LCNF Competition

SEPD LEAN - Interrogation Report

Document No. : FNC 45646-79862V

Issue No. : 003

Date : 30 September 2014

Client : Ofgem

Client Ref. :

Classification : COMMERCIAL-IN-CONFIDENCE

Compiled By : David McNaught

Verified By : Philip Williams

Approved By : John Devlin

Signed : Signed on Original

Distribution :

Copy	Recipient	Organisation
1	Andrew White	Ofgem
2	Project File	Frazer-Nash Consultancy

1. PROJECT SUMMARY

Southern Electric Power Distribution (SEPD) is proposing the Low Energy Automated Networks (LEAN) solution to trial two complementary methods to reduce losses in 33kV/11kV substations. These methods are:

- **Transformer Auto Stop Start (TASS)** which will use remote control to de-energise one in a pair of transformers in a 33kV/11kV substation, when the substation is running at below ~45% of its rated load. By de-energising one of the transformers, this method will reduce the associated losses and, correspondingly, reduce the energy losses attributed to the substation. For substations with older transformers this approach has the potential to save ~90MWh of lost energy per year. There are three different methods which will be considered to deliver TASS at suitable substations:
  - Method 1 will use existing switchgear and telemetry to allow manual switching of transformers. Deploying method 1 is thought to be cost effective in around 30% of substations.
  - Method 2 will build on method 1 but will add protection equipment to reduce the risk that inrush current poses to asset health and mitigate some of the power quality issues that TASS may cause. Deploying method 2 is thought to be cost effective in around 24% of substations.
  - Method 3 will build on methods 1 and 2 but advanced switchgear will be used in addition to protection equipment. Deploying method 3 is thought to be cost effective in around 5% of substations.
- **Alternative Network Topology (ANT)** which will aim to increase the interconnection of TASS enabled substations in order to mitigate risks associated with reducing transformer redundancy on the network. ANT will only be deployed in conjunction with TASS and only where the distribution network configuration local to the substation allows it.

SEPD propose trialling TASS and ANT across a four year phased deployment, including initial computational analysis, engagement with specialists and supply chain partners and off-network trials to de-risk network trials in 2017/18. Steps will be taken to ensure that the methods are

trialled across a range of operational environments relevant to the whole UK distribution network.

SEPD aim to ensure that the learning, new approaches and cost-benefit metrics from the project tests will be made available through a variety of media in order to improve the uptake of any successful approaches within the UK DNO and electrical distribution stakeholder community.

LEAN is a 4 year project with a total project cost of £3,068,000. The total project funding request is for £2,670,000, with SEPD providing £307,000 as their compulsory contribution. SEPD claim the potential net financial benefit is £49,056,635 which is based on the lost energy saved over 45 years if LEAN methods were rolled out UK wide. SEPD claim the potential gross carbon benefits are equivalent to 306,773 $kTnCO_2$ over 45 years.

2. ASSESSMENT AGAINST LCNF CRITERIA

2.1 SUMMARY OF ASSESSMENT CRITERIA

The criteria against which each submission will be assessed are outlined in the LCNF Governance Document, they are listed here for convenience:

2.1.1 LCNF

The criteria for the LCNF projects are

(a) Accelerates the development of the low carbon energy sector and has the potential to deliver net financial benefits to existing and/or future customers;

(b) Provides value for money to distribution customers;

(c) Generates knowledge that can be shared amongst all DNOs;

(d) Involvement of other partners and external funding;

(e) Relevance and timing;

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

2.2 CRITERION (A): ACCELERATES THE DEVELOPMENT OF THE LOW CARBON ENERGY SECTOR AND HAS THE POTENTIAL TO DELIVER NET FINANCIAL BENEFITS TO EXISTING AND/OR FUTURE CUSTOMERS

2.2.1 Key Statements

- The LEAN methodology uses TASS to reduce distribution network losses by de-energising under-utilised transformers eliminating fixed losses and, therefore, the carbon emissions associated with the network losses.
  - Analysis conducted by S&C Consultancy on behalf of SEPD suggests that the energy savings will be of the order of 90MWh/annum for TASS enabled substations.
  - TASS therefore has the potential to save £4,500 per enabled substation per annum (90MWh at £48.42/MWh as per RIIO ED1 value of lost energy calculations).
- Based on these savings: TASS method 1 provides net commercial benefits when deployed on 30% of SEPD's substations; TASS method 2 for 24% of substations and TASS method 3 for 5% of substations.
- Aggregated, the commercial viability of these methods across the UK distribution network, ~1400 suitable substations would generate a reduction in losses equivalent to ~6,400 tonnes CO_2/ annum.
- The LEAN methodology helps the distribution network to cope efficiently with periods of reduced substation loading caused by the connection of distributed renewable generation assets at the 11kV level.

2.2.2 Challenges and Potential Shortfalls

Criterion (A) – Accelerates the development of the low carbon energy sector and has the potential to deliver net financial benefits to existing and/or future customers;	
Sub-criterion (a.i) – Ability to facilitate the Carbon Plan through GB wide roll out.	**Challenge 1**: There is limited substantiation in the submission for the claim of 90MWh/annum savings in TASS enabled substation. Section 3.4 articulates the process that has been followed to estimate the applicability of the methods but detailed results have not been included. Given that the rest of the claims about the applicability of the methods are predicated on the 90MWh claim, the source and validity of the supporting assumptions should be demonstrated and evidenced more rigorously in the submission.
	Answer 1: The figure of 90MWh per annum is indicative of the fixed losses incurred at a typical primary substation transformer. This is based on a transformer having an iron loss of around 10-12kW and then multiplied by 8760 hours to give the annual volume of losses incurred i.e. 96MWh. The figure of 90MWh per year is an example of the typical losses in high-loss transformers that could be saved if the TASS method is adopted. In developing the business case desktop analysis, half-hourly demand profile data from a previous IFI Isle of Wight study was used in conjunction with the iron losses recorded at commissioning. We repeated this exercise across SEPD's asset portfolio using figures from SEPD's Long-term Development Statement to "flex" the Isle of Wight demand profile, reflecting the

