

Low Carbon Networks Fund Full Submission Pro-forma

Section 1: Project Summary

1.1 Project title

New Thames Valley Vision: From Data to Decisions

1.2 The Lead DNO

Southern Electric Power Distribution Ltd (part of Scottish and Southern Energy Power Distribution (SSEPD))

1.3 Project Summary

New Thames Valley Vision (NTVV) will revolutionise the way in which Distribution Network Operators (DNOs) utilise their existing networks. This project is a complete solution that will allow us to anticipate, understand and support behaviour change in individuals, small businesses and larger companies to help us manage our networks more effectively as the UK moves towards a low carbon economy. Building on the techniques developed for supermarket loyalty schemes, NTVV will use data intelligently to identify and predict network stress points in the short, medium and long term in order that DNOs can make more informed decisions.

NTVV will evaluate solutions including: a new network and planning environment; industrial and commercial (I&C) and small and medium sized enterprises (SME) automated demand side response; low voltage (LV) static voltage control; street level energy storage; and a range of communications solutions. The project will incorporate learning from other projects the UK and worldwide.

NTVV will deliver new commercial agreements, procedures, policies and will inform national standards. It will disseminate learning through targeted communication and our low carbon community advisory centre. Ultimately, NTVV will enable DNOs to avoid £5bn of network reinforcement through the involvement of all customers groups and a comprehensive understanding of networks.

1.4 Funding

Second Tier Funding request (£k)

DNO extra contribution (k)

External Funding (£k)

1.5 List of Project Partners, External Funders and Project Supporters

Our partners include:

- University of Reading:** Statistical modelling, analysis and profiling of customer behaviours
- GE:** Innovative technical integration, enabling project outputs to flow into DNO & third party systems
- Honeywell:** Provision of demand response solutions to commercial customers via building management
- EA Technology:** Knowledge dissemination by way of technical policies, procedures and training
- KEMA:** Learning dissemination, stakeholder engagement and technical validations
- Bracknell Forest Council:** Support in the integration of local planning with DNO planning and investment

1.6 Timescale

Project Start Date

Project End Date

1.7 Project Manager contact details

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Section 2: Project Description

NEW THAMES VALLEY VISION: FROM DATA TO DECISIONS

Aims

The principle aim of NTVV is to demonstrate that understanding, anticipating and supporting changes in consumer behaviour will help DNOs to develop an efficient network for the low carbon economy.

Objectives (See figure 1 for NTVV Model)

The aim will be achieved through:

1. Applying proven data analysis from the Energy Demand Research Project (EDRP) to understand the different customer types connected to the distribution network, and their effect on network demand
2. Understanding how the behaviour of different customer types allows informed network investment decisions to be made
3. Demonstrating mitigation strategies, both technical and commercial, in a live environment, to understand:
 - a. The extent to which demand side response (DSR) (when customers change their energy usage in response to certain external triggers) can contribute to network flexibility, and identifying which customers are most likely to be early and effective adopters of DSR
 - b. Where and how power electronics (with and without energy storage) can be used to manage power factor, thermal constraints and voltage to facilitate the connection of renewables on the LV network
4. Undertaking dissemination and scaling activity to ensure validity and relevance to the GB, with learning and understanding provided at two levels:
 - a. Provide front line training courses for the industry to embed real practical knowledge and skills
 - b. Keeping the public informed so the intentions and benefits of the smart grid are clear and opinions informed

Problem

Network demand will change as individuals, small businesses and larger companies act either on their conscience or in response to economic stimuli, to reduce their carbon footprint. The action customers take will have many forms including: energy efficiency measures; the installation of solar thermal or photovoltaic (PV) panels and other small-scale renewable energy devices; and an increased uptake of electric vehicles.

This clearly poses challenges for DNOs some of which have already been verified by data gathered from our Tier 1 Chalvey project. In order to maintain and operate a reliable and cost-effective electricity distribution system, DNOs need an understanding of the expected power flows on their networks. However, at present, DNOs have no sight of the demand of the smaller individual customers, and can only make estimates based on averaging data relating to the total number of customers fed from a distribution substation. This project is focused towards, but not exclusive to LV networks. Data is already showing issues with the LV network, an asset which to replace in GB could cost up to £30.9 Billion.

Network investment is triggered by periodic measurements taken at substations. This is the most accurate indicator widely available, but has the disadvantage of being both a relatively crude lagging indicator which takes no cognisance of variations over shorter timescales. With low carbon solutions now accelerating change on network, this crude monitoring leaves the network exposed to stress as load factors vary; it also hides capacity that could be otherwise utilised. Without advanced monitoring and the smart use of data the network will remain constrained, ultimately slowing the transition to a low carbon economy, reducing security and quality of supply to customers and resulting in unnecessary capital investment and repair costs.

Method(s)

NTVV proposes that a better understanding of and more active role for electricity consumers can minimise the investment required to maintain secure distribution networks that meet customer needs.

1. Link network reinforcement to a better understanding of electricity consumers

The project will demonstrate that common mathematical and statistical techniques used in other areas, such as consumer retail, can be applied to electricity consumers and fed into network planning processes. Such analysis will help to:

- o target investment and the strategic placement of 'distributed LV solutions';
- o facilitate scenario planning;
- o minimise errors in network design; and
- o reduce risk to connected customers

This sophisticated analysis will be complemented by credible alternatives to conventional network reinforcement.

2: Project Description cont.

2. Interact with demand response provided by both large and small businesses

Demand response will be undertaken with both large commercial and SME customers; this will be led by Honeywell, notable as a new entrant to this part of the power sector, and independent of UK energy companies. The learnings from thermal energy storage, in the form of domestic water and storage heating (as trialled in our NINES project on Shetland) will be used to expand the controllable load for the demand response.

3. Use mathematical techniques to reduce the need for low voltage monitoring

We will use customer profiling to inform where network monitoring needs to take place; optimising the investment needs of the LV networks.

4. Tactically deploy power electronics and electrical energy storage on the low voltage networks

Finally, we will deploy power electronics and electrical energy storage on low voltage networks as a tactical 'buffer'. This will demonstrate the extent to which these technologies could manage power factor, harmonics and voltages to provide a fast and flexible alternative ensuring customers have the freedom to deploy low carbon technologies without waiting for time-consuming reinforcement (or their alternatives) to take place. All of the technical solutions outlined above will be fully integrated into the distribution network control room.

Customer engagement

All customers have a role to play in the transition to a low carbon economy, including those previously passive customers connected to the high voltage (HV) and low voltage (LV) networks. Using a representative sample of large commercial, SME and domestic customers, NTVV will assess whether there are solutions applicable to one customer group that can be applied to others. For example, taking modelling techniques used for domestic consumers, or demand response solutions from large commercial customers, and adapting them for SMEs. Key parts of customer engagement will be through the Consumer Consortium programme and Bracknell Forest Council/ Homes and is already underway, further details on page 45.

We aim to establish a low carbon community advisory centre, designed to engage and inform consumers, customers and other stakeholders. This will be an interactive 'high street' presence in Bracknell. The primary aim will be to keep the public informed about our motivations and plans and to ensure that the benefits of smart metering and smart grid programmes are understood and their roll-out welcomed by energy customers (NTVV Customer types are detailed in Figure 2)

Location

The Thames Valley area, to the west of London, takes in parts of Oxfordshire, Berkshire, Buckinghamshire, Hampshire and Surrey. It has a diverse mix of industrial, commercial and small business development, along with a range of housing types with some areas of deprivation.

NTVV, which involves activity throughout the Thames Valley area, is centred on Bracknell, where the project's lead local authority partner, Bracknell Forest Council, is newly committed to developing a lower-carbon economy and is keen to promote the uptake of such technologies. To date, there have been no significant low carbon initiatives, making the project's focus area the ideal blank canvas for the proposed trials. Looking ahead, we expect that there will be increased electricity demand associated with further economic development, along with demand changes linked to the anticipated increased penetration of electric vehicles, solar arrays and heat pumps. As such technologies become increasingly mainstream, the rate of adoption is expected to be accelerated in comparison to that experienced on a national basis to date. This will place additional strain on the network.

Timescale

The project is planned to be five years in duration to ensure results are statistically valid; this will include a phased roll-out of monitoring devices. Outputs will be made available to the industry throughout the RIIO-ED1 consultation period (2013-2014) and as they are identified.

Trials

Understanding customers and their impact on networks

NTVV benefits from input, both in the form of know-how and technical learning, from an existing SSEPD's Innovation Funding Incentive (IFI) project. The project, with the University of Reading's applied mathematics department, applies proven statistical and mathematical techniques, such as those used on data from supermarket loyalty card programmes, to electricity customers (Appendix G). We aim to scale this up to create a statistically valid LCNF Tier 2 project, which will deliver valuable and widely applicable learning for DNOs.

2: Project Description cont.

The trial will involve monitoring via smart meters/ end point monitor of focus zones involving:

- o over 50 large commercial customers
- o 100 small commercial customers
- o 1,000 domestic customers

This will be complemented by widespread network monitoring over 300 substations covering all HV and LV connected consumers including:

- o 93 large commercial
- o 252 small commercial
- o 33,000 domestic customers

The monitoring and metering activity will be undertaken in ways informed by the output of SSEPD's Monitoring LCNF T1 project to deploy novel, non-outage dependant, monitoring across urban, suburban and sub-rural network types (see Appendix G).

Our customer and network monitoring will begin in Bracknell then expand to the broader Thames Valley.

A meter communications and data management service will be provided by an organisation adopting a role similar the UK's proposed Data Communications Company. All of the above datasets will be linked into the DNO's control room system, together with emulation models to show how significant quantities of data can be managed at scale. The ability to manage and utilise this data as an integral part of our existing control and information systems is a fundamental aspect of the project and the benefits we seek.

Anticipating future customer and network behaviour

NTVV aims to demonstrate methods of predicting electricity demands which are as sophisticated and effective as those supermarket use to predict required stock levels. By analysing customer activity and considering environmental factors, NTVV aims to show that electricity demand and usage patterns, even at individual street level, can be adequately forecasted (appendix B(iv)).

NTVV will achieve this by expanding on SSEPD's work with the University of Reading to show how data analysis can be used to simulate future network behaviour. This approach will allow different low carbon technologies (EVs, HPs, PV) to be combined in software models with the accurate predictions of customer behaviour to forecast how loads will change. This allows us to decouple NTVV from the deployment of low carbon technologies (LCTs) in our identified trial areas, whilst still maintaining robust outputs. Datasets on the individual LCTs will be sourced through this project, other SSEPD projects and (to the extent that it is made available) from other LCNF projects.

We will target SME businesses to understand the extent to which the statistical modelling technique can be applied to light commercial customers (eg high street shops, garages and hairdressers).

The modelling outputs will be fed into the commercial software packages used today in the design of LV and HV networks to capture the know-how demonstrated (early learning from T1 1005 'Modelling' project).

Supporting change through deployable solutions

In order to get the most out of understanding network issues and anticipating change, new solutions need to be made available to increase the toolbox used by the DNO planners. The project will extensively trial two solutions that will better allow the DNO to provide network flexibility: one on the customer side and one on the network side. We will also integrate learning from other solutions from our project portfolio and that of other LCNF projects to build up the toolbox of smart solutions.

On the customer side we are deploying demand response solutions with several large commercial customers. Once technically and commercially demonstrated, we will focus on SME businesses, to understand the extent to which demand response solutions can effectively be applied to smaller commercial customers. The demand response solutions will be coupled with thermal storage in a number of instances.

On the network side we will deploy LV connected electrical energy storage and power electronics, in statistically relevant quantities. This will provide a robust understanding of how a DNO can effectively deploy and operate this technology to support customer choice.

Integration is key - both the customer side and network side solutions will be linked to the DNO's control room to provide a robust end-to-end control system. This activity will bridge several vendors' equipment, demonstrating system interoperability, a key component to demonstrate scalability.

2: Project Description cont.

Solutions

Upon completion, NTVV will have demonstrated the following solutions:

- o **Monitoring deployment strategies:** proven methodologies for specifying the locations for customer/network monitoring, with integration to the DNOs' operational environment
- o **Business planning tools:** trigger points for investment will be recognised earlier than is possible today, accelerating low carbon solutions
- o **Operational and planning solutions:** new mitigation tools (demand response, power electronics and energy storage) will be available to DNOs, with clear policy guidance describing target customers, network locations and operating regimes for deployment
- o **Commercial models:** the promotion of current commercial solutions - where necessary new models will be developed, including new ways in which DNOs can interact with customers via energy suppliers and independent players. Where existing regulatory boundaries are challenged we will work with the Regulator and other stakeholders to develop new codes of practice
- o **DNO-ready learning and dissemination:** using measurable outputs, we will understand, develop and adopt changes to DNO practices, policies and operations - including the creation of tailored communications
- o **Outputs for RIIO-ED1:** provided critical learning for dissemination across the industry including: solutions proven ready for utilisation in RIIO-ED1 submissions; and will have answered the question - how effective is demand response in addressing network constraints?

Technical Description of the Project

A detailed description of the complete project can be found in Appendix B. Below, we provide a summarised technical overview and highlight the most technically innovative aspects of NTVV.

Use of statistical techniques - learning from supermarkets

From the late 1990s, the retail sector, notably Tesco, Sainsbury's and Boots, began to change the way they sold produce from simply having items on their shelves, to tailor and target individual shoppers with specific offerings (details in LO-1.2 of Appendix B). In other words, focus changed from the supply side to becoming more customer centric. The introduction of loyalty cards gave access to specific buying habits of individuals - with consumers happy to provide this data in return for points, discounts, or offers on relevant products.

Electricity distribution, in principle, is no different. However the main aim would be to use the information to anticipate, plan, operate and manage the network more effectively and ultimately benefit the customer by limiting the network investment requirements associated with the low carbon transition.

To operate networks effectively and efficiently, DNOs must understand that customers are different, and need to be grouped to a much finer degree of resolution than have been done in the past.

We will demonstrate how mathematical and statistical techniques can be applied to electricity consumers, and feed the analysis into network planning processes in order to motivate and develop a more effective and responsive service that places customer needs at the forefront.

Improved understanding of customer behaviour

With increased consumer choice comes complexity. Categorising customers' energy usage is essential for understanding the behaviour of customers now and in the future.

Analysis of smart meter data from the EDRP trial undertaken between the University of Reading and SSE Energy Retail has shown how varied consumption is by household, and how challenging prediction is by conventional metrics: location, housing stock, assets, or socio-demographic information. There are however, many distinctive behavioural patterns that are evident in 24/7 smart meter data (Appendix B(iii)). All data will be handled in accordance with the Data Protection Act.

SSEPD established the 'Smart Analytics' IFI project earlier this year which has already demonstrated how the techniques could be applied to electricity distribution networks. This technique is highly innovative, having never been used on electricity networks (transmission or distribution), anywhere in the world.

We aim to develop an industry consensus with a standard vocabulary and segmentation of different usage types. Such user types may then characterise consequent issues for electricity distribution networks with certain distributions of behaviour under various scenarios. Additionally, a common vocabulary will enable better communication between DNOs and electricity suppliers.

2: Project Description cont.

We aim to demonstrate how this technique can be applied with both domestic and other non-half-hourly metered customers, including SMEs.

Improved forecasting

We will aggregate the modelled profiles of individual domestic and SME customers on each feeder via statistical grouping to form feeder power flow profiles. We will validate this method for predicting feeder characteristics (volts and amps) against monitoring data from this project and other LCNF projects (to the extent that this data is made available). This will identify whether behavioural demand trends of domestic and SME customers can be drawn and the extent to which this could be of use to the DNO.

We will create an agent-based forecasting model, enabling short, medium and long-term demand predictions with envelopes of uncertainty. We aim to demonstrate how these three forecasts can be used by DNOs for operational, planning and investment activities. Short term forecasts will be continually refined on a rolling basis to produce better and better estimates. Longer term trends will largely be scenario-driven. It is anticipated that take up of low carbon technology will not be uniform across customers, and hence neither across LV networks, but more sporadic in clusters. Our forecasts will be designed to account for this non-uniformity. We will demonstrate how key events, such as a change of home ownership, or change to a small business (eg a sandwich shop becoming a tanning salon), can be accommodated.

A key feature of both the modelling and forecasting techniques proposed is that they are expected to be applicable to, and have sufficient resolution for DNO purposes, regardless of whether smart meter data is available from every household and small business in the country.

Working with local councils in the Thames Valley area, we will aim to combine local planning activity with network planning and investment.

The outputs of this will be fed into software modelling tools (see Appendix G for details of the accompanying Tier 1 project SSET1005) to ensure the outputs can be used in a real DNO environment.

Facilitating change: The 'Methods'

In order to address this aspect of the Method, we will take each of the trial elements in turn.

1. Link network reinforcement to a better understanding of electricity consumers

Monitoring can only provide a lagging indicator for the purposes of network investment. In order to be converted into a useful indicator we must extrapolate the trends into the future. Load forecasting techniques used by DNOs to date have proved to be flawed, generally because the resolution of the model does not go down to the individual consumer level. By aggregating over customers' usage profiles and forecasts, it will not only be possible to emulate monitoring but also predict future demand upon the feeder.

This will result in a significantly better estimate of the headroom of existing LV feeders, simply by having a better understanding of the duty, now and in the future, that the feeder will be called upon to perform and comparing this with its true headroom at any time of the day, at any time of the year, both now and into the future. Where necessary, this headroom can be enhanced by changing set points of existing voltage control devices at primary substations, without violating constraints at other, related parts of the network. This will be possible because of the new and better understanding of the network which is generated from a better understanding of customers.

2. Interact with demand response provided by both large and small businesses

Across the UK many primary transformers are operating close to capacity and won't be able to accommodate further increases in demand without being upgraded. For example 7% of extra high voltage / high voltage (EHV/HV) transformers in the Southern Electric Power Distribution area are at Load Index 4 & 5 (5 being the maximum), meaning there is very little capacity left on them. The increasing connection of LCT, not only at LV but also by industrial, commercial and SME customers, may require these transformers to be replaced in the near future, probably sooner than was estimated for DPCR5.

Demand response will be delivered by way of around 30 building management solutions (BMS) deployed by Honeywell, a company new to this market in the UK. NTVV aims to trial the BMS solution for demand (including lighting circuits and electric space heating/cooling), standby generation and (where available) customers' energy storage (electricity and heat).

2: Project Description cont.

