SECOND TIER REWARD APPLICATION

ADDITIONAL EVIDENCE

**CUSTOMER-LED NETWORK REVOLUTION**

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# Q2.      How has the project changed the culture of innovation in your organisation? Provide evidence of this change.

## Organisation structure and level of resourcing

Our 2016 proposal for a Smart Grid Implementation unit is provided in Appendix 1, including organisation and roles. This has been fully implemented.

## Range of innovation projects

*We now undertake a wider range of innovation projects which are increasingly more collaborative, multi-vector, and with a greater focus on customer experience, particularly vulnerable customers*

Examples include:

[Measuring the Societal Impact of Network Activities](http://www.northernpowergrid.com/innovation/projects/measuring-the-societal-impact-of-network-activities-nia-npg-013)

[Sustainable Multi-storey communities.](http://www.smarternetworks.org/project/nia_ngn_068)

[Microresilience](http://www.smarternetworks.org/project/nia_npg_018)

[Integrel](http://www.integrel.co.uk/)

## Innovation Steering Group

*We have established an Innovation Steering Group (ISG) with director level membership.*

Members are

Professor Phil Taylor (Newcastle University) - Northern Powergrid non-executive director, Director of the EPSRC National Centre for Energy Systems Integration (CESI), and Siemens Professor of Energy Systems

Nick Gill – Operations Director

Mark Drye – Director of Asset Management

Geoff Earl - Director of Safety, Health and Environment

Patrick Erwin - Policy and Markets Director

Jim Cardwell – Head of Trading & Innovation

Iain Miller – Head of Innovation

Summary notes of recent meetings are provided in Appendix 2

## Scale of our innovation activity

Since CLNR we have significantly increased the scale of our innovation activity. The table below shows we have increased our innovation activity since the start of CLNR so that we are now delivering innovation to the full value of the NIA allowance.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | **At the start of CLNR** | **At the end of CLNR** | **Since CLNR** | | |
|  | **2010/11** | **2015/16** | **2016/17** | **2017/18** | **2018/19**  **Forecast** |
| **Total NIA Expenditure** | £0.8m | £1.7m | £1.4m | £4.1m | £4.3 |
| **External** | £0.6m | £1.4m | £1.2m | £3.5m | £3.7 |
| **Internal** | £0.2m | £0.2m | £0.2m | £0.6m | £0.6 |
|  |  |  |  |  |  |
| **% NIA Allowance** | 23% | 35% | 34% | 100% | 100% |
| **%Internal** | 15% | 14% | 14% | 15% | 15% |

We are also increasingly seeking opportunities to use external funding and we anticipate this growing over the next one to two years.

* The Activating Customer Engagement (ACE) project was partly funded through Innovate UK.
* We are currently engaged in new Electric Vehicle programmes alongside one of the UK’s major motor manufacturers. These programmes are also funded by Innovate UK.
* Northern Powergrid is also a longstanding supporter of the Future Power Systems Centre for Doctoral training at the University of Strathclyde and Imperial College. Whilst we fund individual projects, such as Holistic Fault Anticipation, through NIA the supporting programme management aspects of this activity are funded through EPSRC.

Q3.      How has this Second Tier Reward incentive influenced your project management and operational practices? **Provide evidence.**

## Examples of exceptional effort in project management and operational delivery of the project

*Delivery of project alongside BAU – BG billing system constraints, development of smart meters*

The assumption in the bid was that British Gas Phase 3 smart meter would be available for all the detailed energy profiling test cells and for the direct control and restricted hours test cells, which would enable 10-minute monitoring intervals and also perform the restricted hours / direct control functionality.

However, British Gas had delayed their own operational deployment of the Phase 3 smart meter due to complexities of integrating these meters into their operational billing systems, which pushed the availability of this technology beyond the timescales of the CLNR project. We considered the possibility of using the phase 3 smart meters for just the CLNR trial participants. However, retrieving and handling the data from the smart meter would have required changes to existing British Gas data transfer and processing systems to handle the additional parameters and at the greater granularity required for the project. Due to other development work on the British Gas systems in question, this could not be done in the timescales required for the project.

We developed and implemented an alternative solution: using the Phase 2 meter supplemented by additional metering equipment and data transfer and control arrangements at additional cost.

*Estimated £1m of unbilled time*

We also bottom-up estimated that the non-funded contributions made by partners of deploying scarce and valuable resources to overcome the challenges inherent in delivering a project as ambitious as CLNR had been in excess of £1m. This includes senior board level engagement, installation of smart meters for customer trials prospects, non-costed resource deployment including project management, technical design expertise, procurement, and operational engineering support including training 100 operational standby engineers. This project required huge organisational commitment from the partners (particularly from Northern Powergrid and British Gas) which was delivered alongside normal service delivery. There is an unquantified cost to the companies that is the opportunity costs of deploying key resources on this project as opposed to other valuable organisational priorities. Whilst provision of this level of support could be expected on a project of CLNR’s size and importance, it needs to be recognised that customers have not been asked to fund the totality of the costs associated with the project.

## Changes made to our business as a result of CLNR

*Changes in voltage policy and flexible solutions added to EHV design policy*

The following have been updated to incorporate learning about solutions trialled in CLNR

1. [IMP/001/913 Code of Practice for the Economic Development of the EHV System](http://intranet/applications/DBD/DBD_CEEUK/docs/IMP001913.pdf)
2. [IMP/001/912 - Code of Practice for the Economic Development of the HV System](http://intranet/applications/DBD/DBD_CEEUK/docs/IMP001912.pdf)
3. [IMP/001/915 Code of Practice for Managing Voltages on the Distribution System](http://www.northernpowergrid.com/asset/1/document/3006.pdf)
4. [IMP/001/011 – Code of Practice for Overhead Line Ratings and Parameters](http://intranet/applications/DBD/DBD_CEEUK/docs/IMP001011.pdf)
5. [IMP/001/013 Code of Practice for Underground Cable Ratings and Parameters](http://intranet/applications/DBD/DBD_CEEUK/docs/IMP001013.pdf)
6. [IMP/001/007 – Code of Practice for the Economic Development of Distribution Systems with Distributed Generation](http://intranet/applications/DBD/DBD_CEEUK/docs/IMP001007.pdf)

*Changes to ADMD design assumptions*

We have embedded this learning about customer demands into by BAU in NPg by updating the design demands used in our LV designs in our network design policy (see [IMP/001/911 Code of Practice for the Economic Development of the LV System](http://intranet/applications/DBD/DBD_CEEUK/docs/IMP001911.pdf)) and by including PV diversity in our generator connection policy. (see [IMP/001/007 – Code of Practice for the Economic Development of Distribution Systems with Distributed Generation](http://intranet/applications/DBD/DBD_CEEUK/docs/IMP001007.pdf))

## Changes or evidence already recorded in national policy

*P5 LV planning standard changes made*

CLNR learning about customer demands has been made available to other DNOs by the incorporation of this information in the industry guidance document

[Engineering Recommendation P5 (Issue 6, 2017) Design methods for LV underground networks for new housing developments](http://intranet/documents/reference/tech_standards/EA-docs/Eng_recommendations/ENA_ER_P5_6_2_1709271337.pdf)

*Ofgem charging reform evidence*

Ofgem is engaged in a reform of charging to ensure fairness and efficiency in a changed landscape of distributed renewable generation and new local network loads such as EV charging. The Targeted Charging Review (TCR) is examining one aspect of the charging arrangements – how modelled residuals are apportioned between customers.

In March 2018, Ofgem commissioned Frontier Economics to provide analytical input into the TCR, focusing on distributional impacts (identifying ‘winners and losers’) and wider system impacts (assessing market wide impacts on systems and consumer costs). To achieve this, the consultant is heavily reliant on CLNR data to derive profiles for different types of user, in particular domestic (including those with EV, PV and heat pumps) and SME, to assess the level and shape of consumption on a half hourly basis

*Network costs impact for EV charging informing OLEV policy*

The CLNR work on EV charging informed the projections of likely load growth that underpinned work on network costs commissioned by OLEV, carried out by the Energy Networks Association. The actual analysis was done by CLNR partners Newcastle University, looking at the impact of EV charging on residential ADMD.

*Smart grid enablers – developing our control and communications capability*

In CLNR, we deployed a highly sophisticated wide area control scheme, the Grand Unified Scheme (GUS). This was integrated with our existing core SCADA system and combined real-time state estimation (where we modelled the system from 66kV down to 400V) and an online optimisation engine. We fed this from widespread monitoring, down to the ends of LV feeders, and used real-time thermal ratings for lines, cables and transformers. This was a more complete and flexible control solution than had been deployed on any other GB distribution system to date.

The learning from developing and operating GUS was fed into the ENA [active network management (ANM) good practice guide](https://uksmartgrid.org/active-network-management-good-practice-guide/), influencing the development of ANM GB-wide.