	rating of each individual site and commissioning records for each individual primary substation site. This gave an indication of the losses which could be saved from across the SEPD portfolio of primary substations. Each of SEPD's site's potential loss savings has been calculated using best available data. Our project begins with a validation of actual fixed losses in a range of our transformers in order to confirm the level of loss savings.
	Conclusion 1: Response is adequate. No further comment.
Sub-criterion (a.ii) – Delivers the solutions more quickly than the most efficient existing method	**Challenge 1**: No timescale estimates are provided for GB wide rollout of the LEAN methods. The submission contrasts LEAN methods with a 60 years rolling programme of transformer replacements and states that, compared to these replacement timescales, LEAN provides benefit. It is not clear that this is a like for like comparison. What are the estimated timescales for GB wide LEAN method rollout?
	Answer 1: **METHOD 1:** In our business case estimations, we have identified that SEPD would be able to deploy Options 1, 2 or 3 of the TASS solution within between one and three years. Our assumptions are that: 1. Installation of each of the Method 1 options would take between four (for Option 1) and 40 (for Option 3) man-days apiece. We believe these estimates to be 'mid-range' i.e. neither pessimistic nor optimistic. 2. Each of the Method 1 options would involve a resource equivalent to four teams for SEPD. The use of four teams for one DNO is likely to represent an under-estimation of resource availability, particularly when considering the availability of skilled contract labour. 3. Each of the options is required at all sites where a positive benefit is identified. This is because we cannot yet identify the necessary mix of options 1, 2 and 3 to be deployed in SEPD. From these assumptions, we expect that the anticipated deployment duration of three years for SEPD could be reduced through the use of contract labour and a division of effort between each of the three options. For a GB-wide roll-out, we would expect similar availability of resources (pro-rata) at each DNO and therefore anticipate GB-wide deployment to also take up to three years. This is provided that our project findings match our present expectations and each DNO territory includes a similar population of 33/11kV substations where a positive benefit can be identified. As a result of the above assumptions, we estimate that the three Method 1 options can be deployed GB-wide in a period of less than four years.

	METHOD 2: For Method 2 (ANT) deployment we have assumed that existing feeder automation schemes can be relatively easily adapted through the introduction of additional ENMAC (DNO SCADA/DMS system) scripting. Where deployed, ENMAC scripting can usually be extended to additional feeders using in-house resources, often at zero direct cost e.g. control engineers during periods of low activity. In this way, the deployment of ANT throughout GB is not expected to present any issue to DNOs that use the ENMAC SCADA/DMS (the only DNO not to use these systems is ENW although they have an ENMAC system deployed on its Tier 2 projects).
	Conclusion 1: Response is adequate. No further comment.
Sub-criterion (a.iii) – The financial benefit of each method compared to most efficient existing method	**Challenge 1**: The 'Base Case' used by Appendix 5 to the submission assumes simply a 'do nothing' alternative approach –i.e. the LEAN methods are not implemented and no transformer improvements are undertaken. In the submission body text however the LEAN methods are contrasted with a rolling programme of transformer replacements. Appendix 8 also contains significant research on other loss mitigation approaches. However, within the submission little benefit is taken from this research in establishing an alternative 'best practice' base case. Evidence is required to verify that appropriate technical & financial analysis has been undertaken to establish a baseline for network reinforcement in comparison to LEAN method deployment?
	Answer 1: The rolling programme of transformer replacements will result in the replacement of all existing transformers in approximately 60-80 years. LEAN provides us with a method capable of delivering targeted loss savings at sites with periods of low peak demands in a much shorter timeframe. In addition, the EU Directive 2009/125/EC only applies to transformers purchased from 2015. The Directive specifies incremental transformer efficiency specification in two separate phases: Tier 1 to commence from 1st Jul 2015, and Tier 2 from 1st Jul 2021. Fig.1 below shows transformer MVAs versus peak efficiencies for all of SEPD's existing 33/11 kV primary distribution transformers plotted against the EU Directive Tier 1 (blue curve) and Tier 2 (red curve) requirements. Among these primary distribution transformers, only about 17% fall below EU Directive's Tier 1 transformer efficiency specification, and about 25% below Tier 2 specification. In summary, the majority of SEPD's transformers

already comply with (or are more efficient than) the EU Directive's Tier 1 and 2 specifications.

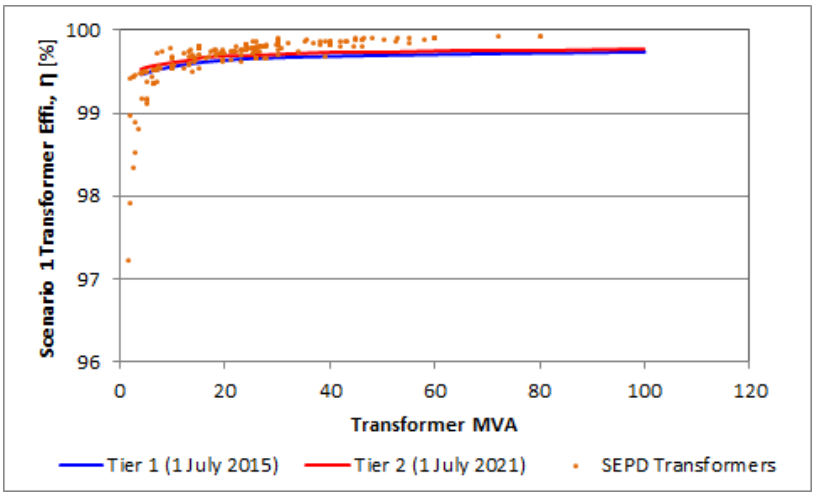


Fig.1 SEPD Transformer Efficiency against EU Requirements

Therefore, from SEPD's existing asset perspective, the impact of this EU Directive on the presented LEAN business case is not expected to have a significant impact on the base case scenario and we have not calculated this within the business case.

The research work detailed within Appendix 8 was completed through SEPD's IFI project on potential loss reduction techniques. The work concluded that only three techniques provided a positive business case in terms of investment over a 45 year life. The three methods outlined in the IFI project have been taken forward to form the basis of the LEAN project and incorporated into TASS and ANT. It is for this reason that the business case has not made a comparison with alternative techniques to those outlined in the IFI work and hence the business case has reflected a 'do nothing' approach to aid clarity.

Conclusion 1: Response is adequate. No further comment.

Challenge 2: The LEAN submission contains no detail estimating the through life costs of the project. In particular the additional control room costs of TASS, which would not feature in the base case, are not considered.

What is the estimated additional burden placed by LEAN methods on network control centres compared to business as usual?

Answer 2:

In order to ensure the widespread adoption of the methods, they must be straightforward to implement. The development of automated switching schedules, which can be implemented in

	existing Network Management packages such as POWERON or ENMAC, will form part of the method cost of implementing the solution. This will ensure that the adoption of LEAN will not place an unacceptable burden on the existing control room infrastructure. Again these cost and assumptions will be tested and validated during Phase 1 of the LEAN project.
	Conclusion 2: Response is adequate. See comments regarding the project's Phase 1 activities in Section 4 of this document.
Sub-criterion (a.iv) – The network capacity released and how quickly	The argument made in the submission is not predicated on the release of network capacity therefore no challenge is presented. No Challenge
	Answer 1: N/A
	Conclusion 1: N/A
Sub-criterion (a.v) – Potential for replication of the method across the GB	Challenges under this sub-criterion are considered to be adequately covered under previous challenges in this section. No Challenge
	Answer 1: N/A
	Conclusion 1: N/A

2.3 CRITERION (B): PROVIDES VALUE FOR MONEY TO APPLICABLE CUSTOMERS

2.3.1 Key Statements

4 The LEAN methodology uses TASS to reduce distribution network losses by de-energising under-utilised transformers eliminating fixed losses and, therefore, the costs associated with the network losses.