Honeywell is one of the largest implementers of automatic demand response solutions in the world. Coupled with over 100 years experience in providing end-to-end energy and demand management solutions for buildings and facilities across the globe, they are able to deliver a fully functioning system and demonstrate the mutual benefits it can deliver for DNOs and buildings enrolled on the programme.

NTVV aims to:

- o Demonstrate, with around 30 customers, how demand management can be achieved for large commercial customers via a building management system
- o Involve around 30 small business customers in exploring the extent to which a version of this building management system could be applied to SMEs
- o Deploy a total of 100 hot water energy storage units and 50 ice cooling storage units to demonstrate the extent to which thermal storage can increase the available `controllable' load within a home or business

3. Use mathematical techniques to reduce the need for low voltage monitoring

Some LV feeders have little or no headroom whilst others have a reasonable amount available for historic network reasons. LV feeders are not monitored and therefore typically network operators apply simple rules to estimate the headroom of LV feeders, resulting in differing levels of available headroom. It is possible to monitor all LV feeders, at source and feeder end, but the cost to monitor all LV feeders is prohibitive. In addition, there could be unusual mixtures of loads and generation which at times could produce localised excursions of thermal, voltage limits or power quality which are not revealed by monitoring at source and feeder end.

We believe that, through the use of statistical and mathematical techniques, it will be possible to create 'virtual' customer monitoring. Through the use of 'buddy' techniques the profile of a given LV network can be emulated using an amalgamation of customers of suitable type. The technique will reveal excursions that would not be achieved by monitoring at source and feeder end.

Moreover, the number of physical monitoring points on a network can be reduced as a consequence of using this emulation technique.

4. Tactically deploy power electronics and electrical energy storage on the low voltage networks

Although better understanding of customers and of network feeders can reduce the need for premature reinforcement, when LCT connections have used up the true available headroom it will be necessary to reinforce. In some cases this may be reactive, particularly in early years before the use of more sophisticated planning tools are widespread.

Indeed learning from our Chalvey LCNF T1 monitoring project has highlighted that a precursor of thermal and voltage constraints will often be power quality issues of power factor and harmonics. These have customer service and safety implications. We will demonstrate how power conversion power electronics can be used to manage these issues with and without energy storage modules at the LV network. The elements in this section will be supported by Imperial College.

NTVV will deploy LV connected electrical energy storage, in statistically relevant quantities. This will provide a robust understanding of how a DNO can effectively deploy and operate this technology to support customer choice. A total of 15 single-phase (10kW/10kWh) domestic storage units and 16 three-phase (25kW/25kWh) street storage units are planned in the NTVV project.

Energy storage units will be used to peak lop both demand and generation to keep supplies within cable limits. The devices also have the capability of four quadrant operation, meaning it is possible to provide voltage support to keep the supply within the given standards.

In the initial stage of NTVV we intend to use the smaller domestic storage facilities to simulate the effect of low carbon technologies - 'stress-testing' the LV network.

2: Project Description cont.

Closing the gap between trials and business-as-usual

Both of the distributed technology solutions (DSR and storage) identified above will be configured with the SSEPD control system (GE's Distribution Management System (DMS)). Whilst focusing on the two technologies, the solution will form a functional stepping stone to any distributed device on the network (eg voltage control schemes, power flow management, etc). The generic requirements of this activity are:

- o GE's DMS will act as the coordination hub for network management which will integrate with various intelligent distributed energy resources to be deployed in the LV network, leading with demand resource and battery storage resources
- o The ability to calculate where and when additional resources can be used to re-enforce the current network during peak demand times
- o The ability to charge LV storage units during off-peak times in order to make them available during peak times without impacting current demand
- o The availability of power analysis information based on load profiles for estimation of current system demand
- o The availability of power analysis information based on substation monitoring information available from the monitoring solution detailed previously
- o The ability to link into the Honeywell ADR as an aggregator of demand response across an estate of buildings to create a despatchable demand resource
- o Systematic evaluation of telecommunications solutions in NTVV and other available projects

Description of design of trials

Robust to deliver learning

NTVV uses a robust learning based methodology to provide an improved alternative to traditional network reinforcement, determining the most efficient and effective ways to meet the needs of our customers reliably over the coming years, and on a longer time horizon towards 2050. The problem can best be summarised by the question:

How will the DNO need to understand, anticipate and support changes in customer behaviour to develop an efficient network for the low-carbon economy?

We have divided this question into five key areas of learning:

- o **LO-1: Understanding** - What do we need to know about customer behaviour in order to optimise network investment?
- o **LO-2: Anticipating** - How can improved modelling enhance network operational, planning and investment management systems?
- o **LO-3: Optimising** - To what extent can modelling reduce the need for monitoring and enhance the information provided by monitoring?
- o **LO-4: Supporting Change** - How might a DNO implement technologies to support the transition to a Low Carbon Economy?
- o **LO-5: Supporting Change** - Which commercial models attract which customers and how will they be delivered?

Structuring the project around Learning Outcomes places the generation of learning at the heart of the project. We have taken this approach to:

- o Address why each element of the project is required and ensure that every part is relevant.
- o Clarify how NTVV complements the portfolio of Tier 2 projects both funded in 2010 and those announced in the 2011 ISP.
- o Generate useable outputs to the benefit of UK plc.
- o Help make future research more effective: NTVV pushes at frontiers; as a result it is likely to encounter challenges - perhaps uneconomic or technically challenging solutions, unreceptive customers. By openly and honestly disseminating these results we will prevent others from potentially wasting time or effort at a later stage.

The learning outcomes have been structured with a clear hierarchy in order to fulfil the overall project goals, shown in Appendix B(ii).

2: Project Description cont.

Ability to extrapolate to the UK

Statistically sound: The statistical robustness of the methodology, and our ability to apply the results elsewhere will be underpinned by our Partners at the Applied Mathematics Department of the University of Reading.

We will scale-up data from the local samples (NTVV's chosen LV and HV networks) so as to make inferences at both regional and national levels. Sampling errors of the project data on the LV networks will be quantified directly through standard Bootstrapping methods (a method used to obtain estimates of summary statistics - in this case repeatedly redrawing similar LV network populations from the given sample(s)). The advantage of this is that it yields a measure of uncertainty (error bar, or hi-low values) for any derived statistical / performance measure (whether linear or nonlinear). This will provide an associated (extrapolated) error onto the same statistic applied elsewhere for larger populations - both regionally and nationally.

Technically sound: We have selected our partners on the basis that they are technology experts, with a solid understanding and track record of delivering results. In particular, Honeywell have building management systems in operation today in offices around the world, and GE have a significant role as system integrator to ensure the solutions developed are knitted into the control systems used by SSEPD (and most other UK DNOs). KEMA will be providing pre and post validation of technologies deployed on the network, and EA Technology will be working with each of our technology partners through the course of NTVV to help ensure the technical outputs can be integrated into DNO business-as-usual activity.

Reliable: As mentioned, the data will be statistically tested by experts from the University of Reading. The project methodology has been developed with EA Technology in order to extract maximum learning from the project.

Verifiable: We will use whole of the Thames Valley area as our test area. In the development of generic tools, processes and policies, we will compare results from this trial to other areas within the SSEPD licence areas. We will draw in learning from new developments on the SSEPD networks, and from other funded LCNF projects.

Changes since the ISP

A number of significant activities have been undertaken since the submission of the 2011 ISP. Whilst the core of the project has not radically changed, the project now has a clearer focus, rationale and structure to maximise learning:

- o A comprehensive review of all Tier 2 projects funded from 2010, and those submitted at ISP in 2011, has been undertaken to ensure the NTVV project effectively builds on the UK's LCNF portfolio
- o Informed by this, NTVV has been restructured around five learning outcomes:
 - o All trial activity has been reviewed against these learning outcomes for fit - where activity was not contributing, it has been removed; some new activities have been added to address gaps
 - o Detailed costing has been carried out following the re-focused project
- o Introduction of focused activity to bridge the gap into UK DNO business-as-usual, including:
 - o Detailed technical evaluation of charging / derogation consideration
 - o Identification of the need for use-cases, policies, procedures and design tools to be developed in the project
 - o Identification of the need to develop training material to educate the range of DNO stakeholders through the project
- o Contact has been made and application submitted to EU (FP7) to link the learning from other European projects to NTVV (and vice-versa)
- o Improvements made to the project readiness:
 - o Key stages completed on a total of seven IFI and Tier 1 projects which have de-risked the Tier 2 project (Appendix G)
 - o Contracts have been put in place with all of our commercial project partners
 - o Advanced stages of the SSE large capital project governance has been reached
- o An evaluation of telecommunications solutions in NTVV and other available projects

2: Project Description Images, Charts and tables.

Figure 1

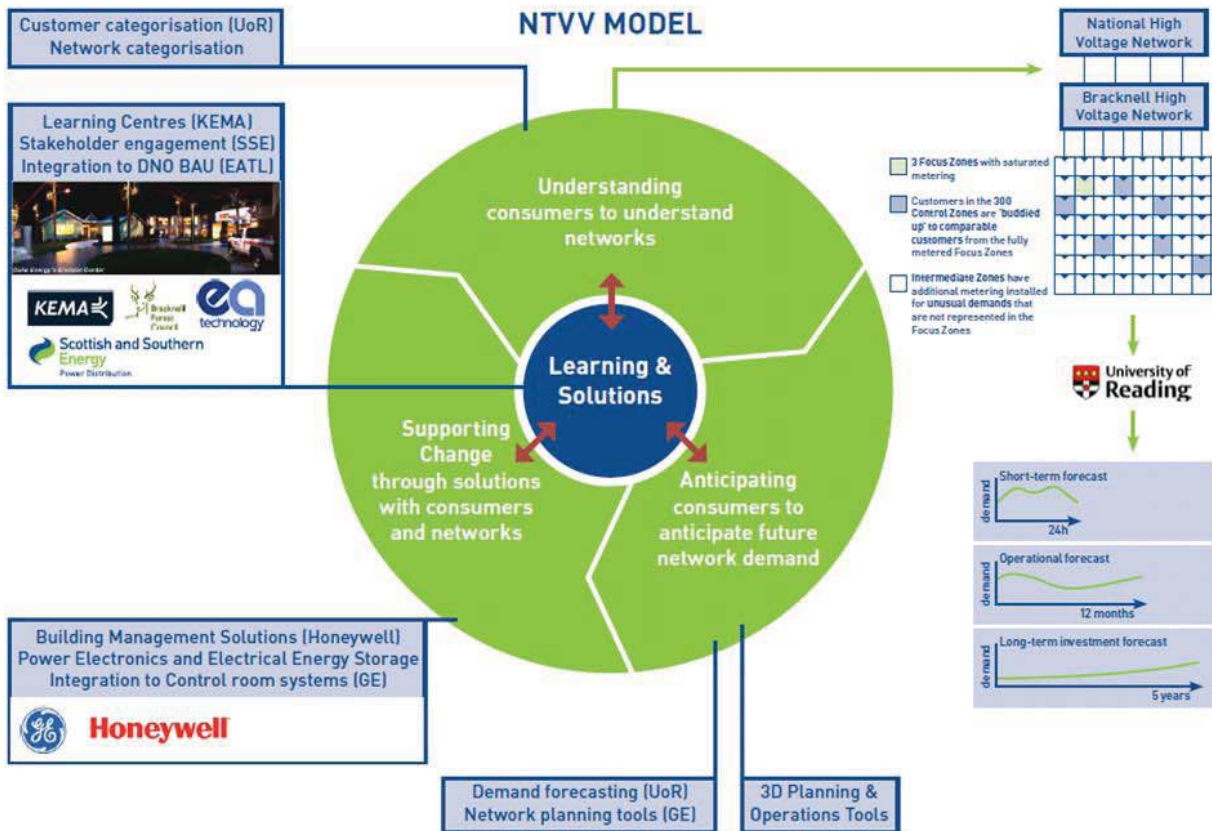


Figure 2 – Customer Types

Distribution Network Voltage	Customer Type	Load Definition*
EVH 132kV 33kV	Industrial	>4MW
HV 11kV	Large Commercial	1-4MW
	SME (Light Commercial) LV HH & LV Domestic	>100kW
	Domestic	<100kW
LV 400V		<20kW

Focus of the NTVV Project

*Definition for the purposes of the NTVV Project

Section 3: Project Business Case

New Thames Valley Vision in an SSE Context

New Thames Valley Vision is proposed by SSEPD, which is part of the Scottish and Southern Energy (SSE) group. SSE is involved in the generation, transmission, distribution and supply of electricity, the production, storage, distribution and supply of gas and in the provision of other energy-related services.

In its latest Annual Report, SSE explains that its priorities for its energy networks are:

'Delivering upgraded electricity transmission networks and operational efficiency and innovation in electricity and gas distribution networks as they respond to the decarbonisation and decentralisation of energy.'

New Thames Valley Vision is part of SSE's strategy to deliver on these priorities. Its role in informing efficient investment, the innovative application of technology and the support the project provides for decarbonised energy and embedded generation are the keys to its success and the reason why SSEPD is submitting this bid to the Low Carbon Networks Fund.

The aim of New Thames Valley Vision is to demonstrate that understanding, anticipating and supporting changes in customer behaviour will help DNOs to develop an efficient network for the low carbon economy. The project has grown out of, and is underpinned by, the core purpose of Scottish and Southern Energy which is:

To provide the energy people need in a reliable and sustainable way

As with all SSE projects, it reflects our 'SSE SET' values:

Safety Service Efficiency Sustainability Excellence Teamwork

Safety: We believe all accidents are preventable, so we do everything safely and responsibly or not at all.

In developing NTVV, safety assessments have been undertaken to ensure the project does not pose a threat to the safety of our customers, our employees or our contractors.

Service: We give our customers service we are proud of and make commitments that we deliver.

We believe that NTVV will improve the service we provide for customers in the Thames Valley and in the longer term will allow us to better meet the needs of our customers throughout the UK, and to facilitate other DNOs in improving their service. At its core NTVV is about facilitating choice for consumers, and ensuring that the network does not become a barrier to customers' adoption of low carbon technologies.

We are committed to minimising inconvenience to customers in its trial area by installing the optimal amount of network monitoring with the lowest practicable level of customer disruption

Efficiency: We keep things simple, do the work that adds value and avoid wasting money, materials, energy or time.

Efficiency is at the heart of NTVV: introducing the proposed measures will deliver a reliable and sustainable electricity distribution network in a far more cost effective way than traditional approaches would allow.

Sustainability: We operate ethically, taking the long-term view to achieve growth while safeguarding the environment.

NTVV epitomises SSE's sustainability value. The returns on NTVV, both environmentally and financially, are long term. Whilst there are quick wins, this is no quick fix. By investing in NTVV now, SSE aims to develop practices which will provide the engineers of the future with a range of new network management solutions which will have longevity and deliver benefits for many years to come.

Excellence: We strive to get better, smarter and more innovative and be the best in everything we do.

By proposing ideas that are all new to the sector or to the UK, NTVV is a model of innovation, made possible by SSE's long deep-rooted commitment to bringing new ideas to the fore.

"Performance has to be improved constantly if a business is to survive in the long term. That's why innovation has become a big thing in SSE. It's part of our Excellence value and it's innovation with a purpose - to deliver business improvements for the long term. We know that 'long term' means a very different energy sector from the one we operate in now, and we're building towards it all the time."

Ian Marchant, SSE Annual Report 2010/11

3: Project Business Case contd.

Complementing our commitment to excellence, Innovation is a core part of SSE's business. SSE recognises that great ideas can emanate from any of our employees and aims to inspire and capture and innovative thinking. As a spur to employee participation, idea generation, continuous improvement and operational excellence, SSE maintains and promotes a systematic approach to implementing ideas that add value. This is through the Licence to Innovate scheme, under which any employee can suggest ideas for improving the way SSE operates, consistent with its core values. People with ideas with significant potential are granted a License to Innovate, under which they can spend two months researching further their proposal. Subject to the outcome of the research, the idea may then be piloted prior to full implementation.

Over 1,800 Licenses to Innovate were issued during 2010/11, of which over 300 were implemented. A number of Licenses have created total value of around £45m. Others have contributed to improved performance in specific areas, such as safety, service and sustainability.

SSE extends this to draw on the innovation of project partners and stakeholders, an approach which has reaped rewards both in SSE's Northern Isles New Energy Solutions (NINES) smart grid project in Shetland and in the development of NTVV.

It is this disciplined yet supportive approach to innovation that gives colleagues and stakeholders the confidence to propose inspiring, challenging and novel projects like New Thames Valley Vision.

In developing NTVV, we have also been inspired by and learnt from an array of successfully delivered projects which have allowed us to gain a useful understanding of the challenges of the future and the tools both commercial and technical that we can utilise to resolve issues. Projects of note include:

- o Orkney Registered Power Zone: the first network based operational Active Network Management system in the UK.
- o Chalvey zero carbon homes: an SSE funded project in conjunction with Slough Borough council which has constructed 10 fully occupied zero carbon homes to demonstrate the most advanced home energy systems available for the new home market.
- o Shetland battery: a six megawatt hour sodium sulphur (NaS) battery - Europe's biggest - installed adjacent to our power station on Shetland

Teamwork: We support and value our colleagues and enjoy working together as a team in an open and honest way.

NTVV has brought together colleagues from all facets of SSE and SSEPD to create a new, never before tried approach to managing our electricity networks and has extended involvement to a range of stakeholders from business, academia and the public sector.

Integration with SSEPD's Business Plan

SSEPD's delivery priority is to deliver upgraded electricity transmission networks, operational efficiency and innovation in electricity and gas distribution networks as they respond to the decarbonisation and decentralisation of energy.

SSEPD's business plan has a focus on achieving this. Through its learning outcome approach NTVV has been designed to feed into the business plan directly. It will:

- o In the short term provide a benchmark network in which the implications of disruptive technologies can be assessed and scaled.
- o Allow us to cost and plan the monitoring of our network with the optimal level of low cost equipment and communications infrastructure taking full account of the longer term input from Smart metering data.
- o Allow us to produce short, medium and long term models of investment requirements for a range of disruptive technology penetration levels
- o Provide us with an evaluation, technical, economic and commercially, of a range of innovative network management tools releasing capacity on the network.
- o Provide a template into which solutions from other SSEPD and other DNO projects can be fed to allow comparative evaluation and inform solution selection for inclusion in our business plan.
- o Quantify and define resource requirements including staff and contractor skill sets to support the roll out of the business plan.
- o Generate new processes, standards and procedures that are required to implement the NTVV approach as business as usual.

3: Project Business Case contd.

