Installation and Interfacing HVDC Control Replicas at The National HVDC Centre

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Context

HVDC Context

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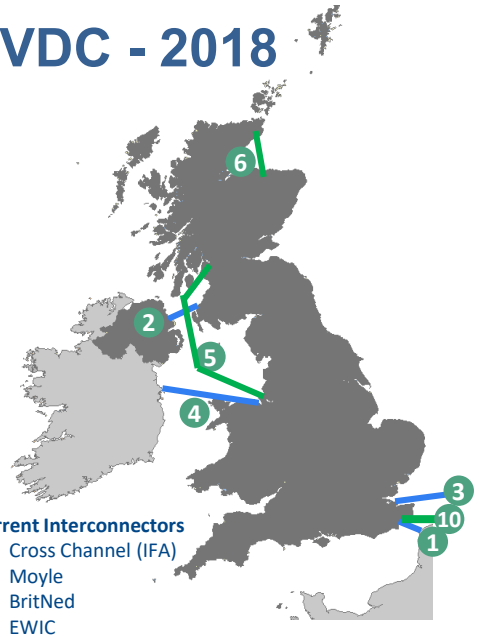
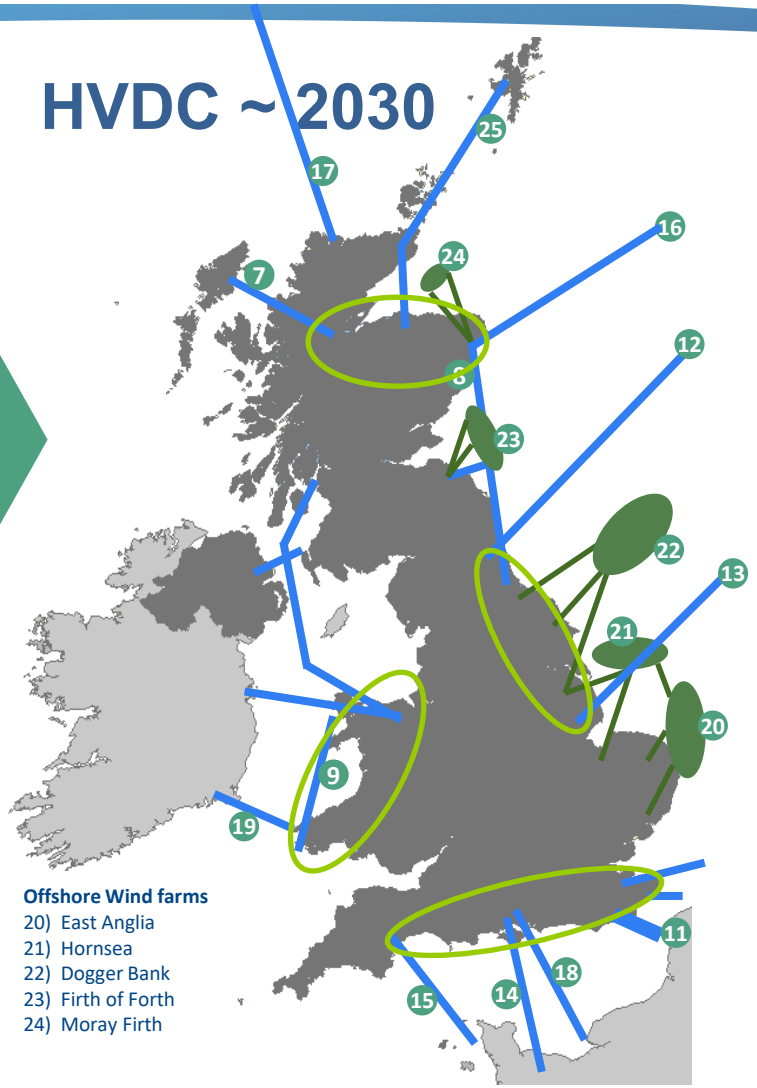
HVDC - 2018



