TIDAL LAGOON POWER

OURS TO OWN

From first mover to mass manufacture

Building a new British industry from our natural advantage

OCTOBER 2016

Cover image
Courtesy of Andritz Hydro

Contents

Welcome

We have a power deficit in this country. We have a need to decarbonise our electricity sources. Addressing the deficit and delivering on carbon emissions reductions entails the transformation of the entire energy market. This is non-negotiable and it's happening right now. The way it happens can have a profound impact upon the fortunes of UK industry and, by extension, the national economy.

This paper looks at the industrial opportunities arising from a programme of tidal lagoon power plants which will provide a home-grown transformation of the energy market and address the power deficit.[1]

The coast around our island nation experiences some of the highest tides in the world. A large number of areas on the western coast also have a shallow sloping seabed, ideal for the development of tidal lagoon infrastructure. This centres on two principal zones: the hyper-tidal range of the Severn Estuary, up to 14m on a spring tide and averaging over 9m, and the more globally typical tidal ranges of Liverpool Bay & the Irish Sea, up to 10m on a spring tide and averaging ~6m, encompassing sites in North Wales and Merseyside to the south and Lancashire and Cumbria to the north.

There are at least nine different sites of considerable interest within these two zones. Under a conservative appraisal of engineering constraints, power generation potential and commercial viability, the development of tidal lagoon power plants in these two zones can deliver an estimated 25,000MW of new electricity generation capacity. This is approximately 12% of the UK's annual electricity demand for over a century. Further opportunity may exist elsewhere in UK waters.

By employing British industry and British money to harness Great Britain's natural resource, we will start to address our energy problems and at the same time give birth to a new phase of national industrial success. What's more, a positive domestic roll-out strategy can act as springboard for UK industry in a number of promising new markets overseas.

It truly is ours to own.

Mark Shorrock
Chief Executive,
Tidal Lagoon Power

Power Deficit in Numbers

85GW
INSTALLED CAPACITY

20GW
ELECTRIFICATION DEMAND
(TRANSPORT, HEAT, ETC.)

+

38GW
GOING OFFLINE
(COAL ETC.)

=

58GW
TOTAL NEW CAPACITY NEEDED

−

18GW
CONSENTED CAPACITY
(NUCLEAR, TIDAL, WIND, ETC.)

−

8GW
INTERCONNECTORS
(NOT YET CONSENTED)

=

32GW
THE POWER DEFICIT

For an assessment of the implications of a tidal lagoon programme for UK energy bills and the efficient operation of the national electricity grid, read our recent study, **The New Power Cost League Table**, available at **tidallagoonpower.com**

The study finds that the UK's first tidal lagoon power plant at full scale would generate the lowest cost electricity of all new UK power stations.

Further studies, currently underway, are looking at how tidal lagoon generation interacts with the operation of the UK electricity system, and the degree to which large amounts of tidal lagoon power on the system can pull down baseload electricity prices and Capacity Market prices, reducing energy bills for UK businesses and consumers.

Mike Edge
Analyst, Tidal Lagoon Power

Footnote
1. You can watch our supply chain film at **www.tidallagoonpower.com**


TEAM ORIENDA

Images above and right
Courtesy of Andritz Hydro

Foreword

As the UK Managing Director of a global manufacturing company based in Wales and supplying the automotive sector, I know that the UK manufacturing and industrial base has the capability to meet far more of this nation's industrial needs and can win in the global marketplace as well.

I have also witnessed the sad demise of many proud Welsh and British industrial businesses unable to sustain an order book in ever-tightening market conditions. With many of our core industries and supply chains in need of support, it certainly feels like we've reached a cross-roads. **Do we throw in the towel or do we embrace change to renew and rebuild the traditional sectors that once powered our national economy?** Since 2014, the independent Tidal Lagoon Industry Advisory Group has pushed for the latter.

The Group is more certain than ever that in the emerging tidal lagoon sector, the country has a game-changer on its hands: one of a new generation of industrial opportunities that can revive British manufacturing while stimulating immense industrial growth (and tax revenues) in its own right.

It is a textbook case:

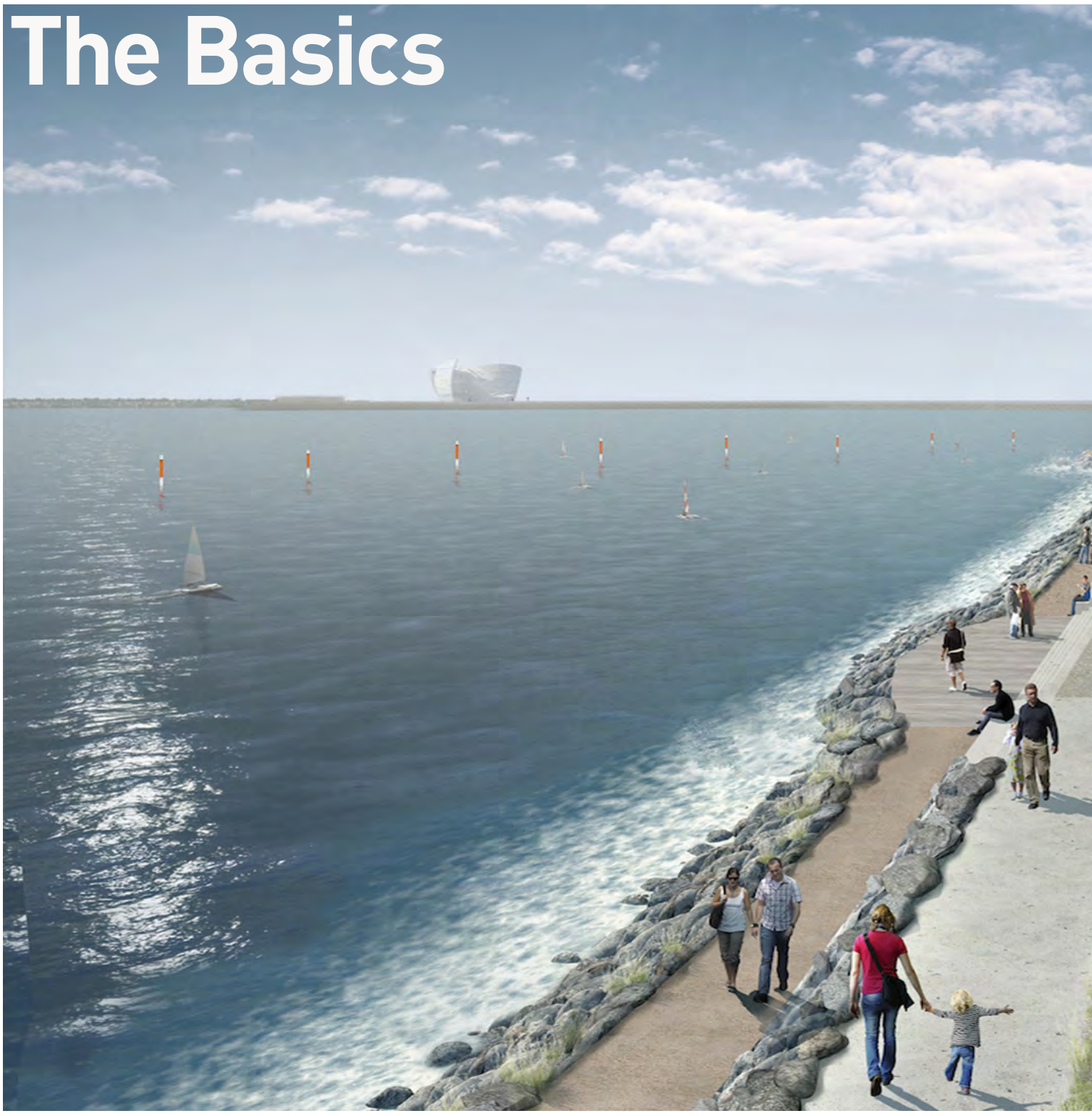
- We have the natural resource on our coastline;
- We need new sources of low carbon power;
- We have a rich industrial heritage which has bequeathed us the skills and capabilities to take on the challenge for ourselves;
- In Wales, as elsewhere, our traditional industries are in decline. We need a reboot;
- Geography dictates that many of the high tidal range regions and industrial heartland areas that stand to benefit from tidal lagoons are those, like Wales, that need it most;
- The core technology has been proven elsewhere, giving the confidence to hit scale almost immediately;
- There is a huge domestic market to warrant that scale;
- Which creates the ideal conditions for standardisation and mass manufacture;
- Which, if achieved quickly and efficiently, gives the UK a competitive edge in a new global market with significant potential.

