Low Carbon London
Project Progress Report
December 2014

Contents

Glossary of Terms

Abbreviation	Term
ANM	Active Network Management
BMRS	Balancing Mechanism Reporting System
CHP	Combined Heat and Power
CNO	Charging Network Operator
CP	Charge Post
DG	Distributed Generation
DNO	Distribution Network Operator
DSO	Distribution System Operator
DSR	Demand Side Response
*d*ToU	Dynamic Time-of-Use tariff trial
EIZ	Engineering Instrumentation Zone
EV	Electric Vehicle
GB	Great Britain
GPRS	General Packet Radio Service
GSP	Grid Supply Point
HH	Half-hourly
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
PORB	Programme Outputs Review Board
PV	Photo-Voltaic
RTU	Remote Terminal Unit
SDRC	Successful Delivery Reward Criterion / Criteria
SMS	Short Message Service
TfL	Transport for London
ULEV	Ultra-Low Emission Vehicles

Executive Summary

The Low Carbon London (LCL) project is funded through the Second Tier of Ofgem's Low Carbon Network Fund (LCNF). It commenced in January 2011 and is due to complete at the end of December 2014. This is the eighth in the series of project progress reports submitted to Ofgem and covers the period July 2014 – December 2014.

This reporting period contains two major Successful Delivery Reward Criteria (SDRC) milestone dates:

September 2014 saw the submission of six SDRC deliverables. This includes, both the reports lodged as evidence to Ofgem in June 2014, with the remaining reports submitted to Ofgem in September 2014. Due to the size and complexity of the project, the reports have been broken down into themes (or series) to better present the findings, and for ease of navigation.

Series A – Demand Side Response and Distributed Generation – Submitted September 2014	
A1	Guide to residential Demand Response for outage management and as an alternative to network reinforcement
A2	Residential consumer attitudes to time varying pricing
A3	Residential consumer responsiveness to time varying pricing
A4	Guide to Industrial and Commercial Demand Response for outage management and as an alternative to network reinforcement
A5	Conflicts and synergies of Demand Response
A6	Network impacts of supply-following Demand Response report
A7	Distributed Generation and demand response services for the smart distribution network
A8	Distribution Generation addressing security of supply and network reinforcement requirements
A9	Facilitating Distribution Generation connections
A10	Smart appliances for residential demand response
Series B – Electrification of Heat and Transport – Submitted September 2014	
B1	Impact and opportunities for wide-scale electric vehicle deployment
B2	Impact of Electric Vehicles and Heat Pump loads on network demand profiles
B3	Impact of LV connected DER on power quality
B4	Impact of LV DERs on network utilisation
B5	Opportunities for smart optimisation of new heat and transport loads
Series C – Network Planning and Operation – Submitted September 2014	
C1	Use of Smart Meter Information for network planning and operation
C2	Impact of energy efficient appliances on network utilisation
C3	Network impacts of energy efficiency at scale
C4	Network state estimation and optimal sensor placement

The end of December will see the delivery of the projects final SDRC. This deliverable provides a consolidated view of the programme outputs, modifications to planning and systems due to LCL findings and a comprehensive guide to how Distribution System Operators may work in the future. The long term impact on CO_2, influenced by the project outcomes, is also quantified. There is also a Summary Report (SR) which will provide both a summary of the project as well as helpful navigation through the various reports. This SDRC deliverable will consist of the follow reports:

Series D – Demand Side Response and Distributed Generation – to be submitted December 2014	
D1	New design and operational practices
D2	DNO tools and systems learning
D3	Real time control and Design of smart distribution networks
D4	Resilience performance of smart distribution networks
D5	Novel commercial arrangements and the smart distribution network
D6	Carbon Impact of Smart Distribution Networks
Summary report – to be submitted December 2014	
SR	DNO Guide to Future Smart Management of Distribution Networks

The complete suite of reports will be made available on the UK Power Networks innovation website in Q1 2015. In addition to this, the project has made the commitment to release the raw data collected from the Smart Meter trials, including the appliance surveys and dynamic Time of Use (*d*ToU) data. The project is running through relevant permissions and data anonymity processes prior to this data being released.

As noted in the previous bi-annual report, the vast majority of trial activities ceased towards the beginning of the 2014 calendar year. Within this reporting period, only the Active Network Management (ANM) technical trials were active. This was limited to two sites, the first of which was the Bunhill energy centre. The works on this site were to complete the fully active control of a 2MW CHP engine. Once complete, this enabled the state of the network to instigate the CHP machine to run and export electricity to the distribution network at times of increased stress. The second site was TFL's Greenwich Power installation. This site, like Bunhill Energy Centre, was fully integrated into the Power stations control system. This allows the network based controllers to dispatch DSR automatically at predetermined load points, network states and times of day.

The project has also continued to produce regular carbon impact reports, based on the empirical data gathered from the trials carried out.

Following the completion of the full instrumentation of the LV network in the three EIZs, and the subsequent identification of data issues with the data being received significant efforts have been made to rectify this situation. This rectification has been successful and where measurement errors were found this as both been fixed and also the correction been retrospectively applied to the recorded data sets.

In addition to the SDRC outputs and trial activities referenced above, the programme has continued the work of decommissioning across the various trial areas across the programme. This not only includes removal of redundant physical assets but the decommissioning of IS systems, interfaces, software and databases.

Risks

The project has operated a comprehensive risk management framework from its inception. There are no identified uncontrolled risks that present a threat to the project successfully completing its objectives or the delivery of its 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	Impact/ Probability	Mitigation
Programme final reports – coordination of analysis, reporting and presentation of findings between UK Power Networks and Imperial College.	High/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. 5. Project co-ordinator appointed to manage report interdependencies between Imperial College and DNO reports. 6. Frequent calls held with all DNO report authors and Imperial College to co-ordinate requests for data & information to Imperial College from DNO report authors. 7. Timely workshops arranged with Imperial College to discuss detailed DNO report data requirements from Imperial College.
Ensure all reports are delivered to time, quality and budget	High/Low	1. Established comprehensive governance framework 2. Established contracts with report-contributing third parties on a fixed-price basis, with staged payments tied to delivery of approved-quality drafts milestone stage payments.
Poor quality of substation data in EIZs	Medium/ Low	1. Checked that all RTUs are correctly configured. 2. Ensured data integrity is maintained and preserved when moving data across different software operating systems, data paths and data interfaces (e.g. signage and units of measure). 3. Ensured all relevant data has been collected and loaded into the ODS. 4. Implemented manual data collection measures as contingency to address data communications issues. 5. Undertake comprehensive lessons learned exercise to identify root causes of issues and make recommendations to minimise or prevent further recurrences in the future. **Retrospective correction applied to all historical data from affected substations**

Risk	Impact/ Probability	Mitigation
Installation risks		
Greenwich Power – fully-active ANM trial	Medium/ Medium	1. Refurbishment of Greenwich Power installation may impact trial – work closely with TfL minimise any disruption. 2. Undertake timely installation of ANM management console at TfL offices in the Palestra building, Southwark, in conjunction with TfL facilities management staff. 3. Trail completed – **Risk closed**

Learning outcomes

The learning outcomes arising during this reporting period reflect the project activities undertaken during this reporting period and focus on trials undertaken and the removal of residential trial equipment.

