The National HVDC Centre

Overview

Simon Marshall

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The National HVDC Centre

Scottish and Southern Energy
Power Distribution

Overview: The National HVDC Centre

The National HVDC Centre

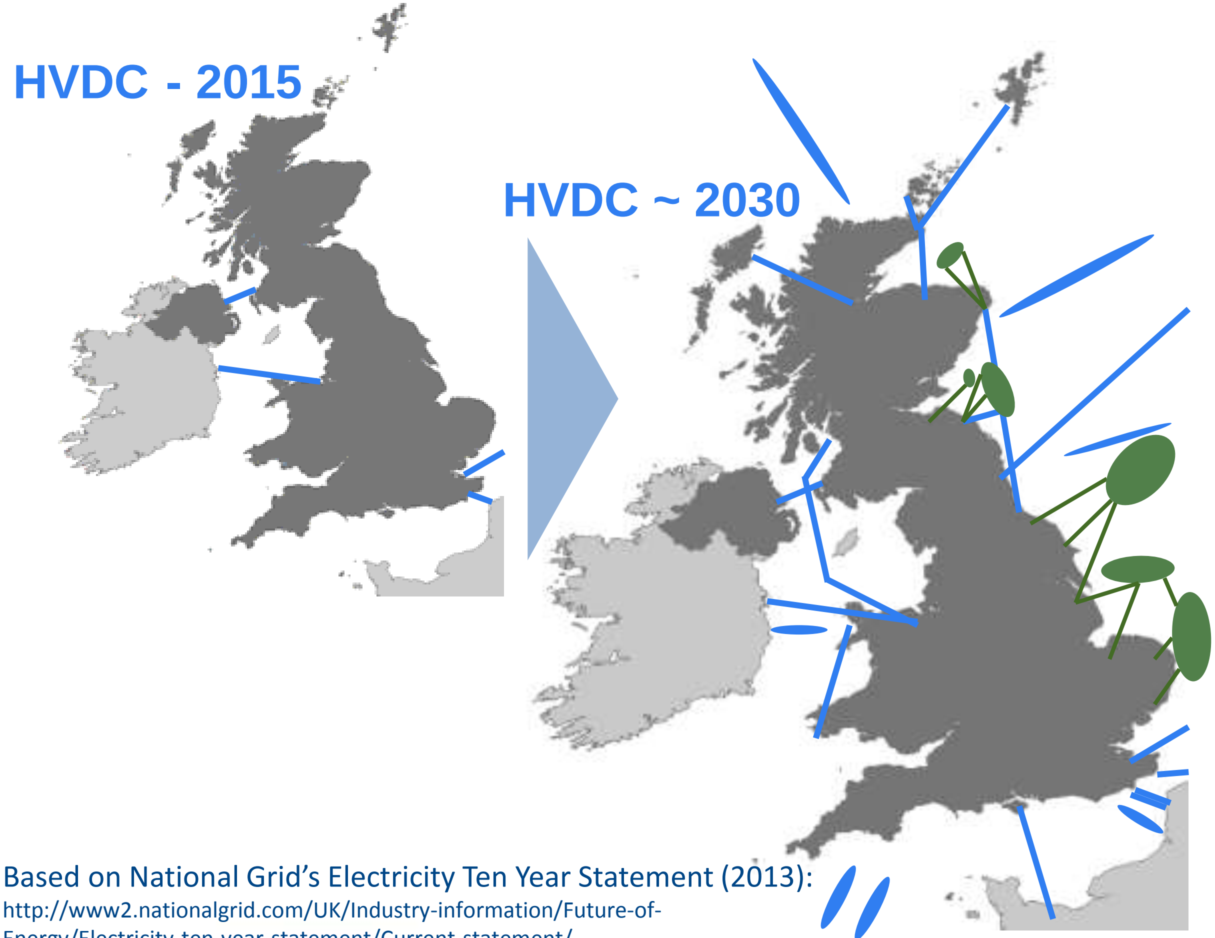
Scottish Hydro Electric Transmission has secured £11.3m funding from Ofgem's Network Innovation Competition (NIC) to create a new facility.

The National HVDC Centre combines real-time simulation with replica control panels from HVDC schemes, to support and de-risks the development and operation of HVDC in Great Britain.

Overview: HVDC Challenges in GB

The National HVDC Centre

There is expected to be significant investment in HVDC in GB to efficiently connect remote renewables.



However this presents a number of Challenges:

- Complexity of Network Planning
- Adverse Control Interactions
- Multi-vendor, Multi-terminal and Multi-infeed
- Standardisation & Interoperability
- Limited Experience

