# Customer Load Active System Services

## Full submission

# Low Carbon Networks Fund Full Submission Pro-forma

## Section 1: Project Summary

### 1.1 Project title

Customer Load Active System Services (CLASS)

### 1.2 Funding DNO

Electricity North West Limited (Electricity North West)

### 1.3 Project Summary


*Is there an opportunity for DNOs to operate their networks more flexibly, by using dynamic voltage control technologies to increase asset utilisation and power system flexibility?*

The CLASS Project will show how a DNO could use innovative voltage management to provide new demand response and utilise it to provide added value for customers. At the heart of CLASS is the natural relationship between voltage and customer demand. CLASS will demonstrate how this relationship can be used in a low cost, rapidly deployable Solution that can provide a range of demand response capabilities and network voltage regulation services. The Trials will demonstrate that the Solution can be applied to reduce peak network demands and to provide a low cost means of voltage management on networks with high volumes of distributed generation (DG). In addition at GB level it provides a new mechanism for frequency management and voltage control to support the System Operator. CLASS is highly transferable and can be readily implemented by all DNOs. The Project will also deliver 4 key outputs: the methodology to allow the Solution to be deployed across GB; an understanding of the changing relationship between voltage and demand; confirmation that the techniques do not affect customers or compromise a DNO's existing demand control obligations; and assurance that there is no detrimental effect on asset health. CLASS has the potential to defer £90 million of future distribution network reinforcements and provide an attractive alternative to the frequency control and reactive power services offered by traditional sources.


### 1.4 Funding

| | | | |
|---|---|---|---|
| **Second Tier Funding request (£k)** | £7 174 | | |
| **DNO extra contribution (k)** | | **External Funding (£k)** | £ 910 |

### 1.5 List of Project Partners, External Funders and Project Supporters

Impact Research - Customer Engagement & Survey

Siemens UK Ltd, General Electric UK Ltd/ Parsons Brinckerhoff Ltd - Technical Support

National Grid - ICCP installation, Trials and NETS SQSS Change Proposal

Chiltern Power - NETS SQSS Change Proposal

The University of Manchester - Data capture/ analysis, modelling and dissemination

Tyndall Centre for Climate Change - Carbon impact assessment

### 1.6 Timescale

| | | | |
|---|---|---|---|
| **Project Start Date** | January 2013 | **Project End Date** | September 2015 |

### 1.7 Project Manager contact details


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# Section 2: Project Description

*The CLASS Project proposes a novel, low risk way of operating existing assets to increase the flexibility and use of the distribution network deriving significant benefits for DNO customers*

**Aims and Objectives**

The problem/challenge which needs to be resolved in order to facilitate the low carbon future

As GB moves to a low carbon future, electricity demand and the level of renewable and low carbon generation is expected to increase significantly. This decarbonisation pathway will introduce a number of key challenges for the operators of GB electricity networks with the potential to necessitate expensive capital investments.

**1. High Peak Demands**

The expected doubling of the demand for electricity by 2050 will progressively erode existing network capacity at Grid and Primary substations. The adoption of Low Carbon Technologies (LCT) by customers will occur at different rates across the network with some groups exhibiting a very rapid rise in demand and others a more gradual increase. Part of this increase will be offset by customer energy efficiency measures and the connection of additional low carbon Distributed Generation (DG). When responding to such changes the DNO needs to assess if the increase is permanent and warrants immediate intervention or will be eventually offset by DG so that network reinforcement can be avoided or delayed. The rate of apparent demand increase can also be aggravated by cold weather and other short term factors. To ensure that only efficient investments are made (for reinforcement, Demand Side Response (DSR) etc), the DNO needs enhanced flexibility to both manage the immediate rise in peak demand, without unacceptably constraining customer activity and to retain optionality in its response for as long as possible. In order to defer or avoid potentially expensive interventions, a new technique is required to enable short term rapid rises in peak demand to be adequately managed and met using existing assets.

**2. Voltage Control**

A new challenge faced by all network operators is managing the unacceptably high voltages that can occur on networks during periods when high DG output coincides with low local demand. Ever improving energy efficiency measures, including decreasing lighting loads overnight, have significantly exacerbated this problem in recent years. A low cost and quickly deployable alternative to traditional expensive asset solutions used to mitigate these excessive voltages is needed.

**3. Excess Generation**

As the volume of renewable generation increases there is an increasing probability that the available generation within a network may exceed the demand or network capacity leading to the need to constrain the generation output. This constraint acts to decrease the efficiency of the generation and hence drive up costs to customers. A new technique is required that minimises the constraint of renewable sources such as wind and solar.

**4. Response and Reserve**

In the period out to 2050, the generation mix in the UK is expected to change significantly from that of today, with increased amounts of low inertia intermittent generation connected to the system along with large nuclear generating units that will increase the largest secured generation loss from 1 320 MW to 1 800 MW. As a consequence there will be an increased need to access system reserves to maintain overall system stability to help avoid cascade tripping events. Owing to the high financial and carbon cost of conventional spinning reserve, fast acting and flexible demand management for frequency, and system balancing is expected to become an increasingly important part of future system operation. This is of particular benefit for local power island balancing within a DNO network, and also offers potential advantages for future Distributed System Operator (DSO) network management.

To be fully cost-effective, solutions may span traditional company boundaries. The CLASS Method is a case in point and this proposal identifies where this arises and addresses equitable treatment for distribution consumers.

## 2: Project Description cont.

### The CLASS Method being trialled to solve the Problem

CLASS is a highly innovative, easily implemented and low cost solution which enables DNOs to deliver significant savings to customers using existing assets to address the above issues. Specifically CLASS will help DNOs to enable customer LCT connections whilst managing peak loads on the network, and timing DNO's eventual interventions efficiently. It will also provide a solution to network voltage control problems on the entire GB network, assist in reducing the requirement to constrain off low carbon generators for network balancing and provide a low cost and effective system stability response facility.

The key benefits of CLASS are expected to include:

- Acceleration of the decarbonisation of the UK energy supply;
- Reduction in the DNOs requirements for substation reinforcement by reducing system peaks.
- Provide rapid distribution network peak loading relief (of limited duration) bridging the operational time period needed until other forms of demand side response (eg via aggregators) or network reconfiguration actions come into effect in real time
- Boost demand in DG dominated DNO networks and hence balance the network flows thereby maximising the output of DG for a given network capacity;
- Provision of frequency control at a fraction of current cost & significant reduction in the need and therefore cost for carbon based spinning reserve;
- Reduction in costs of the ancillary services market borne by all electricity customers.

These benefits can be realised without compromising the quality of supply to customers or impacting the DNOs ability to meet existing demand control obligations.

There are three key themes which comprise CLASS:

### Demand reduction at time of system peak

The ability to actively reduce peak network demand in a manner undetectable by customers has the potential to significantly reduce the need for network reinforcement and therefore the cost borne by customers. Critically peak demand management using CLASS allows DNOs to manage demands whilst future market mechanisms, including smart meter demand signals and the wider DSR market evolve and mature in their effectiveness to elicit a customer demand response. CLASS also retains optionality for networks to reach new self-balancing points using DG and efficiency measures rather than reinforcement. There are two distinct advantages to demand reduction using CLASS during periods of demand peaks:

1. Where in a given network demand rises quickly as is forecast to be the case during the latter half of RIIO-ED1 and during ED2, CLASS provides a low cost, quickly deployed peak demand reduction technique during the period during which other smart grid techniques such as storage, network meshing and active network management are developed, perfected and deployed.
2. Where a network approaches its capacity limit but demand may or may not exceed capacity in the medium term, CLASS allows deferment of reinforcement until such time as the required capacity is clearly known to be an issue. CLASS potentially allows deferment of costly decisions in marginal situations against a highly uncertain future until the situation becomes clearer.

### Voltage Control

The operation of existing Primary transformers in a staggered tap configuration provides a highly flexible and effective means of absorbing reactive power within a network hence controlling potentially unacceptable over-voltages. The method can deliver reactive power requirements quickly in real time, in a highly configurable and flexible manner, so as to meet the needs of both the DNO and the GB System Operator (NETSO). Traditional mitigation measures include installation of reactive compensation assets such as reactors, constraint payments to out-of-merit generation for VAr support and switching out of long lines to reduce capacitive gain. This problem of voltage regulation will progressively worsen as system power factor is further eroded by non- linear loads and by high volumes of non-synchronous DG such as solar PV.

## 2: Project Description cont.

### Technology Explanation

The electrical demand (by which we mean the power consumed at any point in time as measured in kilo Watts (kW) or Amps) of a resistive load is proportional to the square of the voltage. As voltage increases the kW demand increases and vice versa. The effect of any change in voltage is dependent on the magnitude of that change - for example a 2% increase/decrease in the voltage in the home would make a kettle boil approximately 4% (or about 8 seconds!) faster or slower. Importantly the total energy consumed by a given load such as a kettle does not change and hence the cost to the customer of boiling the kettle does not change rather it just boils very slightly slower or faster. The exact relationship between network demand and voltage depends on the type of loads installed at customers' premises; for example the demand of electronic devices such as an LED TV is not directly proportional to voltage unlike a kettle. Understanding the relationship between voltage and demand in a given network allows the network operator to manage the voltage in such a manner as to bring about small changes in demand when needed. When applied to large networks or the entire GB network these small changes in the demand of customer appliances aggregate to become very significant, for example a 2% reduction in voltage to customers across the GB network could provide a 2-3% reduction in national demand which is equal to the output of a large nuclear power station. Equally a boost of 1-2% would provide an increase in demand sufficient to absorb the output of several large wind farms. CLASS allows this response to be used both quickly and effectively across groups of any size and can be initiated automatically or on demand by the network operator when needed.

*Will customers notice?* In a DNO network the system voltage is regulated by altering the tap position of Primary transformers. Each tap changes the voltage by about 1.5%, with a typical tap range of about 20% available on each transformer. A pair of transformers feeding say 20,000 customers will tap up and down typically between 2-20 times every day during the course of normal operation. The resultant changes to voltage are so small as not to be noticeable by customers.

If a pair of transformers feeding a group of customers are operated at different tap positions, ie with “staggered taps”, a circulating current is introduced around the pair. The circulating current decreases the network power factor and effectively *absorbs* reactive power from the upstream network. The consequential increase in reactive demand reduces network voltages higher up in the grid but leaves customer voltages unaffected. This technique is highly effective in controlling potential unacceptable high voltages on the 33, 132, 275 and 400kV networks.

This paired arrangement for Primary transformers can also be utilised to deliver a very fast demand response which can be used to automatically balance a network in the event of loss of a large generation in feed. For example, if one of the pair is disconnected, supplies are still maintained to all customers in the group by the second transformer but the voltage supplied to the group will instantaneously reduce by between 4 - 8% triggering a similar instantaneous demand reduction in the group. When aggregated across many substations, this response is sufficiently large to counteract the loss of a major power station. CLASS allows this response to be delivered in a coordinated and controlled manner which meets the needs of the DNO for network balancing and meets the criteria for primary and secondary frequency response set by the NETSO.

Section OC 6 of the Grid Code allows National Grid to instruct DNOs to reduce demand by up to 20% in four stages, or under certain circumstances up to 40% in eight stages. This is normally only used under extreme conditions when all available sources of reserve generation have been exhausted and the only option available to balance the system is to reduce demand. Demand reduction can be achieved either through voltage reduction or direct disconnection of loads. It has historically been assumed that the first two stages can be achieved through voltage reductions with a 3% voltage reduction providing a 5% demand reduction and a 6% reduction (maximum allowable under the NETS SQSS) providing a 10% demand reduction. Building upon existing infrastructure deployed by DNOs to meet these demand reduction requirements, CLASS aims to show that at least a 1.5% voltage change from transformer tap operation will deliver a predictable and controlled demand response which when aggregated at a point in a network is adequate for demand management, whether locally or nationally whilst at the same time not compromising the DNOs ability to continue to meets its demand reduction obligations or impacting on the quality of supply to customers.

To quantify and understand the effect of applying the above voltage regulation techniques it is proposed to supplement Electricity North West's existing network monitoring equipment at various tactical locations across the Trial networks, including health monitoring equipment on the tap changers of Primary transformers. This quantification exercise will cover all load groups types (city centre - rural) and will provide a valuable prediction tool for determining demand voltage relationships for the GB network.

## 2: Project Description cont.

*Customer Effects*

To demonstrate customers are not adversely affected by the changes in voltage described above, CLASS will survey customers through the Trial period. Prior to engaging customers Electricity North West will use the learning from all existing LCN Funded projects on their customer engagement experiences and use their learning to shape our approach. Given that the small variations in voltage used by the Method are already routinely experienced by customers many times each day, Electricity North West do not expect customers to be negatively affected at all. The network monitoring equipment will quantify the extent of any existing and future affects.

### The CLASS Trials being undertaken to test that the CLASS Method works

The CLASS Method will determine that the application of innovative techniques to existing assets will deliver a flexible demand response to help address the key network challenges highlighted above. To ensure that Trials deliver the results and learning that is transferable to all UK DNOs, the CLASS Method will be trialled on 60 Primary substations across its network, representing 17% of the Electricity North West's total network and serving around 350 000 customers; approximately 348 500 domestic and 1 500 commercial customers.

The Project will undertake three main Trials; described in detail below, with a high level summary shown in tabular form in Table 1:

**Trial 1** will investigate the voltage / demand relationship from the normal increment and decrement of system voltage at Primary substations across an annual period. The outcome from this Trial is a voltage / demand relationship matrix, developed by The University of Manchester, which describes mathematically the relationship for every half-hour in a year for each group type. Additionally this work will also provide a simplified guidance for practical application in updating standards and power system modelling assumptions.

**Trial 2** will investigate the viability of each of the proposed CLASS techniques in delivering a demand response, specifically:

- *Demand Response for Peak Reduction at Primary substations* - The test regime will investigate the use of a demand response, initiated by a voltage reduction, to manage the peak demand at a Primary substation. The outcome of this Trial is the confirmation that a demand response provided at the peak demand of a Primary substation (normally in winter) can defer network reinforcement;
- *Demand Response for Frequency Response 1 support to NETSO* - The test regime will investigate the use of a low frequency relay to switch out one transformer of a standard Primary substation and quantify the demand response. The outcome of this Trial is confirmation that a very fast demand response (ie <0.5 seconds) can be provided to meet the NETSO criteria for use by the DNO or NETSO;
- *Demand Response for Frequency Response 2 support to NETSO* - The test regime will investigate the use of demand response as a means of providing fast frequency response to the NETSO through the lowering of a Primary Substations taps. The outcome of this Trial is confirmation that a fast demand response (ie <10 seconds) can be provided to NETSO or DNO.

**Trial 3** will investigate the viability of the tap staggering technique for the provision of reactive power services (ie voltage regulation) to NETSO and DNO. The test regime will initiate the offsetting of the tap positions across the pair of Primary transformers and will quantify the change in power factor (ie the reactive power absorbed) at each Primary substation. The outcome of this Trial is the confirmation that a reactive power absorption service can be provided and to quantify the impact on the distribution network in terms of losses and network loading and the aggregate impact of this on the transmission network for voltage stabilisation.

During all the Trials, the health of Primary transformers and tap changers will be monitored, which together with academic research will help to understand whether the technique has a material and detrimental impact on these assets.

### The CLASS Solution which will be enabled by solving the Problem

The CLASS Solution is a novel method to exploit existing assets and is both a quick to implement and a cost effective alternative to existing carbon intensive solutions. Applying the technique to reduce the peak demand at a Primary substation can produce a time extension of between one and three years; versus the traditional reinforcement of a Primary substation which typically costs on average £560 000 and takes 1.1 years. In addition the technique defers 58 $tC0_2eq$ per Primary substation.

## 2: Project Description cont.

Scaling this up to the GB level the CLASS Solution is expected to defer the equivalent of building new 40 Primary substations, which would cost the customer £75.9 million using traditional reinforcement techniques, leading to a total asset carbon deferral of 16 266 $tC0_2eq$.

Throughout the CLASS Project a number of outputs will be generated. The sharing of these outputs will allow any other DNO to quickly and effectively implement the CLASS Solution. The key outputs from the Project are:

1. *Installation and Application Methodologies*: The Project will publish the site selection methodology for the Trial sites and a detailed installation methodology for the retrofit of equipment at a typical GB Primary substation.
2. *Voltage Regulation Scheme*: CLASS will publish the data captured in the Trials and deliver a report that assesses the capability of delivering demand response and how this can be used by network operators. This will include a detailed characterisation of each Primary Substation, to the load and customer mix composition on the selected Primary network.
3. *Voltage/ Demand Relationship Matrix*: The Trials will develop a voltage/ demand relationship matrix for application in a new CLASS Dashboard, which will display the real-time demand response capability.
4. *Asset Health Study:* The Project will deliver the results of the study on the change in asset health from the application of the new dynamic voltage regulation techniques.
5. *Customer engagement and feedback:* CLASS will describe the method for attracting and engaging customers in the Trial and detail their feedback, confirming that customers are not affected.
6. *Change proposals for planning standard*: The Project will deliver changes proposals to update the existing planning standard on the demand response available from distribution networks.
7. *Long Term Monitoring test bed:* At the end of CLASS rather than decommission the monitoring equipment National Grid has agreed to fund its on-going maintenance, data collection and analysis as part of a published Long Term Monitoring Study on the changing demand response of networks.

### Technical Description of Project

The CLASS Project demonstrates innovation through the novel configuration and application of existing off-the-shelf voltage control equipment previously untested in GB which is used to augment existing voltage control infrastructure to provide new functionality.

The new Voltage Controllers will be installed at the Primary substation and will communicate with Electricity North West's Control Room Management System (CRMS) via existing SCADA infrastructure. CRMS will in turn pass on the relevant information to the version of GE's PowerOn Fusion recently installed, under the previously funded Capacity to Customers Project. A new CLASS Dashboard, developed within PowerOn Fusion, will display in real-time the forecast demand response capability and provide Electricity North West Control Engineers with the ability to apply, and see the results of, the dynamic voltage control techniques. This will be shared / viewed by National Grid's Electricity National Control Centre (ENCC) via a newly established and separately funded Inter-Control Centre Communications Protocol (ICCP) link. In order to allow for the quantification of the effects and benefits of CLASS, the Project will deploy appropriate levels of representative network monitoring alongside existing monitoring

The basic premise of CLASS is delivery of the following critical demand response services: Demand Reduction/Boost, Voltage Control, and Demand reduction at time of system peak. CLASS will be delivered by a combination of local automatic action and central despatch.

*Local Control*

The local automatic action will be via the operation of frequency sensitive relays which, subject to the system frequency, will operate appropriate control equipment associated with nominated Primary transformers to deliver both fast primary frequency and secondary frequency response. The frequency sensitive relay is expected to interface directly with the Voltage Controller (VC). The Voltage Controller will in turn initiate one of two automatic actions subject to the magnitude of the frequency variation:

1. Disconnection of one of a pair of Primary substation transformers via use of an interposing relay. There may be cases where the Voltage Controller will not initiate the trip owing to active constraints such as network outages, high loads or tap range limitations; and
2. Tapping of the transformer tap changers to reduce/increase demand as a means of providing secondary frequency response.

## 2: Project Description cont.

*Central Despatch*

The central despatch will initiate CLASS via ENWL's existing SCADA infrastructure. Primary substation remote terminal units (RTUs) will be configured to act as the interface between the central systems and the newly deployed Voltage Controllers. Central despatch will be used to initiate the following demand response actions:

1. Demand Reduction/Boost for the purpose of generation/demand balancing or wind following;

2. Tap stagger as a means of providing reactive power absorption to reduce system voltages; and

3. Demand reduction at time of system peak.

The key elements of the end to end CLASS architecture are identified in Figure 1 and detailed further below.

***Voltage Controllers***

The proposed architecture introduces an autonomous Voltage Controller at the Primary substation which is configured with the necessary control logic. The Voltage Controllers will be interfaced with the substations existing Automatic Voltage Control (AVC) scheme. In some instance this may necessitate the installation of replacement AVC hardware. The underlying functionality of the AVC scheme will remain unchanged but will also respond to control tap change operation when prompted to do so by the Voltage Controller. The installation and commissioning of the Siemens autonomous Voltage Controller is a key part of the Project and as such a small number of site inspections have taken place to identify the principal interfacing decisions to be made. These initial site inspections have assisted in the preparation of costs and their findings have informed the site selection methodology.

***CLASS Dashboard***

CLASS will develop a Dashboard hosted within the PowerOn Fusion (POF) Network Management System (NMS) that displays the real-time demand response within a defined region. This innovative real-time display will be developed in conjunction with GE Digital Energy and will take real-time demand data available within CRMS and calculate the expected demand response available based upon the relationship between voltage and demand. During the Trials the forecast voltage/ demand relationship will be characterised by The University of Manchester and the CLASS Dashboard will be periodically updated so that over time the accuracy of the CLASS Dashboard is enhanced. The new CLASS Dashboard and the time series voltage / demand relationship information generated by the Trials will be made available allowing the transfer of this key technology to other DNOs.

***Network Management Systems Interface***

In order to test the capabilities of CLASS and to actively involve National Grid in the Trials, CLASS will establish an interface, via an Inter-Control centre Communications Protocol (ICCP) based link, between National Grid's Network Management System (NMS) and ENWL's (POF) system. As previously noted POF has already been established under the previously LCNF funded Capacity to Customers Project but functionality will be added via the CLASS project. The POF system and Electricity North West s existing NMS will be connected via industry standard protocols, including Common Information Model (CIM) and Simple Object Access Protocol (SOAP). Both National Grid's NMS and POF are developed and licensed by GE, who will also install and commission the ICCP link between the two systems. National Grid and GE will fund this element of the CLASS Project. The newly developed Dashboard will be viewed by National Grid via the ICCP link and provide National Grid both enhanced visibility and direct control of Electricity North West's network. Electricity North West will test the operational capability of the ICCP link by allowing National Grid to directly initiate voltage regulation as part of the Trials under controlled conditions. Having both the visibility and direct operational capability of such a link will be the first dual control link of its kind in GB. This link will further inform the characteristics, processes and feasibility of control on future industry Grid Code Demand Control arrangements.

***Network Monitoring Equipment***

In order to quantify the effects and benefits of CLASS we will locate monitors at tactical points on the network that will provide the data for analysis by The University of Manchester. CLASS will use existing monitoring equipment at 132kV and establish new monitoring equipment at Primary and distribution substations. The University of Manchester has defined the data sampling rates required for this Project.

## 2: Project Description cont.

*Monitoring at 132kV* - For the purposes of the Trials, CLASS will use existing Central Volume Allocation Meters installed at the boundary between Electricity North West and National Grid.

*Monitoring at Primary substations* - CLASS will install new transducers onto the existing current transformers (CT) on Primary transformers so as to more accurately record the demand. The voltage will be recorded using the existing voltage transformers (VT) with both measurements being supplied to the new Voltage Controller. Additional monitoring devices within the Primary substations will record data on the health of the transformer and tap changers during the Trials to assess the long term feasibility of applying these voltage regulations techniques and any affect on the transformers' life.

*Monitoring at Distribution substations* - CLASS will install voltage monitoring equipment on the low voltage (LV) side of the distribution transformer. We will use the equipment and techniques devised under Electricity North West's LCN Fund Tier 1 project, LV Network Solutions.

### Description of design of Trials

**Scope of CLASS**

CLASS explores the potential for DNOs to adopt novel voltage regulation techniques to manage peak demand on a DNO's network and help manage the generation and demand balance on the GB electricity network. The CLASS Method will be trialled on 60 Primary Substations across it's network, representing 17% of Electricity North West's network and is representative of the type of customer mix and Primary network assets on any DNOs' network throughout GB.

**Site Selection Methodology**

The site selection methodology outlined below, has been developed by The University of Manchester in conjunction with Electricity North West and endorsed by Parsons Brinckerhoff. The indicative Trial sites are mapped in Appendix A and the full site selection methodology is detailed in Appendix B.

The University of Manchester has recommended that 60 Primary substations should be included within the Project for the results to be regarded as statistically robust and representative of GB networks. The following three aspects are applied to filter and select the Primary substations for the Trials:

1. *Load Classes* - As different load types respond differently to changes in voltages, a Primary substation can be categorised and highlight different customer groups by load on the network. It is proposed the CLASS Method is deployed at Primary substations across a range of different customer compositions to determine the most responsive type of customers and their loads.
2. *Primary substation loading level* - To understand whether it is possible to defer network investment by peak load reduction, it is proposed that the CLASS Method is deployed at those Primary substations whose annual peak demand is a significant percentage of its Firm Capacity.
3. *Demand Zones* - It is proposed that the CLASS Method is deployed at multiple Primary substation locations in each of the key GSP demand zones within ENWL's area. This is because a GSP represents the boundary point with National Grid and is the point at which the aggregate effect is being considered.

Other additional considerations will also form part of the final selection process, as has been highlighted in Appendix B.

**Hypotheses**

The CLASS Project will test the following hypotheses:

1. CLASS Method creates a demand response and reactive absorption capability through the application of innovative voltage regulation techniques.
2. Customers within the CLASS Trial areas will not see/observe/notice an impact on the power quality when these innovative techniques are applied.
3. The CLASS Method will show that a small change in voltage can deliver a very meaningful demand response, thereby engaging all customers in demand response.
4. The CLASS Method will defer network reinforcement and save carbon, by the application of demand decrement at the time of system peak
5. The CLASS Method uses existing assets with no detriment to their asset health.

## 2: Project Description cont.

**Trials**

The CLASS Trials will occur over a full year with the objective to rigorously test the Hypotheses detailed above. To test Hypothesis 2, CLASS will identify and engage with a representative sample of the domestic and commercial customers supplied from the Trial Primary substations to periodically answer a questionnaire on the quality of their electricity supply. A Control Group will be established outside the Trial area to ensure that we can baseline our results for the customers in the Trial area.
The remaining Hypothesis will be tested under the following Trials:

*Demand Response Trials 1 & 2*

- These Trials and their respective test regime will be developed to provide the evidence to wholly answer Hypothesis 3,4, and 5 and partly answer 1

*Reactive Power Trial 3*

- These Trials and their respective test regime will be developed to provide the evidence to partly answer Hypothesis 1

**Test Regime**

For those Trials where we seek to understand the response across the annual cycle we propose to apply a test programme that initiates an action at least once in one half hour for a weekday and a weekend day for each season, thereby collecting data for a 24 hour period of a weekday and weekend day for every season. For the Trials that we have identified as being more suitable for application to a specific season, our test programme initiates an action in all the half hour periods that the necessary response is required.

CLASS will also test the parallel provision of the demand response and reactive power absorption at specific points during the annual cycle to fully understand the opportunities and boundaries of dynamic voltage regulation. The CLASS test regime will be executed by Electricity North West but will incorporate the initiation of actions by National Grid via the use of an ICCP interface. The test regime, the Trials, and execution methodology will provide The University of Manchester with the data to fully analyse the provision capability of such techniques by a DNO. The test regime and execution methodology will be developed prior to the Trials with the assistance of our Project Partners: Siemens, National Grid, GE and The University of Manchester.

### Changes since initial screening process

The scope of the CLASS Project has reduced from our initial ISP submission. The changes are identified below and in further detailed in Table 2:

1. Deferral of the commercial and market research project elements to a later stage

2. Fewer substations due to the improved selection methodology

3. No DNO collaboration due to the smaller number of sites and improved selection methodology

4. Passive Supplier involvement

5. Revised Customer Monitoring

The redesigned Project will deliver the same benefits outlined in the ISP but now only take 2.75 years to complete and cost only £9 million versus £12.1 million.

## 2: Project Description Images, Charts and tables.

| CLASS TRIALS | | | | | |
|---|---|---|---|---|---|
| | **Trial** | **Technique** | **Speed** | **Trial Period** | **Ref.** |
| ***Demand Response*** | Voltage Increment and Decrement | Raise and lower tap position | Seconds | All Year | T1 |
| | Voltage Decrement | Lower tap position | Seconds | Winter | T2a |
| | Voltage Decrement | Switch out transformer | Milliseconds | All Year | T2b |
| | Voltage Decrement | Lower tap position | Seconds | All Year | T2c |
| ***Reactive Power*** | Reactive Power Absorption | Stagger tap position | Seconds | Summer | T3 |

Table 1 : CLASS Trials

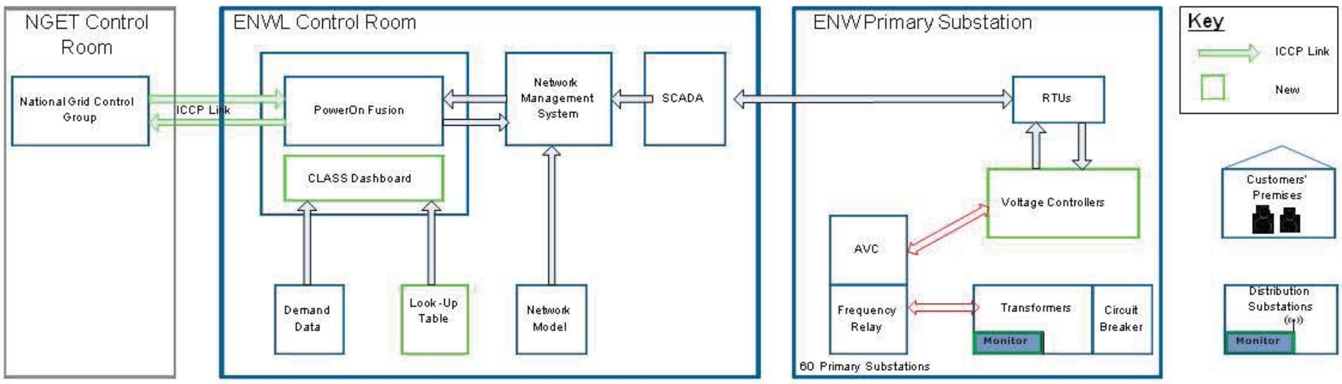


Figure 1 : CLASS End-to-End Architecture

| Changes | Detail |
|---|---|
| CLASS Name | We have revised the name of our project to more fully reflect the benefits to DNO customers and their role in Trials. |
| Reduced Commercial and market research | The research element initially identified in the CLASS ISP has been de-scoped so that the commercial & market arrangement research to be undertaken by Imperial College and Redpoint are no longer part of this Project. |
| Fewer Substations | We proposed in the ISP to deply and trial technologies across eighty Primary Substations. From further feasibility studies undertaken by the University of Manchester, it has been determined that a representative sample of 60 Primary Substation is required to Trial the voltage regulation techniques, to make the result froms the Trials statistically robust. |
| No DNO Collaboration | Analysis undertaken by The University of Manchester has also identified that trialling the voltage regulation techniques on ENWL's network alone will provide a representative sample of the typical loads and customer mixes found at GB level. ENWL originally proposed to use some of SSE's network to provide a network sample representative of the GB network. Whilst ENWL value collaborating with SSE, CLASS wold incur additional costs that would not provide greater value or insight. As a result ENWL has opted not to Partner with SSE as part of CLASS. |
| Passive Supplier Involvement | A further change since our intial ISP submission is that ENWL will not have a Retail Supplier as a Project Partner within CLASS. Discussions with the three largest Retail Supplier within ENWL's distribution services area has failed to justify the resourcing expenditure needed in areas of their business. As a consequence ENWL has opted to undertake the customer engagement and survey work with Impact Research and inform Retail Suppliers when we engage with their customers. |
| Revised Customer Monitoring | We have been unable to agree the use of smart meters to monitor voltage at customers premises. Due to the smart metering roll-out, we do not wish to disrupt the smart metering roll-out or confuse customers by seeking to install an additional voltage monitoring device at the customers' premises. The monitoring at distribution substations will provide us with data that when combined with system models enables us to accurately understand the voltage profiles across our network to uncover any voltage excursions. |

Table 2 : Changes from Initial ISP

# Section 3: Project Business Case

*The CLASS Solution is a smart grid tool which facilitates deferment of network reinforcement and provides potential frequency control and voltage management mechanisms for all GB networks.*

The business case for CLASS is based upon the principle of deploying the CLASS Method in a manner that represents any DNO's network, and facilitate its adoption to all network operators within GB. CLASS will help facilitate the transition to a low carbon economy and delivery of GB-wide benefits for all electricity customers, both in terms of financial and carbon savings. These benefits can be quantified and where appropriate the business case has sought to highlight these. However, there are other benefits that although cannot be directly quantified have also been explored and described in the sections below. The business case includes an investigation into the costs associated with the CLASS Project and these have been developed in collaboration with our Project Partners throughout the bid preparation phase.

The knowledge gained in undertaking the CLASS Project will allow Electricity North West to build on its previous Demand Side Response work, and to identify how a DNO can create an opportunity to defer network reinforcement and provide network services. CLASS will feed this learning into RIIO ED1. Assuming positive customer engagement, the Project demonstrates potential significant customer benefits through reduced DUoS charges.

**Customer Benefits**

Electricity North West, with the assistance of the Tyndall Centre and The University of Manchester, has undertaken initial modelling work on the potential benefits of its CLASS Project. The modelling has been based on an assessment of the range of network reinforcements required at substations when demand exceeds capacity. This modelling work details the type, financial cost, carbon cost and time to complete reinforcement. Additional modelling has been undertaken by the Tyndall Centre to understand the carbon savings available by providing demand response and reactive power absorption capabilities to NETSO and this is included in Appendix H.

*Financial Benefits*

The principal benefit of the CLASS Solution is that it provides a quickly implemented Method to defer reinforcement through the application of voltage decrement techniques at times of peak loading to reduce peak demand. In the short to medium term (within DPCR5 and RIIO-ED1) extending the time to reinforce, creates opportunity to consider alternative infrastructure investment decisions, including customer demand response programs; and in the longer term (ie RIIO-ED2 and beyond) the application of this technique allows the optimal scheduling of resources to manage the expected significant infrastructure development program from the connection of low carbon technologies.

When the CLASS Method is applied across all Primary substations in the Project, Electricity North West could gain up to 11.8 MVA of network capacity, and defer the reinforcement of fourteen Primary substations with an associated expenditure of £7.86 million for up to three years. The CLASS Method can be implemented at one Primary substation 57 times faster and 12 times cheaper than traditional reinforcement. As it takes one week to retrofit into a Primary substation at a cost of £44 000 compared with the typical average time to reinforce a Primary substation of 57 weeks at a cost of £560 000 (Figure 2).

These are the minimum benefits available by reducing the voltage by 1.5% (ie one tap position) at the Primary substation; additional benefits may be available if the voltage is reduced by more than one tap position (ie 3% for two taps etc.). The Trials will determine the boundaries of applying such techniques.

If the CLASS Solution is applied first to all ENWL's Primary substations, it could release 69 MVA (the equivalent of three new Primary substations) and defer £6.7 million in reinforcement expenditure, When applied at GB scale, it is possible to gain up to 937 MVA (the equivalent of 40 new Primary substations) and defer £90 million in reinforcement costs (Figure 3 & 4).

The Grid Code obliges a DNO to provide a demand response to NETSO for the management of frequency but its provision, delivered by the 3% or 6% voltage reduction at DNO substations; but this is generally called upon when other generation and demand management options such as STOR have been exhausted. There is no Base Case for the commercial provision of demand response for frequency reserve or reactive power for voltage control from a DNO to NETSO. This is because the current regulatory model disincentivises such activities. The feasibility study and the scoping studies developed by The University of Manchester and Tyndall Centre in preparation of the CLASS Full Submission highlighted the potential revenues from the provision of these network services to NETSO could be in the region of £25 000 000 per annum, if the CLASS Solution was applied GB wide, which would flow directly to DNO customers, through reduced bills (from lower DUoS charges).

## 3: Project Business Case contd.

Carbon Benefits

In the CLASS Project the deferment of fourteen Primary substations will defer carbon of 588 tCO2eq and potentially reduce network losses delivering a carbon saving. Rolling out across Electricity North West, CLASS would defer 1 251 tCO2eq; whilst GB-wide, the carbon deferred is 16 266 tCO2eq. The actual reduction in losses from applying the peak reduction technique will be assessed within CLASS.

