electricity north west

Bringing energy to your door

RESPOND

Fault Current Limiting Service Contract & Commercial Learning

27 April 2018

CONTENTS

VERSION HISTORY

Version	Date	Author	Status	Comments
1	23 April 2018	T Kennelly	Final	

APPROVAL

Name	Role	Date
Paul Turner	Innovation Manager	27 April 2018
Steve Cox	Engineering & Technical Director	27 April 2018

GLOSSARY OF TERMS

Abbreviation	Term
AC	Alternating current
CBA	Cost benefit analysis
CCCM	Common Connection Charging Methodology
CEP	Customer engagement plan
CB	Circuit breaker
CHP	Combined heat and power or cogeneration plant
BAU	Business as usual
DCUSA	Distribution Connection Use of System Agreement
DNO	Distribution network operator
DG	Distributed generation
DPS	Data privacy statement
DSO	Distribution system operator
DUOS	Distribution use of system charges
ECCR	Electricity Connection Charging Regulations
ECP	Engaged customer panel
FCL service	Fault Current Limiting service
GB	Great Britain
I&C	Industrial and commercial
LCN Fund	Low Carbon Networks Fund
NTC	National Terms of Connection
Ofgem	Office of Gas and Electricity Markets
Q&A	Question and answer
SME	Small and medium enterprise
TSO	Transmission system operator

FOREWORD

This report is submitted as part of Electricity North West's Respond project, which is funded under the Second Tier of Ofgem's Low Carbon Networks (LCN) Fund. Electricity North West received formal notification of selection for funding on 24 November 2014. The project will run for 46 months, between January 2015 and October 2018.

Respond seeks to demonstrate the viability and effectiveness of a range of mitigation techniques to overcome the fault level challenges faced by distribution network operators (DNOs).

The results of the analysis outlined in this report are derived from a research methodology submitted to Ofgem on 17 June 2015, as part of the Respond customer engagement plan (CEP), which sets out the approach and activities to be undertaken throughout the Respond project.

This report is one of a series of project dissemination documents and serves as an addendum to the Respond customer report published on the project website in May 2017. It should also be considered in conjunction with the Fault Current Limiting (FCL) service installation and management agreement, published on the project website in May 2016 along with the FCL service equipment specification and installation report published on 4 April 2018.

This report specifically references commercial learning derived from research with new and existing customers and the proposed contract templates for FCL service provision.

1 BACKGROUND AND OBJECTIVES

As Great Britain (GB) moves to a low carbon future, demand for electricity is expected to rise significantly and this will result in some inevitable increase in fault levels on the distribution network.

Respond is an innovative solution to managing 'fault current', which is the instantaneous surge of electrical energy that occurs under fault conditions.

The Respond trials use an intelligent Fault Level Assessment Tool to calculate potential fault current in near real time, in combination with two new technical solutions and an innovative commercial concept. These techniques are briefly outlined below:

- I_S-limiter – a current-limiting fuse which detects the rapid rise in current when a fault occurs and responds within 1/200th of a second to break the current, operated in series with a primary substation transformer or across an open 11kV bus-section circuit breaker (CB)

- Adaptive Protection (AP) – also known as sequential tripping, this technique re-sequences the operation of circuit breakers and is retrofitted into existing substation equipment. During a fault, AP reduces fault current by opening an 11kV bus-section CB before the downstream 11kV CB has been issued with a trip command from its protection relay

- FCL service – a form of AP that can be deployed at a customer's premises. This commercial technique provides an opportunity for industrial and commercial (I&C) customers that operate large alternating current (AC) rotating plant (such as generators and motors) to earn revenue from providing the DNO with a fault level response, via a managed agreement. The protection relays associated with these machines use an

additional trip setting which is engaged via a remote command when the fault level exceeds a preset level. This operates the equipment's CB more rapidly than normal to curtail its fault current contribution to a system fault on the DNO's network.

The project background is fully documented in the Respond submission document, which is published on the project website.

Ofgem's project direction document outlines certain successful delivery reward criteria (SDRC), against which the success of the Respond project will be assessed. For each criterion, the project direction defines the evidence that is required to demonstrate successful delivery. This report evidences the customer workstream SDRC 9.2.4: *Publish contract templates for FCL service with new and existing customers and commercial arrangements learning by May 2018.*

2 CONTRACT TEMPLATES AND COMMERCIAL ARRANGEMENTS LEARNING

2.1 The FCL service commercial template

One of the key outputs of the project was to develop appropriate commercial arrangements and contract templates for the provision of FCL services. A model commercial contract, based on a variation to the National Terms of Connection (NTC) was published on the project website in May 2016. This could be applied to existing load/generation customers and new connection customers. This template is transferable to other GB DNOs.

