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Ofgem Electricity NIC Year 1 Evaluations

Mobile Extra High Voltage Substation Bays (MSB)

Final Report – with addendum

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CONTENTS

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 NGET in August 2013;
- subsequent question responses through the formal written question process;
- discussions held at meetings between NGET and the Expert Panel and/or PPA Energy; and
- a factual correction provided by NGET

In October 2013 NGET was given an opportunity to submit revised proposals. The traffic light indicators and the metrics shown in Sections 1 to 9 have not been changed to reflect any changes made by NGET in these revised submissions.

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:	Mobile Extra High Voltage Substation Bays (MSB)		Short name:	MSB
			Total cost (£000):	£12,268
Network Licensees group:	National Grid Electricity Transmission Ltd (NGET)		NIC funding request (£000):	£8,804 (£8972 before adjustment for payment in the first year of the project)
The Problem(s):	Transmission substations are a fundamental part of an electricity transmission network. Their key function is to allow power to be directed safely and securely from power generators to demand locations. The existing design philosophy for transmission networks is to provide secure and safe long term, permanent (40 to 60 years or more) solutions for power transmission. Major components of transmission substations may weigh in excess of 200 tonnes and thus require special permits for transportation with limited route options and often involve costly highway reinforcements. Once on site they require special lifting equipment and very substantial foundations. The resulting costs can only be justified for a permanent installation which is likely to be in operation for more than 40 years. NGET states that the increasing penetration of renewable energy will change the way networks operate and require much work to be carried out to make the transmission network fit for its future purpose. They argue that the large investment in the electricity transmission system needed to enable a low carbon electricity system has to be planned against a backdrop of substantial uncertainty around where, when and what proportions of intermittent, base-load and flexible generation will connect to the network. NGET asserts that these changes will reduce the ability to switch substation bays out for reinforcement and maintenance work so that capacity and security levels can be retained and protected. NGET claims that this means that there is a need for flexible solutions to provide capacity on a temporary basis as well as to speedily connect new renewable generation capacity.			
The Method(s):	NGET describes the method that the project would undertake as follows:- • Identify the business needs and further technology developments for			

	400kV transmission network application of the mobile substation bay concept. • Define specifications of the proposed solution based on the results of the feasibility assessment currently underway. • Design, prototype, and test the modular mobile substation bay components (e.g. dealing with size, weight, installation requirements, electrical performance, and reliability issues). • Develop the new procedures, safety rules, installation and commissioning processes necessary for implementation. • Undertake a deployment and demonstration trial of the mobile substation bay in an extra high voltage transmission environment (400kV) in GB. • Remove the mobile substation bay components from the first site, re-test them, service them, and re-deploy them to a second site. • Investigate the commercial arrangements for different ownership, lease and service provision options. • Evaluate the cost, system wide benefits and business case for an optimum roll out of MSBs across GB for all TOs. The learning would be disseminated to the electricity supply community at all relevant stages of the project.
The Trial(s):	NGET asserts that the project will demonstrate the proof of the mobile substation bay (MSB) concept through a real trial application in a live substation environment. The MSB will be installed next to a normal bay in an operational substation. The MSB will then be decommissioned and returned to stores where it will be inspected and refurbished (if necessary) and then prepared for transportation to the redeployment site, once this is prepared, where the MSB will be installed and commissioned. Procedures will be reviewed and revised to include new learning from the relocation activity.
The Solution(s):	The solution which NGET is proposing includes designing, testing and using equipment which can be transported on normal heavy goods transportation, has a rating of more than 100MVA, can be deployed and commissioned within two weeks, removes or minimises the need for cranes by employing self installing systems, removes the need for any significant permanent civil construction, uses 'Plug & play' control and protection, and is suitable for storage or redeployment to another site within two weeks.

	The solution also requires the development of revised methodologies regarding maintenance, safety rules and documentation for operation in the vicinity of MSBs and integration into an operational substation environment, commissioning programmes, control room procedures to use equipment remotely, operational procedures, self installation where possible and procedures for 'hook up' to site services and integration into site safety functions.
Key strengths and weaknesses against the criteria	This is a conceptually relatively easy to understand project and there may well be some occasions where benefits could arise. However based on the information provided by NGET so far there are some significant weaknesses and concerns regarding this project. These can be summarised as follows:- • The potential technical achievability of the project within acceptable costs and timescales does not seem to have been validated and has not been demonstrated; • It is not clear that there is sufficient potential volume of activity to support the business case; • The approach to dealing with potential barriers to implementation (i.e. bringing about the required culture change within NGET) has not been explained; • There has been little transparent senior management commitment to the project during the assessment process. It is also not clear why this approach has not been previously identified and developed by equipment manufacturers.

1 Summary of Assessment against Evaluation Criteria

Criteria	Overall Assessment	
(a) Low carbon and benefits		NGET has argued that the MSB approach has the potential to allow low carbon generation to be connected to the transmission network more quickly than would otherwise be the case. Carbon benefits could emerge from this although their scale may be more limited than NGET has suggested as the assumptions regarding advancement of timescale, number of opportunities, load factor etc may be too optimistic. Similarly there is the potential for financial benefits to arise for the generator from MSB use. However there are considerable concerns about the number of opportunities for such MSB deployment. Although NGET has provided, in response to a PPA question, information about the total number of potential renewable connections and of the volume of switchgear replacement and transformer maintenance this does not amount to a compelling case that there is a reasonable likelihood that the even quite small fleet that they have suggested would actually be fully utilised in providing temporary connections for renewable generation. This concern remains following the provision by NGET - after further questioning - of a forecast of the number of deployment opportunities for MSBs over the next ten years as some twenty. Other uses for MSBs have been suggested by NGET. These are • supporting the carrying out of maintenance work, • asset replacement and • during failure recovery. In some cases, using NGET assumptions, a financial benefit has been demonstrated. Again however there are many concerns about some of the underlying assumptions and the number of opportunities for such MSB deployment.

