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

Construction- Aberdeen

Overview

Converting an oil and gas platform into an energy island involves repurposing the infrastructure to transport and store renewable energy. Oil and gas platforms generally comprise of a topside which includes production equipment, accommodation, walkways, safety equipment, and additional operating equipment. Topsides are typically attached to either a steel jacket which are large lattice-like structures, or gravity base structures which are made of reinforced concrete. Both provide stability and support for the platform deck above.

The legs are the substructure of offshore platforms. These jackets are typically made of high-strength steel to withstand the forces exerted by waves, wind, and currents and are anchored into the seabed. The existing jackets, and foundations will remain in position after the removal of the deck and a new topside will be fabricated and attached (CNOOC, 2019).

The first stage in the construction process is to fully assess the existing infrastructure by doing a load assessment, including inspection for fatigue cracks, weathering, weakened members and all necessary checks to ensure the structural integrity has not been significantly reduced.

Once a full assessment has been done, the next step is to partially decommission the necessary oil and gas infrastructure. The decommissioning process is a huge part of the oil and gas industry and can be done in different ways. It begins with extensive planning to ensure an oil rig is decommissioned safely, whilst ensuring careful consideration about its impact to the environment, society, and the economy, as well as how the decommissioning will be carried out technically. Within Scotland there are several acts and legislation to be followed including The UKs Petroleum act 1998, The Energy Act 2008, SEPA regulations, and Marine (Scotland) Act 2010 along with Marine Scotland regulations. The department of energy and climate change (DECC) also outlines regulations that must be followed whilst the OSPAR ensures a project to provide detailed reasoning and justification why any parts should be left in the sea after decommissioning is complete, and detail how they will not harm the environment.

Decommissioning

The decommissioning of buzzard will be heavily based off the Brent field decommissioning process undertaken by Shell. The Brent oil field was discovered in the early 1970s and had started production by 1976, its original design was to allow a lifespan of around 25 years, but as Brent Charlie was last to stop production in 2021, its lifespan nearly doubled. Production was stopped on each platform within the Brent field at different times; Delta in 2011, Alpha and Bravo in 2014, with Charlie in 2021. All 4 platforms went up to around 300m in height from seabed to top of platforms with 3 out of 4 platforms being gravity base structures, whilst Alpha has a steel jacket support (Shell, 2024).

The method of decommissioning the brent field was to plug all wells, remove debris and completely remove the topside by cutting the concrete or steel legs and bringing in a vessel called the Pioneering Spirit, which is large enough to lift the topside, and transport it back to shore for recycling. The vessel being used is 381.5m long and positions its bows underneath at either side of the platform, once the vessel is in place it lifts the topside vertically off its already cut legs and sails it most of the way, the topside is then transferred to a smaller vessel, which works alongside the Pioneering Spirit for the remainder of the journey. After the platform is taken to shore it is then recycled as much as possible – 98% of the platform was successfully recycled from Bravo (Shell, 2024).

During the brent decommissioning process, Shell have ensured heavy stakeholder involvement and consultation, extensive planning to ensure the process is economically, socially, and environmentally friendly.

For Alpha, the process involved cutting each steel leg using personnel with rope access. Cuts were made with interlocking segments so the topside could not move horizontally – this protects it from lateral loads until the topside can be lifted. Again, the Pioneering Spirit was used to grab each leg simultaneously with horseshoe shaped clamps and lift vertically so the topside could be transported to shore for recycling. A diamond steel cutter was then used to cut the steel jacket 46m below sea level, so the top part of the steel frame could be lifted by the world's largest crane vessel. This part had to be done with careful planning, so all the non-load bearing cuts were made first, and when the final cuts were made the frame could be lifted immediately (Shell, 2021).

The decommissioning process used for the removal of Brent Alpha's topside is what would be implemented for Buzzard, each deck would be cut, lifted, and transported for recycling. Multiple stakeholders made it clear that repurposing is often too expensive and counter intuitive so it would be best to completely remove the topside and install a new one. Reinstating the topside will ensure the structural integrity is known, as well as the life and longevity of the deck.

Deck Construction

The deck of the platform is where most of the equipment and facilities will be located including substation and transformers, hydrogen infrastructure, flare boom, personnel welfare building, a harbour, and a helipad. The new deck will be constructed as four separate steel topsides which will be connected by bridges. Each topside will be prefabricated in large, specialised facilities that are equipped with the latest technology. All components will be transported to the island by specialised vessels – in reference to the Brent Field decommissioning, the Pioneering Spirit could be used. The decks will then be connected to the existing legs by the enormous cranes on the vessel and welding equipment.

