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Ofgem Electricity NIC Year 1 Evaluations

Multi-Terminal Test Environment (MTTE) for HVDC Systems

Final Report with Addendum

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Explanatory Note

This report, including the "traffic light" indicators that reflect issues of concern identified during the evaluation process, (other than Section 10) is based on:-

- the original full submissions that were received from SHE in August 2013;
- subsequent question responses through the formal written question process;
- discussions held at meetings between the transmission owners and the Expert Panel and/or PPA Energy; and
- factual corrections provided by SHE.

In October 2013 SHE was given an opportunity to submit a revised proposal. The traffic light indicators and the metrics shown in Sections 1 to 9 have not been changed to reflect any changes made by SHE in this revised submission.

Section 10 of this report contains an addendum, which summarises changes made between the original and revised submissions, and the impact this has on the evaluation of the project against the criteria. Any significant changes to figures/metrics are noted in this addendum.

Project Summary

Full name:	Multi-Terminal Test Environment (MTTE) for HVDC Systems		Short name:	MTTE
			Total cost: (£000)	£13,978
Network Licensees group:	Scottish Hydro Electric Transmission Plc (SHE)		NIC funding request: (£000)	£11,815
The Problem(s):	An increasing number of High Voltage Direct Current (HVDC) links are planned in GB to address the need for significant additional transmission capacity, some of which is offshore. The overall problem is the lack of experience with, and understanding of, impacts of and interactions between HVDC systems, and the barrier this poses to their widespread take-up, to facilitate the connection of renewable generation. Particular problems include: • transmission planning with HVDC schemes becoming more complex; • lack of tools to understand the detailed impact of HVDC systems on the existing network; • lack of experience with HVDC schemes limiting the ability to specify detailed requirements and negotiate technical details; • risks and impacts of multi-terminal HVDC; • issues with different vendor products interoperability and standardisation; • control interactions between active controlled equipment; • limited experience in HVDC operation; and, • understanding the operation, benefits and risks of new HVDC technologies.			
The Method(s):	Establish a collaborative facility (real-time simulator or RTS) to enable the planning, development and testing of HVDC transmission solutions with the following capabilities: • Model HVDC systems and the associated AC network, to facilitate the planning of HVDC systems and improve requirements specification; • Model multi-terminal HVDC systems; • The ability to incorporate replica control panels;			

	• Allow equipment from different vendors to be modelled, and have the facilities to conduct Acceptance Testing of multi-vendor HVDC systems; • Allow the testing of control interactions; • Provide a training facility for staff; and • Allow studies on system optimisation and new HVDC technologies.
The Trial(s):	The project proposes to build and house a test facility (the MTTE), and includes costs for the MTTE to be operational for four years. A programme of studies will be developed as part of the project, for the four year operational period. Studies will include steady state and dynamic analysis of the operation of HVDC systems, for multi-infeed, multi-terminal, embedded HVDC and HVDC schemes in close proximity to other control devices.
The Solution(s):	Enable and facilitate: • New multi-terminal HVDC schemes (e.g. 3, 4 or 5 terminal HVDC systems), including generation connections if appropriate; • Extensions to HVDC schemes (e.g. adding 3rd, 4th or 5th terminals to schemes); • Multi-vendor schemes (where different manufacturers supply the converter stations at different terminals); and • Multi-infeed and converters in electric proximity (providing confidence of the integration between converters, and other active controlled devices).
Key strengths and weaknesses against the criteria	Key strengths of the project include: • The MTTE has the potential to make a significant contribution to increasing learning and reducing costs for HVDC systems, to facilitate the connection of renewable generation, by providing Transmission Owners (TOs) and Off-shore Transmission Owners (OFTOs) with tools and capabilities that they do not currently have. • The financial benefits estimated from the project range from £133m to £493m in reduced costs for HVDC systems to 2030, and £55m to £180m additional savings per avoided converter station. The lower end of the range of savings is based on reasonably conservative assumptions. • The benefits of the project are expected to flow to customers via reduced transmission network use of system (TNUoS) charges, and the learning is particularly relevant to all transmission network licensees.

	• SHE intends to run competitive tender processes or make use of framework contracts for a number of key project components, including the RTS, the building and academic support. • The project is considered to be relevant and well timed, given the potential rate of HVDC system growth over the next two decades. Key weaknesses of the project include: • This project is important in terms of carbon and financial benefits. The ability to realise the benefits depends on sourcing replica control panels for future HVDC projects. If there is not a robust plan for sourcing these, there is a risk that the opportunity for carbon and financial benefits will be lost. In addition, the business plan for the facility after the NIC funding period does not appear to have been considered in much detail, which also affects the long-term feasibility of the facility. This will be developed as part of the project. • There is currently no external funding for the project. Both project partners are well known to SHE; there is no evidence that the process for recruiting project partners has been effective in recruiting new project partners. There is not a robust level of commitment from project partners or participants, including vendors, whose participation is key to the project. • The Successful Delivery Reward Criteria (SDRC) do not contain detailed evidence. Some key outcomes from the project do not appear to have been captured in the SDRC evidence.

1 Summary of Assessment against Evaluation Criteria

Criteria	Overall Assessment	
(a) Low carbon and benefits		The amount of renewable generation is expected to increase over the next two decades and beyond, in order to meet government targets. This will require significant expansion in the transmission system; all TOs have plans to invest in infrastructure in the RIIO-T1 period. In a number of cases, AC transmission will not be a viable option, so a number of HVDC links are planned. This triggers the need for the MTTE, to study the interaction of HVDC links. The low carbon benefit of MTTE is its contribution to enabling the connection of multiple renewable sources in GB during the RIIO-T1 period and beyond, supporting the delivery of the government's carbon plan. It will do this by accelerating the deployment of multi-terminal and/or multi-vendor solutions. Financial benefits have been considered in two ways. Firstly, SHE claims that cost reductions in HVDC projects as a result of the MTTE would be within the range £133m - £493m (both point-to-point and multi-terminal / infeed). While these savings do not take account of the costs of using the MTTE (in terms of replica control panels and operating costs), the lower end is based on conservative figures. In addition, a mid-point value of £117m of savings per avoided convertor station, due to the facilitation of multi-terminal solutions, has been suggested. The potential replication is based on National Grid (NGET) scenarios. While the number of HVDC projects, particularly multi terminal, is small, the impact comes from the significance of the costs associated with each project. In order to achieve these savings, project developers will require access to the MTTE; this depends on access arrangements once the facility becomes operational.
(b) Value for money		The financial benefits expected to accrue from the MTTE facility are associated with cost reductions of future HVDC installations. These benefits will flow to customers, via Transmission Network Use of System (TNUoS) charges. The benefits in learning, e.g. improved transmission planning and operational training, will accrue to

