

SHE Transmission

Multi-Terminal Test Environment for HVDC Systems (SSEN001)

Project Progress Report

December 2015

1) Executive Summary

Overview of MTTE

The Multi-Terminal Test Environment for HVDC (MTTE) Project, is a collaboration across the Transmission Owners (TOs) to support the feasibility, specification, procurement, testing, operation and maintenance of HVDC transmission systems in Great Britain (GB) and de-risk control interactions; using real-time simulation and replica control panels from HVDC vendors.

This will reduce the cost, increase the efficiency and de-risk GB's investment in HVDC systems.

The MTTE Project is funded through the Electricity Network Innovation Competition (NIC) for 7 years; however the Project aims to create a long-term facility to support HVDC solutions in GB.

The facility that the MTTE Project will create, will be:



The National HVDC Centre will combine advanced real-time simulation capability with replica control panels from HVDC schemes, to maximise the benefits of GB's significant investment in HVDC systems by:

- Supporting transmission planning and improve specification of HVDC schemes;
- Facilitating multi-terminal solutions and interconnected DC hubs;
- De-risking control interactions between converters in electrical proximity, and with other

fast acting power electronic controllers embedded within the AC network;

- Training and developing Transmission Planning and Operations Engineers;
- Undertaking post-commissioning scenario planning and network analysis; and
- Modelling multiple HVDC technologies.

The National HVDC Centre will provide a facility where multiple HVDC schemes on the GB transmission network can be studied to anticipate and resolve potential issues, to ensure the integrity and security of the network.

Progress within this Reporting Period

During this reporting period, the Project has focused on: finalising the procurement of the first set of replica panels, installing and testing the first RTDS® rack and demonstrator workstation, completing the design of the building and establishing the HVDC Operators' Forum.

SDRCs

The first 4 Project SDRCs have been successfully completed in previous reporting periods.

During this reporting period, the 5th Project SDRC was successfully completed:

- SDRC 9.5: Establishing HVDC Operators' Forum and Website: the establishment of the HVDC Operators' Forum (including holding the 1st event), together with the publishing of the MTTE website by end of October 2015.

1) Executive Summary

Events

The Project held the 1st event of the HVDC Operators' Forum at the Power Networks Demonstration Centre in Cumbernauld on 8th October 2015.

A report on this event can be found in Appendix I.

The project had a dedicated stand and presented at the LCNI Conference in Liverpool on 24-26th November 2015.

Communications

Also during this reporting period, the Project launched enhanced functionality on the Website, published the second and third editions of the Newsletter, and participated in various conferences.

- **Website (hvdcentre.com):** The website was launched during the last reporting period, however to tie-in with the HVDC Operators' Forum we launched enhanced functionality in October, which provides discussion forum functionality, and also a secure library; this functionality will support the development of the Operators' Forum community [refer to Appendix II for details and visit hvdcentre.com to view this functionality].
- **Newsletter:** The second and third editions of the quarterly Newsletter were published in July and October. Providing updates to stakeholders and other interested parties [refer to Appendix III for a copy of the Newsletters, which can also be found on the Website].
- **Conferences:** In addition to the LCNI Conference, the project participated in the CIGRE B4 working group and the European 'Best Paths' project conference.



2) Project Manager's Report

Project Summary

The Project is managed as a number of workstreams; an update on the progress made on each workstream during this reporting period is provided below:

IT Infrastructure and RTDS

- The first RTDS® Racks have been received and tested.
- Introductory training on the RTDS® hardware and RSCAD software has been completed by the project team.
- A 'Demonstrator Workstation' (comprising all the components of the actual simulation workstation that will be built at the new Centre) has been set-up and tested.
- The IT architecture design document has been completed.

Replica Control Panels

- The contractual arrangement for the procurement of the first set of replica control panels (for the Caithness-Moray Scheme) have been finalised and signed with ABB, and the order has been placed.

Building

- The detailed building plans have been finalised, and planning permission has been approved.
- A Tender process for the building works is underway, with Tender responses due back in January 2016.