The Innovation Funding Incentive Report (IFI) highlights the subsequent "Scope of Work" reinforcing the potential financial and carbon benefits derived in providing demand response for frequency reserve and reactive power for voltage control. In the CLASS Project, we propose to show that it is possible to support the wider GB system through the provision of demand response and reactive power absorption to NETSO, as well as the carbon savings derived. But initially to understand the potential carbon savings available by adopting CLASS, The Tyndall Centre considered the existing operators in the frequency reserve/ control and reactive power markets and assumed that these would be displaced by the CLASS Solution (see Appendix H).

Demand Response: The CLASS Trials will use the inherent functionality of the Voltage Controllers to sense under frequency events and initiate a voltage decrement by either switching out one of a pair of Primary transformers or lowering the current tap position of each Primary transformer. CLASS will quantify the demand response that can be provided at all times of year, whilst maintaining the quality of supply to customers and the health of our existing assets. Using the Fast Reserve (FR) and the Firm Frequency Reserve (FFR) markets as a proxy for understanding the current carbon intensity of frequency control services the Tyndall Centre has shown is that there are significant carbon savings opportunities available by displacing current providers. The current market participants in FR and FFR have a carbon footprint of between 500 to 800 gCO2eq per kWh. The CLASS Trials will determine the size of the demand response and when it could be provided, but in the CLASS Project a demand response could displace up to 360 tCO2eq per annum from 365 applications ie one hour per day. As the CLASS Method is scaled up the carbon saving at Electricity North West are potentially up to 2 280 tCO2eq per annum or 18 299 tCO2eq over RIIO-ED1; and further to GB are up to 29 637 tCO2eq per annum or 237 888 tCO2eq over RIIO-ED1.

Reactive Power: National Grid procures reactive power to manage the energy flows across the transmission network. This is secured through various market mechanisms or through the operation of compensation equipment e.g. Static VAr Compensators (SVCs) and Mechanically Switched Capacitors (MSCs). National Grid monitors the real power and reactive power flows across its network and at Grid Supply Points, the boundary with distribution network operators. The reactive power requirements change significantly over each day and on a seasonal basis and where there is a requirement for additional reactive support that the reactive market cannot provide, then National Grid will install reactive compensation equipment. The CLASS Trials will apply the `tap stagger' technique to reduce the power factor of the Primary substation by generating circulating current around the pair of Primary substation transformers, thereby increasing reactive power demand on higher voltage networks. CLASS will quantify the reactive power absorption capability that can be created, whilst maintaining the quality of supply to customers and the health of our existing assets. Using the installation of a STATCOM as a proxy for understanding the carbon intensity of the traditional solution for managing transmission system voltage The Tyndall Centre has reported that there are significant carbon savings in the application of the `tap stagger' technique for the provisioning of reactive power . In the CLASS Project, if the technique is applied at all 60 Primary substations for 360 hours per annum ( ie 4 hours per night for 90 days) the CLASS Trials are expected to provide 112 MVAr, totalling 40.4 GVArh per annum, and saving up to 4 071 tCO2eq per annum. As the CLASS Method is scaled up the carbon saving at Electricity North West are 25 845 tCO2eq per annum or 252 527 tCO2eq over RIIO ED1; and further to GB are 335 950 tCO2eq per annum 3 282 819 tCO2eq over RIIO ED1.

Non Quantified Benefit

Whilst the CLASS Method demonstrates significant potential financial and carbon saving benefits there are also a number of non quantifiable benefits that should be noted. The first of these is how the Solution will inform discussions in the RIIO-ED1mid-term review.

A key aspect of RIIO-ED1 is innovation and how customers will benefit from demonstrating this. The CLASS Project demonstrates innovation in the novel use of dynamic voltage regulation techniques to drive the greater utilisation of our existing assets. CLASS, like last year's Capacity to Customers Project follows the same strategy of generating additional value for our customers and stakeholders from the greater use of existing assets.

## 3: Project Business Case contd.

Another key consideration for RIIO-ED1 and beyond is the delivery of network services with long-term value for money for existing and future consumers. Learning from CLASS will inform whether the innovative use of dynamic voltage regulation for demand response paves the way for better value for money delivery of network services. The Project will also confirm whether the Solution can play a role in the delivery of a secure and sustainable energy sector, reducing the carbon intensity of current balancing services provision.

An updated and enriched understanding of consumer voltage/demand characteristics will enhance power system modelling at distribution and transmission levels when determining reinforcement timing (immediate post-fault voltage depressions) and to assess voltage instability risk that can jeopardise power system security on a large scale.

We also anticipate additional benefits through the availability of an enhanced operational interface (the ICCP link included in CLASS) between Electricity North West and NETSO. This interface could provide additional future benefits, as more embedded generation is installed on Electricity North West's network which would otherwise be `invisible' to NETSO.

The development of the network monitoring equipment within CLASS will form the basis of a fully funded Long Term Monitoring Study, conducted by National Grid with support from The University of Manchester. The data collected will help track the change in the voltage /demand relationship over time with the penetration of customers' low carbon technologies.

The flexibility created by CLASS could facilitate the development of other smart solutions. The fast application of CLASS could be valuable in bridging the operational time gap before other solutions come into effect for example enabling forms of DR via aggregators or the effect of price signals from the time of use pricing via smart metering.

**Costs & Assumptions**

By having worked closely with our Partners in the scoping of the CLASS Project and through a robust standardised financial costing methodology, Electricity North West has been able to capture and continually refine the Project costing model. This continual improvement process and the lessons learnt from C2C and other LCN funded projects has enabled Electricity North West to develop an accurate and value for money proposition. The total cost of CLASS is £9 million, with funding for the total costs coming from the following three areas:

| | |
|---|---|
| 1. LCN Fund: | £7.17 million |
| 2. Electricity North West Contribution: | £0.81 million |
| 3. Project Partners' contribution: | £0.91million |

A significant proportion of CLASS will be funded by the Project Partners, with all the Partners contributing to the funding of CLASS. The funding levels from the Partners are:

| | |
|---|---|
| • National Grid: | £0.39 million |
| • Siemens: | £0.31 million |
| • GE: | £0.12 million |
| • The University of Manchester: | £85k |
| • Impact Research: | £10k |
| • Parsons Brinckerhoff: | £5k |
| • Chiltern Power: | £4k |

The total has been broken down into the following main cost segments:

| | |
|---|---|
| • Project Management: | £0.9 million |
| • Technology Build: | £5.7 million |
| ○ ICCP Link & Communications Infrastructure | £0.9 million |
| ○ Dashboard | £0.9 million |
| ○ Voltage Control Scheme | £3.1 million |
| ○ Monitoring | £0.7 million |
| • Trials: | £0.49 million |
| ○ Customer Survey | £0.37 million |
| • Learning & Dissemination: | £1.3 million |
| ○ Research | £1.0 million |
| ○ Dissemination Activities | £0.3 million |
| • Contingency | £0.6 million |

## 3: Project Business Case contd.

In developing the CLASS Project costs the following key assumptions have been made:

- All costs include RPI,
- RPI rates are those issued by Ofgem, and
- Project funding includes a 6% contingency.

The main Project costs are for the development of the technology to operate the CLASS Method. These costs cover the purchase and installation of the Voltage Controllers in the 60 Trial Primary Substations, the purchase and installation of the network and health monitoring equipment across the network, the creation of the ICCP interface (which is fully funded from the Partners' contributions to recognize that these costs should not be borne by DNO customers), and the development of the Dashboard. A detailed breakdown of the cost components can be seen in Table 3 and Figure 5 on page 17, and within the financial workbook in Appendix K.

**Electricity North West Direct Benefits and Contribution**

The Directs Benefits resulting from undertaking the CLASS Project appear in the following two areas and totals £87 960:

1. the replacement of the Automatic Voltage Control schemes in Primary Substation; and

2. the deferment of network reinforcement in the expected four category Load Indices 5 Primary substations in the Trial.

A methodology has been developed to calculate the Direct Benefits for each category and these are described below. The value of the Direct Benefits have been estimated as the 60 Trial Primary substations will be chosen in the CLASS Project using the agreed site selection methodology, the initial draft described in Appendix H.

*Asset Replacement* - There are a wide range of types of AVCs fitted across Electricity North West 's Primary Substation population. Considering the whole population, approximately 49% of the Primary substations have AVC assets that we would expect to replace, due to age and limited functionality. The cost of replacing an AVC scheme is £17 000 per substation. Within the DPCR5 replacement programme Electricity North West expect to replace network assets at six Primary substations in 2013/14. Therefore the Direct Benefits have been calculated assuming that Electricity North West will replace the AVC schemes at three Primary substations as part of the Technology Build Workstream at a cost saving of £52 680.

*Network Reinforcement* - In the CLASS Trials we expect to defer the network reinforcement of four category Load Indices 5 Primary substations, which would typically cost £2.25 million. The CLASS Project will prove that a DNO is able to defer the reinforcement, thereby savings cost of capital for a length of the time extension, expected to be up to three years. Therefore the Direct Benefits have been calculated assuming that Electricity North West will save the financing cost of the £2.25 million, totalling £35 280.

As part of the LCN Fund mechanism Electricity North West is responsible for contributing 10% of the total Project cost, which represents a contribution of £0.81 million. The above commentary details that £87 960 of this would be funded through Direct Benefits and remainder straight from Electricity North West .

The CLASS Project has been through the Electricity North West internal approval process and has been signed off by the Board.

## 3: Project Business Case contd.

### 3: Project Business Case contd.

## 3: Project Business Case images, charts and tables.

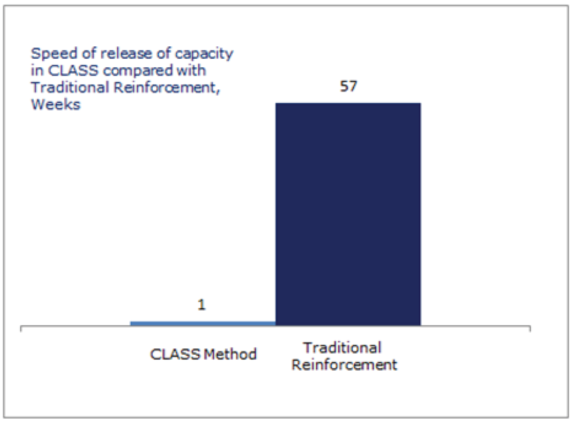


Figure 2 : Comparison of speed of release of CLASS and Traditional Reinforcement

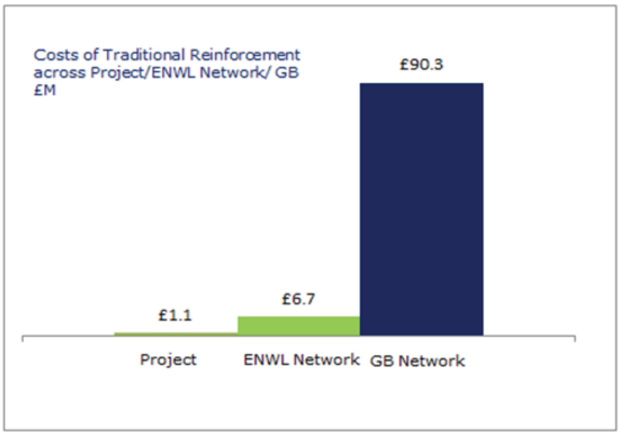


Figure 3 : Reinforcement cost CLASS/ENWL/GB

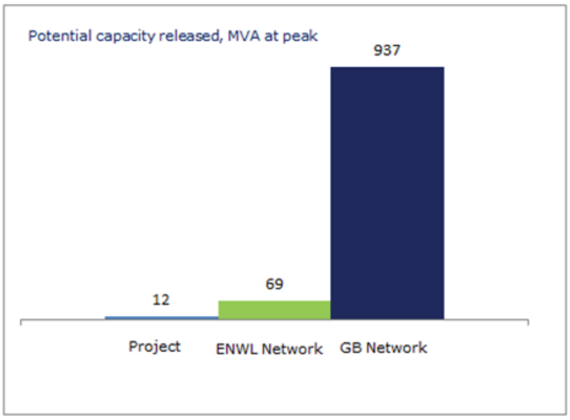


Figure 4 : MW released by CLASS/ENWL/GB

**Cost breakdown *£M per year***

| Cost Category | 2012/13 | 2013/14 | 2014/15 | 2015/16 | Total |
|---|---|---|---|---|---|
| Project Management | £0.06 | £0.38 | £0.36 | £0.17 | £0.97 |
| Technology Build | £0.03 | £5.29 | £0.31 | £0.09 | £5.71 |
| Trials | £0.00 | £0.01 | £0.40 | £0.08 | £0.49 |
| Research | £0.00 | £0.27 | £0.54 | £0.21 | £1.01 |
| Learning and Dissemination | £0.00 | £0.09 | £0.09 | £0.05 | £0.24 |
| Contingency | £0.00 | £0.49 | £0.01 | £0.09 | £0.59 |
| **TOTAL** | **£0.09** | **£6.52** | **£1.70** | **£0.69** | **£9.01** |

Table 3 : CLASS Project costs breakdown pa

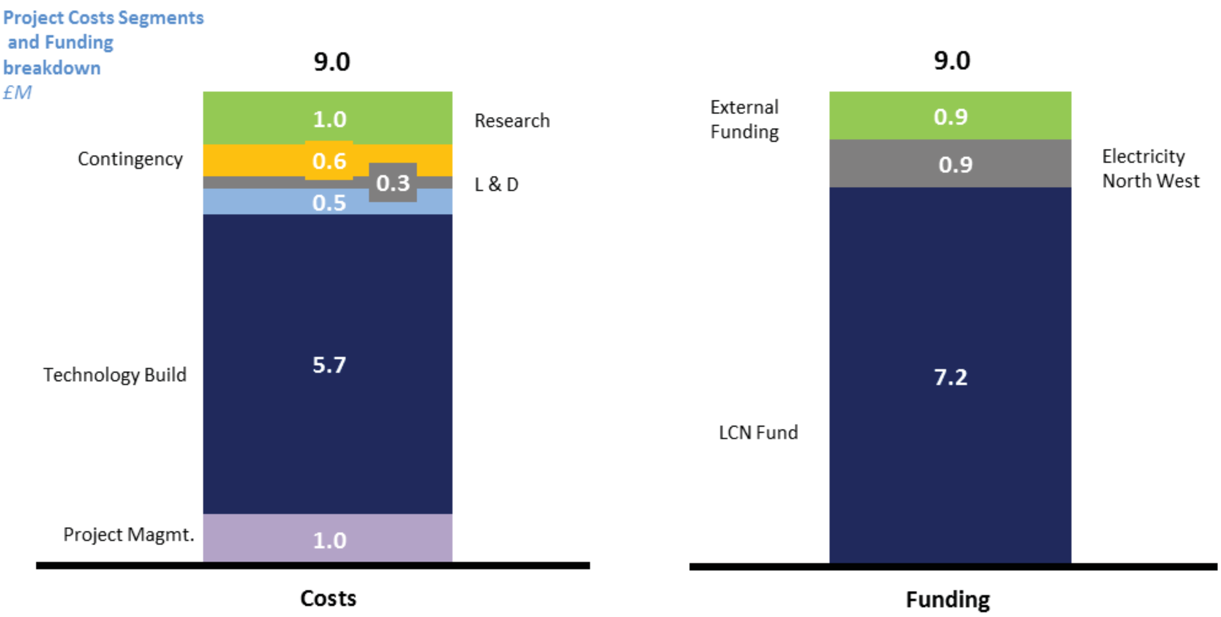


Figure 5: CLASS Project cost and Funding Breakdown

# Section 4: Evaluation Criteria

The CLASS Method implements dynamic voltage regulation into distribution networks to deliver a low cost, low risk, non-intrusive way of creating tools for active network management.

## Accelerates the development of a low carbon energy sector & has the potential to deliver new financial benefits to future and/ or existing customers

CLASS will trial a novel method of actively managing the network, through dynamic voltage control techniques, delivering significant cost and carbon savings to all energy consumers. These savings are derived from i) a demand response capability deferring expensive network reinforcement and ii) Reactive Power Absorption and frequency control capabilities providing NETSO with alternative lower carbon options for the balancing of the network (eg 365 000 $tCO_2eq$ per annum).

In this section and with further supporting material in Appendix H, we set out to further quantify the impacts that the CLASS Solution could have.

**CLASS Project:** The site selection methodology (described in Appendix B) identified that 60 Primary substations would be involved in the CLASS Trials. In the Project, Electricity North West could release, at peak demand, up to 11.8 MVA (the equivalent of a half of a new Primary substation) of network capacity across all the Primary substations, with a 1.5% voltage decrement (provided through a single tap). Greater capacity could be released with further decrements and the Trials will determine the permissible range and any limits on duration, whilst maintaining network integrity and quality of supply for our customers. Installation is 57 times faster at a cost which is 12 times less the traditional reinforcement approach. A one-off installation cost of £44 000 per Primary substation to provide the peak reduction functionality then provides the capability for the demand response for frequency control and reactive power for voltage control.

**Electricity North West:** Roll out across the Electricity North West network could deliver 69.4 MVA (the equivalent of three new Primary substations) and delay the reinforcement of all highly loaded (ie category Load Indices 5) Primary substations for several years. Applied tactically the peak demand management technique can be quickly implemented to provide an opportunity to compare the purchase of a demand-side response programme with other traditional reinforcement options. This quick-win will be highly valuable towards the end of RIIO-ED1 and beyond, as the rate of electricity demand growth is expected to significantly increase. The ability to provide demand response for frequency control and reactive power for voltage control to National Grid has the potential to save up 28 000 $tCO_2eq$ per annum.

**Great Britain:** A rollout of the CLASS Solution across GB could release 937 MVA (the equivalent of 40 new Primary substations) and delay the reinforcement of all highly loaded Primary substations for several years. The flexibility gained by dynamically regulating the distribution network voltage is significant whether it is applied locally to manage network constraints or across the network to assist with GB system stability. The ability to provide demand response for frequency reserve and reactive power for voltage control to National Grid has the potential to save up 365 000 $tCO_2eq$ per annum and will assist the transition to a low carbon electricity sector from the support for intermittent generation.

**A roll-out of CLASS across GB - accelerated contribution to Carbon Plan**

The government's Carbon Plan addresses the challenge of decarbonisation by highlighting the three themes of `Generating our electricity', `Heat for our home and businesses', and `Powering our cars and vehicles'. To meet the Carbon Plan more low carbon electricity generation will be needed to meet increased demand from new electric heat and transport systems. These changes are at risk of delay due to the time and cost of network reinforcement; this is similar to existing constraints on wind generation schemes planned to the North of the Beauly Denny transmission reinforcement scheme.

In addition, the power flows across GB's networks will be more changeable due to the intermittency of low carbon distributed generation. The CLASS Solution will help address these challenges cost-effectively, quickly and with a lower carbon impact than traditional methods. The CLASS Solution contributes to Chapter 2 - Secure, sustainable low carbon energy and specifically the `Reform of the electricity grid' section within the Carbon Plan. Class delivers cost effective and non-intrusive demand response for demand management and potentially demand response for frequency control and reactive power absorption for voltage control. We have also ensured that The Project will not obstruct or interfere with the smart metering roll-out or other green government initiatives.

## 4: Evaluation Criteria contd.

*Secure, sustainable low carbon electricity* - CLASS accelerates the creation of a secure and sustainable low carbon electricity sector in the two ways: firstly the CLASS Solution utilises reliable and proven technology/ assets in a novel way to improve network efficiency whilst maintaining the security of supply to DNO customers; and secondly CLASS facilitates the connection of low carbon generation whilst deferring the financial/carbon costs currently required to reinforce the network in providing such additional capacity.

*Reform of the electricity grid* - The increase in electricity generation and the change in the generation mix will make system control more complex and demanding. The CLASS Project accelerates the reform of the electricity networks in two ways: firstly the flexible demand management technique trialled, facilitates the quick connection of low carbon generation and demand; and secondly the voltage regulation techniques trialled in CLASS will demonstrate how distribution networks can help transmission system stability by providing a demand response for frequency control and reactive power for voltage control. Through CLASS, research and analysis will determine whether distribution network operators can contribute to maintaining an economic and secure electricity system; through the provision of these lower cost and lower carbon options.

**How a roll out of the Method across GB will deliver carbon benefits more quickly**

Traditional reinforcement involves the construction of carbon intensive assets, particularly new switchgear and transformers. Significant time is currently required in the scoping, design, approval, construction and commissioning of a new Primary substation. This is increasingly likely to become a bottle-neck, as electricity demand and generation is expected to grow. In contrast, the CLASS Method is quick-win which provides a window of opportunity for the network operator to make the appropriate investment decision, whether traditional reinforcement or the procurement of demand response directly from customers or via an aggregator. Additional capacity can be released for use in one week simply by installation of a new voltage controller at a Primary substation, compared with a typical reinforcement timescale for a Primary substation of 57 weeks. This quicker delivery of capacity will prevent delays in the connection of low carbon generation and demand to the network, and impact customers' carbon emissions.

CLASS will demonstrate how distribution networks can help transmission system stability by providing a demand response for frequency control and reactive power for voltage control. The capability to generate the demand response and reactive power is available at a Primary substation in one week and within one year across the whole of Electricity North West compared with several years for the installation of new generation assets or reactive power compensation equipment.

**The potential for replication across GB**

CLASS will trial the voltage regulation techniques on 60 Primary substations on it's distribution network, this represents 17% of our Primary substation assets and 1.5% of GB's Primary distribution network. The University of Manchester's review of CLASS identified that the Electricity North West network represents 7.4% of GB's distribution networks at system peak demand. This indicates that the CLASS Method could be scaled up to the GB level via a scaling factor of about 13.5; this facto will be refined during our Project.

With reactive power absorption, the scaling factor is slightly lower due to the necessity of two transformers at each Primary substation and The University of Manchester report indicates a factor of about 11; again , this factor will be refined during our Project.

**Quantifying the potential carbon contribution of a roll out of CLASS across GB**

The Tyndall Centre assessed the carbon impact for the CLASS Project, for an Electricity North West roll-out and a GB roll-out. No carbon savings have been assumed for deferring the reinforcement of Primary substation assets as potentially these assets may be required in the future. However, in the CLASS Project the installation of the Voltage Controllers is marginal at 1.4 $tCO_2eq$, the roll-out across Electricity North West totals 8.7 $tCO_2eq$, and a GB roll-out totals 113 $tCO_2eq$. Whilst the deferral of carbon could potentially be as high as 810 $tCO_2eq$ in the CLASS Project, 1 736 $tCO_2eq$ in an Electricity North West roll-out and 22 571 $tCO_2eq$ in a GB roll-out, assuming the building of each new Primary substation is deferred for three years. These figures exclude the potential carbon impact of reducing losses from the reduction in demand. During the Trials the carbon impact will be determined.

The carbon savings are potentially very large for the provision of demand response for frequency reserve and the provision of reactive power for voltage control. The Tyndall Centre considered the two markets of Fast Reserve and the Firm Frequency Response to estimate the potential lower and upper carbon savings range. For the CLASS Project the carbon savings are potentially up to 360 $tCO_2eq$ per annum assuming the demand response is provided one hour per week. This scales up to 2 288 $tCO_2eq$ per annum for an Electricity North West roll-out and to 29 750 $tCO_2eq$ per annum for a GB wide roll-out. In RIIO-ED1 this technique could conservatively save 5 100 $tCO_2eq$ in an Electricity North West roll-out and 66 306 $tCO_2eq$ in a GB wide roll-out (See Figure 6).

## 4: Evaluation Criteria contd.

For the case of the provision of reactive power for voltage control the Tyndall Centre estimates that in the CLASS Project the potential carbon savings are up to 4 701 $tCO_2eq$ per annum. Extrapolated to Electricity North West wide and GB wide these up to 252 527 $tCO_2eq$ and 3 282 819 $tCO_2eq$ for the RIIO-ED1 period (See Figure 7). Note, these estimates derived through a comparison of the losses created by the tap staggering technique and with the use of STATCOMS to provide the reactive power, rather than generation which is unlikely to be available at the required locations.

**CLASS has the potential to deliver net financial benefits to existing and/or future customers**

The CLASS Project proposes retrofitting 60 Primary substations with new voltage regulation equipment to facilitate the dynamic operation of network voltage. The logic for selecting 60 Primary substation, which represents 17% of Electricity North West 's Primary substations assets, is that it provides a robust and statistically significant sample of the GB's Primary network assets and covers all types of demand and generation customer connected to HV networks. The CLASS Trials will enable The University of Manchester to derive the voltage/ demand relationship for every half hour in a year so that the Dashboard can display in real-time the current demand and the expected demand response available. In addition, the Dashboard will display the expected reactive power absorption capability in advance of each half hour. This information is considered of use to the NETSO operational teams and our Project will report on these benefits.

Our estimates of the net financial benefits to customers are split across the three techniques of:

- *Demand Response providing peak reduction* - The Trials will show that a demand response generated by the dynamic voltage regulation can alleviate the peak demand of a Primary substation. The aim of the Trials is to prove that Primary substation network reinforcement can be deferred;
- *Demand Management for frequency reserve* - The Trials will show that a network wide demand response from the collective dynamic operation of network voltage, initiated by sensing a low frequency event, can be provided in an acceptable time period, for example less than 10 seconds. The aim of the Trials is to prove that the demand response generated can assist with the control of system frequency.
- *Reactive Power for voltage control* - The Trials will show that the power factor of a Primary substation or a group of Primary substations can be altered through the use of the tap staggering technique, thereby drawing reactive power from the higher voltage networks. The aim is to prove that the change in reactive power demand is observed on National Grid's network and can be used to help control the transmission voltage.

No value will be included for the use of Demand response to provide demand boost technique as there is currently no proxy for its use. This technique could be used to provide either additional frequency control or “wind following” ie where demand is boosted to avoid the curtailment of wind generation.

**Method cost and Base Case costs at the scale of the Project**

**CLASS Method Costs*:*** The main network cost of the CLASS Method is the installation of the Voltage Controllers at Primary substations. The total cost for installing this equipment is £2.0 million, assuming a saving of 25% against the Trial costs from the sharing of the retrofit methodology and the voltage regulation scheme.. Once installed there are no additional costs associated to the controllers, and a DNO will have the ability to dynamically regulate the network voltage to create a demand response and reactive power effect.

To identify the total cost of the CLASS Method, the cost of enabling systems must be added to the above installation costs. For the CLASS Project, Electricity North West proposes to develop a Dashboard for real-time display of the current demand and the potential demand response available and the reactive power absorption potential. This will be developed by GE within its PowerOn Fusion software module. The CLASS Project benefits from the installation of the Power On Fusion software under the Capacity to Customers Project, but the marginal cost of extending the licences for its use into 2014/15 is included. This Dashboard development will be completed for the Project and is not intended as an enduring solution. As all the other DNOs operate GE's Network Management Systems, the development cost should be reduced from £430k to £250k. The Dashboard will be shared with National Grid through a standard ICCP interface which could be replicated in the other DNOs' Control Rooms for £200k, plus the National Grid costs of £150k per each DNO. Other DNOs should not need to fit monitoring equipment as extensively on the network and the future Smart Metering roll-out will provide voltage excursion information from end customers, so no cost has been included for network monitoring. On the scale of the Project but once the techniques are proven (excluding all innovation and dissemination costs), this gives a total network costs of £2.6m for the CLASS Method.

## 4: Evaluation Criteria contd.

In the Trial, the total capacity expected to be released across the 60 Primary substations is 11.8MVA, the equivalent of a half a new Primary substations (based on a 1.5% voltage decrement at peak demand). Of the 60 Primary substations selected typically there will be about four or five substations that would fall within the Load Indices 5 category ie those Primary substations requiring network reinforcement. The rapid installation of the Voltage Controllers at a cost of £44 000 has the potential to defer the reinforcement of the Primary substation for up to three years and potentially avoid the network reinforcement (depending on the voltage decrement possible and the demand growth of each Primary substation). The extended time window offers three opportunities to a DNO; the first is confirmation that the Primary substation needs reinforcement, as experience shows that in some instances (eg one in every ten to twelve cases) the peak that initiated the reinforcement recedes; second is it facilitates the optimal investment decision; and third is it allows time to develop or procure a demand response programme.

During the year long Trial, the 60 Primary Substations could provide between 0.22 GWh and 0.43 GWh for frequency reserve. However this would only provide a small proportion of the Fast Reserve requirement and the CLASS Trials will determine the characteristics of the demand response potentially available for use as frequency reserve. National Grid's Fast Reserve market is valued at around £50 000/MW/year, potentially creating significant future value for Electricity North West customers.

The University of Manchester estimated that the total average reactive power absorption per Primary substation in the CLASS Trial is 1.87 MVAr, therefore the potential total network reactive power absorption in the Trial will be 112 MVAr. As reactive power absorption is only required during periods of lowest demand (ie summer nights) this technique can provide 40.4 GVArh in the trial (assuming 4 hours operation per night over a 90 day period). The CLASS Trials will determine the characteristics of the reactive power that can be made available to National Grid and the potential locations for use of the tap staggering technique. Reactive power is valued at around £2.60/MVArh, and National Grid's North region, which covers ENWL's area, needs significant values of reactive power provision, compared with other regions. Again this has the potential to create significant future value for Electricity North West customers.

**Base Case Costs:** The typical costs of reinforcement and the typical time to reinforce has been generated from the analysis of several recent case studies. The case studies were used to understand the range and type of network reinforcement designed and planned when a Primary substation goes out of firm capacity ie the demand at the substation exceeds its capacity rating. The likelihood of each case study was estimated through analysis of recent network reinforcement schemes, as was the time taken to undertake the network reinforcement. Further details can be found in Appendix H. The case studies suggest the typical cost for Primary substation network reinforcement is £560 000 and the typical time to reinforce is 57 weeks. If, out of the 60 Primary Substations within the Trial, fourteen substations fall within the Load Indices 5 category then the typical cost of traditional network reinforcement is £7.86M. This cost can be deferred for several years or potentially avoided.

If the power factor in one part of the EHV or HV network is lower than normal causing voltage or capacity issues a DNO would currently install new network assets in the form of VAr compensation equipment to improve the network power factor ie to generate or absorb reactive power. Electricity North West does not have VAr compensation equipment installed on its network, but this is likely to change in the future from the connection of low carbon technologies. A future DSO and/ or a micro-grid operator could consider the alternative of applying the tap staggering technique within its own network to create a virtual reactor. Therefore there is no Base Case cost for the use of the tap staggering technique but once proven the technique can be used locally within the distribution network or at the transmission level.

There is also no Base Case for the provision of a demand response to a third party from dynamic voltage regulation; although some of Electricity North West 's customers provide a demand response into the Short Term Operating Reserve (STOR) market, directly or via aggregators. Studies in the UK and around the World have explored reducing voltage to reduce energy consumption and losses. This technique, known as Conservation Voltage Regulation, steps down the voltage systematically throughout the year to provide demand reduction for energy saving purposes and typically has shown a 3% reduction in annual energy consumption for a 3%voltage reduction. The Trials will determine the characteristics of the demand response across an annual period and establish the change in energy consumed and losses from a change in voltage.

Based on peak load, Electricity North West 's network represents 7.4% of GB's distribution networks, which equates to a scaling factor of 13.5. Extrapolating the CLASS Method to the GB network results in 937 MVA (the equivalent of 40 new Primary substations), which would be expected to cost £90 million using traditional network reinforcement techniques.

## 4: Evaluation Criteria contd.

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**Summary of benefits analysis:** The net difference between the Method and Base Case costs is £5.26 million, assuming a £7.86 million deferment in network costs against a £2.6 million cost for the CLASS Method. The CLASS Project assumes no value has been assigned for the provision of network services to NETSO.

CLASS's potential customer benefit will be valued within the Project, in terms of proving that a DNO can apply dynamic voltage regulation techniques to its existing assets to deliver a demand response for frequency reserve and reactive power for voltage control to NETSO. The Trials will confirm that these network services can be provided without affecting our customers' quality of supply or the health of our assets. Both of these new network services can deliver substantial DUoS savings (in the order of tens of millions of pounds) to a DNOs' customers if provided commercially at current market prices.

**The potential for replication across GB**

We have assessed the potential for replicating across GB by first assessing the potential for the CLASS Method at an Electricity North West level and then extrapolating to the GB level.

The CLASS Method can be applied to all of Electricity North West 's Primary substations, but not all the voltage regulation techniques can be applied at all Primary substation sites. For example, the demand reduction technique of switching out a single transformer of a pair of Primary transformers (at a standard Primary substation) or the application of the tap staggering technique is not applicable at a single transformer Primary Substation.

There are 354 Primary substations within Electricity North West 's distribution network to which Voltage Controllers, the key element of the CLASS Method, can be applied to. Scaling up to the Electricity North West network using the same approach for deriving the capacity released suggests the CLASS Method could release 69.4 MVA (the equivalent of 4 new Primary substations). The traditional network reinforcement approach to deliver the same capacity would be expected to cost £6.69 million.

The provision of network services to NETSO is uncertain, as the regulatory, commercial, and technical challenges need to be understood first and then resolved. The CLASS Trials will prove that the technology is available and can be readily implemented, with the CLASS Project outcomes providing all the information for other DNOs to implement the CLASS Method within their own estates. Assuming these challenges are resolved, The University of Manchester estimated that Electricity North West could deliver between 25 MW (summer midnight) and 170 MW level (winter peak) thereby displacing up to 40% of the tendered Frequency Reserve. Extrapolating to GB, suggests that the whole of the Frequency Reserve requirement could be provided by the GB DNOs. The University of Manchester also modelled the total reactive power absorption potential as 714 MVAr, whilst GB wide the total reactive power absorption potential is 7 854 MVAr (using the defined scaling factor of 11). This overestimates the capability of the existing asset as it ignores technical restrictions on the use of the tap staggering technique, for example where the reserve power capability of some transformer tap changers makes this technique unviable and CLASS will confirm GB capabilities by reviewing asset limitations.

## 4: Evaluation Criteria contd.

### Provides value for money to distribution Customers

The CLASS Solution will demonstrate, at scale, that existing voltage regulation assets can be augmented and operated in a novel way which increases the flexibility and utilisation of the distribution network. The move from passive to dynamic operation of network voltage can be observed around the world, with the US distribution network operators using it as a smart grid tool to reduce energy consumption and losses. The CLASS Trials will determine the feasibility of using a range of voltage regulation techniques for the direct and indirect benefits of DNO customers. Each Trial is considered in turn below with an indication of where the benefit falls across the participants in the energy supply chain:

**Trial 1** will determine the voltage / demand relationship and with The University of Manchester CLASS will develop a relationship matrix detailing the half-hourly multiplier that when matched with a demand matrix will provide an estimated half-hourly demand response. Throughout all Trials, CLASS will show that there is no impact on the quality of supply to customers and no detrimental effect on assets' health. The knowledge gained would primarily be used by network operators (DNOs, IDNOs and TOs) and the transmission system operator, NETSO. Network operators could apply the knowledge for changing the operation of their networks and NETSO would use the knowledge for enhancing the forecast of the provision of the Grid Code, OC6 obligation. Increasing the accuracy of the forecast by 10% is likely to increase the efficiency of the market by more than 10%, as the purchased safety margin can be reduced.

**Trial 2** will determine the viability of each of the proposed voltage regulation techniques delivering a demand response:

*Demand Response for Peak Reduction* - Determining whether a DNO can deliver a demand response to reduce the peak of a Primary substations enabling the deferment of reinforcement. This knowledge provides an additional tool to a DNO for managing its network, with benefits from optimal network reinforcement decisions following directly to the DNO's customers, through reduced DUoS.

*Demand Response for Frequency Response* - Showing that a DNO could provide a demand response frequency reserve service to NETSO, has the potential to re-define the balancing service market. It is not possible to determine the value that flows to DNO customers as the regulatory framework doesn't oblige or incentivise DNOs to provide this service. However, if a DNO could offer this service through the current market mechanism and achieve the current market price then, all other things being equal, Electricity North West 's expected revenues are potentially in the region of £2.5 million per annum, which would flow directly to DNO customers, through reduced DUoS. This service also generates significant carbon savings from the displacement of carbon intensive balancing services providers, as described above. Whether the NETSO benefits is dependent upon how the market and the regulatory incentive regime operates.

