Capacity to Customers Customer Survey

Reactive Post-Fault Survey Report

27 March 2015

VERSION HISTORY

Version	Date	Author	Status	Comments
First Draft	6th March	Michael Brainch	First draft	
Final Draft	27th March	Kate Quigley	Final draft	
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GLOSSARY OF TERMS

Abbreviation	Term
CATI	Computer Aided Telephone Interviews
C_2C	Capacity to Customers
CCC	Customer Contact Centre
CEP	Customer Engagement Plan
DNO	Distribution Network Operator
EHV	Extra High Voltage
ENW	Electricity North West
HV	High Voltage
I&C	Industrial & Commercial
LCNF	Low Carbon Network Fund
MPAN	Meter Point Administration Number
NOP	Normal Opening Point
PSR	Priority Services Register
SDI	Short Duration Interruption
SDRC	Successful Delivery Requirement Criteria
SECV	Stakeholder Engagement and Consumer Vulnerability

CONTENTS

1. FOREWORD

This reactive post-fault survey report marks the culmination of an 18-month customer engagement exercise that has involved over 700 customers throughout the Electricity North West region.

The customer survey from which this report is derived was jointly designed by Electricity North West and its market research provider, Impact Research. The research methodology and sampling approach was piloted and also externally validated by an independent peer reviewer, Professor Ken Willis of Newcastle University.

Impact Research conducted the customer surveys and summarised their findings in this reactive post-fault survey report.

Electricity North West welcomes the report and recommends it to all LCN Fund stakeholders. The report findings will be incorporated into the closedown report for the Capacity to Customers (C_2C) Project. This report and any related learning material has been published on the C_2C website.

2. EXECUTIVE SUMMARY

This report is submitted as part of the Electricity North West Capacity to Customers (C_2C) Tier 2 Low Carbon Networks Fund (LCN Fund) project.

C_2C seeks to test if new and/or existing customers are willing to adopt new forms of commercial arrangements which allow the network operator to place short duration restrictions on their demand and/or generation as necessary, in response to infrequent fault outage events.

This document and the analysis therein forms part of the project dissemination and specifically details the learning from a strategic piece of customer engagement research undertaken by Impact Research, an independent market research company. The purpose of the research was to understand any relative shift in the overall customer experience due to the changes in operating arrangements brought about by the C_2C Method. The impact of these changes, if any, on the perceived reliability of customers' power quality was measured through perception of the interruption frequency and duration.

The nature of the customer engagement undertaken was reactive in that customers were surveyed after they had experienced a fault on a C_2C Trial circuit, regardless of whether they had subsequently contacted Electricity North West. The research was conducted across 32 occasions during the entire Trial phase of the project. An occasion was defined as a power outage affecting a specific electricity feeder, whereby customers supplied by the feeder were identified and contacted to take part in the customer survey.

The key findings outlined in this report provide evidence that suggests there is a relatively strong relationship between the level of customer acceptance of fault outages and the fault duration experienced. The C_2C method; that is the reconfiguration of HV circuits into HV closed rings, is likely to lead to an increase in short duration interruptions (SDI). An SDI is a specific type of fault to a customer's electricity supply that is more likely to be incurred by using the C_2C Method. C_2C seeks to test if an increase in SDIs is acceptable to domestic customers. The analysis shows that experiencing an SDI has a positive influence on the acceptability of a fault outage occurring versus the business as usual experience. The additional SDIs incurred as a result of the C_2C Method tend to improve power quality perception showing that there is no customer perception barrier to the deployment of the C_2C Method

This particular piece of customer engagement focuses on the acceptability of fault duration as opposed to other measures of power quality, which may include but not be limited to fault frequency and observations of dips and spikes. An additional proactive piece of customer engagement has been conducted, the results of which are detailed in a proactive power quality monitoring report. The proactive power quality monitoring report covers alternative measurements of power quality perception.

2.1. Research hypothesis

The C_2C Project was designed to specifically answer seven key hypotheses:

- The C_2C Method will release significant capacity to customers (in the range of 75% to 100% of available capacity/circuit rating) from existing infrastructure
- The C_2C Method will enable improved utilisation of network assets through greater diversity of customers on the network ring
- The C_2C Method will reduce like-for-like power losses initially but this benefit will gradually erode as newly released capacity is utilised
- The C_2C Method will improve power quality resulting from stronger electrical networks
- The C_2C Method will facilitate lower reinforcement costs for customers for the connection of new loads and generation

- The C_2C Method will effectively engage customers in a new form of demand and/or generation side response thereby stimulating the market and promoting the future use of commercial solutions to address the Problem
- The C_2C Method will facilitate a reduction in the carbon costs of network reinforcement.

A suite of customer engagement studies were undertaken in order to address the key customer related component; hypothesis six, which sought to engage customers in a new form of demand and/or generation side response. The key learnings from this aspect of customer engagement have been disseminated and are accessible through the C_2C website and also video content.

The reactive post-fault project is primarily concerned with enhancing the learning associated with hypothesis four, primarily a technical based assertion that the C_2C Method will improve power quality;

"The C_2C Method will improve power quality resulting from stronger electrical networks."

This hypothesis can be supported through customer engagement if it can be demonstrated that Electricity North West's customer base of domestic and industrial and commercial (I&C) customers have noticed a discernible improvement in their power quality since the C_2C Trial began.

The C_2C Trial was conducted on 13% of the whole Electricity North West distribution network. The initial screening process identified circuits that had the greatest recent connection activity or supplied future development areas in the region and were highly loaded in order to increase the likelihood of attracting C_2C connections during the Trial period. The Trial area included 360 circuits which were operated as closed rings. Circuits with an above average fault history were discounted from the ring selection to prevent an increase in customer fault disturbance. But in order to gain an understanding of these circuits in relation to C_2C, 20 circuits with higher than average fault rates were selected to run as radial feeders.

In addition the circuits were classified to check that the selection was representative of not only Electricity North West's' network but that of other distribution networks. In the interest of representativeness the sites selected as part of the C_2C Trial were geographically spread across the entire North West region, as depicted in Chart 1.1.a. Customer engagement was therefore carried out with customers across the broad C_2C Trial area; with analysis aggregated to Cumbria, Lancashire and Greater Manchester sub regions. A more detailed report on the site selection method is available on the C_2C website.

Chart 1.1a: The C_2C Trial circuits (highlighted in yellow)

The customer engagement was designed to measure customers' perceptions of their power quality/reliability and in particular their levels of acceptance of fault durations throughout the Trial period. The instrument used to measure customers' perceptions was a quantitative customer survey. The design and methodology of the reactive post-fault survey was such that Electricity North West is able to understand the impact of the C_2C Method not only on domestic customers' power quality perception but on I&C customers.

The analysis included within this document examines three key questions:

- Where the C_2C Method is deployed and involves meshing the HV network, do customers report any perceived differences in their power quality or supply reliability?
- If any effects are noticed by customers, do they present a barrier to the roll out of the C_2C Method?
- Where detected by customers, do SDIs enhance perception of power quality or supply reliability?

2.2. The research approach

The research approach referenced within this document was submitted as part of Electricity North West's C_2C customer engagement plan (CEP) approved by Ofgem on 28 June 2012.

In the CEP Electricity North West committed to:

- Identify customers on affected circuits who have experienced a planned interruption and seek feedback from these customers
- Engage with customers impacted by the C_2C Project; and have special regard to priority service register (PSR) customers involved in the C_2C Project.

The research methodology and sampling approach was piloted and externally critiqued by an independent peer reviewer, Professor Ken Willis.

In total, 703 quantitative computer aided telephone interviews (CATI) were completed with customers exposed to a C_2C fault on 32 occasions throughout the Trial period. To qualify for

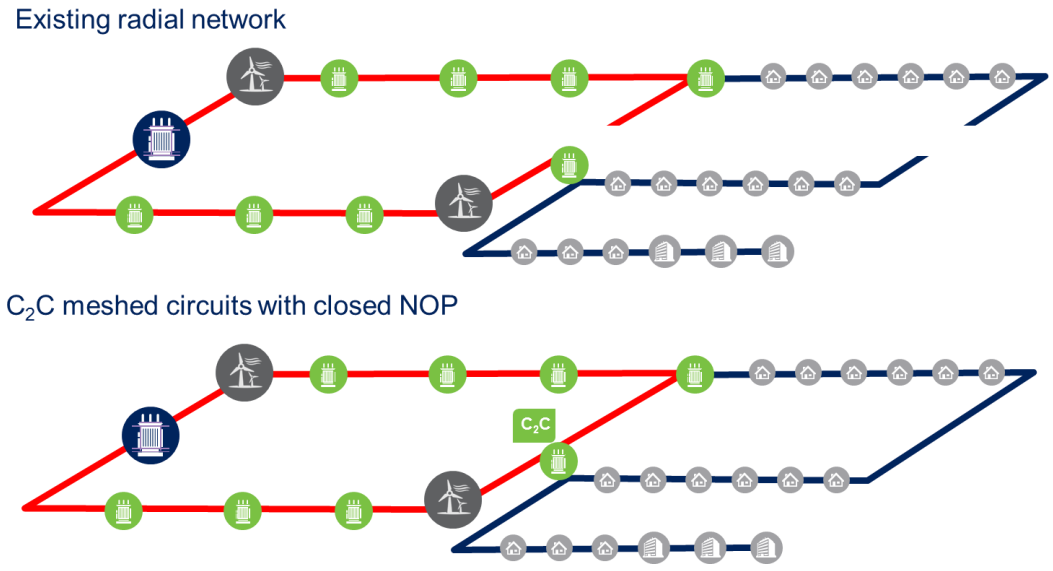
the survey customers were either required to recall the fault occurring unprompted, or recall it after being prompted with the date and time of the power outage. A sample size of 703 is statistically robust and all analysis contained in this report has been significance tested at the 95% confidence level which is a market research industry standard.

In the context of this report an occasion is defined as an event whereby there is a known loss of electricity supply to customers' properties due to a feeder[1] on the network faulting. During the C_2C Trial period one feeder located on Trial circuits faulted more than once. With the exception of this one feeder, the survey population was a different selection of customers in each occasion and the survey itself lasted approximately 15 minutes.

2.3. The C_2C technology

To ensure that the C_2C Project delivers results and learning that is transferable to all UK distribution network operators (DNOs), the C_2C Method has been tested on 180 high voltage (HV) closed rings, from the low to medium fault rate circuits and 20 HV circuits and a smaller number of extra high voltage (EHV) circuits across the network. These networks supply electricity to some 317,000 customers, close to 13% of Electricity North West's overall customer base.

The C_2C Method incorporates changing existing radial electricity circuits to a meshed formation which facilitates interconnection and adaptive automation. In this formation the normally opening point (NOP) on the C_2C Trial circuits is closed. High voltage (HV) networks are generally interconnected by an NOP which is only used in the event of a network fault/outage. Closing the NOP allows all customers affected by a fault to be re-supplied by an alternative circuit. This represents a change in operating arrangements and has the potential to significantly increase the number of customers who are affected by a fault; however, it is anticipated that the faults experienced are likely to be of a much shorter duration.



The analysis contained within this report and its appendices explore the relationship between the change in operating arrangements facilitated by the C_2C Method on each of the C_2C Trial circuits and customers' perception of power quality.

Measurement of power quality can take many forms: the volume of customers affected by a fault (ie a power cut), the frequency of faults occurring and the duration of faults are all

[1] An electrical cable or group of electrical conductors that runs power from a larger central source to one or more secondary or branch-circuit distribution centres

accepted industry measurements. In addition to these measures, customers may observe dips and spikes in voltage that manifest themselves in discernible effects to their appliances and influence their perception of power quality. The reactive post-fault survey concentrated on observations linked to fault duration and therefore the analysis in this document focuses on this particular power quality measure. A detailed understanding of the role that the frequency of fault occurrences and dips and spikes has on customers' perceptions of power quality is the subject of a separate piece of proactive monitoring research.

The application of the C_2C Method could significantly decrease the average duration of faults experienced by customers, because the automation enabled will restore supply to the majority of customers in a matter of minutes. This type of fault is called an SDI and previous qualitative customer engagement has indicated that customers perceive this change as beneficial. This report seeks to verify the assertion of previous research that the change in operating conditions is perceived as good news for customers by virtue of an improved perception of power supply quality.

2.4. Summary of the key findings

The analysis summarised within this section examines the three key questions posed in section 1.1.

2.4.1. Where the C_2C Method is deployed and involves meshing the HV network, do customers report any perceived differences in their power quality or supply reliability?

Overall customers observed a positive change in power quality/supply reliability under C_2C conditions. The positive movement observed was amongst all customers noticing a change, regardless of whether the change was verified by fault data.

In reality accurate recall of C_2C faults is relatively low. Overall only two in five customers were able to provide the date of the fault event unprompted. If the fault that customers were exposed to was an SDI fault, accurate recall decreased to only one in four customers, indicating that C_2C faults are less likely to be noticeable and/or cause any disruption.

The implication of there being changes in customers' perceptions and C_2C faults being less discernible is that either no adverse effect in power quality/supply is detected, or where a change is perceived, on balance it is a positive one.