Current Interconnectors
1) Cross Channel (IFA)
2) Moyle
3) BritNed
4) EWIC
5) Western Link
6) Caithness – Moray
10) Nemo

HVDC ~ 2030



New Interconnectors
11) ElecLink
12) NSL
13) Viking
14) IFA 2
15) FABLink
16) NorthConnect
17) IceLink
18) Aquind
19) GreenLink

Embedded HVDC
7) Western Isles
8) Eastern Link
9) Wylfa – Pembroke
25) Shetland

Offshore Wind farms
20) East Anglia
21) Hornsea
22) Dogger Bank
23) Firth of Forth
24) Moray Firth

Reason:

Best or only technical solution

Challenges:

Adverse interactions (HVDC Schemes, FACTS and Generators)

Multiple vendors and different technologies

Multi-terminal

Based on National Grid's Electricity Ten Year Statement (2013):
http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/Electricity-ten-year-statement/Current-statement/

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The National HVDC Centre

The National HVDC Centre is an Ofgem funded simulation and training facility available to support all HVDC schemes.

Using state of the art simulators, we model and resolve potential issues in real-time before they impact delivery of your project or the Grid Network.

The National HVDC Centre *part of* Scottish & Southern Electricity Networks

together with nationalgrid SP ENERGY NETWORKS

The National HVDC Centre is part of Scottish & Southern Electricity Networks and is funded through the Electricity Network Innovation Competition as the Multi-Terminal Test Environment (MTTE) Project. Scottish and Southern Electricity Networks is a trading name of Scottish Hydro Electric Transmission plc, Registered in Scotland No. SC213461, having its Registered Office at Inveralmond House, 200 Dunkeld Road, Perth, PH1 3AQ; and is a member of the SSE Group www.ssen.co.uk

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The National HVDC Centre Timeline

