Tidal Lagoon Schemes and Regional Development:

Work Package 3: Discussion Report

Quantifying the Impact of Tidal Lagoon Funding and Ownership

Welsh Economy Research Unit

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Summary

This report is part of the Welsh Government Tidal Lagoon Challenge project. We address the objectives of the Challenge Fund by examining potential financing and ownership options for novel tidal range renewables on the coast of Wales. The research seeks to examine how different approaches might better support the long-term prosperity and wellbeing of the people of Wales.

This report (WP3) builds on our two earlier reports (WP1 and WP2). These are available on the Welsh Economy Research Unit website (Welsh Economy Research Unit - Research - Cardiff University). Here in WP3 we seek to provide an initial quantification of how any regional socio-economic and climate-environmental benefit arising from a new large tidal range electricity development will be related to factors in different ownership, funding and operational (OFO) models.

While the report reveals how selected outcomes might be quantified and understood, it should be seen as very much a starting point for discussion, and in terms of offering a high level framework through which local effects might be understood.

The report suggests that regional ownership (in terms of our simple scenarios) *per se* will likely not have a transformative impact on the level of regional surpluses. This is for two reasons. Firstly, as a relatively peripheral and small economy, lacking in innovative firms and products, and in bespoke technical and other services, the level of local sourcing around lagoon/barrage construction is unlikely to increase radically, even where the ultimate client is a regional public or quasi-public body. It may indeed be the case that public ownership and development might serve to restrict local sourcing, for example if the developer falls under the aegis of the Internal Market Act. Secondly, profit margins for generators are, in the UK electricity wholesale market reasonably modest.

The report suggests there might be opportunities for a lagoon to drive far higher levels of regional benefit if it is off-grid: if it can be financed at moderate interest rates and constructed at the cost levels suggested in earlier research work and can operate for close to 100 years. Off grid development also however brings potential benefits that are not quantifiable, not least the ability to direct power independent of UK grid governance and regulation.

1 Tidal Lagoon Challenge project

1.1 The overall project

This Welsh Government Tidal Lagoon Challenge project is led by Cardiff University. We address the objectives of the Challenge Fund by examining potential financing and ownership options for novel tidal range renewables on the coast of Wales. The research seeks to examine how different approaches might better support the long-term prosperity and wellbeing of the people of Wales. Our Tidal Lagoon Challenge project has key objectives that map directly to five work packages (WPs) as follows:

WP1: To examine extant ownership/financing models for energy generation infrastructure to date in Wales and in comparator regions, and to assess their outcomes in terms of sustainable economic development, supporting regional wellbeing, and improving ecosystems condition and functioning. The WP1 was completed in November 2024.

WP2: To examine how far existing developmental and financial models are practicable for potential tidal range schemes given capital requirements, operational timescales, uncertainties and risk, and potential future electricity prices (and pricing schemes). The WP2 was completed in March 2025.

WP3 To develop a simple economic model through which the consequences of different ownership and financial models can be explored with respect to effects on the Welsh economy.

WP4 To provide a framework matrix whereby an indicative typology of different financing, development and ownership models can be reconciled with a range of potential regional socio-economic, community acceptance, supply chain, environmental and climate outcomes.

WP5 To reflect on the scope for, and barriers to, a range of more innovative financial, development and ownership models that involve regional stakeholders, and increase positive local engagement across private, public and third sectors.

Our work seeks to contribute directly to Welsh Government research priorities, with a central focus on revealing and addressing the barriers to tidal development in ways that improve socio-economic and environmental outcomes. This current report is related to the WP3 work around economic modelling. Section 2 of the report outlines our approach and broad assumptions. Section 3 shows how we use the Welsh Input-Output tables to understand the economic and wider impacts of different ownership, funding and operational (OFO) scenarios. Section 4 outlines the scenarios and data employed in the analysis and the findings. Section 5 discusses the results and concludes.

2 Research methods: economic modelling

2.1 Initial assumptions

In this WP3 report we attempt to provide an initial quantification of how any regional socio-economic and climate-environmental benefit arising from a new large tidal range electricity development will be related to factors in different ownership, funding and operational (OFO) models (see also discussion in WP2 report).

We illustrate how these relationships could play out by estimating a subset of these potential benefits arising from different ownership, funding and operational models. This process is indicative. The report reveals how selected outcomes might be quantified and understood and should be seen as very much a starting point. The analysis provides some contextualisation in terms of the strength of any economic or environmental benefits that arise compared to the wider regional context, and then the strength of the relationship between the OFO and the quantum of these impacts.

A number of assumptions, inputs and structures enable our modelling process. The basic logic model suggests the OFO model will affect the following factors, with knock-on implications for the capture of benefits regionally.

