufacturing and assembly are shown in Table 3. The manufacture and assembly activities as defined for this research includes all elements of the power generation work package, which comprises:

- Turbine Sets (the manufacture and assembly of key components[19] and off-site installation)[20];
- Electrical Systems, and
- Mechanical Systems.

The definition also includes aspects of the turbine structure work package related to manufacture and assembly, namely the production of fabricated metal products[21], and the maintenance and repair, and replacement of parts of the power plant[22].

[17] Entitled 'A study to determine the construction labour and skills demand, supply and gaps associated with the creation of a tidal lagoon for Swansea Bay".
[18] A detailed list of the work packages and activities included in the scope of this research is included in the Appendix.
[19] This study only considers the key / major components required for the project, such as turbine sets, sluice gats / stoplogs etc. It does not include periphery components such as handrails, steps and flooring etc.
[20] On-site installation falls within the definition of construction installation and is beyond the scope of this report. This will include activities such as transport, rigging, slinging and crane driving – the labour demand from which may be significant.
[21] Much of this work package falls within the definition of construction so is beyond the scope of this report.
[22] Typically, those activities which have a mechanical engineering / manufacturing requirement.

Table 3 Manufacturing & Assembly Work Packages and Activities – Definition of the Research Scope

Work Package	Description
C122 Power Generation	This work package comprises the manufacture and assembly of turbine sets, electrical systems and mechanical systems. A small amount of on-site construction installation which is not included.
C132 Turbine Structure	The manufacture of structural metal products for the turbine and sluice structures. There will be on-site construction installation that is not included in this report.
C135 Power Plant O&M	The scheduled and un-scheduled maintenance and repair, and replacement of parts of the power plant.

Source: Miller Research (UK) Ltd.

Table 4 Swansea Bay Tidal Lagoon Project as a Whole – Work Packages and their Relationship with Research Study Definitions

Work Package	Description	Included in the Manufacturing & Assembly Report?	Included in Construction Report?	Notes
C122 Power Generation	Includes the manufacture and assembly, and installation of: • 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 and assembly, installation and commissioning of turbine & generator plant, transformers, sluice gates, permanent cranes, stoplog bulkheads, 275kV cable. 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[23]
C131 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, sluice structure and wing walls)	Yes (construction of turbine housing blocks and construction installation)	The manufacturing and assembly elements include the manufacture of structural metal products. There will be on-site construction installation that is not included in this report.
C133 Ancillary Civils	Works to highways and parking, landscaping, marina works and other miscellaneous items.	No	Yes	
C134 Buildings	Construction of visitor centre, boating centre, viewing platform and other tourist / visitor services.	No	Yes	
C135 Power Plant O&M[24]	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	

Source: Miller Research (UK) Ltd.

[23] See paragraph entitled: Pre-assembly of Generating Plant, Sluice Gates and Stop logs at the end of Section 3.1.1 for further detail.
[24] Operations and Maintenance

For the purpose of this research study, the manufacturing and assembly activities of the SBTL project context comprises the following Standard Industrial Classification (SIC) codes (Table 5).

Table 5 Research Scope – Manufacturing Definition

SIC Code	SIC Description
2452	Casting of steel
2511	Manufacture of fabricated metal products, except machinery and equipment
2550	Forging, pressing, stamping and roll-forming of metal; powder metallurgy
2599	Manufacture of other fabricated metal products n.e.c.
2611	Manufacture of electronic components
2651	Manufacture of non-electronic industrial process control equipment
2712	Manufacture of electricity distribution and control apparatus
2731	Manufacture of fibre optic cables
2732	Manufacture of other electronic and electric wires and cables
2740	Manufacture of electric lighting equipment
2812	Manufacture of fluid power equipment
2813	Manufacture of pumps / compressors
2822	Manufacture of lifting and handling equipment
2825	Manufacture of non-domestic cooling and ventilation equipment
3311	Repair of fabricated metal products
3312	Repair of machinery
3313	Repair of electronic and optical equipment
3314	Manufacture of electric motors, generators and transformers
3320	Installation of industrial machinery and equipment
4312	Electrical installation

Source: Miller Research (UK) Ltd.

Notes: n.e.c. = not elsewhere classified.

This study establishes a forecast of the demand for labour for the manufacturing and assembly elements of the project – and seeks to understand how well equipped the Welsh supply chain is to provide the necessary labour and expertise required. Where applicable, commentary has been provided to illustrate the current industrial capability of the Welsh supply chain to meet the demand, and highlights areas where potential investment could enhance Wales' industrial capability.

3 Swansea Bay Tidal Lagoon: The Demand for Labour

The preferred Tier one bidders and independent Tidal Lagoon Industry Advisory Group have provided estimates of the demand for labour, based on a list of work packages that have been produced in collaboration with TLSB. As previously mentioned, the work packages that include manufacturing and assembly, or operation and maintenance (O&M) elements and therefore fall within the definition of this research are:

- C122 Power Generation
- C132 Turbine Structure
- C135 Power Plant Operations and Maintenance (O&M)

This section of the report details the expected level of demand for labour to meet the project requirements for the work packages noted above, addressing each work package in turn.

Considering the project as a whole, there is a forecast labour demand for 1,225[25] Full Time Equivalent (FTE)[26] jobs to deliver the manufacturing and assembly, and power plant O&M. The full work package breakdown is shown in Appendix 2 and a summary is included in Table 6. In total, it is estimated that 1,177 people will be required for power generation related activities (96 per cent of all FTEs) over a 26-month period[27]. The majority of the power generation labour requirement (83 per cent) will be for the manufacture and off-site assembly of turbine sets. Manufacture of electrical systems accounts for 13 per cent of the power generation FTEs and mechanical systems the remaining 4 per cent.

Table 6 Demand for Labour – Manufacturing Work Packages and Schedule of Works

Work Package	Detail	Total Labour Demand (FTEs)	% of project
C122 Power Generation	Power generation plant[28]	982	
	Electrical Systems	153	
	Mechanical Systems	42	
	Sub-Total	**1,177**	**96%**
C132 Turbine Structure	Sheet Piling / Dividing Structure / Sluice Structure / Wing Walls	20	
	Sub-Total	**20**	**2%**
C135 Power Plant O&M	Management and Administration	8	
	Operations	12	
	Maintenance	8	
	Other services	*	
	Sub-Total	**28**	**2%**
	Total Labour Demand (FTEs)	**1,225**	

Source: Data provided by various industry experts and presented by Miller Research.
*Notes: * Data not available at time of writing.*

[25] At the time of writing.
[26] FTE refers to full time equivalent job as a task and finish – that is to complete the quoted works.
[27] With manufacturing times for each component differing, refer to detailed section.
[28] Including pre-assembly / machining of turbine parts off-site.

Using the total labour demand above it is possible to estimate the amount of employment that will be supported in the wider economy. Input / Output tables provide estimates of the indirect[29] and induced[30] employment effects based on the interactions between sectors / industries. The Input-Output tables for Wales (2007)[31] are the most recent tables for Wales. For the metal and metal product industry[32] the multiplier for the impact of the direct, indirect and induced employment effects[33] is 2.07. That is, for every job created (direct employment) a further 2.07 will be supported in the wider economy[34]. Thus, the 1,225 FTEs that will be directly supported by the manufacture and assembly of the SBTL could support as much as 2,536 FTEs in the wider economy[35]. Of course, this simple calculation does not consider the net benefit – that is the additional jobs supported in the economy that would not otherwise have been supported in the absence of the SBTL. Deadweight (the amount of employment that would have been supported anyway) and displacement (the amount of employment that is not new to the economy but which is displaced from elsewhere) should also be taken into consideration[36]. Deriving figures for such discounts is beyond the scope of this research. The quoted figure is therefore a gross (unadjusted) figure only and does not indicate the net number of FTEs that the SBTL could support in the wider economy.

A detailed discussion of the forecast labour demand for each work package follows.

3.1 C122 Power Generation

This work package refers to the set of activities required to manufacture and assemble the necessary power generation equipment. It is broken down into three distinct groups. They are:

- Turbine Sets (including sluice gates and stop-logs)
- Electrical Systems
- Mechanical Systems

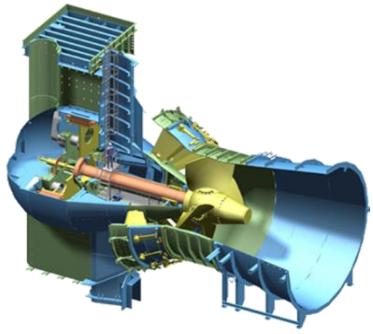
[29] Indirect effect is the effect of the initial output/employment supporting output/employment in the suppliers of the company where the original impact occurred.
[30] Induced effect is the effect of output/employment supported in the supply chain being recycled in the local economy.
[31] Available at http://business.cardiff.ac.uk/sites/default/files/IO_2007_Final_30_6.pdf. It should be highlighted that the tables were last updated in 2007 and therefore may not fully reflect the current situation. They are however, the most recently available tables.
[32] The industry as defined in the report which most closely matches the definition of manufacture and assembly in this report.
[33] The report defines the employment effect as "The direct, indirect and induced employment effect generated as a result of a unit change in final demand."
[34] Please note, forecasting the employment effect using this approach does not indicate in which industry the jobs are supported, but only provides an indication of the potential number of jobs supported in the economy at large.
[35] It should be noted that input/output tables exclude supply side effects which may affect sectors other than that being measured. So, for example, an increase in the wage for semi-skilled manufacturing jobs as a result of SBTL might impact on the ability of construction firms to recruit (as more people seek higher wage employment elsewhere).
[36] Other discounts should also be applied such as optimism bias – the demonstrated tendency for appraisers to overestimate (a standard of 5% discount) and discounts for inflation / net present value.