NIC Bid (MTTE Project)
April-August 2013

MTTE NIC Bid Successful
December 2013

Design & Contractual Agreements
2014

Detailed Design & Procurement
2015

Recruitment, Building & IT Install
2016

Formal Opening
April 2017

Replicas Installed
May 2018

PROMOTioN (WP15 & WP9)
2018

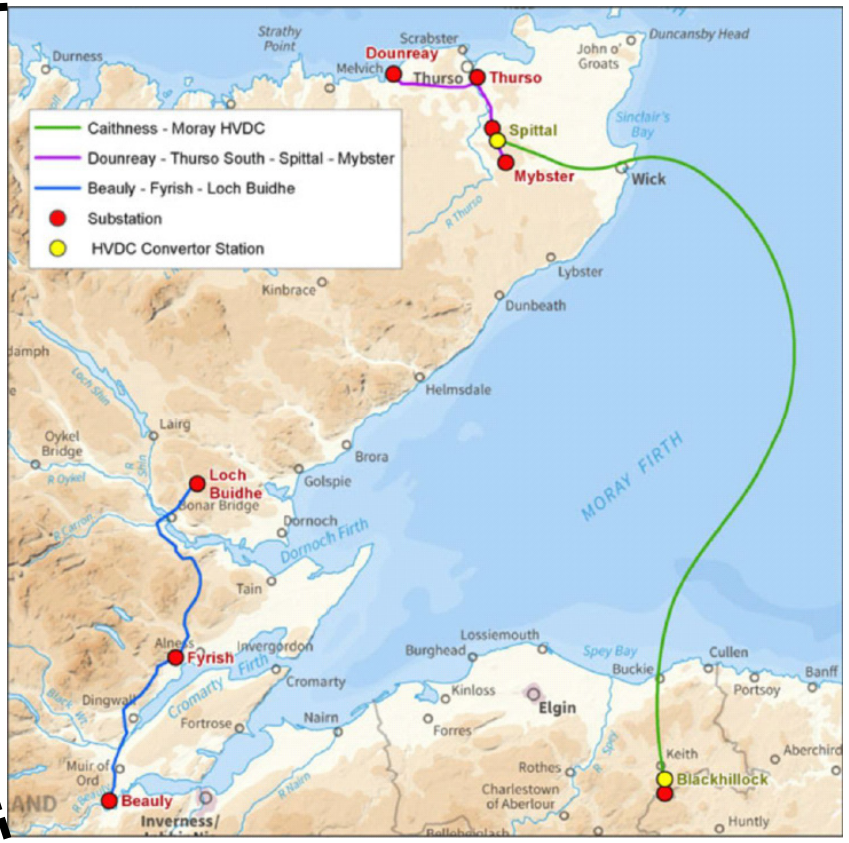
CM Commissioning
Sept-Dec 2018

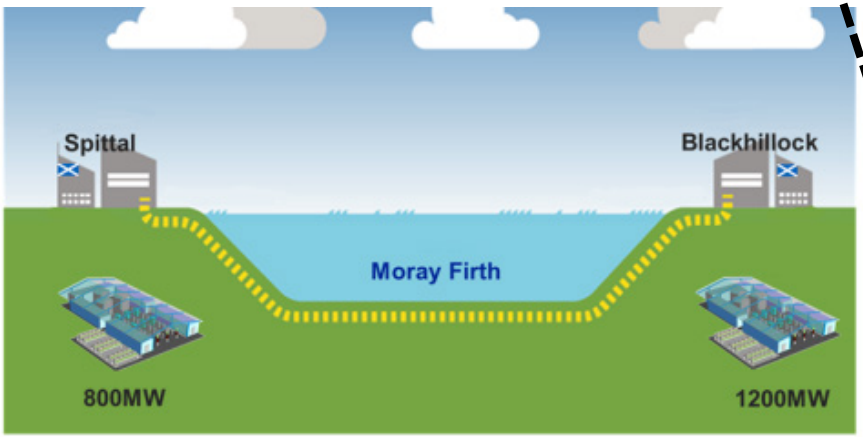
CM Energisation
Dec 2018

2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019+

CM Support: Project Overview

Phase 1 is a point-to-point scheme between Spittal and Blackhillock





CM Support: System Design

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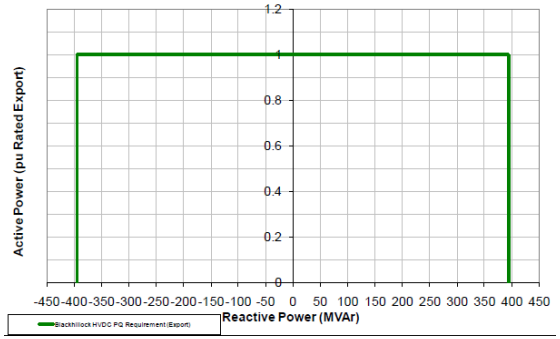
Type: Voltage Source Converter

Design: Symmetrical Monopole

Voltage: ±320kV



Active Power: 1200MW (Blackhillock), 800MW (Spittal)

Reactive Power: ±394 MVAr (Blackhillock), ± 263MVAr (Spittal)

Design choice:

- AC option was slightly more expensive and had a number consenting issues

- Multi-terminal scheme; VSC was only option due to requirement to connect to low SCC system (Shetland, offshore..)

