Electricity Network Innovation Competition

Report and Recommendations 2013

Prepared for

The Gas & Electricity Markets Authority

By

The Electricity Network Innovation Competition Expert Panel

October 2013

1 Introduction

1.1 This report prepared by the Electricity Network Innovation Competition Expert Panel (the Panel) sets out the Panel's recommendations to the Gas and Electricity Markets Authority on the portfolio of projects to be funded in the 2013 NIC funding round. Members of the Expert Panel are as follows:

- Dr Robin Bidwell (Chair)
- Sharon Darcy
- Prof. Nicholas Jenkins
- Prof. David Newbery
- Alan Bryce

1.2 We received three submissions. Full details of each submission will be available on the Ofgem website. The names of the Funding Licensee, titles of the submissions and the amount requested from the NIC Fund are as follows (the values in brackets indicate the total cost of the projects).

- **Visualisation of Real Time System Dynamics using Enhanced Monitoring (VISOR) – Scottish Power Transmission**

  £6.49m requested (£7.37m in total)

- **Mobile Extra High Voltage Substation Bays (MSB) – National Grid Electricity Transmission**

  £8.401 requested (£11.818m in total)

- **Multi-Terminal Test Environment for HVDC Systems – Scottish Hydro Electric Transmission**

  £11.333 requested (£13.394m in total)

1.3 The Expert Panel followed the evaluation process set out in the Electricity Network Innovation Competition Governance Document (11 Feb 2013). Initial submissions were received by Ofgem and were screened by Ofgem staff for compliance with the requirements set out for the Initial Screening

Process. Consultants were appointed by Ofgem to review the submissions (the Consultants' reports will be published in full). The Panel met the Funding Licensees early in the evaluation process to allow the project teams to present their submissions. During the period up to the completion of the Consultants' reports and prior to the second meeting with the Funding Licensees, the Consultants and the Panel sent each of the Funding Licensees a number of questions with the purpose of clarifying the submissions and highlighting areas of concern.

Following these meetings, the Panel met to review each of the submissions in the context of the criteria set out in the Governance Document. In evaluating the submissions, the Panel took into account all of the documents that had been made available: the submissions, their appendices, the Consultants' reports as well as any additional information that had been submitted via Ofgem or the Consultants from the Funding Licensees; they also took account of information from meetings that were held with the Funding Licensees and any material provided during those meetings. Based on this evaluation, the Panel reviewed the projects against the criteria. This report sets out the Panel's recommendations to the Authority.

1.4 This report should be read together with the Consultants' reports, the Funding Licensees' submissions and the other information that is published concurrently with these on the Ofgem website. This report sets out the results of the Panel's deliberations and its recommendations for the Authority. As such it is primarily concerned with the views of the Panel; all the details of the projects and the technical evaluations undertaken by the Consultants are contained in the other published documents.

2 Evaluation Criteria

2.1 The criteria that the Panel is required to take into account in the evaluation process are set out in the Electricity Network Innovation Competition Governance Document (11 Feb 2013). The Panel recognised that the scope of the NIC Fund is broader than the second tier of the LCN Fund as it includes Development as well as Demonstration Projects.

In this section we list the evaluation criteria and briefly discuss a number of points that arose during the evaluation process and that provide some context to the evaluation of the projects described in the following section. A full description of the criteria is set out in the Governance Document.

2.2 **(a) Accelerates the development of a low carbon energy sector and/or delivers environmental benefits whilst having the potential to deliver net financial benefits to future and / or existing customers.**

A successful project must have potential to accelerate the development of the low carbon energy sector, or deliver wider environmental benefits or deliver a combination of both. In addition, it will have the potential to deliver net financial benefits to existing and/or future customers.