(b) Value for money		If successfully delivered the benefits from this project will accrue to customers of the transmission network. The learning relates to the transmission system. NGET is undertaking a competitive tendering process to identify the suppliers of equipment and services. In view of the apparently early stage of development of the MSB concept this does raise the question as to whether this is currently the most effective approach to taking the project forward. At this stage of its development the concept may perhaps be best taken forward by the use of a partnership or consortium building type approach. Costs are high particularly regarding the amount of NGET labour to be used and the contingency costs that are included, which seem disproportionate.
(c) Generates knowledge		There is potential for new knowledge from this project which will be shared with other GB transmission operators. NGET has indicated that it intends to conform to the default IPR arrangements. NGET has envisaged that the equipment providers will fund the detailed design and development of the MSB equipment. However it could be argued that in view of the small fleet size that NGET are initially seeking that the incentive for equipment suppliers to do this may be limited. NGET seems to have included the potential for this funding not materialising within the contingency allowance for the cost of the project. Thus, it may still be possible to achieve the objectives of the project without the expected external funding. IPR associated with the required new specifications and procedures for MSB will be shared by NGET with all GB network licensees free of charge.
(d) Is innovative		The level of both technological, process and procedural innovation required to deploy the MSB concept at 400kV is significant. Very little has been

		attempted at this voltage level overseas and nothing in the UK has been reported. The business case is unproven and hence a development or demonstration project is warranted. However the level of validation reported in the FSP that this is indeed an achievable project is limited. NGET has not indicated that they have undertaken much activity to validate that the requirements that they are seeking to achieve are achievable at an acceptable cost or within an acceptable timescale. Many issues seem to have been left to be dealt with in tender discussions with potential service providers/partners or as part of the project itself.
(e) Partners and Funding		There is considerable reliance on manufacturers coming forward who are prepared to undertake substantial design work on SGTs and other equipment for a relatively small number of sales. It is not clear whether the incentive for manufacturers will be sufficiently strong to maximise participation in the project. It is also noteworthy the equipment providers have not themselves sought to develop this concept and offer it to transmission operators as a product offering. The process that NGET has adopted is primarily that of competitive tendering and is thus somewhat formal. This may not be the most effective approach at this stage of the development cycle when a more collaborative one may be more beneficial.
(f) Relevance and timing		NGET has categorised the drivers for MSB into load related ones and non load related ones. Load related means temporary connections to facilitate the speedy connection of new – particular renewable – generation. A larger number of such requests may increase the relevance of this proposal and suggest that it could be appropriately timed. However, as previously mentioned, the extent to which factors other than the construction of switchgear bays (e.g. planning permission delays associated with overhead lines) are actually the critical issues that slow down plant commission should also be noted and this has the potential to undermine the need for MSB deployment

		even if there are a larger number of opportunities. The non load related drivers for the project include securing demand during transformer maintenance, failure recovery and efficient asset replacement. Whilst these are relevant NGET has not suggested that there is a particular increase at this time although it does argue that the increasing complexity of the network means that tools which offer flexibility would be of benefit. In both cases there are concerns about whether there is a sufficient overall demand to make the development of the MSB concept worthwhile.
(g) Methodology		Many of the key requirements such as, for example, the identification of resources and the development of a clear project plan seem to have been put in place. However a major concern is the extent to which the feasibility of the project has actually been validated so that it has a reasonable chance of success. This has not been demonstrated in the FSP. Whilst it is recognised that the MSB concept can only be fully validated by undertaking this project, the level of confidence that it is achievable would be increased by evidence that some initial exploration of the possible solutions (and identification of some of the issues that could arise in its implementation) has been undertaken. This has not so far been convincingly demonstrated by NGET. Without at least some of this validation, the project has a high level of risk that verges on the speculative. Similarly NGET has recognised that there is a high level of cultural change that may be required in order for the MSB concept to gain acceptance and be fully implemented. However it is not clear what specific actions are envisaged in order to manage this issue. Without this there are significant risks that the project could be delayed at best or wholly frustrated at worst. In response to a PPA Energy question NGET has provided a list of intended actions. Whilst this list seeks to address the issues through meetings and in other ways, there is a remaining concern that this will be sufficient to overcome possible resistance to the MSB approach.

Successful Delivery Reward Criteria (SDRC)		Generally the proposed list of Successful Delivery Reward criteria (SDRC) is satisfactory. The required evidence is fairly detailed, and the SDRC align with the high level activities outlined in the "Development Strategy". The SDRC are spread throughout the length of the project. In some cases it would be helpful if the precise evidence to be put forward was more clearly defined and focused on key deliverables together with the expected dates that they would be completed.

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:	NGET has argued that the MSB approach has the potential to allow low carbon generation to be connected to the transmission network more quickly than would otherwise be the case. Carbon benefits could emerge from this although their scale may be more limited than NGET has suggested as the assumptions regarding advancement of timescale, number of opportunities, load factor etc may be too optimistic. Similarly there is the potential for financial benefits to arise for the generator from MSB use. However there are considerable concerns about the number of opportunities for such MSB deployment. Although NGET has provided, in response to a PPA question, information about the total number of potential renewable connections and of the volume of switchgear replacement and transformer maintenance this does not amount to a compelling case that there is a reasonable likelihood that the even quite small fleet that they have suggested would actually be fully utilised in providing temporary connections for renewable generation This concern remains following the provision by NGET - after further questioning - of a forecast of the number of deployment opportunities for MSBs over the next ten years as some twenty. Other uses for MSBs have been suggested by NGET. These are • supporting the carrying out of maintenance work, • asset replacement and • during failure recovery. In some cases, using NGET assumptions, a financial benefit has been demonstrated. Again however there are many concerns about some of the underlying assumptions and the number of opportunities for such MSB deployment.
Metrics (where available):	
Net financial	£4,790 (per redeployment- based on the redeployment of MSB

