November 2024

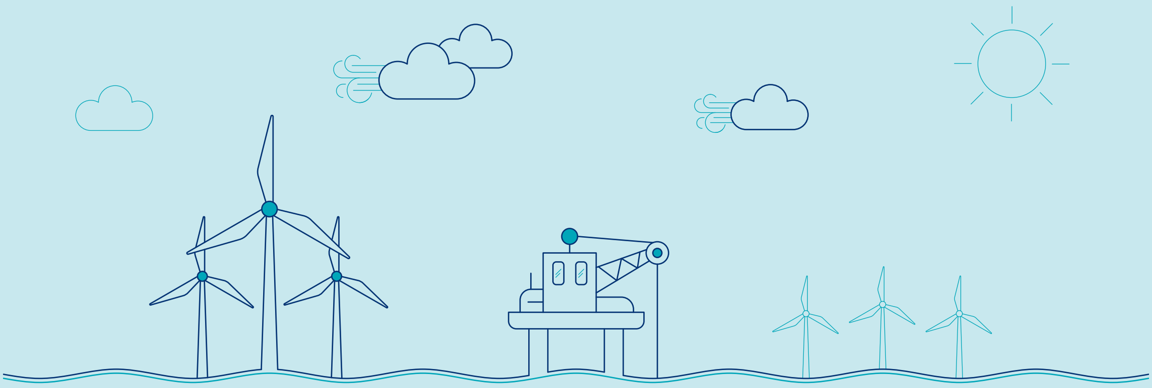
Why do SSEN Transmission propose to use onshore underground cabling as part of their offshore connection projects but not for all projects?

Many people ask why we use underground DC cables for our offshore projects but not for our onshore AC 400kV overhead lines, especially in the Pathway to 2030 projects. The answer lies in the type of electricity transmission system used and the challenges of undergrounding each system.

Understanding the Difference:

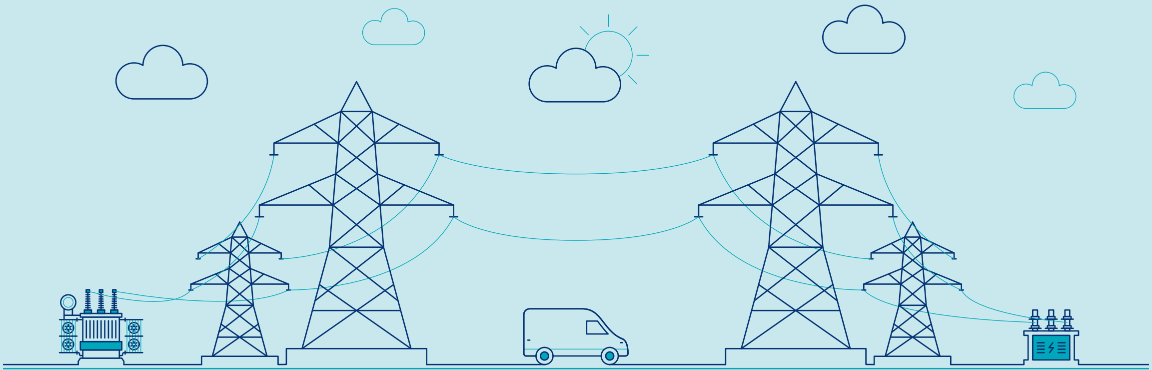
HVDC

For offshore projects, we often use High Voltage Direct Current (HVDC) technology. HVDC is ideal for transmitting electricity directly over long distances, particularly subsea, like between offshore wind farms and the mainland. It's efficient over these long stretches because it loses less power than other systems.



HVAC

Onshore, we use High Voltage Alternating Current (HVAC) technology. HVAC is the standard, well-established technology globally for shorter to medium distances within a region. It's the same type of electricity used in homes and is essential for ensuring the stability and flexibility of our grid. HVAC allows us to transmit electricity to local substations and distribute it where it's needed most.



Why We Use Underground Cables for HVDC Systems:

- **Long Distance Efficiency:**
  High Voltage Direct Current (HVDC) technology, is the preferred option for long distances, such as subsea connections, interconnectors and island connections. HVDC technology has lower electrical losses over long distances when compared to HVAC technology and provides better control over island network conditions, which are driven by low fault levels and intermittent generation (e.g. wind turbines).

- **Power Requirements:**
  Onshore Pathway to 2030 projects require 400kV AC overhead lines to transport much more power, up to 5GW. This arrangement of overhead lines as opposed to underground cables permits the connection of much more generation. For context, achieving a similar rating using HVDC would necessitate at least three HVDC Links. This would mean six x Converter Stations & six HVDC Cables as current HVDC Cable technology and standard rating throughout the industry is limited to 2GW per HVDC Bipole link.