An important role that the transmission networks play in accelerating the development of a low carbon energy sector and supporting the Carbon Plan is associated with ensuring that renewables and other low carbon technologies are connected to the network as quickly and at as low a cost as possible. Over the next 20 years, major investment in the GB transmission system is planned in order to connect new forms of generation at new locations and transport the power to load centres. These large capital investments include transmission technologies not previously deployed in GB and their use presents considerable opportunities for innovation. The aim of each of the three proposals was, through innovation, to make more effective use of the GB transmission networks that are being extended to accommodate low carbon generation. This aim was consistent with the objective of the Competition and successful projects should lead to reduced environmental footprint and lower costs to customers.

However, from some Proposals it was difficult to quantify with confidence the benefits that are anticipated when the intervention proposed would be rolled out. Greater clarity of the anticipated benefits (perhaps through a number of Case Studies) and clear comparisons with the cheapest established alternative approach to achieving the same result would have helped the Panel.

2.3 (b) Provides value for money to electricity customers.

In a number of cases, the Panel found it difficult to determine from the information provided whether or not the costs of all aspects of a project were proportionate to the work proposed and whether the project would be implemented in such a way as offered best value for money. In some cases it was difficult to decide whether individual work streams could perhaps have been done at a lower cost. The Panel recognises that this is an innovation fund and that there is a considerable amount of uncertainty associated with the work necessary to deliver some of the outcomes but greater definition of the costs and activities of each work stream and by each project partner would have been useful.

The Panel would have liked to see clearer evidence that all appropriate steps had been taken to drive down costs through tendering and other measures to encourage competition.

2.4 (c) Generates knowledge that can be shared amongst all relevant Network Licensees.

The NIC Fund is intended to support innovation and create new learning that is of value to all Transmission Network Licensees (NETSO, TOs and OFTOs) – and there needs to be a sound plan to disseminate this knowledge. All the proposed projects had the potential to generate significant and valuable new knowledge. The Panel were disappointed that although the TOs appeared to be well engaged in the NIC there was only limited evidence of engagement by the NETSO and no presence by the OFTOs. This leads to concern over how effectively the new approaches being trialled in the NIC will be adopted. It will be important to ensure all transmission licensees are actively engaged in a timely

fashion in knowledge dissemination and potential implementation events.

The need to develop the transmission system to accommodate renewable generation and replace ageing assets is common throughout Europe and the Panel would have liked to see more evidence of active attempts to gain learning from international transmission companies and other industrial sectors.

2.5 (d) Is innovative (ie not business as usual) and has an unproven business case where the innovation risk warrants a limited Development and/or Demonstration Project to demonstrate its effectiveness

The GB transmission system is being developed rapidly to meet the requirements of the Carbon Plan and all three projects proposed to use innovative technologies to control the costs of this expansion of transmission capacity. All the projects proposed were innovative and would lead to considerable new learning. Two projects proposed advanced equipment that has not been used before in the UK, or integrated into business as usual anywhere in the world. The third project was a combination of technical innovation with new engineering and administrative practices.

All the projects were innovative and went beyond business as usual. In all cases the risks had been assessed and effective risk management plans proposed in the submissions.

2.6 (e) Involvement of other partners and external funding.

Each of the three proposed projects was led by one Network Licensee as the Funding Licensee and, in general, there was evidence of appropriate engagement of the other TO Licensees. The extent of the financial contributions of the Network Licensees varied across the proposed projects. The Panel would have liked to see greater clarity of how the learning from the projects would be disseminated across Network Licensees and Equipment Vendors so that it becomes integrated into business-as-usual.

The Panel were pleased to see effective collaboration between the Transmission Operators in several of these proposals but were not convinced that collaboration beyond the Transmission Operators was

equally well developed. The collaboration of a number of universities was welcomed but on one occasion the selection of a university partner appeared to have come about through a rather ad-hoc process. The Panel considered that a more structured method of soliciting expressions of interest from different vendors including universities would be valuable in increasing the engagement of outside vendors as well as increasing the pool of collaborators including academic partners.

2.7 (f) Relevance and timing.