benefit (£000)[1]:	equipment that has previously been purchased)
Carbon benefits (for example in £/tCO_2) [2]:	If a MSB were to be utilised such that a 100MW wind farm could be connected twelve months earlier than currently possible with an assumed load factor of 30% then it is claimed 263 GWh of low carbon electricity could be generated resulting in a saving of 117,000 tonnes of CO_2 (based on the 2013 emission factor for grid average electricity, published by Defra). Using the NGET estimated cost of redeployment of an MSB of about £2.8 million implies a cost per tonne of CO_2 saved of between £23 and £24.
Network capacity released (kW)[3]:	100,000 kW (based on the example described in carbon benefits above).
Base case time to release capacity (months)[4]:	24 months
Method time to release capacity (months)[5]:	3 months
Potential for	NGET has indicated that the MSB fleet size would depend on a number of factors but for the initial cost benefit analysis has

[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

replication[6]:	been assumed to be five (two with 400/132kV transformers, one with 400/275kV transformers and two with 275/132kV transformers). Each would consist of three elements - HV switchgear, LV switchgear and the transformer - which could be used separately if required. NGET state that "it would not be unrealistic to consider a range of 5-10 MSB units during RIIO T2 period". MSBs are expected to be in place for between around three and eighteen months and it has been assumed can be redeployed ten times. There would be a total of about five redeployments per year which NGET claim is a conservative estimate although this has not been substantiated and there is little clarity about the mix of applications. Overall there is significant concern about the level of replication that is available for this proposed innovation.

Sub-criteria	**Assessment**
Carbon claims (including quantitative analysis, if provided)	According to NGET MSB can aid green house gas (GHG) emission reduction by (a) supporting the management away from SF_6 intensive gas insulated switchgear, although the approach will not reduce the amount of SF_6 currently in the system – merely minimise additions. It is also suggested that hybrid switchgear – thus including some usage of SF_6 – may be used as part of the MSB so the utilisation of SF_6 is not entirely avoided (b) helping to connect renewable generation sooner (c) reducing the carbon footprint of the substation itself. GHG emissions reduction is said to be as "set out in the Carbon Plan". No other direct references to the Carbon Plan have been noted. NGET suggests that if an MSB were to be utilised such that a 100MW wind farm could be connected twelve months earlier than currently possible with an assumed load factor of 30%

	then 263 GWh of low carbon electricity could be generated resulting in a saving of 117,000 tonnes of CO_2 (based on the 2013 emission factor for grid average electricity, published by Defra). However there are significant concerns regarding the claimed carbon benefits. These include • whether there are a sufficient number of actual opportunities for MSBs to be deployed, • the extent to which other factors (e.g. planning permission delays associated with overhead lines) may be the critical factors that slow down plant commissioning, and • the volume of carbon saving that would actually arise (are the assumptions regarding advancement of timescale, load factor etc too optimistic) Nonetheless, NGET claims that it is the Government's aim to run a technology race between different low carbon power generation options and that this creates uncertainty regarding the development of the transmission system. Hence it is argued that MSB could facilitate the carbon plan by providing flexibility and fast response.
Environmental benefits	The quantitative references to environmental benefits (other than those referred to above) are limited. Other environmental benefits are said to result from the reduced carbon footprint and disturbance from civil construction and building works from the use of an MSB as compared to a permanent solution. However this is going to depend on whether the MSB use avoids or delays the permanent solution and the timescale under consideration.
Robustness of financial benefits	NGET foresees four types of benefit from MSB to support the business case • temporary connections – in order, for example, to facilitate the earlier connection of renewable generation, • securing demand during SGT maintenance • efficient asset replacement, and • failure recovery. Looking firstly at temporary connections – these are intended to facilitate the earlier connection of renewable generation.

	Using the example examined above where it is assumed that a 100MW wind farm can be connected 12 months earlier via the deployment of an MSB than would otherwise be the case and that the price for the electricity that is generated is £60 per MWh then the additional income received by the generator in this period would be around £16 million. The cost of the MSB would need to be set against this. In the Full Submission Pro-forma (FSP) NGET indicates that the cost of redeployment of an MSB is £2.77 million. This includes an MSB charge out cost of £0.6 million which is made up of an equipment charge of £0.5 million (cost of purchase of the MSB equipment - £5 million - divided by the assumed number of redeployments - ten times) plus £0.1 million covering maintenance, refurbishment and storage between each redeployment. However in response to a question from PPA Energy NGET suggests that the cost of deploying an MSB in such a case would be £5 to £7 million. It seems likely that in this case the MSB charge out costs has been replaced by the full cost of purchasing the equipment. In either case, assuming that the MSB costs are met by the generator and set off against the additional income, then any resulting benefits would accrue to the generator, who is, of course, a customer of the transmission system. However, as mentioned above, it could be argued that some of the assumptions made are fairly optimistic – for example the length of the 12 month advancement period between the two methods of connection seems quite long, and the wind farm load factor and selling price for electricity could be more modest. There are also some risks in the assumed costs of redeployment. Significantly, again as mentioned above, there are concerns about the number of suitable opportunities for deployment that may arise. NGET initially provided no information on the expected number of renewable generation connections. However in response to a PPA Energy question it has submitted a response which indicates the current contracted position regarding their number and timing. This indicates the potential for some 72 renewable generation connections (59 offshore wind, 6 onshore wind, 3 biomass and 4 tidal). However it should be noted that is only an indication of what may actually happen and when. Also the extent to which NGET has considered the suitability or likelihood of MSB use at such sites is not clear although in response to further questioning, it has estimated that over the next 10 years there could be five opportunities to deploy an MSB to accelerate a connection date (generation or demand). Hence whilst there is