- 4 TASS has the potential to save £4,500 per enabled substation per annum 90MWh at £48.42/MWh as per RIIO ED1 value of lost energy calculations).
- 4 TASS Method 1 is estimated to cost £[redacted] per installation, Method 2 £[redacted] and Method 3 £[redacted].
- 4 Based on these estimated costs and benefits, TASS will only be implemented where it is cost effective to do so.

4 Aggregated across the UK distribution network, LEAN methodology could save £40 million due to the reduction in losses. These cost savings will be passed on to customers through normal business methods.

4 The project will be undertaken using processes designed to provide the best value for the project, whilst also ensuring that the solutions are feasible.

Challenges and Potential Shortfalls

Criterion (B) – Provides value for money to applicable customers;	
Sub-criterion (b.i) – Benefits attributable or applicable to the relevant network vs. elsewhere.	**Challenge 1**: The submission does not seem to compare and contrast the SEPD network with the UK distribution network as a whole. However, the assumptions made to calculate the potential national carbon and cost savings are predicated on this similarity. Are the rural/ urban ratio or substation demand profiles of SEPD's distribution areas directly scalable UK wide?
	Answer 1: We are confident that SEPD's network is reasonably representative of GB as a whole. This is based on a number of factors: • The SEPD network has a mixture of urban and rural areas with a wide range of demand types. • The networks across all DNOs have been designed to comply with a common set of requirements i.e. P2/6. • Historically, the transformer equipment involved has been procured from a common set of Original Equipment Manufacturers. These OEMs have provided equipment that has been designed and manufactured to comply with British safety, operational and maintenance protocols. As an example of the similarity between DNOs, substation load-related reinforcement plans are submitted to OFGEM as a part of the price control review process. It is only those sites which are at 'Load Index 5' that are selected for reinforcement. From data previously published by OFGEM during DPCR5, the table below summarises the number and percentage of substations by Load Index in SEPD and Northern Electric (chosen at random). We expect that analysis of all other DNOs will give similar results.

Comparison of Load Indices for SEPD and NEDL (2010 data)		Load Index	Count of SEPD substations	SEPD %	Count of NDEL substations	NDEL %
LI1 demand 90%	=<	LI1	389	75%	169	80%
LI2 demand <99%	=	LI2	73	14%	27	13%
LI3 demand <115%, <24 hours/year	=	LI3	42	8%	10	5%
LI4 demand <115% >24 hours/year	=	LI4	11	2%	4	2%
LI5 demand <115%, >672 hours/year	=	LI5	5	1%	1	0%

A more detailed assessment of GB sites would require access to data that is not within the public domain or available to other DNOs, such as detailed annual load data/profiles.

We are, therefore, confident that the provision of a Losses Reduction Tool will enable all DNOs to share in the learning gained in this project.

Conclusion 1: Response is adequate. No further comment.

Challenge 2: The presentation of the costings associated with each of the three methods of TASS delivery give no indication of the error bounds, maturity or uncertainty in each of the presented figures.

The viability of the methods individually, and the project as a whole, is likely to be sensitive to the variation in these figures.

Can tolerance values for each of these figures be provided with supporting analysis of LEAN project's tolerance to cost increases?

Answer 2:

SEPD recognise that the overall benefit case for the project is sensitive to a number of potential variables. Phase 1 of the project has been specifically developed to allow SEPD to analyse and validate the underlying assumptions behind the LEAN project. This involves additional technical expertise, detailed analysis using

	"actual" network parameters and engagement with the supply chain. At the end of Phase 1, SEPD will confirm that the project offers sufficient value and warrants deployment. If we identify that the cost of the trials is higher than estimated or that the potential benefits are significantly lower than anticipated we will review the project and make a decision prior to moving to deployment.
	Conclusion 2: Response is adequate. See comments regarding both Risk and Uncertainty and the project's Phase 1 activities in Section 4 of this document.
Sub-criterion (b.ii) – Steps taken to undertaken open, competitive procurement process.	**Challenge 1**: The project outline is not sufficiently mature to allow an understanding of when and how significant elements of the project will be delivered through external procurement; however, the submission includes assurances that the procurement will be undertaken according to SEPD's established processes ensuring clarity and best value for money. Articulation of a more detailed project plan, including the elements of the project that would be procured externally, would facilitate the assessment.
	Answer 1: A revised project plan has been submitted alongside this report which replaces the version included in the original submission documents – please see Annex A. Procurement support is required to (i) recruit transformer specialists (ii) purchase equipment such as advanced switchgear and relays and (iii) source support for knowledge and dissemination related tasks such as website creation, analysis and reporting of data. An early request for information has resulted in a positive response from the supply chain. However, Phase 1 of the LEAN project will validate technical and financial requirement assumptions. The first phase of the project will culminate in a decision regarding the validity of the business case for LEAN. The plan indicates that work with SEPD's procurement team will commence in Q3 of 2015, with actual procurement of equipment taking place between Q1 and Q2 of 2016. Procurement for equipment will only take place after engagement with the supply chain and transformer specialists is undertaken, and once we have a final, functional specification (expected by the end of Q3 in 2015).
	Conclusion 1: Response seems adequate. No further challenge.
	Challenge 2: Whilst no collaborators are named in the submission it's clear from the context that several consultancy organisations have been involved with the background research on this submission.

	How will learning from the submission scoping phases be disseminated to provide a fair and open process for the procurement of future services?
	Answer 2: The LEAN project submission was prepared by SEPD, S&C Electrical Europe (consultancy) and LIG Consultants (sub-contracted by S&C Electrical Europe). Both consultancy companies acted as advisers on the technical solution and as providers of background research in order to help SEPD develop the LEAN submission. In sourcing S&C Electrical Europe, the bid team worked with SEPD's procurement specialists to ensure a fair, competitive tendering process was undertaken in accordance with the SSE Group's governance framework. Future procurement of services will follow the same process i.e. a requirements document will be issued with all relevant information made available to potential suppliers. Companies who apply for the work piece will be considered based on their experience, their level of expertise and value for money. Much of the scoping requirements involved in the submission are based on SEPD's previous IFI projects; reports related to these projects are available to all.
	Conclusion 2: Response is adequate. No further comment.
Sub-criterion (b.iii) – Other steps taken to ensure that funding request represents good value for money.	**Challenge 1**: Throughout the submission - including Appendix 1 which is the standardised cost breakdown spreadsheet - costs are provided as lumped estimates. It is therefore not possible to make a balanced judgement on the appropriateness of the costing elements of the submission and if they represent value for money. Provision of a breakdown of the costs of the various project elements would facilitate the assessment process.
	Answer 1: We accept this point and have updated the cost breakdown spreadsheet and programme plan – please see Annexes A and B.
	Conclusion 1: Response is adequate.

