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Policy Brief

Long term economic viability of tidal range energy: The role of revenue models, social benefits and discount rates

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Summary

New research by the Centre for Energy Policy, as part of the EPSRC TARGET project, shows that under current market arrangements, such as the prevalent Contract for Difference (CfD) framework, tidal range schemes (TRSs) are unlikely to deliver a positive net present value (NPV) during the lifetime of the assets created. This is due to the high upfront costs and long construction periods associated with TRS projects, combined with uncertainty over energy prices and revenue streams. Our research involves conducting cost-benefit analyses for illustrative UK TRSs of varying sizes, including consideration of the impact of valuing social benefits (e.g., flood defences) and other routes to securing a discount rate that is lower than the likely market one for TRSs.

The results suggest that valuing limited social benefits such as the flood defence properties of TRSs may not alter the NPV picture much. Rather, any potential application of a social discount rate associated with such valuation may have a greater impact on economic feasibility outcomes. Another potential context for measurement of a wider range of social benefits and application of a social discount rate may be some extent of public ownership. However, there is not much appetite for such an extent of government intervention for energy system assets in the UK. Thus, we identify another route to achieving lower discount rates, and also earlier revenue streams to support relatively high upfront costs. This is the potential for the UK Government to consider a regulated asset base (RAB) approach, as it has done for nuclear power generation.

The research considers a range of potential policy interventions and how these may impact on the NPV within the lifetime of TRS assets. We find the following:

- Only a relatively high electricity price threshold in excess of £200/MWh, considerably higher than may be expected via the standard UK CfD instrument, is likely to enable TRS projects of any size to achieve a non-negative NPV within a projected 40-year investment return period.
- Valuing social benefits, like flood defence, typically fails to generate a non-negative NPV unless a lower social discount rate, such as the 3.5% rate applied by HM Treasury, is also used.
- The combination of an interest rate lower than the standard market rate and access to an early revenue stream through the RAB model achieves a non-negative NPV at a much lower electricity price threshold of £48/MWh.

Thus, our research suggests that a RAB approach merits UK Government attention in considering the appropriate financing mechanism to unlock the potential contribution of tidal range to securing a low carbon energy future. However, there may be the need for the regulatory framework to evolve in terms of the wider implementation of RAB schemes, especially where critical public infrastructure is involved. On the other hand, if the existing CfD remains the preferred mechanism to promote TRS, the allocation policies may need to be revised to introduce a capacity-based allocation mechanism to better align CfD with the promotion of TRSs. This would be based on its potential to contribute not only to low-carbon electricity generation but also in offering significant energy storage capacity and flexibility for the national electricity grid infrastructure.

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Introduction

Tidal range schemes (TRSs) use the difference in height between high and low tides to drive turbines for renewable electricity (RE) generation. Due to their long operational lifetimes, up to 120 years, and large generation capacity, TRSs can constitute a reliable low carbon energy supply option and serve as energy storage capacity to boost stability of the electricity grid. However, TRS projects in the UK face financial viability challenges when evaluated with private investor discount rates, due to high initial capital cost, lengthy construction periods, and uncertainty over energy price and revenues streams. To investigate these challenges further, the Centre for Energy Policy has conducted an evaluation of policy approaches that might help deliver a positive net present value (NPV) of TRSs over assumed 40-year return-on-investment window. The analysis tested several approaches, including social and private discount rates (with inclusion of revenue from social benefit from flood defence protection), the existing CfD[i] mechanism and the Regulated Asset (RAB) model[ii] funding scheme.

Key findings emerging

The importance of the discount rate

Our research considered 3 illustrative TRS schemes based on size: A (250MW), B (750MW), and C (3000MW). The results in Table 1 show the net present value (NPV) delivered by a cost-benefit analysis (CBA) under varying assumptions about the electricity price profile (with low, central and high cases) and the discount rate applied (taking a social discount rate based on the HMT rate of 3.5%[iii] and a representative market discount rate for TRS of 10%[iv]).The CBA also includes illustration of revenue from flood defence cost savings as an example of social benefit associated with TRS[v].

