This is an extract from the ***final report*** – for the entire document please see the full documents section on the website.

## Options Appraisal

Similar to the initial SHE Engineering Summary Document, the options appraisal was carried out by scoring both the Aberdeen and Shetland proposal on 17 categories. The ranking system used is in Table 13 below. Each category has been weighted 1, 1.5 or 2 based on the expected impact each category will have on the proposal outcome. With the most important categories being weighted a 2.

*Table 13- Ranking System*

| Score | Meaning In Terms of Suitability for An Energy Island |
|---|---|
| 0 | Not Applicable |
| 1 | Bad |
| 2 | Poor |
| 3 | Average |
| 4 | Good |
| 5 | Excellent |

*Table 14- Options Appraisal*

| Category | Weighting | Score | | Justification |
|---|---|---|---|---|
| | | Aberdeen | Shetland | |
| Location | 1 | 5 | 3 | • Aberdeen is more accessible.<br>• Aberdeen is closer to more existing infrastructure.<br>• Reduced transportation distances from Aberdeen.<br>• Shetland will cause more harm to habitat/will have more environmental issues. |
| Existing pipeline utilisation | 1.5 | 5 | 2 | • Aberdeen has more existing pipelines.<br>• Shorter distances to facilities from Aberdeen.<br>• No additional connections required. |
| Cable length required | 1 | 5 | 1 | • Aberdeen requires a 57km cable and Shetland requires a 350km cable.<br>• A longer length of new cable will lead to greater marine habitat disruption. |
| Proximity to existing/planned windfarms | 1 | 5 | 2 | • Aberdeen has 5 time more planned and current capacity for wind energy. |

| | | | | |
|---|---|---|---|---|
| Tidal energy capacity | 1 | 0 | 5 | • Shetland has incorporated tidal energy. |
| Connecting to multiple countries | 1.5 | 3 | 5 | • Shetland have already met with multiple other countries to form a North Atlantic connection.<br>• Further north which is closer to other countries that would like to form a connection. |
| Transport links | 1.5 | 5 | 3 | • Aberdeen has a major airport and a major harbour facility.<br>• Aberdeen has main roads/motorways (No minor roads) to reach from other major cities.<br>• No need to construct a road for Aberdeen. |
| Material Volume | 1 | 3 | 4 | • Aberdeen requires a lot of steel. |
| Material procurement | 1 | 5 | 2 | • Aberdeen has more opportunity to source locally. |
| Ease of Construction | 1 | 2 | 4 | • Shetland requires simpler construction and doesn't require construction in the middle of the ocean. |
| Energy Generation Capacity | 2 | 5 | 4 | • Aberdeen has greater wind energy capacity.<br>• Shetland has tidal potential, but overall Aberdeen can generate more energy. |
| Storage Capacity | 2 | 5 | 3 | • Lack of knowledge on salt cavern availability in Shetland.<br>• Greater potential for future expansion of storage using depleted oil and gas reservoirs. |
| Maintenance Required | 1 | 2 | 4 | • Both require similar level of maintenance, but it will be harder to carry out maintenance on oil rigs. |
| Stakeholder Preference | 1.5 | 5 | 2 | • More stakeholders voted for Aberdeen/Oil and Gas repurposing. |
| Economic Cost | 2 | 2 | 4 | • Aberdeen has the higher cost. |
| Carbon Cost | 2 | 4 | 2 | • From the high-level carbon appraisal carried out, Shetland was the option with the highest carbon cost. |
| Potential Revenue Within the First 20 Years | 2 | 5 | 4 | • Aberdeen generates more revenue over 20 years. |
| **Total** | | 96 | 69.5 | |

The final options appraisal, shown in Table 14, indicating that an energy island based off the coast of Aberdeen provides the most benefits due to its significantly higher score. This is primarily due to high weighting factors such as existing pipeline utilisation, available transport links, storage capacity potentials and stakeholder input. However, it is important to be aware that one of the greatest contributing factors to any major project is the overall cost, which is substantially greater for the Aberdeen based energy island.

Although this may deter key stakeholders and investors, it must be considered that regardless of the outcome for the energy island proposal, 45,000km of hydrocarbon pipelines and all 250 oil and gas platforms in the North Sea must legally be decommissioned at the end of their operational lifespan. This activity will constitute an overall cost of £56 billion to current stakeholders of North Sea assets (Scottish Government, 2024b). By repurposing existing infrastructure into value added products that previously were not accounted for, not only interests current owners of the infrastructure by providing potential future revenue, but it reduces the impact on the environment by minimising disruption caused by constructing future energy assets whilst also helping solve the challenges faced with national energy security.

# 1. Summary

The energy capacity estimates for both proposed options are assessed, taking into consideration the existing plans for the wind farm developments nearby the proposed energy island site. The costs of both projects have been calculated in addition to the estimated revenue – the summary is detailed below in Table 15 and 16. This study also outlines the recommended expansion for both proposals and final outcome.