	potentially a number of sites where an MSB could be utilised the concerns remain about the degree to which this would be taken up in practice. If this were to impact on the amount of time that MSB equipment were utilised then it could also lead to an increase in the MSB charge out cost. Thus it appears that there may well be some cases where a financial benefit could arise from adopting the MSB approach but the evidence to support the scale and possible replication of such benefits has not yet been provided by NGET. In some circumstances (for example, where further existing transmission capacity is expected to become available in the near future perhaps because other generation has reached the end of its life and is being decommissioned) then further transmission network reinforcement may not be necessary. The MSB would be returned to stores or to its next location after the end-of-life generation was decommissioned. In other circumstances then it would be necessary in due course to replace the MSB with a permanent installation. Turning to the second source of potential benefits for an MSB, the equipment could be used to ensure that an appropriate level of security is retained when a Super Grid Transformer (SGT) needs to be maintained. NGET argues that the "business as usual" alternative to the use of MSBs in such a case is to construct a permanent substation bay and has put forward an example of this as part of the business case. However in response to a PPA Energy question it became clear that there were a number of other alternatives such as the use of existing spare capacity or transferring demand to another substation that may be more efficient than providing a permanent substation for a short period of time. Indeed NGET has emphasised that the use of a permanent bay is only adopted as the BAU solution once these alternatives have been considered and ruled out. NGET states that BAU costs are based on typical scheme costs from a historic cost database, and MSB costs have been discussed with manufacturers and are based on historic experience with innovation projects. In response to PPA Energy questions NGET have indicated that there are more than 100 instances each year of major transformer maintenance. In response to further questioning, NGET has estimated that over the next ten years there could be five opportunities to deploy an MSB to reduce the impact of constraints due to maintenance. NGET also provided details of two future projects where they suggested that the

	use of MSBs would be beneficial. No completed projects where a permanent substation bay had been completed in order to facilitate maintenance work was reported. Efficient asset replacement involves the use of MSBs to make the replacement of air insulated switchgear easier. At present limited space and other constraints may mean that it is not possible to implement a "like-for-like" replacement and instead smaller but more expensive gas insulated switchgear (GIS) are sometimes used to replace existing air insulated ones. In addition several outage seasons may be needed in order to carry out the required work. As previously though there is some doubt about the number of opportunities that in practice may utilise the MSB concept although in response to questioning NGET indicated that over the RIIO period 300 switchgear and bay replacements are planned although this include both AIS and GIS. As previously, NGET has estimated that over the next ten years there could be five opportunities to deploy an MSB to facilitate switchgear replacement. Finally NGET states that the MSB would "add a valuable rapid supply restoration capability in the event of extreme events causing failure" although this is not further developed.
Capacity released (if applicable)	In the wind farm case described above then 100 MW of capacity would effectively be released once the MSB was in place. Another example of where capacity could be provided for a relatively short time is for the transition period between a generator which has reached the end of its life and is being decommissioned and a new generator coming online.
Replication	NGET has indicated if this project were successful that the MSB fleet size would depend on a number of factors but for the initial cost benefit analysis it has been assumed to be five. However these are not entirely interchangeable. Each MSB would consist of three elements - HV switchgear, LV switchgear and the transformer. These elements could be used separately if required. However the transformers would be of differing ratios - two would be 400/132kV, one 400/275kV and two with 275/132kV. Whilst the need for these different transformers is recognised, this does have the impact of

	limiting the degree to which there is flexibility between different MSB's in the overall fleet. NGET state that "it would not be unrealistic to consider a range of 5-10 MSB units during RIIO T2 period". MSBs are expected to be in place for between around three and eighteen months and it has been assumed can be redeployed ten times. NGET expects that initially there would be a total of about five redeployments per year. However as previously mentioned there is considerable doubt about the scale of use of the approach. NGET has not provided a compelling case that there is a reasonable likelihood that the even quite small fleet that they have suggested would actually be fully utilised. For example, in response to a question, NGET has projected that 10% of future schemes could benefit from MSB, which is twenty schemes over the next ten years, equally split across four types of deployment (facilitate switchgear replacement, reduce constraints during works / emergency restoration, manage constraints during outages, accelerate connections). If the fleet size has been over estimated it could lead to a low utilisation of the MSB fleet with consequential storage costs which also undermine the basis of the carbon and financial benefits that have been claimed. A question was raised regarding the use of mobile substation bays at lower (i.e. distribution) voltages in GB, which might help to give an indication of the level of usage of existing equipment. NGET indicated that DNOs have "some limited experience" of using mobile bays at lower voltages, primarily to manage emergency supply restoration although the response indicates that a detailed analysis of such usage has yet to be undertaken.

3 Criterion (b) Value for Money

Criterion:	Provides value for money to electricity transmission customers
Overall assessment:	If successfully delivered the benefits from this project will accrue to customers of the transmission network. The learning relates to the transmission system. NGET is undertaking a competitive tendering process to identify the suppliers of equipment and services. In view of the apparently early stage of development of the MSB concept this does raise the question as to whether this is currently the most effective approach to taking the project forward. At this stage of its development the concept may perhaps be best taken forward by the use of a partnership or consortium building type approach. Costs are high particularly regarding the amount of NGET labour to be used and the contingency costs that are included, which seem disproportionate.
Metrics (where available):	
Size of benefits to transmission system[7]	If this project is successful and subsequently rolled out then the benefits will be almost entirely allocated to the transmission system and its customers.

