Review of Low Carbon Network Fund Proposals
Final Report to Ofgem and Expert Panel

Western Power Distribution (South West)

B.R.I.S.T.O.L

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II Report Context

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

This report has been prepared from Western Power Distribution (East Midlands) (WPD) Low Carbon Network Fund Tier 2 Submission of 18th August 2011 and the supporting information received by the Consultants from WPD prior to their final presentations and clarifications to the Expert Panel and Ofgem on the 3rd October 2011.

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

- It sets out any factual clarifications that may 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 submissions; and

- It highlights any concerns 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 may assume that the factual content of the submission pro-forma to be sound unless noted otherwise in this report. For clarity in producing this report and the associated documents the Consultants have avoided reproducing large parts of the submission verbatim, which stands on its own merits for the Expert Panel’s 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 report and any associated documents are not intended to be read in isolation and should be reviewed alongside the pro-forma and compulsory appendices.

III Notice

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IV Circulation

Name	Role	Reason for Issue
Ofgem	Client	Final
Expert Panel	Stakeholder	Final

V References

Ref.	Details	Published by	Issue date
01	LCNF Governance Document Version 4	Ofgem	April 2011

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1. Summary

1.1 Project Description

Project summary	
Objectives	• To strengthen LV distribution networks to support the transition to a low carbon economy using innovative mechanisms that deliver both financial and carbon savings and offer network management opportunities. • The Project combines energy storage (battery) at the customer's premises and integrated network control with variable pricing tariffs. • The Trial is to compare the effectiveness of the Project Method compared to the traditional network reinforcement approach.
Problem	• Technical constraints on the LV network will intensify as the adoption of new low carbon technologies accelerates.
Solution	• The application of emerging smarter grid solutions to avoid delays and costs of traditional reinforcement to overcome constraints
Method	• This proposal is to consider three Methods: (a) battery storage with Demand Response; (b) direct current networks; and (c) a number of variable tariffs. • These will be controlled through two Siemens Devices, LV Network Manager and LV Connection Manager.
Cost	• Total project cost is £2,784k with external funding of £280k. • LCNF Second Tier Funding request is £2,204k.

1.2 Evaluation Summary

The Project proposal is an innovative solution and the Method being Trialled is technically feasible. The overall Project budget is comprehensive and realistic given the Project's scope and objectives, although the experimental nature of the Project is reflected in high costs of equipment in customer premises and substations. The Project will provide modest carbon reduction. It is an innovative but untested solution that includes the introduction of DC circuits in the home.

The development of variable tariffs could provide valuable insights which may also be of benefit to energy retail businesses. Customer willingness to take up the solution and overall acceptance of the proposal could limit the Project. Good project management is in place.

2. LCNF Criteria Evaluation

Acceleration of the development of a low carbon energy sector

- If successful, the Project will contribute to the UK government's Low Carbon Transition Plan (LCTP). It will do this through the installation of battery storage systems in domestic and commercial properties enabling improved demand management, storage of electricity generated by solar PV and customer charging arrangements.
- WPD estimate that the Project will deliver carbon benefits of 1,452 thousand tonnes from roll out up to 2030. This is based on an assumption that carbon emissions reductions from only solar PV are included in Project roll out, and that each unit has a life of 20 years. This figure also assumes that the grid carbon intensity will remain static over time. We estimate that the grid intensity will in fact decrease over time and therefore the cumulative total savings should be closer to 1,200 thousand tonnes of CO_2, using the MARKAL grid intensity factor. This is based on a roll out to 2,480 sites by 2030. WPD also state that roll out carbon benefits account for only those relating to solar PV. As the Method is applicable to electric vehicles (EV) and heat pumps, we believe that overall carbon savings could be higher.
- The Method is Trialling a novel solution. As such, there are no direct comparisons currently in operation.
- The Method is scaled on the basis of network reinforcement of up to 200 distribution substations per year, each with an average of 60kWe installed LCTs. These will be within the WPD network as well as across other DNO networks.

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

- The proposal presents an estimate of the net financial benefits of the Project solution compared with traditional network reinforcement. A positive benefit is forecast, which scales in a linear fashion with volume and exceeds £100m by 2030.
- These forecasts make a number of assumptions. These include a very strong reduction in the costs of equipment from Trial to roll out, and a high level of uptake of the solution by homes on a given feeder.
- Base Case costs are defined by actual costs of conventional network reinforcement for integrating PV into one feeder (Low Voltage overlay and harmonic filtering). Further reference points are required to develop a robust estimate.
- Method costs are based on estimates of the capital costs incurred by the DNO to install new equipment in homes and substations. Product costs are difficult to estimate prior to development and testing, as are domestic installation costs and practicalities. Moreover, cost build up ignores potential upfront costs to customers.
- Cost estimates are based on the Trial area which will include 30 homes (social housing), 10 schools, and one office.
- The Project Solution could be deployed to increase LV network capacity, installed at the same time as a

large uptake of Low Carbon Technologies (LCT) in homes and workplaces.

Level of impact on the operation of the distribution system

- The expected learning, benefits and incentives for DNOs, the efficient planning, operation and development of the network, the wider community environment and customer engagement mechanism are highlighted as outputs are highlighted by the Project.
- Cost savings are attributed primarily to the distribution system and its customers. The Project is also relevant to energy retailers particularly in the area of variable tariffs.
- The proposal clearly defines the parties, roles, areas, and activities being Trialled and the external contribution of the Project Partners. The proposal indicates that the key learning from their involvement will complement and contribute to the overall Project outcome.

Generates knowledge that can be shared amongst all DNOs

- The Project will produce new knowledge about battery storage systems, local DC networks, and LV network communication and control that can benefit both DNOs and customers.
- The Project proposal describes in the learning areas and outputs. The Project information and the knowledge sharing methodology will deliver new knowledge throughout the Trial. The level of incremental learning has been carefully defined.
- The majority of the learning relevant to other DNOs will be disseminated towards the latter stages of the Project.
- The proposal demonstrates that the learning is relevant, timely and will be subject to robust governance and management.
- The DNO intends to conform to the default IPR requirements of the LCN Fund Governance.