Table 1 shows that all but one illustrative TRS scheme (scheme A, the smallest, with the lowest electricity price profile, £75.58MWh) deliver a positive NPV if a sufficiently low (here social) discount rate is applied. On the other hand, when the higher representative market discount rate is applied, none of the schemes deliver a positive NPV. As part of the fuller underlying research, we also considered how the valuation of social benefits (taking the example of flood defence cost savings) may impact outcomes and found that this had little impact on its own. That is, our findings suggest the social discount rate is the key driver of positive outcomes. In practise, with a potential decreasing appetite for state ownership of such large infrastructure assets in the UK, the route for adopting social discount rate for TRS projects as a whole (beyond the delivery of social benefits) is unlikely to be viable, or even put on the table. However, where the challenge lies in the level of the discount rate, rather than whether it is explicitly a social one, there could still be feasible routes for policy intervention.

Table 1: Results of estimate of NPV of the TRS schemes with social benefit using social discount rate (3.5%) and illustration with 10% discount rate with inclusion of flood defence cost savings (assumed social benefit)

NPV (£m)	Electricity price profile (£/MWh)		
	75.58	**87.68**	**105.19**
(social discount rate 3.5%)	**Low**	**Central**	**High**
NPV of Scheme A	-58.14	74.87	267.24
NPV of Scheme B	183.25	549.26	1078.63
NPV of Scheme C	1723.76	3069.51	5015.92
(private market discount rate 10%)			
NPV of Scheme A	-289.44	-258.49	-213.74
NPV of Scheme B	-560.64	-490.89	-390.00
NPV of Scheme C	-1594.40	-1384.78	-1081.60

Source: Authors, 2024. Currency and any conversion are in 2021 pounds (£) equivalent.

The role of policy support mechanisms

An alternative to public ownership and/or the application of full social discounting is the Regulated Asset Base (RAB) model, which enables a longer-term regulated price to be secured by privately owned (or corporatised state-owned) energy supply assets and delivers revenue stream (through a regulated tariff on consumer bills) throughout the lifetime of the asset in question, including the construction and commissioning phase. It could also provide a route by which socioeconomic and environmental benefits to be built in with the application of a lower if not fully social discount rate.

Here we consider a RAB approach with an illustrative 5% discount rate and compare with a case where a sufficiently high CfD is applied to allow Scheme B (750MW), taken as an illustrative case, to achieve a non-negative NPV within the assumed 40-year operating (plus 13-year construction) return-on-investment window.