It is also worth noting that the level of recall varies by the time of day a fault occurs. Customers are more sensitive to C_2C faults when they occur at times of peak electricity demand; hence they have heightened awareness of events at tea time through to the evening. There is also evidence to suggest that in addition to recalling when the fault occurred, customers are more likely to remember the duration of a fault at these times of the day. However, compared to longer fault durations, customers are less likely to recall the fault duration when they are exposed to SDI faults at times when demand is highest.

It is encouraging to report that the typical duration of a C_2C fault is perceived as an improvement relative to those experienced in previous years. Two in three customers who accurately recalled the fault event claimed the fault was shorter than previous experiences, whilst one in two customers who accurately recalled the fault felt that the duration was acceptable. Comparing this to the baseline of Electricity North West's other second tier LCN Fund Project, Customer Load Active System Services (CLASS); this level of acceptability is in line with the average, further demonstrating that there is no adverse effect through the introduction of the C_2C Method. However, it should be noted that the CLASS study was representative of the general population on non-C_2C circuits, whilst the reactive post-fault survey is representative of customers who experienced a fault on C_2C circuits. Therefore, any comparisons made between the two projects are purely indicative.

2.4.2. If any effects are noticed by customers, do they present a barrier to the roll out of the C_2C Method?

A significantly greater proportion of I&C customers (52%) accurately recalled when a C_2C fault occurred than domestic customers (40%). Whilst the majority of I&C customers noticed an improvement in fault duration since the C_2C Trial began, the proportion doing so was marginally less compared to domestic customers (56% vs 64% respectively). Both I&C and domestic perceived no adverse effect overall, rather, the majority of customers noticed an improvement.

Further analysis has indicated that across the network, I&C customers have a lower tolerance to the duration of faults than domestic customers and on average a correspondingly lower level of overall satisfaction. This indicates that I&C customers have a heightened sensitivity to faults and different needs and expectations during fault events. While this finding is relevant, it is not related specifically to the C_2C Method. The conclusion of the analysis is that although there are valuable lessons to be learned about differences in power quality/supply amongst customer typologies, they do not present a barrier to rolling out the C_2C Method.

Analysis was also conducted amongst customers collectively defined as vulnerable (65+ years old, have a member of the household that has a disability; is seriously ill, has mobility problems, visual or hearing impairment and/or medical equipment) and therefore eligible for the priority service register. This enhanced understanding on whether effects were more likely to be noticed by customers who arguably have a greater dependency on their supply. Conversely the level of acceptance of C_2C faults amongst all customers who are already registered or eligible for the priority service register (PSR) is in line with, if not higher than, the rest of Electricity North West's customer base. There is, however, a low awareness of the PSR, but the demand for information regarding membership and associated benefits increases in the event of experiencing a fault. The analysis confirmed that perception of power quality was gain improved and does not present a barrier to rolling out the C_2C Method. It also suggests that it would be beneficial to seek out opportunities to raise awareness of the PSR in the future.

Further profiling of the different types of customers who are already registered or eligible for the PSR indicates that there are some variations in the level of acceptance of fault durations. Customers aged 65 or older have the highest levels of acceptance of fault durations, while customers with medical equipment have the lowest levels. This highlights the importance of tailoring the information and services provided by the PSR according to customers' individual needs and sensitivity to interruptions to their power supply.

The implication of these findings is that a DNO could roll out the C_2C Method as 'business as usual' and it would tend to have a positive impact on customers' perceptions of their power quality/reliability.

2.4.3. Where detected by customers, do SDIs enhance perception of power quality or supply reliability?

Whilst the key findings of the proactive monitoring research suggest that the frequency of faults is the most discernible aspect of power quality, analysis of the reactive post-fault survey recognises that fault duration is also significant in influencing customers' perceptions of power quality/reliability.

At the outset of the project it was anticipated that faults occurring under C_2C operating conditions would be generally shorter in duration than on non-C_2C Trial circuits. Analysis has demonstrated that customers who are exposed to and recall SDI faults are likely to perceive an improvement in their power quality.

The majority of customers accept that faults cannot be entirely avoided but SDI faults are significantly more acceptable than other scenarios.

A positive by-product of SDIs positively enhancing perception of power quality is the potential this has to influence broader operational aspects of a DNO's customer service. Analysis of the reactive post-fault study also indicates that in the event of a C_2C fault, customers are less likely to contact Electricity North West regarding the fault. Further examination of customer feedback has demonstrated that the longer the fault duration is, the more likely customers are to make contact. Under C_2C conditions, faults are typically shorter and therefore fewer customers are likely to contact Electricity North West about the power outage. This, as a result, will put less pressure on the contact centre and by virtue of a reduced workload allow call agents to provide a higher level of customer service to those who do make contact.

3. KEY FINDINGS

3.1. Introduction

This section of the report details the key findings of the customer survey analysis which addresses three key questions, as stipulated in the executive summary.

3.1.1. Where the C_2C Method is deployed and involves meshing the HV network, do customers report any perceived differences in their power quality or supply reliability?

3.1.2. The method used to measure perceived differences in power quality

In order to maximise recall and minimise any potential confusion with other faults or unrelated events, Impact Research contacted customers who were exposed to a C_2C fault within a maximum of five days of the event occurring.

The customer survey measured perceived differences in power quality on C_2C circuits in two ways; firstly, through quantifying the proportion of customers who accurately detected the fault occurring and secondly, by understanding the influence that detection has on perception of fault frequency and duration.

For analysis purposes, accurate recall was defined as customers who could correctly identify the date of the fault event; and secondly, the proportion of customers who were able to provide an estimate of the duration of the fault. The influence that detection of faults has on perception was established through customers comparing the current test situation (C_2C Method applied) to previous fault experiences.

The analysis documented in section 2.2 will address both the recall and effect of perceived differences and makes use of technical fault data supplied by Electricity North West in order to evaluate customer perception in relation to known facts regarding C_2C fault occasions.

3.1.3. Overall summary of the perceived differences in power quality

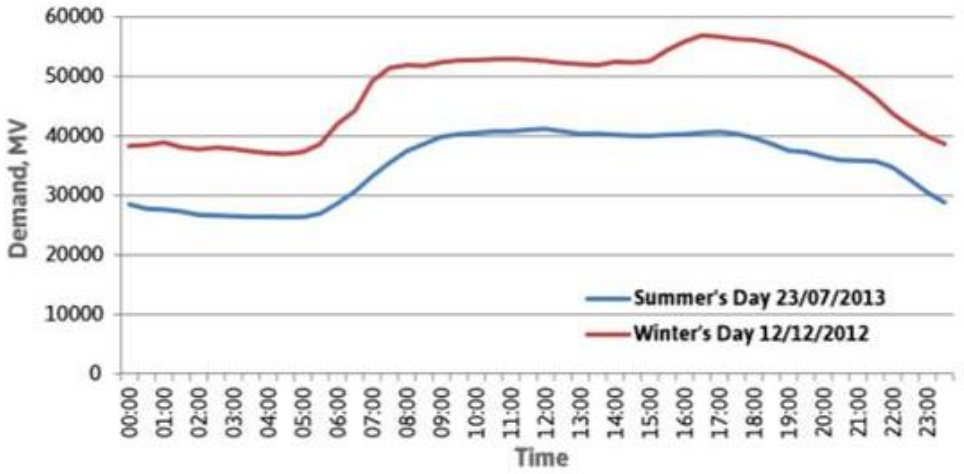
In the reactive post-fault study 42% of customers could accurately recall the day of the fault without any prompting from the interviewer, whilst 77% of customers could provide an approximate fault duration. There is also a heightened level of awareness of the day and/or duration of a fault amongst customers who are either more dependent upon their power supply or more likely to use their power supply at a specific time period of the day.

Overall the C_2C Method has a positive effect on customers' perception of their power quality. On average, the duration of C_2C faults are perceived as an improvement relative to those experienced prior to the C_2C Trial. 63% of customers claimed that the C_2C fault they recently experienced was shorter than previous occasions. Logically, the extent to which recent faults were perceived as shorter varied significantly by their duration, in that the shorter the fault was, the more likely customers were to perceive an improvement.

3.1.4. Accurate recall of faults is strongly influenced by the time of day that the fault occurs

Analysis of technical fault data has indicated that the time of day of when a fault occurs plays a role in the extent to which customers accurately recall an event. It could be hypothesised that customers will be most sensitive to faults that happen at times of peak demand, by virtue of them being more likely to be in at the time of the fault and using equipment connected to their electricity supply during these times. Chart 2.2.3a illustrates the profile of electricity demand at the GB level which indicates that demand for electricity typically peaks between 4pm and 8pm in the winter months.

Chart 2.2.3a: GB electricity demand in the summer and winter months[2]



It is challenging within the confines of the reactive post-fault study alone to analyse how the time of day and season affects the level of accurate recall of faults, due to the sample volumes being available for such detailed sub-group analysis. However, the analysis in Table 2.2.3b provides an indication that in general, customers are most likely to accurately recall when a fault occurs at times of peak demand.

Table 2.2.3b: Levels of unprompted accurate recall of C_2C faults, by time of day

Total *(697)*	42%
Morning (6am-12pm) *(371)*	37%
Lunch (12-2pm) *(21)*	81%*
Afternoon (2-5pm) *(47)*	26%**
Tea Time (5-7pm) *(93)*	41%
Evening (7pm-12am) *(81)*	59%*
Night (12am-6am) *(84)*	49%

* Significantly higher than the total at the 95% confidence level
** Significantly lower than the total at the 95% confidence level

The proportion of customers accurately recalling the fault duration follows the same pattern as awareness of C_2C faults actually occurring, with an increase during times of peak demand as demonstrated in Table 2.2.3c.

[2] Power Saver Challenge, Household Information Booklet

Table 2.2.3c: Percentage of customers who provided an approximate duration of the fault they experienced, by time of day

Total *(703)*	77%
Morning (6am-12pm) *(375)*	79%
Lunch (12-2pm) *(21)*	100%
Afternoon (2-5pm) *(47)*	68%
Tea Time (5-7pm) *(94)*	94%*
Evening (7pm-12am) *(81)*	79%
Night (12am-6am) *(85)*	46%**

* Significantly higher than the total at the 95% confidence level
** Significantly lower than the total at the 95% confidence level

Higher levels of recall are an indication of the effect faults may have on customers. It is well-known in the field of psychology that an event that has a negative effect on a person is more memorable than one with a neutral or indeed positive effect. Hence, when faults occur at a time when customers are in need of their electricity supply, it is more likely to be considered an inconvenience and therefore increases the customers' level of recall.

Further analysis was conducted in order to understand if there was a correlation between the times of day in which the fault was experienced and the acceptability of the duration. Table 2.2.3d illustrates that the highest level of acceptability is achieved with faults occurring during the night and as Table 2.2.3c put forward, this is also when customers are least likely to accurately recall the duration of the fault. The relatively high level of acceptability is likely to be linked to a reduced usage pattern throughout the night relative to other times of the day, which serves to minimise any adverse effects on customers.

Table 2.2.3d: Percentage of customers who found the duration of the fault acceptable and how this varied, by time of day.

Acceptability: *Ratings 8, 9 or 10 (564)*	47%
Morning (6am-12pm) *(305)*	44%
Lunch (12-2pm) *(21)*	57%
Afternoon (2-5pm) *(32)*	41%
Tea Time (5-7pm) *(88)*	43%
Evening (7pm-12am) *(72)*	50%
Night (12am-6am) *(46)*	70%

* Significantly higher than the total at the 95% confidence level

3.1.5. The C_2C Method has a positive effect on customers' perception of their power quality

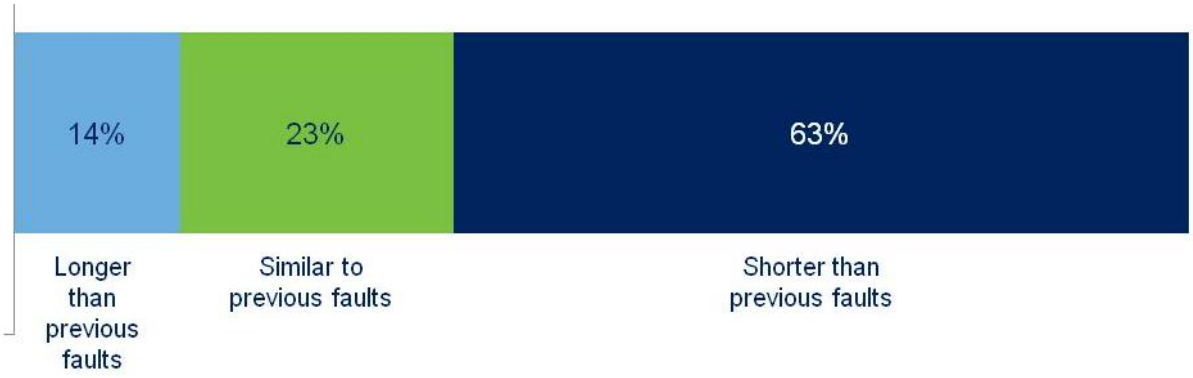
Analysis presented in Chart 2.2.4a demonstrates that the C_2C Method has had a very positive effect on customers' perception of their power quality with almost two thirds of those surveyed feeling that faults were shorter than previously experienced.

