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Customer Load Active System Services
Second Tier LCN Fund
Addendum to Project Closedown Report

31 May 2016

CLASS
Customer Load Active System Services

VERSION HISTORY

Version	Date	Author	Status	Comments
1.0	31/05/2016	Tony McEntee	Completed	

CONTENTS

APPROVAL

Name	Role	Signature & date
Tony McEntee	CLASS Implementation Manager	Tony McEntee Digitally signed by Tony McEntee CN=Tony McEntee C=GB - UNITED KINGDOM OU=Electricity North West EM=Tony.McEntee@enwl.co.uk Date: 2016.05.31 10:47:24
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1. PROJECT BACKGROUND

Electricity North West's Low Carbon Networks (LCN) Fund project, CLASS (Customer Load Active System Services), demonstrated how it is possible to unlock network capacity, defer the need for major capital reinforcement investment and explored opportunities to provide alternative frequency and enhanced reactive power (RP) services to the market by the implementation of innovative, low cost, voltage regulation technologies.

Following the successful completion of the original project and submission of the closedown report, Electricity North West sought permission from Ofgem to extend the project in terms of scope and timescales to demonstrate how this technology can be deployed commercially by distribution network operators (DNO) into the GB electricity market. DNOs do not currently participate in these markets and by demonstrating how this can be done and the value it creates for them and their customers, the project will accelerate the involvement of all DNOs and bring forward the expected benefits to GB customers. This addendum to the original CLASS closedown report covers only the additions to the original CLASS project direction extending the scope of the project.

The aim of the market modelling was to determine GB customers' benefit of network-led provision of CLASS services to the national electricity transmission system operator (NETSO). In order to determine the benefit to GB customers, the following objectives have been identified:

1. To assess the market for each CLASS service, including:

- Market structure, entry qualifications and service price
- Size of market in 2015 and potential size annually to 2031
- Current and potential future competitors, namely the number, type and size of players.

2. To assess the impact of a network-led provision for each CLASS service, including:

- Market structure and service price
- Competitors, namely the number, type and size of players.

3. To determine the benefits for GB customers for each CLASS service, including:

- Costs and benefits for GB customers
- Potential winners and losers in each market
- Whole market impact.

2. EXECUTIVE SUMMARY

Baringa Partners (Baringa) were commissioned to assess the impact of CLASS capabilities on the GB electricity market, focusing on its ability to provide balancing services to National Grid Electricity Transmission (NGET), in its role as NETSO. Their report, which is published on Electricity North West's website (Assessing the impact of CLASS on the GB electricity market), summarises their findings, and accompanies a public version of the cost benefit analysis (CBA) tool developed as part of this work.

Baringa's review of CLASS capabilities, against the balancing services specifications, concluded that it appears particularly well-suited to provide:

- **Firm frequency response (FFR) –** a very fast ramping (within either ten or 30 seconds) increase or reduction in consumption, which may be used for between 30 seconds and 30 minutes
- **Fast reserve** – a fast ramping (within two minutes) reduction in consumption, which may be used for up to 15 minutes at a time
- **Short term operating reserve (STOR) –** a medium-speed ramping product, (20 minutes preferred) which can be used for up to two hours at a time
- **Reactive power (through the enhanced reactive power service (ERPS**)) – the locational absorption of reactive power within two minutes of an instruction.

To assess the impact that CLASS would have in each of these markets, Baringa developed a CBA tool that considered CLASS in the context of the current balancing services market, and a view of what the market could look like in the future:

- The current market is based on 2014/15
- The future market is based in 2027, to allow for a series of expected structural changes to take place.

Within each of these markets, Baringa explored the effect of assuming CLASS were priced either based on its long run marginal costs (LRMCs), or at the least expensive existing provider that CLASS would displace (shadow marginal pricing).

Using this approach, for the initial tranche of CLASS deployment planned by Electricity North West, Baringa estimated that on a net present value basis between 2015 and 2029 the total benefit of CLASS could be in the region of £200 million, with customers receiving between £60 million and £183 million of that depending on how CLASS is priced into the balancing services markets.

The benefit of a wider rollout will depend on the timing of new entrants and the overall volume. Based on the estimated CLASS capability across GB being deployed gradually between now and 2027, the overall benefit would be £466m, of which £128-445m could accrue to GB customers.

Baringa also undertook qualitative analysis of the potential impact of CLASS deployment in the following four areas:

- Improved alignment of CLASS and NGET requirements
- Behaviour of displaced parties
- Security of supply impacts
- Other smaller effects.