1. The **scale of development** will affect the level of regional benefits, with larger projects more impactful in terms of GHG mitigation, but with a weaker relationship between scheme development and regional economic metrics (i.e. leakages in terms of per £1m on capital spend will *ceteris paribus* be greater for larger projects and with this related to the small size of the supply side of the Welsh economy).
2. **Lagoon ownership**, with **within region public (or quasi-public) ownership (or higher share of local ownership)** assumed to drive higher regional benefits (e.g. in terms of more local supply-chain and economic engagement, and regional retention and re-investment of any economic surpluses - treated here as social/community benefits in a potential public ownership (or public private partnership case)).
3. **Costs associated with electricity transmission** through the grid may be avoided if large local customer(s) are available through a private wire (albeit with then potentially additional storage costs arising),
4. **A lagoon's contribution to a faster-decarbonising Welsh grid** might have GHG emissions benefits.

Note that the above would be in addition to a range of non-quantifiable benefits that are potentially variably associated with different OFO models. For example, local ownership might drive higher levels of climate awareness (Bere *et al.* 2017), provide more co-educational and demonstration benefits, or a more sophisticated approach to the allocation of tidal range electricity – e.g. towards more socially impactful or competitively/economically beneficial uses. Moreover, tidal range projects may have even wider benefits – e.g. for coastal flood management, regional resilience (see indicative references at end of this report) – that themselves may be greater or weaker depending on the OFO adopted. Those potentials are not addressed here.

Following the above, there are then a narrower range of regional benefits that are potentially quantifiable and which we address in this report:

- Additional economic output
- Gross value added
- Employment
- Greenhouse gas emission reductions

These flow differently from OFO models through the factors detailed in 1–4 above. Some will apply (or be different) in the development and operational phases: for example, during development, employment impacts will be substantial but temporary, and GHG emissions will increase, whereas in the operational phase employment impacts may be more modest – but long-term, and potentially in a wide range of occupations and activities – and avoided GHG emissions substantial.

Note that our list of relevant factors (and their interactions) results in complex set of inter-related outcomes across a range of regional impact factors. We therefore impose strict restrictions on other variables that will in reality vary. For example, there are a number of electricity supply and demand scenarios produced by the National Grid and others which would add complexity if included, but with uncertain links to OFO models, and we therefore choose one central assumption in terms of the future electricity generation and demand context (see later).

2.2 Employment & Economic Impact

Following prior regional reports on Lagoon investments and on electricity infrastructure more generally (see for example Bryan *et al*., 2017; Jones *et al*., 2019) we estimate the economic effects of tidal range development and operation using the *Input-Output Tables for Wales (IOTs)*. Previously published by Cardiff University, in 2025 Welsh Government published an official set of IOTs, albeit as Statistics in Development.[1] We lever these tables to firstly estimate the extent to which developmental and operational Lagoon spending comprises a positive shock to the regional economy, and secondly, the extent to which this initial shock then generates 'multiplier effects' – further regional activity along supply chains, and via the within-region re-spending of wages.

Even using official IOTs, Input-Output Analysis suffers a set of limitations around, for example, a lack of 'dynamism' on the supply side.[2] Fundamentally a large-scale tidal lagoon project has the scope to change the supply side of the Welsh economy which could negate the usefulness of IOTs for economic modelling of effects – particularly during construction phases. Large projects can also drive up local (and national) construction costs; Input-Output analysis also assumes no scale economies (or diseconomies) occurring.

Strategic infrastructure facilities or other additions to regional economic activity can create significant direct economic and multiplier effects (Munday *et al*., 2023). But these outcomes are variable. For example, international managing contractors on construction projects can win direct contracts but purchase goods and services outside of the region. Moreover, for some infrastructure projects local materials, labour or services – particularly specialised ones – might simply be unavailable, with this reducing regional impacts in the real-world. Indeed in current debates around tidal lagoons in the UK, some interest has focused on whether projects in development will purchase goods and services close to sites of final construction, or whether goods will be imported to support projects (see Severn Estuary Commission, 2025; Munday *et al*., 2026)

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1 See Supply and use tables and input-output tables: 2019 | GOV.WALES

2 See Miller & Blair (2022) *Input-Output Analysis: Foundations and Extensions*. 3rd edition, Cambridge University Press.

We seek to deal with these issues as far as possible by typifying different scales of development, and varying our local contracting and supply chain assumptions between them. We additionally provide some narrative context in terms of how far Wales might be expected to capture economic benefits in light of past experience and research.[3]

Our IOT approach then provides estimates on how far tidal range schemes might impact output, gross value added and employment. We present these in terms of annualised impacts, and for convenience assuming a 100-year notional period covering a decade of development and a 90-year operational phase. Here the shorter-term development phase and operational impacts are conflated for reasons of data limitations, but with some commentary on development versus operational impacts in the supporting narrative. The objective here is to provide a long-term view of average economic outcomes over an assumed project life.

2.3 Social & Community

For electricity generation, a critical difference between schemes financed globally or regionally is the ultimate 'resting place' of returns to capital. Residents of Wales and Welsh organisations, by virtue of their relative lack of scale and resources are not notable investors (at least, direct investors) in large scale energy and infrastructure developments outside of Wales. Returns to such schemes rarely rest in Wales to any significant extent (see Jones and Munday, 2020 for a discussion here).