We've been here before of course. But despite having installed around half of the world's offshore wind turbines in British waters, with many more onshore wind installations, we have failed to nurture a wind industry that is Made in Britain. By acting on the tidal lagoon industrial opportunity now, we can ensure that history does not repeat itself.

As this paper sets out, if we get it right, the country wins with low cost, reliable, clean power and the emergence of a new global industry here in the UK. And we in UK manufacturing are ready to deliver this new supply chain.

Roger Evans MBE
Chair, the independent Tidal Lagoon Industry Advisory Group

The Basics



“There is such a compelling logic here: we have the resource, we have the skills, we have the right market conditions and we have the advantage. When did Wales last see an opportunity like this?”

Nick Revell
Managing Director, Ledwood Mechanical Engineering

The Basics

What is Swansea Bay Tidal Lagoon?

Swansea Bay Tidal Lagoon is a consented, world-first marine hydro power station. It will generate electricity from the natural rise and fall of the tides, which in Swansea Bay reach up to 10m. By capturing a large volume of water behind a man-made 9.5km long seawall that is connected to the shore and designed to fit its local environment, a difference in height ('head difference') develops between the water level inside the lagoon and the sea outside. Head difference is created on both the incoming and outgoing tides, four times daily.

When the optimum head difference is reached, the captured water is released, either filling or emptying the lagoon to drive 16 bi-directional hydro turbines installed in powerhouses within the seawall and thereby generating electricity.

Power output is zero carbon, flexible, year round and entirely predictable. The project will generate electricity sufficient for 155,000 homes. Near-baseload, 24 hour power generation can be achieved across a fleet of geographically dispersed projects.

This form of privately-funded marine hydroelectricity is built to last for 120 years or more, at least double the lifespan of any other new power station. Tidal lagoons can be deployed in short, certain timeframes using standard construction techniques and well proven technology.

What is the industrial opportunity?

Swansea Bay Tidal Lagoon has been brought forward as a pathfinder project for UK and international tidal lagoons at full-scale.

It has given the UK's engineering, construction, steel and manufacturing industries first mover advantage in a new global market.

Tidal lagoons are multi-billion pound infrastructure investments. Capital expenditure is typically split four ways:

- ~36% turbines and generators – including turbines, generators, sluices, electricals and other power generation costs;
- ~38% turbine housings – including turbine housings, sluice housings and other civil engineering costs;
- ~18% marine works[2] – including seawall; and
- ~8% other – including design and services.

The UK has the skills, capabilities and track record to foster growth in each of the four areas.

Our starting ambition has been to ensure that a total of 65% of capital spend for the pathfinder project is on UK content, with half of project spend staying within Wales itself. By readying the UK supply chain and committing to new UK manufacturing facilities, we are on track to fulfil this goal.

The oft-cited benchmark here is the North Sea oil and gas industry where around 70% of capital expenditure is through UK-based suppliers. Getting close to, or possibly matching, that level on a global first-of-kind tidal lagoon will deliver a far higher level of UK content than comparative low carbon energy projects, writing Welsh and British industry into the DNA of this new market from the outset.

The challenge for both industry and Government is to create the market conditions required to sustain and grow this industrial opportunity as the sector scales.

2. The relatively higher seawall to power output ratio at the smaller pathfinder project will see a higher proportion of capital spend on marine works at Swansea Bay.

The Basics

A UK programme

A UK programme of tidal lagoons at full-scale will focus on the two areas with ideal conditions for tidal lagoon infrastructure: the Severn Estuary and Liverpool Bay & the Irish Sea. The hyper-tidal ranges of the Severn Estuary reach up to 14m on a spring tide. The high tidal ranges of Liverpool Bay & the Irish Sea reach up to 10m on a spring tide.

Development of tidal lagoons in these two zones presents the opportunity to scale-up vastly the UK supply chain for the mass manufacture of turbine, generator and turbine housing components. With UK manufacturers selling to both the domestic market and to emerging markets worldwide.

We have already scoped five full-scale UK projects and are actively progressing planning on the most advanced of these, **an £8bn project between Cardiff and Newport planned at equal capacity to Hinkley Point C**. It will generate the lowest cost electricity of all new power stations and can be online in the mid-2020's.

The five scoped projects as a fleet can secure 8% of UK electricity, or power for 30% of UK homes.

The potential domestic market for tidal lagoons is bigger still. A total of nine viable sites have been identified within the Severn Estuary and Liverpool Bay & Irish Sea deployment zones alone. Built out in full, these projects would secure an estimated 25,000MW of new electricity generation capacity, or approximately 12% of the UK's annual electricity demand, for over a century.

The build-out of a fleet of five tidal lagoons to follow the pathfinder project would release over £40bn of private capital. The build-out of a full fleet of nine tidal lagoons after Swansea Bay would see that figure rise to over £65bn.

The scale of the industrial opportunity associated with this level of infrastructure investment in a virgin global market is unprecedented.

