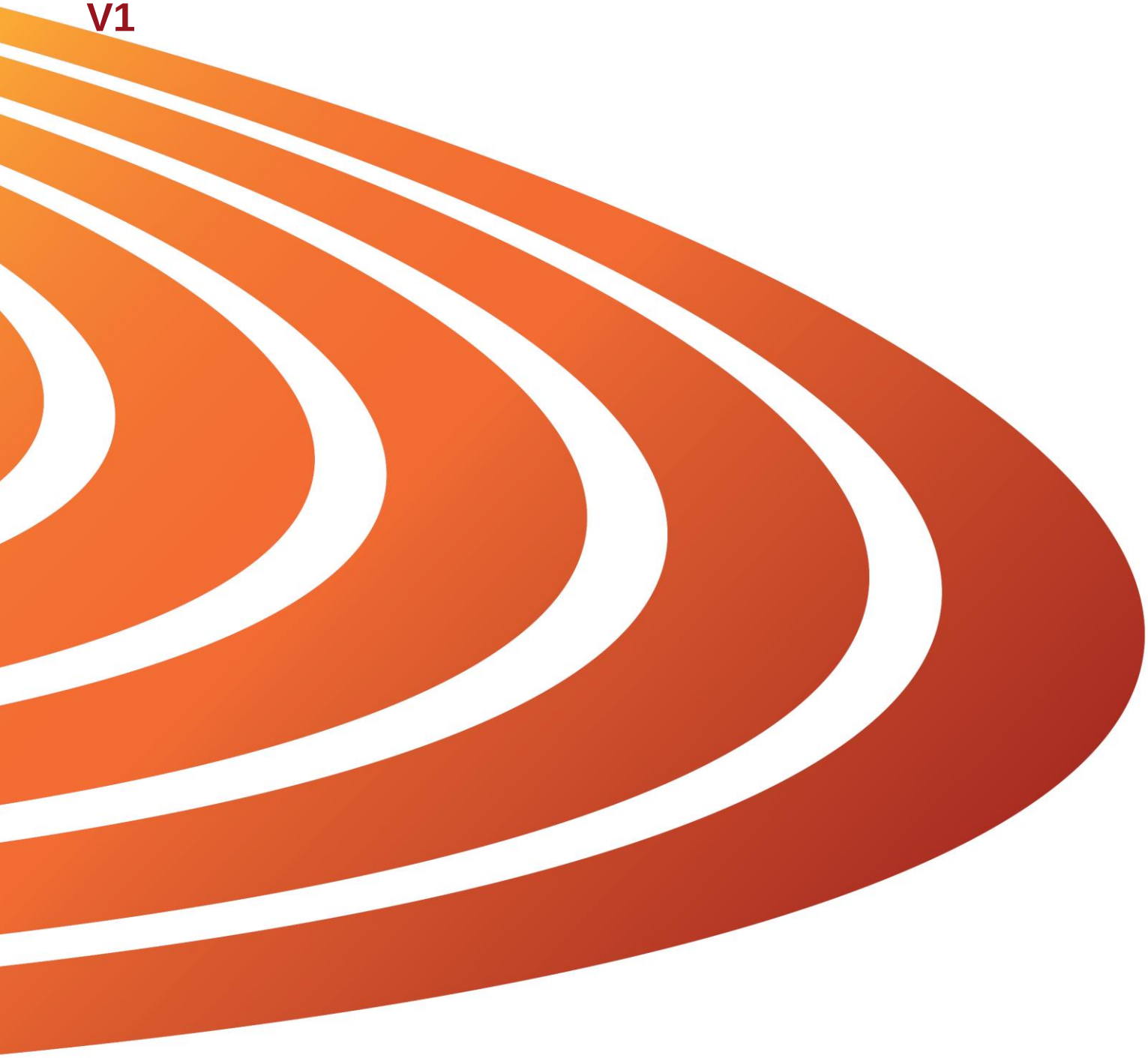
LCNF Successful Delivery Reward Application

Low Carbon London
V1



UK Power Networks
Delivering your electricity

Project Accreditations

Contents

1. Executive Summary

The Low Carbon London (LCL) project has delivered a scope of work originally estimated as £28.3m for a total cost to customers of only £14.9m, far exceeding Ofgem's expectations for cost-sharing and burden-sharing between partners, the DNO, and customers. The project has met all of its Successful Delivery Reward Criteria, including those re-baselined through the change request process. The change request itself (LCL CR01) was identified early, attracted Director-level involvement within UK Power Networks from the outset, and was weighted towards a time extension, with an increased financial contribution from UK Power Networks, and changes in approach rather than any changes to learning.

The project has published an accessible and comprehensive suite of 27 reports accompanied by the underlying datasets, allowing other DNOs and industry stakeholders to adopt the work, investigate further, and challenge ourselves on future adoption. The project led directly to the reduction of our capital investment plans by £43m when preparing our RIIO-ED1 submission to Ofgem, representing a net payback within the RIIO-ED1 period of over 2.5 times, before any other DNOs adopt the results. As such, UK Power Networks is seeking the full 100% reward against the Successful Delivery Reward mechanism for LCL.

In summary, the project had three sequential SDRCs (1, 2, and 3) which measured progress during the build phase. By the completion of the build phase in December 2012, an Operational Data Store (ODS) or database had been established which communicated with a Smart Meter head-end, and was receiving half-hourly reports from more than 5,500 Smart Meters installed in residential premises (*C5, 2014, p. 13*)]. A separate Participant Management System (PMS) had been established to record demographic and survey data about trial participants, and to meet our obligations under data privacy legislation. In parallel, the connectivity, layout, and electrical characteristics of three representative zones or our low voltage network had been converted into a single electronic record from a number of disparate databases and/or map images (*CGI Data Quality Report, 2012*). Finally, a carbon footprint calculation tool had been sourced and tested. This represented all the tools which would subsequently be used to measure energy use and analyse the impact of the trials of interventions in the form of commercial and residential demand response.

Once the build phase was complete, six subsequent SDRCs (4 through 9), scheduled in the Closedown report (*Close Down, 2015, pp. 71-Appendix 79*), tracked the progress of the project in running trials and producing learning output reports.

The final SDRC (number 10) summarised these findings and extrapolated their impact on the processes used now, and in the future, by DNOs.

We believe that LCL has been marked out by the level of preciseness which it has contributed to the industry debate in the process of meeting its SDRCs. Two concrete examples are the manner in which LCL not only reported the remand reduction achieved by residential customers, but the transaction costs in today's environment of recruiting and maintaining their involvement (*A1, 2014, pp. 38 - Table 36*); and carrying out the largest household energy use and appliance survey for over 30 years but also publishing its statistical confidence intervals (*C2, 2014, pp. 19 - Figure 15*). We provide further examples in the body of this report.

The project achieved these outcomes by consistent senior commitment from Chief Executive Officer downwards; by deploying individuals with significant track records of programme delivery or experience in the industry. The right skills and experience were deployed at the right time, culminating in a final year team boasting extensive out-of-sector experience, one PhD, and four Masters.

2. Timeliness and Quality for Successful Delivery Reward Criteria

2.1 Timeliness – Overall approach

The LCL project, in accordance with its project direction, met the ten defined successful deliver reward criteria (SDRCs). All SDRCs were delivered on time, defined either in the original project direction (issued December 2010 or in the amended project direct issued following formal acceptance of the change request issued 21 December 2012.

For each SDRC, UK Power Networks provided either evidence or an output report marking its completion on or before the completion date stated in the project direction. The reports were submitted via e-mail to the Ofgem project officer and were uploaded to the project website.

SDRCs 1, 2, and 3 were delivered early in the project lifecycle and were based around preparation for trials, surveys and building of systems. These were delivered in the first two years of the project and were evidenced by way of six-monthly reports and direct evidence packs to the project officer.

The remaining seven SDRCs are evidenced by the production and submission of project output reports as detailed in the SDRC schedule summarised in the project direction.

2.2 Timeliness – Delivery against SDRC completion dates during the build phase

Appendix 9 of the close-down report (*Close Down, 2015, p. 86ff*) sets out the evidence of delivery for each SDRC 1, 2 and 3. The Appendix to this document contains a sample of the evidence listed in that table, demonstrating both early delivery of elements and the variety of evidence that each SDRC met the stated date. The types of evidence that was sought internally within UK Power Networks to validate progress against these milestones included:

- Completed consultant reports, such as the completion of the data privacy impact assessment carried out by CGI;
- Demonstration of stable releases of IT systems, such as release notes for the first drop of the CGI Smart Meter head end;
- Design documents with evidence of their ratification by the project's Design Authority; and
- Signed contracts, for example with Demand Response providers.

Early in the project, it was identified that a small number of external factors would have an impact on the LCL project's ability to deliver learnings if decisive action was not taken. A key early factor was the delay in finalising the national (DECC) Smart Metering Equipment Technical Specifications (SMETS). This had a material impact on being able to maintain the timelines for delivery of both the 500 pilot smart meter installations and potentially the later full trial roll-out of the meters. This was first identified as a risk early in the project and reported in the (*PPR June 2011, 2011, pp. 3,4,11,12*). During the second half of 2011 an important decision was taken following the DECC announcement that the SMETS specification, and therefore compliant meters, would not be available to late 2012. Early mitigation actions had identified the a L&G 5236 meter had been tested and approved by both relevant partner organisations, EDF Energy and CGI (then Logica), and could be deployed in place of the third generation meter (SMETS compliant). This was deemed to de-risk the project and was progressed with in October 2011, first addressing the engagement and enrolment of the first 500 smart meter trial customers via a comprehensive campaign, which had been readied and prepared in advance, was implemented immediately, encompassing targeted telephone recruitment, day and evening Low Carbon Zone local community drop-in centres supported by internet and postal campaigns. This pre-planning laid the way for the remainder of the main trial recruitment to be completed during the first half of 2012.

Key system milestones also formed part of the early SDRCs including SDRCs 2 and 3 being centred around the delivery of the first stage of solution implementation with testing of ODS release 1 completed in May 2012 ahead of the

Q2 deadline (*PPR June 2012, 2012, p. 26*) despite the early and detrimental impact of the delays to the SMETS-1 smart meter putting pressure on the integration of the data integration to the system.

The overall timeliness of the build phase is best judged from (*C5, 2014, pp. 13 - Figure 15*)and from (*DSR Break-out 2013, p. slide 7*). These are reproduced on the following page for ease of reference.

The first chart was plotted by extracting data from the ODS, and demonstrates the end-to-end flow of data from individual Smart Meters via GPRS through the head-end system and subsequently into the ODS with a corresponding customer record in the PMS. The chart (Figure 1 ***Smart meter volumes and total power***) shows the bulk of the recruitment and data beginning to flow during Q2 2012, well ahead of the Q4 2012 deadline for SDRC 3 marking the end of the build phase. In (*C5, 2014, pp. 19-20*) Imperial College assure the quality of the data within the sample shown here.

Similarly, the second chart shows a review of the Demand Side Response trials carried out during the project. This demonstrates that at the completion of SDRC 2 in Q2 2012 (referred in ***Figure 2*** as "Summer 2012") the industrial and commercial demand side response participants had grown to multiple sites delivered through three aggregators. This demonstrates timely progress and which grew further in the subsequent trial seasons (Winter 2012/13, Summer 2013, Winter 2013/14 and, not shown here, Summer 2014).

In parallel, the connectivity, layout, and electrical characteristics of three representative zones on our low voltage network had been converted into a single electronic record from a number of disparate databases and map images. This is best evidenced by (*CGI Data Quality Report, 2012*) dated 20/09/2012 which detailed the process of importing this data, the data quality and the manual interventions needed to fix data issues where the various source databases did not agree.

2.3 Timeliness – Delivery against SDRC completion dates during the trial phase

SDRCs 4 through 7 involved the analysis of the trial data by our academic partner Imperial College. The results were subsequently interpreted in the context of current DNO practice, UK Power Networks' forecasts of low carbon uptake, and, particularly, evaluating cost/benefit of the methods. Each part of each SDRC was met on time – all Imperial College reports were completed by 30 June 2014 and were sent to Ofgem for information in email (*Ofgem Email, 2014*). The subsequent reports (referred to as "DNO learning reports" or "DNO guides" in the licence direction) were issued to Ofgem on 30 September 2014 in web-ready, desk-top published versions. Drawing on these finished reports, detailed results were able to be presented at Ofgem's Smart Grid Forum workstream 6 dissemination sessions in w/c 13 October 2014 and the Low Carbon Network Fund conference in w/c 20 October.