Within each sub-group there are a list of components that are required in order to satisfy the work package. Each is discussed in turn below.

3.1.1 Turbines

The turbine element of the power generation work package refers to the manufacture and assembly of sixteen turbines in the turbine housing structure of SBTL.

Figure 1 Tidal Lagoon Turbine



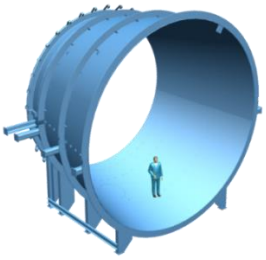
Source: Tidal Lagoon Power. Image used with their permission.

There are twelve distinct components / activities that comprise the manufacturing element of the turbine set work package. Shown diagrammatically in Figure 1, they are:

- Draft Tubes
- Runners
- Runner Blades & Hubs
- Turbine Housing
- Sluice Gates & Turbine Stop Logs
- Bulb Nose & Cones
- Shafts
- Discharge Rings
- Distributors
- Hydraulic Balance of Plant (BOP)
- Hatch Cover & Frame
- Generator

The labour requirement for each component is discussed in turn. Where applicable, commentary is also provided to indicate at what occupational / skills level the labour is required, and whether this demand could be met by the Welsh supply chain.

Draft Tubes



The draft tubes will be fabricated from steel sheets. The manufacture process consists of five main stages: the production of steel sheets, shipping / transportation, plate preparation (including rolling and machining), welding, and installation.

The estimated FTE[37] labour required to manufacture 16 draft tubes is estimated at 36. The estimated delivery timeframe of the tubes is between 12 and 18 months. The majority of jobs will be at a technical / skilled trade occupation level (28) and the remainder will be professional / manager level roles (8).

There is current capability within Wales to participate in most aspects of the draft tubes production process (estimated at around 75 per cent of FTEs quoted). The UK has the potential to supply the required steel plates although at present it is thought that there are no mills in the UK that can currently supply the required thickness or size of plate required, therefore it is a distinct possibility that project economics will drive procurement of the steel plates from Europe.

There is potentially more than one supplier in Wales with the capability for plate preparation although there are gaps in capability (see below).

There is also capability within Wales for the welding and installation activities.

The machining of the flanges is the main restricting factor of current capacity in Wales[39]. Once

Draft Tubes	
Number Required:	16
Manufacturing Method:	Metal Fabrication
Time to manufacture:	12 to 18 months
Estimated labour demand (FTE):	36
Estimated labour currently based in Wales	75%
Potential labour Wales could provide	95%[38]
Professionals / Managers:	8
Technical / Skilled:	28
Size:	40 tonnes
Expected place of manufacture:	UK
Related SIC code:	25110: Manufacture of fabricated metal products, except machinery and equipment
Welsh Capability to provide:	Yes
Gaps in Welsh Capability:	Supply of steel and steel plate
	Insitu Machining of Flanges

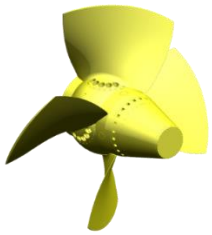
[37] Note: All FTE estimates are for the completion of the component / activity to which it relates regardless of where it is expected to be made unless stated.
[38] If necessary investment was made to purchase the required machinery (see description for further information). Assumes 5% of FTEs for the production of steel plates which could be sourced from the UK, but not Wales.
[39] This issue also applies to the sluice gates, turbine stoplogs, and bulb nose and cone.

the flanges are made, it becomes costly to transport them onto site due to the high level of tolerances required[40]. Furthermore, also due to the high tolerance levels, the steel needs to be heat-treated. Ideally, a suitable static machine should be located on site – although the tubes could be produced on-site using a portable machine. There are suitable portable machines available in the UK which could be purchased, consequently, in theory a Welsh company could manufacture all elements of the draft tubes. This would require investment to purchase a suitable machine (estimated at around £3m to £4m) as well as a new building to accommodate the machine (circa £300k). If this investment was made, approximately 20 per cent of the FTEs could then be based in Wales.

It should also be noted that it is likely that the manufacture of the draft tubes (and other components) will be shared between more than one supplier in order to de-risk the production process. That is, to avoid the risk of disruptions to supply if one company was responsible for all draft tubes.

[40] Note: the tolerance / quality demands on the components is such that they cannot be made in sections. So when they are very large they cannot travel by road. However, it is possible that manufacturing facilities could be relocated on site where it is economically viable to do so.

Turbine Runners



The turbine runners will be cast from steel. It is estimated that 45 FTEs will be required to produce 16 runners. As present, there is no capability in Wales to produce the runners because there are no companies with the ability to cast such large items. However, there are a small number of companies[41] with the necessary skills and expertise, which could have the capability if technology was transferred within the UK, to a site in Wales. This would require appropriate joint ventures and incentives to facilitate such an arrangement.

Runner	
Number Required:	16
Manufacturing Method:	Steel Casting
Time to manufacture:	12 to 18 months
Estimated labour demand (FTE):	45
Estimated labour currently based in Wales	0%
Potential labour Wales could provide	100%
Professionals / Managers:	9
Technical / Skilled:	36
Size:	Unknown
Expected place of manufacture:	UK
Related SIC code:	24520: Casting of Steel
Welsh Capability to provide:	No (yes with investment)
Gaps in Welsh Capability:	No steel casting capability Machining of this size

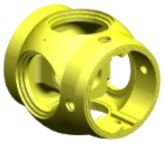
For example, it would be possible to manufacture the runners in Wales if an investment to purchase a large vertical turning centre (VTC) machine was made. The costs to acquire, install and house the machine are estimated to be in the region of £3.5m.

It is likely that balancing of the runners will be finalised in the turbine house with some static balancing[42] prior to this. To consider dynamic balancing would require significant further pre-assembly, which would increase the demand for labour and the costs of production.

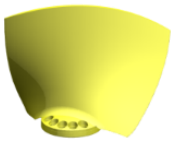
[41] Thought to be less than 10.

[42] Balancing is the process of improving the mass distribution of an object to minimise vibrations during use. Static balancing involves resolving imbalance on one plane through a non-moving (i.e. static) position. Dynamic balancing aims to achieve balance while the object is moving to improve balancing on two planes.

Runner Blades and Hubs



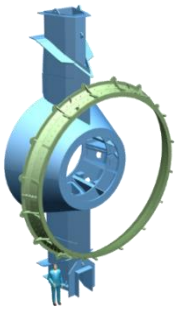
Each runner requires a hub and three blades and it is expected that 196 FTEs will be required to produce 16 hubs and 48 blades. The production process will be similar to that of the runners. They are also steel casted and will take between 12 and 18 months. The runner hubs and blades are similarly not able to be cast in Wales, but could be made in the UK and their smaller size means that they could be transported by road.



However, as with the runners, there is potential for some aspects of the production process to be relocated to Wales should a sufficient investment be made in transferring some of the machining capability to Wales (see discussion on runners above) as well as upgrading existing sites to be able to cast large items. If these investments were made, 100 per cent of the FTEs could be supplied by Welsh based companies.

Runner Blades and Hub	
Number Required:	16 Hubs and 48 Blades
Manufacturing Method:	Steel Casting
Time to manufacture:	12 to 18 months
Estimated labour demand (FTE):	196
Estimated labour currently based in Wales	0%
Potential labour Wales could provide	100%
Professionals / Managers:	15
Technical / Skilled:	103
Semi-Skilled	78
Size:	63 tonnes
Expected place of manufacture:	UK
Related SIC code:	24520: Casting of Steel
Welsh Capability to provide:	No (yes with investment)
Gaps in Welsh Capability:	Steel casting capability Machining of this size

Turbine Housing



As with the draft tubes, the 16 turbine housings are fabricated from steel sheets. The manufacture process consists of five main stages: the production of steel sheets, shipping / transportation, plate preparation (including rolling and machining), welding, and installation. It is forecast that 51 FTEs could result from the turbine housing manufacture, of which the majority (43) would be skilled technical and 8 would be at a professional / managerial level.

Turbine Housing	
Number Required:	16
Manufacturing Method:	Metal Fabrication
Time to manufacture:	12 to 18 months
Estimated labour demand (FTE):	51
Estimated labour currently based in Wales	75%
Potential labour Wales could provide	95%[43]
Professionals / Managers:	8
Technical / Skilled:	43
Size:	90 tonnes
Expected place of manufacture:	UK
Related SIC code:	25110: Manufacture of fabricated metal products, except machinery and equipment
Welsh Capability to provide:	Yes (minor gaps)
Gaps in Welsh Capability:	Supply of steel
	In situ Machining of Flanges

There is the capability in Wales to fabricate all aspects of the turbine housing, with the exception (as with the draft tubes) of the machining of flanges. Either a portable machine or investment to create on site facilities will be required to allow a Welsh company to carry out these tasks – in which case 95 per cent of the FTE could be supplied by Welsh companies. The other options are less clear, as the structures are too big to transport by road and it is not possible to transport them once they have been machined.

