Project Progress Report 3

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Contents

1 Executive Summary 3

2 Project Manager's Report 6

3 Business Case Update 15

4 Progress against Plan 16

5 Progress against Budget 18

6 Bank Account 18

7 Successful Delivery Reward Criteria (SDRC) 18

8 Learning Outcomes 19

9 Intellectual Property Rights (IPR) 24

10 Risk Management 25

11 Other 28

12 Accuracy Assurance Statement 28

Appendix 1 – Regional stakeholder panel meeting 31

Appendix 2 – Industry stakeholder forum 33

Appendix 3 – Foreground intellectual property generated during the period 34

1 Executive Summary

1.1 The Customer-Led Network Revolution (CLNR) project is assessing the potential for new network technology and flexible customer response to facilitate speedier and more economical take-up by customers of low-carbon technologies and the connection to the distribution network of increasing amounts of low carbon or renewable energy generation. This third formal progress report sets out how the project is on track to deliver the learning outcomes relating to understanding existing and future load, customer flexibility, network flexibility, the optimum mix of solutions and the most effective delivery routes to implement those solutions.

1.2 The December 2011 to May 2012 period was characterised by activity proceeding at a high tempo across both the customer and network technology trials. Highlights have included:

- Commencing analysis of smart meter data for ca. 5,000 customers - less than 2% of customers opted out of having their data included;
- Receiving a highly positive response from customers to the time of use tariff trial with 8% of people contacted opting in to the trial leading to this test cell now being over-populated;
- Writing to ca. 30,000 British Gas customers advising of the potential to participate in the trials and producing 59 different items of customer engagement literature;
- Creating solutions to overcome the scarcity of electric vehicle and heat pump customers – the latter involving receipt of a £2.8m grant from the Department of Energy and Climate Change;
- Calling off demand response services with a small cross-section of industrial and commercial customers to test end-to-end processes associated with shifting load from the winter peak period on the network;
- Evaluating the potential capacity headroom created following the installation of real-time thermal rating equipment on the rural overhead line trial site;
- Awarding the two major network technology contracts totalling more than £8m for the electrical energy storage and the control system; and
- Creating 20 network models to simulate effects of the technology being deployed; and
- Specifying up to 220 network field trials.

1.3 In summary, the project remains on track to deliver learning that is relevant, timely and valuable. However, the route to achieving this anticipated learning has continued to be adapted to take account of externalities and learning generated to date.

1.4 On the customer trials, there were some major steps forward in the period with some important milestones reached. Recruitment of customers has commenced on 14 of the 22 separate trials relating to residential and small and medium enterprises (SME) customers. Letters were issued by British Gas to a cross-section of its smart meter customers prior to Christmas asking them to participate in the monitoring trials. Less than 2% chose to 'opt out' and Durham Energy Institute (DEI) has to date been provided with half-hourly smart meter data for ca. 2,000 industrial & commercial (I&C) customers and ca. 5,000 residential customers. Enrolment of trial participants for the solar photovoltaic (PV) trials and the time-of-use trials is going well with the former having 55% of the target numbers recruited and the latter

being oversubscribed. The opportunities for obtaining sufficient heat pump customer numbers were enhanced in the period when British Gas secured £2.8m of additional funding from the Department of Energy and Climate Change (DECC) to subsidise installations in the absence of a residential renewable heat incentive (RHI). Electric vehicle customers remain few in number and we have alternative plans to secure trial participants in the next reporting period through funding of charging infrastructure and joint working with other trials in the Northeast. Likewise, the technology to enable direct control of domestic appliances has proved difficult to source but it is close to being sourced. Again however, we expect these trials to commence in the next period.

1.5 For the SME customers, our experience is that customer interest in participation remains relatively low due to the low financial reward on offer and the potential business disruption. This is useful learning for a sector of the customer base where there is little previous trial experience. Conversely, in the I&C sector, our engagement with customers through the services of commercial aggregators led to contracts and basic processes being tested in the period. We carried out a number of end-to-end tests, including initiation of the demand reduction from the Northern Powergrid control room, that saw a few I&C customers responding to our requests for flexibility to avoid the early evening peak period on a number of consecutive nights in February 2012. Over 75% of requests were successfully actioned. This first phase of I&C trials is now informing our trial design for the next winter period.

1.6 The customer engagement plan and data protection strategy documents were updated and re-approved by Ofgem in order to reflect the new approaches being taken to secure the participation of heat pump and electrical vehicle customers. Ofgem has also reviewed and commented on the 59 individual items of customer correspondence that have been produced to date.

1.7 On the network technology trials, the major contracts have been awarded in the period for the electrical energy storage and the grand unified scheme control system and the installation and commissioning of equipment has continued. Further, the development of network models and trial design is being progressed by Durham Energy Institute. The contract award for the electrical energy storage was made to A123 Systems at the start of the year and manufacture of the six units in three different sizes is progressing to plan with installation planned in November 2012. For the control scheme, the design phase is now progressing following award of the contract to Siemens in April 2012. The most notable work taking place on the network was the installation and commissioning of the real-time thermal rating equipment on the high voltage (HV) overhead line network in February 2012. This equipment is now capturing base line data and helping to validate the accuracy of the network models constructed by Durham Energy Institute (there were a total of 20 network models produced in the period in order to complement the physical trials). The outline design has also been completed for up to 220 network trials.

1.8 Knowledge sharing in the period has been promoted through the operation of both our regional stakeholder forum (March 2012) and the industry stakeholder smart customer response workshop (May 2012). The latter session focussed on sharing the learning developed through the customer enrolment phase. We covered trial design, tariff development and customer engagement to date. The workshop was accompanied by the publication of a comprehensive report on the design of our tariffs produced by Frontier Economics. We have continued to participate at other industry and stakeholder events with 12 other engagements taking place over the past six months to share emerging learning. This included two papers being accepted at the CIRED international distribution network technology workshop in May 2012. We have also shared learning informally with a number of other distribution network operators (DNOs) and other parties. We expect to publish more information and carry out direct knowledge sharing with other projects in the forthcoming period. In particular, we have explored ways to share more with the UK Power Networks Low Carbon London project since much of the learning from both projects is seeking to address similar challenges, albeit with different contexts and

location. Further interaction between both the academic partners and the DNO project teams is envisaged for the mutual benefit of both projects.

1.9 The project continues to be operated to a detailed three-year plan ending in December 2013. All key milestones were met in the period. As reported in the last report, the delivery plan was adapted to take account of the slow uptake of air-source heat pumps and electric vehicles. Despite some slippage against plan in the period, we are holding to the previous forecast where we expect to achieve four seasons coverage for the majority of the customer trials. Slippage against plan has been caused by the complexities of simultaneously mobilising activity across the range of trials, compounded by the difficulties encountered by the scarcity of customers in some areas. We have suggested to Ofgem that if it is not possible to have achieved the required test cycle for the scarce technologies (heat pumps and electric vehicles) then we will continue to operate these test cells and issue an addendum report following the project close to report on any new learning that arises from the extended operation. We propose holding to the original timeline in order to expedite the learning and provide the opportunity to inform the ED1 business plans for the forthcoming price control period.

1.10 We are not forecasting any cost variances to the total project spend of £31.0m.

1.11 There have not been any significant changes in the risk profile for the project since the last report. The key project risks continue to be associated with the application of innovative network technology, the availability of sufficient customers to deliver the required learning from the trials and the limited attractiveness of the trial propositions with consequent risks to trial recruitment. For the network technology, the key risks relate to the availability of the novel technical solutions in the timescales required. For the customer-facing trials we are actively deploying alternative routes to overcome the shortage of customers with air-source heat pumps (ASHPs) and electric vehicles (EVs).

1.12 The following table sets out the key project events that took place in the reporting period.

Key events for period 1 December 2011 to 31 May 2012

Date	Event
23 Dec-11	Notification issued to ca. 30,000 potential monitoring trial customers
05 Jan-12	Electrical energy storage contract award
28 Feb-12	First I&C customer demand response request
28 Feb-12	Commissioned overhead line real-time thermal rating equipment
6 Mar-12	Regional stakeholder forum
28 Feb-12	British Gas secures additional £2.8m funding to subsidise heat pump installations DECC
27 Feb-12	First customer enrolled onto time-of-use tariff trial
27 Apr-12	Grand unified scheme control system contract award
09 May-12	Smart customer response workshop and tariffs design report published
31 May-12	Revised customer engagement plan and data protection strategy formally approved by the Authority

2 Project Manager's Report

Learning Outcomes 1 & 2 – (LO1) Existing and Future Load & (LO2) Customer Flexibility

Activities completed in this reporting period

2.1 Engagement with customers over a total of 22 residential and SME individual trials has necessitated the production of a substantial library of customer-facing materials including for example general trial information, trial–specific information and terms and conditions. The bulk of this material has been produced and approved by Ofgem over the first six months of 2012 and is now nearing completion. This has comprised the production of 59 out of 82 required documents.

2.2 In order to allow the use of retrospective and prospective customer smart-meter data in the trials, an opt-out process was run whereby smart-metered customers received a letter providing them with a mechanism to opt out of their data being used in the trials. This process was run to allow 9,000 residential and 2,250 SME customers to participate in the base monitoring aspect of the trials. Opt-out rates associated with this process have been lower than 2%. Electricity consumption data for 4,882 domestic customers has already been retrieved and analysis of this data set is underway. Having selected customers to fulfil a demographic profile, the Project is now in the process of retrieving a full one-year data set for these customers for the period May 2011 to May 2012.