The project structure and associated outputs delivered as final reports were based are the following areas;

Using smart meters and substation sensors to facilitate smart grids – in which the project re-measured baseline household demand, and demonstrated the use of substation sensors combined with State Estimation to increase visibility of the distribution network.

Enabling and integrating Distributed Generation – in which the project demonstrated full end-to-end control of two participating Distributed Generation sites (Islington Borough Council's Bunhill Energy Centre and Transport for London's (TfL) Greenwich Power) demonstrating how generation sets could be operated under DNO control by agreement with the customer.

Enabling the electrification of heat and transport – in which the project concretely quantified the impact on both power quality and measured the impact of heat pumps and electric vehicles.

Residential and SME Demand side response – in which the project demonstrated the GB's first dynamic time-of-use tariff. The most responsive households nearly doubled their electricity consumption during some low price periods and reduced it by 9% during high price periods.

Industrial &Commercial Demand side response – in which the licence direction called for "real examples of DSM [DSR] contracts with I&C customers" and yet the project called 185 events from 37 different customer sites and a total of 254MWh of displaced energy. On only 19 instances was there no noticeable response from the customer and the project quantified and published this reliability in the format required for planning assessments against the planning standard P2/6.

Wind twinning – in which the project demonstrated, to our knowledge, the GB's first time-of-use tariff designed to simulate days of surplus wind generation; demonstrated Industrial & Commercial customers responding to Demand Response event triggered by the ramp-rate of national wind generation seen by the GB system operator (*Wind Twinning Presentation*); and then drew conclusions about the level to which this could serve to optimise national supply and demand.

Finally, SDRC 10 was issued to Ofgem on 31 December 2014 and comprised the overarching summary report and 5 companion reports summarising the findings in particular functional areas. A mapping was provided in the close-down report (*Close Down, 2015, pp. 36 - Table 38*) demonstrating the correspondence of SDRCs 4 through 10 to the structure of the final reports and should be of benefit to Ofgem in matching previous internal reviews of the reports themselves by colleagues in Ofgem with the corresponding SDRC being considered in this application.

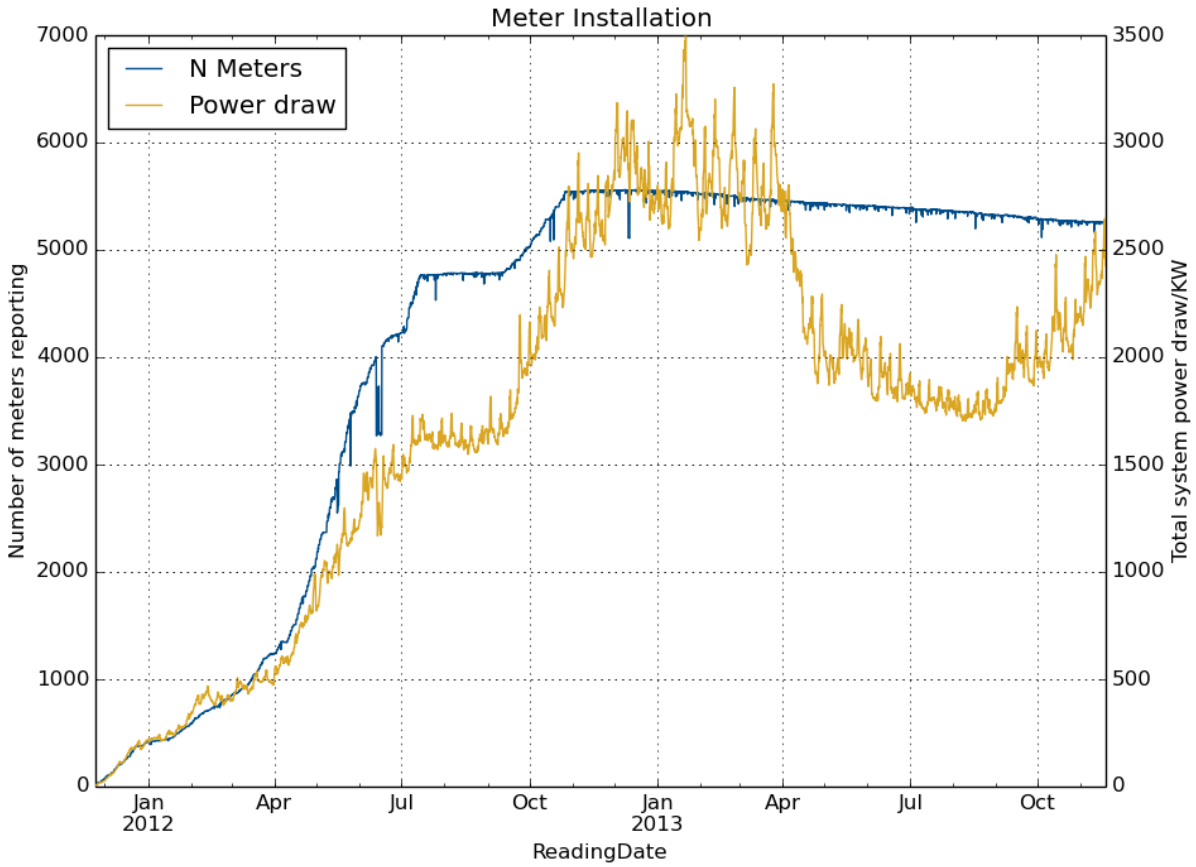


Figure 1 Smart meter volumes and total power

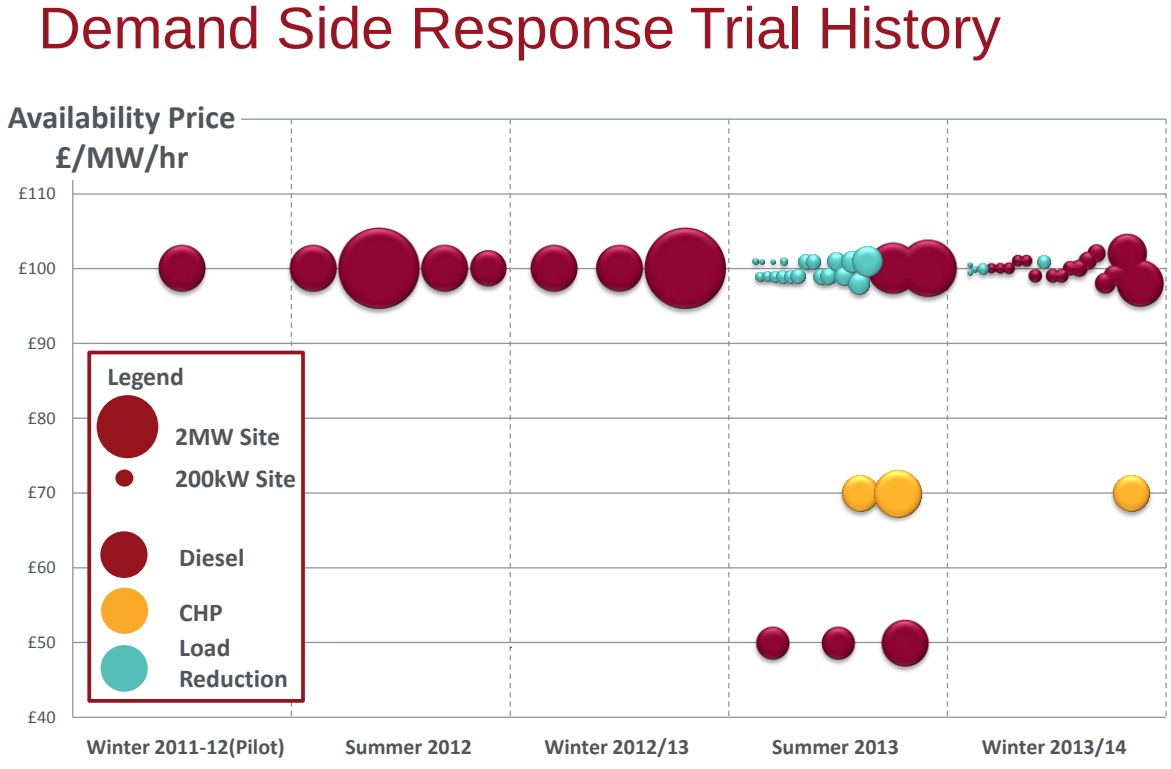


Figure 2 Demand Side response trial history

2.4 Quality of delivery – overview

LCL not only met the terms of its SDRCs but, in our view, delivered to an extremely high quality by:

- Reporting findings to a high level of precision
- Ensuring statistical robustness and relevance of the findings
- Deploying the largest variety of commercial arrangements seen to date within GB Smart Grid trials
- Quantifying, for the first time, the carbon saved from using Smart Grids as opposed to passive grids
- Disseminating in appropriate ways
- Treating customers well throughout their journey with the trials

Furthermore, LCL was shortlisted for the following external awards:

- Environment and Energy Awards 2014
- Utility Week Stars Awards (twice)
- Sustainable City Awards 2014

2.5 Reporting findings to a high level of precision

From the outset, LCL was clear that it needed to run trials which revealed new findings about residential and demand-side response, and the impact of Low Carbon Technologies on the network, but also to be precise in its recommendations and findings. We have sought to create clarity about the precise areas in which costs of solutions need to fall, and by how much; or the dates and periods over which new pressures will emerge on the distribution system. This helps all stakeholders, whether DNOs, energy suppliers, other energy market participants or manufacturers to invest their efforts into the right challenges at the right time. We provide the following concrete examples of this:

- In meeting SDRC 7 “Conclusion of Residential and SME Demand Side Management trials”, LCL not only reported the remand reduction achieved by residential customers, but the transaction costs in today’s environment of recruiting and maintaining their involvement (*A1, 2014, pp. 38 - Table 36*). This is vital to understanding the areas in which cost reductions are required to facilitate wide scale adoption.
- In meeting SDRC 6 “Conclusion of Enabling Electrification of Heat and Transport trials” LCL demonstrated proof-of-concept turn-down of electric vehicle charge posts using Active Network Management (ANM) equipment integrated with the charge posts. We took this further to calculate and report the break-even point at which controlled charging of electric vehicles may be beneficial as opposed to a new connection (*B5, 2014, p. 68*), and for the most relevant immediate market of fleet operators.
- In meeting SDRC 8 “Conclusion of I&C Demand Side Management trials” LCL studied potential conflicts and synergies in the use of Demand Side Response by DNOs, the GB System Operator and energy suppliers. We were able to offer concrete forecasts for the number of occasions on which these entities would make demand calls in sympathy with one another or conflicting with one another (*A5, 2014, pp. 2,53*). This located in time, to much higher precision that available previously, when market arrangements may need to be reviewed to avoid conflicts and entities seeking to out-bid one another.
- In meeting SDRC 10 “Conclusion of final analyses” our report on new network operational practises provided recommended configuration settings for the DNOs to use in accessing voltage alerts from Smart Meters (*D1, 2014, pp. 56 - Table 15*). This is immediately applicable to the DNOs as they establish their links to the Data Communications Company (DCC) which consolidates Smart Meter data. It was based on thorough sensitivity analysis of the effect of different settings (*D1, 2014, pp. 52-55*).

2.6 Ensuring statistical robustness and relevance of the findings

LCL demonstrated some exceptional participation rates in its research: 2,830 households provided details of the appliances they have around the house, 708 households took part in a pre-trial survey before converting to the time-of-use tariff and 408 took part in a post-trial paper survey. 37 households took part in face-to-face or telephone interviews regarding their experiences on the time-of-use tariff. 41 households with EVs took part in a detailed survey about the income, car usage and attitudes towards EVs. An attrition rate of less than 8% was achieved amongst the Smart Meter customers who were having their load monitored (*Close Down, 2015, pp. 47-48*). The LCL results can be trusted since they were assured in partnership with our academic partner Imperial College for their statistical validity. We provide the following examples:

- In meeting SDRCs 4 and 7 which relied on residential Smart Meter data, the project worked extremely hard to recruit both trial groups (i.e. active participants) and observation groups (i.e. passive participants) which matched London's overall demographic (*A3 2014, pp. 25 - Figure 23.24)*. Separately, in meeting SDRC 7, Imperial College were extremely careful to factor out any existing propensity to save energy that was represented in the trial group (*A3 2014, pp. 37-43*).
- In meeting SDRC 6 which measured Electric Vehicle charging profiles, the results showed agreement out to two standard deviations and/or the 95th percentile, with variations only emerging at the third standard deviation and/or 99th percentile (*B1, 2014, pp. 22 - Figure 11*). This is a strong indicator of a robust population of trial data.
- In meeting SDRC 7, LCL carried out the largest household energy use and appliance survey for over 30 years. This was also published with statistical confidence intervals (*C2, 2014, pp. 19 - Figure 15*). This is vital for other researchers and policymakers seeking to use this for follow-on research, and gives confidence in the over-arching findings about energy efficiency reported in (*C3, 2014*).