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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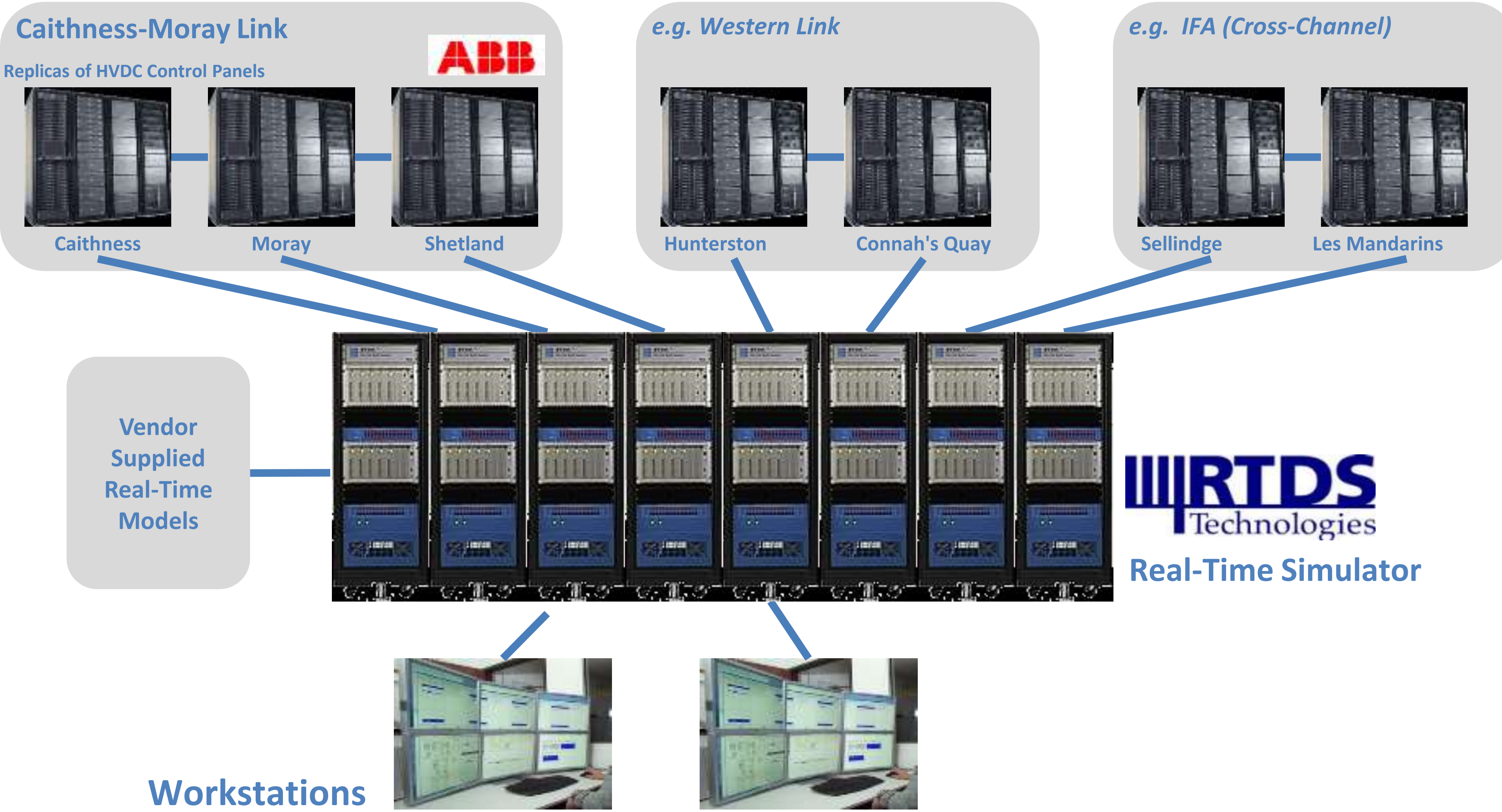
Overview: Technology



Overview: Operation

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Transmission System Owners/Operator

Scottish and Southern Energy Power Distribution, nationalgrid, SP ENERGY NETWORKS

Interconnectors

Current: IFA, Moyle, BritNed & EWIC

Planned: NEMO, ElecLink, IFA2, NSN, NorthConnect, Viking & FABLink

OFTOs

BLUE TRANSMISSION, Balfour Beatty, Transmission Capital Partners

HVDC Vendors

ABB, SIEMENS, ALSTOM

Emerging Vendors

GE, RXPE, MITSUBISHI, CEPRI, HITACHI, LS IS, TOSHIBA, HYOSUNG

Request Support/Studies

The National HVDC Centre

- HVDC Feasibly
- System Specification
- Tender Support
- System Testing
- Operate/Optimise
- HVDC Interactions
- Training
- New Technology

Publish Results

- Full Reports
- Summary Reports

Reports will protect TOs/Suppliers' Intellectual Property.

