Written evidence submitted by Tidal Engineering and Environmental Services Ltd (REW0007)

Response to Welsh Affairs Committee inquiry on support for Welsh Renewables

Response by Tidal Engineering and Environmental Services Ltd. (TEES) – 08.02.21

Tidal Engineering and Environmental Services is a consultancy focused on developing tidal range renewable energy schemes. This response is by Prof Chris Binnie FREng FICE and David Kerr FICE, two of the Directors of the company.

Introduction

The Welsh Affairs Committee has launched an inquiry on how the UK government, in cooperation with the Welsh government, can best support the development of renewable energy in Wales. The Welsh Affairs Committee's inquiry will look for the potential opportunities for development and deployment of renewables in Wales and how Cardiff and Westminster should work together to support them.

This response by Tidal Engineering and Environmental Services Ltd, considers the extent of tidal range opportunities in Wales and responds to the questions asked.

This introduction explains the potential for and the benefits of Tidal Range technology.

<u>Need</u>

The government has committed to net-zero by 2050. Thus the demand for electricity is projected to double by 2050. About two thirds of the existing power stations are expected to close by 2030. A diverse mix of new energy supplies is needed to provide the extra capacity.

<u>Technology</u>

Tidal Range schemes use the rise and fall of the tides to generate energy. Electrical energy is generated by using the difference in water level between the sea and an enclosure - the potential energy - to drive large turbines, similar to the turbines used in some low head hydropower schemes on rivers. Note that this is a different technology to Tidal Stream which uses the speed of the water – the kinetic energy - in fast flowing tidal locations.

Tidal Range is a proven technology, as demonstrated by the 320 MW La Rance scheme in Brittany that has operated for over 50 years with only some updating of electrical equipment. The original turbines and civil engineering works are still operating. This scheme is now reported to produce some of the lowest cost energy in Europe.

<u>Extent of Tidal Range Opportunities</u>

The tidal range around the UK coast is generally large, especially on the West coast. The North Wales/ North West England has an average tidal range of more than 6m and the Bristol Channel/Severn estuary has up to 10m. The latter is the second highest tidal range in the world. Thus UK has unusually high tidal range opportunities and Wales has a significant proportion of that opportunity.

Scheme	Capacity GW	Energy TWh/yr	Approx. Cost £Bn	Ratio Cost to Energy
Swansea Lagoon	0.3	0.5	1.3	2.6
West Somerset Lagoon	2.5	6.5	8.5	1.3
Cardiff Lagoon	3.0	6.0	8.1	1.35
North Wales Lagoon	2.3	5.0	7.0	1.4
Stepping Stones Lagoon	0.6	1.2	1.7	1.4
Mersey River Barrage & Liverpool Bay Lagoon	1 to 5	2 to 7	3 to 9	1.3
Mostyn Lagoon	0.13	0.3	0.6	2.0
Wyre Barrage	0.1	0.2	0.4	2.0

Schemes in Wales are shown in blue text in the table.

Thus Tidal Range in Wales would be able to provide up to 6.3 GW of installed power and 13 TWh of energy per year.

The ratio of cost to energy is an approximate indicator of the relative costs of energy.

Predictability and Long Life

Tidal range output is predictable for many years ahead and is totally reliable. It is indigenous. Such schemes will a long life of at least 100 years. Current economic analysis does not recognise these long term benefits.

Intermittency

Tidal range has only short, 2 to 4 hour, and fully predictable periods of no energy production. This is in contrast with solar power which provides no power for up to 16 hours in winter and wind power which can have periods of several days of low wind speeds resulting in little or no energy. Thus tidal requires less storage backup.

In addition, it has been shown that, because of the variation of the time of highwater around the coast two schemes, one in the Severn Estuary, and one off the North Wales coast could provide continuous power at spring tides, 60% of the month, and with a gap of up to 4 hours at neap tides which could be filled with storage.

Flexibility

The start of generation can be brought forward by up to an hour if required, albeit with some loss of energy output for that tide.

The value of energy varies during any particular day. Recent studies have shown that minimising pumping when the value of electricity is high and maximising when there is a supply shortfall can increase revenue by about 20%.

