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Bringing energy to your door

The future

The Value of Lost Load (VoLL)

Phase Two: Refining the Approach

Pilot Survey – key findings report

30 November 2016

CONTENTS

VERSION HISTORY

Version	Date	Author	Status	Comments
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APPROVAL

Name	Role	Date
Steve Cox	Engineering and Technical Director	30 November 2016
Paul Turner	Innovation Delivery Manager	30 November 2016

GLOSSARY

Abbreviation	Term
CE	Choice experiment
DECC	Department of Energy and Climate Change
DNO	Distribution network operator
ECP	Engaged customer panel
EHP	Electric heat pump
EV	Electric vehicle
GB	Great Britain
IDNO	Independent distribution network operator
LCT	Low carbon technology
NIA	Network Innovation Allowance
Ofgem	Office of Gas and Electricity Markets
PV	Photovoltaic
RIIO-ED1	Electricity distribution price control 2015 to 2023
SME	Small to medium enterprise
VoLL	Value of Lost Load
WTA	Willingness to accept
WTP	Willingness to pay

FOREWORD

The Value of Lost Load (VoLL) project is investigating whether a single uniform VoLL, applied to all customer segments, remains appropriate as Great Britain (GB) moves towards an economy increasingly reliant on electricity, driven by a decarbonisation agenda. It involves extensive customer research which builds on previous studies in this area to determine whether a revised VoLL model would benefit customers.

The project is funded by the Network Innovation Allowance (NIA), introduced as part of the RIIO-ED1 price control, which provides an allowance for RIIO network licensees to fund projects that have the potential to improve network operation and maintenance, and to deliver financial benefits to the licensee and its customers.

The project commenced in October 2015 and will be conducted over a 28-month period. It will culminate in a comprehensive assessment of how VoLL should be defined across a range of customer segments and ultimately inform a potential revised model to help distribution network operators (DNOs) better plan their network investment and customer strategies.

This report and the analysis therein is one of a series of project dissemination documents, which will supplement the final VoLL conclusions and recommendations report, due to be published in January 2018.

This document references the learning from phase 2 of the project, specifically a pilot of the quantitative survey instrument that will be utilised in phase 3, to measure customers' willingness to make or accept a payment for changes in reliability of service. The pilot was conducted with a statistically robust and previously unengaged audience of domestic customers and representatives of small to medium enterprises (SMEs).

This report should be considered in conjunction with the key findings from a strategic piece of qualitative research carried out with an engaged customer panel (ECP) and the peer review of the survey instrument. The development of the pilot survey instrument was informed by qualitative research conducted with the ECP and through depth interviews with a cross-section of customers and stakeholders likely to be in contact with, or involved in supporting, customers during a supply interruption.

The overall research approach was derived from the VoLL Methodology Statement, which was designed by Electricity North West and its market research provider, Impact Research. The approach was also shaped following consultation with two key stakeholders: Citizens Advice and the former Department of Energy and Climate Change (DECC), now the Department for Business, Energy and Industrial Strategy (BEIS). The Methodology Statement and all associated documents are published on the VoLL webpage.

1 EXECUTIVE SUMMARY

1.1 Introduction

This report disseminates the results and learning associated with a pilot of the quantitative survey instrument, prior to a wider rollout across GB. This approach is a direct learning from previous customer engagement projects and ensures that the final survey instrument and supporting materials are correctly understood by the research participants and hence will allow accurate and relevant data to be obtained to enable the project's research objectives.

The quantitative research findings and lessons learned are documented below.

Details of the methodology used to administer the pilot survey are set out in the VoLL Methodology Statement (version 2), which also comprehensively explains the background of the VoLL project and the analysis protocols utilised.

1.2 Summary of key findings

How do customers measure and value lost load?

VoLL is a metric which characterises supply reliability (a function of the frequency, duration, time, season and notice of supply interruptions) and affordability of hypothetical financial penalties.

Analysis of the pilot survey confirms that the existing single value of VoLL, applied to all customer segments, fails to adequately reflect the significant variation that exists in both the financial and social impact of supply interruptions across the full spectrum of customers.

What is the financial impact in £ per MWh?

Initial research obtained during the pilot shows that domestic customers' willingness to pay (WTP) to avoid loss of supply is approximately £1,700 per MWh and the equivalent measurement for SMEs is £11,000.

Customer's willingness to accept (WTA) compensation for lost load is much higher than the comparable WTP figure for both domestic (£2,800) and SME (£30,000) segments.

The higher WTA value was anticipated and reflects previous studies. When consumers are used to enjoying a service for which they pay, they typically expect a greater payment to bear the loss of that service than they are willing to pay to retain it. This is an important point and illustrates that customers are generally far less willing to accept a decrease in supply reliability than pay for an improvement.

How will VoLL change in the future?

The pilot survey results clearly demonstrate that respondents are generally unable to imagine a future scenario involving greater dependency on electricity. However, irrespective of the challenges of projective research techniques, which encourage customers to focus on their changing future needs; the electricity industry accepts that there will be fundamental changes in customer behaviour, associated with the widespread adoption of low carbon technologies (LCTs). This will significantly change current estimates of VoLL and a key objective of this study is to investigate the likely changes and the impact of VoLL assignment to ensure that future policy is driven by evolving customer needs.

An alternate and correlating method of reliably determining a future VoLL can be achieved by comparing the VoLL of current adopters of LCTs with that of non-users of LCTs ie focusing on those customers already in the future scenario.

The WTA value for domestic customers using LCTs is shown to be four times higher than the average for non-users. This again is a very significant finding in determining future network investment needs and standards driven by VoLL.

This is also a significant finding given the projected increase in LCT adoption and hence, increased customer dependency on electricity. This is likely to be a critical factor influencing future VoLL, which consequently, will have a significant impact on DNOs' long-term investment strategies.

How does VoLL vary by customer segment?

There were substantially different assignments of VoLL across the broad customer spectrum sampled, which were influenced by socio-economic, demographic, geographic, attitudinal,

behavioural and event-based factors. For example, younger customers, those in rural locations and those with higher incomes had a relatively high VoLL. Respondents who reported being severely impacted by previous supply interruptions had a VoLL assignment which was below the average.

How can DNOs mitigate the cost of lost load to customers?

VoLL can be reduced by a reduction in the number of supply interruptions and their duration but notably, it can be reduced significantly through proactive communication strategies and the offer of support, particularly for customer segments that are vulnerable during supply interruptions.

One of the most influential support components is a simple telephone call, made directly to affected customers' mobiles or landlines, to provide proactive information about the interruption.