		transmission licensees, i.e. TOs and OFTOs. The learning from the project is highly relevant to all three TOs and OFTOs. In order for OFTOs and renewable generators to realise both the financial and learning benefits from the MTTE, access will need to be ensured. SHE states that OFTOs will be invited to participate fully in the MTTE, with the same access rights as TOs. SHE has adopted a variety of approaches for selecting project partners and other relevant parties. A competitive procurement process or making use of framework contracts is proposed for a number of items in the project, including some of the major cost items (e.g. the building and the RTS). The major cost items have been reviewed; a number of approaches have been taken by SHE to ensure value for money. It is considered that more could be done to ensure best value from partner rates. Financial cost estimates for other building options do not appear to have been considered, and there is no evidence that SHE has sought to minimise building costs.
(c) Generates knowledge		The MTTE project is expected to generate new learning, particularly in the area of studying control interactions between HVDC projects in GB. The learning expected from the MTTE is relevant to TOs, OFTOs and renewable generators, who have immediate and long term plans for develop HVDC links. SHE has identified a clear list of learning objectives and interested stakeholder groups. Key knowledge dissemination methods include establishing an HVDC Operators' forum and providing training for staff. IPR protection is a key issue in this project, particularly relating to vendor equipment and models. SHE has outlined proposed measures to address this issue, to ensure this does not become a barrier to vendor participation; so far vendors have indicated that they are satisfied with the proposed measures.
(d) Is innovative		There are a number of aspects of the MTTE that are innovative, including the use of replica control panels and the capability to study HVDC interactions as part of the GB system. While the use of replica control panels exists in Canada, they are not in use in the UK or Europe. The MTTE will be tailored to GB system studies. The justification for NIC funding is that the MTTE is a

		collaborative facility, which will be a valuable (and open) resource for all TOs and OFTOs. It seems reasonable that the MTTE facility would not be developed without NIC funding, and in particular by one HVDC project developer. A number of risks have been explored, including technical, regulatory and commercial. SHE seems to have identified how they will address the risks that are within their control.
(e) Partners and Funding		There are two formal project partners, NGET and Scottish Power (SP), and a number of other roles identified for project participants. In general, project partners and participants seem to be appropriate, but there does not appear to be a robust level of commitment. This is a particular issue with vendor participation, which is noted as being key to the project. There is no external funding for the project. Scottish Enterprise may be contributing; they are undergoing their internal approval process. The project partners are well known to SHE; the partner recruitment process does not seem effective for recruiting new project partners. The process for recruiting other participants seems to be more open.
(f) Relevance and timing		The MTTE seeks to address current limited experience of multi-terminal and multi-vendor HVDC systems, as the planned number of HVDC schemes is set to grow over the next two decades. This is driven by the projected increase in offshore renewable generation connections, as part of the governments' low carbon plan. If the estimated benefits are realised by future HVDC developers, this will have a significant impact on the costs for connecting offshore renewable generation. In addition, the expected learning from the MTTE impacts on a number of areas within TOs, as well as other licensees, and on a wider scale, could feed into developments of a European "mega-grid".
(g) Methodology		SHE seems to have considered areas of technical feasibility, such as the interface between replica control panels and the RTS, and the provision or development or models. They have gate and risk processes in place, and have identified personnel for key roles. The project plan provided in the proposal does not contain a detailed breakdown of activities; neither have work stream descriptions been provided. However, where clarification

		has been sought on project activities, further information has been provided. A key risk to the long-term feasibility of the facility is ensuring vendor participation, via OFTOs and generators, in terms of providing replica control panels and models for future HVDC projects. It is appreciated that this issue is not straightforward, due to the fragmented nature of the industry. While SHE has demonstrated that they have given consideration to these issues, there are some details around this area that could warrant further exploration.
Successful Delivery Reward Criteria (SDRC)		SHE has set out eight SDRC. In general, the evidence associated with each SDRC is not detailed, and it is considered that some key elements of the project have not been captured.

The "traffic light" system used in the table above gives an indication of PPA Energy's assessment of the information provided by the Network Licensee in support of the project in respect of its detail, alignment with the NIC evaluation criteria as specified in the Electricity NIC governance document, identification and management of project risks and other aspects for each of the criteria. This is not intended to suggest whether projects should be funded or not but to point out those areas which PPA Energy believes merit particular scrutiny or consideration. Thus:-

	• Seems to be generally in line with the objectives and requirements of the NIC evaluation criteria, • Whilst there are some areas where additional information would be useful, that provided is generally comprehensive and provides no immediate cause for concern.
	• Some indication that the project is in line with the objectives and requirements of the NIC evaluation criteria. However, further scrutiny is required to ensure this, • There are some gaps in the information provided, • Further assurance is needed to confirm that the project is viable and that risks are appropriately managed.
	• Significantly more assurance is required that the project is in line with the objectives and requirements of the NIC evaluation criteria, • There are some major gaps in the information provided,

	• Considerable scrutiny is needed to confirm that that the project is viable and that risks are appropriately managed, • Potential major risks to the viability of the project.

In the following evaluations against the criteria, if the project is addressing various problems and/or trialling several methods and solutions, separate analysis of metrics and sub-criteria will be provided, if appropriate, for relevant criteria.

2 Criterion (a) Low Carbon and Benefits

Criterion:	Accelerates the development of the low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and/or existing Customers.
Overall assessment:	The amount of renewable generation is expected to increase over the next two decades and beyond, in order to meet government targets. This will require significant expansion in the transmission system; all TOs have plans to invest in infrastructure in the RIIO-T1 period. In a number of cases, AC transmission will not be a viable option, so a number of HVDC links are planned. This triggers the need for the MTTE, to study the interaction of HVDC links. The low carbon benefit of MTTE is its contribution to enabling the connection of multiple renewable sources in GB during the RIIO-T1 period and beyond, supporting the delivery of the government's carbon plan. It will do this by accelerating the deployment of multi-terminal and/or multi-vendor solutions. Financial benefits have been considered in two ways. Firstly, SHE claims that cost reductions in HVDC projects as a result of the MTTE would be within the range £133m - £493m (both point-to-point and multi-terminal / infeed). While these savings do not take account of the costs of using the MTTE (in terms of replica control panels and operating costs), the lower end is based on conservative figures. In addition, a mid-point value of £117m of savings per avoided convertor station, due to the facilitation of multi-terminal solutions, has been suggested. The potential replication is based on NGET scenarios. While the number of HVDC projects, particularly multi terminal, is small, the impact comes from the significance of the costs associated with each project. In order to achieve these savings, project developers will require access to the MTTE; this depends on access arrangements once the facility becomes operational.
Metrics (where available):	

Net financial benefit (£)[1]:	£8.8 million per HVDC project
Carbon benefits (for example in £/tCO2) [2]:	Not quantified
Network capacity released (kW)[3]:	N/A
Base case time to release capacity (months)[4]:	N/A
Method time to release capacity (months)[5]:	N/A
Potential for replication[6]:	1 HVDC project per year, between 2015 and 2030 (only considered up to 2030)

[1] The financial benefit of each method (at the trial scale) compared to the most efficient existing method; **Net financial benefit = Base case costs** (the lowest cost of delivering the Solution (on the scale outlined as part of the project) which has been proven on the GB Transmission Systems) **– Method costs** (the costs of replicating the method at the trial scale once it has been proven successful)

[2] The Carbon benefits that have been claimed by the application of each Method.

