Tidal Stream Suitability Assessment – Data Centre Offtake

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CONTENTS

NOMENCLATURE

AEP	Annual Energy Production
BESS	Battery Energy Storage System
CAPEX	Capital Expenditure
CfD	Contracts for Difference
LCOE	Levelised Cost of Energy
Li-ion	Lithium ion
OPEX	Operational Expenditure
PPA	Power Purchase Agreement
TSE	Tidal Stream Energy

1 INTRODUCTION

Tidal stream energy (TSE) is an emerging renewable energy source that could make a meaningful contribution to global net zero ambitions. Compared with other renewable energy sources, a key benefit of TSE is that it is highly predictable, both in terms of the quantity and timing of its power. This could provide crucial balancing support to electricity grids, particularly as more intermittent renewable energy generation sources are added to networks. In the case of the UK, studies have shown that TSE could lower the costs of operating the energy system in the order of £100m - £1bn per year [1] [2], due to reduced requirements for grid upgrades, storage systems and electricity imports.

The predictability of TSE also lends itself to alternative offtakes that have consistent demand and require stable energy supply and costs. Preliminary studies have shown that TSE could be highly effective for green hydrogen production and the replacement of fossil fuel generation in off-grid communities [3] [4].

This study investigates the feasibility of using TSE to meet the energy demands of data centres, which are increasingly being built to run digital services necessitated by modern society, including AI and cloud computing. A key challenge to this rapid development is that data centres require significant amounts of electricity. For example, data centres currently consume around 2.5% of the UK's electricity and this is expected to rise four-fold by 2030. This has put additional pressure on already strained grid infrastructure. Limited grid capacity means it can take years to get permission to connect to the national grid.

There are also concerns about the sustainability of data centres. Major data centre operators have committed to achieving voluntary sustainability targets by 2030. They support renewable energy projects through green power purchase agreements (PPA), although it is disputed whether green PPAs contribute to tangible decarbonisation. Some operators have co-located wind and solar with data centres to meet a portion of their energy demands, while others are exploring nuclear power, including small modular reactors, as a source of clean, reliable power.

The assessment presented here considers a range of TSE scenarios combined with a battery energy storage system (BESS) to evaluate the effectiveness of this arrangement in meeting the energy demands of a data centre. A logic model was developed to determine how power should be distributed between the combined tidal-BESS-data centre arrangement.

2 METHODOLOGY

2.1 Project Configuration

The study considers a hypothetical scenario where a data centre is connected via a private network to a TSE farm at the Morlais site, a large-scale tidal energy project off the west coast of Anglesey in Wales. Developed by Menter Môn, Morlais provides shared seabed infrastructure and grid connection (rather than a private network) to allow multiple tidal technology developers to deploy and test commercial-scale TSE devices in one location. The scheme has the potential to generate up to 240 MW of low carbon clean electricity.

Figure 1. Morlais project location off Anglesey, Wales

In this study a BESS is co-located onshore with the data centre to store excess energy from the TSE farm, which is then used to provide power to the data centre when its demand cannot be met by the TSE farm, e.g. during slack water periods. Additionally, the grid connection is available to export excess electricity during high TSE farm generation periods and when the battery is fully charged, whilst also cover any shortfall from the TSE-BESS arrangement during low generation periods, including during neap tidal conditions where the BESS can become fully discharged. The grid connection can also provide backup supply during any TSE farm downtime periods, such as maintenance or storm related outages, although these have not been considered in this analysis.

Table 1 shows the base case TSE farm and BESS capacities assumed for an 80 MW data centre. At 240 MW, the TSE farm has an installed capacity that is 3 times greater than the data centre demand. Meanwhile, the BESS has a 160 MWh capacity, enough to provide 2 hours of storage in full load conditions (80 MW continuous power delivery).

Table 1. Base case scenario project configuration

TSE Farm Capacity [MW]	BESS Capacity [MWh]	Data Centre Demand [MW]
240	160	80

Other TSE farm and BESS capacities are evaluated later in the study as part of a sensitivity analysis to assess how these variables affect overall performance.

2.2 Energy Generation Modelling

2.2.1 TSE Generation Modelling

To model the power output from the TSE farm, a generic turbine power curve was combined with a 1-year time-series of tidal flow speed data from the Morlais site, derived from a validated hydrodynamic model. This allowed the output from the TSE farm to be calculated on an annual basis and over each 10-minute time step, which was required to determine how power should be distributed between the data centre, BESS and grid (see Section 2.2.4). The power curve includes consideration for power conversion and transmission related losses between the turbine rotor and onshore data centre.

Key simplifications applied in the modelling which could impact the energy output from the TSE farm (negatively and positively) include:

- All turbines in the TSE farm are assumed to perform the same, i.e. the TSE farm output is equivalent to the power output of a single turbine multiplied by the number of turbines in the farm. There are several differences with reality that could impact TSE farm performance, including:
    - Flow speed variation across the site will mean that turbines perform differently (better and worse) based on where they are located.
    - Related to the above, Morlais was established to allow the deployment of multiple technologies at the site. Here just one technology is considered, which may not be the most optimum at all locations. The sensitivity analysis does, however, evaluate different turbine sizes (see Section 3.2.3).
    - Wake effects across the TSE farm are not considered, meaning that turbines located downstream of other turbines may have a lower performance due to being in a region where the flow speed has not fully recovered.
    - A TSE farm of this size could create blockage effects, resulting in a change of the hydrodynamics and potentially reducing the extractable energy.
- The turbines are assumed to perform equally in ebb and flood tidal conditions. This assumption is fair for TSE turbines that have yaw capability, but some technologies in

development do not. This is due to the fact that most tidal sites are bidirectional in nature, meaning that a yaw system can be removed by adopting blades that pitch 180° between tidal cycles or are symmetrical in profile. Typically there will be a small performance penalty due to most sites not having perfectly rectilinear ebb-flood tidal flows (including Morlais), plus due to the rotor being downstream of its supporting structure during one tidal state. It is not uncommon for TSE turbines to have differing power curves for ebb and flood generation.