2.4 CRITERION (C) GENERATES KNOWLEDGE THAT CAN BE SHARED AMONGST ALL RELEVANT NETWORK LICENSEES

2.4.1 Key Statements

4 Neither TASS nor ANT have been trialled elsewhere in the UK or the world on transmission or distribution networks.

4 The analysis that SEPD will conduct to validate LEAN methods will simulate scenarios that cover the whole range of events that are feasible on the GB network. This is analysis that will be relevant to, and shared with all UK DNOs.

4 The LEAN process will be conducted in such a way that the learning and improvements realised during the process are made available to other stakeholders, allowing them to draw maximum benefit from the project.

4 As part of the project, SEPD will develop and introduce a toolset for improved sharing of knowledge and a quicker way of performing cost-benefit analysis of LEAN methods.

2.4.2 Challenges and Potential Shortfalls

Criterion (C) – Generates knowledge that can be shared amongst all relevant Network Licensees;	
Sub-criterion (c.i) – The level of incremental knowledge to be provided by the project.	**Challenge 1**: No formal, quantitative estimate of the level of technology readiness of the LEAN methods, either before or after the programme, is provided in the submission. This makes it difficult to assess the claims made for technology maturation in the submission. The aims and expected outcomes of the project in terms of maturing the technology need to be articulated to facilitate the assessment process.
	Answer 1: The Technology Readiness Level for each of the TASS options is detailed below: **Option 1 – TRL 9** This option is not current practice in terms of switching the transformer off on a dynamic basis; however the principle of operation is something that is completed on a daily basis within the current business operations. The perceived innovation is to implement a level of control, allowing the automated switching of transformers and to quantify the resultant impact in relation to asset health or power quality. **Option 2 – TRL 8** The differentiator in Option 2 is the inclusion of an advanced relay to mitigate the potential impact of an increased switching regime (which may happen on a daily basis) on network assets. This product has been proven in other areas of the world but is novel to GB DNOs. **Option 3 – TRL 7**

	The final option includes the installation of a bespoke circuit breaker to further mitigate the impact of the switching regime. This circuit breaker would provide the ability to switch each phase individually. While the use of this is not novel in GB, the combination of this option combined with the use of advanced relay and dynamic switching is an innovative application and is considered to be the lowest of the three options on the TRL scale. Phase 1 of the project involves the development of a detailed requirements specification for the equipment for each option which will be used to engage with the supply chain to test the cost of each option.
	Conclusion 1: Further Clarification Required see comments regarding Technology Readiness Levels in Section 4 of this document.
Sub-criterion (c.ii) – Applicability of new learning to other DNOs.	**Challenge 1**: The submission makes limited attempts to compare and contrast the SEPD network with the UK distribution network as a whole. This comparison is considered an important criterion to assess the applicability of learning to other DNOs. The toolset proposed to disseminate new learning has not been fully articulated, it makes little reference to other DNO's LFE – this needs to be remedied to facilitate the assessment process. In particular more information should be provided on the Network Losses Reduction Tool the submission does not make clear what benefits it provides and why they are needed.
	Answer 1: Comparison with the rest of the GB network is addressed in Sub-criterion (b.i) Challenge 1. The Network Losses Reduction Tool (NLRT) is a key output of the project and will enable DNOs to assess and select the most cost efficient methods and configurations applicable to their respective networks. NLRT will consist of technical and financial cost-benefit assessment modules that will confirm the level of benefits reaped by the application of LEAN methods and options to a substation (or group of substations) under investigation. It will be spreadsheet-based comprising of a LEAN technical module, a LEAN financial module, and a LEAN application summary sheet. The technical module may contain some or all of the following features, although the final content will be determined throughout the project: • Consideration for substation transformer and load profiles. • Impact of use of existing or new EU Directive compliant transformers.

	• Impact of anticipated new load profiles accounting for blend and penetration of new substation load. • Ability to compare all three LEAN options (and related methods), and output a performance comparison of considered options against business as usual scenario. • Calculate annual load factors, losses and savings forecasted with each LEAN option, number of switching operations. • Ability to optimise TASS control parameters to maximise the benefits specific to substation under investigation. • Provide guidance on selection of minimum set of plant equipment for implementation of each LEAN option, and specification of this equipment where applicable. • The output of the technical assessment module will serve as an input to the NLRT's financial assessment tool. • Accuracy of the NLRT technical module will be validated against commercially available power system analysis software. We anticipate that the financial module, as a starting point, will be based on Ofgem's Cost Benefit Assessment (CBA) tool. This will assess the financial viability and benefits offered by each LEAN option. The financial module may include the following features, although as per the technical module, features will be determined during the project: • Accounting for capital investment for each considered LEAN option and DNO avoidable costs, including accounting for any additional costs related to site constraints in implementing each LEAN option. • Calculation of net DNO benefits. • Calculation of societal benefits. • Calculation of net benefits and cumulative discounted net benefits. As part of the preliminary NLRT stage, this tool will provide a summary of performance and benefits (technical and financial) offered by each LEAN option, assessed again the business as usual case over the period of next 45 years. NLRT will be continuously improved during the project, incorporating project lessons learnt and input from learning and dissemination events.
	Conclusion 1: Response is adequate. No further comment.
Sub-criterion (c.iii) – Plans to disseminate learning.	The plans to capture and disseminate the learning of the project are judged to be mature elements of this submission. They are considered adequately planned, evidenced and articulated, therefore no challenge is presented. No Challenge

	Answer 1: N/A
	Conclusion 1: N/A
Sub-criterion (c.iv) – Robustness of the methodology to capture learning.	The plans to capture and disseminate the learning of the project are judged to be mature elements of this submission. They are considered adequately planned, evidenced and articulated, therefore no challenge is presented. No Challenge
	Answer 1: N/A
	Conclusion 1: N/A
Sub-criterion (c.v) – Treatment of IPR.	The treatment of IPR within the submission is uncertain; it is not clear whether the IPR treatment will be consistent with the LCNF default IPR arrangements. SEPD should endeavour to qualify the IPR position or to provide the reasons for the current uncertainty.
	Answer 1: It is our intention that the work undertaken using LCNF awards will adhere to the LCNF default IPR arrangements. However, this will be subject to confirmation depending upon the outcome of the commercial negotiations with equipment suppliers and SEPD's project partners. In all negotiations, SEPD will strive for maximum availability of the project work for dissemination and sharing purposes. Phase 1 of the project includes the development of a detailed requirements specification and involves extensive interaction with potential suppliers. It is envisaged that this will clarify IPR arrangements.
	Conclusion 1: Response is adequate. See comments regarding the project's Phase 1 activities in Section 4 of this document.