Energy increase due to operational changes

The Severn Tidal Power Feasibility Study commissioned by DECC (Department for Energy and Climate Change) was the most recent re-evaluation study of Tidal Range opportunities in the Bristol Channel / Severn Estuary area, published in 2010. The schemes considered were mostly for ebb only generation. Current schemes mostly include ebb and flood tide generation, with pumping. Pumping results in an increase in energy output of about 10%; also artificial Intelligence routines have now been developed to optimise starting head which can also provide about another 10% increase. In addition, triple regulation is has now been developed providing a further significant increase in

energy output, possibly a further 10%. Turbine designs used in La Rance, and most schemes since, have featured "double regulation" in which the angle of both turbine blades and guide vanes can be varied to optimise operation in different tide heights. "Triple regulation" has the added feature that turbine rotation speed can be varied, which has the benefit of further increasing efficiency, especially in pumping mode and it also allows slower rotational speed, which is predicted to be less damaging to fish.

The overall effect of these improvements in turbine design and operation provides a potential increase in energy output is up to 30%.

Recent design development in the civil engineering aspects, which typically comprise around 60% of scheme costs, are predicted to reduce capital cost by about 20%, depending on the specific schemes.

Cost of Energy

As a result of the increases in energy output combined with cost reduction of civil engineering elements, the estimated unit energy costs have reduced very substantially since the DECC Study of 2010, the promotion of the Swansea Bay scheme in 2015 and the Hendry review in 2016.

Non Energy Benefits

Non energy benefits of Tidal range include:

- ✓ Coastal protection
- ✓ Employment
- ✓ Increased marine recreation

Coastal Protection.

Current assessment of the effects of climate change show that there could be a sea level rise of up to about a metre by the end of this century. This would result in substantial effect on coastal defences. Many sections of coast would be unable to cope. There would be breaches, inundation and loss of land and property. The north Wales coast is particularly vulnerable. Having a tidal range scheme would mean that the lagoon water level could be controlled. Thus the devastating storm surge sea levels could be excluded. Further much damage is also caused by oceanic storm waves. However, because of the lagoon walls, these could not enter the lagoon. Because of the short fetch across the lagoon, the wave conditions within the lagoon would be limited. Thus tidal lagoons would do much to provide protection to the coastal community, its houses, and its properties, and could perhaps releasing land for development. This substantial benefit is not currently included with the economic analysis. In our view it should be.

Employment.

North Wales and parts of South Wales are areas of high unemployment. Because of the large civil engineering element in tidal range there would be substantial local employment. As tidal range takes several years to build the wall and caissons, the employment would last for several years. There would also be operational employment for the life of the scheme of over 100 years.

Q1 How can the UK government best support the deployment of renewable generators in Wales?

Tidal range schemes have high capital cost, low operational cost and very long life. Thus they are perhaps naturally joint private-public sector schemes. Such schemes could revert to ownership by the government once the private sector finance had been paid off.

The new National Infrastructure Bank should be considered for provision of low interest funds.

The style of contract could be a Regulated Asset Base, as being currently considered for the nuclear power sector and already used in the water supply industry

The Welsh government could become a cornerstone investor.

Q2 How should the UK and Welsh Governments work together to support the development of renewable energy projects in Wales?

UK and Welsh governments should carry out an full economic assessment of all renewable energy systems including long term costs and benefits over the life of the longest schemes so that adequate comparisons can be made.

Should tis full assessment show that tidal range should be included in the mix of electrical energy production schemes, then tidal range should be supported, if necessary with the proviso that the scheme could ultimately revert to public ownership.

Q3 What mechanisms can ensure that subsidies for renewable generators are good value for money?

<u>Known technology</u>
As noted above, Tidal Range is a proven technology.

However Tidal Range schemes have high capital cost. This will results in high short term energy cost to pay off the capital. Other energy schemes have benefitted by appreciable government subsidy to initial schemes to enable promoters to research and developer their technologies, thus off shore wind benefited such that it has been able to reduce its costs substantially. Subsidy has also been provided to energy systems that have not yet proved themselves at scale. Tidal range is a technology that is known to work, so technological risk is limited. But it has had no such support. It was alleged that this was because it could not reduce its energy costs. This is untrue. More recent assessments of energy output have shown increased energy outputs from more efficient turbines, use of Artificial Intelligence to optimise operational cycles and pumping. Significant design development has occurred since the earlier studies. Thus there has already been a significant reduction in estimated energy cost and, with support, this trend should be able to continue, similarly to other energy cost reductions.