2.7 Largest variety of commercial arrangements seen to date

In future DNOs are likely to play a far more active role in managing load and generation on the network than is currently the case today, and will need to have a wider range of commercial relationships with other partners both within and outside the traditional energy chain. The LCL project has demonstrated these new organisational relationships, and demonstrated that these can be achieved within the current industry structure. Specifically, LCL has demonstrated commercial relationships with four energy aggregators and bilateral arrangements with 37 demand response sites; control room integration with two demand response sites (*Close Down, 2015, pp. 66 & 67 - Appendices 65 & 66*) system integration with a Charging Network Operator (CNO) in order to call off demand response from electric vehicle charge posts but with no perceptible degradation to the EV owner's charging experience; (*B5, 2014, pp. 46-48*); and a shared or multi-purpose Time-of-Use tariff with one of the major energy suppliers (EDF Energy) (*A1, 2014*)].

We believe this is the largest suite of such relationships built at any one time within any Smart Grid programme in the GB to date.

2.8 Quantifying the carbon benefits of Smart Grids

Great Britain will make its greatest gains towards its low carbon targets by reducing the carbon emissions in the generation fleet, continuing to make savings through energy efficiency and shifting more of our fossil-fuel based transport and heating loads to electricity.

However, these can still be supported with either "passive" (or conventional) distribution networks, or with Smart Grids. LCL has demonstrated an additional improvement that can be made by supporting these changes in a 'smart' or optimised way as opposed to necessarily building new network to support the new, unmanaged, load and generation (*D6, 2014, pp. 22 - Figure 14*). The results are significant: carbon emissions from today's electricity system are around

450g/kWh and the Government is seeking ways in which to reduce this by between 100-200g/kWh by 2030. If only one of the initiatives demonstrated in LCL was fully adopted across the country, an additional contribution of 5g/kWh towards this reduction would be achieved, with the potential for far more. This could only be otherwise achieved by replacing a further 700MW of conventional generation with low carbon generation.

We believe this is this first time that results identifying the additional impact of "Smart Grids" have been reported. The results are supported by underlying carbon footprint reports (*D6, 2014, pp. 34ff - Annex A*) allowing other researchers to replicate the findings.

2.9 Dissemination to other DNOs and stakeholders

The project team has had meetings with power companies from Canada, China, France, New Zealand, Thailand, Malaysia, Japan and Vietnam. UK Power Networks and Siemens addressed conferences in Asia and Europe to spread the learning from the programme internationally.

Because the project has never developed a piece of new physical network equipment (or something to cut a ribbon on) it has always strived to ensure that its products, i.e. the output reports making up SDRCs 4-10, are of the highest quality and in a format that is adoptable and recognisable to the other network operators and wider supply chain. For example, in output report A4, we have, through careful planning produced 'F-factor' tables in the same format and using the allowed approach as the documents that already support the current Engineering Recommendation P2/6, namely ETR130. The alternative approach would have been to provide pure statistical numbers or results and let other interested parties have to interpret or return to ask multiple questions on how these could be applied. This has been presented by EA Technology, who worked on this particular area of research, in a CIRED paper which has been accepted to be presented in 2015.

The programme has also provided a comprehensive tool to review opportunities for Industrial and Commercial DSR programmes. This has been shared with the DNO community to support their adoption of DSR. Critically for this tool we have again, through careful planning, ensure that the tool automatically populates the approved Ofgem Cost Benefit Analysis calculator issued as part of the guidance for RIIO-ED1 submissions so DNOs can quickly check the effects/benefits of running a DSR scheme in a common and well understood format.

In other areas, despite the significantly lower growth in Low Carbon Technology's (LCTs) such as Electric vehicles (EVs) and Heat Pumps (HPs), the project has delivered significant findings in easily understood and adoptable formats. For example, diversified maximum demand of electric vehicles has been presented not only as a set of results but as a helpful diversity curve which can be adopted and read by network planners in the future in the same way diversity curves are used currently.

A fuller overview of our dissemination activities can be found in (*Close Down, 2015, p. Section 12*). The project held a series of roadshows with other DNOs in late 2014, to facilitate detailed learning dissemination of the project's trial findings and outcomes. The project designed a series of bespoke sessions, local to each DNO, to enable an opportunity for detailed discussion on the project's trials, findings and outcomes. Each DNO was contacted in advance to discuss any requirements to cover particular aspects or topics within LCL. On the day, a series of presentations about the project gave each DNO a good opportunity to discuss in detail and question any aspect of the project within their own surroundings.

The roadshow structure comprised a series of presentations by LCL, covering all the project's trials, results, findings and outcomes. The format was deliberately informal with questions and challenges to the project encouraged from local DNO personnel throughout the day. The format was designed to give attendees a good in-depth insight into the project's work and findings in an open and candid style with the latter part of the day focusing on how the findings could apply or be applied to the local DNO.

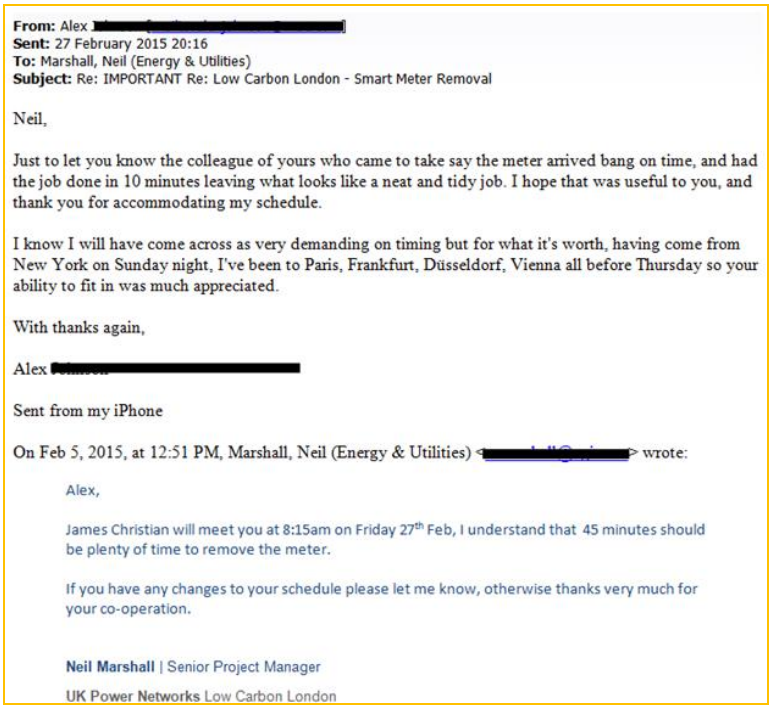
The DNOs were asked to rate the usefulness of individual roadshow components as well as the overall value; the average overall rating was 4.15 out of 5 with no DNO rating lower than 4 out of 5. A consistent aspect of feedback was that all DNOs felt that the ability to use LCL's findings within their own organisation as challenging, with that consideration being rated lowest in three out of four DNO roadshows. Fuller details of the feedback from each DNO roadshow can be found in (*Close Down, 2015, pp. 56-57*).

A further event, subsequent to issuing the closedown report, took place on 21 April 2015 at Imperial College with colleagues from UK Power Networks and two of the other DNOs. This provided an opportunity for a smaller group to interact with the results particularly related to current and future residential demand, and the tools which had been used to derive the results (specifically Imperial's learning laboratory infrastructure and CGI's network planning and data import tools).

2.10 Treating customers well

The vast majority of residential customers taking part in our Time-of-Use tariff trials (79%) did not find them complex and indeed a majority (71%) said that it gave them a greater sense of control. Alongside efforts to simplify tariff structures, and the number of available tariffs, 91% wanted to see it continued and offered to everyone. (*A2, 2014*).

Whilst some equipment remains installed on the distribution network, namely the secondary substation monitoring, the majority of equipment required removal. This was of increased importance with respect to equipment installed on customer properties. Smart meters that were installed to monitor heat pumps and electric vehicles began removal following the completion of the trial in mid-2014. Care was taken to manage the customer relationship and involved working around customer schedules where necessary. Below (***Figure 3 - Decommissioning email***) is an example of emails correspondence thanking the project team for their interaction.



From: Alex [redacted]
Sent: 27 February 2015 20:16
To: Marshall, Neil (Energy & Utilities)
Subject: Re: IMPORTANT Re: Low Carbon London - Smart Meter Removal

Neil,

Just to let you know the colleague of yours who came to take say the meter arrived bang on time, and had the job done in 10 minutes leaving what looks like a neat and tidy job. I hope that was useful to you, and thank you for accommodating my schedule.

I know I will have come across as very demanding on timing but for what it's worth, having come from New York on Sunday night, I've been to Paris, Frankfurt, Düsseldorf, Vienna all before Thursday so your ability to fit in was much appreciated.

With thanks again,

Alex [redacted]

Sent from my iPhone

On Feb 5, 2015, at 12:51 PM, Marshall, Neil (Energy & Utilities) <[redacted]> wrote:

> Alex,
>
> James Christian will meet you at 8:15am on Friday 27th Feb, I understand that 45 minutes should be plenty of time to remove the meter.
>
> If you have any changes to your schedule please let me know, otherwise thanks very much for your co-operation.
>
> **Neil Marshall** | Senior Project Manager
> UK Power Networks Low Carbon London

Figure 3 - Decommissioning email

3. Cost-effectiveness

The project's closedown report (*Close Down, 2015, pp. 4 & 40-41*) demonstrated that the project completed with a net cost to customers of £14.9m whilst delivering a scope of work originally estimated at £28.3m.

This section provides evidence for the way in which the project managed its cost by cost type (equipment, labour, etc); by partner organisation or supplier; and the way in which it managed contingency. It demonstrates that savings were found across many spend categories, were offered and achieved by many different project partners, and that contingency funds were well managed. Finally it concludes with a note with regards to the income generated.

The single largest contributor to savings within the project was the change of approach taken to Industrial and Commercial DSR. The project originally envisaged paying aggregators for their effort in searching for and striking DSR contracts; in practice, this element of "paid search" was removed and instead all of the commercial partners provided their effort in designing contract structures with the DNO in-kind, and then were paid on delivery of DSR events. Whilst each DNO may approach this differently, and an element of paid search is not firmly ruled out, this is a much more sustainable model going forward than was originally envisaged and therefore a vital contribution from the project. This saving, combined with progressively better pricing achieved throughout the successive DSR trials, amounted to £877k.

3.1 Cost effectiveness by cost type

The close-down report (*Close Down, 2015, p. 42*) set out the expenditure against budget in each sub-category which underlies the high-level and line-by-line expenditure categories in the project direction. This is shown in Table 1 below and includes descriptions of spending variances on the following pages. This detail was initially submitted to Ofgem in mid-December (*PPR Dec 2014, 2014, p. Confidential Annex*), and we have updated this below to reflect the movements in the final accounting period since we submitted that report.

The project worked proactively throughout to manage all costs. As a result, the project as a whole completing all its SDRC and objectives with a summary outturn underspend of £4,837K.

Box 6 (Employment costs)
In total, employment costs are £115k under spent.

There are variances on the individual employment cost lines due to a different mix of costs than assumed in the budget. In order for the project to be staffed with the correct skills at the right time, a number of partner resources were employed for their specialist expertise in a limited number of key roles to prevent the project being delayed and for short term deployments to optimise resource.

Box 7 (Equipment costs)
In total, equipment costs are £1,886k under spent. Principal variances are:

40 aggregator equipment/devices (£631k under spend/reallocated)
The original equipment allowance as budgeted was not needed for DSR trials, as equipment cost was recovered through aggregator margin and renegotiation. A small additional allowance was required for interfaces to ANM trial customers for integration with customer's equipment, for which there was no original consideration and allowed budget.

Plugged in Places contribution (£303k under spend/reallocated)
This was an aggregated equipment and tools spend allowance – i.e. more than just EV metering and EV charge-post spend. The spending on the EV lease scheme roll-out cost was lower than expected due to efficiencies identified during the process.

Substation works (260k under spend)
The spending was completed by May 2013. Further close down costs are expected here due to decommissioning costs which were originally captured under the Contingency heading.