For renewable electricity generation schemes inside Wales, local returns have occurred in the form of 'voluntary' community benefit schemes enacted by the owners of capital, leases paid by commercial developers/owners for land use, ownership of capital by individuals (e.g. solar PV on homes and PV, wind and hydro owned by farmers etc.), and direct ownership of larger schemes by community groups and their Wales-resident shareholders. The per-MW installed benefits are greatest for the last of these, arising through the re-spending of export and FiTs/ROCs income directly by community groups, and as dividend income on shares.

3 Our WP1 report for Tidal Lagoon Challenge provides a review of the literature here.

Here then ownership matters very much. Taking cognizance of past projects across a range of technologies and places, we illustrate the potential level of (net) returns to capital for pathfinder and commercial tidal range schemes (essentially the surpluses associated with avoided grid electricity purchases) then treating this as regional social impact on Wales in the form of income for communities and individuals.

2.4 Climate Mitigation

The addition of a tidal range facility could influence territorial climate emissions in nuanced ways;

- directly displacing higher-carbon generation – e.g. substituting for electricity supplied by remaining gas fired capacity (CCGTs);
- through helping protect grid stability with predictable generation in an era of intermittent and unpredictable renewables (particularly overcoming 'flat day' problems connected with low wind and overcast conditions);
- through storage of zero carbon electricity in batteries or liquid hydrogen;
- through quickening the electrification of heat, for example, if deployed across large scales with private wire, or as part of smart grids.

In some of these cases the OFO model may impact climate contribution – either in aggregate, or in terms of territorial emissions. As an example, a large north Wales lagoon might potentially either serve large industries, data centres or residential populations in the north west of England, or be dedicated to more local uses – for example the electrification of Welsh homes or transit.

The nature and location of ownership may influence these outcomes, with potential synergies if that ownership means the reference future Lagoon is a key part of wider spatial planning, systems-decarbonisation or industry cluster development.[4] We thus include climate mitigation impacts in our suite of OFO-linked regional benefits – again of course accepting our analysis is illustrative, and with only selected benefits quantified.[5]

Carbon savings are thus measured conceptually territorially/at generation point and are the same for our on-grid/export and off-grid/private wire scenarios (see below). The opportunities related to these two scenarios are however different and worthy of further consideration.

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4 In respect of industrial cluster development see for example the South Wales Industrial Cluster (SWIC) project SWIC | South Wales Industrial Cluster

5 Additionally here we cannot quantify the 'downstream' benefits of zero carbon generation as the IOTs do not (yet) allow relevant forward greenhouse gas multipliers to be calculated. Forward multipliers generally examine the effect of an increase in primary inputs (like raw materials, labour, or capital) on the total output of all other sectors in the economy. They reveal how much additional output is required across all industries for a given increase in an industry's use of primary inputs, reflecting the sector's position in the supply chain.

3 Lagoon Scenarios and Data

3.1 Potential lagoon size and spending assumptions

We model two lagoon sizes: experimental/pathfinder (250MW) and at-scale (3GW). These 'boilerplate' capacities are translated into annual GWh generation (based on a 90-year generation phase following a 10-year development phase) using data presented in Munday *et al*. (2026). We separate their list of potential future cases into large (1GW+) and smaller proposed developments, then averaging these two classes to achieve discrete estimates of average generation cost etc. per MW capacity. We then scale these estimates to represent our 250MW and 3GW cases.

Table 1 Summary scenario assumption set

		Pathfinder	**At Scale**
Installed power capacity		*250MW*	*3000MW*
Potential start date		*2040*	*2040*
GWh daily generation		*1.4*	*17.9*
General assumption on operational lifetime		*90 years*	*90 years*
Estimated total scheme cost (development, construction and operation) £2024		*£1.07bn*	*£10.12bn*
Estimated distribution of total capital and operational spend by industry sector over an assumed 100 year project life	Percentage distribution of costs for Pathfinder and At-Scale scenarios	Proportion of spend in Wales	Proportion of spend in Wales
Chemicals	0.43	25%	25%
Iron and steel	1.67	25%	12.5%
Forging and pressings	9.18	28%	14%
Machinery	5.48	50%	25%
Electrical motors and transformers	2.27	50%	25%
Industrial electrical equipment	2.39	51%	26%
Electricity, transmission, distribution and supply	1.11	60%	60%
Construction	49.53	50%	25%
Transport services	10.97	50%	25%
Real estate	7.05	50%	50%
Other professional services	2.86	70%	70%
Other services	7.05	50%	50%
Estimated spend Welsh economy		*£515m*	*£2,935m*
Overall project regional purchasing under ***commercial ownership*** *assumptions*		*48%*	*29%*

Overall project regional purchasing under ***local ownership*** *assumptions i.e. chemicals +10%, metals and fabrication +33%, machinery +10%, electrical motors and industrial electrical equipment +20%, electricity transmission +25%, construction +25%, transport and real estate +10%, other profession services +20%, other services +50%*		*59%*	*36%*

Information on the vector of commodity spend, and on within-regional spending propensity for each commodity is drawn from research undertaken for Tidal Lagoon Swansea Bay[6] – now fairly old, but regionally bespoke and drawn directly from the putative developer. These proportions are used as our small-commercial lagoon baseline (suitably scaled down to 250MW)[7]. It is accepted that the distribution of costs, particularly in the tidal lagoon construction stage, is contested and dependent in part on technical differences in construction process (for example, caisson technology or otherwise). We then move to a large-commercial baseline by upscaling commodity spend linearly to match the funding requirement for our 3GW lagoon scenario drawn from Munday *et al*. (2026). However, whilst the commodity expenditure is scaled linearly, the research team significantly increase regional leakage (see Table 1) for a subset of commodity purchases reflecting the potential inability of the Welsh economy to supply bespoke goods and services, and skilled labour, for projects at multi-billion figure scales. This means that whilst local sourcing totals around 48% for our small-pathfinder lagoon this figure drops to around 29% for our large lagoon scenario (with consequent economic impacts then smaller per unit of gross spend of course).