Removal of residential trial equipment

The removal of some residential EV trial monitoring equipment is continuing to be challenging in some instances where those participants have valued the equipment installed and are appearing to be reluctant to allow the equipment to be decommissioned or in some cases have moved from the address that the equipment is installed. The project is continuing to work with the equipment decommissioning team with advice from the UK Power Networks legal team to ensure the enduring situation is acceptable to all parties. The decommissioning process of any equipment installed in any residential premises needs to be articulated clearly as part of the sign-up process to avoid any subsequent misunderstandings. The project continues to lodge relevant information on the UK Power Networks innovation portal within its main public website (www.ukpowernetworks.co.uk/innovation).

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 – these are detailed in Section 6 below.

1 Project manager's report

The project has seven SDRC's scheduled for delivery during this reporting period. Six SDRCs were successfully submitted to Ofgem during September 2014. This comprised of twenty reports spread across the SDRC areas. The final SDRC, covering conclusions and final analysis, will be issued to Ofgem by the end of December 2014 as per the project direction.

The main activities of the project in this reporting period have been concentrated in the following areas:

- Closedown and completion of the project's remaining Active Network Management/DSR trials at Bunhill Energy Centre (CHP) and TFL Greenwich Power Site
- Completing the remaining carbon reporting for the outstanding trials; and
- Continuation of the redundant trial equipment decommissioning; and
- Establishment of the final reports governance framework; and
- Management of final report production.

This report section describes each of these activity areas in more detail.

The high-level timeline of the project is illustrated in Figure 1 - Project timeline on the following page. Figure 2 – Closeout period illustrates a more detailed set of events in Q3 2014 until Q1 2015

Figure 1 - Project timeline

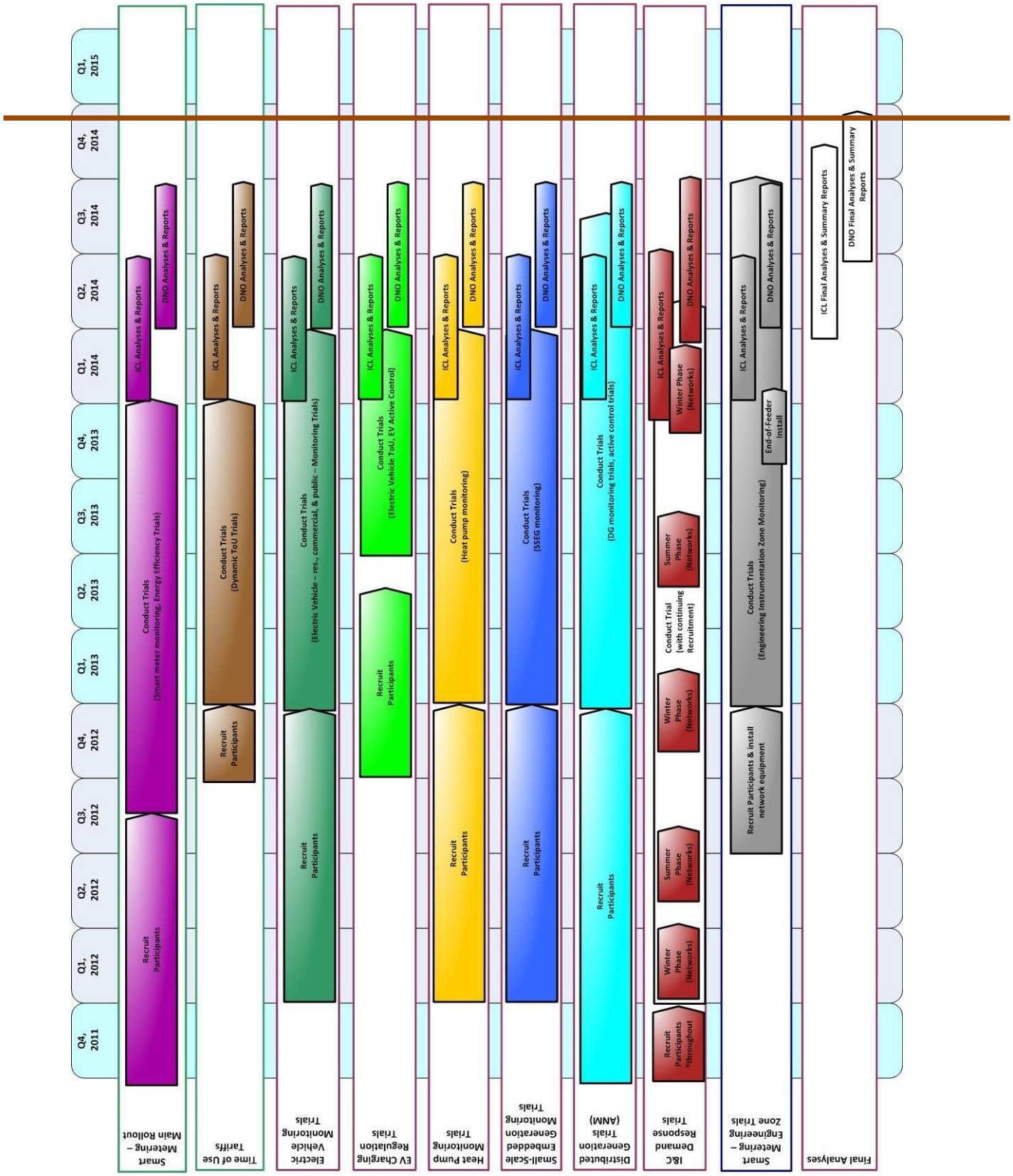
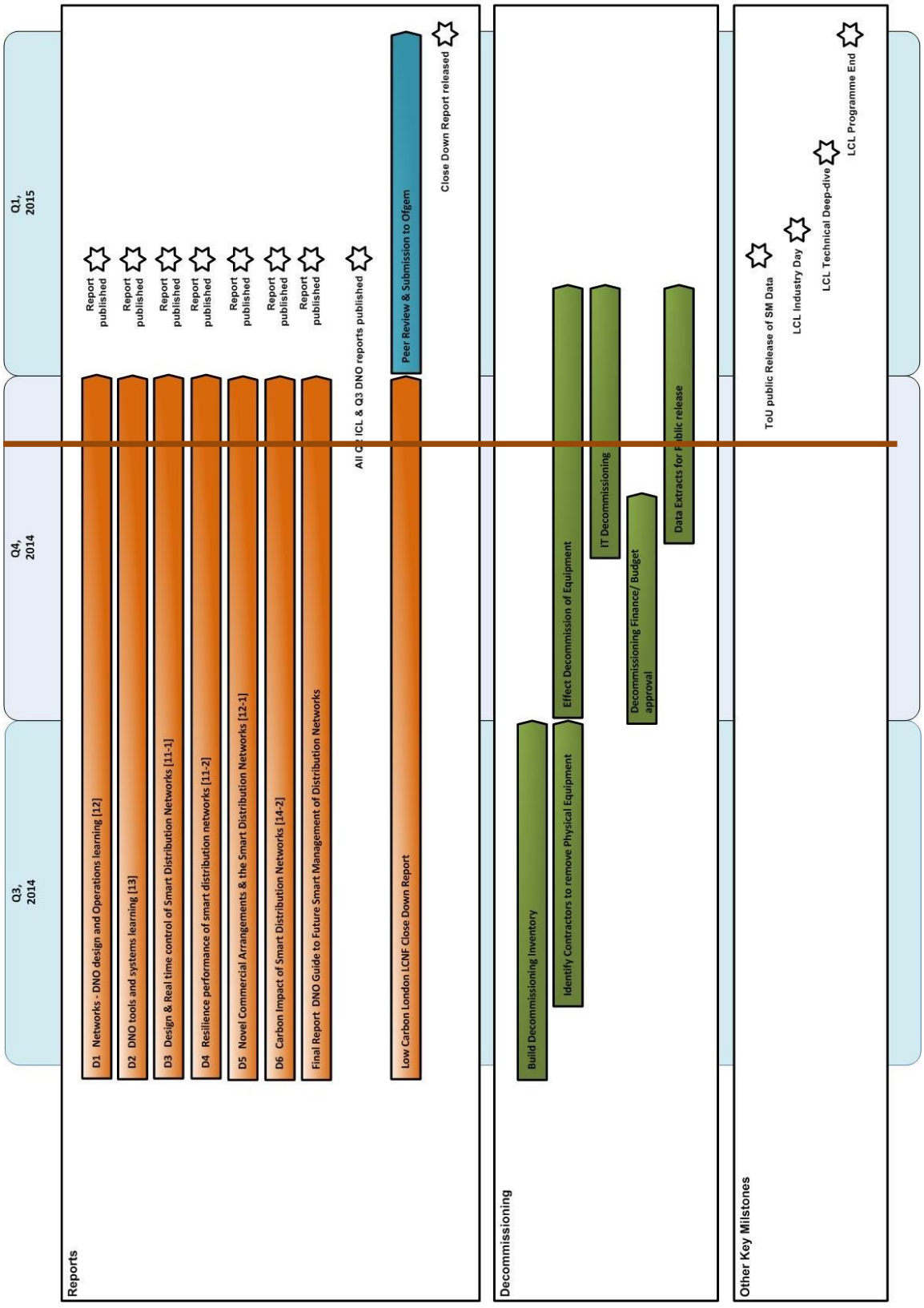


