Review of Low Carbon Network Fund proposals

Report to Expert Panel

Scottish Power Distribution

SPT2001: Demand Side Management of Electric Storage Heating

8th October 2010

Report prepared by TNEI and Arthur D. Little
for project commissioned by Ofgem

Report Context

This report has been prepared for the Expert Panel with the aim of supporting them in their funding allocation decisions for the Low Carbon Network Fund.

Having reviewed the submission pro-forma and all of the supporting material, as well as answers to clarification questions we have put to the DNO, this report is intended to serve two purposes:

- it sets out any factual clarifications that we believe would be helpful to the expert panel when considering the submissions, based on information or data that is not immediately apparent or available in the pro-forma or Appendices A-E; and
- it highlights any concerns we have in any particular areas from, for example, either a technical, commercial or deliverability perspective, that the Expert Panel may wish to explore further with the DNO.

Consequently, the Expert Panel can assume that the factual content of the submission pro-forma to be sound unless noted otherwise in this report.

In writing the report we have avoided merely reproducing large parts of the submission, which stands on its own merits for the Expert Panels' consideration.

This report does not seek to assess the quality of this submission or rank it against any others. In particular, it does not provide any opinion as to whether the proposal should be funded. This is the role of the Expert Panel.

This report is not intended to be read in isolation and should be reviewed alongside the pro-forma and compulsory appendices.

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Project: Demand Side Management of Electric Storage Heating

Description of Project (summarised from pro-forma Box 1)

The Demand Side

Scottish Power Distribution is proposing to install more sophisticated control systems on electric heating replacing radio tele-switching for 1000 customers in a single supply area of Glasgow. The new system will offer two way communications.

Problem

In the transition to a low carbon economy it is anticipated there will be a significant uptake of electric heating and electric vehicles in response to the Government's strategy to reduce emissions from the heat and transport sectors. Significant increases in electric heating and electric vehicles could have an adverse impact on the electricity networks if this load growth is not carefully managed or controlled. In addition to provide a sustainable solution, this demand may need to be controlled to match low carbon generation such as wind. Traditional demand management will need to become more granular and dynamic.

Solution

The solution is to allow new load growth in electric heating and electric vehicles to connect in a manner that meets customer need and lifestyle without excessive costs or problems for the UK network. Electric storage heating is an important part as it provides energy storage and flexible demand response. Taking advantage of this requires that local distribution network constraints can be managed simultaneously.

Method

This project will trial a demand control unit capable of two-way communications as a potential replacement for the existing radio tele-switch, which will be used to provide individual switching control of storage heating loads and capture power quality information. The demand control units will form a part of a novel dynamic load management system scheduled from a centrally located system. It will trial the optimisation of stored energy charging in response to a number of operating conditions and network constraints.

Project

This project will be a trial of 1000 households with existing electric storage heating in low and high rise accommodation in the greater Glasgow area. The new demand control unit will provide real-time fine-control of each storage unit from a centrally located demand management system in Scottish Power's control centre. One objective of the trial is to smooth the overall demand requirements of 4MW of storage heating while balancing the network supply. Temperatures in the properties will be monitored to ensure no change from the current arrangements. The demand control system will be capable of optimum heating solutions to inputs such as wholesale pricing, generation type matching, emissions etc. It will provide learning for electric vehicles and other new technologies.

Key Project Figures

Project
Funding requested: **£2.8M**
Total Project value: **£3.8M** **(including contingency)**
Direct Benefit: **£0.0**

Roll-out	**Proposal**	
Total Carbon Benefit (discounted):	**£2.2B**	**Total Other Benefits (discounted):** **£3.8B**
Total Costs :	**£63M**	
Net Benefit :	**£5.9B**	
Carbon Saved (undiscounted):	**66.5 million tonnes**	

TOTAL WITHOUT CONTINGENCY	3,502,200
Percentages of total cost	
Contingency	9.6%
IT	0.0%
Equipment	46.5%
Staff	40%
Internal	*23%*
Contractors	*17%*
Payments to consumers	1%
Decommissioning	2.9%
Other	9%