- No downtime (partial or full) is assumed in the TSE generation modelling. In reality, downtime associated with planned and unplanned maintenance would be expected, as well as due to extreme storm related conditions. Similarly, no downtime has been applied to the BESS or data centre.

2.2.2 BESS

This investigation considers lithium-ion (Li-ion) batteries as the primary technology for the Battery Energy Storage System (BESS). The key advantages of Li-ion batteries include their high energy density, which minimises system footprint, and their versatility, enabling deployment across a wide range of applications. Li-ion technology also offers high efficiency and supports numerous charge–discharge cycles, making it well suited for long-term operational use.

However, the safety of Li-ion batteries must be carefully managed through the implementation of an advanced Battery Management System (BMS) and the incorporation of multiple safety mechanisms at both the cell and system design levels. These additional control and safety requirements contribute to the relatively high capital expenditure (CAPEX) currently associated with Li-ion battery systems [5].

2.2.3 Data Centre

For this study, it is initially assumed that an 80 MW constant power demand is required for the operation of a locally sited data centre. This assumption is used to assess the effectiveness of TSE in providing baseload power, which could equally be applied to other offtakes with similar demand requirements.

In reality, data centre power demand is highly structured but not perfectly constant. It varies over multiple time-scales, driven by IT workload, cooling requirements, and operational design constraints. Additionally, modern hyperscale operators can actively move workloads geographically to follow electricity prices, renewable availability and carbon intensity. This study also considers how implementing demand flexibility could enable the data centre to operate off grid.

2.2.4 Power Flow Logic

A logic model was developed to determine during each time step the power flow paths between the TSE farm, BESS, data centre and grid. The power flow logic applied in the energy generation modelling is described below:

(a) When electricity produced by the TSE farm exceeds demand from the data centre, the excess generation is used to charge the BESS (dashed blue line). If the BESS is fully charged, excess generation from the TSE farm is exported to the grid (dashed green line).

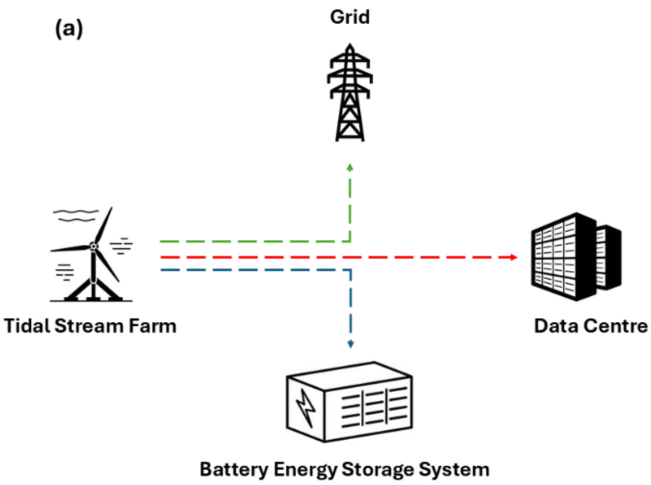

Figure 2. TSE farm output exceeds data centre demand – Scenario (a)

(b) When electricity produced by the TSE farm is insufficient to meet the data centre demand, the energy shortfall is provided by the BESS (dashed blue line) and it discharges.

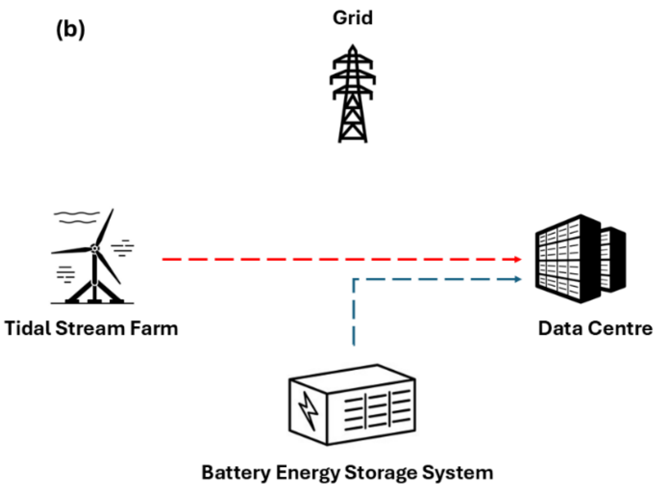

Figure 3. TSE farm output lower than data centre demand - Scenario (b)

(c) When the combined electricity available from the TSE farm and BESS is insufficient to meet the data centre demand, the energy shortfall is provided by the grid (dashed green line).