Figure 2 - Project timeline – Closeout period



1.2 Trial updates

1.2.1 Distributed generation trial

The remaining distributed generation trials were designed to enhance the distributed generation monitoring trials that concluded early in 2014. These are technical trials to confirm the integration of various systems, and commercial constraints, as well as the performance of the automated network triggers and demonstrate the ability of the distribution network to interact in a smart way.

The first of the remaining ANM trials was the Bunhill energy centre. There works on this site were to complete the fully active control of a 2MW CHP engine. This enabled the state of the network to instigate the CHP machine to run and export electricity to the distribution network at times of increased stress. This trial ran for one week from 29th September to 3rd October 2014 with events being triggered by the total power flow through City Road B primary substation.

The second of the remaining ANM trials was interfacing with Greenwich Power Station. This ran autonomously for a two week period from 20th to 31st October 2014. DSR events were triggered by the total power flow through Wimbledon 132kV Section 3&4 substation and trigger the running of a 9MW gas turbine.

Table 2 also provides the contractual terms that were contractually agreed between the generators and UK Power Networks. Both sites were available to participate during weekdays (i.e. weekends are excluded) for the daily window provided. The latest time an event could be triggered by ANM was set up so that the maximum event duration would fall into the daily availability window (e.g. 15:30 for Greenwich Power Station).

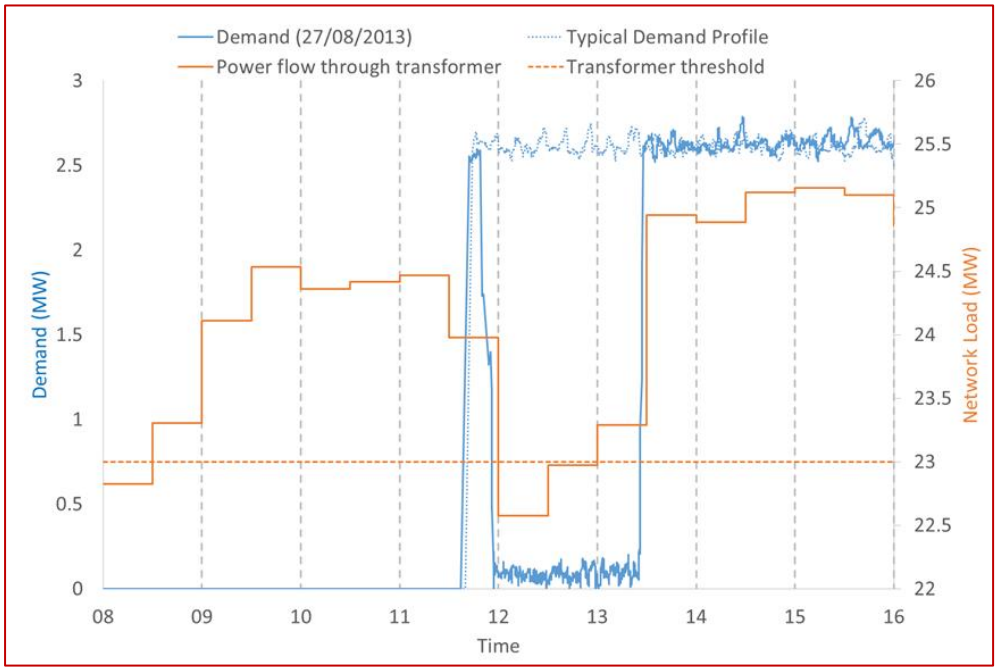
The events for Bunhill Energy Centre had a fixed duration (i.e. equal maximum and minimum times). The events for GPS had a variable duration between a maximum and a minimum, which had to account for a 30-minute response time to on/off requests. The fluctuation in measured power flow with respect to two thresholds, 'Regulate' and 'Reset', determined the duration of an event between the maximum and minimum. A breach of the Regulate threshold triggers a DSR event, while a breach of the Reset threshold ends the DSR event. The maximum running time over the trial for GPS does not consider the 30-minute response time, as the running time is counted once the 30-minute response time has elapsed.

Table 2 – Contractual Terms for ANM trials

Site / Substation	Daily window (hh:mm)	Contractual capacity (MW)	Max number of requests		Max running time over trial (hrs)	Event duration (hrs)	
			Daily	Weekly		Minimum	Maximum
Bunhill / City Road B	10:00 – 19:00	2	1	5	5	1	1
Greenwich / Wimbledon	13:30 – 19:00	9	1	3	15	1.5	3.5

Figure 3 below shows and example of a successful ANM trigger of the Bunhill CHP illustrating the decrease in load due to the engine starting and running export onto the distribution network.

Figure 3 – Example of ANM triggered response event at Bunhill Energy Centre



1.3 Carbon impact reports

The project has continued to produce carbon impact reports using the reporting tool developed by CGI. This tool enables accurate carbon impacts to be calculated using NPL-certified algorithms applied to the empirical data collected from the project's trials. A complete set of reports will be published as part of the final report portfolio.