Academic Support

MANCHESTER 1824 The University of Manchester, University of Strathclyde Glasgow

Design Overview

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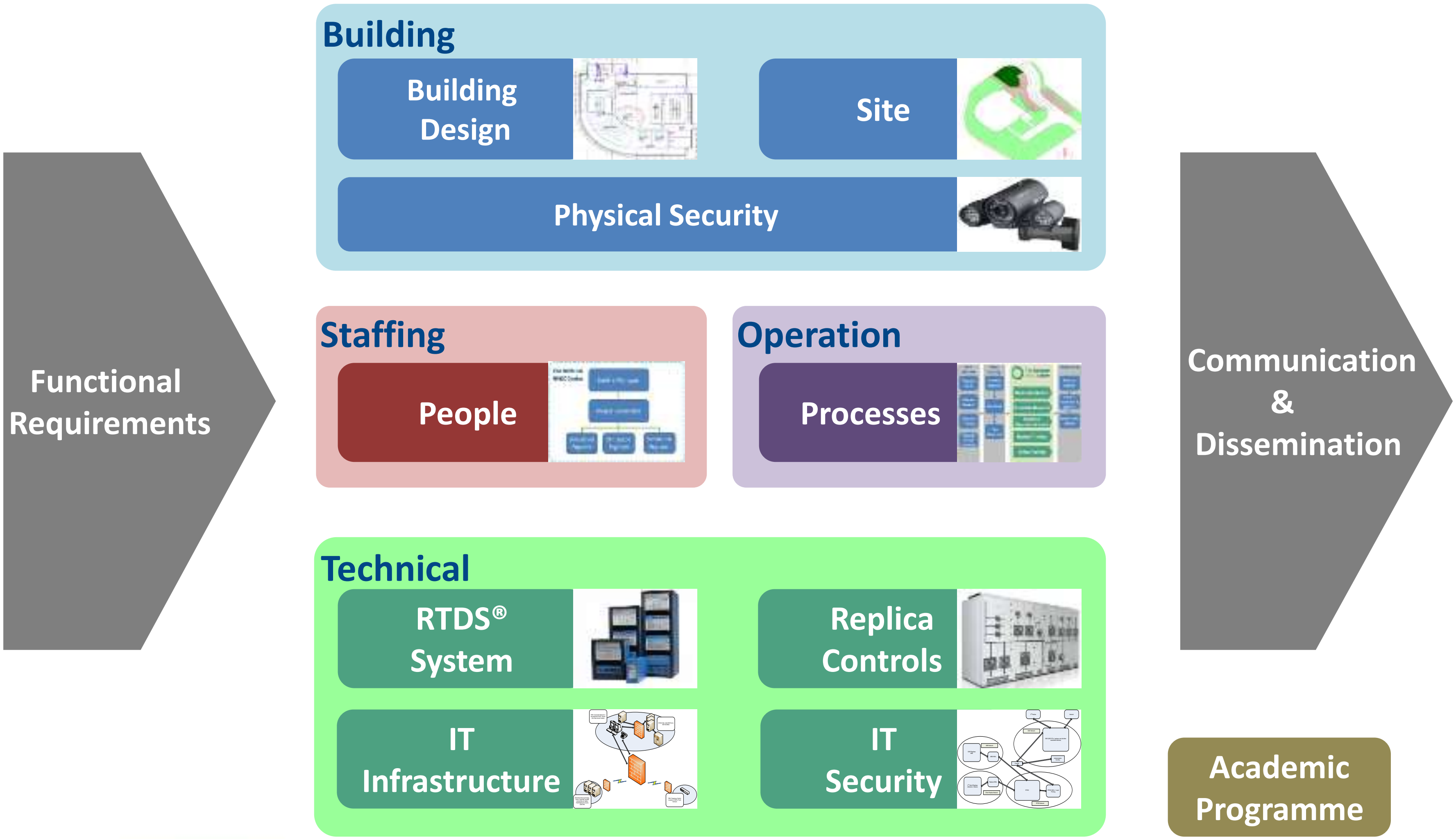

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Building: Location & Plans

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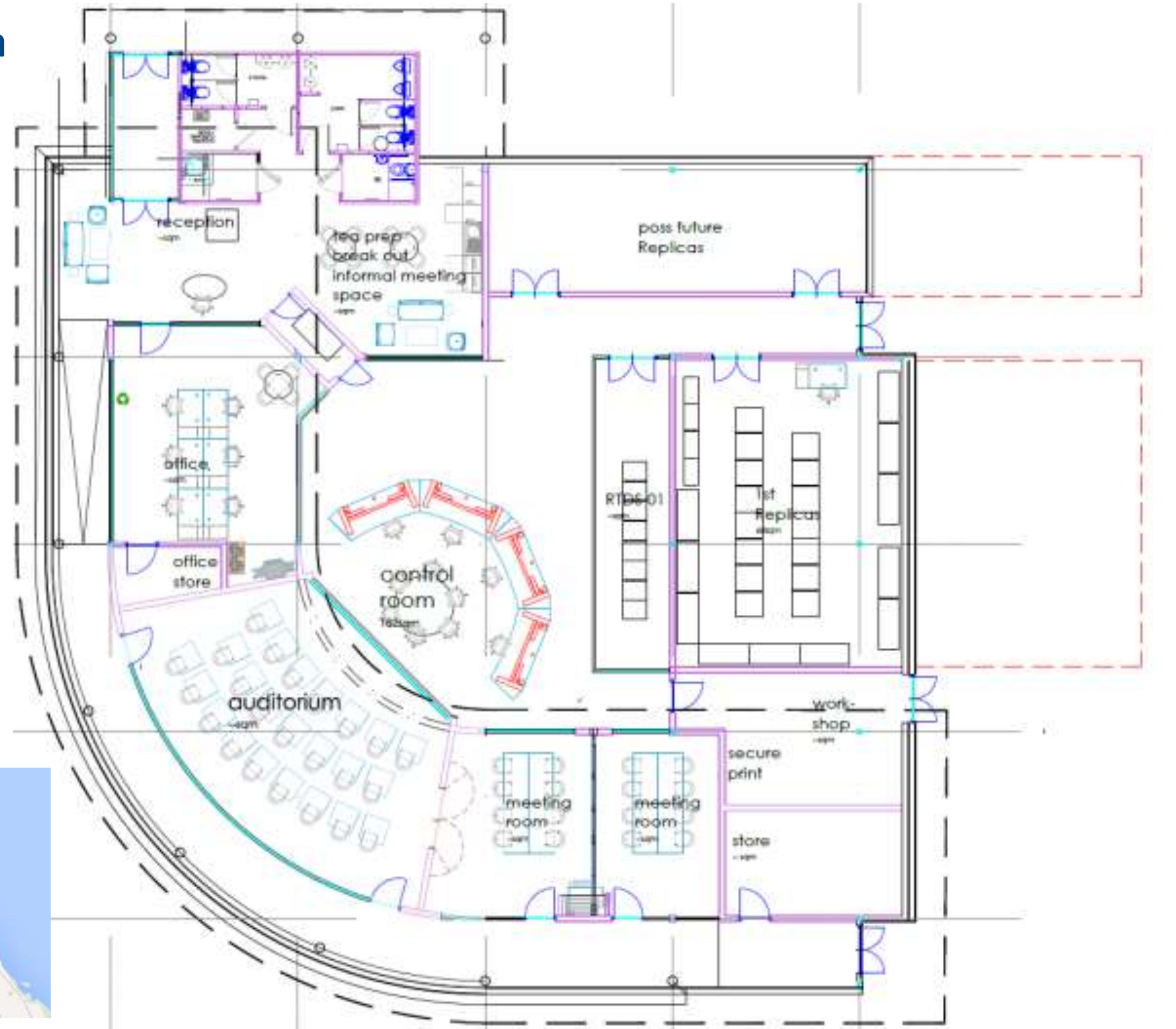
The National HVDC Centre will be a purpose-built building, providing a flexible and secure environment.