- VSC technology attractive due to

- *4-quadrant PQ operation and power reversal achieved with change in current polarity*
- *Can be designed with no minimum short-circuit strength requirement*
- *Reduced converter size compared to other technologies*
- *Symmetrical monopole allows standard AC transformer use and operation during temporary faults*

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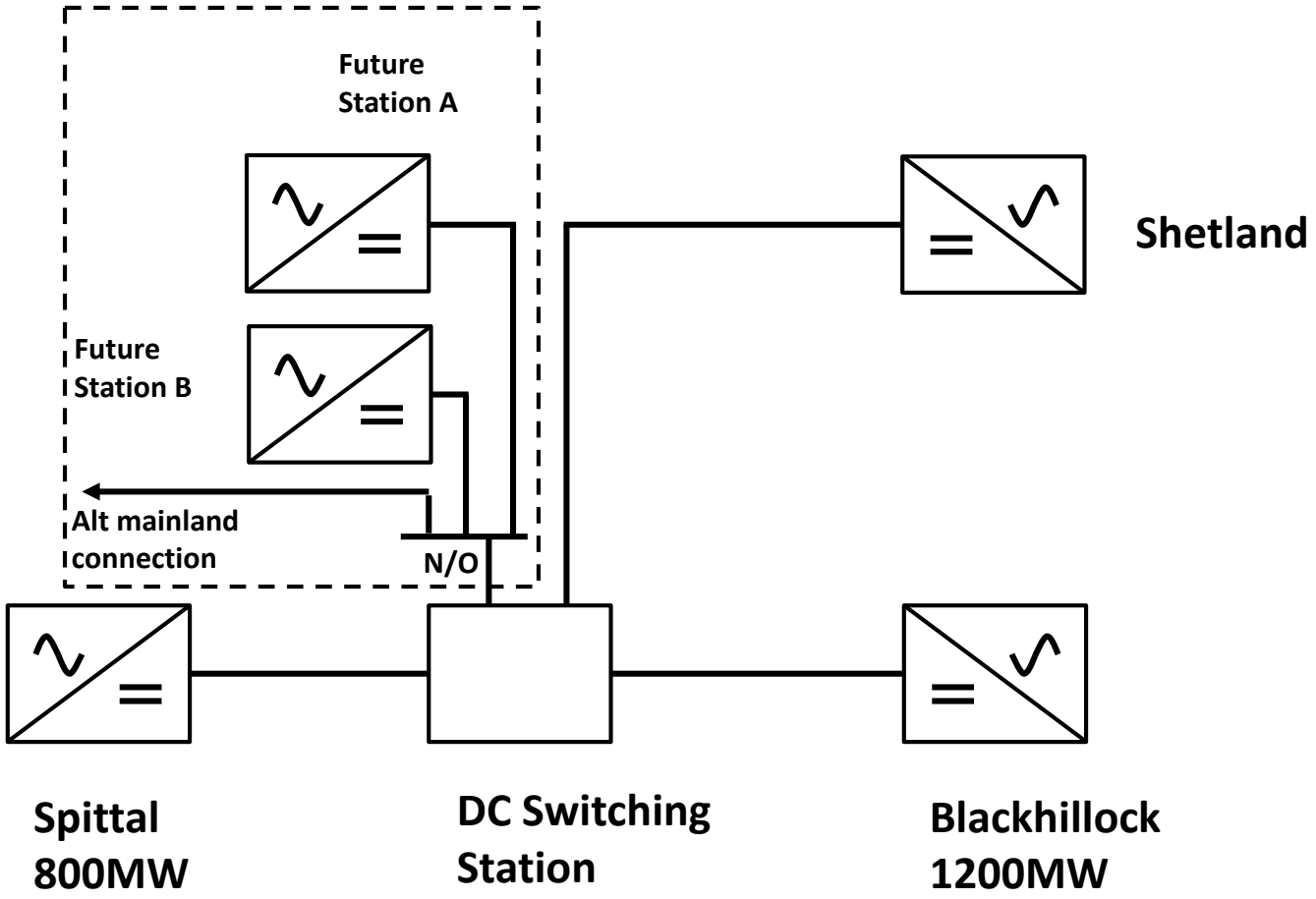
CM Support: Multi-Terminal Design



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Replicas for CM

Replica Specification

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Replica panels are physical duplicates of the control system, and offer the ability to simulate HVDC performance in real time.

