Low Carbon London
Project Progress Report
December 2013

UTILITY INDUSTRY ACHIEVEMENT AWARDS 2012

UTILITY OF THE YEAR

UK Power Networks
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Contents

Glossary of Terms

Abbreviation	Term
ANM	Active Network Management
BEV	Battery Electric Vehicle
CHP	Combined Heat and Power
CNO	Charging Network Operator
CP	Charge Post
CS	Carbon Sync
DG	Distributed Generation
DNO	Distribution Network Operator
DSO	Distribution System Operator
DSR	Demand Side Response
dToU	Dynamic Time-of-Use
EIZ	Engineering Instrumentation Zone
EV	Electric Vehicle
FAQ	Frequently Asked Questions
GB	Great Britain
GPRS	General Packet Radio Service
HP	Heat pump
HV	High Voltage
I&C	Industrial and Commercial
IFI	Innovation Funding Incentive
IHD	In-home Display
kWh	Kilo-watt hour
LCL	Low Carbon London
LCNF	Low Carbon Network Fund
LCT	Low Carbon Technology / Technologies
LUL	London Underground Limited
LV	Low Voltage
MWh	Mega-watt hour
ODS	Operational Data Store
OLEV	Office for Low Emission Vehicles
PHEV	Plug-in Hybrid Electric Vehicle
PMS	Participant Management System
PV	Photo-Voltaic
RTU	Remote Terminal Unit
SDRC	Successful Delivery Reward Criterion / Criteria
SMS	Short Message Service
ULEV	Ultra-Low Emission Vehicles

Executive Summary

The LCL project is funded through Tier 2 of Ofgem's LCNF. It commenced in January 2011 and is due to complete in December 2014. This is the sixth in the series of project progress reports submitted to Ofgem and covers the period July 2013 – December 2013.

During this reporting period the project has continued to make good progress across all fronts and in particular in the core areas of operating the project's portfolio of trials, the continued targeted recruitment into the remaining trials and the detailed design of the project's final reports.

The project had no SDRC due for delivery in this reporting period and remains on schedule and within budget to deliver all of its remaining SDRCs, which are all final-report focused.

The project's ground-breaking residential dynamic time-of-use tariff ("dToU") trial has also continued to operate smoothly, in conjunction with the project's electricity supply partner EDF Energy. The trial, unique to the GB energy market, has 1,065 residential customers using electricity on EDF Energy's "Economy Alert" tariff. This notifies participants via the smart meter IHD and via SMS if available, of price changes 24 hours in advance of their electricity tariff being changed from their normal tariff to one of two tariff bands (a "high" tariff of 67.2p per kWh, or a "low" tariff of 3.99p per kWh). The amended tariff operates for a notified fixed time period of between one and six hours and the project monitors how the participants' electricity consumption behaviour changes in response to these price signals.

The high tariff periods simulate network constraint or peak load scenarios, where the need to reduce demand is paramount; the low tariff periods simulate "wind-twinning" scenarios where the objective is to divert energy consumption away from other periods of higher carbon-intense electricity generation, to those periods where there is an increased availability of low-carbon electricity, such as wind-generated.

The project's third I&C DSR trial ran during summer 2013 and completed in this reporting period. This trial was again highly successful, with over 124MWh of network support provided through 33 separate calls for demand. The trial used demand response clients with a variety of generation and demand sources, including CHP, standby diesel and building turn-down. The trial also developed an innovative approach using Active Network Management (ANM) infrastructure to automatically trigger demand response. In total 18 calls were made using this mechanism during the summer trial with the last 10 calls being made on a fully autonomous basis.

The overall success of the project's demand response trials to date has demonstrated the ability to deliver real savings through avoided or deferred reinforcement. The project has already delivered its committed real benefits of £1.8m through the project's use of I&C DSR to underpin the derogation currently in place with Ofgem for Ebury Bridge substation.

This commitment has been further confirmed into the future with the publication of UK Power Networks Business Plan (2015-2023), which commits to deliver real savings to customers of £13.5m through DSR schemes during the upcoming eight-year regulatory period. In addition, UK Power Networks has also committed to further real savings to customers in its other two distribution network areas of £24.7m in the same regulatory period, giving a total of over £38m of savings in total. The savings to customers demonstrates that the project is already paying back the LCNF fund costs through real savings to customers.

The project now has 142 electric vehicle (EV) charge posts fully metered on the trial, 77 residential posts and 65 posts in I&C locations. These posts all have an EDMI smart meter installed that enables both consumption behaviour and voltage characteristics to be captured. An additional population of 10 residential EV participants on EDF Energy's Eco20:20 static time-of-use tariff, aimed specifically at the residential EV and micro-generation market have also been

enrolled onto the trial. The project has 36 EVs enrolled which have tracking equipment installed, enabling the project to capture and analyse how driving patterns impact charging behaviours.

The project is in the final stages of commissioning a unique EV charging trial to explore the potential to regulate EV charging at peak times. The "smart charge" trial is using ANM equipment from project partner Smarter Grid Solutions, in conjunction with EV charge post supplier POD Point's charge post management console "Carbon Sync". The trial is exploring ways to regulate EV charging during peak periods without any perceptible change in the charging experience for the end user, with 48 selected POD Point EV charge posts clustered over two London Power Networks' substations. Further feasibility work is being undertaken with respect to regulating the charging output of higher output (rapid) chargers on the distribution network. This work is being investigated into utilising the network of 120 22kW chargers installed across the London Underground car park EV charging infrastructure.

The project has now established the three EIZs in carefully selected locations that exhibit high densities of low carbon technologies. This initiative has seen the installation of over 140 separate instruments to capture the impact of low carbon technologies at various points in the electricity distribution network. The EIZs will enable detailed impact analysis of low carbon technologies through all the distribution network voltage levels and key points on the distribution network.

The project's distributed generation trial has continued to encounter reluctance from potential participants to engage in a fully-active ANM trial; however, the project is continuing to work with a small number of potential leads that are expected to participate on an active basis in the coming months. In addition, the project has continued to monitor 12 combined heat and power (CHP) installations and two solar photo-voltaic (PV) installations as part of this trial, which provides valuable information on how HV and LV distribution network-connected DG units are currently controlled, and how they can be monitored and potentially controlled using ANM during constraint events. This trial also delivers a good understanding of the performance characteristics of different LV and HV connected DG units when controlled by ANM (ramp rates, response times, etc.).

LCL has now finalised the involvement of British Gas on the project. The contract formalising their participation was signed by both parties in October 2013 and allows for data from up to an additional 10,936 British Gas customers with smart meters in the London area to be included in the project. This demographically-profiled data will significantly strengthen the statistical base used for analysis and the aggregated database of over 17,000 will represent the largest analytical sample of electricity smart meters ever constructed in the UK.

The data collection activity for a number of the project's monitoring trials will complete on 31 March 2014, an extension from the original end date. This will enable a richer dataset to be collected from the EV, solar PV and heat pump monitoring trials as well as the EIZ instrumentation data, by including additional winter 2013 seasonal data. This has no financial impact on the project budget or on the on-time delivery of the remaining SDRC, the project's final reports.

The project has also recently established a wind-twinning trial in conjunction with Elexon and one of the project's demand aggregator partners Flexitricity, to contract with two I&C DSR clients to provide DSR to be despatched when there is a reduction of 30MW per minute or greater in available wind generation. The trial, which will explore the potential of DSR to mitigate the variability of wind generation, is in its initial stages and will complete by 31 March 2014. The intention is to represent scenarios in which the DNO sells on an existing DSR contract to the system operator, or for future scenarios in which a DSR contract could be jointly called upon by the DNO and the system operator, in which the various DSR-related conflicts and synergies between a DNO and the system operator have been contractually resolved.

The project has also continued to actively mitigate the three areas identified by Ofgem in the letter approving the LCL change request in December 2012. These are a) carbon reporting; b) the use of supplementary external data for small scale embedded generation and heat pump analysis; and c) the instrumentation of the EIZs. The project has now produced internal carbon impact reports on the summer 2013 DSR trial and the residential *d*ToU trial; publicly-available carbon impact reports will be delivered in 2014 and as part of the final reports portfolio. The instrumentation of the three EIZs is nearing completion and will finish by 17 January 2014. The provision of supplementary external heat pump data from the Energy Savings Trust and Passiv Systems, following rigorous technical review by Imperial College London, has now been finalised. The project has also been able to overcome the lack of participation from London-based large-scale PV installations by simulating the impact of PV inverters in the test laboratories at Imperial College's Department of Electrical and Electronic Engineering using a representative test harness of typical PV inverters available in the market today.

The project is now strongly focused on the delivery of its final reports which will comprise an integrated set of reports from Imperial College London and UK Power Networks. This library will collectively present a comprehensive analysis offering a practical guide for DNOs on Smart Grids and the electricity distribution network complemented by academically rigorous study from Imperial College London.

The commitment to deliver useful and practical outputs was reinforced within the change request approved by Ofgem in December 2012, which saw the project propose and commit to the production of additional final reports, aimed specifically at the GB electricity distribution network operator community. The project's academic partner, Imperial College London, is centrally involved both in the analysis of the empirical data collected on the various trials as well as working closely with UK Power Networks project personnel to design the overall report architecture. Figure 1 - Project report themes and architecture below sets out the project's key report themes and our current plans for the overall report portfolio architecture and timeline. This will continue to be fine-tuned as the data is analysed and as it presented to stakeholders for discussion and feedback.
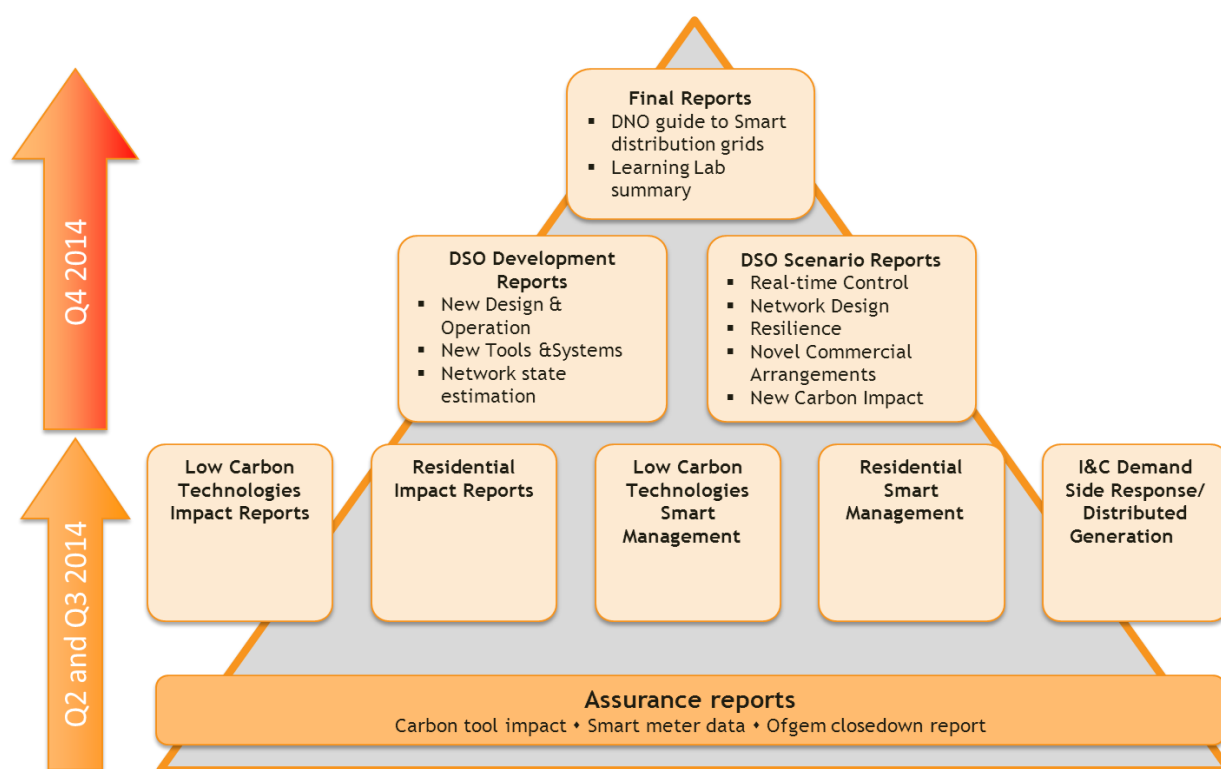

Figure 1 - Project report themes and architecture

Risks

The project has operated a comprehensive risk management framework from its inception. There are no uncontrolled risks that present a threat to the project successfully completing its objectives or the delivery of its remaining SDRC.

The project manages and mitigates a number of controlled risks and the key controlled risks to the project are outlined in Table 1 - Key project risks, below.

Table 1 - Key project risks

Risk	Category / Owner	Impact/ Probability	Mitigation
Programme final reports – coordination of analysis, reporting and presentation of findings between UK Power Networks and Imperial College.	UK Power Networks / Imperial College	Medium / Low	1. Several meetings held with Imperial College to agree detailed contents of final reports. Executive summaries produced for all reports to assist in alignment across reports between Imperial College and UK Power Networks. 2. Draft overall themed report architecture produced for review and comment. 3. Detailed project plans developed for DNO-centric and Imperial College report portfolios. 4. Regular governance meetings in place with UK Power Networks and Imperial College.
Some trials may complete with limited empirical data collected, which may restrict seasonal factors included in the analysis and reports.	UK Power Networks / Imperial College	Medium / Low	1. Supplement with data from other sources. 2. Discussions held and concluded on heat pump data to be collected, with external data from the Energy Savings Trust heat pump trial to be input, with additional voltage data to be collected. 3. Similar discussions held with Passiv Systems with respect to additional power quality data to be collected on existing trial installations 4. Review of other data requirements – in particular PV harmonics. 5. Simulate summer PV loads in the lab with PV inverters and monitor using PQAs. 6. For EV harmonic data – obtain 16A and 32A EV charge post profile data as well as EV data from non-LEAF EVs (e.g. UK Power Network Peugeot Ions). 7. Data collection to continue to 31 March 2014 for monitoring and EIZ instrumentation trials.
Missing EDF Energy smart meter read data.	UK Power Networks	Low / Low	1. Missing data potentially caused by voltage sags and swells. 2. Independent verification of voltage sags and swells through analysis of EDMI EIZ meter data and EIZ instrumentation.
EIZ exit point instrumentation may not all be in place by the end of Q4 2013	UK Power Networks	Medium/ Medium	1. Contract in place with Skanska. 2. Accelerated deployment to EIZ exit points. 3. Daily progress reporting. 4. Exceptions handled separately to avoid delays.