Our site is in Cumbernauld, Central Scotland

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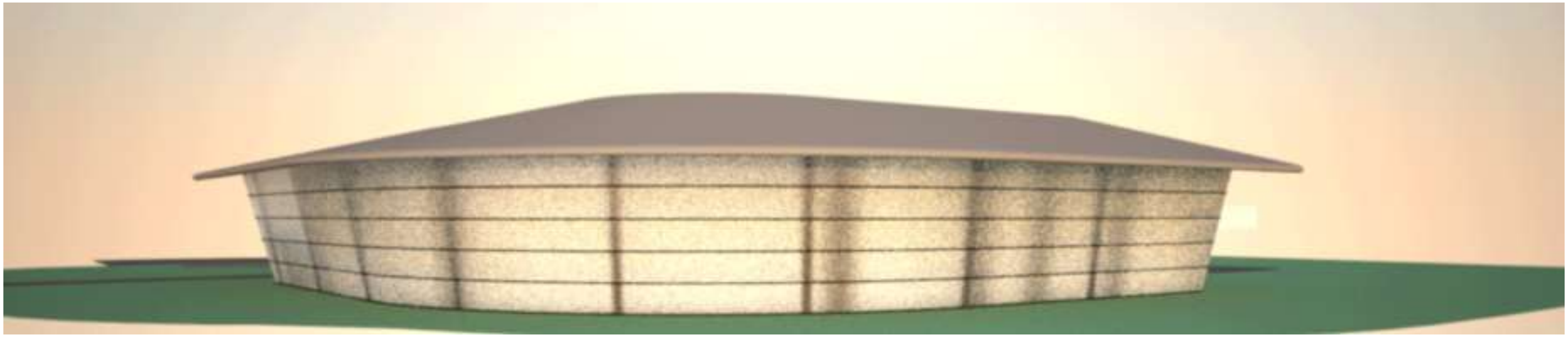
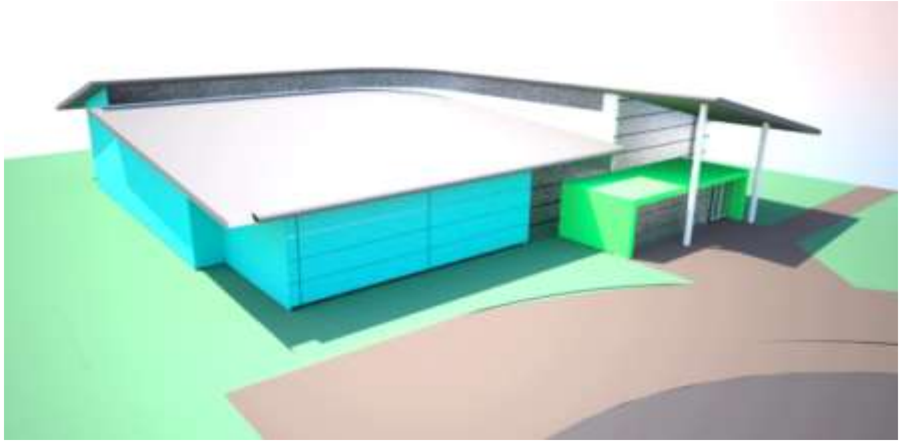
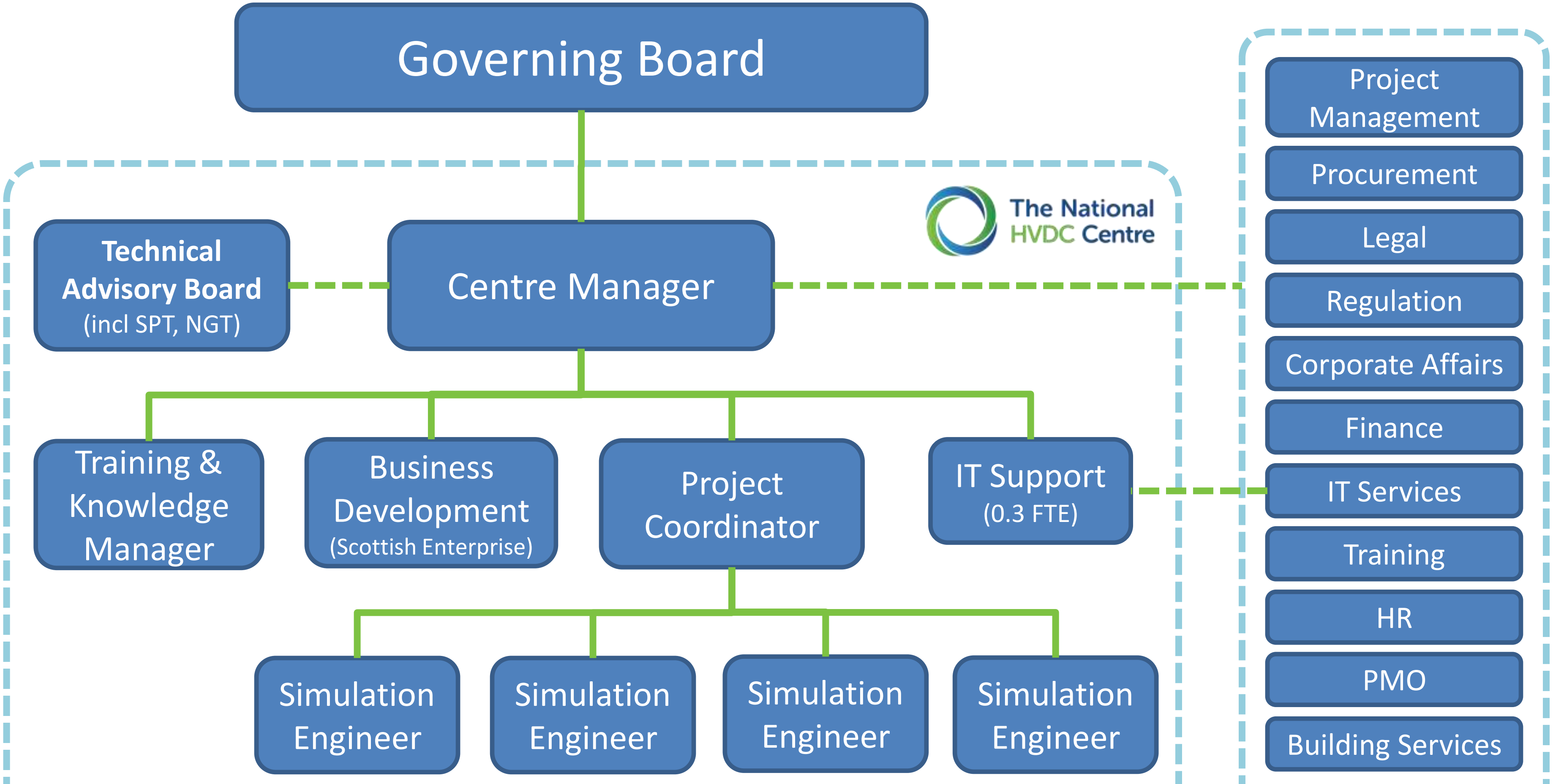
Building: Visualisation