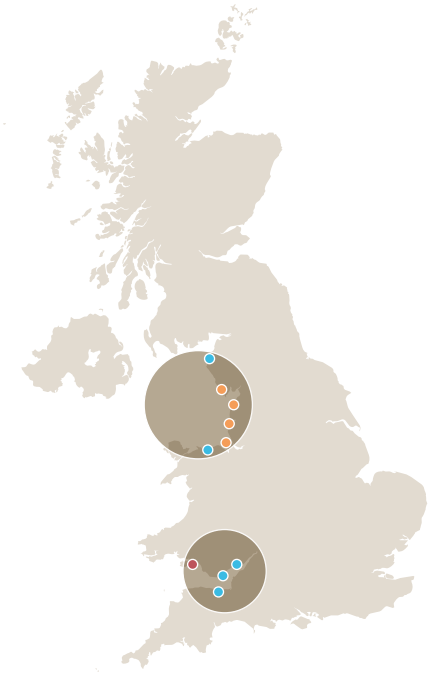


Fig 01
- Tidal lagoon deployment zones
- Tidal Lagoon Power development work already underway
- Additional viable tidal lagoon sites
- Pathfinder project

Our programme has a reverence for nature at its core and we place a strong emphasis on maintaining a high quality functioning environment. This is put into practice through investment in thorough Environmental Impact Assessment (EIA) for all proposed lagoons, as well as adherence to the principles and application of the Habitats Regulations through Habitats Regulations Assessment and the Water Framework Directive through WFD compliance assessment.

We have invested in a detailed Evidence Plan process for the first scale project at Cardiff, involving comprehensive engagement with the statutory nature conservation bodies and environmental non-governmental organisations. This approach will be applied across the roll-out. While through the Ecosystems Enhancement Programme, we are investing in a long-term, dedicated nature conservation initiative that will enhance biodiversity alongside the generation of clean energy.

You can find out more at **tidallagoonpower.com/home/environment**

Tim Carter
Head of Environment, Tidal Lagoon Power

The Industrial Opportunity

Image
Courtesy of Andritz Hydro

The steel industry has had a downturn at almost the same time as the oil and gas industry. We desperately need to identify new markets and we must do so quickly. We cannot keep sending high value manufacturing jobs to China and to Germany and to France.

Bill Clark
CEO, DavyMarkham

Heart of the industrial opportunity: The mass manufacture of 'Made in Britain' tidal lagoon turbines

The large quantity of turbines and generators designed specifically for use in tidal lagoon projects are at the centre of our vision to connect Welsh tides with Manufacturing Britain.

The manufacture and assembly of components for the turbines and generators falls into four broad categories: fabricated metals, steel casting, forging and electrical & power electronics. In their recent report to Welsh Government, Miller Research and Semta estimate that the pathfinder project at Swansea Bay will support 1,197 direct FTE jobs across these categories.[3]

The report goes on to establish that Wales alone has the present capability to provide 54% of the manufacturing and assembly of the main components required for the turbines, generators and sluices at Swansea Bay. It notes the potential to increase this figure to as high as 92% in the future.

Approximately 65% of the capital expenditure on turbines and generators for the pathfinder project at Swansea Bay will be on UK content, with UK manufacturers large and small in line to win restorative supply contracts.

The turbines will be manufactured by Andritz Hydro from a majority of British components. **Machining and pre-assembly of the turbines will take place at the Turbine Manufacturing Plant, a new purpose-built facility in the Swansea Bay City Region.**

Furthermore, heavy fabrication of steel components will take place at a new purpose-built facility, also in the Swansea Bay City Region. Both facilities will be future proofed for exponential market growth. Final full assembly of the turbines will take place on site in the turbine housing itself.

The turbines' control systems and generators, which connect to the turbines and generate renewable electricity, will be manufactured in Rugby by GE Power Conversion, also from a majority of British-made parts. GE's Stafford facility will provide HV switchgear and control/protection systems.

Footnote
3. A second report to Welsh Government, by CITB and Whole Life Consultants, finds a further 1035 direct FTE jobs will be sustained through construction and engineering work at Swansea Bay.