Our own [smart grid development plan](http://www.yourpowergridplan.com/som_download.cfm?t=media:documentmedia&i=1724&p=file) describes how we will use the CLNR GUS as a base for platform for ANM to enable the deployment of distribution state estimation and for active network management of the Northern Powergrid network.

## Lasting positive impact on our follow-on innovation activity

*Electric vehicles*

* [Vehicle to Grid (V2G)](http://www.northernpowergrid.com/innovation/projects/vehicle-to-grid-v2g-the-network-impact-of-grid-integrated-vehicles-nia-npg-014) - studying the bi-directional power flows and the implications for the development of the network in the future
* [e4Future project](https://www.northernpowergrid.com/innovation/news/1-000-vehicle-to-grid-chargers-to-put-uk-at-forefront-of-electric-vehicle-revolution) - to identify and help overcome barriers to V2G charging
* [Customer-Led Distribution System](http://www.northernpowergrid.com/innovation/projects/customer-led-distribution-system-nia-npg-19) project - addressing the issue of how to accommodate large volumes of distributed energy resources (including EVs with V2G) at the least cost while at the same time delivering value so that they can thrive in market-based conditions.
* [GenDrive](http://www.northernpowergrid.com/news/northern-powergrid-part-of-gamification-trial-for-electric-vehicles) - investigating whether gamification can stimulate electric car drivers to engage with Vehicle-to-Grid (V2G) technologies
* [Silent Night](http://www.northernpowergrid.com/innovation/projects/silent-night-hybrid-ev-generator-nia-npg-016) –investigating whether using an electric vehicle equipped with a large battery instead of a diesel generator, can efficiently cut running costs, noise and CO2 emissions.

[*Distributed Storage & Solar Study*](http://www.northernpowergrid.com/innovation/projects/distributed-storage-solar-study-nia-npg-011) *–* domestic batteries reducing customer bills and local network peaks

[*Activating Community Engagement*](http://www.northernpowergrid.com/innovation/projects/activating-community-engagement-nia-npg-005)– using gamification to enable domestic demand side response

[*Battery trading*](http://www.northernpowergrid.com/news/northern-powergrid-battery-pioneers-smart-energy-future)– re-using large CLNR battery to sell services to the System Operator, developing DSO competencies

[*Microresilience*](http://www.smarternetworks.org/project/nia_npg_018)– redeploying CLNR batteries with distributed energy resources to investigate run-through capability for local grids; boosting system resilience for the most vulnerable and integrating hybrid generators in fault conditions

[*Integrel*](http://www.integrel.co.uk/)– whole system demonstrator – heat and gas/electricity interface [(press release)](http://www.northernpowergrid.com/news/northern-powergrid-part-of-industry-leading-collaboration-to-explore-future-energy-systems)

# Q4. Please detail any datasets/other IP, generated as part of the project, that has been shared with other DNOs academia? What efforts did you take to improve access and usability of any such data for interested users (over and above what was promised in your original submission and any subsequent project directions, if applicable?)

## Datasets and other IP shared

Below we list the materials produced to satisfy the project direction, and other additional outputs. All of these are freely available from the project website, except the academic peer reviewed papers which are available via other internet sites.**ng the requirements of the project direction Additional outputs**

**Demand profiles grouped by customer type:** Data sets in an open and useable format issued to distributors and other interested parties

**Planned outputs**

* Dataset (TC1a‎55): Basic profiling of domestic and smart meter customers
* Dataset (TC1b‎56): Basic profiling of small and medium sized enterprise (SME) customers
* Dataset (TC2aHW‎99): Enhanced profiling of domestic customers with electric hot water immersion heating
* Dataset (TC2aHW+SH‎100): Enhanced profiling of domestic customers electric hot water immersion heating & storage heating
* Dataset (TC2b‎101): Enhanced profiling of small and medium sized enterprise (SME) customers
* Dataset (TC7‎20): Business (I&C) Impact of the 2010 Tariff Reform North East & Yorkshire

**Demand profiles grouped by low-carbon technology type:** Data sets in an open and useable format issued to distributors and other interested parties

**Planned outputs**

* Dataset (TC3‎24): Enhanced profiling of domestic customers with air source heat pumps
* Dataset (TC4‎25): Enhanced profiling of domestic customers with micro-CHP
* Dataset (TC5‎26): Enhanced profiling of domestic customers with solar photovoltaics

Dataset (TC6‎27): Enhanced profiling of domestic customers with electric vehicles (EVs)

**Additional outputs:**

We also went beyond just monitoring heat pump consumption profiles and flexibility to **explore customers’ attitudes to the operation and performance of heat pumps**. The benefit of this has been a wider understanding of issues which need to be addressed (e.g. to educate in operation and gain ‘buy-in’) if heat pumps are to become a more active part of the energy system.

* CLNR-L10450 Heat Pump Survey Results
* We also studied the effect of heat pumps, electric vehicles, micro-CHP, or solar photovoltaic generation, both individually in clusters, in order to consider the concerns about widespread uptake of these technologies.
* CLNR-L14652: CLNR Power Quality Assessment – Impacts of Low Carbon Technologies

**Output profiles of existing generation types:** Data sets in an open and useable format issued to distributors and other interested parties

**Planned outputs**

* Dataset (TC8‎102): Establishing a new set of generation profiles to better recognise the contribution of generation to system security

**Output/ demand profiles before and after a range of interventions:** Data sets in an open and useable format issued to distributors and other interested parties

**Planned outputs**

* Dataset (TC9a‎57): Domestic smart meter customers on time of use tariffs
* Dataset (TC10a‎58): Domestic customers on the smart washing machine restricted hours trial
* Dataset (TC11a‎59): Domestic customers on the smart washing machine direct control trial
* Dataset (TC12‎60): Domestic customers with air source heat pump (ASHP) customers on time of use tariffs
* Dataset (TC14‎61): Domestic customers with air source heat pumps on direct control trials
* Dataset (TC20 Auto‎62): Domestic solar PV customers with automatic in-premises balancing for hot water charging
* Dataset (TC20 IHD‎63): Domestic solar PV customers using in-home displays for manual in-premises balancing
* Dataset (TC9b‎103): SME smart meter customers on time of use tariffs
* Dataset (TC10b): SME customers with restricted hours tariff and customer override

**Additional outputs:** The datasets were complemented by a series of technical and socio-technical outputs, delivered by our academic partners. The socio-technical learning which was delivered was beyond the original scope of the submission and gave additional depth to the already extensive learning. Additionally, the academic research generated both conference and journal papers ensuring the reach of the project learning within the academic community.

**In-depth insight reports:**

* CLNR-L093‎64: Insight report: Domestic time of use tariffs
* CLNR-L090‎30: Insight report: Domestic solar PV customers
* CLNR-L096‎65: Insight report: Domestic direct control trials

**Customers’ energy use insight reports:**

* CLNR-L242‎97: High level summary of learning: Domestic smart meter customers
* CLNR-L243‎66: High level summary of learning: Domestic smart meter customers on time of use tariffs
* CLNR-L244‎67: High level summary of learning: Solar PV customers
* CLNR-L245‎51: High level summary of learning: Heat pump customers
* CLNR-L254‎68 : High level summary of learning: Electric vehicle users
* CLNR-L10335: SME Customers: Energy Practices and Flexibility – detailing the barriers preventing these customers from offering greater flexibility to network operators. This was necessary as we had found that this customer group were unable to offer the flexibility services we were seeking and they were also found to be particularly diverse

**Sharing our approach to successful customer interaction and engagement**

CLNR-L036 23 : Lessons learned from trial recruitment: Customer-Led Network Revolution customer trials

CLNR-L26277 : Lessons learned report: Customer trials equipment installations

**Network data showing performance of selected network technologies:** Data sets in an open and useable format issued to distributors and other interested parties

**Planned outputs**

* CLNR-L200‎98 CLNR network trials: A guide to the datasets
* CLNR-L186‎83: Distribution substation, electrical energy storage (100kVA / 200kWh) autonomous power flow Management Trial Dataset
* CLNR-L187‎84: Primary Substation, electrical energy Storage 2.5MVA 5MWha power flow management trial dataset
* CLNR-L188‎85: PV test cell, distribution substation, electrical energy storage (50kVA / 100kWh) autonomous voltage trial dataset
* CLNR-L189‎86: Rural distribution transformer, thermal dataset
* CLNR-L190‎87: Urban distribution substation transformer, thermal dataset
* CLNR-L191‎88: Primary substation transformer, thermal dataset
* CLNR-L192‎89: Real time thermal rating for extra high voltage overhead tower lines
* CLNR-L193‎90: Real time thermal rating for high voltage overhead lines
* CLNR-L194‎91: Enhanced automatic voltage control for low voltage network regulators
* CLNR-L195‎92: Distribution substation tap changing transformer
* CLNR-L196‎93: GUS voltage control of tap changers and energy storage
* CLNR-L197‎94: Real time thermal rating for low voltage underground cables
* CLNR-L198‎95: Real time thermal rating for high Voltage Underground Cables
* CLNR-L199‎96: Real-Time Thermal Rating for Extra High Voltage Underground Cables

**Additional outputs:**

**Designing and running network trials**: we developed an approach to design and optimise network trials which uses a systematic process to define the subset of trials to deliver all of the learning required.