2.5 CRITERION (D) INVOLVEMENT OF OTHER PARTNERS AND EXTERNAL FUNDING

2.5.1 Key Statements

4 On precursor ITI and LCNF projects, SEPD has used a developed partner engagement processes to deliver value for clients and customers. This same process will be applied to the LEAN project in order to obtain the most suitable partnering organisations.

4 During the initial stages of the LEAN project, SEPD will develop a process to rate partners in order to find the best way to select a supplier.

4 No other funding apart from LCN and SEPD's contribution will be required for this project.

2.5.2 Challenges and Potential Shortfalls

Criterion (D) – Involvement of other partners and external funding;	
Sub-criterion (d.i) – Collaborators involved in the project	**Challenge 1**: The submission makes no specific claims about collaborators; therefore no assessment can be made of this sub-criterion. Further arguments and evidence need to be presented in order for a proper assessment to be made. However, the challenges presented under sub-criterion b.ii are pertinent to this sub-criterion.
	Answer 1: SEPD engages with external collaborators when appropriate and cost-effective to do so. LEAN is primarily a technical project and will largely require work to be carried out within SEPD's own network using SEPD's own personnel. Several elements of the project may be delivered with the support of project collaborators, including: • Transformer specialists: these specialists will be involved in asset selection and monitoring to help us understand the effects of the methods on transformer assets. • An academic institution: it is likely that we will use a university partner to carry out data analysis, and to provide knowledge capture and dissemination services. Note that we may choose a private company for this activity if this offers better value. • Members of the supply chain: we have ongoing engagement with the supply chain to ensure that technical equipment required (especially with Option 3) is available. As per challenge b.ii.2, engagement and selection of partners will be done using the SSE Group's established protocols to source the relevant expertise, experience and value for money. The company's procurement specialists will assist the LEAN team with procurement of goods and services. Naturally, this work will only be carried out once the outcome of LCNF T2 funding is announced. Previous experience has shown that successful demonstration of technology is a highly effective tool for securing the interest and participation of other licensees. SEPD has planned a programme of knowledge dissemination and engagement to ensure that other licensees benefit from the project's learning and outcomes.
	Conclusion 1: Response is adequate. No further comment.
Sub-criterion (d.ii) – Steps taken to indentify potential partners and	SEPDs approaches to identifying and developing 'LCNF-suitable' work packages are judged to be mature elements of this submission. They are considered adequately planned, evidenced and articulated, therefore no challenge is presented. No Challenge

ideas.	**Answer 1**: N/A
	Conclusion 1: N/A
Sub-criterion (d.iii) – External funding for the project.	The submission involves no external funding. No Challenge
	Answer 1: N/A
	Conclusion 1: N/A
Sub-criterion (d.iv) – How secure external funding is.	The submission involves no external funding. No Challenge
	Answer 1: N/A
	Conclusion 1: N/A

2.6 CRITERION (E) RELEVANCE AND TIMING

2.6.1 Key Statements

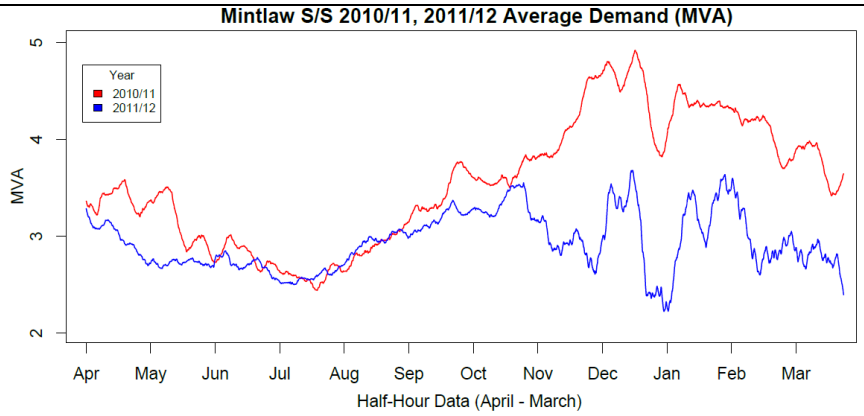
4 The LEAN project is set against the UK's transition to a low carbon economy. The effects that this will have on the distribution network include: a higher use of electricity due to electrification of transport and heating, and increasing penetration of 11kV connected renewable generation assets. The effects that both of these trends have on the network could be alleviated by LEAN methods.

4 The new requirement for DNOs to procure lower-loss transformers from 2015 and further reduction by 2021 is relevant as this solution will offer an immediate reduction in losses rather than having to wait the potential 60 years before a transformer is replaced.

4 DNOs can implement the learning gained by the project in order to reduce losses and greenhouse gas emissions in time for the third Carbon Budget in 2018.

2.6.2 Challenges and Potential Shortfalls

Criterion (E) – Relevance and Timing;	
Sub-criterion (e.i) – The relevance of the solution to the move to a low carbon economy	**Challenge 1**: The submission adequately articulates the political and business context for SEPD and the associated drivers for the LEAN project. However, the additional benefits of this project with the transition to a low carbon economy are relatively underdeveloped. It is judged that more advantage could be taken of these aspects in the project justification by projecting substation demand trends over the next five, ten and twenty years.
	Answer 1: As indicated in the Carbon Plan, it is widely anticipated that a future low-carbon economy, with reductions in fossil fuel consumption, will involve greater use of electricity networks for transport, heating and industry. In addition, it is likely that there will be an increase of low carbon electrical loads and embedded generation connected to the GB distribution system. This may lead to a fundamental change in existing substation load profiles, with potentially higher peak demands due to increased demand such as EVs and lower average demands due to the proliferation of local generation such as solar power. Overall, this will potentially lead to lower substation load factors (a ratio of average electricity demand to peak demand). The impact of distributed generation on average demand can be seen from the graph below; a new wind farm was connected to the Mintlaw network in October 2011 and an obvious reduction in average demand at the primary substation was identified.