1.4 Redundant trial equipment and systems decommissioning

The LCL programme has the duty to remove equipment that can no longer provide a useful purpose or poses a residual risk to any party. Due to the depth and breadth pf the programme, the decommissioning programme is a significant task covering more than physical equipment.

The decommissioning programme covers multiple areas and is broken down into the following categories:

- physical equipment;
- software and communications links;
- virtual servers and associated back-ups;
- access permissions to services and data (e.g. imperial College access to ODS); and
- data extracts and preparation for legacy use by others

The programme has developed a decommissioning plan for each aspect scheduled above. Figure 2 above shows the high level decommissioning time line with all equipment, hardware, software and data extracts being completed during 2014. There are areas where this is not feasible due to systems or equipment being required during the final stages of analysis and report writing. All outstanding items will conclude decommissioning during quarter one of 2015.

Due to significant the nature of the majority of installations being on customer property, interfacing with third party machinery or being in the public domain, there are significant governance measures in place to ensure that approved methods are to be utilised and risks are assessed prior to engagement in works.

Some examples of the physical equipment can be seen in Table 3 below;

Item	Description.	Quantity	Action
Voltage and power quality monitors	Street furniture containing LV harmonics monitoring equipment	104	Remove street furniture make good, scrap returned equipment
CHP/PV Monitors	Combined heat and power or photo-voltaic monitoring equipment	15 sites	Remove ANMs and return to UKPN to re-use / sell / scrap
Power / Voltage / PQ monitors	EV Residential	77	Remove meters and return to vendor where possible
Power / Voltage / PQ monitors	EV Commercial	13	Remove meters and return to vendor where possible
Power / Voltage / PQ monitors	Heat Pumps and Solar PV	12	Remove meters and return to vendor where possible

Where a sale of equipment back to vendor proves viable, any monies recovered will be returned to the project bank account.

With respect to the IT aspects, due to the design philosophy utilising virtual servers, there is little physical equipment that is deployed. This are however significant volumes of data that needs to be extracted prior to the removal or deletion of servers and relevant interfaces. The areas of work are broken down as follows;

- decommissioning of servers
- assurance of data security following project closure
- removal of vpn and sftp links
- removal of firewall entries created for the project
- removal of user access

1.5 Establishment of report governance framework

The project has developed a comprehensive governance framework to oversee the delivery of the project's final reports based upon quality, timeliness and budget. Each report is developed according to a four-stage process, comprising of a conceptual draft, first draft, second draft and

final draft. In addition, technical reviews can be held at any time to address any matters arising or to provide clarification on options and issues.

Formal acceptance certificates will be issued upon successful review at each report and these are used to trigger appropriate stage payments to those third parties engaged on a commercial basis to contribute to the final report production.

Each DNO final report has an appointed UK Power Networks lead officer, who is responsible for all aspects of the creation, development and delivery of the report and acts as a focal point for all involved parties and as an escalation point for any questions of data, analysis and findings.

The framework enables all parties to have a regular touch-point with the project and for cross-report themes to be identified and managed at the appropriate time. The framework is augmented by regular review sessions with Imperial College to address requests for data or to clarify matters arising between the reports produced by Imperial College and those with a strong DNO focus.

The project also maintains the matrix of trial learning points and actively tracks the mapping of learning points to reports as the reports content is developed.

1.6 Final report structure

The project will deliver a comprehensive portfolio of 29 reports. Due to the breadth and depth of the programme, a decision has been made to allocate the final output documents across four themes or series. This will provide the reader significantly more clarity on which reports to read based on the topic they are interested in;

Series A – Demand Side Response and distributed generation

> This series covers all aspects, technical, commercial and behavioural, of demand side response from both residential (via dToU tariffs) and industrial and commercial customers. The series also contains reports on how distributed generation may support the network in the future both from an active and passive perspective. Reports also look at the conflicts and Synergies of how the use of DSR on a distribution network may be in synergy or conflict with other users of DSR services.

Series B – The Electrification of Heat and Transport

> This series reports on both the impact of new electrified aspects of heating and transport such as electric vehicles and heap pumps will have on the distribution network. They also look at the opportunities to interact or control devices and the potential to modify behaviour to lessen the impact of these new loads

Series C – Network Design and Planning

> This series reports on a wide range of topics that distribution network operators will need to consider when designing and operating networks in the future. Topics covered include the use of Smart Meter data, the impact of energy efficiency, the opportunity for techniques such also state estimation. This series also contains some audit report on the data recorded during the Low Carbon London project.

Series D – The Future System Operator

> This series of reports provide a summary of all of the topics described in the earlier series. Reports D1 and D2 look at near term (ED1) opportunities for the subjects studied and

demonstrated in the Low Carbon London project including changes to planning and operations and also how IT systems will need to be modified to cope with new data that will be available to the network operators. The later reports describe medium and long term approaches to how distribution network operators

There is also a final report, or Summary Report, which has designed to be read first and presents both the high level key findings and the recommendations for which reports to read first based on their subject matter interest.

As well as presenting reports in simple themes, the numbering the reports changed to suit this. Figure 4 below present the reports by theme and also shows the mapping between the numbering in the project direction and the new series numbers.

Figure 4 – Example of ANM triggered response event at

1.7 IT Architecture

The IT solution has remained unchanged since the last reporting period and has continued to benefit from the minor enhancements made to components referenced in previous bi-annual reports. Figure 5 - LCL Logical IT Architecture on the next page, illustrates the current IT architecture.