<u>Consideration of full life costs</u>.
At present energy cost comparisons are focussed only on the relatively short term initial capital and operating costs.

Tidal range schemes have a design life of about 120 years. Most other renewables have a design life of no more than about 30 years, at which time they would need appreciable expenditure such as rebuilding/repowering at the end of the life. Some energy sources would need very long term waste disposal costs.

Costs of some renewables developments may not include associated costs such as grid connection costs. Tidal range schemes are generally close to high voltage grid lines. In contrast, some renewables schemes can be a long distance from demand centres and grid connection.

Power intermittency

These effects of intermittency are not included in the government's cost comparison between different forms of energy. Intermittency for tidal range is fully predictable and occurs for only relatively short periods of time, in contrast to the other major renewables, wind and solar.

Coastal protection

Tidal Range schemes would provide protection to the coast against storm surges and waves and, most significant, protection against sea level rise. This benefit should be included in financial assessment of schemes.

Regulated Asset Base funding

Dieter Helm states for nuclear energy schemes *"The cost of capital is so dominant that it can be as much as almost half the cost of a project*." BEIS state "*We are also considering whether a RAB"* Regulated Asset Base" *model could be applied to other firm low carbon technologies."* Such a funding arrangement can mean that certain most unlikely but high impact risks would be borne by the taxpayer. This results in a much more competitive financing charge. The RAB system was applied to the £4bn Tideway Tunnel and reduced the cost to households from £70 to £80/year to £20 to £25/year. Thus applying RAB funding system would provide good value. A Tidal range energy scheme would be a high capital cost. long construction period scheme similar to a nuclear power station and the Tideway Tunnel. Thus the government should agree to RAB funding for tidal range energy schemes.

National Infrastructure Bank.

The Government has announced the formation of a National Infrastructure Bank to take over the role of the EIB for providing low cost funding for certain national infrastructure projects. The government could agree that tidal range energy schemes could be part funded by the NIB.

Return to the public sector

Tidal range schemes are long life schemes with high upfront capital cost and low operational costs. Such schemes are perhaps naturally public sector schemes. it would not be appropriate in the long term after the capital cost has been repaid for the private sector to make profit from a public asset.

Several such schemes have been built by the private sector but once the capital cost has been repaid with interest, they have reverted to the public sector. For example this was the funding method for the Second Severn Crossing, whereby a Private Finance initiative style contract was awarded in 1988 for the design, construction and operation. The Crossing reverted to government ownership in 2018. This could be the right model for Tidal range schemes.

Q4 What opportunities are there for renewable generators in Wales of greater interconnection with other electricity markets?

Tidal Range schemes are typically large schemes that would connect directly to the main electricity grid which is a UK wide grid.

The highest tidal ranges occur along the north and south coasts of Wales. These include the 2,300 MW North Wales tidal energy lagoon, and, along the south coast, the various schemes in the Severn estuary. All these schemes are close to the existing high voltage power lines that connect to UK grid.

Since the UK grid is already connected to the European electricity grid Tidal Range could export any surplus renewable energy to Europe.

Q5 How can the UK government facilitate Welsh contributions to Cop26?

By announcing support for tidal range schemes. This should include assessment of all the whole life cost including the associated benefits.

It should also include agreement in principle for funding support. This could be

- by Welsh government grant
- by the National Infrastructure Bank,
- by agreement to a Regulated Asset Base style contract.

Q6. How can the UK Government facilitate Welsh contributions to COP26?

No comment

Q7. What implications is COP26 expected to have for Wales?

No comment

Q8.What opportunities are there for renewable energy to aid Wales post-covid-19 economic recovery?

Wales is plentifully endowed with renewable energy. To be of most benefit to the Wales economy, as much as possible of renewables projects needs to be manufactured and/or constructed in Wales.

A recent report shows that the proportion of UK content in the construction of offshore wind power sector is about 30%. It is believed that most solar panels are manufactured in China, thus for solar the Welsh content may well be similar or lower.

However hydro power and tidal range power require a large proportion of civil engineering work. The majority of the associated construction would be carried out in Wales, thus benefiting the Welsh economy. For comparison one might expect the Welsh proportion of tidal range cost to be about 60% to 70%.

Response to the Welsh Affairs Committee inquiry on support to Welsh renewables by *Chris Binnie & David Kerr, Directors of Tidal Engineering and Environmental Services, February 2021.*

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