* CLNR-L220105 : Overview of Network Flexibility Trial Design for the CLNR Project

In addition to the trial design methodology, a learning credits system was developed as a mechanism to drive the trials towards gaining the maximum learning from the equipment and time available, thus ensuring that the trials delivered the best learning possible. This is useful for other DNOs to plan their future network trials efficiently in order to maximise the learning by selecting an optimum combination of trials from a larger list of potential trials.

* CLNR-L221 106 : CLNR Learning Credits System.

**Analysis of load profile data:** Proposals for changes to standard load profiles for network planning, issued to fellow distributors and website, and ENA Engineering Committee, with any recommendations to update/replace ACE 49

**Planned outputs**

* CLNR-L185‎34: Review of the Distribution Network Planning and Design Standards for the Future Low Carbon Electricity System

**Analysis of generation profile data**

* Proposals for changes to standard generation profiles for network planning, issued to fellow distributors and website; and ENA Engineering Committee, with any recommendations to update ETR 130.
* Generic GB distribution policy guidance on generator interface protection to secure contribution to system security, issued to fellow distributors and website; and ENA Engineering Committee, with any recommendation to update ER G59.

**Planned outputs**

* CLNR-L185‎34: Review of the Distribution Network Planning and Design Standards for the Future Low Carbon Electricity System

**Provide an understanding of, and disseminate to other distributors, how advanced voltage control, thermal ratings and storage may be integrated to enable more low-carbon technologies to be accepted on the network. Provide a view of the costs associated with these arrangements**

* Quantified, evidence-based cost/benefit analysis of novel network technologies issued to fellow distributors and website
* Generic GB distribution policy guidance on the application of novel network technologies, issued to fellow distributors; and ENA Engineering Committee, with any recommendations to create new engineering recommendations.

**Planned outputs**

* CLNR-L249‎37: Cost analysis report: Electrical energy storage
* CLNR-L250‎44: Cost analysis report: Enhanced automatic voltage control
* CLNR-L252‎69: Costs analysis report: Real time thermal rating
* CLNR-L257‎70: Voltage control policy, proposals for a voltage control policy from CLNR learning
* CLNR-L263‎71: A review of engineering recommendations P15, P17 and P27 (transformers, cables and overhead lines)

**Additional outputs**

From our experience of procuring, installing and operating network equipment, we developed and published a DNO toolkit:

***Operational guidance***

CLNR-L161 [Operational guidance and training requirements: Electrical energy storage systems](http://www.networkrevolution.co.uk/project-library/operational-guidance-training-requirements-battery-electrical-energy-storage-trials/)

CLNR-L157 [OHL Real time thermal rating installation guide](http://www.networkrevolution.co.uk/project-library/ohl-real-time-thermal-rating-installation-guide/)

CLNR-L158 [Operational guidance and training requirements: Trials of secondary transformers with integral OLTC](http://www.networkrevolution.co.uk/project-library/operational-guidance-training-requirements-trials-secondary-transformers-integral-load-tap-changers/)

CLNR-L156 [Operational guidance and training requirements: Grand Unified Scheme (GUS)](http://www.networkrevolution.co.uk/project-library/operational-guidance-training-requirements-gus-etwork-trials/)

***Lessons learned***

CLNR-L163 [Lessons learned report: Electrical energy storage](http://www.networkrevolution.co.uk/project-library/lessons-learned-report-electrical-energy-storage/)

CLNR-L164 [Lessons learned report: Real time thermal rating](http://www.networkrevolution.co.uk/project-library/lessons-learned-report-real-time-thermal-rating/)

CLNR-L165 [Lessons learned report: Enhanced automatic voltage control](http://www.networkrevolution.co.uk/project-library/lessons-learned-report-enhanced-automatic-voltage-control/)

CLNR-L167 [Lessons learned report: Grand Unified Scheme](http://www.networkrevolution.co.uk/project-library/lessons-learned-report-grand-unified-scheme/)

***Network monitoring***

CLNR-L232 [Enhanced network monitoring report](http://www.networkrevolution.co.uk/project-library/enhanced-network-monitoring-report/)

***Technical recommendations for purchase***

CLNR-L147 [Technical recommendation for the purchase of EES systems](http://www.networkrevolution.co.uk/project-library/technical-recommendation-purchase-ees-systems/)

CLNR-L149 [Technical recommendation for the purchase of overhead line RTTR systems](http://www.networkrevolution.co.uk/project-library/technical-recommendation-purchase-overhead-line-rttr-systems/)

CLNR-L150 [Technical recommendation for the purchase of RTTR for transformers](http://www.networkrevolution.co.uk/project-library/technical-recommendation-purchase-rttr-transformers/)

CLNR-L151 [Technical recommendation for the purchase of underground cable RTTR systems](http://www.networkrevolution.co.uk/project-library/technical-recommendation-purchase-underground-cable-rttr-systems/)

CLNR-L209 [Technical recommendation for the purchase of EAVC for HV systems](http://www.networkrevolution.co.uk/project-library/technical-recommendation-purchase-eavc-hv-systems/)

CLNR-L210 [Technical recommendation for the purchase of EAVC for HV-LV systems](http://www.networkrevolution.co.uk/project-library/technical-recommendation-purchase-enhanced-automatic-voltage-control-hv-lv-systems/)

CLNR-L154 [Technical recommendation for the purchase of Active Network Management](http://www.networkrevolution.co.uk/project-library/technical-recommendation-purchase-active-network-management-systems/)

***Training materials***

CLNR-L233 [A guide to the CLNR training packages](http://www.networkrevolution.co.uk/project-library/guide-clnr-training-packages/)

CLNR-L168 [Training Package: Electrical energy storage](http://www.networkrevolution.co.uk/project-library/training-package-electrical-energy-storage-2/)

CLNR-L204 [Training Package: Real time thermal rating for overhead lines](http://www.networkrevolution.co.uk/project-library/training-powerpoint-real-time-thermal-rating-ohl/)

CLNR-L205 [Training Package: Real time thermal rating underground cables](http://www.networkrevolution.co.uk/project-library/training-package-real-time-thermal-rating-underground-cables/)

CLNR-L206 [Training Package: Real time thermal rating for transformers](http://www.networkrevolution.co.uk/project-library/training-package-real-time-thermal-rating-transformers/)

CLNR-L170 [Training Package: Enhanced automatic voltage control](http://www.networkrevolution.co.uk/project-library/training-package-enhanced-automatic-voltage-control-2/)

CLNR-L172 [Training Package: Active network management](http://www.networkrevolution.co.uk/project-library/training-package-active-network-management/)

CLNR-L173 [Training Package: Demand side response](http://www.networkrevolution.co.uk/project-library/training-package-demand-side-response-2/)

**Undertake, and disseminate by end December 2014 to other distributors, a critical review of how commercial models and arrangements between distributor and supplier may evolve to facilitate customer-side response**

Recommendations for changes to industry codes (for example, this could include DCUSA, CDCM and related industry codes) as relevant to industry bodies such as DCUSA Ltd, BSC Review Panel, Ofgem, ENA

**Planned outputs**

* CLNR-L032‎72: Commercial arrangements, phase 1
* CLNR-L145‎81: Commercial arrangements, phase 2
* CLNR-L160 ‎73: Application guide CLNR demand side response trials
* CLNR-L014‎74 and CLNR-L098‎75: Reports on CLNR industrial & commercial demand side response trials (2012 & 2014)
* CLNR-L258‎76: Ceiling price calculator

**Additional outputs**

We undertook a qualitative survey for larger (I&C) business customers’ appetite for DSR to better to understand the reasons behind the difficulties in attracting customers to contract with us for their flexibility and the results are contained in

* CLNR-L098‎75: Report on CLNR industrial & commercial demand side response trials

**Project close down report**

**Planned outputs**

* CLNR-G026: Project closedown report‎1

**Additional outputs**

Three themed reports providing more detail than was possible in the closedown report and providing a bridge to the other materials containing more detailed supporting information.

* CLNR-L246 2 Developing the smarter grid: the role of domestic and small and medium enterprise customers
* CLNR-247 3 : Developing the smarter grid: the role of industrial & commercial and distributed generation customers CLNR-L247
* CLNR-L248 4 Developing the smarter grid: optimal solutions for smarter network businesses

## Datasets and other IP shared: other additional outputs - disaggregated customer datasets

In terms of sharing the data from the customer trials, during the project we delivered the datasets set out in the table above which are ‘aggregate’ datasets ie data that represents the entire group of customers through statistical parameters.