All the proposed projects addressed making better use of the GB transmission networks as they are called on to connect low carbon generation at minimum cost. This is a relevant and urgent issue. The proposed projects would contribute directly to the Carbon Plan and were both relevant and timely.

2.8 (g) Demonstration of a robust methodology and that the project is ready to implement.

The project plan must be sound and the project ready to implement. In particular the anticipated role of project partners needs to be both well-defined and a clear route map designed showing how accountability is to be assigned and the co-operation of partners secured. In two of the projects, the Panel considered that further work could have been undertaken in the preparation of the proposal particularly to increase the certainty that the project partners would contribute as anticipated.

For a number of the projects the Panel was still not entirely satisfied with the Successful Delivery Reward Criteria – it would like to see more emphasis on outcomes as milestones rather than process.

2.9 Comments on process.

The Panel meets the Funding Licensees twice during the evaluation process. Prior to the second meeting the Panel sends a list of questions they would like to see answered at the second presentation. Most companies built their second presentation around these questions. This process worked fairly well although those proposals that were not fully

developed found some difficulties in providing clear, quantified and consistent answers to some questions. It is of concern to the Panel if the objectives of a proposed project, and particularly its projected benefits, appear to change significantly during the evaluation process.

3 Evaluation of submissions

3.1 Visualisation of Real Time System Dynamics using Enhanced Monitoring (VISOR) – Scottish Power Transmission:

£6.49m requested (£7.370m in total)

The GB transmission network is being extensively strengthened in order to increase North-South capacity and so accommodate low carbon generation. The two new key technologies being deployed are HVDC links embedded within the AC circuits and series compensation (the use of capacitors connected in series with transmission lines). Neither of these technologies has been used previously within the UK.

At the same time, enhanced monitoring equipment based on Phasor Measurement Units (PMUs) is becoming available. PMUs allow voltages to be measured simultaneously at different points of the network in real time. By comparing the voltages across the system at exactly the same time, valuable information about the operation of the system can be derived. From these voltage measurements, the currents and power flows of the circuits can be determined. The proposed project will make use of the information provided by PMUs to give a better understanding of the state of the network and, using visualisation techniques, display the voltages and power flows for control operators. The PMU system will provide network planners with more accurate models and a large archive of the performance of the system, including during system disturbances.

The project also proposes to make use of the data from the PMUs to develop a new form of sub-synchronous oscillation (SSO) detector. SSOs are more likely to occur in series compensated circuits and so an ability to detect them more effectively and locate the source of the oscillation is

very desirable. The project will also demonstrate the use of PMU data in State Estimation of the transmission system. State Estimation is an established technique to determine the voltages and flows of the power system from measurements, some of which may be corrupted or delayed, but its use with PMU data is only now emerging from the research domain.

Low carbon/environmental and financial benefits.

The project will lead to an increase in transmission capacity and reduction in constraint costs by providing better information of the state of the network and so allow the loading of transmission circuits to be increased. These benefits are particularly likely to be obtained on the Scottish-English interconnector circuits, where the B6 (Cheviot) boundary is now constrained for significant periods of time. As the amount of wind generation in Scotland is expected to increase, easing the constraints at this point is important for the Carbon Plan. The learning from the VISOR project is expected to lead to an additional 50 MW of transmission capacity becoming available at this boundary. The estimated value of the 50MW capacity released might be between £7.25M (compared to the costs of series compensation) and £22.2M (compared to the costs of the Western HVDC link). In addition, increased knowledge of the state of the network should enable better system utilisation by the NETSO, possibly reducing the costs of constraints by £4M/year. Together these benefits appear large compared to the project cost.

Deployment of PMUs and the resulting increased information on the state of the system will provide an important risk management tool at a time of considerable change of the GB transmission system. Although difficult to quantify with confidence, this is a tool that can be used to investigate high impact but low probability events and may be very valuable in future.

Value for Money.

