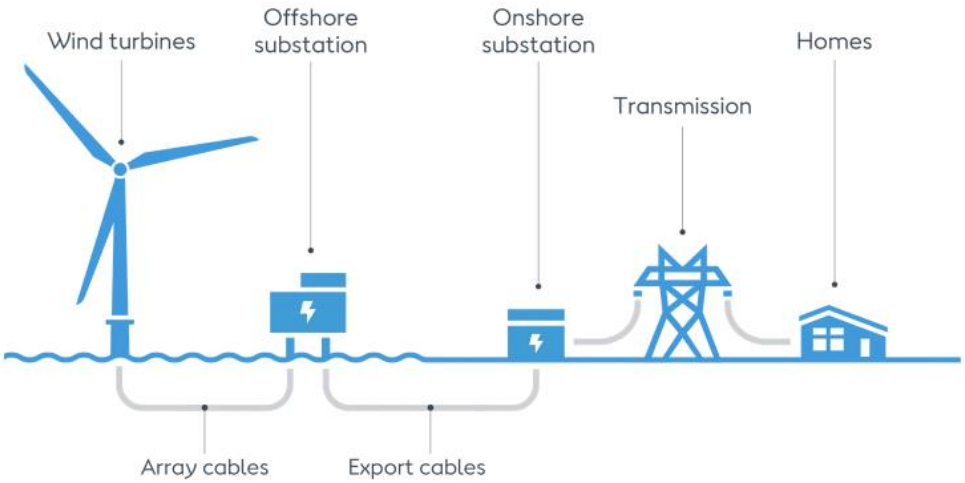
Offshore Wind Explainer

Government of JERSEY

Components of an Offshore Wind Farm

This explainer provides a guide to the typical components that make up an offshore wind farm. This is a generic diagram and not specific to Jersey's potential wind farm project. Technical work is currently being undertaken to understand the possible infrastructure requirements of a Jersey wind farm.



Picture: How do offshore wind turbines work? | Ørsted

Offshore wind farms can be broken down into three broad elements:

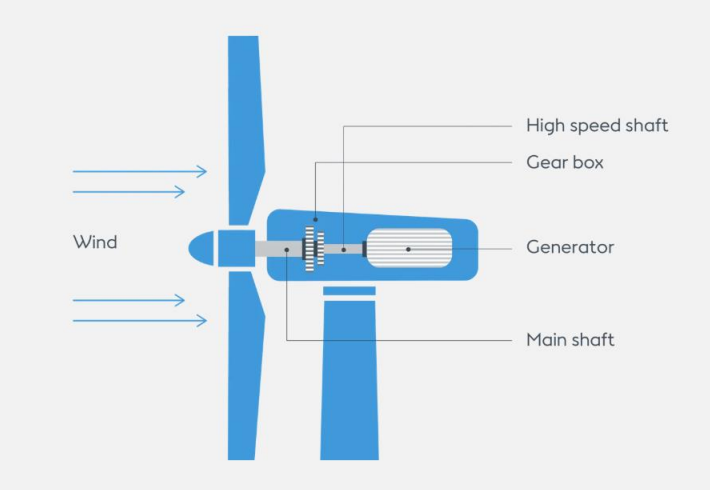
1. **Offshore array assets (the wind farm)**
2. **Transmission to shore (cables to bring the electricity to shore)**
3. **Onshore infrastructure (maintenance buildings and substations)**

1. Offshore array assets (the wind farm)

Turbines

The function of a wind turbine is to convert kinetic energy from the wind into electrical energy. Most turbines have variable speed rotors with three blades which, turn to face the wind, the movement of the air past them causes them to rotate and convert the wind into rotational energy.