Box 9 (Customer and user payments)
Aggregator payments to I&C customers (£877k under spend/reallocated)
Various efficiencies were identified in the process which led to savings. Part of the Customer Payments budget was utilised for incentive payments to customers in the Smart Metering and EV trials. The project took the opportunity to run a winter 2013 DSR trial to enhance results.

Box 10 (Other costs)
IT costs – operational data store (£192k over spend)
The variance was caused by changes to original specification not originally foreseen (e.g. additional interfaces).

IT costs – SGS support & software licence (£303k under spend)
The variance was due to changes in the Programme plan.

IT costs – Aggregator IT costs (£156k under spend)
This is linked to the Aggregator spend – see Box 7.

IT costs – comms, infrastructure, environment and interfaces (£71k under spend)
Total costs were lower than originally budgeted due to efficiency savings with the partners.

IT costs – CGI head end (£81k under spend)
Total costs were lower than originally budgeted due to efficiency savings with the partners.

Contingency (£2,001k not allocated or provisioned)
Spend on unbudgeted items to date is provisioned from the 'contingency' allowance, which remains unchanged as a result of the formal change request approved by Ofgem in December 2012. The budget assumed greater use of the contingency allowance at this stage of the project than has actually occurred. The spend to date includes: British Gas joining costs (principally a reimbursement of the costs of a project manager who is managing the British Gas LCL involvement as an energy supplier and provider of data in respect of trial participant customers and smart meter readings)); feedback to customers on metering trial; and Heat Pump trials. There will be close down costs for decommissioning and preparation of the Close Down Report which will be provided for in December 2014.

Abnormal travel expenses (£21k over spend)
Travel expenses were higher than budget due to a greater involvement of project partner Smarter Grid Solutions (SGS) and the increased costs of travelling to Glasgow to meet with them. The cost of this was offset by anticipated lower SGS software licence fees.

Public engagement/learning dissemination (£7k under spend)
This was due to lower relevant equipment and materials spend.

Inflation (£747k under spend)
Due to the nature of the contracts, no additional costs were required by the partners.

Partner/collaborator labour costs (£229k over spend)
Spending increased due to the external resources assisting in DNO report writing under this category.

Other solution/implementation costs (£42k under spend)

As expected, costs were lower than the allowance overall.

Programme management other (£306k under spend)
Accommodation costs were lower than expected overall. Higher communications costs have been incurred as the original budget was not sufficient to promote and support recruitment/learning dissemination/communications on the programme. This over spend was managed by lower costs elsewhere, such that the project as a whole was not over budget.

£k	Total Project Budget	<- Spend to March 2015 -> Actuals	Variance	%
Box 6 (Employment costs)				
Programme Director	512	335	(177)	-35%
PMO	310	315	5	1%
Communications & Commercial Managers	468	309	(159)	-34%
Administrative Support	154	75	(79)	-51%
Technical Lead	630	397	(233)	-37%
Network Operations Staff	2,520	3,048	528	21%
	4,594	**4,479**	**(115)**	-2%
Box 7 (Equipment costs)				
5 ANM schemes	736	736	0	0%
40 aggregator equipment/devices	650	19	(631)	-97%
Smart Metering	693	-	(693)	
Plugged in Places contribution	1,125	822	(303)	-27%
Substation works	1,186	926	(260)	-22%
	4,390	**2,504**	**(1,886)**	-43%
Box 8 (Contractor costs)	-	-	-	
Box 9 (Customer and user payments)				
Aggregator payments to I&C customers	**2,440**	**1,563**	**(877)**	-36%
Box 10 (Other costs)				
IT costs – operational data store	2,001	2,193	192	10%
IT costs – Carbon Tool licensing	110	110	-	0%
IT costs – SGS support & software licence	465	163	(303)	-65%
IT costs – Aggregator IT costs	163	8	(156)	-95%
IT costs – comms, infrastructure, environment and interfaces	640	569	(71)	-11%
IT costs – CGI head end	394	314	(81)	-20%
Contingency	2,997	1,669	(1,328)	-44%
Travel and expenses	20	41	21	107%
Public engagement/learning dissemination	1,728	1,721	(7)	0%
Inflation	747	-	(747)	-100%
Partner/Collaborator labour costs	6,336	6,565	229	4%
Other solution/implementation costs	380	338	(42)	-11%
Programme Management Other		-	-	
Accommodation	750	444	(306)	-41%
Training	-	-	-	
Communication	150	256	106	71%
	16,881	**14,391**	**(2,490)**	-15%
Total	**28,305**	**22,937**	**(5,368)**	-19%
Allowance for change in interest calculation	(531)			
Total	**27,774**	**22,937**	**(4,837)**	-17%

Table 1 – LCL Financial Summary

3.2 Cost effectiveness by partner

Partner costs were scrutinised by Ofgem's consultants TNEI and the Expert Panel in 2009 (*Submission Review, 2010*). Once awarded, UK Power Networks let contracts to a total value of £17,237k including contingency as set out in the table below (***Table 2*** under the heading "Value of partner agreements"):

		Logica/CGI	Siemens	Imperial College	SGS	Institute for Sustainability	EDF	Flexitricity
	Value of partner agreements	***4,261***	***2,689***	***1,728***	***2,853***	***350***	***250***	***4,054***
	Value of partner agreements - contingency	***852***		***200***				
Box totals								
6	Employment costs	400	340	-	134	-	-	-
7	Equipment costs	51	-	-	736	-	-	-
9	Customer and user payments	-	-	-	-	-	224	694
10	Other costs	3,233	2,684	1,754	1,595	350	-	-
		3,684	**3,024**	**1,754**	**2,465**	**350**	**224**	**694**

Table 2 – Value of partner agreements

The partners worked collaboratively with UK Power Networks to manage costs. The actuals reported in the close-down report are also split by partners in the table above (under the heading "Box totals").

The CGI (previously known as Logica) contract saved £577k, coming in at £3,684k against a provision in contract of £4,261k. The SGS contract saved £388k, coming in at £2,465k against a provision in contract of £2,853k. The EDF Energy contract saved £26k, coming in at £224k against a provision in contract of £250k.

The Institute for Sustainability, and Imperial College, both of whose costs were largely staff costs and who as charitable and academic organisations have less flexibility around labour, largely matched their original contract amounts.

We trust that this level of detail provides confidence to Ofgem that the under-run was the result of collaboration by all parties involved in the project, with no single partner or any single tranche of work delivering the under-run on its own.

As noted in the previous section, whilst the project was funded at a level which expected meeting the cost to partners of inflation on their labour rates and costs, none of the partners exercised this. This represented a tangible additional contribution from the partners.

3.3 Management of contingency

The table below shows an itemised list of items which spent contingency. This demonstrates the change control which was used on the project, since even small items (e.g. £2k) had an accompanying change note and could be itemised. It also demonstrates that, setting aside the asset stranding provision, no single item dominated the project's use of contingency. Each line of contingency allocation underwent significant change control ahead of any spending approval. This process is described in Section 5 of this document.

Box number	Item	Ofgem project direction 21.12.2012	Total	Underspend
10	**Contingency - total**	**2,997**	**996**	**67%**
10	Contingency - stranded meters allowance		1,092	
10	Contingency - other Ofgem funded costs		38	
10	Contingency - smart meters demographic data		3	
10	Contingency - British Gas integration		63	
10	Contingency - BG integration		121	
10	Contingency - Business Depths		8	
10	Contingency - Include clients to Bunhill		19	
10	Contingency - ODS TOU Tariff band loader		2	
10	Contingency - Met Office Weather Services		40	
10	Contingency - EST Heat Pumps		40	
10	Contingency - PassivSystems Heat Pumps		19	
10	Contingency - Norwich Instruments hire		12	
10	Contingency - WS03 Monitoring - Uninstall		32	
10	Contingency - Decommissioning costs		168	
10	Contingency - IT, stationery, audit etc (other expenses)		33	
10	Contingency - allocation to smart metering		- 693	

Figure 4 - Contingency allocation

3.4 Licencing revenue

As we set out in our letter to Ofgem notifying them of earnings by LCL from licencing (*Ofgem Fund Royalties, 2014*), the arrangement was reviewed in detail by auditors acting on behalf of Shell, the licensee. This provides double assurance to Ofgem that the project not only was cost-effective in seeking to earn licence revenue in the first place from the work that had been funded from customers' money, but also that the negotiation itself was executed to a high standard. As set out in the letter, UK Power Networks waived on this occasion any of the income which it may have been entitled to in line with its financial contribution to the project and to recompense effort involved in setting up the licencing agreement.

4. Project Management

As the LCL bid was assembled it was recognised that the project would require a huge investment in a process driven project management approach. The breadth and depth of the project, the significant volume of trials and associated learning points, needed careful design and implementation of design and rigorous management. The project adopted the well-known and established PRINCE2 product-based methodology.

As noted in the executive summary of this document, the project recognised that in some areas it required a skill set that went beyond those traditionally found with in a DNO. This was for the most part; this was addressed through the careful selection of partners of the project at bid stage. Each partner brought a specific skill set which was leveraged to full effect. In particular two key workstreams were established in the embryonic phase of the project. The first is the Project Management office. This workstream sat at the heart of the project ensuring first developing and then applying the governance structure which is key to such a project. The Governance Framework that was developed from the outset reflected the collaborative nature and ethos of the project. Importantly, this enabled all parties and stakeholders to have regular visibility of the project and its progress and, where appropriate, to share in making decisions.

The core of the governance framework was the monthly project steering group meeting (PSG), attended by all the project management team, the project partners and UK Power Networks senior stakeholders. This was the primary operational governance. It represented a more streamlined but inclusive governance framework that better encouraged transparency and partner buy-in to the project. With eleven partners, these meetings were key to sharing the project current position and present the status of trials. These meetings were maintained for the full duration of the four year project and evolved in the latter stages to be the platform for sharing results and findings and also inviting third parties to present into the project with relevant material. From a very early date, the project invited Consumer Focus (now Citizens Advice) to the PSG meetings providing input and opinion and to ensure the project maintained a balanced and fair approach to customers.

The project also established a senior oversight board which met quarterly for the life of the project. Titled Project Partners Strategic Group and chaired by the CEO of UK Power Networks, this group comprised of senior executive representatives from all twelve project organisations. The primary aim of this group was to provide senior-level strategic guidance but also served as a final escalation point for any issues arising.

As would be expected, the project held more frequent meetings and workshops that flexed to suit the period of the project. Throughout the design, implementation and trials phases, the project director held a weekly meeting bringing together all project workstreams. This structured meeting reviewed the weekly workstream reports and was the primary point for reporting, impact assessment and initiating the change control procedure also put in place.

The second key workstream was the establishment of the Solution Design Authority (SDA). The SDA was responsible and owned the progress of learning points, scheduled in the project Use Case Document, through to trial designs that would provide the relevant outcomes and findings to address the original learning objectives. The SDA was the core function in producing the product breakdown structures, product flow diagrams and the associated product descriptions. These documents form the basis for each and every trial and underpinned each trial workstream at more detailed levels of definition and articulation. These SDA products in turn fed into individual project workstream plans and at a higher level, the overall project plan. The overall project plan was continuously maintained to ensure the plan reflects the project in reality and at a day to day

As is expected the project structure flexed to suit the various stages of the project but at its core maintained a workstream structure that reflected the core faculties of the project bid document. As well as breaking the project down into manageable functions, this common workstream structure was important to promote consistency and manage dependencies. The diagram below is an illustration of the project structure highlighting the pivotal position held by the Project Management, PMO and the SDA (sometimes referred to as the Solution Architecture & Design Authority)

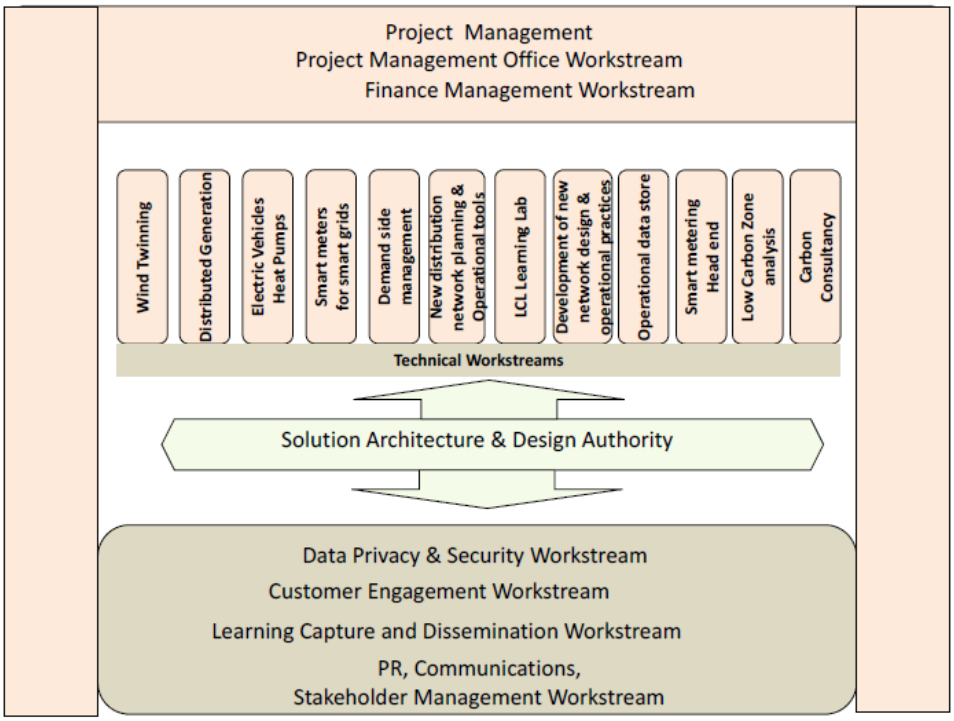


Figure 5 - LCL Simplified Project Structure

The above diagram (Figure 5) describes the 12 technical workstreams that mirror the use cases. The workstreams were clustered into logical groupings led by a project manager. Six further non-technical workstreams were been established for critical dimensions of the project that required a quality and consistent approach throughout the project:

- customer engagement
- data privacy and security
- communications and stakeholder management
- learning capture, analysis and dissemination

The diagram below illustrates the corresponding organisation plan reflecting the above project structure. Where practical, and to suit the resources ability and expertise, certain workstreams may have had a common lead. This served to ensure the project was run most efficiently but also served to manage certain interdependences and also common approaches to network issues. There were also a number of workstreams, by design, led by programme partners who brought their expertise and project contribution.