- **Footprint:**
  Whilst HVDC underground cable takes up a smaller footprint than HVAC underground cable when considered on an individual basis, when the number of HVDC cables required for the equivalent capacity is considered, the required widths become similar for the temporary construction works. In addition, the same issues with regards to operation and maintenance apply to the use of HVDC underground cables as to HVAC. In the event of a fault on our network, it is significantly quicker to locate and repair a fault on an OHL than an UGC, which can take months to locate, identify the issue and conduct the required repair. Given the critical nature of the circuits being progressed it is important that operations can be restored in as short a time as possible to avoid wider issues across the network.

- **Converter Stations:**
  However, using HVDC requires large converter stations to change electricity from AC to DC or vice versa. These stations, like the proposed Fanellan Converter Station, have a significant physical footprint. The size of the overall site which is needed to accommodate a bipole connector such as the one at Fanellan (2 convertor stations) would increase the overall footprint by about 8 hectares or 11 football pitches. As a general guide each converter station would require a site of about 4 hectares or the size of 5 and a half football pitches to accommodate the conversion to the AC substation.

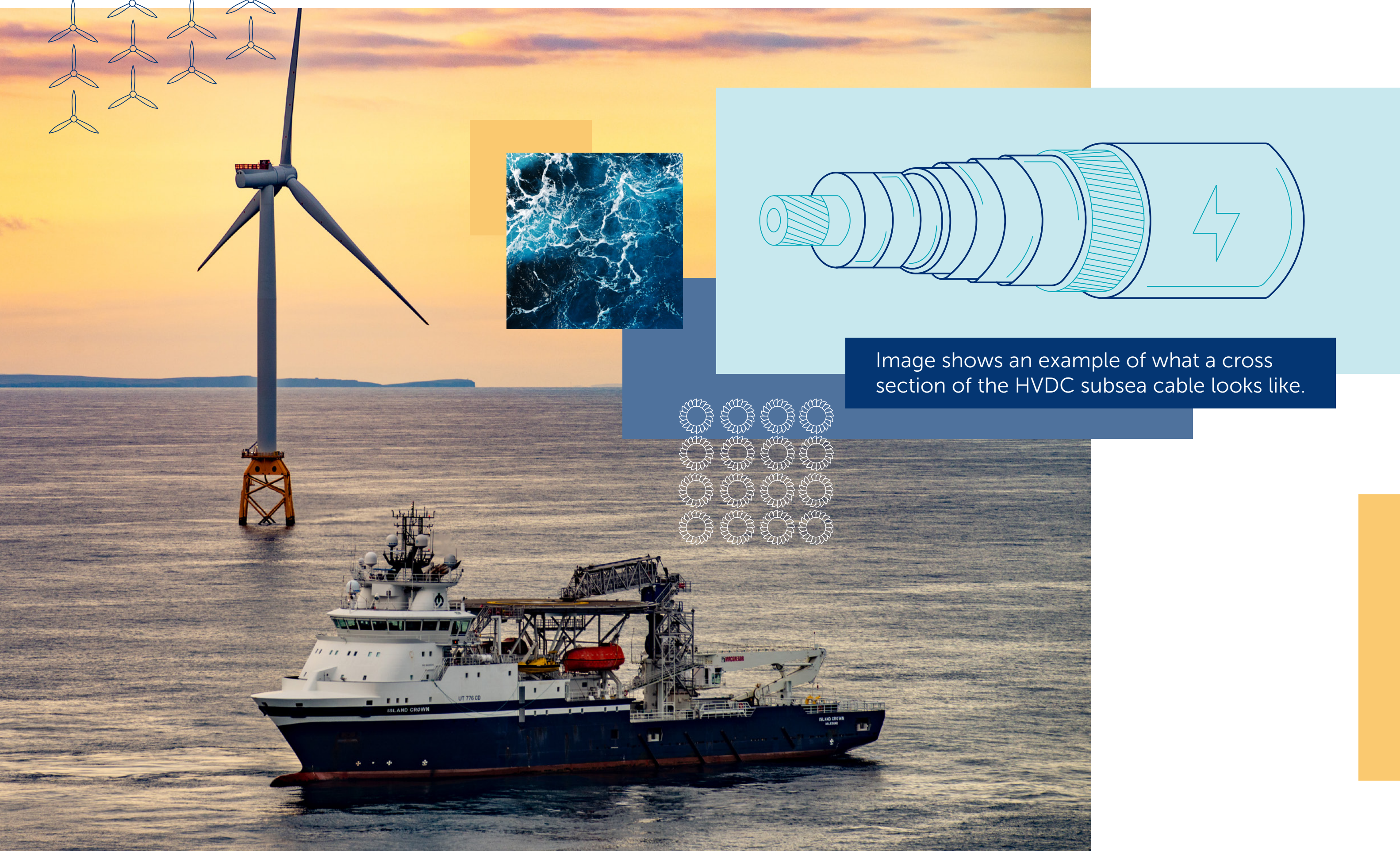


Image shows an example of what a cross section of the HVDC subsea cable looks like.