Involvement of other partners and external funding

- The Project has two funding partners, Siemens and the University of Bath [redacted] and one non-funding partner, Bristol City Council.
- The Project will receive significant contributions from the University of Bath (with RWE npower) and Siemens. Bristol City Council will provide funding for the solar PV installations outside the LCNF scheme.
- The Memorandum of Understanding is not yet signed, although it is planned that the Project will be launched internally within WPD on 1st December 2011, contracts with the Project are scheduled for completion January 1st 2012, when the Project partners are expected to join WPD. Completion of contracts is a risk to the Project.

Relevance and timing

- The Method uses battery storage linked to LCT generation such as solar PV as a means to manage peak load on LV networks. This addresses anticipated network capacity issues associated with the move to a low carbon economy, whilst using a novel LCT-based solution.
- The Project Method, if successful, will form a significant part of the future commercial, technological, and operational planning for the LV network.
- This will happen in two ways: 1) As a short-term fix to integrate LCT into the network quickly and efficiently; and 2) As a long-term planning solution to be used in ED1 as an alternative solution to traditional network reinforcement. In both cases, the DNOs and developers will jointly benefit from reduced network reinforcement costs and quicker connection times.
- The Project proposal demonstrates that the Method will generate a significant amount of early learning and data which will be used to inform RIIO–ED1 and to provide the technical solution to the other DNOs.
- The Method also trials the use of variable tariffs and the potential linkage with Smart Metering and developing the engagement with the consumer. The proposal identifies how the learning will become part of the DNOs own network planning.
- The BRISTOL Trial is independent of the Smart Meter Implementation Programme and customers will be able to switch to smart meters when offered by their chosen Energy Retailer during the Trial.

Demonstration of a robust methodology and that the project is ready for implementation

- There is a detailed Project plan, a clear risk register and a contingency plan. We have concerns regarding resources on this Project and governance, in particular the absence of a steering group and the relationship of the Project with the main business.
- Project internal start date is 1st December 2011. Project partners are expected to join WPD on January 1st 2012; contracts will be signed between the 1st December 2011 and 1st January 2012.
- The Project methodology includes an appropriate, feasible plan for customer engagement through Bristol City Council. The Method being Trialled depends on the Council's and the tenants' adoption of the solution.
- The Successful Delivery Criteria do not include reference to achieved carbon savings and cost savings which are achieved on the Project, which are scalable to GB.

3. Detailed Assessment

3.1 Feasibility Assessment

Summary

- In our view this Project is an innovative approach to overcoming constraints on LV networks, especially in its development of DC circuits. The trial use of batteries is also a progressive proposition, in which value may be shared between consumers and the DNO.
- This Project is focused on the LV network, seeking to overcome constraints affecting the connection of LCTs and facilitating connection through innovative means.
- The Method being Trialled is technically feasible, and the Project will be testing the proposed Solution. However, we are concerned that consumers, especially tenants of social housing, may not like the proposed Solution involving complex equipment and tariffs, which may be perceived as confusing and intrusive.
- We also note high costs per unit of installation on the Project and note that 20% of energy may be lost in the charge/recharge cycling of the batteries.
- It is feasible for WPD to deliver this Project, subject to appropriate resources being available.

3.1.1 Technical Assessment

Is the Project technically feasible?
• Yes. If the Project can demonstrate that the approaches proposed here are effective, then the roll out across WPD and other DNOs would reduce carbon, connection costs, and use-of-system charges, through avoiding network reinforcement. • The shadow tariff proposed in this Project is aggregated by the DNO along with the consumer's usual charge from the supplier. The benefits of the consumer providing storage allocated to the DNO's benefit and controlled by the DNO will be reflected in a payment from the DNO to the consumer. • The carbon intensity of the manufacture of equipment, especially batteries, and their energy losses through the charging/discharge cycle, will have to be offset against the benefits of this Method to facilitate connection of LCTs without the need for traditional reinforcement by replacing cables etc. • With no evidence provided, we are not convinced that the present and projected problems with harmonics are as great as have been described in the submission. Hence the benefits of the Project may be overstated. We understand the potential for increasing harmonics with modern equipment, but also recognise the efforts of manufacturers to avoid harmonic distortion. Nevertheless, if the Project is successful, the new Methods will be of relevance in resolving voltage and current constraints.

Is it safe?
• There are safety issues to consider, especially around the home, both in the Method and in the design and implementation of the Project. This is recognised by WPD and their partners, who will ascribe top priority to the safety in their selection of equipment, testing of equipment, and training of customers in the use of the equipment being Trialled.

Is it innovative? If so, how?
• Yes, the solutions being tested are not Business As Usual and have not been deployed in the past. • The focus on DC circuits is especially novel for DNOs.

How mature is the equipment?
• Some equipment (such as batteries) are very mature and are not being evaluated on this Trial. Other equipment is less so, although as far as possible, off-the-shelf equipment will be used which is already proven. The LV Connections Manager and LV Network Manager are new for this application.

What is the technical impact on customers?
• The very nature of this Project means a major impact on customers, from acceptability of the design of light switches to the safety of the battery in the loft space. The reliability of the equipment will be tested in the Trial. • There will be benefit in this Project in understanding the life of equipment as it will affect both the performance and the economics for the customer. • The complexity of this scheme relative to traditional supply may be a problem for customers. This which will be tested in the Trials.

What is the technical impact on normal operations?
• This Project can proceed with very little impact on the normal operations of the network.

3.1.2 Assumptions

Assumption	Comment
It is assumed that this Project will facilitate connection of LCTs connected to AC and DC circuits. In many parts of the network, there may be a requirement for network reinforcement which may be avoided by the use of the Method being Trialled.	The Project is technically feasible. It will test the concepts, the performance of the Solution and acceptability of the scheme to customers.

3.1.3 Project Delivery Assessment

Is the Project plan robust?
• Yes, all elements of good project management practice are in place. We note that this Project will not be supervised by a Steering Group, but there will be a Project Forum and a Future Networks Programme Board. In our view this provides sufficient oversight of the Project, providing that attention is not diluted by greater time being spent on other projects within the Programme.

Is the Project schedule credible?
• Yes, this is a focused Project within the Bristol Area on localised parts of the LV network. It is realistic to complete this within three years as planned.