The analysis was based on all customers that felt they had a previous fault experience to compare the C_2C event against. On this basis one third of the total survey population were excluded from the analysis; as they had not experienced a fault at the same property in the past. A further 8% of customers were excluded from the analysis on the basis that they could not recall the details of the previous fault accurately.

In total 318 customers were able to answer this key power quality action standard, which provided a statistically robust and representative sample and the confidence to conclude that the C_2C Method has a positive effect on customers' perception of their power quality.

Chart 2.2.4a: How the C_2C fault duration compares to previous experiences amongst customers on C_2C Trial circuits

Duration vs previous faults



The key findings from other customer engagement[3] conducted by Impact Research on behalf of Electricity North West is helpful in enhancing general understanding of customers' acceptance of fault durations. Table 2.2.4a compares the results from the post-fault survey to an on-going customer satisfaction study whereby 660 customers non-C_2C Trial circuits were surveyed after experiencing a fault under 'business as usual' conditions (across the entire Electricity North West footprint) during the period 1 April 2014 to 31 January 2015. The analysis demonstrates that significantly more customers on C_2C Trial circuits find the fault duration acceptable compared to non-C_2C Trial circuits. For the purpose of this analysis and in order to make a direct comparison to the customer satisfaction study, a different measurement was used to that in Table 2.2.3d. In both cases the measurement of fault acceptability was the proportion of customers agreeing that the fault was acceptable, as opposed to the use of a rating scale.

Chart 2.2.4b: How acceptable C_2C faults are amongst customers on C_2C Trial circuits compared to customers on non-C_2C Trial circuits

Total	C_2C Trial circuits n=567	Non-C_2C Trial circuits n=660
Duration of the last fault was acceptable (% saying yes)	75%*	63%

* Significantly higher than the total at the 95% confidence level

Another measurement of power quality is the extent to which customers have noticed dips and spikes in their power supply, defined for the purposes of the customer survey as, '*lights flickering or dimming, wavy lines on computer screen and equipment that trips out'*. In the post-fault survey28% of all customers claimed to have recently noticed dips and spikes in their power supply. This is very similar (no statistical differences) to the measurement taken from the CLASS baseline and proactive monitoring survey. The conclusion of the analysis is that customers are no more likely to see an adverse effect of this type on a C_2C Trial circuit compared to non-C_2C Trial circuits.

[3] Unplanned interruptions (agent) customer satisfaction tracker 2014-2015

In summary, examination of the customer survey results and in particular the various measurements of power quality provides evidence that is conclusive in endorsing the C_2C Method as having a positive effect on customers' perception of their power quality.

3.2. If any effects are noticed by customers, do they present a barrier to the roll out of the C_2C Method?

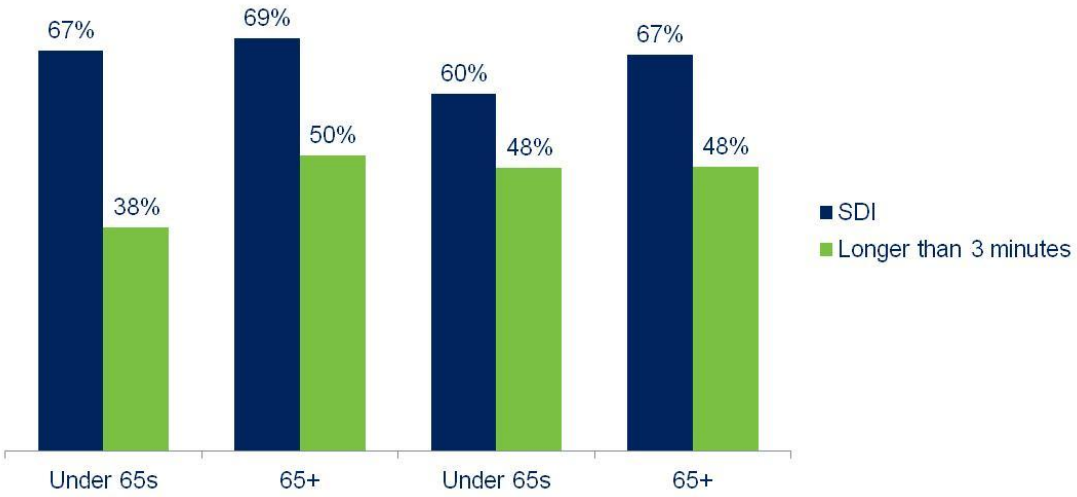
3.2.1. Differences in the demographic and regional profile of customers influences the acceptability of fault durations

Comparisons drawn between the Tier 2 LCN Fund studies have demonstrated the importance that the demographic profile of the survey sample can have in determining absolute levels of fault acceptance. The reactive post-fault survey is intentionally not representative of the general population of the North West, unlike CLASS, but is representative of customers that were in at the time of the power outage and who remember experiencing a fault. This means for instance that the reactive post-fault sample is weighted more towards older customers. The CLASS baseline survey was also conducted as a one off exercise in the spring whereas the post-fault survey was carried out on a rolling basis across all seasons, including winter which is usually subject to a greater volume of interruptions. As a result, the two pieces of customer engagement do not strictly provide a like-for-like comparison but their conclusions are supportive.

The clearest difference between the CLASS baseline survey and C_2C reactive post-fault survey is the age profile and in particular the skew towards domestic customers who are aged 65 years or older (22% and 59% respectively). An important question to contemplate is therefore: to what extent do domestic customers who are aged 65 years or older accept C_2C faults compared with those who are younger than 65 years old? Chart 2.3.1a provides evidence in support of answering this question:

Chart 2.3.1a: Acceptability of faults by age amongst domestic customers, in the CLASS baseline survey and the C_2C reactive post-fault survey

Acceptability of power cut durations by age of domestic customers



The acceptability of a fault duration of longer than three minutes amongst domestic customers who are aged 65 years or older is significantly higher than that of customers younger than 65 years old, a finding in this case that is unique to customers on C_2C circuits. Further analysis has shown that this difference is driven in particular by customers younger than 65 years old living in Cumbria, as indicated in Table 2.3.1b:

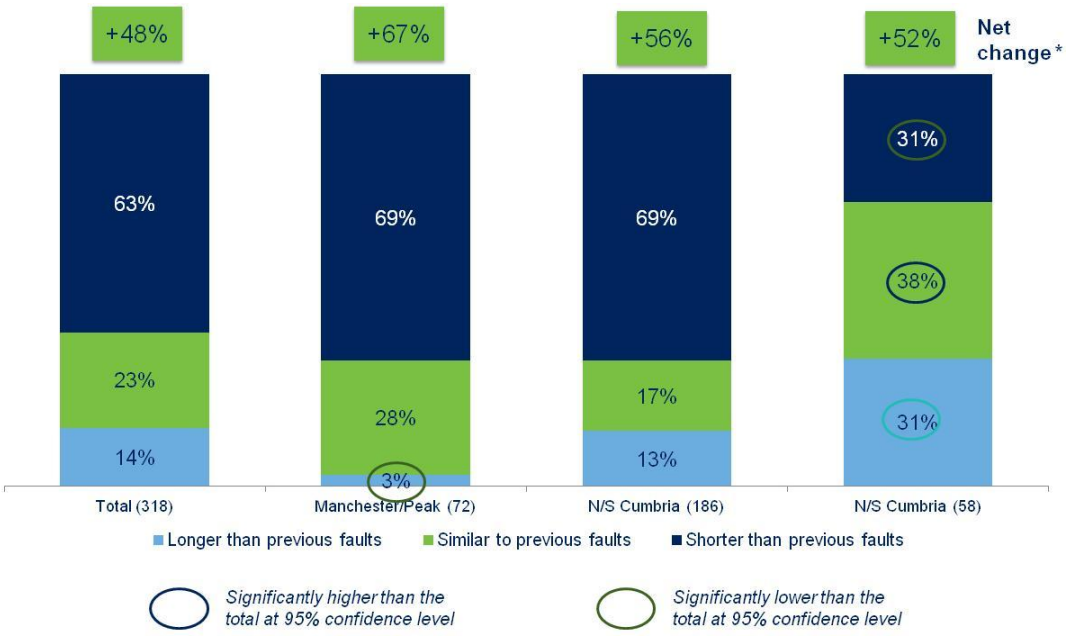
Table 2.3.1b: Acceptability of faults by region amongst domestic customers younger than 65 years old, in the CLASS baseline survey and the C_2C reactive post-fault survey

Acceptability of all fault durations (ratings of 8,9 and 10 on a 1-10 scale where 1 is completely unacceptable and 10 is completely acceptable)		
	C_2C	**CLASS**
Cumbria	**31%**	**63%**
Lancashire	**40%**	**44%**
Greater Manchester	**38%**	**44%**

In summary, the more prolonged a fault event is, the less acceptable it becomes to customers, with the effect more pronounced for those younger than 65 years old and living in rural areas such as Cumbria.

Chart 2.3.1c delineates the positive effect C_2C has had on the perceptions of fault duration in two of the three aggregate regions of the North West:

Chart 2.3.1c: Comparisons of perceived C_2C fault durations versus previous experiences, by region and type of customer



* Note that the net % change = (% decreased - % increased)

Cumbria is the only region where there had been no change in customer perception of the fault duration during the C_2C Trial (when compared to previous experiences). The implication of this is that despite not seeing the same improvement as other regions, there is still no adverse effect detected in Cumbria through the change in operating conditions and therefore no barrier to rolling out the Method as business as usual.

In order to further explore power quality perception amongst the under/over 65 age category, domestic customers on C_2C Trial circuits were profiled to establish if any patterns existed in the ownership of electrical appliances. Table 2.3.1d provides evidence that the appliance ownership of customers within these two age brackets is significantly different. Customers younger than 65 years old have a greater proliferation of electrical appliances and are therefore potentially more likely to have the opportunity to notice any adverse effects, or face disruption to their daily routine when the appliances are being used in the event of a fault to their electricity supply.

Table 2.3.1d: Electrical appliances in domestic households on C_2C circuits, taken from the C_2C proactive monitoring research

Appliance Ownership %	Under 65s (118)	65+ years old (189)
Average number of appliances in household	7	5
Electric kettle	95%	98%
Microwave	95%	95%
Electric oven	71%	65%
Electric shower	71%	57%
Desktop PC/monitor/laptop	83%	45%
Tumble drier	68%	48%
Boiler/water heater	47%	42%
Dishwasher	55%	28%
Games console(s)	47%	5%
Immersion heater	18%	24%
Fan heater/cooler/de-humidifier	24%	20%
Electric storage heaters	5%	14%
Electric car	0%	0%

Significantly higher than the total at the 95% confidence level

Significantly lower than the total at the 95% confidence level

It can be deduced from this analysis that the lower levels of acceptance amongst younger customers are influenced by a broader range and potentially more frequent usage of electrical appliances. This validates the need to collect demographic and appliance ownership information in surveys where the principle objective is to investigate perception of power quality. This is particularly the case where changes in power quality can be detected through dips and spikes in a customer's power supply which are displayed through noticeable differences in the operation of electrical appliances.

The proactive monitoring survey also established the importance of the frequency of interruptions in driving perception of power quality and it is worth considering that the frequency and duration of interruptions is typically higher in Cumbria relative to other regions. This region is mostly rural terrain with a greater concentration of overhead power lines and a relatively higher fault rate compared to Greater Manchester. This may explain why younger customers in Cumbria, who had a greater proliferation of domestic electrical appliances and were in and noticed the C_2C fault, found faults lasting four or more minutes less acceptable than other regions. The anticipated increase in SDI faults on C_2C Trial circuits is likely to mitigate against this effect and gives further credence to there being no barriers to its roll out as business as usual.

3.2.2. I&C customers are more sensitive to fault durations than domestic

Our analysis shows that I&C customers are significantly more likely to accurately recall a C_2C fault occurring (52%) compared to domestic customers (40%). The same analysis amongst SDI C_2C faults found that 48% of I&C customers accurately recalled when a fault had occurred, significantly higher than the 29% observed amongst domestic customers.

When the fault duration lasts longer than three minutes, the difference in recall is much smaller between domestic and I&C customers. It can therefore be concluded that I&C

customers have a heightened sensitivity to faults and that this may be linked to the effect that outages can have on their staff productivity levels and operations. Customer feedback from the proactive monitoring research demonstrated how important a constant power supply can be to commercial customers with feedback such as;

"We need electricity to run our machinery. If the power stops we could miss deadlines and lose business."

Male, 35-44, manufacturing and processing

And also:

"If we lose power then our machinery can't operate. We do have a backup generator; however it couldn't power industrial machinery for very long."

Male, 55-64, manufacturing and processing

Statements such as these were common amongst the manufacturing organisations in the proactive monitoring research. This supports the conclusion that these types of businesses can be particularly sensitive to loss of supply.

I&C customers also exhibit a greater sensitivity towards the duration of a fault. Only 29% of I&C customers felt that the fault duration they experienced was acceptable (22% lower relative to the acceptability observed amongst domestic customers).