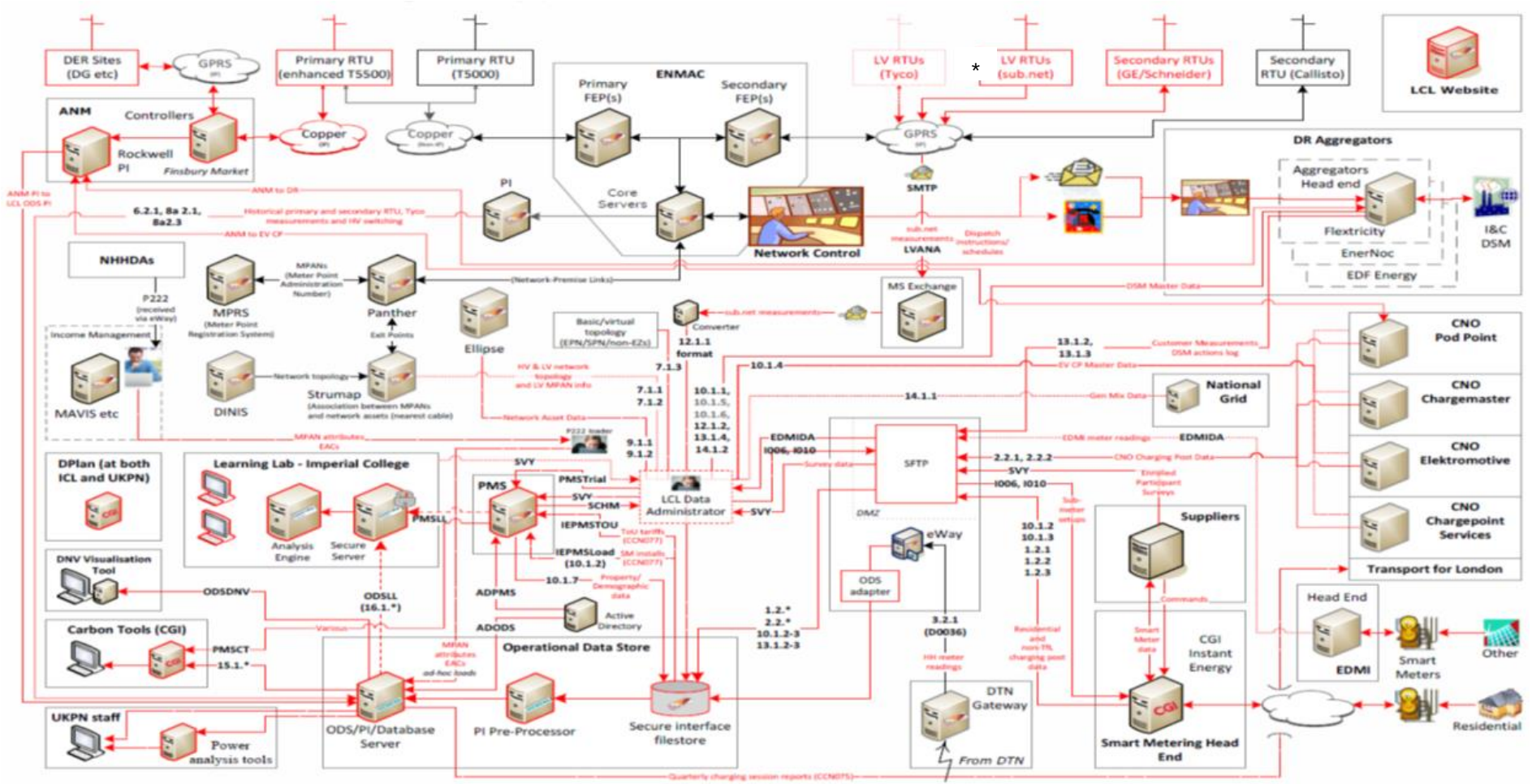
This will be reported in full as part of the final programme outcomes in report D2 DNO tools and systems learning of the final programme outputs

1.8 Project organisation

The project has continued to flex and adapt to emerging requirements as it moves into the final phases of its remit and the organisation of the project has evolved over this reporting period to reflect the priorities of report delivery, learning dissemination and decommissioning.

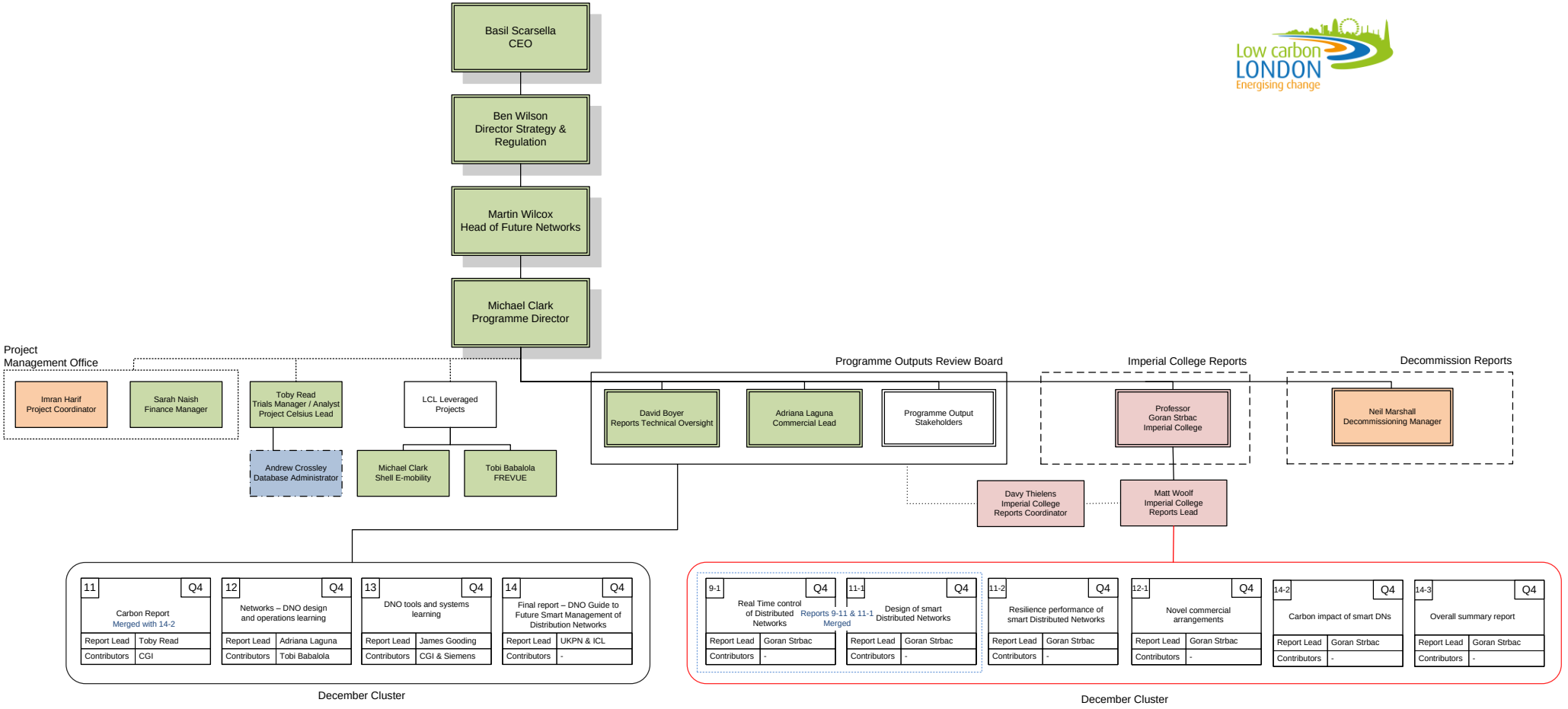
Figure 6 - Project organisation on the page following, outlines the current organisation based on those priorities.

Figure 5 - LCL Logical IT Architecture



* Tyco LV RTUs were never fitted but have had no impact on project outcomes

Figure 6 - Project organisation



2 Business case update

Through the I&C DSR trials, the project has already delivered the committed savings of £1.8m of deferred network reinforcement, specifically delivered through the DSR trial involving Ebury Bridge substation. The success of the DSR trials has also enabled UK Power Networks to commit to a total of £43.4m of savings in its published re-submitted business plan for the RIIO-ED1 period 2015-2023, with £12.1m of that total delivered directly through savings within the London Power Networks' network.

During this reporting period, and following the completion of all relevant analysis, the programme has reviewed both the carbon benefits and the investment benefits tested by LCL attributable to smart grids to 2050. This analysis will be presented once peer reviewed in the programmes close down report which is due to be published in March 2015.

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 are several SDRCs scheduled for delivery during this reporting period. Please note that section 1.6 of this document describes how these reports will be re-numbered when published to ensure they are accessible to readers.