Sub-criteria	**Assessment**
Proportion of benefits attributable to transmission system (as opposed to elsewhere on	As previously mentioned NGET foresee four types of benefit from MSB:- • temporary connections – in order, for example, to facilitate the earlier connection of renewable generation, • securing demand during SGT maintenance • efficient asset replacement, and

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

supply chain)	• failure recovery. Benefits from speedier generation connections, were these to be delivered, would mainly flow to the relevant generator – who is a customer of the transmission and system operator. The other benefits, if validated and accessed, could lead to lower capital and operating costs which would, in due course either be shared with or flow through to customers via charging mechanisms. However there are some doubts about the scale of such benefits and these have been summarised in Section 2 above.
How learning relates to the transmission system	If successful and the business case can be substantiated then the learning is directly related to the transmission system as it relates to substation bays.
Approach to ensuring best value for money in delivering projects	NGET is undertaking a competitive tendering process to identify the suppliers of equipment and services based on NGET's normal procurement process. There seems to have been a conscious decision to seek to use a market approach to get best value. However in view of the apparently early stage of development of the MSB concept this does raise the question as to whether this will be the most effective approach to taking the project forward at this stage. At this stage of its development the concept may perhaps be best taken forward by the use of a partnership or consortium building type approach. NGET has listed a number of other useful steps to ensure value for money as follows • Has appointed of an experienced project manager • Has appointed a buyer to oversee the procurement process. • Is preparing functional design specifications for the necessary MSB equipment
Identify and review major cost items, examine justification for relevant costs, assess choice of	The major cost items (£000) are NGET labour costs £2,176 (4145 days - or 18.8 person years at 220 days per year – at £525 per day) Equipment £5,400 Contingency £2,505

discount rates	Other £1,620 The volume of labour used by the project is high although NGET has provided a detailed list of the tasks that are being undertaken and the amount of resource in each case. "Contingency" costs are high representing about 20% of the total project costs. NGET has built up the contingency at an individual task level. The proportion of such contingency varies considerable with many having none. However there are a number of high value tasks with high contingency rates of more than 30% (and in one case) more than 40%. In response to a question from PPA Energy NGET has argued that as an innovation project there is still a high level of uncertainty associated with the first deployment of mobile substation technology and hence the requirement for the contingency. However the level of contingency seems somewhat disproportionate. "Other" costs are also high at more than £1.6 million. NGET has explained that this is because it has been used to provide information on contractor and sub-contractor labour costs (as distinct to the cost of consultants (which has been shown under the "contractors" heading) and NGET labour costs.

4 Criterion (c) Generates Knowledge

Criterion:	Generates knowledge that can be shared amongst all relevant Network Licensees.
Overall assessment:	There is potential for new knowledge from this project which will be shared with other GB transmission operators. NGET has indicated that it intends to conform to the default IPR arrangements. NGET has envisaged that the equipment providers will fund the detailed design and development of the MSB equipment. However it could be argued that in view of the small fleet size that NGET are initially seeking that the incentive for equipment suppliers to do this may be limited. NGET seems to have included the potential for this funding not materialising within the contingency allowance for the cost of the project. Thus, it may still be possible to achieve the objectives of the project without the expected external funding. IPR associated with the required new specifications and procedures for MSB will be shared by NGET with all GB network licensees free of charge.
Metrics (where available):	
Conforming to default IPR arrangements:	Yes

Sub-criteria	**Assessment**
Potential for new/incremental learning to be generated by the project	Mobile substations bays are relatively common at lower voltages below the transmission levels used by NGET i.e. 400kV and 275kV. The new learning that could potentially be acquired through this project relates to the application of this approach to these higher voltages. NGET lists the specific objectives for new knowledge as

	identifying the rating and voltage capabilities that can be accommodated within category 2 highways requirements, the reduction in installation time and cost of an MSB compared to conventional methods, how much the operational capabilities of MSB are compromised in order to achieve mobility and rapid deployment, the size, costs and benefits of establishing a national fleet of MSB.
Applicability of learning to other Network Licensees	If successful, the general principles that are identified are likely to be beneficial in reducing the construction and operating costs of other transmission operators.
Proposed IP management and any deviations from default IP principles	NGET has indicated that it intends to conform to the default IPR arrangements. Additionally, one of the evaluation criteria for the selection of NGET's partner for the project is "Agreement to work within the NIC default IPR arrangement". NGET has envisaged that in order for possible equipment providers to retain and protect the IPR of the MSB design they will be willing to fund the detailed design and development of the MSB equipment. It is also suggested that they have had some positive responses to this idea from providers. However it could be argued that in view of the small fleet size that NGET are initially seeking that the incentive for equipment providers to do this may be limited. NGET seems to have included the potential for this funding not materialising within the contingency allowance for the cost of the project. Thus, it may still be possible to achieve of the objectives of the project without the expected external funding. There may also be IPR associated with the required new specifications and procedures for MSB. NGET states that they will make these available to all GB network licensees free of charge.
Credibility of proposed methodology for capturing learning from the trial and plans for disseminating	NGET has identified a range of stakeholders who will be interested in the learning disseminated from this project, and what their interest is likely to be. Their approach to learning dissemination includes workshops, a project website, lectures, conferences, webinars, video pod casts, social media, press releases, articles and academic papers, progress reports and the close-out report.

5 Criterion (d) Is Innovative

Criterion:	Is innovative (i.e. 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:	The level of both technological, process and procedural innovation required to deploy the MSB concept at 400kV is significant. Very little has been attempted at this voltage level overseas and nothing in the UK has been reported. The business case is unproven and hence a development or demonstration project is warranted. However the level of validation reported in the FSP that this is indeed an achievable project is limited. NGET has not indicated that they have undertaken much activity to validate that the requirements that they are seeking to achieve are achievable at an acceptable cost or within an acceptable timescale. Many issues seem to have been left to be dealt with in tender discussions with potential service providers/partners or as part of the project itself.