**Trial 3** will determine the viability of the tap staggering technique for the provision of reactive power services to NETSO. Again it is not possible to determine the value that flows to DNO customers. But the current reactive power prices indicate the North West area requires reactive compensation services. If Electricity North West could offer this service through the current market mechanism and achieve the current market price then, with all other things being equal, Electricity North West's expected revenues are potentially in the region of £1 million per annum, which would flow directly to DNO customers, through reduced DUoS charges. Whether the NETSO benefits is dependent upon how the market and the regulatory incentive regime operate.

Prior to the closure of the CLASS Project, National Grid has agreed to initiate a Long Term Monitoring Study to understand the change in the networks' demand response capability over time. Electricity North West will hand-over the data generated by the monitoring equipment, developed under CLASS, for a period of up to 10 years. Although not valued, as it doesn't form part of CLASS, it does save the decommissioning costs in CLASS, totalling £50 000.

The Project Partners were selected in a pseudo-competitive manner to drive value for money throughout the CLASS Project. Electricity North West identified the leading experts of their fields and discussed the outline CLASS Project with each proposed partner to gauge their interest and commitment to the Project. The discussions with Retail Suppliers were concluded without agreement of a Supplier being part of the CLASS Project. Electricity North West's drive to deliver value for money meant that we agreed that the customer engagement and survey activities would be led by us as our costs were significantly less that the Supplier's proposed costs.

## 4: Evaluation Criteria contd.

Electricity North West stipulated that each Project Partner makes a financial contribution to the funding of the CLASS Project, thereby reducing the funding from the LCN Fund. Electricity North West decided to follow this process so that the CLASS Project has all its Partners ready and available to start CLASS when funding is awarded. The Project Partners' total contribution totals £0.9 million. National Grid's contribution will fund the installation of the Inter-Control Communications Protocol interface, as this element could be perceived as only benefitting National Grid.

### Generates knowledge that can be shared amongst all DNOs

The CLASS Project will generate knowledge and learning in a number of key areas which will be of particular interest for DNOs and is likely to feature into their mid-term RIIO-ED1 review and wider ENA industry discussions.

Impact of Dynamic Voltage Regulation: The main learning outcomes for the industry is to understand the impact of adopting dynamic voltage regulation, and confirming there is no impact on our customers, nor on the provision of Grid Code's emergency demand reduction, OC6. In addition, CLASS aims to understand whether there is an impact on the health of the assets that provide the demand response and reactive power absorption functionality (e.g. transformers and taps changers).

Network Operation: During the Trials, power and voltage data will be collected at both the Primary substations, distribution substations and at LV substations using four quadrant metering. The data collected from these devices will enable us to identify the impact that the voltage regulation techniques have on the power quality, energy losses, voltage levels and network capacity performance at different times of day, seasons, etc. The importance of gathering and generating knowledge to be shared amongst interested parties is to fully understand the impact that voltage regulation schemes would have on their network and if it would compromise compliance with licence or statutory obligations.

Dashboard and Relationship Matrix: The Relationship Matrix is a very innovative part of the Project, as it identifies the relationship of demand and voltage and the reactive power absorption capability on a particular part of a DNO's network. The visual representation, displayed via the Dashboard, allows a system operator to understand in real-time or at a short time ahead the expected demand response or reactive power absorption that would be delivered from executing a voltage regulation technique. The specification of the new module and the dashboard relationship matrix will be shared to all GB DNOs at zero licencing costs in the form of a standard pro-forma. This knowledge will enable any DNO to build such a dashboard within their own business or to simply forecast what the relationship is between demand and voltage on their network

Inter-Control Communication Protocol Interface: National Grid, GE and Electricity North West will establish the first operational control ICCP link between National Grid and a DNO business. This link will be used within the CLASS Project to share information via the Dashboard and to trial and run a number of test scenarios led by National Grid. The knowledge generated and lessons learnt from this will be shared with all interested parties, which builds upon the previous DECC funded smart grid project undertaken by NG with another GB DNO. In addition, CLASS will share the processes undertake to configure the interface to meet the technical & security design architecture requirements. The importance of this work package is that the knowledge gained will prove valuable insight to all DNOs as they consider how to establish such a link for their business.

Recommend updates to NETS SQSS: The CLASS Project will recommend changes to the National Electricity System Security and Quality of Supply Standard in the area of demand response. The network monitoring equipment, used for data collection to inform the change proposals will continue to collect data and monitor the network after the LCNF Project finishes, as it will form the basis of a fully funded National Grid Long Term Monitoring Study. The aim of the monitoring study is to assess the changes over time of the demand response which will help the industry understand what changes occur over time as more DG and low carbon technologies get connected to a distribution network.

Carbon and economic modelling: CLASS will share the methodology and results of the carbon and economic modelling undertaken in the Project, to enable other DNOs and third parties to assess the feasibility of adopting dynamic voltage regulation techniques.

Stakeholder Engagement: The customer engagement methodology will incorporate lessons learnt from previous LCN Funded Projects. This early learning has provided an insight into what works and what doesn't. The overall engagement defined within the Learning and Dissemination approach has been developed from the early learning from other projects, but will also trial new innovative approaches with CLASS. The outcome of the engagement is that new information will be presented to the industry as to how best to engage with customers and stakeholders and what the most effective/appropriate channels are in creating a positive experience.

## 4: Evaluation Criteria contd.

**Future Commercial Market Provision:** A secondary outcome from the Project is the greater understanding in what capacity these techniques can and should be deployed. The CLASS Project will not consider the commercial; market and regulatory aspects of a DSO providing these demand response and/ or reactive power capabilities to the Balancing Services Market. We anticipate that subsequent projects will include this because it will be important to understand how the UK can best deliver its decarbonisation agenda in the most cost effective and efficient way whilst maintaining system security.

### Involvement of other partners and external funding

The CLASS Project has a strong consortium of Partners with proven delivery credentials, who are driven to prove at scale that the concept and techniques can be employed to provide a real benefit in enabling the UK to transition to a low carbon economy (See Figure 8). The Project Partners were selected in a quasi-competitive manner, based on the following three criteria:

1. Prior experience in scope of work and reliability to deliver;
2. Involvement represents value for money for CLASS; and their
3. Commitment to Electricity North West, the Project its success and the dissemination of the learning gained.

CLASS's Partners are the leading experts of their fields, be it in research, technology or customer engagement. Below is a list of our Project Partners with a summary of both the scope of work they will undertake in CLASS and how their prior experience supports this.

**The University of Manchester:** The University of Manchester is regarded as one of the leading universities in the world for Electrical Engineering in both its academic curriculum and research.

*Prior Experience brought to the Project*: The University's Electrical Energy and Power Systems Group has deep knowledge and experience in network modelling, power system dynamics and electrical asset health profiling. The well-respected Tyndall Centre for Climate Change Research (at The University of Manchester) will support the carbon impact assessment work within the CLASS Project. Tyndall brings together the leading scientists, academics, economists, and engineers to develop sustainable responses to climate change for the GB economy.

*Role on Project:* The University of Manchester will undertake the following three studies as part of CLASS:

1. Network modelling & analysis: This study researches the profiling of network demand and estimates the network demand response from voltage decrement and increment. The key outputs from this study are the methodology for characterising the demand response from a Primary substation depending on the customers connected and the Relationship Matrix for use in the Dashboard.
2. Voltage profile modelling study: - This study uses the load models developed in the first study and models the capability of Primary substation to deliver demand response and reactive power absorption capability. The model will be validate against the measurements from the Trials and then used to confirm voltage compliance across ENWL's network. The key outcome of this study is the analysis that confirms network voltages at customers' premises will meet statutory limits during use of the dynamic voltage regulation techniques.
3. Asset health study - This study looks into the short to long term impact of adopting dynamic voltage regulation techniques.

These three studies will use the monitoring data gathered within the Trials. The University of Manchester will initially develop and enhance the Relationship Matrix, over the life of the Trails that sits within the Dashboard, to provide an accurate relationship between demand and voltage. The Tyndall Centre for Climate Change Research will undertake the carbon impact assessment study within the CLASS Project. The University of Manchester will be a key learning and dissemination partner for CLASS.

**Parsons Brinkerhoff:** Parson Brinckerhoff is experienced in all aspects of power generation, transmission and distribution, and has particular expertise in the regulatory and restructuring aspects of the industry.

*Prior Experience brought to the Project:* Parson Brinckerhoff works extensively with Electricity North West, in both normal business activities and Future Network Projects (for example Parson Brinckerhoff is working on the Capacity to Customers Project), and the wider industry. Their deep knowledge of the distribution network industry means it understands the engineering aspects of the CLASS Project and the selection of Primary substation for the Project in order for the findings to be regarded as both credible and representative to the GB DNO community. The organisation has also in recent years been involved in delivering key industry papers on planning and policy.

## 4: Evaluation Criteria contd.

*Role on Project:* Parson Brinckerhoff has a number of advisory roles within the CLASS Project. The organisation will finalise the selection of Primary substations sites for CLASS; and manage the consultation process in understanding which aspects of NETS SQSS are affected by the proposed GB roll out of CLASS an Parson Brinckerhoff will be a key learning and dissemination partner for CLASS.

**Chiltern Power:** Chiltern Power is a specialist consultancy focusing on the technical, commercial and regulatory aspects of power systems.

*Prior Experience brought to the Project:* Chiltern Power has been involved in several LCN Fund Projects and worked with the ENA in developing its Future Networks Strategy and programme. John Scott of Chiltern Power wrote the original planning standard, PLM-ST-9 which defined the demand response of distribution networks. The details of PLM-ST-9 were subsumed within NETS SQSS.

*Role on Project:* Chiltern Power will lead the consultation process for developing the change proposals for amending NETS SQSS. John Scott will also support the learning and dissemination of any changes or amendments.

**National Grid:** National Grid owns and operates the high voltage electricity transmission system in England and Wales and, as National Electricity Transmission System Operator (NETSO), operates the Scottish high voltage transmission system and also the GB offshore transmission network.

*Prior Experience brought to the Project*: National Grid has been actively involved in the delivery of a number of IFI and LCN Fund Projects, and play a key role in developing electricity industry codes of practice and policy. They have also led a number of dissemination workshops around demand response, and understand first-hand the challenges posed to the GB network, due to the connection of low carbon and/ or renewable generation and adoption of low carbon technologies.

*Role on Project:* National Grid is responsible for the technical build of the ICCP link within their business and will support the overall build as well as end-to-end testing of the link into Electricity North West's PowerOn Fusion Solution. In addition, National Grid will be actively involved in the testing of the four Trials and will support the work in understanding which aspects of NETS SQSS require amending for the roll out of the CLASS Solution.

National Grid will also be a key learning and dissemination partner for CLASS.

**General Electric (GE):** GE is one of the world's leading technology vendors of power generation and energy delivery technologies.

*Prior Experience brought to the Project:* GE has extensive LCN Fund experience and was previously involved in the installation of the PowerOn Fusion suite within ENWL's Capacity to Customers Project.

*Role on Project:* GE will install both the software and hardware of the ICCP Link, and ensure that any necessary configuration with ENWLs PowerOn Fusion suite is completed and rigorously tested before the Trials are undertaken. GE will also be a key learning and dissemination partner for CLASS.

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**Siemens:** Siemens is one of the world's leading technology vendors of power generation and energy delivery technologies.

*Prior Experience brought to the Project:* Siemens is a global technology vendor, with extensive experience in successfully providing and implementing smart solutions into DNOs. The organisation as a result offers a portfolio of services and products across the Smart Grid ecosystem, and is able to draw from the experience and knowledge that has been acquired in the delivery of such solutions on a global basis.

*Role on Project:* Siemens will supply, install and configure the substation Voltage Controllers at the Primary substations. Additional support will be provided to ensure that implementation of both the software and hardware will successfully interface with the existing systems and that all the necessary testing occurs. The successful supply and installation of the aforementioned will enable Electricity North West to Trial the dynamic voltage regulation techniques.

Siemens will be a key learning and dissemination partner for CLASS.

## 4: Evaluation Criteria contd.

**Impact Research:** Impact Research is a leading marketing and customer engagement organisation within the UK.

*Prior Experience brought to the Project*: Impact Research is a leading marketing research organisation with extensive experience in customer engagement activities within the utilities industry. The organisation has successfully delivered a number of LCNF Projects.

*Role on Project:* Impact Research will support the customer engagement of CLASS by co-ordinating the end-to-end delivery of customer surveys during the Project.

### Relevance and Timing

The core value of CLASS lies in the opportunity to manage the existing assets in a smarter way to help resolve the future challenges driven by the transition to the low carbon economy. Its relevance as to "why now" is to understand and prove that these novel techniques work at scale in good time before any GB wide deployment.

Other Second Tier LCN Fund Projects are attempting to understand the impact on the network from increasing distributed generation and/or demand and develop mitigation techniques. Instead CLASS looks at using what there is now in a smarter way, to help shape how the future DNO business operates.

**Smarter use of existing assets**

The CLASS Solution is a novel method of using dynamic voltage regulation to actively manage capacity constraints on the network. Applying this method provides the opportunity to deliver additional network capacity and defer carbon intensive network reinforcement. The likelihood of such a technique being adopted at an Electricity North West and GB wide scale is very high as this smart method is based around existing assets that are going to be applicable for any DNO business in the foreseeable future regardless of the market arrangements. The low cost CLASS Solution provides a DNO with the flexibility of adopting such techniques at specific Primary substations to manage peak demands and provide location-based reactive power absorption capability or at all Primary substations to derive a network wide demand response and reactive power absorption capability. Dynamically regulating voltage, as proposed in CLASS, will facilitate the move to a low carbon economy in a non-intrusive way with respect to the customer and without impacting other government initiatives (e.g. Smart Metering Deployment).

**Future business planning & Price Controls**

The outcomes of CLASS, could have a significant impact on the mid-term RIIO-ED1 review arrangements, and fundamentally change the operating model of a DNO in a number of ways. The ability to delay network reinforcement and to potentially provide demand response and reactive power absorption capabilities to the Balancing Services Market through commercial arrangements will take a DNO business one step closer to including a DSO role. In addition, the development of the Dashboard and the Relationship Matrix will deliver a standardised platform which through the connection via ICPP can be shared with National Grid in its role as NETSO. The inclusion of a dynamic DNO-NETSO link will improve a DNO's timely response to executing a mandatory voltage reduction under the Grid Code, OC6.

There will be little or no impact on the outcomes from the CLASS Project if the increase in the distributed generation and acceleration of adopting low carbon technologies does not occur or occur at the rate anticipated. The knowledge and benefits derived by CLASS warrants it being incorporated into a DNO's future operating model or business plans. This is because the opportunity window derived by the CLASS Solution from deferring reinforcement and the associated carbon and costs savings both in the short to long term, is of value. Electricity North West will incorporate the findings and conclusions throughout the Project's lifecycle into its future business planning and price control discussions.

**Knowledge and Learning**

The knowledge and learning from CLASS will complement and build on a number of international studies on `Conservation Voltage Reduction' techniques by providing the first study of the new techniques within a deregulated energy market.

## 4: Evaluation Criteria images, charts and tables.

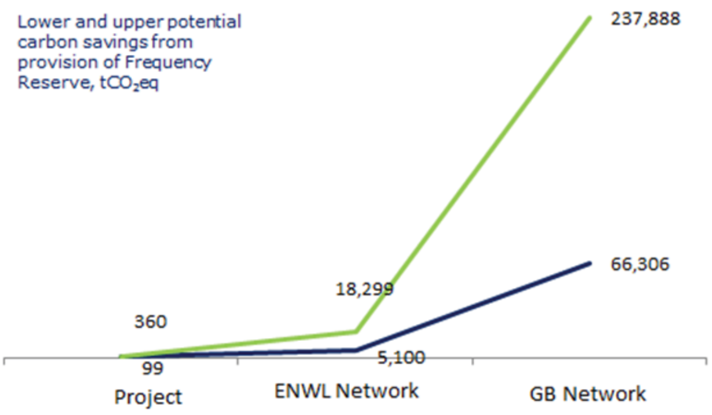



Figure 6: Potential range of carbon savings from provision of frequency reserve

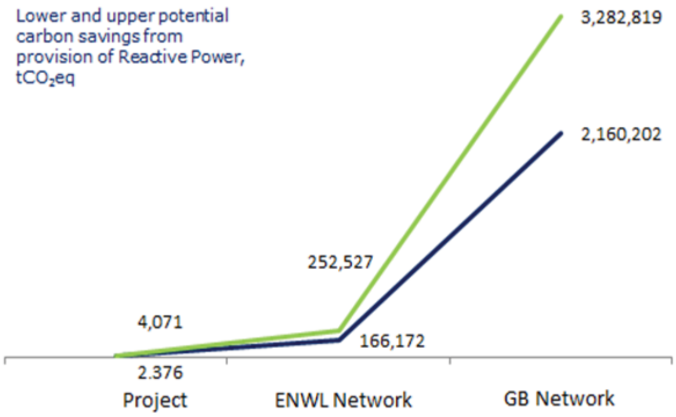



Figure 7 : Potential range of carbon savings from provision of reactive power

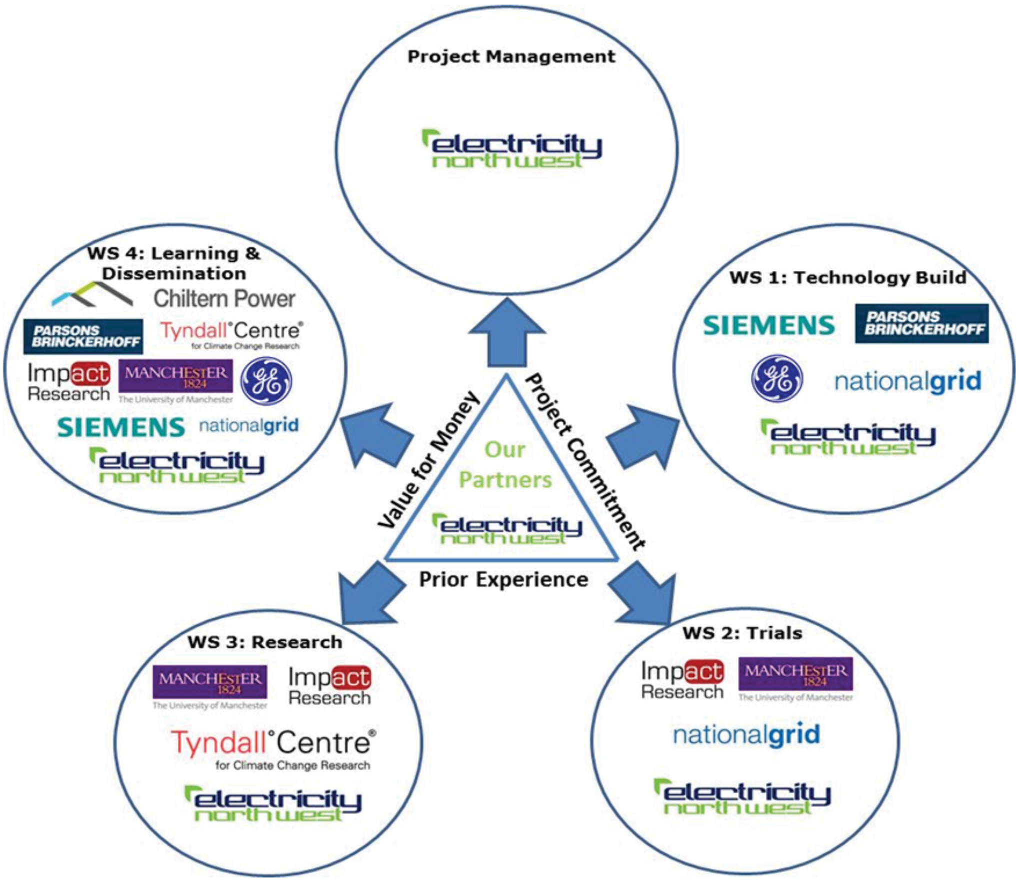



Figure 8 : CLASS Eco-system

# Section 5: Knowledge dissemination

☐ Put a cross in the box if the DNO does not intend to conform to the default IPR requirements

*We will generate significant knowledge that through a structured dissemination program will reach all our stakeholders.*

The CLASS Project will provide the knowledge of whether or not, by adopting the voltage regulation techniques, a DNO can create a range of demand response and reactive power capabilities and apply them to save costs and reduce carbon for customers. The knowledge collected and the manner in which it is disseminated is central to CLASS, as it must provide all audiences with the necessary evidence and confidence for the adoption of the CLASS Solution.

**Audiences**

We identify our main audience/stakeholders as being:

*Customers*: The customer is a crucial part of our dissemination agenda as the voltage regulation techniques will benefit them. Electricity North West has identified that there will be a variety of end customers that we will need to engage within CLASS, from the all the customers in the Trial area to those which will actively participate in the Trials by completing the customer surveys. Within these groups Electricity recognises that not only will their specific interests differ but also level of understanding of demand response , power quality and the low carbon agenda. Informing and engaging our customer in demand response is important as it will provide an insight into the role that DNOs are able to play in the transition to a lower carbon economy.

*Consumer Groups:* Consumer Focus and The Climate Change Group will have a keen interest in the customer impact during the Project and afterwards; especially if the recommendations in the close down report identify using voltage regulation techniques is a viable approach and should be implemented at a GB level.

*Energy Industry Participants:* Our industry participant audience consists of the Generators, Network Operators (ie DNOs, IDNOs, TOs etc) Retail Suppliers, Aggregators, technology vendors, equipment manufacturers, NETSO, and the Balancing Settlement Organisations. All of these energy industry participants will wish to gain a better understanding of one or more of the following:

- Generators, in particular those that supply renewable forms of intermittent energy, will be keen to understand how the utilisation of voltage regulation techniques will impact their business;
- DNOs and IDNOs will be interested in understanding how best they can apply the lessons learnt into their networks to deliver benefits to their customers, in terms of lower cost and lower carbon footprint;
- Retail Suppliers will be keen to understand what the impact is to the customer and their businesses as network operators apply these innovative voltage regulation techniques;
- The technology vendors and equipment manufacturers will be interested in understanding what the impact is on the health of the assets as network operators use voltage regulation techniques, and how the findings and knowledge gained could be incorporated in the development of future products and services;
- Aggregators will be keen to understand if and how the creation of the new network services impact on their business models;
- NETSO and the Balancing Settlement Organisations (eg Elexon) will be interested in understanding how the creation and use of new network services impact on the current systems, incorporating the change in role from a DNO to become more like a DSO.

*Industry Groups:* Our main industry group audience includes the Energy Networks Association (ENA), the Smart Energy Demand Coalition (SEDC), Energy UK and industry lobbyist groups such as Smart Grid GB. The industry groups will be keen to understand our Project outcomes and any impact on DNO and GB network design, operating models and industry regulation.

## 5: Knowledge dissemination contd.

*Academic Institutions:* This will include universities and higher education institutions with an interest in this Project. Their primary interest will lie in access to, and analysis of the raw data that is collected during the CLASS Project, and how they can use this information as part of their on-going programmes. They may also validate or identify alternative conclusions from those which have been identified by our academic Project Partner. These institutions are also likely to have an interest in the engineering mathematics and technical design of the Project.

*Government and Regulator:* DECC, Ofgem and other policy makers will be primarily interested in the outcomes of the Project as it has the potential to change how network operators manage their network and provide network services to other system operators.

*Local Groups:* Local groups including local councils, business leaders, Chambers of Commerce, Greater Manchester Energy Group will be interested in the impact on customers and so will form part of our main audience.

*Electricity North West:* The knowledge and learning developed from this Project will be shared and actively discussed within both the CLASS Project team and in the wider Electricity North West organisation. Teams throughout the organisation e.g. network planning, finance, regulatory policy and our field engineers will be interested in all aspects of CLASS to understand where and how it can be best incorporated and applied in the future, making it business as usual. The CLASS Project team will continually share the knowledge and learning across all parts of our business.

### Dissemination Approach

We will tailor our dissemination in order to best match the interest and structure of each of our stakeholder, identified above. As a result, our approach is pragmatic, simple and targeted, and will use a number of different dissemination mediums to enable individuals to maximise their learning through which ever learning style(s) they prefer. The learning and dissemination approach for CLASS recognises that the key dissemination and engagement mediums must enable two-way communication with our audience. This feedback mechanism will allow the Project to develop a CLASS community for all interested parties and ensures that CLASS is responsive to its environment. The following are some of our proposed dissemination approaches:

*CLASS Website:* The CLASS website will be the hub for all dissemination. It will provide the main public access point for upcoming events, reports, and lessons learnt. This website will have an active blog which will be regularly updated, enabling active participation. In addition to these features the website, will act as the main repository for data and, will enable users to request access to the raw data collected during the Project.

*Video Podcast and Social Media:* Electricity North West has developed a three part seminar series which will educate the viewer at a basic level about the CLASS Project by providing video podcast tutorials on voltage regulation technology and its potential for savings costs and carbon. Additional social media tools such as LinkedIn and Twitter will be used in forming community groups and updating any interested parties on the latest events and Project developments.

*Internal Electricity North West Communications:* Internal team briefing meetings will be held throughout the Project to ensure that the progress and key learnings are shared across the wider organisation. At specific points in CLASS, the Project team will submit articles to Electricity North West 's bimonthly magazine and update the company intranet site to inform the wider organisation of the Project and the various elements that build up the project. This will ensure that the knowledge, lessons learnt and project progress is disseminated to all parts of the business.

## 5: Knowledge dissemination contd.

*Lectures, Conferences & Dissemination Workshops:* We are proposing to hold six dissemination workshops throughout the Project lifecycle. We intend deliver three of these workshops through the normal conference type arrangement, whilst for the remaining three dissemination workshops we will trial the use of webinars as a means of disseminating and engaging with our stakeholders. At these workshops, the Project team will discuss the progress being made to date and enable an environment for all interested parties to actively participate. The Project team will also deliver presentations at a number of industry conferences and the LCN Fund Annual Conference during the life of the Project.

*Six Monthly Progress Reports:* These reports, which go directly to Ofgem, will provide valuable information on the progress being made by the Project; they will also be published on the CLASS website, The feedback will be focused on the overall CLASS Project delivery and provide Ofgem with insight into the learning from CLASS, that will help shape and continually improve the LCN Fund type Programmes

*Press Releases:* The Electricity North West press office will release a number of articles throughout the Project highlighting CLASS, key events and outcomes.

*Journal Articles:* The Project will publish a three peer-reviewed journal articles on topics such as voltage regulation techniques and the carbon footprint or demand response under smarter network designs during the Project lifecycle.

*Close out Report:* A final close out report will be drafted and shared with all interested parties. The report will present the key findings as well as lessons learnt in undertaking the CLASS Project

To ensure that we are providing the right groups with the right information we have defined, in table 4 overleaf, the key deliverables to be generated throughout the course of the CLASS Project, by Project Partner, at each appropriate milestone. These represent examples of the key documents that will be disseminated throughout the CLASS Project.

### Management and Timing of Dissemination

All of the dissemination work will be managed through the Learning & Dissemination Workstream. The key role of this Workstream is to ensure that the right deliverables are made available to the right audience through the methodologies discussed above. The majority of learning will be disseminated in the latter stages of the CLASS Project once all the data has been analysed and conclusions drawn, as is only appropriate. But we aim to distribute at least one piece of key learning every 6 months. Our overall approach in the collection and dissemination of knowledge is very pragmatic and tailored, making sure that the right information is delivered to the right audience in the appropriate manner. This can be seen in table 5. Ensuring that we are able to effectively engage and convey the key learnings of something relatively complex in a simple manner to any and all interested parties.

## 5: Knowledge dissemination images, charts and tables.

| Milestone | Deliverable | Responsible |
|---|---|---|
| Selection methodology Report | Description of the sites selection methodology – which Primary substations we choose and why | ENWL, PB & UoM |
| Installation methodology | Technical documentation on the installation methodology for the retrofit at a typical GB Primary substation with voltage control equipment and monitoring | ENWL & Siemens |
| ICCP Configuration | Technical documentation on the operational ICCP link and undertaking of Trials between ENWL and National Grid | ENWL, NG & GE |
| Dashboard | Technical specification on the development of the dashboard | ENWL , NG & GE |
| Voltage/Demand Relationship Matrix | Mathematical documentation on the demand/voltage relationship Matrix | ENWL & UoM |
| Network Data | Full set of raw data within project database | ENWL & UoM |
| Customer Survey | Customer engagement report including the survey feedback for Trial and control-group customers | ENWL & UoM |
| Network Modelling & Analysis (Academic Report) | Site selection characteristics for estimating potential demand response | ENWL & UoM |
| Voltage Profile Modelling (Academic Report) | Study modelling the network wide voltage profiles, confirming voltage compliance validated from data gathered during the Trials | ENWL & UoM |
| Asset Health Study (Academic Report) | Study investigates the short to long term health impact of adopting dynamic voltage regulation techniques | ENWL & UoM |
| NETS SQSS Change Proposal Report | Based on the results of the Trial a consultation document will be drafted detailed the recommended changes to NETS SQSS relating to Demand Control | ENWL, CP, PB & NG |
| Carbon Assessment (Academic Report) | Carbon methodology and impact assessment of CLASS Solution | ENWL & Tyndall Centre |
| CLASS Project closure & Long Term monitoring study by National Grid | Closure report and hand-over documentation for the Long Term Monitoring Study managed by National Grid | ENWL & NG |

Table 4: CLASS Deliverables

| Audience | Dissemination Method | Milestone |
|---|---|---|
| Customer | CLASS Website, Whitespace, Publicity, | Customer Survey, Carbon Assessment |
| ENWL | Internal Workshops, Intranet site, newsletter | *All key deliverables* |
| Energy Industry Participants | CLASS Website, Whitespace, Webinars, Learning Events | *Various depending on area of interest* |
| Academic Institutions | CLASS Website, Whitespace, Webinars, Learning Events | Network Data & Academic Reports |
| Industry Groups | CLASS Website, Whitespace, Webinars, Learning Events | Network Modelling & Analysis ,Carbon Assessment, CLASS Project closure & Long Term monitoring study by National Grid |
| Government /Regulator | CLASS Website, Whitespace, Webinars, Learning Events | Customer Survey, Carbon Assessment, NETS SQSS Change Proposal Report |
| Local Groups | CLASS Website, Whitespace, Publicity, | Selection methodology Report, Customer Survey, Carbon Assessment |
| Consumer Groups | CLASS Website, Whitespace, Publicity, Learning Events | Customer Survey, Carbon Assessment |
| Other | All of the above depending on individual or group | *Various depending on area of interest* |

Table 5 : CLASS Audience and Dissemination Methods

# Section 6: Project readiness

**Requested level of protection require against cost over-runs (%).**

**Requested level of protection against Direct Benefits that they wish to apply for (%).**

*By applying proven technology in an innovative manner, engaging with diverse customer groups and our experienced partners we have a high degree of confidence over delivery*

Electricity North West is confident it is able to start CLASS in a timely manner due to the preparation that has taken place pre-proposal, proposal and those that will take place should the submission be successful. These factors are discussed in more detailed below but essentially can be summarised as the following:

- Innovative Funding Incentive (IFI) Study and Scope of Work Reports
- Partnership Consortium & Contractual Arrangements
- Project Governance and Methodology Structure
- Project Plan
- Risks, Mitigation & Contingency Strategy
- Use of existing infrastructure
- Customer engagement
- Project Costs and Direct Benefits.

**IFI & Scope of Work Reports**

CLASS was borne out of an Electricity North West `Proof of Concept' IFI funded project. The IFI Project sought to understand at a high level whether or not there was a case for submitting the proposed novel method of trialling dynamic voltage techniques as a Second Tier LCN Fund Project. It concluded how the dynamic voltage regulation techniques identified could be trialled and the effects monitored to identify the quantifiable and non-quantifiable benefits to Electricity North West its customers, and ability to facilitate the GB transition to a low carbon economy. A number of feasibility and project preparation reports have been produced by The University of Manchester, building upon the IFI Project, and these are briefly identified below:

- Selection of load measurement locations & data collection requirements for load modelling
- Methodology for the selection of Primary substations
- Quantification of the potential Electricity North West Network to provide MW and MVAr to GB
- Feasibility study notes on system benefits from flexible transformer tap changer operation
- Assessments of timing of transformer tap changers
- Dynamic Response of Load

These reports have identified opportunities and enhanced CLASS's proposed methodology by building on recent research in Conservation Voltage Reduction (CVR) in North America and the study undertaken by ESB in Ireland. PB's review and validation of The University of Manchester's reports concluded that there is a need to undertake the Project to prove the CLASS Method is viable in GB. In addition, CLASS will enhance the work previously undertaken worldwide, whilst taking GB-specific factors into account. These factors are expected to include GB (BEBS) specifications for existing Primary equipment, including on-load tap-changers and, in particular, GB's customer load characteristics which differ from North America (with air conditioning load) and Ireland, which has yet to migrate from traditional (tungsten filament) lighting to low energy alternatives. PB also restated the necessity to consider how novel low carbon devices may also change GB's CVR characteristics over the next several years. The reports developed by The University of Manchester and validated by PB ensure that the outcomes extrapolated demonstrate that the Project is both statistically, technically representative and credible for wider GB adoption. Finally the University of Manchester's academic rigour, when combined with the Project Partners' industrial and commercial expertise, will ensure that the Project will deliver on its objectives.

## 6: Project readiness contd.

### Partnership Consortium & Contractual Arrangements

One of the key criteria for building a robust CLASS Project was in the selection of the relevant Project Partners, and the forming of a strong dedicated consortium. Identification of our preferred Partners was undertaken after a quasi-competitive tendering process had taken place, culminating in their selection by members of the Electricity North West 's Future Networks Steering Group.

As part of the proposal, Electricity North West have ensured that the consortium is in a position where all our Partners are aligned to the CLASS Project requirements, and are able to commit to and meet their scope of work and defined deliverables. The work schedules that have been developed together with our Partners ensure that CLASS is in a unique position to add the agreed work schedules to existing contractual arrangements.

In addition, Electricity North West has received confirmation from our Partners regarding the Project Plan (See Appendix E), financial costing, contributions and the provision of services/ products. One of the key outcomes of this is that Electricity North West 's approach minimises time spent on agreeing contractual agreements and ensures that the Project is ready to go once funding has been granted.

### Programme Management and Governance

CLASS will use the standard Programme Management and Governance approach which has been enhanced by undertaking the previously funded LCN Capacity to Customers Project. The Project governance structure will ensure that CLASS meets and where possible exceeds the delivery criteria and milestones identified. Project success will be achieved by the bottom-up proven governance methodology and the top-down philosophy to be open, collaborative, and committed in getting it right first-time.

Ultimate Project direction will come from the Project Director, Mike Kay, Network Strategy Director of Electricity North West. Key decisions and sign off will however be managed by a Project Steering Committee, consisting of representatives of the various Project Partners. The Steering Group Committee will sit above the Programme Management Office (PMO), and will have access to the day to day running of the Project enabling them to make key informed decisions as to the strategic direction of CLASS.

### Project Plan

The Project Plan sets out the approach that the CLASS Project team has determined to bring the highest likelihood of success. The Plan identifies four Workstreams in addition to the mobilisation and close down phases. The Plan is described below and shown diagrammatically in Figure 9, a more detailed version is in Appendix E.

1. *Mobilisation Phase:* The mobilisation of both internal and external teams, as well as the retention of those individuals across the Project delivery lifecycle is crucial to the successful start of CLASS. Within Electricity North West we have identified two full time dedicated resources to the delivery of the Project, managed by a full time Electricity North West Project Manager. The team will also receive significant support from within the wider Future Networks and Capacity to Customers teams. All the Partners have identified resources that will be dedicated to the CLASS Project.
2. *Technology Build:* During the Technology Build Workstream, all of the software and hardware will be predominantly installed on Electricity North West 's estate with some ICT enhancements on National Grid's. This Workstream sees the installation and configuration of the voltage regulation control systems, network monitors, re-configuration of the RTU's and the development of ICT changes eg dashboard, ICCP Link.
3. *Trials:* During the Trials Workstream voltage regulation techniques will be carried out as part of the defined Test Regime, led by Electricity North West and involving National Grid via the use of the ICCP link. Alongside the Test Regime five customer surveys will be completed by Impact Research from both selected customers in the trial area and those that form part of the control group.