The deck is designed to support heavy loads while maintaining structural integrity therefore structural, stainless steel is chosen due to its strength, durability, and resistance to corrosion in marine environments. Steel is also highly weldable, allowing for efficient fabrication and assembly of complex structures required for offshore infrastructure. Advanced engineering techniques and coatings will also be employed to enhance corrosion resistance and extend the lifespan of these structures.

The decks will be transported and installed in a 5-phase process:

- Phase 1 will include a deck to accommodate any personnel on the island for maintenance, construction, and future expansion. This will comprise of a steel truss deck with steel sheeting, with welfare facilities, a helipad, and a harbour area for boats to load/unload and fuel up.

- Phase 2 will construct a substation platform with an area of 3000m^2 and an overall mass of 15000tons, made of steel and will include AC/DC converters and voltage transformers, as well as a flare boom. These technologies are constantly advancing, currently each module could accommodate 1GW of energy from the windfarms. This means 2 of these modules would be required to be connected to the mainland cable and additional transformers would be required for hydrogen production.
- Phase 3 will include a hydrogen production plant which will be this will be made of recycled high strength steel, the construction details of this are detailed below.
- Phase 4 will include the fabrication of another, smaller steel deck with steel sheeting. Its purpose will be for future expansion, connecting to other platforms in the North Sea and energy sharing countries.
- The final phase will be the transportation and installation of each deck and connecting each deck with steel bridges.

Table 4- Platform Details

Platform Type	Area (m^2)	Overall Mass Capacity (tons)
Welfare/ship loading/helipad	2600	8000
Substation Platform	3000	15000
Hydrogen Production	3300	15750
Future Expansion	8500	11000

Transport Routes

There are existing transport links on the mainland within the Aberdeen area, including harbours and airports that link to major facilities. There is one airport, one helicopter landing facility and three major harbours/ports. All personnel will be brought in via these routes. On the island, a helipad will be required for health and safety purposes and a small dock would be essential for transporting materials and personnel for maintenance.

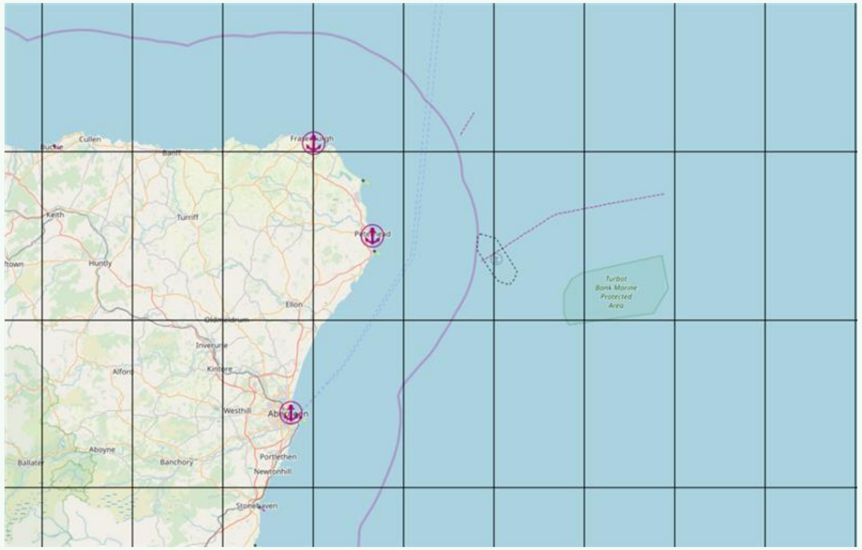

Figure 63- Aberdeen Harbours (Open Sea Map, 2023)

