Newsletter

Issue 26: October 2021

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The National HVDC Centre

Welcome to our COP26 special edition of our newsletter, where we highlight our COP26 events, and the increasing role HVDC will play in meeting our net zero targets; with a focus on the future of meshed HVDC Grids. HVDC projects will need to deliver increasingly more services to the system operator over time, whilst contributing to environmental targets, which some schemes are already doing (for example, the Moyle Interconnector above).

The photo above is of Ballycronan More courtesy of the Moyle Interconnector.

Our COP26 Events

The HVDC Centre is hosting a series of events to explore the role HVDC will play in meeting our net zero targets.

Each event will comprise a framing presentations, discussion with an expert panel, and open discussion (Q&As) from participants.

HVDC & Climate Change: What is HVDC and why is it important to achieving net-zero.

Monday 1 November 2021 - 14:00-15:00 GMT
Register: forms.office.com/r/zV0cxhuyKa

Offshore Coordination: How a coordinated approach enables net-zero.

Wednesday 3 November 2021 - 14:00-15:00 GMT
Register: forms.office.com/r/vmfY5q60Cs

Building a Better Network: A Technical discussion on how HVDC can enable a more stable network whilst integrating renewable generation.

Friday 5 November 2021 - 13:00-14:00 GMT
Register: forms.office.com/r/P3mk00v4JD

Networking for a Net Zero Future.

Led by SSEN Transmission and supported by Hitachi Energy.
Tuesday 9 November 2021 - 14:00-16:00 GMT
Register: Home (eventscloud.com)
Livestream: eu.eventscloud.com/networkingfornetzero/

HVDC R&D Strategy for Coordinated Offshore: Exploring the innovations required to meet net-zero.

Date: Thursday 11 November 2021
Time: 13:00-14:00 GMT
Register: forms.office.com/r/0etQ5natdM

Our Expanding Team

We are delighted to welcome both Nikhil Sharma and Fabian Moore to our team.

- Nikhil joins us from Siemens where he carried out HVDC Projects' Functional and Dynamic Tests, and with previous experience with Tata Power-DDL (ESO), where he carried out Protection & Testing of AIS/GIS Grids.

- Fabian joins the team from National Grid Electricity Transmission, where he focused on managing power quality issues arising from power electronics connected to the AC system, and the simulation of electromagnetic transients in AC systems.

Join Our Team

We are currently recruiting to expand our team further.

Please check out our film, on HVDC opportunities within SSEN-Transmission: vimeo.com/638647918/be5a43e780

If you are interested in joining us, please contact us to discuss further, or apply directly here: careers.sse.com/jobs/simulation-engineer-the-national-hvdc-centre-lanarkshire-scotland-united-kingdom-e20d5c45-2912-4832-8f3f-2543aaac08c2

Simon Marshall

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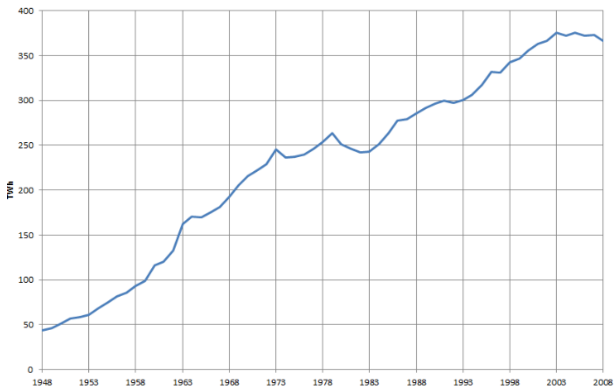
The National HVDC Centre

Research & Development - The key to realising the benefits from Net Zero?

We are in the process of a revolution in the way we generate, transmit and supply energy, of a scale not seen in power transmission since the 1960s.

Back in the 1960s these huge changes were supported by a range of new assets, processes and a whole new supergrid transmission standard for developing the onshore system; alongside that the technical codes (then called “planning memoranda”) drove consistent, efficient and sustained development.



Net electricity supplied- 1948 to 2008

We’ve done it once before; and we can look back to that as a reference as to how to now sustain an unparalleled growth in HVDC infrastructure, providing we can relate that experience to the specific challenges of HVDC R&D.

This is what we did across our R&D and supply chain reports (commissioned by BEIS).