## 6: Project readiness contd.

4. *Research:* The Research Workstream will be led by The University of Manchester who will carry out the research and analysis of data collected, to answer a number of key questions (ie Hypothesis) and deliver a number of key learning's. The University of Manchester will publish these reports drawing conclusions on the viability for a DNO to use the dynamic voltage regulation techniques to resolve the aforementioned challenges

5. *Learning & Dissemination:* The Learning & Dissemination Workstream will incorporate all knowledge dissemination activities from website development, recording of video podcasts to the presenting at conferences. It's important to note that these activities are defined in internal and external dissemination activities, via a number of tailored communication channels for the audiences CLASS has identified.

6. *Close Down & Long Term Project Handover Phase:* During this phase the CLASS Project will be wound down, new equipment will be decommissioned and the Close Down Report drafted, approved and published. Rather than decommission the network monitoring equipment at the end of the Project, it has been agreed that the network monitoring equipment will be kept in service and the data will continue to be made available to National Grid as part of a **Long Term Monitoring Study**, lasting 10 years. National Grid, with support from The University of Manchester, will monitor how the voltage/ demand relationships changes over time with the increase of renewable generation and low carbon technologies connecting to the distribution network.

The Project Plan mitigates the identified risks as far as possible and provides a clear roadmap to steer and to support the Project delivery team in achieving the relevant milestones on time and within budget.

**Risks and Mitigation**

Embedded within our Project management methodology is the capability to manage risks and issues. CLASS will adopt the successful Risk and Issues process currently in operation within Electricity North West. The Risk and Issues Model employed considers risks and issues that are business-as-normal and those specifically related to the CLASS Project all of which will be articulated in a common format. Appendix D outlines the risks that have been identified prior to the start of the CLASS Project. Within the risks model, likelihood and consequences will each be given a score from 1 to 5, and the resulting product of these two ratings used to score and rank the risks on the CLASS Project. The model has been used and refined for many years and has been found to be both robust and recognised as an exemplar approach.

The format and description of the Electricity North West scoring matrix is presented in Appendix E. The scoring matrix will be used by the PMO and Project Steering Committee to continually review Project risks, their mitigating action(s) and controls, and to ensure that risks are managed in priority order. The risk model describes the Methodology for determining an `uncontrolled' risk score. However, if control measures are applied, aimed at reducing the hazard and/or mitigating the risk, it should be possible to produce a `controlled' risk score that is lower than the `uncontrolled' risk.

Also in place is a risk escalation process which documents how certain risk types are escalated up through the Project team. The governance processes to be operated across the Project Partners, will regularly review risks and issues and either remove these if agreed mitigation has occurred and/or bring new issues or risks to the attention of the Project Steering Committee.

The Committee will agree management actions, which may lead to the Project being halted until such time as sufficient mitigation has occurred to enable on-going management of the risk or issue, or to halt the Project and defer further commitment until agreement has been reached with Ofgem on how to proceed. Mitigation and contingency management will form a key part of the risk strategy. When a risk is raised the Project team will be responsible for creating a mitigation action that can be brought into play should the risk be realised.

## 6: Project readiness contd.

### Use of existing infrastructure

The CLASS Project investigates the novel application of dynamic voltage regulation using existing assets. Wherever possible the CLASS Project re-uses infrastructure that have been developed and funded by other means. For example, the CLASS Method will use the PowerOn Fusion hardware and software previously funded in the Capacity to Customers Project; and the ICCP infrastructure funded by National Grid. This increases the value for money of the CLASS Project, and facilitates the Project's readiness.

The uncertainty regarding the costs and installation of the Primary substation Voltage Controllers has been de-risked from the knowledge gained during the sample site surveys undertaken by Electricity North West and Siemens.

### Customer Engagement

Throughout the bid preparation process Electricity North West has discussed customer engagement with Impact Research, our customer survey provider, and three Retail Suppliers. We do not underestimate the effort required to engage with customers in the Trial and these discussions has helped us scope out a comprehensive approach to managing the customer relationship.

### Project Costs and Direct Benefits

The CLASS Project costs have been calculated using input from the Project Partners and a finance resource from Electricity North West . Where applicable the resource costs have been broken down to a day rate and extrapolated over the period of the CLASS Project using the RPI forecast that Ofgem defined.

Within the overall cost calculation we have added an additional 7% as contingency against any potential changes to costs as the Project continues. Benefits and costs have been put through Electricity North West's internal investment appraisal process and approved.

The overall budget will be managed by a Management Accountant embedded in the CLASS Project team. They will be responsible for managing all costs and constructing and delivering the reporting requirements as part of the CLASS Project. Electricity North West will run a robust financial tracking and reporting system in line with its current internal policies and frameworks. As per the Ofgem requirements the Project finances will be held in a separate Project Bank Account which will meet the following requirements:

- Show all transactions relating to (and only to) the CLASS Project;
- Be capable of supplying a real time statement (of transactions and current balance) at any time;
- Accrue expenditures when a payment is authorised (and subsequently reconciled with the actual bank account);
- Accrue payments from the moment the receipt is advised to the bank (and then subsequently reconciled with the actual bank account);
- Calculate a daily total; and Calculate interest on the daily total according to the rules applicable to the account within which the funds are actually held.
- Electricity North West will engage with our auditors, Deloitte, to alert them of their potential responsibilities should CLASS be awarded the funding.

6: Project readiness contd.

## 6: Project readiness contd.

### 6: Project readiness contd.

## 6: Project readiness images

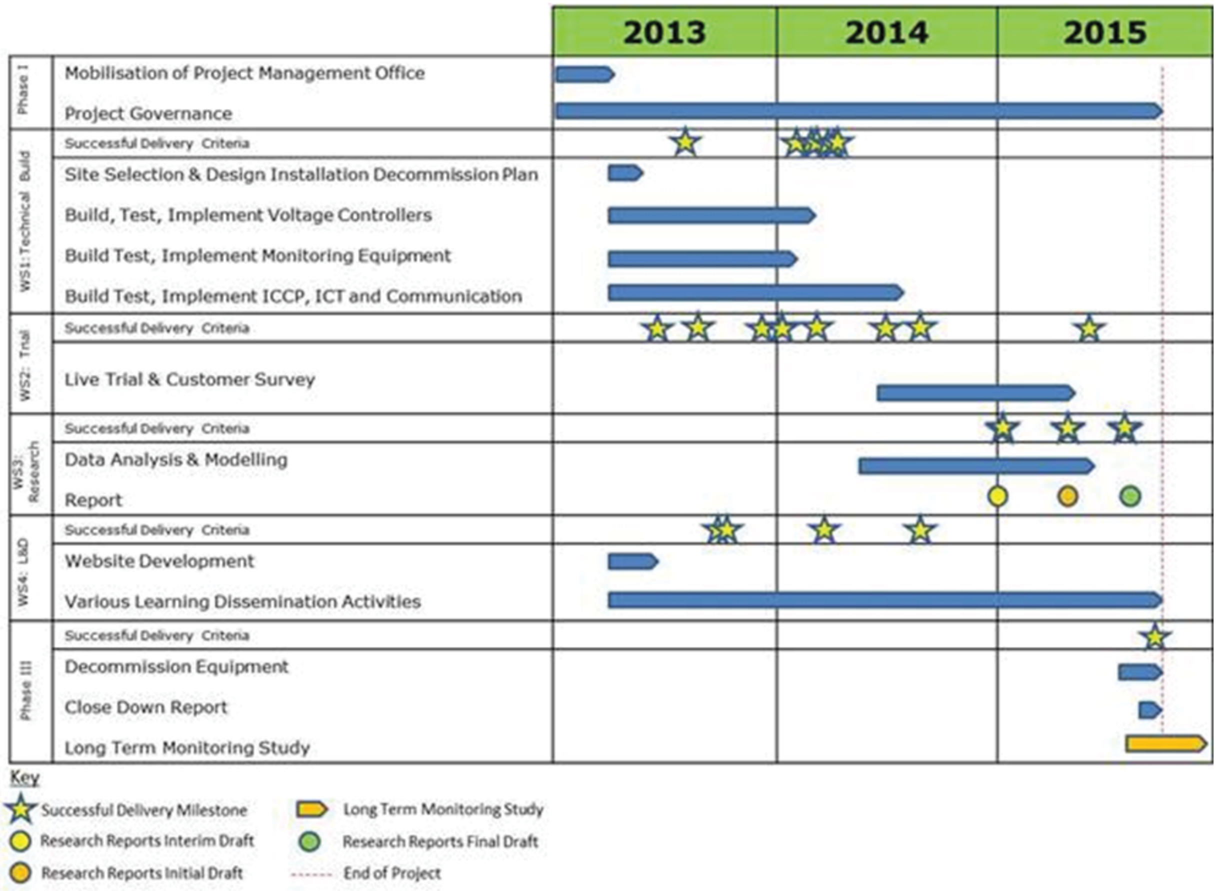



Figure 9 : CLASS High Level Project Plan

# Section 7: Regulatory issues

☐ Put a cross in the box if the Project may require any derogations, consents or changes to the regulatory arrangements.

**Regulatory Impact**

We do not expect that the CLASS Project will require any derogation, licence consent or licence exemption. CLASS explores increasing the flexibility of the existing network assets to trial new techniques for the active management of the distribution network. The learning from the Trials will allow the CLASS Project team to contribute to updating of the Planning Standard, NETS SQSS.

**Long Term Monitoring Study and NETS SQSS**

The CLASS Method will investigate the demand response delivered by a decrease or increase in network voltage. National Grid's Planning Standard, NETS SQSS was originally drafted using data collected by the nationalized industry. The data collected in the Trials will allow the planning standard to be brought up to date. National Grid has agreed to fund the operation and maintenance of the network monitoring equipment and the collection and analysis of data for a further 10 years after the CLASS Project is closed down, allowing the planning standard and modeling assumptions to be periodically updated and changes in demand response to be tracked.

**Long Term Regulatory Impact**

In the longer term CLASS could have profound implications on the operation of distribution network and the involvement of customers in its operation, especially in the development of centrally managed demand response. The potential longer term impact on the regulatory regime applied to network operators is significant with the following areas seeing change:

- Regulatory regime for load related capital expenditure;
- Losses regulatory incentive mechanism;
- National Terms of Connection within Distribution Connection and Use of System Code (DCUSA);
- Distribution and Grid Codes;
- Future opportunities to provide services into the Balancing Services market and the regulatory treatment of such network services; and
- Future DSO operational management.

## 7: Regulatory issues contd.

## 7: Regulatory issues images, charts and tables

Regulatory issues images

Regulatory issues images

# Section 8: Customer impacts

**Customers within the CLASS Project**

The CLASS Method will be trialled on 60 Primary substations located across Electricity North West's network involving about 350 000 customers. Trial sites will be identified as part of the site selection methodology, from which the various customer types will be highlighted. By having identified the affected customer types in the CLASS Trials, Electricity North West as part of the customer engagement plan will segment these customers into three groupings that will be indirect or directly involved:

1. Customers in the Trial area
2. Customers in the Trial area who will participate in the customer survey; CLASS will target the participation of 250 domestic and 100 industrial and commercial customers in the year long survey.
3. Customers outside the Trial area but in the Control Group who will participate in the customer survey; CLASS will target the participation of 250 domestic and 100 industrial and commercial customers in the yearlong survey.

Electricity North West understands that without the support and buy-in of our customers, the Project will not succeed. For this reason CLASS will ensure the customer journey is a good experience by being: informative and easily understood; timely in its response; and accurate in the messages, learning and outputs that the Project conveys. Throughout the Project, Electricity North West will engage with all Trial customers via a number of tailored communication channels and mediums (ie written and Audio & Visual) to explain the CLASS Project, to provide a basic understanding of demand response and the low carbon agenda, and why it's important. The main engagement with the three customer groups will occur during the Trials Workstream of the Project. A more detailed impact assessment is provided by further analysing the customer groups, the method of sampling, recruitment process, and interviewing process.

**Customer Groups**

*Customers in the Trial area*

Electricity North West will publicise the CLASS Project, the Trials and the Trial sites using a range of multi-media communication channels. Press articles in local newspapers will raise the awareness of the CLASS Project. The Electricity North West and CLASS websites will contain information from the scope of the Project to the Trials, the Trial areas, how to get involved, and how best to get into contact with the CLASS Project team. Additional supporting material such as customer pamphlets will also be created to convey the key message of CLASS being non-intrusive and not requiring any planned interruption to any customers in the Trial area.

*Customers inside the Trial area and customers in the Control Group who participate in the Customer Survey*

Understanding whether customers notice a change in their electricity supply during the Trials is crucial to the viability of the CLASS Solution. The Project will therefore seek customers inside the Trial area to participate in a series of customer surveys throughout the length of the Trial period. In addition, CLASS will identify a Control Group outside the Trial area that will also participate in the customer surveys. The aim of the survey is to answer hypothesis 2 (*Customers within the CLASS trial areas will not see/observe/notice an impact on the power quality when the demand response and reactive power absorption are being provided*). The customer surveys will be structured to tease out whether the customer has noticed a change in the electricity supply with the Control Group results being used to baseline the placebo effect. We will ask customers to complete five surveys throughout the Trial period. The timing of each survey is matched to the test regime, and cost-effectively incentives the customers to partake in the Project. The scope and design of the customer surveys will be developed and piloted with a small group of customers prior to it roll-out; this is a direct learning from the Capacity to Customers Project's customer engagement undertaken this year. The robust and value for money process we have identified as part of the proposal to engage with customers within and outside the trial area is summarised in Figure 10 below.

**Method & Sampling**

The method used to engage with customers has been carefully considered based on previous experience on other LCN Fund Projects. Letter drops and other such postal type methods generate low interest and could potentially lead to self-selection bias. A face-to-face methodology would result in high participation rates but will prove to be expensive and therefore not offer value for money. An online approach will potentially increase bias, and retention rates would significantly be reduced. A good compromise between value for money, representativeness and high rates of participation is telephone research.

8: Customer impacts contd.

The target is to achieve 700 recruits to take part in all stages of the research.  This will be split 350 within the Trial area (ie the Trial Group) and 350 outside the trial area (ie the Control Group).

The higher the sample size, the lower the margin of error for a given statistic. The marginal rate, at which the margin of error improves with higher sample sizes, gradually diminishes (as illustrated in Figure 11 ). This means there is an optimal point where the costs of obtaining extra sample outweighs the improvements of margin of error. Looking at the curve in Figure 11 the most cost effective and value for money sample size lies between 100 and 150 for analysing results between sub-groups. This means drawing comparisons between Industrial & Commercial (I&C) customers (100 `Trial' and 100 `Control') with that of domestic customers (250 `Trial' and 250 `Control') will deliver results that are both credible and representative at a GB level. Additional work and analysis will also supplement these results by for example drilling down further by region or demographics.

There will be five occasions when respondents will take part in the research (including the initial recruitment phase). For each occasion, all respondents will take part in the research within a two week period. The first occasion, will be for recruitment, and the proceeding four occasions will be during the trial period. The illustration in Figure 12 shows the interview process.

**Recruitment Process**

The recruitment process would be as follows:

- Domestic household customers and Industrial & Commercial customers within the North West region would be selected according to whether they fall within the Trial area or outside of it.
- Domestic customers selected in the `Trial' and `Control' will be matched by ACORN classification (*Geo-demographic based on census data and lifestyle surveys)* to eliminate bias as a result of demographic, social and regional factors.
- Industrial & Commercial customers selected in the `Trial' and `Control' will be matched by SIC and by how core `energy' is for their day to day functioning (e.g. a local supermarket with fridges will have a different perception of the importance of electricity vs. a small office).
- The target sample size for the whole trial period is 700 interviews with quotas of 350 `Trial' and 350 `Control'.

Electricity North West's and Impact Research's experience from similar projects imply there will be a drop-off rate of around 15% for domestic customers and 30% for industrial and commercial customers during the Trial period, CLASS will therefore oversample by c.15% and c.30% respectively to take this into account.

*Maximizing participation*

There is substantial value that CLASS delivers by resolving a number of key challenges already identified, it is therefore crucial to ensure that the Project is credible and robust in the customer surveys undertaken and that the risk of non-participation is minimal. This will be done by:

- Simple and accurate messaging will help drive the recruitment, engagement and participation of customers in completing the required surveys. For domestic customers, any long periods of absence from their home will be recorded and if this exceeds 6 weeks in a row, they will be excluded from the study. This may include household respondents who are intending to move home or go abroad for an extended period.
- Using effective language with recruitment scripts and follow-up letters, to demonstrate to respondents what an important contribution they are making as a result of their participation.
- CLASS provides cost-effective incentives that encourage participation to the end. Each respondent will be provided with £150 incentive if they participate throughout the Trial period. Based on previous experience, this is the best balance between value for money and relatively low drop-out rate. This will be structured as follows:
    - Initial £50 on recruitment; and
    - £25 for each additional interview (ie four throughout the year).

## 8: Customer impacts contd.

- For Industrial & Commercial customers, they will have an option of a personal incentive or a charity donation.

- Regardless of all the steps taken to ensure participation, there will inevitably be respondents that won't take part following on from initial recruitment; reasons for this may vary. However by over-sampling by 15% and 30% respectively, CLASS ensures that the Project concludes with a robust, credible and representative sample at the end of the Trials.

### The Interviewing Process

*Recruitment stage.* An initial 15 minute telephone survey will introduce the research objectives to participants and the incentive structure to gain buy-in. The survey will broadly cover current behaviours on energy usage, including types of appliances used and frequency of usage. For domestic customers, additional details will be captured including the participant's life stage, employment status and other factors that will help add value to the analysis of results. In addition, general information on any shift patterns to determine when the respondent is likely to be at home will be captured as well. For Industrial & Commercial customers, additional details on company size, nature of business, the importance of energy for day to day running of the business will be captured. Electricity North West and Impact Research will undertake a pilot survey to test and enhance the materials created for the customer engagement and the survey.

Tests will be conducted throughout the year. Respondents will be interviewed on four occasions during these tests to cover seasonality. The bulk of the interviews would take place within two weeks of a Trial having taking place to ensure a high level of recall of any events as a result. In order to ensure maximum participation, respondents may be contacted up to four weeks following a test (the exact date of when the interview takes place will be recorded).

It is inevitable that respondents may not have been present during these tests. Rather than to only report on when respondents were definitely present during the test, comparisons of Trial vs. Control will be performed regardless of whether they would be present or not. This is a true reflection of real life being tested, providing the most representative results. Furthermore, there could still be evidence of disturbances in the house even if the respondent was not present (such as clocks being re-set). In any case the data captured will also include whether respondents were present during the test periods, and analysis can be performed by these if necessary.

*For Domestic Customers:* Once households are chosen, the person responsible (or jointly responsible) for paying the household's utility bills will be the target respondent. The risk of this person moving will be minimised at the recruitment stage (e.g. by asking whether they are intending to move within the next year). If the target respondent moves house, the replacement will be recruited to take part in the Trial. There is a risk the replacement will not want to take part in the Trial; in this instance the data collected from the initial respondent can still be used.

*For Industrial & Commercial Customers: Once the companies to be interviewed are identified, the person responsible for choosing utility suppliers and/or responsible for electricity contracts will be the target respondent.* If the target respondent changes job or leaves, the replacement will be recruited to take part in the Trial. As with the households, there is a risk the replacement will not want to take part in the Trial; in this instance the data collected from the initial respondent can still be used.

### Managing Customer Enquiries

The successful and smooth customer journey in CLASS from project start to finish is critical and central to Electricity North West's philosophy of the customer being at the heart of the business. For this reason CLASS has selected a number of communication channels that will ensure that the management of customer questions/queries is responsive, confidential and convenient.

Customers can ask questions or raise queries related to the CLASS Project using the following channels:

*Telephone* - Electricity North West operates an enquiry service that is continuously staffed and can be contacted 24 hours a day/ 7 days a week on 0800 1954141. Customers will be required to select the `Low Carbon Network Fund Enquiries' option once the automated Interactive Voice Response (IVR) is active.

*SMS* - For customers wishing to receive a call back service, an SMS can be sent to dedicated number quoting “CLASS”, this will ensure an Electricity North West representative will call the customer back as soon as possible.

8: Customer impacts contd.

*CLASS website* - The CLASS website will be the main source of information for the CLASS Project for our stakeholders and customers. Every aspect of the CLASS Project will be hosted on this site, including all customer focused information (eg Trial area, customer pamphlets, contact details, FAQs etc) will be posted on the site and available to download.

*Written Correspondence* - Customers can contact the CLASS Project team by sending a letter to the following address:

CLASS Project Team

Frederick Road

Salford

M6 6QH

Or customers can contact the CLASS Project team at the following email address quoting "CLASS" in the subject heading: futurenetworks@enwl.co.uk

**Customer Engagement Plan**

CLASS has developed, as part of the proposal, a robust customer engagement plan, which identifies the outcomes that need to be achieved, and therefore the key incentives, messages and methods by which they are to be communicated. The engagement plan developed with Impact Research and Electricity North West's Partners identifies through the various Workstreams, key engagement points with customers; from informing them of the Projects objectives, to providing them with Project closure report links. Our Customer Engagement Plan (detailed in Appendix I) follows the principle of ensuring that the customer feels valued and part of the success of the Project. It should be noted that this Engagement Plan has been developed using the learning from the previous LCN Funded Projects and in conjunction with Impact Research.

## 8: Customer impacts images, charts and tables

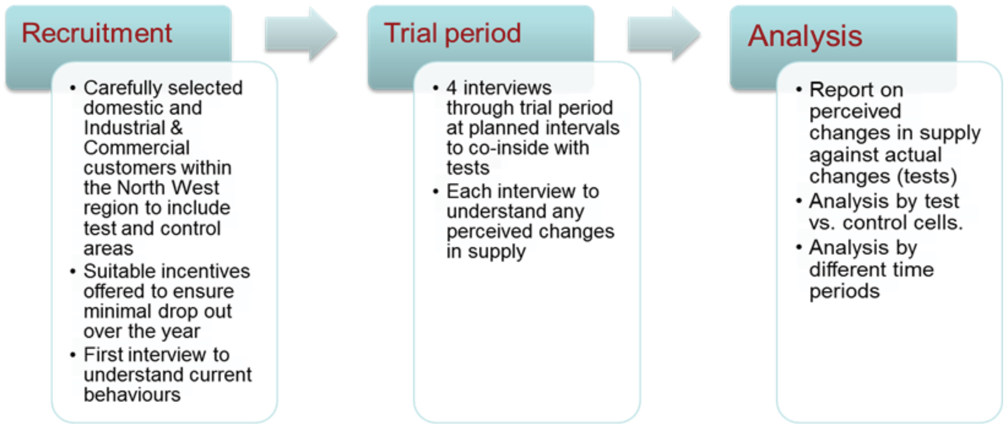



Figure 10: CLASS Customer Survey process

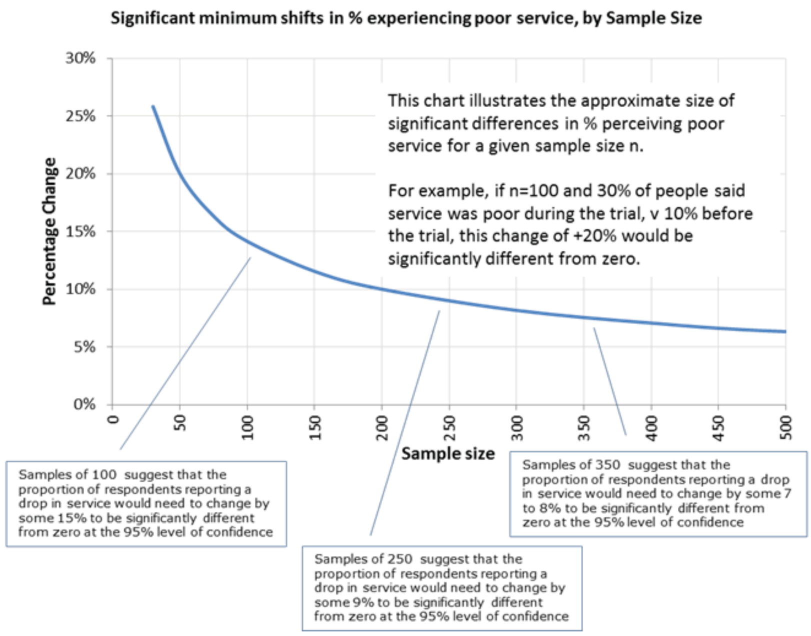



Figure 11 : Customer sample size justification

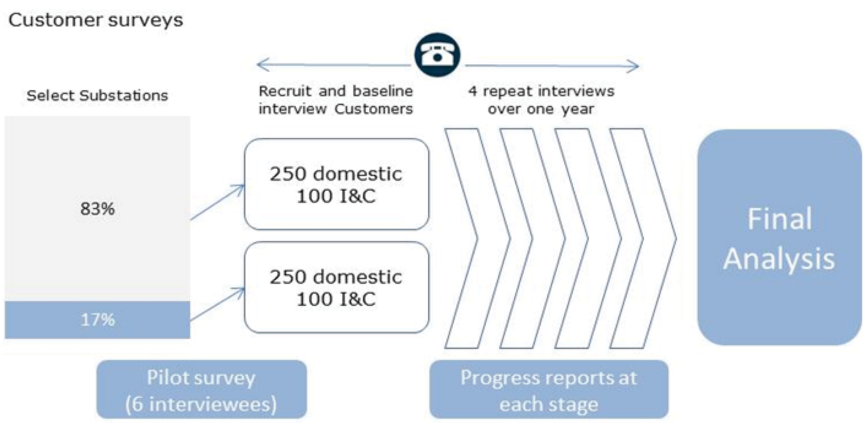



Figure 12 : High Level Customer Survey Approach

# Section 9: Succesful Delivery Reward Criteria

**Criterion (9.1)**

**Technology Build Workstream**

1. Design regulation scheme for substation Voltage Controllers by December 2013;
2. Selected the sites for installing Voltage Controllers and monitoring equipment by June 2013
3. All hardware including substation controllers, and monitoring equipment communications infrastructure installed and commissioned by March 2014;
4. Design, build, test and commission ICCP Link between Electricity North West's and National Grid's Control Centres by March 2014.

**Evidence (9.1)**

**Technology Build Workstream**

1. Publish the design of the regulation scheme for substation Voltage Controllers by February 2014;
2. Publish the site selection report including the methodology by August 2013

3a. Network monitoring equipment installed and commissioned by March 2014;

3c. Publish the commissioning reports by April 2014

3d. Technology go-live by April 2014;

4a. ICCP installed and commissioned by March 2014;

4b. Publish the ICCP commissioning reports by April 2014.

**Criterion (9.2)**

**Trials Workstream**

1. Trial area selected by June 2013;
2. Trials and test regime design completed by December 2013;
3. Live Trials commence in April 2014;
4. Tested the capability of the voltage control system for all Trial scenarios by May 2015;
5. Transfer Trials data every quarter with all Trials data transferred to The University of Manchester by June 2015.

**Evidence (9.2)**

**Trials Workstream**

1. Publish on CLASS website map of Trial area by September 2013;
2. Publish on CLASS website Trials and test regime report in January 2014;
3. Baseline customer survey initiated in April 2014;
4. Publish on CLASS website an initial capability report for all the Trial scenarios by September 2014;
5. Evidence of test Trial data transferred by July 2014.

## 9: Succesful delivery reward criteria contd.

### Criterion (9.3)

**Customer Engagement**

1. Create the Customer Engagement Plan and Data Privacy Statement by July 2013;
2. Produce customer marketing/ campaign materials by January 2014;
3. Deliver the Customer Survey Pilot workshop by March 2014;
4. Control Group and Trial area customers identified and first communication pamphlets distributed in February 2014, subsequent forms of communication will be delivered as per Project Plan;
5. Customer surveys completed by June 2015.

### Evidence (9.3)

**Customer Engagement**

1. Send for approval the Customer Engagement Plan and Data Privacy Statement to Ofgem by July 2013;
2. Publish on CLASS website customer marketing/ campaign materials by September 2013;
3. First customer workshops held by October 2013; workshops completed by December 2013
4. Publish on CLASS website Control Group and Trial area customer communication by January 2014;
5. Customer surveys completed, with an initial summary report published by June 2015.

### Criterion (9.4)

**Research Workstream**

1. Deliver the Network Modelling Reports by September 2015;
2. Deliver the Voltage Profile Modelling Reports by September 2015;
3. Deliver the Asset Health Study Report by September 2015;
4. Deliver Customer Survey Report by September 2015;
5. Develop change proposals for NETS SQSS by June 2015.

### Evidence (9.4)

**Research Workstream**

1. Publish on CLASS website Interim and Final Network Modelling and Analysis Reports by January 2015 and September 2015 respectively;
2. Publish on CLASS website Interim and Final Profile Modelling Study by January 2015 and September 2015 respectively;
3. Publish on CLASS website Interim and Final Asset Health Study Report by January 2015 and September 2015 respectively;
4. Publish on CLASS website Customer Survey Report by September 2015;
5. Publish on CLASS website NETS SQSS Change Proposal Report by June 2015.

## 9: Succesful delivery reward criteria contd.

**Criterion (9.5)**

**Learning & Dissemination Workstream**

1. Produce first Video Podcast of the series by September 2013 with the remaining to follow as per Project Plan;
2. Develop and launch the CLASS Project Website and Social Media Forums by September 2013;
3. First Annual LCN Fund Conference attended and first Webinar and Learning Event held by April 2014, with others to follow as per Project Plan;
4. Raw monitoring data is initially made available on demand by September 2014, and updated per season.

**Evidence (9.5)**

**Learning & Dissemination Workstream**

1. Publish on CLASS website first Video Podcast by September 2013;
2. CLASS website and Social Media Forums is live by September 2013;
3. Active participation at Annual LCN Fund Conference, and first Webinar and Learning Event held by April 2014 with others to follow as per Project Plan;
4. Raw monitoring data is downloadable from CLASS website by September 2014.

**Criterion (9.6)**

**Close Down & Long Term Monitoring Study**

1. Produce a close down report and initiate a long term monitoring study with National Grid.

**Evidence (9.6)**

**Close Down & Long Term Monitoring Study**

1. Provide confirmation from National Grid that the long term monitoring study has been initiated.

## 9: Succesful delivery reward criteria contd.

| Criterion (9.7) |
|---|
| |

| Evidence (9.7) |
|---|
| |

| Criterion (9.8) |
|---|
| |

| Evidence (9.8) |
|---|
| |

# Section 10: List of Appendices

The list below details the appendices, including a short explanation of each:

**Appendix A** **Indicative Site Location Map**

This appendix shows the indicative locations for Primary substations selected for the CLASS Project, from applying the Site Selection Methodology.

**Appendix B** **Site Selection Methodology**

This appendix details the method, developed by The University of Manchester and Electricity North West, for selecting the Primary substations for the CLASS Project.

**Appendix C** **CLASS Technical Description**

This appendix describes at a high level the technical architecture, features and operating methods of the CLASS Project.

**Appendix D** **Risks and Issue Register and Contingency**

This appendix outlines Electricity North West's Risks and Issues methodology. The risks, issues, mitigating actions and the contingency arrangements are detailed for the CLASS Project.

**Appendix E** **Detailed Project Plan**

This appendix details the Project Plan for the delivery of the CLASS Project.

**Appendix F** **Organogram**

This appendix details the management structure for delivery of the CLASS Project, highlighting the main deliverables for each of the four Workstreams and where the Project Partners contribute to their delivery.

**Appendix G** **Project Partner Details**

This appendix describes each Project Partner, its roles and responsibilities in the delivery of the CLASS Project. In addition the details on the ownership and contractual relationship with Electricity North West and its financial contribution to CLASS are described.

**Appendix H** **Base Case Costs & Carbon Impact Methodology**

This appendix contains the methodology for the calculation of the Base Case Costs and the Executive Summary of the Tyndall Centre's Carbon Impact Report.

**Appendix I** **Indicative Customer Engagement Plan**

This appendix contains the draft Customer Engagement Plan for the planned customer communications during the delivery of the CLASS Project.

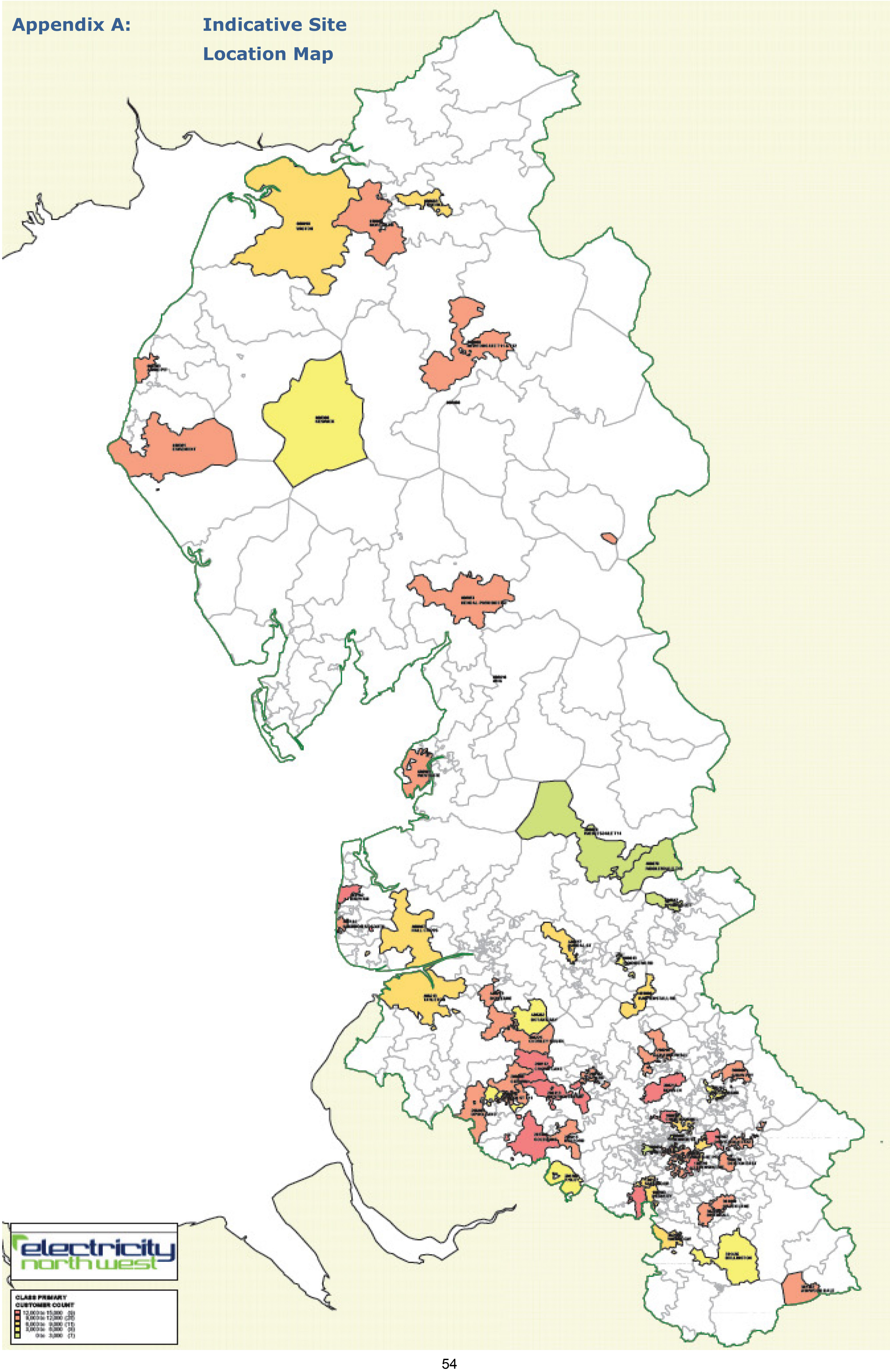
**Appendix J** **Letters of support from Project Partners**

This appendix contains a letter of support from all of our Project Partners. The support letters indicate the innovation of CLASS detailing each Partners' commitment to the CLASS Project.

**Appendix K** **CLASS Full Submission spreadsheet**

This appendix is the Full Submission Workbook for the CLASS Project. This will be appended in a separate document.