EXPLICIT PROJECT MANAGEMENT LABOUR	
Project Working Days	678
Labour Days	1970
Full Time Equivalents	2.9
Project Management	£799,000
Relative to Project Cost	21%

		FUNDING PROPORTION OF TOTAL ITEM COSTS			
Key Items	**Total Cost**	**External**	**LCNF**	**DNO**	
				Compulsory	**Extra**
Labour	799,700	3%	87%	10%	0%
Equipment	1,627,000	22%	70%	8%	0%
Contractors	584,500	17%	75%	7%	0%
IT	-	-	-	-	-
IPR Costs	-	-	-	-	-
Travel & Expenses	41,000	0%	90%	10%	0%
Payments to users	50,000	0%	90%	10%	0%
Contingency	336,000	0%	90%	10%	0%
Decommissioning	100,000	0%	90%	10%	0%
Other	300,000	33%	60%	7%	0%
Total	**3,838,200**	**15%**	**76%**	**8%**	**0%**

Summary of independent analysis

General View:
At present demand is switched as large groups of load, this project is novel in that it provides individual customer level granularity of load switching as well as trialling different demand side management (DSM) control algorithms.

This project comes across well as a clearly defined and focused single issue project. The project cost and balance look appropriate for the scale and scope of the project. The project is likely to be delivered effectively, the tasks are clearly articulated and project design is not overly complex. The collaborators have a strong track-record and are organised appropriately. There are some remaining residual issues however the initial feedback from Scottish Power Energy Networks has alleviated many of these concerns.

Significant Issues:
The programme shows the trials starting and running over summer period which is not likely to be good for heat demand and therefore the learnings would be questionable.

Specific Issues:
- Network related concerns were around how they would manage the potential for conflict between network and market related drivers on the control of the heating load. Scottish Power confirmed that a key part of the trial is to address these aspects and determine the appropriate control algorithms.

- Technical performance and therefore success of the scheme will in part depend on the ability of the storage heater to effectively store heat over more extended periods of time than is typical for current designs. Scottish Power confirmed that the recent refurbishment included replacement of all of the storage heaters. Scottish Power do not envisage any adverse reaction but will be monitoring this closely. This is in fairness is one of the objectives to test whether this will actually work or what customer side changes may be required.

- The project is limited in scope (by design) to DSM of electric heating directly controlled by the DNO in question, so while the principles of the learning will be applicable to other DNOs, the direct impacts captured in the trial would not because these related to wider industry control and operation.

- The project proposes to incentivise consumers through £40 credit on bill in return for participation in the trial. This seems low and we would have concerns over whether this is sufficient to incentivise involvement. Scottish Power responded that the sum of £40 was deemed to be appropriate from previous work and market research that Scottish Power Energy Retail have undertaken.

- The target group (socio economic background) and environmental conditions may not be typical throughout the UK.

- The linkage between risk assessment and contingencies is not clear and the risk assessment does not discuss risks to project timing directly – particularly in the advent of customer suspicion, reluctance or apathy.
- The carbon savings assume 5% demand-side response (shift of demand from peak to off-peak) as a result of the solution. If you treat this project as an enabler then this is correct, but the project does not capture, for example, direct interactions with embedded intermittent generation or electric vehicles, or DSM as a result of other incentives.
- Key collaborators include GE Energy and BT (subcontracting to Arqiva and Detica) who all have strong track-records, however it is not clear whether the role for these collaborators is as equipment/service suppliers, or playing a more active role in the project development and implementation.
- There are a number of areas where more clarity is desirable in project design, the approach for integrating risk assessment into project design and specific roles of partners

1. Accelerates the development of a low carbon energy sector

Summary:
The project is aligned with the need to understand demand side management on the network, although it focuses on DNO controlled DSM and does not consider incentivised DSM (ie, via tariffs or pricing).

It indirectly allows the DNOs to understand the flexibility available on the network, and hence the scope for connecting embedded renewables or accommodating electric vehicles within the distribution network itself, although the trial itself does not test DSM in conjunction with these aspects.

The method is robust, and is capable of being rolled out to other networks. While this is true for the overall learnings its direct applicability may not be as wide due to the demographics of the trial population.