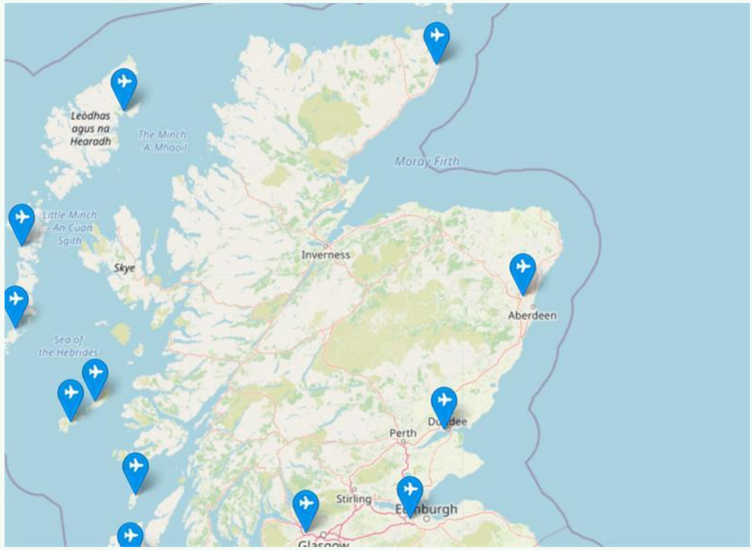

Figure 64- Aberdeen Airport (Aiports DK, 2023)

The port facilities in Scotland have the capacity to support the repurposing of existing oil and gas infrastructure including the facilities for dealing with the small pieces brought to shore, medium component parts that typically do not require heavy lifting, and large elements including full topsides or modules that require heavy lifting and specialist craneage. The facilities currently available for the servicing the oil and gas decommissioning sector will also have the capability to support the repurposing of assets in the North Sea. Most ports in Scotland have already received infrastructure removed from offshore and have processed the materials within local supply chains (Vysus Group, 2021).

Physical considerations include suitable quayside and berthing; craneage; water depth and access; laydown areas; waste management facilities; waste receiving and processing facilities; self-propelled modular transporters; drainage and containment. Aberdeen ports meet this criterion.

Offshore Wind Farm Details

300 8.5MW wind turbines are proposed to be installed on site, resulting in 2.5GW capacity in total. The turbines will exhibit similar characteristics to the wind farms already proposed at Aberdeen with a horizontal axis three-bladed design. Additionally, they will utilise a gravity-based structure along with a jacket structure supported by pin pile foundations. Inter-array cabling designed for this turbine has 34MW capacity, connecting four turbines each, which further connects to offshore substation platforms and AC to DC converter stations. A total of three offshore substations were designed for the electricity capacity of the wind farm.

Hydrogen

In order to construct an offshore hydrogen platform that is completely run by renewable energy, there needs to be a connection to the energy generated from offshore wind turbines, a transformer system to convert the AC energy generated from the wind turbines (Richardson, 2023) into HVDC for the process of green hydrogen production (Infineon, 2024) and a desalination unit is required to turn the seawater into purified water before it enters an electrolyser (Klaudia Ligęza et al., 2023). The two end products of the electrolysis are oxygen and hydrogen, the hydrogen is then compressed using a compressor before being stored subsea. After compression, the hydrogen can be transported through an export pipeline to shore whenever required, the oxygen produced can be either released into the atmosphere or it can be compressed into canisters for export and resale.

The platform used for hydrogen production will have three levels (Mainstream Renewable Power, 2024). On the first level, process functions that are required to power electrolysis are conducted, seawater is taken in where it is desalinated and the power from the wind turbines is taken onboard, distributed and interconnected. On level two, further electrolysis and cooling installations take place, as well as areas for maintenance and control. On the third floor, electrolysis takes place. During electrolysis the conditions must be cool, therefore a cooler must be present here too.

Equipment needed for hydrogen plant:

1. Desalination system
2. PEM Electrolyser
3. Transformer System
4. Heat Exchange System
5. Hydrogen Compression System

Flood Defence

- **Pumping System**
  Flood control pumps should be installed around the energy island to drain away large volumes of water during flooding. These pumps can be activated manually or automatically during areas with chronic flooding to prevent water from accumulating on the site and causing damage to the infrastructures on the island.

- **Monitoring Sensors and Early Warning System**
  Monitoring sensors are used to detect real-time data and insights of water levels, velocity, rainfall, or weather. The analysis of these data allows early warnings of flood risk for immediate actions in emergency response plans such as evacuations, shutdown procedures and contingency plans for restoring operations after the flood.

Connecting Multiple Countries

Though there are no existing power interconnectors from Aberdeen to other countries, proposals have been supported by the government to build power connections with neighbouring countries to enable the exchange of renewable energies. One of the main proposals is the NorthConnect project which connects Long Haven Bay at Peterhead across the North Sea to Simadalen at Norway (North Connect, 2024). The NorthConnect interconnector will includes HVDC subsea cables with a capacity of 1400MW and is planned to be operational by 2024 (North Connect, 2024) There are several links connecting the country such as the Western Link mentioned in the above section, and the Eastern Green Link which connects East Lothian, Scotland to Hawthorn Pit, England with a 2GW HVDC cable starting construction in 2025 (Iberdrola, 2024). The Scottish Government has also proposed an Eastern HVDC which connects the Peterhead to the north-east of England but the project is currently still developing and is proposed to be commissioning in 2028 (Scottish Government, 2019a).