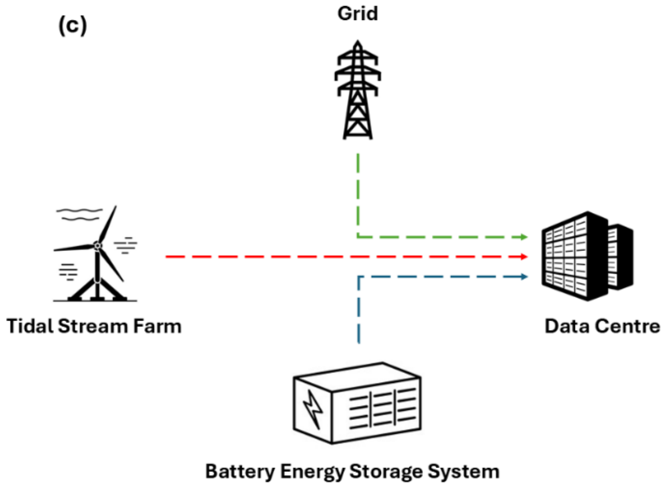

Figure 4. Combined output from TSE farm + BESS is lower than data centre demand – Scenario (c)

The power flow logic is illustrated further in Figure 5, which shows how power is distributed across the system during a period of high generation in a spring tide. It can be seen that the BESS begins to discharge once the TSE farm output drops below the data centre demand (80 MW). The BESS effectively ensures that the data centre's demand is met during slack tide periods and then begins to recharge once the TSE farm output exceeds 80 MW. Once the BESS is fully charged and if the TSE farm output is greater than 80 MW, the excess power is exported to the grid.

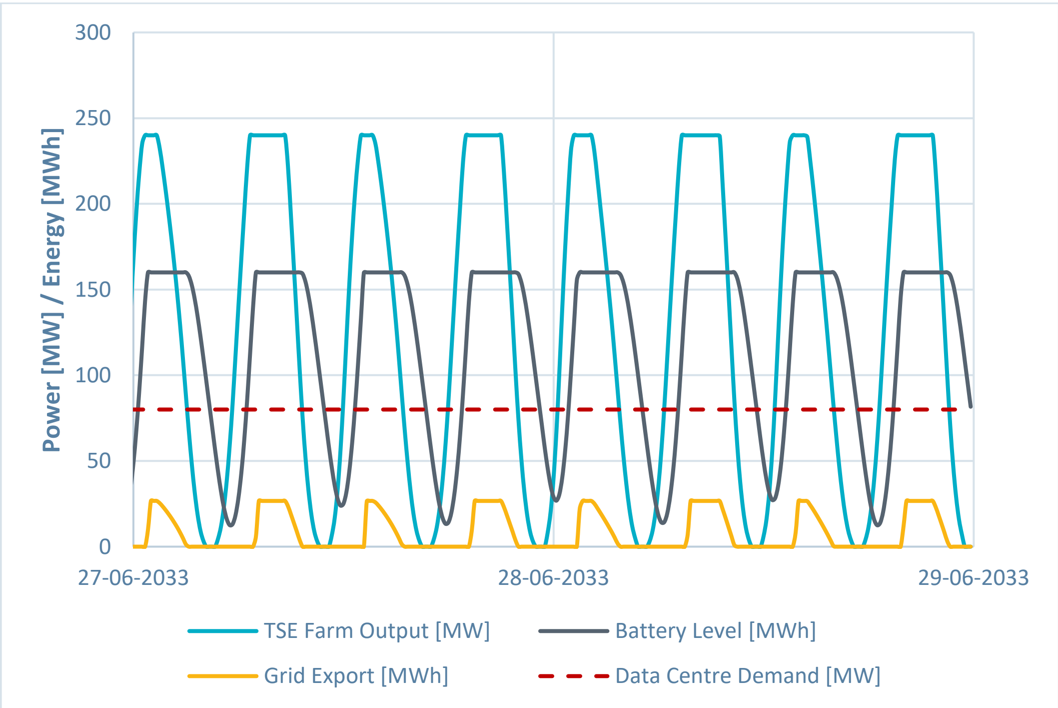

Figure 5. Time-series of power flow during a high generation period

Similarly, Figure 6 shows how power is distributed across the system during a period of low generation in a neap tide. The BESS becomes fully discharged during slack water periods and power is imported from the grid to meet the data centre demand. Note that a maximum import level of 13.3 MWh[1] is shown due to the analysis being conducted over 10-minute time steps.