This project has been well constructed with participation from all three TOs. During the evaluation the Panel questioned the role of the NETSO as many of the benefits of the project will be realised through the system operator. After discussion they were content with the proposed arrangement of the project being led by the Funding Licensee with the

active participation of all three TOs and the NETSO. The Panel were initially concerned that the project management structure proposed lacked clarity and that a triumvirate of three project leads, one from each of the TOs, would considerably increase costs and could dilute responsibility. The project management structure was discussed during the evaluation and changes made in the final submission. Overall the Panel considered this project will clearly produce valuable knowledge and represents good value for money.

Generates knowledge that can be shared amongst all relevant Network Licensees.

This project should provide valuable knowledge for the planning and operation of the GB transmission system. A key piece of learning will be the extent to which capacity on the network can be released by both more precise planning studies and greater visibility during system operation. The obvious first application of this technology is to increase the transmission capacity of the Scottish-English circuits but a better understanding of the behaviour of the GB transmission networks is clearly desirable. The Panel considered the dissemination methods appropriate and that the Proposer had thought through how to get acceptance of the solution amongst key stakeholders.

Is innovative (ie not business as usual)

The use of PMUs proposed in this project is technically innovative. Although PMUs were first developed more than 10 years ago, there is still considerable innovation required to establish how to use the large volumes of data they provide most effectively. Two specific new innovations are proposed: the development of an sub-synchronous oscillation detector and the integration of PMU data into a State Estimator.

Partners and funding.

The project involves all three TOs and the NETSO. It has a good range of potential technical partners, who will be selected though tender. The

university partner chosen has considerable expertise in the use of PMUs on transmission systems. The Panel were pleased to see that international expertise in the use of PMUs had been recognised in the proposal.

Relevance and timing.

The project is relevant and timely and the work should inform both the development and operation of the GB transmission system.

Methodology.

The Panel considered the plan was well thought through. The project management structure and responsibilities of the three TOs and the NETSO were revised in the final submission but the leadership of the project by a triumvirate will require oversight by senior management to ensure a successful project.

Panel Conclusions.

The Panel concluded this was an innovative use of new technologies (the PMUs) to provide greater visibility of the operating state of the GB system and additional confidence in the models used for off-line studies. All three TOs and the NETSO support the project with the main benefit falling to the customers of the Funding Licensee through increased transmission capacity on the Scottish-English (B6 Boundary), hence minimizing the need for new circuits. The Panel were also of the view that, particularly with the installation of new primary plant (parallel HVDC circuits and series compensation), improved measurement of the operating state of the GB system was important.

1.2 Mobile Extra High Voltage Substation Bays (MSB) – National Grid Electricity Transmission

£8.401 requested (£11,818.m in total)

This project involves the design and demonstration of a mobile substation bay on the GB 400 kV transmission network. The current philosophy for the design of transmission substations is to use large items of equipment (up to 200 tonnes for a transformer) installed permanently on

foundations. Thus the installation of an additional substation bay is a major undertaking taking many months.

The new approach being trialled is to use a 400 kV mobile substation bay that can be deployed rapidly (in a matter of weeks) and so provide capacity on a temporary basis. n.

It is proposed to use switchgear and a transformer with a rating in excess of 100 MVA that can be transported with relative ease and installed quickly with limited civil works. The mobile substation bay will be deployed for a time and then returned to store, refurbished if necessary, and then redeployed to a new site. As part of the project the mobile substation bay will be installed in an operational 400 kV substation and its protection and control equipment integrated with those of the existing substation.

The development of appropriate engineering and safety procedures that allow this new way of working is an important element of the proposed project.

Low carbon/environmental and financial benefits.

There are a number of different types of transmission substation bay (e.g. connection of a 400/275 kV transformer, 400/132 kV transformer and 275/132 kV transformer). The fleet size of MSBs required over the next 10 years discussed by the Proposer was estimated to be up to 5 units, comprising 2x 400/132kV MSBs, 1x 400/275kV MSB and 2x275/132kV MSBs. Only one mobile substation will be trialled during the project.