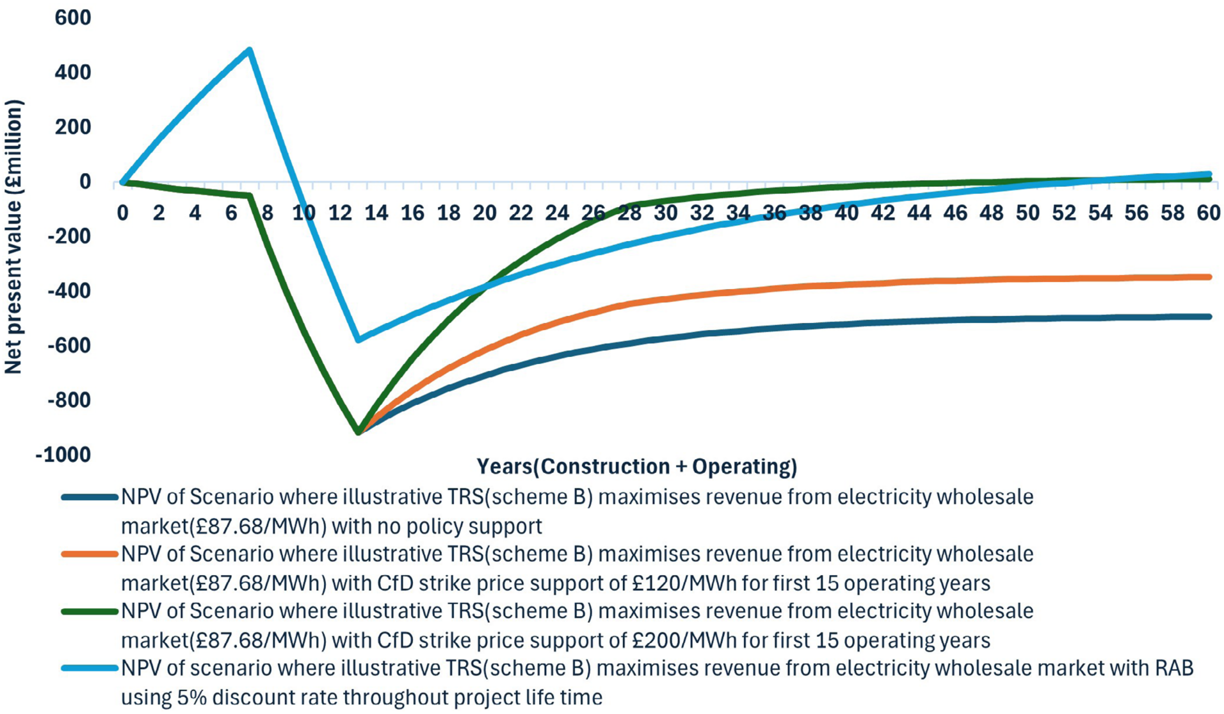

Figure 1. Evolution of the net discounted NPV of scenarios assessing the long run economic viability of illustrative tidal range scheme B (750MW) with CfD and RAB revenue support mechanisms and the case of no policy support. Currency and any conversion are in 2021 pounds (£) equivalent. The assumed return on investment window at which the economic viability is assessed is 40-year operating time. Construction time for scheme B is 13 years (53 years in total). Private market discount rate of 10% is applied for the NPV analysis.

Figure 1 shows that the discounted NPV reaches the economic feasibility threshold at year 48 and 53 (with a 13-year construction plus operating year period) under the CfD and RAB policy support mechanisms, respectively. However, the CfD model requires a high electricity generation strike price of at least £200/MWh (almost double the 2021 average market price and significantly above the high price profile in Table 1) to make the TRS economically viable. In contrast, a positive NPV can be achieved under the RAB model with a regulated price of £48/MWh.

The key difference is that RAB allows the revenue support to be granted for the entire lifetime of the TRS asset starting from the beginning of construction phase (year 1 to year 13) whilst the CfD is only granted for the first 15 years of the asset operating phase (from year 14 to year 28). Thus, the revenue certainty from RAB starting at the construction phase and lasting for longer minimises risks and allows a lower discount rate (here assumed 5%) to be applied to the valuation of the TRS project which contributes to higher positive discounted net cashflow. This RAB model's potential to lower the weighted average cost of capital, thus reducing the overall cost of energy, makes it a promising revenue support mechanism for TRSs.

Conclusion and Policy Implications

The economic valuation analysis of the illustrative Tidal Range Schemes demonstrates that potential policy route may exist to incentivise private investment in such large-scale energy supply and storage projects through the likelihood of a positive return on investment. This is through the combination of securing early revenue streams and securing a discount rate below the likely market one, without having to justify the application of full social discounting. Here, we identify the extension of a Regulated Asset Base (RAB) approach from nuclear to other energy system options with high upfront costs and long construction periods, such as tidal range. Since the application of the RAB model in the UK has been limited to date, there is likely to be a need for the regulatory framework to evolve if it is to be applied more widely, especially where critical public infrastructure is involved.