The network visibility tools and learning that NTVV will give us are key to the development of our business plan. Through re-inventing the way in which we understand and anticipate customer behaviour we will be confident of providing realistic and robust business plans.

NTVV is fundamental to our preparation for RIIO, and is absolutely in line with the values core to the operation of our business. Figures 3 & 4 highlight the predicted cost comparison between 'novel' and 'business as usual' network management methods outlined in the NTVV)

Motivation for New Thames Valley Vision

The motivation for NTVV has two complementary strands:

- o **A desire to continue to provide the energy people need in a reliable and sustainable way; and**
- o **an ambition to make the most of the opportunities offered by the Low Carbon Networks Fund**

In this business case, we will examine each of these in turn.

Providing the energy people need in a reliable and sustainable way

NTVV will allow us to understand much more about customer behaviour, to predict how they will use energy in the future and to plan and develop our networks to support that.

Managing uncertainty

It is often said that the only certainty is uncertainty and this is true of the future of electricity distribution networks. There are many pathways to a low carbon future, and many of them have the potential to create a profound impact on the network. We believe that in order to evaluate and respond to the changes we need to significantly improve the visibility of the network and learn to use this new information to identify and predict network stress points. We then need to have a range of solutions available to manage these stress points where possible taking advantage of this network visibility in the process. To this end NTVV aims to use innovation to understand, anticipate and support changes in customer behaviour to develop an efficient and effective network as the various paths to a low carbon economy maps out before us.

Visibility and stress point identification need to be in place across the network quickly to remain ahead of the low carbon front; it is critical that these systems integrate effectively with our core business systems and do not become unreplicable islanded solutions. To give an analogy, there is no point in inventing the motor car unless we also create a roads network.

Ordinary is good

The fundamental aim of NTVV is to better understand and anticipate customer behaviour, which will help to reduce the uncertainty about future demands on distribution networks. We believe that the Thames Valley is an ideal location for such a project due to the 'ordinariness' of the network. The distribution system has no unique features; it is of average age and reliability; There are no significant low carbon initiatives in the area and no eco-towns. In short, it is typical of much of the UK. We believe therefore that the findings from NTVV will be applicable to much of the country and thus the learning useful to all DNOs.

NTVV has been carefully designed to ensure that it is replicable throughout the business and industry.

Strong stakeholders

Whilst the Thames Valley area has an ordinary distribution network, it is distinguished by having one of the UK's greatest concentrations of technology and engineering businesses. Bracknell in particular hosts GE, Honeywell, 3M, Dell and Cable & Wireless Worldwide, as well as the UK headquarters of prestigious companies including BMW and Waitrose. All of these organisations are playing a role in NTVV. Much as the high presence of financial firms facilitates the pre-eminence of the City of London in money matters, the close proximity of technical businesses within the Thames Valley will allow the area to become the centre of smart grid technology in the UK.

In line with our smart grid ambitions, and our commitment to stakeholders generally, SSEPD's engagement with NTVV stakeholders, on both local and national levels, is for the long term; we are committed to nurturing long term relationships which benefit all parties.

To this end in a completely new approach for a UK utility we will be leading the establishment of a low carbon community advisory centre. It will be a hub for engagement with all stakeholder groups which along with a comprehensive web site will be the window into the Smart Grid.

3: Project Business Case contd.

Making the most of the opportunities offered by the LCNF

The new Price Control changed the framework for operating and capital expenditure to remove the perceived bias in favour of the latter and to ensure the delivery of not only the investment itself but of agreed outputs from it. The most successful electricity distribution companies, therefore, will be those that apply efficiency and innovation to maximise outputs from agreed expenditure.

RIIO-ED1: Change and why we need to respond

Network Disruptive technologies: DECC's UK Low Carbon Transition Plan portrays a number of possible paths for the evolution of energy use as the Low Carbon economy advances. The document considers the impact of a range of potentially disruptive technologies capable of changing the scale and nature of energy flows on the network.

- o Electric cars
- o Supplier drive demand side management
- o Heat pumps
- o Micro Generation
- o Electrification of heat
- o Electrification of transportation

These amongst other factors will have the effect of disrupting the predictability of maximum demands and profiles that have been heuristically evolved over the last 50 years. These demand profiles are the centre of our existing planning methodologies yet within the next few years will be worthless as planning tools as the nature of load flows become more dynamic in nature.

This disruption creates a clear requirement for us to monitor the network. It also highlights the need to use this data intelligently to model future dynamic load to forecast the impact on the network.

Enabling Roll-out

A key element of our business case for NTVV is delivery of a project that is 'complete', where the solutions being evaluated are developed to a level where they are capable of being used by the DNO at scale. Without the ability to roll-out the innovative solutions we are demonstrating the benefits of smart grid will not be realised.

Our experience shows us that whilst individual technical and commercial solutions may be challenging, the real challenges emerge when these solutions are scaled up. We have seen this in a number of projects, including a recent SSE deployment of large scale asset data gathering. This project implemented 20 data gathering units successfully with minimal effort however, rollout across the business was significantly more complex. The systems, procedures and interfaces to provide visibility to the people and processes that required it, highlighted the fundamentally different attributes of successful trial to that of a successful deployment.

This example demonstrates why the real challenge is in scaling up these solutions in such a way that the DNO or other stakeholders are able to operate these solutions effectively at scale. We see this as the 'elephant in the room' and if not addressed will distort the perception of the ease of rollout and leave many critical questions unanswered requiring significant further work before any of the solutions evaluated can be implemented and deliver scalable benefits.

This is the driver behind the creation of a network operations and planning environment, which in essence performs three critical functions:

- o Creates the environment in which planners, operational staff and business systems will interact with the data derived from and solutions implemented in the project.
- o Allows the flow of information from DNO legacy systems to the new solutions to reap the benefit of existing system information eg connectivity, circuit ratings, system operational state.
- o Seamless integration of new solutions into core business and real time system allowing control alongside traditional systems using the same staff infrastructure eg control rooms, planning tools.

In summary, the Network Operations and Planning environment is a key element of the project, without which any claims that the project would provide a replicable ready solution are hollow.

3: Project Business Case contd.

Leveraging European Funding

SSEPD has recognised the value of appropriate engagement in Europe, in the last four years we have participated in four FP7 bids and are now stepping up our engagement.

This enthusiasm has been driven by the synergies that we have established with European operators in some of our innovation projects. In order to ensure structure and purpose to this engagement we have agreed two medium term objectives, one of which is to submit NTVV as a knowledge sharing project in the 2012 FP7 Energy Research 2012 calls (Smart Energy Networks).

Converting innovation to business as usual

SSE's pragmatic approach to developing and implementing research projects and technology trials ensures the generation of outputs which are practical and effective. Conversion of these useful outputs to business as usual, for SSE and for the wider industry includes:

- o the creation of new policies and procedures
- o commercial precedents
- o component specifications
- o vocational and technical training courses
- o management tutorials

NTVV has been designed to act as a template for replication across our networks and those of other DNOs. To this end we have established a dedicated power systems innovation team linked to our policy unit. Within this team is a dedicated 'Knowledge Manager'; part of this role is to ensure that the learning from each project is incorporated into an overall knowledge. This approach is driven by our desire to translate learning and innovation into business as usual as quickly as possible, allowing the benefits to be realised swiftly. This structure also ensures that we can cross-fertilise the solutions and learning from one project to another, a feature clearly demonstrated by the inclusion of NINES-inspired elements in NTVV.

SSE has a strong track record in adopting converting practical, innovative ideas. Examples include:

- o the expansion of active network management solutions to other locations in our network following the success of the Orkney RPZ
- o the adoption of trenchless excavation techniques
- o the use of Bidoyng fuses for specialist underground cable management
- o partial discharge fault location at substations

Benefits

We are confident that NTVV will provide a range of benefits for DNOs as energy is decarbonised. Using the methodology developed for our GB roll-out (Evaluation Criteria 4(b)), and scaling it for our two SSEPD licences yields net benefits of over £600m from 2020 - 2050:

- o Southern Electric Distribution Ltd - **£482m** (based on the difference between £936m of novel deployment costs to £1,400m of conventional reinforcement).
- o Scottish Hydro Electric Distribution Ltd - **£143m** (based on the difference between £302m of novel deployment costs to £440m of conventional reinforcement).

Details are shown on page 17 and Appendix E.

Further to this we anticipate that NTVV will yield more immediate benefits including:

- o Accelerated low carbon technology connection for customer
- o Avoidance of supply failure resulting from unanticipated demand peaks
- o Reduction of network losses as a result of power factor correction
- o Informed business plans going into RIIO-ED1 with the ability to model scenarios
- o Customer groups with an improved understanding of how to self-mitigate network issues through the way in which they select and implement low carbon solutions
- o Evaluation of resource and skill requirements
- o Training and learning dissemination
- o Enhanced data to inform DPCR5 output measures
- o A range of specific innovative alternatives to reinforcement
- o A no-customer minutes lost (CML) impact implementation strategy
- o Enduring productive relationships with stakeholder

3: Project Business Case contd.

Alternatives

In developing NTVV we have considered the implications of the main alternative to the project, which is to do nothing new.

We consider that without the approach we propose in NTVV (or a viable alternative which may or may not arise independently of SSE) widespread adoption of low carbon technologies could result in such stresses on SSEPD's network that would necessitate the replacement of a significant proportion of our network.

The most challenging part of replacing distribution assets would be at low voltage level, with the upheaval and cost of replacing individual service cables, substations and associated plant. The replacement value for the complete renewal of these assets just for SSEPD's two licences would be circa £3 billion.

Disruption to public highways would be a significant consideration and would require the programme to be phased over tens of years, resulting in unacceptable delays to the connection of low carbon solutions.

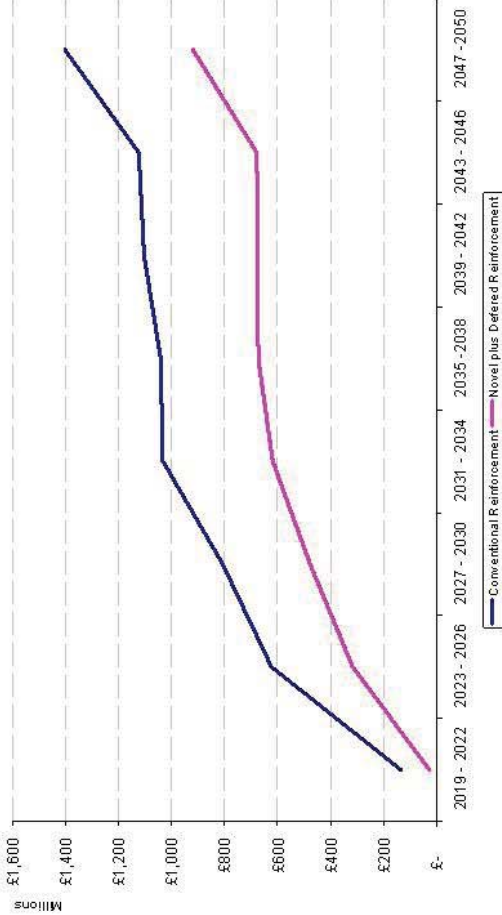
Conclusion

It is clear that the innovative solutions that we are implementing in NTVV carry with them uncertainty, in particular in relation to their ability to perform as planned, level of customer uptake and response and the sustainability of the demand management achieved. However, the alternative - waiting until the network is on the brink of overload and then replacing the low voltage network - would be an extremely high risk strategy from a safety, financial and customer service perspective. This is not compatible with our aim of providing the energy people need in a sustainable way and therefore is not an option.

We need to do something new, now and New Thames Valley Vision is our proposal of choice.

3: Project Business Case Case images, charts and tables.

Figure 3: PV of the projected cumulative cost difference (SSE Southern) using the Method(s) outlined in NTVV

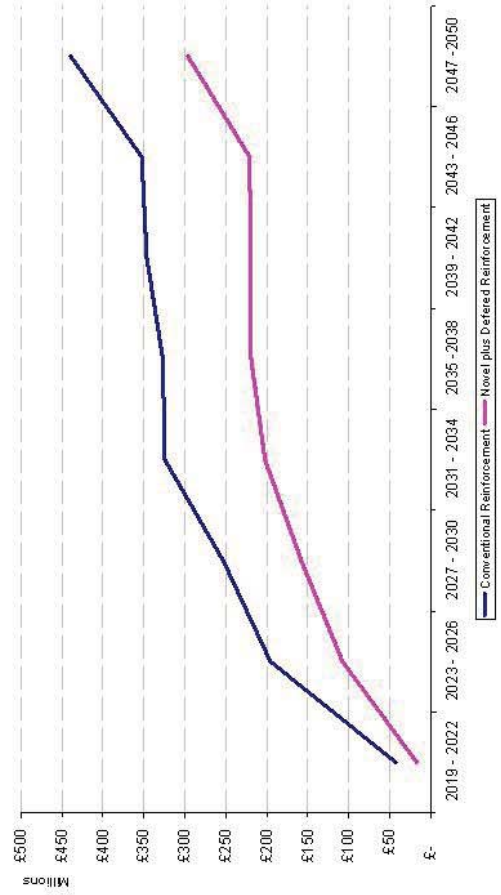


Item	Costs £m			Benefit £m	Comment
	Novel Method	Novel Reinforcement	Conventional		
Total	£ 30	£272	£440	£143	
Method1 Better Understanding of Customers	£17	£235	£393	£142	
Deferred & Avoided LV reinforcement to accommodate PV	£4	£49	£2	£2	40% of applicable networks
Deferred & Avoided LV reinforcement to accommodate HP & EV	£12	£143	£266	£113	60% of applicable networks
Total deferred & avoided LV reinforcement	£17	£192	£324	£115	
Deferred & Avoided Primary Substation Replacement	£-	£42	£69	£27	
Method 2 Demand Management of Commercial Customers					
Deferred & Avoided Primary Substation Replacement	£13	£37	£46	£4	Assumed that method 1 has been applied.
Method 3 Reduced Monitoring of LV feeders					
Monitoring of LV feeders	£4		£9	£5	Note that the cost of monitoring 100% feeders is included in the costs of method 1
Method 4 Technical deployment of battery storage					
Value of avoiding lost FIT payments		£0.07		£0.07	Note that the cost of batteries is included in the costs of method 1

Figure 4 - PV of the projected cumulative cost difference (SSE Hydro) using the Method(s) outlined in NTVV

Item	Costs £m			Benefit £m	Comment
	Novel Method	Novel Reinforcement	Conventional		
Total	£98	£887	£1,480	£482	
Method1 Better Understanding of Customers	£53	£747	£1,252	£463	
Deferred & Avoided LV reinforcement to accommodate PV	£14	£157	£177	£7	40% of applicable networks
Deferred & Avoided LV reinforcement to accommodate HP & EV	£30	£455	£350	£30	60% of applicable networks
Total deferred & avoided LV reinforcement	£53	£612	£1,031	£37	
Deferred & Avoided Primary Substation Replacement	£-	£135	£221	£46	
Method 2 Demand Management of Commercial Customers					
Deferred & Avoided Primary Substation Replacement	£16	£119	£144	£13	Assumed that method 1 has been applied.
Method 3 Reduced Monitoring of LV feeders					
Monitoring of LV feeders	£11		£26	£17	Note that the cost of monitoring 100% feeders is included in the costs of method 1
Method 4 Technical deployment of battery storage					
Value of avoiding lost FIT payments		£0.21		£0.21	Note that the cost of batteries is included in the costs of method 1

PV of Cumulative Cost of Conventional and Novel Methods (Hydro)



Section 4: Evaluation Criteria

(a) Accelerates the development of the low carbon sector

On the assumption that this project is successful and that the learning is adopted nationally (where this learning can be applied), it is estimated that the project will deliver 34Mt CO₂ benefits, to consumers over the period 2018 to 2050 (Figure 5 illustrates the projected carbon saving)

The Low Carbon Transition Plan (LCTP) outlines six key elements of a UK Smart Grid (Box 10, Chapter 3). Of these six, the NTVV project will attempt to demonstrate five, namely:

- Facilitating demand management, providing data to technologies in homes and buildings that can regulate electricity use.
- Enabling individuals and businesses to sell electricity into the network as well as buying from it.
- Enhanced monitoring and information flows for network operators, allowing them to make more efficient decisions about where energy flows across the network on a real time basis. A greater use of energy storage would also increase the need for smarter information flows for network operators on energy storage supply and timing of use.
- Use of a range of technologies including advanced communications and information management systems, intelligent metering, demand side management, and storage. Many of the technologies to enable such capability are already available, but have not yet been integrated together in large scale demonstrations and the actual mix that is deployed will depend on their feasibility.
- More optimal usage of the whole network in meeting demand, which could limit the need for more reinforcement of the grid.

The project aims to demonstrate that this saving can be made while making significant financial savings compared with business as usual. Crucially we seek to demonstrate that understanding and influencing customer behaviours enables better targeting and deferral of both novel and conventional network investments.

The NTVV project will specifically address the following areas of the Low Carbon Transition Plan by making the following contributions (assuming roll-out across GB) :

- **Power - solar PV:** The published data on connections under the Feed in Tariff (FiT) scheme show a significant and accelerating growth of connections, which are highly clustered, creating significant local network issues. If these issues are seen to delay PV connections then the impetus towards the 2020 targets for renewable electricity generation is at risk.
 - NTVV will reduce the network constraints to the connection of PV generators, at a lower cost and more rapidly than business as usual, delivering 21.5Mt CO_{2e}.
- **Transport - PHEV and Full EV:** There is a risk that owners of electric vehicles will choose to charge their electric vehicles at times of peak demand from other loads. Conventional operation of the network is likely to result in overloads or delay the roll-out of electric vehicles.
 - NTVV will reduce the network constraints to the connection of electric vehicles, at a lower cost and more rapidly than business as usual, delivering 8Mt CO_{2e}.
- **Homes and Communities - zero carbon homes:** The recent study 'Achieving deployment of renewable heat', commissioned by the Committee on Climate Change and published in April 2011 has re-affirmed previous UK government policy advice. The study finds that heat pumps form a crucial part of the mix in realising ambitions for heat from renewable sources, providing approximately 50% of renewable heat by 2030.
 - NTVV will reduce the network constraints to the connection of heat pumps, at a lower cost and more rapidly than business as usual, delivering 4.3Mt CO_{2e}.
- **Workplaces and Jobs - reducing emissions:** the project will use building management systems in large commercial sites and SMEs to improve energy efficiency and reduce energy consumption particularly at times of network stress. We will use the customer analysis techniques to identify those customers which have the greatest potential for reducing there consumption. This will result in reduced emissions however we have not at this time quantified this benefit.
 - NTVV will enable the Low Carbon Technologies listed above to be connected earlier than otherwise would be the case (due to network constraints). These technologies will therefore contribute to the reduction in carbon emissions earlier than otherwise would be the case. The potential contribution of each of the methods to the LCTP, financial benefits and impact on the operation of the distribution system is outlined below. More detail is provided in Appendix E.
- **Workplaces and Jobs - supporting skills:** Skills are becoming an increasingly significant topic. If workforce growth requirements reach the high end of forecasts (largely on the back of energy decarbonisation), the sector could need to resource over 69,000 vacancies by 2024; therefore creating substantial demand for both new entrants and the up-skilling of existing staff. This is supported by analysis carried out in 2003 that suggested the average age of a Chartered Engineer

4: Evaluation Criteria contd.

was late 50s, up from early 40s in 1998. Whilst the industry is beginning to address the challenge, needed for tomorrow (as the network becomes more intelligent and complex) will differ from the traditional ones used, and trained for today.

