



Second Tier Portfolio

4 May 2018



GLOSSARY

Term	Explanation
ARS	Automatic restoration system
BAU	Business as usual
CBA	Cost benefit analysis
CMZ	Constraint managed zone
DG	Distributed generation
DNO	Distribution network operator
DSR	Demand side response
EHV	Extra high voltage
DUOS	Distribution use of system
EV	Electric vehicle
GB	Great Britain
HP	Heat pump
HV	High voltage
I&C	Industrial and commercial
LCN Fund	Low Carbon Networks Fund
LCT	Low carbon technology
NIA	Network Innovation Allowance
NOP	Normally open point
NPV	Net present value
PV	Photo voltaic generation/solar panels
RIIO-ED1	First electricity distribution price control to reflect the new RIIO (Revenue = Incentives + Innovation + Outputs) model
SPEN	Scottish Power Energy Networks
SSEN	Scottish & Southern Electricity Networks
WACC	Weighted average cost of capital
WJBP	Well justified business plan

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1 EXECUTIVE SUMMARY

Welcome to our Second Tier Reward submission document which presents one of our most successful Second Tier projects. Capacity to Customers (C₂C) was undertaken by Electricity North West along with our partners and closed down in August 2015.

C₂C explored the potential to use alternative technical and commercial solutions to release network capacity. We did this by offering managed connection agreements to new connections customers and running normally open points (NOPs) on our network in a closed position to release network headroom in the event of a fault.

This document outlines the technological, commercial and customer service innovations delivered but more importantly, how these have delivered real benefits to customers of Electricity North West and across Great Britain (GB).

This submission documents how the main principles of the project have already progressed into business as usual (BAU) in Electricity North West and have been adopted by other GB distribution network operators (DNOs). Furthermore, as a result of robust project management leading to project efficiencies, the C₂C project was delivered significantly under budget with £1.683m returned to customers but with no reduction in benefit. The core principle of the project, in line with Electricity North West's wider innovation strategy was to maximise the use of the assets customers have already paid for and to deliver real solutions to the real problems faced by customers.

Electricity North West has transitioned the technologies and learning from the project into BAU. We have included several million pounds of associated efficiencies within our well justified business plan (WJBP) and worked to realise these savings for customers since the final determination.

Electricity North West now offers all distributed generation (DG) customers a managed connection contract which has reduced both connection costs and timescales. We have also offered and implemented meshed network connections to customers again reducing costs. Additionally, we have implemented managed contracts for existing demand customers, thereby making significant efficiencies in our load-related investment plans as well as generating valuable revenues for these customers. In addition to carbon savings, our customers will realise costs savings of over £120m during RIIO-ED1 alone as a direct result of C₂C. The success of this transition has led to the adoption of similar strategies by a number of other DNOs.

The focus of C₂C was the facilitation of faster and lower cost connections to our network by using innovative commercial models and new network arrangements, which utilise the excess capacity designed into our networks to avoid constraints and costly network reinforcement. Our exceptional project results have led to this commercial approach being successfully transferred into BAU for Electricity North West and other GB DNOs.

Exceptional dissemination activities provided easy access to learning across the life of the project and specific content remains available to customers and stakeholders via a dedicated C₂C platform on our website. This includes, key customer and technical learning reports, academic published papers, details of internal and external presentations including LCN Fund conferences and a dedicated knowledge dissemination closedown event

This document provides details of the C₂C Second Tier project, explains why we undertook the project, how we delivered exceptional performance in the project, how it has benefitted customers and how the learning has been used going forward. We believe that Electricity North West has invested customers' money wisely under the Second Tier and achieved demonstrable value for money from this investment.

2 Description of Project

2.1 Innovation strategy and C₂C

Our smart grid vision is a core part of our overall innovation strategy to manage the long-term challenges of our operator 'trilemma': managing our ageing assets; managing the effects of changing energy use; while meeting the increasing expectations of our customers (Figure 2.1). Innovation is key to resolving these challenges and is therefore central to our business plan.

Figure 2.1: Operator trilemma

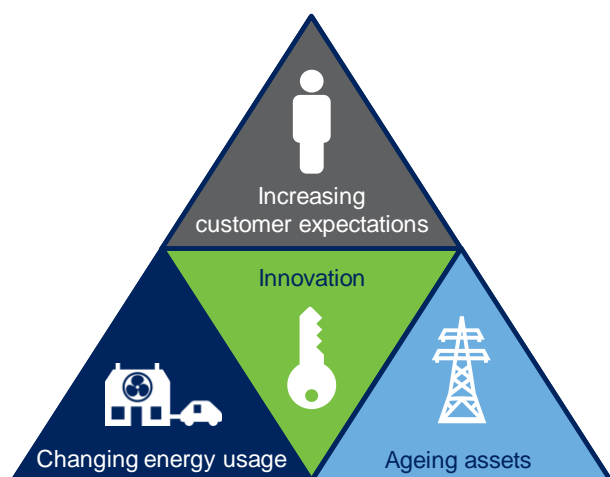
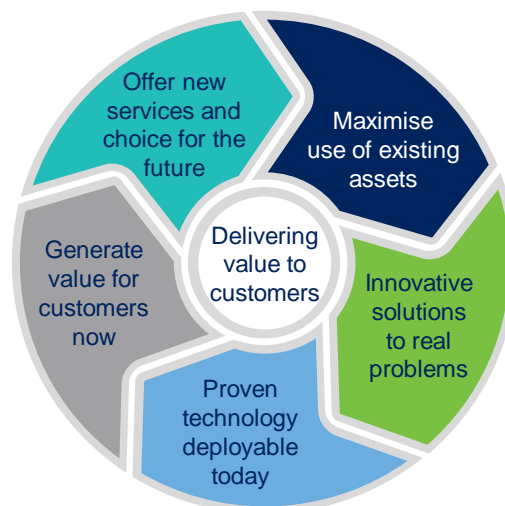