Risk	Category / Owner	Impact/ Probability	Mitigation
Recruitment risks			
ANM recruitment for full active involvement still presents challenges.	Project	High/High	1. The project is working with three prospective participants with a view to engaging in a fully active network management trial; Bunhill Energy Centre, Islington (CHP), Westminster College of Technology (CHP) and Greenwich Power (Gas turbine). The project is continuing to develop commercial and technical solutions to facilitate their involvement. 2. The ANM-enabling DSR trial has been developed as mitigation for the lack of active ANM clients. This trial will deliver most of the learning expected from the full ANM trial.
Large-scale PV	Project	High/High	1. Large-scale PV installations are not prevalent in London and the PV installation community is not aligned to involvement with an R&D project such as Low Carbon London. The project continues to liaise with the main PV installers in London and the South-East, Solar Century and Southern Solar. 2. Building managers with large-scale PV installations are often suspicious of the metering aspects of the proposed trial and how that might impact their FIT arrangements, and hence are not willing to participate in the trials. The project is continuing to work with potential large-scale PV installations to allay concerns.
Installation risks			
Substation physical space	Project	Medium/ Medium	1. Space at substations can often be restricted and so the installation of additional equipment associated with the project's trials can be compromised. The project undertakes detailed site surveys ahead of equipment installations to minimise the potential impact.
Below-ground EV CPs	POD Point	Medium / Low	2. Some of the EV charging posts on the regulated EV smart charge trial are located in underground car parks. These will require additional communications installed to enable the installed SIM cards to function.

Learning outcomes

The learning outcomes arising this reporting period reflect the project activities undertaken and the focus on the delivery of the portfolio of final reports. Two particular areas of learning emerged this period, centring on recruitment and data quality.

A) Active Network Management recruitment

Recruitment continues to be a challenge in the ANM trial, with reluctance from potential participants to hand over full control of their installation to an ANM installation. The roots of the unwillingness to participate can inform a wide variety of learning outcomes:

- Lack of understanding of the proposal – both with specialist energy generation installation consultancies and with potential clients directly;
- The proposal is primarily regarded as a risk to the continuity of service they provide to their customers (e.g. employees in a building), which is their prime role;
- Can be regarded as a very low priority for the client in the context of other issues on their agenda and so does not warrant any management bandwidth;
- Older DG installations may not be able to be adapted for ANM control;
- The client views short-term nature of the trial as being too much effort for little return;
- Potential income streams are not seen as attractive to them, not because of the size of the revenue stream but because they are typically not targeted to deliver revenue; and
- Decisions can involve many diverse parties, including external third-parties and the proposal can get side-lined due to the limited available management bandwidth from all parties involved.

B) Data quality

The project is collecting significant amounts of data from its various trials. Meta-data is collected typically as a one-off exercise and enables critical categorisation and description of trial actors and components. Transaction data is provided through one of two main channels, either directly from instrumentation equipment deployed across the project trials (e.g. RTUs, smart meters, ANM servers etc.), or indirectly via third-parties such as EV charging network operators (CNOs) or demand aggregators, who will collect the data directly themselves and then transmit data to the project as part of the trials being undertaken. Meta-data is primarily held on the project's participant management system (PMS) although network topology meta-data is held in the project's ODS, with all transactional data held in the ODS.

LCL is firmly committed to the robustness and accuracy of its empirical data and the subsequent analysis and conclusions drawn. Initial data quality has been variable across a number of project trials both in terms of meta- and transactional data and the project has had to expend significant manual effort on addressing data quality issues to protect and ensure the veracity of its data. Although not viable on an on-going basis, in the context of the one-off nature of the project, this is most often the most cost-effective approach.

The reasons for the variable data quality are various and can be summarised as:

- Limited manual or automated data validation prior to electronic input;
- Lack of cross-validation routines to identify incorrect data or to enable automatic data correction;
- Lack of clarity on the data master source and owner;
- The R&D nature of the LCL solution focuses on capture and analysis of trial data, and assumes a level of data quality, rather than building a sophisticated high-cost data validation layer into what is a one-off solution;
- The high volumes of transactional data in the project can quickly present sizeable backlogs if errors occur which then require significant manpower effort to resolve; and

- The embryonic state of some low carbon market-place actors such as some CNOs, who are still developing enterprise-level IT infrastructures which will guarantee data quality.

The project's trials are all underway and emerging learning is detailed in section six below. The *d*ToU tariff trials have seen a marked response from trial participants to the price signals communicated which have been manifested in changes in electricity consumption. The I&C demand side response trial has seen successful calls sourced from a variety of demand sources, including building turn-down, which requires a degree of coordination from both demand aggregator and their clients. The EV trial now has a 142 EV charging posts (CPs) metered in both residential and I&C contexts and is also working with the Centre for Transport Studies at Imperial College to analyse the data and underlying driving behaviours.

Whilst not holding any separate learning events, the project has contributed significantly to both the organisation, as co-host and much of the content of many of the sessions at this year's LCNF conference, in particular by sharing the full detail of the composition of the project's I&C DSR portfolio and examples of carbon impact and financial savings compared to conventional reinforcement. In addition, from the residential *d*ToU tariff trial, the project presented the results from the smart meter load profiles being collected as well as the consumer survey and kWhs moved as a result of the ToU tariff.

UK Power Networks has recently launched an innovation portal within its main public website (www.ukpowernetworks.co.uk/innovation). This represents a major investment by UK Power Networks in a comprehensive knowledge portal to be an enduring learning platform for all of our innovation activities, including other LCNF projects, as well as IFI, Technology Strategy Board projects and other innovation-themed initiatives.

The project continues to enjoy a high profile both nationally and internationally and is regularly presenting at conferences on its trials, objectives and emerging findings.

1 Project manager's report

1.1 Project overview

The project has no SDRCs scheduled for delivery during this reporting period however remains on track to deliver its remaining SDRC, which are all associated with the delivery of the project's final reports, on time and within budget. The project's remaining delivery timetable is illustrated in Figure 2 - Project timeline, below. The key activities during this period have focused on the continued operations of the project's various trials, the detailed design of the portfolio of final reports and focused residual recruitment in the remaining areas for participation, namely active network management of both EV charge post infrastructure and DG.

Data collection activities for some of the monitoring trials have been extended by three months to 31 March 2014. This has no impact either financially or on the delivery of the remaining SDRC and final reports and allows for a richer data set to be used for analysis, permitting additional seasonal winter data from January-March 2014 to be included for analysis. This includes the EV charging posts, EIZ instrumentation and small-scale embedded generation monitoring trials.

The project's residential *d*ToU trial will complete at the end of 2013, to be followed with a final survey to be carried out with participants in January 2014. The project's winter 2013 I&C DSR trial will also complete by 31 March 2014.

The instrumentation of the three EIZs provides a unique and comprehensive framework to capture and analyse the current performance of the HV and LV networks. The instrumentation exercise has involved the deployment and installation of over 130 three-phase smart meters at key locations on the LV network. This lowest-level of voltage data capture and analysis has been complemented by the upgrade of 89 existing RTUs at substations within the three EIZs and the deployment of 27 LV monitoring devices to capture specific LV feeder characteristics. All data collected from the monitoring equipment is stored in the project's ODS, which has been designed and built to reflect the precise network topology of the London Power Networks network.

The project continues to recruit and develop potential participants for the fully "active" ANM trial. There are two strong prospects, Bunhill Energy Centre, Islington, and the City of Westminster College, that the project is continuing to work closely with to develop a working commercial and technical proposition. The project is mitigating the lack of active ANM clients through the use of ANM to trigger I&C DSR within the summer and winter 2013 DSR trials, which will deliver the informed analysis and learning to meet the use case requirements submitted with the original bid.

The main focus going forward is on the delivery of the final reports. The portfolio of reports will be comprehensive and address the requirements originally set out in the project's use cases learning points and subsequent project direction. The report portfolio will comprise a set of reports delivered from Imperial College, based on the empirical data collected from the trials and subsequent analysis and extrapolation to GB levels of interpretation. These will be complemented by a further set of reports produced by UK Power Networks that focus on the DNO considerations, perspectives and impacts that serve as useful guides to DNOs regarding the management and development of LCTs and smart electricity distribution networks.

This combined integrated portfolio will represent a comprehensive library of outputs that are underpinned by empirical data with high levels of statistical confidence and precise demographic profiling. The reports will subsequently be capable informing investment not just for London, but other cities both within GB and internationally. The attention to detail applied during the project's trials to ensure the statistical and demographic validity enables extrapolation to national and international levels of analysis. The DNO-centric reports will provide integrated but complementary practical guidance for DNOs on future developments and investment strategy through RIIO-ED1 and beyond.

Figure 2 - Project timeline
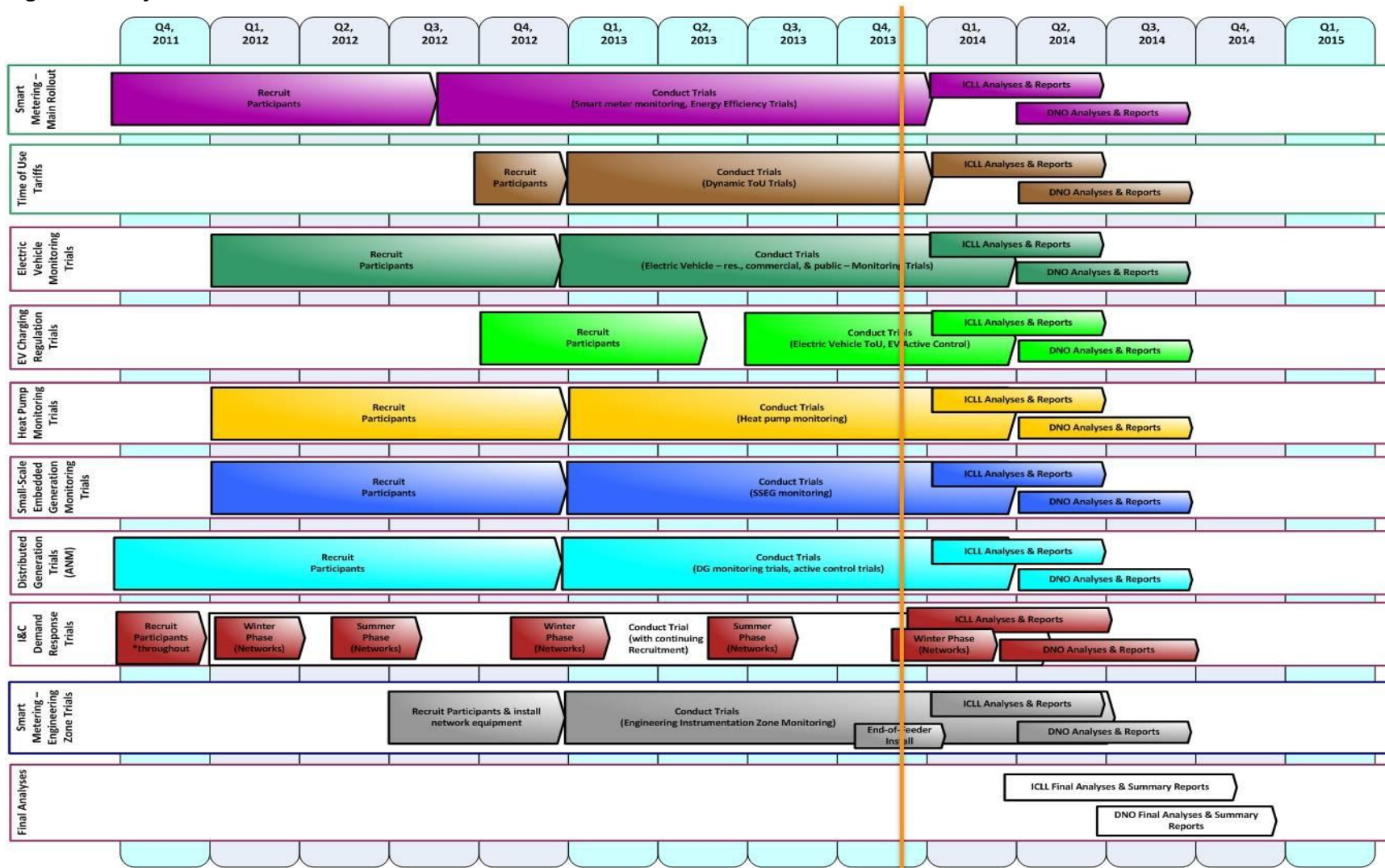
1.2 Project trial updates

1.2.1 Smart meters and dynamic time-of-use tariff trial (dToU)

The project is nearing completion of the year-long "dToU" tariff trial. This ground-breaking trial for the UK has 1,065 smart meter customers enrolled into a year-long trial with EDF Energy's "economy alert" tariff scheme, which helps understand residential demand side response – i.e. how people change their energy consumption behaviours in response to electricity price variations. The results of the trial will help inform whether and how price can be used to reduce peaks in electricity demand profiles, in response to planned or unplanned events. A subset of the project's remaining near 5,000 smart meter population provides the control group to allow precise analysis of the trial population's detected electricity behaviour changes. The demographically balanced profiles of both the trial and control groups have been precisely built to represent London and also enable extrapolation to national and international levels of analysis.