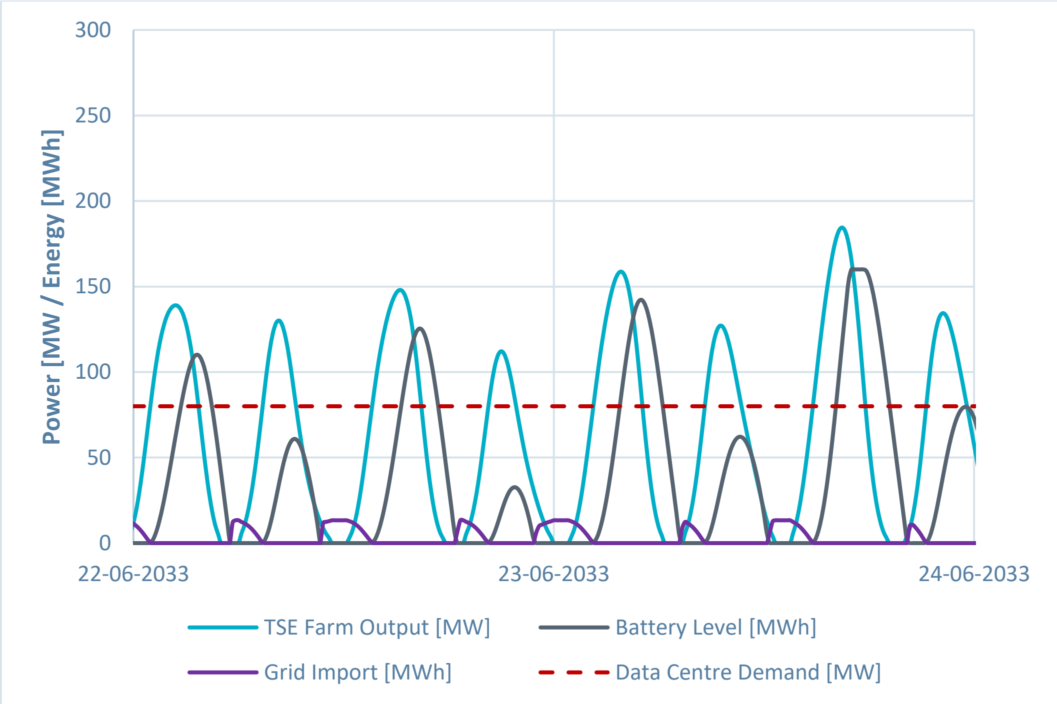

Figure 6. Time-series of power flow during a low generation period

[1] 80 MW is equivalent to an energy usage of 13.3 MWh every 10 minutes

3 RESULTS

3.1 Base Case Scenario

Table 2 summarises the results from the power flow logic model in the base case scenario (Table 1). It can be seen that the TSE farm achieves an annual energy production (AEP) of 739 GWh, equivalent to a capacity factor of 0.35. Approximately 23% of this output (170 GWh) is exported to the grid during periods of high generation and when the BESS is fully charged.

The annual energy usage of the data centre (701 GWh) is slightly less than the TSE farm AEP, but due to the temporal mismatch between energy generation and demand, the data centre is required to import 131 GWh from the grid during periods of low generation. However, the combined TSE + BESS arrangement provides over 81% (equivalent to 570 GWh) of the data centre's electricity requirements. This would be just 59% without the BESS.

Table 2. TSE farm electricity distribution and data centre electricity source in base case scenario

240 MW TSE Farm			80 MW Data Centre Electricity Source		
AEP [GWh]	Capacity Factor [-]	Grid Export [GWh]	TSE Farm [GWh]	BESS [GWh]	Grid Import [GWh]
739	0.35	170	412	158	131

3.2 Sensitivity Analysis

This Section explores how key generation variables affect the electricity sourced by the data centre, relative to the base case scenario in Section 3.1. In all scenarios in this Section, the data centre's demand is unchanged from 80 MW.

3.2.1 BESS Capacity

The base case scenario considered a BESS with a capacity of 160 MWh. Intuitively it should be expected that increasing the BESS capacity will reduce both grid export (from the TSE farm) and import (to the data centre). While these are both true, introducing additional storage capacity does not significantly reduce either, as shown in Figure 7.

For example, doubling the BESS capacity to 320 MWh (enough to provide 4 hours storage at full load) reduces the electricity imported from the grid to 120 GWh, down from 131 GWh in the base case scenario. Similarly, exported electricity is reduced from 170 GWh to 159 GWh. Extending this further, a BESS with a capacity of 960 MWh (12 hours of storage at full load) reduces grid imports to 104 GWh and exports to 143 GWh. Therefore, there is a diminishing return from introducing additional BESS capacity beyond the 160 MWh used in the base case scenario.

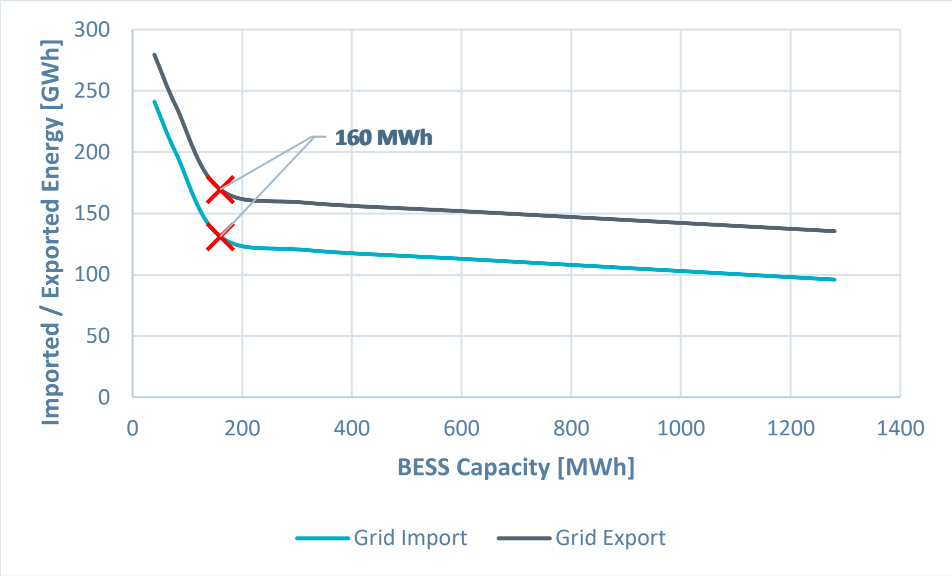

Figure 7. Relationship between BESS capacity and electricity exported / imported

Conversely, if the BESS capacity is reduced, this does significantly impact both grid exports and imports. For example, reducing the capacity to 80 MWh (1 hour of storage at full load) increases grid imports to 199 GWh and exports to 237 GWh. This implies that 160 MWh, or 2 hours of storage, is an approximate optimal point where a good balance between system performance and cost is found. BESS costs are approximately proportional with capacity, meaning that doubling capacity would increase CAPEX and OPEX by a factor of 2.

These findings are supported by Figure 5 which shows the BESS effectiveness at covering slack tidal periods. Conversely, Figure 6 highlights how this becomes more challenging during neap periods, with the BESS becoming discharged and not fully recharging between slack tidal periods. Due to neap tidal periods lasting several days, increasing the amount of storage would help initially but ultimately just delays the point at which the BESS becomes discharged.

3.2.2 Generation Capacity

This section considers the impact of TSE generation capacity (or installed farm size) on the amount of electricity imported by the grid. The BESS capacity is unchanged from the base case (160 MWh) in all scenarios. Figure 8 shows the relationship between TSE farm size and imported electricity.