Another potential connection is the existing gas pipelines on the Norwegian continental shelf. These pipelines are operated by Gassco, with a joint venture with Gassled, to initially transport natural gas from neighbouring countries to Norway and can be repurposed for the transportation of hydrogen gas (Norwegian Petroleum, 2024). As shown in Figure 65, there are four gas pipelines that originates from Peterhead, Scotland to Norway with the main one being the Vesterled pipeline which has a capacity of 1.04 million cubic meter (Norwegian Petroleum, 2024). The pipeline has been used since 1976 hence inspection is needed to assess the effectiveness and safety of the pipeline.

Figure 65- Existing gas pipeline in the Norwegian continental shelf (Norwegian Petroleum, 2024)

Maintenance Schedule

The maintenance schedule, health and safety requirements and environmental considerations will be similar for both islands, all of which are detailed below.

To ensure optimal performance and safe operation, a preventative maintenance plan is required. A preventive maintenance schedule is put in place to avoid costly downtime by implementing scheduled maintenance tasks which include regular inspection, lubrication, repair, part replacement and other necessary actions (Millwright, 2019).

Table 5- Maintenance Schedule

Task	Reason	Timescale
Inspections	To assess the condition of the island components, equipment, and systems.	Visual checks every 6 months Annual full inspections
Lubrication of components	Technicians must lubricate various components to get rid of dirt and ensure cleanliness which increases service life of equipment. (Millwright, 2019)	Every 3 months
Calibration and testing of equipment	Use predictive maintenance methodologies to detect potential issues before they lead to equipment failures.	Constantly monitored electronically
Offshore wind infrastructure	Visual inspections of interiors and exteriors to make sure everything is operational.	Minimum every 6 months
Component replacement	Replace components when a fault is detected before they lead to equipment failures.	Schedule maintenance activities accordingly.
Spare parts management	Ensure that spare parts are readily available when needed to minimise downtime and maximise the reliability of energy generation and distribution.	Minimum every 6 months
Maintenance of steel infrastructure	Corrosion protection (applying protective coatings, cathodic protection systems, and routine inspections for signs of corrosion).	Every 20 years for coating application Monthly inspections (Hurtado, 2023)
Replacement of electrolyser for hydrogen	Lifespan of electrolyser.	After 7-10 years

Health and safety

- Develop and enforce safety procedures for construction/maintenance work, including permit-to-work systems, risk assessments, method statements and confined space entry protocols specific to the energy island environment.
- Provide training opportunities for maintenance personnel to ensure they are equipped with the knowledge and expertise required to perform maintenance tasks safely and effectively.
- Monitor tides and weather to ensure all conditions are safe to carry out any travel, maintenance or construction works.
- Provide adequate training for offshore emergencies, including procedures in case of emergencies during transport to the island.
- Provide training for emergency procedures related to large scale energy infrastructure.
- Ensure all personnel are always equipped with appropriate PPE and are aware of the risks of not wearing correct PPE.

Environmental Considerations

Throughout the construction process for both islands it is essential to implement environmental monitoring programs to assess the impact of the energy island on local ecosystems and marine life. This will include mitigation measures to minimise any potential negative effects, such as artificial reefs to enhance biodiversity or underwater noise mitigation for marine mammals, also throughout construction all marine protected zones will be avoided. This will ensure compliance with environmental protections laws and regulations.

As stated by stakeholders, there is the potential for concern about the wildlife if using a remote, existing island. There is the chance that many of the remote islands in North Sea could be home to unique/rare/endangered wildlife, therefore, it has been acknowledged that the energy island proposal would have to avoid inhabited islands, marine protected areas, and islands with native species. If an existing island was to be the preferred option, more investigation into the wildlife and environment on the island would be carried out and NGOs would be consulted with. An Environmental Impact Assessment (EIA) in line with local policies and context would be developed and it would be ensured that no negative impact was inflicted on any residing wildlife on the island.

Furthermore, to promote biodiversity and wildlife/habitat protection, the energy island has the potential to incorporate measures to provide habitats for animals, increasing biodiversity net gain.