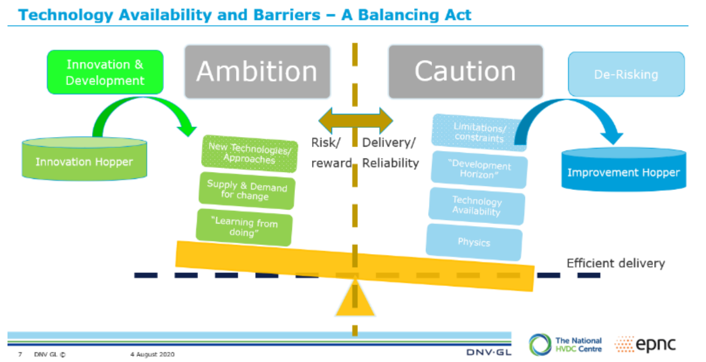
These reports are available on our Website:

- www.hvdccentre.com/wp-content/uploads/2021/07/Offshore_Co-Ordination_RD_Strategy_v2.0.pdf
- www.hvdccentre.com/wp-content/uploads/2021/07/Offshore_Co-Ordination_Supply_Report_v2.0.pdf

It’s easy to get caught up in the scale of the step change in the activity and either reach a state of analysis paralysis for each step; or equally dangerously jump to a perceived end state.

By methodically stepping through the developments required and the time-line; and describing a method to achieve the goals of the net zero transition, while equally being open to developing ways to further optimise; you find a route-map through this.

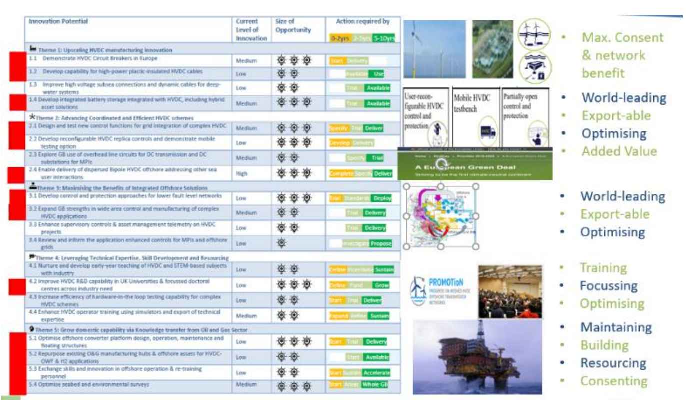
It’s always balancing act between caution and ambition at any given point of time, ensuring that you get the most efficient solutions today, that do not inhibit where you need to get to tomorrow.



R&D is not just a “nice to have”; it’s an essential part of engaging with the technical problems we face with the right solutions available at the time.

This is why at the Centre, as we de-risk real and future planed projects, we also keep our eyes on providing the solutions needed, and how to analyse these and the risks we manage in more efficient, innovative ways.

The pace of growth opens up new technical solutions- Bharath discussed these below in some detail, and we use R&D to help unlock them. Rather than ask should we do it, we should be asking- can we afford not to?



Innovation Potential	Current Level of Innovation	Size of Opportunity	Action required by (0-2yrs / 2-5yrs / 5-10yrs)
Theme 1: Upscaling HVDC manufacturing innovation			
1.1 Demonstrate HVDC Circuit Breakers in Europe	Medium	☀☀☀	Start, Delivery
1.2 Develop capability for high-power plastic-insulated HVDC cables	Low	☀☀	Available, Use
1.3 Improve high voltage subsea connections and dynamic cables for deep-water systems	Low	☀☀	Trial, Available
1.4 Develop integrated battery storage integrated with HVDC, including hybrid asset solutions	Medium	☀☀☀	Trial, Available
Theme 2: Advancing Coordinated and Efficient HVDC schemes			
2.1 Design and test new control functions for grid integration of complex HVDC	Medium	☀☀☀	Specify, Trial, Deliver
2.2 Develop reconfigurable HVDC replica controls and demonstrate mobile testing option	Low	☀☀☀	Develop, Delivery
2.3 Explore GB use of overhead line circuits for DC transmission and DC substations for MPIs	Medium	☀☀	Specify, Trial
2.4 Enable delivery of dispersed Bipole HVDC offshore addressing other sea user interactions	High	☀☀☀	Complete, Specify, Deliver
Theme 3: Maximising the Benefits of Integrated Offshore Solutions			
3.1 Develop control and protection approaches for lower fault level networks	Low	☀☀☀	Trial, Standards, Deploy
3.2 Expand GB strengths in wide area control and manufacturing of complex HVDC applications	Medium	☀☀	Trial, Delivery
3.3 Enhance supervisory controls & asset management telemetry on HVDC projects	Low	☀☀	Trial, Delivery
3.4 Review and inform the application enhanced controls for MPIs and offshore grids	Low	☀	Investigate, Propose
Theme 4: Leveraging Technical Expertise, Skill Development and Resourcing			
4.1 Nurture and develop early-year teaching of HVDC and STEM-based subjects with industry	Low	☀☀	Define, Incentivise, Sustain
4.2 Improve HVDC R&D capability in UK Universities & focussed doctoral centres across industry need	Low	☀☀☀	Define, Fund, Grow
4.3 Increase efficiency of hardware-in-the loop testing capability for complex HVDC schemes	Low	☀☀	Start, Trial, Deliver
4.4 Enhance HVDC operator training using simulators and export of technical expertise	Medium	☀☀	Expand, Refine, Sustain
Theme 5: Grow domestic capability via Knowledge transfer from Oil and Gas Sector			
5.1 Optimise offshore converter platform design, operation, maintenance and floating structures	Low	☀☀☀	Start, Trial, Delivery
5.2 Repurpose existing O&G manufacturing hubs & offshore assets for HVDC-OWF & H2 applications	Low	☀☀	Start, Available
5.3 Exchange skills and innovation in offshore operation & re-training personnel	Low	☀☀	Start, Sustain, Accelerate
5.4 Optimise seabed and environmental surveys	Medium	☀☀☀	Start, Areas, Whole GB