1.1. The proposal is closely aligned to priorities outlined in the current Low Carbon Transition Plan	The scheme proposes additional monitoring combined with demand side management to control system demand by the un-intrusive use of customers own electrical storage heaters. The trial utilises demand display units, but there is no facility for the customer to actively shift load as part of the trial; though any proposed roll-out would utilise smart metering offering such interaction through the switching feature or dynamic tariffs. The scheme affords the DNO greater understanding of power flow on the network to provide increased utilisation and flexibility and thus reduce the need for network re-enforcement. The project does not explicitly allow for either the quicker connection of or increased numbers of renewables to be connected to the distribution network or electrification of transport. However the learning's can be used and will provides DNOs with the controllable flexibility via DSM to be able to respond to unpredictable renewable embedded energy sources, as well as additional demand response to match against centralised wind generation. Current DECC domestic energy efficiency certificates class dwellings with electric storage heaters as "Poor" in terms of their environmental statement, whereas condensing boilers as classed as "Good". This will need to be addressed as part of a coordinated low carbon transition plan.
1.2. The calculations for carbon savings are robust (audit of calculations only)	The calculations are robust. The carbon saving are valued using DECC's Traded Carbon Prices.
1.3. The carbon benefits of the project are credible	Overall the carbon benefits are credible. They take a conservative approach to total demand (Pathway Alpha from the DECC Pathways report) and a 5% reduction in energy consumption from 2020.

	There is a concern as to whether all of this 5% of demand response can be attributed to the method being trialled (demand side management controlled by the DNO) as opposed to DSM induced by other incentives.
1.4. Extrapolation for roll-out is both statistically and technically sound, reliable and/or verifiable.	The extrapolations is sound, with no conservative approaches taken where extrapolations are required (i.e. reinforcement costs are assumed to remain flat).
1.5. Total energy system consideration as well as for DNO	There are no further assumptions on customer or supplier behaviour other than demand-side response.
1.6. Assessment of Method's credibility	The trial tests demand side management utilising the electrical heating of over 700 customers (target of 1000) in an urban environment and thus the learning's can be considered scalable both within the DNOs own network and across all other DNOs. The target group (socio economic background) and environmental conditions may not be typical throughout the UK.
1.7. Significance of the Deliverable	The project demonstrates the use of demand side management to reduce the impact of peak loading on the distribution network and consequently allows more flexible management of the system and reduces the need for network re-enforcement.
Re-estimation of carbon benefits on the basis of "correcting for erroneous assumptions" or re-baselining	

2. Has the potential to deliver net benefits to existing and/or future customers

Summary: The proposal does have potential to deliver net benefits to existing and future customers. Using the assumption of a 5% demand-side shift as a result of the method (see above for comments on this assumption), then the benefits appear reasonable. They consist of carbon savings from displaced demand, avoided reinforcement cost, avoided capital cost for generation build, and avoided wholesale cost. The relatively modest roll-out costs are the result of an assumption that the smart meters being rolled out will have the functionality being trialled.

2.1. The calculations for net benefits are robust	The calculations for net benefits are robust.
2.2. The benefits claimed are credible	The benefits claimed – in addition to carbon savings – are for deferred reinforcement costs (assuming 5% demand displacement and network reinforcement costs from DPCR 5), generation capital expenditure avoided (using Ofgem figures) and annual wholesale electricity costs (using Ofgem figures).
2.3. The costs are credible	The roll-out costs are credible – assumption of one-off £10 million cost per rollout with ongoing £100,000 cost per annum per DNO. We note that there is no assumption of on-going incentive payments to consumers. The roll-out costs assume that the functionality required will be incorporated into the smart meters, and that there will be an effective way for the DNO's to send the necessary signals via the smart meter communication networks. Costs and Benefits have been inflated at 2.5% per annum.
Re-estimation of net benefits on the basis of "correcting for erroneous assumptions" or re-baselining	

3. Has a Direct Impact on the operation of the distribution system

Summary:
This project will have a direct impact on the distribution system as it allows optimisation of network asset loading and reduction in long term requirements for network reinforcement.