- Functionality
- Cost
- Timing
- Lessons Learnt

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Testing

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- Process
- Comparison
- Customer Representation

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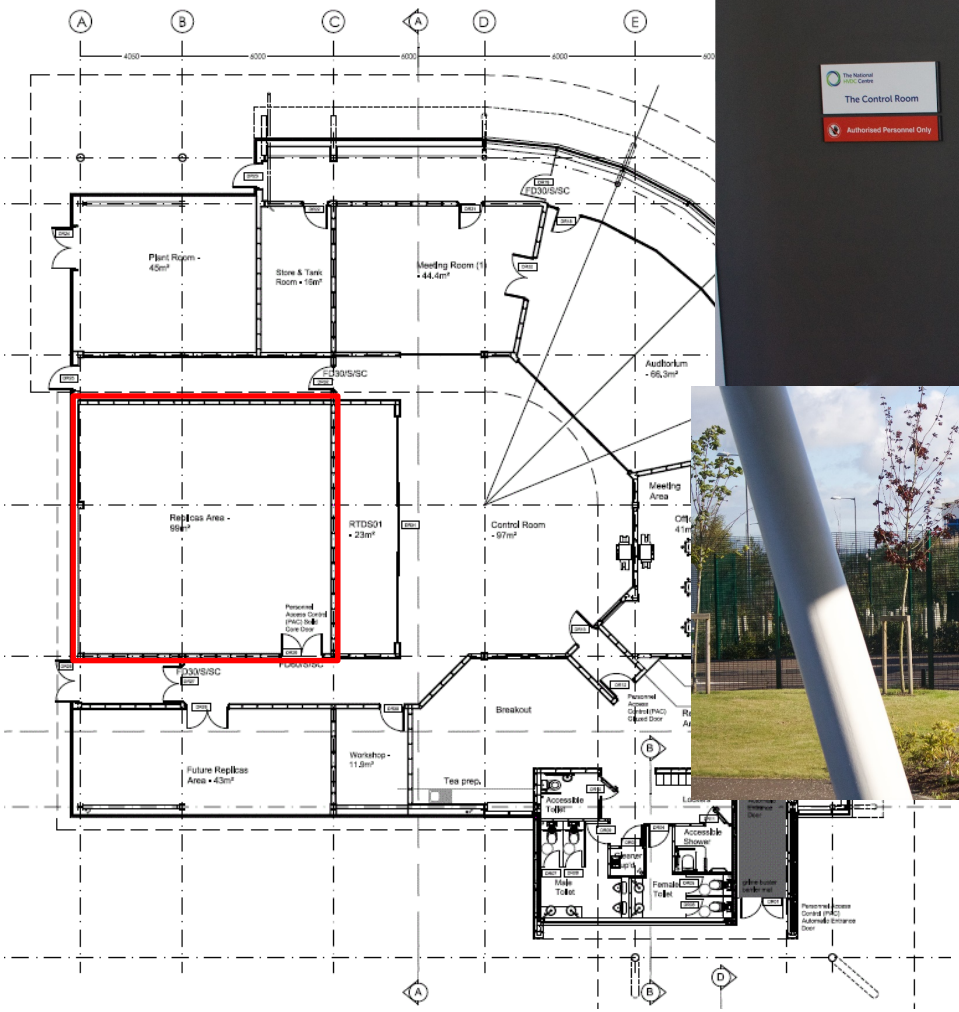
Installation