- o NTVV will develop and test relevant smartgrid training materials as it progresses.

Given the nature and range of companies in the Thames Valley area, we believe our Project will provide a significant boost to the DECCs Low Carbon Transition Plan's aspirations for the UK to be a world centre of the green economy. As a wholly-owned UK business, and already a leader in renewable generation in the UK, SSEPD and the SSE Group would be proud to be at the forefront of this initiative.

In addition to the Low Carbon Transition Plan set by the last Government, the Coalition's July 2011 publication 'Planning our electric future: a White Paper for secure, affordable and low carbon electricity' has set out the Government's commitment to ensure the Electricity Market is sufficiently robust to facilitate the UK's energy policy. Chapter 6, in particular, highlights the need for further consideration of the role that electricity networks can play in delivering these targets. Box 11 within Chapter 6, in particular, depicts a vision for this role, with **demand side response** and **electrical energy storage** highlighted as key to delivering it. The learning from this project will help to inform whether this vision is achievable and, if so, what steps need to be taken to achieve it. SSE is committed to actively contributing to the development and refinement of this vision, both through the direct learning dissemination from this project and also through our contribution to the Smart Grids Forum, chaired by DECC and Ofgem, and recognised in the White Paper as being fundamental to shaping electricity systems policy.

Potential Carbon Contribution from roll-out of each method

We have used a similar methodology to estimating potential carbon contribution to that followed by CE Electric in their Customer-led Network Revolution project bid last year. In essence this approach assumes that project success alone cannot bring about acceptance and use of LCTs. Rather the project can remove barriers that would delay the projected uptake of the LCTs that are considered by the project. Therefore the carbon case is based on the change in overall carbon emitted as a consequence of the project outcomes removing a delay in the implementation of PV, HP and EVs.

For each technology a comparison is made of the number of installed units across the UK based on current predictions against the number which would be made if network constraints delay the roll-out of these technologies.

The difference in installed units for each year gives a carbon benefit in each year as a result of this project. This is scaled by 65%, representing the applicability of our project's outcomes to GB. Aggregating across all of the technologies considered, over all of the years considered, yields a total carbon benefit for each method.

Better understanding of customers and management of the LV network will reduce barriers created by the LV network and will help to reduce barriers created by the HV network, whilst demand management of commercial customers will further reduce barriers created by the HV network. These methods are therefore complementary and will lead to the achievement of the same level of carbon saving. The carbon saving from these methods from 2018 to 2050 is calculated to be **34,000,000 tonnes CO_{2e}**. Details are shown in Appendix E.

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

On the assumption that this project is successful and that the learning is adopted nationally (where this learning can be applied), it is estimated that the project will deliver **£4.95bn** of net financial benefits, to consumers over the period 2018 to 2050. These benefits result from:

- o £4.55bn network capital cost savings from avoided and deferred LV feeder reinforcement, comprising:
 - o £3.62bn from deferral and avoidance of LV feeder reinforcement
 - o £0.66bn avoided primary substation reinforcement
- o £237m network capital cost savings from avoided and deferred primary substation reinforcement resulting from DSM of commercial customers using building management systems
- o £168m network capital cost savings from reduced requirement for monitoring of LV feeders
- o £2.3m direct benefit to customers with PV generators as a consequence of removing constraints that would otherwise prevent earning of Feed in Tariff.

4: Evaluation Criteria contd.

Quantitative assessment of benefits

Potential for replication across GB

We calculate that the learning from this project will be applicable to 65% (by length) of LV feeders within GB networks (Section E.2, Appendix E).

This project focuses on networks in urban, sub-urban and semi-rural areas, therefore the findings of this project will be applicable these types of areas across GB. We will not be including interconnected urban LV networks and networks in fully rural areas in the project, therefore the findings might not be directly relevant to these networks, although the techniques probably could be applied, albeit with different network modelling. We have scaled the results of our analysis to all of GB using the number of LV feeders and the number of primary substations in the areas across GB where the learning is applicable.

Potential Financial Benefit from roll-out of each method (See Figure 6 for an illustration)

We have evaluated the capital cost savings of each method by comparing the cost of the method to the cost of the alternative conventional approach (typically reinforcement). The results are expressed as:

- o cost per year of the conventional solution and present value of that cost
- o cost per year of the method and present value of that cost
- o cost per year of the difference and present value of that cost

This methodology is consistent for both the SSE business case and this evaluation criteria (for GB) with extrapolation scaled as follows:

LV feeders

- o The results of the analysis of LV feeders are presented on a 'per-feeder' basis
- o The 'per-feeder' values are multiplied by the number of feeders in the relevant areas of GB

Primary Substations

- o The results of the analysis of primary substations are presented on a 'per-substation' basis
- o The 'per-substation' values are multiplied by the number of primary substations in the relevant areas of GB

Financial Contribution of each of the Methods

1. Linking network reinforcement to a better understanding of electricity consumers

This financial case considers the capital cost savings for deferred or avoided LV feeder reinforcement by managing the network with a better understanding of electricity consumers.

From measurements of the LV voltage at a range of secondary substations, we have estimated the headroom that is currently available for the connection of PVs. We have also estimated the increase in headroom by using the improved knowledge from this method to better manage the network using conventional, already installed network control assets, together with the strategic deployment of LV batteries and deployment of export control equipment which will limit the export of specific PV installations by using hot water energy storage.

In addition, using the outputs of the study on the Network Benefits of Smart Meters by Imperial College and the ENA, together with the outputs of a Strategic Technology Programme project on the network impacts of widespread adoption of low carbon technologies, we have estimated the increase in headroom (in terms of numbers of heat pumps and electric vehicles) that could be connected by understanding and influencing customer behaviour.

We have estimated the numbers of connections of PV, HP and EV between 2017 and 2050 from authoritative published sources. We have assumed that clustering of these technologies will occur, because those who purchase the technologies will be influenced by their friends and neighbours, and different social groups will adopt the technologies at different rates. The extent to which installations cluster has been estimated using the 'Feed-in Tariff Installation Report 30 June 2011' provided by Ofgem. This data has been used to calculate how rapidly five different groups will adopt the LCTs.

Our analysis reveals that the learning from this project in respect of this method, if adopted across GB, will result in **£4.55bn** of network capital cost savings comprising £3.68bn of capital savings, resulting from the deferral of LV feeder replacement and £861m deferral of reinforcement of primary substations until actually required. The cost of the method would be £7.5bn compared with the cost of conventional reinforcement of £12.57bn (comprising £10.35bn for LV feeders and £2.2bn for primary substations).

4: Evaluation Criteria contd.

2. Interact with demand response provided by both large and small businesses

This case is based on network capital cost savings from avoided and deferred primary substation reinforcement using building management systems. We have estimated the saving due to avoiding upgrade of primary substations by the use of active management of demand using BMS as follows:

- o We have used DPCR5 unit cost for primary substation replacement, assuming an average of ten HV feeders per primary.
- o We have used the experience of Honeywell to identify the amount of load which can reliably be shifted on demand from medium commercial, large commercial and industrial customers.
- o We have identified the proportion of each of these types of customer that are typically connected to the same primary substation to estimate the amount of controllable load that could be available
- o We have calculated the growth in demand on primary substations from LCT, assuming application of the LV method considered above and identified the time during which demand management can be used to defer reinforcement
- o We have scaled this to the rest of GB using the number of HV feeders in GB, applying scaling factors for the degree of applicability of the method to GB (see above) and the percentage of customers across GB that might engage.

This method leads to an avoidance of primary substation upgrade expenditure with a present value of £1.49bn at a cost of £1.25bn, providing a financial benefit of **£237m**.

3. Use of mathematical techniques to reduce the need for low voltage monitoring

We anticipate that a successful outcome of this trial will demonstrate that monitoring costs can be reduced to around 40% of the costs that would be required without the use of customer emulation.

Our budgeted costs for monitoring are £1000 per LV feeder. Assuming that there are around 350,000 LV feeders in urban, suburban and semi-rural areas (calculated using UK LV feeder length from Regulatory Reporting Pack (RRP) data using reasonable assumptions for number of customers per feeder and proportion of LV network in these areas), then a saving of 60% of the costs on monitoring all of these feeders would provide a benefit of **£168m**. It is unlikely that widespread LV monitoring would occur over a short time, rather it is more likely that monitoring would be focused on those areas where LCTs were clustering. We have therefore assumed that this financial benefit from reduction in the installation of monitoring equipment would be spread over 10 years.

4. Tactically deploy power electronics and electrical energy storage on the low voltage networks

This method considers the direct financial benefit provided to customers with PV generators from the tactical deployment of energy storage. It typically takes around 3 to 4 months from recognition of the need to reinforce an LV feeder to completing that reinforcement. During this time customers' generation is likely to be tripping out on G83 protection (if there is an excess of generation connected). Alternatively LV fuses are likely to blow (if there is an excess of HP or EV connected). This would not be remedied by the deployment of automatic replacement fuses such as the Bidoyng fuse. Battery storage units can be deployed in hours, effectively removing the constraint while the feeder is reinforced.

Using the same assumptions as we used for calculating the carbon benefit of this method, our analysis shows a benefit to consumers from avoiding loss of Feed in Tariff earnings of **£2.3m**. The cost to DNOs is likely to be higher than this, but our modelling shows that there would be no net cost to GB if the installed cost of feeder storage units for this purpose can be reduced to £4,500. The power and energy requirements for this purpose is a small fraction of typical LV network values and we aim to assess in this project the extent to which this value can be approached.

(c) Level of impact on the operation of the Distribution System

The benefits relating to planning, development and operation of the network that will result from a better understanding of customers, together with the management of commercial customers using building management systems have been described in Appendix B (LO-1.2, LO-2.1, LO-4.1, LO-4.2).

Additionally, the technologies to be demonstrated in this project, which help the network manage power-flow and/or voltage levels have the potential to enable the network to continue to provide power to customers during fault conditions (possibly under constraints) until restoration can occur, reducing customer interruptions (CI) and customer minutes lost (CML). Additionally they potentially could be used to avoid significant network reconfiguration under fault conditions.

- o Energy storage could provide local power to support the local network
- o Building Management Systems could have an 'emergency' setting where all but essential load is switched off, enabling the network to continue to operate at significantly reduced capacity for a time.

4: Evaluation Criteria contd.

Energy storage cannot be used without knowing when to charge and discharge; this is essential for its future deployment. Reliable forecasting changes in demand and generation on the LV and HV network is essential for its future deployment. This project will demonstrate a robust method to forecast the power requirements of groups of customers, which is being developed by the Smart Analytics IFI project.

Rapid deployment of storage in the event that several EVs or HPs connect into a given street will enable customers to use these technologies without causing overloads of local network assets and avoiding local loss of supply due to the operation of circuit protection. This project will deliver valuable learning related to the process of efficient and effective recognition of need and deployment and connection of the appropriate technology. Experience from other T1 projects has shown that networks can be operating well away from design conditions. For example in the Chalvey monitoring project a secondary transformer was shown, at times, to be operating at zero power factor. This project will provide learning on the use of distributed battery storage to reduce losses and support voltage.

Currently distribution network planning is essentially two dimensional (amps and volts) and conservative. Worst case scenarios are used to calculate the maximum current that could be required to be carried by a given network element and to calculate the highest and lowest voltages that could be experienced within the network element. The concept of after diversity maximum demand has largely removed any consideration of time. This approach has served networks well when the network was demand-led and the characteristics of the loads were well understood. Since this does not apply for LCT, the two dimensional planning approach leads to inappropriately large margins of safety being applied.

By introducing time as a third dimension will enable a better understanding of the varying functional requirements placed on the networks. Combining this with the application to electricity of the statistical techniques employed in the EDRP trial will produce knowledge of the likely behaviours of a wide range of customer types in terms of electricity demand and generation as a function of time.

By resolving down to the individual customer level and adopting agent-based modelling techniques as used in the financial sector, we will be able to produce more accurate forecasts of load flow and voltage profiles in system designs, resulting in a very powerful approach to network planning. This will enable robust long term scenario-driven approaches for network development, providing more surety on customer profiles into the future. It will minimise guesswork when applying regional planning scenarios to long term network planning, resulting in more targeted and robust forecasts of load index.

The benefit will be a significantly more cost effective means to extract value out of existing network assets, and a more granular and better targeted network expenditure with avoidance of unnecessary reinforcement. The learning from exploring the benefits of 3D planning will be recommendations for changes in design policies to free-up network headroom; potential changes to the established distribution network planning standards ENA ER P2/6 and ACE49.

Benefits elsewhere in energy supply chain

Use of customer engagement via the use of the building management systems will, in addition to avoiding the need for reinforcement, result in overall reductions in requirement for generation at specific times of the day. Honeywell has global experience in using this technology for overall energy efficiency (general reduction in demand). Other projects are considering to extent to which network and supply drivers are aligned. NTVV will build on the learning from those projects to inform how building management systems can be used to help manage national and regional electricity supply constraints.

Learning on the extent to which customers can be categorised and understood using statistical methods to limit peak demand also has the potential to help manage issues resulting from the variability of the future generation mix.

Linkage to Bracknell Forest Council and thinking from local government planning

Local government has an important role to play in helping to meet UK energy and climate change policies: by reducing carbon emissions from their own estate and operations; by encouraging and enabling residents, businesses and visitors to reduce their carbon emissions; by protecting the most vulnerable from fuel poverty; and by achieving national priorities such as the Green Deal, smart metering and renewable energy deployment in a locally appropriate way.

Local planning policy is already driving low carbon and renewable energy installation in new developments and local authorities are conducting low carbon and renewable energy studies to inform local plans.

4: Evaluation Criteria contd.

The information generated by these studies could feed into DNOs' network planning, allowing more efficient investment decisions to be made. There are mutual benefits to local government, in aligning network capacity to develop planning policies to encourage the installation of appropriate technologies to suit local circumstances.

Local government should therefore be a key stakeholder to the DNO, in gauging both where reinforcement may be required, and also the types of customers, and therefore the possible suitability in providing demand response support.

(d) Generates Knowledge that can be shared amongst all DNOs

Level of learning

The central aim for NTVV is to demonstrate how the DNO will need to understand, anticipate and support changes in consumer behaviour to develop an efficient network for the low-carbon economy. Beneath this are five key areas of learning. Below describes why these are the critical issues we need to resolve to facilitate informed customer choice and to ensure the electricity network does not become a barrier in the move to a low carbon economy.

Why each LO is relevant

LO-1: Understanding - What do we need to know about customer behaviour in order to optimise network investment?

- o Customer behaviour is expected to change at an accelerated pace with the advent of new low carbon technologies
- o We are actively targeting the complete set of demand customers: from large commercial, to SMEs, to domestic households

By monitoring targeted areas of the network with these customers we will link this data with forecasting models to see whether behavioural demand trends can be identified, and the extent to which this could be of use to the DNO. Although other LCNF projects are also monitoring the network, NTVV will focus on the Thames Valley area to specifically draw out trends for commercial (both large and SME) and targeted groups of domestic customers. We intend to share monitoring data with UKPN and CE Electric UK.

LO-2: Anticipating - How can improved modelling enhance network operational, planning and investment management systems?

- o Crucially, this project will seek to:
 - o Categorise the behaviour of domestic customers and their electricity usage patterns
 - o Categorise the behaviour of SME customers and their electricity usage patterns
 - o Build from individual electricity usage patterns, via statistical grouping on feeders, into feeder power flow profiles
 - o Validate this method for predicting feeder power flow against monitoring data from this project and other LCNF projects (to the extent that this data is made available. We have an agreement in principle to share data with UKPN and CE Electric)

The trigger points for network investment are generally dictated by either measurement, or software modelling, eg system design studies, which contain crude underlying assumptions of demand patterns, and customer behaviour. Knowing more about the specifics of individual customer behaviour, and coupling this with the appropriate solutions such as storage, would assist in flattening demand peaks which would have the effect of altering the investment trigger points. Being able to effectively categorise and predict this behaviour will further improve the efficiency of network investment, spending money only where it really necessary.

LO-3: Optimising - To what extent can modelling reduce the need for monitoring and enhance the information provided by monitoring?

- o If modelling of customer behaviour can be shown to be reliable, there is a strong likelihood that the amount of monitoring needed at LV or with individual customers could reduce, hence reducing the cost of operating the network.

We are keen to understand the extent to which modelling can work for the full gambit of customers from large commercial to domestic. Crucially, we are looking to understand the extent to which small businesses (the much overlooked SME customers) demand can be predicted. This LO focuses on the blend between LO-1 and LO-2, and the commercial solutions or mechanism needed to effect a change.

4: Evaluation Criteria contd.

LO-4: Supporting Change - How might a DNO implement technologies to support the transition to a low carbon economy?

- o Focusing on the technical solutions for managing the effects low carbon technology is likely to have on a distribution network

All network mitigation techniques rely upon the deployment of appropriate solutions such as the conventional network assets; novel network assets; or novel customer side solutions. NTVV will focus on the integrated application of two key solutions, one on the network side and one on the customer side, in a range of scenarios. On the network side, electrical energy storage will be deployed in statistically relevant quantities and managed at key locations and working with Honeywell on the customer side NTVV aims to deploy 30 demand management systems.

LO-5: Supporting Change - Which commercial models attract which customers and how will they be delivered?

- o Focusing on the commercial models required to deliver the outputs of LO-4 into business-as-usual

We will use the outcomes of categorisation and modelling of customer behaviour to produce network investment and network planning tools. The NTVV will work with (Prof. Goran Strbc) of Imperial college and Honeywell to conduct analysis of the ADR results.