The Industrial Opportunity

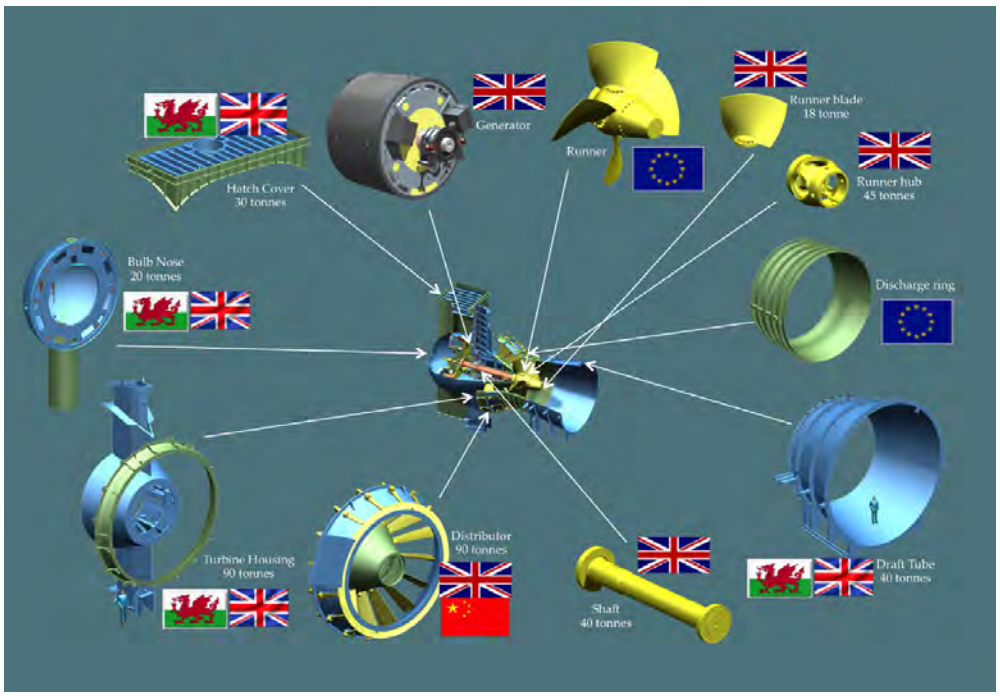


Fig 02a
Turbine components and their anticipated country of origin

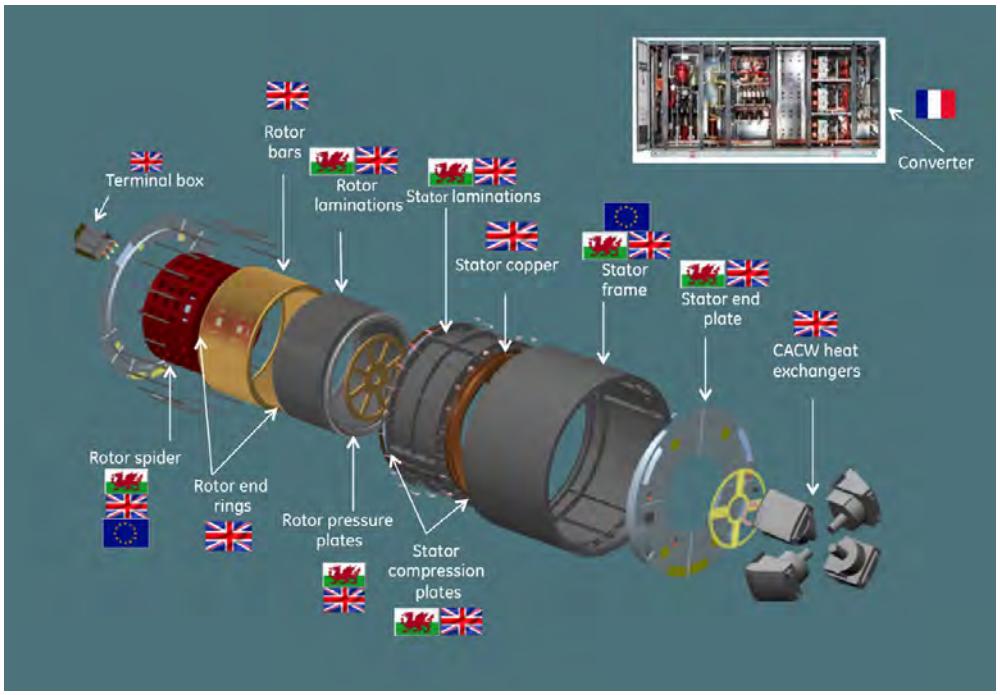


Fig 02b
Generator components and their anticipated country of origin

> *Being part of the Tidal Lagoon project would be an important win for this business. The prospect of working on a new power generation concept is an exciting one and is inspiring to our team. The possibilities for this concept, which could play a huge part in addressing the global power deficit, are vast. For such a project to be delivered through British designs and implementation would also be a great boost to the UK economy.*

Graham Honeyman
CEO, Sheffield Forgemasters

Revitalising a mature technology for a new growth market

The turbine selected for the pathfinder tidal lagoon at Swansea Bay is a bi-directional, low head, Kaplan bulb hydro turbine.

Bulb turbines are a mature and proven technology used in hundreds of conventional hydro projects worldwide. They are commonly used in run-of-river hydro projects which experience a low head range and varying flow conditions. Andritz Hydro, the turbine manufacturer for the pathfinder project, has supplied more than 500 units worldwide with an installed capacity of 10GW. Each set of units for each of the projects has to date been produced on a bespoke basis.

Typically, turbines for large hydro power stations are bespoke to a particular project and engineered to fit site flow conditions and geometry. This means they are usually manufactured in a relatively small number of units and are not able to benefit from the cost reductions and efficiencies associated with mass manufacture.

Because tidal lagoon sites will not experience the same location-specific constraints as conventional hydro schemes, where submergence depth, and the width and length of the hydraulic passage vary greatly between projects, the hydro turbine manufacturing industry has been able to plan a move from short, bespoke manufacturing runs to the serial mass manufacture of a standardised technology for tidal lagoons.

Development of the pathfinder tidal lagoon at Swansea Bay has produced a state-of-the-art and highly flexible bulb turbine design for use at tidal lagoon sites across the UK and worldwide which lends itself to standardisation and mass manufacture at new, purpose-built facilities.

Project development at Swansea Bay has been steered by the most in-depth engagement of the world's leading hydro turbine manufacturers in a tidal range market opportunity for many decades.

This work has involved the innovation and modernisation of established and proven turbine technology, resulting in higher plant efficiencies, higher energy yields and maximum energy outputs.

The maximum theoretical potential energy that can be captured by a tidal range power station over a year is termed the 'E-max'. Typically, proposals for a Severn Barrage and the existing tidal barrage projects employing bulb turbines worldwide extract approximately 20% of the E-max.

Through close engagement with manufacturers, extensive turbine R&D, and development of Tidal Lagoon Power's highly sophisticated energy modelling capability, we are now able to extract close to 60% E-max with state-of-the-art tidal lagoon bulb turbines.

Our turbine design has also increased greatly the flexibility of output. As well as delivering very high efficiencies across a broad head range in both directions, the integration of variable speed generator technology in bulb hydro turbines for the first time ever can be leveraged to help tidal lagoon projects integrate with local ecosystems and ever-evolving grid demands. This in-built operational flexibility allows the same technology to be more adaptive to a wider range of site conditions.

If the UK can harness its abundant natural resource and emerging tidal lagoon deployment plan to quickly achieve mass manufacture of 'Made in Britain' marine hydro turbine technology, as the Danes did with wind, it will secure a considerable competitive edge over new market entrants from day one. This will underwrite a strong domestic order book and the real prospect of major future technology export markets.

Scaling up

The UK tidal lagoon industry can be certain in its ability to reduce costs immediately by simply moving to bigger sites with similar or higher tidal range to the pathfinder at Swansea Bay. It does not rely on an assumption of technology learning over time.

Economies of scale apply: large scale lagoons generate cheaper power than small scale lagoons by passing far greater volumes of water through their turbines. Tidal Lagoon Power has shown that the larger lagoons to follow Swansea Bay can be immediately cost competitive with all other forms of low carbon power – but last many times longer.

That is not to say that the tidal lagoon sector will not witness significant additional learning-derived savings. Across its portfolio of larger development projects, Tidal Lagoon Power and its partners forecast initial capital cost reductions of around 10%, scaling to as high as 18% for later projects. Pathways to achieve these reductions have been mapped across a number of areas, including measures to shorten build time, increase supply chain efficiencies and increase funding efficiencies.

For the turbines and generators, General Electric and Andritz Hydro estimate that the move from the smaller production run of sixteen 20MW turbines and generators at Swansea to the manufacture of around one hundred turbines at a 30% higher power rating for the Cardiff project could deliver at least a 20% reduction in turbine and generator cost.

These cost efficiencies, together with the requirement for UK manufacturers and suppliers to invest in the expansion of their facilities and workforce in order to fulfil the much larger orders associated with tidal lagoon projects at full scale, are expected to more than compensate for any initial 'British premium' associated with sourcing turbine and generator components for the pathfinder project locally rather than, for instance, from China.

By scaling the 7.2 metre runner diameter tidal lagoon turbine design prepared for Swansea Bay pathfinder project, Tidal Lagoon Power and its partners envision the tidal lagoon industry standardising production around an 8 metre runner diameter turbine available at two power ratings.

We are segmenting the UK and international market into hyper-tidal range sites and high tidal range sites. A 25MW capacity turbine will be used for the high tidal range conditions in the Liverpool Bay and Irish Sea deployment zone and international markets such as Mexico, China and parts of France, India and Korea. A 30MW capacity turbine will be used for the hyper-tidal range conditions in the Severn Estuary deployment zone and international markets such as Canada and parts of France, India and Korea.

Fig 03a
Tidal lagoon bulb turbine

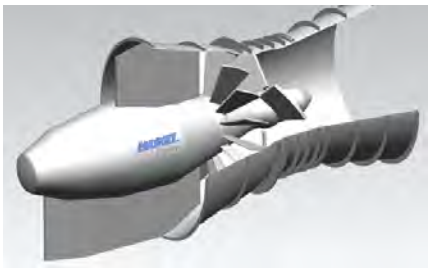
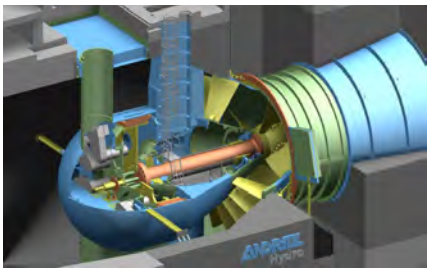


Fig 03b
Conventional bulb turbine



> *In under a decade, we could be fuelling the manufacture of British-made GREENSTEEL with clean power from British-made tidal lagoon turbines, helping to regrow UK industry and creating tens of thousands of jobs.*
>
> **Sanjeev Gupta**
> Executive Chairman, Liberty

Value of the potential domestic market for turbines and generators

As set out above, the UK's natural resource and coastal conditions offer a significant potential domestic market for tidal lagoon turbines and generators. The value of this market is estimated in the table right.