Are resources adequate?
• The Project has support from WPD's Directors and those of the parent company. • The proposal does not include details of the number of people from WPD engaged on the Project. There is medium risk of shortage of resources but the mitigating action of the business being aware of the shortage, is unconvincing. • The resources have not yet been identified but will be available from within the Future Networks team. WPD have not identified specific personnel for this Project and we believe that resources remain a higher risk to this Project than has been assessed.

How do partners add value, how are they tied in to the Project, and is their contribution appropriate?
• There is a set of partners on this Project, funding the Project at 10% of total Project cost. In our view this is appropriate and manageable. • Moixa Energy may be included in this project. We understand that this is as sub-contractors to Siemens if their contribution will be of value to the Project. The IPR default arrangements remain relevant, and in our view these arrangements are reasonable. • We identify a Project risk regarding the relationship with University of Bath and npower. The University

of Bath and npower collaborate on a project by project basis and will enter into a written agreement specifically for Project BRISTOL. .

Is the customer/stakeholder communication plan appropriate?
• Yes. Further detail provided in Section 3.6.

Are successful delivery criteria appropriate?
• The Project has eight Successful Delivery Reward Criteria each mapped to a checkpoint within the Project Plan, each with outputs to report on the relevant findings of the Trial. Three criteria relate to the commencement of the Trial, three relate to the operational and network performance, one measures changes to customer opinion over time and one considers the suitability for mainstream adoption. • Otherwise the SMART objectives are met.

Have key risks been identified and mitigated? Is contingency appropriate?
• There is an extensive risk register, with mitigating actions and a separate contingency plan.

3.1.4 Assumptions

Assumption	Comment
This Project will proceed with the objective of demonstrating the success or otherwise of a variety of techniques to allow LCT demand and microgeneration to be connected to the LV power system.	There are reservations regarding resources, customer acceptance, economics and development of tariffs.

3.2 Commercial Assessment

Summary

- The Project involves the storage of energy in customer premises, new variable tariffs and new network management to overcome generation and load constraints. It will make extensive use of DC power in the customer premises.
- In our opinion, if rolled out the Project will significantly change the commercial arrangement between the customer and the supplier.
- The Project will test this approach for 18 months.

3.2.1 Nature and Scale of Commercial Impact

Does the Project involve innovative commercial arrangements, if so, how?
• Yes it does involve innovative commercial arrangements based upon local storage and, in particular, variable tariffs. • Variable tariffs will be set relative to the wholesale market price for energy. Traditionally customers have had a flat tariff with, in some circumstances, a night rate. The tariffs have not been linked to the wholesale price before, as it varies during the day. • The objective is to reduce customer load at times of high energy price and increase consumption when generation is high (i.e. the wind is blowing). This can increase the viability of interruptible generation. • The customer will keep their existing supplier and be able to switch supplier at any time during the Trial. A shadow charging system will be set up whereby the effect of the variable tariff is calculated. The customer will pay their energy bill based upon their normal metered bill in the normal way. The customer will receive a refund based upon the difference between their supplier metered bill and the shadow variable tariff. The customer bill will not be higher than their normal bill i.e. the customer may save up to £200 on their energy bill. • In our opinion these arrangements are innovative; the Project will need to test how best to get take up and effect change.

How does the Project impact upon the customer (demand and generation)? What is the nature of this impact and does it endure beyond the Project?
• The customer will have a DC circuit to supply their DC appliances (particularly lighting) and connect to battery storage. • The customer will be able to supply energy from the batteries. WPD claim that the customer should benefit from lower energy costs. In our opinion this will be dependent upon the customer's adoption of different behaviour patterns. • If replicated, this will endure beyond the Project.

How does the Project impact upon the broader electricity and technology supply chains? What is the nature of this impact and does it endure beyond the Project?
• Resilience will be provided at the customer premises. In the event of a mains AC power failure the customer will still have DC power from the batteries. • We believe that there can be very broad learning for the DNO. • In our opinion, if successful, it could be provide a pricing tariff that will enhance the use of intermittent generation by sending a price signal to the consumer at times of high intermittent generation.

Within current regulatory frameworks, where will financial benefits accrue within the supply chain (suppliers, DNOs, customers etc.)?
• WPD claim that the customer may save up to £200 on their energy bill.

Are these commercial arrangements replicable across the GB distribution network on roll out?
• The commercial arrangements are replicable across GB.

3.2.2 Assumptions

Assumption	Comment
Consumers will adopt the new DC network in the home.	This behavioural change is not insignificant.
Consumers will readily accept and adopt the variable tariff and change their behaviour to it.	Consumers will require a lot of help to adopt this.

3.3 Wider Context Assessment

Summary

- The Project is Trialling an innovative solution that integrates a number of technologies and new commercial tariffs to deliver an effective alternative to the traditional LV network reinforcement. The proposal describes that the learning from this Project will be added to and will inform the learning from other projects within the WPD networks. The Project will engage with the end-user and introduce DC circuits into homes and schools alongside renewable generation and shared batteries which act as storage and a buffer to the network.

To what extent will the Project overcome current obstacles to the future low carbon network?
• The proposal clearly describes a solution that, if successful, overcomes obstacles to a low carbon network by reducing barriers to the uptake of solar PV generation, extending the effectiveness of the solar PV using a battery to power and buffer end-user DC circuits. • The solution includes benefits to the DNO from access to DC storage to alleviate network constraints, reduce the cost and delays of using traditional reinforcement techniques. • The solution trials the use of variable tariffs in the residential setting to incentivise technology adoption and to promote behavioural changes that support better use of the local grid infrastructure.

To what extent will the Project trial new technologies that could have a major low carbon impact?
• The proposal describes the potential technologies to promote the introduction of low-carbon generation technologies including those to integrate renewable generation with DC output, automated measurement, and control systems – all incorporated into the end-user premises and local substations. • Extending the control systems into the home offers alternative methods to mitigate grid constraints and demonstrates a lower cost and impact compared to traditional reinforcement techniques – with battery technology having a potentially wide reach. • The Project will Trial and quantify both the losses and the effectiveness of the solution.