PATHWAY TO 2030

- In-flight Investments
- Pathway to 2030 Investments

New Infrastructure (Routes shown here are for illustrative purposes)

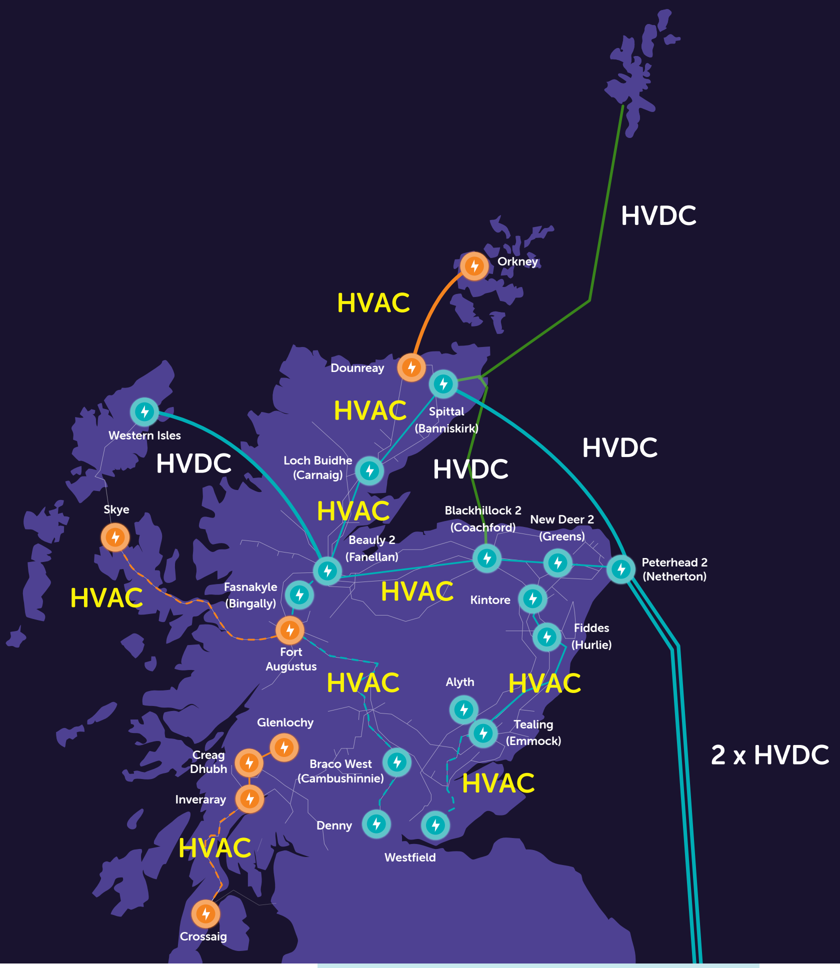
Upgrade/Replacement of Existing Infrastructure

Existing Network

All new reinforcements remain subject to detailed consultation and environmental assessments to help inform route and technology options

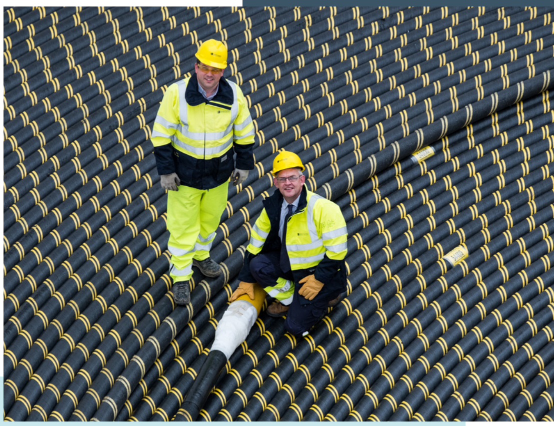
High Voltage **Direct** Current - HVDC

High Voltage **Alternating** Current - HVAC



Why HVAC Is Used Onshore:

The onshore system within our network operates on HVAC with the system being interconnected across the different voltages to allow connections of generators to the system as well as to supply businesses and houses via our connections to the Distribution Network. With an HVDC system, additional Convertor Stations would be required at every point along the routes required to connect the system back to the existing network to either supply the Distribution Network or allow Generators to connect. These drive significant additional costs to the consumer to construct this infrastructure to allow connection to the existing HVAC network, as well as requiring additional land take on the routes to construct these.



Conclusion:

We use underground HVDC cables for offshore projects because they're more efficient over long distances. However, for onshore projects, HVAC technology is better suited due to its compatibility with the existing grid. For more details on the challenges of undergrounding HVAC systems, you can refer to our document, "The Challenges of Undergrounding at 400kV."

What is reactive compensation?

Reactive power is required on an AC electrical network to maintain electrical and magnetic fields within the network components; lines, cables and transformers etc.

Practical use of the electrical network requires the voltage magnitude to be maintained within a set range. Reactive power flow within the network effects the voltage magnitude and therefore reactive power needs to be controlled so that the voltage will remain within the designed range and achieve stable operation of the network.

Consequently, reactive compensation balances reactive power in AC transmission, improving voltage stability and reducing losses. At substations, physical devices such as capacitors or reactors are installed to achieve this, affecting power flow and voltage control. These physical devices are large in scale which typically lead to increase in size of the substations.