The trial is based on price changes being communicated to participants via their smart meter IHD and also via SMS if the participant has given permission. The price signals are sent out 24 hours in advance of the price change coming in to effect and the tariff change can operate for a period of between one and six hours. The dToU trial is based on a three-tier tariff, with a "low" price of 3.99p/kWh, a "normal" price of 11.76p/kWh and a "high" price of 67.2p/kWh. On completion of the high or low price window the tariff usually reverts back to the normal tariff band but on occasion this has been varied to incorporate combinations of high and low tariffs immediately following each other.

All trial participants have a safety-net reconciliation process and guarantee that ensures that at the end of the trial they will not have paid any more for their actual electricity consumed than if they had stayed on their pre-trial tariff. Any upside gained during the trial is theirs to keep.

The trial has enabled the project, through the low price tariff, to simulate wind-twinning by encouraging participants to bring forward energy consuming behaviours by giving them 24 hours advance notice of the price change. Similarly, the trial has simulated peak load avoidance by use of the high tariff to discourage energy consumption behaviours at the times indicated by the price signal communicated.

Over the course of the 12 months of the trial, participants will have been sent 161 separate price change signals, split between 69 high price signals and 92 low price signals. Within this reporting period a total of 61 separate price signals have been communicated, split between 22 high price signals and 39 low price signals. Table 2 below, sets out the monthly breakdown of price signals during this reporting period.

Month	Low price signals	High price signals
July	7	4
August	5	2
September	4	4
October	8	6
November	8	3
December	7	3

Table 2 - Monthly analysis of dToU price signals

The project's remaining smart meter population currently comprises almost 5,000 smart meters, all EDF Energy customers. The project has recently signed a contract with British Gas to contribute data from up to a further 10,936 smart meters located in London. Both these populations together will

represent the largest GB sample of smart meters ever constructed and the data from the meter population together with the associated meta data gathered from surveys on both premises and households will enable a review of the Profile Class 1 demand curve with detailed customer context data obtained from the associated surveys. The installation experience will also provide essential insights and learning to inform the national smart meter roll-out, in particular the level of DNO interventions that can be expected.

Figure 3 below illustrates the distribution of the project's smart meter population from EDF Energy.

Figure 3 - Smart meter distribution across London (EDF Energy)

The smart meter population was carefully constructed against a precise target demographic profile to enable accurate extrapolation to a London-wide context and beyond to other large cities and to national and international levels contexts. The *d*ToU trial evaluates a range of important smart grid considerations:

a) The measurement of consumer response to peak load avoidance;
b) The investigation and modelling of network reinforcement deferral through peak load avoidance;
c) Constraint management modelling of planned outages; and
d) Supply following – for the integration and absorption of renewable generation at a GB-level, as part of a de-carbonised generation fleet.

By testing the elasticity of residential demand in response to price variations the project can gain critical insights to the above applications. The early findings from the *d*ToU trial are clearly indicating the impact on demand of the dynamic tariff changes, as shown in Figure 4 below.
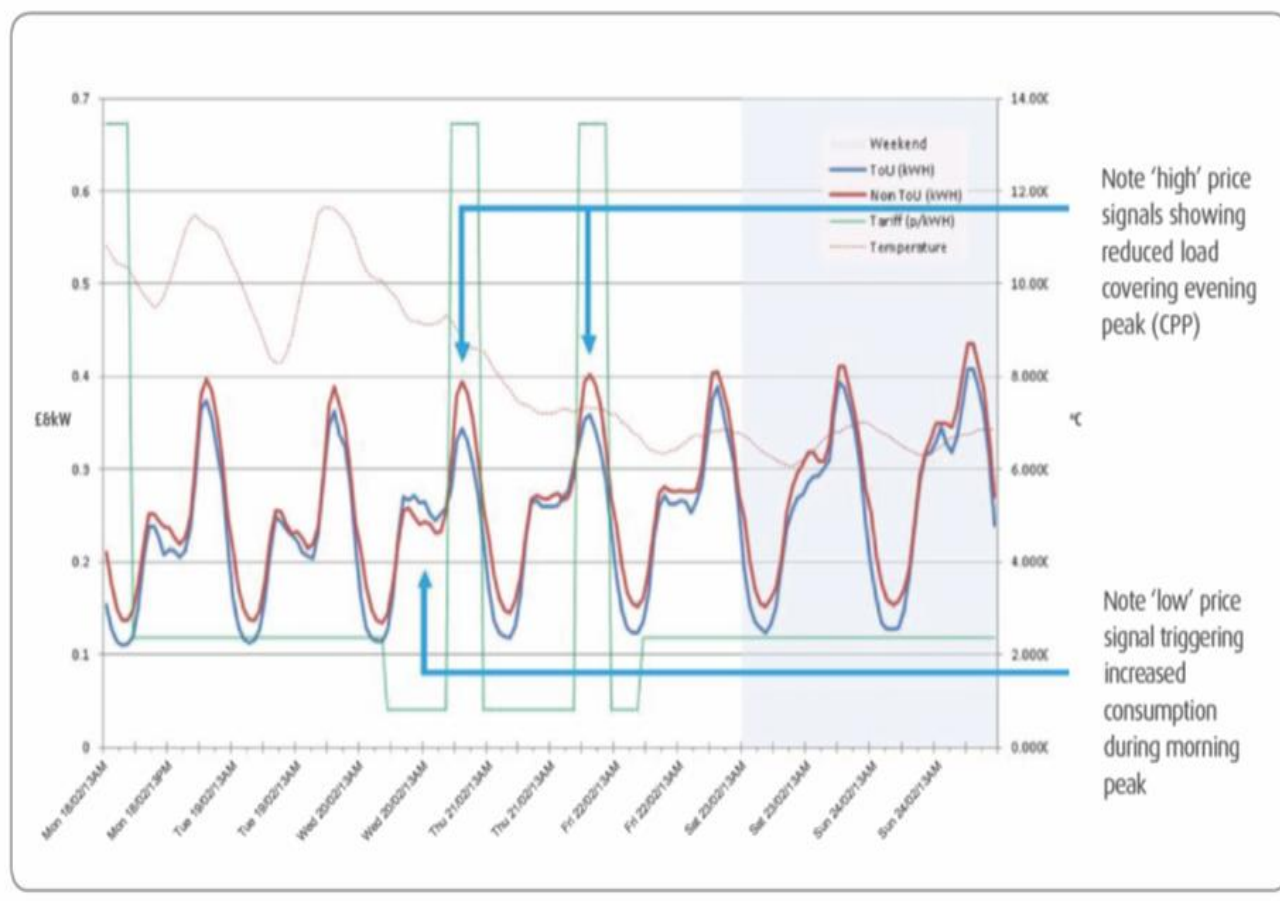
Figure 4 - *d*ToU impact on residential demand

Figure 4 above illustrates a weekly analysis from early in the trial's operation in February 2013. The graph clearly shows a reduction at times of peak demand in the trial (blue) group, when compared against the control (red) group's consumption at similar times of the day. Conversely, the *d*ToU sample group use more electricity during times when the "low" tariff is in operation, when compared against the control group's energy consumption at the same times of the day.

Figure 5 below reinforces this clear differentiation between the trial group (in this case, orange) and the control (in this case, blue) group with the definite skew of the *d*ToU participants to the lower right quadrant indicating that on average they are increasing their electricity consumption during the operation of the "low" tariff and decreasing the consumption at times when the "high" tariff is in operation.
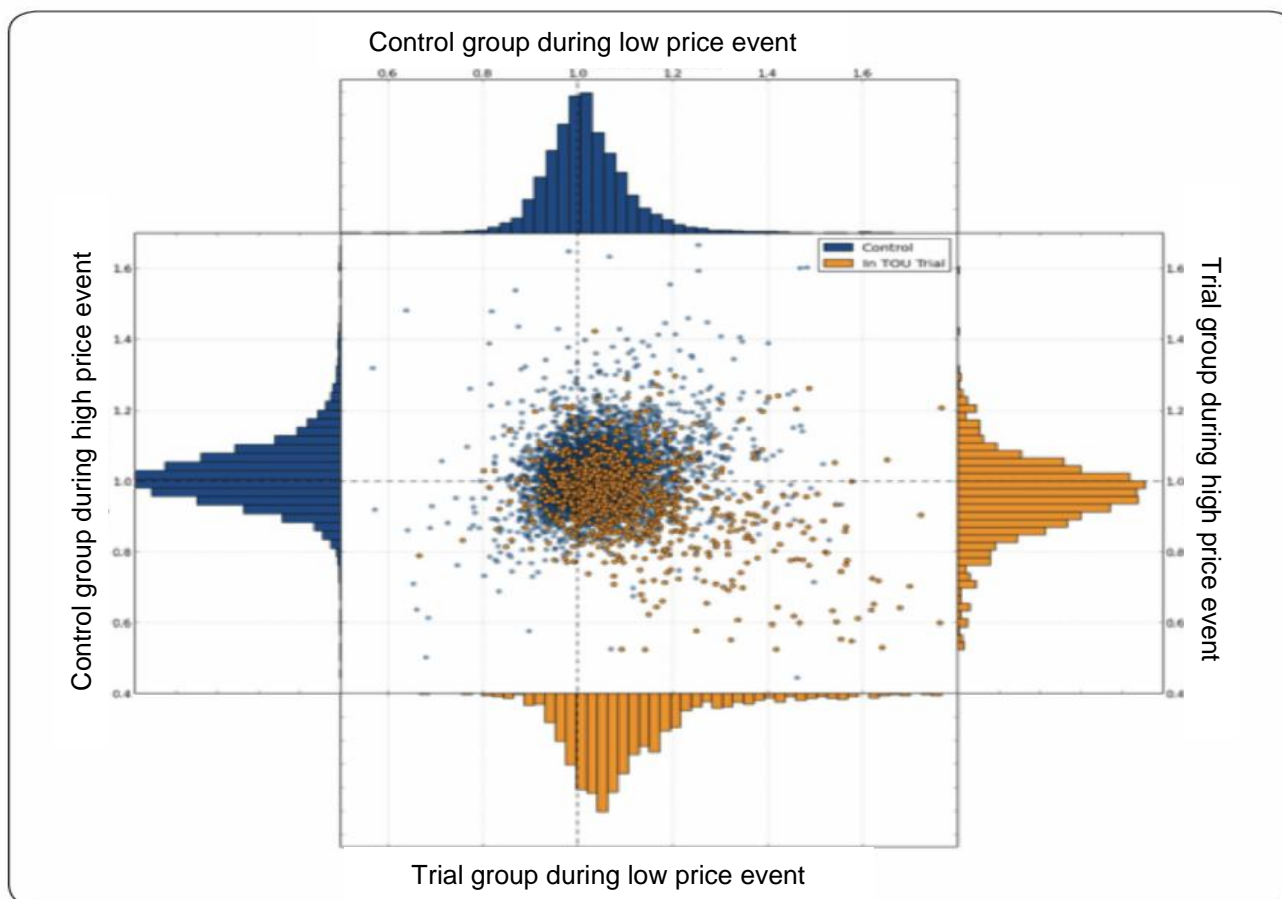
Figure 5 - Variance in energy consumption of *d*ToU group (orange) from control group (blue)

The project will continue to operate the trial until its completion on 31 December 2013. Subsequently, a detailed survey will be carried out with trial participants to complete the trial phase. Work is already well in progress to manage the smooth transition of participants out of the *d*ToU tariff trial and back onto EDF Energy mainstream tariffs at the end of the trial.

Following the completion of the trial, the detailed data analysis activities will continue to develop the content for the relevant final reports. The reports will include comprehensive coverage on the lessons learned, the reconciliation and settlement process and the DNO-energy supplier relationships needed to deliver the national rollout of smart meters commencing in 2015.

1.2.2 Instrumenting the EIZs

The project has a determined commitment to be able to accurately determine and baseline the performance of the HV and LV electricity distribution network, which has not been previously intensively monitored. Smart grids mark a significant step change in the complexity of distribution grids as measured across a broad set of measures. The numbers of events happening at any moment in time is increasing at a rapid pace and the energy flows are no longer uni-directional. The clarity of the "correct" response to a set of events for efficient management of the grid may not be a clear and unambiguous as has previously been the case in traditional grid scenarios and may require sophisticated multi-layered responses incorporating a variety of solutions and techniques.

The three EIZs have been established as a rigorous test-bed to be able to detect, capture and measure the impact of LCTs within the project's trials. The three EIZs are located in three of what were the Mayor of London's ten Low Carbon Zones, which were discontinued in early 2012, in

Brixton, Queens Park and Merton. Each EIZ contains a single 11kV HV feeder, along with the associated secondary substations and LV circuits. Monitoring equipment has been installed at these locations and in addition, further monitoring equipment has been installed at the remote ends of the LV feeders to better assess the performance of the LV network under these LCT operating conditions. The complete set of monitoring equipment comprises 89 upgraded RTUs at primary and secondary substations, 27 installations of specialist LV circuit monitoring equipment to monitor LV feeders and an array of 133 three-phase smart meters at remote ends of the LV network.

Figure 6 - Location of EIZs in London

All data collected is held within the project's ODS, which has been configured to reflect the precise network topology.

The data collected is being analysed to deliver the following outcomes:

a) Validation of current design assumptions and standards;
b) Identification of future considerations to facilitate the connection of LCTs;
c) Definition of the uses, benefits and optimal installation strategies for network monitoring equipment; and
d) How to measure and maintain regulatory compliance for network quality supply and voltage performance with network monitoring and smart metering infrastructure.

Figure 7 below shows a typical EIZ instrumentation installation on the LV network.

Figure 7 - Instrumenting the EIZs

The project has investigated the use of new network tools to assist in the planning and visual representation of smart grids, in particular with the DPlan software product. Products such as they that provide "what if?" features, enables different scenario outcomes to be created using differing smart grid assumptions and the consequent network impacts played out on the displayed network topology.