To what extent will the Project demonstrate new system approaches that could have widespread application?
• The Project is focused on social housing but should deliver learning beyond social housing. • The Project demonstrates a new approach with a limited scope of customers involved in the Trial. This approach has the potential of widespread application but this may need to be proven via future projects. • The proposal demonstrates that this Project will inform and be informed by other LCN Fund projects within the DNO, specifically the WPD 2011 LCNF Tier 2 FALCON and the WPD 2010 Tier 2 LV Network Template project, under the leadership of University of Bath.

3.4 Carbon Emissions Reduction Assessment

Summary

- We believe that the Project can provide modest carbon reduction, however, it will use an innovative solution that has not been tested before that may lead to innovative approaches to carbon reductions
- The Project aims to enable a smoother transition to a low carbon economy by easing pressures on LV networks. Energy storage and integrated network controls will be used to overcome generation- and load-related constraints from an increase in the number of installations of LCTs.
- It will explore the use of DC power in customer premises, connecting low carbon (microgeneration) technologies to energy storage batteries whilst also running DC equipment on these networks. Active control of LV networks using battery storage will facilitate the connection of low carbon devices at a reduced cost as it moves peak load, thus reducing generation carbon emissions.
- Once rolled out, this Project will use the new insight on LV network management to enable a greater density and faster paced low carbon (microgeneration) technology roll out.

3.4.1 Nature and Scale of Carbon Emissions Reduction

Does the Project align with the Low Carbon Transition Plan? If so, how?
• The Project aligns with the LCTP as it enables the deployment of LCTs to occur at a faster rate and using innovative techniques. The Project aims to form local DC networks that use energy storage (batteries) as a means to manage network demand during peak times within the local area. In our view this aligns with the LCTP in two ways, it: ○ Enables an increased roll out of LCTs meaning renewable energy targets could be met faster. It also facilitates roll out of more energy efficient DC appliances in the home; and ○ Reduces load on electricity networks leading to less electricity losses and need for carbon emitting network upgrades, such as digging up roads to install new cables will result in lower emissions.

What is the nature of claimed carbon emissions reductions and what is the balance between the technological and behavioural change?
• The proposal's stated carbon emissions reductions are based on an assumption that the Project facilitates a greater roll out of solar PV, displacing existing generation supply, and is therefore a technological change rather than behavioural. However, behavioural changes will be required by customers in order to change energy use and adopt a new system that includes both energy storage and local DC circuits. We believe that it is difficult to predict the level of carbon reductions because of the impact of the user behavioural change on the ultimate saving.

Nature of emissions reductions

	Type of reduction
Facilitate LCT uptake more quickly & lower	xxx
Avoidance of asset upgrades	
Network efficiency	
Efficiency of use	

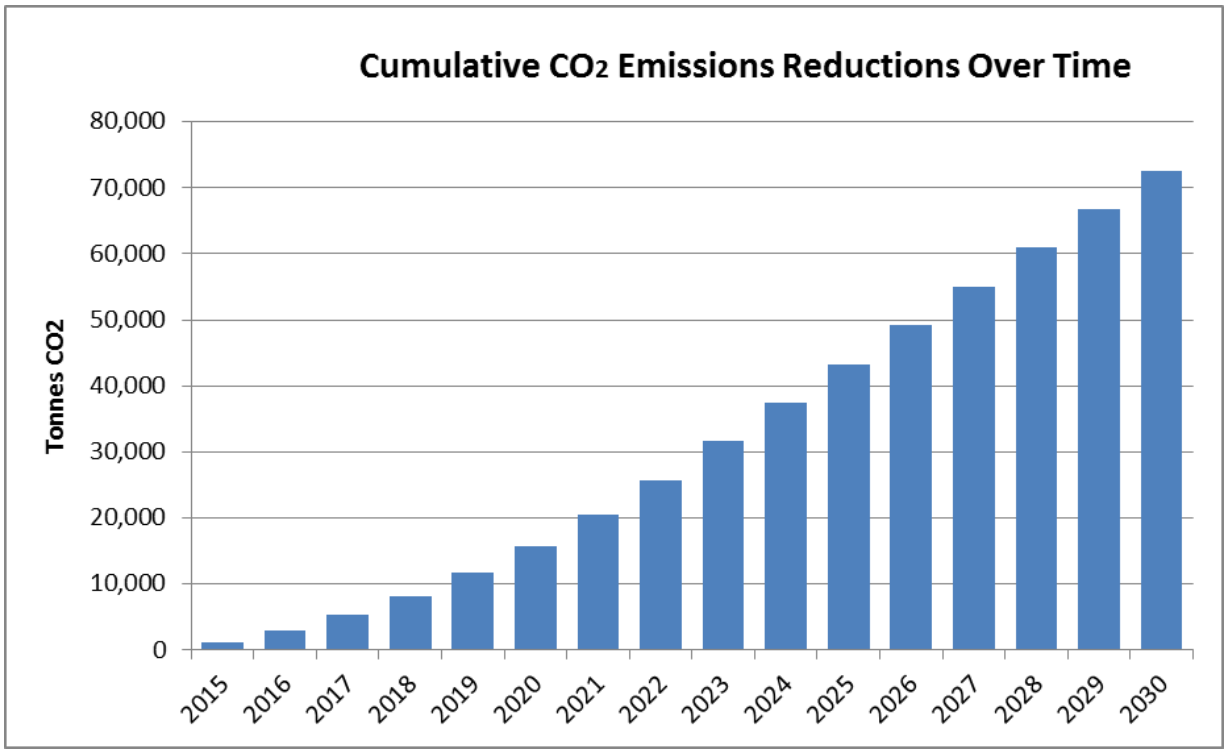
xxx - Main focus
x - Secondary focus

What is the size of claimed carbon emissions reductions?
• WPD estimates that a cumulative total of 1,452 thousand tonnes of CO_2 could be displaced by solar PV that would not have otherwise been connected in the period between 2015 and 2030. • We understand that the benefits of the solution will extend over multiple years and WPD states that each installation will last for 20 years. We estimate that the cumulative total savings should be approximately 1,200 tonnes of CO_2, based on a roll out to 2,480 sites by 2030. This is lower than the DNO's stated figure as it includes the impact of a decreasing carbon intensive grid, using the MARKAL factor.