However, there is a further central challenge in designing the policy and regulatory framework to ensure that the low electricity generation price afforded to private investors of TRSs or other long operational lifetime assets under the RAB scheme translates into long-term reductions in consumer bills. This is especially important when the consumer bills, in most cases, may be used to fund a substantial part of the infrastructure project (to guarantee an early stream of revenue for the private investor).

If CfD remains the preferred mechanism of intervention in the UK, policy adjustments will also be necessary, in the case of TRSs to accommodate the high CfD strike price needed for projects to achieve financial viability. The current review of electricity market assessment by the UK Government's Department for Energy Security and Net Zero[vi] could arguably benefit from including a capacity-based CfD allocation mechanism, on the basis of TRSs' potential to contribute not only to low-carbon electricity generation but also in offering significant energy storage capacity and flexibility for the national electricity grid infrastructure.

In short, while our research findings do suggest potential routes forward, determining the State's role in financing large, high-cost infrastructure projects with long operational lifetimes - like TRSs - remains a complex policy question. Ultimately, any decision around support for tidal range will hinge on political considerations rather than purely economic analysis, given the need to balance national energy goals with fiscal responsibility and public-private sector dynamics.

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End-notes and references to underlying research

i CfD is currently the UK government's main mechanism for advancing low-carbon electricity generation where renewable energy electricity producers or developers are paid flat indexed rate electricity generation price for a 15-year period which is equivalent to the difference between a 'strike price' and 'reference price'. The 'reference price' is a measure of the average market price for electricity in the UK while the 'strike price' is a price for electricity reflecting the cost of investing in a particular low carbon technology.
See: DESNZ, 'Contracts for Difference (CfD): Allocation Round 7', 2023e. [Online]. Available: https://www.gov.uk/government/collections/contracts-for-difference-cfd-allocation-round-7.
DESNZ, 'Contracts for Difference (CfD)':, 2016. [Online]. Available: https://www.gov.uk/government/collections/contracts-for-difference.

ii RAB model is a financing method used in the UK for large-scale infrastructure projects, such as water, gas, and electricity networks. The Nuclear Energy (Financing) Act 2022 introduced the RAB model as an option to finance future nuclear energy projects which typically derisks an investment by providing a regulated asset-based financing where lower discount rate is charged, with the costs of financing typically paid by consumers through a regulated tariff right from the beginning of the construction phase of the project.
See: OECD, 'The Regulatory Asset Base Model and the Project Finance Model: A comparative analysis', Internal transport forum. [Online]. Available: https://www.oecd-ilibrary.org/docserver/5jrw13st0z37-en.pdf?expires=1725899731&id=id&accname=ocid177542&checksum=0B345DBB5E513C230F5928538061E3FF.
UK Government, 'Nuclear Energy (Financing) Act 2022', 2022. [Online]. Available: https://www.legislation.gov.uk/ukpga/2022/15/contents.

iii UK's Green Book, 2022. [Online]. Available: https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-government/the-green-book-2020

iv DESNZ, 'Review of Technical Assumptions and Generation Costs Levelised Cost of Electricity from Tidal Stream Energy.', 2023d. [Online]. Available: https://assets.publishing.service.gov.uk/media/655372484ac0e1001277d819/tidal-lcoe-report.pdf

v In calculating the flood defence benefit from the TRS, an opportunity cost/savings approach is adopted which involves calculating the number of houses protected with the flood defence as against the assumed costs and fixed payment rate offered by the government to potential affected households. We used the UK Census data to first locate coastal communities who are likely to be affected by flooding resulting from the proposed TRSs (here, we focused on 4 TRSs of varying sizes, namely Swansea Bay Lagoon; Cardiff Bay lagoon; Colywn Bay lagoon and West Somerset tidal lagoon) and applied the flood defence calculation. We then calculated that of our illustrative schemes from these initial results.

vi DESNZ. 'Review of Electricity Market Arrangements (REMA)'. GOV.UK, 12 March 2024. https://www.gov.uk/government/collections/review-of-electricity-market-arrangements-rema.