Academic Programme

- The first academic project is being set-up (with Manchester University).

Communication & Stakeholder Engagement

- The Project launched enhanced website functionality, issued two Newsletters, and participated in three conferences.
- The inaugural meeting of the HVDC Operators' Forum was held.

Project Management & Governance

- The Project has continued to hold monthly Steering Group meetings, and monthly stakeholder teleconferences.
- The Project is in the 'Execution' stage.



2) Project Manager's Report

SDRCs

The Project has previously met the first four Project SDRCs (which are detailed in prior Progress Reports).

During this reporting period SDRC 9.5 (Establishing HVDC Operators' Forum and Website) was completed.

A key component of our knowledge and dissemination strategy is the establishment of the HVDC Operators' Forum (to which all Network Licensees, including OFTOs will be invited), the associated members' website (which provides a secure area to share the MTTE outputs with Transmission Licensees), and the public website.

- **Requirement:** The establishment of the HVDC Operators' Forum (including holding the 1st event), together with the publishing of the MTTE websites by end of October 2015.
- **Evidence:** The HVDC Operators' Forum event was held on 8th October 2015, and a report detailing this event was produced (refer to Appendix I). The website (hvdccentre.com) was launched in April 2015 (as described in the April 2015 Newsletter). Enhanced functionality was deployed in October 2015 to tie-in with the HVDC Operators' Forum and a report describing this functionality was produced (refer to Appendix II).
- **References:** Refer to Appendix I for the HVDC Operators' Forum event report; and refer to Appendix II for a summary of the website's functionality. Furthermore, the website can be visited to access its functionality (hvdccentre.com).

Business Case Update

No changes have been made to the Business Case for the MTTE Project, described in the NIC Full Submission document.

Summary

The Project has made significant progress over the last 6 months and continues to be delivering on plan and within budget.

3) Progress Against Plan

Summary of Progress

Overall the Project is progressing on plan and within budget.

Risks

The main risk to the Project has been identified as the ability to recruit appropriately skilled and expert resources to the Centre. A 'People Strategy' has been developed which defines the recruitment strategy to mitigate this risk.

Focus This Reporting Period

As reported in the June 2015 Progress Report, the focus over this reporting period has been to:

- Present The National HVDC Centre at the LCNI conference in November 2015;
- Gain planning permission for the building;
- Commence construction of the building (for which the Tender process is underway);
- Set-up an RTS Demonstrator; and
- Establish the Operators' Forum.

Key Activities Next Reporting Period

The Key Activities during the next reporting period are planned to be:

- Complete the Operating Model for the centre;
- Start recruiting the Centre's roles;
- Significantly progress the building works.



4) Progress Against Budget

The table below details the spend to date against the Project budget for each cost category.

Cost Category	Total Budget	Spend to Date ⁽²⁾	Comment
Labour			
Project team resource costs	£2,181.68k	£509.50k	33%* below plan (refer to Note 3)
MTTE resource costs	£2,032.13k	£0	On Plan
Contractors			
Project team resource costs	£288.44k	£33.83k	77%* below plan (refer to Note 3)
IT			
IT Infrastructure (incl RTS and Replica Panels)	£3,828.21k	£558.12k	64%* below plan (refer to Note 4)
Annual Running Costs of the MTTE	£304.37k	£0	On Plan
Travel & Expenses			
Travel & Expenses	£197.40k	£10.35k	77%* below plan (refer to Note 5)
Other			
Academic Support	£827.07k	£0	100%* below plan (refer to Note 6)
Learning & Dissemination	£165.41k	£2.93k	92%* below plan (refer to Note 7)
MTTE Building Facility	£2,916.20k	£39.86k	98%* below plan (refer to Note 8)
Annual Running Costs of the MTTE	£515.09k	£0	On Plan
Recruitment & Training	£137.90k	£0	On Plan
Total	£13,393.91k	£1,154.58k	

Notes:

- 1) *The percentage below plan, refers to spend-to-date as a percentage of the budget-to-date. The budget-to-date is calculated as a pro-rata of the annual budget in the Full Submission Spreadsheet (to November 2015).
- 2) Project Spend as extracted from the finance system (Harmony) on 3rd December 2015.
- 3) Current spend on project team resource costs is lower than the average spend profile in the Full Submission Spreadsheet; though the total is forecast to be within 5% of the total budget.
- 4) The Full Submission Spreadsheet assumed that the RTDS® racks would be delivered in 2015, however the remaining 6 RTDS® racks will be ordered in 2016.
- 5) In-line with the resource cost, travel and expenses spend is lower than the average spend profile in the Full Submission Spreadsheet; though the total is forecast to be within 5% of the total budget.
- 6) Academic support projects are expected to start in 2016, later than assumed in the Full Submission Spreadsheet.
- 7) The spend associated with the project's involvement at the LCNI Conference will come through in the next reporting period.
- 8) Current spend on the MTTE Building facility is lower than the average spend profile in the Full Submission Spreadsheet; though the total is forecast to be within 5% of the total budget.
- 9) There is no Project budget nor Project spend under the Cost Categories: Equipment, IPR Costs, Payments to Users, Contingency and Decommissioning.
- 10) Up to 23rd October 2015, the project had spent £1,099,613 and this has been processed through the Project Bank Account. From 23rd October 2015 to 30th November 2015 the project spent £54,969 (which has yet to be processed through the Project Bank Account) so the total project spend to 30th November 2015 is £1,154,582 as detailed in the above table.



5) Bank Account

A copy of the current Project bank account statement is provided in Appendix IV.

6) SDRCs

An update on the Project's SDRCs is provided below.

The MTTE identified eight Successful Delivery Reward Criteria (SDRC) which span both the objectives and the lifecycle of the Project, furthermore Ofgem's decision letter (27th March 2015) added an additional criteria (SDRC 9.9).

The following table lists each SDRC in chronological order and details the Project's progress towards their achievement.

SDRC	Due	Description	Evidence	Status
9.1	31/8/2014	<p>Formal Agreement with Project Partners.</p> <p>The success of this Project will be crucially dependent on the involvement of the Project partners & stakeholders. Therefore, an early indication of success of the Project is the establishment of formal agreements with the Project partners (National Grid, Scottish Power and NETSO) and HVDC expert support.</p>	<p>Signed agreements with Project partners (National Grid, Scottish Power and the NETSO)(note, agreement will include IP security requirements) and HVDC expert support.</p> <p>Refer to Appendix I for the Agreement between SP Transmission, National Grid Electricity Transmission and SHE Transmission.</p>	<p>Completed (SDRC met)</p> <p>Formal agreements with Scottish Power and National Grid were signed and concluded on 29 August 2014.</p> <p>Parsons Brinkerhoff was engaged as external HVDC expert support in February 2014.</p>
9.2	31/10/2014	<p>OFTOs and Renewable Developers Event</p> <p>Given the anticipated number of HVDC schemes in GB for connection of offshore renewable, the engagement of OFTOs and Renewable Generators is important to ensure the benefits of the MTTE are maximised, therefore the MTTE Project will hold an event to inform and encourage their participation.</p>	<p>Holding an event to which all OFTOs and Renewable Generators are invited, to inform and encourage their participation in the MTTE.</p> <p>Refer to Appendix II for the Letter of Support from the ENA OFTO Forum.</p> <p>Refer to Appendix III for a detailed report on the Engagement Event.</p>	<p>Completed (SDRC met)</p> <p>The OFTOs and Renewable Generators Event was held in Glasgow on 11 September 2014.</p> <p>In addition, the Project presented to the ENA's OFTO Forum on 20 August 2014.</p>
9.3	31/12/2014	<p>Engagement with 1st HVDC Project</p> <p>The purchase of the 1st set of replica control panels for the MTTE will be key to its success, and the panels will be purchased through an HVDC Project. Therefore the formal engagement of the initial HVDC Project is an important early milestone.</p>	<p>Formal agreement between the MTTE Project and an HVDC Project, which includes the intention to purchase/supply replica control panels through the HVDC Project's procurement process.</p> <p>Refer to Appendix IV for the Memorandum of Understanding between the MTTE Project and the Caithness-Moray Project.</p>	<p>Completed (SDRC met)</p> <p>A memorandum of understanding has been signed, between the MTTE Project and the Caithness-Moray Project, confirming the arrangement for the provision and use of replica control panels.</p>