Figure 8 below illustrates an example simulated planning scenario, with particular areas of the distribution network requiring attention highlighted in red.

Figure 8 - DPlan scenario visualisation

The emerging findings from the instrumentation exercise are indicating that:

a) There may be geographically widespread voltage sag and swell issues as detected by installed non-SMETS smart meters. This is currently the subject of further detailed investigation and independent verification with other alternative equipment and an update will be reported in both subsequent progress reports and the project's final reports;

b) Data quality issues in legacy IT systems will need systematic attention to ensure enduring on-going accuracy of all grid-related data; and

c) Data communications can present real issues in achieving robust predictable and timely transmission of data. The required location of the equipment is often in situations that have poor or non-existent mobile data communications (e.g. GPRS) reception and so ancillary external antennae may need to be installed or alternative locations sought for the equipment installation.

The instrumentation of the EIZs has deployed a variety of measurement equipment. Table 3 below describes the equipment used and the data collected.

Table 3 - Instrumentation used

Monitoring Equipment	Measurement	Statistic	Units	Phase
EDMI MK7B	Real power	avg.	W	Single
	Reactive power	avg.	VAR	Single
	Apparent Power	avg.	VA	single
	Phase Angle Main	avg.		single
	Current	min, max, avg.	A	single
	Voltage	min, max, avg.	V	Single
	Voltage THD	avg.	%	Single
	Current THD	avg.	%	Single
EDMI MK 10A	Real power	avg.	W	A,B,C
	Reactive power	avg.	VAR	A,B,C
	Voltage	min, max, avg.	V	A,B,C
	Voltage THD	avg.	%	A,B,C
	Current THD	avg.	%	A,B,C
HV Substation Monitoring Device Remsdaq Callisto 1 RTU	Current	avg.	I	A,B,C
	Voltage	avg.	V	A,B,C
	Real Power	avg.	kW	A,B,C
	Reactive power	avg.	kVAR	A,B,C
	Apparent Power	avg.	kVA	A,B,C
	Power Factor	avg.	n/a	A,B,C
	Voltage THD	avg.	%	A,B,C
	Air temperature	avg.	degrees	A,B,C
	Current THD	avg.	%	A,B,C
	Harmonic Content (1st-50th)	avg.	%	A,B,C
Primary Substation Monitoring Device GE Converteam T5000 or 5500 RTU	Current	avg.	I	A,B,C
	Voltage	avg.	V	A,B,C
	Real Power	avg.	kW	A,B,C
	Reactive power	avg.	kVAR	A,B,C
	Frequency	avg.	hz	A,B,C
	Power Factor	avg.	n/a	A,B,C
LV Substation Monitoring Device	Current	Max, min, avg.	I	A,B,C

Monitoring Equipment	Measurement	Statistic	Units	Phase
EMS Sub.net LV	Current THD			
	Voltage	Max, min, avg.	V	A,B,C
	Voltage THD			
	Real Power	Max, min, avg.	kW	A,B,C
	Reactive power	Max, min, avg.	kVAR	A,B,C
	Apparent Power	Max, min, avg.	kVA	A,B,C
	Voltage Harmonic Content (1st-50th)	Max, min, avg.		A,B,C
	Current Harmonic Content (1st-50th)	Max, min, avg.	%	A,B,C
LV Feeder Monitoring Device - 3 phase connections EDMI MK 10A	Current	Max, min, avg.	I	A,B,C
	Voltage	Max, min, avg.	V	A,B,C
	Real Power	Max, min, avg.	kW	A,B,C
	Reactive power	Max, min, avg.	kVAR	A,B,C
	Apparent Power	Max, min, avg.	kVA	A,B,C
	THD	Max, min, avg.	%	A,B,C
LV Feeder Monitoring Device - single phase connections Outram PM100	Voltage	Max, min, avg.	V	A
	Voltage THD	Max, min, avg.	%	A
	Current THD	Max, min, avg.	%	A
	Harmonic Content (1st-50th)	Max, min, avg.	%	A
	Flicker			A
	Transients			A
LV Feeder Monitoring Device - Temporary installations Outram PM7000	voltage	Max, min, avg.	V	A,B,C,N
	Voltage THD	Max, min, avg.	%	A,B,C,N
	Current THD	Max, min, avg.	%	A,B,C,N
	Harmonic Content (1st-50th)	Max, min, avg.	%	A,B,C,N
	Flicker			A,B,C,N
	Transients			A,B,C,N
	Real Power	Max, min, avg.	kW	A,B,C,N
	Reactive Power	Max, min, avg.	kVAR	A,B,C,N
	Apparent Power	Max, min, avg.	kVA	A,B,C,N

1.2.3 Electrification of heat and transport

The electrification of heat and transport will result in a significant change in the demand and generation profile on the electricity distribution network. The shift away from fossil fuel based sources of energy for heating and transportation leads to the increased electrification of heating and transportation as well as the uptake of small scale embedded generation. The project's trials in this sector set out to understand the impact on the electricity distribution network through monitoring these LCTs.

Transport

The project has established a sizeable population of EV charging posts that are being instrumented with dedicated EDMI MK7A single-phase or MK10A three-phase smart meters that capture a range of voltage characteristics in addition to EV charging consumption data. The project has developed an EV charge post monitoring population of 142 posts, 78 being located in residential premises, typically

serving just one EV, with a further 66 posts located in I&C locations where the posts may each be servicing more than one EV. The project has also worked with UK Power Networks, POD Point and London Underground Ltd (LUL) to monitor 120 EV charge posts installed in LUL car parks. Where the project has installed its own EDMI meters the relevant data is collected from those devices via EDMI's own smart meter head-end system. The project also collects public EV charging post information directly from the various charging network operators' own IT systems.

The project is also operating a trial with leased Nissan LEAFs, with 25 residential and seven I&C participants. These EVs have additional tracking equipment fitted to them to enable analysis of both charging behaviours and driving patterns. The project has been working with the Centre for Transport Studies located at Imperial College to develop the specialised analysis framework using this data.

LCL has also enrolled 10 participants with Mercedes-Benz Smart ED EVs who are on EDF Energy's static time-of-use Eco20:20 tariff which offers 20% discount on electricity between 2100-0700 on weekdays and any time at weekends which is aimed at the EV market and customers with micro-generation. These participants have had an EDMI MK7A smart meter installed on the local radial circuit supplying the EV charging posts, to enable EV charging consumption data and voltage characteristics to be gathered.

LCL is operating an innovative trial that explores the potential to actively control and manage the charging of EVs at peak times. This trial has been established by devising an EV charging management framework using POD Point's Carbon Sync EV charge post management solution in conjunction with Smarter Grid Solution's active network management framework. This trial is using 168 charge posts in the POD Point network. Further details can be found in section 1.2.3 below.

Table 4 below details the overall EV monitoring framework.

EV component	Numbers monitored	Notes
Residential EV charge posts	78	All EDMI MK7A single-phase meters (10 on EDF Energy's Eco20:20 static time of use tariff)
I&C EV charge posts	65	19 EDMI MK10 three-phase meters, 46 EDMI MK7A single phase meters
Public EV charge posts	1251	Operated across London by four EV charging network operators (CNOs)
London Underground Ltd car parks EV charge posts	120	Part of the active peak load EV charging management trial
POD Point charge posts	48	Part of the active peak load EV charging management trial
Residential Nissan LEAFs	25	Fitted with data loggers to enable analysis of driving and charging patterns
I&C Nissan LEAFs	7	Fitted with data loggers to enable analysis of driving and charging patterns

Table 4 - EV trial components

The data from the trials will ultimately inform DNO investment decisions by assessing and quantifying the contribution the electrification of transport will have on network loading. The findings emerging from the trials demonstrate the early charging patterns and load profiles.

Figure 9 below illustrates the emerging charging pattern for residential EVs averaged over the period July-September 2013, with a skew towards evening charging of EVs.
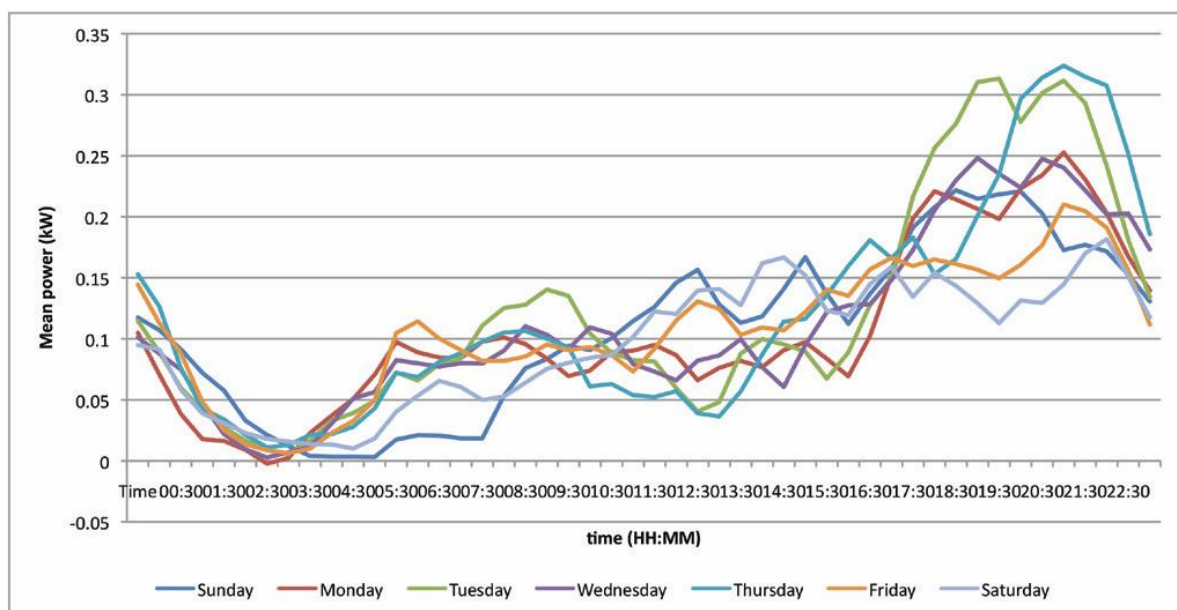
Figure 9 - Residential EV hourly charging profile

The data from I&C charge posts illustrated in Figure 10 below shows a different charge pattern, with a peak starting earlier in the afternoon. This data is averaged from data gathered April-September 2013.
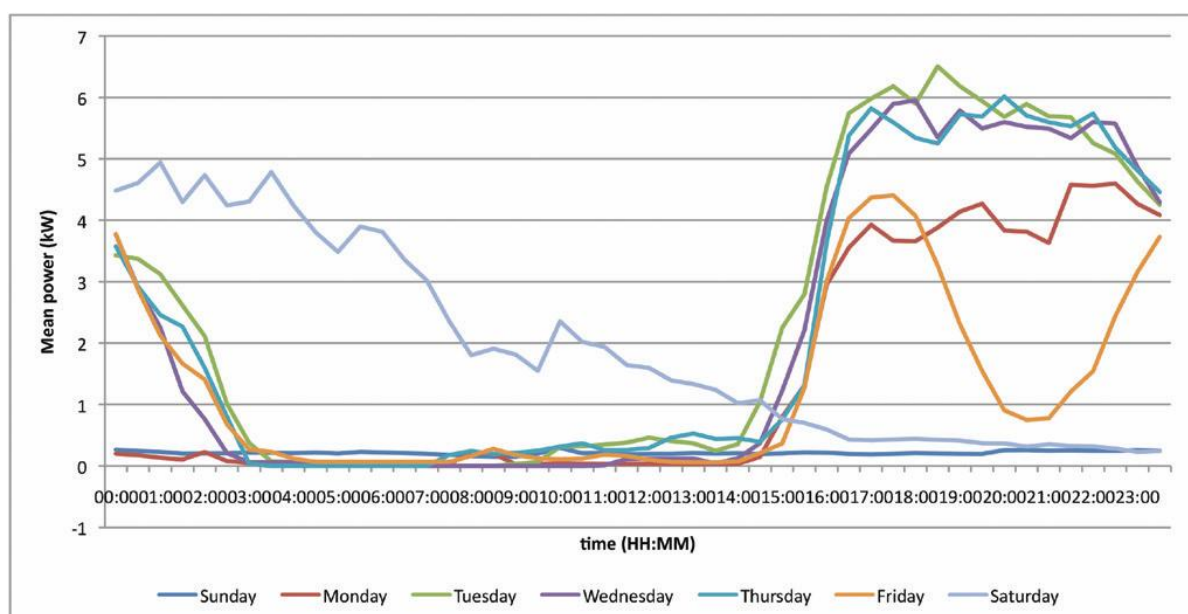

Figure 10 - I&C hourly charge patterns April-September 2013

The numbers of EVs in use within Great Britain has been impacted by economic factors with actual numbers below forecasts in place at the start of the project. However, the variety of EVs available is increasing with vehicle manufacturers bringing new models to the marketplace on a regular basis. The development of vehicles addressing range constraints using combustion engines has also given impetus to the EV marketplace, so the consumer has the option of three main categories of low-emission electrically driven vehicles, the battery EV (BEV), e.g. Nissan LEAF, the plug-in hybrid (PHEV), e.g. Toyota Prius, and range extending vehicles (E-REV), such as the Vauxhall Ampera or BMW i3. Forecasts from the Office for Low Emission Vehicles (OLEV) show a marked increase in

ultra-low emission vehicle (ULEV) numbers on UK roads from 2015 onwards[1]. An ULEV is defined as a vehicle having either a pure electric engines or plug-in hybrid engines or cars with CO2 emissions below 75 g/km at tailpipe.