Survey instrument and research methodology

As a result of the pilot, the following refinements were made to the survey instrument to increase its effectiveness and enhance the associated research methodology:

- Elements of the stated preference choice experiment (CE) were simplified
- The volume of educational material included in the survey instrument was reduced
- The layout and formatting were improved
- Modifications were made to obtain respondents' addresses, to help identify supply and consumption information, if they were unable to provide MPAN details from their bills
- Adjustments were made to processes for recruiting early adopters of LCTs.

1.3 Next steps

The quantitative surveys, which represent a significant proportion of the customer engagement activity associated with the VoLL project, will commence with a winter season survey during December 2016 and January 2017. This will conclude with a summer season survey in August 2017.

A total of 6,000 surveys will be completed by customers from across the whole of GB; 3,000 of which will involve domestic and SME customers from within Electricity North West's operating region. 5,000 of the interviews will be conducted with domestic customers and 1,000 will comprise a broad sample of SME customers.

The ECP will be reconvened after completion of the survey analysis, to review and evaluate the research findings.

There will be ongoing knowledge sharing and dissemination as the project progresses.

2 PEER REVIEW OF THE SURVEY INSTRUMENT

Professor Ken Willis, Emeritus Professor of Environmental Economics at Newcastle University, conducted a peer review of the pilot survey instrument and this report is published on the VoLL webpage. The purpose of the peer review was to assess the suitability of the VoLL customer survey instrument.

2.1 Summary of Professor Ken Willis' key findings

The questionnaire developed by Impact Research is an admirable and rigorous tool to estimate VoLL across different segments of customers.

The questionnaire provides sufficient information for customers to enable them to provide accurate and reliable answers to questions. The combination of factual and attitudinal questions allows the respondent to fully consider the issues before answering the stated preference CE questions.

The stated preference CE question sets, proposed by Impact Research, will allow estimates of WTP to be made for variations in frequency, duration, notification and timing of supply interruptions. There are some minor issues, related to screening and presentation of the CE cards, which Impact Research might consider in the application of the CE, and in the analysis of the data.

The research methodology and analysis proposed by Impact Research to estimate VoLL, based on the future needs of customers, is a practical and effective way of investigating whether a single uniform VoLL, applied to all customer segments, remains appropriate, as GB moves towards an economy increasingly reliant on electricity. The questionnaire is comprehensive and rigorous in its approach to trying to derive accurate information from customers, and customers' preferences for electricity supply characteristics.

2.2 Modifications to the planned approach

Based on the recommendations of the peer review, Electricity North West implemented minor refinements to the survey instrument to facilitate better customer understanding and more robust data acquisition.

Additional screening questions were incorporated to ensure that respondents met certain suitability criteria. These included a prerequisite to either jointly or solely pay the utility bills of their household or, in the case of SME representatives, have an appropriate level of responsibility for the financial decisions made by their organisation.

A commitment was also made to review the data collected during the pilot exercise to evaluate two primary methodological concerns:

- The balance achieved between show card information being sufficient to provide customers with accurate information on which to base their choices, whilst avoiding excessive and unnecessary detail, which might overwhelm and disengage respondents
- The validity of three groups representing low, medium and high energy usage among domestic customers.

Commentary on these concerns and other key findings from the pilot survey are included in Section 4 of this document.

3 ANALYSIS AND RESULTS

This section of the report details the analysis and results of 930 surveys administered during the pilot.

The development of the pilot survey instrument was informed by qualitative research conducted with an ECP and through depth interviews with a cross-section of customers and also with stakeholders likely to be in contact with, or involved in supporting, customers during a supply interruption. This phase of engagement affirmed the key characteristics of supply interruptions, core to the measurement of VoLL, which had formed the basis of previous studies. The exercise also identified additional characteristics likely to influence or mitigate VoLL. This phase of engagement was instrumental in guiding the design of a robust, quantitative customer survey and specifically, the stated preference CE.

The CE involved asking customers to trade off different levels of supply reliability and possible support mechanisms available during an interruption, in exchange for a hypothetical

financial incentive or penalty. Nine service attributes were included in the CE as a direct result of the consultation with customers and stakeholders. These attributes are documented in the ECP report, which is available on the VoLL webpage, and will be referenced fully in the final survey report, due to be published in January 2018. For parity of approach with previous studies, VoLL was measured both in terms of customers' WTA compensation for lost load and WTP for avoidance of lost load.

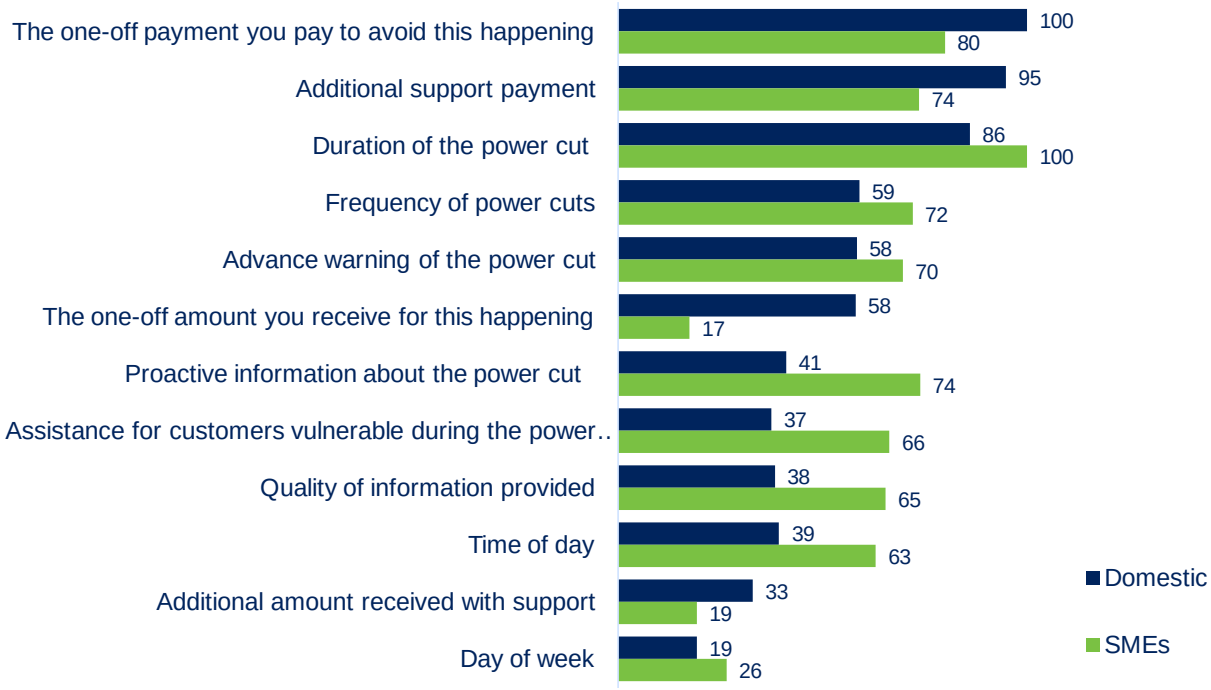
The analysis utilises a fixed baseline scenario of a supply interruption lasting one hour and occurring at peak time, which is consistent with that applied by London Economics in 2013. This baseline is considered appropriate as it is founded on an assessment of electricity demand profiles produced by DECC which are suitable for the conversion of WTA estimates into VoLL in £/MWh. The data referenced herein is weighted to ensure it is representative of the demographic (gender, age and affluence) and geographic (urban and rural) profile of customers in GB.