Applicability to other DNOs

The approach taken in the GB financial business case (Evaluation Criterion (b)) has been scaled using robust engineering principles using RRP data. Via this approach we have predicted that NTVV is applicable to 65% of networks in GB. To further assist in transferring the outputs from this trial into business-as-usual, we are focusing on both developing the robust technical means (including control systems, data management, and communications infrastructure) and the necessary policies, procedures and training to support implementation. (See Section 5 for more details).

(e) Involvement of other partners and external funding

Project Partners

SSEPD has always worked with partners and collaborators as part of its business as usual operations. As utility networks become more complex with more data to handle and complicated forms of technical solutions are required, we are conscious that the value of this interaction is greater than ever. Accordingly, the partnerships at the core of NTVV have further strengthened over the past year.

Following the announcement of the 2010 projects, we held a series of workshops and reviews with our partners and product suppliers. As a result of these workshops we have re-focused some of our partners' roles and responsibilities (GE and KEMA) and strengthened the team with the addition of EA Technology to assist in refining the structure of the NTVV project.

'Open innovation' is an important part of NTVV. To quote Harvard Business Press 'In today's information-rich environment, companies can no longer afford to rely entirely on their own ideas to advance their business, nor can they restrict their innovations to a single path to market allows companies to help with innovation and solutions.' We are encouraging a different and aspirational approach with partners, suppliers, network operators etc to providing the necessary solutions to the future low carbon challenges.

The main project collaborators and their roles for NTVV are detailed in Appendix D:

- o **General Electric** (Gross £11m; Net £8.4m) - Technical integration, ensuring the outputs of the project can be knitted into conventional DNO systems
- o **Honeywell** (Gross £2.7m; Net £2) - Provision of building management systems, including recruitment of commercial customers
- o **University of Reading** (Gross £2.5m; Net £1.9) - Statistical modelling, analysis and profiling of customer behaviours
- o **KEMA Consulting** (Gross £620k; Net £560k) - Development of the low carbon community advisory centre, including stakeholder engagement and website
- o **EA Technology** (Gross £1.1m; Net £1m) - Development of technical policies, procedures and training to embed the outputs in UK DNO business as usual
- o **Bracknell Forest Council** - Support and input in the development and integration of local planning with DNO planning and investment

4: Evaluation Criteria contd.

During 2010/2011 we attracted significant attention to the original TVV Project from communications companies, although we have engaged in substantial discussions with a range of communication provider companies, we decided to develop requirements after completing the detailed scoping of our project rather than attempting to select a partner with an early, draft specification. We will be issuing a tender for the communication elements of our project, shortly after the bid submission. Therefore, vendor selection can be completed immediately upon project award avoiding any delay to project implementation.

Other project partners include:

Corporate customer consortium:

- o Thames Valley Chamber of Commerce - leading our communication programme
- o Bracknell Chamber of Commerce - supporting our communication program

Large demand users and project participants:

- o John Lewis and Waitrose; BT; Cable and Wireless; Dell; Honeywell; Regus; BMW; Syngenta; Boehringer Ingelheim; Capital; 3M; MWB Business Exchange; BFC Street Lighting & Leisure Facilities

Domestic customer consortium:

- o Bracknell Forest Council - community advice and management
- o Bracknell Forest Homes - large housing stock manager
- o Bracknell Residents Association - community engagement advice
- o East Berkshire Education Business Partnership (EBEBP)- schools programme advice

Energy Suppliers:

- o npower
- o Green Energy
- o Good Energy
- o Scottish Power
- o Southern Electric

To provide appropriate information on Bracknell customers and discuss future communications agreements. Southern Electric has also agreed to provide up to 1000 smart meters and associated communications.

Other support partners:

- o Davis Langdon - consultancy, funding advice and provision
- o Ergon Energy - Australian energy/network company - support/advisory role
- o Thames Valley and Berkshire Local Enterprise Partnership (LEP) - advisory role
- o Imperial College - Power Electronics & DSR analysis

Other knowledge transfer partners:

- o IET - Institution of Engineering and Technology

Technology Partners:

- o Nortech - Data management systems supplier
- o SENTEC - current transformer and monitoring equipment supplier
- o S&C - active network management equipment supplier
- o DIgSILENT - analysis and planning systems supplier
- o CURRENT Group - Current Transformers and monitoring equipment supplier
- o Cool Power - demand matching management systems

Details on how the contracts have been structured are in Section 6 of this document.

(f) Relevance and Timing

Building on our previous submission: NTVV builds on our commended 2010 Thames Valley Vision (TVV) bid submission, which in the words of the expert panel was:

- o *'a well developed project with the potential to create significant benefits for customers and would directly improve the operation of the distribution system'*
- o *'[focused] on determining the optimum number of data collection points [with] strong learning'*
- o *'[inclusive of] a consortium [that]was strong'*
- o *'had good dissemination arrangements involving dedicated centres.'*
- o *'[was considered] a bid with some strong elements and with strong partners and with the potential to create considerable learning'*

4: Evaluation Criteria contd.

Since the 2010 submission we have taken time to learn from other projects both internal (NINES, NaS battery project, Chalvey project) and external to SSE. This has allowed us to ensure that we have governance, contractual arrangements and internal support structures to allow robust, rapid and efficient delivery of TVV's improved successor: New Thames Valley Vision.

We have also focused on strengthening the clarity, breadth and quantity of the project learning outcomes from the project. The result is an even stronger, more focused, deliverable project with clear learning objectives.

We believe that NTVV addresses many issues that are not covered by any of the registered LCNF Tier 1 or Tier 2 projects* that are approved or being assessed this year. These include:

- o Categorising the behaviour of domestic customers and their electricity usage patterns.
- o Categorising the behaviour of SME customers and their electricity usage patterns.
- o Demand management via building management systems.
- o Use of the outcomes of categorisation and modelling of customer behaviour within operational systems and to produce investment and planning tools.

How it addresses developments that are more likely to happen

This project addresses barriers to installation of PVs, heat pumps and electric vehicles. The evidence from the Feed in Tariff (FIT) data is that the uptake of PV is greater than the projections which were made last year. Also it is clear that the installations show very strong clustering features. For example in Poole there are 2,500 PV installations on social housing planned for delivery by March 2012; in Sheffield there is strong clustering of LCTs. This project will provide early learning on the use of tactical deployment of storage on the LV network to facilitate connection of low carbon technologies.

How it will be used in future business planning

The UK's LV networks are designed on a fit-and-forget basis. Assumptions are made around the load that will be required based on a rudimentary understanding of customer behaviour, with most up-to-date information being from the late 1970s. A lack of LV network monitoring mean that once installed, the DNO does not know what the load on a circuit is other than that recorded periodically (annually or bi-annually) from simple devices, which measure the peak demand located at the feeding substation.

The reality is that the DNO does not know what the load is from one visit to the next, nor if the peak recorded existed for 99% of 1% of the time between inspection periods. Low carbon technologies are expected to radically change network demand profiles, which will exacerbate this issue. If this is not appropriately managed, a secondary effect will be the accelerated ageing of the UK's electrical asset base, further increasing investment requirements. The extent to which investment rises will depend on both the rate at which network headroom changes, and on the mitigation solutions used to connect and manage the low carbon technologies.

All network mitigation techniques rely upon the deployment of appropriate solutions: conventional network components; novel network assets such as electrical energy storage and dynamic thermal ratings; or new customer side solutions - demand response, demand automation. The trigger-point for knowing when to deploy any of these solutions is dictated by either measurement or software modelling including system design studies, which contain crude underlying assumptions of demand patterns and customer behaviour.

Understanding customers and networks

- o Demonstrate and validate the effectiveness that can be achieved from the minimum number of network sensors, demonstrating sustainability and cost effectiveness
- o Install sensors by a method that avoids customer interruptions as far as reasonably practicable, this demonstrates our commitment to supply quality and stakeholder concerns (it would be ironic if the first customer experience of Smart Grid is the power being switched off to install a smart meter and the second was the power being switched off to install a network sensor)
- o Installing sensors in a way that required the lowest level of operator skill to assist with the resolution of workforce renewal and accelerate the roll out programme
- o Use of power conversion electronics for management of power quality at low voltage

*except those of SSE which will feed into this project; see Appendices G and H for more details

4: Evaluation Criteria contd.

Anticipating

- o Producing short term operational dynamic demand forecast models to allow the optimal operation of energy storage assets and the early identification of network loading issues to avoid supply disruption.
- o Produce medium term models to identify network constraints and allow planning processes to be managed by exception to keep pace with the significant rate of change in the network with the minimal amount of specialist planning resource
- o Produce long term models to inform the long term investment requirements under a range of technology adoption scenarios

Supporting Change

- o Evaluate a range of commercial and technology solutions within a monitored and modelled environment to allow robust evaluation of each solution and provide a platform for the evaluation of future solutions; this will ensure that the solutions are in reality cost effective and sustainable in a real environment and benchmarked against traditional solutions

Working with the industry and academia

- o Our experience in innovation has already demonstrated that some of the best solutions come from strong two-way engagement with stakeholders; this is particularly demonstrated in Shetland and Orkney
- o We have a strong relationship with the University of Reading which has allowed us to take some of the vast pool of knowledge used to forecast and predict the consumption of consumer goods and translate it to the associated load growth in the network
- o EA Technology is working with us to help with the translation of the academic modelling into language and tools that can be utilised by all DNOs.

How it would affect RIIO submission

Load related network reinforcement in Great Britain is on the increase - the UK case for 'HV and LV general reinforcement' increased by 7% from £282m in DPCR4 to £302m in DPCR5 (ref. Table 11, Electricity Distribution Price Control Review - Final Proposals). This upward trend is likely to accelerate into RIIO-ED1 and beyond as the penetration of electric vehicles, solar arrays and heat pumps (ref. DECC Low Carbon Transition Plan) increase, placing new stresses on, in particular, the LV network.

This project will impact on RIIO submissions by delivering:

- o **Clarity in investment triggers** through more accurate knowledge and forecasting of individual and aggregate customer demand, with informed scenario modelling. This will significantly increase confidence in the assessment of load index and associated investment plans, particularly for HV and LV networks.
- o **Efficient operation:** Current thinking indicates that the move to smart grids to facilitate the transition to a low carbon economy will require increased monitoring of the networks. There is a cost associated with this monitoring, both in terms of capital expenditure for the deployment of appropriate equipment and operational costs to process the data collected and turn it into meaningful information. This project will consider the extent of monitoring that is required and the extent to which this can be supported by statistical modelling to keep capital and operational expenditure at an acceptable level.
- o **Alternative network or customer management solutions** that could affect the amount of load-related investment required in the period.
- o **A greater understanding of the role of third parties** in the delivery of efficient networks. This project will inform the industry's understanding of the opportunities for third parties to participate in the delivery and development of smart grids by demonstrating the roles required and allowing interested stakeholders to understand the challenges and opportunities associated with a third party's involvement.

4: Evaluation Criteria images, charts and tables.

Figure 5: Projected cumulative carbon savings (GB extrapolation) using the Method(s) outlined in NTVV

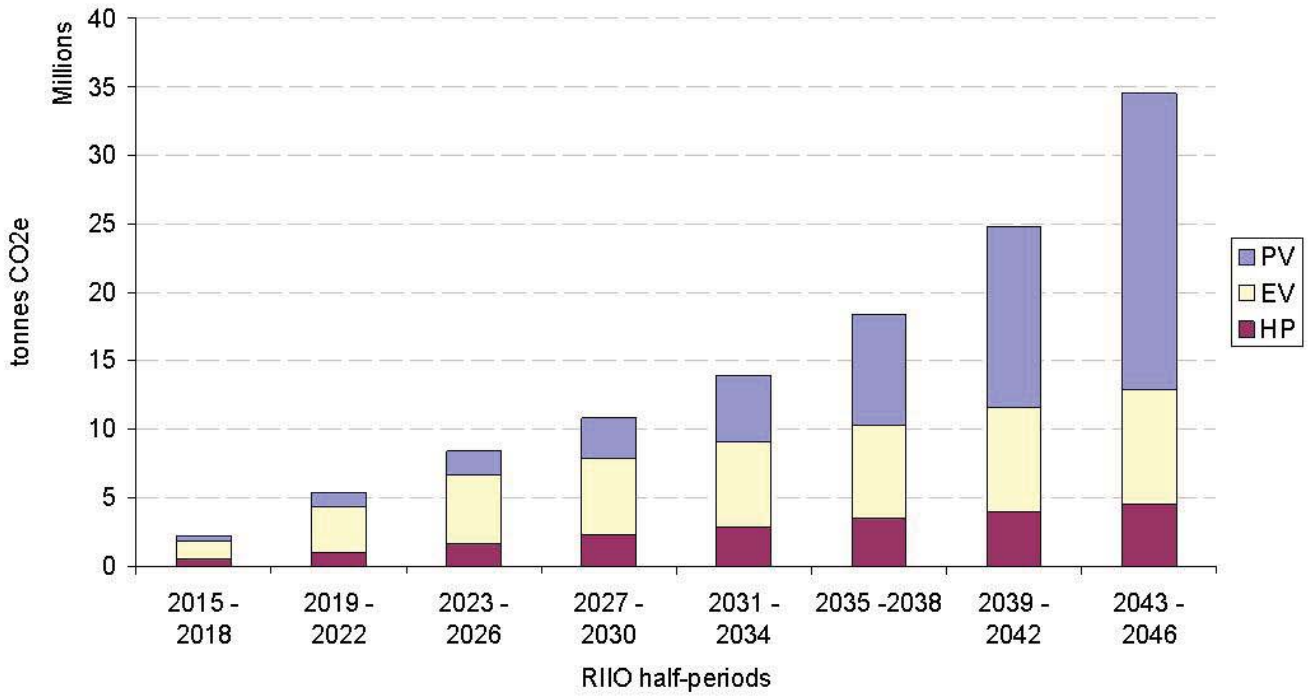
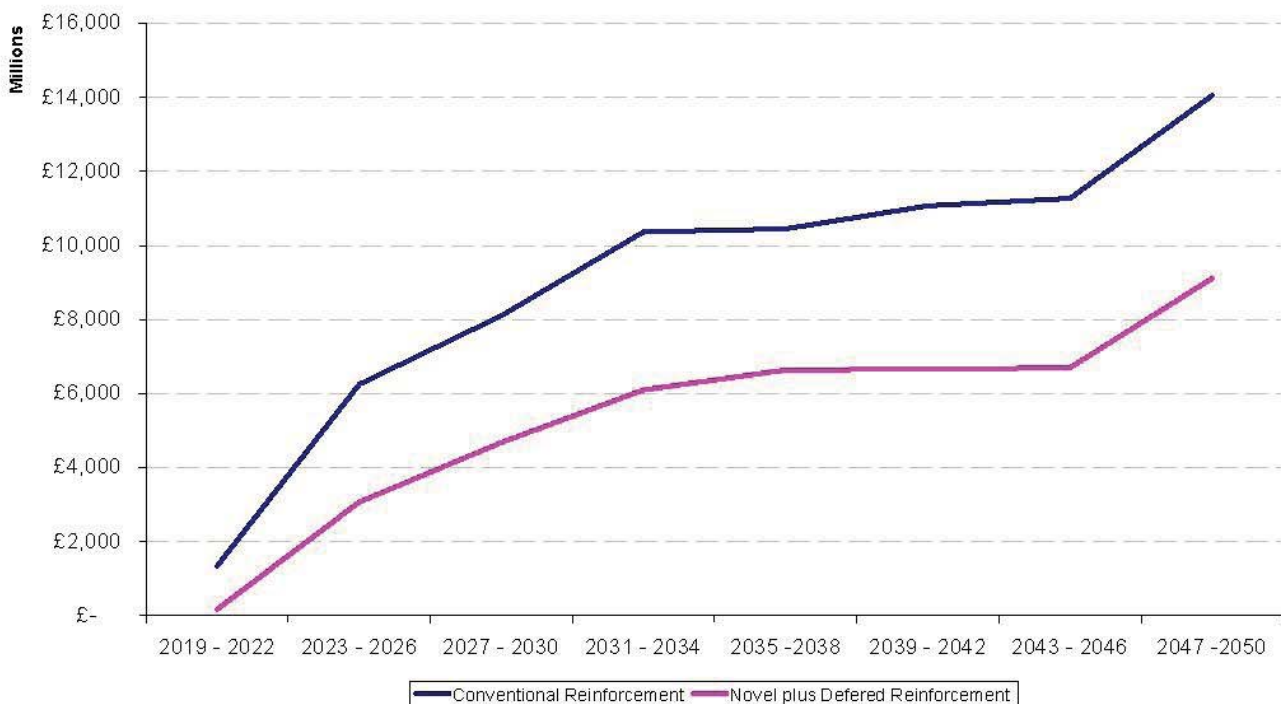


Figure 6: PV of the projected cumulative cost difference (GB extrapolation) using the Method(s) outlined in NTVV



Section 5: Knowledge dissemination

Put a cross in the box if the DNO does not intend to conform to the default IPR requirements

Our knowledge dissemination falls into two areas:

- o **Learning dissemination:** communications activity to share the knowledge of NTVV as an ongoing project activity
- o **Integration activities to support adoption to UK DNO business as usual:** developing DNO-relevant policy, standards and training to close the gap between the trial outputs and business as usual (Figure 8 shows mock up training material for implementation into BaU)

We firmly believe that these activities are necessary and complementary to ensure the outputs of the project are shared and made useful to other DNOs and other stakeholders. The key influencers we are aiming to engage are:

- o Those who will be directly affected by internal change (including DNO staff)
- o Those whose service may be affected or behaviour will need to change (customers; property developers; landlords)
- o Those whose business models and operations may be impacted (generators; electricity suppliers; energy service companies (ESCOs); retail service providers)
- o Those required to deliver the services and resources for the future (system providers and integrators; equipment manufacturers; academia and training providers)
- o Those who will need to consider the risk/reward profile of the new approach (shareholders; policy makers /regulators/transmission and distribution companies)
- o Those parties that have the potential to influence other stakeholders (media; think tanks; interest groups; community groups)

Learning Dissemination: Beyond the conference

Only a fraction of learning dissemination can be achieved with conferences. Useful dissemination will be achieved through the production of real procedures, real practical training. Core to our dissemination plan is the development of practical training of industry participants at all levels.