Figure 2.2 Innovation strategy



Our innovation strategy (Figure 2.2) focuses on delivering value to our customers by maximising the use of our existing assets and ensuring that we develop innovative solutions to real problems. Our business plan ensures that we focus on the projects which are likely to deliver real value to customers in the near to medium term.

The C₂C project forms part of a suite of innovative approaches which have contributed to the reform of electricity networks by developing and testing low cost solutions and new network configurations which facilitate the faster connection of increasing amounts of low carbon technologies. This improves the network's efficiency and increases security and continuity of supply, while reducing the financial and carbon costs incurred by traditional reinforcement solutions.

Stakeholder feedback shows that reliability of supply and affordability are key priorities for our customers. This will be even more important as reliance on electricity increases with the take-up of low carbon technologies (LCTs) such as photo voltaic (PV) generation, electric vehicles (EV) and electric heat pumps (HP).

The C₂C project is a clear demonstration of where we have used innovation to improve the service we offer to all our customers using a combination of innovative network management technologies in conjunction with new commercial arrangements which introduce customer choice. This application is focused on the exceptional benefits that we have provided to both our customers and those of other DNOs as a direct result of the C₂C project.

2.2 C₂C project overview

The C₂C project focused on answering specific questions. What are our industrial and commercial (I&C) customers' attitudes towards managed connection agreements, and what impact would changing to managed connections have on the cost of connection? In addition we sought to explore how our network would perform when the NOP between two adjacent high voltage (HV) circuits was run closed as a fault management tool to deliver improvements in supply performance?

The traditional asset based approach to the provision of additional demand or generation capacity is unable to facilitate the decarbonisation of energy and transport at an affordable cost and will act as a barrier to successfully achieving carbon reduction targets. C₂C was expected to demonstrate capacity release through a combination of innovative network management technologies in conjunction with new commercial customer arrangements.

Current extra high voltage (EHV) and HV networks use redundancy and network interconnection to achieve security of supply standards. HV network feeders are interconnected by a NOP which is only utilised in the event of a network fault or planned outage. This means circuits typically operate at only 50 – 60% of their rated capacity. C₂C sought to release this inherent capacity for use by customers to facilitate the connection of new loads and generation.

To ensure that security of customer supply was maintained and supplies could be restored during fault outages, C₂C developed new post-fault demand response contracts to either reduce consumption or reduce generation depending on the nature of the post-fault constraint being addressed. These contracts allowed Electricity North West to manage a customer's consumption or generation at the time of a fault and ensured supplies could be restored to all other customers.

The C₂C project demonstrated that new operating procedures and commercial arrangements can avoid the costly reinforcement of electricity networks and bring significant benefits to all GB customers. We successfully trialled these new approaches with customers to provide easier and cheaper connections to our network while maintaining reliability and releasing capacity.

The C₂C method was demonstrated to be highly transferable across GB and will accelerate a low carbon future by releasing a significant amount of pre-existing capacity on the distribution network. This capacity can be used to play a significant part in meeting the UK's carbon emissions objectives.

C₂C has been successfully transferred to BAU and is now delivering benefits for Electricity North West and its customers. All new generation connections are now installed on a managed contract basis. This has contributed to the release of 544MW of capacity while delivering a saving of over £45m to customers in reduced connection and network reinforcement costs.

We have signed a managed demand contract with a water treatment works which alone has released 4.7MW of capacity and delivered a saving of £1,964,240 in deferred reinforcement.

The use of managed contracts for new generation has allowed the connection of 274MW of solar, wind and storage facilities, along with multiple smaller low carbon generation sites much faster than could be achieved by traditional methods. This is a direct contribution to the Carbon Plan and aids the transition to the low carbon economy.

Managed contracts are now used by other DNOs to manage constraints on their networks, such as SSSEN adopting the constraint managed zone (CMZ) and SPEN modifying policy to offer 'alternative connection offers'. Due to differences in network construction and demand growth some DNOs use variations of these contracts to manage system normal constraints rather than post-fault.

As the penetration of low carbon technologies increases, the use of managed contracts will become even more vital in the operation of a cost-effective distribution network.