[43] If necessary investment was made to purchase the required machinery (see description for further information). Assumes 5% of FTEs for the production of steel plates which could be sourced from the UK, but not Wales.

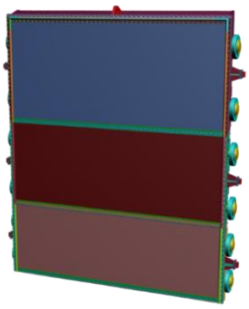
Sluice Gates and Stop logs

Sluice Gates and Stop logs	
Number Required:	40
Manufacturing Method:	Metal Fabrication
Time to manufacture:	12 months
Estimated labour demand (FTE):	194
Estimated labour currently based in Wales	75%
Potential labour Wales could provide	95%[44]
Professionals / Managers:	39
Technical / Skilled:	155
Size:	40 no. of 15m x 2m high (19 tonnes each)
Expected place of manufacture:	UK / EU
Related SIC code:	25110: Manufacture of fabricated metal products, except machinery and equipment
Welsh Capability to provide:	Yes (minor gaps)
Gaps in Welsh Capability:	Some machining works i.e. wheel bearings/rollers Supply of Steel Plates

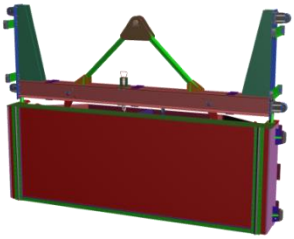
Sluice gates are located adjacent to the turbines which allow tidal flows to bypass the turbines. The majority of the time they will be used to quickly empty the lagoon at low tide to create a head difference which the turbines need to turn them and to quickly utilise the top of the tide to take as much water inside the lagoon. The operation of the sluice can be supplemented in both occasions, by pumping as appropriate. Stop logs in contrast are used to isolate one or more of the turbines and sluice gates by sealing the ends of the turbine draft tube to enable draining down or other maintenance activity or to seal the sluices for maintenance. They are both fabricated in steel which could be carried out by UK/Welsh companies. Specifically, the plate preparation and profiling could be conducted in Wales and the majority of the employment (165 FTEs) lies in the welding, which is within the capabilities of Welsh businesses. There are some areas of engineering which also lie outside UK capabilities; notably machining works for wheel bearings and rollers – due to the fact that current companies do not have the necessary machinery. The components require beam milling machinery to work on such items. However, as with the other components, the necessary machinery can be purchased, if it is economically viable to do so.

[44] If necessary investment was made to purchase the required machinery (see description for further information). Assumes 5% of FTEs for the production of steel plates which could be sourced from the UK, but not Wales.

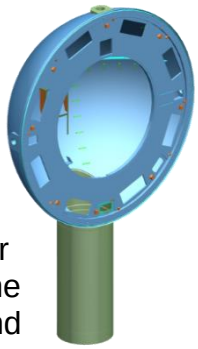
Sluice Gate



Stop log element



Bulb Noses and Cones

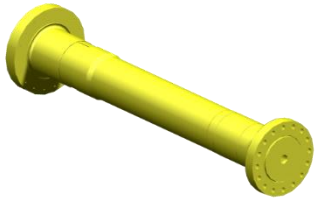


Sixteen bulb noses and cones will be required (one for each turbine), supporting 26 FTEs, of which 4 are expected to be professional / managerial and 22 skilled / technical. The majority of the fabrication of the bulb noses and cones could be manufactured in Wales, except for the dished end[45] of the cone. There are no identified suppliers in the UK that can make these at present although if sufficient investment is made for machines that can accommodate the thickness of the plate and the width/length required, they could be. Therefore, at present, the dished end may need to be contracted elsewhere in Europe.

Bulb Noses and Cones	
Number Required:	16
Manufacturing Method:	Metal Fabrication
Time to manufacture:	12 to 18 months
Estimated labour demand (FTE):	26
Estimated labour currently based in Wales	75%
Potential labour Wales could provide	95%[46]
Professionals / Managers:	4
Technical / Skilled:	22
Size:	20 tonnes
Expected place of manufacture:	Wales (dished end outside UK)
Related SIC code:	25110: Manufacture of fabricated metal products, except machinery and equipment
Welsh Capability to provide:	Yes (minor gaps)
Gaps in Welsh Capability:	Specialist machining / profiler
	Manufacture of dished end

[45] An estimate of the FTE to produce each dished end is around 0.5 FTEs.
[46] If necessary investment was made to purchase the required machinery (see description for further information). Assumes 5% of FTEs for the production of steel plates which could be sourced from the UK, but not Wales.

Shafts



Shafts	
Number Required:	16
Manufacturing Method:	Steel Forging
Time to manufacture:	12 to 18 months
Estimated labour demand (FTE):	130
Estimated labour currently based in Wales	0%
Potential labour Wales could provide	100%
Professionals / Managers:	18
Technical / Skilled:	47
Semi-Skilled	65
Size:	40 tonnes
Expected place of manufacture:	UK
Related SIC code:	2550: Forging, pressing, stamping and roll-forming of metal; powder metallurgy
Welsh Capability to provide:	No (yes with investment)
Gaps in Welsh Capability:	No steel forging capability

The shafts will be forged from steel and they require high level of tolerances on the production quality. It is estimated that their production will support 130 FTEs.

At present, there are no facilities in Wales to forge such large components, but they could be forged elsewhere in the UK. However, these components could be made in Wales if there was a suitable investment in facilities. An investment of some £10m will be required to purchase a large (~6,000t) press and a further investment of approximately £10m would be needed for a suitable furnace. It is thought that existing steel works such as that at Port Talbot could be a suitable site to house a forging facility that could produce the shafts. Clearly, for such an investment to be made in Wales, there will need to be a guarantee of further demand for forging to make the investment economically viable. The potential for further tidal lagoons in Wales could provide the level of demand needed to make such an investment viable.

Discharge Rings

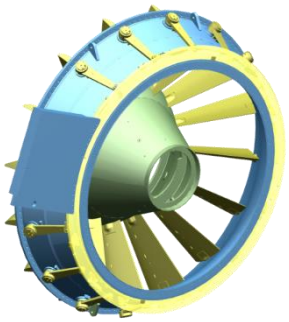
The discharge rings (16) will be fabricated from steel sheets, as for the draft tubes. Total labour demand for the manufacture of 16 discharge rings would be expected to be 32 FTEs, of which 7 would be at professional / managerial level and the rest technical / skilled. At present, the discharge rings are expected to be manufactured outside Wales because the type of machines required to process the steel for a ring of this size do not exist in Wales. However, such machines could be purchased (for an estimate of around £2m) in which case they could be produced in Wales.

Discharge Ring	
Number Required:	16
Manufacturing Method:	Metal Fabrication
Time to manufacture:	12 to 18 months
Estimated labour demand (FTE):	32
Estimated labour currently based in Wales	0%
Potential labour Wales could provide	100%
Professionals / Managers:	7
Technical / Skilled:	25
Size:	unknown
Expected place of manufacture:	EU
Related SIC code:	25110: Manufacture of fabricated metal products, except machinery and equipment
Welsh Capability to provide:	No (yes with investment)
Gaps in Welsh Capability:	Supply of steel
	In situ Machining of Flanges

Distributors

Each turbine has a distributor (16), which is a complex fabrication that cannot be made in Wales at present. It is expected that these will be made in China at plants already providing similar components for one of the preferred bidders – largely due to the large sizes and high tolerances required. The demand for these components will create some 88 FTEs, of which 5 can be expected to be professional / managerial and the rest (83) skilled / technical. The distributors will need to be shipped by sea, given their size and weight. It is thought that the UK has the capability to support aspects of production.

Distributor	
Number Required:	16
Manufacturing Method:	Metal Fabrication
Time to manufacture:	16 months
Estimated labour demand (FTE):	88
Estimated labour currently based in Wales	0%
Potential labour Wales could provide	0%
Professionals / Managers:	5
Technical / Skilled:	83
Size:	90 tonnes
Expected place of manufacture:	China/UK
Related SIC code:	25110: Manufacture of fabricated metal products, except machinery and equipment
Welsh Capability to provide:	No
Gaps in Welsh Capability:	Machining



Hydraulic BOP (Balance of Plant)

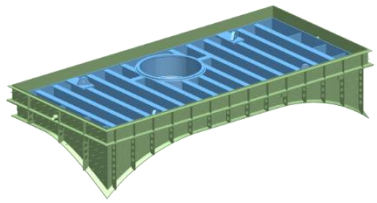
Hydraulic BOP is a safety device designed to store and control hydraulic energy, in this case in relation to the turbine governor pressure accumulators and sluice gate hydraulic rams. It is believed that this can be made in Wales and its manufacture is likely to support around 25 FTEs. It is assumed the distribution of these roles by occupation level is a four to one ratio of technical / skilled personnel for every one professional / manager.