Sub-criteria	**Assessment**
Justification that the project is truly innovative	NGET argues that the MSB concept requires both technological innovation and innovation in process and procedure. Technological innovations include low weight transformers, lightweight transport structures, temporary transformer fire and oil containment, redesigned switchgear and easily transported and installed protection and control systems. Innovations in process and procedure include maintenance, safety rules, commissioning programmes, control procedures and others. Whilst such arrangements may have been deployed at lower voltage levels, very little has been attempted at the 400kV level overseas and nothing in the UK has been reported.
Justification that NIC funding is required and credibility of	NGET claims that the project has an unproven business case. The level of innovation is described in the previous box and demonstrates this. A concern could be that the level of innovation and development is quite challenging and may either be inherently unachievable or be too difficult to complete

claims	within the proposed level of funding or available timescale. NGET has not indicated that they have undertaken much activity to validate that the requirements that they are seeking to achieve are achievable at an acceptable cost or within an acceptable timescale. Many issues seem to have been left to be dealt with in tender discussions with potential service providers/partners or as part of the project itself. Whilst NGET has to some degree recognised this in the project risk register, the level of risk mitigation so far put into place seems somewhat limited (see below).
Identification of project specific risks (including commercial, technical, operational or regulatory risks)	NGET states that "the major risks for the roll out of MSBs are whether it can be safely deployed with acceptable environmental and reliability performance". As mentioned previously a risk register has been established and this broadly appears to capture the majority of likely risks to the extent that they can be identified at this stage of a project expected to last more than four years. However, again as mentioned above, the level of risk mitigation that so far has been deployed is somewhat limited.

6 Criterion (e) Partners and Funding

Criterion:	Involvement of other partners and external funding		
Overall assessment:	There is considerable reliance on manufacturers coming forward who are prepared to undertake substantial design work on SGTs and other equipment for a relatively small number of sales. It is not clear whether the incentive for manufacturers will be sufficiently strong to maximise participation in the project. It is also noteworthy that equipment providers have not themselves sought to develop this concept and offer it to transmission operators as a product offering. The process that NGET has adopted is primarily that of competitive tendering and is thus somewhat formal. This may not be the most effective approach at this stage of the development cycle when a more collaborative one may be more beneficial.		
Metrics (where available):			
Total cost of project (£000):	£12,268	NIC support (£000):	£8,804 (£8,972 before adjustment for payment in the first year of the project)
Costs met by Network Licensee (£000):	£2,706	Costs met by others(£000):	£590
NIC support (% of total cost):	73.1%	Costs met by Network Licensee (% of total cost):	22.1%
Costs met by others (% of total cost):	4.8%	Number of consortium members:	NGET is currently carrying out a competitive process to select either a substation Original Equipment Manufacturer (OEM) or other

			solution providers that may be a consortium of specialists to be project partners. NGET indicate that the project is supported by Scottish Power Transmission, Scottish Hydro Electric Transmission and the Carbon Trust.

Sub-criteria	**Assessment**
Appropriateness of collaborators (including experience, expertise and robustness of commitments)	Involvement of possible partners in the development of the project so far seems somewhat limited. There are references to workshops and bilateral discussions held in 2012 between National Grid, suppliers, and existing and potential new collaboration partners aimed at assessing future challenges. From this process a long list of challenges and innovative ideas was collated. This fed into a competition with suppliers and contractors from which the concept for MSB emerged. A feasibility study is underway but in response to questioning NGET has indicated that this is generic and high level. In addition NGET state that external market research is currently being carried out looking at relevant areas of technology and logistics associated with making transmission equipment lighter, more compact and mobile. Collaboration with other parties thus seems to have been restricted and instead a formal tender process has been initiated. Some 26 (amended from 28 by NGET) companies have responded to an "expression of interest" request. However their current level of commitment and

	the experience and expertise of the successful company or consortium is not known. The Carbon Trust do appear to have been selected to participate in the project but their role is limited to assessing the CO_2 impact, knowledge dissemination and representation on the steering committee for which they do seem to have the appropriate skills.
External funding (including level and security of external funding)	A level of external financial support - around £0.5 million - is shown in the proposal but this has yet to be agreed by potential suppliers. This links to the detailed design and development work which it is expected, as mentioned previously, that the equipment provider will want to fund in order to protect the resulting foreground IPR. It is noted that one of the evaluation criteria for selecting the equipment provider is the "contribution to the project". However even if the equipment provider is not willing to fund this development work (perhaps because it cannot see a sufficiently large resulting market) it may still be possible to achieve many of the objectives of the project. The Carbon Trust has indicated that they may be willing to give a small discount on their charges to the project in certain circumstances
Effectiveness of process for seeking and identifying new project partners and ideas	See above. The process that NGET is adopting is somewhat formal which may not be the most effective approach at this stage of the development cycle when a more collaborative one may be more beneficial.

7 Criterion (f) Relevance and Timing

Criterion:	Relevance and timing		
Overall assessment:	NGET has categorised the drivers for MSB into load related ones and non load related ones. Load related means temporary connections to facilitate the speedy connection of new – particular renewable – generation. A larger number of such requests may increase the relevance of this proposal and may suggest that it could be appropriately timed. However, as previously mentioned, the extent to which factors other than the construction of switchgear bays (e.g. planning permission delays associated with overhead lines) are actually the critical issues that slow down plant commission should also be noted and this has the potential to undermine the need for MSB deployment even if there are a larger number of opportunities. The non load related drivers for the project include securing demand during transformer maintenance, failure recovery and efficient asset replacement. Whilst these are relevant NGET has not suggested that there is a particular increase at this time although it does argue that the increasing complexity of the network means that tools which offer flexibility would be of benefit. In both cases there are concerns about whether there is a sufficient overall demand to make the development of the MSB concept worthwhile.		
Metrics (where available):			
Start date:	April 2014	Project time scale:	4 years 2 months