Working with EA Technology, KEMA, The IET and our university partners we will package the learning for this project and others into courses accompanied by the appropriate template procedures to generate 'know how' across the relevant stakeholder groups - we believe this to be important as it will help to bring all of our key stakeholders with us on the journey, and mitigate any negativity that could become a barrier to adoption. Learning dissemination is crucial to allow all stakeholders to take the most expedient and appropriate actions that will be required for network businesses to be best able to meet the needs of the low carbon future and the continued uncertainties as to how that might evolve.

We do not consider learning dissemination to be a one-way channel - it is also important to understand how disseminated information is received by the audiences, what their consequent actions may be, and what influences that action may have. This will seek to avoid the risk of any unintended consequences.

Adopting an 'open book' approach to share experiences (both good and bad) to refine the learning of all parties and projects will provide confidence to all stakeholders, particularly those considering the risk/reward profile, that no inappropriate activities are conducted beyond their useful purpose.

NTVV has identified the inclusion of all customers as the key to successfully promoting low carbon solutions. By clearly presenting the issues and possible solutions to customers, their reactions and subsequent behaviours will help to inform and shape the way the industry prepares for the future network investment for a low carbon economy.

With this in mind NTVV learning dissemination activities will be focused to provide the means for assessing stakeholder reaction and gauging the propensity for change that will provide an additional learning outcome for the project. These objectives will be achieved through a range of activities and deliverables via several key means.

5: Knowledge dissemination contd.

Dedicated community service / facility: This high street presence - occupying a site in Bracknell town centre - will be established to promote the NTVV project initiatives and the supporting Bracknell Forest Council's initiatives for change to a range of stakeholders including customers, developers, and regional investors. Bracknell Forest Council will provide a 'Low Carbon Advisory Service' facility to promote existing Government and Local Authority backed schemes provided by energy suppliers and other third parties. (eg Bracknell Forest Council operates an equity release scheme which residents can use for energy efficiency measures).

The low carbon community advisory centre and website serves the NTVV central learning outcome in providing the focus for learning dissemination to DNOs and all other stakeholders. It provides the means to capture and evaluate that the learning dissemination is being appropriately received and acted on.

The low carbon community advisory centre will extend the learning dissemination of NTVV to monitor the appetite for behavioural and societal change within the different audience groups. By gathering qualitative research on an ongoing basis, attitudinal changes can be monitored over time.

The centre will be supported by a website and a range of smart phone 'Apps' that will allow visitors and non-visitors to continually engage. While the focus will be on networks, wider power system aspects will be included where this is necessary for information to be put in context.

NTVV Website: Further Info

The intention is to capture disseminate learning and capture peoples views through the website. To achieve this, the following is proposed:

- Introductory Video
 - This is proposed to be a high impact video to highlight the environmental, energy security and sustainability reasons why a low carbon future is necessary
- Smart Grids Animation
 - This will demonstrate how the energy industry works now, and the changes that are happening that require a move to a new energy system, and the consequences this may have on the end-customer.
- Expanded Animation/Video
 - In order to address particular topics from the Smart Grids Animation, and to reflect the issues and activities of each of the intended "Energy Zones" of the Learning Centre, additional animation/video material will be produced. This might include a "virtual" tour of the DUKE Energy Envision Centre and/or such facilities and initiatives.
- Information Capture
 - At various points of interaction with the website - after the Introductory Video; Smart Grids Animation; or each section of expanded video/animation, the visitor to the site can be asked for their opinion on related issues.
- Target Audience
 - The website may require separate navigation, for different stakeholder audiences, who would be required to identify their interest at the outset of their visit. Certain aspects of the site would be "publicly" available, but, as with any networking site registration would be required.

Linkage to broader based project activity: From a national point of view the NINES project on Shetland provides a valuable vehicle for exchanging learning and sharing news and views (between respective projects). Access to project data would be a mixture of live data feeds together with displays, poster material and critical learning experiences. On an international level we are applying to Cluster 4, an EU FP7 call, where we are engaging in with the Austrian Institute of Technology to share learning of NTVV with other established EU projects, and vice-versa.

5: Knowledge dissemination contd.

New products and opportunities: New products will be evaluated through the Consumer Consortia addressing the Commercial and SME business sector. The Consumer Consortia will address large national organisations down to the individual small business customer through local chambers of commerce.

The Consortia will provide for a two-way exchange of information and ideas: Customers will be invited to share their best practices in the field of energy management, and SSEPD will develop an discuss what solutions are required for the network business to continue to provide a continued high quality and affordable service.

General publication / industry presentations: SSEPD and its partners will promote the learning outcomes through various industry publication, exhibition and presentation opportunities.

Integration activities to support adoption to UK DNO business as usual

Simply telling people the outputs of the project is unlikely to prompt their widespread adoption. Integration activities are vital to ensure the successful outputs of the project can be streamlined into day-to-day operation for all DNOs. Working with all of our project partners we will actively seek through the course of the project to develop:

- o **New policies, procedures and related documentation:** We will review all of the current policies across the asset life cycle (cradle-to-grave) to identify what will have to change. This will focus initially on SSEPD's documentation, with an intention to develop generic outputs and/or form the basis of national standards or guidelines such as ER P2/6 or ACE49, that will be made available to other DNOs.
- o **New design tools:** As the toolbox of solutions increases through new technologies and/or commercial models, with technologies like energy storage and building management systems, so too does the complexity of the design. To simplify this activity, we plan to develop design tools that can help a design engineer in selecting which solution to use at a given location. The solutions are likely to differ depending on which the solutions are available for each network voltage and/or customer type.
- o **Changes to regulation:** Stakeholder engagement has been recognised as being of increasing importance to the regulation of energy networks. This project will increase the understanding of the engagement needs of domestic and SME customers, particularly the degree to which statistical representation can and should be used in the development of focus groups to ensure that the views of different customer types are represented.
- o **New commercial models:** New commercial models with which DNOs can interact with commercial and smaller commercial (SME) customers. Stakeholder engagement of commercial customers will play an important part of the NTVV project, particularly in understanding what sort of mechanisms suit different customer types.
- o **Training material:** Coupled with the above, we recognise that training material will need to be developed to ensure the right piece of knowledge is passed on to the right type of person (and skillset) of our key stakeholders and will be freely available to the wider DNO community.

Why we believe this approach is optimum

We are confident that this approach is the best for dissemination as it:

- Informs stakeholders of the reasons for change and scale of change
- Shares experiences (both good and bad) to refine the learning of all parties and projects
- Supports stakeholders in the actions needed to change and promoting the solutions aimed at optimising network investment
- Provides the ability to understand and influence stakeholders to educate their wider audiences
- Provides documented learning outcomes to promote the wider adoption of innovative technical commercial and social solutions
- Provides a tangible focal point for engagement and dissemination

5: Knowledge dissemination images, charts and tables.

Figure 7 – ‘Mocked up’ NTVV Website

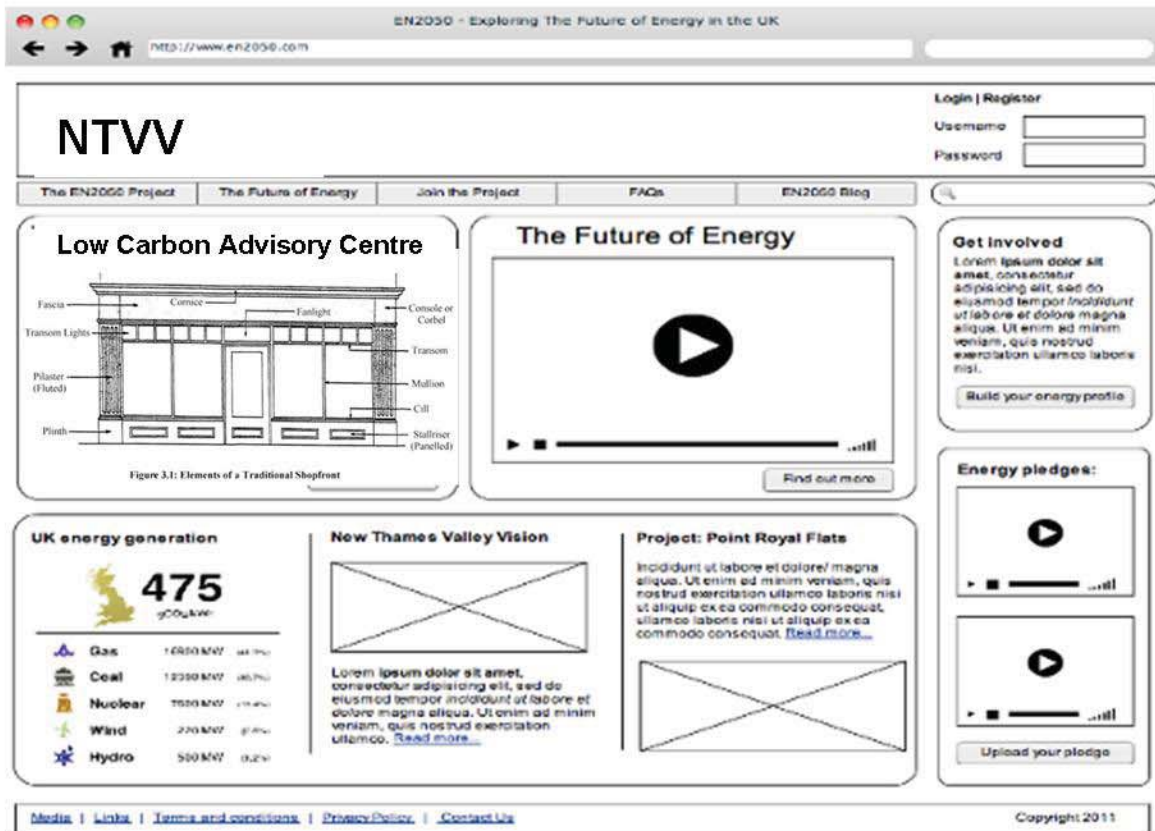


Figure 8 - Example Training Material linked to Adoption to BAU

Indicative course portfolio:

- Evaluating DMS for network management for network designers (DNO designers)
- Advanced demand analytics for Distributors a course for network forecasters and planners
- Installation and commissioning of DSM systems (DNO project engineers)
- How to make your office grid responsive (Facilities Managers and engineers)
- Designing LV energy storage solutions
- Installation, operation and management of 3D network modelling tools
- Storing green energy in your home, a course for householders
- Operating the network, how your DNO is using Smart metering information to keep the lights on. A presentation for the public/ schools etc and part of EN2050 centre.
- Telecommunications network installation and operation for Secondary Substation monitoring.
- Planning in 3D, course for planners looking to plan and implement demand shifting solutions.
- Degree course: HV and LV network active network management, from ANM to ES

how to make your office grid-responsive

A one-day workshop helping Facilities Managers and Plant Engineers understand the opportunities and benefits that are associated with providing commercial solutions to your local network company.

What is the course about?
Today's electrical energy networks are changing, creating new opportunities for business customers to offer commercial services to help maintain stable energy supplies, with no impact on business operations. Understanding the opportunities enables you to make an informed choice as to whether or not your business can benefit from participating.

This one-day workshop will provide an accessible overview, that requires no prior knowledge, and will allow you to decide whether or not you wish to enter into discussions with your local network company.

Who should attend?

- Facilities Managers, Plant Engineers and Procurement specialists responsible for energy contracts in their organisation
- Business Managers and Owners
- Consultants, Architects and Building Designers

What will the course cover?

Role of your local network operator	UK Energy Policy
Overview of Grid-Responsive Services	Grid-Responsive Technologies
Benefits of being Grid-Responsive	What does this mean for my business?

Learning outcomes
Attendance on the course will help delegates to:

- Understand the role of their local network operator
- Understand the opportunities to deploy Grid-Responsive technologies and systems in the workplace
- Evaluate commercial opportunities from providing Grid-Responsive services to the network company

Key benefits
After attending this course delegates will be able to:

- Assess opportunities to provide Grid-Responsive services
- Handle negotiations for providing Grid-Responsive services
- Evaluate Grid-Responsive equipment and assess its costs and benefits

How much does it cost?

One-day course	Price + VAT £..
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the power skills centre - leading energy learning

Section 6: Project readiness

Requested level of protection require against cost over-runs (%).

0

Requested level of protection against Direct Benefits that they wish to apply for (%).

0

Why a timely start is possible

New Thames Valley Vision, which has been in development since March 2010, is led by an experienced, disciplined team who are ready to start on delivery as soon as the project is approved. Key appointments have been made; a detailed implementation plan has been developed; contract terms and purchasing frameworks have been established with our major collaborators; and seven related Tier 1 and IFI projects are underway. NTVV is poised for immediate commencement (Please see Figure 10 - Project Time line)

Key appointments have been made

SSEPD has six experienced members of staff dedicated, along with collaborator resource, preparing the project for bid submission. These people will remain engaged in NTVV work, involved in further detailed preparations in order to be active and ready to commence work immediately on project award. There will therefore be an established, and 'up to speed' core team with which to initiate the necessary activities on day one, and this is reflected in our Project Plan detailed in Appendix C(i).

A detailed implementation plan has been developed

Management of NTVV will be conducted in accordance with SSE's Large Capital Project Governance Framework Manual and its associated documentation and templates. The manual has been prepared to ensure the delivery of projects '..safely, on time and with the level of returns committed to...' and to assist in the delivery of £6.4bn of investment across the SSE Group over the period 2000-2013.

A key element closely coupled to clarity brought by our learning outcome approach was to develop a detailed project plan with our delivery partners.

We have taken cognisance of learning from both NINES and that of our partners' involvement in other LCNF Tier 2 projects, to ensure we can hit the ground running come approval of NTVV by Ofgem. Reflecting this, we have developed two documents:

- this **bid submission**: outlining the whys of the project, the high level summary and the business case;
- a '**Project Document**': a robust technical document which captures the thinking that has gone into the bid, and forms a reference to inform any party coming onto the project of the rationale behind the elements of the bid and how they align to our Learning Outcomes.

Following successful notification, further appointments will be made to allow the team to move to delivery mode and all work packages will be agreed and formalised with our partners. We will then proceed to deliver the project in line with the summary shown in Appendix C(i).

Contract terms and framework agreements have been established

During 2011 we have carried out considerable contract negotiations with our main project collaborators, and have developed a structure similar to a standard framework agreement (information available on request).

The agreed framework agreement provides information for the supply of products or services over a given time period. It is not in itself a contractual agreement to supply, but is an enabling agreement providing agreed specifications, delivery terms, prices, and terms and conditions of contract. Framework agreements are in place with all project partners and this allows individual purchase orders to be placed against it under the agreed terms and conditions.

Although the signed framework agreements do not specify definite quantities of goods or services that will be ordered against it, indicative quantities will be provided before funding allocation. Framework agreements are normally used to set up general supply arrangements with a supplier (eg use of a supplier's catalogue), or to set up central supply arrangements for use by local operational areas.

6: Project readiness contd.

The project suppliers will work with a combination of the above framework contract and a call off contract, as appropriate. Each agreement that has been put in place is backed by individual work order's which formally outline the individual projects and clearly shows how this supports the NTVV project.

The procurement engagement is important to SSEPD's bid as it facilitates work commencing without delay upon contract award.

SSEPD have reached agreements with its key partners GE, Honeywell, University of Reading, KEMA and EA Technology. Using these agreements, it has placed orders and commitments that commence the delivery of the Tier 1 contracts (GE and Honeywell).

As part of these agreements, each commitment will include a work order which will clearly outline the deliverables for the project and provide an audit trail. This will be backed by the specific contract schedules that will support these diverse projects. These are:

- o Main framework agreement
- o IT services addendum
- o Non-IT services addendum
- o Product development
- o Services addendum

SSEPD have placed particular importance on this process of contracting and see this milestone as a key deliverable in its bid submission.

Supporting IFI and Tier 1 projects are in progress

NTVV will aim to take learning from the following T1 & IFI projects to de-risk the main project and test technology and concepts and being run by SSE (details are given in Appendix G)

IFI - Smart Analytics (SSE 2011_10) - UoR: By taking agent-based modelling as used in the financial sector, and applying them to electricity, we are proving the extent to which more accurate demand can be forecast in a system design, network planning and pseudo real-time manner. This is a key activity in derisking NTVV, proving the concepts on smaller datasets ahead of the larger trial.

IFI - Supply Point Monitoring (SSE 2011_13) - Senecal: The development of a monitoring device that will undertake most of SSEPD's supply point monitoring requirements described above. The unit will be suitable for deployment in most consumers premises in combination to a conventional or smart meter. The focus of this project is to develop a small number of pre-production prototype units and evaluate the performance of the units against the design specification. We are proposing to install a number of these units in NTVV.

IFI - LV Connected Batteries (SSE 2011_03) - S&C: This project seeks to understand the benefits of installing three single-phase 25 kWh / 25 kW peak lithium-ion batteries at strategic points on the LV network. The storage is to be located in combination with solar PV and electric vehicle charging points, and the outputs will be used to model and analyse the benefits the energy storage can provide to the low voltage network using theoretical cable limits. Power quality monitoring is to be installed at the substation to provide historical data and to aid with the battery evaluation.

T1 - Chalvey - Slough Monitoring (SSET1002) - Several (GE Digital Electric/Current Group/Sentec/Nortech): This Tier 1 project introduces 11kV/LV substation monitoring to obtain directional energy usage data over a period of 12 months. The substation monitoring makes use of a variety of manufacturers products to test air-gap current transformers, intended for retro-fit involving no CML impact.

T1 - ADR Trial (SSET1004) - Honeywell: This T1 project was put in place to test the feasibility of the automated demand response (ADR) technology proposed in NTVV. This project is testing the technology, in 3-5 buildings, ahead of the full integration and wide scale implementation planned for NTVV. As of the 15th 2011 August this project has conducted it's first automated load she (details can be seen in appendix G, under the relevant project (SSET1004)).

6: Project readiness contd.

T1 - Modelling (SSET1005) - GE: This project is identifying, testing, demonstrating and evaluating a low carbon network modelling environment for a selected small sub-set of HV/LV network in the UK. It will put in place the foundation for NTVV including providing the opportunity to identify those HV/LV substations where LV monitoring is or will be required and identifying the customers (by MPAN) who will most likely cause LV network load related reinforcement and/or demand management.

IFI - Manage - GE: This project is designed to simulate the collection of meter data (both retail and operational) within a meter management system as will be anticipated from the Data Communications Company (DCC). Demonstrating how data can be managed at scale in a DNO operational environment.

T1 - Domestic Demand Management Solutions (SSET1003) - Glen Dimplex Heating, Smarter Grid Solutions: Demonstrates the dynamic control of domestic customer’s heating equipment in six properties in order to prove how this can support the network. The heating devices can be controlled in real time from a central location and can respond autonomously to frequency setpoints. This T1 project has been established to derisk a larger deployment in the NINES and NTVV projects.