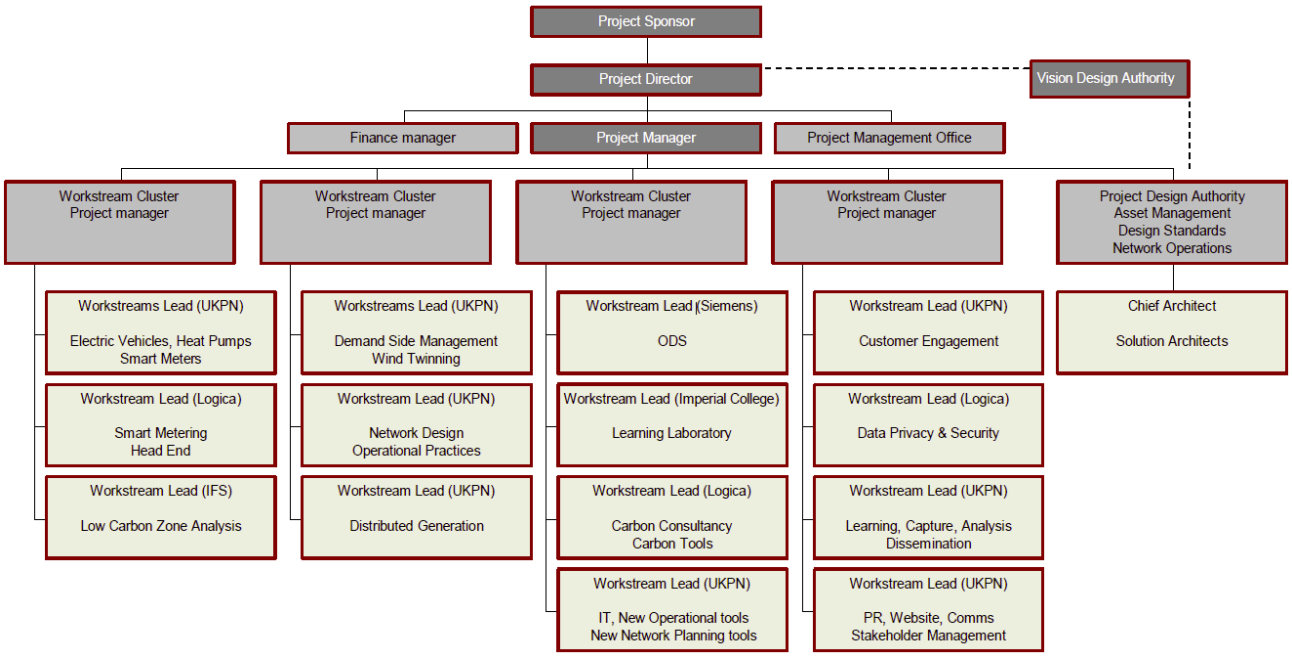


Figure 6 *LCL Core Organisational Structure*

By retaining the core functions and management of the project from start to finish the project has gained the direct experience and knowledge has always been a core philosophy to the UK Power Networks approach. This enables the learnings to be maximised internally and also enhances the ability to share and disseminate this learning across the other DNOs and wider industry rather than relying exclusively on a project partner for instance.

The project also stands up longer term. Project team members, with the expertise gained on the project, have moved into areas of the business specifically to transfer the skills and knowledge. DSR is a prime example. Not only has the findings of the project manifested in significant savings, due to the roll out of DSR, to the recent RIIO-ED1 submission but employees that worked on the LCL project are rolling this out across UK Power Networks as a BaU activity.

As referenced above, the project used the PRINCE2 approach to the project and ensured all key roles were PRINCE2 practitioners. Below is an example of the products and process flows developed and used by the project from initiation to delivery.

Process Name	Identify and Engage with Suitable Customers for Demand Side Response Trials
Process Owner	Trials Manager and/or Demand Side Response workstream lead
Process Objective	To engage, via the Aggregators, with potential Demand Side Response customers suitable to participate in Low Carbon London DSR Trials. This includes installation of appropriate equipment where customers are deemed suitable and technical testing of the customer installations.
Process Frequency and Duration	Ad hoc process

Process Name	Identify and Engage with Suitable Customers for Demand Side Response Trials
Initial Inputs and Sources	Trial Requirements from UK Power Networks (e.g. Stressed Substation Information) and participant requirements as described by Demand Side Response Test Approach Document
End Outputs and Destinations	Either: Customer Rejected OR Customer accepted onto trial and Aggregator notified of acceptance
Process Owner Responsibilities	Review data received from the Aggregator about potentially suitable customers Respond to the Aggregator with acceptance or rejection Once installations have been performed, and Aggregator test certificate provided, co-ordinate UK Power Networks testing effort and provide appropriate updates to the Aggregator
Supporting Team Responsibilities	Engage with potential customers, based on UK Power Networks requirements Manage customer rejections as appropriate Manage customer sign up, including the installation of appropriate equipment Test installation and provide Test Manager with Acceptance Certificate Manage customer confirmation of full enrolment

Table 3 – example of product definition

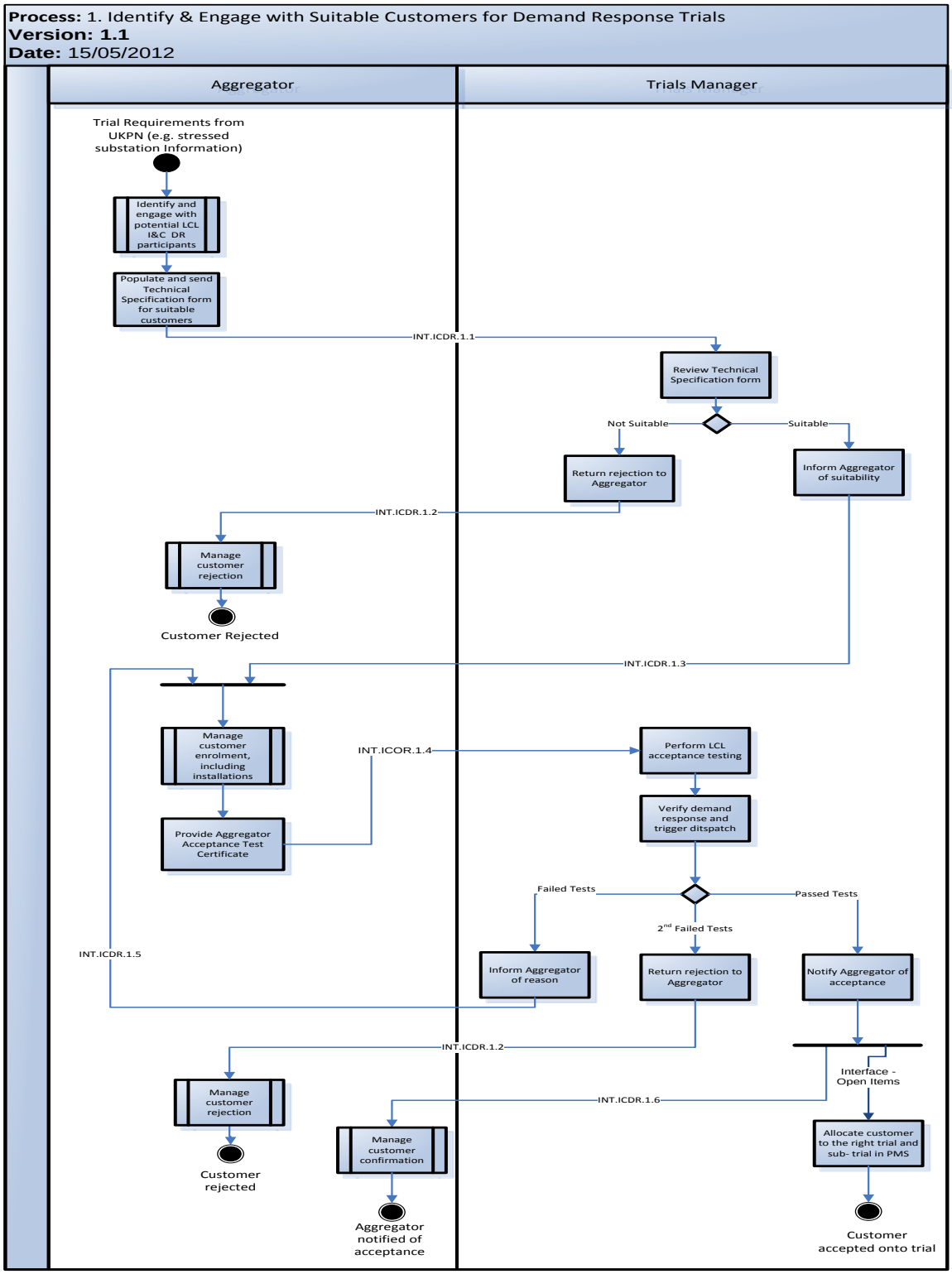


Figure 7 - I&C DSR - Identify and Engage with Suitable Customers for Demand Response Trials

5. Change Management

All major projects and especially those of multi-year duration require a robust process for managing change. From the outset, the project developed and instigated a formal change request process. Any project spend, with the exception of the milestone payments established in the collaboration agreements, went through this process. All changes were submitted by workstream leads following an impact assessment via a formal change control note (CCN). The programme held weekly change management meetings where the change was presented and either approved, requested modification or more detail, or rejected.

The above described process was essential to maintain firm control of the projects budget. This process has benchmarked the change control process at UK Power Networks for projects of this type and has proved hugely valuable in budget efficiency which has contributed to the project underspend.

In addition to the day to day change management of the project, one of the core contributors to the success of LCL is the early identification of risks and bold decisions to mitigate. During its life, the project has met and overcome a number of challenges inherent in such an ambitious, complex and wide-ranging project.

Examples of key risks and mitigations faced by the project:
The significant and creeping delay of the third generation SMETS meter was identified and reported as a risk very early in the project and was described in the first six monthly report (*PPR June 2011, 2011, p. 3*). This had an impact of the timescales that EDF Energy, the supplier programme partner, could not recruit and install the preferred specification smart meter against the original timescales. This was addressed by going outside the original project implementation and making direct contact with smart meter suppliers and seeking alternative routes. The programme was able to flex and establish that the Landis & Gyr meter was the most appropriate and had been tested and approved by both the partners at the centre of the delivery of the Smart Meter and Residential Time of Use (ToU) tariff trials. CGI (then Logica) had already tested this meter type through their head end project, Instant Energy. EDF Energy had deployed this meter on a previous small pilot. This flexible approach ensured that the programme could establish the trials and remain on track. The downside of scaling back on the smart meter specification was that details of voltage were not available via the smart meter. The mitigation for this was established via the Engineering Instrumentation Zones referenced below. In addition to the substation metering already planned, the programme installed smart meters at the end of all available feeders to collect voltage allowing the same learning to be delivered.