The key findings from other customer engagement [4] conducted by Impact Research on behalf of Electricity North West is helpful in enhancing general understanding of I&C customers' acceptance of fault durations and the extent to which this influences their overall satisfaction with the service provided. Table 2.3.2a summarises the results from an on-going customer satisfaction study whereby 759 customers were surveyed after experiencing a fault under 'business as usual' conditions (across the entire Electricity North West footprint) during the period 1st April 2014 to 31st January 2015. The analysis clearly indicates that across the network, I&C customers have a lower level of tolerance to the duration of faults with correspondingly lower levels of overall satisfaction.

Table 2.3.2a: 'Business as usual' fault acceptability and overall customer satisfaction ratings amongst domestic and I&C customers 2014-2015

Total *(759)*	Domestic n=686	I&C n=73
Duration of the last fault was acceptable (% saying yes)	65%	43%*
Overall satisfaction with the service provided during the last power outage event (% satisfied)	86%	78%*

* Significantly lower relative to domestic at the 95% confidence level

It was outside of the scope of the reactive post-fault survey to carry out an in-depth profile of I&C customers by type of industry sector, however, given the implied greater discernibility of faults it is a lesson learned for future customer engagement that this is incorporated into the survey design.

Currently the level of service provided to I&C customers during a fault scenario under the C_2C Method or 'business as usual' conditions is not purposefully different to that which is provided to domestic customers. However, analysis of power quality perceptions amongst I&C customers suggests that there would be merit in contemplating a different approach in

[4] Unplanned Interruptions (Agent) Customer Satisfaction Tracker 2014-2015

the future; one which takes into consideration the effect that a power outage can have on commercial organisations in different industrial sectors.

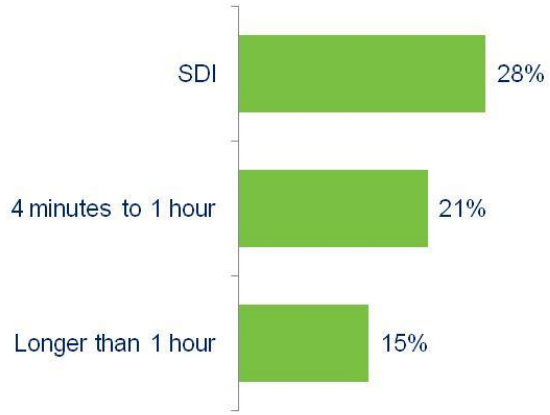
3.3. Where detected by customers, do SDIs enhance perception of power quality or supply reliability?

3.3.1. SDIs are less discernible and promote an enhanced perception of power quality

During the customer survey interviewers were provided with technical fault information which enabled them to guide customers towards thinking about the correct power outage. The data, supplied by Electricity North West, confirmed the duration of the fault each customer was exposed to. Subsequently Impact Research conducted analysis of the technical data by comparing it to the perceived fault durations elicited from the customer during the survey.

Analysis of the technical data indicates that SDI faults are harder for customers to detect. Chart 2.4.1a provides supporting evidence that SDI faults are less discernible by illustrating the relationship between the level of customer recall and the length of the fault duration. In comparison to longer fault durations, a smaller proportion of customers could recall the length of the SDI fault that they were actually exposed to.

Chart 2.4.1a: Percentage of customers claiming they could recall the duration of the fault, by the actual fault duration



In the proactive monitoring research it was found that customers on Trial circuits, who did not detect a fault that they were actually exposed to, perceived an improvement in both fault frequency (net% change of +6%[5]) and fault duration (net % change of +6%). Under C_2C conditions it is anticipated that customers will be exposed to a greater number of SDI faults. Therefore, as illustration 2.4.1a suggests, by implementing the C_2C Method as business as usual, there are likely to be lower levels of fault detection and as a result, a perception of improved power quality.

As previously stipulated, under C_2C operating conditions it is anticipated that customers will be exposed to a greater proportion of SDI faults, so it is useful to evaluate if this is likely to influence recall of such events depending on the time of their occurrence. Table 2.4.1b compares the level of detection of SDI faults against those of longer faults, and indicates that accurate recall is significantly higher amongst customers experiencing longer faults during the morning, afternoon and night time when compared to customers being exposed to SDI faults. The implication of this is that there are times of the day when SDIs are significantly less likely to be noticed. It is worth noting, however, that customers are as likely to notice an SDI as longer faults during hours of peak demand in the evening.

[5] Net score calculated by subtracting the proportion of customers saying that the power quality measure had deteriorated from the proportion of customers saying that it had improved over time.

Table 2.4.1b: Levels of unprompted accurate recall of C_2C faults, by time of day

% accurate recall of fault occurring	SDI	Longer than three minutes
Morning (6am-12pm)	24%	48%*
Lunch (12-2pm)	79%	n/a
Afternoon (2-5pm)	21%	44%*
Tea time (5-7pm)	38%	42%*
Evening (7pm-12am)	59%	59%
Night (12am-6am)	17%	65%*

* Significantly higher than the total at the 95% confidence level

Supplementary evidence presented in 2.4.1c demonstrates that accurate recall of SDI fault durations is significantly lower than faults of a longer duration. However, at tea time through to the evening, when demand peaks, levels of recall amongst customers experiencing both fault durations are relatively similar. This is another indication of an elevated sensitivity of customers to SDI faults at these specific times of day.

Table 2.4.1c: Percentage of customers who provided an approximate duration of the fault they experienced, by time of day

% accurate fault duration recall	SDI	Longer than three minutes
Morning (6am-12pm)	74%	84%*
Lunch (12-2pm)	100%	n/a
Afternoon (2-5pm)	66%	78%
Tea time (5-7pm)	97%	92%*
Evening (7pm-12am)	78%	80%
Night (12am-6am)	17%	61%**

* Significantly higher than the total at the 95% confidence level
** Significantly lower than the total at the 95% confidence level

From this analysis it can be concluded that the duration of the fault and the time it is experienced have a direct bearing on the extent to which faults are recalled accurately.

3.3.2. SDIs significantly increase the acceptability of fault durations and enhance perception of power quality

Electricity North West's 'business as usual' fault management procedures mean that in the event of a fault, approximately 90% of customers' power supplies are currently restored in approximately one to three hours. However, findings in the reactive post-fault survey suggest that this is generally regarded as unacceptable fault duration and that customers expect power to be restored in a much shorter time period.

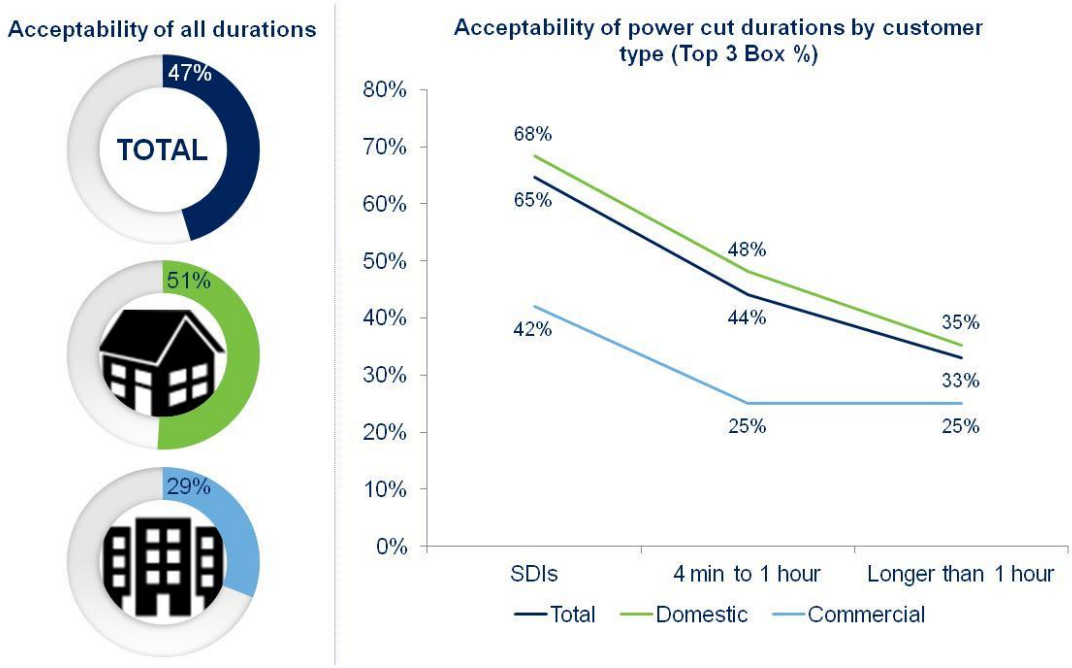
Amongst customers who experienced a C_2C fault within the current 'business as usual' standard (one to three hours), the acceptability of it (asked on a one to ten rating scale) was 34% (ratings of 8-10 combined), 13% lower than the average for all faults. The implication of this is that any change in operating conditions that serves to increase the proportion of faults that are SDIs, such as the C_2C Method, is likely to enhance power quality perception.

Analysis strongly suggests that the increased frequency of SDI faults associated with the C_2C Method will improve customers' perceptions of fault durations and their power quality. Approximately half of all customers surveyed felt that the duration of the C_2C fault that they

experienced was acceptable. The level of acceptability increases significantly when customers experience an SDI fault.

Chart 2.4.2a demonstrates that this is also true of I&C customers where acceptability increases significantly from 25% for faults lasting four or more minutes to 42% for SDIs. This is noteworthy because as previously distinguished; I&C customers have a lower tolerance of faults than domestic customers.

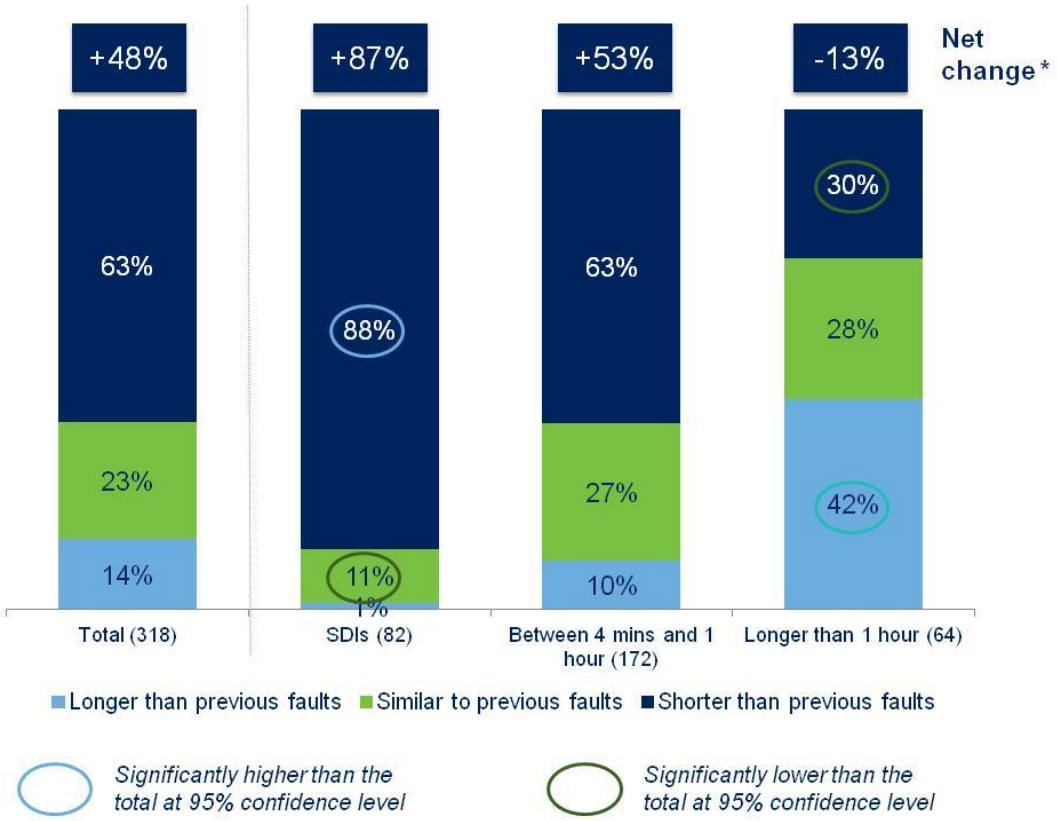
Chart 2.4.2a: Acceptability of fault durations amongst domestic and I&C customers



Faults of a duration longer than three minutes result in significantly lower levels of acceptance amongst I&C customers. Interestingly these customers perceive no real difference between a fault of four minutes to an hour and a fault that is longer than an hour, in that they are both as unacceptable as each another. This emphasises the importance of introducing the C_2C Method in order to expose a greater proportion of I&C customers to SDI faults and consequently increase their levels of acceptance. It also reinforces the argument for Electricity North West and other DNOs to consider the implication that I&C customers should be handled differently to domestic customers, perhaps prioritising them, where possible, for power restoration and proactive communication, due to their different needs and tolerance of interruptions to their supply.