Hydraulic BOP	
Number Required:	1
Manufacturing Method:	Metal Fabrication
Time to manufacture:	12 – 18months
Estimated labour demand (FTE):	25
Estimated labour currently based in Wales	100%
Potential labour Wales could provide	100%
Professionals / Managers:	5
Technical / Skilled:	20
Size:	Unknown
Expected place of manufacture:	UK
Related SIC code:	25110: Manufacture of fabricated metal products, except machinery and equipment
Welsh Capability to provide:	Yes
Gaps in Welsh Capability:	None

Hatch Covers and Frames

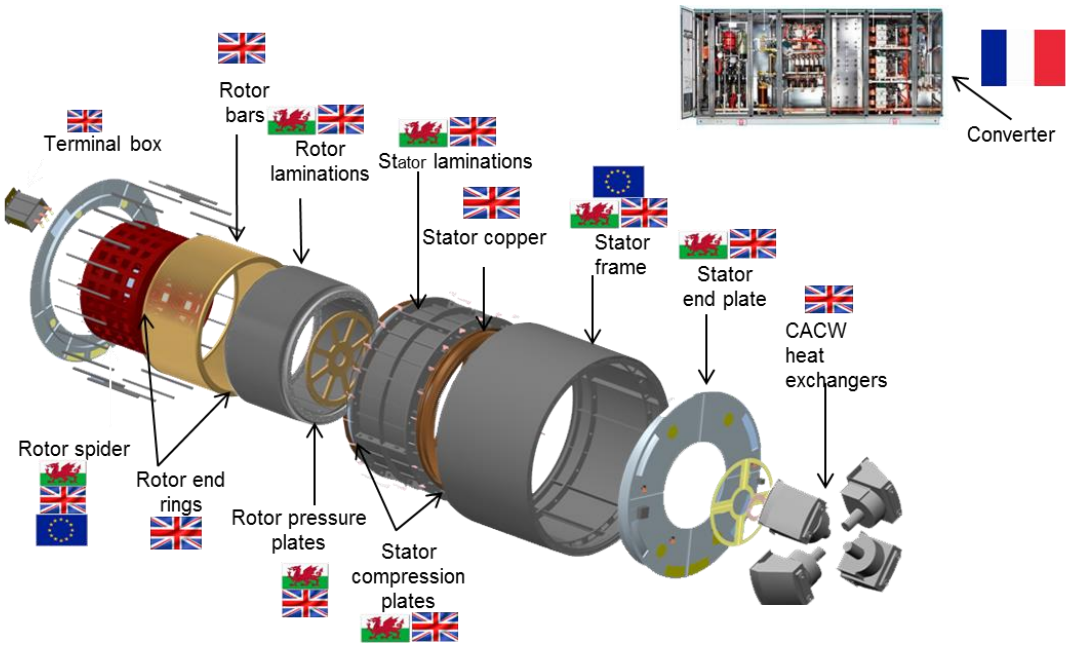
Each turbine housing has a hatch cover and frame, fabricated from steel. The 16 covers and hatches would be expected to require 20 FTEs of which 4 would be at professional level and 16 skilled / technical. Welsh businesses have the capability to make and install these covers, which weigh around 30 tonnes each.

Hatch Covers and Frames	
Number Required:	16
Manufacturing Method:	Metal Fabrication
Time to manufacture:	12 to 18 months
Estimated labour demand (FTE):	20
Estimated labour currently based in Wales	100%
Potential labour Wales could provide	100%
Professionals / Managers:	4
Technical / Skilled:	16
Size:	30 tonnes
Expected place of manufacture:	Wales
Related SIC code:	25110: Manufacture of fabricated metal products
Welsh Capability to provide:	Yes
Gaps in Welsh Capability:	None



Generator

The generators connected to the turbines consist of a number of components, which can be sourced from Wales. At present, only the supply of rotor spiders has been quantified by industry experts. These could be supplied by Welsh companies and would support 80 FTEs, of which 16 would be professional/ managerial and 64 skilled / technical posts. It is likely that items such as rotor laminations, stator laminations, stator frames, end plates, compression plates and rotor pressure plates could all be sourced from Wales. An estimation of the associated FTEs has been made by using a FTE per tonne of steel average from the other components that require a similar manufacturing process. Then, if it assumed that the total tonnage of the generator is 40 tonnes then a futher 34 jobs could be suppoted by the construction of the generators (potentially in Wales).



Pre-assembly of Generating Plant, Sluice Gates and Stop logs

The installation of the generating plant, sluice gates and stop logs includes the pre-assembly / machining in the turbine manufacture plant of the turbine parts – which falls within the definition for this study. The remainder of this activity falls outside the definition as it refers to on-site construction installation[47]. An estimation of 25 FTEs is provided, all of which are expected to be sourced by the supplier of the component.

3.1.2 Power Generation: Electrical Systems

Following the turbine sets, the second element of power generation is that of electrical systems: manufacture and installation. As far as can be assessed at the time of writing, this is expected to support 153 FTEs during the construction phase. Of these, 4 were identified as professional / managerial, 9 skilled / technical, 80 semi-skilled and 26 unskilled jobs. The levels of the other occupations were unknown at the time of writing.

Table 7 Labour Demand for Power Generation: Electrical Systems

Components / Activity	Total Labour (FTEs)	Prof…/ Manager	Technical / Skilled	Semi-skilled	Elementary / Unskilled
BoP Installation - Electrical/Cabling	40	1	3	26	10
Cabling and cable containment systems	50	2	4	30	14
Electronic Components	4	-	-	-	-
Engineering computer systems	5	-	-	-	-
Wiring - fibre optic	4	0	0	4	0
Wiring	10	-	-	-	-
Electrical equipment repair	5	-	-	-	-
Generator and unit transformers	10	-	-	-	-
Gas insulated switchgear, GIS	Unknown	-	-	-	-
275kV cable	Unknown[48]	-	-	-	-
MV/LV switchgear, electrical/I&C Control and distribution panels	25	1	2	20	2
Total	**153**[49]	**4**	**9**	**80**	**26**

Source: Data provided by various industry experts and presented by Miller Research.

Notes: - denotes where data was not available at the time of writing. As the occupational split was not available for some components / activity, the total of the occupations does not equal total labour.

A total of 78 per cent of the identified jobs could be housed in Welsh businesses, with the remainder split between the EU and China.

[47] However, an estimate of the on-site installation FTEs was provided by industry experts at around 60 (which is also not included in the construction report).

[48] At the time of writing it was not possible to obtain an estimate for the FTE requirement of gas insulated switch gear and 275kV cables.

[49] It should be noted that this estimate omits a small number of unknown FTEs for the components for which estimates could not be obtained. Thus, the number is likely to be a minimum requirement.

3.1.3 Power Generation: Mechanical Systems

The final element of the power generation work packages is that of the mechanical systems and installation equipment. Although suppliers have not yet been identified for these packages, an estimated 42 FTEs could accrue, mainly for permanently installed cranes.

Table 8 Labour Demand for Power Generation: Mechanical Systems

Components / Activity	Total Labour
Core component handling equipment	1
Process Control Equipment	1
Fluid Power Equipment	1
Manufacture of Pumps	1
Raw water treatment package	1
2x Powerhouse Cranes	12
2x turbine stoplog cranes	12
2x sluice gate stoplog cranes	12
Sensors and detectors	1
Total	**42**

Source: Data provided by various industry experts and presented by Miller Research.

3.2 C132: Turbine and Sluice Structures

The single element of manufacturing input into the turbine structure is that of structural metal products to support the sheet piling, dividing structures, sluice structures and wing walls.

This is likely to represent a total of around 3,000 tonnes of steel fabrication during the construction phase, or 250 tonnes per month for 1 year. The skilled labour requirement is likely to be around 20 FTEs as steel is fabricated for taking to site. There will be additional demand for installation work, which comes under construction jobs.

3.3 C135: Power Plant Operations and Maintenance

Operations and maintenance of the power plant covers all operations relating to the turbines and associated infrastructure, along with building services and systems (utilities, safety, general management) and other, outsourced services such as cleaning and waste management, scaffolding, spares and consumables. These categories are likely to support 28 FTEs, split between skilled and semi-skilled workers.

Table 9 Labour Demand for Power Generation: Operations and Maintenance

Components / Activity	Total Labour
Management and Administration	8
Operations	12
Maintenance	8
Total	**28**

Source: Data provided by various industry experts and presented by Miller Research.

4 Tidal Lagoon: Welsh Supply Chain Response – The Supply of Labour

This section of the report examines the capability of Welsh businesses to respond to opportunities presented by the new emerging tidal lagoon industry. Matching supply and demand in this context is an inexact science, as:

- SIC Codes may not adequately describe the specialist needs of a particular work package;
- A business which appears to be capable of entering the supply chain may not have the capacity to take on additional work, or may not want to;
- A business that works in a relevant sector may lack specialist capabilities thereby rendering it unsuitable as a supplier.

However, the matching exercise is important, as it allows us to indicate areas that may benefit from investment or brokerage to build interest in accessing supply chain opportunities.