Figure 2.3: C₂C project cost summary

Project summary	Second Tier funding £k	Licensee compulsory contribution £k	Other contributions £k	Link to closedown report
Project trialled a new commercial connections framework and the running of closed NOPs to decrease the cost of connection, avoid reinforcement and increase headroom on the network.	£7 732.8	£859.2	£489	Closedown report

3 CAPACITY TO CUSTOMERS (C₂C)

3.1 Background

As GB fulfils its decarbonisation obligations to cut greenhouse gas emissions by 80% by 2050, the demand on electricity networks is projected to increase significantly. This increase in network demand will be driven primarily through the decarbonisation of heat, transportation and local electricity production rather than by population growth. In common with other DNOs we have experienced a sharp increase in the number of new connection requests related to the installation of new LCTs and distributed storage and generation on our network.

Meeting growing demand and facilitating these new connections requires additional network capacity, traditionally delivered by capital intensive reinforcement techniques, which incur significant costs to our customers and have a significant carbon impact in addition to wider societal impacts.

The traditional asset-based approach to the provision of additional demand or generation capacity is unable to facilitate the decarbonisation of energy and transport at an affordable cost and will act as a barrier to successfully achieving carbon reduction targets. C₂C released capacity through a combination of innovative network management technologies in conjunction with new commercial arrangements for customers.

Current EHV and HV networks use redundancy and network interconnection to achieve security of supply standards. Network feeders are interconnected by an NOP which is only utilised in the event of a network fault or planned outage. It is of note that nearly half of circuits do not suffer any faults, and one third experience faults lasting 1 – 2 hours in any five-year period. Closing the NOP allows all customers affected by an outage associated with a fault to be re-supplied from the alternative circuit. This means EHV and HV circuits typically operate at only 50 – 60% of their rated capacity. It is this inherent capacity that C₂C sought to release for use by customers to facilitate the connection of new loads and generation.

Specifically, C₂C reconfigures the network to enable the NOP to be run closed, allowing the whole capacity of the ring to be used by joining the two circuits. To ensure that security of supply is maintained and supplies can be restored during fault outages, C₂C developed and trialled new post-fault demand response contracts (known as managed contracts). These commercial arrangements allow Electricity North West to either reduce consumption or generation depending on the nature of the post-fault constraint being addressed.

When a new customer connects to the network they are offered the option to sign up to a managed contract in exchange for a reduced connection charge (equivalent to the saving of reinforcement costs).

3.2 Outcome

The C₂C project successfully delivered all of its key objectives. With support from Ofgem's incentive schemes, we devised a simple concept, developed a framework, trialled this with our customers and transitioned it through the development and trial cycle into BAU, to meet a real customer need.

The trial produced a new connections process detailing the technical and commercial steps required to extend C₂C's benefits to future customers.

Managed connection agreements offer network benefits in terms of managing constraint during a fault and the avoidance of general load-related network reinforcement. This approach ensures that we maximise the use of our regulatory assets and that reinforcement is based upon genuine need when it is the least cost option available. The project learning and commercial offering developed in C₂C was disseminated widely during and after the project. Evidence of the success of this dissemination strategy is demonstrated from the subsequent adoption of the approach by other GB DNOs, which as a consequence has directly benefitted wider GB customers.

The section below identifies the key learning relevant to the reward criteria.

3.3 Reward Criterion A

A1: Carbon plan

Key learning relevant to reward criteria	Associated project details
Managed contracts can speed up the connection of low carbon technologies and reduce carbon-intensive reinforcement	<p>By offering a reduced cost solution to new connections customers in return for a managed contract, C₂C has proven that we can optimise the operation of our network to facilitate new connection requests at least cost, while maintaining security of supply for the majority of our customers in the event of a fault.</p> <p>The C₂C solution negates the need for significant engineering works associated with reinforcement, by better using the inherent network capacity from installed assets. This has significant additional benefits.</p> <p>Firstly it enables a much more rapid connection of load and generation, as little or no engineering works are required. This enables customers to quickly move to low carbon heat and transport technologies, and adopt distributed generation technologies without the delays typically associated with completion of reinforcement works. Connection times can be reduced by around six months; therefore C₂C can facilitate 39,000-67,000 tCO₂e of emissions reductions in Electricity North West's network area to 2035 depending on how the capacity is used. At GB scale, this carbon saving would be of the order of 0.5-0.9m tCO₂e.</p> <p>Since C₂C was transferred to BAU the use of managed contracts has allowed the connection of 274MW of solar, wind and storage generation in the over-1MW market as well as over 20MW of smaller low carbon generation sites. These sites were able to connect and start generating in a much faster timescale than using traditional contracts involving reinforcement. This is a direct contribution to the Carbon Plan and aids the transition to the low carbon economy.</p> <p>Although enabling release of capacity is the primary benefit, a secondary benefit resulting from the technique is that it significantly reduces the carbon associated with asset installation and construction. This also reduces disruption and pollution to customers arising from constructing these new assets. The C₂C deployment in conjunction with</p>