The potential benefits of the mobile substation bay described by the Proposer (and the number of opportunities to deploy MSBs over the next 10 years together with the estimated customer benefits) were to:

Reduce capital costs during substation development (5 deployments with customer benefits estimated at £5-20m)

Reduce constraints due to substation development (5 deployments with customer benefits estimated at £1-5m)

Reduce impact due to maintenance (5 deployments with customer benefits estimated at £5-10m)
Accelerate connection dates of low carbon generation (5 deployments with customer benefits estimated at £25-40m)

The estimated benefits of early connection assume that five 100 MW wind farms would be able to connect 12-18 months earlier than would otherwise be the case, and this represents the bulk of the benefits calculated in Appendix 11 of the revised submission. If these early connection benefits are ignored the remaining undiscounted benefits are modest.

In the context of connecting renewable generation, a 400 kV substation bay would only be used for the connection of a large quantity of renewable generation and the Panel were not convinced that the construction of the substation bay would often be on the critical path of a project, compared to the time required to obtain planning permission and build the low carbon generators and the transmission circuit.

The panel were concerned about the clarity of the evidence underlying the calculation of the financial and carbon benefits. Neither the carbon nor financial case was made convincingly.

Value for money.
The Funding Licensee is presently going through a competitive process to select a project partner to design and develop the mobile substation equipment. This appeared to be an appropriate mechanism by which to procure the equipment but does rely on appointing an appropriate partner. The Panel were concerned that Equipment Vendors had not previously offered MSBs for the 400 kV network and this might indicate a limited market for a standardised product.

Generates knowledge.
The project will generate significant knowledge of the engineering and safety processes/procedures necessary for such an approach to the

development of 400 kV substations. The project will also generate important knowledge to understand the robustness of this high voltage plant that will be relocated and re-used a number of times. The integration of the secondary equipment of the mobile bay into the substation will be a particular challenge and generate significant new knowledge.

Is innovative (ie not business as usual)

Mobile substation bays have not previously been used at 400 kV. Considerable technical innovation will be required to develop EHV plant that can be re-located a number of times. Integration of the protection and control schemes of the mobile bay into the substation systems will be demanding and lead to new learning. Equally there will be considerable innovation required in the engineering and administrative practices of the TO.

Partners and funding.

The Funding Licensee is National Grid who will engage a substation Equipment Vendor through a competitive process to develop and supply the equipment. Other solutions providers (e.g. logistic specialists) will be recruited as required. The process for the selection of the substation Equipment Vendor is on-going. There were no other project partners but the project is supported by the two other TOs and the Carbon Trust.

Relevance and timing.

The Proposers describe high volumes of new connections and asset replacement at 400 kV substations in the 2013-2021 period where the mobile substation bay might be useful. Thus the project might be relevant and timely but greater clarity on the circumstances under which a MSB would be the lowest costs solution would have assisted the Panel.

Methodology.

The appointment of a substation Equipment Vendor who wishes to undertake the development of the equipment is critical to the success of this project. Although preliminary meetings had been held with major

Equipment Vendors, the Panel was concerned that these discussions had not advanced sufficiently for there to be sufficient clarity on feasibility and cost. The Panel were concerned about the readiness of the project and saw insufficient evidence of feasibility studies to underpin the business and technical case. The Panel was concerned that considerable variations emerged during discussion around the number of MSBs and the types of use to which they were to be used.

The Proposers recognise the importance of ensuring that the new approach becomes integrated into the business-as-usual of National Grid and the Panel were encouraged by the enthusiasm of senior management for this initiative.

Panel conclusions.

The Panel recognised the extent of the work that will be undertaken on 400 kV substations up to 2021 and the potential usefulness of mobile substation bays for certain applications. They also recognised that successful deployment of a mobile substation bay would require considerable innovation of processes and procedures in addition to the development of the plant.