*Table 15- Shetland Capacity*

| **Source** | | **Current/Proposed Capacity** | **Cost** | **Revenue (over 20 years)** |
|---|---|---|---|---|
| Wind | 5MW horizontal axis three bladed wind turbines | 2.8GW planned windfarms<br>0.5GW Initially Planned by SHE Engineering | £4.68 billion | £37.80 billion |
| Tidal | 100kW tidal turbine | 15.63MW planned/existing<br>10MW Initially planned by SHE Engineering | | |

*Table 16- Aberdeen Capacity*

| **Source** | | **Current Capacity** | **Cost** | **Revenue (over 20 years)** |
|---|---|---|---|---|
| Wind | 8.5MW horizontal axis three bladed wind turbines | 4.5GW planned windfarms<br>2.5GW Initially Planned by SHE Engineering | £5.23 billion | £49.20 billion |

Note that the revenue is not a representation of net profit, and that further research must be done to detail this further, including a calculation of operational costs, maintenance and repair fees, staffing costs, and overheads.

The potential of both energy islands can be expanded further with energy storage, allowing for any excess electrical energy generated from the wind turbines to be used to generate and store green hydrogen during low demand or high levels of wind supply. Any hydrogen that has been stored can be transported through the hydrogen pipeline and used at times of high demand or low wind supply. Transporting energy through hydrogen pipelines is not only more economical than through an electrical cable, but also more efficient. The two options in this study have different potential capacities for hydrogen storage.

In Aberdeen, a large offshore hydrocarbon well asset has a typical storage capacity of 600MWh when considering its potential for hydrogen storage (Vysus Group, 2021). In the initial energy island proposal, it is suggested that 5 depleted reservoirs are utilised (taking storage capacity to approximately 3GW) with the ability to expand if necessary. GIS maps, alongside the NSTA database shows the buzzard hydrocarbon field to have 28 wells that could be investigated for the purpose of hydrogen storage on the energy island. Additionally, the UK hydrogen storage database shows that in the relative area of the Buzzard platform there is the potential to expand the storage capacity to 158,000 GWh (The University of Edinburgh, 2024).

On the Shetland Island there is no available data regarding the abundance, size and scale of underground salt caverns, therefore, the storage capacity will be based on the hydrogen production and storage facility at Teeside that utilises three 70,000 $m^3$ salt caverns, storing 10 GWh each (Cline, 2022). It is suggested that a similar storage capacity is exploited for the energy island in order to maximise its potential, therefore, if naturally occurring salt caverns are unavailable, there would be benefit in investigating rock cavern storage options, naturally occurring aquifers or manmade salt caverns, although these options may come at a greater cost.

In the future, more wind farms would be proposed for both islands which will require more substations, and in turn, increase the energy capacity. There is space and potential for additional substations and hydrogen storage facilities to be constructed on both islands, as well as the connection of additional windfarms. On Shetland, an assessment will be carried out to determine the number of salt caverns in the area and if there are more than anticipated on or around the island, then these can also be utilized to store hydrogen. Similarly, offshore, there are around 28 oil wells below the wellheads deck, therefore there is an opportunity to retrofit more of these wells to facilitate hydrogen storage, further boosting the islands' renewable energy infrastructure. To successfully expand the chosen energy island, it is important to keep up to date with technological advancements and industry best practices in renewable energy and offshore engineering to continually improve the projects capabilities and competitiveness.

**Final Outcome:**

Through extensive research and careful evaluation of both options it is suggested that the Aberdeen energy island is proposed, utilising existing offshore infrastructure such as the Buzzard platform that is legally required to be decommissioned after its operational lifespan. Although this option is significantly more challenging and expensive, with less experience of the construction process (such as repurposing oil and gas reservoirs for hydrogen storage), there are a variety of benefits that align with the interests of the Scottish Government and current investors in offshore assets.

By repurposing existing infrastructure that is planned for decommissioning, the energy island can accelerate the North Sea and Scotland's energy transition. Repurposing assets - as opposed to removing or burying them in the ocean - provides an investment opportunity for current owners of the platforms and pipelines who's previously may have had an uncertain future, stained with looming decommissioning costs. Additionally, leaving as much infrastructure in its current position causes the least disruption possible to marine and land environments, helping preserve ecosystems that have had to adapt to the evolving landscape of the North Sea over the last century.

Furthermore, Aberdeen is in a key location to facilitate an energy island. As one of the global energy hubs, Aberdeen has the understanding, capacity and supply chains to enable the nations shift from oil and gas and meet Scotland 2045 Net Zero targets. By utilising the city's knowledge, help from local sustainability initiatives and position at the forefront of energy research, an energy island off the coast of Aberdeen can help make Scotland completely green.