[3] The network capacity released by each method (the additional headroom released on the transmission system following implementation of the Method)

[4] The time it would take in months to deliver the capacity shown in "Network capacity released" under the Base Case

[5] The time it would take in months to deliver the capacity shown in "Network capacity released" using the replicated Method

[6] The estimated number of sites or % of the GB Transmission System where the method could be rolled out, up to 2040

Sub-criteria	Assessment
Carbon claims (including quantitative analysis, if provided)	The UK's carbon plan states that 15% of UK energy needs will by met from renewable sources by 2020, with around 30% of UK electricity generation coming from renewable generation. In addition, increased and rapid decarbonisation is expected during the 2020s and 2030s, with similar implications for the connection of renewable generation. Offshore and onshore wind are expected to make significant contributions to the generation mix over the next decades. SHE Transmission (SHE) claims that these developments will result in a significant expansion across the GB transmission infrastructure, a proportion of which will be HVDC as AC will not be viable. HVDC typically becomes more economic than AC transmission for distances over 50km when using cable – so there is a significant role for HVDC in offshore wind connections. The low carbon benefit of MTTE is its contribution to enabling the connection of multiple renewable sources in GB during the RIIO-T1 period and beyond, supporting the delivery of the government's carbon plan. It will do this by accelerating the deployment of multi-terminal and/or multi-vendor solutions. SHE also claims that, through transmission system optimisation tools at the MTTE, more capacity will be made available on the AC transmission system, which could be used to connect renewable generation. The carbon benefits have not quantified.
Environmental benefits	The main environmental benefit from MTTE is the facilitation of renewable generation connections using HVDC systems, as discussed above.
Robustness of financial benefits	Most existing HVDC links (and all links in the UK) are "point-to-point". However multi-terminal and/or multi-infeed HVDC offers the potential to reduce costs and enhance system performance. There is limited international experience in the design and operation of such systems. Problems limiting the use of HVDC include (1) complexity of planning and lack of tools, (2) novelty of multi-terminal, multi-infeed and multi-vendor HVDC systems make them difficult to specify and

	negotiate, (3) additional risks of multi- terminal schemes, (4) additional risks of multi-vendor schemes, (5) potential control interactions, (6) need for training of planning and operational engineers, (7) limited experience of operation of such systems, and (8) need to model new HVDC technologies. There are several strands to the financial benefits of MTTE. Firstly, the financial benefits claimed are based on reducing costs in HVDC systems (point-to-point and multi-terminal/infeed). Cost reductions of 2-4% per HVDC scheme are claimed, based on a TNEI report. These savings have been applied to 2/3 of the potential number of point-to-point links in GB between 2015 and 2030 (assumed to cost £500m each), based on NGET's slow progression and gone green scenarios. The resulting savings range from £113m to £493m. Each of the assumptions in the calculation are considered: • The number of links that has been considered is a conservative portion of those identified in the NG scenarios. Links will only benefit from the MTTE once it is operational, i.e. from 2017. Under the slow progression scenario that is 13 links to 2030, and under gone green, 25 links to 2030. • The assumed cost per link is £500m, derived from an international review of HVDC projects carried out by TNEI as part of study for Scottish Enterprise. This figure is comparable with published cost data on GB HVDC schemes. • The assumed cost reduction is 2-4% per HVDC link. Cost savings are achieved through increased competition, reduced risk and increased availability, although the TNEI report notes that "It is difficult to extract the percentage reduction in cost for each cost driver". The cost reduction assumed does not seem unreasonable. A range of financial benefits has been provided, including conservative estimates based on the least aggressive HVDC build scenario and the lower estimation of scheme cost reduction. The savings above do not appear to take account of the cost of trialling an HVDC scheme on the MTTE, estimated at £1.2m per scheme, or MTTE operating costs, so the net benefits are slightly lower than this. Given the scale of the

	costs associated with HVDC schemes, a cost saving in only one or two projects would cover the cost of the MTTE project. Secondly, SHE considers savings by reducing the number of converter stations required by facilitating multi-terminal, rather than point-to-point, links (£117m mid-point saved per avoided converter station). Finally, savings associated with system optimisation leading to reduced losses in DC and AC networks are discussed; these have not been quantified.
Capacity released (if applicable)	No claims have been made on capacity released.
Replication	The claim is that the MTTE will lead to cost savings for all future HVDC installations. To achieve this, project developers will require access to the MTTE, which depends on the post-NIC plans for the MTTE. The potential number of future HVDC links considered is based on NGET scenarios published in their ten year statement. The Slow Progression and Gone Green scenarios have been used to calculate financial benefits, which are the two most conservative scenarios. In addition, to calculate benefits SHE has assumed that 2/3 of these projects will proceed. For illustrative purposes, SHE has shown a single HVDC project per year from 2015 to 2030 in the net benefits worksheet. The number of projects, particularly multi terminal, is small. The impact comes from the significance of the costs associated with each project.

3 Criterion (b) Value for Money

Criterion:	Provides value for money to electricity transmission customers
Overall assessment:	The financial benefits expected to accrue from the MTTE facility are associated with cost reductions of future HVDC installations. These benefits will flow to customers, via Transmission Network Use of System (TNUoS) charges. The benefits in learning, e.g. improved transmission planning and operational training, will accrue to transmission licensees, i.e. TOs and OFTOs. The learning from the project is highly relevant to all three TOs and OFTOs. In order for OFTOs and renewable generators to realise both the financial and learning benefits from the MTTE, access will need to be ensured. SHE states that OFTOs will be invited to participate fully in the MTTE, with the same access rights as TOs. SHE has adopted a variety of approaches for selecting project partners and other relevant parties. A competitive procurement process or making use of framework contracts is proposed for a number of items in the project, including some of the major cost items (e.g. the building and the RTS). The major cost items have been reviewed; a number of approaches have been taken by SHE to ensure value for money. It is considered that more could be done to ensure best value from partner rates. Financial cost estimates for other building options do not appear to have been considered, and there is no evidence that SHE has sought to minimise building costs.
Metrics (where available):	
Size of benefits to transmission system[7]	

[7] Size of benefits attributable or applicable to the Transmission System versus elsewhere

Sub-criteria	Assessment
Proportion of benefits attributable to transmission system (as opposed to elsewhere on supply chain)	The financial benefits are associated with cost reductions of future HVDC installations (achieved by encouraging competition, de-risking projects, increasing reliability / availability). These benefits will ultimately be passed on to all consumers, whether the projects are built by TOs, renewable generators or Offshore Transmission Owners (OFTOs). OFTOs are allowed to earn a regulated rate of return on the costs of building and operating offshore networks for a period of 20 years. OFTO annual revenue is received from NGET as System Operator, and passed onto consumers through Transmission Network Use of System (TNUoS) charges. Any savings in OFTO costs will be passed onto customers through TNUoS charges. SHE outlines benefits to transmission licensees (i.e. TOs and OFTOs) in terms of all of the capabilities of the MTTE and what the MTTE will allow them to do. These include supporting transmission planning of HVDC schemes, improving the specification of HVDC schemes, de-risking control interactions, training transmission planning and operational engineers. Regarding OFTOs, the realisation of these benefits will depend on access arrangements for the MTTE. SHE states that OFTOs will be invited to participate fully in the MTTE, with the same access rights as TOs. The TNEI report notes additional benefits, including training and addressing skills shortage for HVDC; the potential for spin-out companies to develop; encouraging growth of a Voltage Source Converter (VSC)-HVDC supply chain in UK. If the MTTE facilitates competition, there are potentially benefits for new market entrants.
How learning relates to the transmission system	SHE states that the learning expected from the MTTE is relevant to all three TOs, as they all have HVDC projects planned, as well as OFTOs and renewable generators; a large proportion of OFTO infrastructure is expected to be HVDC. There are current developments in the regulatory landscape relating to the co-ordination of offshore transmission assets, with potentially roles for both TOs and OFTOs. The development of the MTTE is led by SHE, due to the large