2.3 Customer recruitment has continued to pick up momentum, with the most significant developments in the areas of domestic time of use and PV trials. Specifically on the time of use trials, this proposition has proved very attractive to customers resulting in the number of recruits being over the required number of 600. Well over half of these recruits have now been migrated onto the time of use tariff currently. On solar PV, we have ca. 250 of the required 450 customers recruited to either the base monitoring or within-premises balancing trials and we have plans in place that should satisfy the remaining requirement for customers through working with Gentoo and its PV customers in the Northeast of England. We encountered some delays due to unsuccessful discussions with a solar 'rent-a-roof' provider in our region. These discussions resulted in our inability to access a customer-base of *ca.* 160 customers via their assets.

2.4 On the micro-CHP trials, to date we have firm plans to install five of the required 20 units for the trial and will progress towards the installation of customer monitoring equipment for these units in the customers' homes.

2.5 Where possible, i.e. after customers have signed up to the trials, Durham Energy Institute has been engaged in conducting face-to-face qualitative interviews for the trials. These have comprised ca. 25 home tours of residential customers, and ca. 15 site surveys / interviews SME customers to date.

2.6 On the SME side, recruitment into the enhanced monitoring, time of use, restricted hours and direct control trials has been favourable to expectations with 479 of the required number of 600 recruits having either expressed a strong interest in joining or already having joined. Those customers who have joined the time of use trial are in the process of being migrated onto the three-rate tariff. For the restricted hours and direct control test cells, the technical solutions for monitoring and interventions are being worked up, influenced heavily from the results of site visits. However, we are finding that some of the customers that have expressed an interest are dropping out when they understand more about the conditions of trial.

2.7 The incorporation of DECC-subsidised heat pumps for deployment onto the trials is providing heat-pump units in sufficient numbers so as to meet the trial objectives. The CLNR trial has and will continue to work closely with British Gas New Energy to

deliver a potential 681 heat-pump units onto the trial, with ca. 80 units currently installed and ready for the installation of the relevant monitoring equipment.

2.8 Scarcity of EV customers is also proving to be a limiting factor for the trials. In mitigation, the CLNR project is pursuing three routes for recruitment. Specifically, these include sourcing customers who have adopted the British Gas two-rate electric-vehicle tariff, offering a fully-funded British Gas electric-vehicle charge point to incentivise participation in the restricted hours aspects of the trials and working to leverage customers of Charge Your Car (North) by offering incentives on fully-funded charge points.

2.9 Scarcity of EV customers and the adoption of the British Gas two-rate tariff as the baseline for British Gas EV users resulted in a decision to drop the three-rate time of use and direct control aspects of the trial. This means therefore that we now have a base monitoring trial for electric-vehicle users, which will likely incorporate a mixture of different tariff types up to a maximum of 250 customers and a restricted-hours trial, which we intend to populate to a maximum of 50 customers via fully incentivising adoption and installation of a British Gas electric-vehicle charge point.

2.10 Issues of customer scarcity on the heat pump and electric-vehicle test cells and the successful incorporation of DECC funding for air-source heat pump installations into the project has meant that the Project will now engage with non-British Gas supply customers in these areas. Specifically with the deployment of heat-pump units via the local authority and housing authority route, it is inevitable that a spread of customers with different electricity suppliers will be encountered. This has meant therefore that the Customer Engagement Plan and Data Protection Strategy documents have had to undergo revision to allow for this additional route to engage customers. Associated processes have also had to be configured and implemented to ensure customers are handled appropriately by the CLNR Project. The revised Customer Engagement Plan and Data Protection Strategy have received formal approval from Ofgem.

2.11 Following development of the tariffs and cost incentives associated with the time of use, restricted hours and direct control trials, the tariffs report has now been produced by Frontier Economics and has been made available on the CLNR website.

2.12 Regarding the I&C aspect of the trials, demand-side response (DSR) contract discussions were undertaken with a number of commercial aggregators. DSR contracts with ESP Response and KiWi Power were successfully concluded for the provision of DSR from three sites. The sites providing DSR comprised a web-hosting site with standby diesel generation, a mining plant with combined heat and power (CHP) generation and a refrigeration site utilising load-reduction. The events where called by both the project team and the operational control rooms. A total of 13 DSR events were called with 10 being successful. The failed events related to a generator failure, a fire at one site and a DSR response falling short of the contracted requirement.

2.13 The following table shows the original plan, current target and actual recruitment/ expressions of interest to date for each of the test cells:

Test Cell		Original Plan	Current Target	Expressions of interest to date
1	Residential - basic profile	9,000	9,000	7,219
	Business - basic profile	2,250	2,250	2,250
2	Residential - enhanced profile	600	150	0
	Business - enhanced profile	150	150	153
3	Heat pump - flat-rate	600	600	32
4	Micro-CHP - flat-rate	20	20	5
5	Photo Voltaic - enhanced profile	150	150	66
6	Electric vehicles - enhanced profile	150	250	4
7	Business (I&C)- impact 2010 tariff reform	14,000	14,000	2,000
8	Distributed generation - basic profile	230	230	63
9	Residential - time of use	600	600	779
	Business - time of use	150	150	101
10	Residential - hot water (restricted hours)	300	-	0
	Residential - hot water (enhanced monitoring)	-	150	0
	Residential - wet white goods (restricted hours)	300	75	0
	Business - restricted hours	150	150	109
11	Residential - hot water (direct control)	300	-	0
	Residential - storage heating (enhanced monitoring)	-	150	0
	Residential - wet white goods (direct control)	300	75	0
	Business - direct control	150	150	106
12	Heat pump - time of use	600	400	3
13	Heat pump - restricted hours	50	50	0
14	Heat pump - direct control	150	50	0
15	Electric vehicles - time of use	50	-	0
16	Electric vehicles - restricted hours	50	50	0
17	Electric vehicles - direct control	50	-	0
18	Business (I&C)- ancillary service (fast reserve)	15	15	3
	DG - ancillary service (fast reserve)			
19	DG - ancillary service (voltage support)			
20	PV - automatic within premises balancing	300	150	103
	PV - IHD within premises balancing	300	150	80

Activities planned for the next reporting period

2.14 Retrieval of a full annual data set of half-hourly smart meter readings for 9,000 domestic and 2,250 SME customers is set to be achieved in the third quarter of 2012. Analysis of this data will then be undertaken by Durham Energy Institute.

2.15 Installation of the DECC-subsidised heat-pump units is set to increase significantly over the coming months and this increase has been enabled with the approval of the revised Customer Engagement Plan and Data Protection Strategy for the Project to allow engagement with non-British Gas customers.

2.16 The installation of monitoring equipment, and therefore numbers of customers who have monitoring "live" in their premises, will ramp up significantly over the coming months. Initially, this will be most prevalent with regard to the solar PV, heat pump and micro-CHP trials. This will be followed by the electric-vehicle customer recruits as they join the trials.

2.17 Technical solutions for customer monitoring and interventions will be finalised for SME customers for the enhanced monitoring, restricted hours and direct control trials. This work will continue to be influenced by the results of site surveys conducted by British Gas technical staff.

2.18 Early in the next quarter, all of the required customers will have been moved onto the time of use tariff for the project.

2.19 For our enhanced monitoring trials for residential customers we will be launching an expression of interest initiative within our partner organisations with a view to recruiting employees to make up the required number of 150 participants for this aspect of the project.

2.20 We will be pursuing all of the opportunities presented above for the recruitment of electric-vehicle customers onto the trials. Notably, we will commence the installation of smart charge points for EV customers to allow testing of restricted-hours functionality and will progress our relationship with Charge Your Car (North).

2.21 Efforts to secure a new partner to supply load-controllable washing machines for the residential restricted hours and direct control aspects of the trials is set to complete early in quarter 3 2012. These units, 150 in total, are set to be deployed equally over the restricted hours and direct control test cells.

2.22 The project is focused on delivering a second winter trial for I&C and generation customers during 2013. The focus for the remainder of 2012 will be to locate DSR sites in specific geographic locations replicating a business as usual scenario. The project will seek to contract with a minimum of 12 sites. In addition, we will be working on the automation of the process for calling the demand-response events in the winter 2013 trials. The project has also engaged Flexitricity to undertake an I&C research work package to provide a deeper insight as to which companies can provide DSR and what needs to change to encourage further DSR participation.

2.23 We are also going to be designing a series of small power quality tests within households ready for implementation winter 2012.

Learning Outcome 3 – (LO3) Network Flexibility

Activities completed in this reporting period

2.24 We have continued to refine our network technology delivery plans further with specific details of network locations and equipment to be installed.

2.25 We have produced specifications for network monitoring equipment, EAVC and RTTR equipment, storage, and the grand unified scheme (see Appendix 3: Foreground intellectual property generated during the period). Further work on the specifications for the data warehouse and for the demand side response solution is in progress.

2.26 We have completed the procurement process for all items of network technology except for enhanced automatic voltage control of the HV and LV distribution networks. The procurement of the distribution transformer with on load tap changer solution is progressing with market ready applications discussed with a European manufacturer.

2.27 For the grand unified scheme, we have awarded the overarching control scheme to Siemens. The detailed design and development phases of the control system are in progress with a design freeze expected in July 2012.

2.28 For the electrical energy storage aspect, we have awarded the contract for all six Electrical Energy Storage units to A123 Systems and we now are in the planning and civil design phases for the installation and commissioning of these devices due to commence at the end of October 2012.

2.29 For the underground cable thermal rating equipment, we have secured a contract with EA Technology to install a real-time rating system on EHV, HV and LV underground cables.

2.30 For the thermal rating of primary transformers we have secured a contract with Fundamentals and Maschinenfabrik Reinhausen to supply their Trafoguard advanced transformer monitoring device.

2.31 For LV Monitoring, we have secured a contract with Prysmian Cables for the supply of link boxes with integrated monitoring capabilities, including power quality monitoring.

2.32 In continuation of 2012 network delivery, we have undertaken location-specific surveys and have completed wayleave enquiries. We have secured either in the short or long term the required permissions for the desired site locations. In addition, we have mostly completed necessary pre-installation activities such as enhanced security and vegetation management.