The evidence presented in chart 2.4.2b suggests that during the Trial the change in operating conditions on C_2C Trial circuits improved customers' perceptions of fault duration compared to previous experiences. Chart 2.4.2b demonstrates that overall, a greater proportion of customers felt that the fault they had experienced was of a shorter duration than those they had experienced in the past. It should also be noted that although the net change in perception amongst customers on C_2C circuits is generally positive, especially when customers experience an SDI fault, longer faults of one or more hours can still have a negative effect on power quality perceptions:

Chart 2.4.2b: Comparisons of perceived C_2C fault durations versus previous experiences, by length of fault



* Note that the net % change = (% decreased - % increased)

A key take-out from this analysis is that that the ratio of longer faults (more than one hour) to SDI faults from one time period to another is highly influential in determining overall changes in power quality perception amongst the population of interest. This is particularly evident when interpreting regional analysis.

Regional analysis of perceived fault duration further demonstrates the influence SDI faults can have on customers' perceptions of changes in power quality. The most significant changes were in Greater Manchester and Lancashire, where 28% and 27% of customers respectively claimed to have experienced an SDI fault. This is in contrast to Cumbria, where only 5% claimed to have experienced an SDI fault and instead 52% experienced a fault of longer than one hour. Positively, there is an indication that customers in all regions notice an improvement where an SDI fault does occur (as seen in Table 2.4.2c):

Table 2.4.2c: Net % change in perceptions of fault duration for SDI faults, by region

All SDI faults	+87%
Greater Manchester *(20)*	+75%
Lancashire *(59)*	+92%
Cumbria *(2)*	+50%

*Note that the net % change = (% decreased - % increased).

This analysis provides further reassurance that by rolling out the C_2C Method as 'business as usual', there will be no detrimental effect on perceptions of fault duration at a regional level. However, Electricity North West still faces the challenge of increasing the proportion of SDI faults in Cumbria, a largely rural area of the North West where historically faults have tended to be of a longer duration, in order that more customers can benefit from the C_2C Method.

3.3.3. SDI faults reduce the number of customers feeling the need to contact Electricity North West in the event of a power outage.

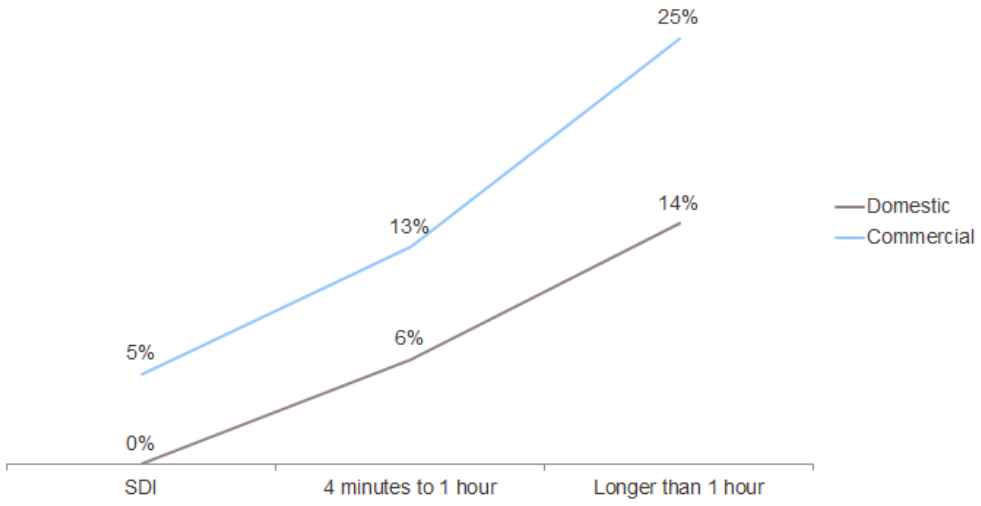
Faults are currently one of the main drivers for a customer to engage with a DNO like Electricity North West and their fault experience is therefore a key determinant of their overall satisfaction with their electricity supply. The implication of this is that any attempt to improve the experience of customers being affected by a fault by reducing the fault duration is likely to have a significant impact on the acceptability of the fault occurring for those customers.

There is sufficient evidence to suggest that a higher frequency of SDI faults may reduce the number of customers feeling the need to contact Electricity North West in the event of a power outage. In the reactive post-fault survey 7% of customers contacted Electricity North West to discuss the fault that they were experiencing. This falls to 1% amongst customers who experienced an SDI fault, but can increase to 17% amongst those who experienced a fault of one hour or longer.

In order to investigate this trend further Electricity North West provided Impact Research with data from its call centre operation, which consisted of the volume of inbound calls and the total number of customers affected by unplanned interruptions across its entire network since April 2014. Between April and June 2014 (when the final phase of customer engagement took place) 21% of customers affected by an unplanned fault contacted the Electricity North West call centre. According to the survey data, in the same time period only 3% of customers affected by a C_2C fault made contact by telephone to discuss the fault. Electricity North West, as well as other DNOs, could therefore potentially benefit from the C_2C Method being implemented as 'business as usual', with a reduced number of inbound unplanned fault related enquiries.

As previously noted, I&C customers are more likely to make contact with their DNO during an unplanned power outage due to an elevated sensitivity to faults occurring. Chart 2.4.3a shows that as the fault duration increases, the proportion of I&C customers contacting Electricity North West climbs more steeply than the proportion of domestic customers.

Chart 2.4.3a: The proportion of domestic and I&C customers who contacted Electricity North West.



This highlights the complementary benefit in addition to capacity release of implementing the C_2C Method across the network. However, it also further supports moving away from the current model of providing the same fault management service to both domestic and I&C customers and highlights the need for a more differentiated service better tailored to the needs of I&C customers. Overall, an improved perception of fault management amongst the general customer base also has the potential to reflect itself in Electricity North West's standing in the Interruption Incentive Scheme (IIS) introduced by Ofgem.

The C_2C Method has the potential to relieve at least some of the pressure placed upon the customer contact centre (CCC) during a fault event. This piece of research has indicated that the longer a fault is, the more likely it is that customers will contact their DNO. Evidence collated in the reactive post-fault survey indicates that through reducing the average duration of faults, there is likely to be an improved perception of fault management and power quality. This combined with a reduced volume of inbound calls during power outages, has the potential to positively reflect itself in Electricity North West's standing in the IIS.

4. PRIORITY SERVICES CUSTOMERS

4.1. Introduction

This section of the report details the key findings of the customer survey analysis, specifically in relation to customers either registered or eligible for the priority services register (PSR) and addresses three key questions, as stipulated in the executive summary. In addition consideration is given to general awareness and interest in the PSR.

The PSR is a scheme which offers extra free services to people who are of pensionable age, are registered disabled, have a hearing or visual impairment, or have long term ill-health. PSR customers may have an elevated dependency on their electricity supply, thus DNOs and electricity suppliers alike are committed to providing greater support and demonstrating a duty of care towards vulnerable customers.

Acceptance of smart grid technologies such as the C_2C Method by customers is a prerequisite to it being considered a viable proposition and thereafter being transitioned to 'business as usual' operating conditions. This is not least why active customer participation was an integral part of the C_2C Project and taking into consideration the views of vulnerable customers, an important part of the learning and development for future low carbon programmes.

Key learnings from a previous LCN Fund C_2C Project; engaged customer panel, highlighted the desire amongst customers to acquire greater knowledge about changes to their electricity supply (particularly if the message is positive) and understand more about their DNO and what to do in the event of a power cut.

In the C_2C customer engagement plan (CEP), Electricity North West committed to communicating with customers from the outset and providing a basic understanding of the Project objectives and the importance of the low carbon agenda. This was achieved through the publication of a customer leaflet, distributed to all customers on each of the C_2C Trial circuits. The leaflet made reference to the PSR, the extra support and services available to vulnerable customers and hints and tips for all customers on what to do in the event of a power cut.

Of the 703 quantitative post-fault surveys conducted, 386 (55%) were customers either already registered, or eligible for the PSR register. This was a statistically robust sample and enabled Impact Research to gain a comprehensive understanding as to whether PSR customers perceived differences in their power quality or supply reliability.

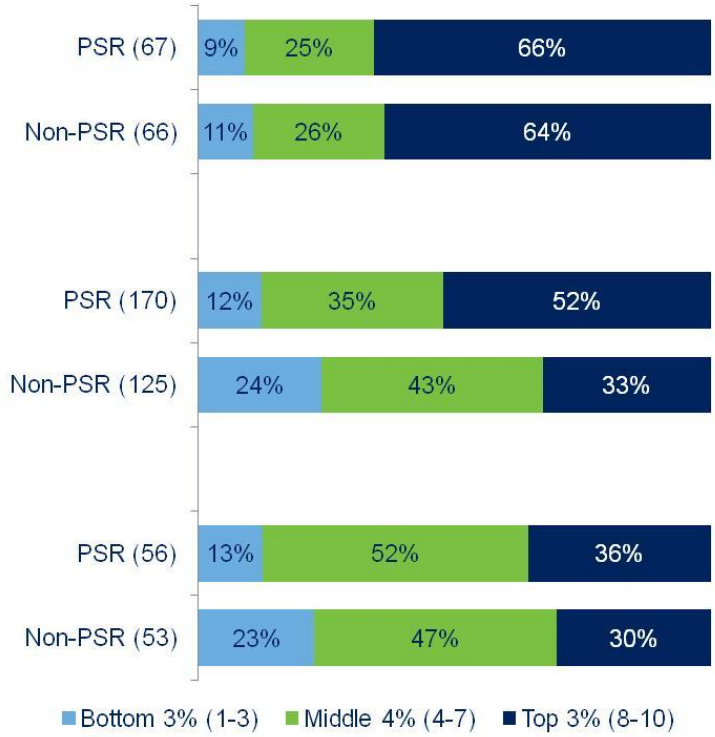
4.2. Where the C_2C Method is deployed and involves meshing the HV network, do PSR customers report any perceived differences in their power quality or supply reliability?

The net improvement in perception of fault duration compared to previous occasions, (calculated by deducting the proportion of customers saying that faults were longer than previous occasions from the proportion that claim faults were now shorter) is greater for PSR customers (52%) than non-PSR (45%).

Furthermore, the acceptability of fault duration (ratings of 8, 9 and 10 on a 1-10 scale) was significantly higher amongst PSR customers (52%) than non-PSR 41%. This is driven by

greater acceptability of faults of 4 minutes or longer, which is illustrated in Chart 3.2a. Customers eligible for the PSR are generally more accepting of all fault durations compared to those not eligible for the PSR. However, despite a greater tolerance to faults, it is also apparent that levels of acceptability significantly decrease when a fault lasts longer than one hour. In contrast, the acceptability amongst those who are not classified as vulnerable significantly falls as soon as a fault lasts beyond three minutes.

Chart 3.2a: Acceptability of fault durations amongst domestic customers eligible and not eligible for the PSR



The implication of this analysis is that where detected, PSR customers do not report any adverse effect in their perception of power quality or supply reliability under C_2C operating conditions.

4.3. If any effects are noticed by PSR customers, do they present a barrier to the roll out of the C_2C Method?

Although some of the sub-groups of interest within the vulnerable customer classification have small sample sizes, there is still an indication from the survey analysis carried out that the circumstances for which customers are on the PSR can affect the level of fault duration acceptability. 38% of customers with medical equipment in their household found the duration of the fault they experienced acceptable, which is the lowest of all the types of PSR customers (compared to 52% for all PSR customers).

It should be noted that only a small minority of customers registered or eligible for the PSR had medical equipment in their household (4%). Hence whilst the variation in power quality perception by type of PSR classification is useful to inform future communication and support services targeted at PSR customers, it is not sufficient to suggest that the effect noticed is a barrier to rolling out the C_2C Method. Indeed as previously noted in section 3.2, at an aggregate level, PSR registered or eligible customers actually rated power quality more positively than non-PSR customers.

4.4. Where detected by PSR customers, do SDIs enhance perception of power quality or supply reliability?

66% of PSR customers detecting an SDI fault found the duration acceptable, marginally higher than non-PSR customers (64%) and significantly higher than the average for all customers and all types of faults (47%). In both cases ratings of fault acceptability were significantly higher when an SDI was detected compared to interruptions lasting four minutes or longer.

The implication of this analysis is that the C_2C Method will benefit customers in improving power quality perception through reducing the average fault duration, and can therefore be rolled out as business as usual.

4.5. Are customers aware of the PSR?

It is an Ofgem requirement that all suppliers and DNOs must maintain a PSR and offer non-financial help to registered customers. According to research conducted amongst customers across the United Kingdom (UK), 24% are aware of the PSR offered by suppliers, DNOs and gas distribution networks. The reactive post-fault survey also included a series of questions regarding the PSR. Only 6% of surveyed PSR-eligible customers, who were currently not registered, were aware that they could sign up to it if desired. Furthermore 62% of eligible customers wanted to know more about how they could sign up to the PSR. These customers were contacted after the survey had been completed and told how they could sign up, with this activity serving as an additional positive outcome of the customer engagement. Overall this analysis is a strong endorsement of the notion that Electricity North West should consider measures to increase the level of awareness of the PSR amongst its customers.

By way of comparison, the proactive monitoring survey included the same question regarding the perceived need to have more information about the PSR, and only 37% of eligible customers requested information about how to sign up to the service. This difference can be explained by the nature of the two pieces of research. The proactive monitoring survey was carried out amongst customers on both C_2C Trial circuits and control (non-C_2C) circuits, who may or may not have experienced a fault. In contrast, the sample for the reactive post-fault survey composed of customers who had definitely experienced a fault. The higher proportion of customers requesting information regarding the PSR in the reactive post-fault survey suggests that a fault event heightens a customer's predisposition for finding the PSR appealing.