6 See Environmental Statement Appendix 22.1.PDF Turning Tide: the economic significance of the Tidal Lagoon Swansea Bay

7 Although TLSB was notionally regionally owned it was for-profit locked fully into national and global supply chains.

3.2 Effects of ownership differences

Our regional ownership scenario then adjusts (increases) regional sourcing propensities to reflect the potential of regional ownership on foregrounding regional economic development. This might include bespoke sector and product-development support that meshes with tidal lagoon requirements; long term engagement and relationship development with key locally-present firms, including multinationals (e.g. in steel) to procure key inputs; integrated and long term sector skills and career development in relevant sectors. Our amendments here are based on research team expertise on regional potentials drawn from prior research in the energy sector, and with some inference drawn from other data sources (including the IOTs). Note that the adjustments made to individual commodities here are more modest than those made in the scaling from 250MW to 3GW; we typically increase the level of regional purchases by between 10% - 30%. This means our project regional purchasing propensities for regionally owned facilities (averaged across developmental and operational phases) then sit at around 59% (250MW Pathfinder) and 35% (3GW At-Scale).

We further posit **two** regional ownership scenarios:

A: Integrated into the UK Grid

Here we abstract from issues of net return on capital by assuming a 'strike price' type agreement with UK Government that allows for a reasonable level of return on generation facilities – with this realised in wholesale markets. This approach reflects prior arrangements for renewables and to some extent nuclear. In order to proxy for this regional financial return we use the financial performance and EBITDA information from EDF's Consolidated Segmental Statement for 2023[8] (the latest available). EDF operates the UK nuclear fleet and has a large renewable presence, making it the best current corollary for a potential lagoon operator. This document suggests a wholesale profit margin of around 5%, and we apply this ratio to lagoon estimated generation totals (based on 250MW and 3GW installed capacities). This then comprises our initial social return that we model within the Welsh Government IOTs, to proxy direct-plus-indirect regional returns.

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8 https://www.edfenergy.com/sites/default/files/2024-10/EDF%20CSS%202023.pdf

B: Private Wire with Public Anchor Customer

Our second scenario posits a lagoon which is not connected to the UK grid but services a large (single or set of) geographically proximate public sector (or quasi-public sector) clients. This approach requires a very different set of assumptions and modelling from the first scenario above.

Regional social surplus is no longer driven by wholesale market profits. Instead, it is the difference between the holistic cost of capital (including development and operational costs and interest payments[9]) and the avoided cost of electricity bought retail by our notional relevant customer(s) over the period of lagoon operation (here assumed at 90 years).

We assess the above using the following assumptions:

- The retail cost of electricity for large customers remains unchanged (in £2024) over the period, drawing on a number of forecasts that suggest either price stasis or moderate decline[10],
- Annual power generation estimates for the two lagoons are drawn from our Munday *et al.* (2026) derived averages,
- Noting the lack of grid balancing, we add 4hr-battery storage costs to our 'investment ask'[11], with enough storage required to cover 30% of generation within a tidal cycle.

Table 2 reveals the main assumptions underlying the scenarios A and B.

Table 2: Key assumptions and figures underlying Scenarios A and B

A: Grid connected-regionally owned		
	Pathfinder	**At-Scale**
Gross cost excluding battery	£1.07bn	£10.12bn
GWh daily generation (assumed)	1.4	17.9
GWh generation (assumed) over 90 year operation	44,600	589,500
Annual revenue (assuming £72.58 wholesale price £2024)	£35.98m	£475.40m
Annual wholesale profit at 5% equating to direct social and community impact in modelling	**£1.80m**	**£23.77m**

9 Assumed at 5%, beginning in year 1 of development phase.
10 e.g. https://eibi.co.uk/wp-content/uploads/BNEF2024_UK-Power-Market-Outlook-2024_U-Shaped-Prices_Exec-Summary-Only.pdf; https://www.cornwall-insight.com/files/cornwall-insight-gb-power-market-outlook-to-2030-q4-2023-5af6d256.pdf
11 See https://research-hub.nrel.gov/en/publications/cost-projections-for-utility-scale-battery-storage-2025-update