Key learning relevant to reward criteria	Associated project details
	<p>strategic traditional reinforcement on Electricity North West's HV network in the period 2015 - 2035 would give a net network wide reduction of 237,000-328,000 tCO₂e. This is based on saving 58,000-89,000 tCO₂e from reduced deployment of assets, but decreasing carbon associated with losses by 179,000-239,000 tCO₂e.</p> <p>The C₂C solution contributes directly towards the reduction of carbon emissions:</p> <ul style="list-style-type: none"> • By enabling generation, storage and low carbon technologies to connect to the network at lower cost than previously possible • By the avoidance of load and constraint-related network reinforcement, avoiding the carbon impact and social disruption of the relevant works and the embedded carbon wasted by replacing assets before the end of their useful life • By enabling renewable generation and low carbon technologies to build positive business cases for projects, thereby stimulating economic growth in these areas.

A2: Network capacity release

Key learning relevant to reward criteria	Associated project details
Offering managed contracts to customers and closing NOPs releases unused built-in capacity on our network	<p>Since completing the project, Electricity North West has embedded the principle of C₂C into BAU and offers managed contracts as standard to all new generation connections. This change in policy has led to the connection of 308MW on the 11kV network and 236MW on the 33kV and 132kV networks, all on managed contracts.</p> <p>This has released 544MW of capacity that Electricity North West can use to supply other customers in the event of a fault.</p> <p>As a consequence of the success of C₂C we have undertaken a review of our general load-related reinforcement strategy to better understand the opportunities that exist to release additional capacity.</p> <p>As a result of a number of economic factors, overall UK electricity demand has shown a steady year on year decline¹ each year since the C₂C project was concluded.</p> <p>Overall demand dropped as a result of the recession which led to a reduction in new building works and manufacturing output. Stagnant economic growth in subsequent years, rising fuel prices and regulatory pressures has seen an increase in energy efficiency by consumers, who have reduced their consumption and adopted more energy efficient devices. The distributed generation installed on our network has led to an artificial drop in the demand seen by the DNO as the power generated offsets the power required for load.</p> <p>This decline is reflected in a reduction of maximum demand and overall consumption across Electricity North West's network meaning that there are currently less load-related interventions required than forecasted.</p>

¹ <https://www.gov.uk/government/statistics/electricity-chapter-5-digest-of-united-kingdom-energy-statistics-dukes>

Key learning relevant to reward criteria	Associated project details
	<p>Although overall electricity demand has declined it is predicted to increase in future years due to the electrification of transport and heating. The National Grid future energy scenarios to 2050 suggest the C₂C method with the availability of demand side response (DSR) could replace much of the traditional HV reinforcement activity up to 2050.</p> <p>C₂C has produced a toolbox for DNOs to use when demand increased again and we are now beginning to see an upturn in the need for demand-based contracts.</p> <p>Since completion of C₂C, Electricity North West has identified a network constraint at one of our primary substations and has applied the C₂C solution to manage this issue. This involved negotiating a managed contract with the main demand customer served by the substation, whose maximum import capacity represented over 50% of the substation's load. This equates to a demand response of 4.7MVA which has been released to use for post-fault response.</p> <p>We have since conducted further detailed network analysis which has revealed that there are now a further seven substations that will have constraint issues at certain times during the next winter period. To address this, we have issued 'expression of interest' proposals to a group of customers for fault-based demand side services. These networks are in regions where industrial customers' load is contributing to high localised constraint, and where traditional approaches will otherwise incur costly load related reinforcement. In addition to contacting specific organisations directly, we have hosted a webinar to provide further information to customers in the affected areas. This was communicated via a number of channels including letters, e-newsletters, our website and social media platforms. The details of this expression of interest can be found here.</p> <p>This tender will seek to contract for services to deliver during winter 2018/19 and winter 2019/20.</p>

A3: Financial benefits

Key learning relevant to reward criteria	Associated project details
Offering managed connections significantly reduces the cost of connection for our customers	<p>In the C₂C trials and in the 31-month period since the project has closed down, we have been able to provide significantly cheaper connection quotations to new connections customers by offering a managed connection as standard under BAU. This approach has now also been widely adopted across the industry, reducing connection costs to customers across GB.</p> <p>Because the standard offering for new generation connections has moved from an unmanaged to a managed solution, our connections engineers do not design or cost the unmanaged alternative scheme unless the customer specifically requests this alternative. In order to calculate the cost saving represented by offering the C₂C solution, we have undertaken a desktop analysis to ascertain the costs of an unmanaged solution for all of the managed connections greater than 1MW that have been commissioned since the project closedown until March 2018.</p>