Any possible roll out of the C_2C Method will provide Electricity North West with another opportunity to proactively engage with customers and encourage eligible customers to sign up to the PSR. This is particularly relevant at the moment given the introduction of a new incentive scheme, RIIO-ED1 Stakeholder Engagement and Consumer Vulnerability (SECV) incentive, which is being used to encourage DNOs to engage with their customers and provide enhanced services to those who are registered on the PSR or otherwise classified as vulnerable.

5. LESSONS LEARNED FOR FUTURE INNOVATION PROJECTS

5.1. Introduction

This section of the report seeks to disseminate the lessons learned from conducting the reactive post-fault study. The lessons learned are specifically focused on describing how Electricity North West and other stakeholders can utilise the learning from this process to support with the challenges faced in similar types of future customer engagement. The lessons learned are as follows:

5.2. Any research with customers regarding a specific event must be conducted as soon after the event as feasibly possible.

From the outset of the reactive post-fault survey it was planned for customers to be surveyed no more than five days after the fault event occurred. However, the outcome of this was still that the majority could not recall (unprompted) the time and date of the relevant fault and approximately a quarter could not provide the duration. The increased indiscernibility of SDI faults will have contributed to this finding. However, 14% of customers who could not remember the fault duration claim it was because the fault was too long ago.

Although a similar proportion of customers exposed to a fault on C2C Trial circuits correctly claimed to have experienced a fault in the proactive monitoring research, customers were not required to correctly identify when the fault occurred, unlike customers in the reactive post-fault survey. Analysis of network technical data in the proactive monitoring study demonstrated that no customers on Trial circuits, who were exposed to a fault, accurately recalled when the fault occurred. Most, if not all, of these customers had been exposed to a fault at least two months prior to participation in the survey.

The implication of this is that any future customer engagement regarding a specific event must be carried out promptly after the event, in order to maximise the volume of customers who recall a fault and minimise any possible confusion with other events that may have occurred since that particular C2C fault. It is recommended that post-event customer engagement takes place within 48-72 hours of the event occurring to maximise accurate recall whilst also balancing the practicality of responding to the event in the first place.

5.3. It would be beneficial in future customer engagement to survey a robust number of vulnerable customers based on their circumstances for being eligible for the PSR.

Levels of acceptance of fault durations are generally higher amongst vulnerable customers than amongst the rest of the population. However, analysis shows that these levels vary by the reason for which customers are eligible for the PSR. The highest levels of acceptance observed were amongst customers aged 65 years or older, while customers with medical equipment in their household were the least accepting of fault durations. This suggests that circumstances are more likely to influence the perception and tolerance of PSR-eligible customers during a fault, whether it is under C_2C or 'business as usual' conditions.

In the reactive post-fault survey the number of customers who were eligible for the PSR fell out naturally in the sample. In future customer research, and in order to gain a better understanding of PSR customers, some of whom have different needs, a higher volume of customers with specific needs (eg medical equipment) could be surveyed. This will allow for robust analysis of each PSR customer type and help DNOs to make more informed decisions as to how to roll out future innovations on to the network without any adverse effects on the individual needs of these customers.

5.4. Where a statistically robust volume of I&C customers are surveyed, it would be beneficial to include survey questions which gather the sector/industry the organisation operates within.

Analysis contained within this report has demonstrated a distinct difference between domestic and I&C customers in their assessment of power quality. I&C customers are more likely to find faults discernible; they have lower levels of acceptance of fault durations, and they are more likely to contact their DNO when they experience a fault. This is due to the effect faults can have on the equipment they have, on their business premises and therefore on their productivity.

Feedback provided by I&C customers in the proactive monitoring report suggest that organisations involved in manufacturing are particularly adversely affected by faults. However, the instrument used in the reactive post-fault survey did not include a question to

gather the sector or industry the organisation is in. Therefore, it cannot be concluded if a particular industry really does drive the differences observed amongst I&C customers.

By including such a question in future surveys, analysis could be conducted which will then aid DNOs in their strategy for handling I&C customers during fault management and the implementation of future innovations projects.

6. RESEARCH METHODOLOGY

6.1. Introduction

This section of the report provides supplementary information on the customer engagement methodology used to test the hypothesis;

"The C_2C Method will improve power quality resulting from stronger electrical networks."

A quantitative research method was used to evaluate the hypothesis.

6.2. Quantitative research

In order to demonstrate the viability of scaling up the C_2C Method for broader use across GB a quantitative research approach was recommended by Impact Research. Through conducting research quantitatively sufficient evidence could be provided, within an accepted statistical margin of error, to support the notion that the C_2C Method would either have no adverse effect on customers' perceptions of power quality, or in fact serve to improve their perception. The method used was also sufficiently robust to also highlight if the C_2C Method did cause any adverse effect with regards to customers' perception of their power quality.

Sufficient evidence has been provided to support the hypothesis through a large and statistically robust sample of participants who took part in customer surveys over the course of the C_2C Trial. The survey collected information regarding observations survey participants had made, if any, regarding the quality of their power supply and asked how these compared to previous experiences.

Computer aided telephone interviews (CATI) offered a good compromise between value for money, being able to reach a representative survey sample of customers experiencing C_2C faults and relatively high rates of participation. CATI was therefore the methodology used for the reactive post-fault survey.

6.3. Customer sample frame

6.3.1. Customer type

In order to understand if customers' perceptions of power quality had changed as a result of the C_2C Method, Impact Research engaged with I&C and domestic customers who recalled experiencing a C_2C fault and were in the property at the time of the interruption. This ensured that the survey population was one that would be able to have an informed opinion of the C_2C fault and, where appropriate, how it compared to previous power outages.

6.3.2. Survey targets

Electricity North West reviewed historical data relating to each of the C_2C Trial circuits and their average fault rates and estimated that there would be approximately 50 faults on C_2C Trial circuits in the 18-month Trial period. In total Impact Research proposed interviewing 1,000 customers allowing for 20 customers to be surveyed after every C_2C fault event. In order to achieve robust sample sizes for the analysis of both domestic and I&C customers, Impact Research aimed to achieve 750 surveys with domestic customers (15 after each fault event) and 250 surveys amongst I&C customers (5 after each fault event).

In reality, three months into the Trial period there had been only two C_2C faults. It was therefore apparent that the original forecast of 50 C_2C faults during the 18-month Trial period would need to be revised. For that reason Impact Research and Electricity North West agreed to double the survey target to 40 customer surveys after every fault event and halve the number of expected faults to 25.

Aside from the occurrence of C_2C faults, it was anticipated that achieving the target number of customer surveys after every fault would be dependent upon the following factors:

- The availability of accurate customer telephone numbers
- The volume of customers based on the electricity circuit affected by the fault
- The proportion of customers who were at home and had the opportunity to notice the power outage
- The proportion of customers who recalled the power outage occurring.

After fault event 23 in April 2013, Impact Research and Electricity North West came to the conclusion that these combinations of factors were driving the relatively slow fieldwork progress made until that point and that the survey target should therefore be increased to 80 interviews per fault event for the remainder of the customer engagement. A flexible approach was also taken to agreeing upon the number of fault events that would prompt customer surveys to be undertaken, whereby it was decided that as many events would be represented as possible within the Trial period in order to generate as close to the 1,000 completed surveys as possible.

6.3.3. Sampling methodology

In order to avoid any systematic bias as to who was contacted and in what order, Impact Research used a tried and tested sampling technique called probability sampling. Probability sampling is a technique wherein the samples are gathered in a process that gives all the individuals in the target population equal chances of being selected. Randomisation was applied to the samples that were created in response to each fault event. Through applying probability sampling, random selection and contacting customers across a range of daytime and evening shifts the survey sample was more likely to be representative of the general population.

Survey participants were sourced from a C_2C Trial circuit master database. The approach taken to selecting customers to take part in the survey ensured that there was no bias towards customers that had contacted Electricity North West in the past.

6.3.4. Screening criteria

The primary objective of the customer survey methodology developed by Impact Research and peer reviewed by Professor Ken Willis was to elicit customers' perceptions of their most recent power outage and the impact this had, if any, on their perception of power quality. Therefore, in the case of domestic customers it was not necessary to survey the electricity bill payer of the household. This approach runs contrary to common practise in market research studies which generally aim to sample customers with decision making responsibility. The screening criteria used to recruit participants to take part in the domestic customer survey ensured that respondents were at least a permanent member of their household.

Conversely the screening criteria used to recruit I&C customers to take part in the survey was devised to seek feedback from the individual in the organisation responsible for their electricity supply. In a small business, the individual paying the electricity bill is also likely to be the person managing the enterprise. But for larger I&C establishments employing greater numbers of workers, it was more important to survey the most appropriate person affected by electricity supply considerations. Previous learnings from the C_2C programme of customer engagement had demonstrated that the likely job titles of customers within the target sample frame would be:

- Facilities manager
- Production (operations) manager
- Property manager
- Managing director/CEO
- Office manager or administrator.

This screening criteria has since been used successfully in Electricity North West's other second tier LCN Fund Project, Customer Load Active System Services (CLASS) whereby 200 I&C customers were recruited to take part in a series of customer surveys regarding their power quality

To further validate the suitability of the individual taking part in the customer engagement they were also required to recall experiencing the C_2C fault. Impact Research asked customers in an unprompted manner if they recalled experiencing a power outage at their property recently. If the customer recalled an interruption, they were asked if they were able to recall the approximate date that they experienced the interruption. Interviewers then prompted the customer with more information, including the following:

- Time and date of the fault
- Fault duration
- Feeder(s).

Relevant information regarding C_2C faults was provided by Electricity North West, and sharing this with customers meant that they were then able to really focus on the particular fault of interest.

6.4. Customer survey

The final version of the customer survey can be found in Appendix A of this report. It should also be noted that a peer review was conducted of the customer survey methodology itself which makes references to the survey and this review can be found in Appendix B.

In practise the customer survey was completed, on average, in 15 minutes. This was of a sufficient duration for customers to discuss the fault that they had recently experienced and their perceptions of power quality, whilst also mitigating the risk of a decrease in response rates due to excessive questionnaire length.

Measurement of power quality can take many forms. The volume of customers affected by a fault (ie a power cut), the frequency of faults occurring and the duration of faults are all key regulatory measurements. In addition to these regulatory measures, customers may observe dips and spikes in voltage that manifest themselves in discernible effects to their appliances and therefore influence their perception of power quality. In order to support the research hypothesis, the power quality metrics included in the survey were as follows:

- The duration of the most recent fault
- Levels of acceptance of the duration of the most recent fault
- How the most recent fault duration compared to previous faults
- Observations of any dips and spikes in the customer's power supply recently.

6.5. Survey completion

In order to increase the extent to which customers could accurately recall C_2C faults, Impact Research contacted customers within a maximum of five days of the power outage occurring. This was of particular importance due to the anticipated increased frequency of short duration interruptions (SDIs) under C_2C conditions, which could mean that customers find it more challenging to detect and remember faults under C_2C operating conditions.

Table 3.6a indicates the target volume of survey responses and how many surveys were actually completed in each wave of the customer engagement:

Table 3.6a: Volume of surveys completed vs targets set

Wave	Time of fault	Date of fault	Fault duration	Feeder affected	Target	Completed
1	23:12	11/07/2013	All customers had power restored by 23:12	4002084CW27	20	20
2	23:12	11/07/2013	Approx. 1,128 were restored within 4 minutes and the remainder were restored within 2 hours	4002084CW15	20	17
3	09:20	09/10/2013	All restored within 5minutes	1001193CW05	40	35
4	09:20	09/10/2013	1425 customers restored within 1 minute, 111 customers restored within 54minutes	1001193CW13	40	33
5	06:18	18/11/2013	64 customers out of 136 restored in 162 secs	6096684CW13	40	8
6	06:18	18/11/2013	1132 customers restored in 54 secs	6096684CW04	40	27
7	10:05	24/11/2013	1650 customers restored in 52 secs	3000154CF23	40	31
8	10:05	24/11/2013	515 customers in 3 mins; 751 restored in 1 hr 3 mins	3000154CF29	40	32
9	14:32	02/12/2013	2 minutes	2001143CW18	40	38
10	14:32	01/12/2013	>1.5hrs	2001143CW09	40	8
11	11:46	05/12/2013	1+ hours	6096054CF12	40	32
12	11:46	05/12/2013	1+ hours	6096054CF13	40	33
13	18:01	05/01/2014	40 minutes	2004053CF10	40	31
14	18:01	05/01/2014	2 minutes	2004053CF02	40	34
15	19:29	15/01/2014	20 minutes	4000073CW05	40	22
16	19:29	15/01/2014	Not sure	4000073CW11	40	22
17	11:42	17/01/2014	Not sure	4000734CW09	40	40
18	11:42	17/01/2014	< 3mins	4000734CW13	40	40
19	04:52	20/01/2014	< 3mins (544, later for 100 customers)	3000154CF27	40	25
20	07:52	25/02/2014	< 3mins and < 1 hour	2001083CW17	40	12
21	07:52	25/02/2014	< 3mins	2001083CW23	40	18
22	03:47	30/03/2014	1 hour	4000023CF52	40	5

Wave	Time of fault	Date of fault	Fault duration	Feeder affected	Target	Completed
23	03:47	30/03/2014	< 3mins and < 1 hour	4000023CF44	40	3
24	12:28	14/05/2014	3 mins and longer	4000543CW03	80	20
25	12:28	14/05/2014	3 mins	4000543CW12	80	1
26	05:16	15/05/2014	3 mins	4000543CW06	80	4
27	05:16	15/05/2014	3 mins and 6 hours	4000543CW14	80	5
28	18:26	27/05/2014	2 hours	2001023CW12	80	9
29	18:26	27/05/2014	20 mins	2001023CW17	80	19
30	01:25	29/05/2014	10 mins	4000023CF43	80	31
31	01:25	29/05/2014	3 mins and 6 mins	4000023CF50	80	12
32	11:17	31/05/2014	<3 mins and 1.5 hours	3000154CF27	80	35
32 waves of customer engagement in total					**1,000**	**702**

Although the original target of 1,000 customer surveys was not achieved, the total volume of surveys completed is still a statistically robust survey population and a sound basis with which to address the research hypothesis.