The graph below in Figure 11 illustrates the average number of EVs plugged into Source London public charge posts per hour, for July-September 2013.
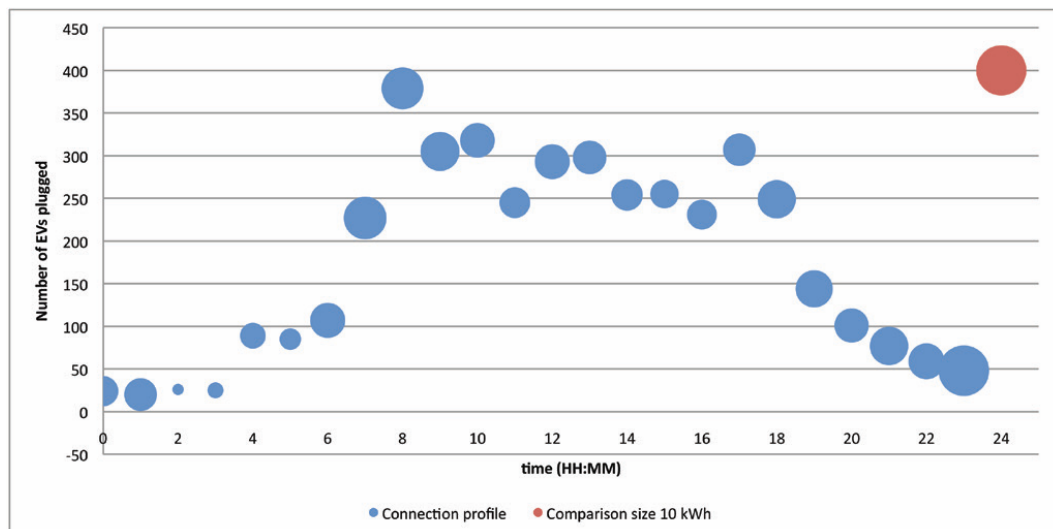

Figure 11 - Public EV charge post usage July-September 2013

The profile, when compared to the load profile in figures nine and ten, suggests that the duration of the charge when using a public charge post is less than that when an EV is connected to a private charge post.

E-car club

The project has also assisted in the establishment of "E-Car club", the UK's first entirely electric pay-per-use car club, with its first installation in Chrisp Street, London E14, officially opened by the Minister of State for Transport, Baroness Kramer, on 23 October 2013. The club offers pay-per-use of EVs, including both cars and vans, from £5.50 per hour together with an annual membership fee. Figure 12 below illustrates the E-Car club launch day.

Figure 12 - E-car club launch day

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[1] OLEV publication June 2011 - Making the Connection – The Plug-in Vehicle Infrastructure Strategy

Heat pumps

The project is currently monitoring three heat pumps. These are instrumented with EDMI MK7A smart meters and data is collected from EDMI's meter head-end system.

As part of the change request approved by Ofgem last year, it was recognised that due to a change in material circumstances outside of the project's control, the project would not meet its original objectives in heat pump recruitment. It was agreed with Ofgem however, as part of the change request that appropriate external data would be used to supplement the small number of heat pumps recruited to the trials. The project has arranged for additional heat pump data to be obtained from both the Energy Savings Trust and Passiv Systems Ltd. The data specification has been carefully constructed with input from Imperial College to ensure it meet the analysis requirements. Some existing data is available for use from these sources and is being enhanced with additional monitoring where appropriate.

Photo-Voltaic installation (Solar PV)

The project has enrolled a small number of clustered solar PV installations for detailed monitoring. There are 12 installations currently enrolled on the trial. Data is collected via EDMI MK7A meters and the EDMI smart meter head-end. All are typical residential ~4kW installations. The data collection process is underway with analysis of findings scheduled to start in 2014. The locations of the solar PV and heat pump installations are highlighted in Figure 13 below.

Figure 13 - Heat pump and PV clusters
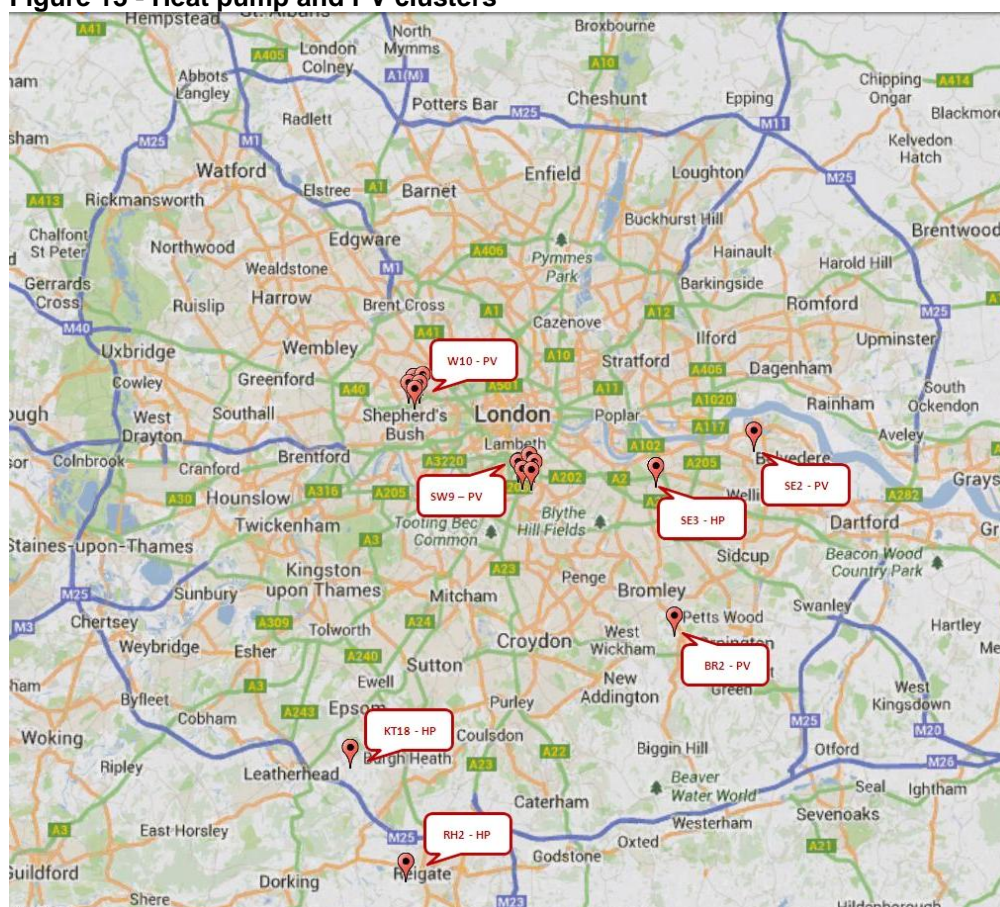
1.2.4 Active Network Management (ANM)

The increasing complexity of electricity distribution grids is largely being driven by the growing incidence of LCTs on the network. The efficient management of smart grid networks requires increased visibility and controllability of network components and parameters, connected devices and DG units.

ANM monitors the constraints or bottlenecks in the electricity network and controls both demand and supply in order to alleviate those constraints and maintain the network within its agreed safe operating parameters. This functionality also potentially provides a platform to both automate and distribute the management of key aspects of smart grids to improve overall system resilience and reduce the amount of data to be communicated and managed on a centralised basis.

The project is monitoring 12 CHP and two PV installations using ANM equipment. The data is transmitted from the ANM infrastructure installed at the local generation installation back to the project's ODS, using GPRS communications protocols.

The monitoring of the installations enables a better understanding of how both HV and LV connected DG units can be effectively monitored and controlled, as well as gaining a deep understanding of the differing control and management capabilities of the various DG units on the project's trials. The data collected is also enabling the development of performance characteristics of the various HV and LV connected DG units when under ANM control (e.g. ramp rates, response times etc.).

The project is continuing to progress recruitment of participants into a full active and currently is developing detailed technical and commercial propositions with two DG installations at Bunhill Energy Centre, Islington and the City of Westminster College to enrol them into an active trial. Both are CHP installations. Progress on this will be reported in subsequent progress and final reports.

ANM has been used to both manage I&C DSR over the summer 2013 trials and will also be used in the current winter 2013 DSR trial. When the power supplied through a constraint breaches the ANM thresholds, the participating sites are requested to decrease their consumption or increase their power export to alleviate the constraint. They are then 'released' and allowed to operate normally when the power flow is back within the safety parameters.

The summer 2013 DSR trial had both partially and fully autonomous events based on ANM-triggered DSR. The partially autonomous events remove the manual despatcher out of the loop, but are not yet wired into the building management system or the generator control. A building services manager on-site still has to trigger the response manually with the ANM system evidencing the response. The fully autonomous events had no manual interventions whatsoever, and involved two standby diesel sites that were able to exhibit a sub-three minute response when activated autonomously through ANM.

The ANM system successfully dispatched 10 autonomous DSR events and a further 8 via a manual trigger. These events occurred on sites grouped into two portfolios on two substations comprising building turndown and CHP.

Figure 14 below describes the ANM-triggered DSR system architecture used in the two DSR trials.
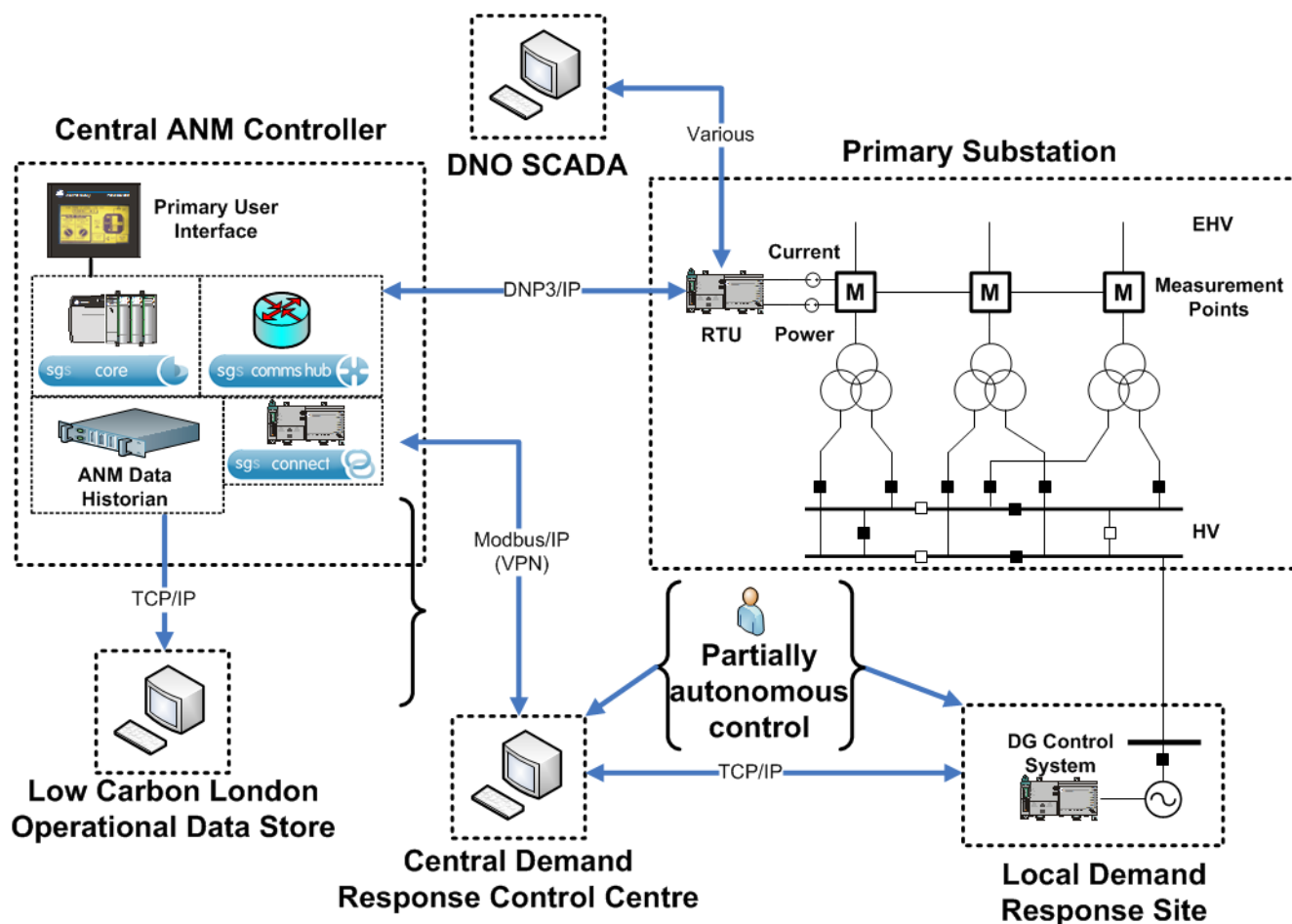
Figure 14 - ANM-triggered DSR system architecture