Roll-Out at Scale

	tonnes CO_2	Base case emissions	Method emissions	Net carbon
Trial / Method	Facilitated solar PV	0.0	-£72,600	72,600
	Total	**0.0**	**-£72,600**	**72,600**

When will the carbon emissions reduction occur?
• The carbon emissions reductions occur from the roll out of the Project in years 2015 to 2030. • Carbon emissions reductions for the Project Trial are not specified.



3.4.2 Carbon Emissions Reduction Assessment

How comprehensive are the carbon emissions reduction estimates?
• The emission reductions estimates per KW installed solar PV appear to be accurate and rely on documented, sourced assumptions. • The calculation doesn't account for embodied carbon. This is a potential issue for the solar PV arrays, where the carbon embodied in the silicon panels and the batteries can take several years to pay back. This effect has not been quantified but is a material consideration for projects with PV and/or batteries. The batteries will be removed at the end of the Project and recycled. • We believe these estimates to be slightly over-stated, however there is potential for further carbon benefits if the Solution is transferrable to other LCTs. This has not been calculated in the proposal.

Are carbon emissions reduction estimates additional to business as usual?
• Largely, yes. We would expect to see a small number of solar PV and other microgeneration projects installed in the target area in the period of the Project, but this Project represents a step-change increase in installed capacity through to 2030, significantly dwarfing what would be expected as part of business as usual. The proposal makes claims to all subsequent carbon savings as a result of additional installations up to 2030. The carbon benefits are realised over a 20 year period post-installation; therefore carbon benefits as a result of BRISTOL will be seen up to 2050 (20 years after 2030 installations).

Are carbon emissions reduction estimates realistic?
• Carbon emission reduction estimates do not include an assessment of the embodied carbon of the silicon panels in the PV arrays or the batteries. This is an over-simplification, which mildly overstates the carbon savings claimed by WPD in the proposal from the Project. The magnitude of this effect has not been quantified by WPD or the Consultants. The proposal uses the DEFRA 2008 grid intensity figure and assumes that this is constant through to 2030. As the grid will be decarbonised over time, the actual carbon savings by displacing this electricity will be lower than predicted, particularly in later years. Our simple carbon calculation gives cumulative savings of 1,200 $kTCO_2$, rather than the 1,452 $kTCO_2$ claimed by WPD. • The proposal refers to technologies other than solar PV (e.g. heat pumps); however the carbon savings are only based upon solar PV. While there may be an opportunity to increase the installed capacity of LCTs by including other technologies in the Project, the effect of this assumption is to say that any other LCT would displace solar PV, leading to no further displacement of grid electricity. • The calculation of the amount of energy generated by the PV arrays is based on an Energy Savings Trust analysis of the expected annual energy generated from a 1kW panel installed in the Bristol area. This is an extrapolation but a reasonable assumption given the other uncertainties in the calculation. • The Energy Saving Trust energy production figure is for a location in Bristol but solar panel output differs by location. The Project roll out is across a relatively small number of locations (2,480) and we must therefore assume that these would be locations with a similar solar intensity level to Bristol. • Overall, the proposal put forward a realistic projection for potential carbon emission reductions. Carbon claims are also relatively small in absolute terms, reflecting the small size of the Project. The overall savings will be dependent upon customer adoption.

3.4.3 Assumptions

Assumption	Comment
The Project will lead to increased LCT installations, significantly beyond business as usual and therefore all carbon saved can be attributed to the Project.	Carbon emission reductions rely on facilitated uptake of LCTs beyond business as usual. Given the levels of funding already secured, use of Bristol City building stock and the scale of the roll out plans, this seems reasonable.
There will be no improvement in grid electricity carbon intensity from 2008 through to 2030.	The carbon emissions reductions to 2030 may not result in the same quantity if the CO_2 per site in fact decreases over time.
Solar PV produces 901kWh of electricity annually per kW of installed capacity.	Improving PV efficiency over time means that this is an under-estimate of the potential carbon savings.

3.5 Project Costs and Cost Benefits Assessments

Summary

- The overall Project budget appears to be comprehensive and realistic in light of the Project's scope and objectives.
- The experimental nature of the Project is reflected in high costs of equipment in customer premises and substations.
- The proposal presents an estimate of the net financial benefits of the BRISTOL solution compared with traditional network reinforcement. A positive benefit is forecast which scales in a linear fashion with volume and exceeds £100m by 2030 with only modest penetration levels in GB homes and corresponding substations.
- It is important to note, however, that these forecasts make a number of key assumptions including a very strong reduction in the costs of equipment from Trial to roll out, a high level of uptake of the solution by homes on a given feeder, the Method can be widely replicated, and the validity of Base Case costs based on only one example. Moreover cost build up ignores potential upfront costs to customers.
- The estimates ignore potential economies of scale, operational savings that may arise from the virtual sharing of embedded battery storage and the value of enhanced resilience.