3.1 How do customers measure and value lost load?

Statistical models were utilised to examine respondents' decision-making processes and quantify the influence of each attribute on their choice between a pair of scenarios in the CE. This produced a measure of the value placed by customers on each attribute. The ratio of each non-monetary attribute relative to the monetary attribute indicates an inferred WTP or WTA value.

In Figure 3.1 the attributes are rank ordered from most important to least important and values are indexed such that 100 represents the most important attribute in determining VoLL.

Figure 3.1: Relative importance of attributes appraised in the CE



The need for a segmented VoLL is illustrated in this high level analysis by simply comparing the responses between domestic and SME customers. The results demonstrate a greater sensitivity in the domestic sample to any form of financial incentive or penalty than the SME respondents ('The one-off payment you pay to avoid this happening', 'Additional support payment' and 'The one-off amount you receive for this happening'). For domestic customers, the attribute 'The one-off payment you pay to avoid this happening' is more than five times as

influential in driving decision-making, as the day of the week in which the supply interruption occurs.

It is also evident that proactive information, given about a supply interruption, is statistically more important to SMEs in mitigating any associated impact, when compared with domestic customers. This supports the proposition that customers are affected by supply interruptions in different ways and validates the approach taken of asking respondents to trade off additional support components in exchange for a hypothetical financial incentive or penalty.

However, a commonality between the domestic and SME segments is the relative importance placed on the duration of the supply interruption, supporting the key findings of the ECP, who considered this to be a critical component in the definition of supply reliability. It is notable that the duration of a supply interruption holds considerably more importance than the day of the week or the time of day on which it occurs.

3.2 What is the financial impact of supply interruptions in £ per MWh?

A conditional logistic regression econometric estimation method[1] was utilised to convert the CE results into £/MWh VoLL figures and confidence intervals. The WTA measurement of VoLL produced a much larger estimate than the comparable WTP for domestic and SME segments (see Figure 3.2).

Figure 3.2: VoLL in £/MWh among domestic and SME segments

VoLL measure	Domestic	SMEs
Willingness to pay (£/MWh)	£1,700	£11,000
Willingness to accept (£/MWh)	£2,800	£30,000

The higher WTA value was anticipated, as when consumers are used to enjoying a service for which they pay, they typically expect a greater payment to bear a loss of that service than they are willing to pay to retain it. This is because individuals feel a sense of ownership for something they already have (in this case a reliable electricity supply). For this noted 'ownership' effect, using the WTA estimates is most appropriate in the context of valuing security of supply for electricity; the WTA indicates consumers' inconvenience value if the reliable service they already enjoy is interrupted.

Psychologically, the loss from giving something up feels greater than the gain from retaining it and avoiding the loss, and thus WTA is generally empirically greater than WTP. These constructs have been studied for roughly 30 years within a wide variety of goods and services[2]. Research has concluded that the less the good is like an 'ordinary market good', the higher the ratio of WTA relative to WTP. A similar effect can be observed in insurance and travel sectors. In the latter case, the amount of money consumers are willing to pay for their travel ticket is substantially lower than the compensation expected when that service is disrupted or temporarily withdrawn.

The degree of 'consumer impact' that a supply interruption causes is the most important factor in reflecting differences in the WTA estimates observed in the pilot survey results.

[1] The conditional logit model is a standard limited dependent variable estimation method and is a well- known method for choice experiment modelling

[2] Department of Agricultural and Resource Economics, University of Maryland, 2002. A Review of WTA / WTP Studies

The WTP value cited in Figure 3.2 for domestic customers is comparable to that reported by London Economics in 2013[3] (£2,000). However, the one-off payment expected by customers (WTA value) is significantly lower than in the London Economics study (£12,000). This is believed to be a reflection of the difference in the frequency of interruptions for the WTA questions, set in this research as once every three years, compared with once every 12 years in the London Economics study. These findings appear counter intuitive, indicating the expectation of a smaller payment to accept a greater frequency of interruptions. Both studies introduced the WTA CE questions as a 'one off' payment that respondents would be prepared to accept in compensation for a supply interruption; however, each explained the baseline in quite different ways. The London Economics '1 in 12' frequency estimate was based on Ofgem's 2012 capacity assessment, which estimated that in 2015/16 the expectation of customer disconnections would be around once in 12 years. As such, this perception measure is not directly comparable to the actual customer interruptions[4] and customer minutes lost [5] data referenced in this study. The deviation from the approach of London Economics was made to optimise the research, by more accurately reflecting average industry service performance for supply reliability and availability.

3.3 How will VoLL change in the future?

Although the same stated preference CE method was used to derive VoLL across the full spectrum of survey participants, the robust size of the pilot sample afforded the opportunity to ask half the respondents to make their choices in the context of a future scenario, where they would be more dependent on electricity, framed specifically around the use of one of three LCTs:

- An electric vehicle (EV)
- A photovoltaic (PV) system
- An electric heat pump (EHP).

The remaining respondents were not furnished with LCT information and therefore, made choices relative to their actual experience. This approach was designed to elicit a realistic estimation of the potential future shift in VoLL in a low carbon future. Pilot responses were analysed to assess customers' ability to imagine the future scenario with sufficient clarity.

Initial analysis demonstrated that for domestic customers, there were on average, no significant statistical differences between the WTP and WTA estimates for current and imaginary future scenarios. These results suggest that respondents are generally, *unable* to imagine the greater dependency on electricity that is likely to exist in the future.

More detailed analysis revealed some differences depending on the specific type of future LCT context considered. Those imagining a future with greater usage of EHPs as a primary heating source had the lowest WTP and highest damage function (the multiple of this segment's WTA compared with the average for domestic or SME customers).