The anticipated rise in number of EVs in London over the coming years will result in significant change in demand profiles on the electricity distribution network. We are exploring the potential to use EV charge points as a load management resource via a new smart control system to help alleviate network constraints by briefly interrupting the flow of charge at peak times on a rolling basis. An interface has been created between the ANM system (developed by Smarter Grid Solutions) and the new EV charge point management technology called 'Carbon Sync', developed by EV charge point supplier, Pod Point. The system has been designed to have no noticeable effect for the end user. The trial will help UK Power Networks and other DNOs understand how effective the newly-developed control system is at providing rapid response, short term electrical load shedding. Figure 15 below illustrates the overall trial architecture.
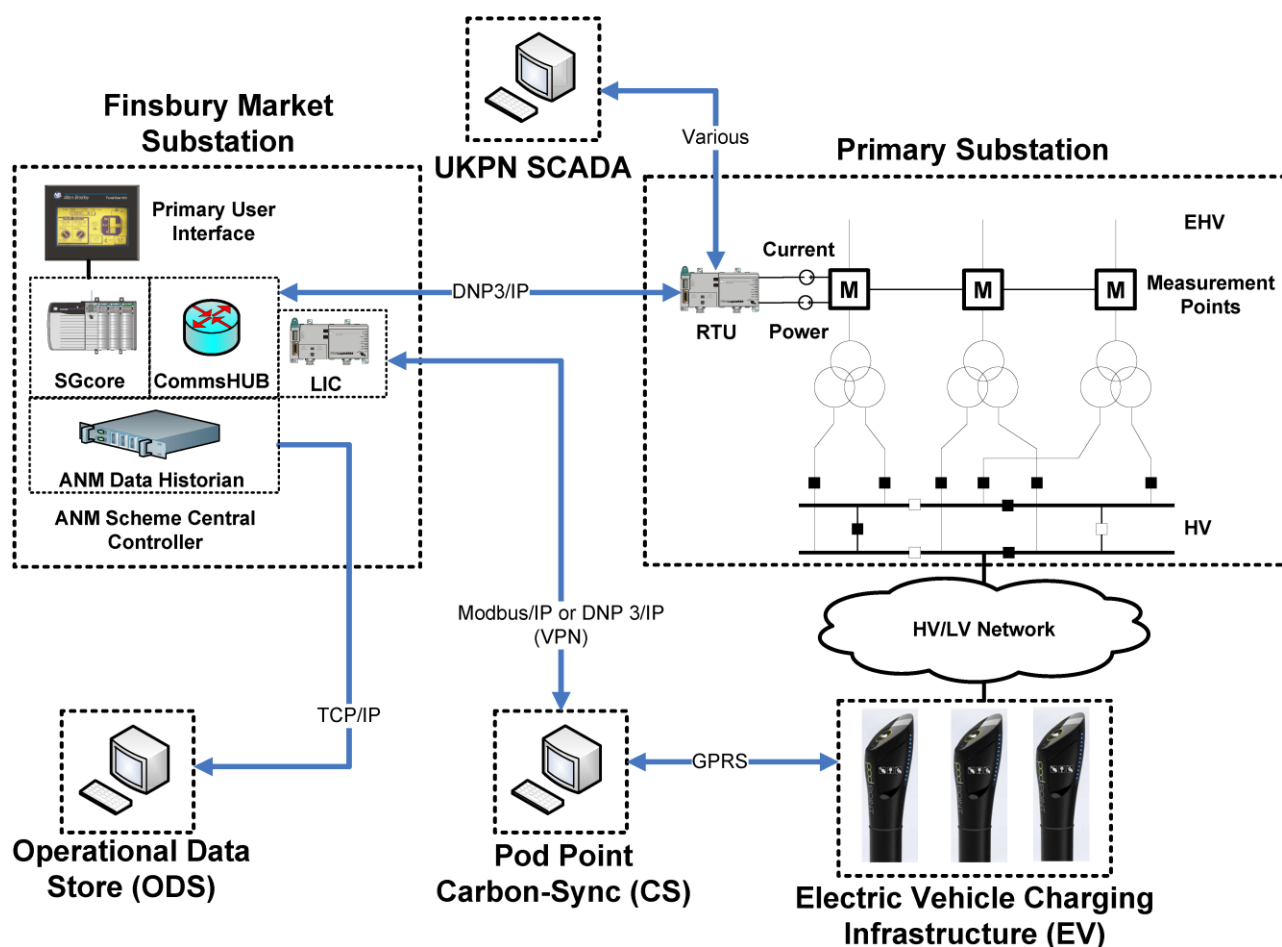
Figure 15 - ANM - EV charging trial architecture

The deployment of technologies such as ANM will allow DNOs to maximise the use of the existing network, avoiding or delaying the requirement to invest in new network infrastructure to enable for example, increased DG connections.

1.2.5 I&C Demand Side Response

The DSR trial has been investigating the ability of contracted demand aggregators to provide I&C-demand side response services, tailored to the specific requirements of the London Power Networks network through the control of I&C customers' generation and demand. UK Power Networks, together with aggregators, have recruited both generation and load reduction sites supplied by sub-stations identified as requiring reinforcement now or in the future.

Over the duration of project five separate DSR trials will have been completed, across both winter and summer periods, contracting with a variety of demand types, sizes and response mechanisms including CHP, diesel, and building turn down as well as combined hybrid responses. To date, over 100 successful DSR calls have been made providing over 200MWh of network support.

The project has been able to already deliver the committed real savings of £1.8m over the project's lifetime; this has been achieved through the deferred reinforcement of Ebury Bridge substation, achieved through the operation of a DSR service from within the project using one of the project's demand aggregator clients. This is underpinned by a formal derogation from Ofgem regarding the substation.

The emerging findings are demonstrating the reliability of I&C DSR to the extent that UK Power Networks in its recent RIIO ED1 submission have indicated the use DSR as a smart solution to traditional reinforcement with committed savings to customers of £38m across the period (2015-23). Assessment of the asset base in the UK Power Networks licenced areas as a whole have identified 12 sites where DSR is proposed to be used to defer reinforcement or support capital delivery and planned maintenance.

The trials are informing understanding of where and when DSR is a viable alternative to traditional reinforcement, through the testing of response times including sub 3 minute, 30 minute and day ahead, aligned to both planned and unplanned outage scenarios.

The trials have also enabled the development of commercial contracts suitable for deployment by a DNO that ensuring sufficient contracted capacity to confirm predictable delivery of required demand without unnecessary over-booking of demand.

The data from the trials is collected directly by the demand aggregators' infrastructure, or in the case of ANM-triggered DSR, the ANM infrastructure. This is then transmitted to and stored in the project's ODS for further analysis. Figure 16 below illustrates the effect of an actual DSR call from a four-site portfolio of hotel building turndown demand.
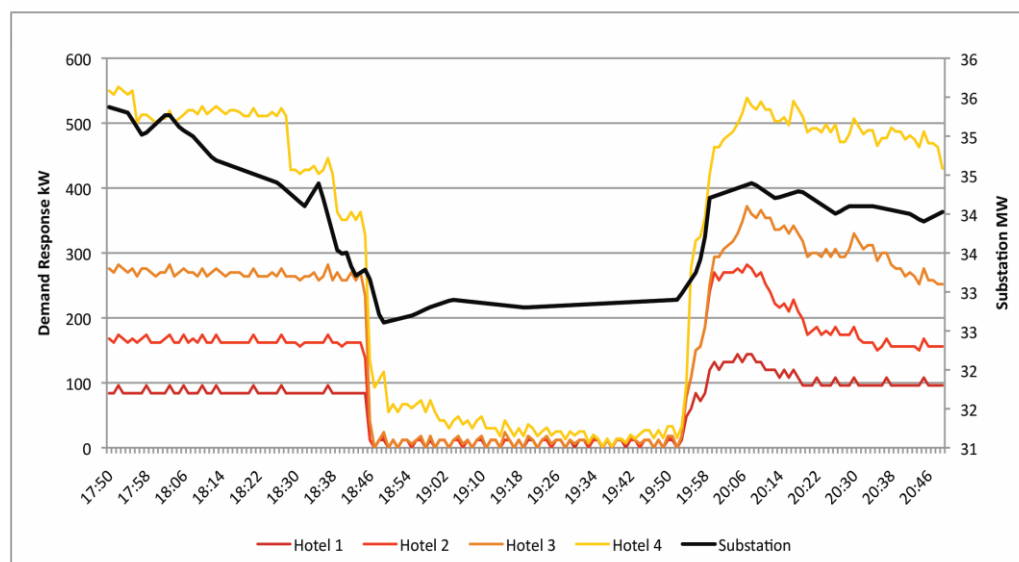

Figure 16 - DSR call impact

1.2.5 IT solution development

The IT solution has continued to be enhanced through this reporting period, with minor enhancements made to components as requirements are identified. The ODS has undergone continued enhancements to meet emerging requirements and address minor issues. The overall IT solution has also evolved to accommodate the additional trials of ANM-triggered DSR and the regulated EV charging trial employing ANM and Carbon Sync have required the IT solution to be enhanced.

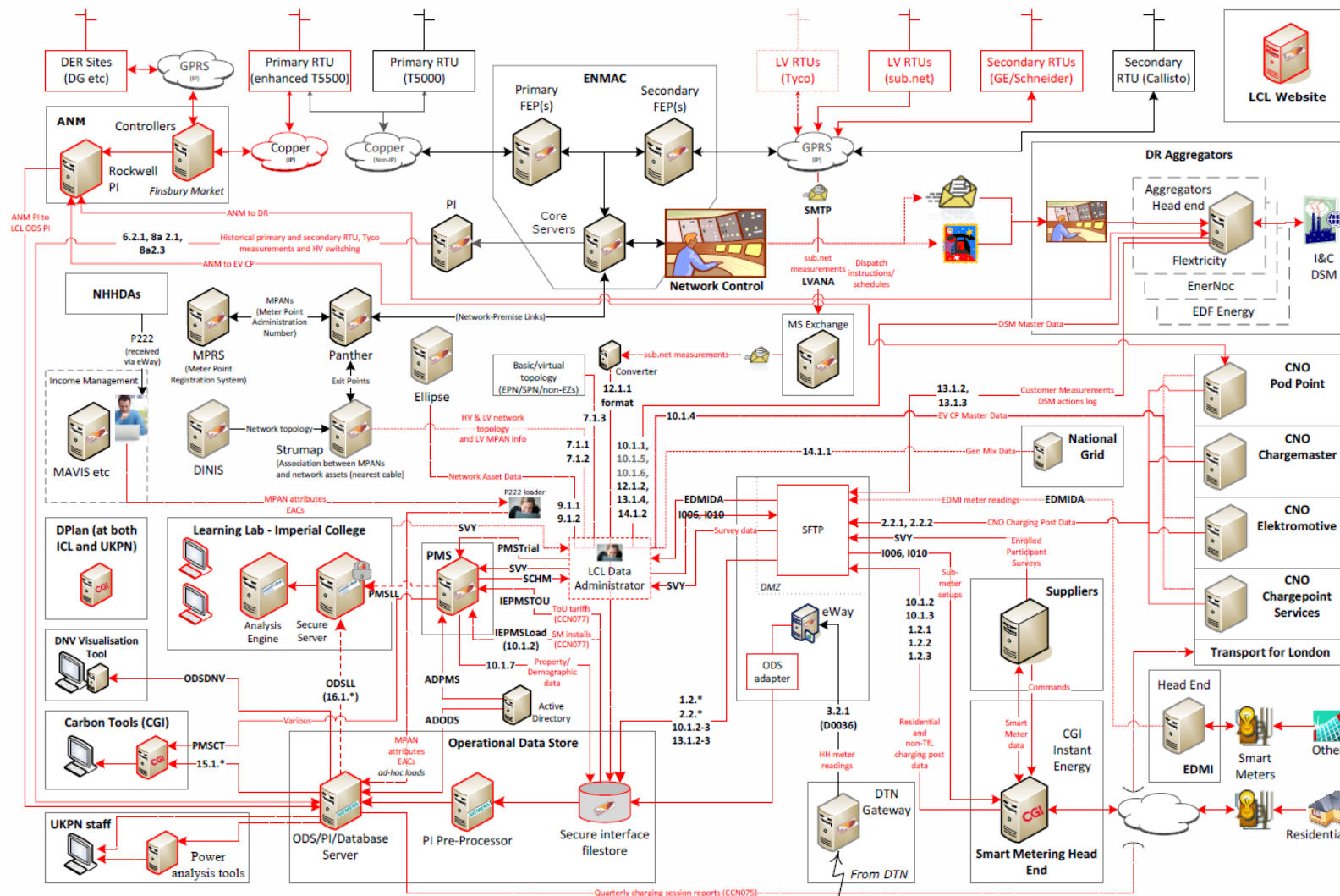Figure 17 below illustrates the current IT architecture.

Figure 17 - Logical IT architecture

1.2.6 Organisation

The organisation has continued to evolve with the needs of the project. The current project organisation is set out in Figure 18 below.
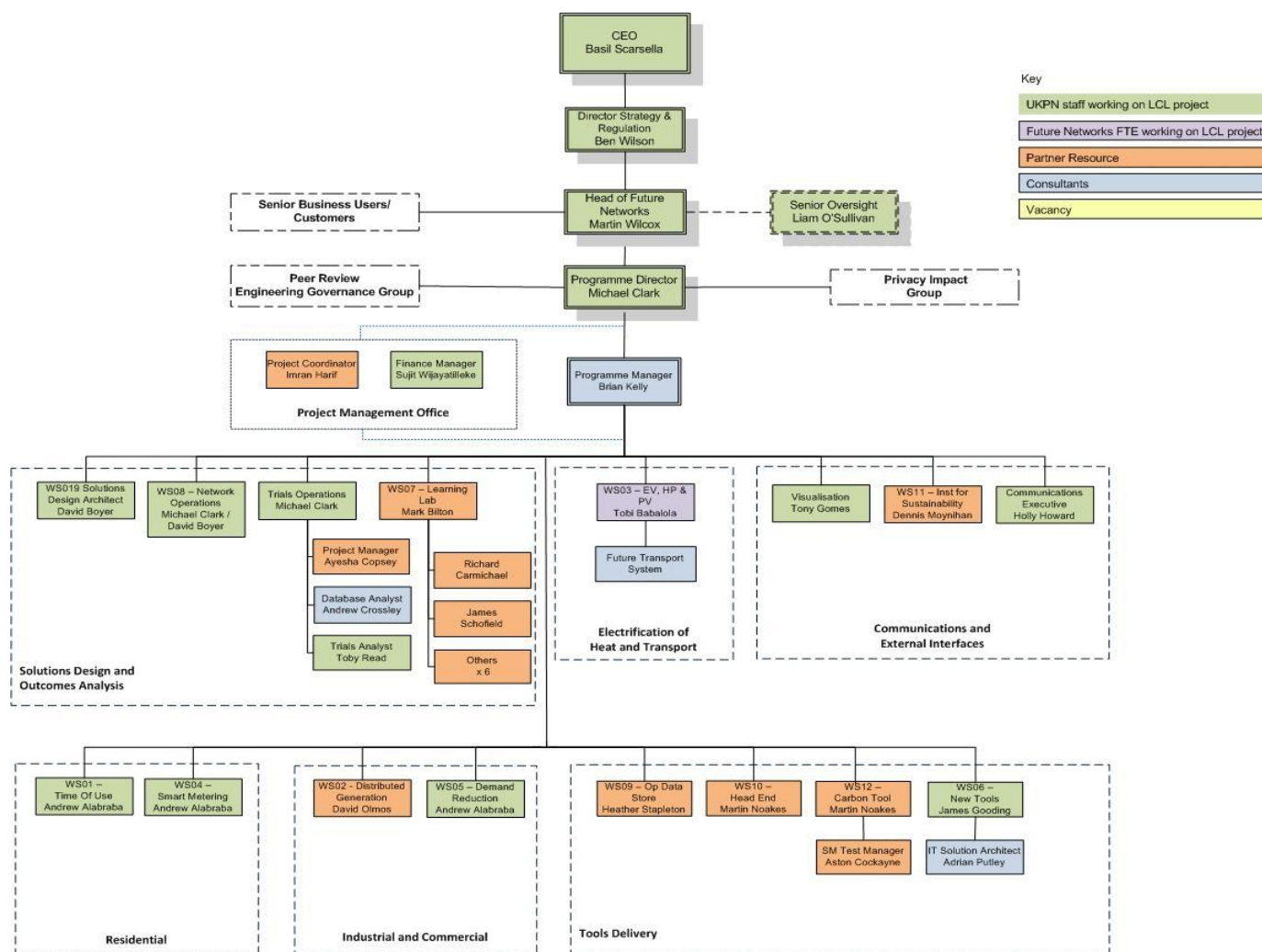