# Appendix A: Indicative Site Location Map



## Appendix B: Site Selection Methodology

### Introduction

This Appendix describes a methodology to be used for the selection of Primary substations to be included within the CLASS Trials. Primary substations are defined as those sites with voltage transformation having a line-to-line voltage of 132kV or 33kV to 11kV or 6.6kV. The applicability of the approach to other distribution network operators (DNOs) has been considered in the development of this methodology. The proposed methodology has been developed to ensure the selection of representative samples covering different load classes and loading levels within each of the 15 major Grid Supply Point (GSP) regions within Electricity North West's operating area. The Primary substations selected are expected to cover the range of network constraints that could typically require the reinforcement of electrical networks using a traditional approach, and that the CLASS Project looks to mitigate. Further, the proposed methodology aims to support the strong research emphasis of CLASS and the investigation of the complex relationship between voltage and demand by ensuring that a broad spectrum of demand types and customers are included within the Trials.

### Site selection methodology

The methodology proposed for the selection of sites where CLASS will be trialled comprises of the following three aspects:

*Demand Zone (Grid Supply Point (GSP))* - In order to ensure that a representative sample of Primary substations is obtained it is proposed to deploy CLASS at Primary substations within each of 15 key GSP demand zones within Electricity Northwest's operating area. Furthermore, given GSPs represent the network interface between the distribution network operator (DNO) and National Grid and that it is the aggregate effect of these changes (as seen by National Grid) which are being considered it is considered appropriate to trial CLASS at multiple Primary substations within each of the 15 major GSP groups.

*Loading Level (Minimum forecasted peak load relative to firm capacity)* - Of significant benefit to ENWL's customers will be the deferral of investment in network assets as a result of peak load reduction. Consequently, Primary substations whose annual peak load (forecasted for the next 3-4 years) is a significant percentage (*$X_1$%)* of the substation firm capacity will be considered. For ENWL, $X_1$ is expected to be in the range 80% to 85%. In order to test the peak reduction technique within the Trials fourteen Primary substations categorised as Load Index 5 (ie $X_1$ is >100%) will be selected.

*Load Classes (Peak load share – PLS)* - Given that differing load types will respond differently to changes in voltages (eg resistive vs inductive loads), Primary substations are to be categorised according to their customer composition. This will allow the CLASS trials to identify the role of the load class (ie contribution to demand response) during periods of peak load. This categorisation will allow identification of the most representative substations that can then be studied through trials in order to determine the most responsive type of customers/loads. The Load Classes chosen are:

1. Largely Industrial & Commercial – Primaries where $Y_1$% or greater of the demand at time of peak demand is supplying industrial and commercial type loads (ie non-domestic or Profile Classes 3 through 8)
2. Largely Domestic – Primaries where $Y_2$% or greater of the demand at time of peak demand is supplying domestic loads (ie Profile Classes 1 through 2)
3. Mixed – Primaries where there is a roughly equal share of domestic and non-domestic loads at time of peak demand

Figure 1 shows the flowchart of the site selection methodology. The selection criteria described above are considered as filters that are sequentially applied to the full set of Primary substations with the ENWL operating area.

- The value for $X_1$ can be adjusted according to the particular characteristics of the DNO – for Electricity Northwest and to support the CLASS bid submission the value was set at 84%.
- The values for $Y_1$ and $Y_2$ can be adjusted to the particular characteristics of the DNO – for Electricity Northwest the value is expected to be set at 75%. It should be noted however that further work will need to be done in order to identify these percentages based upon assessment of the contribution to the load profiles of individual profile classes.

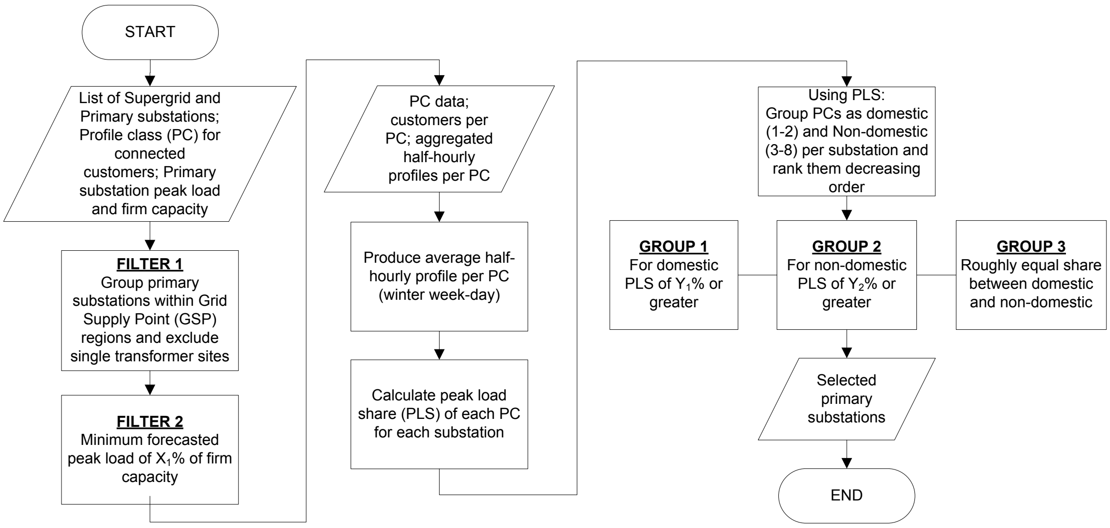



Figure 1: Flowchart showing methodology for selecting Primary substations for CLASS trials

**Process for determination of peak load share (PLS)**

To estimate the power-based composition (or load share) per PC during a given moment in time, half-hourly load profiles per type of customer (according to CDCM tariff) are to be used to create average ones (by dividing the total power consumption by the total number of customers of that particular type). Given that most of the peaks occur during a winter weekday, February 9th 2011 (Wed) was arbitrarily chosen (from the aggregated load profiles).

Considering that per Primary substation the number of customers is related to the profile class rather than the CDCM tariff, the allocation presented in Table 1 is to be adopted. This includes further assumptions/simplifications based on the similarity of the average profiles and their peak values.

| Profile Class | Average Half-hourly Profile per CDCM Tariff |
|---|---|
| PC1 | Domestic Unrestricted |
| PC2 | Domestic Two-Rate |
| PC3 | Small Non-Domestic Unrestricted |
| PC4 | 50% Small Non-Domestic Off-Peak<br>50% Small Non-Domestic Two-Rate |
| PC5 to PC8 | LV Medium Non-Domestic |

Table 1 - Relationship between customer Profile Class and Tariff

With these average half-hourly profiles per PC it is possible to produce a winter weekday profile for each substation taking into account the corresponding number of customers per PC. Moreover, given that it is possible to identify the peak half-hour, the load share of each PC can also be identified. It is important to highlight that due to the assumptions and simplifications considered in this analysis, it will not be possible to mimic the actual half-hourly power demand of the substation. However, the profiles are likely to carry the consumption behaviour of each profile class and their corresponding load 'share'.

**Other Considerations**

Other more practical considerations which will be needed as part of the final site selection process are listed below.

- Interconnected Primary substations are out of scope of the CLASS trial.
- Planned reinforcement/asset replacement works during the CLASS trial period at Primary substations has been considered. Such sites have the potential to introduce complex programming issues and as such these sites have been removed from the list of available sites.
- The presence of synchronous Distributed Generators (DG) could cause control issues for the proposed scheme and so Primary substations with DG connected will be carefully assessed before including.

- In addition, the impact of domestic-scale distributed generation (e.g., photovoltaic panels) on the demand response should also be investigated. It is likely that 11kV or 6.6kV circuits with a high penetration of this technology are considered in the trial.
- A number of reactive compensation schemes are being installed at certain sites as a way of correcting power factors to reduce system losses. As part of the site selection process investigations will be undertaken to determine whether this might affect the proposed scheme.
- Sites expected to have increasing penetration of low carbon technology such as electric vehicles or heat pumps will also be considered in order to study the effects of this technology on the demand response scheme.

**Initial application of site selection methodology - Sample Size for CLASS Trials**

For meaningful results (ie to avoid potential anomalies) at least 4 Primary substation types should be selected per demand zone. As there are 15 key demand zones (ie GSP groups), this gives a requirement for a CLASS trial size of 60 Primary substations.

It is expected that following final site selection more than 4 Primary substations may be selected in some of the zones (and consequently less in others) to ensure the collection of accurate trial results and that there is a reasonable mix of primaries which meet the required criteria. Particularly accurate results may be required for a certain Primary substation type because it is considered to be of the type for which CLASS offers the most benefit or because there are more of this type of Primary than other types or because of other more practical considerations associated with the deployment of CLASS technology. However, there should be flexibility in terms of the number of Primary substations selected and contained within each demand zone.

## Appendix C: CLASS Technical Description

### Purpose

This appendix outlines proposals for the various architectures, features and methods of the CLASS project. A high level outline of the operating principles and proposed functionality of CLASS is provided; including the expected implementation methods of the demand response features of CLASS in existing control room management systems both within Electricity North West (ENWL) and National Grid (NGC). A brief commentary of the implications for substation control and protection equipment is provided and a proposed mode of operation outlined. The appendix provides an overview of the CLASS architecture and how it is proposed that monitoring data will be captured and recorded.

### Objectives of CLASS

CLASS explores the potential for DNOs to provide a non-intrusive form of demand response that could help to balance generation and demand on GB's electricity network whilst at the same time managing peak loads across its network. This would provide value to consumers by providing an alternative more cost-efficient, low carbon solution to addressing system imbalances and reinforcement network requirements. CLASS will investigate these challenges:

- **Voltage Control** – The operation of Primary substation transformers with differing tap changer tap-settings (ie staggered taps) has the potential to increase the demand for reactive current drawn from the grid thus artificially increasing the observed demand for reactive power. This increased demand for reactive power has an expected benefit to the NETSO and DNO during periods of low real power demand when voltage regulation can be troublesome. Traditional mitigation measures include installation of reactive compensation such as reactors, constraint payments to out-of-merit generation for VAr support and switching out of long lines to reduce capacitive gain.
- **Demand reduction/boost** – The ability to apply small controlled voltage increases and reductions to the LV busbar at a Primary substation through operation of transformer tap changers has the potential to increase or decrease the real power consumed by the load supplied via that substation. This indirect demand control function would support the operation of the NETSO in its attempt to control system frequency and manage thermal constraints. It will in addition offer the DNO the potential to avoid or defer the need for network reinforcements owing to demand spikes.
  - **Primary response** – This is expected to involve automatic tripping of one of a pair of Primary substation transformers (or alternatively reactive compensating devices fitted to the distribution network) via operation of an appropriately set frequency sensitive relay thereby resulting in an immediate reduction in the voltage at the Primary. The subsequent voltage recovery characteristic could if necessary be governed by operation of transformer AVC which could require modification.
  - **Secondary response** – Expected to be offered by either remote control operation of transformer tap-changers via SCADA or via AVC relays as required by the NETSO and dispatched by them via use of a live link between the NETSO and the Primary substation. The time taken for this service to be made available and the period over which it can be sustained will be determined during the project.
- **Demand reduction at time of system peak** – The ability to reduce the observed demand at a highly loaded Primary substation by means of voltage reduction to defer or avoid potentially expensive reinforcement of the Primary or associated network.

### Existing Network Infrastructure

ENWL's Network Management System (NMS) has real-time SCADA capability allowing remote operation and data acquisition of the 132kV, 33kV and Primary network voltages. This architecture is illustrated in Figure 1 below. ENWL are connected to the National Grid system at 132kV at various points within the network. From here electricity is distributed throughout the ENWL geographical region at varying voltage levels (ie 132kV, 33kV, 11KV or 6.6kV and finally 415V or low voltage).

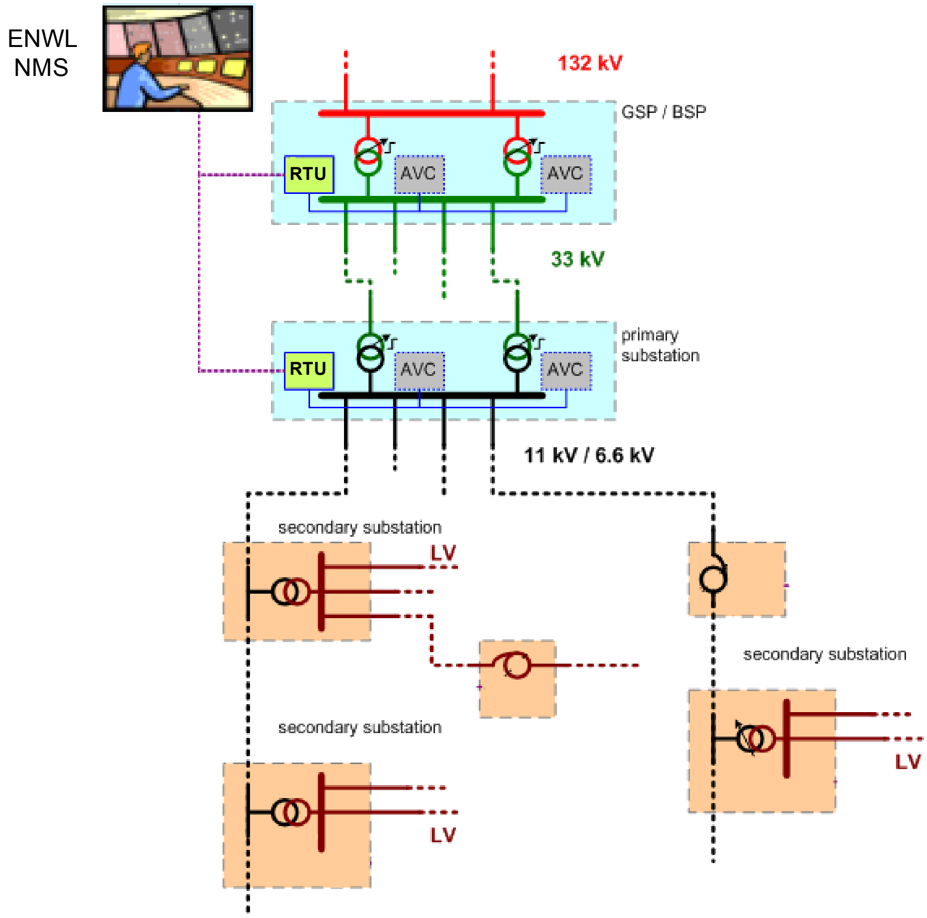



Figure 2 - Existing ENWL Network Infrastructure

ENWL operates the low voltage networks at 240 volts phase-neutral / 415 volts phase-phase. This voltage is maintained in the range of +10%/-6% in accordance with the requirements of the European standard EN50160. All electrical networks experience voltage drops proportional to the circuit loadings as illustrated in Figure 2.

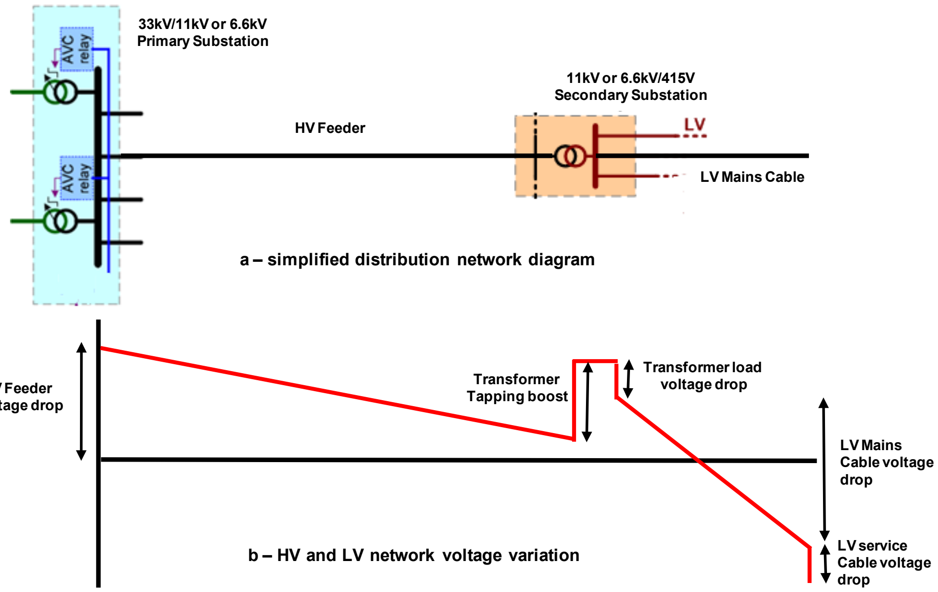



Figure 3 - Variations in network voltage and voltage compensation

Voltage compensation is provided at suitable points to offset the resultant variations in voltage and to maintain the voltage within operational limits.

ENWL uses automatic on-load tap changers (OLTC) at 132/33kV and 33kV/11kV or 6.6kV. The tap changers alter the transformer windings ratio thus changing the transformer output voltage as directed by the automatic voltage relay sensing the secondary busbar voltage. In ENWL and most GB DNOs, the magnitude of these voltage step changes per tap is 1.67% of nominal. This thus compensates for variations in the higher voltage levels (ie 132kV and above) or the voltage drops owing to changes in the load flowing through transformers.

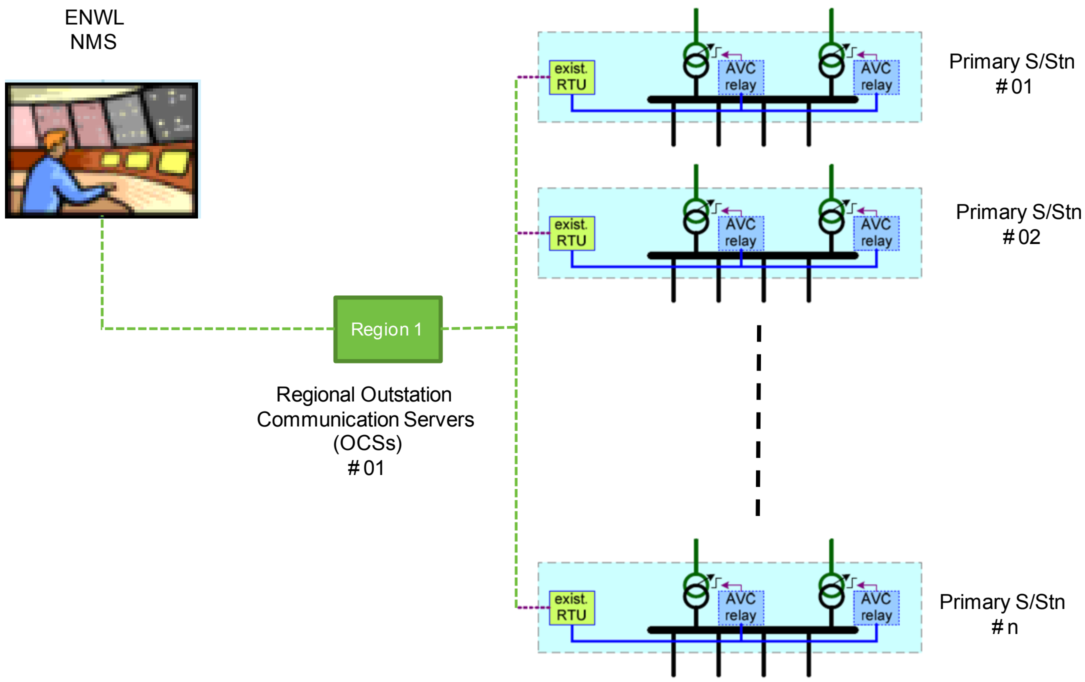
Secondary substation transformers (ie 11kV or 6.6kV to 415V) have off-load tapping capability to take account of 11kV or 6.6kV voltage drops and subsequent distribution transformer load voltage drops. The tapping range of these transformers is typically +/-5% in $2^{1}/_{2}$% steps either side of the nominal ratio.

All electricity network infrastructure can be operated manually by local control systems. However, in common with all GB DNOs, ENWL has introduced Supervisory Control and Data Acquisition functionality (SCADA) into its electricity network to facilitate remote control and real-time visibility of key infrastructure via its central control room situated in Manchester. The main SCADA systems do not currently extend beyond the Primary voltage levels into the HV or LV networks.

The NMS is connected to six regional Outstation Communication Servers (OCSs) which are in turn connected to a set number of Primary substation remote terminal units (RTU). The Primary substation RTU provides the interface between the Primary substation plant and the NMS. It is responsible for the exchange of digital and analogue data between the two domains and allows the ENWL control engineers to issue control commands and receive alarms and indications.

Figure 3 shows the communications architecture between the various ENWL systems. From the SCADA base station, communication is via serial 4 wire VF lines running at 9.6k using DNP3 and Teleconnect II (GEC proprietary) protocols. An RTU may share a given line with up to 20 other RTU's and both protocols can be mixed on the same 4 wire VF line. Overall the typical communications latency is around 9 seconds.

The ENWL electricity distribution network comprises approximately 400 Primary substations. The SCADA systems controlling these are grouped within 9 regional communications servers.




## Proposed Network Infrastructure for CLASS

Section OC 6.5 of the Grid Code allows the NETSO to instruct users to reduce demand by up to 20% in four stages, or under certain circumstances up to 40% in 8 stages. Each stage is nominally 5% and must be delivered within 5 minutes. This is normally only used under extreme conditions when all available sources of generation have been exhausted and the only option available to balance the system is to reduce demand.

It is a well established that the amount of real and reactive power absorbed by a given load (ie its demand) is related to the voltage applied to the load. Different loads are known to exhibit different voltage/demand characteristics with the demand consumption of highly resistive loads being particular sensitive to changes in voltage.

Demand Reduction for OC 6.5 can be achieved either through voltage reduction or direct disconnection. It has historically been assumed that the first two stages can be achieved through voltage reductions with a 3% voltage reduction providing a 5% demand reduction and a 6% reduction providing a 10% demand reduction.

The implementation of voltage reduction for OC 6.5 within ENWL's is by use of pre-defined voltage reduction schedules which when implemented result in the operation of the Primary substation transformer tap changers. The change in the transformer tap position directly changes the voltage at the Primary substation. These schedules are held within the NMS and can be initiated, following instruction from the NETSO, by an ENWL control engineer using a purpose built interface within the NMS. Subject to the requirements of the NETSO, these voltage reductions can be initiated at an individual Primary substation, regional or global level. The NMS issues commands to the appropriate Primary substation RTUs via SCADA. The RTUs interfaces with the Primary substation automatic voltage control schemes (AVC) which provide direct control of the Primary transformer tap changers.

CLASS will augment this existing voltage reduction functionality with additional features which will allow a much finer level of voltage control to be implemented at the Primary substation. The enhanced voltage control features of CLASS allow the DNO to provide a range of demand response services tuned to the particular requirements of both the local network infrastructure and the NETSO.

To do this, additional hardware will be deployed within the Primary substation to sit alongside existing equipment. It is proposed to use a Siemens plc substation voltage controller device (VC) to provide the additional control logic required for CLASS operation.

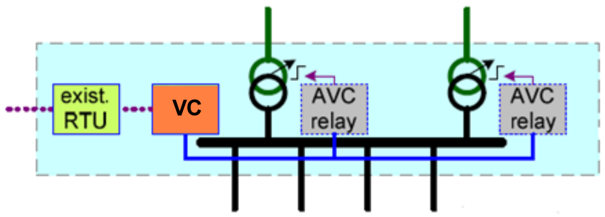



Figure 4 - Siemens plc Voltage Controller (VC) alongside existing infrastructure

In Primary substations the control room houses the voltage control and communications panels. It is proposed to locate the VC equipment in the control room in a wall-mounted cabinet. Cabling will be required to the VC panel and the communications panel (ie RTU) in the same room.

For the interface with the circuit breakers it is proposed to achieve circuit breaker switching as follows:

- In newer single room substations, and other substations with easily accessible cable routes: by fitting an interposing relay in the trip/close circuits, within the circuit breaker panels; or
- Where the RTUs have separate interposing relays to provide the remote trip/close interface: add an additional interposing relay in the communications panel; or
- Where neither of the above options are possible, circuit breaker switching will not be included in the solution for that substation.

Where older AVC relays are used which are unable to support communications and/or cannot provide the necessary measurements (voltage and frequency) it is proposed to replace these AVC relays with modern equivalents.

At some substations with old AVC equipment, the equipment is located in an external kiosk at the transformer (e.g. Tardy Gate), which will restrict the ability to install the necessary interfaces. These AVC relays will be replaced and housed in the control room. This may require ground works to install new cables to the transformer marshalling kiosk.

The interface between RTU and the VC will use hardwired signals. Whilst this may restrict the flexibility of the scheme it will be easier to deploy.

CLASS will be delivered by a combination of local automatic action and central despatch.

The local automatic action will be via the operation of frequency sensitive relays which subject to the system frequency will operate circuit breakers associated with nominated Primary transformers to deliver Primary frequency response.

The frequency sensitive relay is expected to interface directly with VC. The VC will then initiate the tripping command to the CB trip relay via use of an interposing relay. There may be cases where the VC will not initiate the trip owing to constraints such as outages or high loads.

The Primary substation RTUs will be reconfigured (and where necessary fitted with additional I/O) to make available a number of CLASS related inputs and outputs which are listed below:

- **Arm/disarm primary frequency response function**
  - This input will be initiated via a setting with CRMS and will be issued to the Primary substation RTU which in turn will pass an associated output to the ASC.
- **Arm/disarm secondary frequency response function**
  - This input will be initiated via a setting with CRMS and will be issued to the Primary substation RTU which in turn will pass an associated output to the ASC.
- **Initiate primary frequency response (ie via transformer trip)**
  - This input will be initiated via an instruction from CRMS (or alternatively via NGC's NMS using the ICCP functionality). This instruction will be received by the Primary substation RTU and output to the ASC for action via the interposing relay to the CB trip circuit.
- **Initiate demand boost function**
  - This input will be initiated via an instruction from CRMS (or alternatively via NGC's NMS using the ICCP functionality). This instruction will be received by the Primary substation RTU and output to the ASC for action via the AVC scheme.
- **Initiate demand reduction function**
  - This input will be initiated via an instruction from CRMS (or alternatively via NGC's NMS using the ICCP functionality). This instruction will be received by the Primary substation RTU and output to the ASC for action via the AVC scheme.
- **Initiate MVAr absorption function**
  - This input will be initiated via an instruction from CRMS (or alternatively via NGC's NMS using the ICCP functionality). This instruction will be received by the Primary substation RTU and output to the ASC for action via the AVC scheme.

As a result of the CLASS functionality there will be a requirement for additional indications to be available with the NMS from the Primary RTU. The additional indications are listed below:

- Primary Frequency Response Initiated
- Demand boost active/inactive
- Demand reduction active/inactive
- ASC healthy/unhealthy
- Tap position indication

*Additional Network Management Systems for CLASS*

In order to implement CLASS functionality a number of enhancements are needed within ENWL's NMS. These are in addition to the technology deployed in the Primary substation outlined in the previous section. The enhanced NMS functionality is illustrated in figure 4.

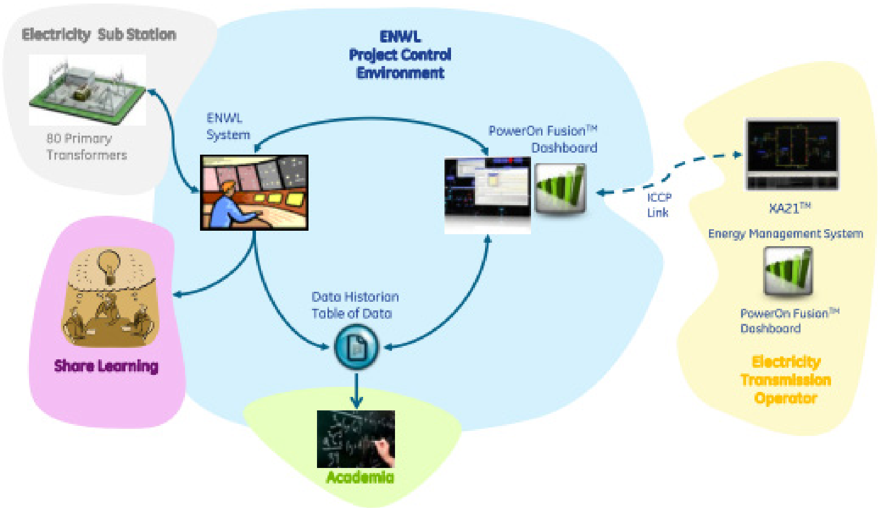



Figure 5 - Enhanced NMS architecture

The NETSO NMS system (GE Energy's XA21) will interface directly with a recent implementation of the GE Energy PowerOn fusion system via use of an Inter-control Centre Communications Protocol (ICCP) link. The ENWL implementation of PowerOn fusion forms a key part of an ongoing LCNF tier 2 project (Capacity to Customers - C2C) and therefore represents a 'shadow' network management system with limited functionality. The PowerOn fusion module acts to augment ENWL's existing NMS with real-time power-flow functionality and economic despatch for management of contracted demand. The exchange of information between PowerOn fusion and the ENWL NMS is via SOAP messaging. Status and analogue data is exchanged via use of the CIM protocol.

The enhanced NMS architecture with ICCP interface to the NETSO allows National Grid to both observe in real-time the availability of demand response within the DNO network and to directly despatch this demand response. These commands are passed along the ICCP interface and through to ENWL's CRMS/SCADA system providing the NETSO with the ability to alter the voltages thus producing the required demand response.

**CLASS Dashboard**

To facilitate the despatch of demand response by both ENWL's control room personnel and the NETSO, it is proposed to establish a CLASS dashboard.

It is expected that a pre-defined schedule of the available real-time demand response would be established using similar logic to that used to create the 3% and 6% voltage reduction schedules for OC 6.5. These schedules will be presented to operators both in the NETSO (ie within the XA21) and ENWL (ie via PoF/CRMS interface) in the form an interactive real-time dashboard as per figures 5 and 6 below.

| Demand Response Services | Demand Zones | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | | 2 | | 3 | | 4 | | 5 | |
| Demand Boost | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| | 2% | 4% | 2% | 4% | 2% | 4% | 2% | 4% | 2% | 4% |
| Demand Reduction | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| | -2% | -4% | -2% | -4% | -2% | -4% | -2% | -4% | -2% | -4% |
| Voltage Control | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 | 1 | 2 |
| | 1 Mvar | 2 Mvar | 1 Mvar | 2 Mvar | 2 Mvar | 3 Mvar | 0.5 Mvar | 1 Mvar | 1 Mvar | 2 Mvar |
| Frequency Response | 10 MW | | 15MW | | 20MW | | 30MW | | 40MW | |

Figure 6 – Illustration of the potential CLASS dashboard

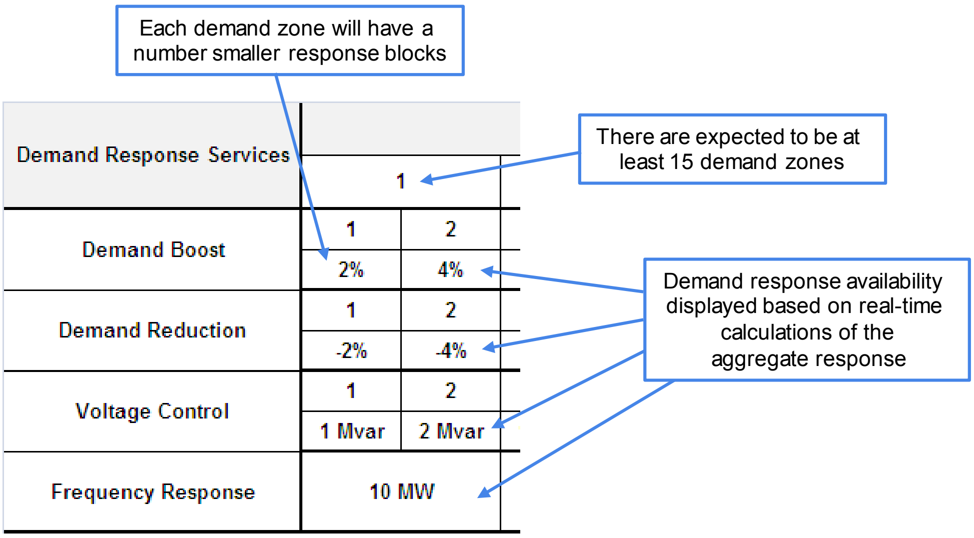



Figure 7 - CLASS Dashboard description of layout

A number of demand zones would be agreed between ENWL and the NETSO and corresponding 'response blocks' would be allocated to each of these according to the theoretical response that could be provided by the flexible operation of Primary transformers (or indeed the disconnection of reactive compensation devices) within the response block.

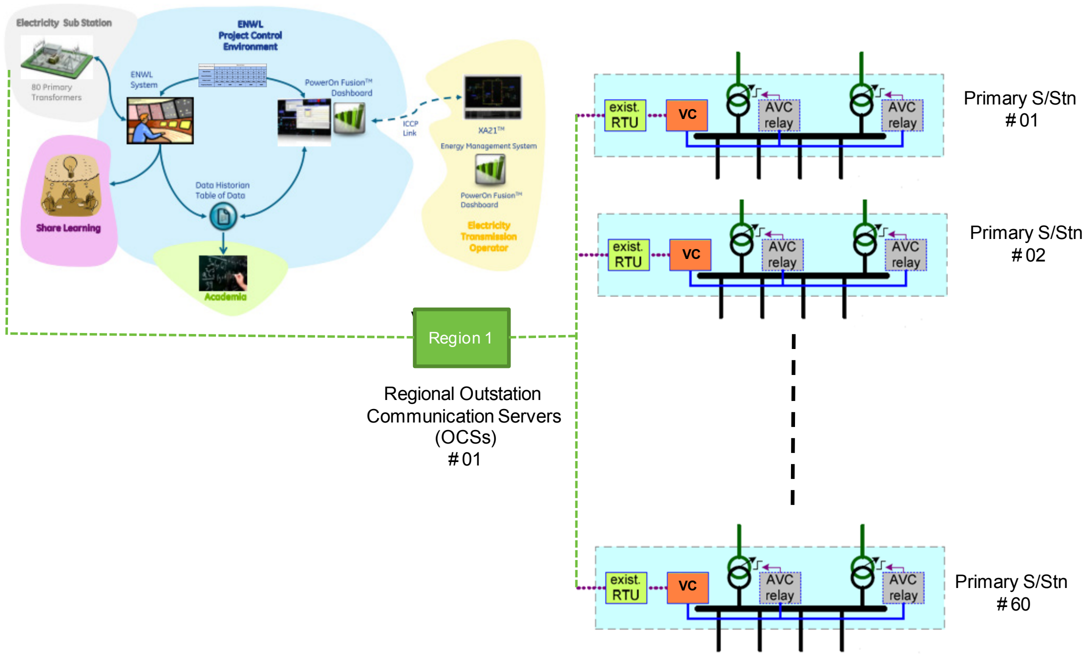
It is proposed to make use of analogues available within existing SCADA systems to display in CRMS, real-time demand response availability as the aggregate of all potential response within the associated group. Current proposal is that these values would be calculated within the PoF system. The PoF system would determine these values based on parameters passed to it by ENWL's CRMS system and an off-line voltage-demand look-up table containing information on the mathematical relationship between voltages and demands.

The voltage-demand look-up table would contain approximately 365 x 24 x n (where n = the number of Primary pairs) sets of scaling factors which would be advised by work to be undertaken by the UoM reflecting the relationship between demand and voltage.

The determination of these response block values and the population of the CLASS dashboard will be developed within GE Energy's PowerOn Fusion using basic algorithms which aim to map the various Primary substations within the CLASS trial to the appropriate demand zones. The dashboard will be made available to ENWL via the CRMS/PowerOn Fusion interface and to the NETSO via the ICCP link.

**High level CLASS architecture**

The final CLASS architecture is presented in figure 7 below which shows the enhanced NMS featuring the CLASS dashboard hosted within the GE PowerOn Fusion system and the ICCP link to National Grid. Also shown is the SCADA extension to include to the Siemens VC equipment housed within the 60 Primary substations forming the CLASS trials.




**CLASS network monitoring requirements**

In order to allow for quantification of the effects and benefits of CLASS there is a need for appropriate levels of additional measurement of relevant analogues at various points on the network.