The regulatory and legal necessity for specific clauses to protect the network operator, its network and the customers served, prevents significant material changes to the document. However, as documented in the customer report, dated May 2017, existing customers, electing to provide a voluntary fault level response to the DNO for commercial gain, are expected to challenge specific terms and clauses. The document explains how such complications could be negated by offering the FCL service as a constrained connection agreement, to provide a quicker and lower cost connection for new customers (and exiting customers adding new demand and generation) than a standard quotation.

2.2 Evaluating the commercial template in the marketplace

Qualitative evidence and commercial learning obtained from developing the commercial framework and taking the solution to market is comprehensively documented in the customer report. This explains the motives and barriers to customer participation in the trials and the challenges that the solution could present to the DNO.

The project aim was to establish up to five FCL service contracts with existing customers during the trial period. It was originally proposed that two of these managed agreements would be provided by project partner United Utilities.

Due to the perceived commercial risk, contract negotiations to commence trials with project partner, United Utilities, took considerably longer than was originally envisaged. This delay restricted the time available to develop the design and technical arrangements required to actively test the interface technologies at two proposed sites and consequently, it was not possible to proceed to the installation stage.

Despite a robust customer engagement strategy, the Respond project team found it extremely challenging to engage with suitable I&C customers, already connected to Electricity North West's network, that were willing to participate in the FCL service trial.

Customers in the target market were extremely risk averse and their appetite for new commercial opportunities was heavily influenced by the earning and/or saving potential available from other well established schemes in the capacity and balancing market. These

schemes were exclusively operated by National Grid Electricity Transmission PLC (the UK's transmission system operator (TSO) and these arrangements were commonly externally managed by aggregators.

Furthermore, complex operating arrangements were common, which constrained a customer's ability to agree to new commercial services, particularly where critical plant was owned, operated and subject to warranty conditions dictated by a third party provider.

The key barriers and drivers to participation are fully documented in the customer report and are briefly summarised below:

- Damage to equipment
- Impact on operations
- Unpredictability of the FCL service
- Frequency of curtailment/fault level events
- Acceptability of price point
- Responsibility for reclosing the circuit breaker after the fault has cleared
- Maintenance and warranty arrangements
- Relinquishing control of equipment
- Installation and commissioning downtime
- Other commercial operating arrangements and alternative revenue streams
- Customer confidence in the concept.

Active discussions took place with 13 organisations who had indicated a willingness to participate; however, only one entered the final stage of technical and commercial negotiations. Those discussions failed to secure an agreement to trial FCL service technologies, primarily because the arrangement was not deemed competitive with existing commercial contracts that the customer had in place.

All customers directly engaged in pre-contract negotiations were furnished with the contract template and encouraged to provide feedback. However, this was not forthcoming and therefore learning about the management agreement, in its current format, is limited.

2.3 Assessment of the current and future market for the FCL service

In light of the failure to agree terms for the limited trial of the FCL service with United Utilities or any other existing I&C customer, it is concluded that there is currently little appetite for this provision in the marketplace. However, this situation may change in the future as customers increasingly require cost-effective and early integration of generation and demand connections on ever more constrained networks.

DNOs are adopting innovative strategies to managing a rapidly-evolving 'smart grid' and a more collaborative approach is expected to emerge as they transition to a DSO (distribution system operator) model of network management. It is envisaged that there will be greater partnership with the TSO, aggregators and other industry stakeholders in the future. This will provide customers with more choices when connecting and integrating equipment with the network, thereby allowing all parties to benefit from potential synergies.

A range of demand side response (DSR) arrangements are expected to emerge that will allow the system operator to manage constraints and provide customers with commercial opportunities from such flexible services. Customers are expected to have greater confidence in schemes such as the FCL service as more DNO/DSO managed arrangements are rolled out and their benefits are realised.

Technical design and installation arrangement

In the absence of a commercial trial of the FCL service, a generic design of the proposed installation arrangement was developed, incorporating new protection and tripping relays which can be tailored to suit any particular installation. However, it is recognised that the

technical arrangements to facilitate AP on a customer's equipment will vary from site to site and will require some bespoke elements of works.