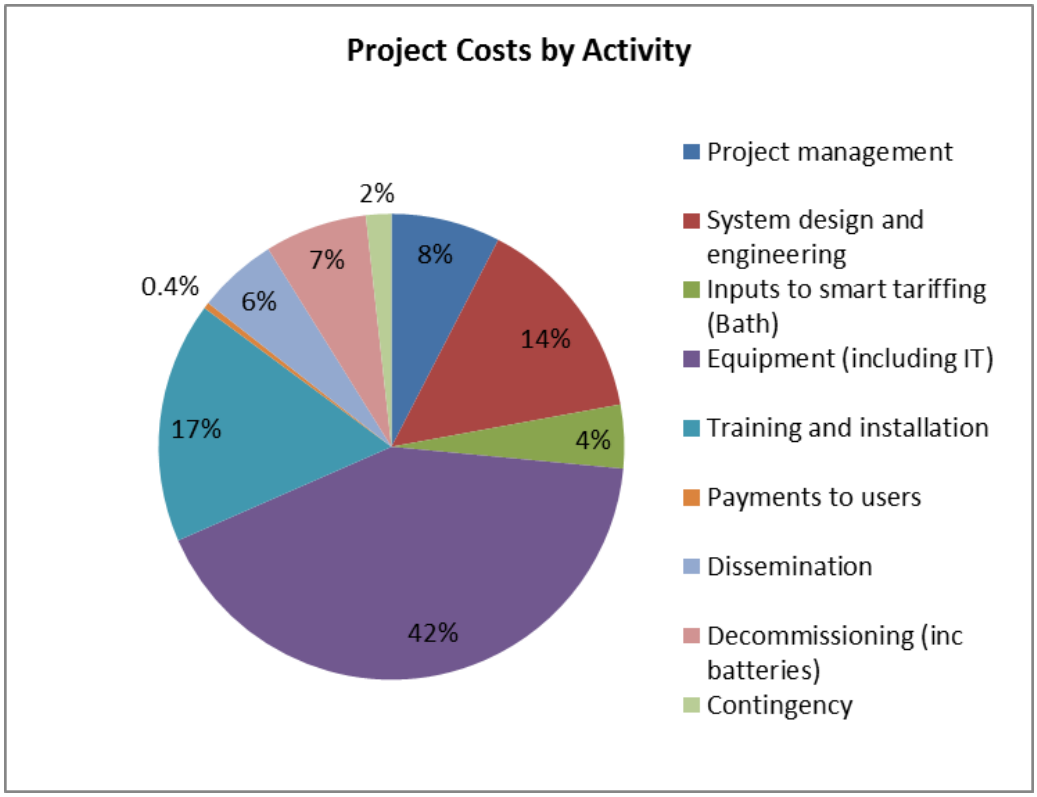
3.5.1 Project Costs

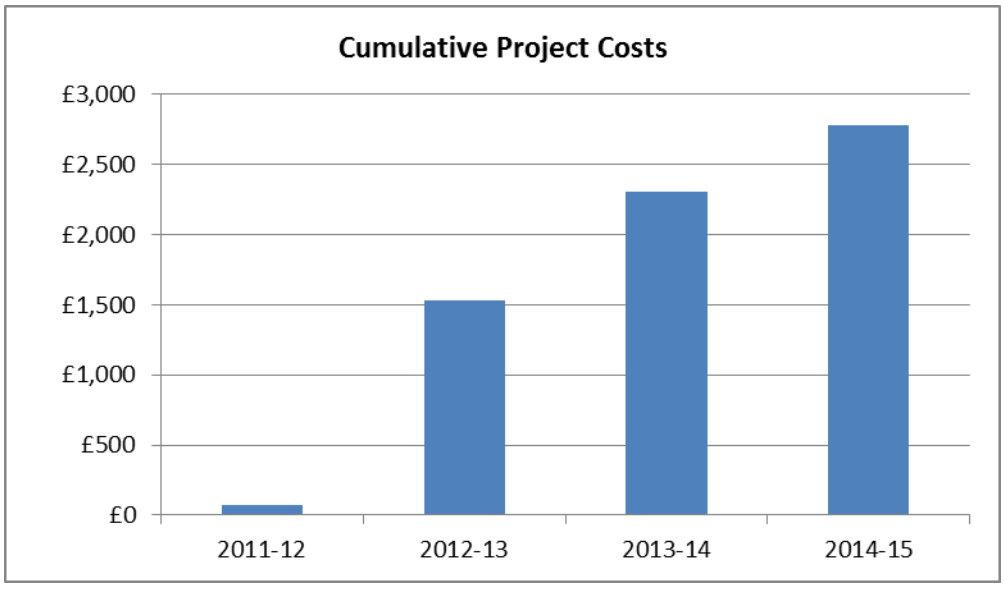
Project Funding

		Total
Project Participants Contribution (£'000s)	University of Bath	[redacted]
	Siemens	[redacted]
	DNO Extra Contribution	£0
	DNO Compulsory Contribution/Direct Benefits	£250
	Oustanding Funding Required	**£2,254**
	Total Project Costs	**£2,784**

Project Costs by Activity and Year

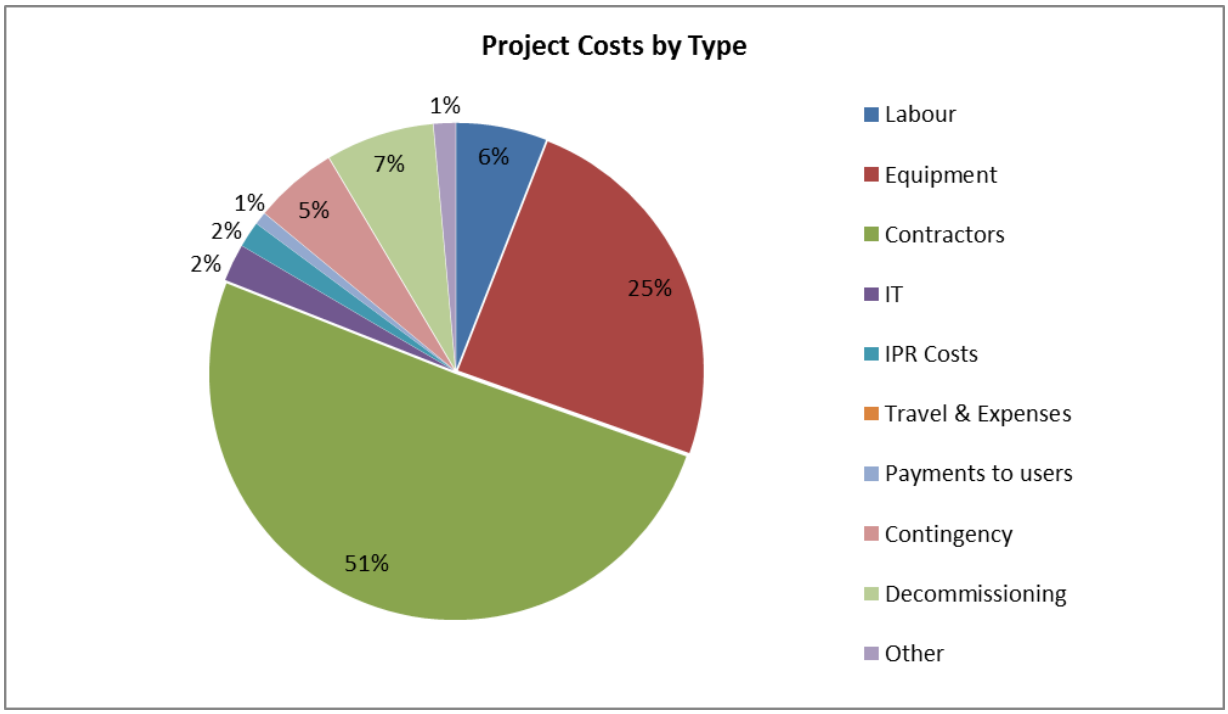
		Year				
		2011-12	2012-13	2013-14	2014-15	Total
Costs by activity (£'000s)	Project management	£29	£93	£50	£39	£211
	System design and engineering	£20	£238	£74	£72	£404
	Inputs to smart tariffing (Bath)	£0	£47	£29	£47	£123
	Equipment (including IT)	£17	£881	£237	£32	£1,167
	Training and installation	£5	£123	£293	£45	£466
	Payments to users	£0	£0	£6	£6	£12
	Dissemination	£0	£40	£73	£41	£154
	Decommissioning (inc batteries)	£0	£0	£0	£198	£198
	Contingency	£0	£38	£11	£0	£49
	Total	**£71**	**£1,460**	**£772**	**£480**	**£2,784**
	Cumulative total	**£71**	**£1,532**	**£2,304**	**£2,784**	**£2,784**