The BESS becomes increasingly ineffective at the lower end of the generation scale as there are fewer periods in which the TSE farm output exceeds the data centre demand and can charge the BESS. At the extreme end, where there is just 80 MW TSE generation, the BESS cannot be charged and all of the TSE farm's output goes to the data centre. The majority of the data centre's electricity (65%) must be sourced from the grid in this scenario. Increasing TSE generation to 160 MW, still lower than the base case, reduces imported electricity significantly to 32%. In this same scenario less than 4% of the TSE farm's output is exported to the grid.

Increasing generation has the expected result of reducing grid imports and increasing exported electricity from the TSE farm. Imported electricity decreases from 19% to 8% between the 240 MW base case and 400 MW generation scenarios. Similar to the BESS capacity results (Section 3.2.1), the returns on the reduction of imported electricity diminish with increasing generation capacity.

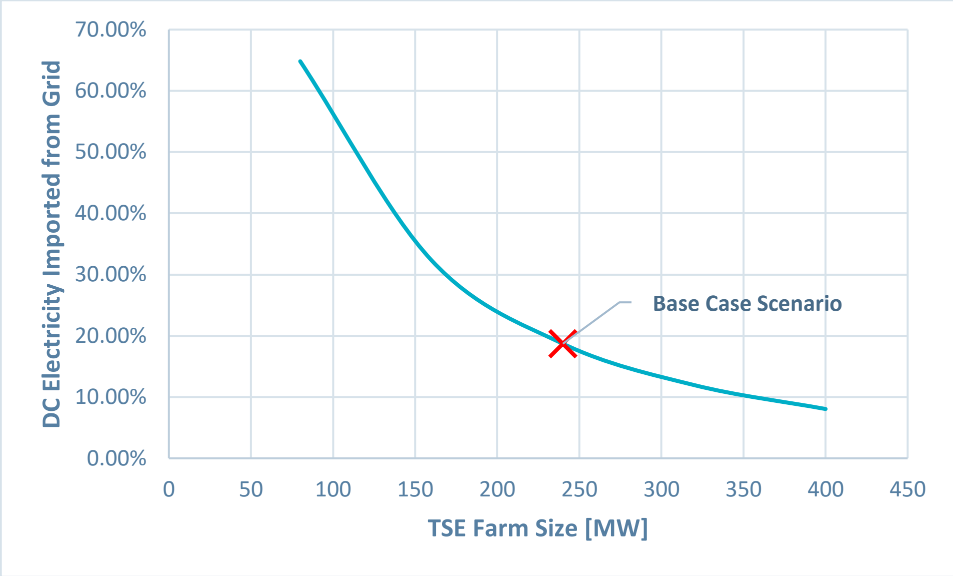

Figure 8. Relationship between TSE farm size and electricity imported from the grid

Increasing the BESS capacity would enable the higher generation scenarios to get closer to 0% imports, but the findings from Figure 7 still apply here and only marginal gains are found through the inclusion of storage beyond 2 hours.

3.2.3 TSE Farm Capacity Factor

This section considers the impact of the TSE farm capacity factor on the amount of electricity imported from the grid. Differing capacity factors could be achieved in several ways, including:

- **Site flow conditions** – a more energetic tidal stream site enables turbines to produce higher power outputs more regularly, leading to a higher capacity factor. Morlais can be considered a medium flow speed site.
- **Technology choice** – different types of TSE technologies will achieve different capacity factors in the same site flow conditions. For example, tidal kites (such as those in development by Minesto and SeaQurrent) are primarily designed for low-medium flow speed sites and can achieve higher capacity factors than turbines in these locations.
- **Technology sizing** – increasing rotor swept area will lead to a higher capacity factor. Alternatively, selecting a generator with a lower rated power increases capacity factor, but requires more turbines to be installed for the same TSE farm size (in MW) and enable a net increase in AEP. Technology sizing is a key part of the project optimisation process that aims to make design choices that will achieve the lowest levelised cost of energy (LCOE).

This study varied the technology size to assess the effects of higher (0.41) and lower (0.30) capacity factors relative to the base case (0.35). The Morlais tidal flow speed data and TSE farm size (240 MW) were maintained. Figure 9 shows the relationship between capacity factor, TSE farm size and electricity imported from the grid.

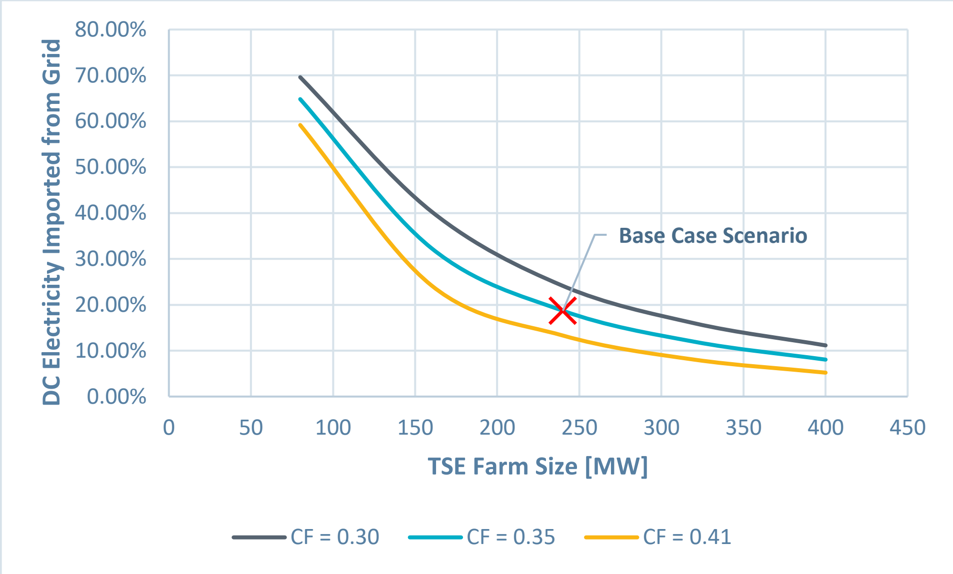

Figure 9. Relationship between TSE farm size, capacity factor and electricity imported from the grid