Sub-criteria	**Assessment**
Significance of the project in: (a) overcoming current obstacles to a future low carbon economy	As explained previously the MSB approach may allow generation to be connected to the transmission system more quickly. Where this generation capacity is renewable this has the potential to contributing to the low carbon economy. However it should be noted that MSBs could equally be utilised for the connection of other generation technologies. In previous sections the possible limitations of the approach as

	currently outlined by NGET have been summarised.
(b) trialling new technologies that could have a major low carbon impact	See above.
(c) demonstrating new system approaches that could have widespread application	It remains unclear whether there is sufficient volume of activity that can be addressed by this approach – both in terms of the total number of opportunities and the extent to which generic equipment can be used in many varying circumstances.
The applicability of the project to future business plans, regardless of uptake of LCTs (Low carbon Technologies)	NGET argues that even if the number of requests to connect renewable generation reduced the MSB approach could still be applied and have value for maintenance and asset replacement cases.

8 Criterion (g) Methodology

Criterion:	Demonstration of a robust methodology and that the project is ready to implement		
Overall assessment:	Many of the key requirements such as, for example, the identification of resources and the development of a clear project plan seem to have been put in place. However a major concern is the extent to which the feasibility of the project has actually been validated so that it has a reasonable chance of success. This has not been demonstrated in the FSP. Whilst it is recognised that the MSB concept can only be fully validated by undertaking this project, the level of confidence that it is achievable would be increased by evidence that some initial exploration of the possible solutions (and identification of some of the issues that could arise in its implementation) has been undertaken. This has not so far been convincingly demonstrated by NGET. Without at least some of this validation, the project has a high level of risk that verges on the speculative. Similarly NGET has recognised that there is a high level of cultural change that may be required in order for the MSB concept to gain acceptance and be fully implemented. However it is not initially clear what specific actions are envisaged in order to manage this issue. Without this there are significant risks that the project could be delayed at best or wholly frustrated at worst. In response to a PPA Energy question NGET has provided a list of intended actions. Whilst this list seeks to address the issues through meetings and in other ways, there is a remaining concern that this will be sufficient to overcome possible resistance to the MSB approach.		
Metrics (where available):			
Requested level of protection against cost over runs (default 5%) (%):	0%	Requested level of protection against direct benefits (default 50%) (%):	0%
Level of resources committed to the	NGET labour resources amount		

project (person-months):	to 4145 days (or 226 person months/ 18.8 person years at 220 days per year)	

Sub-criteria	Assessment
Feasibility of project proposal	NGET has laid out the specific functional performance that it is seeking to achieve. There are references to an ongoing feasibility report, a market study that is being undertaken, and various interactions with equipment manufacturers and other external parties. However little information is provided about how NGET believes that the performance that it is seeking is inherently achievable at the cost levels that have been used to construct the business case and within acceptable timescales. NGET has not indicated the extent to which the project feasibility has been validated in the development work that has so far been undertaken. It is argued that the technology and equipment being used in the MSB project is still in development and testing in order to make it rapidly deployable. However the progress made to achieve this has not been presented. For example, it is assumed that the requirement for permanent foundations for MSB can be eliminated. However there is no discussion of the method by which this would be done or its feasibility. This is one example of many where the degree of validation undertaken by NGET provided in the FSP regarding the project is limited or non-existent. Whilst it is recognised that some elements of this are likely to emerge through the tender process and the project itself there is a need to ensure before embarking on such a process that there is a reasonable chance of success. It is also recognised that a greater level of risk will exist for a potential NIC funded project than would be the case for a "business as usual" one. Nevertheless without at least some validation the project has a yet higher level of risk verging on the speculative. In response to a PPA Energy question NGET has indicated that regular bilateral meetings have been held with leading suppliers, and has provided documents from such meetings (e.g. presentation slides from manufacturers) Whilst this provided some assurance that the relevant concepts were being

	considered, at a high level it remained unclear that these ideas were sufficiently mature at transmission voltage levels to give confidence that there was a reasonable likelihood that equipment could be deployed that would meet the specifications that NGET had set. Similarly NGET has recognised both in the FSP and in the meetings with the Expert Panel and PPA Energy that there is a high level of cultural change that may be required in order for the MSB concept to gain acceptance and be fully implemented. However it was not initially clear what specific actions are envisaged in order to manage this issue. Without this there are significant risks that the project could be delayed at best or wholly frustrated at worst. In response to a PPA Energy question NGET has provided a list of intended actions. Whilst this list seeks to address the issues through meetings and in other ways, there is a remaining concern that this will be sufficient to overcome possible resistance to the MSB approach.
All risks, including customer impact, exceeding forecast costs and missing delivery date	NGET has included within the FSP a discussion of the risks associated with this project and a risk register which lists them together with the suggested mitigating actions. Three circumstances are identified where the project may need to be changed, delayed or suspended – firstly where a transformer cannot be built with sufficient capacity to support the trial scheme, secondly if a light enough transformer cannot be built or the circumstances change at the selected trial site such that the work is no longer necessary. Whilst some risk mitigation actions are suggested in the risk register to respond to the risks identified within it, it is not yet clear that these will be sufficient to optimise the chances of a successful conclusion to the project. Customer impacts from the MSB project that exceed those of the "business as usual" approach seem very limited
Whether items within project budget provide value for money	Covered under Criterion (b) Value for money.
Project methodology	The key personnel (for example, the project manager and lead engineers) have been identified, and a process has been

(including depth and robustness of project management plan)	initiated to identify potential demonstration sites although this work is not yet completed. A well structured project plan has been provided with clear identification of its phases. However it should be noted that there been little evidence of senior management commitment and support to the project during this assessment process.
Appropriateness of Successful Delivery Award Criteria (SDRC)	See Section 9, below.