How costs and benefits have been estimated

Project costs

(GROSS - £32.84M) less (External funding - £4.60M) less (DNO funding - £2.99M) = NET - £25.26M

The project costs have been provided by our project partners following the agreement of the core Learning Outcomes. We have made reference to available public source information, international comparisons, and academic input to ensure these are robust. Each of the delivery tasks have been benchmarked and compared by SSEPD to ensure closely aligned tasks by separate partners have not been erroneously replicated.

Below is a breakdown of the key components of the NTVV (costs are pre-tender but are inclusive of benefit in-kind contributions from our project partners). The below figures show the gross cost of each element.

Learning Outcome 1 - Understanding	£5,766,000
Research, Customer behaviour and typology	
S/Stn monitoring equipment	
S/Stn monitoring installation, enclosures, power supplies and end of project decommissioning	
End-point monitoring equipment, operations, maintenance and de-commissioning	
Other monitoring equipment (HV and LV)	
Wireless equipment, infrastructure and data charges	
Data storage, management & Mods to SSE corporate Network and deployment	
Integration Software (Pi, ENMAC, SMOS and ANM), implementation and testing	
 Learning Outcome 2 - Anticipating	 £2,740,000
Research: Demand forecast aggregation	
Modelling software	
Modelling hardware	
Data management tools	
 Learning Outcome 3 - Optimising	 £1,208,000
Research: Rolling Forecast Adaption	
Update LV Enmac	
SSEPD Engineering design and management	

6: Project readiness contd.

Learning Outcome 4 - Supporting Change (Technology) £10,531,000
 Research: Smart control algorithms
 Communications architecture, design, installation and operation
 Development of Distributed Solutions Interface
 Distributed Solutions Interface integration, licence & support
 Automated Demand Response development, customer engagement, hardware, installation and maintenance
 Thermal storage, (Ice Bear & Coolpower systems)
 SSEPD Electrical network studies and connection work
 Electrical storage units

Learning Outcome 5 - Supporting Change (Commercial) £664,000
 Incentive Payments
 Customer engagement, community events and relationship management
 Data Training and de-commissioning

Enabling and Integration £3,478,000
 SSE Hardware, Setup, Testing and Development
 PowerOn Fusion, licence and Operation Costs
 Third Party Software (not from project partner)
 GE Energy Programme, Project and Technical Management
 GE Energy bid preparation

Learning and Dissemination £3,164,000
 Web site development, analysis, reviews and reporting
 Low carbon community advisory centre and use of GE IQ Centre & facilities
 Project Partners learning dissemination and consumer consortium
 Dissemination of learning with DNOs, stakeholders, conferences and external events
 Development and delivery of training for asset managers, control engineers and operational engineers
 Development of policies and procedures in light of project outcomes and wider industry learning

Project Management £2,363,000
 Project Management Office
 Engineering, management and design of specific deliverables

Direct project benefits
 There are no Direct Benefits being claimed from NTVV.

6: Project readiness contd.

Measures to reduce cost over-runs or direct benefit shortfalls

NTVV is managed in accordance with the SSE Large Capital Project Governance Framework (LCP). LCP is a whole-lifecycle tool designed to ensure projects are governed, developed, approved and executed in a consistent and effective manner, with consideration of best practice in project delivery. The framework is applied across all projects >£10m within SSE and the strength of its application demonstrated by ongoing project successes such as Clyde Windfarm - which at £500m is one of Europe's largest onshore windfarms and the Ferrybridge carbon capture project.

The governance framework is phased with six gates at appropriate decision points, with clear, consistent deliverables for each gate. Project governance rules are established and defined for each phase, with standard project organisational structures and key roles.

As NTVV develops through the development and refinement stages it has been and will continue to be subjected to stage gate reviews. The initial reviews consider project readiness and the underlying needs case in order to allow the project to proceed, or if further re-working is required. Similarly, as the project enters the execution and operation stages the project will continue to be reviewed to assess the cost and completion of deliverables.

The governance framework requires increasing cost accuracy as projects pass stage gate reviews. The costing information used in this proposal represents the best available information from SSEPD and our NTVV project partners. However uncertainties in the costs and benefits may prevail due to certain assumptions made:

- availability of technical installation resources
- assumed prices for equipment provision still subject to tender response, and the prevailing exchange rate for equipment purchases.

Each of the detailed Learning Outcomes packages has identified associated risks and developed mitigating actions to form the basis of the contingency plans. Risk management will be conducted under the auspices of the SSE LCP Manual 'Project Risk Management Plan'.

Our project has been constructed as an integrated whole, and any scope changes (if required) by Ofgem prior to project award will require a period of re-planning and possible re-negotiation with collaborators/suppliers which would delay commencement, and possibly impact on some critical path elements.

Our NTVV Project Manager has identified technical, commercial and engineering risks, and will continually review progress on a regular basis. Following the reporting and escalation process already in place.

Contingency Plan

The project risk register is used to identify inherent risks, specific controls/mitigation and the resulting residual risk. Specific contingency plans have been developed to enhance and support the specific risk controls where: the residual risk remains medium or high, where significant reliance is placed on management controls or where the inherent impact is significant.

The detailed work produced to support the bid preparation provides a significant degree of comfort on our cost and funding estimates. However, there are still significant elements of the solution that are still to be tendered or subject to contract finalisation, and may be subject to variation from our assumptions (both up and down).

See project contingency plan - Appendix C(iii)

We are comfortable to accept the 0% level of protection against cost overruns.

6: Project readiness contd.

Verification of all information included in this proposal

Information in this proposal has been developed in conjunction with all project partners and has been subject to checks and analysis to ensure its validity.

Structure of bid: We have worked with all of our project partners to develop and agree our Learning Outcomes approach. Taking this methodology as the core project principle, the individual deliverables and technologies have been tested to ensure they are relevant. Likewise, the same individual deliverables have been considered in the context of overall technologies and have been similarly tested to ensure they are achievable and effective. Learning Outcomes have facilitated both a bottom-up and a top-down appraisal of the deliverables and technologies as both individuals and in combination.

Benefits cases: The carbon and financial case outlined the Evaluation Criteria has been developed by EA Technology. The methodology is robust taking input from: modelling activities undertaken in the industry funded Strategic Technology Programme; methodologies developed from the 2010 Customer-led Network Revolution LCNF bid submission (with the permission of CE Electric UK); datasets for the roll-out of LC technologies from publically available sources; input from SSEPD and industry representatives on typical network headroom figures; Imperial College were consulted to understand the detail behind the models developed for the ENA's smart metering consultation. To ensure consistency between the GB case and the SSEPD case, the models have been adapted and rigorously checked to ensure their validity.

Supporting projects: To support and prepare for NTVV a number of Tier 1 and IFI projects have been instigated and considered in order to build on their learning, de-risk the main project and ensure the related aspects of the NTVV submission is realistic and reliable. Key learning from these projects - see Appendix G.

Project costs: Cost and technology information has been developed directly by Project Partners. Project Partners are experts in the industry and independent of each other and SSEPD. Since the design of project deliverables requires the interaction of different partners the validity of individual solutions are inherently verified as the project has been established. See Appendix A - summary of Costs.

Project management and governance: Overall project rigour and review is in accordance with the SSE Large Capital Project Governance Framework which provides a whole-life cycle stage-gate review process and assess the project viability, delivery and safety with an independent steering group and review bodies. The LCP review process has been applied to verify this bid submission.

The project plan has been developed following input from our project partners, to ensure the timescales are both achievable and robust.

Regulatory matters: The requirements for derogations in NTVV have been developed by SSEPD and its consultants and have been discussed with Ofgem (see Section 7 for more detail).

Customer impacts: Developed by the SSEPD team with linkage to our project partners (Please see Figure 9 for an Illustration of the NTVV project partners and stakeholders).

Successful Delivery Reward Criteria: This has been developed in conjunction with our project plan to ensure the criteria put forward is SMART (see Section 9 for more detail).

Partner Support: To support our project readiness and provide a indication of the importance of the NTVV project we have attached quotations of support from our project partners (see Appendix D) and the full letters of support can be provided if required.

Due to restrictions in the bid submission length for 2011 and as mentioned on page 33, this document is a summary of our larger 'Project Document'. This more detailed document captures the thinking from all of our partners on specific aspects of the project; it is available on request.

6: Project readiness contd.

Process to identify when project should be suspended

Risk monitoring procedures will be in accordance with SSE's Large Capital Project Governance Framework. Our project's risk monitoring procedures will be supported by the establishment of a Project Assurance Board for quality management purposes. Also, given the complex nature of our Project and the associated challenges, a Technical Assurance Board will be established. This is reflected in the Project Organogram of and the associated Roles and Responsibilities - Appendix C(iv) & C(v).

Our Project Management Office will be responsible for the co-ordination of relevant project materials via risk/issue registers; planning; document control; finance control and project status reporting.

Our Delivery Manager and project partners / suppliers will be responsible for preparing progress control reports, and the PMO will be responsible for preparing materials for the monthly project review board and quarterly steering group meetings.

The members of these Boards will be drawn from relevant SSEPD personnel and the key partners (GE, Bracknell Forest Council, Honeywell, Universities of Reading and Imperial College, KEMA and EA Technology) whose credentials in this area are vital to the status of our Project. In addition, our Consultants will provide a vendor-independent view of the technical proposals and solutions.

We have also included a Community Advisory Board to provide input and advice on approaches to customer and community engagement.

The NTVV Project and Technical Assurance Boards will meet on a quarterly basis, ahead of the Steering Group - which will be convened at a suitable time prior to the required quarterly Ofgem reports. The Steering Group will also meet on an emergency basis, as required by any risk/issue escalation actions.

An initial Project Risk Register (Appendix C(ii)) has been prepared and this will be maintained following the Bid Submission. Risk and issue identification will be the responsibility of all participants in our Project. Changes and additional risks/ Issues will be managed by the Project Manager.

Our Project Risk/Issue Registers will be reviewed by the Monthly Project Review Board - including our Project Director; and risks/issues categorised as 'High' (impact/likelihood) will be tabled at the Quarterly Steering Group - unless a Risk/Issue warrants an exceptional meeting of the Steering Group - for example for significant cost over-run or project suspension.

Our Project Manager and team is responsible on a daily basis for monitoring the status of the risks/issues on their registers, and reporting any changes. They are also responsible for identifying and agreeing with the next level of seniority, any mitigating actions and contingency plans.

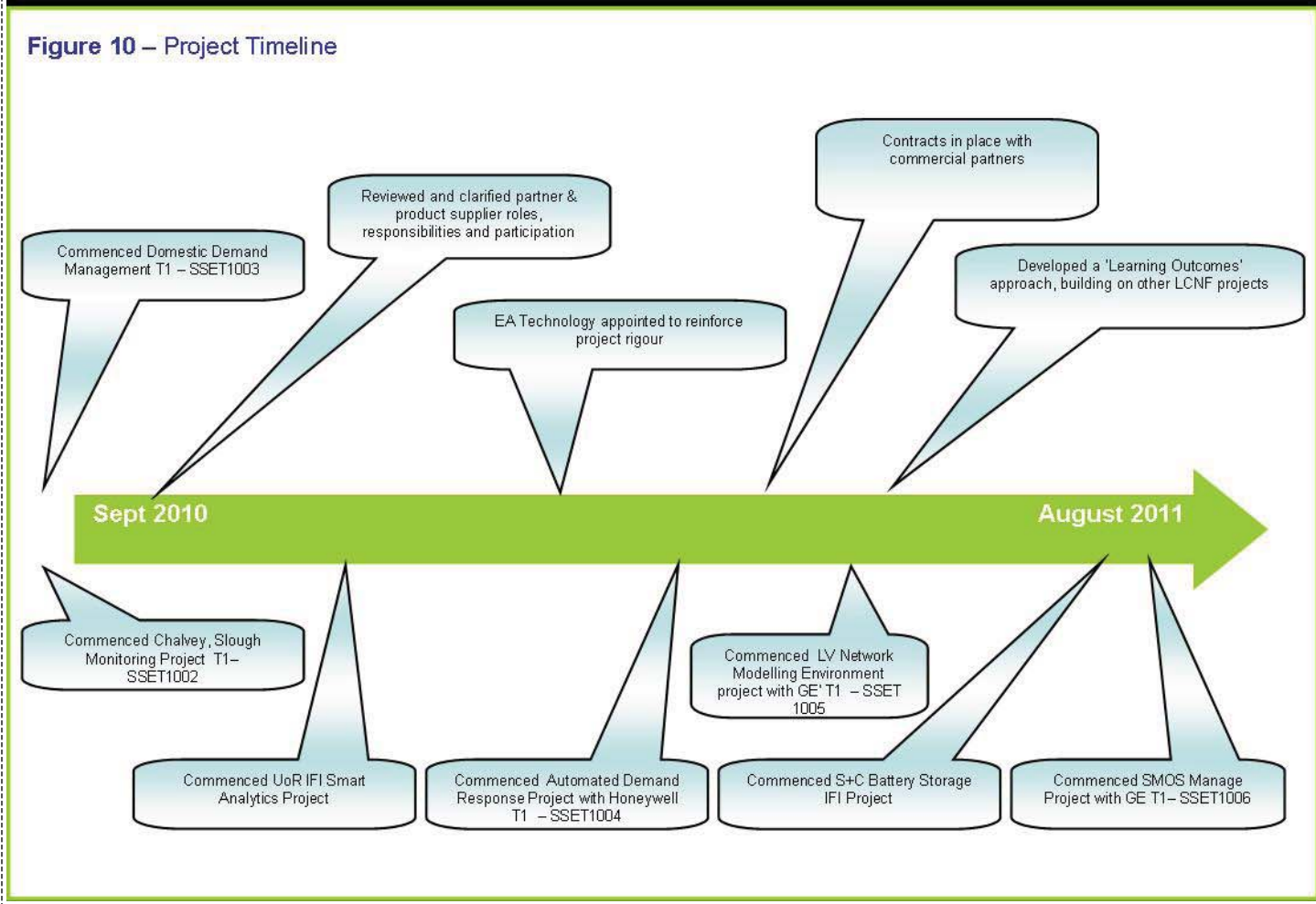
In addition the Large Capital Project governance framework stage gate reviews prior and during construction provide a final assurance that project deliverables are being met, if corrective action is required or, in conjunction with Ofgem, if the project should be terminated.

6: Project readiness images

Figure 9 – Project Partners & Project Stakeholders



Figure 10 – Project Timeline



Section 7: Regulatory issues

- Put a cross in the box if the Project may require any derogations, consents or changes to the regulatory arrangements.

Regulation changes

UK Regulation has continued to evolve since the early 1990s. At this stage in the project it is difficult to predict if, or the extent to which, changes may be likely for the start of RIIO-ED1 (Revenue = Incentives + Innovation + Outputs: Electricity Distribution period number 1) in 2015. Areas we will explore as part of NTVV include:

- o Stakeholder engagement has been recognised as being of increasing importance to the regulation of energy networks. This project will increase the understanding of the engagement needs of domestic and SME customers, particularly the degree to which statistical representation can and should be used in the development of focus groups to ensure that the views of different customer types are represented.
- o Operational outputs: Alternative network or customer management solutions that could affect the amount of load-related investment required in the period.
- o The role of Third Parties in the delivery of efficient networks is a common theme in the RIIO model. This project will inform the industry's understanding of the opportunities for Third Parties to participate in the delivery and development of Low Carbon Networks by demonstrating the roles required and allowing interested stakeholders to understand the challenges and opportunities associated with a Third Party's involvement.
- o Efficient operation: Current thinking indicates that the move to Low carbon Networks to facilitate the transition to a low carbon economy will require increased monitoring of the networks. There is a cost associated with this monitoring, both in terms of capital expenditure for the deployment of appropriate equipment and operational costs to process the data collected and turn it into meaningful information. This project will consider the extent of monitoring that is required and the extent to which this can be supported by statistical modelling to keep capital and operational expenditure at an acceptable level.

Commercial models

The commercial models that electricity distribution companies employ have too continued to evolve over the years. At this stage in the project it is difficult to predict if, or the extent to which, changes may be likely for the start of RIIO-ED1 in 2015. Areas we will explore as part of NTVV include:

- o New commercial models with which DNOs can interact with commercial, particularly smaller commercial (SME) customers. Stakeholder engagement of commercial customers will play an important part in the NTVV project, particularly in understanding what sort of mechanisms suit different customer types (Figure 12).
- o Charging methodologies too have continued to evolve to the Common Distribution Charging Methodology (CDCM). An outcome of the NTVV project is an improved understanding of the behaviours of customers, particularly in profile classes 3 and 4, that will allow this methodology to be reviewed to ensure that the apportionment of DUoS to these customers is appropriate.
- o Potential national commercial changes that may be required in RIIO-ED1:
 - o We will examine whether the cost signals and incentives provided by distribution use of system charges and credits under the CDCM give appropriate incentives to customers and generators to co-ordinate their demand and generation management actions with the needs of the network.
 - o We will review and report on whether the CDCM's approach of charges based on long-term cost-based annuities plus a fixed adder can be reconciled with the potential need to reflect forward-looking avoided investment. This will include a comparison of the CDCM with the FCP and LRIC forward-looking elements of the EDCM, and if with relevant developments and ideas from the TransmiT project.
 - o This review will be based on data from the modelling of customer demand patterns created as part of the project, and on the experience to be gained from offering load management options to customers and generators, and from the record of compliance of customers and generators with instructions or requests from the DNO.
 - o If we find that there are intractable difficulties in integrating appropriate incentives with the connection charging methodology or the CDCM, we will review and report on possible alternative charging methodologies.
 - o We expect that, once experience has been gained from the project, the outcomes may include formal proposals for changes to charging methodologies. We will put any such proposals forward through the appropriate MIG and DCUSA governance processes.

7: Regulatory issues contd.

- o One of the ways in which the learning from the project will be disseminated and applied will be through these industry governance processes: evidence from the project about the relative effectiveness of different types of contracts or incentives will be an important input to the work of industry groups considering changes to the contractual framework or the charging methodologies.

Details of Derogations from regulatory and commercial arrangements

We will only apply for derogations when strictly necessary to implement the project, and even then only in cases where we are able to be specific about the proposed technical and commercial arrangements that would be covered by the derogation, including data protection safeguards, security of supply safeguards, and competition safeguards (ensuring that no supplier or generator gains an unfair advantage in the market as a result of the project). See Appendix F for supporting information.