4.1 What Skills does the Project Require?

By totalling the data from the previous section, an estimate for currently identified labour requirements, by SIC and SOC, along with a total requirement can be derived.

The occupation / skills requirements for the project are listed in Table 10 by 4-digit SIC and broad occupational category. The data shows that the majority of posts will be technical / skilled work (SOC levels 3 to 5 or an equivalent skill level 3[50]) and that the largest proportion (63 per cent) of the FTE labour requirement will be for the manufacture of fabricated metals products, except machinery and equipment (606 of 1,225 or 49 per cent). Anecdotal evidence suggests that there is an acute shortage of skilled metal fabricators in Wales - which implies that there is a need to train more people in this field. Given the importance of experience in metal fabrication roles, an unknown degree of upskilling will be necessary but considering that underlying qualifications pre-empt experience, then the need to increase the number of people training in metal fabrication qualification at all levels is required.

The table shows that around three quarters (76 per cent) of the direct manufacture/assembly jobs created by the SBTL will require a skill Level 3 or higher, indicating that the project will support higher level, and thus higher value jobs. Only one quarter (24 per cent) of the jobs will be semi-skilled or elementary occupations. A little more than three quarters of the jobs (79 per cent) will be provided by companies operating within three SIC code areas: 2452, 2511 and 2550 which relate to steel casting, the manufacture of metals, and forging of steel (or other metals) respectively.

Figure 2 provides an overview of the distribution of skills for the manufacture and assembly aspects of the SBTL project – which illustrates the fact that the project mainly requires higher level (Level 3+) skills. Three quarters (76 per cent) of all jobs require at least a Level 3 qualification. This includes almost two-thirds (63 per cent) of the demand

[50] Skills levels as defined by the UK government https://www.gov.uk/what-different-qualification-levels-mean/compare-different-qualification-levels. See Appendix 3 for reference table.

for skills identified to date at skilled technical level (Level 3), followed by semi-skilled - Level 2 (22 per cent), professional / managerial - Level 4 (13 per cent) and unskilled - Level 1 (2 per cent).

Many of the technical / skilled jobs within the SIC code 'manufacture of fabricated metal products, except machinery and equipment' (2511) – which account for 39.6 per cent of all manufacture and assembly jobs[51], will be required for welding metal during the fabrication process. Given the special types of steel and the varying levels of tolerances that will be required there will be a range of welding skills required to meet manufacturing requirements. The welding standards will be set by the chosen manufacturers when they are appointed and they have been through the manufacturing design process Thus, the precise detail regarding the welding and test plans for each component will is currently unknown[52].

Of course, the extent to which there will be a requirement for welders to be upskilled (i.e. for a welder to obtain the necessary procedure code standard) will depend on the extent to which the current workforce already have the necessary procedures – but this will not be known until detailed manufacture plans are prepared and the resulting welding standards and test plans are decided. Therefore, given the level of information currently available regarding the manufacture of the components, it is not possible to provide more detailed information about the precise welding standards that the manufacturers require – and so the associated impact on skills development in the current workforce is also unknown.

There will also be a need for weld examination / inspection tests for all components however, similarly to the point made above, the skills levels of the non-destructive testing personnel will be specific to the component being made. Thus, the exact requirements of the components welding standards are currently unknown and will only be known when the manufacturers are procured and the components have been designed in detail[53]. Typically, large components require two inspectors working one to two days a week during the fabrication process to test welding standards.

[51] 472 jobs are estimated at technical / skilled level 3 for SIC code 2511.

[52] Nonetheless, an example was provided by industry experts for the turbine housing welding requirements for illustrative purposes. It shows that there is an expectation that the welding standards might vary between the following harmonised standards:

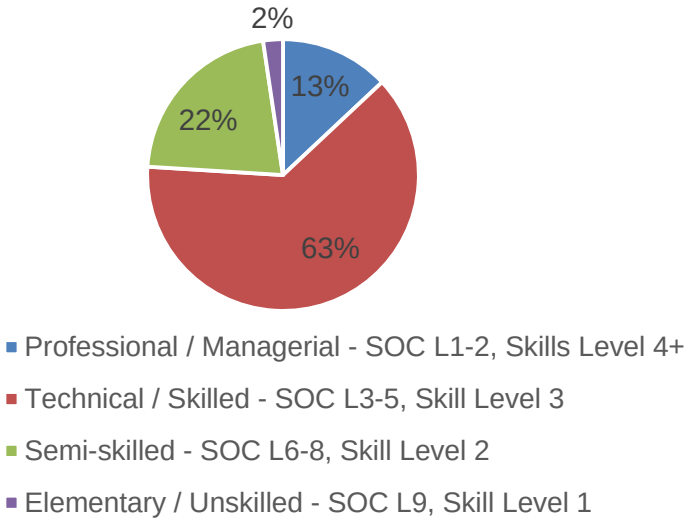
General Rules for all type of welding (EN ISO 15607),

Welding Specifications for Arc Welding (EN ISO 15609-1),

Welding Procedure Test for Steel and Nickel Alloys (EN ISO 15614-1 or ASME IX).

[53] Drawing on industry expertise again, there is an expectation that non-destructive testing personnel will be required to have at least qualification to EN473 or ASNT-SNT-TC-1A.

Figure 2 SBTL Labour Demand by Broad SOC Groups and Skills Levels



Source: Miller Research (UK) Ltd

Table 10 SBTL Manufacture & Assembly Skills Requirement by SIC (4 digit) and SOC (major groups)

SIC Code	SIC Label	Professional / Managerial SOC Levels: 1-2 Skill Level 4+	Technical / Skilled SOC Levels: 3-5 Skill Level 3	Semi-skilled SOC Levels: 6-8 Skill Level 2	Elementary / Unskilled SOC Level: 9 Skill Level 1	Total Labour (FTEs)	%
2452	Casting of steel	24	139	78	0	**241**	20
2511	Manufacture of fabricated metal products, except machinery and equipment	107	499	0	0	**606**	49
2550	Forging, pressing, stamping and roll-forming of metal; powder metallurgy	18	47	65	0	**130**	11
2599	Manufacture of other fabricated metal products n.e.c.	2	4	30	14	**50**	4
2611	Manufacture of electronic components	0	0	4	0	**4**	<1
2651	Manufacture of non-electronic industrial process control equipment	0	0	1	0	**1**	<1
2712	Manufacture of electricity distribution and control apparatus	1	4	0	0	**5**	<1
2731	Manufacture of fibre optic cables	0	0	4	0	**4**	<1
2732	Manufacture of other electronic and electric wires and cables	0	0	10	0	**10**	1
2812	Manufacture of fluid power equipment	0	0	1	0	**1**	<1
2813	Manufacture of pumps / compressors	0	0	1	0	**1**	<1
2822	Manufacture of lifting and handling equipment	0	36	1	0	**37**	3
2825	Manufacture of non-domestic cooling and ventilation equipment	0	0	1	0	**1**	<1
3311/3312	Repair of fabricated metal products / machines	2	14	10	2	**28**	2
3313	Repair of electronic and optical equipment	1	4	0	0	**5**	<1
3314	Manufacture of electric motors, generators and transformers	1	7	25	2	**35**	3
3320	Installation of industrial machinery and equipment	5	20	0	0	**25**	2
4312	Electrical installation	1	3	26	10	**40**	3
	Total	**162**	**777**	**258**	**28**	**1,225**	
	Proportion of Total (%)[+]	13	63	21	2		

Source: Miller Research (UK) Ltd.

Notes: [+]Totals do not equal 100% due to rounding.

4.2 Matching Supply and Demand

Table 11 SBTL Labour Requirements Matched against Welsh Business Capacity[54]

SIC	SIC Description	Labour Requirement	Establishments	Employment	Requirement / Employment Quotient
2452	Casting of steel	241	0*	46	524%
2511	Manufacture of fabricated metal products, except machinery and equipment	606	155	3,019	20%
2550	Forging, pressing, stamping and roll-forming of metal; powder metallurgy	130	25	202	64%
2599	Manufacture of other fabricated metal products n.e.c.	50	165	1,871	3%
2611	Manufacture of electronic components	4	30	2,489	0%
2651	Manufacture of non-electronic industrial process control equipment	1	75	4,733	0%
2712	Manufacture of electricity distribution and control apparatus	5	20	679	1%
2731	Manufacture of fibre optic cables	4	5	338	1%
2732	Manufacture of other electronic and electric wires and cables	10	15	1,022	1%
2812	Manufacture of fluid power equipment	1	5	109	1%
2813	Manufacture of pumps / compressors	2	5	86	2%
2822	Manufacture of lifting and handling equipment	37	40	601	6%
2825	Manufacture of non-domestic cooling and ventilation equipment	1	20	615	0%
3311/3312	Repair of fabricated metal products / machines	28	285	2,693	1%
3313	Repair of electronic and optical equipment	5	15	337	1%
3314	Manufacture of electric motors, generators and transformers	35	45	370	9%
3320	Installation of industrial machinery and equipment	25	65	1,249	2%
4321	Electrical installation	40	140	1,146	3%
	Total	**1,225**	**840**	**21,605**	**6%**

Source: Data from various industry sources, ONS. Analysis and Interpretation by Semta and Miller Research (UK) Ltd. Establishments: UK Business Counts – Local Units (IDBR December 2015) data provided by NOMIS. Employments: Number of Employees (BRES December 2014) data provided by NOMIS

Notes:

1. *Coloured cells highlight potential areas of supply issues. Red cells indicate that the level of demand is greater than the current supply of labour. Dark orange cells highlight where demand is greater than 50% of current supply. Light orange cells indicate where demand is approximately one to two tenths of current supply.*
2. ** The number of establishments categorised as casting of steel is zero in Wales, yet the number of people employed is 46 which suggest these people live in Wales but travel to work outside Wales.*

[54] It should be noted that a company operating in a given SIC code does not necessarily indicate that employees have the exact skill set to meet the requirements of the SBTL project. This is the best estimate at the potential pool of labour using existing information, from which the SBTL project could source labour - and is only intended to be identify potential areas of undersupply. i.e. where it is clear that Welsh industries do not have the capacity to meet demand.