During the project we had 30 requests from academics for access to the disaggregated customer data from the CLNR trials for further research. These ‘disaggregated’ datasets contained the data for individual customers for each time slot during the trials.

Following the closedown of the Project, we funded(circa £50k) data analysis and project management to prepare and publish 9 datasets of disaggregated and anonymised data from the customer trials, thus making the data available for further R&D by academics or interested third parties and maximising the learning available from the investment in CLNR. We worked with British Gas (who were the legal data controllers) to ensure a suitable data format could be provided, whilst maintaining our obligations to customer data privacy.

The data sets were initially distributed on a trial basis via hard drives to a small number (circa 7) of academics who had expressed interest in exploring the data further, following which they were made available on a self-serve basis via the project website.

The datasets prepared were as follows:

|  |  |
| --- | --- |
| TC1a | Basic profiling of domestic smart meter customers |
| TC1b | Basic profiling of small medium sized enterprise SME customers |
| TC2a | Enhanced profiling of domestic smart meter customers |
| TC3 | Enhanced profiling of domestic customers with air source heat pumps |
| TC5 | Enhanced profiling of domestic customers with solar photovoltaic (PV) |
| TC6 | Enhanced profiling of domestic customers with electric vehicles (EVs) |
| TC9a | Domestic smart meter customers on time of use tariffs |
| TC20auto | Domestic solar PV customers with automatic in-premises balancing for hot water charging |
| TC20IHD | Domestic solar PV customers using in-home displays for manual in-premises balancing |

## Improving access to and usability of project outputs

The project direction requirement was to develop a project website and to update it in line with project developments. During and post-project we took a number of actions to improve access to the project’s outputs and their usability.

### Closedown report and structuring project outputs

All reports and datasets were made available on the project website through the project library, and post-project a separate page was added for access to the disaggregated customer datasets.

With the large amount of IP, we structured the project outputs to help people navigate the materials:



The closedown report and three key learning reports set out the implications of our findings and these draw on the other preceding high quality outputs where more detail can be found.

We undertook a period of consultation to ensure that our stakeholders, in particular DNOs, had the opportunity to explore, absorb and give feedback on our findings through written feedback and the opportunity to participate in face-to-face feedback at a consultation event. This was well attended and included delegates from all DNOs, Ofgem, the Department of Energy & Climate Change, academics, consultants and other industry parties. In addition, UKPN undertook a formal peer review of the closedown report (part of a collaboration that also saw us jointly present to the Gas and Electricity Markets Authority board meeting).

The ‘Optimal solutions for smarter network businesses’ report is a generic smart grid safety case. To enable CLNR solutions to be rolled out by other DNOs, we considered it essential to develop and share a ‘DNO toolkit’ that would enable them to benefit from experience of procuring, installing and operating network equipment. The toolkit comprises 16 detailed documents for each new technology deployed by CLNR encompassing operational guidance, lessons learned, network monitoring, technical recommendations for purchasing equipment and systems, and training materials.

### Website functionality and usability

The original website (2011) featured a simple navigation structure which clearly signposted the important project library resource and clearly communicated the projects drivers, aims and outcomes. In 2012 we launched the CLNR social media channels ([Twitter](https://twitter.com/clnruk), [LinkedIn](https://www.linkedin.com/groups/CustomerLed-Network-Revolution-4709444) and [YouTube](https://www.youtube.com/user/CLNRUK)) which we used to increase the reach of the project and drive more traffic to the website.

We recognised however, that as a key part of the enduring legacy of the project and most people’s first port of call for information, the website would require regular updates and improvements to its functionality.

Links to the social media channels and content were included



Summary pages for every report or output uploaded to the project library provide a brief synopsis of content, help with SEO and provide links to related learning and video content

In July 2014, we completed a major refresh and re-launch of the website to improve the visitor experience and to support the sharing of knowledge with our stakeholders. This was documented in progress report 8‎12.

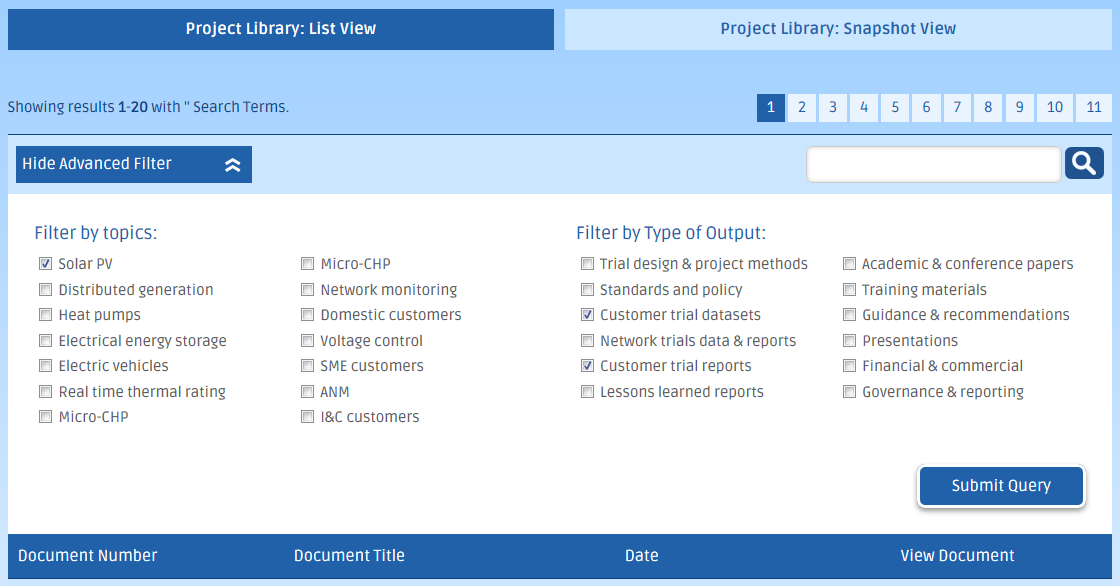
The major upgrades we made were as follows;

* A new content management system allowed us to perform document uploads and content updates in-house, instead of relying on external suppliers. This proved particularly important in the latter stages of the project when it became necessary to upload multiple project outputs.
* A new and improved project library allowed users to search and filter documents, share them via email and social media channels and access any related reports or video content.
* The website was made responsive across all platforms meaning it could be accessed from laptops, tablets and mobile phones.

The website content was written in such a way as to be search engine optimised. Links to the CLNR social media sites and content were displayed and users were given clear signposts of how to ‘contact us’ with any questions about the project. New pages were added which gave an overview of each of the CLNR trials, its purpose, its progress and links to relevant learning and videos ([see solar PV trials example](http://www.networkrevolution.co.uk/customers/domestic-customer-trials/solar-pv/)). The usability of the project library was also significantly improved with the addition of a snapshot view and summary pages for every project output uploaded. The summary pages give a concise synopsis of the report or datasets content, helping the user locate the information they are interested in and help with search engine optimisation.

Following feedback from our industry consultation process, we further improved the usability of the project library by implementing an advanced search function which enables users to drill down and locate the specific document or range of documents they were interested in.

We updated the website content to reflect the project’s completion and added new pages to clearly signpost the project’s findings and conclusions. This update to the CLNR website was rolled out in April 2015.



Email was our primary tool for disseminating learning and engaging with our stakeholders and the list of opt-in subscribers had reached over 900 by the time of project closedown. Subscribers received priority updates on the release of any new project outputs and an e-news bulletin which kept them up to date with the latest project news, driving traffic to the project website.

We also used our Twitter, LinkedIn and YouTube channels to significantly increase the visibility and reach of the project, giving our followers a medium to disseminate learning on our behalf and to drive traffic to the website. Our CLNR Twitter channel had 564 followers, our LinkedIn group consisted of 243 members and the 15 videos on our YouTube channel have been viewed over 14,000 times.

There have been over 4,900 visitors to the project website with over 28,200 unique page visits. The CLNR online project library[[1]](#endnote-1) holds over 200 outputs (the main ones are listed in the appendix) and there have been over 10,000 views of the top ten items:

|  |  |
| --- | --- |
| **Most accessed materials in CLNR project library** | **Hits** |
| After Diversity Maximum Demand Report | 5,518 |
| Project Closedown Report | 1,253 |
| Domestic Smart Meter Customers Profiling | 1,022 |
| Developing the smarter grid: optimal solutions for smarter network businesses | 603 |
| Developing the smarter grid: the role of domestic and small and medium enterprise customers | 569 |
| Review of the Distribution Network Planning & Design Standards for the Future Low Carbon Electricity System | 517 |
| Dataset (TC6): Enhanced Profiling of Domestic Customers with Electric Vehicles (EVs) | 388 |
| Developing the smarter grid: the role of domestic and small and medium enterprise customers | 569 |
| Developing the smarter grid: the role of industrial & commercial and distributed generation customers | 267 |
| Lessons Learned Report: Electrical Energy Storage | 264 |
| Insight Report: Domestic Baseline Profile | 247 |

### The disaggregated customer data additional datasets

In order to facilitate open access to these additional datasets, we developed a self-service web platform which was launched on the CLNR project website in early 2016. This was accompanied by a document describing the data and its format and instructions on how to access the data.