To further verify the robustness of the survey methodology and representativeness of the survey population, a weighting was applied to the customer survey results that reflected the incidence of the electricity feeders serving the customers who were part of the survey sample throughout the course of the C_2C Trial. The proportion of surveys conducted amongst customers on each of the electricity feeders and the volume of customers supplied by each feeder in reality, as a proportion of the total population of all the feeders represented in the survey sample, were important considerations in constructing the additional weighting. By looking at the data in this way, Impact Research was able to give customers who were served by an electricity feeder covering a wider customer base, a higher level of influence than those who were served by feeders covering a much smaller area. The results produced from this weighting technique (Table 3.6b below) were very similar to the original demographic and socio-economic weighting method, giving the sampling methodology further credibility. Therefore, in order to avoid any distortion of the data, the analysis that has been presented throughout this report is based on unweighted data.

Table 3.6b: Sample demographic unweighted and weighted

	Unweighted	Weighted
Male	41%	40%
Female	59%	60%
18-24	1%	1%
25-34	5%	4%
35-44	8%	8%
45-54	13%	13%
55-64	23%	23%

65+	50%	49%
Eligible for PSR	55%	54%
Non-PSR	45%	46%

6.6. Use of technical network data

In order for customer engagement to be initiated Electricity North West provided Impact Research with information about each C_2C fault shortly after it occurred. Further to the customer surveys being completed Impact Research then, where prior consent had been gained, shared the details of customers who had taken part in the reactive post-fault survey with Electricity North West in order for them to confirm the exact duration of the fault each customer was exposed to. This included the customer's MPAN, a unique identifier. This process involved Electricity North West appending real fault data to the customer survey perception data collected at an individual customer level. Impact Research was then able to compare the technical fault data with customers' perceptions of their power supply quality and explore the correlation, if any, between the two.

6.7. Peer review

6.7.1. The objective of the peer review

A peer review considered the suitability of the reactive post-fault research methodology proposed by Impact Research and its ability to provide robust quantitative research in support of the C_2C hypotheses. The peer review was also intended to maintain standards of quality, improve performance, and provide enhanced credibility.

The Peer Review was undertaken by Professor Ken Willis. Ken Willis is Emeritus Professor of Environmental Economics at Newcastle University. His research concentrates on environmental valuation (using stated preference, and revealed preference travel-cost and hedonic price models) and cost-benefit analysis; covering biodiversity, cultural heritage, energy, forests, landscape, quarries, recreation, transport, waste disposal, and water quality and supply.

6.7.2. Executive summary of peer review

The narrative within this section is an executive summary of the peer review submitted by Professor Ken Willis. The full report, which includes the executive summary contained therein, is included in Appendix B.

The reactive post-fault survey research will test the hypothesis (H_1) that customers on C_2C circuits, who have experienced a C_2C fault, have noticed a discernible effect on their power quality.

The research methodology outlined by Impact Research is a rigorous examination of the effect of C_2C on customer perceptions. The sample size proposed by Impact Research, should be adequate to test the hypothesis, for domestic customers, and for industrial and commercial (I&C) customers, as a whole. Whether the sample size is large enough to derive statistically significant results on the perception of power quality and tolerance, will depend on how much segmentation of data is undertaken in the analysis.

The interviewing approach proposed is exemplary: asking customers in an unprompted manner if they recall experiencing power problem to their property recently, and if so the date, time and duration of the fault. This approach, with interviewers being conducted as soon as possible after the fault occurred, will ensure that any recall error is minimised.

The proposed analysis of the data is practical, investigating whether customers have perceived or experienced a discernible effect on their power quality by customer type (domestic versus I&C); region; and fault duration. Any more detailed analysis eg by region needs to standardise for socio-economic or I&C structure of customers, to ensure that results are not just a function of the socio-economic or I&C sample profile of customers in each region.

7. CONCLUSION

The reactive post-fault survey customer engagement has provided an essential forum to gain constructive and independent feedback from customers on the perception of their power supply quality after being exposed to a C_2C fault.

The use of customer perception data and technical network data was particularly powerful in illustrating the benefits of SDIs in particular to both Electricity North West and the customers it serves and therefore validating the hypothesis that, "*The C_2C Method will improve power quality resulting from stronger electrical networks.*"

This report summarises the key findings of the reactive post-fault customer engagement carried out with a robust and representative sample of customers on C_2C Trial circuits throughout the 18-month Trial period.

8. NEXT STEPS

There will be ongoing learning and dissemination as the C_2C Project is closed down and the key learnings will be reviewed to reflect customer feedback across the various customer engagement activities, of which the reactive post-fault survey is just one.

In line with the vision of the LCN Fund, all outputs and learning gained from customer engagement activities will be made available to other DNOs. Specifically, all communication materials, research materials and key findings developed in the Project are publicised on the C_2C website. All relevant learning will be shared at C_2C learning events, through trade magazines and in other appropriate forums.

9. APPENDICES

9.1. Appendix A: Survey instrument

Introduction (Phone Interview)

INTERVIEWER TO CODE THE FOLLOWING DETAILS FROM THE SAMPLE PROVIDED:

- UNIQUE ID
- RESEARCH DIP NUMBER /50
- CUSTOMER TYPE: DOMESTIC OR COMMERCIAL
- CUSTOMER NAME
- CUSTOMER ADDRESS
- CUSTOMER TELEPHONE NUMBER
- DATE AND TIME OF POWER CUT
- DURATION OF POWER CUT
- FEEDER
- MPAN CORE

INTERVIEWER PROMPT FOR DOMESTIC CUSTOMERS:

Good morning/afternoon/evening. My name is ..... from Feedback Research

INTERVIEWER PROMPT FOR COMMERCIAL CUSTOMERS:

Good morning/afternoon/evening. My name is ..... from Feedback Research

Please can I speak to "*whoever is responsible for matters relating to your electricity supply"*?.

INTERVIEWER INFORMATION FOR COMMERCIAL CUSTOMERS: Note that the job titles and/or responsibilities of commercial customers could cover, but not be limited to the following: Electricity Management, Operations/Maintenance/Site Manager, Facilities Manager, and Procurement.

INTERVIEWER READ OUT TO ALL CUSTOMERS:

We are carrying out a market research study on behalf of Electricity North West, your regional electricity distributor.

Your feedback is really important to us. This survey should take approximately **5 minutes** to complete.

As a thank you for taking part and **completing** our survey you will be entered into a **one off prize draw** at the **end of the month** you participated in, where you can win a **£20 online gift card**.

You will have a **one in forty** chance of winning the gift card. If you win, you will be able to **select one** of the following retailers to spend the value of your gift card at; Amazon, B&Q, Pizza Express, Starbucks, Zizzi, Dorothy Perkins, Burton or Zara.

Unprompted Awareness

INTERVIEWER READ OUT:

It's Electricity North West's job to deliver a safe, reliable supply of electricity from the national grid to your home through their network of overhead lines, underground cables and substations. Most of the time they provide you with a continuous and reliable electricity supply. But occasionally an unforeseen fault might cause a power cut to your home or business.

ASK ALL

SINGLE CODE

Q1 Can I just check, have you experienced a power cut recently at your property?

Interviewer briefing note: By recently we mean in the last month

Yes.....1 **CONTINUE TO Q2**
No .....2 **GO TO Q3**
Don't know.....3 **CLOSE IMMEDIATELY**

C_2C Power Cut

ASK ALL

SINGLE CODE

Q2 You mentioned that you have recently experienced a power cut at your property.

Are you able to recall the approximate date that you experienced the power cut?

INTERVIEWER BRIEFING: THIS QUESTION IS DESIGNED TO UNDERSTAND HOW CLEARLY THE CUSTOMER RECALLS WHEN THE POWER CUT WAS. PLEASE CAPTURE THEIR RESPONSE.

Yes [**Insert customers verbatim response as they answer**…] .....1 **CONTINUE**
No I cannot recall the date of the power cut.....2 **CONTINUE**

ASK ALL, SINGLE CODE

INTERVIEWER BRIEFING: IF YES AT Q2 CROSS REFERENCE WITH ACTUAL DATE OF POWER CUT

Q3 According to our records there was a power cut on your electricity circuit on <INSERT DATE FROM SAMPLE> at <INSERT TIME FROM SAMPLE>. Do you recall experiencing this power cut at your property?

Interviewer: If the customer says no, please ask them if they recall any adverse effects after the Power cut had happened, such as having to restart equipment/machinery/appliances or anything else. If they do recall some effect(s) then code yes and proceed to Q4.

Yes.....1 **CONTINUE**
No .....2 **CLOSE**

ASK ALL

SINGLE CODE

Q4 Were you personally in the property when a power cut on <INSERT DATE FROM SAMPLE> at <INSERT TIME FROM SAMPLE> occurred?
Yes.....1 **CONTINUE TO Q6**
No .....2 **ASK Q5 IF DOMESTIC, CONTINUE TO Q6 IF COMMERCIAL**

ASK IF CODE 2 AT Q4

SINGLE CODE

Q5 Was there anyone else in the property at the time of this particular power cut?
Yes.....1
No .....2 **CLOSE**

IF Q5=1 THEN PROMPT FOR PERSON AND THEIR CONTACT DETAILS, CLOSE THE SURVEY, RESTART SURVEY WITH NEW CUSTOMER CONTACT

Name	
Telephone Number	

ASK ALL

SINGLE CODE

Q6 Thinking about **this particular** power cut/interruption you experienced, how long did it last?

INTERVIEWER - IF TALKING TO A COMMERCIAL CUSTOMER WHO WAS NOT ON SITE AT THE TIME OF THE POWER CUT, PLEASE SELECT "COMMERCIAL CUSTOMER NOT ON SITE", CODE THIS QUESTION BASED ON THE DURATION GIVEN IN THE SAMPLE FILE AND TELL THE CUSTOMER THAT THAT WAS THE LENGTH OF THE POWER CUT THEIR SITE EXPERIENCED SO THEY CAN ANSWER THE REMAINING QUESTIONS

PLEASE TAKE CARE WHEN CODING THE TIME GIVEN. AN ANSWER OF "3 HOURS" WOULD BE ANSWER CODE 4 RATHER THAN CODE 3

UNPROMPTED, CODE INTO THE FOLLOWING LIST:

3 minutes or less 1
Between 4 minutes and 1 hour.....2
From 1 hour up to 3 hours.....3
From 3 hours up to 8 hours 4
More than 8 hours 5
Don't know.....6

ASK ALL WHO DO NOT RECALL THE LENGTH OF THE POWER CUT (Q6=6)

MULTI CODE

Q6B May I ask, why do you not recall the length of the power cut? Which of the following, if any, apply?

The power cut didn't interrupt what I was doing at the time/I didn't pay attention 1
I only knew there had been a power cut *after* it had happened 2
(eg by having to reset time switches, appliances etc.)
After the power cut happened I left the property/went to sleep.....3
I cannot remember the duration accurately as it happened a while ago.....4
Other [PLEASE SPECIFY] 5

ASK ALL WHO CODE 1-5 AT Q6

SINGLE CODE

Q7 How does the length of this power cut compare to your previous experiences of power cuts **at this property**?

I haven't experienced a power cut at this property before 1
Shorter duration compared to previous experiences 2
Similar to previous experiences 3
Longer duration compared to previous experiences 4
Don't know.....5

ASK ALL

SINGLE CODE

Q8 Most of the time Electricity North West provides you with a continuous and reliable electricity supply. But occasionally, an unforeseen fault might cause a power cut to your home/property. On average customers experience a power cut once in every three years. [INTERVIEWER, PLEASE FOCUS THE CUSTOMERS ATTENTION NOT ON THE FACT THE POWER CUT HAPPENED, BUT ON THE LENGTH OF TIME IT LASTED]

Despite having this recent power cut, did you find **the length of this power cut/interruption** acceptable?

Yes.....1
No.....2

SINGLE CODE

Q9 On a scale of 1-10 where 1 is completely unacceptable and 10 is equal to completely acceptable to what extent did you find the length of this power cut/interruption acceptable?