If industry and Government are able to work together to build upon the first-mover advantage currently held by UK industry, 75% of this market value will be realised by UK companies.

	Installed capacity	Estimated number of turbines and generators requiredd	Estimated expenditure on turbines and generators
Swansea Bay	320MW	16	£360m
Cardiff	3,240MW	108	£2.9bn
TLP fleet of 5 projects, plus pathfinder	16,000MW	604	£15.2bn
UK market of 9 projects, plus pathfinder	25,000MW	940	£23.0bn (75% = £17bn)

Turbine housings

The other main driver of value for UK industry are the turbine and sluice housings. 100% of capital expenditure in this area at Swansea Bay will be on UK content.

The most effective way to stimulate new supply chain hubs, lean manufacturing and increased quality is through the offsite manufacture of large concrete parts. This can be achieved through Design for Manufacture & Assembly ('DfMA'), through use of caissons, or both.

Design for Manufacture & Assembly

The sixteen turbines deployed at Swansea Bay will be housed in a 400m long concrete and steel housing structure. Rather than constructing the turbine housing in-situ offshore, the more efficient use of precasting, or 'DfMA', techniques will enable the modular construction of concrete turbine housing sections offsite. This approach will reduce time, risk and cost in the construction schedule.

Dartford headquartered Laing O'Rourke, a Preferred Partner on Swansea, is a pioneer of DfMA methodologies within the UK construction market. Working with a number of the UK's leading design consultants, Tidal Lagoon Power has designed a kit of ninety separate pre-cast concrete turbine housing sections that can be manufactured and pre-assembled offsite.

There are currently at least 10 UK precast concrete facilities capable of supplying turbine housing sections to the programme. They are located in Suffolk, Essex, London, Yorkshire, the West Midlands and Northern Ireland.

To supplement the UK's capability in this area for the pathfinder project and especially for the scaled tidal lagoon market thereafter, Tidal Lagoon Power and its partners will invest in a new, 20+ acre precasting yard. We are currently assessing sites in Wales.

The roll-out of tidal lagoon infrastructure in the UK will trigger the expansion of a national industry to mass produce standard design commodity precast concrete products. This will also serve to ease the pressure on the UK's traditional steel and concrete capability, in line to supply a long list of major infrastructure projects in the pipeline nationwide.

Fig 05

Current UK pre-cast concrete capability

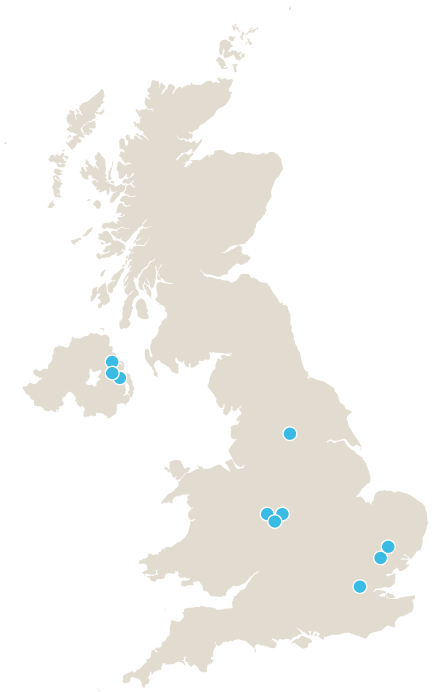
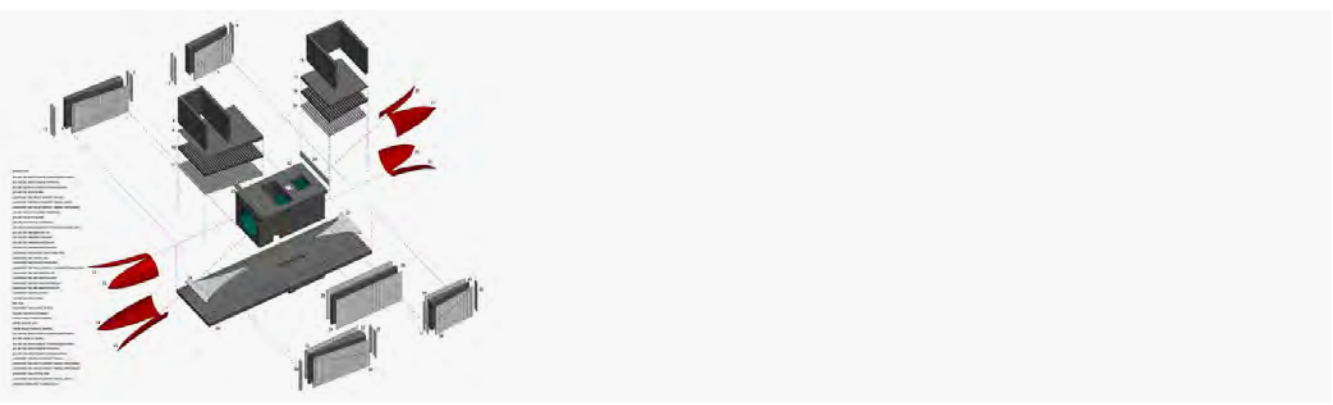


Fig 04

Turbine house build components



Caissons

Tidal Lagoon Power and its partners are developing additional innovations in UK civil engineering and construction methodologies to drive out risk from the programme of lagoons beyond Swansea Bay, which will provide further time and cost savings.

The turbine and sluice structures can be constructed in-situ or with the use of caissons.

The in-situ method involves first constructing a temporary cofferdam to create a dry working area in the sea. The civil contractor then casts the concrete structures in-situ using concrete delivered directly to the cofferdam. Even with offsite precasting of turbine housing sections, in situ pours of fresh concrete are required. This traditional methodology is dependent upon sequential working i.e. the concrete structures can only be constructed following completion of the de-watered cofferdam.

Tidal Lagoon Power is investing in development of a caisson solution whereby the turbine and sluice structures are constructed in batches offsite in either dry docks or purpose-built basins in a safe and controlled environment. Once constructed, the dry docks or basins are flooded and the caissons floated before being towed to site and lowered into place.

Caissons remove the need for temporary cofferdams and can be built in parallel with the remaining infrastructure. Furthermore, caissons provide an opportunity to install and dry commission the turbines and generators offsite, which significantly reduces the extent of weather-dependent site-based activities. Caissons are not being considered for the Swansea Bay project because the quantity of caissons does not justify the investment needed in setting up a caisson construction facility.

Roll-out of a pipeline of full scale tidal lagoon projects will incorporate multiple turbine and sluice structures which creates the level of demand required for Tidal Lagoon Power and the wider supply chain to invest in caisson construction infrastructure.