However, the Panel had two key concerns. The Panel considered the Licensee had not made a clear, consistent and quantified case to demonstrate the projected benefits, particularly the low carbon benefits that would result from the project.

The Panel's second concern was that the substation Equipment Vendor is only now being selected and different Vendors have different solutions at different stages of readiness. The Proposer provided examples of current innovation in equipment for temporary or mobile substations that might be regarded as potential component building blocks or starting points for the development of an MSB. The Panel noted that many of these solutions were bespoke and had been developed to satisfy particular requirements in specific circumstances, rather than with the aim of building a general purpose MSB. Without the benefit of a more evolved feasibility study, it was difficult for the Panel to form a view of the level of

further innovation required, and the costs and risks involved, in moving from existing innovative component technologies through to a complete MSB solution.

The Panel considered that the economic and carbon benefits of the project proposal were insufficiently demonstrated and for the reasons stated above the project was not ready for implementation at this time.

2 Multi- Terminal Test Environment for HVDC Systems – Scottish Hydro Electric Transmission

£11.333 requested (£13.394 m in total)

Most of the GB Transmission system operates with alternating current and voltage (AC). HVDC schemes are deployed either to input or extract large quantities of power from the AC system, or to provide a pathway for power to be moved between two or more terminals on the AC system. HVDC schemes typically contain two or more converter stations, which interface to the AC system to convert the currents and voltages between AC and DC, connected together by HVDC circuits, often several hundred kilometres in length.

This project is in response to the anticipated increase in the use of HVDC circuits, particularly for the connection of offshore wind farms and for the increase in transmission of energy from low carbon generation. HVDC technology is developing rapidly with new designs of converters and their controls being offered by a number of manufacturers. Both point-to-point links and multi-terminal schemes are being proposed. The limited international experience of multi-terminal HVDC schemes leads to a significant requirement for studies and testing of control systems before they can be deployed with confidence and connected into the GB system.

It is proposed to establish a testing facility to allow the three Transmission Licensees to study and test HVDC schemes. The heart of the facility will be a large Real Time Simulator (RTS) which will allow representation of the HVDC convertors and cable circuits and parts of the GB AC power

system to which HVDC schemes are (or will be) connected. The HVDC circuits will be represented either by software models (generic or specific to a Vendor's equipment) or hardware replica control panels. These replica control panels are reduced versions of the real panels used to control the converters. Using the equipment proposed, HVDC schemes and their interaction with the GB system can be investigated before contracts are awarded using the generic models and with the detailed controls once Vendors are identified.

At present most HVDC schemes are supplied in their entirety by a single Vendor. In Europe this is presently ABB, Siemens or Alstom, although as the market for HVDC equipment expands it is anticipated that other Vendors may come forward. Such a single vendor approach is not appropriate for the planned multi-terminal schemes that may connect a number of wind farms and countries. The HVDC equipment Vendors consider the intellectual property of their control schemes to be very valuable and there are a number of patents covering aspects of multi-terminal HVDC. Hence the test facility will be designed specifically to allow testing and investigation of multi-vendor HVDC schemes while respecting the intellectual property of the Vendors. This will be achieved by carefully segregating the replica panels of each Vendor in a separate secure room.

Low carbon/environmental and financial benefits.

Cable circuits, either submarine or terrestrial, must use HVDC for transmission of high power over significant distances and the Slow Progression scenario of National Grid anticipates 20 new point-to-point HVDC links by 2030. For the Round 3 offshore wind farms, there is no alternative to using HVDC for transmission of the power to shore and already two HVDC submarine circuits are being proposed (one in construction) to bring power from Scotland to England.