Investigation into the potential variation of VoLL, in relation to LCT adoption, was not confined solely to comparisons of results for the current and imagined future contexts. Stratified random sampling was utilised to ensure that a cross-section of current LCT users were included in the survey population. VoLL for these existing adopters was compared with the VoLL assignment of non-users of LCTs; additionally, VoLL for high users of electricity was compared with VoLL for low users. The potential change in VoLL associated with

[3] London Economics, 2013. The Value of Lost Load (VoLL) for Electricity in Great Britain, Final Report for Ofgem and DECC.

[4] The total number of individual interruptions that an average group of 100 customers suffers in a year

[5] The average number of minutes that a customer will be off supply in a year

increased LCT adoption, and consequently higher future electricity consumption, can be reliably inferred from both of these comparisons.

As shown in Figure 3.3, current domestic users of LCTs have a much higher WTA than the average for all domestic customers. Within the general segment of current LCT adopters, the PV-only users' WTA is twice the average than that of all domestic customers.

Respondents who are currently relatively high consumers of electricity also have twice the WTA compared with the average for all domestic customers. The implication of this finding is that current behaviour is a more reliable proxy than an imaginary scenario for measuring VoLL in the context of an LCT-dependant future.

This approach has the advantage of using values that are derived from actual experience, but it assumes that future adopters will have the same values as current LCT users, which requires further investigation and verification. This is an important consideration given the anticipated increase in LCT adoption and hence, customers' greater dependency on electricity. This will be a critical factor influencing future VoLL and consequently, will have significant implications for DNOs' long-term investment strategies.

Figure 3.3: WTA in £/MWh based on current behaviour of domestic customers

Customer segment	WTA £/MWh	Damage function *(multiple of average domestic WTA)*
All domestic customers	£2,800	x 1.0
Current domestic LCT[6] users	£6,050	x 2.2
Current domestic PV users	£5,500	x 2.0
Current domestic high usage[7] of electricity	£5,560	x 2.0

3.4 How does VoLL vary by customer segment?

Prior to undertaking the analysis, there were no presuppositions about how VoLL might be segmented or how this information could be utilised by DNOs.

VoLL was initially analysed by means of a high level and simplistic domestic and SME classification and then segmented at a more granular level by key demographic, socio-economic, geographic, attitudinal, behavioural and event-based information collected during the survey.

Early indications (see Figure 3.4) are that VoLL assignment differs across various customer segments; for example, younger customers, those in rural locations, those from households that are off the gas grid and individuals with higher incomes have a relatively high WTA compared with the average of £2,800/MWh. However, respondents that had been severely impacted by a supply interruption have a low WTA. The full customer survey will include qualitative questions intended to elicit the reasons for participants' choices.

[6] LCT users own and/or operate EVs, PV systems or EHPs.

[7] An average 'low user' is defined in terms of energy usage of 2,000 kWh of electricity a year. An average 'medium user' is defined as using 3,100 kWh of electricity a year. An average 'high user' is defined as using 4,600 kWh of electricity a year.

Figure 3.4: WTA in £/MWh among specific domestic customer segments

Domestic segment	WTA £/MWh
Affluent[8]	£5,253
Off-gas[9]	£4,111
Rural[10]	£3,946
Young[11]	£3,174
Previously severely impacted by supply interruptions	£672

The research methodology was designed to analyse VoLL at a much more granular level than in previous studies, by taking account of more detailed customer information. The objective of achieving an enhanced and segmented understanding of VoLL will allow DNOs to consider their investment strategies in a more informed and targeted manner, driven by customer need.

By employing stratified sampling techniques, VoLL was analysed in even greater granularity by assessing the variation in value assignment associated with:

- The extent of the financial and social impact of previous supply interruptions on customers
- Levels of satisfaction with the service provided by DNOs
- Attitudes currently held by customers about what DNOs' future investment priorities should be.

The data indicates that dissatisfied customers and/or those who perceived that the most recent unplanned supply interruption that affected their home or organisation had a large or very large impact, have a substantially reduced WTA. The 'ownership effect' described in Section 3.2 is likely to be much lower for these consumers, who expect a proportionally smaller payment to bear the loss of a service that they are not benefitting from as much as others. For example, customers who state that a power cut has or is likely to have only a limited impact on their home or business generally have a high WTA because they tend to regard their supply as reliable. However, where the impact has been high, or is likely to be high, customers report the lowest WTA. This is typically because they have less to lose and already feel a deeper sense of inconvenience. The WTP values attributed by these customers are also low because of a belief that they already pay enough for what should be a more reliable service and consequently have little appetite to pay more. Analysis of the main survey will test the elasticity of this relationship.

There is also evidence to support a substantially reduced WTP among customers who consider that the priority for DNOs should be to keep customer bills constant and maintain the current level of supply reliability.

[8] Social grade category AB: a socio-economic classification produced by the ONS (Office for National Statistics) where AB represents higher and intermediate managerial, administrative and professional occupations.

[9] Properties that are off the gas grid, ie do not have a mains gas supply

[10] 2011 Rural-Urban Classification of Local Authority Districts and other higher level geographies

[11] 18-29 years old

3.5 How can DNOs mitigate the cost of lost load to customers?

In addition to the core set of supply interruption attributes included in the CE, a secondary CE was incorporated to evaluate mechanisms by which VoLL could potentially be reduced through a range of communication and customer support strategies, deployed during supply interruptions. These were:

- Level of additional assistance available for vulnerable customers
- Communication channels via which information about the supply interruption can be proactively given
- Quality of information provided.

Analysis was conducted to identify the relative importance of specific types of additional support. The analysis in Figure 3.5 demonstrates the degree to which support components mitigate the loss of supply based on the industry's key availability measure of service performance, measured in customer minutes lost.

Figure 3.5 illustrates that *targeted* customer communications, such as telephone calls made directly to domestic customers, are more than twice as important in mitigating the impact of a supply interruption as updates through social media.

In the case of proactive telephone calls, the analysis suggests that these can directly mitigate the loss of supply for up to 83 minutes. The implication is that offering support to customers could provide an economically efficient means of reducing the impact of lost supply and consequently, positively influence VoLL.

Figure 3.5: Importance of support components relative to the least important (social media) in mitigating the impact of a supply interruption lasting one hour and occurring at peak time

Support component appraised by domestic customers	Relative importance of each component	Mitigated time (h:min)
Phone call(s) made directly to mobile or landline	x 2.7	01:23
Accurate information about when the power is expected to be restored	x 2.4	01:14
Short message service (SMS) to mobile phone	x 2.4	01:16
Automated text-to-speech message (to landline phone)	x 2.3	01:10
A justified reason for the power cut	x 2.1	01:04
A welfare pack to help cope with the power cut	x 2.1	01:05
A mobile catering van to provide hot food and drinks	x 2.1	01:05
Confirmation that electricity is back on	x 2.0	01:02
Advice about what to do during a power cut	x 2.0	01:02
A mobile unit allowing customers to charge mobile phones etc	x 1.7	00:52

Support component appraised by domestic customers	Relative importance of each component	Mitigated time (h:min)
Nominated friend, family member or colleague who can be sent updates instead of, or in addition to those directly affected	x 1.7	00:53
Home visits to offer help and advice	x 1.5	00:47
Public address/tannoy system	x 1.4	00:44
Social media (Twitter, Facebook etc)	x 1.0	00:31

The variability of VoLL is significant and hence it is likely that application of a specific VoLL, determined by customer population analysis, will enable DNOs to produce much more customer-focused investment decisions. It also shows that such decisions should encompass damage mitigation measures as well as traditional asset interventions.