2.33 The network field trials with Durham Energy Institute have been developed and constitute up to approximately 220 individual trial scenarios designed to exercise the new technologies and generate the learning on network flexibility. The trials are designed to align with the planned installation of network equipment and will begin with standalone trials of components and increase in complexity, with collaboration with other components and then the control system.

2.34 We successfully installed and commissioned the high voltage overhead line real-time thermal rating devices in February 2012, including six monitoring and weather stations. We have been monitoring the output from these devices over the past 4 months.

2.35 We have commenced the modification of automatic voltage control schemes at primary sites and high voltage network regulators. Replacement voltage control panels have been procured and installation schematics are being prepared.

2.36 We have commenced monitoring at the selected heat-pump cluster site in Hexham, Northumberland. Further work is ongoing on this site to introduce enhanced automatic voltage control and apply real-time thermal rating to the HV/LV transformer.

Activities planned for the next reporting period

2.37 The network technology is scheduled for installation by the end of 2012 such that the majority of the equipment will have been commissioned in the next reporting period.

2.38 At the start of the next period we will complete the detailed planning required for the enabling civil works, installation works and commissioning regimes required for the successful introduction of all the required network technology.

2.39 In relation to the storage, we will complete the construction and groundwork required at the Rise Carr primary site plus the five smaller sites where the battery

storage components will be deployed. Each of these sites has an individual design to meet the specific substation layout and available footprint. Our supplier A123 has commissioned Efacec of Portugal to provide the enclosures for the smaller storage devices. In advance of the delivery to site of the storage units in October we will develop the necessary; safety case, risk assessments and method statements required for this type of electrical energy storage system.

2.40 On the enhanced automatic voltage control we will have completed an overseas site visit to observe the secondary transformer with on load tap changer units currently installed on an actively managed distribution network, completed our technical assessment, placed purchase orders and taken delivery for installation. We will also have completed the detailed planning and installation requirements of the changes required for the installation of enhanced automatic voltage control devices at our primary substations, at the HV regulator sites of Glanton and Hepburn Bell and at the switched capacitor site of Hedgeley Moor. These units will then be installed.

2.41 For the real-time thermal rating, we will complete our preparations and then installation of the thermal rating system for underground cables that has been developed by EA Technology and also the necessary integration required. Similarly in the period we will complete the installation of the overhead line real-time thermal rating equipment onto the EHV circuit on our Denwick rural trial network.

2.42 We will complete the detailed planning and integration for our real-time thermal rating for primary transformers, with the primary substations of Denwick and Rise Carr being the first installations. We have also procured further devices in preparation for deployment at other primary sites, that will be identified via our I&C demand response trial project. Once identified, these devices will be installed at the selected primary substations that supply the demand response providers.

2.43 We will complete the design specification phase of our grand unified control scheme and data warehouse, locking the design down by the end of July 2012 with Siemens then moving into the build phase with factory acceptance testing due to be undertaken in November and installation at our Northern control centre at Penshaw in December.

2.44 We will have progressed the planning of the field trials designed by Durham Energy Institute and will have commenced delivery of certain trials for key items of autonomous network equipment, with the combined grand unified scheme trials planned to be delivered in 2013.

2.45 Other network equipment that will be installed in the next reporting period will be our ground mounted substation monitoring equipment and our innovative novel monitoring LV link box devices across our trial test cells.

Learning Outcome 4 – (LO4) Optimum Solutions

Activities completed in this reporting period

2.46 Work has commenced on the development and validation of network models, network equipment models and smart home models by Durham Energy Institute, with 20 models successfully completed during the period.

2.47 We have completed five network models to cover each of the principal network technology trial locations; the Maltby PV cluster distribution network, LV network at Maltby Road feeder, Denwick rural network, Rise Carr urban network and a model of the heat pump cluster in Hexham.

2.48 The development of network equipment models has been split across the three technology types being trialled in the CLNR Project, Electrical Energy Storage (EES), Enhanced Automatic Voltage Control (EAVC) and Real-Time Thermal Rating (RTTR), with nine completed to date. Of these, for EES four models have been completed including a 3-phase model and a single-phase generic model, and models of the Denwick and Rise Carr networks. The remaining five models have been completed for RTTR and this includes three overhead line models, one generic transformer model and one generic underground cable model.

2.49 Development on the smart home models has been broken down across photovoltaic (PV), electric vehicle (EV), heat pump (HP) and demand side response (DSR), with six completed during this reporting period, which includes two PV models, two HP models and two DSR models on the Denwick and Rise Carr networks.

2.50 During this period Durham Energy Institute has continued to define the methodology and approach in LO4 for the optimum solution, which is summarised as follows:

- Validation (pre-trial and post-trial models)
- Extensions (longer duration, missing trials)
- Extrapolation (input from LO1, LO2, LO3 and Smart Grid Forum)
- Enhancement (new low carbon technology locations and combinations)
- Generalisation (generic and representative)

2.51 Design of the interface between LO4 outputs (trial analysis and design) and LO5 inputs (network design tool requirements) has begun, to ensure a smooth transfer of findings and knowledge between the two project workstreams.

Activities planned for the next reporting period

2.52 Continued development of the interface between the outputs of LO4 and the inputs to LO5 and full definition of the data requirements of these workstreams.

2.53 Continued development and validation of network models, network equipment models and Smart Home models by Durham Energy Institute, with the remaining planned 19 models to be completed during the next period.

2.54 Validation of network models and trial design as data is collected from the LO1, LO2 and LO3 trials.

2.55 Further refinement of the technical solutions and the development of plans for delivery of trial data and perform of gap analysis from the LO1, LO2 and LO3 trials data to determine the number of data extensions, extrapolation and enhancements required.

2.56 There will be continued engagement with Northern Powergrid senior users to validate and refine pre-trial and post-trial models.

2.57 Commence evaluation of potential optimum solution based on the field trials and input from LO1, LO2 and LO3 data.

Learning Outcome 5 – (LO5) Most Effective Delivery

Activities completed in this reporting period

2.58 The LO5 work during this period has focused on the need to baseline current ways of working across a range of project deliverables to identify the policies, procedures and industry standards that may need to change as a result of the learning from the CLNR project.

2.59 A key piece of work undertaken during this reporting period has been a major

exercise of engagement with design engineers and senior managers in Northern Powergrid to communicate the network and customer flexibility trials, baseline current ways of working and perform gap analysis against business as usual processes. The wider scope of interaction has involved senior users input from Standards, System Design, System Strategy, Training, Health and Safety and Operational Delivery. As part of this engagement process we have sought views on the requirements of the proposed Network Planning and Design Decision Support (NPADDS) Tool. This engagement and communication process is important as the learning gained from the project will need to be validated by the senior users in Northern Powergrid throughout the lifecycle of the project in order to generate learning and results that may be incorporated into DNOs' business as usual operation.

2.60 We have commenced work to baseline current Northern Powergrid strategies, policies, codes of practice and guidance notes, with the focus on gap analysis against the new network technologies deployed as part of the CLNR project.

2.61 Work has started on the specification of the Network Planning and Design Decision Support (NPADDS) Tool, with engagement with design engineers at Northern Powergrid assisting with the refinement of the detailed specification and prototype tool development.

2.62 A baseline position for operational procedures and safety rules has commenced with engagement completed with network construction (LV, HV and EHV), protection, network repairs, network restoration and network operations. This work has enabled us to capture current ways of working and make initial assessment on any gaps associated with the implementation of novel technologies installed as part of the CLNR project.

2.63 Evaluation of the key knowledge training requirements has commenced, with EA Technology assessing current ways of working and best practice for introduction of new technologies.

2.64 Durham Energy Institute have produced a high-level methodology and scoping document that defines the specification and appropriate planning requirement to deliver learning associated with commercial arrangements and economic structures. Initial engagement via a workshop with senior users from Network Trading and Network Connections in Northern Powergrid was successfully completed as part of the requirements capture phase.

Activities planned for the next reporting period

2.65 A baseline strategies and policies summary report will be produced by EA Technology and validated post trial results.

2.66 Continue the NPADDS prototype development, with further refinement of scope and initial software development, which will include on-going engagement with senior users from Northern Powergrid. A summary report from EA Technology is due for approval in next reporting period.

2.67 A summary report on the findings from the training requirements work will be produced during the next reporting period to capture the learning and make appropriate recommendations to business as usual processes.

2.68 Assessment of power quality impacts resulting from new disruptive technologies with a summary findings report of test cell outputs.

2.69 Complete engagement with Northern Powergrid senior users on required changes to Operational Procedures and Safety Rules and production of a summary report which will be validated post trial results.

2.70 Complete requirements capture phase and specification for recommendations to

update ACE 49 & 105 and complete requirements capture phase and specification prior to release of SDRC data in December 2012.

2.71 Further definition of the requirements of the commercial arrangements between customers, suppliers and distributors.

Communications and Knowledge Dissemination

Activities completed in this reporting period

2.72 The following communication and dissemination events have taken place during this reporting period:

Dates	Event type	Event title
05 Dec-11	Conference	IEEE PES ISGT Europe 2011
14 Dec-11	Lecture / debate	IET local branch evening lecture
06 Feb-12	Meeting	Nomura Research Institute (NRI)
16 Feb-12	Conference	Network 2012: Communicating a smarter future
26 Feb-12	Conference	Association of American Geographers' Annual Meeting (1 paper)
28 Feb-12	Conference	Acumen 2012
01 Mar-12	Project stakeholder	Housing associations forum
06 Mar-12	Project stakeholder	CLNR Regional Stakeholder Panel (see paragraph 7.2)
07 Mar-12	Lecture / debate	IET Prestige Lecture, IET Yorkshire and Humber regional network
13 Mar-12	Conference	IMechE: Energy storage for electricity networks
27 Mar-12	Conference	The Future of Utilities
26 Apr-12	Project stakeholder	The Future of Connections
09 May-12	Project stakeholder	CLNR National Industry Stakeholder Forum (see paragraph 7.3)
29 May-12	Conference	CIRED workshop - Integration of Renewables into the Distribution Grid (2 papers)

2.73 The project issued the first CLNR quarterly newsletter during the period and materials relating to the key events in the table above have been added to the CLNR website for access by a wider audience.