The FCL service equipment specification and installation report, published in April 2018 defines the proposed installation arrangements that could be utilised to facilitate the technique at a customer's premise and outlines the generic commercial arrangements that would be required to facilitate the service.

2.4 Proposed charging methodology for provision of the FCL service

Increase in system fault level can be due to the connection of new load or because of a general increase in demand and/or generation connected to the network. For a general increase in system fault level, reinforcement is fully funded by the DNO as part of their capital programme.

Network reinforcement required by an increase in fault level due to a new connection requires a financial contribution from the customer. This is in accordance with the Common Connections Charging Methodology (CCCM) reinforcement apportionment rule, with the balance being funded by the DNO as connections-driven reinforcement.

The reinforcement costs associated with paying a customer to provide an FCL service in the event of a fault needs further consideration. This depends on whether it is provided by the new or existing customer causing the increase in fault level, or by an existing customer providing a service to facilitate additional demand by a third party. These considerations are documented in the Respond DCUSA change proposal document published in March 2018.

Provision of the FCL service provision from existing customers

In the case of a new or existing customer providing an FCL service due the increase in fault level ***caused by the connection of their new equipment*** then it is considered inappropriate to make any payment as the customer benefits from not having to contribute to a traditional reinforcement scheme.

In the case of an existing customer providing an FCL service to facilitate the connection of additional demand by a new customer, it is proposed to introduce the concept of an FCL service cost apportionment factor (CAF) to determine the proportion of the reinforcement costs that should be paid by the new customer. However, until there is clarity on how the fault level CAF rule is applied to these new engineering solutions there is an opportunity for misinterpretation by the network operators, potentially negatively affecting customers' contributions.

$$\text{Fault Level CAF} = 3 \times \frac{\text{Fault Level Contribution from Connection}}{\text{FCLS Capacity}} \times 100\% \quad \text{(max 100\%)}$$

The FCL service capacity is the additional capacity made available by the purchase and implementation of an FCL service.

The costs associated with the provision of an FCL service arise from the contractual payments to be made to a third party and the following options have been considered:

- The DNO negotiates an annual contract with the customer providing the fault level reduction service and collects the payments each year. The payment due to the DNO from the new connectee would be calculated by applying the fault level apportionment factor and include a cost to cover administration.

- The DNO negotiates a longer-term (five-year) contract with the existing customer providing the fault level reduction service, and uses the total amount payable to the customer as the FCL service cost in the calculation used to apportion the costs payable by the new connections customer. The contribution from the new connectee would be

calculated by applying the fault level apportionment factor and including a cost to cover administration.

There are a number of things to consider with Option 1. Firstly it requires the DNO to set up a system to collect annual payments from the newly connected customer and pass them through to the customer providing the FCL service. While this arrangement should be covered in a connection contract there is a financial risk to the DNO if payment is not received. This is because the FCL service will still be required until the demand causing the increase in fault level is disconnected and, in the interim, the DNO will still have to purchase the service from the existing customer.

Secondly, there is a risk that if the contract with the service provider (existing customer) is terminated or not renewed for subsequent years, then the DNO would have to immediately implement an alternative reinforcement solution. It may be possible to address this situation by including a clause in the connection agreement requiring an additional contribution from the customer to fund an alternative (more expensive) reinforcement solution in the event of the FCL service being discontinued. However, it is considered that this approach would require the level of financial risk and timescales to be accurately articulated to the new connections customer, so that they can consider their potential liabilities before entering into the connections contract.

Option 2 has the advantage to the customer in that all of the costs associated with the new connection would be dealt with at the outset and the DNO would carry the risks identified in Option 1 associated with contract termination.

Price point to procure the FCL service from existing customers

The provision of an FCL service from an existing customer will require an ongoing payment regime, which could be monthly or annually. This may extend for a number of years and will involve additional administrative costs.

There is a need to consider the duration for which an FCL service is required, particularly if passing a proportion or all of the costs through to a new connections customer, as this may require regular payments and corresponding pass-through charges over many years.

New customers pay only a proportion of the reinforcement costs; therefore logically, this apportionment would also apply to the cost of making payments to existing customers for the provision of an FCL service.