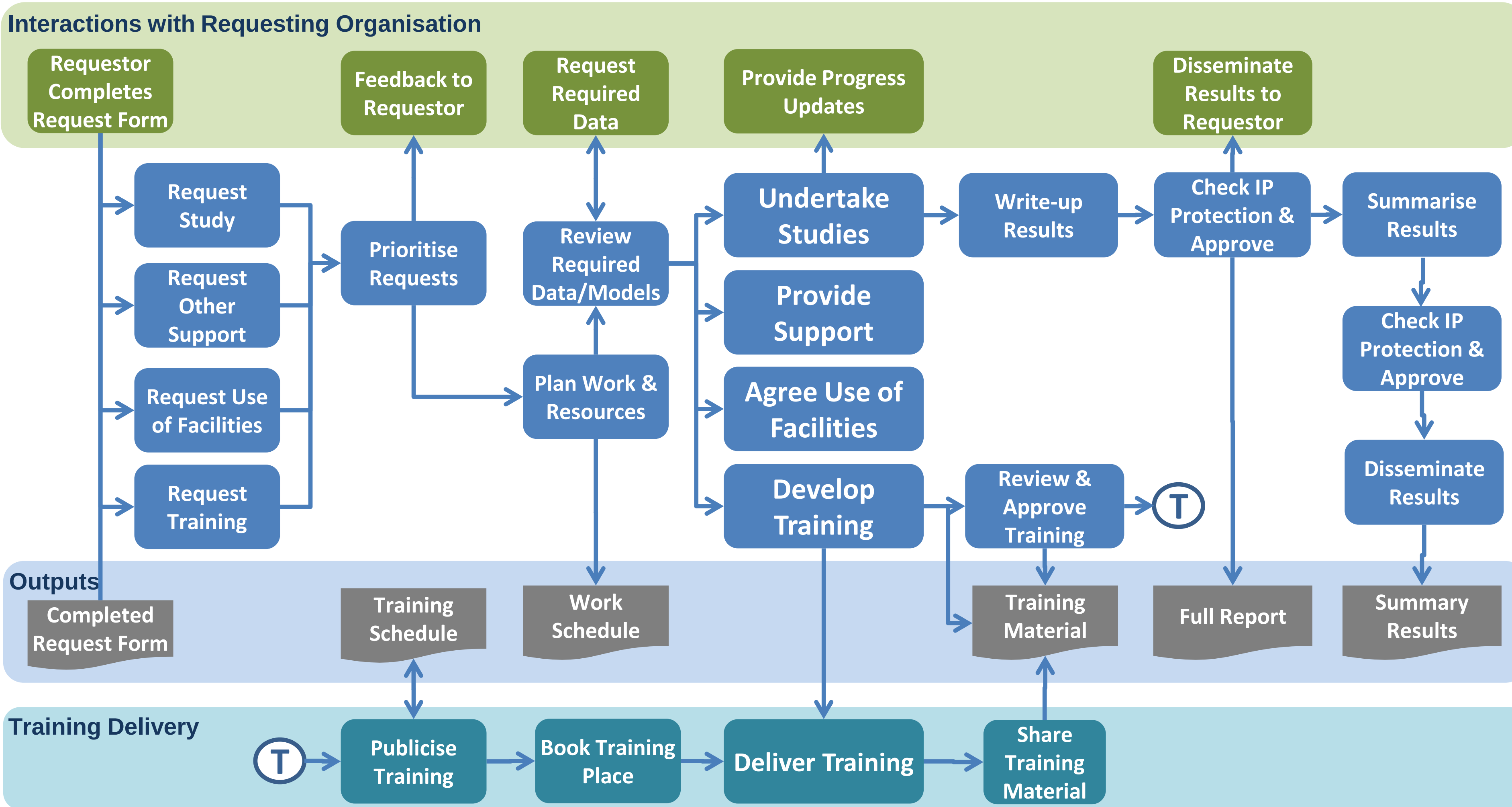


People



The National HVDC Centre will be owned, operated & staffed by SHE Transmission

Processes


Interactions with Requesting Organisation
Requestor Completes Request Form
Feedback to Requestor
Request Required Data
Provide Progress Updates
Disseminate Results to Requestor
Request Study
Request Other Support
Request Use of Facilities
Request Training
Prioritise Requests
Review Required Data/Models
Plan Work & Resources
Undertake Studies
Provide Support
Agree Use of Facilities
Develop Training
Write-up Results
Check IP Protection & Approve
Summarise Results
Check IP Protection & Approve
Disseminate Results
Review & Approve Training
T
Outputs
Completed Request Form
Training Schedule
Work Schedule
Training Material