Activities planned for the next reporting period

2.74 The key external events in the next reporting period are:

Dates	Event type	Event title
06-Jun-12	Conference	Realisation of the Future Smart Grid
25-Jun-12	Conference	Grid Scale Energy Storage
27-Jun-12	Conference	European Demand Response and Dynamic Pricing
12-Jul-12	Project stakeholder	CLNR Distributor Project Review Meeting
04-Sep-12	Conference	Smart Grid Demonstrators: Forum and Tutorial (part of UPEC 2012)
14-Oct-12	Conference	IEEE PES ISGT Europe 2011
25-Oct-12	Conference	ENA LCNF annual conference 2012
27-Nov-12	Conference	Asset Management Conference

2.75 In addition to this, we will continue to produce the quarterly CLNR newsletter and issue press releases as appropriate.

3 Business Case Update

3.1 The key quantitative information used for the original business case development was the take-up projections for three key low carbon technologies (LCTs). These are heat pumps, solar photovoltaic generation and electric vehicles. Despite some changes to the underlying assumptions for electric vehicles the business case has not materially altered.

3.2 In the last year DECC have published the fourth carbon budget[1] which updates assumptions about LCT take-up and presents new projections to 2050.

3.3 Assessment of these new take-up projections for both heat pumps and for photovoltaic generation effectively confirm the assumed number of devices that were included in the original business case, certainly to within 10%. On this basis the carbon savings and associated business benefits associated with these LCTs are assumed to be as originally stated.

3.4 For electric vehicles however the figures have been substantially altered. Total electric vehicles for 2030 are approximately one quarter of that originally assumed; and at 2040 approximately half the original assumed value. Take-up is then back in line with the original assumption by 2050. i.e. the profile is more back-end loaded to 2050.

3.5 This reduction in vehicle numbers reduces the carbon benefit and value of the projects' business case. However the assumed value for electric vehicle emissions has been substantially reduced (from 104gCO_2/km to a weighted average of around 85gCO_2/km), balancing off some of this reduction.

3.6 Furthermore, the figures are now disaggregated into sub categories comprising fully electric vehicles, plug-in hybrids, extended range electric vehicles and electric vans. Each of these vehicle types has a different base case and a different future value for emissions.

3.7 Taking all of these changes into account and re-calculating carbon benefits for electric vehicles indicates that the reductions in technology take-up and the increase in carbon benefit net off one against the other and that the original case is not materially impacted.

[1] The Carbon Plan: Delivering our low carbon future, DECC, Dec. 2011

3.8 Capital costs of generation were included in the original carbon and business case. We can find no evidence that would cause us to make any substantial change in the assumptions used.

3.9 The final variable used in the business case is the network applicability and clustering assumptions. New information is not yet available but is currently under development; particularly within the Smart Grid Forum. An initial assessment of draft outputs indicates that changes to the original cases may be necessary. The CLNR carbon and business cases will be re-assessed when this work is complete. We anticipate that this will be during the second half of 2012.

3.10 In summary, despite some changes in base assumptions the business and carbon cases for the project remain unchanged.

4 Progress against Plan

4.1 The project continues to be operated to a detailed three-year plan completing in December 2013. During the period we have completed the test cell specification and selection phase for the customer trials in LO1 and LO2 that was ongoing at the last report in December 2011 and produced the customer-facing materials and detailed tariff design work that act in support of the customer recruitment phase. The production and approval of the customer-facing materials for all of the trials has been a significant undertaking, with quality materials produced by the project team and approved by Ofgem in a timely fashion. Elements of our customer facing material have already been shared with the Low Carbon London project.

4.2 In addition we have completed the first year's monitoring for the base monitoring test cells for residential and SME customers.

4.3 We have now commenced recruitment of residential, SME and I&C customers across a range of test cell propositions. Recruitment has been particularly positive amongst a number of these propositions, in particular the general load time of use tariff and solar PV trials. All of the customer monitoring and direct control equipment has been specified and the majority has already been procured. Installation of monitoring equipment has commenced in 6 out of 17 residential test cells, and this is planned to increase to 15 out of 17 by the end of August 2012, with only the two direct controlled white goods test cells outstanding at that point.

4.4 We have completed as planned our first Winter (2011/12) demand-side response (DSR) trials successfully engaging through aggregator companies with three selected I&C customers. We called thirteen DSR events of which nine delivered a successful response, within negotiated contract parameters when called.

4.5 In our LO3 network trials we remain on plan to complete the network installations by the end of 2012. During the period we have completed all of our equipment specifications, designed our network trial combinations and procured all of our network equipment with the single exception of the enhanced automatic voltage control of the HV and LV distribution networks, which is underway. Particular procurement achievements during the period have been the successful full market tender and key equipment contract awards for the Electrical Energy Storage (EES) devices to A123 Systems with installation and commissioning on target to commence at the end of October 2012 and the grand unified control scheme awarded to Siemens, also on target for installation by year end 2012. We consider completion of these contracts a significant milestone. Tendering for these novel types of equipment has required a significant resource commitment from within the project.

4.6 Network equipment has continued to be installed during the period, with monitoring devices installed at a number of substations within our selected network areas and the real-time thermal rating devices installed on our rural overhead line network at

Denwick. Post-installation the data from these devices is being monitored and assessed by Durham Energy Institute.

4.7 Where we have encountered delays we have adapted our plans in the period in respect of certain test cells, particularly those involving air-source heat pumps and electric vehicles. As these technologies have been subject to slow take-up within the market, we have extended our engagement to non-British Gas customers, via local authorities and community housing, plus other electric vehicle service providers. This extended engagement has been enabled by the most recent approval by Ofgem of our Customer Engagement Plan and Data Protection Strategy documents to include this wider customer base.

4.8 Whilst we have made significant recruitment gains in the solar PV test cells, which have been well subscribed, we were unfortunately delayed due to unsuccessful discussions with a solar 'rent-a-roof' provider in our region, with whom we could not reach agreement on accessing their assets to apply our equipment. We do remain confident in obtaining the required customer numbers through alternative providers although the start of these test cells has been delayed by ca. two months.

4.9 Similarly we have also encountered an issue over the market-ready availability of direct controllable white goods, with our primary supplier contact pulling out of the market during the period. We are currently in pre-contract non-disclosure discussions with another supplier and have targeted quarter 4, 2012 for supply and installation in an effort to achieve Winter 2012/13 trials.

4.10 In these areas of scarcity, where recruitment has taken longer than originally planned, we plan to mitigate this delay and maximise the learning in spite of the delayed start. In order to maximise customer numbers, wherever possible we have targeted a significant proportion of our planned customer monitoring equipment to be installed by the end of September 2012 thus giving us the optimum data set for analysis by Durham Energy Institute through 2013.

4.11 In our last report we proposed to Ofgem that the project closedown report will include all the learning completed by the end of September 2013. However for heat pump and electric vehicle customers we propose to collect further data and report on any additional learning generated through analysis of that learning in an addendum report in 2014.

4.12 In LO4 and LO5 we are on target with our design and delivery methodologies for this work and in conjunction with both Durham Energy Institute and EA Technology we are also on plan to integrate LO4 outputs into LO5 and to provide the appropriate inputs to the Network Planning and Design Decision Support (NPADDS) Tool, which is already in production by EA Technology.

4.13 Overall, despite the full project plan being more back-end loaded, we are still targeting four seasons' coverage for the trial period and we are confident that our analysis will deliver quality learning outputs of value to all distribution network operators. In addition, we still aim to release certain batches of data in advance of the year end; starting in September 2012.

4.14 In terms of achieving the 2012 critical milestones as per the Project Direction, we have completed the two milestones planned for the first half of 2012. The remaining five 2012 milestones are running to plan. The two completed milestones are:

- Host the second annual regional stakeholder panel meeting at Durham University in March 2012.
- Host the second annual industry stakeholder forum on Smart Customer Response in London with Sustainability First and National Energy Action in May 2012.

4.15 In summary, the plan addresses the delays encountered to date, supports the delivery of valuable learning and remains on track for the project key milestones.

5 Progress against Budget

5.1 The following table sets out, at "box total" level, the actual project costs to 31 May 2012, the forecast costs for the entire project compared to the budget set out in the project directions and the movement in these forecasts since the December 2011 progress report.

Budget Category	2011 Actuals	2012 to Date	Total project (to December 2013)				Total project (to December 2013)		
	Actual	Actual	Budget	Forecast	Variance		Dec Report Forecast	Variance	
	£m	£m	£m	£m	£m	%	£m	£m	%
6 - Employment costs	0.6	0.4	3.5	3.3	(0.2)	-5%	3.3	(0.0)	0%
7 - Equipment costs	0.2	1.8	11.0	13.0	1.9	18%	12.1	0.8	7%
8 - Contractor costs	2.1	1.2	11.4	10.4	(1.0)	-9%	10.5	(0.0)	0%
9 - Customer and user payments		0.1	0.8	0.8	0.0	5%	0.8	0.0	5%
10 - Other costs	0.0	0.0	4.4	3.5	(0.8)	-19%	4.4	(0.8)	-19%
Total costs	**2.9**	**3.5**	**31.0**	**31.1**	**0.0**	**0%**	**31.1**	**(0.0)**	**0%**

5.2 The current outlook is that we are still on target to deliver the agreed learning outcomes within budget.

5.3 There has been and will continue to be a need to reallocate budget between categories as the project progresses through its various phases and Ofgem will continue to be informed of such changes in accordance with the LCN fund governance requirements.