Overall Baringa concluded that while there is a degree of uncertainty over how CLASS will be deployed and how the markets for balancing services will evolve, it seems clear that there is significant potential for this technology to reduce consumer costs. In addition, the use of CLASS could result in material reductions in the CO_2 emissions associated with holding and utilising plant for the provision of balancing services. The impact on security of supply is less certain, but it would appear that the overall effect of delivering more dependable voltage control is a net positive for the security of the overall system.

Electricity North West is looking to procure new enhanced automatic voltage controllers (EAVCs) to undertake the CLASS functionality. This will enable further development of CLASS services so that the maximum value from the approach can be realised.

3. DETAILS OF THE WORK CARRIED OUT

In order to undertake the market modelling, Baringa identified the following key tasks:

- Task 1: Validating viable ancillary service markets
- Task 2: Market assessment
- Task 3: Market impact assessment
- Task 4: Customer benefit assessment and cost benefit analysis tool.

3.1. Task 1: Validating viable ancillary service markets

The first task was to map CLASS services to the balancing services required by NETSO to produce a traffic light system assessment as follows:

Assessment	Description
	The CLASS service meets the stated technical requirement
	The CLASS service does not meet the stated technical requirement
	The CLASS service may not meet the technical requirement as currently stated, however, it is expected that NETSO could consider revising its specifications to allow participation

3.2. Task 2: Market assessment

For each of the accessible ancillary service markets, publicly-available sources will be used to describe the current market conditions, including:

- Market structure for the service (commercial vs mandatory, dispatch vs availability, reporting requirements, penalties for non-provision)
- Technical requirements to qualify for participation
- Prices achieved in £/MWh or £/MW (current and recent historic)
- Overall market size in £m (current and recent historic)
- Competitors: the number, type and size of competitors.

Where possible, the above would be given in quantitative terms. For the future view, a qualitative assessment of each of these topics will be made.

3.3. Task 3: Market impact assessment

For each of the identified ancillary services, an assessment would be made of the impact that introducing CLASS services into the marketplace would have. The impact is expected to be a function of the following variables:

- The potential volume of CLASS services that could be delivered by all DNOs relative to the size of each of the balancing service markets, which would be calculated by scaling up from the response seen in the CLASS trials
- The cost of each CLASS service relative to its competition (both the cost of making the service available and the, presumably negligible, cost of dispatch)
- The competitiveness of the particular balancing service market (one or two existing providers with rolling contracts vs large number of smaller providers with regular tendering)
- Any technical differences between CLASS and the incumbent providers that may be taken into account by the NETSO when assessing tenders (eg fine control of frequency response).

The above assessment will be made both on the current state of each market and the expected future market.

3.4. Task 4: Customer benefit assessment and cost benefit analysis tool

To identify the consumer benefits accruing via:

1. CLASS reduces the overall cost to NETSO of procuring balancing services, some proportion of which would translate into reduced balancing services use of system (BSUoS) charges imposed on suppliers; this may be passed through to consumers but this will depend on competitive pressures in the supply market, and any pass-through obligation that may be imposed
2. NETSO paying for balancing services provided by CLASS, the net benefit of which (after installation and operating costs) would be shared with customers.

These benefits would be assessed for each ancillary service and expected to take the following form:

- The net societal benefit of the scheme (reduced balancing services cost minus the opex and annuitised capex associated with CLASS)
- The portion of that benefit that accrues to NETSO
- The portion of that benefit that is passed to consumers via reduced BSUoS charges
- The lost revenue faced by incumbent balancing services providers
- The portion of Electricity North West's additional revenue that is passed through to consumers
- The portion of Electricity North West's additional revenue that is held by its shareholders.

The CBA tool is in the form of a Microsoft Excel workbook.

4. THE OUTCOMES OF THE PROJECT

The main outcomes from each task of the CLASS project are detailed below.

Task 1: Validating viable ancillary service markets

Figure 4.1 below summarises the ability of the CLASS services to meet the requisite characteristics to be eligible for entry. See Section 4 of the Baringa report for further detail.

Figure 4.1: Summary of the eligibility of the CLASS services

Product	Eligibility	Summary
Firm frequency response		
Primary (low)		10 MW de minimis deliverable through aggregation. Service delivery through switching out a transformer
Secondary (low)		10 MW de minimis deliverable through aggregation. Service delivery through changing positions of transformer tap changers
High		10 MW de minimis deliverable through aggregation. Service delivery not covered as part of CLASS trial – though tap stagger could unlock a high service at the ramp rates that NETSO requires
Fast reserve		50 MW de minimis deliverable through aggregation. Service delivery through changing positions of transformer tap changers
STOR		Meets 1 MW de minimis. Service delivery through changing positions of transformer tap changers, though erosion of provision from changing baseline, or compensation of equipment working on switched power supplies (for example) may require derating/layering of CLASS to maintain a response for the duration
Reactive power		Absorption achievable through varying degree of tap stagger. CLASS trials achieved this manually, though working assumption is that this would be deliverable under ICCP control for any rollout

The Baringa analysis confirms the finding of the original project that the CLASS services are eligible for providing services into the balancing markets.