Key manufacturing and engineering sectors in Wales of importance to the Tidal Lagoon supply chain include metals, electronics, electrical equipment, mechanical equipment and repair and installation of machinery and equipment. These sectors are fundamental to the power generation and turbine structure work packages of the SBTL project.

Although it is currently not possible to *directly* match the entire demand for labour with the supply available in Welsh businesses[55], it may be informative to review the capabilities of Welsh businesses in the relevant areas of work. Table 11 provides data which offers such insight. It shows the demand for labour by 4-digit SIC set against the number of (business) establishments and total employment for Wales – as a proxy for the size and scale of sectors in Wales, which might have the capability to provide the services required to deliver the manufacture and assembly aspects of the SBTL project.

In total, there are an estimated 840 businesses identified within related sectors within Wales, employing 21,605 people - although these may not match the detailed needs of the project.[56] Table 11 clearly shows that the labour requirement for steel casting (SIC: 2452) is significantly greater than the current employment levels in that sector in Wales. The labour requirement is more than five times greater than the current number of people working in the sector. Therefore, clearly, Welsh employment cannot meet the demand for this element of the project at present.

Similarly, the labour requirement for metal forging, stamping and pressing - estimated at around 130 for the Swansea Bay project, represents 64 per cent of the current number of people employed in the sector (SIC: 2550). There is a risk therefore, that the Welsh labour market will struggle to meet the demand for metal forging – given that such a high proportion of all employment in the sector is required for this project. Once more, the demand for people to manufacture fabricated metal products is around one fifth (20 per cent) of all people currently working in the sector – which is a significant proportion of the workforce required for one project.

Comparing the distribution of employment with the demand for labour generated by the Swansea Bay Tidal Lagoon project (Table 12) shows that there is a possible constraint in terms of skills / technical staff within Welsh manufacturing businesses, in that 48 per cent of employees are at Level 3 or equivalent, whereas, this skill level represents 63 per cent of overall forecast demand for the project.

Thus if skills shortages are to be avoided (or indeed if Welsh businesses are to avoid losing business because of skills gaps) then the current workforce needs to upskill to ensure there is sufficient supply of Level 3 employees.

[55] Because the true supply of labour can only be fully known by surveying the capabilities of the Welsh labour market in direct response to the specific set of skills required by the SBTL project – which is beyond the scope of this study.

[56] It should be noted that this estimate omits a small number of unknown FTEs for the components for which estimates could not be obtained. Thus, the number is likely to be a minimum requirement.

Table 12 Number & Proportion of People Employed in Manufacturing Industries and Occupations Related to the Tidal Lagoon Project in Wales and proportion of SBTL labour demand – by Skill Level

Skill Level	Number of Employees in Wales	Proportion of Employees	SBTL Labour Demand
4	6,890	33%	13%
3	9,928	48%	63%
2	1,967	10%	21%
1	1,806	9%	2%
	20,591	**100%**	**100%[+]**

Source: Data from various industry sources, ONS. Analysis and Interpretation by Semta and Miller Research (UK) Ltd.
Employment: Number of Employees (BRES December 2014) data provided by NOMIS
Skills Level = National Qualifications Framework.
[+]*Totals do not equal 100% due to rounding*

This analysis highlights potential areas where the Welsh labour market might not be able to meet the demand of the project. Moreover, when the potential for other future lagoons around the Welsh coast are considered – which could be significantly larger than the Swansea Bay project, the issue of potential labour shortages in these areas becomes particularly enhanced.

The SBTL project represents a significant opportunity for investment and job creation in Wales. However, this analysis suggests that the labour requirement will be greater than current supply levels for a few key sectors. Work is therefore required to ensure that adequate training and robust skills development strategies are implemented to ensure that Wales maximises the opportunities arising from SBTL and future lagoons. Furthermore, to meet future demand that could arise from not only the Swansea Bay lagoon, but also future lagoons around the Welsh coast, there is a need to start training individuals now, so that they are suitably qualified and experienced to be able to capitalise on the opportunities. For example, the lead in-time for a Level 2, semi-skilled metal fabricator to gain the necessary qualifications to become a job-ready Level 3 skilled technician (at the level where two thirds of the jobs will be required – see discussion below), might take 1 to 2 years[57]. If the SBTL project commences as planned, the Level 3 jobs will be needed within 2 years, therefore current employees need to be undertaking training courses as soon as possible for them to be utilised on the project. Similarly, as employees already working in the industries move along the skills ladder, more new entrants into the industry will be required to fill gaps, therefore, there needs to be an increase in the amount of students graduating from colleges and universities with related qualifications.

In addition to the analysis carried out in this report, there may also be a requirement for further work to assess competing infrastructure projects over the SBTL construction timeline, to ascertain whether bottlenecks in the supply of labour could occur. These

[57] For example, a typical work based learning (WBL) course for an NVQ level 2 or 3 course or equivalent will be around 1 to 2 years depending on the course content. Similarly, a Further Education (FE) course typically takes between 1 to 2 years depending on the mode of study (part time / full-time) and the content of the course etc.

could include projects such as the Hinkley Point and Wylfa B nuclear power stations, Circuit of Wales and the M4 Relief Road around Newport to name a few. In other areas of activity, there should be sufficient supply of labour to meet the needs of the project, subject to:

- Capability constraints: i.e. Do businesses active in the relevant sectors have the specific knowledge and skills to meet the requirements of the project?
- Capacity constraints: i.e. Do capable business have the room on their order books to meet the needs of TLSB?

4.3 Potential Supply Chain

4.3.1 What Can Wales Provide now? And what could it potentially provide?

The demand analysis in Chapter 3 of this report provides an estimation of industry experts' expectations of the elements of the SBTL project that could currently be supplied by Welsh companies.

It also offers views on the potential for Welsh companies to meet the demands in the future, should suitable investment be made to bring the capability into Wales. This information is summarised in Table 13.

Table 13 shows that given the current status quo, companies in Wales could potentially supply around half (52 per cent, equivalent to 623 FTEs) of the FTE labour required to deliver the manufacturing and assembly aspects of the main components of the SBTL project. This could potentially rise to around 91 per cent (1,088) if sufficient investment in the necessary machinery / facilities was made[58]. Of course, this depends on there being the necessary capability of the workforce, a willingness in the supply chain to supply the project and the capacity for companies to do so. Other exogenous factors such as competition from other non-Welsh companies, competing infrastructure project demands among other things will impact on the proportion of the labour requirement. This analysis is simply intended to illustrate Wales' potential, based on the information that was available at the time of writing.

The supplier database of interested companies maintained by TLSB offers an alternative insight into the distribution of potential capacity[59]. The list of companies registering an interest as of October 2015, is shown in Table 14 categorised into SIC divisions. It shows that the largest proportion (45 per cent) are involved in the manufacture of fabricated metal products (except machinery), which is reassuring, given that this SIC represents a potential pinch point. A further 20 per cent are involved in the manufacture of machinery and equipment, while 11 per cent of companies are involved in the manufacture of basic metals and a similar proportion the manufacture of electrical

[58] It should be noted that this labour analysis is not exhaustive. There are some gaps in existing knowledge regarding the amount of labour required for a number of components which will affect this analysis. The quoted figure therefore, is only intended to be used for illustrative purposes and may not reflect the reality.

[59] Please note that the supplier database is a list of companies that have shown an interest in the SBTL project which does not necessarily mean that they have the capability or capacity to meet the demands of the project.

equipment. The industries with the fewest interested companies are the manufacture of computer, electronic and optical products and the repair and installation of machinery and equipment. Notably, there are interested companies for every industry division for which demand is expected, although it is not known whether they have the capability or capacity.