To maximise reuse, we provided access to these datasets under the Creative Commons Attribution-ShareAlike licence, without any limitation on how it could be used, provided that copyright was not infringed. We subsequently wrote to third parties to actively promote the new availability of this data.

Since going live, the project data that we made available has been downloaded by more than 300 individuals from over 100 organisations in 20 different countries including; international academic institutions in China, Germany, Greece, India, Iran, Jordan, Korea, Russia, Singapore, Spain, Switzerland, Taiwan, Turkey, the UK and USA; consultants in the UK, Netherlands and UAE; and established suppliers and new entrants, energy services companies, DNOs and technology companies in the UK, Canada, USA and India. The reach of CLNR is significant and moves beyond UK DNOs and the electricity sector, and further benefits will follow in future as this data is used by more people to address more research questions. By requiring third parties to register their details prior to downloading the data, we have been able to trace the significant interest in CLNR and how its impact continues to ripple out.

# Q5.  Please provide evidence of how CLNR led to the TRANSFORM model? What were the outputs from CLNR that fed into TRANSFORM? What is the level of acceptance and use of TRANSFORM model in GB DNOs (please provide evidence of active current use of the model and where it has triggered tangible investment decisions)?

## CLNR solutions templates

CLNR fed its outputs into Transform via the standard solutions template. A template was prepared for a number of variants of each solution type, as listed below.

**Real Time Thermal Rating**

RTTR for EHV/HV underground cables

RTTR for LV underground cables

RTTR for EHV overhead lines

RTTR for HV overhead lines

RTTR for EHV/HV transformers

RTTR for HV/LV transformers

**Enhanced Automatic voltage Control (EAVC)**

HV circuit voltage regulators

LV circuit voltage regulators

HV/LV Transformer Voltage Control

Switched Capacitors

HV/LV Transformer Voltage Control with GUS

LV circuit voltage regulators

**Electrical Energy Storage (EES)**

HV connected EES - medium

LV connected EES - large

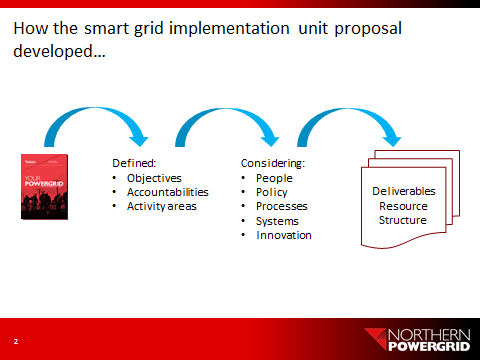
LV connected EES - small

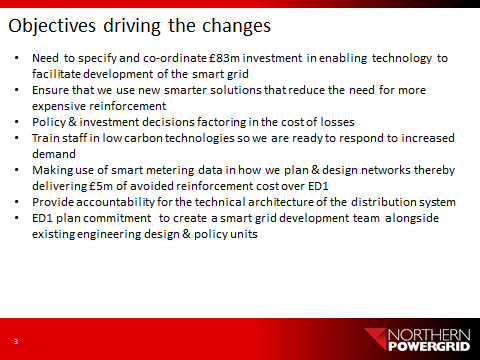
One of the templates is shown below as an example:

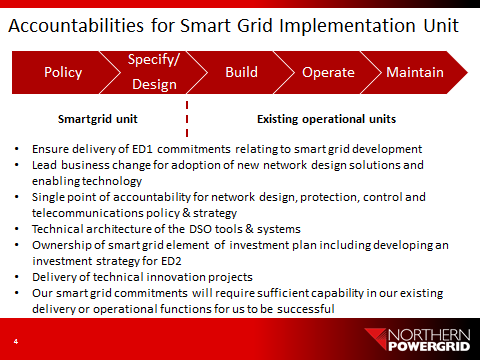


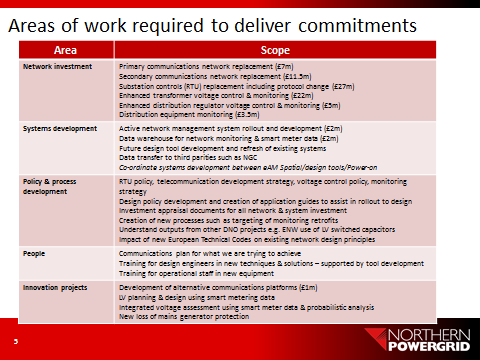
# Appendix 1 – Smart Grid Implementation Unit

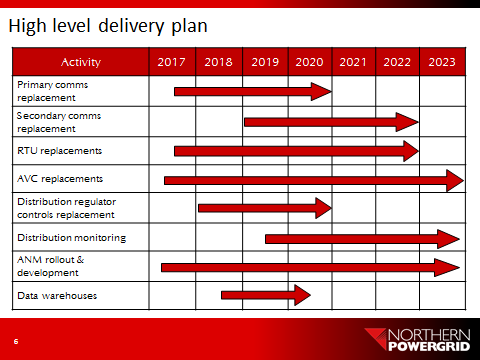
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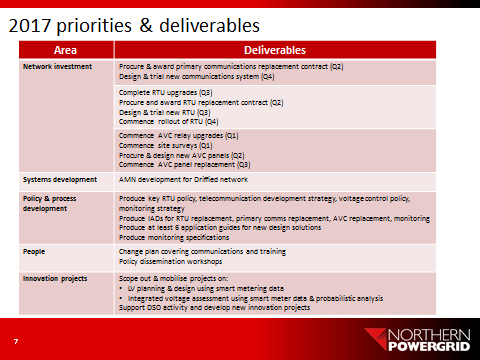
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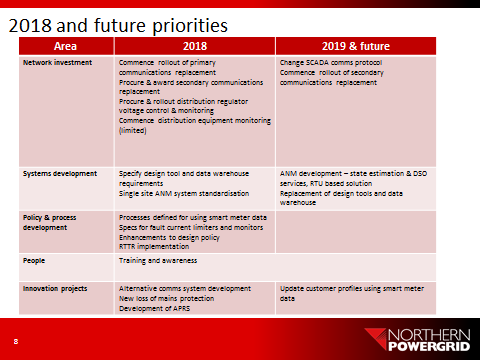
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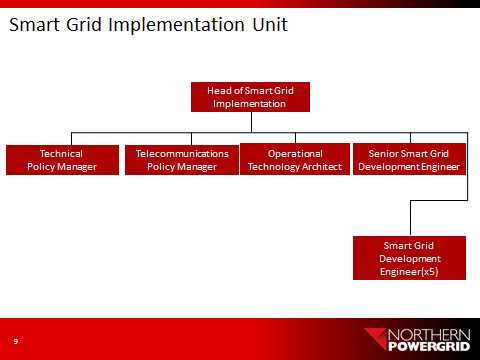
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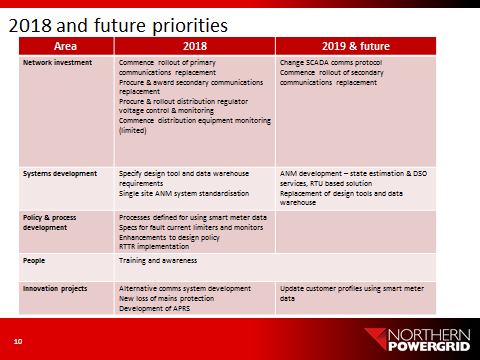
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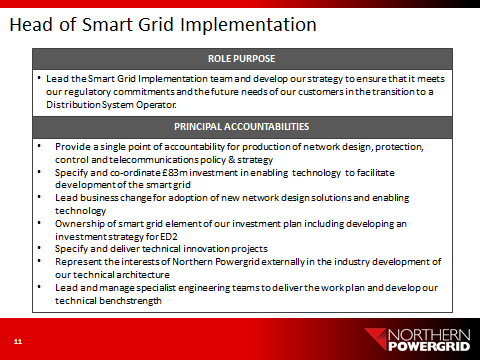
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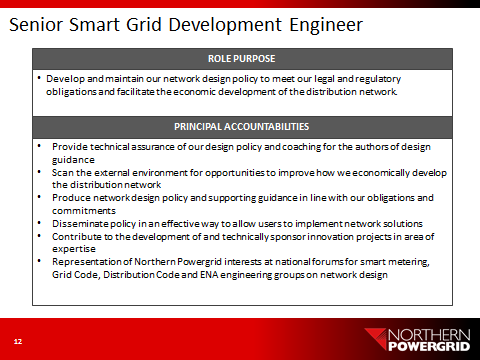
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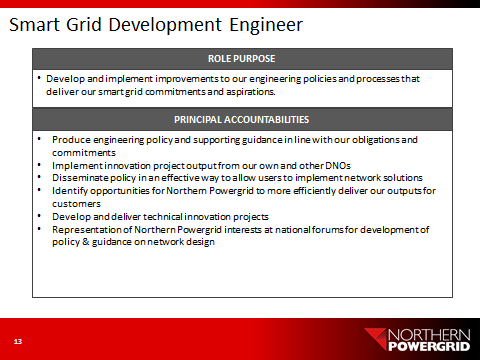
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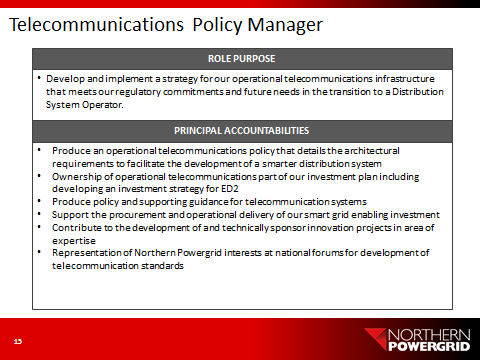
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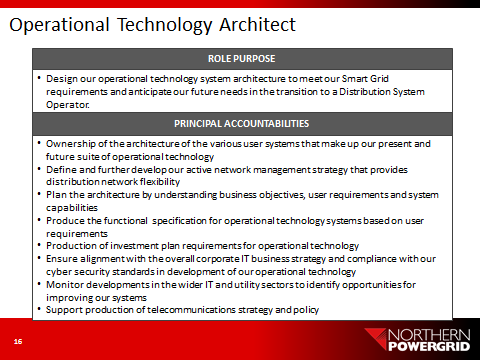
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# Appendix 2 – Summary notes from recent meetings of the Innovation Steering Group