	number of potential HVDC projects in their licence area. However it is intended that all TOs and OFTOs will be able to use the facility. SHE has indicated that GB TOs and OFTOs are the intended long-term users of the MTTE. Overall the learning is considered to be relevant to the transmission system.
Approach to ensuring best value for money in delivering projects	In terms of project partner selection, MTTE has two named project partners; NGET and SP. SHE states that "the three TOs have been collaborating on jointly developing the NIC proposals through a series of meetings and workshops"; it is assumed that SP and NGET were selected as project partners at these meetings. The rationale for selecting SP and NGET as partners is to form a collaborative facility, so that all GB TOs can participate in, and benefit from, the MTTE facility. The day rate for the project partners is based on information provided by NGET and SP; there is no evidence that SHE made efforts to ensure best value rates with project partners. SHE describes the process for recruiting academic partner(s) and the RTS (Real Time Simulator) supplier. Regarding the former, the process has involved carrying out research to identify institutions with HVDC expertise, and inviting them to respond to a Request for Information (RFI). SHE issued the RFI to eight academic institutions, and has received responses from seven (one organisation was conflicted). It is understood that the number of RTS suppliers is limited; SHE has issued a Request for Quotation (RFQ) to the two main equipment suppliers, and received positive responses from both. There are further roles in the project for external support, HVDC technical expertise, an OFTO and the SO. SHE intends to initiate a competitive tender process for the external support and HVDC technical expertise, if the project is awarded funding. SHE claims to be delivering the MTTE at a competitive cost by (i) leveraging existing framework agreements with potential suppliers, (ii) intending to enter into formal collaboration agreements with HVDC equipment suppliers at an early stage of the project, and (iii) adopting competitive tendering processes for major cost items.

	The following major cost items are expected to go through a procurement process (either competitive tender or framework contracts): • The RTS ([redacted]); • The MTTE building facility and running costs ([redacted] and [redacted] for 4-year operational period); • HVDC technical expertise and external support ([redacted] resources); and • Academic support ([redacted] It is intended that the replica control panels will be procured as part of an HVDC project (e.g. the Caithness-Moray project is one possibility) – this is discussed further below.
Identify and review major cost items, examine justification for relevant costs, assess choice of discount rates	SHE has described a general approach to ensuring that cost estimates are robust. This includes basing some cost estimates on quotations (the RTS) and validating costs with external consultants (PB Power and TNEI) and with the Power Networks Demonstration Centre (PNDC). The largest cost item in the project is the MTTE building facility, at [redacted] or [redacted] after inflation (including design, building costs, external building works, etc.). This cost is based on building a new facility, which is half data-centre specification and half office space. SHE has cross-referenced their cost estimate with the PNDC and intends to run a procurement process for the building works. SHE claims that they have not decided for certain that the facility will be a new build. But they do not appear to have explored the costs associated with other options (e.g. renovating an existing building). In discussions, SHE claim that the requirements of the building will be quite specific (e.g. data centre requirements), and therefore it could be unlikely that an existing building could efficiently be renovated to meet requirements. Another large cost item is the MTTE resources ([redacted]), covering four technical members of staff and one facility manager for the operational period. This is based on the SHE

	day rate of [redacted]. Project labour is another significant cost item. There are 4,739 person-days across all parties; 4,069 excluding "internal on-costed"; and 3,483 person days for SHE – excluding the MTTE dedicated staff. Over the seven year project period, the days allocated do not seem unreasonable. The RTS and replica control panels are each estimated to cost [redacted]. The RTS cost is based on responses from two suppliers to a RFQ. The cost for a set of replica control panels is based on discussions with vendors. SHE intends to source the replica control panels at the same time that an HVDC project is contracted to provide the full set of control panels, to minimise costs. SHE claims to have specified minimum requirements for the replica control panels, to minimise costs.

4 Criterion (c) Generates Knowledge

Criterion:	Generates knowledge that can be shared amongst all relevant Network Licensees.
Overall assessment:	The MTTE project is expected to generate new learning, particularly in the area of studying control interactions between HVDC projects in GB. The learning expected from the MTTE is relevant to TOs, OFTOs and renewable generators, who have immediate and long term plans for develop HVDC links. SHE has identified a clear list of learning objectives and interested stakeholder groups. Key knowledge dissemination methods include establishing an HVDC Operators' forum and providing training for staff. IPR protection is a key issue in this project, particularly relating to vendor equipment and models. SHE has outlined proposed measures to address this issue, to ensure this does not become a barrier to vendor participation; so far vendors have indicated that they are satisfied with the proposed measures.
Metrics (where available):	
Conforming to default IPR arrangements:	Yes

Sub-criteria	**Assessment**
Potential for new/incremental learning to be generated by the project	The new learning expected from the MTTE is around being able to study control interactions between HVDC links, which may be in close proximity due to the geographic nature of GB. These HVDC links may be multi-terminal or multi-vendor. The project proposes to make use of replica control panels (rather than modelled control systems), and conduct studies in real-time. VSC multi-terminal systems and multi-vendor systems are a new and complex area operationally, and the MTTE will provide GB transmission licensees with the opportunity to conduct studies that they currently do not have

	the capability to conduct. SHE plans to build on the knowledge gained from existing test facilities by combining the use of the RTS to study the impact of HVDC systems on the AC network, and the use of replica control panels to test the interaction of control and protection systems. The MTTE could be used for anticipatory studies, to allow users to understand and anticipate both planning and operational issues.
Applicability of learning to other Network Licensees	The learning from this project is relevant to all TOs, OFTOs and renewable generators, and NETSO, as discussed in Criterion (b) (how learning relates to the transmission system). SHE has listed a number of currently planned HVDC projects, including the Western HVDC link (NGET and SP) and the Eastern HVDC link (all TOs). A number of the HVDC projects shown in NG's future energy scenarios are for the connection of offshore wind, which will be OFTO schemes. SHE claims that the learning generated in the MTTE will provide TOs with an "essential step change" in the capability to assess the potential impact of future HVDC systems, prior to commissioning. The claimed learning for other licensees includes: • Better informing transmission planning through improved information on HVDC asset condition; and • Providing TOs with additional knowledge to ensure optimum performance of DC/AC systems.
Proposed IP management and any deviations from default IP principles	The IPR arrangements in the project are particularly significant, in terms of insuring vendor participation. It will be critical for vendors to be assured that the IP relating to their control and protection equipment is protected at the facility. This is identified by SHE as relevant background IPR, to be retained by vendors. SHE has described measures that will be taken to provide this protection, which include: • The physical arrangement of vendors' equipment within the MTTE (e.g. physical separation and locked rooms); • The design of the IT system architecture (e.g. the use of firewalls and "islanding" the RTS system from the