Task 2: Market assessment

This is covered in detail in Section 3 of the Baringa report. One of the key attributes of CLASS is its rapid response and that the trials of the CLASS technology to date have focused on short ramping, short duration balancing service products; their report focuses on the following services where the value of CLASS could be greatest:

- Firm frequency response (FFR)
- Fast reserve
- Short term operating reserve (STOR)
- Reactive power.

Their report summarises key elements of the various markets which is summarised below in Figure 4.2.

Figure 4.2: Summary of the key characteristics of each balancing service

Name of product procured forward	Ramping time and duration	Description (written from perspective of a generator)
Firm frequency response *Primary*	Ten seconds, hold for further 20 seconds	Increase output for frequency containment (containing the change in system frequency)
Secondary	30 seconds, hold for further 29.5 minutes	Increase output for frequency restoration (restoring the frequency back to the target 50Hz)
High	Ten seconds, hold (indefinite)	Decrease output for frequency containment (containing the change in system frequency)
Rapid (Low and high)	Five seconds, hold for 20 seconds (low) and indefinite for (high)	Either increase or decrease output for frequency containment (Containing the change in system frequency)
Fast reserve	Two minutes, hold for 15 minutes	Increase output for replacement reserves (replacing faster response services to enable them to return to "standby")
STOR	240 minutes, hold for up to two hours	Replacement reserves (replacing faster response services to enable them to return to "standby")

The market assessment is further developed in Section 5 where Baringa use the 2014/15 market information to produce supply stacks for each of the current balancing services markets. These indentify the volumes and costs of meeting NETSO's requirements. Comparable stacks are prepared for the future scenario (2027) and for each of the balancing services.

Figure 4.3: Supply stack representation of each balancing service

Task 3: Market impact assessment

This is covered in detail in Section 6 of the Baringa report.

The report assesses the overall impact of CLASS participating in the market for balancing services. This assessment is performed both in the current market structure (from the 2014/15 full year of balancing services results), and in a future scenario (2027), where NGET's requirements have changed, and where the stack of providers has a different composition from currently.

The section focuses only on the quantifiable impacts of introducing CLASS into the balancing service markets. The underlying assumption is that CLASS displaces the most expensive existing providers of those services, and that once displaced these providers no longer operate in balancing service, although they may continue to operate in the electricity market.

The benefit of CLASS is given in terms of reduced balancing service costs. The net benefit to the different stakeholders (NGET, DNOs and GB customers) is a function of the price at which CLASS is offered into the balancing service markets of CLASS; the net benefit is shown under a range of pricing

strategies. This section considers the effect of offering CLASS under what is considered to be the two extremes:

- ***LRMC pricing:*** DNOs offer CLASS at a cost that allows them to recover their initial capex and ongoing opex assuming a regulated weighted average cost of capital (WACC) and discount rate, and
- Shadow ***marginal pricing:*** DNOs offer CLASS at the volume-weighted average price of the firm balancing service providers that they would be displacing.

In the short-term it is assumed that 200MW of peak CLASS capability will be deployed, so this figure is used as the basis of the 2014/15 impact assessment. By 2027 it is assumed that 3 000MW of peak CLASS capability could be deployed. The capability at any specific period in time will be lower than this maximum level, since capability varies as a function of the underlying demand.

Task 4: Customer benefit assessment and cost benefit analysis tool

Section 7 of the Baringa report shows a cost benefit analysis (CBA) of CLASS over multiple years based on the analysis described in Section 6. It reflects all of the quantified impacts discussed in the previous section, and shows how the costs and benefits accrue to different stakeholders.

The distribution network licensees received clarification from Ofgem during the CLASS extension period as to how costs and benefits associated with CLASS implementation would be treated from a regulatory perspective. In March 2016 Ofgem issued a direction to all DNOs that "distribution network voltage control and network management services procured from the DNO by NGET for the purposes of its system operator residual balancing activity should be included in category Directly Remunerated Services 8 (Valued Added Services) (DRS8)". The reasons for this view are that:

- These services will utilise existing DNO assets
- The inclusion of the services referred in category DRS8 will mean that:
    - DNOs will be incentivised to provide these services to NGET and this should benefit consumers by contributing to the efficient procurement of system balancing services
    - Customers should benefit by sharing any net revenue received by DNOs for these services.