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	<p>We have divided these completed schemes into HV and EHV connections and calculated the additional costs for an unmanaged solution. The results are summarised in the following tables.</p> <p><i>High voltage connections</i></p> <table><tr><th>MEC (MW)</th><th>Total schemes</th><th>Additional cable required for enhanced connection or reinforcement (m)</th><th>Cable laying rate £k/m</th><th>Switchgear costs (£k)</th><th>Total savings (£k)</th></tr><tr><td>over 4</td><td>19</td><td>3000</td><td>0.2</td><td>30</td><td>11,430</td></tr><tr><td>2 - 4</td><td>16</td><td>1000</td><td>0.2</td><td></td><td>3,200</td></tr><tr><td>1 - 2</td><td>18</td><td>500</td><td>0.2</td><td></td><td>1,800</td></tr><tr><td colspan="5">Total savings (31 months)</td><td>16,430</td></tr><tr><td colspan="5">Annual savings</td><td>6,360</td></tr></table> <p><i>Notes</i></p> <ul style="list-style-type: none">• 4MW split chosen to correspond with the full load rating of a typical HV cable• The scheme numbers are the actual managed HV connections >1MW completed in the period August 2015 until March 2018• The cable lengths for the enhanced connection and/or reinforcement is based on a desk top study of the schemes• Cable laying costs taken as an average of those in the Electricity North West Connections Charging Methodology statement 2018• It is assumed that schemes with a demand >4MW will require a primary switchboard extension• The annual cost saving is based upon the total of projects connected since project closedown. <p>Using the annual cost savings from the above table and assuming that new connections customers contribute 80% of the total cost reveals that the cumulative customer savings from the end of the project in August 2015 up until 2050 at present day values are as follows.</p> <table><tr><th>Year</th><th>Saving £m</th></tr><tr><td>2016</td><td>2.97</td></tr><tr><td>2020</td><td>23.32</td></tr><tr><td>2030</td><td>74.20</td></tr><tr><td>2040</td><td>125.08</td></tr><tr><td>2050</td><td>175.96</td></tr></table> <p>On the assumption that under the cost apportionment factor rule in the Common Connection Charging Methodology statement Electricity North</p>	MEC (MW)	Total schemes	Additional cable required for enhanced connection or reinforcement (m)	Cable laying rate £k/m	Switchgear costs (£k)	Total savings (£k)	over 4	19	3000	0.2	30	11,430	2 - 4	16	1000	0.2		3,200	1 - 2	18	500	0.2		1,800	Total savings (31 months)					16,430	Annual savings					6,360	Year	Saving £m	2016	2.97	2020	23.32	2030	74.20	2040	125.08	2050	175.96
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Analysis of the EHV schemes revealed that all the unmanaged solutions required an enhanced connection meaning the customers would be required to fund the full amount. Additionally, one solution would require a primary transformer to be changed and this reinforcement work would result in a contribution of £0.24m from Electricity North West. This contribution is less than 1% of the total additional costs for all the solutions; therefore, it is considered that undertaking a cost benefit analysis of the costs avoided by Electricity North West would not provide any meaningful benefit.																																																	