4 KEY FINDINGS

The pilot survey, conducted in line with the VoLL methodology, constituted a critical part of the review and endorsement of the proposed instrument. The pilot was extremely valuable in providing clear and objective feedback, which will guide refinements to the instrument, optimising data capture and results.

The key findings of this piece of customer engagement are presented below through a number of insights and associated actions taken as a result of the engagement.

4.1 Simplification of the stated preference CE

The primary area of focus in the critical evaluation of the pilot was the suitability of the stated preference CE method for measuring VoLL.

Insight

The CE model was developed to allow the linear and non-linear effects of the attributes on customers' choices to be evaluated. The predictive ability (goodness-of-fit) of the model was assessed through an R-squared term. The model generated a relatively strong fit (R-squared of 0.90) compared to that reported by London Economics in its 2013 study (R-squared of 0.34)[12]. The implications of this finding are that the approach adopted in the pilot is more robust statistically in its own right as a measurement of VoLL, and that comparison of its results with those of the London Economic study are valid.

The suitability of the stated preference exercise was also gauged through customers' ability to make choices. This was measured in terms of the proportion of trade-offs in which they were unable to make a choice (selected 'don't know') and their own overall assessment of the level of difficulty involved in making choices, determined from a traditional research rating scale.

[12] London Economics, 2013. The Value of Lost Load (VoLL) for Electricity in Great Britain, Final Report for OFGEM and DECC, p140

The ‘don’t know’ choice available to customers was selected in response to fewer than 10% of the scenarios and presented little concern. When questioned, respondents suggested that the main driver for selecting ‘don’t know’ was ‘not liking either option presented’ rather than ‘being shown too many options’ or ‘having insufficient information to make an informed decision’.

The ‘difficulty’ self-assessment measure indicated that 50% of survey participants found it ‘easy’ to make a choice between the two options, 20% found it neither easy nor hard and 30% assessed the task as ‘difficult’. Normative survey experience data held by Impact Research suggests that this level of difficulty is typical for similar exercises.

While the exercise in its pilot format was appropriately challenging, simplifying the presentation of information could further improve the quality of the data collected by assisting participants in making informed decisions more easily. Therefore, a set of actions is recommended to simplify the exercise without compromising the quality of the research outcomes.

Actions

Subject to confirmation in a full scale survey, the data collected in the pilot indicates that customers are substantially more tolerant of planned than unplanned supply interruptions. While the measurement of VoLL in planned scenarios is important, more robust results could be achieved by splitting the CE to assess planned and unplanned interruptions independently, placing greater emphasis (and survey numbers) on the unplanned interruptions. The survey instrument and sample design was therefore amended to ensure that:

- Respondents trade off only planned or unplanned scenarios during an interview
- Service attributes and the associated levels, specific to planned interruptions, are only ever evaluated alongside other planned attributes and levels within a pair of CE scenarios. The same principle applies to questions that relate to unplanned interruptions.

Analysis of the duration and cost attributes found that the levels appraised are relatively linear, suggesting that the range tested could be reduced. The appropriateness of a linear functional form is not surprising given that the presented outage durations do not span weeks or months. Intuitively, it is reasonable to suggest that over a wide range of durations, adaptations or other changes, the impact of outages does not change linearly with time. For example, food in a refrigerator could theoretically start to spoil as a result of an interruption lasting over five to six hours. However, if an outage extends over several days, the consumer is likely to adapt and purchase food supplies not in need of refrigeration. Typically, estimating models with fewer variables is favourable in cases where additional variables do not improve the performance of the model. The survey instrument was therefore amended so that:

- The number of levels tested for duration of the supply interruption is reduced from seven to five
- The number of levels tested for the one-off amount paid or received is reduced from seven to five.

It is also recommended that the introductory text which prompts participants to make a trade-off is optimised through improved wording and formatting to highlight more clearly whether the individual is being asked to consider *making* or *receiving* a payment.

The CE design adopted in the pilot scaled the WTP and WTA findings to the London Economics study against common attributes and associated levels of duration of outage, time of day and day of the week. In doing so, participants were asked to trade off a range of different times that an unplanned interruption may occur, over which in reality, neither the customer nor the DNO have any control. Therefore, having completed comparisons to previous studies, a justifiable departure from the original method was implemented to

achieve a more robust measure of VoLL, assessed against the most disruptive period for an outage, specific to individual respondents, meaning:

- The time of day and day of the week is fixed throughout the scenarios. This will involve asking each participant to respond to the CE based on the time of day and day of the week when an outage would have the greatest negative impact on them and their household/business. This period will be captured in questions prior to the CE, thereby allowing supply interruption scenarios in the CE to be presented in the context of the worst possible time for the individual.

It is anticipated that this approach will make it easier for customers to consider the full range of variables being presented, ultimately providing a more robust and credible measurement of VoLL.

Section 3.3 concluded that customers are unable to clearly imagine and realistically understand the future implications of LCTs, rendering current behaviour a more dependable proxy for measuring future VoLL. The implication is that:

- There will be no requirement for any participant to imagine a specific LCT future where they rely much more on electricity.

The process of responding to the CE scenarios will therefore be simplified considerably, further enhancing the credibility of the data collected.

Another important criterion was the degree of realism presented in the CE scenarios. The nature of the stated preference technique is such that all potential combinations of service attributes and levels are presented to participants in the various scenario pairings. In the absence of prohibitions preventing specific combinations of attributes and levels appearing together, some of the paired scenarios were construed to be confusing, unrealistic or questioned as being too obvious a choice. To mitigate inappropriate pairings of the CE variables, a further review of all potential service attribute and level combinations was conducted. Consequently, the survey instrument was amended so that:

- When no proactive information about the supply interruption is offered to participants in a trade-off scenario, the default level for the attribute 'quality of information provided' is set at 'none' and the associated cost for additional support is also set to 'none'
- The range of assistance for vulnerable customers during a supply interruption is tailored dependent on the length of the supply interruption. For instance, a generator to provide a partial supply for essential medical equipment, appliances and lights will only be presented in scenarios where the duration of the outage is six hours or over, which more accurately reflects the DNO's response criteria for this type of support.