Table 13 Wales Capability to Meet SBTL Opportunities - Present and Potential Future

	Estimated FTEs	Wales Capability (present)		Potential Wales Capability (future)		Gap in Wales' Capability	Notes
C122 Power Generation		%	No.	%	No.		
Turbine Sets							
Draft Tubes	36	75%	27	95%	34	Suitable machine & supply of steel	1, 3
Runners	45	0%	0	100%	45	Suitable machine	4
Runner Blades and Hubs	196	0	0	100%	196	Suitable machine	4
Turbine Housing	51	75%	38	95%	48	Suitable machine & supply of steel	1, 3
Sluice Gates and Stop logs	194	75%	146	95%	184	Suitable machine & supply of steel	5
Bulb Noses and Cones	26	75%	20	95%	25	Suitable machine & manufacture of dished end	3
Shafts	130	0%	0	100%	130	Steel forging	6
Discharge Rings	32	0%	0	100%	32	Suitable machine & supply of steel	1, 3
Distributors	88	0%	0	0%	0	Machining	7
Hydraulic BOPs	25	100%	25	100%	25	None	
Hatch Covers and Frames	20	100%	20	100%	20	None	
Generators	114	100%	114	100%	114	None	8
Pre-assembly	25	100%	25	100%	25	None	
Electrical Systems	153	100%	153	100%	153	None	
Mechanical Systems	42	100%	42	100%	42	None	
C123 Turbine Structure	20	100%	20	100%	20	None	1
C135 Power Plant O&M	28	100%	28	100%	28	None	2
Total (No.)	**1,225**		**657**		**1,122**		
Total (%)	**100%**		**54%**		**92%**		

Source: Miller Research (UK) Ltd.

Notes:

1 Wales could also benefit from the unknown amount of labour associated production of steel plates if it had a steel mill capable of producing the required sheet thickness- which it currently does not.

2 Generally a fixed amount although there will be a small amount of unknown labour associated with unforeseen repairs etc.

3 The cost of this machine is estimated at around £3.5m

4 The cost of a vertical turning centre machine is estimated at around £3.5m

5 Requires suitable beam milling machining estimated at around £3.5m

6 To bring suitable steel forgings sites to Wales would require an investment of around £10m for a press and £10m for a furnace

7 Unknown amount of investment required to bring this capability to Wales

8 Only one component of many have been estimated for the generator. There is an unknown quantity of FTE related to the other components not included in this analysis.

Table 14 Number & Proportion of Companies Registering on SBTL Supplier Database in SIC Divisions Relating to the Manufacturing and Assembly Aspects of the project

SIC Division	Number of Companies	Proportion of Companies
24 - Manufacture of Basic Metals	15	10%
25 - Manufacture of Fabricated Metal Products (except machinery)	66	45%
26 - Manufacture of Computer, Electronic and Optical Products	10	7%
27 - Manufacture of Electrical Equipment	17	11%
28 - Manufacture of Machinery & Equipment	29	20%
33 - Repair and Installation of Machinery & Equipment	11	7%
	148	**100%**

Source: Data from Swansea Bay Tidal Lagoon, Analysis and Interpretation by Miller Research.

The distribution of interested companies is shown in Table 15. It shows that the slight majority (52 per cent) were located outside of Wales (elsewhere in the UK), but 24 per cent had a presence in Swansea. Considering the distribution by SIC division, there are a similar number of Welsh companies in SIC divisions 25 (manufacture of fabricated metal products) and 28 (manufacture of machinery & equipment) as there are companies from elsewhere in the UK – which might suggest that Welsh companies will compete well for work packages in these industry divisions. Notably, in SIC division 33 (repair and installation of machinery & equipment), there are more interested companies in Wales than there are outside. This might suggest that Welsh companies will be competitive for work packages in this area – although it should be noted that having a larger number of companies does not necessary infer better competition.

Table 15 Location of Interested Supply Chain Companies by SIC Division

	SIC Division						Total	
Region	**24**	**25**	**26**	**27**	**28**	**33**	**No.**	**%**
Elsewhere in the UK	8	32	6	14	14	3	**77**	**52%**
Swansea	5	13	3	2	7	5	**35**	**24%**
Elsewhere in Wales	1	13	0	0	4	2	**21**	**14%**
Neath Port Talbot	0	4	0	0	1	0	**5**	**6%**
Cardiff	0	0	0	1	0	1	**2**	**3%**
Other	1	4	1	0	3	0	**9**	**1%**
Total	**15**	**66**	**10**	**17**	**29**	**11**	**148**	
Proportion Outside Wales	53%	48%	60%	82%	48%	27%	**52%**	
Proportion in Wales	40%	45%	30%	18%	41%	73%	**43%**	

Source: Data from Swansea Bay Tidal Lagoon, Analysis and Interpretation by Miller Research. October 2015

Note: Totals add up to 95% - 5% were unknown.

5 Key Findings

SBTL is the pathfinder for a potential new global industry that will be born in Swansea Bay and bred in the UK. Wales is ideally placed to capitalise on this £1.3 billion investment and the jobs that it will create. However, work needs to begin now to prepare the supply chain and future recruits for the opportunities that will arise from this new 'green' industry.

SBTL is potentially the first in a series of potential tidal lagoons around the Welsh coast. In essence, it is a relatively small scale project that will pave the way for future, much larger lagoons around the Welsh coast. As the world's first man made tidal lagoon it provides the unique opportunity for the Welsh economy to construct an entire industry that could supply not only other lagoons around the Welsh coast but also the rest of the UK and around the world. It provides the opportunity for Wales to develop a tidal lagoon supply chain and to establish Wales as a globally recognised centre of tidal lagoon excellence.

It is important to re-iterate that the analysis in this report applies only to the manufacturing and assembly of major component parts, and power plant operations and maintenance labour requirements. No allowance has been made for construction as this is the subject of a separate report[60].

The demand for labour of the manufacturing and assembly related activities of the main components for the SBTL project are significant. Over a 5-year build period, an estimated 1,197 full time equivalent (FTE) jobs will be supported, with the main manufacturing taking place during a 30-month timeframe. Beyond the build period, a further 28 FTEs are expected to be supported annually, for the duration of its operation (minimum of 120 years). In total therefore, a conservative estimate[61] of the total number of FTEs supported by the manufacturing and assembly elements of this pilot project is around 1,225 people. To put the scale of the potential size of the supply chain in Wales into context, SBTL is a relatively small scale project with 16 turbines whilst there are already another three sites around the Welsh coast with the potential for tidal lagoons, with an average number of turbines at each lagoon estimated at around 70 turbines. Clearly, the SBTL is an important catalyst for creating a tidal lagoon industry in Wales – with the potential to support thousands of jobs for many years.

At present, Welsh companies have the capability to provide the labour required for most aspects of the project. However, there are areas that will require investment and upskilling if the opportunity is to stay within Wales. For example, there are no companies in Wales that have the capability to manufacture/fabricate large steel castings, yet a significant amount of labour is required to produce steel casted components for this project. The runner blades and hubs will support around 196 FTEs for between 12-18months. Similarly, the manufacture of the shafts (forged steel) will support 130 FTEs. At present there are no facilities in Wales to manufacture these components – a strategy is therefore required to ensure that Wales can develop in

[60] There will also be other elements of the project that will generate a demand for labour. This report, and the other construction report consider only the major project components / activities.

[61] There are gaps in the estimates for some of the main components, noted in the report, which primarily relate to the manufacture of the generator with a few smaller gaps elsewhere.

these areas. Clearly therefore, the SBTL has the potential to be a catalyst for establishing a manufacturing site in Wales. Should such investments be made in Wales then the challenge will be to ensure the local workforce is upskilled to meet the demand as in the short-term, labour will be brought in from elsewhere to meet demand.

Investment will be essential. With the correct machinery, aspects of the manufacturing can be handled in Wales and this will further support job creation. Furthermore, the development of a fleet of lagoons in Wales will most certainly lead to further job creation and a new export industry. Specific areas for development include sluice gate, stop logs, bulb noses, cones, shafts and distributor manufacture and assembly.

Much of the labour demand (49 per cent) is for the fabrication of metal – and Wales has a strong history of manufacturing metal products, yet there are still gaps in the Welsh labour force's capabilities to meet the demands of SBTL. That being said, it appears that there is sufficient interest amongst Welsh companies to meet the metal fabricating demands of the project – especially considering the tidal lagoon potential around Wales beyond the SBTL. As a nation, Wales must now make sure that capacity matches capability to take advantage of this opportunity. Of course, this depends largely on the current workload and commitment of such companies as well as the extent to which other large manufacturing projects in the area compete for this labour – for example, Hinkley and HS2.

Furthermore, the evidence suggests that Wales' labour force needs upskill to meet the demand for the SBTL and new entrants need to be encouraged by aligning further and higher education provision to the requirements of the SBTL project. There is clearly a need for Wales to ensure that adequate training and robust skills development strategies are implemented, to ensure that Wales maximises the opportunities arising from Swansea Bay Tidal Lagoon and future lagoons.