Full Report
Summary Results
Training Delivery
T
Publicise Training
Book Training Place
Deliver Training
Share Training Material

Communications

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LCNI
Low Carbon Networks
& Innovation Conference

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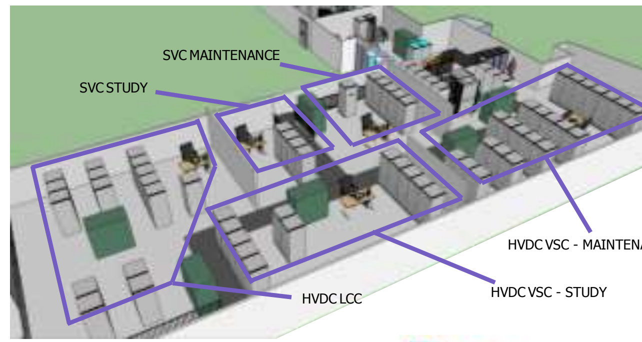
Collaboration

We are collaborating with three other, TO-led, real-time HVDC test facilities with integrated replica controls.

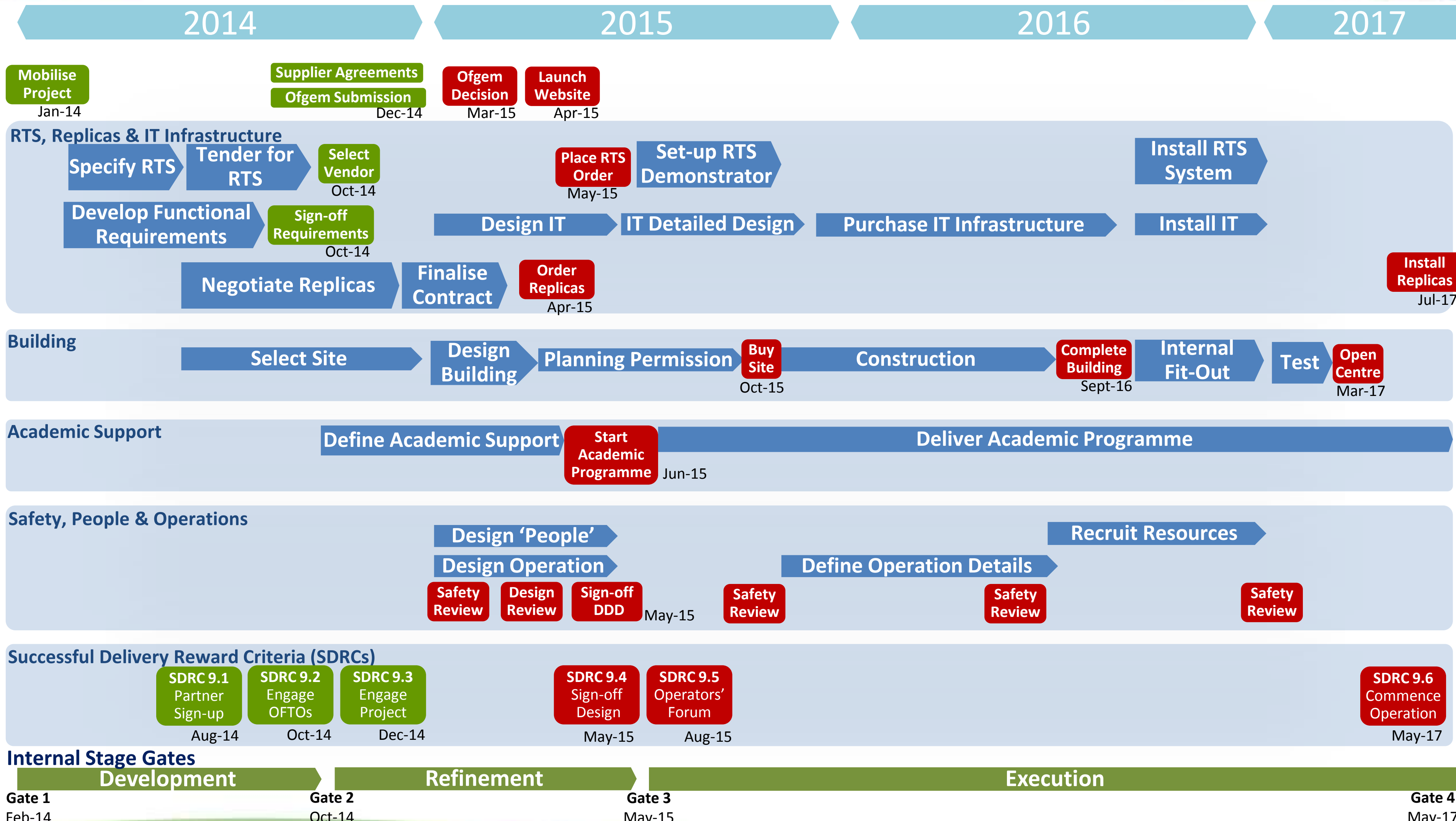
Hydro Québec



Rte

Manitoba Hydro

Key Milestones



Conclusion

The National HVDC Centre

The National HVDC Centre will provide a world-class facility to support and de-risk the deployment and operation of HVDC transmission solutions in GB.