4.2 Reduction in the breadth and depth of educational communication materials

Insight

Because of the complex nature of the study, it is unavoidably comprehensive. However, it was intended that the pilot questionnaire should take no more than 30 minutes to complete, ensuring the exercise was not too onerous and thus able to maximise potential participation.

A significant amount of briefing material was embedded into the survey to provide respondents with an appropriate level of education, and to assist in the acquisition of customer data from respondents outside Electricity North West's operating area, which is otherwise unavailable to the DNO. This information included, but was not limited to:

- A description of the different types of companies and organisations involved in supplying electricity in GB
- A description of the different types of electricity meters fitted in household and commercial premises

- Background information regarding how supply interruptions occur
- Explanatory information about the importance of the market research being conducted and how it may be utilised in the future
- Instructions on how to interpret and respond to the hypothetical CE trade-offs
- A reminder that participants should consider the implication of a change in bills on their overall household or business expenses
- Explanatory information to support participants in thinking about a future scenario where there is greater usage of electricity.

The pilot survey was timed before being launched and on the basis of multiple tests, it was anticipated that, on average, it would take approximately 25-30 minutes for a participant to thoroughly read all of the questions and educational material and respond diligently.

In reality, the median duration to complete the pilot survey was 19 minutes and the first quartile was 14 minutes.

Actions

Initially, the analysis data file was sorted from quickest to slowest response time and the first quartile of responses was discounted because of concerns that these participants may not have paid sufficient attention in reading and understanding the full suite of survey materials. Analysis was subsequently conducted to compare the discounted responses with those from the core survey population that had taken longer to complete the exercise.

It was concluded that retaining the first quartile of the data set would not adversely affect the reliability of the VoLL model. The implication of this finding is that participants were able to complete the survey accurately without reading, or by skim-reading a significant proportion of the embedded educational material.

As a result of this learning, a further review of the supplementary materials was conducted and consequently, the embedded information will be reduced to:

- A description of the different organisations involved in supplying electricity in GB
- Instructions about how to interpret and respond to the hypothetical CE trade-offs.

Reassuringly, when questioned about information that might have been helpful in completing the survey, only 3% of respondents considered there was a requirement for additional information. This result is not expected to change significantly when the survey is re-launched with fewer educational materials. However, to be confident that reducing supplementary information does not compromise the survey, a small pilot exercise will test the refined instrument before it is administered on a larger scale.

To ensure that pertinent information is accessible to respondents but does not overwhelm them, it is proposed that selected reading material and visual stimuli will be embedded in the survey script in a number of pop-up hyperlinks. This means that all information that a respondent might require is available as an optional, rather than an implied mandatory, reading requirement. This modification will have the additional benefits of reducing the length of the survey and will improve its aesthetic.

4.3 Clarity over the survey length

Insight

While timed survey tests conducted before the pilot predicted completion times in the region of 25-30 minutes, the median was 19 minutes across the full spectrum of respondents. The actions proposed in Sections 4.1 and 4.2 make provision for a significantly simplified survey instrument, which is likely to reduce the anticipated completion time to 15-20 minutes.

Actions

The incentivisation strategy was revised to take into account not only the reduced survey length, but also the increased effort required in the pilot to recruit SMEs, relative to domestic customers. This was attributable to domestic customers being generally easier to reach than SME customers, and more specifically, the difficulties encountered in trying to engage suitable representatives within organisations who were willing to commit the time to participate, in exchange for the available incentive.

In light of these two factors:

- Recruitment materials were updated to reflect the change in survey length
- The incentive for domestic customers was reduced from £15 to £10
- The incentive for SME customers was increased from £15 to £20.

4.4 Refinement of the survey administration approach

Insight

The pilot customer survey was conducted via a combination of the following three platforms:

- An online panel of respondents, pre-registered and open to research of this kind
- Over the telephone
- Face-to-face with the assistance of a professional interviewer.

Of the pilot surveys completed, 58% were conducted online, 38% were face-to-face and 4% were administered over the telephone. This distribution not only reflects customers' preferences but demonstrates the technical difficulty in administering a relatively complex survey over the telephone, supplemented with significant stimulus materials.

Actions

Revisions to make the survey instrument more concise are likely to improve the level of engagement and reduce the time taken to complete it. The enhancements may also overcome some of the difficulties encountered in conducting the survey over the telephone. To ensure optimal accessibility, administration by telephone will be offered during the main survey, but only where it is considered appropriate to the participant. However, it is proposed that engagement by telephone is utilised primarily as a recruitment method for the online survey. This approach also has the benefit of enabling interviewers to provide instructions to participants before they access the online survey.

4.5 Requirement to optimise the survey instrument's layout

Insight

Only 2% of the pilot population experienced any form of technical difficulty during the survey. However, anecdotal feedback regarding general aesthetics of the survey and the overall user experience necessitated a review of the structure and manner in which some questions were asked, and how information was presented.

Actions

The survey generally, and the CE specifically, was considered to be aesthetically poor and disengaging. The inherent risk that this poses is that trade-off instructions are not read properly and that the exercise is therefore not fully understood. In light of this feedback a review of the survey experience was conducted and the following changes made:

- The form of words used to describe the various attributes and levels in the CE has been simplified for clarity and to highlight whether the trade-offs presented relate to

hypothetical financial *incentives* or *penalties*. In addition, bold and italic text has been utilised to emphasise key words
- Colour shading has been implemented to differentiate the WTA and WTP scenarios, helping respondents to distinguish the type of payment being presented
- A progress bar has been added, providing participants' with a visual aid to indicate advancement and set expectations about the volume of remaining questions
- Superfluous explanatory text has been removed and most supplementary material will appear behind optional pop-up hyperlinks, allowing participants the choice of actively selecting information that might assist them in answering specific questions
- The survey template has been optimised and aesthetically improved by including greater use of colour in its design
- Where possible, multiple related questions are scripted on the same screen, when this does not introduce excessive scrolling.

Some participants expressed a desire to move backwards during the survey to change an answer they had previously given. Due to the technical complexity of the script embedded in the survey, it is not possible to provide this functionality without compromising the quality of the data collected. However, in the interests of transparency, further guidance will be added to the survey which explains that a back option is unavailable.

4.6 Mitigation required for data that customers are either unable or unwilling to provide

Insight

The survey design aimed to ensure that the segmented VoLL matrix aligns value assignments with standard industry data, to ensure that the template is applicable across GB. Data alignment can be achieved for customers within Electricity North West's operating region. However, half the surveys will be conducted with customers outside North West England, served by other DNOs. The rationale of this approach is to validate transferability of the VoLL matrix and assess regional differences. Access to the data of customers served by other DNOs is more problematic because of data protection issues and as such, the survey design needs to elicit supply and consumption information from 'out of area' customers, based on their responses to the question set.