9 Successful Delivery Reward Criteria

Overall assessment:	Generally the proposed list of Successful Delivery Reward criteria (SDRC) is satisfactory. The required evidence is fairly detailed, and the SDRC align with the high level activities outlined in the "Development Strategy". The SDRC are spread throughout the length of the project. In some cases it would be helpful if the precise evidence to be put forward was more clearly defined and focused on key deliverables together with the expected dates that they would be completed.

Successful Delivery Reward Criteria	Review
9.1	**Evaluation and selection of preferred solution provider**
	This is a key requirement so it is good to have a SDRC linked to it. It would be beneficial to specify some of the evidence somewhat more clearly. For example "procurement process" should be split into some specific actions with associated dates. The second evidence point could probably be shortened and focused on key deliverables as it is so key to the project.
9.2	**MSB design and specification**
	No comments.
9.3	**Detailed design, manufacture and testing**
	Some of the actions would be strengthened if target dates are included.
9.4	**Development of MSB safety and operational procedures**
	Again some target dates could be added.
9.5	**First deployment of the MSB on the Transmission System (site A)**
	It is good to see this important milestone included. Some clarification of the evidence would be beneficial. For example how would it be demonstrated that "the specific location and work programme" has been agreed.

9.6	**First redeployment of an MSB (to site B)**
	Again this is an important milestone included. Some clarification of the evidence also would once again be beneficial. For example how would it be demonstrated that "the specific location and work programme" as indicated in the first two items of evidence have been agreed.
9.7	**Alternative commercial arrangements for MSBs**
	Some clarification of the deliverables and their associated delivery dates would be helpful.
9.8	**Project learning, knowledge dissemination and project close out**
	No comments.

10 Addendum: Changes made in resubmission

10.1 Summary of Changes

The key changes made by NGET in their resubmission are noted below.

10.1.1 Total Project Cost and NIC Funding Request

The total project cost has been reduced in the resubmission from £12.268 million to £11.818 million – some £450,000 or 3.7%. This entirely relates to reductions in contingencies for switchgear manufacture, transportation rig development and manufacture, and the second deployment of the mobile substation bay. As a result the overall NIC funding request has been reduced from £8.804 million to £8.401 million – some £403,000 or 4.8%.

The relevant parts of the main submission document and the cost spreadsheets have been appropriately updated.

10.1.2 Project Business Case

In order to support the project business case a further appendix has been added in the resubmission containing additional information which NGET claims illustrates how it is envisaged that MSBs will be used, provides a review of schemes completed in the last 10 years that could have benefited from them (selected from approximately some 300 of such projects), indicates forecasts of the likely future volumes of MSB deployments over the next 10 years or 300 schemes and discusses the technology maturity of the project.

This appendix is cross referenced to the business case section of the main submission

10.1.3 Headings and corrections

Headings have been updated to reflect that the resubmission is version 2 of the documents.

A graph indicating a comparison of the costs of providing additional substation capacity was incorrect in the original submission and has been corrected and re-structured. The additional appendix has been identified in the list of appendices.

10.2 Impact on NIC Funding Application Criteria

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

10.2.1 Criterion (a) Low Carbon and Benefits

In PPA Energy's initial analysis of this proposal under this criterion concern was expressed about the scale of use and applicability of the MSB concept. NGET has sought to respond to this in the additional appendix that they have provided in its resubmission.

In this appendix a number of generalised scenarios are described where NGET assert that MSBs could be used. These are described and illustrated more clearly than in the original submission and in greater detail. This is useful.

In addition an attempt is made to explain the scale of use that NGET claims could be achieved by the use of MSBs. This indicates NGET's assessment that a fairly small proportion (5%) of schemes undertaken in the last 10 years would benefit from this initiative. The specific schemes that NGET has identified are listed together with a similar sized list of specific future projects which it is stated could benefit. There is no clarity about the criteria and methodology used to select these schemes. This is interesting material and had it been provided earlier in the review process it would have been subjected to considerable scrutiny in order to assess its reliability and the way that it had been used in estimating possible future use of the MSB concept.

The appendix also examines the calculation of potential customer and other benefits that NGET state could be achieved by the use of MSBs although much of this was already included in the original submission.

Overall, although NGET has provided some interesting new material which has the potential to reduce or allay concerns in regard to this criterion a comprehensive and convincing case for the asserted level of use of MSBs has not been given. In the absence of the opportunity to further scrutinise the methodology and approach used, this new material is insufficient to affect PPA Energy's initial assessment of the project under this criterion.

10.2.2 Criterion (b) Value for Money

During the assessment process for this project both PPA Energy and the Expert Panel raised concerns about the level of contingency that had been assumed. In its resubmission NGET has reduced this from £2.505 million to £2.055 million i.e. some £450,000 or 18%. In the original submission the contingency costs represented about 20% of the total project costs whilst in the resubmission it amounts to a little over 17%.

Whilst the reduction in the contingency costs is welcome it is 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 NGET regarding this criterion and hence there is no change to PPA Energy's initial assessment.

10.2.4 Criterion (d) Is Innovative

In the additional appendix provided by NGET in its resubmission further information is provided in regard to the technological readiness of this project. Whilst this is interesting and welcome it still fails to provide a comprehensive overview of the likely path of the project and hence does not indicate that there should be a change to PPA Energy's initial assessment.

10.2.5 Criterion (e) Partners and Funding

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

10.2.6 Criterion (f) Relevance and Timing

See Section 10.2.1. No change to PPA Energy's initial assessment is proposed.

10.2.7 Criterion (g) Methodology

See Sections 10.2.1.and 10.2.4. No change to PPA Energy's initial assessment is proposed.

10.2.8 Successful Delivery Reward Criteria (SDRC)

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

10.3 RAG (Red Amber Green) Analysis

In the light of the above assessment of the resubmission, no changes are proposed to the red/amber/green assessment of the project against the criteria recorded in the main report.