	 The LEAN approach is applicable to substation sites which have a load factor less than 50%; therefore a reduction in substation annual load factors will create an increasing number of sites with a positive business case for LEAN deployment. However, there is uncertainty related to the timing and level of uptake of some of these low-carbon technologies. Therefore SEPD has taken a conservative approach in evaluating the business case by using existing demand profiles. If future changes in demand result in reduced utilisation factors at primary substations this will result in an increased benefits for customers from the LEAN solution. **Conclusion 1**: Response is adequate. No further comment.
Sub-criterion (e.ii) – How the method will be used as part of future business planning.	The submission makes no specific claims about the methods' contribution to planning; therefore no assessment can be made of this sub-criterion. Further arguments and evidence need to be presented in order for a proper assessment to be made. **Answer 1**: This LCNF project will demonstrate and deploy the LEAN solution. If successful, this will provide DNOs with the confidence to adopt the LEAN methodology. One of the key learning outputs from the project will be the 'Network Losses Reduction Tool'. Further information about this can be found in the response to Challenge (c.ii).1 This tool will allow Asset Managers and System Planners to consider loss reduction when considering future management of primary substation transformers. It is envisaged that the tool could be used to inform investment decisions on new transformer installations, replacements and upgrades. There is also potential for the tool to help take account of changing demand patterns at primary substations. This will allow the LEAN method to be deployed where appropriate to reflect changes in network demand patterns.

	Conclusion 1: Response is adequate. No further comment.
Sub-criterion (e.iii) – How the method will be used as part of future business planning if uptake of LCTs is less than expected	The claims made about the LEAN methodology's benefits are not predicated on the uptake of low carbon technologies, therefore no challenge is needed. No Challenge
	Answer 1: N/A
	Conclusion 1: N/A
Sub-criterion (e.iv) – The appropriateness of the timing of the project.	The claims made about the LEAN methodology's benefits are not predicated on the timing of the project or other events, therefore no challenge is needed. No Challenge
	Answer 1: N/A
	Conclusion 1: N/A

2.7 CRITERION (F) DEMONSTRATE A ROBUST METHODOLOGY AND THAT THE PROJECT IS READY TO IMPLEMENT

2.7.1 Key Statements

4 A project plan has been created that is ready to be put to use. It is provided at Appendix 4.

4 Within SEPD there is the support in place to ensure that the project proceeds according to plan, and the budget has been checked to ensure that the project can be delivered. A team structure for LEAN delivery is provided within the submission at Appendix 9.

4 All budget estimates are based upon SEPD's previous experience in similar projects that is combined with information that has been gathered with the supply chain. The costings for the project are provided at Appendix 1 to the submission.

4 All aspects of the project have been reviewed by teams within SEPD to ensure that they are feasible. Risk registers and mitigation measures were created to identify potential areas of concern so that they could be managed effectively. A project risk register is provided at

2.7.2 Challenges and Potential Shortfalls

Criterion (F) – Demonstrate a robust methodology and that the project is ready to implement;	
Sub-criterion (f.i) – Their project plan, risk management, mitigation and contingency plans, risk register and resources to deliver the project	**Challenge 1**: Section 4.d refers to a 'robust plan for the project's delivery, with all responsibilities clearly detailed and interdependencies identified' which is attached as Appendix 4. However the project plan provided in Appendix 4 is considered immature against this sub-criterion requirement and detracts from the confidence in SEPD'S capability to deliver the LEAN project.
	Answer 1: SEPD have revised the project plan ahead of the resubmission – please find a copy of this in Annex A.
	Conclusion 1: Response seems adequate.
	Challenge 2: The risk plan is considered immature against this sub-criterion requirement and detracts from the confidence in SEPD'S capability to deliver a LEAN project.
	Answer 2: The risk register is included in Appendix 6 of the Full Submission document. This describes almost thirty of the potential risks identified for the project; a contingency plan contained in Appendix 10 has also been developed for the major risks identified. The management of project risk is a key requirement of the SEPD Governance process and will form part of the reporting requirement for the ISB. Phase 1 of the project has been specifically developed to allow SEPD to further develop and validate the underlying assumptions behind the LEAN project. This will include further identification of risk and development of appropriate mitigation measures. If the level of risk is at an unacceptable level at the end of Phase 1 then the project will be reviewed before proceeding to deployment.

	Conclusion 2: See comments regarding the project's Phase 1 activities in Section 4 of this document.
	Challenge 3: The resource plan is considered immature against this sub-criterion requirement and detracts from the confidence in SEPD's capability to deliver a LEAN project.
	Answer 3: Please see Annex A and B
	Conclusion 3: Response seems adequate.
	Challenge 4: The potential impact of additional transformer failures as a consequence of LEAN deployment is not costed as part of the UK roll out in the submission. This cost uncertainty needs to be substantiated to facilitate the assessment.
	Answer 4: Phase 1 of the project has been specifically developed to allow SEPD to further develop and validate the underlying assumptions behind the LEAN project. This will include further identification of risk and development of appropriate mitigation measures. The impact of the LEAN method on the long term health and reliability of assets is a key element of the project. For this reason, a programme of engagement with the supply chain was considered to be a necessary component. Furthermore, we have planned to work with transformer specialists as part of the LEAN project to ensure that key risks, costs and impact on asset health are fully understood. We have placed a project viability review at the end of Phase 1 – this will be used to determine whether the level of risk is acceptable and whether the project should proceed.
	Conclusion 4: See comments regarding the project's Phase 1 activities in Section 4 of this document.
Sub-criterion (f.ii) – The customer impact of the project	**Challenge 1**: The actual monetary savings provided by this project are marginal, (circa; £6.3m given the overall cost of losses to the distribution network £1B UK wide). The lack of a base case, other than the 'do nothing' option, makes it hard to contextualise these savings against comparable interventions. SEPD state that LCNF funding is required in order to make this project viable due to the historic problems with interventions to improve efficiency. However, this economic case needs be articulated in more detail in order to facilitate the assessment process.
	Answer 1: The business case described in Section 3 of the submission states that the LEAN approach has the potential to provide benefits in excess of £40 million for customers. Whilst SEPD fully recognise that this represents a very small benefit when compared with the £1 billion total cost of network losses, LEAN represents a valuable opportunity to contribute to the reduction of losses. The LEAN method can be easily and quickly deployed and will produce benefits in a reasonably short time frame. SEPD