5.4 In the period since the last progress report we have requested and received Ofgem's approval to release £0.8m from the contingency budget in "other costs" (Box 10) for allocation to "equipment costs" (Box 7) to cover the higher than budgeted costs for the control interfaces.

6 Bank Account

6.1 During June 2012 Deloitte conducted a review of the transactions on the memorandum account. The outcome of this review was successful and no significant issues were noted.

7 Successful Delivery Reward Criteria (SDRC)

7.1 During this reporting period two SDRCs were completed to plan:

Regional stakeholder panel meeting

7.2 The second Regional Stakeholder Panel was held at Durham Energy Institute on 6 March 2012 with invites issued to around 30 attendees comprising academics from Newcastle, Durham, Northumbria and Teesside universities, local authorities and other related companies and opinion formers. Its aim was to provide an update on project progress and review plans for community engagement relevant to the project. Further information regarding the Regional Stakeholder Panel can be viewed within appendix 1 of this report.

Industry stakeholder forum

7.3 The second Industry Stakeholder Forum was held in the form of a workshop on smart customer response in London on 9 May 2012 with an invited audience of over 40 people. The attendees comprised all other DNOs, energy suppliers and other related companies and opinion formers. Its aim was to provide an update on project progress, including achievements made concerning trial design, tariff design, customer engagement and industrial trials of demand side response, together with providing an opportunity to review progress on two other projects concerning customer response, one of which had been supported as part of the CLNR project.

Further information regarding the Industry Stakeholder Forum can be viewed within appendix 2 of this report.

Remaining SDRC for 2012 and 2013

7.4 Work is progressing well towards the remaining five SDRC planned for completion in 2012 and the 10 SDRC planned for completion in 2013. All of these SDRCs remain on target to be completed to the original planned dates.

7.5 The key risks to delivery are set out in section 10 of this report.

8 Learning Outcomes

8.1 The learning described in this section of the report has been gathered during the current reporting period and builds on the learning reported in the December 2011 report. The ongoing programme of communicating the work of the project and disseminating the learning is described in section 2 above.

Learning from the customer trials

8.2 British Gas has been collecting information from the recruitment phase of the project which is producing some interesting learning insights.

Trial tariffs

8.3 Our work on tariffs and the associated customer propositions has been completed in the period and has been incorporated into all of our tariff based trials. This knowledge has been disseminated out to a wider industry group by Frontier Economics at our Industry Stakeholder forum in London on 9th May 2012 and also available on the CLNR website.

CDCM

8.4 Initial analysis of I&C consumption data (based on 1,200 customers) before and after the introduction of the Common Distribution Charging Methodology (CDCM) shows that the tariff changes did not influence a change in customer consumption patterns.

Residential customer recruitment insights

8.5 During the residential recruitment campaigns, the following data and information is being captured.

- Customers dialled vs. customers recruited;
- Response rates to direct marketing;
- Take up rates - smart existing vs. eligible, warm leads vs. cold;
- Opt in, opt out and drop out reasons and trends;
- Customer response/reaction to propositions;
- Demographic breakdown and imbalances;
- Fuels used by off-gas grid customers;
- Voice recordings of inbound/outbound calls;
- Additional feedback from call centre agents; and
- Consent to face to face interviews with Durham Energy Institute.

8.6 Initial review of this information has led to some interesting early insights being drawn:

- *Direct marketing success* - The direct marketing campaign which was carried out as part of the recruitment exercise has been a resounding success, with good response rates for both the ToU and Solar Test Cells.
  - TOU (8%): Mailed 23,227, had 1,847 responses; and
  - PV (11%): Mailed 1,105, had 121 responses.
- *A positive reception on time of use* - It would appear that from the higher

recruitment rates, the offer of a Smart Meter is seen as an incentive for signing up to the trial with Smart Eligible recruitment rates being 11% higher than Smart Existing recruitment rates.

- *Saving money on bills* - From the information collected, it appears the majority of customers have signed up to the trials as they feel they can make savings on their bills. Some had even already agreed to join the trials before the mention of the customer payments. It was also found that only a few customers appear to be motivated by reducing their carbon emissions.
- *Time of use - a lifestyle choice?* - About half of those who have signed up for the trial said they were interested because they rarely use electricity during peak hours anyway. What people do and what people say may be two different things and it will be interesting to see whether people's actual consumption habits are consistent with their expectations.
- *Solar PV customers appear highly engaged in their energy usage/generation* - Many solar customers have expressed an interest in knowing in real time how much their solar panels are generating versus how much electricity they are using. It will be interesting to see whether this engagement converts to action and whether we will observe customers turning on appliances in direct response to exactly when they are exporting excess generation.

8.7 In addition, some operational insights have been obtained as the project progressed from initial recruitment through to making arrangements to install the monitoring equipment.

- *PV Rent-A-Roof* - During the customer recruitment campaign for the CLNR Solar PV trial it became apparent that around 194 of the 368 customers recruited had their solar panels installed as part of a rent-a-roof agreement, which required the Project to obtain consent from not only the customer but also the rent-a-roof supplier in order to proceed with the installation of monitoring equipment. We were unable to secure this permission.
- *Economy 7 tariffs & hot water storage* - The Project's findings to date, based upon a review of 1,150 British Gas customers, indicate that hot water is not normally heated electrically during peak hours and that the majority of customers who heat their domestic hot water electrically typically do so overnight and on an Economy 7/10 tariff. Initial conclusions therefore indicate that electric hot water is not a suitable load for demand response, furthermore there appears to be very limited knowledge around electric hot water usage and customer behaviour in the UK and literature on the subject appears to be largely theoretical. The decision has therefore been made that Test Cells 10a(HW) and 11a(HW) are removed from the Project and the LO2 objective and replaced with two alternative Test Cells which look to contribute to the LO1 objective by understanding the usage and energy consumption of electric hot water heating and where available for electric storage heating. Sustainability First have done some recent research in this area that will help qualify this, but on the whole more research needs to be done.
- *EV Scarcity* - Residential EV numbers are far lower than expected at trial design phase. Industry forecasts were that ca.1% of all new car sales would be EV by 2012 (ca. 20,000), whereas current data shows ca.1,500 EVs are registered. The Project therefore has to cast the net more widely to find participants and is working through the Partner's existing networks and stakeholders, such as Plugged-in-Places NE region (Charge Your Car) and existing British Gas charging point customers. Furthermore British Gas is looking to leverage its recently launched 2-rate ToU tariff, by inviting customers to join the CLNR trial.
- *Heat pump market is very much still in its infancy* - There has been a lower than anticipated overall population of ASHPs in the Project region due, in part, to delay in availability of domestic Renewable Heat Incentive (RHI). DECC funding has therefore been secured to subsidise the installation of heat pumps which will be monitored as part of the Project, of particular interest are those installations that will use thermal stores since this enables restricted hours or direct control operation of these appliances in order to reduce load at times of peak network loading without compromising comfort levels.

- *Social landlord (SL) sector - early adopters of heat pumps* - The project has seen the majority of interest so far in heat pumps from the SL sector as they perceive heat pumps as a significant "value-add" to properties and are often part-funded through refurbishment budgets. We have seen the prestige of the CLNR project, carbon targets and competition with other SL as key drivers to uptake. SLs appear to have significant experience with heat pumps and some are actively targeting vulnerable customers for installations, due to the resulting improved thermal comfort and lower energy bills. However there is some wariness over time of use tariffs as peak pricing may impact some customers' attitude to heating and there may be significant educational requirements for the tenants to get the most out of a heat pump.
- *Broadband uptake in social housing* - A significant barrier the project is facing is with regard to the installation of monitoring equipment in social housing. There is a relatively low propagation of broadband, which is an essential prerequisite for the trials. Experience of the Project's installation supplier has suggested this could be as low as 50% although early findings indicate that this could be even lower. Given the customer scarcity and the importance of monitoring the heat pumps installed as part of the DECC funding, the project has taken the decision to pay for one year's subscription of broadband and also to provide assistance in setting up the account and hardware.
- *Mains isolation switches* - One of the fundamental Project requirements is to monitor whole house consumption. In some cases however and certainly for non-British Gas customers, instead of installing a smart meter, we are having to install a secondary meter. This requires a mains isolation switch to be fitted to the property, however due to MOCOPA regulations only a licensed meter operator appointed by the customer's electricity supplier is authorised to fit this equipment. This poses an operational challenge to the project as obtaining monitoring data will, in these cases depend upon third-party suppliers. Furthermore there appears to be very little market information on how many properties have an isolation switch already fitted, but indications are that it is only 2%. We therefore need to plan for arranging these to be fitted for all non-BG customers having monitoring equipment fitted as part of the Project via their electricity supplier.
- *Smart metering challenges* - The fact that the majority of heat pump trial participants are likely to come from the social housing sector leads to a further challenge with regards to the restricted hours and time of use test cells (12, 13) as they will both require the customer to have a smart meter fitted. The Project is finding that many social tenants would need to switch from Economy 7 or pre-payment meters to Smart Meters, a process that is currently not yet "business as usual" within British Gas. Given the scarcity of heat pump customers and their value to the project, British Gas is seeking to accelerat the development and deployment of these types of meter exchange for the purpose of the project, which will in itself produce valuable insight and learning.

Business (SME) customer recruitment insights

8.8 The business customer recruitment activity has also provided us with interesting learning, particularly on the reasons why small business customers do or do not want to take part in the trials.

8.9 Why some business customers want to take part:

- Enthusiasm for environmental projects;
- Wanting to save money;
- Having an interest in the results of the monitoring trial if possible;
- Agreeing to take part as long as it's not intrusive to the business.