Figure 18 - Project organisation

1.2.7 Outlook for next period

The outlook for the next reporting period sees the completion of the project's various trials and the focus centred upon the production of the first tranche of reports. There are no significant risks identified by the project to place the outcomes of the activities for the next reporting period at risk. The first tranche of reports will be delivered by the Learning Lab at Imperial College London within the next reporting period and activities will be in progress across of the project's final reports.

There are two notable trials that will continue into 2014, the winter 2013 I&C DSR trial and a trial that has been established to test a key element of wind-twinning with DSR for the scenario of when there is a significant decrease in wind generation due to "storm cut-out". Working with one of the project's demand

aggregators, Flexitricity and working with Elexon, the project has contracted with two DSR clients, one with 3MW of standby diesel and the other with 2MW of CHP and 400kW of building turndown, to provide DSR to be despatched when there is a reduction of 30MW per minute or greater. Both these trials will complete by the end of March 2014.

2 Business case update

As mentioned earlier in the report, the project has already delivered the committed savings of £1.8m through deferred network reinforcement delivered through the project's DSR trial involving Ebury Bridge substation. The success of the DSR trials has enabled UK Power Networks to commit to a total of £38m of savings in its published business plan for the RIIO-ED1 period 2015-2023, with £13.5 of that total delivered directly through savings within the London Power Network alone.

Indirect benefits are built around use case learning points, which have been disseminated throughout the project via the various learning events organised. No formal learning events were held during this reporting period, however the project made a significant contribution to the annual LCNF conference held in November 2013, sharing the emerging learning from the DSR and *d*ToU trials in some detail.

The carbon impacts of the trials are being analysed and reported through the custom-built carbon tool.

Separately, a licencing deal has been concluded with a third party, which will have the net effect of bringing in additional income and reducing the overall cost of the project to consumers.

3 Progress against budget

The project is on track to meet all its commitments and SDRCs on schedule and within budget. Details of the project finances are contained in the confidential annexe.

4 Bank account

This section is contained in the confidential annexe.

5 SDRC

There were no SDRCs scheduled for delivery during this reporting period. The remaining SDRC for the project are all focused on the project's portfolio of final reports which will be delivered in three tranches scheduled for 30 June 2014, 30 September 2014 and 31 December 2014. The reports are primarily informed by analysis of the empirical data currently being captured through the project's various trials and work is well underway on the detailed work to scope the individual reports as well as an orchestration framework to ensure cross-report integrity during report production. Appendix one details the complete list of SDRCs and the status of each one.

In summary, the project's remaining SDRC are all on track to be delivered on time and the project does not foresee any significant challenges that will not be successfully mitigated through its risk management framework and process.

6 Learning outcomes

LCL is a stretching and ambitious project. It is breaking new ground in a number of areas against a backdrop of challenging economic and political conditions. The ethos within the project is to mitigate challenges and find innovative ways to deliver the anticipated learning points whilst remaining true to the original objectives and ambitions. These activities all contribute to the overall learning gathered by the project. The detailed design of the final reports is ensuring that the original use case learning points will all be addressed in the final reports' analyses, conclusions and recommendations.

The main learning outcomes this reporting period are set out below.

Commercial arrangements

The project has successfully utilised building turndown-sourced demand as part of its summer 2013 I&C DSR trial. This arrangement was delivered in conjunction with the project's demand aggregators and their clients and enabled the project to expand the variety of demand sources used in the DSR trial to include an important demand source.

The project also put in place a separate commercial arrangement with one of the demand aggregator partners, Flexitricity and the ANM partner, Smarter Grid Solutions. This arrangement underpins the ANM-triggering DSR trial which featured in the summer 2013 DSR trial and will also be the mainstay of the winter 2013 DSR trial.

As highlighted in the formal change request approved by Ofgem in December 2012, challenges still continue to be faced in recruiting participants for the full active ANM trial. The project continues to develop potential trial participants for this trial but finding a commercial proposition that is both viable and attractive to potential participants requires continued investigation. The project has previously commissioned independent market research that identified significant gaps in the level of understanding within the market-place and a climate of reduced management bandwidth to invest the time to gain that understanding.

The project has also developed a set of commercial arrangements to enable two EDF Energy customers with PV installations to participate in the small scale embedded generation (SSEG) monitoring trial.

A set of commercial arrangements were developed by the project, underpinning the leasing of 25 Nissan LEAFs for inclusion in the project's residential EV monitoring trials as well as a separate commercial lease agreement that enabled a further eight vehicles to be placed with six I&C companies.

Table 5 below summarises the main commercial artefacts developed this period.

Commercial Arrangement	Trial	Comments
Personal EV leasing scheme	EV monitoring	25 Nissan LEAFS leased to private individuals
I&C EV leasing scheme	EV monitoring	Eight Nissan LEAFs leased to six separate companies
Building turndown	Summer 2013 DSR trial	Hotel group providing demand to aggregators
Residential PV participation arrangement	PV monitoring	Two EDF Energy customers with PV installations

Table 5 - Commercial arrangements developed this period

Customer engagement

The recruitment of participants for the full active ANM trial continues to be met with resistance from potential participants, although three potential customers, Greenwich Power, City of Westminster College and Bunhill Energy Centre continue to be developed as potential participants for a trial to operate in Q1 2014. Each prospect requires the development of tailored technical and commercial proposals, with several rounds of negotiation between the various stakeholders, hence the prolonged recruitment period and sizeable management bandwidth required to progress to a satisfactory conclusion.

A recruitment letter, welcome letter and frequently asked questions (FAQ) list have all been developed this period, jointly with EDF Energy within the PV monitoring trial. This exercise generated two

participants from a small pool of six potential triallists. A "thank-you pack" has also been developed for use at the end of the trial in March 2014.

The *d*ToU trial completes at the end of this reporting period on 31 December 2013 and a set of trial close-down and transfer activities have been prepared to transition trial participants out of the trial and onto mainstream tariffs. These include an end of trial survey, thank you letters and the bill protection and reconciliation process that ensures that no trial participant will at the end of the trial actually pay more for their electricity used during the year's trial, than had they stayed on their pre-trial EDF Energy tariff.

The project has prepared carefully for the winter 2013 DSR trial and produced a document that describes the targeted recruitment to be undertaken by demand aggregators to fulfil the trial's technical objectives. This was shared with demand aggregators to provide recruitment guidance.

Table 6 below summarises the main customer engagement learning artefacts this period.

Customer engagement learning	Trial	Comments
ANM trial propositions	ANM	Bespoke commercial and technical arrangements for each potential customer. Significant management bandwidth required from the client (or their representative)
PV recruitment, welcome and trial completion documentation	PV monitoring	Recruited two participants from a small pool of six potential trial participants, making a total of 12 PV trial participants.
*d*ToU closedown documentation	*d*ToU	End of trial survey prepared for distribution in early January 2014. Arrangements developed by EDF Energy to transition trial participants from the dToU tariff scheme onto a mainstream tariff product. Reconciliation process in place to ensure bill protection for all *d*ToU participants

Table 6 - Main customer engagement artefacts this period

The project continues to enjoy a high profile both nationally and internationally and is frequently hosting visitors to the Learning Lab to explain the project's aims and objectives. This period has seen visitors from China, Japan and Europe all visit the project. The project has also presented at conferences and exhibitions, notably providing the keynote closing remarks at the Smart Metering Forum held in London in November 2013, which focused on the project's insights in smart meter trials, testing, interoperability and how the project's findings will be disseminated during 2014.

The UK Power Networks innovation microsite was launched in this reporting period and serves as a knowledge and learning portal for all the innovation projects underway within UK Power Networks, including LCL. This is a significant investment in a facility that is available to members of the public, other DNOs, academics and other interested parties and contains all the relevant information from the project. Figure 19 below illustrates the home page of the innovation portal.

Figure 19 - UK Power Networks innovation portal

UK Power Networks was the co-host of this year's LCNF annual conference held in Brighton with LCL featuring prominently in a number of the break-out meeting presentations as well as in the plenary and keynote sessions. The project also attracted much attention and interest within the conference exhibition, as shown in Figure 20 below.

Figure 20 - LCNF 2013 conference – Low Carbon London

The project also presented in two conference sessions on stakeholder engagement and DSR, as illustrated in Figure 21 below.

Figure 21 - Low Carbon London – LCNF presentations

A second video has also been produced by the project that provides a useful update on progress within the project's various trials. This has been used extensively both internally and externally as a learning dissemination tool that explains how the project's trial have been implemented and operated.

LCL has developed a comprehensive learning dissemination framework which articulates the overall approach and shapes the project's learning dissemination activities, as set out in Figure 22 below.

Figure 22 - Learning dissemination framework

The project's dedicated learning hub, the Low Carbon London Learning Lab, is located at Imperial College's School of Electrical Engineering, will feature prominently as the focus for learning dissemination is 2014. The facility has been widely used to analyse data gathered, present the project to interested parties and going forward will be the centre of learning dissemination of a technical nature. The facilities have been designed and installed to provide effective presentation, visualisation and learning dissemination of complex technical finings and analysis. Table 7 below lists the key learning outcomes from the Learning Lab to date.

Table 7 - Imperial College Learning Lab learning outcomes

Output	Title	Comments
Paper	Network Benefits of Energy Efficient Lighting - *22nd International Conference on Electricity Distribution Stockholm,*	10 June 2013
Paper	Application of demand Side Response and Energy Storage to Enhance the Utilisation of the Existing Distribution Network Capacity - *22nd International Conference on Electricity Distribution Stockholm,*	10 June 2013
Report	Distribution Network Impact of Electric Vehicles	5 December 2012
Report	Final reports - scope and deliverables	25 January 2013
Report	Final reports - scope, tasks, outputs and timelines	25 September 2013
Report	Data requirements briefing for power quality report	7 October 2013
Presentation	Learning Lab objectives and infrastructure	12 September 2011
Presentation	Understanding Consumer Behaviour, presentation for Low Carbon London Learning Laboratory Launch	5 October 2011
Presentation	Bottom modelling for application to Low Carbon London (Ofgem visit)	8 March 2012
Presentation	Learning Lab progress update	8 March 2012
Presentation	Low Carbon London - Project Update, Presentation for Ofgem	8 March 2012
Presentation	Understanding the Consumer - Residential ToU Trial	6 June 2012
Presentation	Learning Lab infrastructure and analysis	6 July 2012
Presentation	Network benefits of energy efficient lighting	21 February 2013
Presentation	Low Carbon London Dynamic time-of-use Tariff Trial	15 April 2013
Presentation	Dynamic Time-of-Use tariff trial (ToU learning event)	5 May 2013
Presentation	Learning lab workflow and tool requirements	5 July 2013
Presentation	Consumer engagement & the LCL Residential Dynamic Pricing Trial	15 November 2013
Document	Research Aims by Report	8 October 2011
Document	Briefing document on issues for SM/ToU trial design and recruitment	12 December 2011
Document	Control Group and Pre-treatment measure	18 January 2012
Document	Metadata requirements	3 May 2012
Document	Monthly dToU feedback design	1 July 2012
Document	*d*ToU notification strategy	1 August 2012
Document	Ofgem change request appendices one and two	1 October 2012
Document	Briefing document for Smart Meter trial design	9 December 2012
Document	ToU interview Discussion Guide	1 February 2013
Document	*d*ToU Control Group Exclusions	1 July 2013
Document	Planning Analyses of DSR and Savings	2 July 2013
Document	Draft summary skeletons for final reports	3 August 2013
Survey	Smart meter / dToU Household survey	3 April 2013
Survey	dToU closing survey	8 November 2013

As the project moves into its reporting and dissemination phases next year, the Learning Lab will function as a high-profile and prestigious centre for learning emanating from the project.

7 IPR

The project maintains a register of prospective candidates that may contain foreground IPR. The register is reviewed on a quarterly basis. The project copyrights potential artefacts to protect IPR emerging from

the project. The IPR register will be refined in the latter stages of the project as part of the project closedown and decommissioning phase in late 2014.

The current list of prospective candidates is included in the confidential annexe.