	recognises that the overall benefit case for the project is sensitive to a number of potential variables. Phase 1 of the project has been specifically developed to allow SEPD to further evaluate and validate the underlying assumptions behind the LEAN methods. The project delivery team will seek additional technical expertise, carry out more detailed analysis using "actual" network parameters and engage with the supply chain. This will allow SEPD to develop a much greater understanding of the costs, benefits and risks associated with the project. At the end of Phase 1, SEPD will validate the underlying cost and benefits assumptions, allowing the team to confirm that the project offers sufficient value and warrants deployment. If we identify that the cost of the trials is higher than estimated or that the potential benefits are significantly lower than anticipated we will conduct a review of the project prior to moving to deployment. It should also be noted that there are other regulatory and policy drivers which require both DNOs and Ofgem to address losses - LEAN represents a valuable option to achieve this aim.
	Conclusion 1: See comments regarding the project's Phase 1 activities in Section 4 of this document.
	Challenge 2: The submission is clear that the introduction of TASS could have a negative effect on grid stability and power quality. In particular inrush current from transformer energisation could cause adverse voltage dips on the network. In order to understand the effects that this would have on customer service the negative effects of the introduction of this technology need to be articulated with an evaluation of the potential financial impact, to facilitate the assessment process.
	Answer 2: Security of supply is of critical importance to SEPD and the trials will only go ahead when any risks are reduced to an acceptable level. Note that site selection is a key component of the trials and great care will be taken to avoid disruption of any type on the network. We do recognise that frequent switching activity may carry a risk to power quality i.e. flicker in supply quality and harmonics, therefore SEPD have factored mitigation against this into the project's risk and contingency planning. We have planned the budget to include procurement and installation of monitoring equipment. This is to ensure that suitable measurements are carried out in advance at trial locations to assess background power quality. Monitoring will continue after the installation of the trial equipment and

	throughout the operational phase. If there are any indications that power quality has been adversely affected outwith industry limits, work will halt until a suitable resolution can be identified. SEPD will also ensure that appropriate contingency plans and response arrangements are in place at network control centres, emergency service centres and local depots to ensure that any issues are promptly recognised and remedial actions initiated.
	Conclusion 2: See comments regarding the project's treatment of uncertainty in Section 4 of this document.
Sub-criterion (f.iii) – Uncertainties in costs and benefits	**Challenge 1**: No uncertainties in costs and benefits are articulated throughout the submission; no attempt is made to upper/lower bound figures or to provide uncertainties in any numerical value provided. Given that the majority of these numbers are estimates, this is a key shortfall in the submission.
	Answer 1: SEPD recognise that the overall benefit case for the project is sensitive to a number of potential variables. Phase 1 of the project has been specifically developed to allow SEPD to further develop and validate the underlying assumptions behind the LEAN project. This will include seeking additional technical expertise, carrying out more detailed analysis using "actual" network parameters, engagement with the supply chain, etc. This will allow SEPD to develop a much greater understanding of the costs, benefits and risks associated with the project. At the end of Phase 1, SEPD will validate the underlying cost and benefits assumptions, allowing the team to confirm that the project offers sufficient value and warrants deployment. If we identify that the cost of the trials is higher than estimated or that the potential benefits are significantly lower than anticipated we will conduct a review of the project prior to moving to deployment.
	Conclusion 1: See comments regarding the project's Phase 1 activities in Section 4 of this document.
Sub-criterion (f.iv) – Project methodology	**Challenge 1**: ANT is not described in detail, its costs are not estimated as part of the project costings and the energy savings associated with its deployment are not claimed for in the LEAN methodology. An analysis of the strengths, weaknesses, costs, opportunities and threats of the ANT method should be provided to facilitate a full and proper assessment.
	Answer 1: During 2012-2013, SEPD commissioned an IFI funded desktop-based, detailed technical feasibility study and cost benefit analysis to consider a range of loss reduction mechanisms. As part of this study, a comprehensive set of network interventions were

considered for their effectiveness in reducing electrical losses against Isle of Wight networks. The key outputs are described in Appendix 2 of the main submission document.

During the development of the full submission it became clear that the deployment of the ANT method deployed in isolation did not produce a positive benefit. However, where appropriate it should be deployed to supplement TASS, and to provide risk mitigation against supply interruptions.

The findings from the earlier studies suggest that it would be very difficult to accurately quantify reduction in losses solely due to the ANT method SEPD have therefore taken a conservative approach in claiming for losses savings and have only quantified the losses from TASS and ANT when they are implemented together.

ANT method, however, has merit in maintaining security of supply (as directed by Engineering Recommendation P.2/6) and reliability when combining two adjacent TASS implementing substations as part of LEAN Option 3.

Conclusion 1: No further comments.

Challenge 2: Some of the key technical details of the trial are not clear from the content of the submission. For example, it is not clear how many substations will be involved in the initial trial period or whether trial assets are reusable or interchangeable between substations.

A step-by-step plan for implementing each TASS/ ANT method should be provided to facilitate a full and proper assessment.

Answer 2:

TASS will be deployed on a maximum of 11 substations. The key outcome from the LEAN project is the development of a Network Losses Reduction Tool, which can be used by DNOs to assess the benefits of applying TASS methodology to their own assets. TASS application on a number of substations and the outputs arising from this will validate the outcomes from the Network Losses Reduction Tool.
Three options for the TASS solution have been identified, all of which will be deployed. The number of deployments in the trials correlate to the anticipated cost of each option, and the potential for replication if the method is adopted as business as usual:

Option	Description	Indicative number of deployments
Option 1	Remote switching using existing equipment	Max 5 deployments
Option 2	Advanced switching using existing equipment	Max 4 deployments

	Option 3 **Advanced switching using new higher performance switchgear** **Max 2 deployments** During Phase 1 the Network Losses Reduction Tool will be developed using the actual load profiles and network details for each location. This will give further confidence on the level of loss reduction that can be anticipated from each location. Phase 1 will also see the development of a requirements specification for each of the TASS options; this will be used to engage with the supply chain to develop a more detailed cost for each of the three options. At the end of Phase 1, SEPD will validate the underlying cost and benefits assumptions, allowing the team to confirm that the project offers sufficient value and warrants deployment. If we identify that the cost of the trials is higher than estimated or that the potential benefits are significantly lower than anticipated we will conduct a review. The options will be examined and we may reduce the number of deployments to ensure that the project remains within the allocated budget.
	Conclusion 2: Response is adequate. No further comment.
	Challenge 3: Given that new transformers are often installed with significant margin for load increases, has the benefit in exploring in more detail the application of LEAN methods on new transformer installations been undertaken?
	Answer 3: Due to the low rate of replacement of power transformers in GB (an assumed lifetime of 65 years indicates a replacement rate of 1.5% and likely rates during RIIO-ED1 may be lower than this (they are driven by condition rather than age), we excluded these from our analysis. We intend to include new sites within our LEAN project work and it is possible that the losses benefits will be enhanced by a consideration of the incremental cost of any cost of deployment instead of the full cost at other sites.
	Conclusion 3: Response is adequate. No further comment.
	Challenge 4: The submission suggests that old transformers will be targeted as they are likely to have the highest fixed losses and therefore the highest deployment. Given that these are also likely to be the transformers most likely to be selected for imminent replacement with new efficient models, is the 45 year life-cycle assumption realistic?
	Answer 4: Initial assessment of commissioning records suggest that older transformers may have fixed losses which are higher than the