8.10 Why some business customers do not want to take part:

- Previous problems with the installation of smart meters in their business;
- Don't like the idea of equipment being installed;
- Concerns about the size/impact of the monitoring/interrupting equipment;

- Some companies are already involved in a green project or doing other energy saving projects and don't want overlap;
- No decision power on the matter - Landlord/serviced properties, part of larger organisation, dealing with electricity through broker;
- No longer British Gas customers, about to sell/lease property;
- For test cells 10/11 (restricted hours and direct control) - Businesses not open between the relevant hours of 4-8pm /not using much energy between 4-8pm/having few/no non-essential items - some respondents are adamant that they have nothing to interrupt even after reassurances that a British Gas specialist would go through this with them.

8.11 It is important to emphasise that the small business recruitment phase is in the early stages, but early indications from feedback received by small business customers is that restricted hours and direct control propositions as designed for CLNBR may not be feasible in practice for the majority of businesses as non-essential business equipment tends to be limited and we are finding that businesses have already reduced their loads through energy efficiency measures in order to reduce cost. Further details in this area are being captured through technical surveys and interviews and will provide valuable insight into an area in which there currently appears to be very little knowledge.

Learning from the network technology trials

8.12 In delivery of the network equipment, there have been a number of learning insights that were not identified at the outset primarily relating to the installation of the thermal rating equipment and the preparation of the storage components. These include the development of method statements, risk assessments, wayleave changes, security issues, safety case development, engagement with local authorities and fire services. Other initial findings relate to the outputs of the monitoring equipment that we continue to roll out across our trial sites, including; monitored levels of power quality, system loading and phase imbalance, and information that informs system design at an early stage of network concerns. These additional unplanned outputs will be combined with the proposed learning schedule.

8.13 The four current HV overhead line sites on the Denwick rural network have shown that different real-time thermal ratings are derived at the same point in time for different locations on the same HV feeder. This is as expected due to the variation in site topology e.g. sheltered sites, open sites.

8.14 A paper was presented at CIRED 2012, entitled "Customer-Led Network Revolution - Integrating Renewable Energy into LV Networks using Energy Storage". This paper presents a solution to voltage rise issues arising from large-scale PV integration, using EES. It is based on data analysis from the PV reception network in Maltby, PSCAD simulation, and laboratory emulation. This study is an illustration of the "Validation", "Extension", "Enhancement" and "Extrapolation" parts of the VEEEG analysis methodology developed for the CLNR project.

8.15 An abstract entitled "Distribution Network Voltage Control using Energy Storage and Demand Side Response" has been accepted for ISGT 2012. This paper presents a solution using EES and DSR to control voltage drop issues related to high penetration of EVs and heat pumps. The research was carried out using an IPSA2 model of Denwick, results from I&C DSR trials, and simulation and emulation work carried out within DEI. Again, this study is an illustration of the VEEEG analysis methodology.

8.16 We are using a number of systems to gather and process data to support our learning. The conclusions to date are that dealing with a new data hosting solution is not a straightforward process, and there are many obstacles to overcome before the system can be used effectively, especially for real-time control and for rapid turnaround of results analysis. More specifically, our experiences are as follows:

- GE-FMC Tech data hosting system experience for the real-time thermal rating network devices shows that the data download function seems robust, and the functionality to download results for all data fields at all sites in one file is a useful system that is an open format than can be imported by many applications.

- Kelvatek data hosting has likewise produced some learning relating to its system. The learning relates to the limitations of using data that is not real-time. The data can be accessed only after a time delay, which varies from several hours to nearly one month, which means it is not suitable for real-time control. It is also difficult to download long periods of data. Missing data and duplicated data cause analysis difficulties.

- Finally, data hosting experience has been gained from the iHost (Nortech) system.– This site does not have the same bulk data download function at present and is missing certain data fields (e.g. calculated RTTR). The current website login does not give us full access to the rating engine so we are therefore unable to modify the calculations for our research. As with the Kelvatek system, missing data and duplicated data are currently causing analysis difficulties that we are working to resolve.

8.17 A number of technical insights were recorded during the preparation of the network equipment specifications by EA Technology and the subsequent procurement exercise.

- The technical issues that arose most during the solution development and site selection were size (of the solution) and space (at the site).
- We found that pictures were a powerful way to inform others in the project of the type of things that were being considered. We regretted not asking permissions from suppliers earlier for use of their copyright sales and technical materials as it became more difficult later to obtain such permissions.
- As storage devices affect the network upstream of their connection, the maximum benefit is likely to be obtained when they are sited closest to the load/ generation. A position approximately two thirds of the length of an LV feeder away from the substation was adjudged to be optimum for the smallest (50kW) storage unit.
- We found that lack of clear understanding of the IPR ownership from previous collaborative projects was an inhibitor of free exchange between the project partners.
- We have determined that an elegant solution for voltage control is the ability of enhanced devices at key nodes to accept new voltage set-points occasionally from an overall control system. The solution also turned out to be eminently implementable as several of the automatic voltage control relays in common use already have this facility.
- A useful first step in the implementation of real-time rating systems is to establish a measurement of the limiting factor for an asset; this is often temperature.
- Large voltage optimiser devices, developed for use on customers points of connection can be applied to provide a single step voltage control solution for 3-phase underground distributors with little modification.
- The frequency with which voltage information is required to ensure sufficiently prompt action can be taken could not be accomplished by smart meter communication. A modified link box has been adopted to provide voltage measurements at key LV network normally-open points.

Learning from the solutions development workstream

8.18 The process of collecting and delivering large volumes of smart meter data for analysis has not been straightforward. As information from smart meters is intrinsic to the concept of a smart grid, being able to understand and overcome the issues faced on CLNR will be very important.

- Privacy and commercial concerns have required the implementation of a complex solution for transferring and analysing data.

- Within the supplier the use of third-party outsourced data handling has led to unexpected outcomes: existing business practices and contracts do not allow for rapid data querying; the data itself suffers from dropouts and loss; data rates and connectivity to meters can be poor; billing systems are not designed to allow access needed for detailed and sustained analysis.
- Required IT security standards are tightening all the time, and future projects such as CLNR will need to look ahead in the planning phase to the information landscape two to five years into the future.

8.19 There is an apparent "value gap" surrounding demand side response. Frontier Economic's tariff paper for CLNR suggested that there is little value to an individual customer providing DSR. However, such a service, in aggregate, would be of high value to the DNO. Understanding how to close this gap and provide a service which is of value to all participants is valuable for the industry.

8.20 The Irish Trials (CER Smart Meter Customer Behaviour Trials) have provided CLNR with an important model for data dissemination, and have provided some important supplementary data that will be incorporated into CLNR analysis. In particular the design of the customer surveys has influenced survey design for CLNR.

8.21 The EDRP study data has not been forthcoming yet but the project report itself has provided valuable information on smart meter trials. The learning from EDRP has been cast in the light of the learning outcomes for CLNR and will be used to inform our results.

8.22 In the process of developing advice for updating ACE49 and ETR130 we have discovered that a lot of the assumptions that informed the historical studies have been lost, or may be challenged. This has led to a re-evaluation of what CLNR will be able to say robustly about current and future load and generation profiles. Work on a solution to this issue is on-going.

8.23 In LO4/5 EA Technology have been involved in activities to determine the extent to which present document sets (policies, procedures and guidelines) will remain valid as low carbon network solutions become adopted.

- Early learning is that more documents than originally envisaged will be affected as the headline issues of flexible voltage control, real time thermal ratings and application of electrical energy storage are not covered by single policies.
- The standards to which these policies and procedures refer will also require some revision to support the adoption of low carbon network technologies.
- Of the 224 external documents referred to in the policies and procedure documents researched, it is estimate that 37 have the potential to be impacted by the introduction of the low carbon network technologies being trialled in this project.

9 Intellectual Property Rights (IPR)

9.1 In this reporting period, the work of the project has been focussed primarily on the customer recruitment aspects of the customer phasing trials, the specification, procurement, trial design and installation phase of the network trials and the policy base lining and design tool specification for the solutions development part of the project. These aspects of the project are captured in a number of artefacts which constitute foreground intellectual property, and are listed in Appendix 3 – Foreground intellectual property generated during the period.

9.2 No IPR has been registered or royalties resulted in this reporting period, and we do not forecast any IPR registrations or royalties in the next reporting period. We are actively considering our approach to the preferred and most appropriate approach to protecting relevant foreground intellectual property rights and licensing, and developing appropriate procedures that deliver the objective of timely and cost effective dissemination.

10 Risk Management

10.1 As specified by Ofgem, this section provides an update on the five key risks identified in box 26 of the bid document (with project risk register reference numbers):

- Risk 1: Network equipment (EAVC, RTTR and storage) fails to operate as specified.
- Risk 2: Failure to deliver the integrated demand response system that links the network with the customers' equipment.
- Risk 3: Insufficient numbers of customers are recruited to populate the individual test cells.
- Risk 4: British Gas withdraws from the project.
- Risk 5: Emerging findings indicate a major change of project scope is required.

10.2 Risks 1, 2 and 3 remain actively managed to mitigate the probability of their occurrence and the consequence of their impact. Risk 4 (the withdrawal of British Gas) and Risk 5 (emerging findings indicate a major change of project scope is required) are now mitigated; Risk 4 as a result of the ongoing collaborative working relationship with British Gas and the evident high level of commitment to the project and Risk 5 has diminished with time on the basis that the project is unique in the UK, will complete as one of the first tranche of Tier 2 projects and that findings from other studies would serve to enhance rather than diminish our own project outcomes.

10.3 Additional key risks were identified in the last report and the following two risks replaced Risk 4 and Risk 5 in the list of five key risks:

- Risk 20: External events or markets adversely affect project progress (particularly the delay / downgrading of RHI).
- Risk 29: The HV/LV transformer required as part of the EAVC cannot be purchased at acceptable cost and within timescales required.