1. Timescales

The timescale from the planning to the operation of an energy island is typically 10 to 15 years. The general steps are as follow:

- Preliminary studies (1-2 years): to assess the feasibility of the energy island by analysing the site location, conducting environmental impact assessments, exploring potential renewable energy recourse, and analysing economic viability of the project.
- Planning, approval and permitting (3-4 years): to plan out the timescales and secure funding for the project and to obtain permits and approvals from relevant authorities.
- Detailed design (2 years): to develop detailed engineering designs for the energy island including its structure and infrastructure such as hydrogen storage, together with the connections within renewables, substations, national grid, and with other neighbouring countries.
- Construction (3-5 years): the construction of energy island's infrastructure which was included in the detailed design.
- Construction of offshore wind farm (5-8 years): to design and construct the offshore wind farms to be connected to the energy island (Wind Cycle Energy, 2024)
- Construction of pipelines (5 years): to design, produce and install interconnecting pipelines for power transmission (Energistyrelsen, 2022)
- Commissioning and testing (1 year): to test the power generation and transmission throughout the energy island, ensuring its effectiveness and safety performance (Energistyrelsen, 2022)
- Operational: energy islands have a typical design life of 80 years; it is proposed that a smaller amount of power will be generated in the first three years after construction with a goal to expand to 10GW (Energistyrelsen, 2022)

Aberdeen

Additional time is allocated for the energy island at Golden Eagle and Buzzard platform for the decommissioning. In reference to the Brent Field decommissioning programme, the planning and process of obtaining permits for Brent took five years (NES Fircroft, 2019). The Golden Eagle or Buzzard in this case will likely take less time in the planning and permitting stages, due to less decommissioning steps to be carried out, and the difference in size between Buzzard and Brent Field. Therefore, decommissioning planning is estimated to be three to four years. The construction duration is shorter compared to Shetland as the steel decks can be constructed onshore hence it is possible for the decks to be built during the decommissioning stage and installed after. The construction phase for the energy island also includes the construction for hydrogen storage which requires reservoir and well survey to understand the feasibility of utilising depleted oil and gas wells for hydrogen storage which is around two years (Hychic, 2024). The energy island is planned to reach 7GW in the first year of operating, connecting other planned wind farms such as the MarramWind, Green Volt and Aspen Wind Farm. As it has a higher starting capacity, it is planned to reach 10GW capacity five years earlier than the Shetland Island, which is preferable for the Scotland's net zero emissions goal by 2045.