RTDS Hardware

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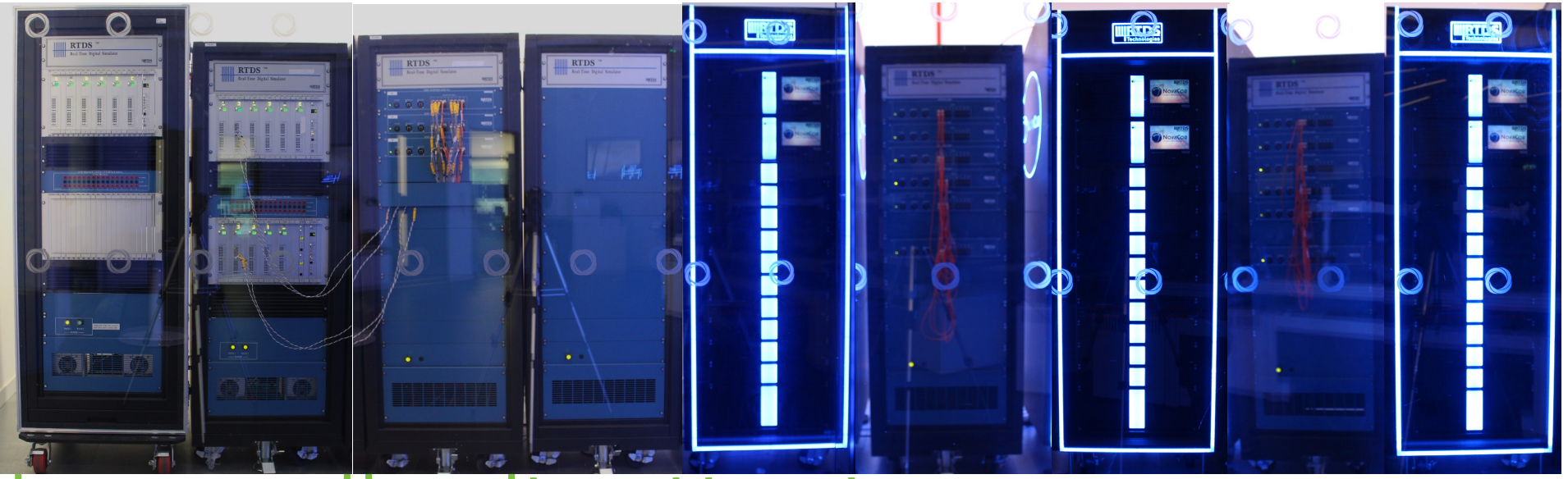

3 x RTDS Racks, each including (5 x PB5 cards, 1 x GTWIF)

3 x MMC Support Units

I/O cards: GTNET, GTAO, GTAI, GTDO and GTDI

2 x NovaCor chassis (5 cores activated)

6 x GTFPGA

2 x NovaCor chassis (5 cores activated)

6 x GTFPGA

2 x NovaCor chassis (5 cores activated)

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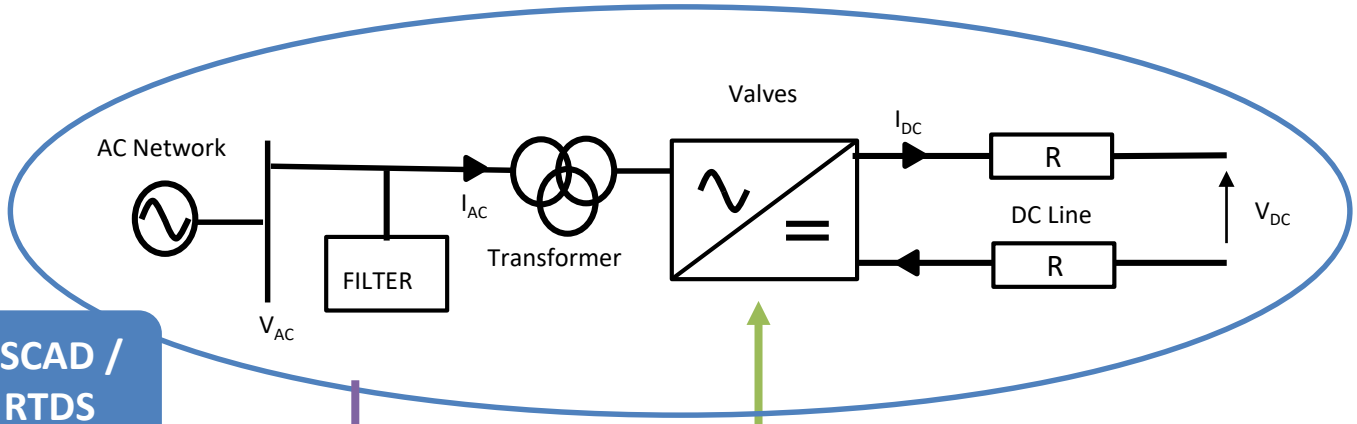
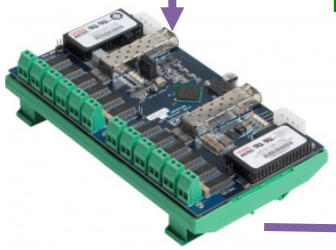
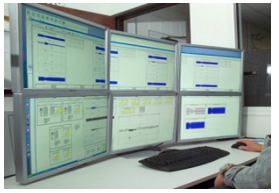
RTDS Hardware Meets Replica