- **132kV** - At 132kV there will be need to measure the power provided/consumed to the NETSO ie what variation in demand or VAr absorption is actually observed. Whilst in any wider deployment these measurements would need to be high accuracy given they could conceivably be used for financial purposes, for the purpose of this trial existing instrumentation is expected to suffice. There is currently central volume allocation (CVA) metering installed at strategic 132kV sites. These units are owned by NGET but it is expected that CLASS will be able to gain access to some of the relevant data from them for the purposes of this project.
- **33/11kV** - At Primary substations there is need to measure what effect operation of tap changers has on the Primary busbar voltage. Additionally, there is a need to record the voltage response following either a trip of one transformer or a tap change to facilitate, amongst other things, the assessment of potential modification to the AVC scheme so that the voltage does not return to nominal too quickly (ie droop characteristics). All of ENWL's Primary substations have MW and MVAr transducers installed – it is proposed to replace these units with a modern equivalent which provides greater accuracy. The readings from existing transducers are fed into the Primary substation tele-control outstation (RTU), which converts them into half hour averages. It may be possible to gain access to the raw data from the transducers and feed it into an alternative RTU / Computer which can store and display the real time data. Further work is required to scope out the required functionality.

  Consideration is also being given to the need to install transformer monitoring to assess if operating a long term tap stagger has any detrimental effect on substation plant. It is currently unclear where or how to measure this and advice will be sought from academic partners. Further, it may also be necessary to monitor the extra duty on the tap changer to ensure that there is no undue stress on the equipment.
- **Low Voltage** - At distribution level it is necessary to install voltage monitoring at remote ends on specified feeders. This may be installed both in substations (as per ENW's LCNF Tier 1 project) and customer's premises using smart meters or similar. The purpose of this monitoring is to quantify the extent of any changes in the power quality provided to the end customer. It may be beneficial if some of this monitoring could communicate with the Primary substation and if the power quality goes out of limits corrective actions can be taken.

Monitoring data will be obtained from a number of different systems and therefore consideration is to be given to the need for data warehousing in addition to existing ENW systems.

## Appendix D: Risk and Issues Register and Contingency arrangements

The proven risk model employed by ENWL looks at the risks in a holistic manner, identifying business as usual issues, and any other potential internal/external impacting risks to the Project. In the ENWL model, likelihood and consequences be it financial, reputational etc are given a score from 1 to 5, and the resulting product of these two ratings are used to score and rank the risks on the business. The model has been found to both be robust and recognized as an exemplar approach. The format of the ENWL scoring matrix is presented in below.

### Risk Impact Descriptors

| **Risk Area** | **1<br>Negligible** | **2<br>Minor** | **3<br>Moderate** | **4<br>Significant** | **5<br>Serious** |
|---|---|---|---|---|---|
| **Financial (F)** | <£100k | £100k-£1m | £1m-£5m | £5m-£10m | >£10m |
| **Legal (L)** | No legal impact. | Criticism from Regulatory Bodies. | Financial penalties imposed. | Significant financial penalties imposed. Breach of statutory duty, competition law or corporate manslaughter legislation. | Loss of Licence. Persistent Breach of statutory duty or risk of imprisonment of staff or directors. |
| **Regulatory Performance (RP)** | No impact on regulatory performance. | Request for performance improvement with no comparative shift in position. | Request for performance improvement requiring movement in comparative position. | Failure to deliver promised improvements. | Regulatory penalties are incurred. |
| **Health (H)** | On site work related sickness to individual employee. | Short term work related sickness absence exceeds departmental target. | Long term sickness exceeds departmental target. Involvement of company doctor. | Major injury or occupational risk exposure eg contact with hazardous substance / HSE Letter of Concern. | Occupationally contracted disease eg HAVs >5% of employees involved in specific activity/ HSE Enforcement notice or Prohibition Notice issued. |
| **Safety (S)** | No impact on safety. | Near miss incident. | Minor accident - HSE request for information after accident. | RIDDOR reportable lost time injury. HSE Letter of Concern. | Major accident. Potential for HSE Enforcement or Prohibition Notice to be issued. |
| **Environment (E)** | Near miss incident. | Small localised incident contained on site with minimal remediation resourcing required eg oil leak, diesel spillage. | Large scale on site incident requiring moderate remediation resourcing - EA request information / Improvement Notice issued. | Major incident leading to offsite pollution eg contamination of water course - EA Prohibition Notice or withdrawal of consents. | Catastrophic release causing pollution of Local Nature Reserve (LNR)/ Site of Special Scientific Interest (SSSI)/ RAMSAR site (Int. recognised conservation |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | area). Fundamental break-down in working relationship with EA or Local Authority regulator resulting in prosecution. |
| **People (P)** | Insignificant effect on staff morale and will not lead to staff absence/retention issues. | Small impact on staff morale amongst a few individuals, with little impact in terms of staff absence/retention and business continuity. | Decreased staff morale in a small number of teams around the business which may result in absence and productivity issues which need to be managed at line manager level. Corporate absenteeism increases by up to 1% over normal rate. Requires consultation with Union. | Impacts a significant number of company employees and results in uncertainty and lower levels of morale across more than one business directorate with increasing staff absence (<5% above normal rates). This may result in decreased productivity for the business as a whole. Inability to recruit appropriately skilled employees. Potential for extensive consultation/grievance with Union. Limited industrial action. | Decreased staff morale for a large number of staff across all business directorates. Potential for key staff leaving and increasing staff absence (>5% above normal rates) and staff turnover which will leave the business with serious risk exposure in terms of business continuity and productivity. Industrial action including strike action. |
| **Reputation (R)** | Insignificant. | Local press article – low running order e.g. Electricity North West action criticised from key stakeholders such as our investors, the Regulator, partner forums, local pressure groups, or other alleged "expert". | Criticism in Industry Press or local press – front page. Electricity North West proposals/outcomes receive negative reaction in the electricity forums, and/or from Regulator(s) and other key stakeholders such as our investors. | Local TV/Tabloid Press – low running order. Electricity North West brand raised into prominence (e.g. incident, business performance,) and publicised negatively by Regulator, electricity pressure groups or other key stakeholders. Significant effect on or prominence for owning consortia. | National Media Coverage – TV and newspapers. Failure to adequately address known problem or to anticipate or prepare for unpredictable occurrence. Electricity North West and owning consortia heavily criticized in media. Heavy criticism from key stakeholders. |
| **Security of Supply (SoS)** | Small numbers of customers affected. Concluded within 18 hours. | Small numbers of customers affected after 18 hrs. | Moderate numbers of customers affected. Restoration of supplies outside Standards of Service. | Large numbers of customers affected. Restoration of large numbers of supplies outside Standards of Service. | Large numbers of customers affected. Widespread service failure. |

## Risk Likelihood Descriptors

| | | | |
|---|---|---|---|
| **5** | More than likely | >75% chance of happening. | Regularity of risk is once in a quarter year. |
| **4** | Fairly likely | <75% chance of happening. | Regularity of risk is once in one year. |
| **3** | Medium chance | <50% chance of happening. | Regularity of risk is once in five years. |
| **2** | Low chance | <25% chance of happening. | Regularity of risk is once in ten years. |
| **1** | Very low chance | <5% chance of happening. | Regularity of risk is once in more than ten years. |

The scoring matrix is used by ENWL's Board and senior management to continually review business risks, their mitigating action(s) and controls, and to ensure that risks are managed in priority order. The risk model presented here describes the methodology for determining an 'uncontrolled' risk score. However, if control measures are applied, aimed at reducing the hazard / mitigating the risk, it should be possible to produce a 'controlled' risk score that is scored lower than the 'uncontrolled' risk. As part of the risk register, ENWL has identified contingency plans, should the risk mitigation actions undertaken not resolve the issue. The selection and application of control measures can be influenced by a number of factors, e.g.:

- Severity of the hazard;
- Magnitude of the risk;
- Consequences of an undesirable event occurring;
- Constraints on the use of control measures, e.g: cost, practicality, resource.

Throughout the bid preparation process the following potential risks have been identified. These risks have been linked to the Project Phase or Workstream in which they will likely occur and have been scored based on the scoring matrix set out above. Some example risk-mitigation actions have been documented.

| Project Phase/ Workstreams | Description | Likeli-hood | Impact Rating | Impact Area | Mitigating Action/ Contingency Action | Revised Likeli -hood | Revised Risk Rating |
|---|---|---|---|---|---|---|---|
| Phase II Mobilisation | **Resource Mobilisation all Partners:**<br>There is a risk that ENWL and/or Partners are not able to mobilise their resources in time because of other commitments. This risk leads to a delay in achieving potential milestones which could have a Project, reputational, and financial repercussion. | 3 | 3 | R, F | • Framework agreements and Terms have been identified for all Partners<br>• Work Schedules have already been agreed identifying the resources and mobilisation plan needed to achieve the Project milestones<br>• A Project Initiation Document has also been sent to the Project Partners to ensure that all parties are Project ready<br>*Contingency Plan: ENWL will seek new Partners should existing Partners fail to mobilise* | 2 | 2 |
| WS1: Technology Build | **Siemens**:<br>There is a risk that Siemens do not achieve the delivery and installation of the voltage control systems in Primary substations on time, because of resourcing and timing constraints. This risk leads to the UoM not having a full years' worth of data to analyse. | 3 | 3 | R, F | • Work Schedules have already been agreed identifying the delivery and installation schedule of Siemens equipment with specific Project milestones<br>• Siemens have identified their internal resources for the CLASS Project<br>• A financial contingency of 10% has been put in place in case of any unforeseen obstacles to ensure the successful timely delivery or installation of equipment through additional resource<br>*Contingency Plan: ENWL will seek new Partners to achieve the delivery and installation of the voltage controllers and/or seek extension to Proect life* | 2 | 2 |
| | **ENWL Site:**<br>There is a risk that the older Primary substation sites have an incomplete set of layout drawings because of misplaced copies. This risk leads to certain sites needing additional work done to them, which could have an extra cost associated to it. | 4 | 3 | S | • Primary Substation sites have been visited to understand and map the architecture and installation process.<br>*Contingency Plan: Extra time allowed in installation programme for older Primary substations with incomplete drawings* | 3 | 2 |

| | | | | | | | |
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| | **ICCP Link:**<br>There is a risk that there will be a delay in connecting the ICCP Link to ENWL's and NG's Control Systems because of unforeseen complications. This risk leads to a lower number of Trials being able to be executed by NG. | 3 | 3 | R | • Lessons learnt from previous ICCP link installations will be used throughout the design, build, test and deploy phases<br>*Contingency Plan: A manual approach will be taken should the ICCP Link fail to connect with all of the Primary Trial Substations* | 2 | 2 |
| | **ICCP Link II:**<br>There is a risk that the establishment of the link could impact ENWL and NG system processes because of the additional software installation. This risk leads to the business as usual processes being adversely impacted, incurring additional financial costs to resolve them. | 4 | 3 | F, R, SoS | • ENWL has led a number of workshops during the proposal phase with all affected stakeholders to ensure that the ICCP Link will have no adverse impact to the business as usual operations<br>• Lessons learnt from previous ICCP link installations will be used throughout the design, build, test and deploy phases<br>*Contingency Plan: Extra time allowed for the installation programme of the ICCP Link* | 3 | 2 |
| WS2: Trials | **National Grid:**<br>There is a risk that NG is not able to undertake their responsibilities in executing some of the Trials, because of other commitments. This risk leads to a delay in the CLASS test regime being executed. | 3 | 3 | R | • A detailed Trial schedule will be agreed with NG including the identification of the resources needed in executing NG's responsibilities<br>• Design of Trials/ test regime and approval of Trials/ test regime planned in the delivery schedule<br>• Regular stakeholder meetings will be held to ensure that any risks in executing the assigned Trials for NG are identified and resolved<br>*Contingency Plan: Emergency Stakeholder Meeting will be held with Senior Management within National Grid to ensure the execution of responsibilities.* | 2 | 2 |
| | **National Grid & ENWL I**<br>There is a risk that Trials compromise the security of supply commitments that both NG and ENWL have because they could be conducted during unsuitable times. This risk | 2 | 4 | SoS | • As part of the Project Plan, ENWL and NG have agreed specific dates to undertake the Trials to ensure that there is no compromise being incurred to the security of supply commitments<br>*Contingency Plan: If executed during unsuitable times, Trial will be immediately stopped, and executed at a more suitable time* | 1 | 2 |

| | | | | | | | |
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| | leads to a potentially negative effect to the network. | | | | | | |
| | **National Grid & ENWL II**<br>There is a risk that the Trials are executed when there is work being undertaken at the specific Primary substation site. This risk arises because the test regime collides with known and unknown planning/ maintenance work. The impact that this has is that the Trial will be executed either unsuccessfully and/or be interfered with. | 3 | 3 | R | • CLASS will regularly engage with the engineering and planning teams to ensure that the maintenance of substation sites does not adversely impact the Project<br>• As part of the site selection methodology, Primary substations will be selected that have a low risk in requiring planned/planned maintenance work<br>• CLASS will have a robust Test Regime, that will be developed with all potentially impacted Stakeholders (ENWL & NG) to avoid unforeseen planning/maintenance work<br>*Contingency Plan: Re-execute the Trial at the same selected time on a different day* | 2 | 2 |
| | **Customers:**<br>There is a risk that ENWL does not know whether some customers in the Trial area have voltage optimisers fitted within their premises. This risk leads to the data collected from these customers not showing the true impact of the Trials. | 2 | 3 | R | • Further research will be undertaken to understand whether customers have voltage optimisers fitted in the Trial area via the customer survey recruitment<br>*Contingency Plan: Additional customers will be recruited to ensure that the data collected is credible and shows a true reflection of the Trials undertaken.* | 1 | 2 |
| WS2: Trials & Customer Engagement | **Customer Impact Noticed**<br>There is a risk that customers in the Trial area notice a change in their voltage levels because of the Trials being undertaken. This risk leads to a hypothesis failure and a potential public outcry, impacting ENWL's reputation. | 2 | 4 | R | • To ensure that there is no public or reputational damage to ENWL, CLASS will inform all customers and stakeholders (ie Suppliers, local authorities and all other likely points of customer contact) in the Trial area of the Project (Pro-active Approach).<br>*Contingency Plan: Temporarily halt the Trials until our customers and stakeholders are reassured.* | 1 | 3 |
| | **Customer Survey I:**<br>There is a risk in getting customers engaged and participating in the Project because of the complex nature | 4 | 2 | F | • Impact Research, a specialist market research company, will Partner with ENWL to undertake the customer engagement work. Ensuring that an appropriate, well-structured and value for money incentive scheme is in place for consumers wishing to participate in the Project | 3 | 1 |

| | | | | | | | |
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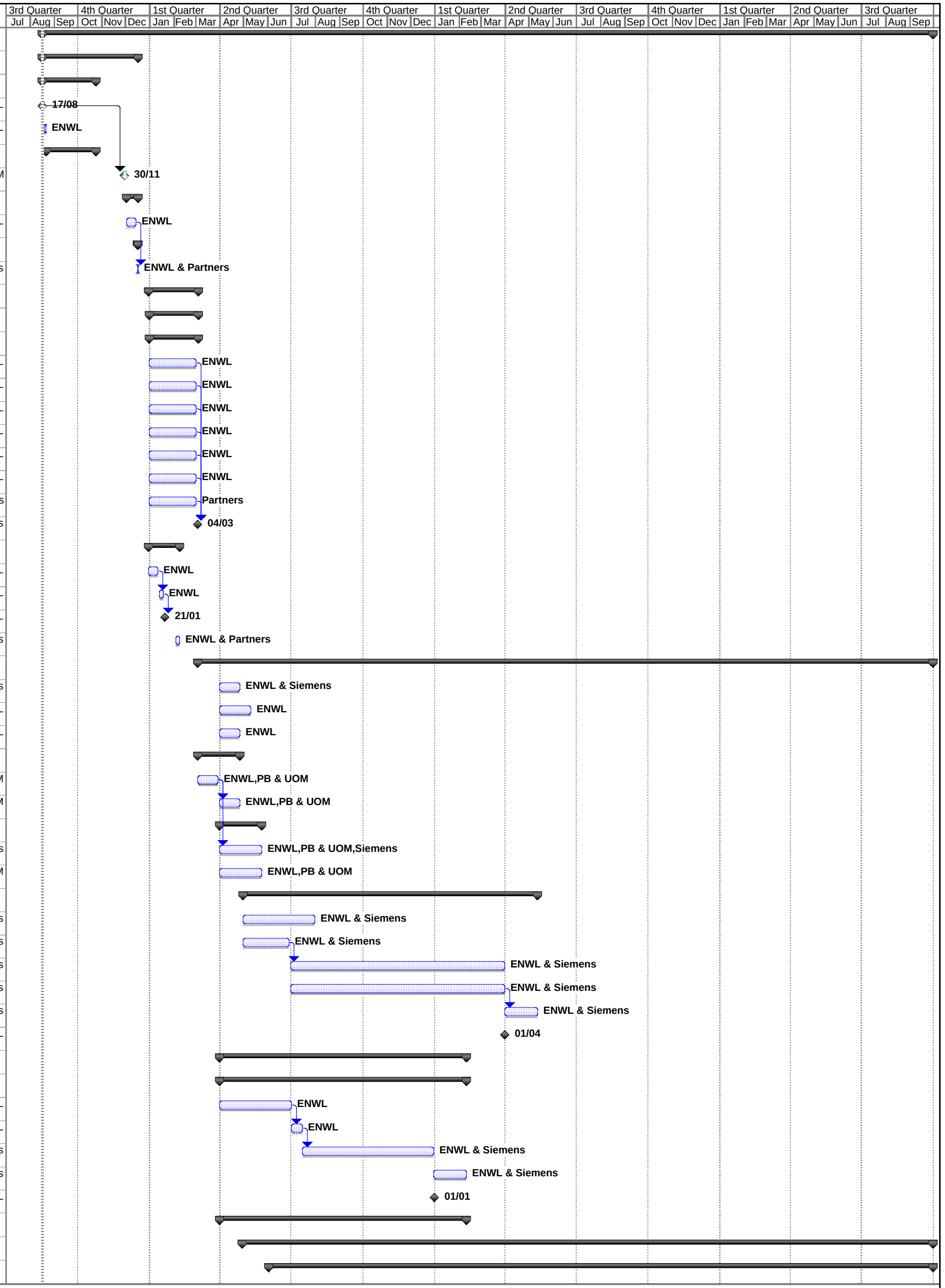
| | of CLASS and the method it Trials. This risk leads to potential Project deliverables not being met on time and additional costs being incurred to incentivise their participation in the Project. | | | | • Impact Research & ENWL will undertake a pilot communication Trial, with a range of stakeholders to ensure that we are able to effectively communicate and engage with our stakeholders<br>*Contingency Plan: More customers will be approached and incentivised to participate.* | | |
| | **Customer Survey II:**<br>There is a risk that customers become critical for the sake of being critical because they understand that a Trial is being undertaken. This risk leads to the customer feedback from the surveys not being credible. | 3 | 3 | R | • Impact Research and ENWL will measure the response feedback from surveys with a Control Group outside of the Trial area. This will ensure that a true credible reflection is given during the Trials<br>*Contingency Plan: More customers will be approached and incentivised to participate* | 2 | 2 |
| | **Customer Survey III:**<br>There is a risk that the customers engaged in the Project will only complete some of the surveys because of their other commitments. This risk leads to an incomplete set of surveys for the entire Trial period, and impacts the quantity of feedback needed for the customer analysis report to be regarded as representative. | 4 | 2 | R | • ENWL have taken the lessons learnt from C2C and other LCN Fund Projects to optimise the approach taken in engaging customers in CLASS<br>• Impact Research and EWNL will tailor the time at which customers will be engaged, dependent upon their daily commitments<br>• An additional 15% of domestic customers and 30% of commercial customers will be included in the survey to ensure that any drop outs during the year will not fall below the representative survey feedback required.<br>*Contingency Plan: More customers will be approached and incentivised to participate* | 3 | 1 |
| Research Work | **Personnel Changes:**<br>There is a risk that the UoM, will undergo personnel changes during the Project because of the individual's circumstance. This risk leads to specific skills potentially leaving the UoM impacting the quality of deliverables for which EWNL selected them. | 3 | 3 | P | • The terms of agreement with the UoM has been tailored to ensure that all deliverables involve multiple individuals to deliver the highest standard of work<br>*Contingency Plan: Another university will be approached to support the University of Manchester* | 2 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Learning & Dissemination | **Effective Learning Dissemination:**<br>There is a risk that the learning is not disseminated effectively to all stakeholders because different parties will have different interests and learning styles. This risks leads to some of the learning getting lost. | 3 | 3 | R | • CLASS's identifies a range of stakeholders and has ensured that there are multiple communication channels to disseminate the learning's to all interested parties<br>• ENWL has engaged the support of Project Partners to help in the L&D Project Plan<br>*Contingency Plan: Interested parties are able to contact the Project Team for any queries and request additional information* | 2 | 2 |
| Other | **Grid Code OC6 Requirements**<br>There is a risk that ENWL will not be able to respond to OC6 within the Project area because of an ongoing initiated Trial. This risk leads to ENWL not being compliant with the mandated Grid Code. | 1 | 5 | R | • NG are an actively involved Partner in CLASS and through regular stakeholder meeting, any issue in not being able to respond to OC6 will be addressed as a matter of urgency.<br>*Contingency Plan: ENWL's CLASS Project will undertake any necessary action to respond to an OC6 request by NG to any part of their network* | 1 | 3 |
| | **Green Deal & Smart Metering Roll-Out**<br>There is a risk that customers will get confused with the Project because of the other ongoing government initiatives e.g. The Green Deal and Smart Metering Roll-Out. This risk leads to its engagement being affected. | 3 | 3 | R | • The CLASS Customer Engagement Plan, is both non-intrusive and simple, minimising the potential for confusion with other government initiatives.<br>*Contingency Plan: Additional messages will be developed and communicated to clarify any confusion about the Project* | 2 | 2 |

# Appendix E   Detailed Project Plan

| ID | Task Name | Duration | Start | Finish | Predecessors | Resource Names |
|---|---|---|---|---|---|---|
| 1 | **CLASS Project** | **814 days** | **Fri 17/08/12** | **Wed 30/09/15** | | |
| 2 | **Phase I - Actitivies Pre-Start** | **87 days** | **Fri 17/08/12** | **Mon 17/12/12** | | |
| 3 | **Phase a) - Activities Pre-Award** | **49 days** | **Fri 17/08/12** | **Wed 24/10/12** | | |
| 4 | Full Submission issued to Ofgem | 1 day | Fri 17/08/12 | Fri 17/08/12 | | ENWL |
| 5 | Identify activities to complete prior to award | 2 days | Mon 20/08/12 | Tue 21/08/12 | | ENWL |
| 6 | **Contractual Agreements** | **46 days** | **Wed 22/08/12** | **Wed 24/10/12** | | |
| 11 | Contract Awarded | 1 day | Fri 30/11/12 | Fri 30/11/12 | 4 | OFGEM |
| 12 | **Phase b) - Project Readiness** | **11 days** | **Mon 03/12/12** | **Mon 17/12/12** | | |
| 13 | Design, Develop and Issue the PID to all Project Partners | 10 days | Mon 03/12/12 | Fri 14/12/12 | | ENWL |
| 14 | **Partnership Discussion** | **1 day** | **Mon 17/12/12** | **Mon 17/12/12** | | |
| 15 | Hold Pre-Start Mobilisation Meeting | 1 day | Mon 17/12/12 | Mon 17/12/12 | 13 | ENWL & Partners |
| 16 | **Phase II - Mobilisation** | **46 days** | **Mon 31/12/12** | **Mon 04/03/13** | | |
| 17 | **Project Management Office Start-Up** | **45 days** | **Tue 01/01/13** | **Mon 04/03/13** | | |
| 18 | **Identify & Mobilise Project Management Office** | **45 days** | **Tue 01/01/13** | **Mon 04/03/13** | | |
| 19 | Identify & Mobilise Project Manager | 44 days | Tue 01/01/13 | Fri 01/03/13 | | ENWL |
| 20 | Identify & Mobilise Workstream Lead Technical/Trial Manager | 44 days | Tue 01/01/13 | Fri 01/03/13 | | ENWL |
| 21 | Identify & Mobilise Workstream Lead Research & Customer/Communications Manager | 44 days | Tue 01/01/13 | Fri 01/03/13 | | ENWL |
| 22 | Mobilise Project Director | 44 days | Tue 01/01/13 | Fri 01/03/13 | | ENWL |
| 23 | Identify & Mobilise Finance Support | 44 days | Tue 01/01/13 | Fri 01/03/13 | | ENWL |
| 24 | Identify & Mobilise Customer Communication Support | 44 days | Tue 01/01/13 | Fri 01/03/13 | | ENWL |
| 25 | Partner Resourcing | 44 days | Tue 01/01/13 | Fri 01/03/13 | | Partners |
| 26 | Project Management Office and Partner Resources Mobilised | 1 day | Mon 04/03/13 | Mon 04/03/13 | 0,19,22,23,24 | ENWL & Partners |
| 27 | **Financial & Contractual** | **30 days** | **Mon 31/12/12** | **Fri 08/02/13** | | |
| 28 | Identify and implement project budget controls within ENW | 10 days | Mon 31/12/12 | Fri 11/01/13 | | ENWL |
| 29 | Set up project bank account | 5 days | Mon 14/01/13 | Fri 18/01/13 | 28 | ENWL |
| 30 | Financial controls established | 2 days | Mon 21/01/13 | Tue 22/01/13 | 29 | ENWL |
| 31 | Contractual agreement signed | 5 days | Mon 04/02/13 | Fri 08/02/13 | | ENWL & Partners |
| 32 | **Workstream 1 - Technology Build** | **673 days** | **Mon 04/03/13** | **Wed 30/09/15** | | |
| 33 | Design Authority for Monitoring Established | 20 days | Mon 01/04/13 | Fri 26/04/13 | | ENWL & Siemens |
| 34 | Define Monitoring Equipment for Primary, Distribution, LV, Customer Premises | 30 days | Mon 01/04/13 | Fri 10/05/13 | | ENWL |
| 35 | Design of Voltage Regulation Scheme | 20 days | Mon 01/04/13 | Fri 26/04/13 | | ENWL |
| 36 | **Sites Selected** | **40 days** | **Mon 04/03/13** | **Fri 26/04/13** | | |
| 37 | Idenify and Select Primary Substations | 20 days | Mon 04/03/13 | Fri 29/03/13 | | ENWL,PB & UOM |
| 38 | Idenify and Select Monitoring Substations | 20 days | Mon 01/04/13 | Fri 26/04/13 | 37 | ENWL,PB & UOM |
| 39 | **Design of Installation & Decomissioning Plan** | **40 days** | **Mon 01/04/13** | **Fri 24/05/13** | | |
| 40 | Define Primary Substations Controller & Monitor Installation Plan | 40 days | Mon 01/04/13 | Fri 24/05/13 | 37 | ENWL,PB & UOM,Siemens |
| 41 | Define Distribution & Low Voltage Substation Monitoring Installation Plan | 40 days | Mon 01/04/13 | Fri 24/05/13 | | ENWL,PB & UOM |
| 42 | **Primary substation Voltage Controllers** | **269 days** | **Wed 01/05/13** | **Mon 12/05/14** | | |
| 43 | Purchase Primary substation Voltage Contollers | 66 days | Wed 01/05/13 | Wed 31/07/13 | | ENWL & Siemens |
| 44 | Site Survey & Voltage Controller Quality Checks (Component) | 43 days | Wed 01/05/13 | Fri 28/06/13 | | ENWL & Siemens |
| 45 | Install, Reconfigure Primary Substation Voltage Controllers & Interface to RTUs | 196 days | Mon 01/07/13 | Mon 31/03/14 | 44 | ENWL & Siemens |
| 46 | Commission & Witness Test Primary substation Voltage Controllers | 196 days | Mon 01/07/13 | Mon 31/03/14 | | ENWL & Siemens |
| 47 | Support of Primary substation Voltage Controllers | 30 days | Tue 01/04/14 | Mon 12/05/14 | 46 | ENWL & Siemens |
| 48 | All Primary Monitors Live | 1 day | Tue 01/04/14 | Tue 01/04/14 | | ENWL |
| 49 | **Monitoring** | **226 days** | **Mon 01/04/13** | **Mon 10/02/14** | | |
| 50 | **Primary Substation Monitoring** | **226 days** | **Mon 01/04/13** | **Mon 10/02/14** | | |
| 51 | Purchase Distribution Monitors (inc Equipment Support) | 66 days | Mon 01/04/13 | Mon 01/07/13 | | ENWL |
| 52 | Monitor Quality Check (Component) | 10 days | Tue 02/07/13 | Mon 15/07/13 | 51 | ENWL |
| 53 | Install, Commission & Witness Test Distribution Substation Monitors | 120 days | Tue 16/07/13 | Mon 30/12/13 | 52 | ENWL & Siemens |
| 54 | Support of Primary Substation Monitors | 30 days | Tue 31/12/13 | Mon 10/02/14 | | ENWL & Siemens |
| 55 | All Primary Monitors Live | 1 day | Wed 01/01/14 | Wed 01/01/14 | | ENWL |
| 56 | **Distribution & LV Monitoring** | **226 days** | **Mon 01/04/13** | **Mon 10/02/14** | | |
| 62 | **ICT & Communications** | **632 days** | **Tue 30/04/13** | **Wed 30/09/15** | | |
| 63 | **CLASS Dashboard** | **608 days** | **Mon 03/06/13** | **Wed 30/09/15** | | |




Project: Project Plan Final Proposal - F
Date: Thu 16/08/12

| Task | Progress | Summary | External Tasks | Deadline |
|---|---|---|---|---|
| Split | Milestone | Project Summary | External Milestone | |

Page 1

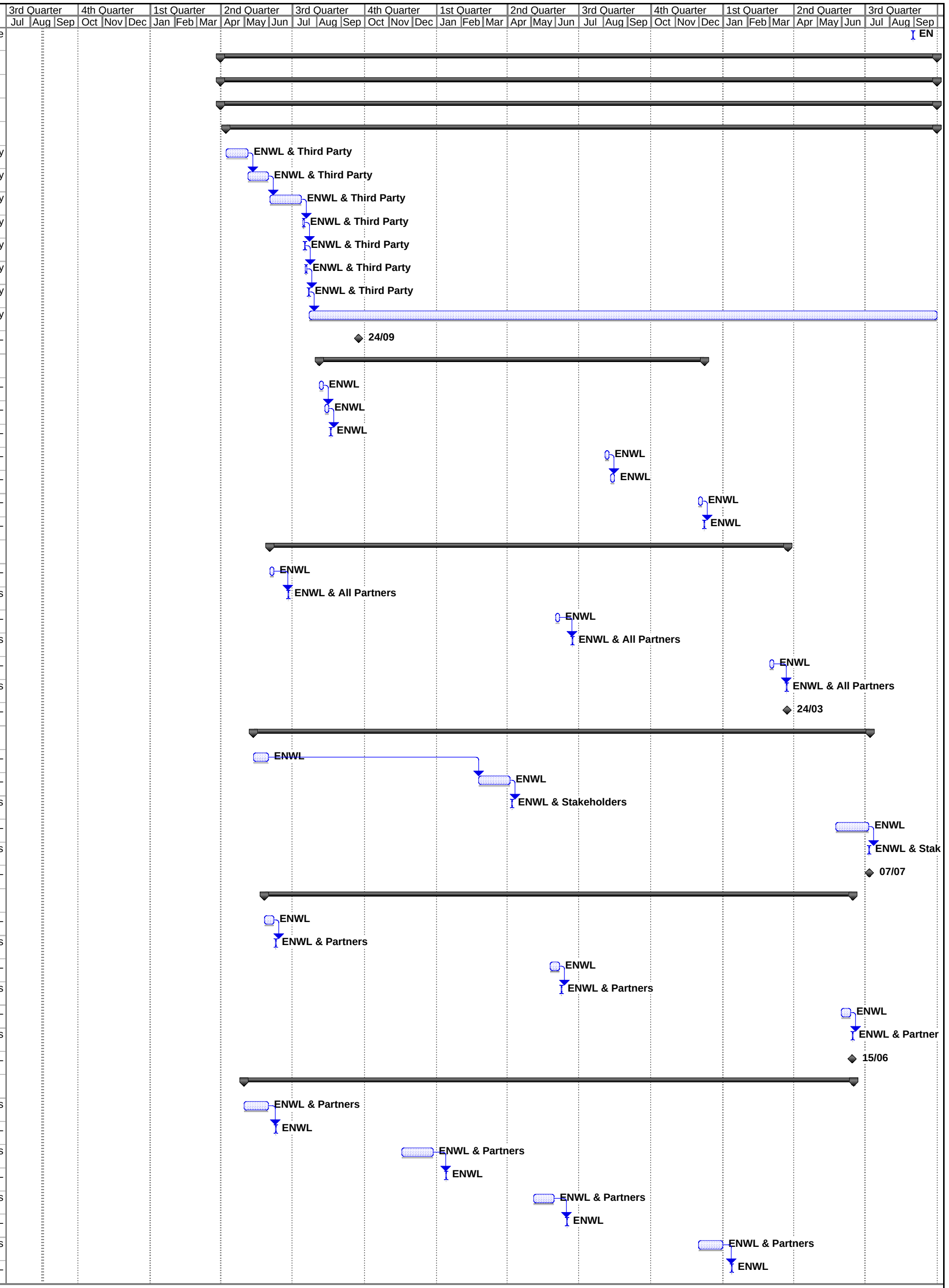
# Appendix E Detailed Project Plan

| ID | Task Name | Duration | Start | Finish | Predecessors | Resource Names |
|---|---|---|---|---|---|---|
| 64 | Design CLASS Dashboard (inc NMS Interface Solution) | 20 days | Mon 03/06/13 | Fri 28/06/13 | | ENWL & GE |
| 65 | Build CLASS Dashboard | 140 days | Mon 01/07/13 | Fri 10/01/14 | 64 | ENWL & GE |
| 66 | Test CLASS Dashboard | 10 days | Mon 13/01/14 | Fri 24/01/14 | 65 | ENWL & GE |
| 67 | Deploy CLASS Dashboard | 10 days | Mon 27/01/14 | Fri 07/02/14 | 66 | ENWL & GE |
| 68 | Support of CLASS Dashboard | 428 days | Mon 10/02/14 | Wed 30/09/15 | 67 | ENWL & GE |
| 69 | **ICCP Interface** | **632 days** | **Tue 30/04/13** | **Wed 30/09/15** | | |
| 70 | Design ICCP Link (ENWL) | 20 days | Tue 02/07/13 | Mon 29/07/13 | | ENWL,NG & GE |
| 71 | **ENWL ICCP Link Estate** | **134 days** | **Tue 30/07/13** | **Fri 31/01/14** | | |
| 74 | **National Grid ICCP Link Estate** | **365 days** | **Tue 30/04/13** | **Mon 22/09/14** | | |
| 79 | Support of ICCP link | 131 days | Wed 01/04/15 | Wed 30/09/15 | 78 | ENWL,GE & NG |
| 80 | **Data Collection & Transferal** | **307 days** | **Tue 01/04/14** | **Wed 03/06/15** | | |
| 81 | Data Capture | 262 days | Tue 01/04/14 | Wed 01/04/15 | | ENWL |
| 82 | Data Transfer to the UoM | 307 days | Tue 01/04/14 | Wed 03/06/15 | | ENWL & UoM |
| 83 | Successful Data Transfer Report to ENWL | 307 days | Tue 01/04/14 | Wed 03/06/15 | | UoM |
| 84 | **Workstream 2 - Trials** | **523 days** | **Mon 03/06/13** | **Wed 03/06/15** | | |
| 85 | Design of Trials and Test Regime | 110 days | Mon 03/06/13 | Fri 01/11/13 | | ENWL & Impact Research |
| 86 | Identify Customers | 87 days | Mon 02/09/13 | Tue 31/12/13 | | ENWL & Impact Research |
| 87 | Finalise Customer Proposition | 21 days | Mon 02/09/13 | Mon 30/09/13 | | ENWL & Impact Research |
| 88 | Design & Create Customer Communication Engagement Material | 66 days | Tue 01/10/13 | Tue 31/12/13 | | ENWL & Impact Research |
| 89 | Project Awareness/Recruiting Customers | 64 days | Wed 01/01/14 | Mon 31/03/14 | 86,87,88 | ENWL & Impact Research |
| 90 | Pilot Customer Survey Trial | 20 days | Mon 03/02/14 | Fri 28/02/14 | | ENWL & Impact Research |
| 91 | Customer Survey - Baseline | 22 days | Mon 07/04/14 | Tue 06/05/14 | 90 | ENWL & Impact Research |
| 92 | Trials - Summer | 44 days | Mon 02/06/14 | Thu 31/07/14 | | ENWL & NG |
| 93 | Customer Survey- Summer | 21 days | Fri 01/08/14 | Fri 29/08/14 | 92 | ENWL & Impact Research |
| 94 | Trials - Autumn | 45 days | Mon 01/09/14 | Fri 31/10/14 | | ENWL & NG |
| 95 | Customer Survey - Autumn | 20 days | Mon 03/11/14 | Fri 28/11/14 | 94 | ENWL & Impact Research |
| 96 | Trials - Winter | 44 days | Tue 02/12/14 | Fri 30/01/15 | | ENWL & NG |
| 97 | Customer Survey - Winter | 20 days | Mon 02/02/15 | Fri 27/02/15 | 96 | ENWL & Impact Research |
| 98 | Trials - Spring | 43 days | Thu 05/03/15 | Mon 04/05/15 | | ENWL & NG |
| 99 | Customer Survey - Spring | 22 days | Tue 05/05/15 | Wed 03/06/15 | 98 | ENWL & Impact Research |
| 100 | **Workstream 3 - Research** | **326 days** | **Mon 02/06/14** | **Mon 31/08/15** | | |
| 101 | Analysis of Data | 282 days | Mon 02/06/14 | Tue 30/06/15 | | UoM |
| 102 | **Report 1: Customer Survey Report** | **171 days** | **Mon 05/01/15** | **Mon 31/08/15** | | |
| 103 | Interim Report | 1 day | Mon 05/01/15 | Mon 05/01/15 | | ENWL & Impact Research |
| 104 | Initial Draft | 1 day | Mon 15/06/15 | Mon 15/06/15 | 103 | ENWL & Impact Research |
| 105 | Final Draft | 1 day | Mon 31/08/15 | Mon 31/08/15 | 104 | ENWL & Impact Research |
| 106 | **Report 2: Network Modelling & Analysis** | **171 days** | **Mon 05/01/15** | **Mon 31/08/15** | | |
| 107 | Interim Report | 1 day | Mon 05/01/15 | Mon 05/01/15 | | ENWL & UoM |
| 108 | Initial Draft | 3 days | Mon 15/06/15 | Wed 17/06/15 | 107 | ENWL & UoM |
| 109 | Final Draft | 1 day | Mon 31/08/15 | Mon 31/08/15 | 108 | ENWL & UoM |
| 110 | **Report 3: Voltage Profile Studies** | **171 days** | **Mon 05/01/15** | **Mon 31/08/15** | | |
| 111 | Interim Report | 1 day | Mon 05/01/15 | Mon 05/01/15 | | ENWL & UoM |
| 112 | Initial Draft | 1 day | Mon 15/06/15 | Mon 15/06/15 | 111 | ENWL & UoM |
| 113 | Final Draft | 1 day | Mon 31/08/15 | Mon 31/08/15 | 112 | ENWL & UoM |
| 114 | **Report 4: Health of Assets Studies** | **171 days** | **Mon 05/01/15** | **Mon 31/08/15** | | |
| 115 | Interim Report | 1 day | Mon 05/01/15 | Mon 05/01/15 | | ENWL & UoM |
| 116 | Initial Draft | 1 day | Mon 15/06/15 | Mon 15/06/15 | 115 | ENWL & UoM |
| 117 | Final Draft | 1 day | Mon 31/08/15 | Mon 31/08/15 | 116 | ENWL & UoM |
| 118 | **Report 5: Change Proposal for NETS SQSS** | **23 days** | **Fri 29/05/15** | **Tue 30/06/15** | | |
| 119 | Initial Draft | 1 day | Fri 29/05/15 | Fri 29/05/15 | | Chiltern Power,PB,ENWL & NG |
| 120 | Publish Final Draft | 1 day | Tue 30/06/15 | Tue 30/06/15 | 119 | Chiltern Power,PB,ENWL & NG |
| 121 | **Report 6: Carbon Impact Studies** | **171 days** | **Mon 05/01/15** | **Mon 31/08/15** | | |
| 122 | Interim Report | 1 day | Mon 05/01/15 | Mon 05/01/15 | | ENWL & Tyndall Centre |
| 123 | Initial Draft | 1 day | Mon 15/06/15 | Mon 15/06/15 | | ENWL & Tyndall Centre |


| | | | | | |
|---|---|---|---|---|---|
| Project: Project Plan Final Proposal - F<br>Date: Thu 16/08/12 | Task | Progress | Summary | External Tasks | Deadline |
| | Split | Milestone | Project Summary | External Milestone | |