Caissons enable serial production of modules in a construction facility utilising a local workforce deploying a range of skills.

Today there is no UK facility of a sufficient size to serve the tidal lagoon sector with caissons. Tidal Lagoon Power and its partners have identified a number of potential sites for a purpose built facility around the Welsh and Scottish coastline. **The construction of such a facility would further enhance the UK's civil engineering capability and upskill its industrial workforce.**

Fig 06a, b

Example of dry and flooded caisson docks

Value of the potential domestic market for turbine housings

Turbine housing structures account for a high percentage of the capital expenditure of a tidal lagoon project. The value of this new domestic market is estimated in the table right.

Through the enhancement of the existing UK civil engineering capability, 100% of this market value will be realised by UK companies.

	Installed capacity	Estimated number of turbine housings required	Estimated expenditure on turbine housings
Swansea Bay	320MW	16	£350m
Cardiff	3,240MW	108	£2.8bn
TLP fleet of 5 projects, plus pathfinder	16,000MW	604	£15.3bn
UK market of 9 projects, plus pathfinder	25,000MW	940	£23.8bn

Clustering
Today

The roll out of tidal lagoon infrastructure in the UK will see industrial growth cluster around the two principal UK tidal lagoon deployment zones in South and West Wales, and North Wales and Liverpool Bay.

New manufacturing facilities at these two large hubs will be served by a UK-wide supply chain. Original manufacturing will be spread throughout the UK with particularly important parts coming from a number of regional centres of excellence, mirroring the UK's historic manufacturing heartlands and including South Yorkshire, West Wales, South Wales, the West Midlands, Western Scotland and Tyneside/Teesside.

Turbines for the pathfinder project will be manufactured from a majority of British parts. Machining and pre-assembly of the turbines will take place at the Turbine Manufacturing Plant, a new £22m purpose-built facility in the Swansea Bay City Region. Heavy fabrication of steel components will take place at a new £25m purpose-built facility in the Swansea Bay City Region. Precasting of concrete turbine housing sections will be led from a new £50m purpose-built facility in Wales.

The turbine's control systems and generators will be manufactured in Rugby by GE Power Conversion from a majority of British-made parts.

More than 1000 UK businesses have registered an interest in supplying parts and skills to the pathfinder project.

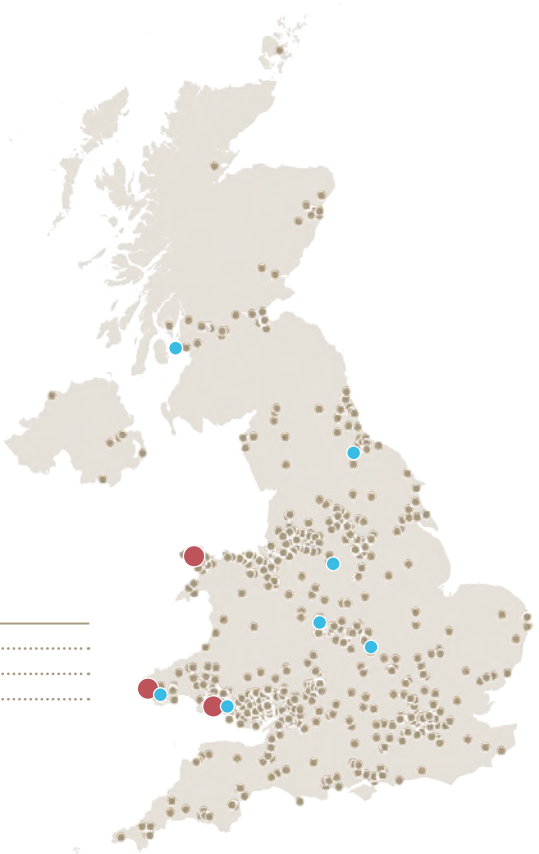


Fig 07a:
- Registered suppliers
- Regional Centres of Excellence:
- New Manufacturing Facilities:

Future

The continued growth of these regional industrial clusters will be steered by the pipeline of tidal lagoon infrastructure projects to pass successfully through the consenting process, against a clear and supported national delivery strategy.

Even at this early stage, it is clear that major investment in the following manufacturing facilities is likely to be required:

1 A second, £40m Turbine Manufacturing Plant located in the Cardiff Capital Region;
2 A third, £40m Turbine Manufacturing Plant located in the Liverpool Bay Region;
3 A new £100m generator manufacturing facility located in the Cardiff Capital Region; and
4 A new £250m caisson yard, location to be confirmed. Options in Wales and Scotland.

Fig 07b:
● **Future New Manufacturing Facilities**

> *Perhaps the most appealing aspect of this plan is that it zooms in on those hard-to-reach corners of the Welsh and national economy.*
>
> **Robert Lloyd Griffths OBE**
> Director, Institute of Directors, Wales

Economic and Employment Impacts

The Centre for Economics and Business Research estimates that the development of six tidal lagoon power plant in the UK, including the pathfinder at Swansea Bay, would contribute £27bn to UK GDP during construction and a further £3.1bn in each year of operation.

The development of tidal lagoon infrastructure in the UK presents considerable opportunity to catalyse economic regeneration in deprived regions and to create and support jobs across the UK with the growth of a new global industry.

Over the five year development of Swansea Bay Tidal Lagoon and its supply chain, third parties have analysed data provided by Tidal Lagoon Power and its partners to estimate the scale of these opportunities.

This evolving work is summarised in the table below.

Fig 08

Economic and employment impacts

	Installed capacity	Homes powered annually	Investment	Employment at peak (during construction & manufacturing)	Employment long-term (during operation)	Gross Value Added, construction	Gross Value Added, operation
	MW	GWh	£bn			£m	£m, p.a.
Swansea Bay Tidal Lagoon	320	155,000	1.3	2,232 direct jobs	181 direct, indirect & induced jobs	316	76
Cardiff Tidal Lagoon (estimated)	~3,000	1.4m	~8	~11,000 direct jobs	1,000 direct, indirect & induced jobs	1,300	513
Fleet of 4 tidal lagoons in Wales (estimated)	~8,000	3.3m	~20	~33,500 direct jobs	3,014 direct, indirect & induced jobs	4,296	1,368
Fleet of 6 tidal lagoons in UK (estimated)	~16,000	8.0m	>40	71,000 direct, indirect & induced jobs	6,400 direct, indirect & induced jobs	10,404	2,935

Sources

CITB/Whole Life Consultants, report to Welsh Government; Miller Research/Semta, report to Welsh Government; Centre for Economics and Business Research, report to Tidal Lagoon Power; CITB/Whole Life Consultants, report to Tidal Lagoon Power; Miller Research/Semta, report to Tidal Lagoon Power.

What this could mean for industry in Wales

Positioned uniquely within both the Severn Estuary and Liverpool Bay & Irish Sea tidal lagoon deployment zones, Wales will play a pivotal part in the roll-out of UK tidal lagoon infrastructure.

The world's first tidal lagoon power plant will be at Swansea Bay. The first of the UK's projects to be built at full scale is being developed between Cardiff and Newport, as are two further large tidal lagoons at Colwyn Bay and Newport.