The above example is one that was managed by the project, within the available budget. The project also faced a number of material changes which formed the basis for a formal change request. The change request was approved by Ofgem in December 2012 to mitigate three specific material changes in circumstances outside of the project's control. These related to:

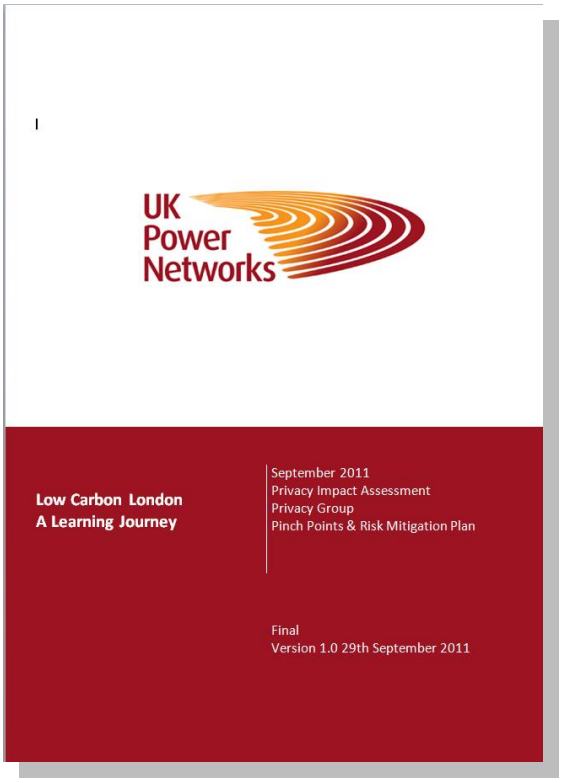
a) a fresh focus on three Engineering Instrumentation Zones (EIZs) geographic areas in London with a diverse mix of Low Carbon technologies (LCTs) and intense instrumentation and away from the ten Low Carbon Zones (LCZs) which became obsolete (May 2012) during the project due to a change in Mayoral policy;
b) the unavailability of heat pumps in London, in part probably due to delays in the launch of the Renewable Heat Incentive (RHI) scheme; and
c) a new approach to acquiring a carbon impact reporting tool due to changes in ownership of the software company originally identified. The revised approach met the original project requirements and are discussed in section 2.8 of this document.

The move to the three instrumentation zones had a number of positive impacts on the project, primarily detailed in Reports C1 and D1, providing the framework for new work on state estimation and also providing the basis for the most comprehensive end-of-feeder measurement and LV Network voltage data to date. This work has fed heavily into the work around the DNO settings and requirement for the national smart meter roll-out.

The revised approach to heat pumps both delivered on the project requirements but importantly has reported findings on the impacts of power quality that have not been observed elsewhere in other projects.

Appendix 1 – Successful Delivery Reward Criteria (SDRC)

SDRC	Successful Delivery Reward criterion	Status – Completed on time (September 2011)
1	Build Phase: Preparation of solution implementation complete: Logica smart metering Head End solution and Learning Laboratory commissioned (Appendix 2, Use Case U07.1 and U07.2) Preparation for c.5000 smart meter roll out complete, including address selection, acceptance surveys, privacy and security measures (working with GLA and Consumer Focus)	Evidence – Outputs and Learning Demonstration of the Learning Laboratory facilities at Imperial College with documented schedule of trials • Clear visibility of scope of work packages • Clear alignment to Use Cases • Clear identification of project deliverables Results of customer smart meter acceptance surveys • Overall quantification of acceptance • Identification of key concerns • Actions to improve level of acceptance Documented Privacy and Security strategy • Overall risk assessment • Identification of pinch points • Scope for risk mitigation through data aggregation • Risk minimisation plan Statistical analysis of smart meter trial sample size • To ensure statistical validity for extrapolation • Ensure samples sufficient to address variables (e.g. method of home heating / socio-economic consumer groupings / etc.) Demonstration of initial functionality of Head End • Ability to (two-way) communicate with smart meters • Data volume



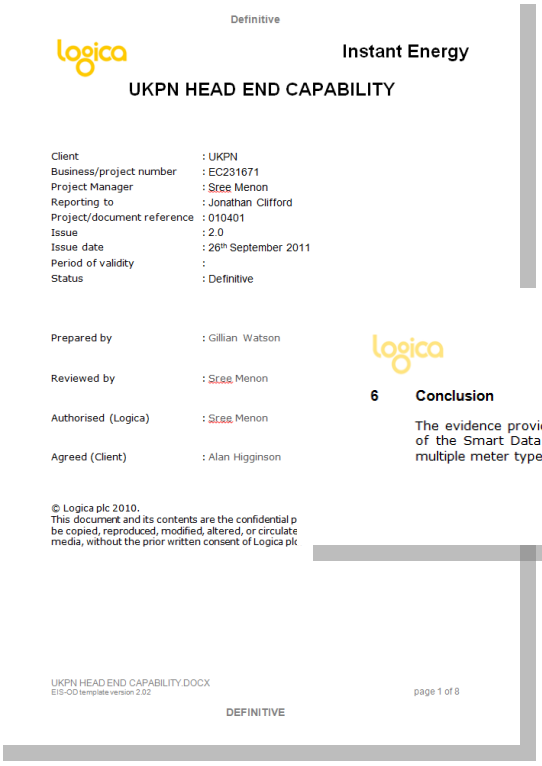
UK Power Networks

Low Carbon London
A Learning Journey

September 2011
Privacy Impact Assessment
Privacy Group
Pinch Points & Risk Mitigation Plan

Final
Version 1.0 29th September 2011

Report forming part of the SDRC submission documenting the Privacy and Security strategy



Definitive

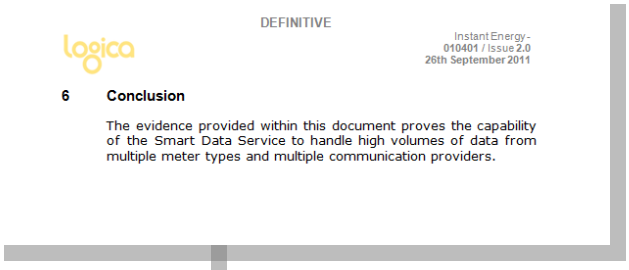
Logica

Instant Energy

UKPN HEAD END CAPABILITY

Client	: UKPN
Business/project number	: EC231671
Project Manager	: Sree Menon
Reporting to	: Jonathan Clifford
Project/document reference	: 010401
Issue	: 2.0
Issue date	: 26th September 2011
Period of validity	:
Status	: Definitive

Prepared by	: Gillian Watson
Reviewed by	: Sree Menon
Authorised (Logica)	: Sree Menon
Agreed (Client)	: Alan Higginson



DEFINITIVE

Logica

Instant Energy -
010401 / Issue 2.0
26th September 2011

6 Conclusion

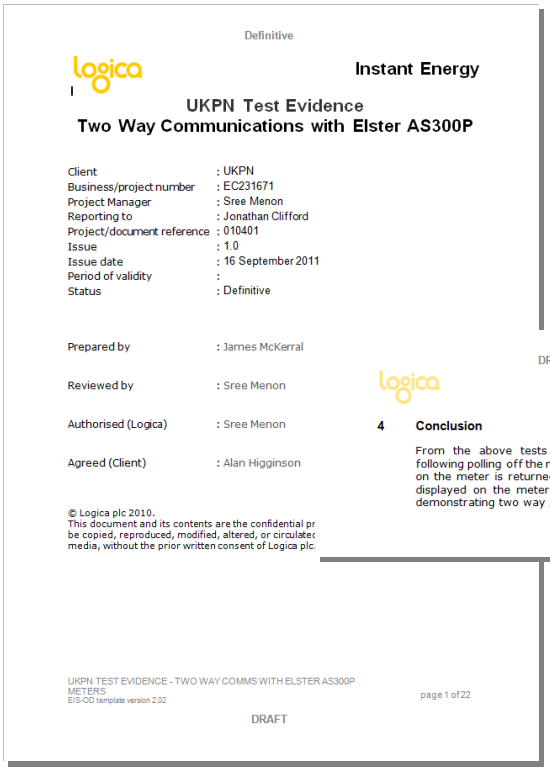
The evidence provided within this document proves the capability of the Smart Data Service to handle high volumes of data from multiple meter types and multiple communication providers.

UKPN HEAD END CAPABILITY.DOCX
EIS-OD template version 2.02

page 1 of 8

DEFINITIVE

Test report, including conclusion, forming part of the SDRC submission documenting the capability of the project head end system



Definitive

Instant Energy

UKPN Test Evidence
Two Way Communications with Elster AS300P

Client	: UKPN
Business/project number	: EC231671
Project Manager	: Sree Menon
Reporting to	: Jonathan Clifford
Project/document reference	: 010401
Issue	: 1.0
Issue date	: 16 September 2011
Period of validity	:
Status	: Definitive

Prepared by	: James McKerral
Reviewed by	: Sree Menon
Authorised (Logica)	: Sree Menon
Agreed (Client)	: Alan Higginson

UKPN TEST EVIDENCE - TWO WAY COMMS WITH ELSTER AS300P METERS
EIS-OD template version 2.02

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DRAFT

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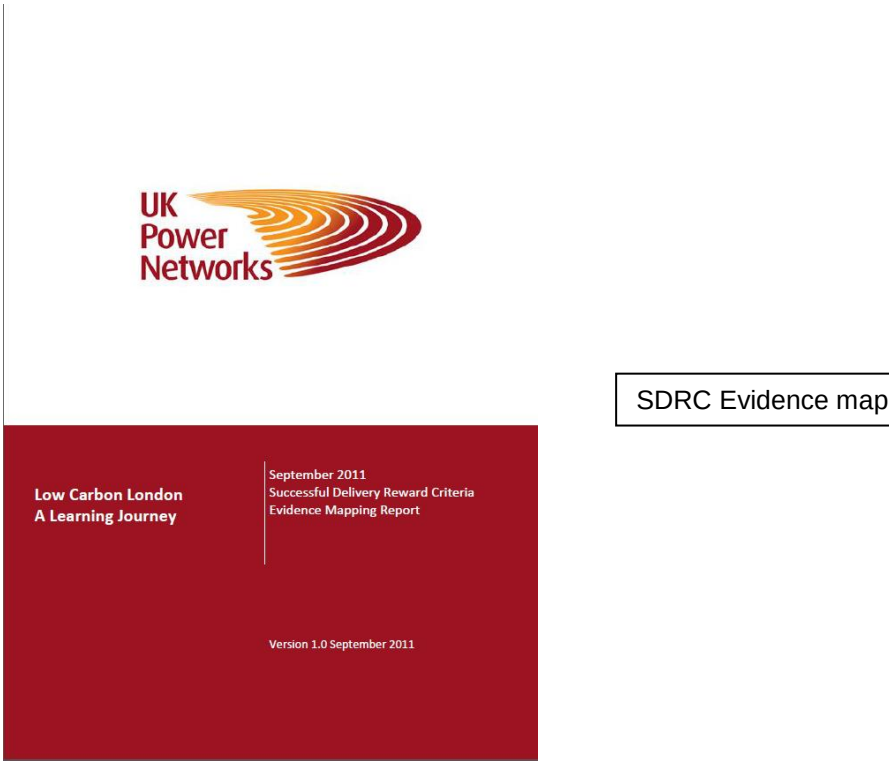
Instant Energy - Two Way Communications with Elster AS300P
010401 / Issue 1.0
16 September 2011

4 Conclusion

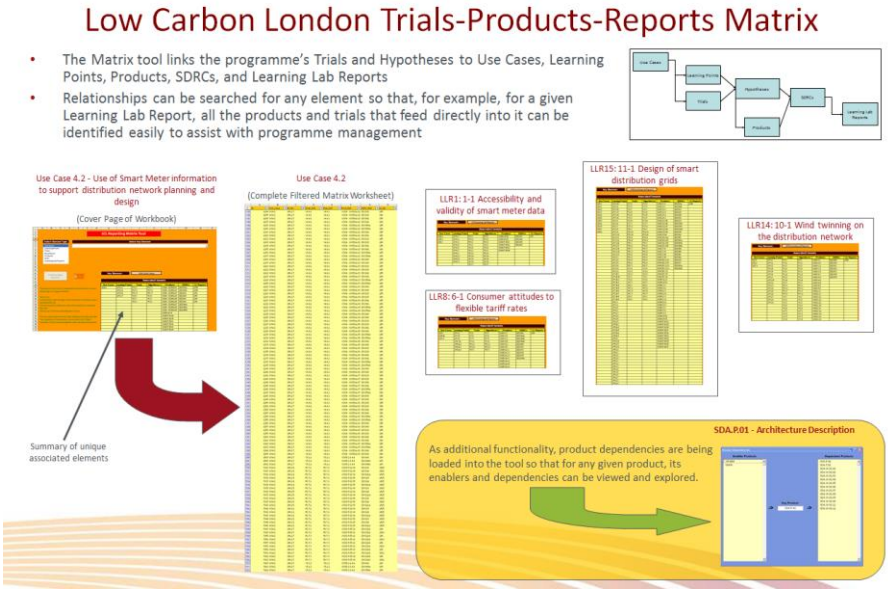
From the above tests carried out it can be ascertained that following polling off the meter from the head end, the consumption on the meter is returned to the head end. This returned value is displayed on the meter readings screen on the head end. Thus demonstrating two way communication to the meter.