Key learning relevant to reward criteria	Associated project details																												
	<p>However, if the additional customer contributions that would have been required over the period since the project ended are assumed to be typical and remain constant up until 2050 then the cumulative customer savings can be summarised as follows:</p> <table><tr><th>Year</th><th>Savings £m</th></tr><tr><td>2016</td><td>6.60</td></tr><tr><td>2020</td><td>51.86</td></tr><tr><td>2030</td><td>165.00</td></tr><tr><td>2040</td><td>278.15</td></tr><tr><td>2050</td><td>391.29</td></tr></table> <p>The above tables show that the additional costs that would have been incurred by customers and Electricity North West for unmanaged connections and network reinforcement is significant, and that by offering managed connections to our customers we are enabling cost-effective connections to customers, thereby accelerating the low carbon transition.</p> <p>For general load-related reinforcement we use our real options CBA model (developed as part of the Demand Scenarios NIA project) to consider the reinforcement based upon a set of projected demand scenarios and a set of potential interventions, both traditional and smart alternatives.</p> <p>We built a positive NPV for a demand response solution to be implemented where one of our primary substations was demonstrated to exceed its firm capacity in the event of a fault. We utilised the contract template developed in the C₂C project and contracted with the main demand customer on the constrained primary substation, whose maximum import capacity represented over 50% of the substation’s load. The regulatory cost benefit analysis view can be seen below:</p> <table><tr><th>Case</th><th>Demand Response (C₂C)</th><th>Reinforcement Cost (£)</th><th>Difference (£)</th></tr><tr><td>Best case cost @ £13.5k per MVA</td><td>£1,330,310</td><td>£4,536,550</td><td>£3,206,240</td></tr><tr><td>Technical losses</td><td>£4,409,000</td><td>£3,167,000</td><td>(1,242,000)</td></tr><tr><td>Total costs</td><td>£5,739,310</td><td>£7,703,550</td><td>£1,964,240</td></tr></table> <p>* Regulatory Cost Benefit Analysis View (3.5% Discount Rate over 46 years 2016 – 2061)</p> <p>The finalised contract was agreed at the best case cost of £13,500 per MVA, representing a saving of £1,964,240.</p> <p>Since this contract was agreed we have issued ‘expression of interest’ proposals to a group of customers for fault based demand side services at a further seven of our primary substations and bulk supply points. These networks have been identified as areas where industrial customers’ load is contributing to high localised constraint, and where traditional approaches will otherwise incur costly load-related reinforcement.</p>	Year	Savings £m	2016	6.60	2020	51.86	2030	165.00	2040	278.15	2050	391.29	Case	Demand Response (C ₂ C)	Reinforcement Cost (£)	Difference (£)	Best case cost @ £13.5k per MVA	£1,330,310	£4,536,550	£3,206,240	Technical losses	£4,409,000	£3,167,000	(1,242,000)	Total costs	£5,739,310	£7,703,550	£1,964,240
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Key learning relevant to reward criteria	Associated project details
<p>The managed connection solution has been adopted by other DNOs as their BAU connection offer for post-fault response</p>	<p>Following the lead of the C₂C trials, the managed connection offering has been adopted as BAU by all other GB DNOs and is therefore delivering real improvements in service and cost benefits for all GB customers.</p> <p>During the C₂C trials, it was identified that engineering standard ER P2/6 and supporting document ETR 130 did not explicitly allow or disallow responsive demand to be included within the security of supply assessment for any given group demand. Consequently there was uncertainty whether the benefit to customers who contractually agree to an interruption or reduction of demand for network contingencies can be realised and remain strictly within the requirements of ER P2/6.</p> <p>Electricity North West conducted an industry workshop to investigate this issue further and establish a solution. Findings from the industry workshop revealed that none of the attendees considered ER P2/6 to preclude the application of DSR. However, when asked the question "From your company's point of view could responsive demand be employed without breaching ER P2/6?" approximately half of the respondents indicated that they were uncertain if ER P2/6 would not be breached.</p> <p>This response supported the requirement for further clarification regarding DSR within ER P2/6, and therefore, Electricity North West proposed a change to ETR130 to clarify this area. This proposal was accepted and a revision to ETR 130 in accordance with our recommendation was successfully implemented in June 2015.</p> <p>In light of this change, each DNO has taken steps to enable managed contracts on their networks. SSEN has adopted the CMZ service where load is managed to avoid constraint², and SPEN has modified policy to offer 'alternative connection offers'³ to its customers. The ENA has published a summary listing each DNO's approach⁴.</p> <p>Through the C₂C trial we also successfully developed advanced network control functionality that is now available to all DNOs through our project partner GE.</p> <p>We have issued over 2,000 managed contract offers under BAU for all HV and EHV customer connection requests to our network since 2015, with other DNOs also adopting this approach.</p> <p>Knowledge from this project has been widely disseminated via a large number of platforms, examples of which include our website, multiple industry conferences, social media, press releases, customer seminars, IET white papers, internal communication reports, academic documents and training materials.</p>

² <http://news.ssen.co.uk/news/all-articles/2016/12/ssen-opens-constraint-managed-zone/>

³ https://www.spenergynetworks.co.uk/pages/alternative_dg_connection_offers.aspx

⁴ <http://www.energynetworks.org/electricity/futures/flexible-connections.html>

A5: Value for money to customers

Key learning relevant to reward criteria	Associated project details
The C ₂ C project was delivered significantly under budget and the subsequent BAU offering has delivered significant cost savings to new demand and generation connections customers, as well as avoided costs to distribution use of system (DUOS) customers from deferred reinforcement	<p>The total project costs for delivering C₂C were £8,592k, significantly under the allowed budget of £10,275k. This was achieved through effective project management and the use of robust financial controls throughout the lifecycle of the project.</p> <p>Project-related procurement was conducted in line with the requirements of EU legislation, statutory law, and our own internal control manual. All procurement was carried out by the Electricity North West procurement team supported by the project delivery team to ensure that the agreements were delivered at a competitive cost.</p> <p>Closing NOPs on our HV and EHV networks provides access to the inherent capacity that is built into our network. This can, when combined with customers on C₂C managed connection agreements, be used to maintain security of supply for customers in the event of a fault.</p> <p>The subsequent BAU rollout of the C₂C-developed managed connection strategy has delivered further significant savings for connections and DUOS customers. As stated previously the use of managed connections has saved £45m in reduced connection costs and associated reinforcement.</p> <p>Because demand on our network has fallen since the trials closed down, there has been no requirement for widespread use of post-fault DSR. However, this arrangement is considered for all new connections and is now considered an established BAU tool. One of our primary substations in Catterall, Lancashire was constrained; utilising the contract template created in C₂C we contracted with the main demand customer served by the constrained primary substation, whose maximum import capacity represented over 50% of the substation's load. This intervention now has the potential to release 4.7 MVA of load from the constrained substation, removing the need for reinforcement with a saving of £1,964,240 to DUOS customers.</p>

A6: Relevance and timing

Key learning relevant to reward criteria	Associated project details
The C ₂ C approach enabled faster uptake of LCTs at a time of significant growth in renewable generation, storage and LCTs requesting connections to our network	<p>The number of new connections requests we receive at HV and EHV has increased significantly recently. In the last 12 months we have issued over 1,000 EHV connection offers alone, with approximately 90% of these offers for generation connections.</p> <p>By offering a managed solution as standard we have dramatically reduced the cost and increased the speed of connection, which has consequently enabled generators and storage projects to connect faster than would previously been possible. Where a traditional non-managed solution was the standard offering, the cost of connection was recognised as making certain generation projects economically unviable. This was demonstrated by a significant increase in speculative connection applications, with potential connecters seeking the most cost-effective development site. Of those that did go ahead, delays of up to 3 and 12 months were typical prior to energisation, to facilitate the necessary reinforcement works.</p>