Extract of our R&D Strategy

Ben Marshall

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The National HVDC Centre

Bipolar VSC-HVDC Scheme: A future trend

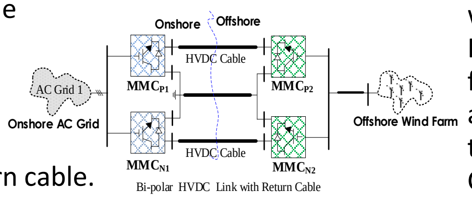
One of the key components of successful offshore grids is increasingly seen as the use of bipole VSC configurations for HVDC connections; both in GB and in Europe, most recently in Tennets reference design for 2GW HVDC.

Why VSC? VSC has been used for years in HVDC wind farm connections, for example in Germany, with GB currently constructing the largest example in the world to date. VSC has an essential capability to offshore systems to "grid form" via an islanding control where the offshore wind array frequency and voltages are regulated.

Why are bipole arrangements desirable? There's a number of reasons why this is the case:

- Reliability/availability unlike for monopole arrangements, controls on a bipole can be designed that mean:
  - Whenever any single pole is maintained, or suffers a fault, the other pole remains available; and
  - Whenever any earth return cable in the arrangement shown below is lost, the bipole can continue to operate at, or near, full power (depending on its specification).
- Allows high capacity yet contains the maximum loss. Currently the maximum offshore loss would be 1320MW, with 2640MW capacity bipole arrangements available as we approach 2030 delivery, allowing the maximum capacity bipole to deliver the most "bang for the buck" when considering how to connect the most offshore wind volume with the least assets; and
- Reduces the asset footprint and environmental impact of the capacity required. For monopole arrangements, 4 cables rather than 3 would be needed to achieve the same capabilities. The converter size of the same in monopole form would be larger and have other asset considerations that would be expected to influence the overall footprints required on and offshore.

The figure below illustrates a high-level block diagram of bipolar HVDC scheme configuration. Each bipolar converter station comprises of two VSC converters grounded via a return cable.



Bi-polar HVDC Link with Return Cable

These VSC-HVDC bipoles can form effective functional building boxes for large scale offshore connection or multi-purpose interconnectors. Part of the remit of The National HVDC Centre is in identifying key control opportunities from such arrangements, and supporting the de-risking of their integration in the GB system.

Md Habibur Rahman & Ben Marshall

HVDC Technology Choice for AC Grid Reinforcements

Offshore HVDC links are being used to reinforce the GB transmission system by providing point-to-point links from Scotland to England embedded within the existing AC transmission system. As inverter-interfaced renewable generation displaces traditional fossil fuel based synchronous generators, transmission system fault levels are ever decreasing. Under these conditions the choice of HVDC converter technology is key.

The two technologies for HVDC converters are Line Commutated Convertor (LCCs) and Voltage Source Convertor (VSC). The HVDC Centre have been looking at the performance of the two technologies both under steady-state conditions, and when faults occur on the surrounding AC system. Using LCC based converters is particularly challenging when low system fault levels can prevail, and the risk of commutation failure is significant, driving further reinforcement needs.

Fabian Moore

The Development of HVDC as the World Shifts to Renewables Sources

The development of key renewable sources, such as offshore wind, requires the use of HVDC to connect back to the load centers. As with the examination of coordinated offshore in the UK there is a shift away from point-to-point schemes to offshore HVDC grids. This was examined for the North Sea in the PROMOTioN project with the commitment from the Danish government to develop its power island an important milestone in this becoming a reality. Recent announcements from the US indicate that similar developments are to be undertaken form each of its coasts.