# Appendix E Detailed Project Plan

| ID | Task Name | Duration | Start | Finish | Predecessors | Resource Names |
|---|---|---|---|---|---|---|
| 124 | Final Draft | 1 day | Mon 31/08/15 | Mon 31/08/15 | | ENWL & Tyndall Centre |
| 125 | **Workstream 4 - Learning & Dissemination** | **653 days** | **Mon 01/04/13** | **Wed 30/09/15** | | |
| 126 | **Knowledge Transfer Events** | **653 days** | **Mon 01/04/13** | **Wed 30/09/15** | | |
| 127 | **External Learning & Dissemination** | **653 days** | **Mon 01/04/13** | **Wed 30/09/15** | | |
| 128 | **CLASS Website** | **648 days** | **Mon 08/04/13** | **Wed 30/09/15** | | |
| 129 | Procure Website Development Supplier (inc Support) | 20 days | Mon 08/04/13 | Mon 06/05/13 | | ENWL & Third Party |
| 130 | Design of CLASS Website | 20 days | Mon 06/05/13 | Fri 31/05/13 | 129 | ENWL & Third Party |
| 131 | Build of CLASS Website | 30 days | Mon 03/06/13 | Fri 12/07/13 | 130 | ENWL & Third Party |
| 132 | Test of CLASS Website (Product) | 2 days | Mon 15/07/13 | Tue 16/07/13 | 131 | ENWL & Third Party |
| 133 | Deploy CLASS Website to Test Environment | 1 day | Wed 17/07/13 | Wed 17/07/13 | 132 | ENWL & Third Party |
| 134 | Test of CLASS Website (Pre-Production) | 2 days | Thu 18/07/13 | Fri 19/07/13 | 133 | ENWL & Third Party |
| 135 | Deploy CLASS Website | 1 day | Mon 22/07/13 | Mon 22/07/13 | 134 | ENWL & Third Party |
| 136 | Support & maintenance of CLASS Website | 572 days | Tue 23/07/13 | Wed 30/09/15 | 135 | ENWL & Third Party |
| 137 | Project Learning and Outcome Capture - Website Updates | 527 days | Tue 24/09/13 | Wed 30/09/15 | | ENWL |
| 138 | **Video Podcasts** | **351 days** | **Mon 05/08/13** | **Mon 08/12/14** | | |
| 139 | Design of Whitespace Video Podcast | 5 days | Mon 05/08/13 | Fri 09/08/13 | | ENWL |
| 140 | Record Video Podcast 1: Project, LCNF and the Low Carbon Agenda | 5 days | Mon 12/08/13 | Fri 16/08/13 | 139 | ENWL |
| 141 | Launch Video Podcast 1 | 1 day | Mon 19/08/13 | Mon 19/08/13 | 140 | ENWL |
| 142 | Record Video Podcast 2: Voltage Regulation Technologies | 5 days | Mon 04/08/14 | Fri 08/08/14 | | ENWL |
| 143 | Launch Video Podcast 2 | 5 days | Mon 11/08/14 | Fri 15/08/14 | 142 | ENWL |
| 144 | Record Video Podcast 3: Early Results CLASS | 5 days | Mon 01/12/14 | Fri 05/12/14 | | ENWL |
| 145 | Launch Video Podcast 3 | 1 day | Mon 08/12/14 | Mon 08/12/14 | 144 | ENWL |
| 146 | **Webinars** | **472 days** | **Mon 03/06/13** | **Tue 24/03/15** | | |
| 147 | Planning, advertising and preparation of Webinar 1 | 5 days | Mon 03/06/13 | Fri 07/06/13 | | ENWL |
| 148 | Webinar 1: First 6 Months in the Project | 1 day | Wed 26/06/13 | Wed 26/06/13 | 147 | ENWL & All Partners |
| 149 | Planning, advertising and preparation of Webinar 2 | 5 days | Mon 02/06/14 | Fri 06/06/14 | | ENWL |
| 150 | Webinar 2: Mid Project Update | 1 day | Mon 23/06/14 | Mon 23/06/14 | 149 | ENWL & All Partners |
| 151 | Planning, advertising and preparation of Webinar 3 | 5 days | Mon 02/03/15 | Fri 06/03/15 | | ENWL |
| 152 | Webinar 3: End of Project | 1 day | Mon 23/03/15 | Mon 23/03/15 | 151 | ENWL & All Partners |
| 153 | Webinar Complete | 1 day | Tue 24/03/15 | Tue 24/03/15 | | ENWL |
| 154 | **ENWL Hosted Learning Event** | **562 days** | **Mon 13/05/13** | **Tue 07/07/15** | | |
| 155 | Identification of stakeholder groups for workshops and seminars | 15 days | Mon 13/05/13 | Fri 31/05/13 | | ENWL |
| 156 | Planning/advertising and preparation of workshops 1 | 30 days | Mon 24/02/14 | Fri 04/04/14 | 155 | ENWL |
| 157 | Workshop 1 | 1 day | Mon 07/04/14 | Mon 07/04/14 | 156 | ENWL & Stakeholders |
| 158 | Planning/advertising and preparation of workshops 2 | 30 days | Mon 25/05/15 | Mon 06/07/15 | | ENWL |
| 159 | Workshop 2 | 1 day | Mon 06/07/15 | Mon 06/07/15 | 158 | ENWL & Stakeholders |
| 160 | Workshops Complete | 1 day | Tue 07/07/15 | Tue 07/07/15 | | ENWL |
| 161 | **Conference Attendance & Presentation** | **536 days** | **Mon 27/05/13** | **Mon 15/06/15** | | |
| 162 | Planning/advertising and preparation of conference 1 ENA | 10 days | Mon 27/05/13 | Fri 07/06/13 | | ENWL |
| 163 | Conference 1 | 1 day | Mon 10/06/13 | Mon 10/06/13 | 162 | ENWL & Partners |
| 164 | Planning/advertising and preparation of conference 2 ENA | 10 days | Mon 26/05/14 | Fri 06/06/14 | | ENWL |
| 165 | Conference 2 | 1 day | Mon 09/06/14 | Mon 09/06/14 | 164 | ENWL & Partners |
| 166 | Planning/advertising and preparation of conference 3 ENA | 10 days | Mon 01/06/15 | Fri 12/06/15 | | ENWL |
| 167 | Conference 3 | 1 day | Mon 15/06/15 | Mon 15/06/15 | 166 | ENWL & Partners |
| 168 | Conferences Complete | 1 day | Mon 15/06/15 | Mon 15/06/15 | | ENWL |
| 169 | **OFGEM Six Monthly Reports** | **555 days** | **Wed 01/05/13** | **Tue 16/06/15** | | |
| 170 | Preparation of Ofgem Report 1 | 23 days | Wed 01/05/13 | Fri 31/05/13 | | ENWL & Partners |
| 171 | Ofgem Report 1 | 1 day | Mon 10/06/13 | Mon 10/06/13 | 170 | ENWL |
| 172 | Preparation of Ofgem Report 2 | 30 days | Mon 18/11/13 | Fri 27/12/13 | | ENWL & Partners |
| 173 | Ofgem Report 2 | 1 day | Mon 13/01/14 | Mon 13/01/14 | 172 | ENWL |
| 174 | Preparation of Mid Term Ofgem Report 3 | 20 days | Mon 05/05/14 | Fri 30/05/14 | | ENWL & Partners |
| 175 | Mid Term OFGEM Report 3 | 1 day | Mon 16/06/14 | Mon 16/06/14 | 174 | ENWL |
| 176 | Preparation of Ofgem Report 4 | 23 days | Mon 01/12/14 | Wed 31/12/14 | | ENWL & Partners |
| 177 | Ofgem Report 4 | 1 day | Mon 12/01/15 | Mon 12/01/15 | 176 | ENWL |

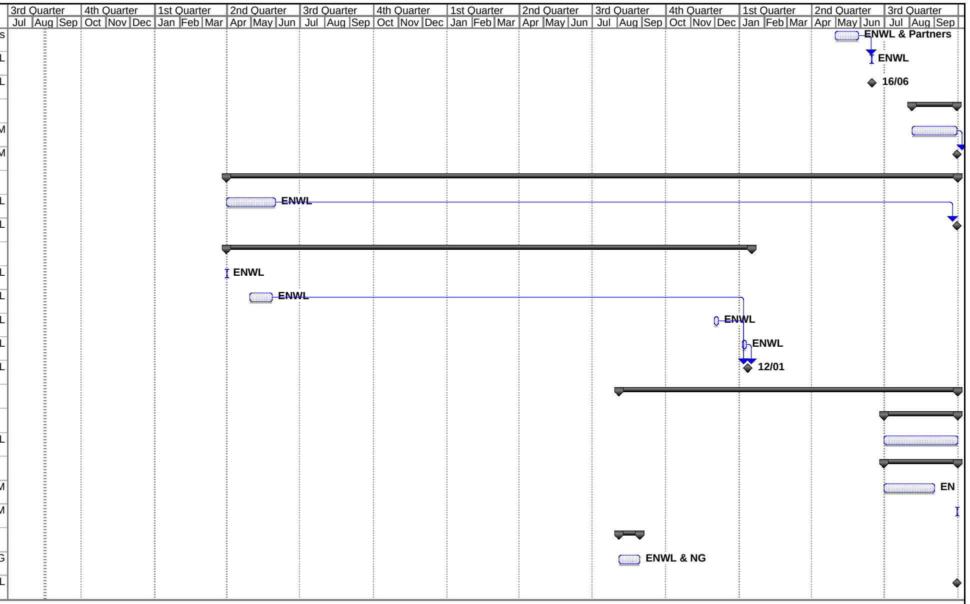



Project: Project Plan Final Proposal - F
Date: Thu 16/08/12

Task | Split | Progress | Milestone | Summary | Project Summary | External Tasks | External Milestone | Deadline

# Appendix E Detailed Project Plan

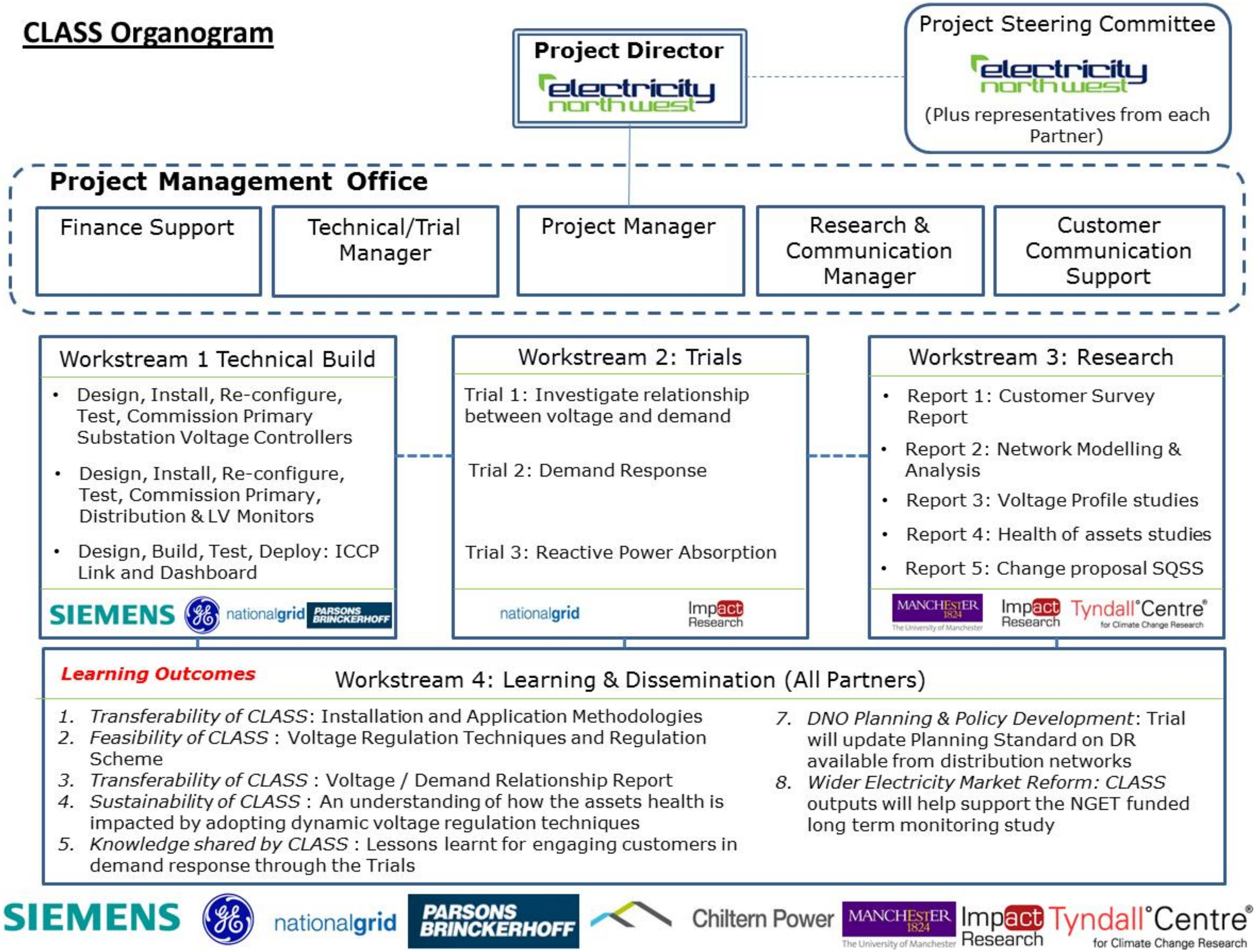
| ID | Task Name | Duration | Start | Finish | Predecessors | Resource Names |
|---|---|---|---|---|---|---|
| 178 | Preparation of OFGEM Report 5 | 21 days | Fri 01/05/15 | Fri 29/05/15 | | ENWL & Partners |
| 179 | OFGEM Report 5 | 1 day | Mon 15/06/15 | Mon 15/06/15 | 178 | ENWL |
| 180 | OFGEM Reports Completed | 1 day | Tue 16/06/15 | Tue 16/06/15 | | ENWL |
| 181 | **Technical Journal Articles** | **40 days** | **Wed 05/08/15** | **Wed 30/09/15** | | |
| 182 | Draft Journal Article | 40 days | Wed 05/08/15 | Tue 29/09/15 | | UoM |
| 183 | Publicise three journal articles on technical aspects of CLASS Project | 0 days | Wed 30/09/15 | Wed 30/09/15 | 182 | UoM |
| 184 | **Publicity** | **653 days** | **Mon 01/04/13** | **Wed 30/09/15** | | |
| 185 | Identification of publication/websites | 45 days | Mon 01/04/13 | Fri 31/05/13 | | ENWL |
| 186 | Eight Press Article Released at Key Milestones | 1 day | Wed 30/09/15 | Wed 30/09/15 | 185 | ENWL |
| 187 | **Internal Workshops and Company Briefings** | **470 days** | **Mon 01/04/13** | **Fri 16/01/15** | | |
| 188 | Identification of internal stakeholder groups for workshops and company briefings | 1 day | Mon 01/04/13 | Mon 01/04/13 | | ENWL |
| 189 | Briefing 1 | 20 days | Tue 30/04/13 | Mon 27/05/13 | | ENWL |
| 190 | Briefing 2 | 5 days | Mon 01/12/14 | Fri 05/12/14 | | ENWL |
| 191 | Briefing 3 | 5 days | Mon 05/01/15 | Fri 09/01/15 | | ENWL |
| 192 | Internal Workshops/Company Briefings Complete | 5 days | Mon 12/01/15 | Fri 16/01/15 | 191,189,190 | ENWL |
| 193 | **Phase III - Close Down & Long Term Project Handover** | **303 days** | **Mon 04/08/14** | **Wed 30/09/15** | | |
| 194 | **Decommission Equipment** | **66 days** | **Wed 01/07/15** | **Wed 30/09/15** | | |
| 195 | PowerOn Fusion Software | 66 days | Wed 01/07/15 | Wed 30/09/15 | | ENWL |
| 196 | **Close Down Report** | **66 days** | **Wed 01/07/15** | **Wed 30/09/15** | | |
| 197 | Close Down Report Draft | 45 days | Wed 01/07/15 | Tue 01/09/15 | | ENWL & UoM |
| 198 | Close Down Reports Publish | 1 day | Wed 30/09/15 | Wed 30/09/15 | | ENWL & UoM |
| 199 | **Long Term Monitoring Study** | **20 days** | **Mon 04/08/14** | **Fri 29/08/14** | | |
| 200 | Agree details to National Grid | 20 days | Mon 04/08/14 | Fri 29/08/14 | | ENWL & NG |
| 201 | **Project Closure** | 1 day | Wed 30/09/15 | Wed 30/09/15 | | ENWL |




Project: Project Plan Final Proposal - F
Date: Thu 16/08/12

Task | Progress | Summary | External Tasks | Deadline
Split | Milestone | Project Summary | External Milestone

## Appendix F: CLASS Organogram



## Appendix G: Project Partner Details

| Name | Type of Organisation | Different Ownership from DNO | Funding Provided | Contractual Relationship | Role of Project Partner | Funding benefits to Project |
|---|---|---|---|---|---|---|
| National Grid | National Electricity Transmission System Operator for Great Britain. Transmission Owner for England & Wales | Yes | £388k | Terms & Conditions agreed, just requires contract drafting and the inclusions of work schedules for CLASS | • Configuration of the ICCP Link on the NG estate<br>• Support in executing Trials<br>• Learning & Dissemination Support | NGET is fully funding the ICCP link configuration functionalities for the National Grid estate and providing expert resource for the Technical Build, Trials and Learning and Dissemination workstreams. |
| GE | GE Energy is one of the world's leading suppliers of power generation and energy delivery technologies | Yes | £111k | Terms & Conditions agreed, just requires contract drafting and the inclusions of work schedules for CLASS | • Configuration of the ICCP Link<br>• Development of the CLASS Dashboard<br>• Learning & Dissemination Support | GE is fully funding the ICCP Link for the ENWL estate, and providing expert resource for the Technical Build. |
| Siemens | Siemens is one of the world's leading technology vendors of power generation and energy delivery technologies. | Yes | £306k | Framework agreement is in place, just requires the inclusion of work schedules for CLASS | • Supply, install and configure the substation voltage controllers<br>• Learning & Dissemination Support | Siemens is funding a significant portion of the substation technology to enable the trials + fully funding Learning & Dissemination Support |
| Parsons Brincker-hoff | PB is experienced in all aspects of power generation, transmission and distribution, with particular expertise in | Yes | £5k | Framework agreement is in place, just requires the inclusion of work schedules for | • Finalise the selection of Primary substations sites<br>• Manage the consultation process in understanding which | PB is providing additional resource support for the finalisation of the selection of the Primary substation sites and NETS SQSS consultation paper. |

| | | | | | | |
|---|---|---|---|---|---|---|
| | regulatory and restructuring issues | | | CLASS | aspects of NETS SQSS<br>• Learning & Dissemination Support | |
| Chiltern Power | Specialist consultancy organisation | Yes | £4k | Terms & Conditions agreed, just requires contract drafting and the inclusions of work schedules for CLASS | • Chiltern Power will lead the consultation process for developing the change proposals for amending NETS SQSS.<br>• Learning & Dissemination Support | Chiltern Power is funding a number of additional days for developing the change proposals for amending NETS SQSS. |
| Uni. Of Manchester | The University of Manchester is an academic institution | Yes | £85k | Framework agreement is in place, just requires the inclusion of work schedules for CLASS | • Delivery of three studies as part of CLASS<br>• Learning & Dissemination Support | The University of Manchester will provide extra resource where suitable in the delivery of the three studies as part of CLASS. |
| Tyndall Centre (Uni. Of Manchester) | Carbon Research Institution (part of the Uni. Of Manchester) | Yes | N/A | Framework agreement is in place, just requires the inclusion of work schedules for CLASS | • Carbon study and Impact assessment<br>• Learning & Dissemination Support | N/A |
| Impact Research | Impact Research is a specialist marketing research organisation | Yes | £10k | Terms & Conditions agreed, just requires contract drafting and the inclusions of work schedules for CLASS | • Lead the Customer Survey Engagement<br>• Learning & Dissemination Support | Impact Research is funding additional interviews with customers support the development of the Customer Survey Report |

## Appendix H: Base Case Costs & Carbon Impact Methodology

### Base Case Cost Methodology

This section describes the methodology for the calculation of the Base Case costs.

The typical costs of reinforcement and the typical time to reinforce has been generated from the analysis of several case studies that reflect the range of schemes for making available network capacity fulfilling the most efficient method currently available. The seven case studies shown below in Table 1 were used to understand the range and type of network reinforcement designed and planned when a Primary substation goes out of firm capacity ie the demand on the substation exceeds its capacity rating.

| | | | |
|---|---|---|---|
| **Case 1** - Move load off Primary to an adjacent Primary substation by moving open point - no reinforcement | **Case 2** - Move load off Primary to an adjacent Primary substation by moving open point - HV reinforcement required (assume 1km of u/g cable). | **Case 3** - Upgrade one 23 MVA transformer to 32 MVA at Primary substation: assuming no issues with circuits or switchgear. | **Case 4** - Upgrade both 23 MVA to 32 MVA transformers at Primary substation: assuming no issues with circuits or switchgear. |
| **Case 5** - Upgrade both 23 MVA transformers to 32 MVA at Primary substation: upgrade incoming circuits (0.5km cable new lay), assume switchgear ok. | **Case 6** - Upgrade both 23 MVA transformers to 32 MVA at Primary substation: upgrade circuits (0.5km u/g cable new lay and switchgear. | **Case 7** - Build new Primary substation | |

Table 1 Case Studies of Primary substation reinforcement

The costs of each case study, the likelihood of undertaking each case study and the time taken to undertake the network reinforcement were estimated through analysis of recent network reinforcement schemes. Tables 2 and 3 below show the results of this analysis.

| | Primary Substation Network Reinforcement Cost, £ | Percentage split of cases across DPRC5 Projects | Weighted average, Network Reinforcement Cost, £ |
|---|---|---|---|
| **Case 1** | £0 | 5 | £0 |
| **Case 2** | £120,000 | 50 | £6,000,000 |
| **Case 3** | £486,039 | 5 | £2,430,195 |
| **Case 4** | £972,078 | 20 | £19,441,560 |
| **Case 5** | £1,099,078 | 10 | £10,990,780 |
| **Case 6** | £1,596,906 | 5 | £7,984,530 |
| **Case 7** | £1,862,916 | 5 | £9,314,579 |
| | | | **£561,616** |

Table 2 Typical cost for Primary substation reinforcement

| | Percentage split of cases across DPRC5 Projects | Ave time to commission Primary Substation Network Reinforcement, years | Weighted average, time to reinforce (years) |
|---|---|---|---|
| **Case 1** | 5 | 0.014 | 0.06849 |
| **Case 2** | 50 | 0.5 | 25.00000 |
| **Case 3** | 5 | 2 | 10.00000 |
| **Case 4** | 20 | 2 | 40.00000 |
| **Case 5** | 10 | 2 | 20.00000 |
| **Case 6** | 5 | 2 | 10.00000 |
| **Case 7** | 5 | 1 | 5.00000 |
| | | | **1.1** |

Table 3 Typical time to undertake Primary substation reinforcement

The analysis shows the typical cost for Primary substation network reinforcement is around £560 000 and the typical time to reinforce is 57 weeks. If, out of the 60 Primary substations within the Trial, fourteen substations are within the Load Indices 5 category then the typical cost of traditional network reinforcement is £7.86M. This cost may be deferred for several years or potentially avoided.

**CLASS Carbon Impact Methodology**

*This document is a summary of a fuller report providing a detailed estimate of the emission changes anticipated in the CLASS Project. It has been prepared by Dr John Broderick and Jaise Kuriakose at the Tyndall Centre (University of Manchester) with input from Simon Brooke (ENWL).*

## 1 Overview

Three new modes of operation have been identified, each providing a different operational function to the distribution network. They are:

1) Demand Response (DR) via voltage reduction, providing:
   a. Peak Reduction (PR) to defer the need for reinforcement at Primary substations;
   b. Demand Management (DM) to National Electricity Transmission System Operator for peak reduction and/or frequency control (either Frequency Response or the Fast Reserve markets);
2) Reactive Power (RP) absorption via tap staggering, providing reactive power absorption to manage the voltage profile for lightly loaded circuits.

The main carbon impacts identified in the CLASS Project relate to the *assets*, i.e. the emissions embodied in the physical equipment required to provide a service, and *operational* impacts, namely the different quantities and locations and energy consumed by operating the network in this way relative to "business as usual" (BAU). This approach is modelled on the UN's international carbon trading Project framework. Estimates are provided at three scales; that of the CLASS Project trial and also the same technique scaled up to the whole of the ENWL network and the GB network.

### *1.1 Peak Reduction*

As PR assumes for *deferral* of investment rather than complete obviation of new assets, the embodied carbon difference between scenarios is not counted as an emissions reduction. The assets required to implement the FTC in CLASS have very low embodied emissions in comparison to reinforcement options (two orders of magnitude in fact; less than 2 tonnes vs potentially more than 200 tonnes). However, as might be expected, the base case of network upgrade achieves meaningful reductions in emissions due to continuous reduced resistive losses. The CLASS voltage reduction will reduce energy consumption at load but it has not been possible to calculate this effect. Nonetheless, the Project is still likely to increase operational emissions to some degree.

### *1.2 Demand Management*

Modest savings of 99 to 360 tCO2 are anticipated in the CLASS trial. This is in part due to the conservative assumptions on hours of delivery and voltage reduction. However, this technique could supply 1-2% of the GB Fast Reserve market if applied across the ENWL network following the trial, saving 5100 t$CO_2$ to 18,000 tCO2 in the remainder of the RIIO price control period. At a GB scale, this might be equivalent to 66,000 to 238,000 tCO2 savings over the whole RIIO period. These are likely to be under estimates as emissions savings in the Project operations are anticipated as a consequence of reduced losses, although these are not calculated. Nationally, Firm Frequency Response accounts for 0.6% of energy supply CO2 emissions, however, contributing to the Fast Reserve has the greatest carbon saving per unit of energy due to the higher marginal emissions factor of the existing units in this market (pumped storage).

### *1.3 Reactive Power*

The use of tap staggering to replace the construction of new STATCOMs for reactive power absorption has the potential to offer substantial savings in both assets and operations. Over the period of the trial, net savings may be in the order of 2376 t$CO_2$ to 4071 t$CO_2$. If successful, rollout across the ENWL network could result in savings of up to 250,000 tonnes over 8 years.

## 2 BAU Scenarios and Scale of Services

The calculation of emissions reductions is performed against a single alternative BAU scenario which is different for each of the functions offered. Briefly; for PR the alternative is reinforcement of the network e.g. upgrading of Primary substations. For DM, it is taken that CLASS trial substitutes for existing Balancing Units in the the Fast Reserve and Firm Frequency Response markets. It is expected that over the relevant time period there will be no significant changes in the providers, their relative contribution, or overall scale of these services balancing services market. For RP, the base case is the provision of new absorption capacity with newly built STATCOMs.

The scale of functions offered has been determined in a series of feasibility studies by Dr Li and colleagues at the University of Manchester. The time period chosen for the carbon assessment varies according to network scale. For the CLASS trial it is one year during the Project period 2013 to 2015, whilst the larger scales are considered over the eight years of the forthcoming RIIO price control period, 2015 to 2023.

### *2.1 Peak reduction*

At any point in time, ENWL identify approximately 8% of their Primary substations as at or near the upper bounds of operating capacity. The effect of applying PR has been estimated by Mancarella (2012b) under a number of different assumptions. It is assumed that fourteen substation reinforcements are delayed by one year during the trial period and that scaling up to the ENWL level, 30 reinforcements may be deferred by a year within the period 2015-2023. These are both considered conservative estimates; it may be that a larger number of deferrals is possible or for a longer time period in practice. The potential national scale estimate is pro-rated on this same basis, suggesting 390 substations nationally. However, to give a sense of the upper bounds of the impact of this technique it is assumed that deferral is effective for 3 years.

### *2.2 Demand Management*

Fast Reserve (FR) and Firm Frequency Response (FFR) markets have been identified as indicative of the potential of the DM function (Mancarella 2012). The scale of this function is estimated for the respective settlement periods which the National Grid places requires greatest demand on these markets. 60 Primary substations in the CLASS Project could offer 0.22 GWh to 0.43 GWh of FR equivalent services over a year. If this is scaled across the ENWL network it could plausibly provide 1-2% of the total market, and were similar interventions provided at a GB scale there is the possibility that much greater proportion, up to 21%, of the FR service might be met by demand management. DM potential for the FFR service is slightly higher due to the wider time band demanded, although the market as a whole is much greater volume and at a GB scale DM might only provide 1-2%.

### *2.3 Reactive Power*

The total average reactive power absorption per transformer pair for both 33/11 kV and 33/6.6 kV transformers is estimated to be 1.87 MVAr (Li 2012). Since there are 382 pairs of 33 kV transformers in the ENWL network the total reactive power absorption in the network will be 714 MVAr (Chen & Li 2012a). Additional RP absorption is anticipated to be required during periods of lowest demand, i.e. summer nights. Therefore under a CLASS Project trial of 60 substations, 4 hours per night over a 90 day period, the reactive power absorption and energy absorption are expected to be 112 MVAr and 40.4 GVArh respectively. The maximum reactive power that may be absorbed in the ENWL region would be 257 GVArh and across the GB grid 3343 GVArh might be possible. To provide the reactive power outlined, nine STATCOMs would be required for the CLASS trial, 55 if the ENWL network was considered as a whole, whilst the GB scale would require the deployment of 714.

## 3 Carbon Impact

### *3.1 Assets*

Carbon embodied in the Project assets is counted once, totalled and divided between the multiple services provided. This assumes that it is possible to provide all three functions on the scales described within the same year. For each of the 60 substations involved in the trial, two substation voltage controllers, one per transformer, will be installed to enable flexible tap changes. No other assets are anticipated to be required to implement the three functions outlined. For each of the functions, asset carbon has been estimated under the BAU scenarios; details of the assumptions are given in the full report.

| Peak Reduction | Scale CLASS | ENWL | GB wide |
|---|---|---|---|
| Number of 23 MVA substations | 14 | 30 | 390 |
| *Base case assets - Case 1: Move open point, no reinforcement* | | | |
| No change in asset carbon | - | - | - |
| *Base case assets - Case 4: 23MVA transformer pair upgrade to 38MVA* | | | |
| Number of transformer replacements | 28 | 60 | 780 |
| Embodied carbon | 526 | 1,128 | 14,663 |
| Transport carbon | 61.6 | 132.0 | 1,716 |
| Total asset carbon deferral /tCO2eq | 588 | 1,260 | 16,379 |
| *Base case assets - Case 7: additional 23MVA transformer substation* | | | |
| Number of new transformers | 14 | 30 | 390 |
| Embodied carbon | 798 | 1,709 | 22,221 |
| Transport carbon | 12.6 | 26.9 | 350 |
| Total asset carbon deferral /tCO2eq | 810 | 1,736 | 22,571 |
| *Project assets* | CLASS | ENWL | GB wide |
| Number 11/6.6kV Substation voltage controllers | 28 | 60 | 780 |
| Embodied carbon | 0.94 | 2.01 | 26.2 |
| Transport carbon | 0.02 | 0.05 | 0.64 |
| Total project asset carbon /$tCO_2eq$ | 0.96 | 2.06 | 26.8 |

| Demand Management |
|---|
| No new assets assumed to be required or retired due to FR and FFR provision |

| Reactive Power | Scale CLASS | ENWL | GB wide |
|---|---|---|---|
| *Base case assets* | | | |
| Number of STATCOMS installed | 9 | 55 | 714 |
| Embodied carbon | 290 | 1771 | 22994 |
| Transport carbon | 8.1 | 49.4 | 641 |
| Total asset carbon | 298 | 1821 | 23635 |

| CLASS Project Assets | Scale CLASS | ENWL | GB wide |
|---|---|---|---|
| Number of 23 MVA substations | 60 | 380 | 4,940 |
| Number of 11/6.6kV remote actuators | 120 | 760 | 9,880 |
| Embodied carbon | 4.03 | 25.5 | 331 |
| Transport carbon | 0.10 | 0.63 | 8.1 |
| Total project asset carbon /$tCO_2eq$ | 4.12 | 26.12 | 340 |
| **Project carbon shared/$tCO_2$ eq** | **1.4** | **8.7** | **113** |

## 3.2 Operations

The Peak Reduction operational impact is taken to be the comparative resistive losses on the network after reinforcement. These are expected to be lower in the base case than in the Project case as upgraded assets will operate at lower temperatures and with lower resistance. They have been estimated for different reinforcement cases by Chen & Li (2012b) and converted to a carbon impact at the grid marginal emissions factor, 690 $gCO_2$/kWh (Hawkes 2010). The PR service is expected to lead to a reduction in energy consumption in the load itself. This is not a straightforward calculation given the variety of possible load types and responses; it has not been possible to provide a numerical estimate at this stage although empirical measurement will be made in the CLASS Project itself.