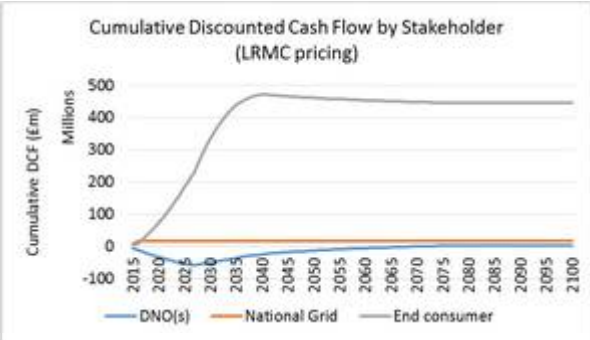
Depending on the pricing strategy, an amount of revenue is generated from providing CLASS. The three parties incur costs and revenues by the following logic:

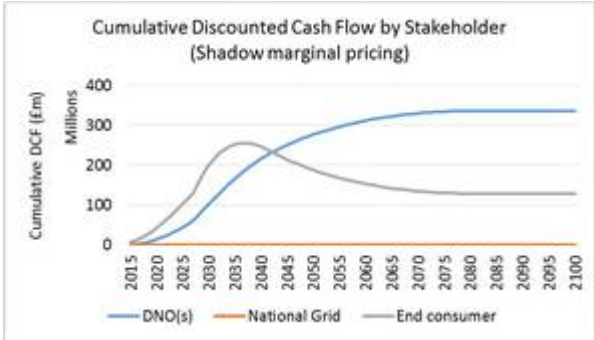
- ***DNO:*** Under DRS8, the cost of CLASS and any payments from NGET are netted off and shared between the DNO and the DUoS customer. The DNO receives some revenue (or incurs costs) in year 1 as "fast money", while an amount is added to its regulated asset value (RAV), resulting in payments from DUoS customers (through increased DUoS charges) over 45 years.
- ***NGET:*** The majority of the savings seen from reduced balancing services costs are passed through to customers, but for the first two years it is assumed that NGET receives 30% of the net benefit through incentive payments.
- ***Customers*****:** Customers benefit through two routes. They receive reduced BSUoS charges from the reduced cost of balancing services (net of any NGET incentive). While they share the cost of CLASS with the DNO, they also share in the benefit.

Analysis was undertaken for the estimated projection of CLASS deployment across GB. In this case, it was assumed that CLASS volume is added incrementally in each year, following a linear path from 2014/15 to 2027. Figure 4.4 below shows the overall potential benefit is £466.1 million.

Under LRMC pricing the DNOs are almost neutral in NPV terms, with most benefit passing to end consumers via reduced BSUoS payments, while under shadow marginal pricing, DNOs are the main beneficiaries. However, it should be reiterated that in reality this volume of CLASS will not be provided by a single DNO. In the future, DNOs faced with competition from existing CLASS providers and expecting future declines in value from the balancing services markets may not be able to form a positive business case for CLASS services.

Figure 4.4: CBA for projected CLASS deployment under two pricing strategies





	Value (£m, 2015 real)	Year NPV turns positive
DNO	**3.9**	**2069**
National Grid	**17.0**	**2015**
End Consumer	**445.1**	**2015**
Total	**466.1**	

	Value (£m, 2015 real)	Year NPV turns positive
DNO	**336.3**	**2015**
National Grid	**1.3**	**2015**
End Consumer	**128.5**	**2015**
Total	**466.1**	

5. PERFORMANCE COMPARED TO THE ORIGINAL PROJECT AIMS, OBJECTIVES AND SDRC

Figure 5.1: Successful delivery reward criteria

Title	Criterion	Required evidence	Evidence
Learning and dissemination workstream	5. Hold webinar by February 2016 and host a learning event by April 2016 on the market implications of the CLASS services	5. Webinar and learning event held by 30 April 2016	Webinar Learning event
Closedown	2. Produce an addendum to the closedown report to publish the outputs of the customer benefits workstream by 31 May 2016	3. Publish addendum to closedown report on CLASS website by 31 May 2016	Addendum to project closedown report
Customer benefits workstream	1. Deliver market impact assessment, customer benefit assessment and cost benefit analysis tool(s) by 31 May 2016	1. Publish report detailing the methodology and results of the benefits modelling and associated model(s) created for the analysis by 31 May 2016	Baringa report Baringa CBA tool

6. REQUIRED MODIFICATIONS TO THE PLANNED APPROACH DURING THE COURSE OF THE PROJECT

No changes were required to the planned approach.