	internet); and • The centre's operational procedures. SHE claims to have discussed the proposed arrangements with vendors, and does not foresee any barriers. So far vendors have indicated that they are satisfied with the proposed measures. SHE also intends that vendors will be involved in defining the security requirements of the facility, to ensure they satisfy the vendors. As well as protecting the IP associated with replica control panels, models provided by vendors will also need to be protected. SHE proposes a "configuration management and control process" to ensure this. SHE has identified relevant foreground IPR as: • The results of modelling studies and tests; and • Requirements which can be used to specify HVDC systems. All relevant network licensees, which presumably includes TOs and OFTOs, will be able to access publications on the above. Vendors will have access to the results of studies involving their systems.
Credibility of proposed methodology for capturing learning from the trial and plans for disseminating	SHE has a list of learning objectives: support transmission planning of HVDC schemes; improve requirement specification of HVDC schemes; facilitate multi-terminal and multi-vendor schemes, and competition; de-risk control interactions; train transmission planning and operational engineers; undertake post-commissioning scenario planning and operational optimisation; and model new HVDC technologies. SHE has identified the different groups of stakeholders who are likely to be interested in the learning outcomes from the project. TOs and OFTOs are the primary audience for learning. Other interested parties include the SO, codes / standards bodies, academics, generators, government and regulators.

	Standard dissemination methods have been proposed, including a project website and attending annual events. In addition, SHE is proposing to establish an HVDC Operators' forum, to act as a knowledge platform. TOs and OFTOs will have membership to the forum, which will offer at least 3 events per year, the opportunity to request specific studies, published outputs from the MTTE programme of work, and access to a secure online members' area. SHE is also proposing a launch event in 2017, when the MTTE becomes operational, as well as a final event when the post-NIC arrangement will be launched. Another important element of the knowledge dissemination activity is providing training to system planners, control room staff and operational units. SHE has an internal resource role for learning and dissemination (576 person-days for the seven year project period). Total learning and dissemination costs appear to be in the order of £450k.

5 Criterion (d) Is Innovative

Criterion:	Is innovative (ie not business as usual) and has an unproven business case where the innovation risk warrants a limited Development or Demonstration Project to demonstrate its effectiveness.
Overall assessment:	There are a number of aspects of the MTTE that are innovative, including the use of replica control panels and the capability to study HVDC interactions as part of the GB system. While the use of replica control panels exists in Canada, they are not in use in the UK or Europe. The MTTE will be tailored to GB system studies. The justification for NIC funding is that the MTTE is a collaborative facility, which will be a valuable (and open) resource for all TOs and OFTOs. It seems reasonable that the MTTE facility would not be developed without NIC funding, and in particular by one HVDC project developer. A number of risks have been explored, including technical, regulatory and commercial. SHE seems to have identified how they will address the risks that are within their control.

Sub-criteria	**Assessment**
Justification that the project is truly innovative	The main innovative aspects of the MTTE are specified, as the capability to: • Test replica hardware; • Study multiple HVDC converters in close proximity and multi-terminal systems; • Study any part of the GB network; • Study the impacts and interactions of HVDC schemes; and • Use the MTTE for long term operational planning and system optimisation. The use of replica control panels for independent study of HVDC systems has not been used elsewhere in the UK or Europe. The Manitoba HVDC Research Centre in Canada makes use of replica control panels. However, the MTTE will

	be dedicated to GB specific needs (i.e. modelling parts of the GB system). This is important to the project as the GB system has some key differences to other areas with HVDC schemes (e.g. island network with limited DC interconnectors, expected growth rate of HVDC systems to connect offshore wind). The MTTE also has the potential to encourage innovation in control and protection systems. Learning from the MTTE aligns with several of SHE's innovation objectives (Innovation Strategy January 2012), including "accelerating network development and connections including the integration of increasing amounts of renewable generation".
Justification that NIC funding is required and credibility of claims	The justification for NIC funding is that the MTTE is a collaborative facility, which will be a valuable (and open) resource for all TOs and OFTOs. As such, SHE believes that the costs, benefits and risks of the MTTE should be shared across all licensees. SHE argues that developing the MTTE avoids the need for individual HVDC project developers to replicate the proposed functionality of the facility to study individual projects, thus offering economies of scale for GB transmission customers. As SHE notes, it is unlikely that a single project developer could justify the expenditure to build such a facility. A likely alternative is that multi-vendor studies would not take place, and HVDC projects could continue to be provided by single vendors. In addition, GB TOs and OFTOs may need to wait for learning relating to multi-terminal solutions to come from elsewhere (other GB institutions or other countries).
Identification of project specific risks (including commercial, technical, operational or regulatory risks)	In terms of technical risk, key issues include the interface between the RTS and the replica control panels, and modelling capability. Regarding the former, SHE's HVDC expert has stated that interfacing with replica panels has been done for at least 20 years, either by manufacturers or at research facilities (e.g. Manitoba HVDC Research Centre), and does not envisage problems in this area. It is intended that models will either be provided by vendors (e.g. multilevel VSC models), or generic models will be provided with the RTS software. The role of the academic partner includes identifying gaps or requirements to improve models, and then making the necessary developments.

	The focus of the MTTE is on conducting real-time studies. Where necessary, offline studies will be conducted, e.g. to create and validate reduced system models. In considering regulatory risks, SHE notes that the allowance of TO HVDC projects will be dependent on the Strategic Wider Works (SWW) assessment process, run by Ofgem. This includes the Caithness-Moray project, which has been identified as a potential project to be studied in the MTTE during the operational period. This is outside of the MTTE project team's control. As noted in the TNEI report executive summary, there is a considerable skills gap in power engineering in general, including HVDC and Power Electronics. SHE recognises this risk, and proposes to work with the academic partner(s) to develop expertise. SHE recognises that failing to develop a sustainable business model for the MTTE is a key risk. They intend to develop the business model during the course of the project; there is not currently a future business plan. Options include (1) the MTTE continues to be used as a TO/OFTO facility, (2) there is some scope for studies for third parties, generating revenue, (3) the facility is handed over to another organisation. Concerning the first option, SHE considers the costs for the facility could be covered by price control revenue allowances. SHE believes the first option is the most likely scenario for the long term operation of the facility. Risks around the long-term operation of the facility are discussed under criterion (g) methodology.

6 Criterion (e) Partners and Funding

Criterion:	Involvement of other partners and external funding		
Overall assessment:	There are two formal project partners, NGET and SP, and a number of other roles identified for project participants. In general, project partners and participants seem to be appropriate, but there does not appear to be a robust level of commitment. This is a particular issue with vendor participation, which is noted as being key to the project. There is no external funding for the project. Scottish Enterprise may be contributing; they are undergoing their internal approval process. The project partners are well known to SHE; the partner recruitment process does not seem effective for recruiting new project partners. The process for recruiting other participants seems to be more open.		
Metrics (where available):			
Total cost of project (£000):	£13,978	NIC support (£000):	£11,815 (£12,581 before adjustment for payment in the first year of the project)
Costs met by Network Licensee (£000):	£1,397	Costs met by others (£):	£0
NIC support (% of total cost):	90%	Costs met by Network Licensee (% of total cost):	10%
Costs met by others (% of total cost):	0%	Number of consortium members:	2 partners (SP and NGET) Roles and resources for Academic(s), OFTO, NG SO, external support, HVDC technical

			expertise. Potential financial contribution from Scottish Enterprise. Expect to enter into collaboration agreements with vendors. RTS and building supplier.