The original research methodology proposed adopting Ofgem's published typical domestic consumption values to classify low, medium and high users of electricity among domestic customers. It was proposed that SME customers' usage classification would be based on consumption data from their bill, with these respondents encouraged to refer to recent bills to promote response accuracy.

Analysis of the pilot survey identified that 47% of domestic respondents retrieved their electricity bill to assist in completing the survey (43% of which were administered online and 50% face-to-face). In the SME sample, 60% of respondents had their bill available. In total, 10% of all participants were unable to specify their typical spend on electricity consumption. Additionally, the estimate of customers responding without bills is likely to have been inflated on the basis of recognised cognitive bias, which infers a tendency to over rather than under estimate personal outlay.

The amount of missing data was compounded by only 60% of SMEs knowing their electricity meter profile class, 31% knowing their maximum export capacity (MEC) and only 13% knowing their maximum import capacity (MIC).

Missing or incomplete data is likely to compromise the accuracy of the VoLL model and prevent more comprehensive analysis; therefore, it is important that all practicable steps are taken to improve the quality of the supply and consumption data captured. Any enhancement to the model, which enables it to draw on data typically already held by DNOs, will improve transferability of learning across operators of GB electricity networks.

Actions

A mandatory requirement for participants to have a recent electricity bill available during the survey would significantly assist in the acquisition of standard DNO data that can be obtained via the respondent's meter point administration number[13] (MPAN). This provides the ability to access accurate supply and consumption information from other internal data sources. However, making this a mandatory requirement poses a significant risk of constraining the number of potential respondents willing or able to take part in the customer survey.

To mitigate missing or incomplete data, modifications will be made to the instrument to obtain respondents' addresses, to facilitate identification of their MPAN. Consent will also be obtained to use this information to access associated supply and technical data, including supply profile classifications and settlement codes; and for customers of Electricity North West, associated maximum import capacity (MIC) data. The ability to consensually match responses with standard industry held data will allow accurate assumptions to be made about VoLL in relation to supply type and broad electricity consumption parameters.

Maximum demand or half hourly metering has not historically been a requirement for commercial supplies under 60kVA. Therefore, for three-phase supplies, where the MIC is unspecified, it is proposed that a supply capacity of 60kVA will be assumed. Similarly, single phase commercial supplies will be assumed to have a capacity of 20kVA. Customers will be asked to provide general information about their supply and patterns of consumption. However, where consent is obtained to match customer data to technical records from industry databases, a more accurate assessment of actual consumption may be achieved. This will facilitate more precise categorisation of high, medium and low usage and by association, assumptions about dependency on availability of supply. The intention of this approach is to extrapolate the responses from SME customers operating businesses in Electricity North West's distribution region, to represent an aggregated profile for GB.

Previous innovation projects have consistently demonstrated that most customers struggle to differentiate the unique responsibilities of DNOs, suppliers and electricity transmission companies. To negate further confusion, the pilot instrument intentionally made no reference to independent distribution network operators (IDNOs), when respondents were asked to identify their distribution region. In reality, a number of respondents, served by IDNOs, recognised that in the event of a supply interruption, they would not contact the regional DNO, but would be required to approach their respective IDNO. As such, supplementary information will be included in the survey for clarity. Nevertheless, it is anticipated that most customers will be unable to make the distinction between a DNO and an IDNO and as such, it is proposed that all customers will be asked to provide their address details, allowing the distributor to be identified and verified retrospectively.

5 LESSONS LEARNED FOR FUTURE INNOVATION PROJECTS

This section of the report disseminates the learning outcomes from this piece of customer research with a previously unengaged survey population. The learning is focused on describing how DNOs and their stakeholders can capitalise on this process by identifying and responding to challenges that may arise in future customer engagement activities of a similar nature.

The lessons learned are as follows.

[13] A 21-digit reference used in GB to uniquely identify electricity supply points, such as individual domestic residences.

5.1 Customers struggle to imagine a future scenario with a greater presence of LCTs

The projective technique utilised in the pilot CE trade-off involved providing supplementary educational materials and phrasing questions in the context of future electricity usage and dependency, linked to a greater presence of LCTs.

Analysis failed to provide sufficient evidence that either the materials were effective in conveying this future scenario, or that participants' future VoLL was substantially different from their current VoLL.

In future innovation projects it is recommended that projective techniques and associated materials are appraised by an ECP before they are employed more widely. Evaluation of this nature should provide a reasonable understanding of whether projective techniques are capable of attaining the desired research outcome. If materials are sufficiently able to contextualise an imaginary future and critically, should qualify whether customers can envisage or are willing to accept that imaginary future.

It is also recommended that a stratified random sampling approach is employed to ensure that a cross-section of early adopters and high consumers of electricity are included in the survey population. These participants' responses are based on actual experience, which is typically easier to recall, analyse and articulate than hypothetical scenarios.

5.2 Allow ample time to access early adopters of LCTs

The pilot survey was conducted between 17 August and 16 October 2016. During this time it became apparent that early adopters of some LCTs are particularly challenging to identify and recruit. This finding was specific to EV and EHP users, because of the relatively low uptake of these technologies across GB at the present time.

Permission must be obtained from the landowner and/or operator of EV charging points, such as those located in large shopping precincts, before market research interviews can commence on site. This process can take up to eight weeks and therefore, forward planning is essential. A further observation was that EV users who were engaged at charging points were often unwilling to complete the survey on site, demonstrating a preference towards the online survey, when this was suggested as an alternative. The implication of this finding is that it is important to have a variety of administration methods to capture a sufficient number of surveys from the target population.

A significant proportion of properties, identified as having an EHP installation, are in social housing stock; and many of these systems are in high rise blocks. It is recommended that wardens are engaged in advance to arrange convenient access times. Furthermore, third party collaboration of this nature, with a person likely to be known and trusted by respondents, may encourage and maximise recruitment opportunities.

Interviewers should also be provided with a letter from the client, which provides a brief overview of the research and a point of contact. This promotes participation by allaying potential concerns about the genuine nature of the survey and clarifies that participation will not result in any subsequent direct sales or marketing. Additionally, it is advisable that interviewers should visit in pairs, where an assessment of the target area presents a concern for safety; and these additional costs should be factored into the research budget.

5.3 Computer-aided telephone surveys are not an appropriate medium for administering surveys with a significant volume of stimulus material

The pilot survey contained a large quantity of educational materials to contextualise the narrative. Some of this information was embedded in a visual format, which was extremely challenging to convey over the telephone. The survey also included a complex CE trade-off exercise which, in its original format, was time-consuming to explain over the telephone.