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Title:** | Innovation Steering Group | | | **Date:** | 31/05/18 | |
| **Location:** | Lloyds Court, Newcastle | | | **Time:** | 12:00-14:00 | |
|  | Present | | Absent | | | |
| **Attendees:** | Patrick Erwin | PE | Geoff Earl | | | GE |
| Nick Gill | NG | Jim Cardwell | | | JC |
| Mark Drye | MD | Mark Nicholson | | | MN |
| Phil Taylor | PT |  | | |  |
| Iain Miller | IM |  | | |  |
| Ross McFarlane | RM |  | | |  |
| Chris Goodhand | CG |  | | |  |

|  |  |  |
| --- | --- | --- |
| **Actions** | **Owner** | **Status** |
| * Red Top Report to include separate line stating Innovate UK funding values | IM |  |
| * Create an Intellectual Property Strategy which considers customer/stakeholder funding | IM |  |
| * Develop monthly reports in line with Investment Delivery and PEP Reports and circulate ‘gold standard’ to Innovation Project Managers | RM |  |
| * Amend close down reports to include a BAU section | CG | Complete |
| * Enforce close down reports process and format | IM / Project Sponsors |  |
| * Establish position and flag any risks regarding Foresight project | NG |  |
| * Establish position and flag any risks regarding AutoDesign project | MD |  |
| * Losses Project to be included in monthly reporting cycle | RM |  |
| * Develop InTEGReL strategy and discuss with PT | IM |  |
| * Challenge whether 2018 projects are sufficiently innovative (e.g. Centralock) | IM/CG |  |
| * Discuss acquisition interest of company who produce Pollywood poles with Lawrence Fletcher | CG |  |
| * Arrange a Steering Group meeting to discuss NIC bid | PE |  |
| * Address concerns over CLDS work quality | PE / IM / JKC |  |
| * Ensure reporting shows opportunities as clearly as risks | RM / IM |  |
| * Plan and dashboard for EMMM collateral and cycle | CG / RM / IM |  |