The price point tested was based on the cost savings associated with the avoidance of upgrading the network to remedy a potential fault level issue. This was calculated on £/kA per event or £/kA per contract in accordance with the proposal in the original project submission. A Respond pricing calculator used two elements:

- The contribution to system fault level by the customer's equipment

  The customer report explains how contribution to fault level at the restricting asset (usually on the primary substation controlling CB) is dependent on a number of factors including the type of equipment and the effect of network impedance.

- The price per MVA of contribution, which is based upon the deferred cost of reinforcement.

  The cost of 1MVA of fault level contribution is based on the cost of traditional reinforcement associated with changing the HV switchgear in a primary substation (£442,208) and dividing this value by the rated fault level (250MVA) to provide a rate of £1,769 per MVA of fault level headroom released. This is the cost of providing the service until the asset is due for normal replacement. This will differ on each network because of the age of the asset and will consequently affect the overall payment.

Therefore, if the fault level response is required for 20 years, the costs should be apportioned accordingly and it is expected, using this mechanism, that the customer would receive ~£88.45 per MVA per year.

In the absence of a recognised apportionment factor (as suggested above), a customer providing 25MVA of fault level headroom would receive around £44k, which, if paid annually, would overtake the cost of the traditional reinforcement solution after 10 years.

Viability of procuring FCL service from existing customers

The Respond interim customer survey report, published in February 2016, documents the approach to testing the price point and appetite for the FCL service. This research suggested that take up might be achieved by offering a financial incentive of up to 10% over the tested price point of £1,769 per MVA of contribution to fault level reduction, if combined with a short duration contract of just one year.

Suitable customers were largely unwilling to engage, even to discuss a mutually agreeable incentive. However, limited direct customer engagement with 13 organisations suggests that survey responses do not accurately reflect commercial reality.

To assist in the validation of the pricing model the organisations consulted were asked to provide a realistic estimate of the cost of a ten-minute constrain to their generator or motor. This confirmed that customers have expectations of payments significantly greater than the indicative £/kA per event or £/kA values tested. They seek to achieve optimal earning potential, assessed in relation to risks the method might present, which are unique to individual organisations. Responses from those providing an estimate ranged from £1,000 to £100,000, with around 45% claiming each event could have a financial impact of over £10,000.

The Respond trials have highlighted that procuring an elective FCL service from an existing customer is likely to involve a period of contractual negotiation and introduce challenges about specific terms and the expected payment.

In each case a cost benefit analysis (CBA) will be necessary, to assess terms in relation to:

- Specific network conditions
- Customer's contribution to fault level
- Contract period, relative to the life of the asset.

Research has demonstrated that customers' drivers are completely different from those of the DNO, and are influenced by purely commercial considerations. Payment expectations will vary according to the market sector, perceived risk and the specific demands of the provider. While it is impractical to offer bespoke pricing models, the DNO should anticipate these challenges.

As such, a CBA model must be applied to determine the financial viability and appropriateness of a commercial solution to fault level management versus traditional reinforcement and other technical solutions, to establish the optimum solution.

2.5 FCL service provision from new customers

The Electricity Connection Charging Regulations (ECCR) make provision to recover the costs of connections-driven network extensions by requiring a future connectee to make a contribution to the initial costs of any shared asset. ECCR applies only to the cost of providing a new connection, not to the reinforcement, as the customer only pays for the proportion of the network reinforcement that they use. However, it is important to note that where it is unlikely that the additional capacity is required for other customers within five years, then the connectee should pay the whole of the reinforcement cost and ECCR would then apply if the asset was subsequently to be used by another customer.

All customers applying to connect embedded generation onto Electricity North West's network are routinely offered a 'managed connection', to mitigate the need for reinforcement.

The constrained connection, sometime referred to as a 'flexible' or 'alternative' connection, allows the generator to export up to an agreed limit, under certain conditions, ie when the network is operating 'normally'. However, under abnormal conditions, typically because of a network fault, the generator's export is constrained to an agreed level.

Therefore, connections are designed to export to an intact network only (n-0) unless the customer chooses to pay for a higher level of security. This generally provides the least cost connection and is considered most appropriate for intermittent generation.

A constrained connection allows the isolation of export capability, to ensure it is unable to continue supplying electricity in the event of a network fault. Typically this is managed via a CB, which the DNO can control and trip remotely during fault conditions. This ensures that the generator remains 'off' until either the network returns to 'normal' or the DNO deems it appropriate to switch the generator back on during the fault.