It is technically feasible to assist a survey participant by guiding them through an online survey with simultaneous telephone support, allowing both the respondent and interviewer to view the same information at different locations. However, this involves the interviewer sharing their screen, which requires the respondent to install specific software on their computer or tablet device. Understandably, respondents may be unable or unwilling to go to these lengths, simply to take part in a survey and because of concerns about online security.

Nevertheless, it remains important to include the use of telephone recruitment and/or facilitation in customer engagement plans as this is an effective method of reaching harder-to-engage groups such as the vulnerable and fuel poor. It is recommended that, for complex surveys of this nature, the telephone method is utilised to recruit customers, at which time, arrangements can be made for a subsequent face-to-face or self-completion online interview, as appropriate.

5.4 Survey participants will not read excessive communication materials if they can understand and complete survey questions without them

Respondents were able to complete the survey without reading a significant proportion of the embedded educational material. This was substantiated by analysis of the data collected from those who completed the questionnaire quickly and comparing these results against the survey respondents who took longer. This analysis considered the time taken to answer each question, taking into account the relevant briefing material and evaluating this against the overall mean. The analysis demonstrated that those responding quickly, who would realistically have been unable to thoroughly read the supplementary information, were equally able to provide an accurate view of their willingness to make or accept a payment, in return for changes in the reliability of service or provision of support.

Earlier in the project an ECP had assisted in identifying and evaluating the key characteristics of supply interruptions that should be tested in this research. The suite of educational materials shared with the ECP were valuable in assisting the panel to develop an appreciation of the role of a DNO within the energy sector. They also conveyed the meaning and significance of VoLL and critically, the importance of studying the different impacts of supply interruptions on a range of customer segments across GB.

These comprehensive materials enabled participants to make informed and considered judgements on related matters, which were critical in allowing the project team to develop the survey instrument and its supplementary educational content. However, the pilot population revealed that respondents did not require this level of understanding for the purpose of the survey.

In future innovation projects it is recommended that greater emphasis is placed on the ECP to consider how best to tailor research aimed at previously unengaged customers. This should pay particular attention to evaluating the most appropriate type of information and the optimal volume required for the specific task. For instance, future ECP members may be asked to recruit a friend, relative, neighbour or colleague to complete a proposed survey and report their feedback at a subsequent ECP meeting.

To further reduce the amount of reading material presented in the survey, it is recommended that some information or visual stimuli is hidden behind optional pop-up hyperlinks, while ensuring that sufficient information is retained for those who might require it to answer specific questions.

5.5 Outcome

The pilot survey was a successful method of reviewing the survey instrument and supporting materials before being rolled out more widely. In particular, it allowed a useful evaluation of how the most accurate results can best be achieved to measure potential variations of VoLL in the context of future dependency and LCT adoption. The required adjustments captured

during the pilot stage will ensure that the survey instrument is optimised before the main customer survey takes place and will provide more robust and meaningful results.

6 CONCLUSIONS

This report sets out the key findings from a pilot phase of strategic quantitative market research and its subsequent analysis. This research successfully met the objective of thoroughly testing the survey instrument and research methodology. Overall, these were proven to be robust but some areas of concern were identified, which require implementation of refinements prior to launching the full customer survey.

The results of the pilot survey provide clear evidence to support the project's primary research objective that a single uniform VoLL, applied to all customer segments, is no longer appropriate. Analysis from the pilot population demonstrates significantly different impacts of supply interruption within a range of domestic and SME sectors, which has the effect of large variations in the segmented assignment of VoLL, as different degrees of importance are placed on the various elements of impact. Similarly, variations were observed in the mitigation effects of various support mechanisms across different customer segments. These differences were apparent in the WTA and WTP values revealed so far by the pilot study.

The customer engagement methodology deployed in this phase of the project was effective and demonstrated the importance of a robust and appropriate research approach, specifically tailored to achieve the objectives of phase 3, namely, the accurate and granular measurement of VoLL.

The engagement was also successful in further enhancing the project's communication materials to optimise responses from participants of the main customer survey during phase 3.

7 NEXT STEPS

7.1 Further pilot

Due to the requirement for fundamental amendments to the survey instrument, as a result of feedback from the pilot, a further pilot study will be conducted to test the updated instrument before launching the full customer survey.

7.2 Measuring VoLL

The final stage of VoLL customer engagement will be conducted during the third phase of the project and will involve a large scale quantitative survey. The large scale survey will be conducted in two stages to ensure seasonal variations are captured. The initial stage will commence in December 2016, followed by a second phase of fieldwork in summer 2017.

A total of 6,000 interviews will be completed by customers from across the whole of GB, 3,000 of which will involve domestic and SME customers in Electricity North West's operating region. 5,000 of the interviews will be conducted with domestic customers and 1,000 will comprise a broad sample of SME customers.

The survey will include a stated preference exercise that was identified in phase 1 during the literature review, as being the most robust technique for measuring VoLL, building on, and providing parity with, previous studies. This approach will involve asking customers to trade off different levels of supply reliability and support in exchange for receiving a hypothetical financial incentive (WTA) or making a payment (WTP). This method, as with previous research, is expected to demonstrate quite different results from these two approaches, with WTP values being notably lower than WTA values.

Additional qualitative questions will be incorporated into the survey to understand the participants' perceptions and their current experiences of supply reliability. These questions are intended to elicit reasons for statistical trends, such as the causation of a higher than average VoLL assignment in a particular segment. These experiences may be influential when survey respondents are considering hypothetical situations in the trade-off exercise. The additional questions will include, but should not be limited to, the following topics:

- Experience and perception of unplanned and planned interruptions, including frequency and duration
- Satisfaction with supply reliability and the associated customer service experience, ie the DNO's handling of, and communication strategies during, the supply interruption
- Context of the interruption(s), for example, a localised fault affecting a relatively small number of customers or a lengthy, widespread outage caused by severe weather events.

The ECP will be reconvened after completion of the survey analysis, to review and evaluate the research findings.

7.3 Dissemination of findings

In line with the vision of the NIA funding mechanism and the project commitments documented in the VoLL Methodology Statement (version 2), all outputs and learning acquired from VoLL customer engagement activities will be made available to other DNOs. Specifically, all communication and survey materials developed as part of this project will be publicised on the VoLL webpage. Ongoing learning will be disseminated through an annual NIA project progress report, quarterly stakeholder updates and other appropriate forums. The project findings, lessons learned and implementation recommendations will be documented in a final report, which will be submitted to Ofgem for publication on the Energy Networks Association's smarter networks portal by January 2018.