Sub-criteria	**Assessment**
Appropriateness of collaborators (including experience, expertise and robustness of commitments)	SHE has identified two formal project partners (although they are not contributing any funding or benefits in kind to the project); SP and NGET. It is not clear why the OFTO(s) is not a project partner, as it is understood the OFTO(s) will have the same role in, and level of access during, the project as the TOs. Although there are only two formal project partners, there are references to many other parties in the Full Submission Pro-forma (FSP). Where there are roles and resources for other parties, none of these have been named yet, including academic support, the OFTO, external support and HVDC technical expertise. SHE has started the recruitment process for the academic partner(s); responses to the RFI have been assessed, but SHE has not yet decided who or how many academics will form the academic consortia. Based on the short list of academic institutions, it is likely that the academic partner(s) will have relevant expertise. SHE intends to recruit other roles, including external support and expertise, after funding is awarded. SHE has started discussions with OFTOs, but an OFTO participant has not been identified. In general, project partners and participants seem to be appropriate, but there does not appear to be a robust level of commitment. This is a particular issue with vendor

	participation, which is noted as being key to the project.
External funding (including level and security of external funding)	Although there are several references in the FSP to benefits in kind from collaborators, there is no external funding for this project. SHE claims to have taken this prudent approach to ensure that there is sufficient level of resource to ensure the delivery of the project, that the project remains focussed on TO requirements and that they can maintain buy-in from vendors (in relation to protecting IPR). Scottish Enterprise may be providing additional funding, with the aim of extending the scope of the MTTE (in the area of integrating offshore renewable HVDC links). They are going through their approval process for financial support.
Effectiveness of process for seeking and identifying new project partners and ideas	The named project partners are SP and NGET, who are well known to SHE. As mentioned previously, SHE has stated that "the three TOs have been collaborating on jointly developing the NIC proposals through a series of meetings and workshops"; it is assumed that SP and NGET were selected as project partners at these meetings. This process does not seem effective for recruiting new project partners. However, the project allows for a number of other collaborators, who are being and will be recruited through a competitive process.

7 Criterion (f) Relevance and Timing

Criterion:	Relevance and timing		
Overall assessment:	The MTTE seeks to address current limited experience of multi-terminal and multi-vendor HVDC systems, as the planned number of HVDC schemes is set to grow over the next two decades. This is driven by the projected increase in offshore renewable generation connections, as part of the governments' low carbon plan. If the estimated benefits are realised by future HVDC developers, this will have a significant impact on the costs for connecting offshore renewable generation. In addition, the expected learning from the MTTE impacts on a number of areas within TOs, as well as other licensees, and on a wider scale, could feed into developments of a European "mega-grid".		
Metrics (where available):			
Start date:	January 2014	Project time scale:	7 years

Sub-criteria	**Assessment**
Significance of the project in: (a) overcoming current obstacles to a future low carbon economy	The planned increase in the number of HVDC systems will present the TOs with new challenges and risks, in an area where systems have significant costs and the market place is currently dominated by a few large suppliers. There is limited experience of multi-terminal and multi-vendor systems, in GB and internationally, but these have the potential to decrease costs in the longer term. As the number of HVDC installations increases, so does the potential for adverse interactions. As noted previously, TOs are seeing an increasing requirement to provide network capacity for new renewable generation, driven by the government's low carbon drive. The government's carbon plan suggests that 60 – 80 GW new capacity will be required by 2030, of which 35 – 50 GW could be renewable.
(b) trialling new technologies that could have a major	While there is experience with point-to-point HVDC links, SHE notes that there is limited international experience in the design, construction and operation of multi-terminal and multi-

low carbon impact	infeed systems. Work undertaken on offshore transmission co-ordination has demonstrated that multi-terminal offshore networks would reduce costs of offshore transmission (e.g. wind farm connections).
(c) demonstrating new system approaches that could have widespread application	The MTTE has applications in a number of areas, including transmission planning, requirements specification of schemes, training, and scenario planning. The outcomes will be particularly relevant to GB TOs and OFTOs, but also of interest to a number of stakeholders, including manufacturers, academics, and codes / standards developers. In a broader sense, and in the longer term, the learning from MTTE will be of interest to European "mega-grid" developments.
The applicability of the project to future business plans, regardless of uptake of LCTs (Low carbon Technologies)	SHE acknowledges that a lower rate of deployment of offshore wind will lessen the needs case for HVDC projects, and that if HVDC projects do not proceed this "erodes the anticipated benefits from the MTTE". However, given the number of planned HVDC links in GB, the assumption that there will be GB investment in HVDC over the next two decades is considered a safe one. The project is planned to complete within the RIIO-T1 price control period. SHE believes that the MTTE will accelerate learning in HVDC systems during this period, which will help TOs to inform the development of their RIIO-T2 business plans.

8 Criterion (g) Methodology

Criterion:	Demonstration of a robust methodology and that the project is ready to implement		
Overall assessment:	SHE has gate and risk processes in place, and have identified personnel for key roles. The project plan provided in the proposal does not contain a detailed breakdown of activities; neither have work stream descriptions been provided. However, where clarification has been sought on project activities, further information has been provided. SHE has noted that vendor participation is key to the project, in terms of provision of replica control panels and models. As discussed previously, the level of commitment to the project from vendors to the project appears to be low at present. A key risk to the long-term feasibility of the facility is ensuring vendor participation, via OFTOs and generators, in terms of providing replica control panels and models for future HVDC projects. It is appreciated that this issue is not straightforward, due to the fragmented nature of the industry. While SHE has demonstrated that they have given consideration to these issues, there are some details around this area that could warrant further exploration.		
Metrics (where available):			
Requested level of protection against cost over runs (default 5%) (%):	0%	Requested level of protection against direct benefits (default 50%) (%):	50%
Level of resources committed to the project (person-months):	Total resources 4,759 person-days (21.6 person-years or 260 person-months @ 220 days per year) SHE resources 4,173 person-days (19.0 person-years or 228 person-months @ 220 days per year)		

Sub-criteria	**Assessment**

Feasibility of project proposal	It is considered that a key project risk is ensuring vendor participation during the project and in the long-term, including the provision of replica control panels – particularly as one of the project objectives is to increase competition to achieve price reductions in HVDC equipment. In terms of vendor participation during the project period, SHE has letters of support from the three main European HVDC vendors; this does not guarantee a level of commitment at this stage. SHE's proposed mitigating action is to enter into collaboration agreements with the vendors at an early stage in the project. They entered into discussions with vendors from an early stage of the proposal development and believe that vendors are keen to participate in the project, and recognise that competition will happen in HVDC systems. SHE believes the counterfactual risk to the vendors is that they could lock themselves out of the market by not participating in the MTTE, and that the MTTE will be the most cost efficient means of vendors testing their systems to demonstrate they meet requirements. SHE has provided examples of where vendors have provided equipment for collaborative testing. The three European vendors are not the only suppliers in the market; there are Japanese and Chinese vendors who might also be interested in participating in the MTTE. SHE has had positive initial discussions with some of these. The main route for securing vendor participation will be through individual HVDC projects, and their procurement processes. This is discussed further below. Also of concern is the long-term feasibility of the facility. While this is outside of the project period, it is important in terms of value for money, as it is the long-term feasibility of the facility that will allow the estimated carbon and financial benefits to be fully realised. There are concerns about the means by which future vendor participation, in terms of replica control panels and models, could be ensured. PPA Energy has raised queries on the impacts of one of more future HVDC projects not participating in the MTTE on the capability to conduct studies and potential benefits. SHE's response indicated that: • If a project does not supply replica control panels or vendor models, MTTE staff would model the relevant components in the RTS – this would reduce the accuracy of studies involving such a project, but would not prevent the studies