Test report, including conclusion, forming part of the SDRC submission documenting the two way communication between the head end and the smart meter

Basil Scarsella (CEO), Barry Hatton (Executive Sponsor), Professor Goran Strbac (ICL Lead) at the opening of the LCL Learning Lab



SDRC Evidence mapping report



LCL Trials products reports matrix

SDRC	Successful Delivery Reward criterion	Status Completed on time (June 2012)
2	Build Phase: 1st stage of solution implementation complete: Operational Data Store and interface to Logica head end commissioned, smart meter installation underway and ”carbon impact tools” delivered Trial Phase: Implementation of initial trials based on data from the initial smart meters and half hourly industrial & commercial (I&C) customer meters with analysed results	Evidence – Outputs and Learning: • Functioning Operational Date Store and head end accessing/processing smart meter information • Multipartite demand side management (DSM) contracts between Aggregators, I&C customers, and EDF Energy Networks (documented contract implementation) • Initial CO2 impact assessments

~~15 SEP 2011~~

Contract between UK Power Networks and the Aggregator.

This **Agreement** is made on the 26th day of September 2011 **between**

(1) **UK Power Networks (Operations) Limited** a company registered in England and Wales with number 3870728 whose registered office is at Newington House, 237 Southwark Bridge Road, SE1 6NP (**"UKPN"**, which expression shall include its successors and/or permitted assigns); and

(2) **EnerNOC UK Limited**, a co company number 06937931 w 10 Noble Street, London EC2 shall include its successors an

This Agreement is entered into in res managed by the Aggregator to provid has agreed, subject to the terms of thi available to UKPN from any of the D the Commencement Date of this Agre Agreement.

1. Introduction

1.1 UKPN is seeking to develop a with a number of service provid is the action taken by electrici consumption or to run on-site e undertaken at times of pe UK electricity supply with den response services are intended peaks in electricity demand on Aggregators can also provid individual customers' demand demand.

1.2 The parts of the Project relatin objectives and pricing decided such, it is anticipated that the t an amendment to this Agreem

1.3 Participating Customers signe the fact that, as a minimum, th duration of their contract. Afte Demand Response group be of be made available to the Phase 1 customers deem these terms these new terms from the date notification. With the exceptio Groups selected by UKPN all Phase 1 will also be offered th competitive basis with custom

11.1.5 Remedies.

The Parties acknowledge that the Confidential Information is valuable and unique, and that damages would be an inadequate remedy for breach of this Agreement and the obligations of the Receiving Party are specifically enforceable. Accordingly, the Parties agree that in the event of a breach or threatened breach of this Section 11.1 by the Aggregator, or their respective parent company(ies), subsidiaries and/or affiliates, who shall be third party beneficiaries of this Agreement, the non-breaching Party shall be entitled to seek an injunction preventing such breach, without the necessity of proving damages or posting any bond. Any such relief shall be in addition to, and not in lieu of, monetary damages or any other legal or equitable remedy available to the disclosing Party and their direct and indirect parent company(ies), subsidiaries or affiliates.

12. Liability

12.1 Neither Party shall be liable to the other for indirect or consequential loss or for pure economic loss howsoever arising. The total liability of each Party to the other Party in relation to this Agreement, whether for breach of contract, tort (including negligence) breach of statutory duty or otherwise shall not exceed one million pounds (£1,000,000.00) in aggregate.

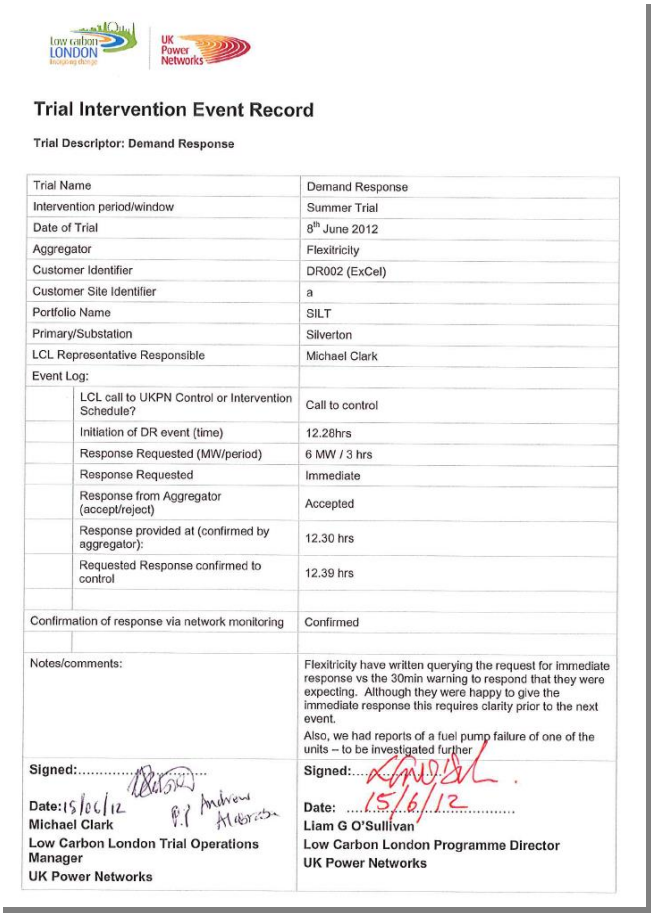
In Witness Whereof the hands of the duly authorised representatives of the Parties hereto at the date first above written

SIGNED BY)
for and on behalf of)
UK Power Networks)
(Operations) Limited)

SIGNED BY)
for and on behalf of)
the Aggregator)

Example of Aggregator DSR contract signed 26 September 2011

13



low carbon LONDON | UK Power Networks

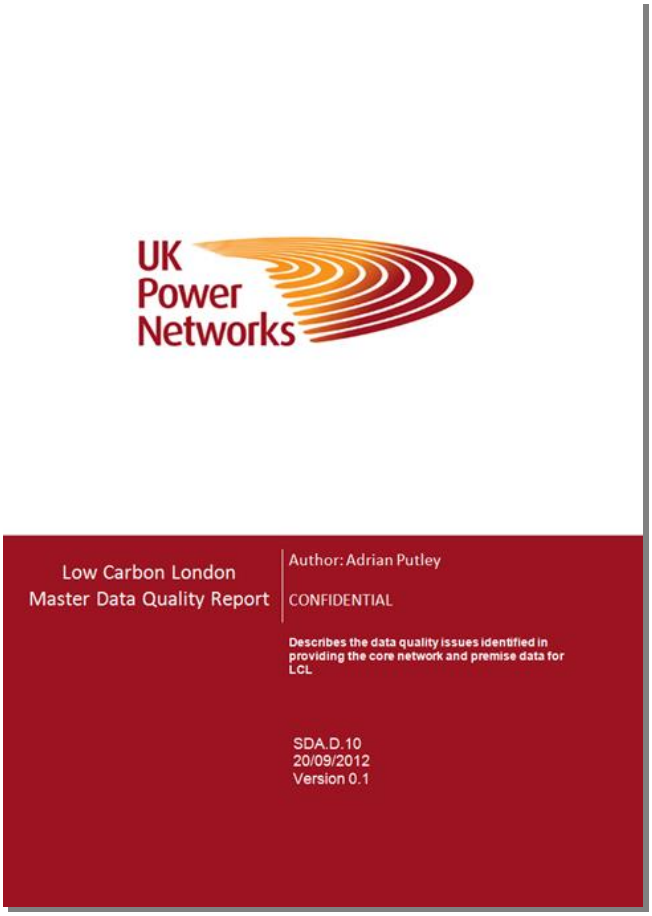
Trial Intervention Event Record

Trial Descriptor: Demand Response

Trial Name		Demand Response
Intervention period/window		Summer Trial
Date of Trial		8th June 2012
Aggregator		Flexitricity
Customer Identifier		DR002 (ExCel)
Customer Site Identifier		a
Portfolio Name		SILT
Primary/Substation		Silverton
LCL Representative Responsible		Michael Clark
Event Log:		
	LCL call to UKPN Control or Intervention Schedule?	Call to control
	Initiation of DR event (time)	12.28hrs
	Response Requested (MW/period)	6 MW / 3 hrs
	Response Requested	Immediate
	Response from Aggregator (accept/reject)	Accepted
	Response provided at (confirmed by aggregator):	12.30 hrs
	Requested Response confirmed to control	12.39 hrs
Confirmation of response via network monitoring		Confirmed
Notes/comments:		Flexitricity have written querying the request for immediate response vs the 30min warning to respond that they were expecting. Although they were happy to give the immediate response this requires clarity prior to the next event. Also, we had reports of a fuel pump failure of one of the units – to be investigated further
Signed:..... **Date:** 15/06/12 **Michael Clark** **Low Carbon London Trial Operations Manager** **UK Power Networks**		**Signed:**..... **Date:** 15/6/12 **Liam G O'Sullivan** **Low Carbon London Programme Director** **UK Power Networks**

Example of Aggregator DSR submission approval document for the summer 2012 trials

SDRC	Successful Delivery Reward criterion	Status Completed on time (December 2012)
3	Build Phase: Final stage of solution implementation complete: Operational Data Store and interface to Logica head end commissioned, smart meter installation completed	Evidence – Outputs and Learning: Functioning Operational Date Store and head end accessing/processing smart meter information - Proven capability to process data from head end, undertake event processing to identify key data, aggregate and map data to network nodes



Mater Data Quality Report complete with descriptions of data flows from UK Power Networks systems into the LCL datasets

Extract from the Mater Data Quality Report showing basic high voltage and low voltage networks on GIS background

Extract from the Mater Data Quality Report showing high voltage and low voltage networks on GIS background complete with nodal/exit point locations

Map showing high level view of the three Engineering Instrumentation Zones

Table 4: Delivery Required in Q3 2014

SDRC	Successful Delivery Reward criterion	Status – Completed on time (June 2014)
4	Trial Phase: Conclusion of "Using Smart Meters and Substation Sensors to Facilitate Smart Grids" trials: Understanding customer behaviour and potential network impact (Appendix 2, Use Case U04.1) Use of smart meter information to support distribution network planning and design (Appendix 2, Use Case U04.2) Use of smart meter data to support network operations (Appendix 2, Use Case U04.3) Complete Q3, 2014	Evidence – Learning: Assimilation of network voltage and load profiles from smart meter data (up to 6,500 smart meters) to validate ADMD assumptions and determine critical design criteria as a guide to the more efficient planning of LV networks (for example with regard to thermal limits, losses, power quality and voltage optimisation) Evidence – Outputs: Learning Lab reports (Q2, 2014): 1-1 Accessibility and validity of smart meter data 2-1 Network state estimation and optimal sensor placement 2-2 Accessibility and validity of substation sensor data DNO learning reports (Q3, 2014): DNO learning report on the use of smart meter information for network planning and operation
5	Conclusion of "Enabling and Integrating Distributed Generation" trials: Facilitating connections to LV and HV distribution networks (Appendix 2, Use Case U02.1) Active management of DG to address security of supply concerns and postpone network reinforcement (Appendix 2, Use Case U02.2) Exploring the impact of LV, G83 connected generation Complete Q3, 2014	Evidence – Learning: Proven capability of technical and commercial dispatch/curtailment of generation (est. 5 Active Network Management Schemes) with beneficial impact on network utilisation, voltage, load factor and/or fault level Validation of ER P2/6 / ETR130 assumptions including Tm and F factors for specific generation technologies and applications Guidance on successful approaches to, and value of, managing SSEG connections in order to preserve network operation and power quality while best enabling their connection Evidence – Outputs: Learning Lab Reports (Q2, 2014): 3-1 Impact of LV connected DER on power quality 4-2 Impact of LV DERs on network utilisation 7-1 Opportunities for DG in the distribution network DNO learning reports (Q3, 2014): DNO learning report for facilitating DG connections DNO learning report for DG addressing security of supply and network reinforcement requirements