It is suggested that the test facility might lead to a reduction in the costs of HVDC links of 2% (£133m by 2030). This saving will be achieved by the use of multi-terminal links so reducing the number of converter stations and also by encouraging competition though allowing different Vendors

to provide converter equipment at the ends of links. The Panel noted that a large proportion of the benefits of this project comes from creating a competitive market and a key part of receiving this benefit would be the participation of the equipment Vendors.

Value for money.

The Panel recognized the importance of providing a facility in which the equipment Vendors would be confident that their intellectual property was secure. However, the Panel were concerned over the cost of the proposed building and questioned whether an existing building could not be converted at lower cost. In their resubmission the Licensee states that purchase and upgrading of an existing building is the most likely option.

Generates knowledge.

The project would generate considerable knowledge of HVDC schemes and particularly their likely impact on the GB system. There was no OFTO involvement in the Proposal and, as potentially important users of HVDC, they need to be drawn into the dissemination. This was recognised in the re-submission.

Is innovative (ie not business as usual)

HVDC technology is developing rapidly and the project proposes to exploit the new technical innovation of multi-terminal HVDC. It will also facilitate commercial innovation through multiple vendors supplying and integrating equipment into the same link. There are very few examples worldwide of either multi-terminal or multi-vendor HVDC schemes and none using the newer Voltage Source technology. The provision of a testing facility where competing vendors can test their equipment is innovative and will generate considerable learning for the TOs.

Partners and funding.

The three TOs are Partners in the Project and the RTS supplier will be selected through a tender process. Initial contacts have been made with seven universities and a preferred academic partner(s) will be chosen during the project. The Funding Licensee engaged effectively with academia during the preparation of the proposal.

The success of the project relies critically on the co-operation of the HVDC equipment Vendors supplying software models of their converters for use in the RTS and replica panels for hardware-in-the-loop testing. The letters of support from the HVDC vendors included in the proposal, although encouraging, did not in the Panel's view provide sufficient evidence and reassurance that the required close cooperation would be forthcoming.

Relevance and timing.

HVDC circuits are being proposed to increase North-South transmission capacity in GB and bring power from large offshore wind farms (20 circuits by 2030 in the Slow Progression scenario). The project will allow the TOs to specify schemes with greater confidence and seek competitive bids from a wider range of equipment suppliers. HVDC projects have a long development time and it is timely to undertake this project now.
A further important use of the facility would be to train the operators and optimise the operation of HVDC circuits as they are integrated into the GB system.

Methodology.

The methodology appears to be appropriate although there remains uncertainty over the role and willingness of the HVDC equipment Vendors to take part in the trials. Their engagement is essential if the benefits are to be realized and for this project to be value for money. The initial Successful Delivery Reward Criteria did not measure the successful outcome of the project for the benefit of customers although these were improved in the re-submission

Panel Conclusions.

The Panel considered this to be an important project that would generate the knowledge the TOs need to implement and operate successfully the large number of increasingly complex HVDC schemes that are being proposed, and integrate them into the GB system. A test environment of the kind proposed is necessary to investigate and model multi-terminal HVDC schemes and their interaction with the GB system. At present it is usual for a single Vendor to supply a complete HVDC scheme and the

project will provide a facility in which multiple Vendors can test and demonstrate their different equipment and control approaches at the same time as protecting their intellectual property. The use of the facility should lead to reduction in the cost of HVDC links. This may be through technical innovation, by a reduction in the number of converter stations in multi-terminal schemes, as well as through increased competition and ensuring interoperability of Vendors' equipment.

However the Panel had a major concern over the limited evidence presented that the HVDC equipment Vendors and project developers would co-operate fully. The Panel proposed that the funding for this project is made contingent upon the Licensee demonstrating that sufficient commitment and cooperation has been secured in writing from manufacturers of HVDC convertor and control equipment as well as developers of multi-terminal HVDC schemes.

4 Recommendations to the Authority

4.1 We set out below our recommendations to the Authority on the funding of the 2013 Network Innovation Competition projects.