# Appendix 3 – Materials in the CLNR website project library

|  |  |
| --- | --- |
| CLNR-G026 | 1. [Closedown report](http://www.networkrevolution.co.uk/project-library/project-closedown-report/) |
| CLNR-L246 | 1. [Developing the smarter grid: the role of domestic and small and medium enterprise customers](http://www.networkrevolution.co.uk/project-library/developing-smarter-grid-role-domestic-small-medium-sized-enterprise-customers/) |
| CLNR-L247 | 1. [Developing the smarter grid: the role of industrial & commercial and distributed generation customers](http://www.networkrevolution.co.uk/project-library/developing-the-smarter-grid-the-role-of-industrial-and-commercial-and-distributed-generation-customers/) |
| CLNR-L248 | 1. [Developing the smarter grid: optimal solutions for smarter network](http://www.networkrevolution.co.uk/project-library/optimal-solutions-smarter-network-businesses/) businesses |
| CLNR-G013 | 1. [Progress report 3](http://www.networkrevolution.co.uk/project-library/progress-report-3/) |
| CLNR-G014 | 1. [Progress report 4](http://www.networkrevolution.co.uk/wp-content/uploads/2014/02/Progress-report-4.pdf) |
| CLNR-G016 | 1. [Progress report 5](http://www.networkrevolution.co.uk/wp-content/uploads/2013/06/CLNR_Project_Report_5.pdf) |
| CLNR-G018 | 1. [Progress report 6](http://www.networkrevolution.co.uk/wp-content/uploads/2014/02/CLNR-G018_Progress_Report_6.pdf) |
| CLNR-G020 | 1. [Progress report 7](http://www.networkrevolution.co.uk/wp-content/uploads/2014/07/CLNR-Progress-Report-7-New-links-.pdf) |
| CLNR-G024 | 1. [Progress report 8](http://www.networkrevolution.co.uk/project-library/progress-report-8/) |
| CLNR-L253 | 1. [ESOF Good Practice Guide](http://www.networkrevolution.co.uk/project-library/esof-good-practice-guide-electrical-energy-storage/) |
| CLNR-L010 | 1. [Initial load and generation profiles from CLNR monitoring trials](http://www.networkrevolution.co.uk/project-library/initial-load-generation-profiles-clnr-monitoring-trials/) |
| CLNR-L071 | 1. [CLNR customer trials: A guide to the load and generation profiles](http://www.networkrevolution.co.uk/project-library/guide-datasets-august-2014/) |
| CLNR-L216 | 1. [Insight report: Domestic baseline profile](http://www.networkrevolution.co.uk/project-library/insight-report-domestic-baseline-profile/) |
| CLNR-L217 | 1. [After Diversity Maximum Demand (ADMD) report](http://www.networkrevolution.co.uk/project-library/diversity-maximum-demand-admd-report/) |
| CLNR-L261 | 1. [Test cell report: Baseline SME profiles & SME subgroup analysis](http://www.networkrevolution.co.uk/project-library/test-cell-report-baseline-sme-profiles-sme-customer-sub-group-analysis/) |
| CLNR-L094 | 1. [Insight report: Enhanced domestic monitoring](http://www.networkrevolution.co.uk/project-library/insight-report-enhanced-domestic-monitoring/) |
| CLNR-L088 | 1. [Datasets: Business (I&C) impact of the 2010 tariff reform North East & Yorkshire](http://www.networkrevolution.co.uk/project-library/clnr-test-cell-7-april-2010-tariff-reform-analysis-north-east/) |
| CLNR-L087 | 1. [April 2010 tariff reform analysis: An introduction to the Common Distribution Charging Methodology (CDCM)](http://www.networkrevolution.co.uk/project-library/april-2010-tariff-reform-analysis-introduction-common-distribution-charging-methodology-cdcm/) |
| CLNR-L011 | 1. [Dataset to accompany CLNR-L010](http://www.networkrevolution.co.uk/project-library/dataset-accompany-clnr-l010/) |
| CLNR-L036 | 1. [Lessons learned from trial recruitment: Customer-Led Network Revolution customer trials](http://www.networkrevolution.co.uk/project-library/project-lessons-learned-trial-recruitment-customer-led-network-revolution-trials/) |
| CLNR-L075 | 1. [Dataset (TC3): Enhanced profiling of domestic customers with air source heat pumps](http://www.networkrevolution.co.uk/project-library/dataset-tc3-enhanced-profiling-air-source-heat-pump-customers-flat-tariff/) |
| CLNR-L076 | 1. [Dataset (TC4): Enhanced profiling of domestic customers with micro-CHP](http://www.networkrevolution.co.uk/project-library/dataset-tc4-enhanced-profiling-micro-chp-customers-flat-tariff/) |
| CLNR-L077 | 1. [Dataset (TC5): Enhanced profiling of domestic customers with solar photovoltaics](http://www.networkrevolution.co.uk/project-library/dataset-tc5-enhanced-profiling-solar-photovoltaic-pv-users/) |
| CLNR-L078 | 1. [Dataset (TC6): Enhanced profiling of domestic customers with electric vehicles (EVs)](http://www.networkrevolution.co.uk/project-library/dataset-tc6-enhanced-profiling-electric-vehicles-ev-users-flat-rate-tariff/) |
| CLNR-L086 | 1. [Report on enhanced profiling of domestic customers with micro-CHP](http://www.networkrevolution.co.uk/project-library/micro-chp-trial-report/) |
| CLNR-L091 | 1. [Insight report: Domestic heat pumps](http://clnr.cargodev.co.uk/project-library/insight-report-domestic-heat-pumps/) |
| CLNR-L090 | 1. [Insight report: Domestic solar PV customers](http://www.networkrevolution.co.uk/project-library/insight-report-domestic-solar-pv-customers/) |
| CLNR-L095 | 1. [Technical note: Solar PV](http://www.networkrevolution.co.uk/project-library/solar-pv-technical-note/) |
| CLNR-L092 | 1. [Insight report: Electric vehicles](http://www.networkrevolution.co.uk/project-library/insight-report-electric-vehicles/) |
| CLNR-L012 | 1. [Initial load and generation profiles from CLNR intervention trials](http://www.networkrevolution.co.uk/project-library/initial-load-profiles-clnr-intervention-trials/) |
| CLNR-L185 | 1. [Review of distribution network planning and design standards for the future low carbon electricity system](http://www.networkrevolution.co.uk/project-library/review-distribution-network-planning-design-standards-future-low-carbon-electricity-system/) |
| CLNR-L103 | 1. [SME customers: Energy practices and flexibility](http://www.networkrevolution.co.uk/project-library/sme-customers-energy-practices-flexibility/) |
| CLNR-L161 | 1. [Northern Powergrid operational guidance and training requirements: Electrical energy storage](http://www.networkrevolution.co.uk/project-library/operational-guidance-training-requirements-battery-electrical-energy-storage-trials/) |
| CLNR-L249 | 1. [Cost analysis report: Electrical energy storage](http://www.networkrevolution.co.uk/project-library/electrical-energy-storage-cost-analysis/) |
| CLNR-L147 | 1. [Technical recommendation for the purchase of electrical energy storage systems](http://www.networkrevolution.co.uk/project-library/technical-recommendation-purchase-ees-systems/) |
| CLNR-L163 | 1. [Lessons learned report: Electrical energy storage](http://www.networkrevolution.co.uk/project-library/lessons-learned-report-electrical-energy-storage/) |
| CLNR-L168 | 1. [Training package: Electrical energy storage](http://www.networkrevolution.co.uk/project-library/training-package-electrical-energy-storage-2/) |
| CLNR-L118 | 1. [CLNR trial analysis: Electrical energy storage (100kVA/200kWh) power flow management](http://www.networkrevolution.co.uk/project-library/electrical-energy-storage-2-100kva200kwh-powerflow-management/) |
| CLNR-L121 | 1. [CLNR trial analysis: Electrical energy storage (2.5MVA/5MWh) power flow management](http://www.networkrevolution.co.uk/project-library/electrical-energy-storage-1-2-5mva5mwh-powerflow-management-rise-carr/) |
| CLNR-L158 | 1. [Northern Powergrid operational guidance and training requirements: Trials of secondary transformers with integral OLTC](http://www.networkrevolution.co.uk/project-library/operational-guidance-training-requirements-trials-secondary-transformers-integral-load-tap-changers/) |
| CLNR-L250 | 1. [Cost analysis report: Enhanced automatic voltage control](http://www.networkrevolution.co.uk/project-library/enhanced-automatic-voltage-control-cost-analysis/) |
| CLNR-L209 | 1. [Technical recommendation for the purchase of EAVC for HV systems](http://www.networkrevolution.co.uk/project-library/technical-recommendation-purchase-eavc-hv-systems/) |
| CLNR-L165 | 1. [Lessons learned report: Enhanced automatic voltage control](http://www.networkrevolution.co.uk/project-library/lessons-learned-report-enhanced-automatic-voltage-control/) |
| CLNR-L170 | 1. [Training package: Enhanced automatic voltage control](http://www.networkrevolution.co.uk/project-library/training-package-enhanced-automatic-voltage-control-2/) |
| CLNR-L119 | 1. [CLNR trial analysis: EES1 andEAVC1 with GUS voltage control](http://www.networkrevolution.co.uk/project-library/analysis-electrical-energy-storage-1-ees-enhanced-automatic-voltage-control-1-eavc-gus-voltage-control/) |
| CLNR-L135 | 1. [CLNR trial analysis: Collaborative voltage control on HV and LV networks](http://www.networkrevolution.co.uk/project-library/clnr-trial-analysis-analysis-collaborative-voltage-control-hv-lv-networks/) |
| CLNR-L104 | 1. [Heat pump survey results](http://www.networkrevolution.co.uk/project-library/heat-pump-survey-results/) |
| CLNR-L245 | 1. [Report on interviews with domestic customers with air source heat pumps](http://www.networkrevolution.co.uk/project-library/high-level-summary-learning-heat-pump-customers/) |
| CLNR-L146 | 1. [Assessment of power quality impacts from disruptive technologies](http://www.networkrevolution.co.uk/project-library/clnr-power-quality-assessment-impacts-low-carbon-technologies/) |
| CLNR-L038 | 1. [IEEE ISGT 2013: Integrating smart meter and electric vehicle charging data to predict network impacts](http://www.networkrevolution.co.uk/project-library/ieee-isgt-2013-integrating-smart-meter-electric-vehicle-charging-data-predict-distribution-network-impacts/) |
| CLNR-L070 | 1. [Applied Energy Journal: A probabilistic approach to combining smart meter and electric vehicle charging data to investigate distribution network impacts](http://www.networkrevolution.co.uk/project-library/probalistic-methods-applied-power-systems-2014/) |
| CLNR-L072 | 1. [Dataset (TC1a): Basic profiling of domestic smart meter customers](http://www.networkrevolution.co.uk/project-library/dataset-tc1a-basic-profiling-domestic-smart-meter-customers/) |
| CLNR-L073 | 1. [Dataset (TC1b): Basic profiling of small and medium sized enterprise (SME) customers](http://www.networkrevolution.co.uk/project-library/dataset-tc1b-basic-profiling-small-medium-sized-enterprise-sme-customers/) |