RSCAD / RTDS

Firing Pulses





System Voltage and Current

Protection and Control Cubicles

OWS (Operator Work Station)

Interfacing

Week 1 Electrical contractors arrive on site and begin initial wiring works

Week 2 Replicas arrive on site. Wiring work continues.

Week 3-8 Complete wiring

Week 9 Supplier begins pre-commissioning work

Week 10 Supplier testing

Week 11 Supplier testing

Week 12 User Acceptance Testing (UAT)

Week 13 Supplier provided training on use of Replicas

Applications and Benefits

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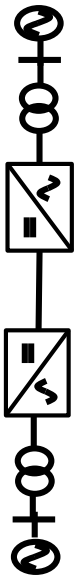
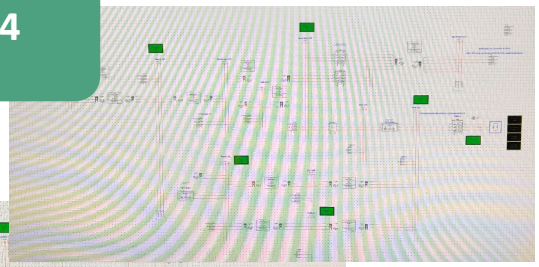
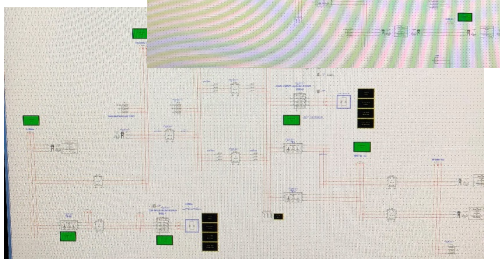


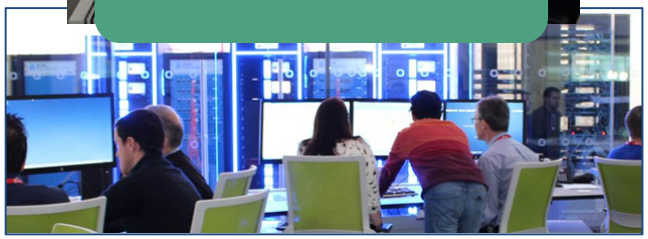
FST4





Commissioning

Operator Training



EPC

Operational Support

- Respond to Network Changes
- Diagnose Faults/Alarms
- In-House Training
- Scheme Updates/ Upgrades
- Long-term Model

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Summary

Summary

- **Owners of HVDC schemes** require Replica HVDC controls to minimise project delays and outages.
- **Transmission system owners/operators** require Replica HVDC controls to ensure system stability and minimise adverse interactions.
- A powerful **real time simulator** is required to accurately model the AC Network connected to Replicas.
- Replicas are an additional project activity and expense, but **pay-back many time over** throughout the life of an HVDC scheme.

Thank you!

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