4.2 The Expert Panel recommends that the following project is funded without any conditions.

- **Visualisation of Real Time System Dynamics using Enhanced Monitoring (VISOR)**

4.3 The Expert Panel recommends that the following project is funded but subject to the conditions listed below.

- **Multi- Terminal Test Environment for HVDC Systems**

The Panel recommends that the funding for this project is made contingent upon the Licensee demonstrating that sufficient commitment

and cooperation has been secured in writing from manufacturers of HVDC converter and control equipment, and developers of multi-terminal HVDC schemes. To provide reasonable assurance that the project will achieve its goals of testing both multi-vendor solutions, and multi-terminal schemes, the Licensee should demonstrate that it has secured commitment from a minimum of two of the established European HVDC Vendors (i.e. ABB, Alstom and Siemens) and from at least one developer of a potential multi-terminal HVDC scheme that will make use of the facility.

4.4 The Panel recommends that the Authority does NOT fund the following project.

- **Mobile Extra High Voltage Substation Bays (MSB)**

The proposal focused on addressing the important issue of extending 400 kV substations and proposing a novel solution that would be appropriate in some circumstances. The Panel recognised the extent of the works that will be undertaken on 400 kV substations up to 2021 and the potential usefulness of mobile substation bays. They also recognised that successful deployment of a mobile substation bay would require considerable innovation of processes and procedures in addition to the development of the plant. However, the Panel had two key concerns. Firstly, on the information presented, they were unable to develop a clear and quantified understanding of the likely demand for mobile substations and the associated low carbon, financial and environmental benefits that would result from their deployment. The Panel would like to have seen a clear and consistent set of assumptions for how and when the MSBs would be deployed and how they would facilitate the Carbon Plan. Secondly, the substation equipment Vendor is only now being selected. As Vendors have different solutions at different stages of readiness, the project cannot yet be defined fully. Thus the Panel were unable to recommend this project for funding at this time.

4.5 The Panel was pleased to see a number of high quality innovative proposals that supported the Carbon Plan and offered significant benefits to customers. It would be useful to remind the Network Licensees of those

aspects of the evaluations that caused the Panel difficulty so that these can be addressed in future submissions.

- It is important that the Panel is provided with a clear, consistent and quantified understanding of the benefits of a proposed project (where appropriate by method) and every effort needs to be made to state clearly the underlying assumptions in the submission.

- The projects must offer value for money: the potential benefits (financial and carbon) must be proportionate to the trial cost and subsequent roll out cost.

- There should be evidence that project costs have been kept to a minimum through competitive procurement and appropriate contributions in kind from partners. This is particularly important at a time of increasing electricity prices.

- Funding Licensees must show clear evidence that they and their partners and contractors are undertaking the work at a competitive price based on a realistic assessment of the resource required. This evidence may take the form of the results of tendering, market testing or benchmarking of costs.

- Given that one of the goals of the competition is to encourage wider engagement in innovation in this sector, encouragement should be given to involving a wider range and type of partners. There are also potential benefits from increased diversity in Project Teams.

- If a project outcome is concerned with system operation and is to be implemented through the NETSO, then it is important to ensure their co-operation at an early stage.

- The lack of engagement by the OFTOs was a particular concern.

- The Panel would like to reiterate its concerns about Successful Delivery Reward Criteria: these should be tied to outcomes and not just stages in the process.

- In future competitions, the Panel would hope to see the Licensees making effective use of the NIA for initial studies. The Panel would also like to see evidence that learning from outside the UK had been identified and brought into the proposal. Licensees are encouraged to look widely for project partners e.g. internationally or to other industrial sectors.

The Panel are always reassured by the presence of senior management at the evaluation meetings to demonstrate the commitment of the organisation to the project and a preparedness to take the results of the project into business-as-usual.

4.6 The Panel would like to thank the Project Teams for their hard work and for their engagement during the evaluation process; we would also like to thank the external consultants and the Ofgem team for all of the support and assistance that was provided.