| CLNR-L079 | 1. [Dataset (TC9a): Domestic smart meter customers on time of use tariffs](http://www.networkrevolution.co.uk/project-library/dataset-tc9a-smart-meter-customers-time-use-tariffs/) |
| CLNR-L089 | 1. [Dataset (TC10): Domestic customers on the smart washing machine restricted hours trial](http://www.networkrevolution.co.uk/project-library/dataset-tc10-smart-washing-machine-wwg-restricted-hours-trial/) |
| CLNR-L080 | 1. [Dataset (TC11a): Domestic customers on the smart washing machine direct control trial](http://www.networkrevolution.co.uk/project-library/dataset-tc11a-wwg-smart-washing-machines-direct-control-trial/) |
| CLNR-L082 | 1. [Dataset (TC12): Domestic customers with air source heat pump (ASHP) customers on time of use tariffs](http://www.networkrevolution.co.uk/project-library/dataset-tc12-air-source-heat-pump-ashp-customers-time-use-tariffs/) |
| CLNR-L083 | 1. [Dataset (TC14): Domestic customers with air source heat pumps on direct control trials](http://www.networkrevolution.co.uk/project-library/dataset-tc14-air-source-heat-ashp-customers-direct-control-trial/) |
| CLNR-L084 | 1. [Dataset (TC20 Auto): Domestic solar PV customers with automatic in-premises balancing for hot water charging](http://www.networkrevolution.co.uk/project-library/dataset-tc20-auto-solar-pv-users-premises-balancing-automatic-hot-water-charging/) |
| CLNR-L085 | 1. [Dataset (TC20 IHD): Domestic solar PV customers using in-home displays for manual in-premises balancing](http://www.networkrevolution.co.uk/project-library/dataset-tc20-ihd-solar-pv-users-premises-balancing-using-home-displays/) |
| CLNR-L093 | 1. [Insight report: Domestic time of use tariffs](http://www.networkrevolution.co.uk/project-library/insight-report-domestic-time-use-tariffs/) |
| CLNR-L096 | 1. [Insight report: Domestic direct control trials](http://www.networkrevolution.co.uk/project-library/insight-report-domestic-direct-control-trials/) |
| CLNR-L243 | 1. [High level summary of learning: Domestic smart meter customers](http://www.networkrevolution.co.uk/project-library/high-level-summary-learning-domestic-smart-meter-customers/) |
| CLNR-L244 | 1. [High level summary of learning: Solar PV customers](http://www.networkrevolution.co.uk/project-library/high-level-summary-learning-solar-pv-customers/) |
| CLNR-L254 | 1. [High level summary of learning: Electric vehicle users](http://www.networkrevolution.co.uk/project-library/high-level-summary-learning-electric-vehicle-users/) |
| CLNR-L252 | 1. [Cost analysis report: Real time thermal rating](http://www.networkrevolution.co.uk/project-library/real-time-thermal-rating-costs-analysis/) |
| CLNR-L257 | 1. [Voltage control policy: Proposals for a voltage control policy from CLNR learning](http://www.networkrevolution.co.uk/project-library/voltage-control-policy-proposals-voltage-control-policy-clnr-learning/) |
| CLNR-L263 | 1. [A review of engineering recommendations P15, P17 and P27 (transformers, cables and overhead lines)](http://www.networkrevolution.co.uk/project-library/review-engineering-recommendations-p15-p17-p27-transformers-cables-overhead-lines/) |
| CLNR-L032 | 1. [Commercial arrangements study, phase 1](http://www.networkrevolution.co.uk/project-library/clnr-commercial-arrangements-study-review-existing-commercial-arrangements-emerging-practice/) |
| CLNR-L160 | 1. [Application guide CLNR demand side response trials](http://www.networkrevolution.co.uk/project-library/application-guide-clnr-demand-side-response-trials/) |
| CLNR-L014 | 1. [Initial report on CLNR industrial & commercial demand side response trials (2012)](http://www.networkrevolution.co.uk/project-library/initial-report-industrial-commercial-demand-side-response-trials/) |
| CLNR-L098 | 1. [Report on CLNR industrial & commercial demand side response trials (2014)](http://www.networkrevolution.co.uk/project-library/report-clnr-ic-demand-side-response-trials/) |
| CLNR-L258 | 1. [Ceiling price calculator](http://www.networkrevolution.co.uk/project-library/dsr-ceiling-price-calculator/) |
| CLNR-L262 | 1. [Lessons learned report: Customer trials equipment installations](http://www.networkrevolution.co.uk/project-library/lessons-learned-report/) |
| CLNR-L228 | 1. [Reconstruction of the ACE 49 methodology](http://www.networkrevolution.co.uk/project-library/reconstruction-ace49-methodology/) |
| CLNR-L251 | 1. [Cost analysis report: Grand Unified Scheme (GUS)](http://www.networkrevolution.co.uk/project-library/grand-unified-scheme-costs-analysis/) |
| CLNR-L256 | 1. [CLNR solutions template](http://www.networkrevolution.co.uk/project-library/clnr-solutions-template/) |
| CLNR-L145 | 1. [Commercial arrangements study, phase 2](http://www.networkrevolution.co.uk/project-library/commercial-arrangements-study-phase-2/) |
| CLNR-L232 | 1. [Enhanced Network Monitoring Report](http://www.networkrevolution.co.uk/project-library/enhanced-network-monitoring-report/) |
| CLNR-L186 | 1. [Dataset: Distribution Substation, Electrical Energy Storage 100kVA 200kWh Autonomous Powerflow Management Trial](http://www.networkrevolution.co.uk/project-library/dataset-primary-substation-electrical-energy-storage-2-5mva-5mwh-autonomous-powerflow-management-trial/) |
| CLNR-L187 | 1. [Dataset: Primary substation, Electrical Energy Storage (2.5MVA / 5MWh) autonomous power flow management trial](http://www.networkrevolution.co.uk/project-library/dataset-primary-substation-electrical-energy-storage-2-5mva-5mwh-autonomous-powerflow-management-trial/) |
| CLNR-L188 | 1. [Dataset: PV test cell, distribution substation, Electrical Energy Storage (50kVA / 100kWh) autonomous voltage trial](http://www.networkrevolution.co.uk/project-library/dataset-pv-test-cell-distribution-substation-electrical-energy-storage-50kva-100kwh-autonomous-voltage-trial/) |
| CLNR-L189 | 1. [Dataset: Rural distribution transformer, thermal dataset](http://www.networkrevolution.co.uk/project-library/dataset-rural-distribution-transformer-thermal-dataset/) |
| CLNR-L190 | 1. [Dataset: Urban distribution substation transformer thermal dataset](http://www.networkrevolution.co.uk/project-library/dataset-urban-distribution-substation-transformer-thermal-dataset/) |
| CLNR-L191 | 1. [Dataset: Primary substation transformer, thermal dataset](http://www.networkrevolution.co.uk/project-library/dataset-primary-substation-transformer-thermal-dataset/) |
| CLNR-L192 | 1. [Dataset: Real time thermal rating for extra high voltage overhead tower lines](http://www.networkrevolution.co.uk/project-library/dataset-real-time-thermal-rating-extra-high-voltage-overhead-tower-lines/) |
| CLNR-L193 | 1. [Dataset: Real time thermal rating for high voltage overhead lines](http://www.networkrevolution.co.uk/project-library/dataset-real-time-thermal-rating-high-voltage-overhead-lines/) |
| CLNR-L194 | 1. [Dataset: Enhanced automatic voltage control for low voltage network regulator](http://www.networkrevolution.co.uk/project-library/dataset-enhanced-automatic-voltage-control-low-voltage-network-regulator/) |
| CLNR-L195 | 1. [Dataset: Distribution substation tap changing transformer](http://www.networkrevolution.co.uk/project-library/dataset-distribution-substation-tapchanging-transformer/) |
| CLNR-L196 | 1. [Dataset: GUS voltage control of tap changers and energy storage](http://www.networkrevolution.co.uk/project-library/dataset-gus-voltage-control-tap-changers-energy-storage/) |
| CLNR-L197 | 1. [Dataset: Real time thermal rating for low voltage underground cables](http://www.networkrevolution.co.uk/project-library/dataset-real-time-thermal-rating-low-voltage-underground-cables/) |
| CLNR-L198 | 1. [Dataset: Real time thermal rating for high voltage underground cables](file:///C:/Documents%20and%20Settings/user/My%20Documents/Downloads/CLNR-L198%20-%20Dataset:%20Real-Time%20Thermal%20Rating%20for%20High%20Voltage%20Underground%20Cables) |
| CLNR-L199 | 1. [Dataset: Real time thermal rating for extra high voltage underground cables](http://www.networkrevolution.co.uk/project-library/dataset-real-time-thermal-rating-extra-high-voltage-underground-cables/) |
| CLNR-L242 | 1. [High level summary of learning: Domestic smart meter customers](http://www.networkrevolution.co.uk/project-library/high-level-summary-learning-domestic-smart-meter-customers/) |
| CLNR-L200 | 1. [CLNR network trials: A guide to the datasets](http://www.networkrevolution.co.uk/project-library/clnr-network-trials-guide-datasets/) |
| CLNR-L211 | 1. [Dataset (TC2aHW): Enhanced profiling of domestic customers with electric hot water immersion heating](http://www.networkrevolution.co.uk/project-library/dataset-tc2ahw-enhanced-profiling-domestic-smart-meter-customers-electric-hot-water-immersion-heating/) |
| CLNR-L212 | 1. [Dataset (TC2aHW+SH): Enhanced profiling of domestic customers electric hot water immersion heating & storage heating](http://www.networkrevolution.co.uk/project-library/dataset-tc2ahwsh-enhanced-profiling-domestic-smart-meter-customers-electric-hot-water-immersion-heating-storage-heating/) |
| CLNR-L213 | 1. [Dataset (TC2b): Enhanced profiling of small and medium sized enterprise (SME) customers](http://www.networkrevolution.co.uk/project-library/dataset-tc2b-enhanced-profiling-small-medium-sized-enterprise-sme-customers/) |
| CLNR-L011 | 1. [Dataset (TC8): Establishing a new set of generation profiles to better recognise the contribution of generation to system security](http://www.networkrevolution.co.uk/project-library/dataset-accompany-clnr-l010/) |
| CLNR-L214 | 1. [Dataset (TC9b): SME smart meter customers on time of use tariffs](http://www.networkrevolution.co.uk/project-library/dataset-9b-sme-smart-meter-customers-time-use-tariffs/) |
| CLNR-L215 | 1. [Dataset (TC10b): SME customers with restricted hours tariff and customer override](http://www.networkrevolution.co.uk/project-library/dataset-10b-sme-customers-restricted-hours-tariff-customer-override/) |
| CLNR-L220 | 1. [Overview of Network Flexibility Trial Design for CLNR](http://www.networkrevolution.co.uk/project-library/overview-network-flexibility-trial-design-clnr/) |
| CLNR-L221 | 1. [CLNR Learning Credits System](http://www.networkrevolution.co.uk/project-library/clnr-learning-credits-system/) |

1. [↑](#endnote-ref-1)