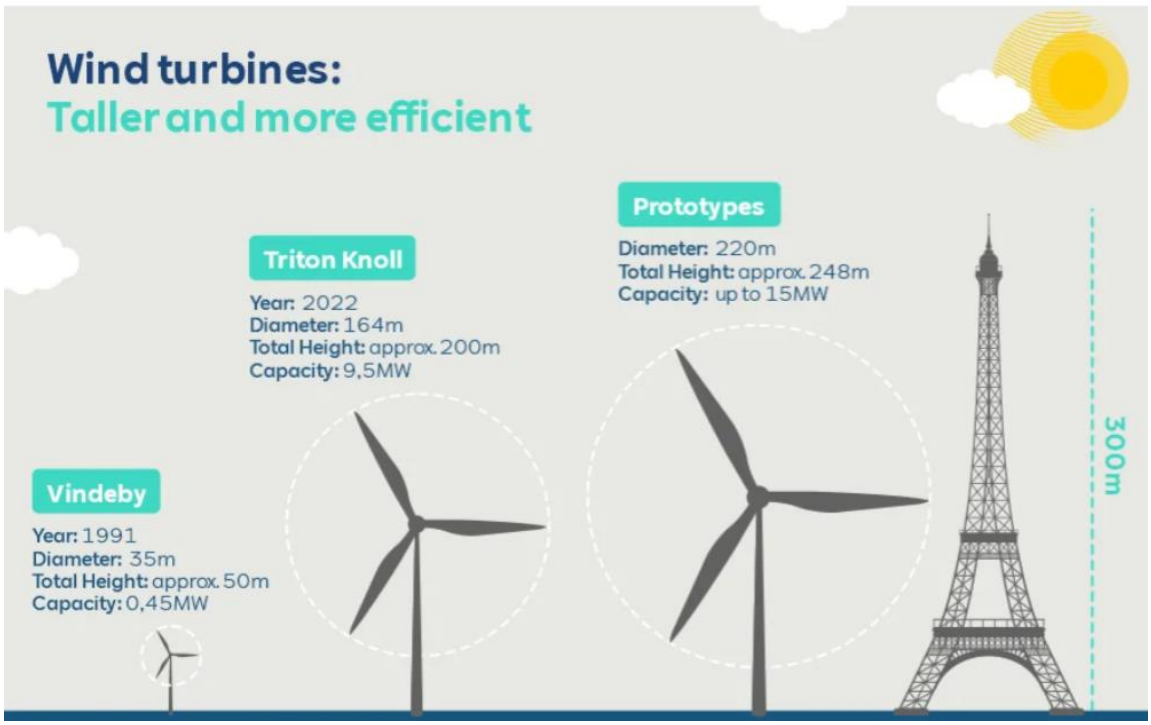
The wind turbine has a non-rotating part on the top of the tower called a nacelle. The nacelle contains the high-speed shaft, gear box and generator. The blades' rotation is passed through the high-speed shaft via a gear box, to turn magnets inside a coil of wire. This generates electricity.



Picture: How do offshore wind turbines work? | Ørsted

The nacelle is installed at the top of a (typically steel) tower.

As technology has advanced, wind turbines have increased in size. Offshore turbines currently being installed are approximately the size of the Gherkin tower in London (about 180 metres). Future turbines will exceed the height of the Eiffel Tower (about 300 metres):



Picture: Offshore wind: Clean power harvested at sea

Foundations

Offshore wind turbine foundations are critical for supporting turbines in marine environments. The type of foundation used depends on factors like water depth, seabed conditions, turbine size and environmental impact.

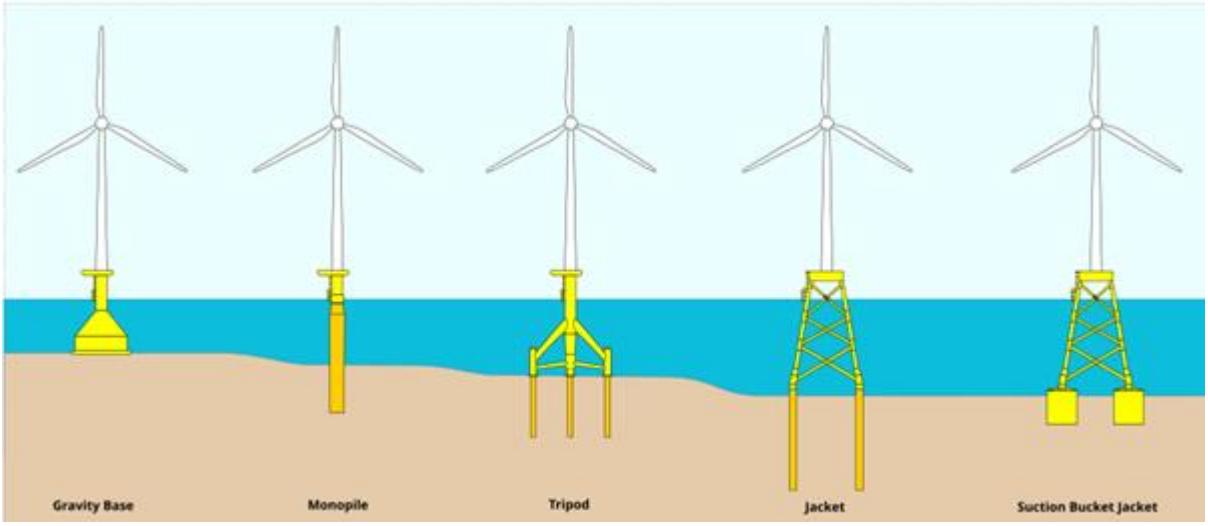


Image: Offshore wind foundation types by Ghost456. Licensed under CC BY-SA 4.0.