6) SDRCs



<p>9.4</p>	<p>31/5/2015</p>	<p>Complete Design of MTTE Facility The completed design of the MTTE facility, both technical design and physical design, and the agreement of this design with the Project stakeholders (including vendors), is a key milestone for the Project. The detailed design will be consolidated within the Design Development Document, and will adhere to the requirements defined in the requirements specification.</p>	<p>Design development document and requirements specification for the MTTE facility endorsed by participating vendors and signed-off by SHE Transmission, NGET, NETSO and SPT.</p>	<p>Completed (SDRC met) The Design Development Document and Functional Specification were reviewed at the Design Workshop on 23rd April 2015, following which each stakeholder provided written confirmation of their endorsement.</p>
<p>9.5</p>	<p>31/10/2015</p>	<p>Establishing HVDC Operators' Forum and Website A key component of our knowledge and dissemination strategy is the establishment of the HVDC Operators' Forum (to which all Network Licensees, including OFTOs will be invited), the associated members' Website (which provides a secure area to share the MTTE outputs with Transmission Licensees), and the public Website.</p>	<p>The establishment of the HVDC Operators' Forum (including holding the 1st event), together with the publishing of the MTTE Websites.</p>	<p>Completed (SDRC met) The HVDC Operators' Forum event was held on 8th October 2015. The website (hvdccentre.com) was launched in April 2015; to tie-in with the HVDC Operators' Forum enhanced functionality was deployed in October 2015, providing discussion forum functionality, and a secure library.</p>
<p>9.6</p>	<p>31/5/2017</p>	<p>Commence Operation of the MTTE The criteria consolidates the: <ul style="list-style-type: none"> o Completion of the building/upgrade of the MTTE facility; o Commissioning of the IT/RTS infrastructure; o MTTE Resourcing; o Management structure in place; o Processes and procedures agreed; o Data sets of the AC network received (from NETSO); and o Plan of studies and tests agreed. When all of these are in place, the MTTE will be able to commence operations, therefore this is a key milestone and measure of success of the Project.</p>	<p>Commencement of MTTE Operations.</p>	<p>On Target</p>
<p>9.7</p>	<p>31/3/2018</p>	<p>Publishing Studies & Test results The key outputs from the MTTE are the reports on specific scenarios which are completed within the MTTE, which will be disseminated to transmission licensees. Therefore, a key success criterion is the publishing of studies or test reports on the MTTE members' Website.</p>	<p>Publishing the first set of reports on a specific Transmission Licensee led Project, on the MTTE members' Website.</p>	<p>On Target</p>





6) SDRCs

9.8	31/3/2020	Future Business Model At least 12 months prior to the end of the funded operation of the MTTE (i.e. by end of March 2020), the MTTE management team will submit a proposal for the future operation and funding of the MTTE (post NIC funding), to Ofgem.	Submission of proposal regarding MTTE ongoing operation and funding to Ofgem.	On Target
9.9	31/3/2021	Second Replicas Use reasonable endeavours to secure the provision and testing of a second set of replica control panels for the MTTE from a second vendor. The panels would be provided by an HVDC Project, a transmission Licensee or a second vendor.	Submission of evidence of the use of reasonable endeavours for the provision and testing of the second vendor's replica control panels at the MTTE facility; by the end of March 2021.	On Target*

 Completed (SDRC met)
 On target

 Emerging issue, remains on target
 Unresolved issue, off target

 SDRC completed late
 Not completed and late

*Note: In September 2015, the project team meeting with Alstom at their Stafford offices, at which we discussed the provision of replica hardware, for which discussions are ongoing.