Key learning relevant to reward criteria	Associated project details
<p>The C₂C project was delivered significantly under budget and delivered exceptional results in spite of external factors that hampered recruitment into the trials</p>	<p>Electricity North West's approach to the delivery of the C₂C project was defined in the full submission submitted to Ofgem in 2011. The full submission divided the project into workstreams which were each given a specific owner. This approach ensured that the costs, project plan, project milestones, outputs and the gathering of evidence to prove or disprove the hypothesis were structured around each workstream.</p> <p>The C₂C project commenced with expectations about the 'state of the world' during the life of the project. Electricity North West made reasonable assumptions about network capacity for the duration of C₂C.</p> <p>What was experienced in project delivery was a 6.6% reduction in maximum demand on our network, and this reduction has continued since the project closed down. This led to a situation where most new industrial and commercial firm connections could be offered without the need for reinforcement. This was in stark contrast to the 2010 demand position when new connections would have resulted in reinforcement across most circuits. This had an impact on the number of customers to whom a C₂C connection agreement could be offered. To mitigate this and ensure that a statistically robust sample size was recruited, a three month extension for securing new customer contracts was requested and granted at a cost of £108k.</p> <p>In spite of the three-month project extension, in our June 2014 project progress report, Electricity North West forecasted an 'at completion cost' of £8.741m against a budget of £10.275m. The variation request required that we maintain resources associated with securing the connection agreements until they were obtained and the project successfully closed down. The estimated revised cost at completion was £8.804m and the project's final cost was £8.592m. The project successfully delivered all of its SDRC including the recruitment of a robust sample size and outperformed project budget by £1.4m. By closedown, the project had increased this outperformance to £1.683m which has been returned to customers.</p>

A8: Other benefits

Key learning relevant to reward criteria	Associated project details
<p>The C₂C solution complements other innovation initiatives bringing stacked benefits to our customers</p>	<p>Facilitating the connection of new generation and demand to our network more quickly and at reduced cost to our customers has far reaching benefits. When compared to traditional approaches the following direct benefits are released:</p> <ul style="list-style-type: none"> • Reduced cost of connection for distributed generation and low carbon technologies reduces the carbon footprint of the energy system, actively benefitting the transition to the low carbon future • Assets can to be used until the end of their useful lives, there is avoided disruption from excavation work for new cables, reduced visual impact of new transformers and overhead lines and less disruption to our customers as time spent off supply in the event of a fault is dramatically reduced • The cost associated with traditional approaches has a direct impact on DUOS and connection customers; the reduced cost of providing post-fault DSR offers a cheaper and more sustainable solution to the issue. <p>Electricity North West operates an automatic restoration system (ARS) to restore customers quickly in the event of a fault. ARS is software driven and forms part of our Control Room Management System. The application of C₂C required the ARS coding to be amended to include the managed connections. The in-depth analysis of the coding carried out as part of the C₂C project resulted in changes which led to overall improvements in restoration times for all customers.</p> <p>To enable some customers to participate in the managed connection market it was sometimes necessary to use the customer's equipment to activate the response. Operating customer's equipment from the Electricity North West control system required a fundamental change in policy to be implemented. This implementation allowed Electricity North West to respond to the 'requirement for generators' change in EU network codes in a more timely manner.</p>

3.4 Reward criterion B

We are not submitting any evidence in respect of this reward criterion.

3.5 Reward criterion C

C1: Demonstrate where the portfolio has delivered more learning than was expected

We recognise, because of the very nature of innovation, that not all projects will deliver more learning than expected; however we believe that the C₂C project has provided significantly more learning than was anticipated and this has benefitted all GB customers in the following areas:

- The project has uncovered that I&C customers are willing to accept a managed connection agreement in return for appropriate compensation, or as a standardised offering. This introduces a crucial additional tool to our planning toolkit, enabling us to offer reduced costs to our customers and avoid costly and unnecessary asset replacement.