The project can be rolled out in part with smart meter functionality. It fits alongside the existing RTS (Radio Tele Switch) or RTS replacement system so it should be easily scalable nationally.

The trial will provide improved understanding of customer behaviour in relation to DSM. It may influence design of future schemes.

There is a clear outline of the system, installation and operational philosophy. This is clearly a trial at sufficient scale to obtain useful measureable information. It has a focus on single activity of controllable electric storage demand with customer comfort monitoring and control groups to measure performance against.

3.1. Directly contributes to the planning, development and operation of an efficient distribution system.	Potential risk of conflict between peak management versus utilisation of low carbon generation. This was also highlighted in the recent ENA report on DSM as a conflict of objectives. Adoption in current form requires existing electric storage heaters, the percentage of UK of homes with these currently and assumption for the future has not been clearly stated. Potential for EV integration but not a tested part of this trial.
3.2. The size of benefits that can be attributed to the Distribution System, taking into account the level of funding requested.	Not clear whether this is definitely Low Carbon Networks, or something that should be supplier driven. Clearly DSM is about networks, but demand flexibility for low carbon generation usage is more a supplier/retailer remit. Needs to be clarified whether this will actually look at wind balancing or wind following as part of the trial and how the conflict between network constraints versus high wind generation will be managed. *(Clarification indicates that it will address these issues as part of the trials)* Also to test implications on supplier balancing position in the event that distribution network constraints are reached, and how this will be reported and reconciled.

4. Generates new knowledge that can be shared amongst all DNOs

Summary:
At present demand is switched as large groups of load, this project is novel in that it provides individual customer level granularity of load switching as well as trialling different DSM control algorithms.

Monitoring will cover both pre-existing electrical demand as well as internal temperatures within 100 of the homes and external temperature at the local substation. The trials will also have a control group that will not be part of the new switching scheme to provide a baseline for reference.

Learning on heat demand modelling is transferrable as well as learning from the Energy Retail business on other ways of using and managing DSM in a market/retail sense.

Knowledge is predominantly single type around demonstration of DSM on electric storage heating. BT (and Arqiva/Detica) alternative communication solution will be demonstrated as part of this which is learning for smart meter roll-out and potential smart grid applications.

The dissemination plan has a clear list of activities shown ranging from internal team briefings and corporate communications through to site visits for other DNOs/interested parties, published papers and a Web Portal.

There is a range of outputs from high level information through to detailed academic analysis at undergraduate and graduate level.

Learning Chain Summary:
Project has elements of Data, Information, Knowledge and Learning

4.1. Robust methodology to capture the results from the Project	One unknown is the quality of the electric storage heaters in the buildings and whether these have been refurbished. *(Confirmed that they were replaced as part of the refurbishment)* Will the trials be done as a true blind or even double blind to ensure that the behaviour is not affected by the fact this is a trial?
4.2. Applicability of the new learning to the other DNOs.	Storage heating in a mixture of high rise tenement and low-rise. This appears to be social housing and as such whether the learnings can be applied to all social groups or predominantly applicable to that group and that style of housing Learning on heat demand modelling is transferrable as well as learning from Retail business on other ways of using and treating DSM in a market/retail sense.
4.3. Effective plans to disseminate learning from the Project	Clarity on whether the raw data would be made available to other parties. Also whether the collaborator learnings would be disseminated in a similar fashion or this is just the DNO teams. Gantt chart only shows dissemination activities at the back end of the project. More detail on the timing of the activities would be appreciated

4.4. Knowledge generated is novel including innovative plans, tools and techniques which will be shared openly and easily with DNOs.	Not clear if SPEN, BT and GE learnings will also be disseminated General scale of learning is in proportion to scale and cost of project
4.5. Effective treatment of IPR. (Where a DNO wishes to deviate from the default requirement for IPR)	Default IPR conditions with possible exception if software development generates significant IPR Clarify which partner wants software IPR and what this IPR may be and why this should not be subject to default conditions. If IPR is on the table, then they have indicated software development will be at their own cost, what are the implications on the project cost if this happens? *(Clarified that GE Energy was the partner interested in IPR)*