7 Learning Outcomes

HVDC Operators' Forum

The HVDC Operators' Forum provided the opportunity for HVDC schemes in GB to share their insights and experiences. This proved to be a very valuable event, with significant learnings shared.

A report on this event can be found in Appendix I; and all the presentations from the event have been shared on the secure library on the website.

The following learning objectives have been set for the MTTE Project:

- **Support Transmission Planning of HVDC schemes:** The MTTE will produce analysis and reports on the development scenarios investigated, and will share these with the other TOs/OFTOs to increase the understanding of the impact of HVDC development scenarios on the existing network. In addition, the models developed will be shared with Network Licensees.
- **Improve Requirement Specification of HVDC schemes:** The MTTE will produce analysis and reports advising Network Licensees on the specification of HVDC schemes, and these will be shared with the other TOs/OFTOs to increase the understanding of specifying requirements for HVDC schemes.
- **Facilitate Multi-Terminal HVDC solutions:** The MTTE will produce analysis and reports on the Multi-terminal scenarios, and will share these with the other TOs/OFTOs to increase the understanding of Multi-Terminal HVDC.
- **Facilitate Competition and Multi-Vendor HVDC schemes:** The MTTE will produce reports on multi-vendor compatibility to inform the development of HVDC standards and interoperability. Acceptance testing reports will also be produced.

- **De-risk Control interactions between co-located and electrically connected converters, and with other active controlled equipment:** The MTTE will produce reports on the impact of planned HVDC systems, providing detail on any control interactions with converter stations in close proximity and active controlled equipment. These reports will be shared with all Licensees to improve sector-wide understanding of the associated issues. This would include reports on the integration of generators into HVDC networks and the associated risk of adverse control interactions and their control protocols and strategies.
- **Train Transmission Planning and Operational Engineers:** The MTTE will produce training material which will be available to all Transmission Licensees.
- **Undertake Post commissioning scenario planning and operational optimisation:** The MTTE will produce recommendation reports on specific HVDC schemes to enable optimisation which will be shared with all Licensees.
- **Model New HVDC Technologies:** The MTTE will produce analysis and reports on the performance, impact and interactions of new HVDC technologies or active controlled devices in accurately simulated GB situations and their suitability for specific applications / locations.

These learning objectives will start to be achieved when The National HVDC Centre has been commissioned.

IPR

No relevant IPR has been generated or registered during this reporting period



8) Risk Management

Risk Management Plan

The Project has a Project Risk Management Plan that describes how Project risks are managed throughout the Project.

The Project risk register is regularly reviewed by the Project team and the key Project risks are highlighted and discussed at the monthly steering group meetings, where mitigating actions are agreed.

Risk Register

The current Project Risk Register is provided in Appendix V.

9) Accuracy Assurance Statement

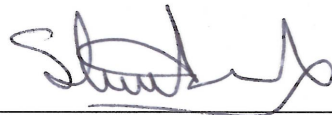
PPR Preparation Steps

To ensure that the information contained in this report is accurate and completed, the following steps have been taken, the report has been:

- Prepared by the Project Manager;
- Reviewed by the Project Team;
- Reviewed by the Steering Group; and
- Approved by the Project Director and Regulation.

Sign-off

As the senior manager responsible for the MTTE Project, I confirm that the processes in place and steps taken to prepare this PPR are sufficiently robust and that the information provided is accurate and complete.



Stewart A Reid

Head of Asset Management & Innovation
Scottish Hydro Electric Transmission



Appendices

Appendix I

HVDC Operators' Forum Event Report

Appendix II

Website Functionality

Appendix III

July and October 2015 Newsletters

Appendix IV

Project Bank Account Statement

Appendix V

Risk Register

Note: Appendices I, IV & V are considered 'Confidential'.