New connection customers can still request a non-constrained offer; however, these are not only more expensive, but generally take significantly longer to deliver because of the time taken to plan and complete network reinforcement works. These works are also recognised to be extremely carbon-intensive.

As the FCL service is a new and untested commercial and technical arrangement, it was not appropriate to secure a managed agreement to trial the technologies with a new customer. However, the offer of an alternative constrained connection, specifically to mitigate fault level, could theoretically be accommodated by adopting a similar mechanism to the existing protocol for embedded connections.

This represents the most reasonable and fair approach, as the new generation customer is responsible for adding to system fault level. As such, this organisation carries the risk of curtailment when a network fault occurs and system fault level is above the design rating.

Application of the FCL service in this manner provides a commercial solution to fault level by offering customer choice; and for new generation customers effectively operates as an extension of existing G59 regulations. It also negates the requirement for ongoing payments by the DNO which would be required if procuring the service from an existing customer.

The cost of the provision of the FCL service by a new connections customer will be reflected by a lower reinforcement contribution charge and will be governed by specific conditions in the customer's connections contract. As such, mitigation for a breach of conditions may be easier to enforce than an elective agreement provided by an existing customer.

Connections charging policy does not currently have a provision for collecting ongoing annual charges from new customers.

The new commercial arrangements would require modifications to Electricity North West's existing policy and standards documentation.

However, the study has also demonstrated that a standard connection is likely to be more appropriate for some organisations, and customers would, as is currently the case, have the option of requesting an un-constrained connection, which would involve greater cost and delivery timescales associated with the requisite reinforcement.

It is assumed that constrained connections will be offered only to customers applying for a new connection (including the addition of new generation or large motor load to an existing installation) on the basis that the customer's connection adds to overall system fault current, resulting in higher fault level.

As such, it would be inappropriate and impractical for the DNO to approach existing customers to offer a managed FCL service, to accommodate a lower cost and expedited connection for a third party. This situation would also be challenging to administer in terms of fault level cost apportionment.

2.6 Frequency of a fault level response

As part of the connection study, historic HV circuit fault rates measured over the previous five years should be used to provide a generator with an indication of the likely curtailment rates for n-0 Managed Connections. The fault rate for the circuit that the generator is connecting to should be used.

This calculation should consider the percentage of time that the Fault Level Assessment Tool will enable the protection, as the service is only required when fault level is exceeded. The estimate would then be based on an annual average of the cumulative number of phase-to-phase faults on all HV circuits served by the primary substation, when assessed over a five-year period.

In line with current connection policy it is anticipated that a curtailment index trigger will form part of the curtailment forecast which will lead to a review of a solution once the trigger point has been reached.

2.7 Proposed buy order

One of the Respond project's success criteria was to produce cost benefit analysis figures based on actual installed costs and derive a buy order for Respond. The results are documented in the cost benefit analysis and buy order report published on the project website in January 2018.

The technical solutions (AP and I_S-limiters) were installed as part of the Respond trial and the associated installation, operating and maintenance costs, quoted in the above document are based on trial data. Figure 1 compares the costs of the FCL service to traditional solutions. However, in the absence of any trial data for the procurement of an FCL service, the assumed costs are those used in the original project submission document.

Figure 1: Summary of costs

	Capital Cost	Additional O&M costs	Advantages compared to traditional reinforcement	Disadvantages compared to traditional reinforcement
Traditional reinforcement (*replace HV cables at primary substation)*	£1,115k	None	N/A	N/A
Traditional reinforcement *(change primary HV switchgear)*	£442k	None	N/A	N/A
FCL service	£10k	£30k-£540k	Low capital cost	Ongoing annual payments required. Service could easily be terminated

Customers were unwilling to conduct a rigorous CBA to assist in substantiating the optimal price point for the provision of commercial fault level mitigation services. Unlike the DNO's calculation, a customer's assessment of a suitable pricing mechanism (where provided) had no basis on their equipment's contribution to fault current contribution and was based solely on commercial factors including perceived risks and income-generation aspirations.

The cost and complexities of ongoing payments suggests that buying a fault level response from existing generation or demand customers may not provide DNOs with a credible long-term solution to a fault level problem. However, cost benefits could be realised by introducing the service as a managed, constrained connection agreement for new connectees, where the requirement for ongoing payments is negated.