Further details on The National HVDC Centre can be found on our web site:

www.hvdccentre.com

The National HVDC Centre

Contact one of our Team:

The National HVDC Centre

Simon Marshall

T: +44 (0)1738 516 588
M: +44 (0)7880 180 700
E: simon.marshall@sse.com

hvdccentre.com

The National HVDC Centre

Yash Audichya

T: +44 (0)141 224 7644
M: +44 (0)7767 850 762
E: yash.audichya@sse.com

hvdccentre.com

The National HVDC Centre

Colin Cameron

T: +44 (0)141 224 7241
M: +44 (0)7500 912 633
E: colin.cameron@sse.com

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Execution Stage Plan

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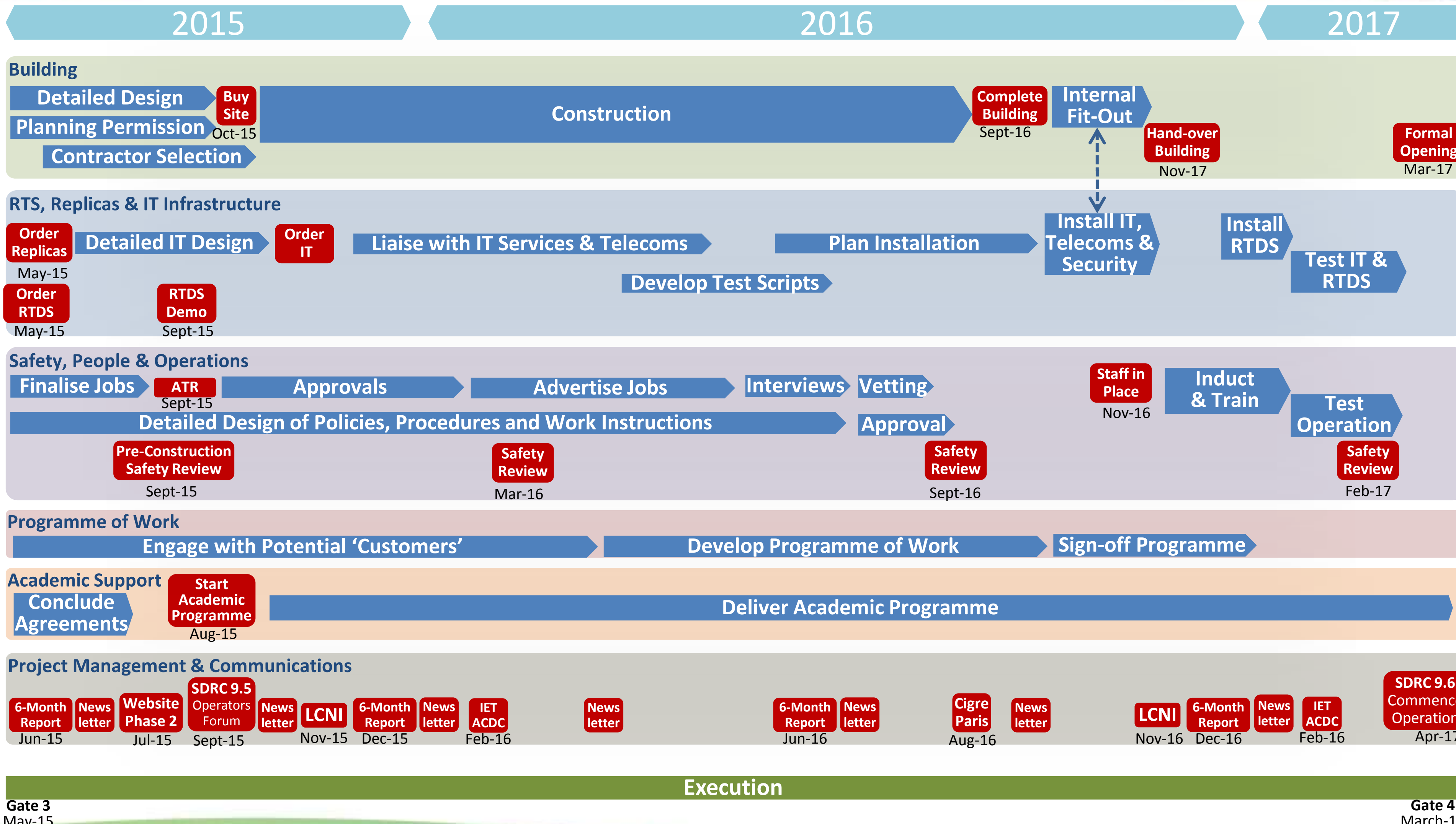

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Context: HVDC Basics – Why use HVDC?

Using Direct Current (DC) reduces losses and increases transmission capacity.

For Cables (underground or Subsea):

- Cable design is like a long co-axial capacitor, and since capacitance increases with cable length; long cables have a high capacitance.
- This capacitance requires current to 'charge' the cable (50 times a second), and this extra current causes additional I^2R losses and uses-up current carrying capacity.
- For long AC cables, the entire current capacity of the cable may be needed just to charge the cable, so it can't transmit any usable power.
- With Direct Current the cable capacitance is charged only when the cable is first energized.
- However, HVDC converter stations are costly; for cables the break-even length is approximately 80km.