Increasing the capacity factor leads to an expected decrease in imported electricity, due to more of the data centre's power being generated by the TSE farm. Imported electricity decreases from 19% to 13% between the equivalent 240 MW base case and high capacity factor scenarios. Conversely, the equivalent low capacity factor scenario increases imported electricity to 24%. The curves begin converging at the lower and higher ends of TSE farm size, suggesting that changing capacity factor has reduced impact on grid imports in these regions. This can be explained due to similar levels of BESS utilisation in both regions. As TSE farm size decreases, the BESS is charged less frequently (no charging takes place in 80 MW farm scenarios) and the difference in imported electricity becomes increasingly dependent on TSE farm AEP. Similarly, as TSE farm size increases, it can more regularly provide all the required electricity for the data centre and BESS utilisation does not change significantly, despite being discharged less often. This is supported by Figure 10 which shows that the BESS utilisation levels (represented by a BESS capacity factor[2]) are comparable at the low and high ends of TSE farm size, irrespective of TSE farm capacity factor.

Increasing TSE farm size and capacity factor does, however, lead to more electricity being exported to the grid, in absolute terms, which would provide benefit if revenue support can be secured for export.

[2] The ratio of the electricity supplied by the BESS compared to its theoretical maximum output over an annual period.

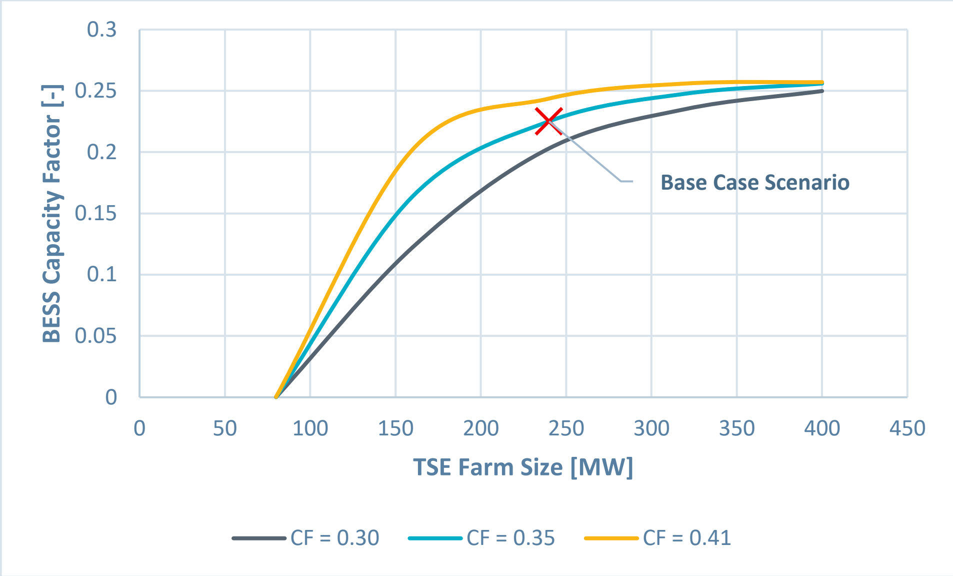

Figure 10. Relationship between BESS capacity factor, TSE farm size and capacity factor

3.3 Economic and Environmental Considerations

Figure 11 shows the exported and imported electricity as a function of TSE farm size, with base case capacity factor and BESS assumptions. Imported electricity represents additional cost whereas exports could be a revenue source, meaning that these variables directly impact the overall financial viability of the project. The crossover point of imports and exports occurs when the TSE farm size is approximately 228 MW. The dynamics will change as TSE costs come down and as electricity suppliers' underlying costs fluctuate, plus the PPA between the data centre and TSE farm will be the key determining factor in the overall financial viability.

Figure 11 also shows how the inclusion of the BESS significantly decreases both the exported and imported electricity, reducing overall dependence on the grid. In terms of imported electricity only, the inclusion of the BESS is increasingly advantageous as TSE farm size increases, evident by the diverging import lines. For example, a 130 MW TSE farm with BESS imports the same amount of electricity (300 GWh) as a 220 MW farm without BESS, saving 90 MW of installed TSE generation. Similarly, for the 240 MW base case scenario, a 2,500 MW TSE farm without BESS is required to achieve equivalent import levels, a factor of 10 saving on installed generation.

Sourcing a large proportion of the data centre's electricity from the TSE farm rather than the grid also leads to a significant reduction in emissions. Table 3 shows that compared with a purely grid connected data centre, the inclusion of TSE reduces CO_2 emissions from grid-produced electricity by over 70,000 tonnes. This is reduced further to over 100,000 tonnes with the addition of the BESS. This does not account for the overall footprint of building the TSE farm and BESS, but these would be classed as scope 3 emissions, as opposed to scope 2 for grid electricity.