The FCL service has the potential to negate significant public infrastructure disruption associated with traditional reinforcement. These costs have not been included here but should be factored into the CBA for any future provision.

The study concluded that there is not a 'one size fits all' solution to determine the buy order for a particular scenario and it is necessary to undertake a CBA exercise to establish the most appropriate solution to a particular set of circumstances.

2.8 DNO considerations – commercial, security and resilience issues

The FCL service introduces a number of technical and commercial considerations that challenge the suitability and applicability of deploying AP at a customer's site as a viable solution to mitigate fault level.

These issues are considered individually in Section 5 of the customer report, most notably of which are those associated with security and resilience. The contract with an existing customer to provide an FCL service will have a termination or break clause which would mean that the FCL service could be withdrawn, prior to alternative fault current limiting arrangements being put in place.

Certain risks apply irrespective of whether the response is purchased from an existing customer, or applied as a new constrained connection agreement. Therefore, the DNO must be confident that agreed terms are sufficiently robust to 'future proof' the contract and provide appropriate penalties, mitigation for breach and offer the requisite levels of network security.

Introducing competition to the market

Electricity North West's experience in its Capacity to Customers (C_2C) project highlighted the difficulties of engaging commercial and technical decision-makers in I&C organisations; the challenge of building relationships and ultimately, agreeing terms for participation in new commercial arrangements.

(C_2C) trialled three routes to market:

- DNO direct
- Via an agent or aggregator utilising a finder's fee but using the DNO technology infrastructure and contract forms. Final contracts were bilateral between Electricity North West and the customer
- Via an aggregator using their technology infrastructure and contract forms.

In C_2C, DNO direct engagement was demonstrated to be the most effective route to market, with customers valuing the strong ongoing relationship with the DNO, which provided confidence in the method. It also identified the value of collaborating with trusted partner organisations that have access to, and well established relationships with, potential customers.

Two project partners were appointed to forge these links but the strategy had limited success in overcoming barriers and supporting customer engagement activities, leading to a commercial agreement to trial the service.

Larger I&C customers tend to be more educated and engaged with the DNO than most. However even these organisations can be confused about the complex structure of the electricity sector and reticent about entering commercial arrangements outside their core business. However, the commercial opportunities offered from the TSO have introduced significant income streams, which large I&C customers are increasingly seeking to exploit.

The viability of commercial fault level mitigation services, operated locally by a DNO, is dependent, not only on its acceptability to customers (largely driven by risk versus the incentive available), but its ability to integrate with other well-established and emerging schemes.

This underpins the importance of industry and stakeholder collaboration in customer engagement/education, which will be key to providing an effective route to market for products such as the FCL service in the future.

Conflicts with other commercial operating schemes

Respond research has definitively demonstrated that customers are reluctant to introduce unnecessary complications which might impact existing and potentially new lucrative arrangements with the TSO. However, organisations that are able to offer commercial services by entering their equipment into new commercial markets are likely to take advantage of synergies that could emerge from holistic industry solutions emerging in the evolving marketplace.

In addition to being financially competitive, commercial fault level mitigation services must be easily managed. Many organisations do not have sufficient internal expertise about the energy market to make decisions about which of the available schemes are most appropriate for their particular organisation. As such, generator operators typically rely on suppliers for guidance and to manage payments under the Renewables Obligation and Feed-in Tariff Schemes, and Power Purchase Agreements for exported electricity.

Organisations that are able to derive benefit from entering the commercial energy market tend to do so in collaboration with aggregators or electricity supply companies (ESCO) that are able to manage their load and generation capacity as part of a portfolio of sites. This provides the business with predictable income throughout the year via an aggregated, flexible arrangement. Aggregators provide expert guidance about the most appropriate commercial service/s for individual businesses and the most lucrative terms.

Their expertise allows them to manage and optimise both their own and their customers earning from the appropriate revenue streams. Greater engagement with aggregators is likely to be required if the FCL service is to be successfully rolled out as a BAU initiative. However, customer ‘finders fees’, set-up charges and the commission models of these organisations would have to be factored as additional costs in the CBA.

3 CONCLUSIONS

The FCL service standard contract (installation and management agreement) was completed and published on the project website in May 2016. This commercial template was made available to customers interested in participating in the project trials and will provide the framework for a new commercial service to mitigate fault level, if and when the solution is adopted as a future BAU solution. This template is available for dissemination to other DNOs, customers and any other interested parties as part of this report.