Completely Unacceptable									Completely Acceptable
1	2	3	4	5	6	7	8	9	10

ASK ALL WHO DID NOT FIND THE DURATION ACCEPTABLE Q8=2

MULTI CODE

Q10 Why do you find the length of this power cut/interruption not acceptable?

UNPROMPTED LIST, CODE INTO FOLLOWING CATEGORIES

I had to restart equipment/machinery/appliances.....1
I experienced a loss of data.....2
I have experienced too many power cuts at this address so a power cut of any duration is not acceptable to me.....3
I had to locate my trip switch.....4
It disturbed what I was doing at the time.....5
It caused a loss of productivity (if work from home/commercial customer).....6
I/someone in my household is vulnerable/ill.....7
Other [**PLEASE SPECIFY]**.....8

Customer prompted comments box:

Interviewer- use this box to note down any comments the customer makes as they answer this question, it is really important we understand all of the reasons the customer considers the duration of the power cut to be unacceptable

ASK ALL

SINGLE CODE

Q11 Thinking about the electricity supply to your property, have you recently noticed any dips or spikes in your power from time to time?

INTERVIEWER:

By dips and spikes we mean lights flickering or dimming, wavy lines on computer screen and equipment that trip out.

Yes.....1
No.....2
Don't know.....3

ASK IF Q11=1

SINGLE CODE

Q12 And have these dips and/or spikes affected your daily routine at your property?

Yes.....1
No.....2
Don't know.....3

ASK IF Q12=1

SINGLE CODE

Q13 And why do you say that these dips and/or spikes have affected your daily routine at your property?

Customer prompted comments box:

Interviewer- use this box to note down any comments the customer makes as they answer this question, it is really important we understand all of the reasons the customer gives for their routine being affected.

ASK ALL

SINGLE CODE

Q15 Did you, or anyone else within the property, contact Electricity North West to discuss the power cut you experienced?

Yes I contacted Electricity North West about the power cut 1
I didn't contact Electricity North West 2

ASK ALL
SINGLECODE
IMPACT TO PROVIDE INTERVIEWERS WITH A COPY OF THE CARD IN A BRIEFING PACK

Q14 Do you recall receiving a leaflet through your letterbox from Electricity North West at any stage, explaining that they had made some improvements to the electricity circuit your property is located on?

Interviewer: please explain what the leaflet looks like in order to help customers answer this question.

Yes.....1
No.....2

ASK ALL
SINGLE CODE

QD1. Code respondent gender [**DO NOT ASK-INTERVIEWER TO CODE**]

Male.....1
Female.....2

ASK ALL
SINGLECODE

QD2. For classification purposes, can you tell me which of the following age bands do you fit into?

18-24.....1
25-34.....2
35-44.....3
45-54.....4
55-64.....5
65+.....6

ASK ALL DOMESTIC CUSTOMERS
MULTICODE

Some groups of people have more dependency or need for electricity at all times than others.

QD6. Which, if any, of the following applies to you or your household?
Select all that apply

	A – I (the customer being spoken to)	**B – Someone else in my household**
Have a disability	3	3
Have medical equipment (eg dialysis)	4	4
Are seriously ill	5	5
Have mobility problems	6	6
Have visual or hearing impairment	7	7
None of the above	8	8

ASK IF QD6=4 OR QD6=4
SINGLE CODE

QD7 You mentioned that you have medical equipment in your household. Did the most recent power cut, which we have been speaking about, affect your medical equipment?

Interviewer- by this we mean has a power cut interrupted the operation of medical equipment, by having to stop treatment, re-set equipment, visit hospital etc.

Yes.....1
No 2

ASK IF QD7=1
OPEN ENDED

QD7B You mentioned that your medical equipment was affected during the most recent power cut. Please could you describe what happened?

INTERVIEWER – PLEASE PROBE FOR AS MUCH INFORMATION AS POSSIBLE:WHAT HAPPENED? HOW DID THE CUSTOMER FEEL WHEN IT HAPPENED? WHAT DID THE CUSTOMER DO?

ASK IF QD2=6 OR QD6A/QD6B=3 OR 4 OR 5 OR 6 OR 7
SINGLE CODE

QD8 Electricity North West offer a priority service for their more vulnerable customers, who may need additional specialised help from them during a power cut. As part of its priority service Electricity North West works with the British Red Cross who can help you with practical necessities when things go wrong.

According to the answers you have given in the previous questions, you/your household are eligible to sign up to Electricity North West's priority service register. Are you already on this register?

Yes.....1
No 2

ASK IF QD8=2
SINGLE CODE

QD9 Were you aware that **you** could sign up to this register?

Yes.....1
No 2

ASK IF QD8=2
SINGLE CODE

QD10 Would you like to know now how to register for the priority services register?

Yes.....1
No 2

ASK IF QD10=1
SINGLE CODE

QD10B To register you can call Electricity North West on 0800 195 4141 or complete the form on the website www.enwl.co.uk. If you would like to receive more information about the priority services register, Electricity North West can send you a leaflet about it.

Would you be happy to have your details, including address, passed on to Electricity North West so they can send you this leaflet?

Yes.....1
No 2

ASK IF QD10B=1
SINGLE CODE

QD10C Please can you confirm your address, so Electricity North West can send you this leaflet?

Address	

Thank you for your help in this research

Please be assured that the answers that you have given will not be attributed to you personally, but will be presented in grouped form only for analysis purposes, **unless you give your express permission for us to attribute your responses to you...**

ASK ALL
SINGLECODE

QD3a Would you be happy to have the feedback you have given to us today attributed to you so that Electricity North West are aware that you have taken part in this market research?

Yes.....1
No 2

ASK ALL
SINGLECODE

QD4 Would you be happy for us to get in touch with you again in the future to discuss the service you receive from Electricity North West for market research purposes?

Yes.....1
No 2

QD5 Would you be happy for your data to be passed to Electricity North West, or one of its 3rd party partners in order that they can discuss with you any aspect of your electricity supply in the future?

Yes..... 1
No..... 2

9.2. Appendix B: Peer review

Executive summary

The reactive post-fault survey research will test the hypothesis (H_1) that customers on C_2C circuits, who have experienced a C_2C fault, have noticed a discernible effect on their power quality.

The research methodology outlined by Impact Research is an excellent and rigorous examination of the effect of C_2C on customer perceptions. The sample size proposed by Impact Research, of 1000 customers, should be adequate to test the hypothesis, for domestic customers, and for industrial and commercial (I&C) customers, as a whole. Whether the sample size is large enough, to derive statistically significant results on the perception of power quality and tolerance, will depend on how much segmentation of data is undertaken in the analysis.

The interviewing approach proposed is excellent: asking customers in an unprompted manner if they recall experiencing power problem to their property recently, and if so the date, time and duration of the fault. This approach, with interviewers being conducted as soon as possible after the fault occurred, will ensure that any recall error is minimised.

The proposed analysis of the data is practical, investigating whether customers have perceived or experienced a discernible effect on their power quality by customer type (domestic versus I&C); region; and fault duration. Any more detailed analysis eg by region needs to standardise for socio-economic or I&C structure of customers, to ensure that results are not just a function of the socio-economic or I&C sample profile of customers in each region.

The objective of this peer review

This peer review considers the suitability of the reactive post-fault survey methodology proposed by Impact Research to provide robust quantitative research that will assist in answering the C_2C hypotheses. The peer review is also intended to maintain standards of quality, improve performance, and provide credibility.

This review has been undertaken by Professor Ken Willis. Ken Willis is Emeritus Professor of Environmental Economics at Newcastle University. His research concentrates on environmental valuation (using stated preference, and revealed preference travel-cost and hedonic price models) and cost-benefit analysis; covering biodiversity, cultural heritage, energy, forests, landscape, quarries, recreation, transport, waste disposal, and water quality and supply.

He is currently the editor of the Journal of Environmental Economics & Policy. He has undertaken research projects on renewable energy and its impact on rural development and sustainability in the UK, for the Department of Trade and Industry; on the growth potential for

micro-generation in England, Wales and Scotland, for the Department of Business, Enterprise & Regulatory Reform; a Cost-benefit analysis of sustainable public procurement, for the Department for Environment, Food & Rural Affairs; and consumer values and uptake rates for photovoltaic systems by households in Cyprus.

Ken also has a wealth of experience in evaluating the suitability of market research methodologies and the application of advanced statistical analysis techniques onto market research data. Given his expertise within the energy sector he is well placed to provide a peer review of the C_2C reactive post-fault survey methodology.

The rest of this report focuses on an assessment of the reactive post-fault survey methodology prepared by Impact Research for Electricity North West and is based entirely on the informed opinion of Ken Willis.

Reactive post-fault research objectives

The reactive post-fault survey methodology report, by Impact Research for Electricity North West, clearly documents the research hypothesis. The report describes in detail the method Impact Research will adopt to engage customers to test whether a C_2C demand side management and generation side response will be indiscernible to customers.

The report provides the context for the reactive post-fault survey methodology by outlining the previous steps in the research programme.

The reactive post-fault survey research will test the hypothesis (H1) that customers on C_2C circuits, who have experienced a C_2C fault, have noticed a discernible effect on their power quality.

Research and survey methodology

The research methodology outlined by Impact Research is an excellent and rigorous examination of the effect of C_2C on customer perceptions.

The Computer Aided Telephone Interview (CATI) survey proposed by Impact Research is appropriate: it is more cost-effective then a Computer Aided Personal Interview (CAPI) survey, whilst minimising self-selection bias compared to an on-line survey.

The sample size proposed by Impact Research, of 1000 customers, should be adequate to test the hypothesis, for domestic customers, and for industrial and commercial (I&C) customers, as a whole. The split between domestic customers (750) and industrial and commercial (I&C) customers (250) is reasonable. Impact Research is right to suggest spreading this sample of customers across a number of fault occurrences. 50 fault occurrences should provide a good coverage of areas, timings, and different types of customers within the domestic and I&C samples.

Most supply interruptions are likely to be short duration interruptions (SDI), which customers may or may not detect depending on their electricity appliances (type and number, and whether the appliance automatically resets time after an interruption) and whether the customers is on the premises at the time of the interruption. The sample needs to ensure, if the analysis is to be segmented by duration of the interruption, there is an adequate number of observations in different supply interruption categories to derive statistically meaningful results. This could be achieved through stratified random sampling, if deemed necessary.

Whether the sample size is large enough, to derive statistically significant results on the perception of power quality and tolerance, will depend on how much segmentation of data is undertaken in the analysis, eg by different times of day, length of supply interruption, socio-economic group or industrial classification, region or area, prior fault history on circuits, etc. for domestic and I&C customers.

Fieldwork

The interviewing approach proposed is excellent: asking customers in an unprompted manner if they recall experiencing power problem to their property recently, and if so the date, time and duration of the fault. This approach, with interviewers being conducted as soon as possible after the fault occurred, will ensure that any recall error is minimised.

Impact Research aim to interview customers affected by a C_2C fault within a maximum of 5 days of the fault occurring, but more usually about 48 hours after the fault. Interviews should be completed as soon as possible after the fault occurrence to minimize recall bias. There are practical limitations on how soon interviewing can start, given that the Electricity North West technical team have to inform the customer delivery team of a fault occurring, and then inform Impact Research who subsequently have to identify customers affected from their database before interviewing can commence. However, the time scale for this process needs to be minimized as much as possible. In reporting the results of the reactive post-fault survey, it would be useful to include some statistics on the distribution of interviews completed within 24 hours, 24-48 hours, 48-72 hours, etc. of the fault occurring.

The questionnaire covers appropriate topics: length of supply interruption; knowledge of any dips and surges in power supply; demographic profile of customer; and awareness of recent power faults. Consumers' acceptability of supply interruptions may be conditioned on their past experience of supply interruptions. Studies have shown that consumer acceptability is conditioned by previous experience (see for example Samuelson and Zeckhauser, 1988; Levy-Garboua and Montmarquette, 2002). Thus it might be useful to ask customers about their perceptions and experience of supply interruptions over the previous 12 months or two years.

The questionnaire should note the postcode of the customer. This will allow some analysis on whether there is a spatial variation in discernible effects by customers of variations in power quality.

Analysis

The proposed analysis of the data is practical. The analysis will look at whether customers have perceived or experienced a discernible effect on their power quality by customer type (domestic versus I&C); region; and fault duration; with further analysis by customer type and fault duration, and customer type split by region.

Regional variations in domestic customer perceptions may arise because of differences in the socio-economic composition of customers, and or fault duration. Any regional analysis needs to standardize for the socio-economic composition of domestic customers across regions, and fault duration. Similarly for I&C customers, the analysis needs to standardize for I&C structure. A binary logit model of individual customer responses could be undertaken to assess which variables, including an instrumental variable for 'region', account for a noticed discernible effect on power quality. This would indicate whether customers in each region had statistical significant different perceptions.

Conclusion

The reactive post-fault survey methodology proposed by Impact Research is, admirable. The research methodology will provide an accurate and reliable test of the hypothesis that customers on C_2C circuits, who have experienced a C_2C fault, will have noticed a discernible effect on their power quality.

References

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Samuelson, W. and Zeckhauser R. (1988). Status quo bias in decision making. Journal of Risk and Uncertainty 1: 7-59.