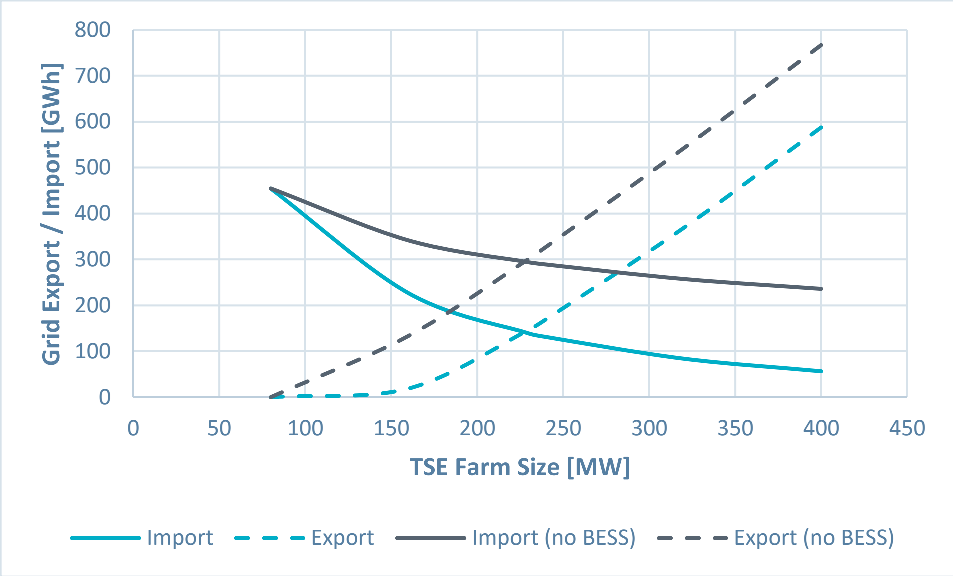

Figure 11. Relationship between exported / imported electricity and TSE farm size, with (blue) and without (black) BESS

Table 3. Data centre emissions associated with importing electricity from the grid

	Data Centre Grid Import [GWh]	Grid-Related Emissions[3] [tCO_2e]	Reduction in Grid-Related Emissions [tCO_2e]
No TSE or BESS	701	124,077	-
With 240 MW TSE	289	51,153	72,924
With 240 MW TSE + 160 MWh BESS	131	23,187	100,890

[3] Based on the 2025 emissions factor for UK electricity generation (0.177 kgCO2e/kWh).

3.4 Incorporating Demand Flexibility

As shown in Figure 6, grid imports are required only during neap tidal periods when the BESS becomes discharged. This section considers if grid imports could be avoided through the incorporation of energy demand flexibility in the operation of the data centre. Some modern data centres can schedule non-time-critical IT workloads, temporarily reducing energy demand. This can be utilised to support periods of grid stress and to reduce costs when electricity is more expensive.

Figure 12 compares the battery level in a neap tidal period from the base case with a scenario where a temporary cap of 50 MW is applied to the data centre's demand. This prevents the BESS from becoming discharged and necessitating grid imports, whereas the base case is reliant on the grid during every slack water period shown. Decreasing the data centre demand also leads to more excess generation when the BESS is fully charged.

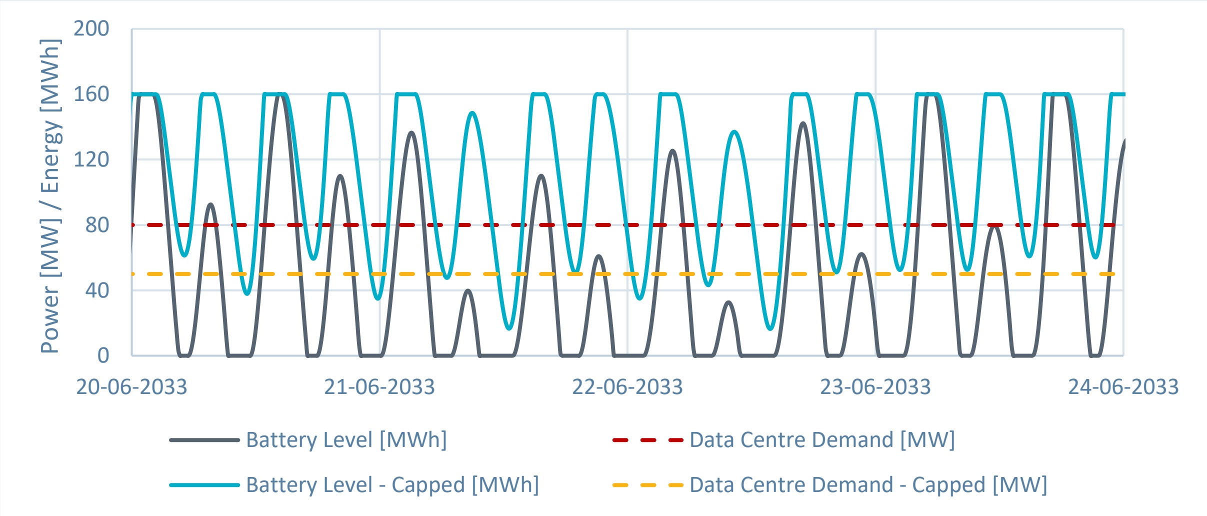

Figure 12. Comparison of battery levels during a neap period with data centre demand capping

4 DISCUSSION

4.1 Key Findings

This study has demonstrated a high level of technical feasibility in TSE combined with BESS in meeting the energy requirements of data centres. The findings are equally applicable to other offtakes with similar demand profiles and provide further evidence on the value of predictable TSE in supporting complex energy systems that are increasingly underpinned by non-dispatchable generation sources.

The base case scenario showed that 81% of a data centre's energy requirements can be met with TSE + BESS, reducing CO_2 emissions associated with sourcing electricity from the grid by over 100,000 tonnes. These figures can be improved upon further by increasing TSE farm size and / or capacity factor, while smaller farms still perform well with at least 60% of energy requirements being met in most of the cases considered.