- Some customer acceptability issues remain a consideration, for example some customers only wanted part of their installation to be managed because they had vital processes which could not be interrupted for protracted lengths of time. This required new methods of working and control arrangements to allow Electricity North West to operate customers' equipment.
- Customers that operate manufacturing processes consistently report that they prefer not to experience any interruptions. However, where they do, the restoration could be delayed for a number of hours without further material impact on the manufacturer as their start-up processes can take several hours.
- The learning from C₂C on closed ring has been extended to the LV network as part of the Second Tier project, Smart Street. Smart Street has just reached a conclusion and has further proven the benefits of meshing networks for capacity release and losses.
- C₂C also investigated 'open linked rings'. This philosophy uses a customer on one half of the ring to support a fault on the other half; this can be used when it is not possible to close the NOP due to issues such as fault level. The success of this trial expanded the use of managed contracts on our network.
- Monitoring deployed as part of C₂C required an LV supply to power it which led to difficulties at some sites as they don't all have LV supplies. Electricity North West has used this learning in later projects, such as Celsius, where we specified a battery operated solution

C2: Additional learning as a result of exceptional effort of the DNO

To allow all customers the opportunity to enter the demand response market Electricity North West developed a solution to allow the operation of customer owned equipment by a DNO which included:

- A new policy permitting Electricity North West to operate customers' equipment
- An automated LV circuit breaker and monitoring combination which gave access to Electricity North West to understand the magnitude of the response and operate equipment to provide the response
- Installation procedures including any specific requirements relating to an individual customer's equipment
- Employee familiarisation training for customers' installations.

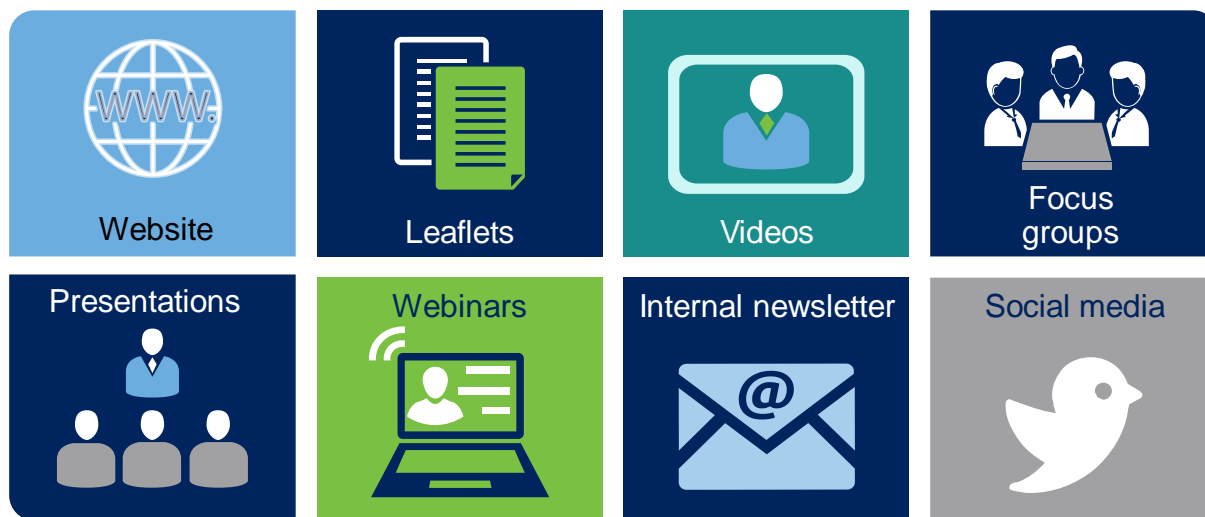
The C₂C project also developed the concept of protected days which allowed customers to specify if there were specific days or time periods when they didn't want to remain off supply. This required a modification to the control system (including ARS) to take into account protected days and find alternative ways of restoring customers in the event of a fault, either through a change in network configuration pre-fault or by using alternative managed contracts.

C3: Exceptional capture and dissemination of learning in a way that maximises value for all customers

Electricity North West is committed to exceptional capture and dissemination of learning through a variety of methods to suit a range of audiences. A number of audiences have been identified as key stakeholders for learning derived from our innovation projects. These consist of various industry groups which include, but are not limited to, Ofgem, Department for Business, Energy & Industrial Strategy (BEIS), wider government agencies, GB DNOs, the Energy Networks Association (ENA), and various academic institutions. Data collected from our projects is currently used by students and researchers in universities to develop a better understanding of electricity networks.

We also disseminate learning internally with a focus on the new business processes and policies required for BAU adoption. Dissemination activities from all our projects reflect the diverse needs and interests of the type of audience and project as illustrated in Figure 3.1.

Figure 3.1: Dissemination channels used for Second Tier projects



We have worked with universities on many of our projects in our innovation portfolio and the students involved publish and present papers on our behalf in internal publications and at associated conferences.

Our overriding principles are to maintain an open and transparent approach, ensure that information is easily accessible and that our dissemination methods match the needs of our stakeholders. This maximises the learning gained by other parties to the benefit of all GB customers.

We take a proactive approach in knowledge dissemination throughout the development and delivery of our innovation projects, sharing learning at the annual Low Carbon Networks and Innovation (LCNI) conference and at many other industry events. Further knowledge transfer is delivered through our industry engagement at the ENA and the many working groups that comprise their technical and commercial portfolio.

To ensure our stakeholders receive a balanced view of our learning, our project partners, suppliers and sometimes trial customers participate in our dissemination events. We attend supplier trade conferences to explain our work and regularly hold briefings with local companies on particular techniques or technologies. Our website is the repository for sharing the learning derived from our projects.

The knowledge dissemination activities from C₂C can be seen on the [project website](#).