In the Demand Management base case, FR and FFR services are predominantly provided by pumped storage and CCGT units. A composite marginal emission factor for each market has been calculated from National Grid utilisation data over the last year and emissions factors from the literature (Hawkes 2010). All Project operational energy savings are assumed to be accounted for in the estimation of the service delivered. In the Reactive Power base case, the active power loss for a STATCOM typically varies in the range between 0.5% to 0.75% of the reactive power output (Haghighat & Canizares 2010). A scenario is considered using ABB 6000 PCS STATCOM with a 13 MVAr capacity in the 33 kV line. The operation of the CLASS Project tap staggering is assumed to consume electricity due to circulating current losses within the transformers. The extra losses from the network (without distributed generation) is estimated to be 0.088 MW per tap staggered pair (Li 2012).

## 3.3 Net Reduction Estimates

Figures displayed below are totals in $tCO_2$ for both asset carbon and a sum of operational impacts across the indicated time period.

| Peak Reduction | | CLASS Trial | | ENWL Network | | GB wide | |
|---|---|---|---|---|---|---|---|
| Time Period: | | 2014 | 1 | 2015 to 2023 | 1 | 2015 to 2023 | 3 |
| | | Case 4 | Case 7 | Case 4 | Case 7 | Case 4 | Case 7 |
| Assets | Base | 210 | 289 | 1260 | 1736 | 16379 | 22571 |
| | Project | 1.4 | 1.4 | 8.7 | 8.7 | 113 | 113 |
| Operations | Base | -907 | -1753 | -5500 | -10638 | -218213 | -421633 |
| | Project | *Emissions savings anticipated due to load reduction but not quantified.* | | | | | |
| Net Reductions | | *Net comparison inappropriate* | | | | | |

As can be seen, the reduction in losses due to the upgrading of assets may be substantial but comes with substantial asset carbon impacts, expense and disruption. The difference between the two services is partly due to the emissions factors of their respective displaced providers, FR being provided exclusively by pumped storage stations with a higher marginal emissions factor in demand than the CCGT stations which also contributing to FFR, and partly due differing quantities of DM possible during the settlement periods most likely for each market.

| *Demand Management* | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | CLASS Trial | | ENWL Network | | GB wide | |
| Time Period: | | 2014 | 1 | 2015 to 2023 | 8 | 2015 to 2023 | 8 |
| | | Lower | Upper | Lower | Upper | Lower | Upper |
| Assets | Base | - | - | - | - | - | - |
| | Project | 1.4 | 1.4 | 8.7 | 8.7 | 113 | 113 |
| Operations | Base: Fast Reserve | 133 | 256 | 6739 | 12979 | 87610 | 168730 |
| | Base: Firm Freq Response | 101 | 361 | 5109 | 18308 | 66419 | 238001 |
| | Project | *Emissions savings anticipated due to load reduction but not quantified.* | | | | | |
| Net Reduction Range | | 99 | 360 | 5,100 | 18,299 | 66,306 | 237,888 |

| *Reactive Power* | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | CLASS Trial | | ENWL Network | | GB wide | |
| Time Period: | | 2014 | 1 | 2015 to 2023 | 8 | 2015 to 2023 | 8 |
| | | Lower | Upper | Lower | Upper | Lower | Upper |
| Assets | Base | 298 | 298 | 1821 | 1821 | 23635 | 23635 |
| | Project | 1.4 | 1.4 | 8.7 | 8.7 | 113 | 113 |
| Operations | Base | 3391 | 5086 | 172710 | 259065 | 2245233 | 3367850 |
| | Project | 1312 | 1312 | 8350 | 8350 | 108553 | 108553 |
| Net Reduction Range | | 2,376 | 4,071 | 166,172 | 252,527 | 2,160,202 | 3,282,819 |

Potential emissions reductions are dominated by operational impacts, notably the continuous standby power demands of STATCOMS. It can be seen that savings made against the base case are potentially substantial. The GB case incorporates the assumption that new RP capacity on this scale would be supplied by STATCOMS, although intuitively it seems more likely that synchronous compensation may be deliberately deployed. The asset impact calculation also uses an uncertain proxy likely to be an over-estimate in the base case. Further investigation and empirical measurements will be required to validate these findings but they are a useful indicator at this stage.

## 4 Analytical boundaries

An estimation of the emissions reductions facilitated by the Project in other sectors, for instance by the increased uptake of electric vehicles, are not included. The use of generalised emissions factors and data sources, as well as a number of simplifying assumptions, mean that these figures are credible approximations in advance of the full Project. Substations will be identified and uniquely characterised with empirical measurements during the operation of the CLASS Project. The scale of PR, DM and RP services provided, in terms of active power, reactive power, energy, hours and time of operation, will therefore be monitored directly. Where wider changes in power generation have an impact on calculations, e.g. new powerstation consents, retirements and variation in operations affecting the grid marginal emissions factor or balancing market emissions factors, they will be reviewed and empirical measures used where possible. As was noted in the previous ENWL $C_2C$ Project submission, emissions reductions calculated in the power sector should be regarded as notional rather than physical due to the operation of the EU ETS.

## 5 References


Chen, L. & Li, H., 2012a. *Case studies of parallel transformers in ENWL master model V66*, University of Manchester.

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Mancarella, P., 2012. *Feasibility study notes on commercial opportunities from flexible transformer tap changer operation*, University of Manchester.

## Appendix I: Indicative Customer Engagement Plan

### 1. Executive summary

This Customer Engagement Plan reinforces our commitment to ensure best practice in engagement and customer communication for our three distinct customer groups, namely:

- Wider Customer & Community group: Customers inside the Trial area affected by the Project and interested in the Project's outcomes
- Customer Trial group: Customers inside of Trial area, participating in the customer survey scheme
- Customer Control group: Customers outside of Trial area, participating in the customer survey scheme.

Our targeted customer communications strategy will launch an easy to understand awareness campaign for directly and indirectly affected customers, and the wider community. Our awareness campaign will deliver key messages, some examples of which are identified below:

- The role and objectives of CLASS in facilitating the transition to a low carbon economy
- CLASS and its potential benefits to the customer in the short and long term
- The CLASS Trial area
- How a potential customer can participate in the Project by completing a number of surveys
- Reinforce the message that CLASS is a non-intrusive Project, not requiring any planned interruption to their supply or any on-site premise visits/work to take place.

We will ensure that customers are able to inform themselves of the Project, request queries, and provide feedback about CLASS in a manner that is convenient to them. CLASS will achieve this throughout the Project, via a number of traditional and social communication channels, for example:

- Traditional: CLASS Website, Email, Telephone, & Mail
- Social Communication: Twitter, Linked-in, Facebook.

Impact Research will manage the recruitment of participants and delivery of surveys for both the Trial and Control Group Customers during the Trials period. All surveys will be conducted by telephone at planned intervals to coincide with the test regime. These surveys managed by Impact Research will investigate and answer the hypothesis that "Customer within the CLASS Trial area will not see/observe/notice an impact on the power quality when these innovative techniques are applied".

As we receive feedback from our customers, stakeholders and Partners we may need to revise our plans going forward. The CLASS Project will share all our customer communications materials, findings and consult Ofgem in advance of any significant changes from our original approach.

ENWL is committed to be open and to clearly communicate/incorporate the valuable new learning gained about the best way to engage customers in demand response and reactive power absorption. This approach is shared by all our Project Partners and any future suppliers or Partners will also be required to commit to this.

### 2. Background

As GB moves to a low carbon future, electricity demand and the level of renewable and low carbon generation is expected to increase significantly. This decarbonisation pathway will introduce a number of key challenges for the operators of GB electricity networks with the potential to necessitate expensive capital investments.

The CLASS Project will generate outputs and learning in a number of key areas; this will be of particular interest to other DNOs, Ofgem, DECC and other parties feeding into the future use and or policy/planning discussions to deliver additional benefits to customers. Active customer participation is an integral part of CLASS and will form an important part of the learning and development for future low carbon programmes. Our engagement with CLASS customers will be designed to promote a positive customer experience throughout the Project. We will therefore take all practicable steps to ensure that customers' best interests remain a primary concern at all times.

### 3. Customer Engagement

Customer engagement includes all aspects of customers' involvement with the CLASS Project;

- Establishing which customers need to be engaged

- Planning customer selection and approach
- Developing and implementing engagement plans
- Bringing customers into the Project and associated customer contracts
- Keeping customers engaged in the Project
- Managing customers' issues, enquiries and complaints
- Managing customers who leave the Project
- Managing the exit methodology for customers at the end of the Trial

### 3.1 Our Partners

Electricity North West (ENWL) has selected Partners on their knowledge, experience and commitment to the CLASS Project and their strong credentials in the area of customer engagement and approach to customer relations. All our Partners are represented on the CLASS Project Steering Group on a quarterly basis which forms part of the governance for the Project. These Partners are;

- Siemens
- GE Digital Energy
- National Grid
- Chiltern Power
- Parsons Brinckerhoff
- The University of Manchester
- Impact Research

### 3.2 Stakeholder consultation

We have consulted all our Partners and relevant departments in Electricity North West to produce this engagement plan. Throughout the bid preparation process we worked to engage a number of groups to gauge support for and understanding of the CLASS Project. These include the ENWL Board and the Future Networks Steering Group.

### 3.3 Project Steering Group

The Project Steering Group (PSG) will comprise representatives of all the Project Partners and will guide the strategic direction of CLASS. The PSG will review and guide the Projects activities, deliverables and objectives. The Project will be subject to the robust governance procedures, employed by Electricity North West, from Project mobilisation until Project closure.

## 4. Class Customer Groups

### Scope of CLASS Project

The CLASS Project aims to enhance a DNO's capability to provide demand response by means of innovative dynamic voltage control and in so doing create potential for further added value opportunities for any DNOs customers. CLASS is a low-cost, rapidly deployable solution that investigates, at a GB-representative scale, the application of novel solutions to provide: (i) a range of demand response capabilities and (ii) an innovative system voltage regulation service. The CLASS Method will be trialled on 60 Primary substations across ENWL's network, representing 17% of ENWL's network, serving around 350,000 customers. Three Trials will be undertaken across a full year, within a Project that is bounded in length to be 2 ¾ years in length from mobilisation to closure. As part of the three Trials being undertaken, three customer groups have been identified as being indirectly and directly involved:

### 4.1 Effect on customer in the Trial area who will not participate in the Trial for the Customer Survey (Wider Community)

Whilst there is no active involvement from the wider community, we will launch a targeted CLASS awareness campaign to build on existing customer, supplier and stakeholder relationships;

- To embed our on-going stakeholder engagement, we will form a Customer Panel to help us formulate effective communication plans to provide clear information for customers. The panel will be made up of an appropriate cross section of customer segments;
- We will publish trade magazine articles to publicise CLASS outlining the aim and objectives of the trial within the context of the GB's low carbon agenda;

- We will produce leaflets which will be made available to all customers outlining the scope, size and areas of the distribution network included in CLASS and how to participate in one of the Trials;
- Information about CLASS and our other low carbon activities, and all our communications materials will be published initially on the ENWL website and subsequently on the CLASS website;
- We will contact electricity suppliers, whose customers have been chosen to participate in the Project, advising them of the nature of the Trial and details of the timing and nature of communications with these customers;
- Internal team briefings will be held throughout the Project to ensure that CLASS objectives are fully understood and lessons learned are shared across the wider Electricity North West community. Regular updates will also be included in the internal Company magazine (Newswire).

### 4.2 Effect on Customers in the Trial area who participate in the trial for the Customer Survey only

The following potential effects have been identified;

- We intend to undertake a survey of 350 customers in the Trial areas, with the aim of proving that customers will see no impact on the quality of electricity service delivered to their premise
- We will ask customers to complete five surveys throughout the Trial period, the timing of each survey is matched to the test regime
- The customer survey activity will be undertaken by Impact Research.

### 4.3 Effect on Customers outside the trial area but in the Control Group who will participate in the Customer Survey Only

We intend to undertake a survey of 350 customers in Control Group areas with the aim of understanding the placebo effect and validating the results gained from the trial area customers can be base lined against;

- We will ask customers to complete five surveys throughout the Trial period, the timing of each survey matched to the test regime
- We will ask customers to complete five surveys throughout the Trial period, the timing of each survey is matched to the test regime
- This customer survey activity will be undertaken by Impact Research
- Control Group Customers will not be informed that they are the control group or that they are not part of the Trial area, to ensure credibility of results

## 5. Customer communications including priority service customers

### 5.1 Our Partners

Each Project Partner brings existing customer relationship experience and a proven approach to customer communications. They have significant experience of customer engagement and customer protection. For the purposes of CLASS, the Project Partners will adhere to the key principles outlined below:

- Project Partners responsible for any form of customer contact will ensure that their codes of practice include guidance on ensuring that customer contact is appropriate. This includes making clear to customers that the contact relates to the CLASS Project. As a minimum, contact will involve
- Clear information on the CLASS Trials they are participating in
- Clear information on the aims and objectives
- Information on data protection
- Information on how to cancel their participation in the trial
- Project Partners with access to customer data gathered for CLASS will sign an agreement to ensure that this data is not used for purposes other than in relation to the CLASS Project (see also CLASS Data Privacy Statement). In addition we will ensure that our Data Security Manager takes responsibility for all aspects of data privacy within the CLASS Project
- Where Project Partners have also have relationships with customers participating in CLASS that are outside the scope of the Project, the Partners will make it clear in customer communications whether their communication relates to CLASS or the wider relationship

- Any customer considering participation in CLASS will receive clear information about what the Trial will involve, together with details both of who to contact if they have queries or complaints, and of who will have access to their data
- Any customer agreeing to participate in CLASS will receive sufficient information to enable them to understand what will be expected of them, and the purpose and scope of the programme
- When collecting data, the Project Partners will be transparent about why they are collecting the data and how it will be used, stored and accessed.

### 5.2 Priority Services Register Customers

Electricity North West appreciates that some of our customers have additional requirements due to being disabled, elderly or having a chronic illness and promotes safety and security at home to our vulnerable customers. We run a Priority Services Register (PSR) for such customers who are vulnerable during a power outage. Entry on the register provides ENWL with an awareness of which of our customers has additional requirements and might enable us to get assistance to them more promptly.

The CLASS Trial areas will distribute electricity to an estimated 350,000 customers the majority of which are domestic. A number of these customers will be registered on Electricity North West's PSR. Throughout the CLASS Project we will have regard to any potential effects on our PSR customers and we will plan and implement the Project in ways that minimise any such effects. We will make all customer information about the CLASS Project available in alternative formats such as audio CD, Braille or minority languages on request.

## 6. Customer strategy and customer relations

### 6.1 Communications Strategy

CLASS will require targeted communications with all the separate groups of customers as outlined in section 4 above. The underlying communications strategy will be to;

- Launch a targeted awareness campaign to build on existing customer relationships in each of the customer segments
- Engage with these customers on an on-going basis throughout the Project to ensure that the customer experience remains a positive one
- Consider the needs of any Priority Services Register customers affected by the Project

  Electricity North West understands that without the support and buy-in of our customers, the CLASS Project will not succeed, and for this reason, ensuring that the customer journey is a good experience is essential for the delivery of a successful Project.

### 6.2 Customer Relations

Several communication channels will be available for customers, Partners and stakeholders who require further information about the CLASS Project.

#### 6.2.1 Website

Details will be available on the CLASS website at www.enwl.co.GB/CLASS providing general information on the Project and trial circuits, FAQs and contact details. Queries can be raised on the website using the online enquiry service. The Project website will be the hub for all information relating to the CLASS Project.

#### 6.2.3 Enquiries

Customers can ask questions or raise queries related to the using the following channels:

**Telephone**

Electricity North West operates a contact service that is continuously staffed and can be contacted 24 hours a day on 0800 195 4141. There will be a specific Interactive Voice Response (IVR) option available for all low carbon enquiries.

**SMS**

For customers who wish to receive a call back service, an SMS can be sent to 555-55555 quoting "CLASS". This will ensure an ENWL representative will call the customer back as soon as possible.

**Written correspondence**

The CLASS Project team will handle written enquiries from customers and stakeholders. Customers can contact the Project Team by post at the following address:

CLASS Project Team

Frederick Road

Salford

M6 6QH

Alternatively, customers can contact the Project team at the following email address: futurenetworks@enwl.co. GB for queries or further information.

Response times will be in line with Electricity North West's standard practice of within 10 working days.

### 6.2.4 Information for Project Partners and Other Interested Parties

We will provide regular updates on the CLASS website and interested parties will be able to register for a newsletter which will be produced on a periodic basis. We will share our learning experience of the CLASS Project outcome with interested parties, including other DNOs and academic institutions throughout the Project.

## 6 Communication Plan – Customers in the Trial areas who participate in the customer survey

Understanding whether the customer is affected during the trials is crucial to the viability of the CLASS Solution. Therefore we will seek customers inside the trial area to participate in a series of customer surveys throughout the length of the trials period. The aim of the survey is to answer hypothesis 2 (Customers within the CLASS trial areas will not see/observe/notice an impact on the power quality when the demand response and reactive power absorption are being provided).

The customer surveys will be structured to tease out whether the customer has noticed a change in the electricity supply quality. We will ask customers to complete five surveys throughout the trial period, the timing of each survey matched to the test regime and we will offer a financial incentive for customers to participate and complete in the customer surveys. The scope and design of the customer surveys will be developed and piloted with a small group of customers prior to it roll-out; this is a direct learning point from the Capacity to Customers Project's customer engagement undertaken this year.

This on-going survey requirement will form part of the communication provided to potential participants in the trial. The customer survey activity will be undertaken by Impact Research.

Until the trial sites have been selected the Project is unable to detail the approach methodology for attracting customers to participate in the customer surveys. The geographic density of customers across our trial sites will drive our approach to engaging with customers. Other LCN Fund Projects have found that letter drops generate low interest whilst door knocking and community led programmes can deliver much higher participation rates. Once the geographic spread of the trial sites is known CLASS will define and detail the engagement approach, but the preference is to form alliances with community groups to help attract their members to be part of the CLASS Project.

## 7 Communication Plan – Customers outside of the Trial areas who will participate in the customer survey

We will identify a Control Group of customers outside the trial area that will also participate in the customer surveys. The selection of the Control Group could potentially be less dependent upon geographic spread but to ensure the Control Group is representative of the trial group (ie a similar geographic spread is achieved) it is proposed to apply the same approach. Targeting customers in adjacent areas to the trial areas will help deliver economy of scales.

The customer surveys will be structured to tease out whether the customer has noticed a change in the electricity supply quality with the Control Group results being used to baseline the placebo effect. We will ask customers to complete five surveys throughout the trial period, the timing of each survey matched to the test regime and we will offer a financial incentive for customers to participate and complete in the customer surveys. The scope and design of the customer surveys will be developed and piloted with a small group of customers prior to it roll-out; this is a direct learning point from the Capacity to Customers Project's customer engagement undertaken this year.

This on-going survey requirement will form part of the communication provided to potential participants in the trial. The customer survey activity will be undertaken by Impact Research.

Until the trial sites have been selected the Project is unable to detail the approach methodology for attracting customers to participate in the customer surveys. The geographic density of customers across our trial sites will drive our approach to engaging with customers. Other LCN Fund Projects have found that letter drops generate low interest whilst door knocking and community led programmes can deliver much higher participation rates. Once the geographic spread of the trial sites is known CLASS will define and detail the engagement approach, but the preference is to form alliances with community groups to help attract their members to be part of the CLASS Project.

## 8 Communication Plan– Wider Customers & Community not directly involved in the Trial

Our customer communications strategy will be to launch a targeted awareness campaign with customers, stakeholders and the wider community to publicise CLASS. We will also engage with every customer affected by CLASS, having special regard to any PSR customers in the trial area.

We will use a range of multi-media approaches. Press articles in newspapers will raise awareness of the CLASS Project; customer pamphlets will be created to explain the scope of CLASS; and initially the ENWL website and subsequently the CLASS website will contain information about the Project.

Our communications materials will outline the scope, size and areas of the distribution network included in CLASS as well as outlining the objectives of the trial within the context of the GB's low carbon agenda. They will provide general information about CLASS and how to participate in one of the trials. The materials will also advise customers that installation of voltage recorders at Primary substations and the network monitoring equipment at distribution substations will not require a planned interruption.

## 9 Feedback & Review

This Customer Engagement Plan is a starting point for our communication with customers throughout the CLASS Project from January 2013 to September 2015. All CLASS Partners will adhere to the Plan and the basic principles outlined however there will be a need to review the plan on an on-going basis to reflect on feedback and lessons learned as we progress with the CLASS journey.

CLASS will develop a series of communication materials throughout the Project which will be published on the CLASS website. We will submit all our customer communications materials and new commercial contracts to Ofgem before sending them out to customers and allow Ofgem adequate time to consider and comment on these documents.

### Customers

Through the CLASS Project and in all the activities which involve engagement with our customers we will seek feedback on the customer experiences.  We will use a range of contact methods, as appropriate, including postal form, telephone and web based survey form to obtain feedback from customers. We will use the results of the feedback to amend our processes.

### DNOs, Project Partners and Interested Parties

We will work with Partners to disseminate the learning points from the Project, and seek feedback from interested parties.

Chiltern Power

To: Simon Brooke
Electricity North West Limited

Our Ref: CPL/LOS/0712
Date: 30/7/2012

**Dear Simon**

# Letter of Support - CLASS project

I am delighted to provide a letter of support for the CLASS project.

This work has my full commitment and personal interest, as the project is the first to address an important area of power systems management that has been largely neglected since privatisation in 1990.

Load Response (change of real and reactive power demands to voltage) is an important physical characteristic to understand if distribution and transmission network investments are to be made optimally and system security margins are to be fully understood as network stability limits are approached.

The changes of demand make-up since 1990 are likely to result in national design assumptions needing to be updated, with further changes being anticipated as GB moves to a Low Carbon future. I was involved personally with Load Response analysis in the CEGB and was author of planning standard PLM-ST-9 that encompassed this for use in investment planning models.

The CLASS project is particularly imaginative as it seeks to not only update this important area of work, but also to deploy modern control and communication techniques that will enable demand response to be used as an operational tool. (In the CEGB era it was regarded as a fact of life that needed to be understood, rather than a facility to be deployed.)

ENWL are to be commended on their proposal to explore this issue and in planning their project such that the benefits for the distribution network and its customers can, in due course, be expanded to provide wider support to the operation of the national transmission system. Once proven and understood, this has potential application across all GB distribution networks.

Yours sincerely,

John Scott, Director

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www.pbworld.com

14 August 2012

**ENW CLASS LCNF Tier 2 project**

Parsons Brinckerhoff (PB) fully supports ENW's bid for LCNF Tier 2 funding for its CLASS project.

PB is a leader in electrical power distribution consultancy, providing independent technical advice and project management to stakeholders throughout the energy sector and around the world. Clients include regulators, utilities, asset owners and managers, government departments, project-financing banks and academic institutions. PB offers the ability to deliver excellence and innovation to our clients within the growing field of low carbon and sustainable electricity networks.

PB believes that the CLASS project is a worthwhile opportunity to demonstrate a novel application of traditional system operating methods and practices using previously untried technologies to deliver best value to ENW's customers and other stakeholders.

Once demonstrated, the methods identified in CLASS can deliver rapid lowest capex solutions for the deferment of network capex particularly where reinforcement is required under existing Licence Conditions, e.g. to match network capacity with peak demands where these peaks are of very limited duration.

Yours faithfully
**Parsons Brinckerhoff**

David Hawkins

**DAVID HAWKINS**
Chief Engineer, Future Networks

**SIEMENS**

## Infrastructure and Cities

**Steve Cox, Head of Future Networks**

Electricity North West Limited
Network Strategy
304 Bridgewater Place
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| | |
|---|---|
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| Your letter of | |
| Our reference | |
| Date | 13 August 2012 |

**Electricity North West – Customer Load Active System Services (CLASS) Project**

Dear Steve,

Siemens is delighted to provide a Letter of Support for the CLASS Project, having worked as a partner to Electricity North West (ENW) in development of the technical proposal for the CLASS Project.

The key strength of CLASS is in its consideration of using existing network assets - supplemented by modern control and communication technologies - to deliver flexibility through active voltage management in the distribution network. The deployment of the CLASS method is quick and non-intrusive to customers, delivering load control within the network stability limits, providing network flexibility and facilitating faster connection of low carbon technologies at lower cost - compared to traditional techniques.

The concept of CLASS is innovative and builds upon the use of Demand Response - as an operational tool - to manage distribution network constraints; further its use can be extended to help balance the national transmission system as an ancillary service. Siemens consider that the CLASS application, once proven can be deployed on any modern control platform within the DNO substation, and is therefore highly transferrable across the UK.

Siemens has experience of working with a number of the UK Distribution Network Operators as part of their Low Carbon Network Fund (LCNF) submissions; and is a partner in several of the currently funded Tier 2 projects. From this experience Siemens sees the advantage of CLASS in that it is complementary to other LCNF projects, and can be deployed as either a standalone method, or as part of a wider network wide optimization.

Siemens has the local experience and global technologies to deliver the CLASS project and is committed to help Electricity North West and the project partners with the learning and dissemination programme.

Siemens continually seeks engagement in thought leading and innovative projects and is proud to be part of CLASS with Electricity North West.

Yours sincerely,

Kevin Tutton
**UK Divisional Lead – Smart Grid Division**

GE
Energy

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United Kingdom

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Electricity North West
Hartington Road
Preston
PR1 8LE

15th August, 2012

For the Attention of Simon Brooke, Low Carbon Projects Manager

**LOW CARBON NEWTWORKS FUND – CLASS PROJECT**

Dear Simon,

GE is delighted to provide this letter of support for the Electricity North West Limited CLASS Project application for Low Carbon Network Funding for 2012.

GE is a prominent supplier of energy management services and technology solutions to the distribution network sector in the UK and is supportive of Ofgem's initiative to deliver innovation to the sector and accelerate the achievement of the UK Government's low carbon objectives.

Managing load response under a low carbon future is a significant challenge to network operators and without adequate information, will be a costly source of future capital expenditure. GE believes that the CLASS project will allow current design rules to be safely challenged and to deliver outcomes to lower capital cost and mitigate the risks associated with network reinforcement and load response.

GE believes that the CLASS project is both innovative and challenging; and will deliver learning outcomes that will benefit the whole of the UK. The CLASS project builds on our positive experience of working with ENWL under the C2C project and we believe that both companies will be enhanced further through continued participation under the CLASS project.

Yours sincerely

D. Daly

David Daly
GE Energy
Product Line Leader
Outage & Distribution Management Systems

National Grid House
Warwick Technology Park
Gallows Hill, Warwick
CV34 6DA

Richard Smith
Future Transmission Networks Manager

richard.smith@nationalgrid.com
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Mobile : +44 (0)7747 006321

www.nationalgrid.com

14th August 2012

Dear Sir/Madam,

**Electricity North West, Customer Load Active System Services (CLASS) Project**

National Grid is pleased to be a proposed partner for the Electricity North West LCNF CLASS project. Projects such as this are an important part of how we respond to market changes, possibly paving the way for national benefits and savings.

By 2020 our electricity transmission system will have evolved to connect extensive renewable generation to achieve UK renewable and carbon targets. Beyond 2020 the demands on the UK on electricity networks will dramatically increase o with increasing levels of variable wind generation, new larger nuclear power stations and increased electricity demand. Managing the transmission system and balancing electricity supply and demand will become more complex; with this the opportunity for the market to provide new roles and services will grow. National Grid's June 2011 update of 'Operating the Electricity Transmission Networks in 2020' states that "*In the first 2020 consultation an estimate of a three fold increase in balancing actions was suggested and response to the consultation generally agreed that the level of balancing activity will increase. Whilst balancing activity instructed by National Grid will be driven by the incentive on market participants to balance, it will be increasingly necessary to despatch generation and demand automatically. […] The average operating reserve requirement increases by 53% from 4777MW to 7335MW, between 2010/11 and 2020/21.*"

The CLASS project's aim is to trial how the current action of tap changing at substations can in the future be used, increasing or decreasing voltage, and providing reactive power to create network services that can be used by a system operator, whether NETSO or DSO, to manage it's network. If successful the project will demonstrate how network investments might be delayed and provide alternative/additional methods for demand response services and reactive power resulting in a lower cost to the end consumer than would have been seen otherwise whilst ensuring that customers and existing Distribution and Transmission assets are not adversely affected.

**Demand Response:** The CLASS method aims to prove how small changes in voltage can deliver a very large demand response. This has the potential to be a cost effective and non-intrusive service. It could defer reinforcement of substations by reducing system peaks and has the potential make savings by displacing reserve and response holdings.

**Reactive Power:** The operation of staggered taps has the result of circulating current around the pair of primary transformer, which appears as the reactive power drawn down from the grid, thus artificially increasing the reactive power absorbed by the distribution network. This creation of reactive power could be used for managing system voltage instead of installing new reactive compensation equipment.
It could avoid the running of the remaining traditional plant at power factor limits or the installation of reactive devices to manage system voltage profile.

DSO, NETSO, networks and services are being considered in this project. Therefore this trial could provide insight into future electricity system design and participant interactions, an area many market participants are increasing their focus on.

National Grid has been actively involved in the LCNF for the last two years participating in several projects from both; previous rounds of the competition and current projects bidding. This includes already being a partner with Electricity North West on the existing project Capacity to Customers. I wish to reemphasise our support to the LCNF and ENW's CLASS project our commitment to work with ENW towards making this a successful project.

Yours Sincerely,

Richard Smith
Future Transmission Networks Manager

MANCHESTER
1824

The University of Manchester

Professor A. K. Brown,
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Date: 05 August 2012

To: Simon Brooke
Electricity North West Limited

Dear Simon,

**Letter of Support from University of Manchester for ENWL CLASS project**

I am pleased to write a supporting letter for the Electricity North West Limited (ENWL) CLASS project.

Regional Electricity Companies, such as, ENWL, are being encouraged by OFGEM to facilitate the transition of today's distribution network to a future Low Carbon Network (LCN). LCN will encourage the installation of significant renewable energy resources and allow the connection of new forms of demand, such as electric vehicles and heat pumps. The intermittency of renewable energy production and expected variations in demand requires radical solutions, such as the CLASS proposal which uses flexible tap changer control strategies to cope with a shortage of active generation during peak demand periods and excessive reactive power problems when the demand is low. I believe the CLASS project provides an excellent opportunity to demonstrate how primary substation reinforcement can be deferred in the short term by the novel use of existing voltage control assets.

The CLASS project will build upon the excellent research links that ENWL has already established with the world renowned Electrical Energy and Power System (EEPS) group at the University of Manchester. The EEPS group consists of 12 full-time academic staff and over 90 researchers, PhD students and academic visitors. It has core expertise covering transmission and distribution networks planning, monitoring, control, protection, HV technologies and substation automation. Facilities include the largest HV research facilities in a UK university and the recently refurbished control, protection and automation laboratories.

The University of Manchester is strongly committed to the success of the CLASS project and is dedicated to providing appropriate academic staff expertise as indicated in the proposal submitted by the EEPS group. The School of Electrical Engineering will where possible provide extra resources as appropriate, such as PhD scholarships, to maximise the CLASS project outcomes.

Yours sincerely,

Anthony Brown, Head of School

Impact Research

Impact Research Ltd.
Lancaster House
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Surrey
KT12 2TY

Simon Brooke
Electricity North West Limited
304 Bridgewater Place
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Warrington
WA3 6XG

31st July, 2012

**Ref: CLASS Project**

Dear Simon,

Impact Research is very pleased to be part of the Consortium Of Partners to provide customer engagement insight for the CLASS Project to support the UK's transition to a low carbon economy. The CLASS Project is a creative initiative and we are delighted to play a significant part in assessing domestic customers during the trial period.

Impact Research's main role ranges from recruiting and interviewing customers for the trial through to reporting on the trial findings. Impact Research recognises the importance of its involvement and will be fully committed to the success of CLASS. Impact Research has experience working on other customer engagement projects related to Low Carbon initiates covering qualitative and quantitative research. Ensuring a strong and robust method to provide reliable results are factors central to Impact Research's approach. Additional extensive experience in a variety of other research projects within utilities and other sectors will support the expertise demonstrated in this project.

Low Carbon initiatives such as CLASS are vital in ensuring the UK achieves its carbon emissions reductions target and Impact Research is proud of being part of such initiatives.

We are delighted to have been invited by ENW to be part of the Consortium Of Partners, and I have full confidence the team at Impact Research will deliver a successful, high quality and robust project.

Yours sincerely,

Darryl Swift
Manager Director

# List of Changes

This section documents the changes from the original CLASS Full Submission version ENWLT204/01, submitted on 17 August 2011, to this version, ENWLT204/02.

The table below details each change and the reason for the change. The changes are collated into the two sections of the evaluation phase for the CLASS Project, namely the Questions and Answers Process and the Expert Panel / Consultants' Review.

The first half of the table below details the changes to the document resulting from the answers provided during the Questions and Answers Process of the evaluation phase. These proposed changes are to provide clarity.

The second half of the table details the changes to the document following the feedback from the Expert Panel and the Consultants' Report. The changes made address the feedback on 1) understanding the range of potential benefits for applying the CLASS Solution to Load Index 5 Primary substations that undergo differing demand changes, described as scenarios A, B and C; and 2) on ensuring the customer survey is statistically robust and representative of GB customers.

All changes to the CLASS Full Submission and Appendices documents are easily identifiable as they are coloured red.  The exceptions to this rule are the opening sentence in Full Submission Sections 1.3, 2, 3, 4, 5 & 6, Table 3 and Figure 10 as they are written in red to emphasise the key messages.

| ***Questions and Answer Process*** | | | |
|---|---|---|---|
| **Location** | **Change** | **Reason** | **Generated** |
| Section 2, page 10. | Updating Figure 1 | Clarification | Q30 |
| Section 3, page 11; section 4, pages 23. | Clarifying scope of benefit is GB wide | Clarification | Q25 |
| ***Expert Panel / Consultants' Report*** | | | |
| **Location** | **Change** | **Reason** | **Generated** |
| Section 3, pages 11 & 12; section 4, pages 19, 21 & 22.<br><br>Appendix B, page 55.<br><br>Appendix H, pages 82, 83 & 84.<br><br>Workbook: Net benefits Tab – cells C10 & C11. | Financial and carbon benefits updated to reflect increased network reinforcement deferred<br><br>Site selection Methodology amended to specify capturing fourteen LI 5 category substations in the Trials<br><br>Amending Base Case Cost Methodology and CLASS Carbon Impact Methodology to fourteen LI 5 category substations in the Trials<br><br>Net Benefits calculation updated to reflect increased LI 5 category substations in the Trials | Value for money | Expert Panel |
| Section 8, pages 45 & 46; Appendix D, page 72. | Doubling in oversampling rates | Robust survey results | Expert Panel |