B: Private wire-regionally owned		
	Pathfinder	**At-Scale**
Gross cost including battery	£1.18bn	£11.615bn
GWh daily generation (assumed)	1.4	17.9
Total cost over 100 years assuming 5% cost of capital	£4.14bn	£40.65bn
Wholesale value of generation (assuming £72.58 wholesale price £2024)	£3.23bn	£42.79bn
Avoided costs (£224.98per MWh*total GWh over 90 year operation*1000/1000000	£10.04bn	£132.63bn
Net benefit (Avoided costs - Total costs)	£5.9bn	£92.0bn
Net benefit per annum equating to direct social and community impact in modelling	**£58.9m**	**£919.7m**

3.3 The Future Electricity Generation Context

In terms of territorial carbon mitigation in Wales, in the best case we would estimate a grid baseline in terms of CO_2e per kWh generated. This is very difficult to do over the expected 100 year lifespan of a tidal lagoon power project. Welsh Government has promised the equivalent of 70% of territorial electricity demand in renewables capacity by 2030, and the UK grid *should* effectively be fully decarbonised by 2050 – but with much uncertainty on the path and generation mix (which might indeed include tidal lagoon power projects). Wales itself has seen a limited renewables capacity increase in the last decade[12].

To abstract from these issues, we model a single-year's carbon mitigation in territorial electricity generation based on a notional 2040. Here we assess the total forecast renewables generation (in TWh) for 2040 and compare this with total territorial electricity demand. We:

- Take the current/latest Welsh grid generation mix and grid renewables generation as a starting point,

12 See https://www.gov.wales/energy-generation-wales-2023

- Take the average renewables onshore development in recent years (in terms of MW and estimated GWh) – largely wind and solar PV – and roll this level[13] of increase through to 2040 (in MW terms), thus estimating total TWh from onshore renewables by 2040,
- Add offshore developments; Awel-y-Mor (576MW) already consented off the north Wales coast, plus experimental Celtic Sea floating offshore (400MW total),
- Assume Welsh territorial electricity demand of 26.2TWh in 2040 based on the National Energy System Operator *Holistic Transition* Future Energy Scenario for Wales.[14]

We have a decision to make as regards the large (4.5GW capacity) leasing round for Celtic Sea floating offshore wind, hoped to be operational in the mid-2030s. If the entirety of Celtic Sea generation, estimated here at approximately 14TWh per annum[15] arrives onshore – and is 'allocated to' Wales, all Welsh demand can be potentially serviced by renewables. This means lagoon benefits are in complementing intermittent renewables – bringing reliability and predictability – but then with 'emissions avoided' extremely hard to calculate. If, however, Celtic Sea on-shores in England, Wales faces a potential shortfall in renewables generation – of, in our approximate calculations, around 8.7GWh.

We thus use this second, far simpler scenario to assess the potential power-generation GHG savings associated with our two tidal lagoon scenarios – i.e. assuming Celtic Sea power is delivered to north Devon. Note here we also assume that in the absence of a lagoon, the remainder of Wales' territorial demand is served by legacy power generation (CCGT) at approximately 180g of CO_2 per kWh[16]. We do not include any potential new within-Wales nuclear in our 2040 electricity generation mix, noting firstly, that the Office for Nuclear Regulation has currently suspended licensing procedures at Wylfa[17] (which appears third-in-line behind Hinkley Point and Sizewell C) and that there are no active discussions on future developments or funding, and secondly that small modular nuclear reactors are some way from UK licensing[18].

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13 In raw MW-capacity-installed terms
14 See https://www.neso.energy/publications/future-energy-scenarios-fes/regional-breakdown-our-fes-2025-data
15 See https://en.wikipedia.org/wiki/Offshore_wind_power
16 See https://assets.publishing.service.gov.uk/media/6846b0870392ed9b784c0187/2025-GHG-CF-methodology-paper.pdf
17 See https://www.onr.org.uk/our-work/what-we-regulate/new-reactors/licensing-of-new-reactors/wylfa-newydd
18 See https://www.onr.org.uk/news/all-news?category=SMRs

As well as estimating the carbon potentially displaced by small and large lagoons[19] we value the avoided social cost based on the UK Government central valuation for 2040 (£326 per tonne of CO_2e)[20].

Table 3 Assumptions on carbon savings

Wales electricity demand 2040 (NESO)	26.211TWh
Assumed TWh gap without Celtic Energy	8.7TWh
Assumed CCGT tCO2 per TWh	180,000
Assumed CO2 connected to 'Gap'	1.567m
Social cost of CO2 connected to 'Gap' £326/tonne	£510.8m
Tidal generation from Pathfinder 250MW (TWh)	0.446
Tidal generation from At-Scale 3000MW (TWh)	5.895
Pathfinder saved CO2 and cost	**80,304 (£26m)**
At-Scale saved CO2 and cost	**1,061,100 (£346m)**

19 Neither of which completely fills the TWh gap in our 2040 scenario.
20 See https://www.gov.uk/government/publications/valuing-greenhouse-gas-emissions-in-policy-appraisal

4 Impact Matrix and Results

A visual representation of the above is presented as Table 4, which inter-relates our three OFO models with the varied (quantifiable) outcomes. Table 4 presents our results in terms of a single average year (for economic and social benefits), and for a notional 2040 in the case of greenhouse gas emissions mitigation. We effectively here sum all development, construction and operational[21] economic impacts for the notional 100 year project period and spread evenly across the period. We nuance this in the narrative.