	from being carried out. • The benefit estimates are based on a prudent assessment (e.g. assume two thirds of the links in the slow progression scenario progress), and so the impact of projects not participating is already covered within prudent assumptions. It is appreciated that the long-term engagement of parties is not a straightforward issue, due to the fragmented nature of offshore network development and the number of parties involved, including future parties who may not even exist at present. This has been explored in discussions and through the formal question and answer process. SHE's stance is as follows: • New projects will be required to demonstrate that they meet with certain performance requirements; • The MTTE will provide a unique facility to demonstrate compliance, in a secure and safe environment; • SHE believes that the MTTE will provide the lowest cost method to of demonstrating compliance, and will therefore be the natural choice for OFTOs / generators; and • As such, SHE envisages that OFTOs / generators could choose to supply replica panels and/or models, as part of a successful contract for delivering HVDC infrastructure. While SHE has demonstrated that they have given consideration to these issues, there are some details around this area that could warrant further exploration.
All risks, including customer impact, exceeding forecast costs and missing delivery date	SHE has outlined ways in which they intend to minimise cost overruns. These include capping the amount of money available for external support, seeking quotes for certain items of equipment, and benchmarking rates. SHE will implement a gated management process; at each gate the project feasibility and risks will be reviewed. SHE will hold risk review workshops during the project. Project risks have been identified and assessed in a risk register. The risks that are considered to have the highest

	impact have been discussed in more detail, in terms of potential mitigations. Some of these key risks have been discussed under criterion (d) Is Innovative, and above. The significant risk of future vendor participation has been discussed above.
Whether items within project budget provide value for money	Covered under Criterion (b) Value for money.
Project methodology (including depth and robustness of project management plan)	The project planning appears to have taken two different formats; 5 phases, where the project is currently in Phase 2 (Development), and 8 work streams running across the phases, each with a work stream leader. The project plan has been shown in terms of the phases. The plan has not been shown to a great level of granularity, and the proposal does not contain descriptions of the activities to be undertaken in each of the work streams. However, where clarification has been sought on particular activities, further information has been provided. The MTTE has passed SHE's internal gate processes (Gate 0 and Gate 1) and key roles have been filled. SHE claims that the project has support from every level within the organisation. A Project Board has been established.
Appropriateness of Successful Delivery Award Criteria (SDRC)	See Section 9, below.

9 Successful Delivery Reward Criteria

Criterion:	Appropriateness of the SDRC definitions and timing and adequacy of links to key project milestones.
Overall assessment:	SHE has set out eight SDRC. In general, the evidence associated with each SDRC is not detailed, and it is considered that some key elements of the project have not been captured. Core outputs of the project, which do not appear as evidence in the SDRC, include: • The operational procedures and processes to be developed for the facility during Phase 4, detailing access and IP protection arrangements; and • The programme of work for the MTTE 4-year operational period; • The successful installation of replica control panels, and relating studies; • Developing a long term business plan for the MTTE; and • The number of MTTE operations staff to be recruited. The NIC governance document makes reference to SDRC being at least on an annual basis. As this project spans seven years, this is not considered to be practicable in this case.

Successful Delivery Reward Criteria	**Review**
9.1	**Formal agreement with project partners**
	The proposed evidence is signed collaboration agreements with SP and NGET. While this is vital, there is also key input to the project from other participants, including OFTOs, who will have the same role in the project as the TOs, academic support, HVDC expertise, and vendor participation.

	The evidence could be extended to cover entering into agreements with more project participants than just the partners.
9.2	**Complete design of MTTE facility**
	The evidence states that the design development documents should be signed off by SHE, SP and NGET. This could be extended to include reference to vendor agreement with the proposed IPR measures of the facility.
9.3	**Design, Build and Publish Internet Site**
	This SDRC relates to knowledge dissemination, in terms of the project website. The HVDC Operators' forum also seems to be a key component of knowledge dissemination, but is not referenced here.
9.4	**Completion of Building Works**
	No comments, apart from general comment that the evidence is not very detailed.
9.5	**Installation, Testing and Commissioning of the RTS and IT infrastructure**
	No comments, apart from general comment that the evidence is not very detailed.
9.6	**Commence Operation of the MTTE**
	Evidence could be much more specific, and include production of business plan (management structure), processes and procedures, plan of studies.
9.7	**Publishing Studies and Test results**
	A key output from the project is reports on the studies conducted at the facility. SDRC 9.7 relates to this, but the evidence is not specific. There is no reference to studies using replica control panels.
9.8	**Project Close**
	The evidence is very vague here; this could be more specific, detailing the documents that will be associated with the project close.

10 Addendum: Changes made in MTTE Resubmission

10.1 Summary of Changes

SHE submitted a revised full submission in October 2013 following meetings and discussions with the Expert Panel and PPA Energy, and after receiving and responding to written questions.

The key changes that SHE has made to their submission are:

- Reduction in project costs due to (i) reduced rates applied to resources provided by TO partners and (ii) a revised resource profile for the MTTE operational period;
- Clarification on (i) the approach to assuring value for money with the MTTE building and (ii) partner and stakeholder engagement;
- A new project milestone to review the status of stakeholder participation prior to committing to spending money on major cost items; and
- Revisions to the SDRC.

The edits in the revised submission relate solely to these changes. Each area is discussed in more detail below.

10.1.1 Reduction in Project Costs

Overall the NIC funding request has reduced by £0.482 million, from £11.815 million to £11.333 million. The total project costs have reduced by £0.585 million, from £13.978 million to £13.393 million. The changes arise from a number of categories and are summarised below:

- Labour: £558,000 reduction (MTTE Operations and TO partner rates);
- Contractors: £3,800 reduction; and
- Travel and expenses: £22,700 reduction (TO partner reduction).

The TO partner rates have been reduced from £600 per day to £523 per day. This is as a result of SHE engaging in further discussions with National Grid and Scottish Power on their initial rates. The travel expenses, which have been estimated as 10% of labour costs, have been adjusted accordingly. The total impact of these changes is a reduction in project costs of £27,000.

More significantly, SHE has revised the resource requirements for the operational phase of the MTTE facility. They have reduced the total number of FTEs expected to be in place at the facility by the end of the operational period (from five to four), and have slightly altered the phasing of resources. The impact of this change is a reduction in project costs of £456,000.

The total reduction in project costs is £483,000, which has been deducted from the original NIC funding request. The relevant parts of the main submission document and the cost spreadsheets have been appropriately updated.

10.1.2 Clarifications on approach

SHE has made two clarifications on their approach in the revised submission, to reflect concerns that were raised during the evaluation process.

