This is an extract from the ***final report*** – please find the complete document under the full documents section on the website.

Cost

The future expansion of both Shetland and Aberdeen has not been costed as this will not reflect the true economic and carbon cost of building an energy island. However, the possibility of future expansion and connection to multiple countries will be considered in the options appraisal.

As this is a feasibility study, the costings are provisional sums, which are place markers for values when details are finalised. Through benchmarking, a cost envelope was established, however, due to the projects unique scope, there is a lack of framework and examples to follow.

This cost estimate is subject to changes due to factors like, the market economy, technology advancements, inflation and relationships with other countries.

Table 6- Shetland Cost

Element	Details	Size	Total Cost	Reference
Platform				
Geotechnics (excavation, surveying, and levelling).	£4.31/m^3 (3m excavation)	190,000m^2	£2.5 million	(AECOM, 2023)
Roads	£2.13 million/km	1000m	£2.13 million	(Archer and Glaister, 2006)
Foundations	£110/m^3 concrete	15000m^3	£1.65 million	(Archer and Glaister, 2006)
Pipes	£5.62 million/km	350km	£1.97 billion	(Statista, 2021)
Cables	2.63 million/km to transfer 2GW of power	350km	£920 million	(National Grid, 2022)
Other				
ACDC Energy Converter	£217 million at each end.	X2 converters	£868 million	(National Grid, 2022)
Offshore floating windfarms	£1.3 million/MW. Proposing 100 turbines which in total will generate 0.5GW of power.	-	£650 million	(Equinor, 2023)
Welfare Building	Steel welfare unit including toilet facilities and kitchen	20ft x 8ft	£12,000	(AngloScottish, 2024)
Helicopter Pad	Standard on island helipad based on Gigha project on West Coast Scotland Island	-	£150,000	(Campbeltown Courier, 2024)
Harbour	£110 /m^3 of concrete	400m^3	£44,000	(AECOM, 2023)

Maintenance of equipment	**Subsea cable maintenance** - £134/km **Convertor station maintenance** - £1 million / convertor station / year **Turbine operations and maintenance** - £71,000 /mw/year	-		(National Grid, 2022) (Sinclair, 2024)
Shetland – Hydrogen				
Repurposing one onshore salt cavern 300,000m^3 in size	£380MM including contingency at 30%	Assuming capacity of 210,000m^3	266 million	(Vysus Group, 2021)
			TOTAL COST	£4.68 billion

Table 7- Aberdeen Cost

Element	Details	Size	Cost	Reference
	Platform			
Steel	£2.39 / Pound	6613.868lbs	£15,800	(Checkatrade, 2023b)
Pipes (replacement)	£5.62 million/km	57km	£320 million	(Statista, 2021)
Pipes (repurposing)	Included in decommissioning cost	57km	£0	-
Cables	£2.63 million/km to transfer 2GW of power	57km	£149.91 million	(National Grid, 2022)
Other				
Decommissioning of platform	Report provides an estimated cost using PEAS software which takes into account data from a range of decommissioning projects and experts to estimate a cost for the decommissioning of a 4-pile deck oil rig. The cost estimate is around £3 million, this would represent the decommissioning of one of Buzzard's 4 decks, whilst this cost would need to be multiplied by 4, it would be an overestimation as we are only removing the topside, debris and flushing the pipes and wells.	-	£10 million	(Byrd et al., 2014)
ACDC Energy Converter	£217 million at each end.	X2 converters	868 million	(National Grid, 2022)
Offshore floating windfarms	£1.3 million/MW. Proposing 300 turbines which in total will generate 2.5GW of power.	-	£3.3 billion	(Equinor, 2023)
Welfare Building	Steel welfare unit including toilet facilities and kitchen	20m x 10m	£20,000	(AngloScottish, 2024)
Helicopter Pad	Assumed the same as onshore	-	£150,000	(Checkatrade, 2023a)

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Maintenance of equipment	**Subsea cable maintenance** - £134/km **Convertor station maintenance** - £1 million / convertor station / year **Platform maintenance -** £80,000/year **Turbine operations and maintenance** - £71,000 /mw/year	-		(National Grid, 2022) (Sinclair, 2024)

Repurposing Oil and Gas Infrastructure for Hydrogen Production		
	Cost	**Reference**
Utilising depleted gas field for compressed storage (2 cycles/year at 250 bar)	Approx £0.5/kg	(Department for Energy Security and Net Zero, 2024)
Capital cost of PEM Electrolyser based on Brent Delta Asset (creating 19,626 Kg H2/ Asset / day – 11 assets)	£581M	(Department for Energy Security and Net Zero, 2024)
	TOTAL COST	£5.23 billion