SDRC	Successful Delivery Reward criterion	Status – Completed on time (June 2014)
6	Conclusion of "Enabling Electrification of Heat and Transport" trials: Exploring impact of electric vehicle charging (Appendix 2, Use Case U03.1) Exploring the impact of heat pump demand (Appendix 2, Use Case U03.2) Complete Q3, 2014	Evidence – Learning: Evidence of real changes in load patterns due to: () - Heat pumps - Electric Vehicles - Micro-generation Guidance on successful approaches to, and value of, smart optimisation of EV charging to minimise peak demand and losses impact (maximising load factor) and to minimise need for reinforcement (maximising utilisation) Evidence – Outputs: Learning Lab Reports (Q2, 2014): 3-1 Impact of LV connected DER on power quality 5-1 Impact of opportunities for wide-scale electric vehicle deployment 4-2 Impact of LV DERs on network utilisation DNO learning reports (Q3, 2014): DNO learning report on the impact of EV and HP loads on network demand profiles DNO learning report on opportunities for smart optimisation of new heat & transport loads
7	Conclusion of "Residential and SME Demand Side Management" trials: Energy efficiency programmes and technologies (Appendix 2, Use Case U05.1.a) Consumer behaviour demand response and responsiveness to TOU tariffs" trials (Appendix 2, Use Case U05.1.b) Complete Q3, 2014	Evidence – Learning: Quantified impact of DSM and energy efficiency measures in terms of reduced peak demand Effectiveness of TOU tariffs and analysis of price elasticity and hence necessary level of tariff incentive to deliver effective response Evidence – Outputs: Learning Lab Reports (Q2, 2014): 6-1 Residential consumer attitudes to time varying pricing 6-2 Residential consumer responsiveness to time varying pricing6-4 Smart appliances for residential demand response 4-1 Impact of energy efficient appliances on network utilisation DNO learning reports (Q3, 2014): DNO learning report on network impacts of energy efficiency at scale DNO guide to residential DR for outage management and as an alternative to network reinforcement

SDRC	Successful Delivery Reward criterion	Status – Completed on time (June 2014)
8	Conclusion of "I&C Demand Side Management" trials: Demand side management with I&C customers (Appendix 2, Use Case U05.2) Demand side management conflicts and synergies (Appendix 2, Use Case U05.3) Complete Q3, 2014	Evidence – Learning: Real examples of DSM contracts with I&C customers covering highly utilised networks with clear benefits of peak demand shifting capability under unplanned outage conditions Quantification of risk and benefit of using I&C DSM as an alternative to network reinforcement - as a guide to more efficient planning for network security and as an input to an expanded version of ETR 130 (for example deriving equivalent F and Tm factors) Visibility of synergies (and/or method of resolving conflicts) between NGET and UK Power Networks requirements for responsive demand Evidence - Outputs: Learning Lab Reports (Q2, 2014): 7-1 Distributed generation and demand response services for the smart distribution network DNO learning reports (Q3, 2014): DNO guide to I&C DR for outage management and as an alternative to network reinforcement Conflicts and synergies of DR DNO impacts of supply-following DR report
9	Conclusion of "Wind Twinning" trials: Wind twinning through ToU tariffs with suppliers (Appendix 2, Use Case U01.1) Wind twinning through responsive demand contracts with commercial aggregators (Appendix 2, Use Case U01.2) Complete Q3, 2014	Evidence – Learning: Identification of scope for manipulating demand (through commercial incentivisation) to follow wind output Assessment of potential for: o optimisation of system level real time demand to minimise CO2 emissions; o reducing cost of system residual balancing; o minimising requirement for generation plant margin; and o minimising price volatility Evidence - Outputs: Learning Lab Reports (Q2,2014): 7-1 Distributed generation and demand response services for the smart distribution network DNO learning reports (Q3, 2014): DNO impacts of supply-following DR report

Table 5: Delivery Required in Q4 2014

SDRC	Successful Delivery Reward criterion	Status – Completed on time (December 2014)
10	Conclusion of final analyses: New network design and operational practices (Appendix 2, Use Case U08) New network planning and operational tools (Appendix 2, Use Case U06) Complete Q4, 2014	Evidence – Learning: Consolidation of outputs from all trials as a comprehensive guide to the future smart management of distribution networks with high penetrations of DERs and low carbon applications, including the applicability of commercial contracts and incentives to encourage smart management of demand and generation Quantified overall CO2 savings and LCTP contributions Evidence – Outputs: Learning Lab Reports (Q4, 2014): 11-1 Design of smart distribution networks 11-2 Resilience performance of smart distribution networks 12-1 Novel commercial arrangements and the smart distribution network 14-2 Carbon impact of smart distribution networks 14-3 Overall summary report DNO learning reports (Q4, 2014): DNO design and operations learning report DNO tools and systems learning report Final Report - DNO Guide to Future Smart Management of Distribution Networks

Appendix 2 – Successful delivery reward criteria project output reports

FINAL REPORT	DESCRIPTION	LINK
 **SUMMARY REPORT**	Provides project overview, a summary of the projects findings and also navigation as to which reports are most appropriate to read for your interests	http://tinyurl.com/nj7gth7
 **A1** Residential Demand Side Response for outage management and as an alternative to network reinforcement	Presents the impact on the distribution network of a wider scale roll out of a dynamic Time-of-Use tariff	http://tinyurl.com/ofe5u2s
 **A2** Residential consumer attitudes to time varying pricing	Outlines the results from the quantitative and qualitative assessment from the survey and interviews of customers on the dToU trial	http://tinyurl.com/ogf78vh
 **A3** Residential consumer responsiveness to time varying pricing	Explicitly describes the quantitative results in terms of load reduction and load shifting	http://tinyurl.com/njuruh4
 **A4** Industrial and Commercial Demand Side Response for outage management and as an alternative to network reinforcement	Presents the results from the I&C DSR trials and outlines the key considerations for DNO implementation of DSR and P2/6 planning assessments	http://tinyurl.com/pr7btc7
 **A5** Conflicts and synergies of Demand Side Response	Analyses the impact of multiple parties contracting DSR and potentially accessing the same resource	http://tinyurl.com/pelxeko
 **A6** Network impacts of supply-following Demand Side Response report	Focuses on the impact of low carbon led generation and the DSR market as DNOs will experience it in the years ahead	http://tinyurl.com/nl8p8zf

FINAL REPORT	DESCRIPTION	LINK
 **A7** Distributed Generation and Demand Side Response services for smart Distribution Networks	Presents the quantitative analysis of the I&C DSR trials and introduces alternative baselining techniques	http://tinyurl.com/np7kkov
 **A8** Distributed Generation addressing security of supply and network reinforcement requirements	Looks at the impact of having more DG connected to the distribution network and the potential improvement on security of supply	http://tinyurl.com/nn86eln
 **A9** Facilitating Distribution Generation connections	Determines how smart technologies such as Active Network Management can facilitate more capacity on the urban network for generation	http://tinyurl.com/o976jg5
 **A10** Smart appliances for residential demand response	Outlines potential response from smart appliances	http://tinyurl.com/pm7q3cn
 **B1** Impact and opportunities for wide-scale Electric Vehicle deployment	Focuses on presenting the results from the EV monitoring trials and the analysis on diversity and profiles for the observed loads.	http://tinyurl.com/phfdcqa
 **B2** Impact of Electric Vehicles and Heat Pump loads on network demand profiles	Considers and models the expected impact of EVs and HPs at a wider scale based on the trial findings	http://tinyurl.com/one8k5o
 **B3** Impact of Low Voltage connected low carbon technologies on power quality	Connected low carbon technologies on Power Quality – covers the detail of the power quality of LCTs and the impact on the LV network	http://tinyurl.com/qeb9ym3

FINAL REPORT	DESCRIPTION	LINK
 **B4** Impact of Low Voltage connected low carbon technologies on network utilisation	Connected low carbon technologies on network utilisation – analyses the direct impact of high EV and HP uptake on the network at scale	http://tinyurl.com/qjpyguy
 **B5** Opportunities for smart optimisation of new heat and transport loads	Outlines the potential smart solutions such as Time-of-Use tariffs and ANM to address the impact of EVs and HPs on the network	http://tinyurl.com/oluu3es
 **C1** Use of smart meter information for network planning and operation	Presents the analysis of domestic customer's profiles as well as the voltage assessment from the engineering instrumentation zones	http://tinyurl.com/nvfcxra
 **C2** Impact of energy efficient appliances on network utilisation	Outlines the potential for reduction on energy use by efficient appliances	http://tinyurl.com/oqay4rq
 **C3** DNO Learning Report on Network impacts of energy efficiency at scale	Models the impacts and benefits of appliance efficiency on the distribution network	http://tinyurl.com/pwqaphf
 **C4** Network state estimation and optimal sensor placement	Describes a new approach to calculate the status of the networks without having full visibility of the network using a state estimation technique.	http://tinyurl.com/qxqfvh3
 **C5** Accessibility and validity of smart meter data	Assesses the validity of the smart meter data gathered throughout the trials	http://tinyurl.com/no9rsgn

FINAL REPORT	DESCRIPTION	LINK
 **D1** Development of new network design and operation practices	Outlines the key changes and considerations required for implementing the LCL findings into planning and network operation processes.	http://tinyurl.com/npttz9h
 **D2** DNO Tools and Systems Learning	Describes the Information Systems and Operational telecom systems required for the integration of smart meters and smart grid solutions	http://tinyurl.com/nryu73r
 **D3** Design and real-time control of smart distribution networks	Considers the potential new planning approaches including Option Value of DSR and Min/Max regret investment	http://tinyurl.com/ocauo2g
 **D4** Resilience performance of smart distribution networks	Develops the assessment of reliability for DSR and introduces an alternative approach to network reliability consideration	http://tinyurl.com/o739mqr
 **D5** Novel commercial arrangements for smart distribution networks	Defines some of the key considerations for the electricity industry on how dynamic networks will require more commercial flexibility	http://tinyurl.com/pye5e3o
 **D6** Carbon impact of smart distribution networks	Quantifies the carbon impact of deploying a full smart network and presents the impact of LCLs trials	http://tinyurl.com/osyoxoh

LCL learning event - Wind Twinning presentation

Wind Twining - A presentation (2015). UK Power Networks. London. At the time of this report, this was a confidential document that is available upon request as part of learning events.

CGI Data Quality Report

Master Data Quality Report (2012). UK Power Networks. London. At the time of this report, this was a confidential document that is available on request as part of Low Carbon London.

Close Down

Low Carbon London Close Down Report (2015). UK Power Networks. London. At the time of this report, this was a confidential document submitted to Ofgem as part of final reporting.

DSR Break-out

Demand Side Response – From Trial to Reality (2013). UK Power Networks. LCNF conference 2013 - DSR break-out session: November 2013. Retrieved from http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Presentations/LCNF+2013+-+Demand+Side+Response+-+Nov+2013.pdf.

Ofgem Email

Submission of Evidence Email to Ofgem Director (2014). UK Power Networks. London. At the time of this report, this was a confidential email submitted to Ofgem as part of an evidence submission.

Ofgem Fund Royalties

Low Carbon Network (LCN) Fund royalties (2014). Ofgem. London: 21 January 2014. Retrieved from https://www.ofgem.gov.uk/ofgem-publications/85779/publicletterlclroyalties.pdf.

PPR Dec 2014

Six Monthly Project Progress Report - Dec 2014 (2014). UK Power Networks. London: 9 February 2015. Retrieved from https://www.ofgem.gov.uk/publications-and-updates/low-carbon-london-six-monthly-report-december-2014.

PPR June 2011

Six Monthly Project Progress Report - June 2011 (2011). UK Power Networks. London: June 2011. Retrieved from http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/Low+Carbon+London+PPR+V1+Final.pdf.

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Six Monthly Project Progress Report - June 2012 (2012). UK Power Networks. London: June 2012. Retrieved from http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/Project-Documents/Low+Carbon+London+June+2012+15+June+2012.pdf.

Submission Review

Review of Low Carbon Network Fund proposals: Report to Expert Panel (2010). TNEI and Arthur D. Little. London: 8 October 2010. Retrieved from https://www.ofgem.gov.uk/ofgem-publications/45920/edfe2001consultants-report.pdf.