	'typical' 11kW discussed previously. Phase 1 of the project will see a robust investigation of the losses at each site using actual network data and demand profiles. Part of the Phase 1 work will include verifying the actual loss figures at selected site to determine if they have varied significantly since commissioning. Even if these transformers are replaced with modern equivalents, there is the potential that LEAN may still be beneficial particularly if the load profile becomes more "peaky" due to the greater proliferation of distributed generation and other low carbon technologies. Therefore, we feel that a 45 year assessment of the benefits from a particular site is appropriate.
	Conclusion 4: See comments regarding the project's Phase 1 activities in Section 4 of this document.
Sub-criterion (f.v) – Successful Delivery Reward Criteria	**Challenge 1**: The Successful Delivery Reward Criteria are provided as a qualitatively described set; they are not articulated against a rigorous project programme. A project deliverable programme should be provided to facilitate a full and proper assessment.
	Answer 1: Please see Annex A for a revised programme to which SDRCs are aligned.
	Conclusion 1: Response seems adequate. No further challenge.

3. INITIAL FINDINGS

The SEPD submission for the LEAN project details two methods which are technically novel and may have the potential to enable cost and carbon savings in the UK distribution network. However, there are significant shortfalls in the content and quality of the submission, which reduces the level of assurance around the LEAN project's economical viability and cost benefit.

The following are the most concerning shortfalls in the case for investment made by the submission:

- The quality of the evidence base for the carbon and cost benefits articulated by SEPD;
  - The submission provides limited detail describing the calculations that have been done to demonstrate the viability of the project,
  - A particular concern with the suitability of scaling estimates based on a limited population of substations to the whole UK distribution network.
- The lack of treatment of uncertainty and risk throughout the submission;
  - All of the figures relating to costs and benefits quoted in the submission are estimates and would therefore be expected to have confidence intervals or error bounds associated with them; no such approach is taken,
  - The risk of supply interruptions to the SEPD customer base has not been dealt with in detail; it is anticipated that the cost of a single supply outage to customers and the DNO could outweigh the benefits of this project. Whilst the project discusses phased deployment of solutions to counter that possibility, the issues associated with network disruption, compared to the marginal cost and carbon benefits of the project, is not judged to have been adequately addressed.
  - The risks of GB-wide rollout have not been fully considered by the submission. It is considered unlikely within the trial time-line that sufficient evidence will be gathered to fully de-risk the GB wide deployment of this technology.
- The lack of an adequate project plan;
  - Appendix 4 to the submission contains a rough outline Gant chart of the proposed project time scales – this is not considered to be a 'robust plan for the project's delivery, with all responsibilities clearly detailed and interdependencies identified'. The plan in its current form is not judged to be adequately mature to given confidence in the project's delivery.
  - Much of the preparatory activity for this project is to mature the understanding of the proposed technologies, which we would expect to be done to substantiate the claims made in the submission, this preparatory activity is proposed to be delivered in the first year of the LEAN programme.
- The lack of an auditable, detailed break-down of the costs of the project;
  - Costs across the project are estimated as lumped annual figures with non-specific titles (labour, equipment, consultants, etc). This makes it very difficult to assess in detail the cost claims of the project and therefore to understand whether it is providing value against the LCNF criteria.

4. UPDATED FINDINGS FOLLOWING DNO RESPONSES

From the review of the responses provided by SEPD, it is judged that the majority of the challenges raised by Frazer-Nash Consultancy have been addressed. From the responses provided it is judged that there is a significant amount of material that should have been included in the initial submission and would have resolved many of the challenges at an earlier stage. However there are a number of areas where further clarification should be sought.

4.1 PROJECT PHASE 1

Much work has been done to correct the potential shortfalls of the original draft project proposal; this has largely been successful. SEPD have addressed the challenges and provided significant further detail in the following areas:

- Project Plan;
- Project Cost Breakdown;
- TRL associated with each Method.

However, the new project scope places much emphasis on a project break or decision point which occurs at the end of Phase 1 of the project. It is assumed that this milestone correlates with row 28 of the new project planning spreadsheet. Whilst this is a reasonable project approach, using the break point to mitigate the risk of future project phases, it is not clear that SEPD have an intention to formally agree the break point with Ofgem. If, for example, clear measures of the performance of Phase 1 were included as part of the Successful Delivery Reward Criteria for the LEAN project, that would deliver confidence that this will be effective in limiting the LCNF project's exposure to risks.

4.2 RISK AND UNCERTAINTY

One major criticism of the original submission was the poor treatment of risk and uncertainty. The submission was challenged around it's provision of numbers without confidence intervals, error bounds or evidence. The responses to the six criteria above have generally provided adequate evidence for the most important numbers (for example, values around the expected energy saving from a substation, the number of substations involved in the trial and the cost of a each of the TASS Options). Estimates of uncertainty however, have not been as forthcoming; on one level this is understandable – articulating the uncertainty around key values may increase the perceived riskiness of the project. However, given that the focus of this project is to remove uncertainty from the deployment of technology, an initial estimate of the level of uncertainty around costs and benefits, would be helpful in making the case. In short, if one of the aims of the project is to de-risk the deployment of technology then an initial estimate of the value of that risk is essential in developing the success criteria for the project.

The measures described under sub-criterion f.ii, Challenge 2 to provide confidence around grid stability and power quality are post event analysis activities via monitoring equipment. They will not mitigate power quality issue but will tell you, post-event, what happened. As part of the work can SSE demonstrate by modelling or analysis that any impact by the deployment of these technologies that the impact on Power Quality has been minimised to be As Low As Reasonably Practical (ALARP).

4.3 TECHNOLOGY READINESS LEVELS

Firstly, the LCNF Governance Document specifically excludes the funding of systems at technology readiness level (TRL) 9.[1] Such systems are considered to be mature technologies and therefore suitable for adoption with a cost benefit case made as part of normal business. SEPD's assertion that Option 1 is currently at TRL 9 is therefore problematic: if it is true the

[1] P16, para 2.17, Low Carbon Networks Fund Governance Document v.6, Issued 12 April 2013

option is not suitable for LCNF funding. However, it is our judgement that the argument contained under sub-criterion c.i could equally be used to justify Option 1 at TRL 8. For example, the fact that the technology has not previously been deployed for this purpose suggests that it has not been proven under 'mission conditions'; a key performance aspect of TRL9 systems.

Secondly, it is our judgement that the as a technology development programme we would expect to see the project benefits articulated in terms of advancing the TRL associated with a given Option. e.g. A justified statement along the lines of "The LEAN project will advance the TRL of Option 3 from TRL6 to TRL8."