7. SIGNIFICANT VARIANCE IN EXPECTED COSTS

Figure 7.1: Expenditure table detailing variance from budget

£000s Cost Category	Total Forecast	Budget	Variance	Variance	Reasons for >10% variance
Labour	**243**	**243**	**0**	**0%**	
Project management for extension	61	61	0	0%	
Technical and regulatory support to consultants	182	182	0	0%	
Contractors	**158**	**260**	**102**	**39%**	See below
Market modelling research	113	210	97	46%	
Policy documentation	45	50	5	10%	
Contingency	**0**	**43**	**43**	**100%**	No requirement to utilise the contingency
General contingency	0	43	43	100%	
Other	**64**	**76**	**12**	**16%**	See below
Publicity and dissemination	57	69	12	17%	See below
Accommodation	7	7	0	0%	
TOTAL	**465**	**622**	**157**	**25%**	

The request for an amendment to the project direction included estimates of the consultancy costs that would be required to undertake the market modelling and policy documentation work. In the event, the actual costs that have been incurred are less than originally estimated. The costs associated with publicity and dissemination were also less than anticipated.

The project also included estimates for knowledge transfer and support from expertise developed during the original CLASS project including some work to ensure the commercial modelling was using accurate data. Overall the actual costs incurred are less than originally estimated.

8. UPDATED BUSINESS CASE AND LESSONS LEARNT FOR THE METHOD

Financial benefits conclusion

The cost benefit analysis undertaken by Baringa has indicated that the potential benefits of deploying CLASS on a GB basis could amount to £466 million. Depending on the pricing strategy that is adopted, the benefits to customers are projected to be in the range of £128 million to £455 million.

Carbon benefits conclusion

The Baringa report identified the potential carbon benefits from deploying CLASS. This was quantified at £0.2 million in the first year and rising to £3.5 million in 2027.

9. PLANNED IMPLEMENTATION

The CLASS project used existing off-the-shelf products to which configuration changes and some new designs of AVC schemes (Argus 8) were made. As such there are no technical hurdles to prevent the full rollout of CLASS in any GB DNO. Following further consideration of the implementation approach, Electricity North West is looking to procure new enhanced automatic voltage controllers to undertake the CLASS functionality. This will enable further development of CLASS services to enable the maximum value from the approach to be realised.

The planned implementation of the CLASS service may modify the data available for the ongoing monitoring study from the original project.

10. LEARNING AND DISSEMINATION

The Baringa report and the public CBA tool are the key elements of the dissemination approach to ensure sharing of project learning. This was supplemented by the learning event in April 2016 where the findings and approach were communicated to stakeholders.

Electricity North West intend further dissemination of this work at the 2016 Low Carbon Networks & Innovation conference and anticipate continued interest from the industry post the completion of this project.

11. KEY PROJECT LEARNING DOCUMENTS

Key learning documents are listed below. A more extensive range of project-related key documentation can be found on the project website.

Figure 11.1: Key learning documents

Title	Date	Summary	Website link
Baringa report	31 May 2016	Assessing the impact of CLASS on GB electricity market	Baringa report
Baringa cost benefit analysis tool	31 May 2016	Excel model which allows users to assess market impacts of CLASS	Cost benefit analysis tool
Addendum to closedown report	31 May 2016	Report summarising the output from the project extension	Addendum to closedown report

12. CONTACT DETAILS

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13. APPENDICES

APPENDIX A: LEARNING AND DISSEMINATION ACTIVITIES

Figure 13.1: Learning and dissemination activities

Date	Activity	Audience	Evidence
Dec 2015	Briefing presentation to other DNOs	DNOs	Slide presentation
Feb 2016	Webinar	All interested external stakeholders	Webinar slide presentation
Feb 2016	Podcast from the webinar	All interested external stakeholders	Webinar recording
April 2016	Knowledge sharing event	All interested external stakeholders	Knowledge sharing event slides

APPENDIX B: GLOSSARY OF TERMS

Figure 13.2: Glossary

CBA	Cost benefit analysis
DNO	Distribution network operator
DUoS	Distribution use of system
EAVC	Enhanced automatic voltage controller
FFR	Firm frequency response
GB	Great Britain
ICCP	Inter control centre communication protocol
NETSO	National electricity transmission system operator
NG	National Grid Electricity Transmission
RP	Reactive power