8 Risk management

LCL identified a number of key risks to the delivery of the project as part of its original full submission. The subsequent amendment request and revised full submission identified further key risks that had arisen since the original full submission. All these risks are detailed below, together with additional current key risks the project is mitigating.

The project maintains a comprehensive risk register and regularly reviews all risks as part of the routine project management framework. Risk status is reported in both weekly and monthly cycles, with the status of key risks reported to the project steering group on a regular basis.

Risk	Category / Owner	Impact/ Probability	Mitigation
INDUSTRIAL & COMMERCIAL			
Demand response – unable to recruit sufficient demand of the required type (*previously identified in original full submission*).	Recruitment / DNO	High / Medium	1. Business proposition shaped to compete with National Grid STOR. 2. Additional aggregators brought in to fill gaps. **Closed – summer and winter 2013 trials have a wide range of generation types and demand**
DISTRIBUTED GENERATION			
Insufficient levels of distributed generation available (*previously identified in original full submission and highlighted in formal Ofgem-approved change request December 2012.*)	Recruitment / DNO	High / High	1. Detailed market research undertaken with prospective participants. 2. Incentives offered to participate. 3. Innovative ANM solutions developed to expand potential trial participants. 4. ANM-triggering DSR trial undertaken 5. Regulated EV charging trial with POD Point and Smarter Grid Solutions underway 6. Three prospects (Greenwich Power, Bunhill Energy centre and City of Westminster College) being progressed with a view to full ANM trial participation.
SMART METERS			
May not be sufficient energy efficiency measures in place in the smart meter locations (*previously identified in original full submission*)	Recruitment/ / DNO	Medium / Medium	1. Develop detailed energy survey to determine exact measures in place with trial participants. 2. Supplement with external data and known trends. **Closed – surveys completed, external information on trends collected for analysis**
Installation issues relating to the installation of smart meters: a) site accessibility b) functionality c) data confidentiality (*previously identified in original full submission*)	Recruitment / DNO	Medium / High	**Closed – Smart Meter installs complete. Roaming SIM cards used, inaccessible locations dropped from trial. See data security risk below for mitigations with respect to data confidentiality.**

Risk	Category / Owner	Impact/ Probability	Mitigation
Take up of ToU tariffs may be low *(previously identified in original full submission)*	Recruitment / DNO	Medium / High	1. Provide incentives to participate and operate a safety net to ensure no customer is worse off when compared to what they would have paid on their current tariff. **Closed – trial has recruited sufficient numbers and with the required demographic spread to meet required statistical confidence levels.**
Poor SIM-card reception is smart meters *(identified in amended full submission)*	Recruitment / DNO	Medium / High	1. Use roaming SIM-cards to maximise telecommunications provider coverage **Closed – trial has successfully used roaming SIM cards and learning fed into national rollout planning**
Mayor's Low Carbon Zones represent a skewed demographic London, inhibiting potential extrapolation of findings to London and GB-wide levels of analysis *(identified in amended full submission)*	Recruitment / DNO	High / High	**Closed – Imperial College confirm that the Smart Meter roll-out has met its demographic targets. More detail is provided in Section 2.2.4.**
Unavailability of a SMETS-2 meter *(previously identified risk in amended full submission)*	Procurement / DNO	High / High	**Closed – Smart Metering installs complete, and used the various technical work-around mitigations discussed in previous 6-monthly reports.**
ELECTRIC VEHICLES			
Insufficient numbers of electric vehicles *(previously identified in original full submission)*	Recruitment / DNO	High / High	1. Offer incentives (e.g. free EV charging post) and discounted EV leasing schemes to attract participants. **Closed – project has recruited sufficient numbers of EV users**
The project is unable to add monitoring software to electric vehicle charging posts or control the use of the posts *(previously identified in original full submission).*	Installation / DNO	Medium / Medium	1. Residential EV charging posts are being instrumented with smart meters in-line with the dedicated EV charging post spur. 2. Intense instrumentation was undertaken of the public EV charging posts used at the Olympic Park during the 2012 Olympics and Paralympics. **Closed – EDMI MK7A smart meters have been installed. Data loggers installed on leased Nissan LEAFS.**
The majority of charging posts are privately owned and cannot be monitored *(previously identified in original full submission).*	Other / DNO	Medium / Medium	**Closed – The project has gained access to sufficient charge post data, as set out in Section 2.2.3.2. On-going monitoring takes place to ensure data continues to flow into the database (ODS) from these.**

Risk	Category / Owner	Impact/ Probability	Mitigation
Data security – requirements on 3rd party access to personal data (*previously identified risk in amended full submission*).	Other / DNO	High / High	1. Undertake data privacy impact assessment. 2. Establish data privacy governance framework. 3. Establish data privacy steering group. 4. Monitor all data access regularly to ensure compliance. 5. Work with partners' IT Security teams to ensure required data security measures are enacted and fit for purpose. 6. Data catalogue is being developed to documents all data sources, formats and storage arrangements
EIZ exit point instrumentation will all be in place by the end of Q2 2013 (*new risk not previously identified in original or amended full submissions*)	Other / DNO	Medium / High	1. Potential sites identified in all three EIZ. 2. Prices obtained for installation from Skanska to determine how many can be budgeted. 3. Prices obtained for feeder pillars and three phase meters, orders to be placed once Skanska price known. 4. Installations sites to be selected and prioritised. 5. Installation delayed due to wider Skanska parent contract negotiations, now in place. 6. Installation underway, forecast to complete in January 2014.
Installation of measurement equipment in LV substations may require derogations (*previously identified in original full submission*).	Installation / DNO	Medium / Low	1. No derogations required to date, nor expected in the future. **Closed – all LV substation monitoring installed without derogations.**
The collaborative nature of the project may lead to an infringement of the Competition Act (*previously identified in original full submission*).	Other / DNO	High / Low	1. The project works closely with UK Power Networks procurement to ensure no potential infringements 2. The project issued a formal invitation for expressions of interest to the demand response market-place when considering additional aggregators. 3. Regular briefings given to project team members on Competition Act requirements
A partner may withdraw from the project (*previously identified in original full submission*).	Other / DNO	High / Low	1. All delivery partners have signed collaboration agreements, enabling partners signatures are being finalised. 2. No partner has withdrawn to date and none are expected to withdraw. 3. All partners represented on project steering group and quarterly project partners meeting with UK Power Networks Chief Executive Officer to ensure engagement and pro-active management of any emerging issues.

Risk controls assurance

The project assures the effectiveness of the controls in place to manage risks through two key processes. Regular risk management workshops are held, as a minimum on a quarterly basis, where the existing risks held on the risk register are all individually review in detail. In addition, any new risks identified are proposed and reviewed at the workshop, for inclusion on the register, together with an owner and initial impact/probability assessment. The owner of the risk subsequently undertakes a full impact assessment and detailed mitigation, updating the risk register accordingly.

On a more regular basis, the status of existing risks is updated on a monthly basis through the reporting framework together. This is supplemented by a weekly review of key risks as part of the weekly project review meeting.

The effectiveness of the risk controls in place is managed through the Project Management Office providing an oversight analysis of risk status, highlighting those risks where the mitigation is not improving the risk status over time (i.e. ineffective mitigation). In addition, key risks are reported to the bi-monthly project steering group, where steering group members are encouraged to actively challenge the effectiveness of risk controls in place.

Learning from risk mitigation activities is captured as part of the project's workstream learning logs.

9 Consistency with full submission

The project is working to the full submission that was amended by the change request approved by Ofgem in December 2012. Following approval of the change request by Ofgem the project undertook detailed configuration reviews to ensure all aspects of the project were consistent with the amended full submission. This work was completed in January 2013 and continues to be monitored on a regular basis through the workings of the project's solution design authority and change management process. Figure 23 below illustrates the scope consistent with the full submission.
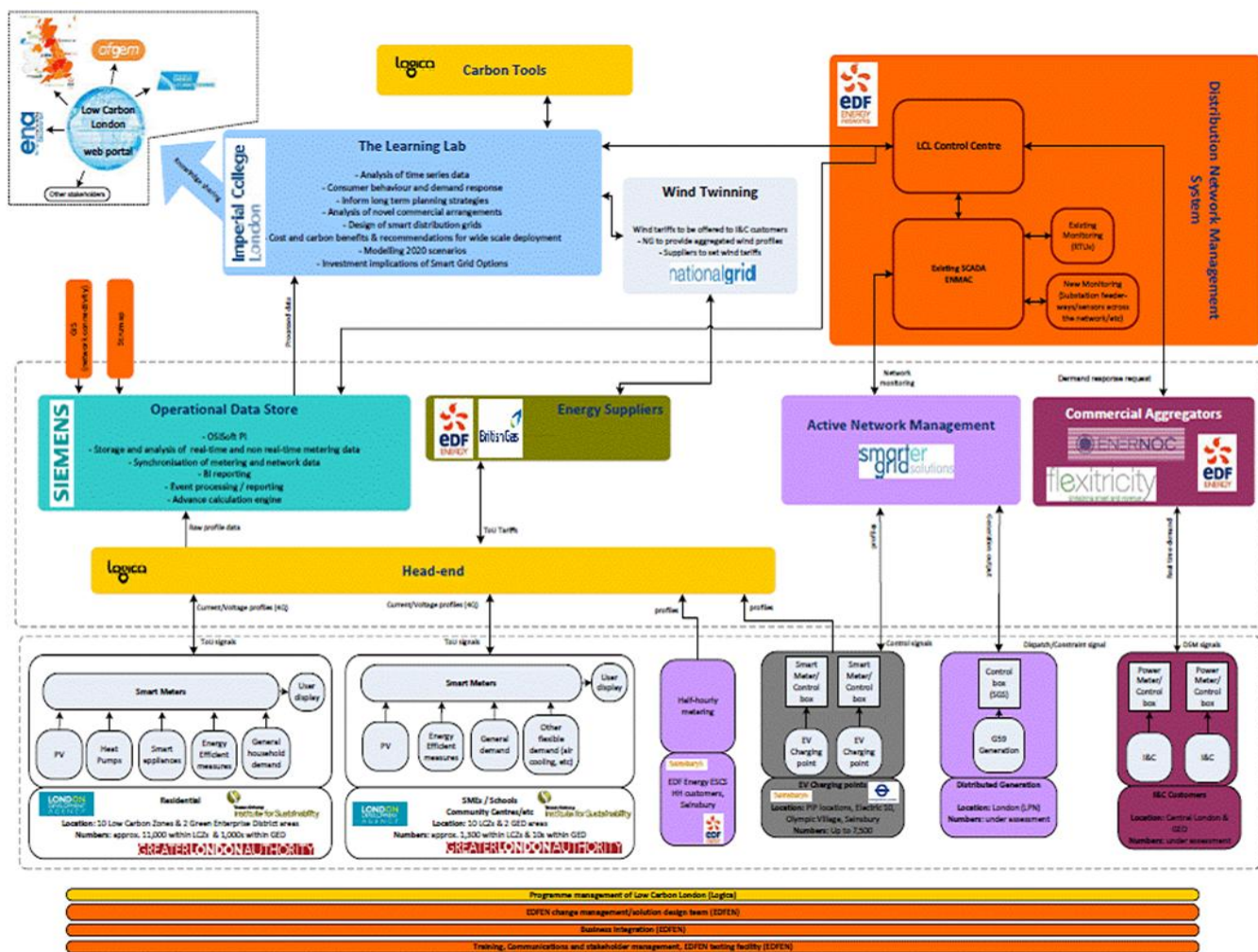

Figure 23 - Scope of full revised submission

10. Other

There are no other items to report.

11. Accuracy assurance statement

I hereby confirm that this report represents a true, complete and accurate statement on the progress of the Low Carbon London project in its sixth six-month period and an accurate view of our understanding of the activities for the next reporting period. A robust process was in place to produce the report.

Signed

Ben Wilson

Date

16/12/13

Ben Wilson
Director of Strategy & Regulation and CFO
UK Power Networks

Appendix 1 Successful delivery reward criteria

Successful Delivery Reward criterion	Evidence

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)
 	
Completed Q3, 2011
	Evidence – Outputs and Learning
	
	• Demonstration of the Learning Laboratory facilities at Imperial College with documented schedule of trials
	
	    o Clear visibility of scope of work packages
	
	    o Clear alignment to Use Cases
	
	    o Clear identification of project deliverables
	
	• Results of customer smart meter acceptance surveys
	
	    o Overall quantification of acceptance
	
	    o Identification of key concerns
	
	    o Actions to improve level of acceptance
	
	• Documented Privacy and Security strategy
	
	    o Overall risk assessment
	
	    o Identification of pinch points
	
	    o Scope for risk mitigation through data aggregation
	
	    o Risk minimisation plan
	
	• Statistical analysis of smart meter trial sample size
	
	    o To ensure statistical validity for extrapolation
	
	    o Ensure samples sufficient to address variables (e.g. method of home heating / socio-economic consumer groupings / etc.)
	
	• Demonstration of initial functionality of Head End
	
	    o Ability to (two-way) communicate with smart meters
	
	    o Data volume capability proven

Successful Delivery Reward criterion	Evidence
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 **Completed Q2, 2012**	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
Build Phase: • Final stage of solution implementation complete: Operational Data Store and interface to Logica head end commissioned, smart meter installation completed **Completed Q4, 2012**	Evidence – Outputs and Learning: • Functioning Operational Date Store and head end accessing/processing smart meter information o Proven capability to process data from head end, undertake event processing to identify key data, aggregate and map data to network nodes
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

Successful Delivery Reward criterion	Evidence
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

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: ()
	
	    o Heat pumps
	
	    o Electric Vehicles
	
	    o 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)

Successful Delivery Reward criterion	Evidence
	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
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

Successful Delivery Reward criterion	Evidence
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 NG and EDF Energy 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

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

Successful Delivery Reward criterion	Evidence
	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
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 CO_2 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