5. Involvement of other partners and external funding

Summary:
Key parties involved in the project are summarised below. Organisations with an asterisk represent organisations which could have been categorised as collaborators

	Equipment providers	***Comms. providers***	***Energy retailers***	***Academic organis-ations***	***Project managers/ consultants/advisors***	***Public sector players***
Collaborators	GE Energy	BT	SP Energy Retail			
Partners					Scottish Power Energy Management	Glasgow Housing Association* Glasgow City Council
Others mentioned		Detica/ Arqiva (subcontracted by BT)	Other energy suppliers have been approached			

Collaborators
SP Energy retail is under the same ownership as DNO; this is not seen as an issue and it is noted that the project has made efforts to engage with other retailers operating in the project site.

Collaborators GE Energy and BT whose main role appears to be equipment supply for the project; the split between collaborators and suppliers is not clear. Funding and benefits are clearly articulated and the share of benefits appears appropriate to contributions made

The key areas of expertise are covered with no gaps identified. These represent a small group of large multinationals and universities with previous experience of similar projects. Given the project size/complexity, there are an appropriate number of collaborators.

Collaborators all have track record as they are primarily - large multinationals with previous experience of similar projects.

Partners
The specific role of Glasgow City Council is not clear.

The means by which Scottish Power Energy Management will engage in the project are not explicitly discussed

External Funding
The project is not dependent on further external funding sources. The proposal lists funding provided by collaborators (Funds committed are between £105k and £245k); these mainly reflect discounted costs and supply of equipment/materials.

6. Relevance and timing

Summary:
Timing and technology fits easily alongside Smart Meter roll-out plans, does not duplicate functionality as the implementation is only for the DSM trial purposes. It will provide learning to assist future transition to electric storage heating as part of the low carbon transition plan.

The learning will be used to aid network investment decisions for increases in electric heating and electric vehicle technologies. In particular it has potential to improve asset utilisation, investment deferral/avoidance, life extension etc.

Electric heat storage is a viable technology and provides a relatively easy transition onto a low carbon footing provided that it is matched by low carbon generation sources. It matches the requirements of flexible demand to help with management of distribution network constraints and system level intermittent generation integration.

6.1. The timing of the project is appropriate	The project does line up well against low carbon transition plans and the project does adopt the ENSG (Electricity Network Strategy Group) philosophy of "think big, start small, scale fast". If anything, the "Think Big" element has not been as clearly stated as it could have been.
6.2. Use of solution as part of their future business planning and how it would impact on its business plan submissions in future price control reviews, including DPCR6.	These benefits are useful although arguably not strictly Low Carbon in their own right. Opportunity to facilitate the update of technologies for Low Carbon Networks with all key parties, i.e. Suppliers and Consumers.
6.3. Focus on developments associated with a move to a low carbon economy that are more likely to happen.	The potential for extension to domestic hot water, and the question on how to replace water radiator based heating systems were not addressed.
6.4. Time to tangible results	Program shows the trials starting and running over summer period which is not likely to be good for heat demand. Customer engagement not until 06/2011 and installation 12/2011. Quite a long lead-in time for the initial customer engagement and why this could not be started earlier. Installation timescale is probably realistic.

7. Demonstration of a robust methodology and that the Project is ready to implement

Summary:
The project has clearly articulated tasks and project design is not overly complex. The plan describes interdependencies between equipment approvals and customer engagement; and between DSM and communications providers.

All main collaborators have scale and quality to deliver the project; the responsibilities are allocated clearly for equipment providers; community engagement mentioned under several players;

The project plan involves establishing collaboration agreements between 12/2010 and 01/2011); project complexity unlikely to require significantly more activities prior to start-up. All main relationships are supported by letter of intent.

Uncertainties in costs are reflected by contingencies in costs broken by key topics. The project has requested the default cost protection. The project does not envisage any direct benefit and therefore no protection is applied for. However the links between risk assessment and the project cost/schedule are not clear.

The project is trialling demand side management of electric storage heating in a number of tenement buildings in the Townhead area of Glasgow. The scheme utilises existing technology but in an application not currently used by DNO's and therefore is novel in that regard.