Note also that we present all results with no future discounting. This diversion from the HM Treasury Green Book approach reflects our view that such discounting is inappropriate for climate-mitigation project that might become more valuable as climate change impacts worsen – and further that such discounting is at odds with the Wellbeing of Future Generations Act (Wales) 2015. A full discussion is available in Jones (2024)[22], and we additionally indicate the net present value of our economic impacts in the narrative.

Table 4 – Ownership, Funding & Operations and Regional Benefits (Single Average Year)[23]

<table>
<tr><th colspan="5">Pathway (250MW)</th></tr>
<tr><td colspan="2">OFO Model</td><td>Commercial/ Non-regional</td><td>Regional via Grid/ for Export</td><td>Regional Private Wire/ local use</td></tr>
<tr><td rowspan="3">Economic Impact (direct+ indirect)</td><td>Output</td><td>£7.9m</td><td colspan="2">£9.8m</td></tr>
<tr><td>GVA</td><td>£4.0m</td><td colspan="2">£5.0m</td></tr>
<tr><td>Employment (FTE)</td><td>120</td><td colspan="2">145</td></tr>
<tr><td colspan="2">Social & Community income (direct)</td><td>-</td><td>£1.8m</td><td>£59.0m</td></tr>
<tr><td colspan="5">Territorial Greenhouse Gas Mitigation (Notional 2040)</td></tr>
<tr><td colspan="2">Tonnes CO2 (direct)</td><td colspan="3">80,304t</td></tr>
<tr><td colspan="2">Avoided cost at £326/tonne CO2e (£m)</td><td colspan="3">£26.0m</td></tr>
</table>

21 But not decommissioning

22 See also for a discussion and review of the issues: Schoenmaker, D and Schramade, W 92024) Which discount rate for sustainability? Journal of Sustainable Finance and Accounting, 3, 100010. Which discount rate for sustainability? - ScienceDirect

23 Note that economic, social and climate benefits are not linear to installed capacity due to differing cost and generation profiles between large and small lagoons. Also note that benefits are averaged over 100 years but only begin in Year 11.

At Scale (3000MW)				
OFO Model		Commercial/ Non-regional	Regional via Grid/ for Export	Regional Private Wire/ local use
Economic Impact (direct+ indirect)	Output (£m)	£44.7m	£55.6	
	GVA (£m)	£23.5m	£29.2m	
	Employment (FTE)	645	800	
Social & Community income (direct)		-	£23.8m	£920.0m
Territorial Greenhouse Gas Mitigation (Notional 2040)				
Tonnes CO2 (direct)		1,061,100t		
Avoided cost at £326/tonne CO2e (£m)		£346.0m		

The above results suggest that a small, experimental lagoon might support between £7.9m – £9.8m of economic output over its decade of construction and 90-year operational lifetime, depending on the level of regional sourcing – which we assume here is positively related to regional ownership. This additional output is associated with £4.0 - £5.0m of annual gross value added over that period. Lagoon construction and operation will require between 120 – 145 FTE employees (direct and indirect) throughout that period – a total of around 10,000 – 15,000 job years. Prior research would suggest that around half of these impacts are associated with the construction and development phases of a tidal lagoon project.

Unsurprisingly the construction and operation of a 3GW lagoon results in far larger economic impacts – up to £56m annually of output and up to close to £30m of GVA. Employment demands reach 650 – 800 FTEs on average over the operational period, with perhaps 30-40,000 person-years required for construction.

Whilst there are some differences in economic and employment outcomes associated with regional/public versus commercial ownership, these differences are far larger when we examine operational mode: economic (and hence in the public ownership case, social) benefits are far higher when the lagoon is financed via debt, and the repayments made, effectively by utilising the savings from public organisations consequently not having to buy electricity on the retail market.

Staying with the ‘at scale’ 3GW case, we posit that at an effective interest rate of 5%[24], and with the assumption of a 100-year project phase with static (in real terms) electricity prices, the avoided cost of retail electricity, net of lagoon-plus-battery storage costs would translate to over £900m of economic/social benefit.

Note that for reasons earlier explained we do not discount these financial returns to achieve a net present value. If we were to apply HM Treasury long term discount rates, our £900m of annual social benefit would (if evenly spread over 100 years, but with returns beginning in Year 11) be worth around £21,000m over the operational period in terms of present value[25].

If we assume that the electricity generated by the 4.5GE Crown Estate leases in the Celtic Sea is transferred to north Devon rather than Wales, a lagoon has a potential role to play in directly displacing legacy fossil fuel (gas) generation. The greenhouse gas emissions savings here, in a notional 2040 for a 3GW lagoon, could reach over 1MT. Using HM Treasury estimates of the social cost of GHG emissions in 2040 would value this saving at almost £350m in that year alone.

[24] Whether financed via shares, municipal bonds or direct borrowing

[25] A present value assessment of the direct plus indirect output and GVA benefits would be more complex due to their front-ending as construction takes place.