The project collated a set of 11 final reports on 30 June 2014, which act as SDRC evidence artefacts delivered on 30 September 2014:

- LL 1-1 Accessibility and validity of smart meter data;
- LL 2-1 Network state estimation and optimal sensor placement;
- LL 2-2 Accessibility and validity of substation sensor data;
- LL 3-1 Impact of LV connected DER on power quality;
- LL 4-1 Impact of energy efficient appliances on network utilisation;
- LL 4-2 Impact of LV DERs on network utilisation;
- LL 5-1 Impact of opportunities for wide-scale electric vehicle deployment;
- LL 6-1 Residential consumer attitudes to time varying pricing;
- LL 6-2 Residential consumer responsiveness to time varying pricing;
- LL 6-4 Smart appliances for residential demand response; and
- LL 7-1 Opportunities for DG in the distribution network.

The remaining SDRC for the project are all reports and due for delivery in two tranches; one set of reports will be delivered by 30 September 2014 and the further set of reports will be delivered by 31 December 2014. All these are on track to be delivered on time, and comprise of the following reports:

Tranche One:

- DNO 1 Use of Smart Meter Information for network planning and operation
- DNO 2 Network impacts of energy efficiency at scale
- DNO 3 Guide to residential Demand Response for outage management and as an alternative to network reinforcement
- DNO 4 Guide to Industrial and Commercial Demand Response for outage management and as an alternative to network reinforcement
- DNO 5 Conflicts and synergies of Demand Response
- DNO 6 (Network) impacts of supply-following Demand Response report
- DNO 7 Distribution Generation addressing security of supply and network reinforcement requirements
- DNO 8 Facilitating Distribution Generation connections
- DNO 9 Impact of Electric Vehicles and Heat Pump loads on network demand profiles
- DNO 10 Opportunities for smart optimisation of new heat and transport loads

Tranche Two:

- LL 9-1, 11-1 Design & Real time control of Smart Distribution Networks;*
- LL 11-2 Resilience performance of smart distribution networks;
- LL 12-1 Novel Commercial Arrangements & the Smart Distribution Networks;
- LL 14-2 Carbon Impact of Smart Distribution Networks;
- DNO 12 Networks - DNO design and Operations learning;
- DNO 13 DNO tools and systems learning;
- Final Report DNO Guide to Future Smart Management of Distribution Networks.**

*Reports 9-1 and 11-1 have been merged into a single document. All learning points have been maintained

**Report 14-3 and the Final DNO report have been merged into a single document.

Appendix One details the complete list of SDRCs and the status of each one.

The September and December reports are a collaborative effort between the project partners, UK Power Networks, and expert consultancy where required. All reports had a brief and detailed content list agreed early February and individuals were appointed to lead delivery of each report by the end of April.

6 Learning outcomes

The project continues to be strongly committed to the effective dissemination of the learning accumulated during the project. The portfolio of final reports that have been or will be submitted in 2014 will represent a significant body of learning available to other DNOs and other interested parties and will cover both in-depth academic analyses of the trials by the reports produced by Imperial College as well as practical guidance and insights for DNOs in the set of reports delivered by UK Power Networks.

The project has taken a decisive new approach to sharing project findings and also gaining feedback during the period of analysis and report writing. This was undertaken by visiting four other DNO companies in what were nicknamed 'DNO Roadshows'. These visits were made during September 2014 and has enabled the LCL programme to ensure that the output reports are both relevant to DNOs and addressing any areas identified by the other DNO as requiring more explanation or analysis. The details of the presentations, the workshop sessions and the feedback were captured in detail and will be available in the closedown report at the end of the project. All events are recorded and presented in table 3 below.

6.1 Learning outcomes this period

The learning outcomes arising during this reporting period reflect the project activities undertaken and the focus on the closedown of the remaining project trials and production and delivery of the portfolio of final reports.

6.1.1 Data loss from LV substation monitors

Following the identification of the data loss from the LV substation monitors (EMS Sub.net LV), fixed through rectification of the communication issue (3G modem replacement), a plan was put in place to recover the data that was stored locally.

All affected sites were visited to manually download data from RTUs. This data was then uploaded to the ODS to address data gaps where possible. The alternative communication solutions put in place where needed in order to ensure reliable data capture for the remainder of the trial.

6.1.2 Removal of residential trial equipment

The removal of trial monitoring equipment is proving to be challenging in some instances where those participants have valued the equipment installed and are appearing to be reluctant to allow the equipment to be decommissioned. The project is continuing to work with the equipment decommissioning team and UK Power Networks' legal team to ensure the enduring situation is acceptable to all parties. The decommissioning process of any equipment installed in any residential premises needs to be articulated clearly as part of the sign-up process to avoid any subsequent misunderstandings.

6.2 Learning dissemination

The project maintains a comprehensive register of learning outcome artefacts, built up as part of the project's routine learning dissemination activities. Table 4 below details the learning outcome artefacts to date.