Project Costs by Type and Year

		Year				
		2011-12	2012-13	2013-14	2014-15	Total
Costs by type (£'000s)	Labour	£24	£87	£30	£24	£166
	Equipment	£0	£590	£91	£0	£682
	Contractors	£44	£561	£572	£229	£1,407
	IT	£0	£46	£17	£6	£68
	IPR Costs	£2	£29	£12	£4	£47
	Travel & Expenses	£0	£0	£0	£0	£0
	Payments to users	£0	£0	£6	£6	£23
	Contingency	£0	£131	£21	£0	£152
	Decommissioning	£0	£0	£0	£198	£198
	Other	£0	£16	£23	£12	£40
	Total	**£71**	**£1,460**	**£772**	**£480**	**£2,784**



Direct Benefits

Are the Direct Benefits of the Project realistic?
• There are no direct benefits claimed for the Project itself which is reasonable in light of its experimental nature.

3.5.2 Project Costs Assessment

How comprehensive are the Project costs?
• The proposal includes detailed costings for the Project and these appear to be comprehensive. • Project Partners have been involved in the build-up of costs, sharing detailed planning for each section of the Project. • The Project is proposed to operate for 18 months and will Trial the Methods at 30 domestic properties, 10 schools and one office. Modifications to be carried out at each property include: LV Connection Manager; battery storage; PV panels; DC lighting; smart appliances; and computers and central heating pump converted to DC operation. • It is understood that the LV Network Manager and LV Connection Manager are not commercial products but will be designed and built by Siemens, based on existing electronics modules.

Are the Project costs realistic?
• The overall Project budget appears to be realistic in light of the Project's scope and objectives. • The total Project budget is £2,783k of which 59% relates to equipment, and training and installation. • It is understood that costs for "off the shelf items" have been used where possible, and many external Project costs are fixed. • Project Partners have built up the costs, sharing detailed planning for each section of the Project. • The costs of equipment to be supplied to the Project amount to £11,946 per home (30), £30,200 per school (10) and £31,300 per workplace (one), plus £161,100 for substation equipment. • Moixa Energy is a recent „Project Supporter'. Moixa Energy markets a range of products including DC micronets. We understand that formal contracts with Moixa Energy have not yet been finalised. • Bilateral contract negotiations are taking place in parallel with discussions about a multiparty Memorandum of Understanding (MoU). • It is understood that payment models for the sharing of battery storage have yet to be worked out. Bilateral contract negotiations are taking place in parallel with discussions about a multiparty MoU.

Does the Project provide value for money?
• The Project aims to test a novel LV system including communications and control, virtual sharing of battery storage, PV and DC networks. In addition, variable tariffs will be trialled with the aim of incentivising domestic customers to reduce consumption when the price of electricity is high and vice versa. • The Project is innovative and relatively small. As such it can be considered value for money in terms of what is learnt.

Is the Project feasible within the budget?
• The Project appears to be feasible within the total budget which includes a modest contingency.

3.5.3 Assumptions

Assumption	Comment
Full communications and control functionality of the LV systems can be achieved.	LV Manager is a novel system but based on existing electronics modules. Costs understood by Siemens.
The target numbers of customers volunteer to participate in the Project.	Customer communications plan being put in place including use of recruitment company. May result in overrun.
Installation of batteries and DC circuits is feasible within budget.	Battery installation in loft may present challenges and therefore increase costs.

3.5.4 Cost Benefits Assessment

Financial Benefits

- Financial benefits to customers expected to come from lower energy bills through a better control of energy, a variable tariff and more transparent energy bills, together with improved energy efficiency through use of DC networks.
- The primary financial benefit to DNOs is expected to be cost savings on LV network reinforcement.
- The Project will provide the opportunity for equipment suppliers to develop and demonstrate new products which may improve prospects for future sales.

Non-Financial Benefits

- Non-financial benefits to customers include quicker connections compared to conventional reinforcement and enhanced resilience during power outages.
- BRISTOL has the potential to reduce voltage harmonics on the network through the use of standard, high quality inverters.
- The Project will provide learning such as the, use of embedded battery storage and variable tariffs.

Method Costs

Are the unit Method costs calculated on an appropriate basis and are the unit Method costs realistic?
• Method costs are based on estimated DNO costs for installation of equipment (batteries and LV Connection Manager) in 10 homes (£1,550 per property) and substation costs (£2,400 per unit) including LV Network Manager, communications and associated equipment.

- Product costs are difficult to estimate prior to development and testing. Moreover cost build up ignores potential upfront costs to customers. The proposal indicates an assumption that 50% of battery costs will be funded by customers.
- Method costs for 10 homes plus one substation totals £17,900.
- The model ignores potential economies of scale.