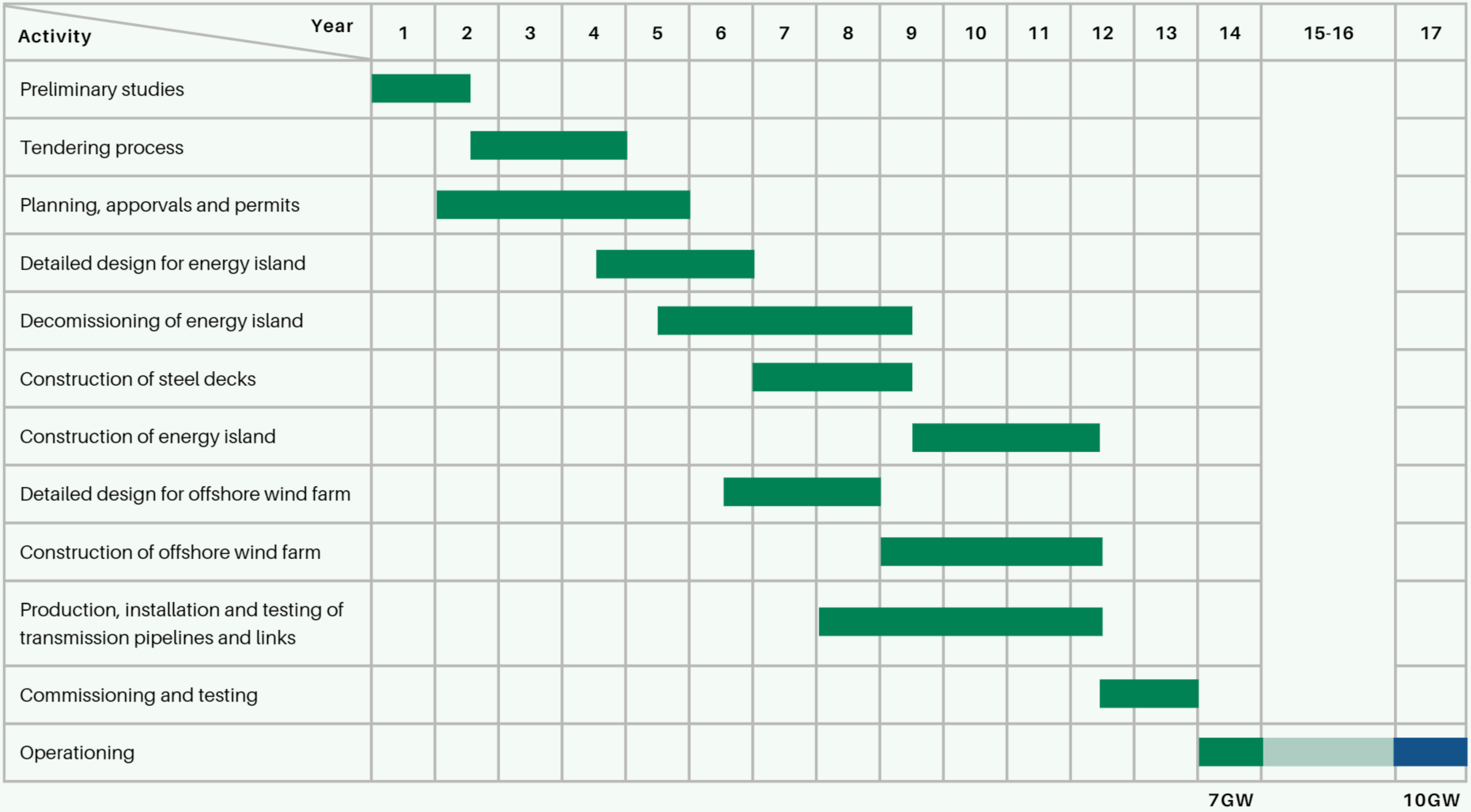

Figure 67- Timescale of Energy Island for Golden Eagle/Buzzard

2. Meeting Legislation Requirements

National Legislation and Policies

The UK set out policies responding to the climate emergency with the *Climate Change Act 2008***,** introducing legally binding 2050 targets to reduce greenhouse gas emissions by at least 80% relative to 1990 levels. In Scotland, there are objectives to meet the *Paris Agreement* by 2045. Due to these commitments, there is a need to action the energy transition more than ever and there is the vast opinion that hydrogen will play a critical role in this shift.

Key Legislation

The Oil and Gas Authority (OGA) has a role to boost the economic recovery of the UK's oil and gas resources whilst also helping the UK achieve Net Zero goals. OGA are empowered by:

- *The Petroleum Act 1998*
- *The Energy Act 2016*
- *Energy Act 2011*

In 2021, the OGA strategy was revised to place an obligation on the oil and gas industry to support the Secretary of State in meeting the target of net zero carbon by 2050. By repurposing existing rigs and pipelines to accommodate renewable energy production, the oil and gas industry can successfully undertake these commitments whilst also having a monetary incentive of producing and exporting energy.

The Offshore Safety Directive Regulator (OSDR) is the Authority responsible for overseeing industry compliance of the safety of offshore oil and gas operations in conjunction with the EU Directive. Directive 2013/30/EU ('the Directive') is implemented in the UK by various regulations including:

- *Offshore Installations (Offshore Safety Directive) Regulations 2015*

Acting in conjunction with HSE (the Health and Safety Executive), the OSDR helps to regulate any activity undertaken offshore, ensuring that appropriate measures have been taken to prevent, mitigate and control any major safety and environmental hazards that may present as well as the consequences of these hazards. OPRED and HSE are regulatory bodies that also have responsibilities to apply health and safety and environmental provisions made for the directive. These include activities that involve offshore: pipelines; decommissioning; reacting to incidents and emergencies; development of regulatory policy and technical matters; sharing regulatory information; and legal issues.

Other Regulations and Regulatory Bodies and Policies

- Marine Scotland
- Crown Estate Scotland
- Statutory Consultancies including Scottish National Heritage, Local and National Planning Authorities, Maritime and Coastguard Agency, Northern Lighthouse Board, Marine Planning Partnerships, Marine Renewables Facilitators Group and the Scottish Environment Protection Agency (SEPA)

- *Health and Safety at Work Act 1974*
- *Environmental Protection Act 1990*
- *Supply of Machinery (safety) Regulations 2008*
- *CDM 2015 Regulations*
- *MCA obligations (use of vessel for host of hydrogen generation or service provider)*
- *The Energy Act 2008*
- *The Carbon Dioxide Regulations 2010.*

It is also important to engage with local communities, governmental agencies, and stakeholders to address concerns, obtain necessary permits, and obtain support for the project before any work is undertaken.