5 Discussion

The quantitative analysis presented here is necessarily illustrative. However our objective here is in part to consider how complex issues around the ownership and financing might be understood in a transparent economic modelling framework. We then accept that this is a starting point for discussion. More fine-grained analysis is difficult because of the limited information on the actual costs of barrage construction and limited information in respect of future energy demand and supply scenarios. This latter will determine what economic surpluses and climate mitigation benefits are generated by a lagoon – and then how much of those accrue to Wales.

We can however say that regional ownership (in terms of our simple scenarios) *per se* will likely not have a transformative impact on the level of regional surpluses. This is for two reasons. Firstly, as a relatively peripheral and small economy, lacking in innovative firms and products, and in bespoke technical and other services, the level of local sourcing around lagoon/barrage construction is unlikely to increase radically, even where the ultimate client is a regional public or quasi-public body. It may indeed be the case that public ownership and development might serve to restrict local sourcing, for example if the developer falls under the aegis of the Internal Market Act[26]. Secondly, profit margins for generators are, in the UK electricity wholesale market reasonably modest. Note however that we do not here include any (unknowable) future price premium which may arise for reliable and predictable power generation in an increasingly intermittent world.

26 See https://www.legislation.gov.uk/ukpga/2020/27/contents/enacted

What is clear is that there is the potential for a lagoon to drive far higher levels of regional benefit if it is off-grid: if it can be financed at moderate interest (here 5%), constructed at the cost levels suggested in Munday *et al*, and can operate for close to 100 years. None of this is certain of course – and neither are lagoon reliability and long-term maintenance (and decommissioning) costs[27]. Additionally, an off-grid/private wire solution requires the identification of an appropriate and reasonably local public sector customer(s); the development of very long term (and novel) power purchase agreements; and probably extensive electricity storage to enable matching of power supply and demand over tidal cycles. Off grid development also however brings potential benefits that are not quantifiable, not least the ability to direct power independent of UK grid governance and regulation – for example, to the modest developmentally or socially useful uses, be this (just for example) an energy hungry inward investor or those in fuel poverty. A final option not modelled here – a hybrid approach with local customers taking precedence but then surpluses exported to the grid – might also comprise an opportunity.

[27] Notably of course the latter are socialised for nuclear power generation

6 References

Allan, G., Comerford, D., Connolly, K., McGregor, P., and Ross, A. G. (2020). The economic and environmental impacts of UK offshore wind development: The importance of local content. *Energy*, 199, 117436. https://doi.org/10.1016/j.energy.2020.117436.

Allan, G., Lecca, P., McGregor, P. G. and Swales, J. K. (2014). The economic impacts of marine energy developments: A case study from Scotland. *Marine Policy*, 43, 122-131. https://doi.org/10.1016/j.marpol.2013.05.003

Allan, G., McGregor, P. G., Swales, J. K. and Turner, K. (2007). Impact of alternative electricity generation technologies on the Scottish economy: An illustrative input—output analysis. *Proceedings of the Institution of Mechanical Engineers, Part A: Journal of Power and Energy*, 221(2), 243-254.

Allan, G.J. and Gilmartin, M. (2015) Regional employment impacts of marine energy in the Scottish economy: A general equilibrium approach. Regional Studies, 49(2), 337-355. DOI: 10.1080/00343404.2014.933797;

Allan, G.J., McGregor, P.G. and Swales, J.K. (2011). The importance of revenue sharing for the local economic impacts of a renewable energy project: A Social Accounting Matrix approach. *Regional Studies*, 45(9), 1171-1186. DOI: 10.1080/00343404.2010.497132.

Bere, K., Jones, C., Jones, S. and Munday, M. (2017) Energy and Development in the Periphery: A regional perspective on small-scale hydro-projects, *Environment and Planning C*. 35 (2), 355-375. https://doi.org/10.1177/0263774X16662029

Bianchi, M. and Fernandez, I. F. (2024). A systematic methodology to assess local economic impacts of ocean renewable energy projects: Application to a tidal energy farm. *Renewable Energy*, 221, 119853. https://doi.org/10.1016/j.renene.2023.119853

Bryan, J., Evans, N., Jones, C., and Munday, M. (2017). Regional electricity generation and employment in UK regions. *Regional Studies*, 51(3), 414-425. https://doi.org/10.1080/00343404.2015.1101516.

Dalton, G., Allan, G., Beaumont, N., Georgakaki, A., Hacking, N., Hooper, T., Kerr, S., O'Hagan, A., Reilly, K., Ricci, P., Sheng, W. and Stallard, T. (2015). Economic and socio-economic assessment methods for ocean renewable energy: Public and private perspectives. *Renewable and Sustainable Energy Reviews*, 45, 850-878. http://dx.doi.org/10.1016/j.rser.2015.01.068

Fanning, T., Jones, C. and Munday, M. (2014). The regional employment returns from wave and tidal energy: A Welsh analysis. *Energy*, 76, 958-966.

Faria, F. A. M. de, Davis, A., Severnini, E. and Jaramillo, P. (2017). The local socio-economic impacts of large hydropower plant development in a developing country. *Energy Economics*, 67, 533-544. https://doi.org/10.1016/j.eneco.2017.08.025.