Base Costs

Are the unit base case costs calculated on an appropriate basis and realistic?
• WPN's estimated conventional network reinforcement for integrating PV into one feeder (Marwood Road substation) is £21,240 based on LV overlay and harmonic filtering. • This estimate is increased to £63,700 when scaled to a substation serving 30 homes.

Summary of Net Benefits of Roll Out

		Base Cost	Method Cost	Net benefit
Trial / Method	10 homes + one substation	£21,240	£17,900	£3,340
	30 homes + one substation	£63,700	£48,900	£14,800
	GB roll out (2015-30)	£158,025,600	£121,272,000	£36,753,600

Are the forecast benefits of roll out realistic?
• Estimates suggest that the capital costs of the BRISTOL technology solution will be lower than those for traditional reinforcement. • A number of key assumptions are made in producing these estimates which include a very strong reduction in the costs of equipment from Trial to roll out, a high level of uptake of the solution by homes on a given feeder and the validity of base case costs based on only one example. Moreover these estimates ignore upfront payments that may be required from customers on roll out. • Note also that these estimates do not include operational savings that may arise from the virtual sharing of embedded battery storage or the value of enhanced resilience.

3.5.5 Assumptions

Assumption	Comment
Equipment and installation costs are significantly lower on roll out than in Trial.	Prototype equipment is being developed for the Trial. Costs would be expected to reduce significantly in production. These are however difficult to estimate in advance.
High level of uptake by homes on a given feeder can be achieved.	Similar situation to cable TV. Economics depend on an uptake per substation.
Reinforcement cost example described in proposal in representative of average GB feeder.	Probably need larger sample. Could have major impact on estimated net benefits.

3.6 New Learning Potential

Summary

- WPD describes the high-level programme and processes to disseminate the knowledge to the target audience that includes other DNOs, the end-user community and the other stakeholders. The roles of the individual Project Partners are defined and details supporting both qualitative and quantitative data will be captured from the start of the Project Trial were presented in the proposal.
- WPD describes how the learning to be generated in the Trail and other related Low Carbon Network Fund projects will be captured and integrated.
- The high-level programme includes the communications processes and areas for new learning, along with the methods to capture the relevant data, undertake the analysis and a number of media and communications channels to disseminate the knowledge.
- The Consultants have identified a risk that the complexity of the Project may reduce the effectiveness of the communication, particularly to the consumer.

3.6.1 New Learning Assessment

What is the potential for new learning?
• WPD details the areas of new learning expected from the Project and describes a clear method to capture and gather both the quantitative and qualitative data in a number of innovative areas which in the Consultant's view will be effective. Clear responsibilities are assigned to the Project Partners to undertake the analysis and knowledge creation during the Trial.

What are the plans for disseminating such learning?
• The learning and knowledge dissemination process is identified by WPD as a critical aspect of the Project and the responsibilities are clearly defined alongside the target audience and a number of media channels. • The proposal describes a series of communications channels and media appropriate to the message and to the audience, which is predominantly segmented into the DNO and end-user communities. The proposal intends to utilise the communications strengths of the Project Partners.

What is the IP management strategy and does it deviate from the default IPR conditions, if so, how?
• Project parties and stakeholders have progressed with the IPR arrangements and a multi-party MoU is in the process of being agreed. The proposal is clear that the expectation is that contracts will be in place prior to any Project commencement. • The submission confirms that the treatment of the IPR is compliant with the LCNF requirements.

Are the IP benefits to partners adequately reflected in the proposal?
• All Parties contribute background IP to the Project and share the foreground learning and have contributed to the costs of the Project. • Two Project Partners, Siemens [redacted] and University of Bath [redacted] have directly contributed £280k (12%) towards the LCN Fund request of £2,204k.

3.6.2 Assumptions

Assumption	Comment
That customer acceptance and engagement is obtained at the start of the Trial and retained throughout the Trial period.	Careful selection of the target prospects and, for residential customers, the use of incentives and early engagement programme.
That the DC technologies and controls are developed, available and installed.	Project relies on the development of communications and network management software which is identified within the Project Risk Register.

3.7 Risk Assessment

- The technical interventions are considered innovative and technically feasible. There are risks associated with the timely development of the controllers and there are further risks surrounding the integration and connectivity of the controllers are identified and mitigated in the Project Risk Register.
- A key risk identified by the consultants is that the Project will not deliver sufficient learning from the current sample within the Project timeframe. A key risk identified by WPD is to correctly specify and install the batteries and DC circuits. The consultants consider a further risk is that it may not be possible to make a safe and secure installation.
- Within the Risk Register WPD recognise a series of high-impact, mitigated risks associated with identifying, motivating, and keeping a sufficient number of customers during the Project. The consultants consider that there are further risks surrounding customer understanding and engagement in the acceptance and use of the Method.
- WPD details risks in the Project Risk Register and these quantify the impact, probability, cause, trigger, effect, and mitigation.
- Key risks identified by the consultants are identified in the Project Risk table below.

WPD BRISTOL				
PROJECT RISK				
Index	***Type***	***Risk***	***Mitigation Plan***	***Contingency***
1	Project	The AC wiring in homes, schools and the office cannot be converted to DC operation.	Yes	Yes
2	Project	30 homes do not volunteer to participate in BRISTOL in one area, connected to one distribution substation.	Yes	Yes
3	Project	10 schools do not volunteer to take part in the Project.	Yes	Yes
4	Project	Bristol City Councils M&E teams or normal qualified electrical contractors are unable to install and maintain the premises BRISTOL equipment.	Yes	Yes
5	Project	There is no suitable location to store the equipment in homes, schools and an office.	Yes	Yes
6	Project	RWE npower are unable to support the development of the Smart tariffs, feeding information into the University of Bath.	Yes	Yes

WPD BRISTOL				
FURTHER RISK				
Index	*Type*	*Risk*	*Mitigation Plan*	*Contingency*
1	Project	The ultimate sample size throughout the Trial period is too small leading to insufficient learning gathered.	No	No
2	Project	Methodology not adopted by DNO.	No	No
3	Project and roll out	FiTS incentive not available unless an AC meter is fitted.	Yes	No