Scottish Power has assessed the associated technical and project risks and has mitigation in place in terms of both a readily available fall-back position of the pre-trial condition and an alternative test group.

Collaborators have been identified, agreements are in place and a detailed project plan produced with responsibilities and inter-dependencies clearly shown.

7.1. Detailed Project plan, with responsibilities clearly established and inter-dependencies identified.	This is a straightforward project with key links/independencies highlighted The project design is not overly complex and all tasks have clearly articulated; Interdependencies have been provided between equipment approvals and customer engagement; and between the DMS /communications network.
7.2. Resources to deliver the Project are of a sufficient size and quality to be reasonably expected to ensure its delivery.	Community engagement is led by SP Energy Retail but supported by the Glasgow Housing Association; it is not clear how this will be led Details of the contribution of other partners is not clear in all cases: - Glasgow City Council endorses the project but not clear if it is making an active contribution - Unsure on size of team at the project partner, Scottish Power Energy Management and resources required to "analyse and assess the commercial impact of dynamic controllable demand on electricity network and customers" All main collaborators have scale and quality to deliver the project and responsibilities allocated clearly for equipment providers. Community engagement has been mentioned under several players and the role of Glasgow City Council is not clear.

7.3. Demonstration that the Project can be started in a timely manner.	The team structure is organised and ready to proceed. All main relationships supported by letter of intent with the establishing collaboration agreements planned for between 12/10 -01/11. The project complexity is unlikely to require significantly more activities prior to start-up.
7.4. Risks to costs and benefits of the Project have been reasonably estimated.	While linkage between risk assessment and contingencies not clear, the risks to costs are not considered to be substantial given the identification/costing of items and specific contingency included. The risk assessment does not discuss risks to project timing directly: for instance. If GHA tenants fail to engage, the mitigation measure is engage with N. Lanarkshire Council - the implications of timing for this are not mentioned. The Project does not envisage any direct benefit and uncertainties in costs are reflected by contingencies in costs (box10) broken by key topics. Non-participation is likely to be the biggest risk to this project.
7.5. Assessment of proposed cost overrun percentage (if non-default?)	Default applied
7.6. Assessment of Direct Benefit protection (if non-default?)	Default applied
7.7. Identification of appropriate risk mitigation processes	The project requires more than 700 properties (1000 target) to justify learning from the project. In the event of this number not being reached an alternative customer group has identified as a fall-back position
7.8. Direct Impact on Distribution Networks on roll-out has been correctly identified	DNO's will have to change from passive control to active demand side management and thus has an Impact on planning, development and operation.
7.9. Immediate Project impacts on the proposer's network have been correctly identified	The impact on the distribution network is minimal but the scheme carries the risk of faulty equipment inhibiting heating. The system has been designed as fail safe where possible issues. In all cases it is possible to revert back to existing RTS system in the event of failure.
7.10. Customer Impact and change required have been correctly identified	The project proposes to incentivise consumers through £20 credit on bill at start and £20 at end These seem low and whether this is sufficient to incentivise involvement. *(SPEM have confirmed that from market research and prior experience this level of incentive will be sufficient)* The roll-out of the scheme once accepted is un-intrusive but will require

	customers to install heat stores that hold heat efficiently and delivery heat effectively. The scheme needs to consider domestic hot water and how changes from combi-boiler type systems will work. Risk to low-income customers having to use overrides because insufficient heat stored, this will increase their heating costs as the over-ride is metered by the standard rate tariff rather than the low rate tariff.
7.11. Technology Viability	Very simple scheme. There may be issue with demand side load algorithm and communications but this should be resolvable within the timescales and is effectively what the trial is about. It is possible to revert back to existing RTS system in the event of failure as this remains in service as the Master and the new system is designed to fail-safe.
7.12.Successful Delivery Criteria	Revised successful delivery criteria align with project milestones and timescales provided. Needs to cover customer engagement aspects and report on different method success and future recommendations for engagement
7.13. Contractual proposals	The project appears to be based on credible contractual arrangements; it is also seeking to involve other energy suppliers See customer incentive mechanism in 7.10
7.14 Derogations and exemptions	