10.4 We have now mitigated Risk 20 by securing DECC funding to subsidise the purchase of up to 600 air source heat pumps, which will enable sufficient acceleration in the take-up of this technology to populate the relevant test cells.

10.5 We have also closed Risk 29 by identifying and (imminently) placing and with a European manufacturer that can provide a prototype HV/LV transformer with on-load tap-changer for installation at Maltby, Wooler and Darlington within acceptable budget and time parameters.

10.6 One new key risk has been identified during the current reporting period (Risk 34) and an existing risk (Risk 7) has been elevated to be included in the list of five key risks.

10.7 The current five key risks are therefore;

- Risk 1: Network equipment (EAVC, RTTR and storage) fails to operate as specified.
- Risk 2: Failure to deliver the integrated demand response system which links the network with the customers' equipment.
- Risk 3: Insufficient numbers of customers are recruited to populate the individual test cells.
- Risk 7: Lack of take-up for direct control.
- Risk 34: Contracting with suppliers of novel technology.

10.8 Further detail is provided below on these five key risks.

Risk 1: Network equipment (EAVC, RTTR and storage) fails to operate as specified

10.9 At the time of the bid, we recognised that this was a high-impact risk. Some mitigation was built into the design of the project and the plan for its delivery; a preference for market ready products and, where possible, test bed operation followed by a phased roll out. The trials have been designed to contain different combinations of equipment and network applications in order to avoid the risk associated with single point technical failure.

10.10 Where possible, we have taken action to further reduce the level of risk by identifying additional suppliers of equipment. For example, in the case of network monitoring equipment, we have purchased and installed equipment from three different manufacturers. However, for some items, such as the storage devices, the practicality of this approach is limited by the long lead-time and cost and the availability of the small size storage devices.

10.11 The risk remains high impact but the mitigation in place has reduced the probability to a low level.

Risk 2: Failure to deliver the integrated demand response system that links the network with the customers' equipment

10.12 Siemens has now been appointed as the supplier of the grand unified scheme control system and this contract is progressing well. However, the risk level has not changed significantly from the time of the bid and the risk will remain in the top five until there is more certainty on the technical details and delivery timescales for the connection between the control system and the controllable loads with I&C, SME and residential customers' premises.

10.13 However we do have the mitigation position, where we would utilise the control system to control the network technology and when required within the trial context to generate the demand response signal. This signal would then be despatched via a manual system where the signal is passed to either the commercial aggregator operating the I&C trials, or the British Gas DSR control centre/operative who then sends a signal out to the British Gas SME or residential customers. This approach, whilst not ideal, would still prove DSR delivery concept and enable the key DSR elements of the project to be delivered.

Risk 3: Insufficient numbers of customers are recruited to populate the individual test cells

10.14 Customer scarcity issues were encountered at an early stage of the project in respect of heat pumps, electric vehicles and most recently electric hot water.

10.15 The incorporation of DECC-subsidised heat pumps for deployment onto the trials and a decision to widen the recruitment channels to both include non-British Gas customers and in certain circumstances to recruit out of region is now expected to provide heat-pump units in sufficient numbers to meet the trial objectives.

10.16 Mitigation of EV customer scarcity is being pursued by three routes. These include sourcing customers who have adopted the British Gas two-rate electric-vehicle tariff, offering a fully-funded British Gas electric-vehicle charge point to incentivise participation in the restricted hours aspects of the trials and working to leverage in customers from the Northeast's Charge-Your-Car scheme by offering incentives on fully-funded charging / monitoring points.

10.17 Scarcity of EV user customers and the adoption of the British Gas two-rate tariff as the baseline for British Gas electric-vehicle users resulted in a decision to drop the time of use and direct control aspects of the trial. This means therefore that we now have a base monitoring trial for EV users, which will incorporate a mixture of different tariff types up to a maximum of 250 customers and a restricted hours trial, which we intend

to populate to a maximum of 50 customers via fully incentivising adoption and installation of a British Gas electric-vehicle charge point.

10.18 Issues of customer scarcity on the heat pump and electric-vehicle test cells and the successful incorporation of DECC funding for air-source heat pump installations into the project has meant that the Project will now engage with non-British Gas supply customers in these areas. The Customer Engagement Plan and Data Protection Strategy were revised and approved for this new approach.

10.19 The project closedown report will include all the learning completed by that date. For heat pump and electric vehicle customers, which is likely to be based on less than four seasons trial data by the scheduled monitoring end date, we propose to continue to collect trial data and document any additional learning generated by the release of an addendum report in 2014.

10.20 During the project, issues of extreme scarcity of non-Economy 7 customers with electrically heated hot water have arisen and a redefined proposal has been developed to monitor the energy consumption profiles of immersion and storage heaters for customers on an Economy 7 tariff, which will include features such as monitoring of the boost facility for hot water and measurement of the quantity of hot water used per day per household. The decision means the replacement of test cells 10a and 11a from the trials as they were designed as LO2 intervention cells and their re-designation as LO1 monitoring cells. This will deliver valuable learning and it is not thought to have been conducted in a similar manner elsewhere. The proposal has been produced in conjunction with our advisory partners, Sustainability First. Unfortunately, it has the effect of depleting the options available to trial restricted hours and direct control operations with customers.

Risk 7: Lack of take up for direct control

10.21 The bid proposal for direct control included:

- Residential general load (electric hot water and wet white goods);
- SME general load;
- Electric vehicles; and
- Heat pumps.

10.22 Customer scarcity is having an effect on recruitment which has resulted in the dropping direct control of electric hot water. In direct control for electric vehicles the test cell was dropped due to the price signal having already been given to move out of the peak period by the prevailing market two rate tariffs employed by British Gas and other Suppliers. The incentives available for the direct control of wet white goods, SME loads and heat pumps have been developed to encourage customer take up in these areas.

10.23 Direct control of hot water heating has been dropped from the trial and replaced by the alternative monitoring proposal described in paragraph 10.20

10.24 The recruitment of customers with controllable wet white goods has been delayed due to the original manufacturer deciding at a late juncture not to supply these goods into the UK. However, a new manufacturer has now been engaged and the washing machines that are expected to be supplied will provide customers with information on the most economic time to run the machine and will also have the functionality to remotely disable the operation of the machine during demand reduction periods; however, the customer will have the facility to manually override this if they require. Due to the much reduced deployment time available, take up of the proposal will be incentivised by the provision of 150 fully funded washing machines rather than the original proposal to partially fund 600 machines.

10.25 Whilst the recruitment of SME customers for direct control trials has been healthy, we have recently encountered issues where customers at the pre-installation survey phase have considered the extent to which the interruptions would affect their business and

have subsequently withdrawn from the trials. We are monitoring the impact of this SME customer drop out.

10.26 The heat pump subsidy from DECC is now accelerating the installation of heat pumps and the purchase of a thermal storage variant now allows direct control to take place. We have reduced the duration of the interruption for the heat pump direct control to maintain customer comfort levels.

Risk 34: Contracting with suppliers of novel technology

10.27 In addition to the risk of required functionality not being available, we have identified that there is an enhanced supply chain risk with providers of novel technology.

10.28 In the project to date there have been examples where vendor lead times have been significantly greater than initial expectations due to prolonged risk assessment or type testing processes in order to manage appropriately the introduction of new technology onto the network. We are managing this risk by planning ahead and seeking to address issues at the earliest possible stage.

10.29 Further, suppliers may be financially less stable; particularly start-up companies where the product portfolio is relatively narrow and their customers are in emerging markets. Therefore there is a heightened risk that orders will not be ultimately fulfilled. We are managing this risk by identifying the incidences where this is a factor and ensuring that the order is being appropriately fulfilled with payments linked to stage milestones.

11 Other

11.1 Further supporting information has been included within the report as appendices, which are as follows:

- Appendix 1 – Regional stakeholder panel meeting
- Appendix 2 – Industry stakeholder forum
- Appendix 3 – Foreground intellectual property generated during the period

12 Accuracy Assurance Statement

12.1 Our approach to ensuring the accuracy of the information contained in this report is based on building in quality to the whole process/lifecycle of the progress report and the data and information contained therein. This quality assurance is provided by the following processes and controls:

- The integrity of the underlying systems and professional competence of the staff involved.
- Referencing existing 'within project' reports, records and materials to avoid errors or omissions.
- Independent checking of the financial aspects of the report, by Northern Powergrid staff where appropriate and by external auditors where mandated (i.e. the Project Bank Account transactions).
- Regular scheduled review of the project financial data with the senior Northern Powergrid financial staff including the Finance Director.
- Review by project board members who represent a wide range of interests and competencies and include representatives from all four project partners.
- Approval by the executive board, providing senior management endorsement by all four project partners in addition to the Accuracy Assurance Statement from a Northern Powergrid board director.

12.2 The key steps in this approach are:

Step	Rationale
Content has been contributed by project personnel according to their areas of responsibility and expertise. The financial sections of the report are prepared by a chartered accountant.	This provides confidence in the capability of the responsible staff to produce a meaningful and accurate report.
External auditors have certified Northern Powergrid's accounting arrangements for the project as being satisfactory, and will revisit this on an annual basis (i.e. the provision of the annual report to Ofgem to confirm compliance with the requirements set out in the Bank Accounts section of the Project Direction). The most recent annual audit was undertaken in December 2011 and is included in the second progress report.	This provides confidence that sources of data for the financial aspects of the report are indeed reliable.
Responsibility for preparing the financial sections of the report has been allocated to the project accountant who is a chartered accountant.	This provides confidence that the financial aspects of the report are professionally prepared.
The schedule of memorandum account transactions is audited by Northern Powergrid's external auditors.	Required by the Project Direction, this provides confidence in this aspect of the report
As part of our quality assurance process, we will check that the actual expenditure figures in 'Progress Against Budget' reconcile with records in Northern Powergrid financial systems, and this check will be carried out by a person other than the person who has prepared this information for inclusion in the report.	This reduces the possibility of human error
The report is reviewed by all members of the project board and approved by the executive board. Both the project board and the executive board include representatives from each project partner including Northern Powergrid. Members of the Executive Board are at director level in their respective organisations. Review also conducted by Northern Powergrid Chief Executive.	This ensures that the report is comprehensive and balanced.