Beyond these national developments there are ever increasing plans for interconnection between nations to allow these weather dependent sources to be fully utilised by moving the power to where it is needed when it is available. The map below shows a view of an HVDC supergrid across the globe. Although this may at first appear somewhat aspirational, there are projects already looking at very long interconnections from Israel through to Greece via Cyprus and from Morocco into Europe which start to make some of these lines a reality.

Whatever is eventually realised in the path to decarbonization; it is clear that renewables sources are a key part of that with HVDC a vital enabling technology in their utilisation.

Ian Cowan

Meshed Grids For Europe

At present, Europe primarily has point-to-point HVDC connections, like the world's first offshore wind HVDC hub in Germany (BorWin1), which was subsequently followed by multiple offshore HVDC wind projects. With the UK Dogger Bank offshore wind project, we will soon see the biggest yet. In addition, subsea HVDC interconnections (like the recent NordLink project connecting the Norwegian and German power grids) have become well established.

But there is more that Europe could achieve with HVDC technology, and which has already been implemented in China. Multi-terminal systems and HVDC grids include more then two converter terminals so the additional complexity of co-ordinating converter controls and aligning design parameters must be mastered.

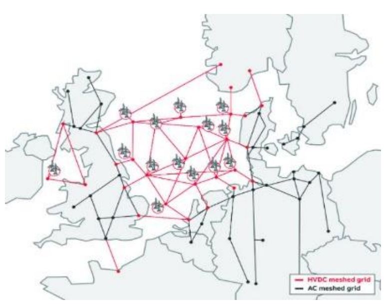
China has shown that meshing AC and DC grids can be done. The Zhangbei project, commissioned by the State Grid Corporation of China (SGCC), one of two transmission system operators in the country and the largest utility in the world, has integrated four 535 kV HVDC transmission links, in total 648 km in length. Essentially, this means we have gone from having an HVDC installation linking two points, to connecting four points, forming a meshed HVDC grid.

SGCC's new grid infrastructure enables interoperability also, via a flexible grid including HVDC circuit breakers. It also represents per km the lowest total transmission losses in their system, up to 40% less than conventional AC, while also maintaining grid resilience.

Each link has a capacity of 3000 MW. It will allow the region to integrate more efficiently exponentially more hydro, wind and solar power generation, reducing its CO2 emissions by 40 million tons per year.

World's First HVDC Grid - China

By enabling grid interconnections and facilitating the transmission of electricity beyond borders, with minimal environmental impact, HVDC is shaping a stronger, smarter, and greener Grid and boosting the transition towards renewables. It can help Europe achieve a sustainable and reliable transmission grid, based on renewables.



European Meshed Offshore Grid Concept

Nikhil Sharma

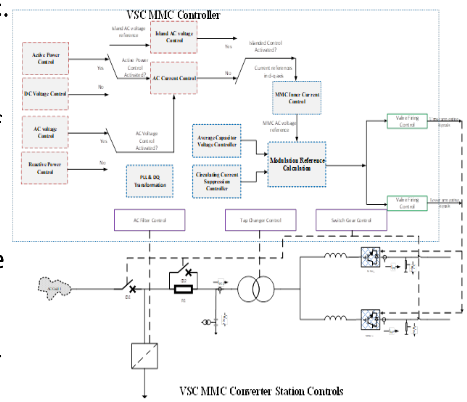
What is Islanded Mode/Grid Forming in HVDC Control? *Why it is key to enable NetZero?*

Islanded Mode controls, otherwise called as grid forming control, is a key HVDC converter control that controls and maintains the frequency/voltage of the AC network that the HVDC Converter is connected to. Converters with this type of control are able to create their own internal references to control the AC grid, instead of following the voltage & frequency at the point of connection in the AC grid. This control is also used to re-energise a blacked-out AC network.

This control is required to connect the large offshore windfarms that are connected through HVDC converter links. In these links usually the onshore end of the HVDC offshore connection is in DC voltage control and the offshore end is in islanded mode control, where the HVDC converter would connect to the offshore network and helps to main the voltage and frequency of the offshore network.

The islanded mode controls are also employed in other types of HVDC converter links like interconnectors, embedded links etc.

So, with the future of NetZero transition relying of large offshore wind farms and interconnectors for energy security, the islanded mode controller is acting as a key enabler for NetZero transition.



Bharath Ponnalagan

ISO 9001 Certification

The HVDC Centre is delighted to announce that we have achieved ISO 9001 Quality Management System (QMS) certification. This is the world's most popular quality management standard, and it provides a framework that can be used to ensure the quality of our services is consistent.

ISO 9001 certification was chosen to demonstrate that we have taken due care to maintain high standards, ensuring that our customers can have confidence in performance. This is only the start of our ISO 9001 journey; going forward this helps drives improvement in organisational efficiency and increased capacity; key to complementing increases in our work supporting the Net Zero transition.

Linda Rowan

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