For Overhead Lines:

- AC lines suffers from the 'Skin Effect' (pushing all of the current to the outside of the conductor), which increases the resistance of the line (& therefore I^2R losses).
- Overhead lines also have capacitance (though much less than cables), adding to I^2R losses.
- In addition, overhead lines can operate with a constant DC voltage that is the same as the peak AC voltage. The AC Power transmission is only the root mean square (RMS) of the peak voltage (i.e. about 71% of the peak voltage).
- DC doesn't suffer from Skin Effect or Capacitance, and can transmit at constant 'Peak' voltage.
- However, HVDC converter stations are costly; for overhead lines the break-even length is approximately 600km.

Also HVDC can be used for:

- Connecting unsynchronized AC networks or networks operating at different frequencies (e.g. 50 Hz and 60 Hz).
- Increasing the capacity of an existing network where additional lines are difficult or expensive to install.
- Control power flow.

Context: HVDC Basics - Converters

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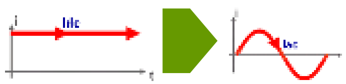
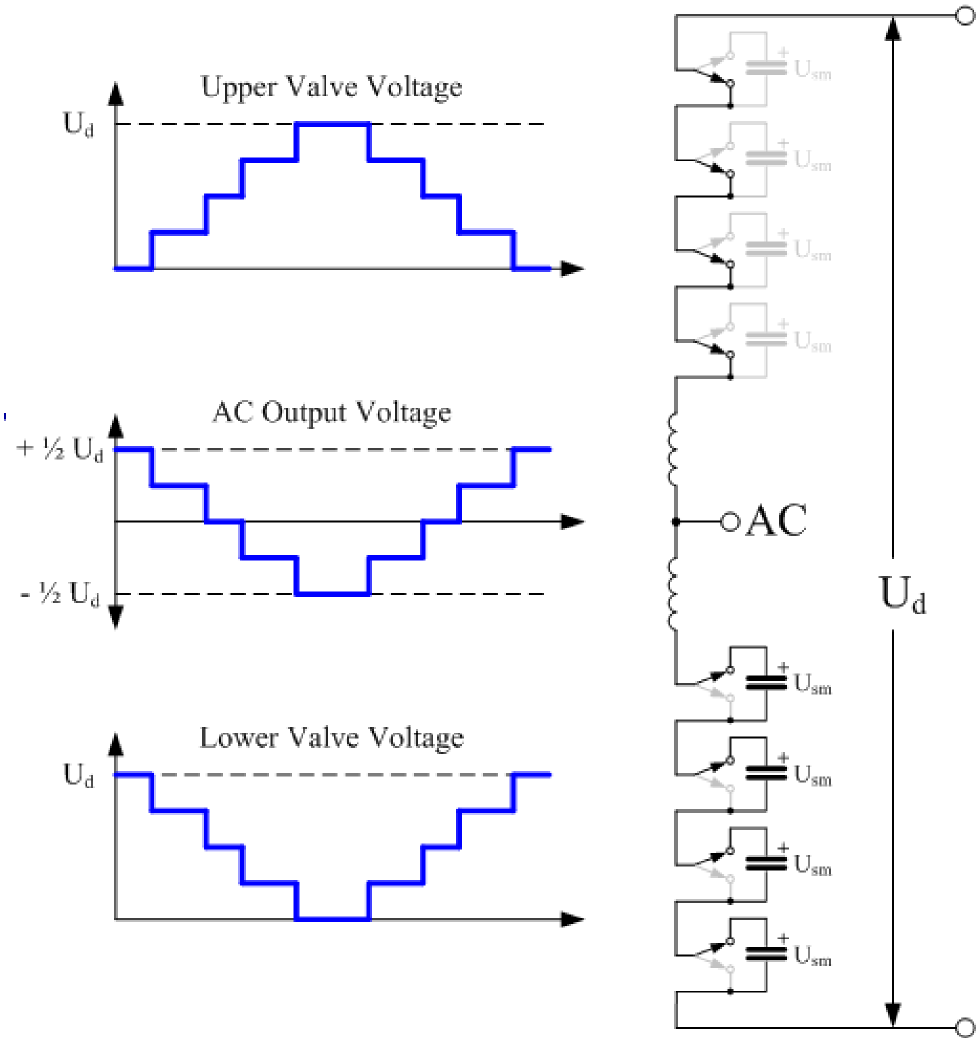
HVDC Converter Stations converts **A**lternating **C**urrent into **D**irect **C**urrent.

The Converter Station at the other end coverts **DC** back to **AC** to feed into the AC Network.



Using an array of switchable valves (like capacitors).

Controlling the switching of these valves, dynamically at high speed, requires complex Control & Protection systems.



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Design: Academic Programme

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The National HVDC Centre will support an aligned Academic Programme.

Multi-infeed Scenarios

Multiple HVDC stations in close proximity are expected, with equipment from multiple vendors.

Investigation is required on how combination of converter topologies and their respective controllers operate together, and any potential adverse interactions.

AC System Stability

Investigate WAM techniques coupled to HVDC station controls to improve system stability.

Coupling PMU phase angle information to controllers, to provide activate damping on the AC network.

Interaction with Adjacent Controllers

Investigation of control interaction modes between an HVDC controller and other device controllers in the vicinity.

Such devices could include:

- WTG of the DFIG design
- WTG of the FC design
- SVC
- STATCOM
- FSC (with segmented capacitor banks)
- TCSC

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Policies

Safety

- Health & Safety Policy

IP

- Creating Intellectual Property
- Protecting Intellectual Property

Security

- Physical Security Policy
- Information Security Policy

Oversight

- Governance Policy
- Audits

Day-to-Day Management

- Visitor Management Policy
- Financial Management Policy
- IT Maintenance Policy
- Facility Management Policy

Other

- Procurement of Replica Panels
- Business Continuity & Disaster Recovery
- HR Policy
- Communication Policy