Monopile

A single steel tube driven deep into the seabed, used in shallow waters up to 30 metres. They are widely used due to their simple design and cost effectiveness but are not suitable for deeper waters or a soft seabed.

Jacketed

A jacketed foundation has a lattice like steel framework with three or four legs which are anchored to the seabed which provides stability in deeper waters and an irregular seabed.

Gravity Based Structure

A large concrete base, that relies solely on its weight to stay in place. It sits in shallow waters with a firm seabed. Typically used in water depths of 30 meters.

Tripod foundations

Used in intermediate depths of water (between 20 and 50 metres. They are steel structures with three legs which are connected to a central column, providing good load distribution.

Floating Foundations

Long cylindrical structures anchored with mooring lines and used for deeper waters (greater than 60 metres)

Array Cables

Array cables are subsea cables that transmit electricity and communications from individual wind turbines to an offshore substation, or directly to the onshore grid in smaller projects.

Picture: 04-cables-accessories-r2.pdf

2. Transmission to shore (cables to bring the electricity to shore)

Picture: B.3 Offshore substation | Guide to an offshore wind farm

An offshore substation is the central hub of an offshore wind farm's electrical system. Its main role is to collect, transform, and transmit the electricity produced by the wind turbines before sending it to shore.

An offshore substation consists of a main electrical power system, auxiliary systems, a topside structure to house the systems and a foundation to fix it to the seabed. Substations are sized to each wind farm. A substation for a 1GW wind farm can weigh between 12,000 and 18,000 tonnes which is the equivalent weight of 80 blue whales or three Eiffel Towers[1]

[1] B.3 Offshore substation | Guide to an offshore wind farm

Because of the proximity of wind farms to shore, most substations are not primarily used as service platforms, but the majority will still have a workshop and frequently a helideck.

Export cables serve a different purpose from array cables and carry the electricity from the offshore substation to the onshore substation. They link the offshore wind farm to the distribution network or national transmission grid. Export cables are robust to cover long distance high voltage transmissions. The robust design of an export cable is also to minimise energy loss over long distances. An export cable core is made from aluminium and typically weighs between 70kg and 150kg per metre. Over 1km the cable would weigh roughly the same as 10 African elephants. The outer diameter is typically 200-300mm which is about the same width as a plate.

Picture: B.1.1 Export cable | Guide to an offshore wind farm

3. Onshore infrastructure (Transition Joint Bay, Substation, Operations and Maintenance (O&M) buildings)

Transition Joint Bay

A **transition joint bay (TJB)** is an underground reinforced concrete structure that securely joins offshore and onshore electricity cables, typically located on land behind the beach or in a car park, and is itself buried beneath the ground. These bays provide a secure and stable environment for making the cable connections and may have buried access covers for maintenance. They are constructed at the landfall site, where cables emerge from the seabed after being brought ashore. The picture below is the landfall site of the Calvados interconnector cable in northern France.

Substation

Pictured below is the Hornsea Onshore Substation. The substation is ideally located close to the offshore export cable landfall and is a critical facility where electricity generated by offshore wind turbines is received, transformed, and integrated into the power grid. It serves as the final link in the chain from sea to land.

The key functions of an onshore substation are:

- **Voltage transformation:** Converts the high voltage electricity from the export cable to a lower voltage suitable for grid distribution.
- **Grid Connection:** Enables the delivery of the renewable energy to homes and businesses.

Picture: Hornsea Onshore Substation shortlisted for prestigious regional award - Business Up North

Operations and Maintenance (O&M) Hub

The O&M hub is a centralised facility that serves as the operational and maintenance base for offshore wind farms, providing a location for storing equipment and materials, housing staff, and coordinating the daily operations, safety, and upkeep of the turbines to ensure optimal energy output and safety for offshore technicians. These hubs are crucial for the efficient and cost-effective management of wind farms, especially for the largest offshore projects.

September 2025