The first relates to the approach taken to consider options for the MTTE building. SHE has provided evidence in their resubmission that a number of options for the building were considered. SHE has listed the options, and assessed each option at a high level in terms of suitability and value for money. The review concluded that leasing a building would be the option that provided the least value for money, as the costs would be comparable with other options (as the data centre related costs represent a high proportion of the costs and would be required for every option) but would not provide residual value to the project, and there is a risk that additional costs would be incurred in returning the building to its original state. SHE maintains that a new building represents the best value option; although not the lowest cost, which is purchasing and upgrading an existing building, it is considered to be the next best and most likely option.

The second area of clarification relates to engagement with partners and stakeholders. SHE has clarified in their resubmission that the main route to ensuring vendor participation is through engagement with individual HVDC projects, as the project procurement processes will incorporate requirements for the required input (e.g. replica panels). SHE states that the MTTE management team will continue to engage with HVDC projects. SHE has provided new information on wider stakeholder engagement; they propose to hold a stakeholder engagement event with renewable developers and OFTOs at an early stage in the project, in order to ensure that the MTTE team understands their requirements.

10.1.3 New project milestone

Also in response to concerns on vendor and project participation, and the risks this poses to the project, SHE has proposed the inclusion of project reviews in their revised submission. The proposal is that, prior to committing to each major cost item, including the building, the RTS system and replica panels, SHE will hold a review meeting. This will consider the level of stakeholder commitment and engagement

(including vendors and HVDC projects), and whether it is appropriate to commit to the expenditure. SHE intends to inform Ofgem of any areas of significant concern.

10.1.4 SDRC

SHE has made significant revisions to the SDRC. These include:

- SDRC 9.1 has been expanded to include entering into formal collaboration agreements with more participants (HVDC vendors, HVDC expert support and academic partners). The agreement with HVDC vendors will include security requirements.
- A new criterion has been introduced relating to the stakeholder event for OFTOs and renewable generators (new SDRC 9.2).
- A new criterion has been introduced which covers reaching a formal agreement with an HVDC project, including the provision of replica panels (new SDRC 9.3).
- SDRC 9.4 (was 9.2) on completion of the building design has been revised such that the design should be endorsed by participating vendors (which should address IP requirements).
- SDRC 9.5 (was 9.3) relating to knowledge dissemination has been expanded to include establishing the HVDC operators' forum.
- SDRC 9.6, on commencing operations at the MTTE, has been updated to include elements of other criteria that have been removed, such as completion of building works and commissioning of the RTS and IT infrastructure.
- A new criterion has been introduced which captures the future business model for the MTTE, after the NIC funded operational period (new SDRC 9.8).
- Three of the original criteria have been removed and/or amalgamated into other criteria.

10.2 Impact on NIC funding application

The impacts of the changes made by SHE to their submission are considered for each evaluation criterion as follows.

10.2.1 Criterion (a) Low Carbon and Benefits

There is no additional information provided by SHE regarding this criterion and hence there is no change to PPA Energy's initial assessment.

10.2.2 Criterion (b) Value for Money

A number of the revisions impact the assessment of this criterion. During the evaluation process for this project, PPA Energy raised the issue of partner rates, in terms of a lack of evidence that SHE sought to achieve value for money in this area. SHE has since had further discussion with National Grid and Scottish Power. Their rates have reduced, as well as associated travel expenses. While the impact of this change is relatively small (£27,000), it does show that SHE has sought to improve the value for money of the project.

In addition, SHE has revised the resource requirements for the operational period of the MTTE. This has resulted in a much more significant saving of £456,000. This will have improved the value for money of the project, provided the project can still deliver the same set of outcomes.

Another concern raised during the assessment process was the lack of evidence that SHE had considered options for the MTTE building facility, and sought to minimise building costs. The clarification SHE has provided in their revised submission does demonstrate that a number of options were considered and assessed. This additional information has been helpful, and is considered to improve the assessment of the project against this criterion.

Overall, the additional information provided is welcomed, and has provided further reassurance of the project against this criterion, provided that the reduction in MTTE operational resources does not impact on achieving the stated outcomes of the project. However, the revisions are insufficient to affect PPA Energy's initial assessment of the project under this criterion.

10.2.3 Criterion (c) Generates Knowledge

There is no additional information provided by SHE regarding this criterion and hence there is no change to PPA Energy's initial assessment.

10.2.4 Criterion (d) Is Innovative

There is no additional information provided by SHE regarding this criterion and hence there is no change to PPA Energy's initial assessment.

10.2.5 Criterion (e) Partners and Funding

The original concerns around this criterion included a lack of robust commitment from participants and no external funding. One of the clarifications SHE has provided in their revised submission relates to stakeholder engagement and the use of collaboration agreements. Whilst the proposed use of collaboration agreements to more project participants is welcome it is insufficient to affect PPA Energy's initial assessment of the project under this criterion.

10.2.6 Criterion (f) Relevance and Timing

There is no additional information provided by SHE regarding this criterion and hence there is no change to PPA Energy's initial assessment.

10.2.7 Criterion (g) Methodology

The key concerns of the project were considered under this criterion, in relation to project risk. The risk of particular concern is vendor participation, via HVDC projects, both during the project and in the longer term. This was explored with SHE during the assessment process. SHE has made two revisions to their submission that are relevant for this issue. Firstly, SHE is proposing to hold a project review meeting prior to committing to items of major cost, including the building, RTS and replica panels. The meeting will consider whether the spend is appropriate, given the level of partner and stakeholder engagement, including vendors. This is considered beneficial for the project period, but does not address participation concerns in the long run.

Secondly, SHE is proposing to hold a stakeholder engagement event for OFTOs and renewable generators, in order to fully understand their requirements for the facility. This is thought to be beneficial for the project, as these stakeholders are intended to be long-term users of the facility, and they are the means by which vendors for offshore HVDC projects will engage with the facility. While the proposed stakeholder event is welcomed, and considered beneficial for the project, it could be argued that SHE could have been undertaking this engagement in the proposal development stage, and thus now have provided more evidence of engagement with vendors and HVDC projects and demonstrated their level of commitment.

While the additional information is considered to be beneficial to the project, and these measures may improve the assessment against this criterion, the outcomes from the measures will not be known until the project commences.

10.2.8 Successful Delivery Reward Criteria (SDRC)

The concerns around the original set of SDRCs were that the evidence was not detailed, and some key elements of the project had not been captured. SHE has made significant revisions to their SDRC, including removing criteria, revising existing

criteria and adding new criteria. The changes are summarised in Section 10.1.4. There are a number of improvements resulting from the new criteria, including expanding 9.1 to include collaboration agreements with other participants (not just TO partners); new criteria for important elements of the project, such as the engagement event for OFTOs and renewable generators, engagement with the first HVDC project and submitting a proposal for a future business model; extending the MTTE design SDRC to include endorsement by vendors; extending the knowledge dissemination SDRC to include the HVDC Operators' forum. Overall the revisions to the SDRC are considered to improve the assessment against this criterion.

10.3 RAG (Red Amber Green) Analysis

In the light of the above assessment of the resubmission, the assessment for the Successful Delivery Reward Criterion (SDRC) is considered to be elevated from red to orange. No other changes are proposed to the red/amber/green assessments of the project in the main report.