More than £20bn of private capital could be invested into tidal lagoon infrastructure in Welsh waters over the coming years.

Tidal Lagoon Power and its partners have committed to securing a high percentage of project spend at the Swansea Bay pathfinder project for Wales. The anticipated clustering of industrial growth around the UK's principal deployment zones is likely to further grow Wales' stake in the UK tidal lagoon industry **with investment in up to seven new manufacturing facilities in Wales.**

With continuing uncertainty as to the future of the Welsh steel sector and following the vote to leave the European Union, many observers have pointed to a troubled future for the Welsh economy.

In tidal lagoons, Wales has the opportunity to shore up and diversify its industrial sectors, sustaining long term employment in a new and growing global market. Tidal lagoons can be of strategic economic importance to Wales.

In a report to Tidal Lagoon Power, extending on its earlier work for Welsh Government, Miller Research and Semta found that the development of the **four tidal lagoons in Welsh waters would support 22,846 direct FTE jobs[4] in the manufacture and assembly of the main component parts of the turbines, generators and sluices. This equates to 15.7% of the total number of people employed in the manufacturing industry in Wales in 2014.**

> *If we get it right, the roll out of tidal lagoons promises a double-whammy for Welsh industry: a welcome new domestic market for our core sectors and a lifeline of indigenous, long-term and affordable low carbon power.*
>
> **Ian Price**
> Assistant Director, Confederation of British Industry, Wales

Footnote
4. A second report by CITB and Whole Life Consultants finds a further 10,675 jobs will be sustained directly through the construction of four tidal lagoons in Welsh waters

Going Global

Academic studies have identified over 300GW of untapped potential tidal range capacity globally, more than twelve times the scale of the tidal lagoon market that has been mapped to date in the UK.

In a 2014 study, the Centre for Economics & Business Research found that a global tidal lagoon market of 80GW valued at £383bn could stimulate a UK export market worth around £70bn. It found that the export of tidal lagoon electricity and of the components and expertise to support the delivery of tidal lagoon projects abroad, combined with a reduction in fossil fuel imports, could increase net exports by as much as £3.7bn per year by 2040, equivalent to 13% of the current trade deficit.

Early work

Tidal Lagoon Power's international teams have looked closely at the opportunities to apply UK learning, design and technical expertise to advance projects in international waters.

We have a team developing projects in Northern France, a joint venture to progress projects in India, and are actively examining opportunities in both Canada and Mexico. A total of 14 potential sites for large tidal lagoon projects have been identified in these territories to date.

Progression of all 14 projects would necessitate approximately £84bn of capital expenditure.

Tidal Lagoon Power estimates that UK industry could secure approximately 35% of this global market value, approximately £30bn. Under a lower deployment scenario of 7 tidal lagoon projects in international waters, and with UK companies securing 15% rather than 35% of the work, UK industry would capture approximately £6bn from the £43bn global market.

Further tidal lagoon markets may exist in South America, SE Asia and Oceania.

Exportable content

As set out in this paper, should the UK leverage its first mover advantage and build out a world-leading industrial capability through the scale deployment of tidal lagoons in UK waters, we consider the primary opportunities for UK exports as follows:

Components for turbines, generators, sluices and mechanical & electrical balance of plant. The complete replication of the level of investment required to scale UK supply chain facilities for mass manufacture is both unlikely and uneconomical. While there will be pressure for local assembly in any given market and a pre-existing supply chain capable of taking on some tidal lagoon work, the opportunity exists for UK industry to retain up to 40% share of the global market for components. This position is likely to be supported by the accrual of intellectual property within the UK supply chain.

Development expertise. The UK has already built a wealth of knowledge and expertise in multi-disciplinary engineering and professional services relating to all facets of tidal lagoon development. This will be particularly valuable to international markets in the fields of project design, civil engineering, electrical engineering, and specialist hydraulic and financial modelling. This body of expertise, which will be advanced considerably as the UK roll-out programme progresses, will become a major UK export asset, securing as much as 80% of international project development value in certain markets.

Delivery expertise. The UK has created an intelligent design, procurement, construction and installation capability likely to be of value to developers of projects in international waters.

Operations. The UK tidal lagoon programme will build up a wide body of bespoke maintenance and engineering support expertise, securing for the UK a very high percentage of lifetime project spend. Export of skills, knowledge and human resource to projects in the first phase of international tidal lagoon deployment could be significant, securing up to 80% of global market value in this space.

A lesson from history 1:
North Sea oil and gas

Like today's renewable energy industries, the advent of the North Sea oil and gas industry in the 1960's was in part spurred by the need to regain energy independence. It presented the UK with an opportunity, on the back of an abundant natural resource, to nurture a new industry of strategic importance to the national economy.

The response to that opportunity was founded upon skills. From the outset, a holistic approach was adopted whereby British expertise was either repurposed from existing industries or built up from scratch in partnership with foreign business at each level of the value chain, from exploration through to refinement and distribution.

By ensuring a place for UK industry at the table, a national skill-set was built over time to become a thousand business-strong domestic supply chain. The UK was able to seed and grow a body of world-beating industrial and technical expertise that has continued to deliver great value (in tens of billions) and employment (in tens of thousands) to the nation even though the finite natural resources of the North Sea have entered decline.

The decades of industrial expertise developed by populating a new domestic growth market with British skills remains an important contributor to British exports today. The UK has also seen the direct transfer of many of these skills to support growth in the relatively immature renewable industries.

A lesson from history 2:
Danish wind

The Danish wind industry turned over €11.9bn last year. It employs tens of thousands of workers, many of whom contribute to one of the world's largest wind turbine manufacturing industries, with Danish wind exports standing at €6.5bn. The Danish Wind Export Association has more than 300 corporate members.

Like the UK, Denmark has leveraged a natural advantage. The two countries have between them many of the world's earliest onshore and offshore wind farms and have from there built out a significant portfolio of power plant. Wind-generated electricity accounts for over 40% of demand in Denmark today, with a target to increase this to 50% by 2020. In the UK, wind power accounted for 11% of UK electricity last year, with that figure set to grow further.

But it is acknowledged that Denmark has also been able to secure far deeper industrial success on the back of large and early levels of domestic wind deployment and today exports technology and expertise to markets worldwide, not least the UK.