Heinbach, K., Aretz, A., Hirschl, B., et al. (2014). Renewable energies and their impact on local value added and employment. *Energy, Sustainability and Society*, 4. 1. https://doi.org/10.1186/2192-0567-4-1.

Jenniches, S. (2018). Assessing the regional economic impacts of renewable energy sources: A literature review. *Renewable and Sustainable Energy Reviews*, 93, 35-51. https://www.sciencedirect.com/science/article/pii/S1364032118303447

Jones, C. (2022) *Input-Output tables for Wales, 2019*. Available from Welsh Economy Research Unit, Cardiff Business School.

Jones (2024) Cheapening tomorrow? Revisiting HM Treasury's discount rate. City-REDI Blog, 16th April 2024, https://blog.bham.ac.uk/cityredi/2024/05/16/

Jones, C. and Munday, M. 2020. Capital ownership, innovation and regional development policy in the economic periphery: an energy industry case. *Local Economy*, 35(6), 545-565. https://doi.org 10.1177/0269094220968048

Khojasteh, D., Shamsipour, A., Huang, L., Tavakoli, S., Haghani, M., Flocard, F., Farzadkhoo, M., Iglesias, G., Hemer, M., Lewis, M., Neill, S., Bernitsas, M.M., and Glamore, W. (2023). A large-scale review of wave and tidal energy research over the last 20 years. *Ocean Engineering*, 282, 114995. https://doi.org/10.1016/j.oceaneng.2023.114995

Lyddon, C., Plater, A. J., Brown, J. M., Prime, T. and Wolf, J. (2015). The impact of tidal lagoons on future flood risk on the North Wirral and Conwy coastline, UK. *National Oceanography Centre Internal Document*, No. 16. https://nora.nerc.ac.uk/id/eprint/512250/1/NOC_ID_16_revised.pdf

Munday, M., Reynolds, L. and Roberts, A. (2023). Re-appraising 'in-process' benefits of strategic infrastructure improvements: Capturing the unexpected socio-economic impacts for lagging regions. *Transport Policy*, 134, 119-127. (10.1016/j.tranpol.2023.02.012)

Munday, M., Ahmadian, R., Turner, K., Formosa, N., & Roche, N. (2026). Might tidal range schemes change the local economic impact dial on renewable electricity generation?. Renewable and Sustainable Energy Reviews, 226, 116200.

Pappas, K., Chien, N.Q., Zilakos, I., Beevers, L., and Angeloudis, A. (2025). On the economic feasibility of tidal range power plants. *Proceedings Proc. R. Soc. A*. 481: 20230867. https://doi.org/10.1098/rspa.2023.0867

Prime, T., Wolf, J., Lyddon, C., Plater, A. and Brown, J. (2017). The potential of tidal barrages and lagoons to manage future coastal flood risk. *Geophysical Research Abstracts*, 19, 18785.

Severn Estuary Commission (2025). *Socio-economic workstream. Final report*. https://www.severncommission.co.uk/wp-content/uploads/2025/03/Severn-Estuary-Commission-Socio-Economics-Workstream-Final-Report-v2.0-compressed-compressed.pdf

7 Appendix 1 Wales Input-Output Framework

The local economic effects of tidal range projects were estimated using the framework on input-output tables for Wales. This framework is based on the assumption that new economic activity in Wales can have economic impacts, according to the level and nature of related spending and how that spending links to other parts of the Welsh economy. To examine the economic significance of a tidal range scheme it is important to differentiate between the direct and the indirect economic consequences.

Direct consequences are those associated with the activity itself, usually expressed in terms of outputs (or turnover), gross value added and jobs. Here then the scenario tidal range projects could be associated with different amounts of capital spending through the construction and development period.

These direct economic impacts are a part of the economic impact. Direct spending associated with a tidal range projects would have indirect consequences according to how monies are spent locally. The project developers could buy as inputs some of the outputs of other Welsh industries, such as electricity, professional services, security etc. This local purchasing then leads to further local spending and so on. These 'supplier' effects then depend on the level of local sourcing for the particular sector and on levels of regional sourcing by its suppliers etc.

This 'supplier' effect is just one element of local economic effects. In addition the employment supported directly and indirectly by potential tidal range schemes adds to local household incomes and some of these incomes are also spent locally, and this adds to local economic effects. Similarly, regional suppliers to the tidal range development also add to local incomes, as will their suppliers etc. These are called 'induced-income' effects and when added to 'supplier' effects they form the total indirect consequences of the direct regional economic activities, which can be expressed in terms of spending, incomes and jobs.

To estimate these indirect or multiplier consequences a model of the regional economy that shows how the various sectors fit together in terms of their trading relationships is required. This then allows the effects of activity in one sector to be traced through the entire local economy. In Wales there are a developed framework of Input-Output tables which can be used for this analysis. Then estimates of economic impact found in Table 2 of this report makes use of output, value added and employment multipliers to establish relationships between estimated TRS capital and operational spending and then wider Wales-level impacts in terms of employment, value added and output supported. Further information on the Wales Input-Output tables is available in Jones (2022).