12.3 Sign off: I confirm that the processes in place and steps taken to prepare this report are sufficiently robust and that the information provided is accurate and complete.

Signature

John Barnett

Commercial Director

14 June 2012

Appendix 1 – Regional stakeholder panel meeting

Agenda for the Regional stakeholder forum held on 6 March 2012 at the College of St Hild and St Bede, Durham

Purpose:

1. Assist in developing the community engagement plan for Wooler, Rise Carr, etc, where engagement with stakeholders will need to start from March

2. General update on the CLNR project, to include seeking an input into the customer scarcity issue and any potential solutions.

3. Part of the wider stakeholder engagement work on the Northern Powergrid business plan, specifically on environmental issues.

An important aspect of developing the community engagement plan for our clusters is to consult relevant stakeholders about how we should go about this. This is already supported by Durham Energy Institute as representing best practice. But if we are to be able to take account of comments in amending the plan and then delivering it in time for the installation of equipment in Aug/Sep, we need to press on.

The Regional Stakeholder Forum also provides Northern Powergrid with a ready-made environmental forum for discussions about its business plan. The timing means that the Regional Stakeholder Forum fits well into the pre-consultation phase of the stakeholder dialogue and will focus on key areas of interest for further discussion.

Item	Presenter
Session 1 – CLNR update	
1. Introduction and project update	Jim Cardwell
2. Feedback from previous forum	Jon Bird
3. Customer scarcity	Jon Bird
Session 2 – Community engagement	
4. Principles of engagement and best practice	Gareth Powells
5. Clusters and community engagement plan	Jon Bird
6. Open discussion on plan	
7. Table discussion on particular items	
8. Feedback	
Session 3 – Northern Powergrid Business Plan	
9. Stakeholder engagement process	Siobhan Barton
10. What are our environmental issues?	Jon Bird
11. Open discussion about priorities	
12. Table discussion about possible improvements	
13. Feedback	
14. Next steps and conclusion	Jim Cardwell

Invitees

Northumberland National Park
Newcastle University
Evive Intelligent Transport Systems
CO2 Sense
NEA
North East Renewables Association
Sunderland City Council
NAREC
Stockton Borough Council
One North East
Energy Saving Trust
Community Renewable Energy (CORE)
Community Foundation
NEA
Durham Energy Institute
Teesside University
Yorkshire Energy Services
Association of North East Councils
Community Energy Solutions
Gentoo Homes
NECC
CBI
Northumbria University
Newcastle University
Northumberland County Council
Durham County Council

Appendix 2 – Industry stakeholder forum

Northern Powergrid held a workshop on smart customer response on 9 May 2012, entitled:

Smart customer response: the journey so far

Since the workshop held a year previous, understanding of the issues involved in customer response has been considerably developed by work in a number of areas. The projects that gained support in the first round of the Low Carbon Network Fund (LCNF), including Northern Powergrid's Customer-Led Network Revolution (CLNR), are now well into their second year. Sustainability First's Smart Demand Forum project, the first year of which is funded by Northern Powergrid's CLNR, has produced and published important research on the scope for customer response. And a joint project between the Energy Network Association and the Energy Retail Association, led by Engage Consulting, has been developing possible commercial frameworks for customer response. The purpose of this workshop was to:

- Provide a review of progress on the CLNR project, concentrating particularly on issues relating to engagement with customers;
- Provide an update from Sustainability First and Engage Consulting on their work;
- Provided an opportunity for all attendees to discuss the implications of this work for smart grid development and policy formation.

Invitees

Northern Powergrid
Sustainability First
British Gas
Durham Energy Institute
Frontier Economics
Engage Consulting
Scottish & Southern Energy
Scottish Power
UK Power Networks
EdF
E.ON
Electricity Northwest
Western Power Distribution
National Grid
Npower
University of Oxford
Elexon
NEA
Consumer Focus
Which?
DECC
Ofgem
Data aggregator
Policy Studies Institute
BEAMA
Intellect
CBI
Siemens

Appendix 3 – Foreground intellectual property generated during the period

The following table contains a list of the materials containing foreground IP which we consider to be relevant foreground IP.

Product containing relevant foreground IP	LO	Primary creator
Test cell recruitment learning	LO1/2	BG & Optimisa
Customer communication materials/T&C's	LO1/2	BG
Test cell specifications - These detail the equipment to be installed, customer prerequisites, process summary and any tariff details for each customer test cell on CLNR. Documents as follows : • Test Cell 2a - Disaggregated Monitoring System Details V0_1.doc • Test Cell 3 - Heat Pump Monitoring System Details V0_1.doc • Test Cell 5 - Solar PV Monitoring System Details V0_3.doc • Test Cell 6 - Electric vehicle Monitoring System Details V0_1.doc • Test Cell 10a - Restricted Hours Hot Water System Details V0_1.doc • Test Cell 10b - SME Restricted Hours System Details V0_1.doc • Test Cell 11a - Direct Control Hot Water System Details V0_1.doc • Test Cell 13 - Restricted Hours Heat Pump System Details V0_1.doc • Test Cell 20a - Solar PV Manual Balancing System Details V0_1.doc • Test Cell 20b - Solar PV Automatic Balancing System Details V0_2.doc • Test Cell 20b - Solar PV Automatic Balancing System Details V0_3.doc	LO1/2	BG
Equipment Specifications - These detail the end-to-end solutions required from suppliers to the individual trials on CLNR. These have been developed to adapt the available solutions to the specific trials : • CLNR White Goods Gateway and Server Implementation Proposal.docx • CLNR White Goods Requirements Summary.DOC • LCNF Heat Pump Control Requirements V0_2.doc • Hot Water Demand Response LCNF - Key Requirements.DOC • CLNR EV Charger Requirements Summary.DOC • LCNF SME Requirements draft 0_1.doc	LO1/2	BG
CDCM Interim Report - Initial findings of the effectiveness of the April 2010 tariff reform in shifting I&C demand to off-peak	LO1	DEI
TN Notes on ACE49 Planning Standard - Assessment of the unknowns inherent in the analysis method presented in ACE49, and the effect this will have when reproducing equivalent load profiles in CLNR	LO1	DEI
Generation Profiles Analysis - Examination of a limited set of commercial generators, to understand the nature of the data and to determine if "generic generation profiles" might exist.	LO1	DEI
Smart Meter Data Analysis - First set of TC1 customer load profiles, for a limited subset of TC1 customers.	LO1	DEI
Qualitative Design Rationale - Summary of the techniques used to conduct the qualitative work	LO1&2	DEI
CLNR Survey Design - Description of the development of the CLNR surveys, including review of surveys from other smart trials.	LO2	DEI

Product containing relevant foreground IP	LO	Primary creator
Researching Practices: Customer-Led Network Revolution Social Science Methodology Document - A review of practice theory and its applicability to CLNR as a tool to support explanations of electricity customer flexibility	LO2	DEI
HV-OHL-RTTR sites Denwick Initial findings	LO3	DEI
HV-OHL-RTTR sites Denwick initial findings	LO3	DEI
IGST Berlin 2012 Abstract - Application of VEEEG (Validation, extensions, extrapolation, enhancement and generalisation) to investigate the effect of increasing PV penetration and mitigation of effect with energy storage	LO3	DEI
HV-OHL-RTTR Sites Denwick Initial Findings - Site verification and understanding the nature of the measured data and the HV trial sites.	LO3	DEI
Field Trial Design Matrix - Understanding, design and realisation of LO3 field trials	LO3	DEI
Post Trial Diagram Chart VEEEG - Development of the field trial analysis methodology.	LO4	DEI
Demand Side Response for Distribution Network Voltage Control Assisted with Energy Storage - Application of VEEEG to investigation of effect of increasing PV penetration and mitigation of effect with energy storage	LO4	DEI
Experiencing the Smart Grid in 3D AAG 2012 - Study of smart grids from social, technical and economic perspectives		DEI
GUS (Grand Unified Scheme) Purchase Specification - A technical specification to accompany invitation to tender documentation to potential suppliers of the proposed low carbon network control system.	LO3	EATL
Data Warehouse Purchase Specification - A technical specification to accompany invitation to tender documentation to potential suppliers of a Data warehouse to securely store and enable later analysis of the project network data	LO3	EATL
Technical Paper for CIRED Workshop 2012 - Demonstrating enhanced automatic voltage control in today's low carbon networks.	LO3	EATL
Technical Paper for CIRED Workshop 2012 – Integrating renewable energy in to LV networks using energy storage.	LO3	DEI
Integration Plans and Checklists for EAVC RTTR and EES - A set of three spreadsheets to plan and monitor action to be undertaken to integrate technologies onto the network.	LO3	EATL
Monitoring Evaluation Platform - A single document recording the user requirements for access to and supplier-independent management of network monitoring systems used on the project in the form of a functional specification.	LO3	EATL
Network Models – Various models of the networks under study and the technologies to be connected (PSCAD, WinDebut, DINIS, IPSA2) have been developed and validated.	LO3	DEI
RTTR videos	LO3	Northern Powergrid
I&C Demand Side Response contract	LO2	Northern Powergrid
Report on Domestic & SME Tariff Development for the Customer-Led Network Revolution	LO2	Northern Powergrid