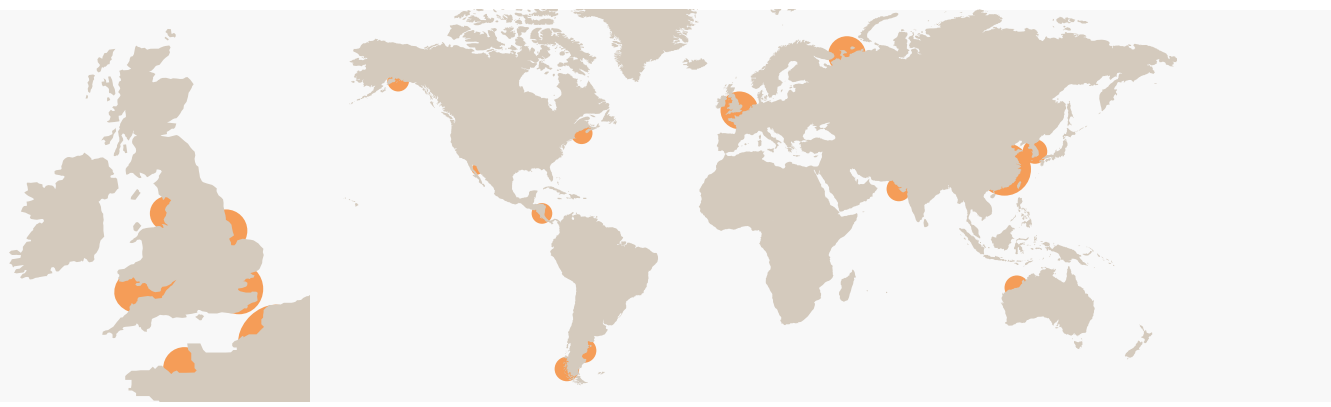
When Taylor Woodrow, British Aerospace and GEC combined forces to form Wind Energy Group in the late 1980's the picture looked very different. British and Danish wind technology prototypes enjoyed level pegging on the world stage. But a hesitant British industry and a less proactive British Government soon saw early advantage dwindle.

Adopting a long-term view, the Danish government invested in the rapid growth of industrial capability through both state-backed R&D programmes and state-owned market players. This built the nation's technical lead, in turn supported by significant public support of capital costs for early domestic deployment of the technology. Industrial capability was scaled accordingly, driving down costs and stimulating market competition that gave rise to further technical innovation and a competitive edge on the world stage.

By comparison, the UK achieved very little value from onshore wind outside of civil works and cabling. In offshore wind, Denmark was able to export wind turbine technology to the UK for well over a decade before, responding to long-term Government signals, the UK saw investment in its first domestic manufacturing facilities.

Fig 09

Tidal range hotspots worldwide



A Plan for Industrial Success

Swansea Bay Tidal Lagoon has been brought forward as a pathfinder for a new global industry. The design of the manufacturing process places UK industry in pole position. Only through collaboration and a clear vision shared between Government and industry will the UK go on to win the race.

Tidal Lagoon Power's contribution to this vision, shared across its many industrial partners, is summarised here:

1

Seize the moment

After five years and expenditure of over £35m, the pathfinder project at Swansea Bay is ready to start construction. The project has planning consent, strong funders, strong industrial partners, political and public support, and a delivery team and supply chain ready to kick into action.

It has also proved to the international marketplace that successful commercial development of tidal lagoon infrastructure can be achieved. International competition is alert to this success and now is the moment for UK based industry to secure the opportunity before it.

2

Define success

The Swansea Bay project is a starting point. Industry needs Government commitment to a programme of project construction over the next two decades. A clear and sustainable project pipeline beyond the pathfinder project is necessary if the UK is to maximise the industrial opportunity.

UK industry can leverage the resultant order book potential to achieve ambitious goals that deliver for the national economy. This includes a commitment over at least two decades to thousands of long-term jobs, to investment in training and skills, to investment in new and existing facilities and to the ultimate reduction of energy bills for consumers and businesses from clean, reliable, low cost power from tidal lagoons.

Industry alone cannot deliver such significant infrastructure developments without the active and substantial engagement of Government to set policy, support domestic development plans and to promote international cooperation and exports – success depends on this.

3

Map the national capability and open for business

It is necessary to conduct a full audit of UK industrial skills and capabilities against the requirements of a short and medium-term tidal lagoon roll-out plan – to be used as the basis for policy development and selective investment that will enhance the UK supply chain skill-set. A full audit has already been completed in Wales.

UK academic institutions and prospective inward investors should be encouraged to compete to fill any gaps that exist.

A commitment to regular reviews will ensure current and efficient interaction between Government, academia and industry.

4

Stimulate immediate supply chain investment through a short-term roll-out plan

Should the UK decide to develop a programme of tidal lagoons, UK industry must invest immediately in equipment, skills and facilities if it is to scale its capability and sustain its advantage.

A national commitment to deliver two or more full-scale projects within the Severn Estuary and Liverpool Bay & Irish Sea deployment zones over the next decade would trigger that investment. Vital consenting processes and environmental protections at any given development site will continue without prejudice.

Such a commitment would also advance considerably the UK's export ambitions through the development of a flagship reference project at full scale in the two prevailing global market conditions.

Research and development investment would also be unlocked, allowing the design, manufacturing and construction elements developed and deployed at the pathfinder project to be optimised. This will provide an industry resource to capture and exploit early engineering and environmental learning for the benefit of the programme.

5

Review and develop policy

The Hendry Review is shortly to be published. After six months of thorough scrutiny, the tidal lagoon industry waits with bated breath the endorsement of its findings.

6

Drive a pathway to cost reduction

Industry will develop a pathway to cost reduction in all tiers of the supply chain, furthering the UK's position as a global centre of excellence that reduces costs for domestic advantage and exports to overseas markets.

Government is encouraged to actively engage in the development of that pathway through initiatives to promote regional industrial development at the two tidal lagoon deployment zones, and through grant funding to support new entrants in the supply chain to increase competition, increase innovation and lower capital costs.

7

Think export

UK industry must position for likely requirements of the international market now, forging the partnerships and alliances that see it best placed to participate. The UK doesn't have a monopoly over good ideas and early collaboration and knowledge share across international peers will also help UK industry to fulfil its domestic market ambitions.

Government support for and facilitation of export initiatives is required, as are activities designed to stimulate the development of global tidal lagoon markets.

> *"In becoming the global leader in tidal power with the world's first power generation tidal lagoon in Swansea Bay, Britain is building the technologies and manufacturing techniques that will set the standard for all future lagoon projects worldwide.*
>
> *Swansea Bay Tidal Lagoon is quickly becoming more than just a symbol of the UK's commitment to renewables; its marks a global energy future that can continue to be 'Made in Britain'."*
>
> **Mark Elborne**
> President & CEO, GE UK & Ireland

The Tidal Lagoon Industrial Opportunity

The immediate opportunity is for the UK's engineering, construction, steel and manufacturing industries to win contracts totalling over £800m for a world first tidal lagoon project at Swansea Bay and over £6bn for the first project to employ its template at full-scale at Cardiff.

An effective partnership between industry and Government can sustain and grow this opportunity as the tidal lagoon market scales.

On top of significant value captured through project design, services and operations, as well as more than half a billion pounds of investment in new UK industrial facilities, the potential value of the tidal lagoon sector to UK industry is shown right:

Domestic market for tidal lagoon turbines and generators

£17bn

Domestic market for tidal lagoon turbine housings

£24bn

Exports to international tidal lagoon market

£30bn

Through shared ambition, the tidal lagoon sector can become a key driver of industrial growth in Wales and across the UK.

It is ours to own.

Contact us

Tidal Lagoon Power
Pillar & Lucy House
Merchants Road
The Docks
Gloucester
GL2 5RG

T: 01452 303892
E: info@tidallagoonpower.com