Both the DNO and its customers are faced with a number of technical and commercial issues that present varying degrees of concern and must be overcome before the terms of a managed agreement are acceptable to both parties. These considerations introduce questions about the suitability and applicability of deploying AP at a customer's site.

The project has identified particular concerns about the practicalities of purchasing a commercial fault level response from existing customers, the reasons for which are outlined in this document and are fully explained in the customer report published in May 2017.

Therefore, Electricity North West is unlikely to actively procure FCL services from existing demand or generation customers at the present time.

Furthermore, the project has demonstrated that there is currently no commercial appetite for FCL service provision in the market. However, this may change in the future as customers require more cost-effective connections, which offer the early integration of generation and demand onto increasingly constrained networks.

Failure to secure a commercial contract to trial the FCL service has limited potential learning about the viability of the method from the customer's perspective. The challenges encountered in effectively engaging customers also generated little practical insight into actual impacts on customers' equipment or operations from deploying enabling technologies.

It was not possible to determine the optimum price point that is likely to be acceptable to existing customers to procure the FCL service. However, offering the solution as a constrained connection for new customers negates the cost and complexity of ongoing payments. It also eliminates any requirement for the DNO to enter complex negotiations to agree terms, as the conditions of a managed connections offer are non-negotiable.

Installing AP at a primary substation will always provide the DNO with greater headroom, at less cost, than procuring a fault level response from an existing customer. AP at a substation also provides the DNO with greater network security and negates uncertainty about customer commitment to the method and critically the challenges that would arise from early termination.

As such, application of the method as a new form of constrained connection agreement is considered more appropriate for the DNO for BAU rollout and provides a solution that could mutually benefit a DNO and its customers in the future. While it was not possible to test enabling technologies as part of the project, the technique has the potential to defer or avoid significant capital investment by creating a wider choice of connection options for customers who are able to accept a flexible connection to the network.

The benefits of introducing the FCL service as a managed connection for new customers (and existing customers that propose connecting new load or generation) are:

- Allows the DNO to fulfil its obligation to facilitate the connection of DG
- Facilitates quicker and lower cost connections compared to traditional reinforcement for networks approaching fault level limits (providing connectees with opportunities to develop/expand businesses in desired locations, where costs and timescales would otherwise be prohibitive)
- Represents an extension of existing G59 regulations for generation designed to run in parallel with the distribution network
- Delivers a potential short-term solution to a fault level problem during the planning and commissioning stages of alternative methods, including traditional reinforcement
- Negates the requirement for ongoing customer payments by the DNO.

The reinforcement costs associated with paying a customer to provide an FCL service in the event of a fault needs further consideration depending on whether it is provided by the new

or existing customer causing the increase in fault level or by an existing customer providing a service.

The appropriateness of the solution must be assessed on a case-by-case basis using a robust CBA model, which considers the unique network conditions and an individual customer's fault level contribution, against the whole lifetime costs of the solution. The CBA must consider these costs in relation to the headroom provided by traditional and alternate new techniques. Certain risk factors apply irrespective of whether the response is purchased from an existing customer, or applied as a new constrained connection. Therefore, the DNO must be confident that the agreement is sufficiently future proofed and provide appropriate mitigation for a breach. As such, the CBA should be undertaken in conjunction with a thorough risk assessment, which considers the full lifetime network security implications of implementing the FCL service at any potential customer's site.

Potential conflicts with other commercial arrangements and industry players in the current commercial services market have been identified as a significant barrier to the uptake of an FCL service. This suggests that greater commercial acumen is likely to be required in the DNO community to better understand the acceptability of this type of scheme among customers who are already well positioned to offer other lucrative commercial services, to third parties, in an expanding and competitive marketplace.

Introducing new elective commercial services in a competitive market will require the adoption of a collaborative approach with customers and their agents/aggregators who understand the specific needs and challenges of the organisations they represent and can provide expertise on the most appropriate commercial opportunities available from the TSO and the DNO.

While the project has demonstrated that conflicts currently exist, which deter participation in a local scheme, future DNO collaboration with other industry players may offer network and customer benefits from synergies, where customers can offer multiple local and national services.

In conclusion Electricity North West has produced commercial templates for fault level mitigation via the FCL service for demand and generation, applicable to existing and new customers. These contracts are modifications to existing industry framework contracts and can be adopted by other DNOs.