Appendix 1 – Research Scope: Definition of Manufacturing & Assembly Work Packages

Work Package	Detail	Additional Detail	Industry Description	Research Definition
C122 Power Generation	Preliminaries and Design	NM	NM	NM[62]
	Turbine Sets	Manufacture of Turbines	Turbine Manufacture	M&A[63]
			Steel Casting	M&A
			Manufacture of structural metal products	M&A
			Large forgings	M&A
			Welding / Profiling / Cutting / Precision Engineering	M&A
			Metal Treatment / Coating	M&A
			Manufacture of tubes	M&A
			Accumulators, tanks, heat sink	M&A
			Manufacture of wires / stud tensioners etc.	M&A
			Electric Motor Manufacture	M&A
			Manufacture of Key Interlocks / Relays	M&A
			Manufacture of Valves	M&A
			Manufacture of Bearings	M&A
		Installation of turbines	Pre-Assembly / Machining in TMP of Turbine parts	M&A
			Turbine housing &Draft Tube Installation	NM
			Turbine And Generator Installation And Alignment In Pit	NM
			Support For Dry And Wet Commissioning	NM
	Electrical Systems		Balance Of Plant Installation - Electrical/Cabling	M&A
			Cabling and cable containment systems	M&A
			Electronic Components	M&A
			Electronic Board manufacture	M&A
			Control room equipment	M&A
			Engineering computer systems	M&A
			Wiring - fibre optic	M&A
			Wiring	M&A
			Wiring devices	M&A
			Electric Lighting Manufacture	M&A
			Electrical equipment repair	M&A
			Generator and unit transformers	M&A
			MV/LV switchgear, electrical/I&C Control and distribution panels	M&A

[62] Non-Manufacturing
[63] Manufacturing & Assembly

	Mechanical Systems		Core component handling equipment	M&A
			Process Control Equipment	M&A
			Fluid Power Equipment	M&A
			Manufacture of Pumps	M&A
			Raw water treatment package	M&A
			Sensors and detectors	M&A
			Metal products - repair	M&A
			Machinery repair	M&A
			Non-metal / electrical equipment repair	M&A
	Miscellaneous Costs	NM	NM	NM
	Spares	NM	NM	NM
	Planning	NM	NM	NM
C131 Marine Works	Preliminaries and Design	NM	NM	NM
	Mobilisation/Demobilisation	NM	NM	NM
	Permanent Bund	NM	NM	NM
	Temporary Bund	NM	NM	NM
	Landfall Construction	NM	NM	NM
	Worksite Preparation	NM	NM	NM
	Miscellaneous Marine Works	NM	NM	NM
	Sewer Outfall	NM	NM	NM
	Public Realm Works	NM	NM	NM
C132 Turbine Structure	Planning	NM	NM	NM
	Preliminaries and Design	NM	NM	NM
	Sheet Piling		Steel Casting	M&A
			Manufacture of structural metal products	M&A
			Large forgings	M&A
			Welding / Profiling / Cutting / Precision Engineering	M&A
			Metal Treatment / Coating	M&A
	Turbine Housing Blocks	NM	NM	NM
	Dividing Structure		Manufacture of structural metal products	M&A
			Metal Treatment / Coating	M&A
			Metal products - repair	M&A
	Sluice Structure		Steel Casting	M&A
			Manufacture of structural metal products	M&A
			Large forgings	M&A
			Welding / Profiling / Cutting / Precision Engineering	M&A
			Metal Treatment / Coating	M&A
	Wing Walls		Manufacture of structural metal products	M&A

			Metal Treatment / Coating	M&A
			Metal products - repair	M&A
	Scour Protection	NM	NM	NM
	Planning	NM	NM	NM
C133 Ancillary Civils	Preliminaries and Design	NM	NM	NM
	Marina Works	NM	NM	NM
	Highways and Parking	NM	NM	NM
	Exterior Lighting	NM	NM	NM
	Landscaping	NM	NM	NM
	Services	NM	NM	NM
	Miscellaneous Works	NM	NM	NM
	Planning	NM	NM	NM
C134 Buildings	Boating Centre	NM	NM	NM
	Off Shore Visitor Centre	NM	NM	NM
	Visitor Centre Viewing Platform	NM	NM	NM
	Tourist Infrastructure	NM	NM	NM
	Building Services	NM	NM	NM
	Planning	NM	NM	NM
C135 Power Plant O&M	Management and Administration			NM
	Operations		24/7 operations and despatch	NM
	Maintenance		Power generation equipment and systems, including:	M&A
	Other services		Building services equipment and systems, including:	NM
			Outsourced / Subcontracted	M&A
C150 Lagoon Maintenance	TBC	TBC	NM	NM
C151 Infrastructure Maintenance	TBC	TBC	NM	NM
C152 Facilities Management	TBC	TBC	NM	NM

Appendix 2 – Labour Demand by Work Package

Work Package 1	Work Package 1 (a)	Additional Detail	Components / Activity	Sub-components / Activity	Total Labour
C122 Power Generation	Turbine Sets	Manufacture of Generating Plant, Sluice Gates and Stoplogs	Draft Tubes	n/a	36
			Turbine Housing	n/a	51
			Sluice Gate & Turbine Stoplogs	n/a	194
			Bulb Nose & Cone	n/a	26
			Hatch Cover & Frame	n/a	20
			Distributor	n/a	88
			Runner Blades & Hub	n/a	196
			Runner	n/a	45
			Shaft	n/a	130
			Discharge Ring	n/a	32
			Generator	Terminal Box	34
				Rotor Bars	
				Rotor laminations	
				Stator laminations	
				Stator copper	
				Stator Frame	
				Stator end plate	
				CACW heat exchangers	
				Rotor end rings	
				Rotor pressure plates	
				Stator compression plates	
				Rotor spider	80
			Hydraulic BOP		25
		Installation of	Pre-Assembly / Machining in TMP of Turbine parts	n/a	25

		Generating Plant, Sluice Gates and Stoplogs	Turbine housing & Draft Tube Installation	n/a	not in scope
			Turbine and Generator Installation and Alignment In Pit	n/a	not in scope
			Installation of Sluice Gates and Associated M&E Plant		not in scope
			Installation of Sluice Gate Stoplogs		not in scope
			Installation of Turbine Stoplogs		not in scope
			Support For Dry And Wet Commissioning	n/a	not in scope
	Electrical Systems		Balance Of Plant Installation - Electrical/Cabling	n/a	40
			Cabling and cable containment systems	n/a	50
			Electonic Components	n/a	4
			Engineering computer systems	n/a	5
			Wiring - fibre optic	n/a	4
			Wiring	n/a	10
			Electrical equipment repair	n/a	5
			Generator and unit transformers	n/a	10
			MV/LV switchgear, electrical/I&C Control and distribution panels	n/a	25
			Core component handling equipment	n/a	1
			Process Control Equipment	n/a	1
			Fluid Power Equipment	n/a	1
	Mechanical Systems		Manufactur of Pumps	n/a	1
			Raw water treatment package	n/a	1
			2x Powerhouse Cranes		12
			2x turbine stoplog cranes		12
			2x sluice gte stoplog cranes		12
			Sensors and detectors	n/a	1
C132 Turbine	Sheet Piling / Dividing Structure / Sluice		Manufacture of structural metal products	n/a	20

Structure	Structure / Wing Walls				
C133 Ancillary Civils	Exterior Lighting		TBC	n/a	n/a
C135 Power Plant O&M	Management and Administration		TBC	n/a	8
	Operations		TBC	n/a	12
	Maintenance		TBC	n/a	8

Appendix 3 – Regulated Qualifications and Skills Levels

Regulated qualifications in England, Wales and Northern Ireland – Regulated Qualifications Framework (RQF) and Framework for Higher Education Qualifications (FHEQ). Taken from https://www.gov.uk/what-different-qualification-levels-mean/compare-different-qualification-levels.

Level	RQF examples	FHEQ examples
Entry	- Entry level certificate - Entry level Skills for Life - Entry level award, certificate and diploma - Entry level Functional Skills - Entry level Foundation Learning	
1	- GCSE (grades D-G) - Key Skills level 1 - NVQ level 1 - Skills for Life level 1 - Foundation diploma - BTEC award, certificate and diploma level 1 - Foundation Learning level 1 - Functional Skills level 1 - Cambridge National level 1	
2	- GCSE (grades A*-C) - Key Skills level 2 - NVQ level 2 - Skills for Life level 2 - Higher diploma - BTEC award, certificate and diploma level 2 - Functional Skills level 2 - Cambridge National level 2 - Cambridge Technical level 2	
3	- AS and A level - Advanced Extension Award - Cambridge International award - International Baccalaureate - Key Skills level 3	

	- NVQ level 3 - Advanced diploma - Progression diploma - BTEC award, certificate and diploma level 3 - BTEC National - Cambridge Technical level 3	
4	- HNC - Certificate of higher education - Key Skills level 4 - NVQ level 4 - BTEC Professional award, certificate and diploma level 4	- Certificate of higher education - HNC
5	- HND - NVQ level 4 - Higher diploma - BTEC Professional award, certificate and diploma level 5	- Diploma of higher education - Diploma of further education - Foundation degree - HND
6	- NVQ level 4 - BTEC Advanced Professional award, certificate and diploma level 6	- Bachelor's degree - Graduate certificate - Graduate diploma
7	- BTEC Advanced Professional award, certificate and diploma level 7 - Fellowship and fellowship diploma - Postgraduate certificate - Postgraduate diploma - NVQ level 5 - BTEC Advanced Professional award, certificate and diploma level 7	- Master's degree - Postgraduate certificate - Postgraduate diploma
8	- NVQs level 5 - Vocational qualifications level 8	- Doctorate