Table 4 - learning dissemination outputs

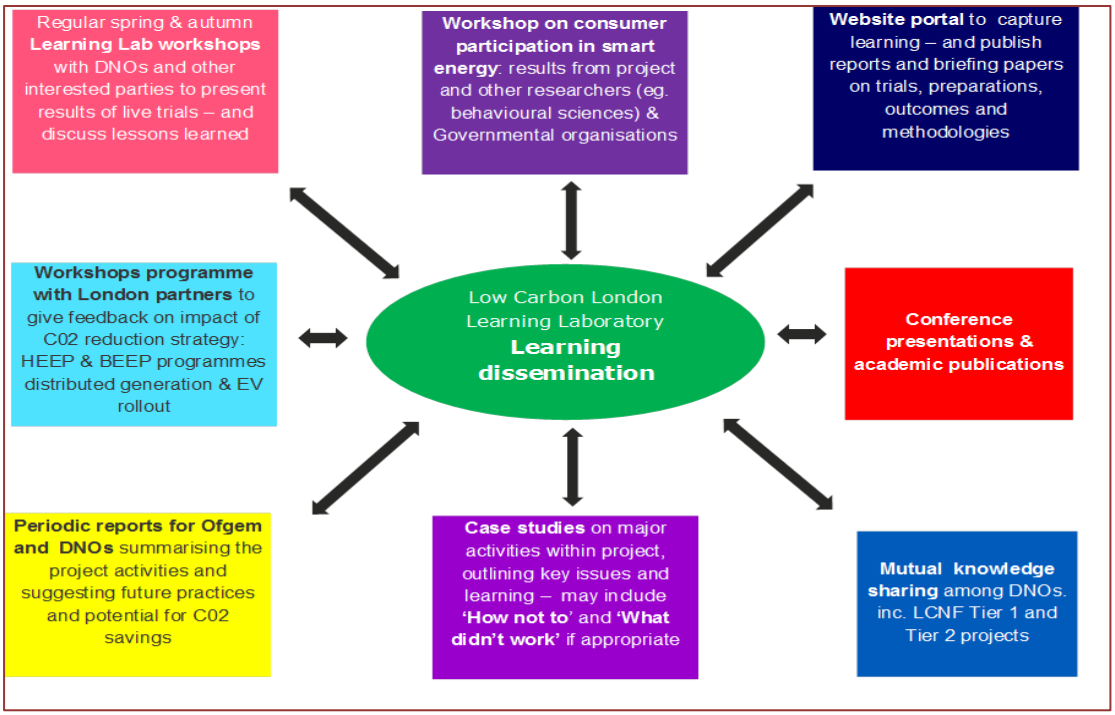
Output	Title	Comments
Paper	CIRED'14	March 2014
Paper	CIRED Workshop 11th June Rome	June 2014
Paper	Network Benefits of Energy Efficient Lighting - *22nd International Conference on Electricity Distribution Stockholm*,	June 2013
Paper	Application of demand Side Response and Energy Storage to Enhance the Utilisation of the Existing Distribution Network Capacity - *22nd International Conference on Electricity Distribution Stockholm*,	June 2013
Report	Distribution Network Impact of Electric Vehicles	December 2012
Report	200028-ANM3-06A HMI Specification	November 2013
Report	200028-ANM3-07A Demand Response Notification Interface Specification	April 2014
Report	ANMDR Winter Trials - Bankside C and Lithos Road Analysis	November 2013
Report	200028-LIC-05B Security of Supply Trials Local Interface Controller Specification	November 2013
Report	200028-ANM1-07B ANM Drop 1 Bankside C Demand Response	August 2013
Report	200028-ANM1-08A ANM Drop 1 Moreton St Demand Response Analysis Report	January 2013
Report	200028-ANM1-09A ANM Drop 1 Bankside C Threshold Analysis Report	November 2013
Report	200028-ANM1-04B Drop 1 FDS as built	January 2014
Report	200028-ANM1-05B Drop 1 Site Acceptance Test Specification SCAN	January 2014
Report	200028-ANM2-02A ANM Drop 2 Moreton Street Demand Response	January 2014
Report	200028-ANM2-04B Drop 2 FDS as built	January 2014
Report	200028-ANM2-05B Drop 2 Site Acceptance Test Specification SCAN	January 2014
Report	200028-ANM2-06A Drop2 Lithos Road Demand Response Analysis Report	November 2013
Report	200028-ANM4-04B Drop 4 FDS as built	October 2013
Report	200028-ANM4-05B SAT Issue	October 2013
Report	200028-ANM4-06A Drop 4 Carbon Sync Integration Specification	July 2013
Report	200028-ANM4-06B Drop 4 Carbon Sync Integration Specification	August 2013
Report	200028-ANM4-07A Test Evidence	October 2013
Report	Data requirements briefing for power quality report	October 2013
Presentation	Learning Lab objectives and infrastructure	September 2011
Presentation	Understanding Consumer Behaviour, presentation for Low Carbon London Learning Laboratory Launch	October 2011
Presentation	Bottom-up modelling for application to Low Carbon London (Ofgem visit)	March 2012
Presentation	Learning Lab progress update	March 2012
Presentation	Low Carbon London - Project Update, Presentation for Ofgem	March 2012
Presentation	Understanding the Consumer - Residential ToU Trial	June 2012
Presentation	Learning Lab infrastructure and analysis	July 2012
Presentation	Network benefits of energy efficient lighting	February 2013
Presentation	Low Carbon London Dynamic time-of-use Tariff Trial	April 2013

Output	Title	Comments
Presentation	Dynamic Time-of-Use tariff trial (ToU learning event)	May 2013
Presentation	Learning lab workflow and tool requirements	July 2013
Presentation	Low Carbon London / Preparing Smart Grids – Arup event, London	October 2013
Presentation	Consumer engagement & the LCL Residential Dynamic Pricing Trial	November 2013
Presentation	Consumer acceptance, engagement and responsiveness on the UK's first trial of a dynamic time-of-use tariff for residential electricity - Norwegian University of Science and Technology, Trondheim, Norway	April 2014
Presentation	Eurelectric 2nd June London	June 2014
Presentation	6th Smart Grids & Cleanpower Conference 3rd June Cambridge	June 2014
Presentation	Base London 26th June London	June 2014
Presentation	LCL Roadshows: WPD 1st September Dudley	September 2014
Presentation	LCL Roadshows: ENW 15th September Preston	September 2014
Presentation	LCL Roadshows: SPEN 25th September Glasgow	September 2014
Presentation	LCL Roadshows: SSE 29th September Reading	September 2014
Presentation	HubNet Smart Grids Symposium 9th September Glasgow	September 2014
Presentation	DG Forum 15th September London	September 2014
Presentation	IET Power in Unity 2nd Oct Birmingham	October 2014
Presentation	Ofgem presentation: Optimising the future distribution network: strategies and options 8th Oct London	October 2014
Presentation	Ordnance Survey Energy & Infrastructure Seminar 8th Oct Daventry	October 2014
Presentation	LCNF workshops for Ofgem: Consumers 13th Oct London	October 2014
Presentation	LCNF workshops for Ofgem: DG & Storage 16th October London	October 2014
Presentation	2nd annual Utility Week Congress 14th October Birmingham	October 2014
Presentation	Low Carbon Networks and Innovation conference 20th – 22nd October Aberdeen	October 2014
Presentation	European Utlity Week 4th – 6th November Amsterdam	November 2014
Presentation	The smart electricity consumer : developing domestic DSR 5th November London	November 2014
Presentation	Westminster Energy, Environment & Transport Forum 26th November London	November 2014
Presentation	IET Future Intelligent Cities 4th December London	December 2014
Document	Research Aims by Report	October 2011
Document	Briefing document on issues for SM/ToU trial design and recruitment	December 2011
Document	Control Group and Pre-treatment measure	January 2012
Document	Metadata requirements	May 2012
Document	Monthly dToU feedback design	July 2012
Document	*d*ToU notification strategy	August 2012
Document	Ofgem change request appendices one and two	October 2012
Document	Briefing document for Smart Meter trial design	December 2012
Document	ToU interview Discussion Guide	February 2013
Document	*d*ToU Control Group Exclusions	July 2013
Document	Planning Analyses of DSR and Savings	July 2013
Survey	Smart meter / dToU Household appliance survey	April 2013
Survey	dToU closing survey	November 2013

As mentioned above, the project is planning to investigate the feasibility of developing a knowledge access tool to facilitate search and location of themed report content across the portfolio of reports.

The project's original learning dissemination framework still drives the project's approach and is set out in Figure below.

Figure 7 - LCL learning dissemination framework



7 IPR

The project maintains a register of prospective candidates that may contain foreground IPR. The register is reviewed on a quarterly basis. Partners copyright potential artefacts to protect IPR emerging from the project. The IPR register will be finalised as part of the project closedown process in late 2014 and early 2015.

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. As previously mentioned, one new risk related to data loss from the LV substation monitors (EMS Sub.net LV) is being actively managed and mitigated as described 6.1.1 above.