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Table 8- Hydrogen Costs

Hydrogen Costs- Applicable to Both		
Tank/vessel for compressed H2 (120 cycles/year at 700 bar)	Approx. £2/kg	(The Oil and Gas Technology Centre, 2020)
PEM electrolyser (CAPEX (£/ MW of H2) for 893 kg/unit/day of H2 at 99.999% quality, equipment area of 61 m2/MW H2 and an efficiency of 66%	15 (£/ MW of H2)	(The Oil and Gas Technology Centre, 2020)

Converted bulk carrier? If needed	£40MM	(Vysus Group, 2021)
Total facilities CAPEX	£5MM	(Vysus Group, 2021)
CAPEX (£/kg H2)	£2.59/kg H2	(Vysus Group, 2021)
Cost Of H2 (ex. Power) (£/kg H2)	£5.30/kg H2	(Vysus Group, 2021)
Electricity (£/kg H2)	£7.2/kg H2	(Vysus Group, 2021)
Cost of H2 production (including power) (£/kg H2)	£12.25/kg H2	(Vysus Group, 2021)
Compressor	£80,000	(Vysus Group, 2021)

***hydrogen costs applicable to both proposals will not be added to the total cost as it will increase both by the same amount.

The cost to benefit analysis can be classified as Class 4. This class represents a study or feasibility at early stages which lacks detailed information on wave patterns, material amounts and carbon values. Furthermore, the price estimate is based on construction and detailed design being a preliminary assumption. Table 9 states a project of class 4 has a 1-15% level of project definition and the expected accuracy range for costing is on a lower scale of -15% to - 30% and on a higher scale of 20% to 50%. Overall, this highlights the uncertainty on the price estimate is 20-50% at this stage of the project, however, uncertainty will decrease gradually as the project is developed and becomes more well-defined (COWI, 2022).

Table 9- Estimated Cost Accuracy

	Primary Characteristic	***Secondary Characteristic***			
ESTIMATE CLASS	**LEVEL OF PROJECT DEFINITION** Expressed as % of complete definition	**END USAGE** Typical purpose of estimate	**METHODOLOGY** Typical estimating method	**EXPECTED ACCURACY RANGE** Typical variation in low and high ranges [a]	**PREPARATION EFFORT** Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	Capacity Factored, Parametric Models, Judgment, or Analogy	L: -20% to -50% H: +30% to +100%	1
Class 4	1% to 15%	Study or Feasibility	Equipment Factored or Parametric Models	L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/ Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take-Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes: [a] The state of process technology and availability of applicable reference cost data affect the range markedly. The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

[b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and tools.

Revenue

The energy output of a wind farm can be calculated through the following formula:

$$Energy\ (kWh) = Capacity\ (kW) \times Capacity\ Factor \times Hours\ in\ a\ Year$$

The capacity factor is the actual energy output of the wind farm compared to its maximum potential over a given period and is estimated according to the wind conditions, turbine downtime for maintenance and other operational consideration, which is typically around 0.25 to 0.45 (Andrew, 2022). Offshore wind farms usually have a higher factor due to a higher wind speeds for better efficiency. To calculate the revenue for the energy islands, the energy output is multiplied by the average revenue of electricity in the UK for wind power which is around 8 pence per kWh (Renewables First, 2024).

Shetland

For Shetland, the initial energy capacity is proposed to be 3.5GW with an estimated capacity factor to be 0.40. After calculation, the power supply of the energy island is around 1.07 x 10^6 kWh, which leads to a revenue of 0.98 billion per year. Over the years, the revenue will increase to 2.80 billion per year when the capacity reaches its maximum at 10GW.

Golden Eagle and Buzzard

The initial energy capacity is proposed to be 7GW with an estimated capacity factor is 0.38 as the wind speeds is slightly lower. After calculation, the power supply of the energy island is around 1.07 x 10^6 kWh, which leads to a revenue of 1.86 billion per year which will then increase to 2.66 billion per year 10GW capacity.

The revenue for both sites was compared for 20 years (design life for wind turbines) from operation.

Table 10- Comparisons of revenues for Shetland and Golden Eagle/Buzzard platform

Year	Revenue for Shetland (£bil/year)	Revenue for Golden Eagle and Buzzard (£bil/year)
1 – 5	0.98	1.86
6 – 10	0.98	2.66
10 - 20	2.80	2.66
TOTAL	**37.80**	**49.20**