The TSE + BESS arrangement was found to be highly effective in reducing grid imports with just 2 hours of storage, which provides enough backup to cover slack water periods when no power generation occurs. The share of grid imported electricity is reduced from 41% to 19% in the base case scenario when the BESS is added. Achieving an equivalent reduction without a BESS requires approximately a 10-fold increase in TSE generation, highlighting the role that storage plays in enabling a more cost-effective arrangement.

Little benefit was found by increasing the BESS capacity further, showing that only a modest amount of storage is required due to the cyclical nature of TSE. While a comparison with other renewable technologies has not been performed in this study, this finding supports previous work that has shown that TSE requires less storage to reduce dependence on backup generation [4]. The periodic charge and discharge cycles (4 times per day) also lead to a high overall utilisation of the BESS, which achieves a capacity factor of 0.23 in the base case scenario. This high utilisation improves the economics associated with the addition of the BESS.

Imported and exported electricity were found to be approximately equivalent when the TSE farm size is 228 MW, slightly smaller than the base case scenario. Securing a revenue stream for exported electricity would help offset the costs associated with importing. This is possible in the CfD scheme via a private network agreement and a partial connected generator configuration [6]. A larger TSE farm would improve the financial return as it would export more and import less, plus it would be expected to achieve a lower LCOE due to economies of volume. However, larger projects require more upfront finance which could become increasingly disproportionate relative to the size of the data centre.

The data centre could function without a grid connection if demand flexibility was incorporated into its operation, and the predictable nature of TSE could simplify the implementation of this. Increasing TSE farm size and capacity factor makes off-grid operation more achievable, with some scenarios showing that the data centre would need to reduce its annual energy demand by less than 10%. This could significantly reduce the time and cost associated with establishing a grid connection. It is not uncommon for energy projects to wait 10 years for a grid connection in the UK, although recent reforms from the National Electricity System Operator are expected to accelerate connections.

Removing the grid connection would, however, prevent excess generation from the TSE farm being exported, requiring curtailment or another offtake. This creates a dilemma where increasing TSE farm size reduces grid dependence for import but is needed more for export. Furthermore, the data centre would become more vulnerable to periods of reduced output from the TSE farm, including maintenance and storm enforced outages.

4.2 Recommendations and Future Work

While this study has shown a high level of initial technical feasibility, further work is required to better understand the practicalities of co-locating TSE with data centres, as well as resolve non-technical challenges associated with implementation. This should begin with engagement with data centre operators to understand their willingness to consider TSE as a primary energy source. Previous work exploring alternative markets for TSE has shown that offtakers recognise the advantages of dependable TSE, but the high costs and risks due to its nascent status represent challenges [3]. There is, however, growing interest in the usage of emerging technologies, including wave energy, to power data centres [7], [8]. Furthermore, data centre operators are typically credit strong and could materially reduce finance risks, improving the weighted average cost of capital. Engagement with data centre operators would also help further the overall technical feasibility, including the likelihood of demand flexibility being used as a means of removing a grid connection.

The 240 MW TSE farm considered in this study is significantly larger than any individual UK project in development that has secured a seabed lease and consent[4]. Therefore, immediate opportunities will be smaller in size but represent an appropriate scale to trial TSE co-location with data centres. A demonstration project would help reduce perceived technical risks.

Longer-term, projects of this nature will require separate consenting for the TSE farm and data centre, increasing the time, cost and risk associated with this process further. The development of a joint or parallel consenting pathway for co-located projects would significantly reduce this risk.

Another challenge to scaling up is the CfD budget available for TSE, which could be a problem for grid connected projects that need to export excess generation. TSE has so far received limited budget in previous CfD allocation rounds, resulting in mostly small annual capacities (generally <50 MW) being awarded. If this continues to be the norm, there will not be enough budget for large projects unless they are built in phases. This is a wider issue for the industrialisation of TSE as a whole, and larger budgets are expected to be introduced once further commercialisation has taken place and more eligible capacity becomes available.

In terms of technical improvements to the feasibility assessment, the study made a number of simplifications in the TSE generation modelling, highlighted in Section 2.2.1. These were all considered appropriate for this initial assessment, but future work should aim to produce a more accurate representation of energy generation in a TSE farm of this size and account for downtime. The modelling of the BESS should also be improved upon to account for factors that will affect its performance, including round-trip efficiency. Similarly, incorporating any BESS operational constraints designed to maximise its lifetime, such as limits on the state of charge (e.g. within 20-80%), would improve its representation.

The analysis considered a simple case where the data centre’s demand was temporarily reduced to 50 MW during a neap tide to demonstrate that off-grid operation could be possible. Future work should aim to optimise the required reduction in energy demand during neap tides, which would simultaneously minimise excess generation. The high predictability of TSE could enable this to be

[4] Morlais is a 240 MW site split into 8 project development berths

achieved on a tide-by-tide basis, rather than for the entirety of a neap period, and via a gradual reduction in demand rather than a step change.

Another way in which off-grid operation of the data centre could be achieved is via the inclusion of other renewable generation sources, e.g. solar and wind. This would diversify the generation mix and make the data centre less vulnerable during neap tidal periods. Future work should evaluate how the dynamics of the energy provided to the data centre change as other generation sources are added, with a view to identifying configurations that are unlikely to require grid imports. Based on the findings in this study, TSE would still be expected to provide most of the data centre's energy, even if its capacity was reduced to introduce other generation.

The findings in this study are equally applicable to tidal range schemes. However, one potential advantage of tidal range is its ability to pump water in and out of the basin, utilised to increase overall AEP and provide more flexibility in the timing of generation. While pumping requires electricity from the grid, it would reduce overall imported electricity, possibly to levels lower than the TSE cases considered in this study everything else being equal. A similar study should evaluate the benefits of pumping in meeting the energy demands of a data centre.

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