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 positioned in the market-place to be attractive to existing National Grid STOR providers. 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			

Risk	Category / Owner	Impact/ Probability	Mitigation
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. **Closed - Greenwich Power Station have agreed a contract to participate as a fully-active ANM trial participant, starting in June 2014.**
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 appliance 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.**
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.**

Risk	Category / Owner	Impact/ Probability	Mitigation
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 confirmed that the Smart Meter roll-out met its demographic spread targets**
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. A number of EDF Energy "eco 20:20" EV owners have EDMI smart meters fitted to their residential EV charge post spur. **Closed – EDMI MK7A smart meters have been installed. Data loggers installed on leased Nissan LEAFS.**

Risk	Category / Owner	Impact/ Probability	Mitigation
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.**
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 developed to documents all data sources, formats and storage arrangements 7. Protocol agreed to halt data collection for customers who elect to leave the trial. 8. Anonymise data where possible.
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. **Closed – 106 devices installed and commissioned by March 2014. Data being routinely collected in ODS.**
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.**

Risk	Category / Owner	Impact/ Probability	Mitigation
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. Briefings given to project team members on Competition Act requirements **Closed – all project contractual arrangements complete**
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 reviewed 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.

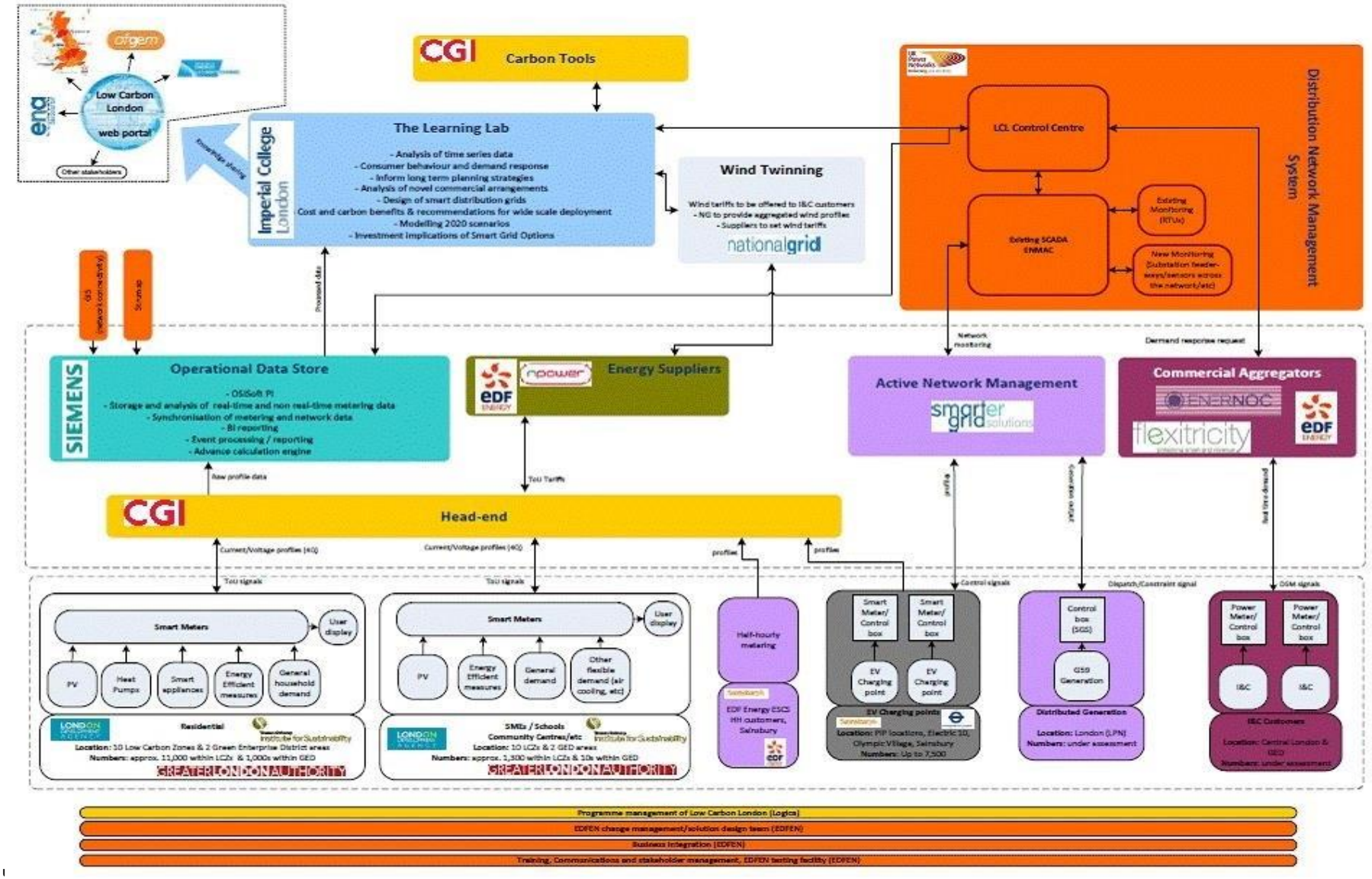
Learning from risk mitigation activities is captured as part of the project's workstream learning logs.

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 8 below illustrates the current project scope which is fully compliant and consistent with the full submission.

Figure 8 - Project scope



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 ……

18 December 2014

Date ……

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

Successful Delivery Reward criterion	Evidence
	sensor data DNO learning reports (Q3, 2014): • DNO learning report on the use of smart meter information for network planning and operation
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 **Completed 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	Evidence – Learning: • Evidence of real changes in load patterns due to: ()

Successful Delivery Reward criterion	Evidence
charging (Appendix 2, Use Case U03.1) Exploring the impact of heat pump demand (Appendix 2, Use Case U03.2) **Completed Q3, 2014**	○ Heat pumps ○ Electric Vehicles ○ Micro-generation • Guidance on successful approaches to, and value of, smart optimisation of EV charging to minimise peak demand and losses impact (maximising load factor) and to minimise need for reinforcement (maximising utilisation) Evidence – Outputs: Learning Lab Reports (Q2, 2014): • 3-1 Impact of LV connected DER on power quality • 5-1 Impact of opportunities for wide-scale electric vehicle deployment • 4-2 Impact of LV DERs on network utilisation DNO learning reports (Q3, 2014): • DNO learning report on the impact of EV and HP loads on network demand profiles • DNO learning report on opportunities for smart optimisation of new heat & transport loads
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) **Completed 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

Successful Delivery Reward criterion	Evidence
	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
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) **Completed 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

Successful Delivery Reward criterion	Evidence
	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) **Completed Q3, 2014**	Evidence – Learning: • Identification of scope for manipulating demand (through commercial incentivisation) to follow wind output • Assessment of potential for: ○ optimisation of system level real time demand to minimise CO2 emissions; ○ reducing cost of system residual balancing; ○ minimising requirement for generation plant margin; and ○ minimising price volatility Evidence – Outputs: Learning Lab Reports (Q2,2014): • 7-1 Distributed generation and demand response services for the smart distribution network DNO learning reports (Q3, 2014): • DNO impacts of supply-following DR report
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)	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

Successful Delivery Reward criterion	Evidence
Due date: Q4, 2014	and generation • Quantified overall CO2 savings and LCTP contributions Evidence - Outputs: Learning Lab Reports (Q4, 2014): • 11-1 Design of smart distribution networks • 11-2 Resilience performance of smart distribution networks • 12-1 Novel commercial arrangements and the smart distribution network • 14-2 Carbon impact of smart distribution networks • 14-3 Overall summary report DNO learning reports (Q4, 2014): • DNO design and operations learning report • DNO tools and systems learning report • Final Report - DNO Guide to Future Smart Management of Distribution Networks

End of report