A derogation against P2/6 for the trial network will enable the project to demonstrate the use of Demand Side Response (DSR) as an appropriate means of avoiding or delaying network reinforcement without impacting security of supply. This is summarised at the end of this section (Figure 11).

The project entails different treatment of network users in the Thames Valley area - in particular, customers in Thames Valley will be offered load management options that might not be available at the same time elsewhere on the SEPD network. We propose to structure these additional options as voluntary contracts outside the ordinary DCUSA-based contractual structure. We consider that the different treatment of network users for the purposes of this pilot project constitutes due discrimination and, as such, we do not expect any licence changes to be required to facilitate this. However we propose to work with Ofgem and other distribution licensees to improve the wording of relevant standard licence conditions, as appropriate, to provide further clarity on this matter.

We have decided to establish all arrangements related to the project in separate agreements with individual customers and/or suppliers and/or aggregators to improve the effectiveness of this project. Smart DSR agreements will provide for the additional data flow required to operate the project, and for the payment of rewards for successful DSR actions.

This proposal means that any modification to charging arrangements in the trial area will be expressed as a difference from the normal CDCM charging arrangements. Thus, power flows in the trial area would continue to be handled through the ordinary settlements system, and to be subject to normal CDCM charges and credits invoiced in the normal standard way. Additional invoices or credit notes would be issued to give effect smart DSR agreements where appropriate.

The cost of funding payments through smart DSR agreements is included in the project's budget.

Smart DSR agreements may provide for financial flows with the following effects:

- o A lump sum reward for participation.
- o A credit against unit rates for consumption at times at which the general network was expected to be stressed, and therefore the CDCM unit rate is high, but the relevant parts of the local network in Bracknell are not so stressed).
- o A system of rewards for accepting requests from SSEPD to reduce/increase consumption/production when this would help the network.
- o A credit against standing charges or unit rates in exchange for placing particular parts of the customer's equipment on a switched circuit controlled by SSEPD.

Credits or rewards in exchange for the acceptance of special restrictions on new connections (eg maximum export/import capacities subject to change depending on the time of day or the operational status of the network).

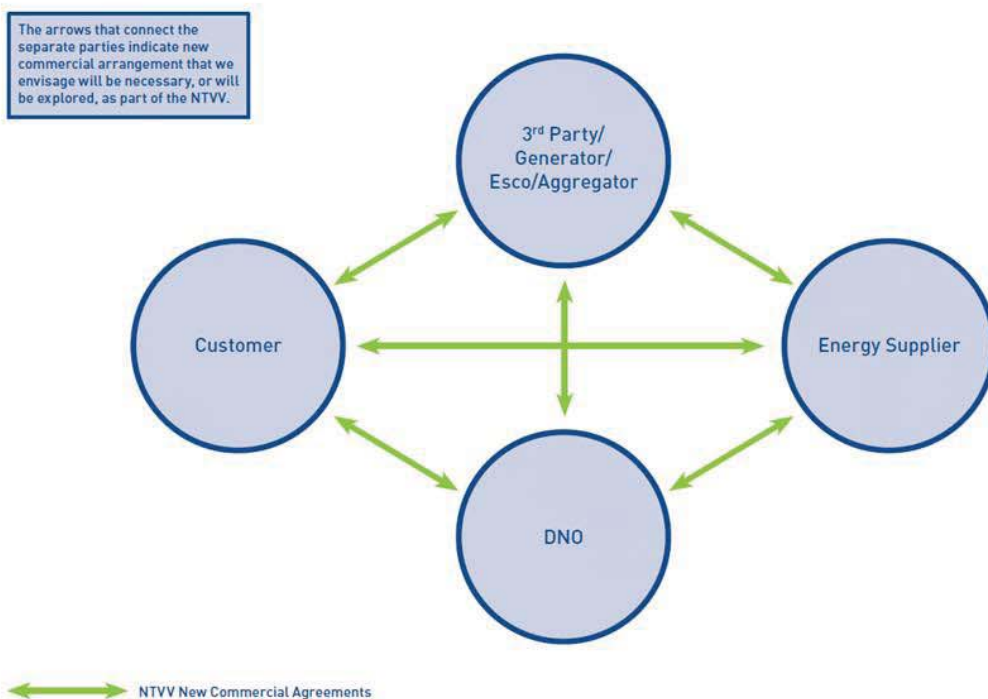
We will experiment with rewards based on long-run costs (i.e. based on generic measures of avoided network capacity and long-run annuity-based charges) and rewards based on forward-looking costs (i.e. specific amounts in respect of identified avoided capital or operating expenditure).

7: Regulatory issues images, charts and tables

Figure 11 – Derogation Request

REQUIREMENT	TECHNICAL DEROGATION
Details of the applicant	SEPD (add name and address of company secretary)
A clear description of the non-compliance including:	
o Type of licence and relevant licence condition number and technical code or standard	Engineering Recommendation P.2/6
o The required performance	ER P.2/6 requires the network to be capable of supplying 'Group Demand' under described conditions, including first and subsequent outages.
o The existing capability of the system or plant;	The TVV system will demonstrate how it is possible to make use of demand response measures to reduce Measured Demand, where appropriate, in order to maintain Group Demand within existing system capability.
A clear description of the reasons why the non-compliance has occurred or is expected to occur;	Demand response is not a recognised means of modifying Measured Demand (ETR 130 Section 5.2 refers - Determine the Group Demand and Class of Supply)
A comprehensive and, wherever possible, quantitative assessment, of the impact of the non-compliance on:	
o Consumers	By making use of demand response, it is intended that consumers will benefit from a speedier response to requests for additional capacity
o Security of supply	It is intended that the overall Security of Supply is not impacted through the measured use of demand response A register will be maintained and shared with OFGEM that will summarise where this derogation has been applied, the extent of network affected and those customers who are connected to/supplied by that network together with the hours at risk.
o Competition	The deployment of demand response to reduce Group Demand will avoid any requirement to consider registering the Project Area as a Load Managed Area which itself constrains competition. It is possible that some demand response will interfere with some trading of managed demand for some periods. The project will include the impact on competition as an Learning Outcome
o Sustainable development	The use of demand response will assist with accelerating sustainable development by enabling the quicker adoption of low carbon technologies in the project region.
o Health and safety and the associated risk management measures	There is no intended adverse impact on Health and Safety. Avoiding reinforcement works will reduce construction-related risks to health and safety.
o Other parties affected by the non-compliance, including the ability of the relevant system operator to operate its system;	We believe any inset networks (currently none in this area) in the project area will require a back-to-back derogation.
o Details of actions to mitigate risks to consumers or other authorised electricity operators while the non-compliance exists;	The project will include planning for Business As Usual (BAU) network reinforcement under P.2/6 so that reinforcement can be effected, if proved necessary, as quickly as is practicable.
o A description of the proposal for restoring compliance (where applicable) including timetable of works;	Compliance will be restored at the completion of the LCNF project and following DNO BAU reinforcement design, planning, construction and commissioning activities; typically these take up to 12 months from start to finish.
o A description of the alternative actions that have been considered; and	We have considered the alternative option of reinforcing the network in line with current practices. We have rejected this option as reinforcing the network would prevent the project from giving a full assessment of the effectiveness of demand-side management as an alternative. We have considered the alternative option of proposing modifications to P2/6 and other documents to reflect the project's thinking about the role of demand response to deliver security of supply. We have rejected this option between it would create a risk of introducing excessive delays in implementation, which we did not consider to be appropriate for this demonstration project.
o The proposed duration of the derogation requested	The derogation will be required for the duration of the LCNF Tier 2 project and for a limited time thereafter during which any BAU reinforcement can be carried out.

Figure 12 – NTVV New Commercial Arrangements



Section 8: Customer impacts

Tapping into a diverse mix of customers

The electricity network in Bracknell and the wider Thames Valley area is typical of many urban and suburban areas in the UK: it serves a diverse mix of industrial, commercial, small business, residential and economic development along with a range of housing types including pockets of severe deprivation (Figure 13)

Bracknell Forest unitary authority area, has a population of 115,000 and is situated in the Thames Valley and centred on the town of Bracknell, just 28 miles from London. Bracknell itself is characterised by a higher than average representation of engineering and other high tech businesses, many of which are playing an active role in NTVV.

The new low carbon solution we propose with our project needs a period of rigorous evaluation in a real environment, and we believe that the Thames Valley location, in conjunction with our project approach, will provide the necessary vision to facilitate this change for Great Britain, its energy customers and the industry as a whole - to provide truly representative learning for the future.

As the area has developed, its electrical demand has increased and the demand profile has changed. Looking ahead, we expect that there will be increased demand associated with further economic development, along with demand rises linked to the anticipated increased penetration of electric vehicles, solar arrays and heat pumps (ref: DECC Low Carbon Transition Plan). As outlined in Section 2, the approach planned for NTVV decouples the project from having large deployments of LC technologies, allowing us to import datasets on individual technologies from other projects (SSEPD project and other T2 projects as data is made available).

Bracknell Forest Council, in common with many local authorities, now aims to develop a lower-carbon economy and is keen to promote the uptake of such technologies. As such technologies become increasingly mainstream; the rate of adoption is expected to be accelerated in comparison to that experienced on a national basis to date. This will place additional strain on the network.

In addition Bracknell plays host to half of Europe's Silicon Valley and is home to the UK Headquarters of many leading multi-national companies. Through our Consumer Consortia, Focus Groups and Smarter Building solutions, we therefore anticipate our initiatives to be recognised and adopted on a local, regional, national, and international basis.

A key part of NTVV is the engagement of commercial customers. As part of this endeavour SSEPD has set about organising a programme of events where we (as a DNO) have spoken directly to the largest customers in Bracknell to get 'sign on' for our project. All energy suppliers were also invited and the response so far has been fantastic with companies such as Dell, BMW, BT, Waitrose/ John Lewis, Cable & Wireless, Boehringer Ingelheim, Syngenta all showing interest in our bid.

The companies listed above have all been briefed on our 'Low Carbon Networks' project and are keen to be a part of it, many have, so far, signed 'letters of intent' as an indication of their interest.

Our vision in the Thames Valley is to leave a legacy and we agree with Ofgem's philosophy that DNO's should again be speaking to customers. With these points in mind it was decided that we should build on our work of last year and continue with our programme of events pre 2011 bid submission. This is exactly what we did and the Thames Valley Chamber of Commerce has agreed to run the events as a part of their programme on a quarterly basis. This is an arena for the Large companies and commercial businesses in Bracknell and the Thames Valley to discuss their ideas with us as the DNO and progress the low carbon vision.

SSEPD has already started to investigate and exploring DSR/ ADR solutions and new commercial agreements with our NTVV Consumer Consortium and many of the members.

Through the Consumer Consortium, our work with load aggregators on the development and control of customer Building Management Systems and stand-by generation facilities, NTVV will seek to optimise net community carbon benefits in addition to site-only energy efficiency improvements.

SME and domestic demand side response applications will be promoted through the development and application of commercial incentives and customer focused products. Our Project will also address high PV penetration by balancing generation and demand utilising heat storage capability in the customer property.

8: Customer impacts contd.

We have already developed a Customer Engagement Plan under as part of our existing Tier 1 ADR project which we intend to use throughout the NTVV (see Figure 14 for potential ADR load reductions)

Engaging Domestic Customers

Our Project will promote existing Government Low Carbon Promotion incentives to the local community. This will provide evidence of the challenges of customer acceptance, resulting network constraints, and a means of alleviating fuel poverty. Our Project has facilitated Bracknell Forest council's plans with the installation of Electric Vehicle (EV) charging posts.

Domestic customers will be engaged through the project in two important ways and will be focused on highly metered focus zones that were developed and identified in conjunction with Bracknell Forest Homes and Bracknell Forest Council (image shown below):

1. **Suppliers** - NTVV is supplier agnostic and a large program of work is underway to engage with every supplier to ensure access to domestic customers. At the time of bid submission we are already engaged with 5 energy suppliers (npower, Scottish Power, Southern Electric, Good Energy and Green Energy). We have invited all suppliers to be involved and will continue with our endeavors to contact/ involve all suppliers.
2. **RSLs (Registered Social Landlords)** - We are engaging with local RSLs and in particular, the NTVV team has a good relationship with Bracknell Forest Homes and there is an agreement in place to install low carbon devices onto their domestic properties to allow us to study the impact on the network.

Southern Electric have committed to installing 1,000 smart meters in the area and they will be deployed in three housing Zones (specified by NTVV). As part of the project we will investigate/ evaluate the cost of this data as well as considering alternative options. These options will initially be the devices demonstrated in T1 & IFI projects across the UK.

Working with Communities

The engagement with customers and communities is vital to the success of our Project and to underpin effective demand response and participation. To address the challenge of raising community engagement and actively promoting UK industry learning and dissemination, SSEPD will establish a Community Low Carbon Energy Centre. This will communicate the concepts of low-carbon solutions and smarter grids in a highly interactive visual way and provide a 'live window' on to the TVV project.

Working with Business Customers Through the Consumer Consortium

A key part of the NTVV Low Carbon Network Fund bid is the engagement of industrial & commercial (I&C) customers. As part of this endeavour SSEPD have set about organising a programme of events where we (as a DNO) have spoken directly to the largest customers in Bracknell to get 'sign on' for our project. All energy suppliers were also invited and the response so far has been fantastic with companies such as Dell, BMW, BT, Waitrose/ John Lewis, Cable & Wireless.

We will be engaging with large commercial organisations to enrol them on the NTVV Demand Response programme. The learning outcomes will be generated as we look to develop appropriate targeting, engagement & incentive models that would enable other DNOs to implement an ADR programme much easier. This work will be carried out in conjunction with Honeywell and the Consumer Consortium programme of events will be key when engaging this group. Due to requests we have already received from some large companies in the area NTVV will now also run focus groups for interested organisations to gain a more detailed insight into incentive schemes and the wider project as a whole.

Identifying SME customers poses issues as we predict it may be challenging to segregate them from either domestic premises (which may house hairdressers/ pubs etc) or from large commercial buildings.

We will investigate ways in customers can be identified and segmented as part of the project and the method we propose to use is a mix of our ideas from the large commercial and domestic elements of the projects. The diagram, Figure 14, on page 49 highlights our intentions. We will be bringing a MD rating approach down from the ADR solution to identify light commercial users, bring the University of Reading's 'usage pattern' based segmentation up from domestic.

8: Customer impacts contd.

NTVV Project implementation

The project has been designed to maximise our positive interaction with customers whilst minimising any potential negative impacts from the trial. Out of the three phases of the work, only the manage phase will result in a direct impact to customers.

Interruptions / Quality of Supply

A key part of the trial is the installation of sensors at all 325 low voltage substations in Bracknell. The sensors will use innovative non-invasive near revenue quality monitoring equipment which does not require disconnection for installation. The monitoring equipment is specified to be capable of live, uninterrupted installation and there will be no planned supply interruptions required.

The monitoring equipment has already being proved under an SSEPD Tier 1 project at Chalvey, Slough where the results are very positive. Therefore, we are confident that a suitable solution exists and that no customer will suffer a worse supply quality as a direct result of installing the monitoring equipment.

However, as with all new technologies there is a risk that not all installations will go to plan which might result in some unplanned interruptions. At this stage we cannot estimate the likely frequency or duration of such unplanned interruptions, although we note that these are likely to be caused by unexpected physical difficulties in accessing obsolete types of distribution network equipment or through inadequate access space in some substations: in these rare circumstances, each unplanned interruption is very unlikely to exceed two hours. We are not seeking any derogation from interruption incentive schemes or guaranteed standards and affected customers will be compensated in the normal manner for any unplanned interruptions or customer minutes lost on these occasions.

Amended Contractual /Charging Arrangements

The project's main direct impact on customers will be through the changes in charges and commercial arrangements given to customers who choose to participate in the demand-side response (DSR) element of the trial. These changes will take a number of different guises, but will normally involve a payment in return for a demand-side response service. This service will entail either active load management by the customer in response to SSEPD signals or via permitted remote control over customer loads by SSEPD during periods of network constraints.

We intend to trial Smart DSR agreements through modifications to connection agreements and the introduction of time-of-use DUoS charges (all measured as changes from CDCM or EDCM, as appropriate).

The trial aims to assess the effectiveness of such measures in order to understand the potential for demand-side response in future network planning and operations. It is therefore vital that we are able to recruit an appropriate number and range of willing customers to participate in the trial. This will require interaction with a number of different customers as part of the recruitment process. SME and domestic demand side response applications will be promoted through the development and application of commercial incentives and customer focused products. We will be engaging directly with large commercial and industrial organisations to enrol them on the project's demand-side response programmes.

The project will also trial a 'zero cost' time-of-use incremental charge an alternative solution where customer inertia means that there is insufficient response to time-of-use charges. This solution will enable DNO interventions to be limited to a pre-defined number of hours per day/week/year and can be seen as an extension and improvement to the previously-deployed use of E7 demands under DCUSA Schedule 8 - Demand Control via Load Managed Areas. The project will demonstrate that its alternative solution does not require all dispatchable demand to be removed from energy trading and thereby reduces monopoly DNO impact to specific periods and locations of constraint only while maintaining energy trading access in all other circumstances. We do not see the need for a load managed area to be established during the trial period and would expect to demonstrate how DSR in existing Load Managed Areas can be similarly improved.

This solution fits with an 'active networks serving passive customers' philosophy which may be required to suit customers who do not have the time or inclination to respond to price signals. The customers will also experience a better service than usual for the connection of low carbon technologies as we intend to prove that a 'connect and manage' method is suitable as part of the project, instead of the traditional 'invest then connect' approach which generally involves delay and expense.

8: Customer impacts contd.

Summary

Our customer recruitment will principally be led by our partners (energy suppliers for domestic customers, Honeywell for both large and smaller commercial customers). We will use our consumer consortium and low carbon community advisory centre to engage customers of all different types throughout the course of NTVV.

Our use of non-invasive monitoring technology will demonstrate enhanced HV and LV network monitoring with a low to no risk of interruptions to customers and we believe this will encourage interaction with our trials by minimising any potential negative connotations with the project.

The project will provide an understanding of how improved customer modelling and increased demand-side response can lead to a sustainable low carbon network at minimum additional investment, leading to better distribution services, less need for road works or planned interruptions to invest in increased network capacity, and lower distribution charges than would otherwise be required.

8: Customer impacts images, charts and tables

Figure 13 – Top 100 MD Customers & Domestic Trial Zones

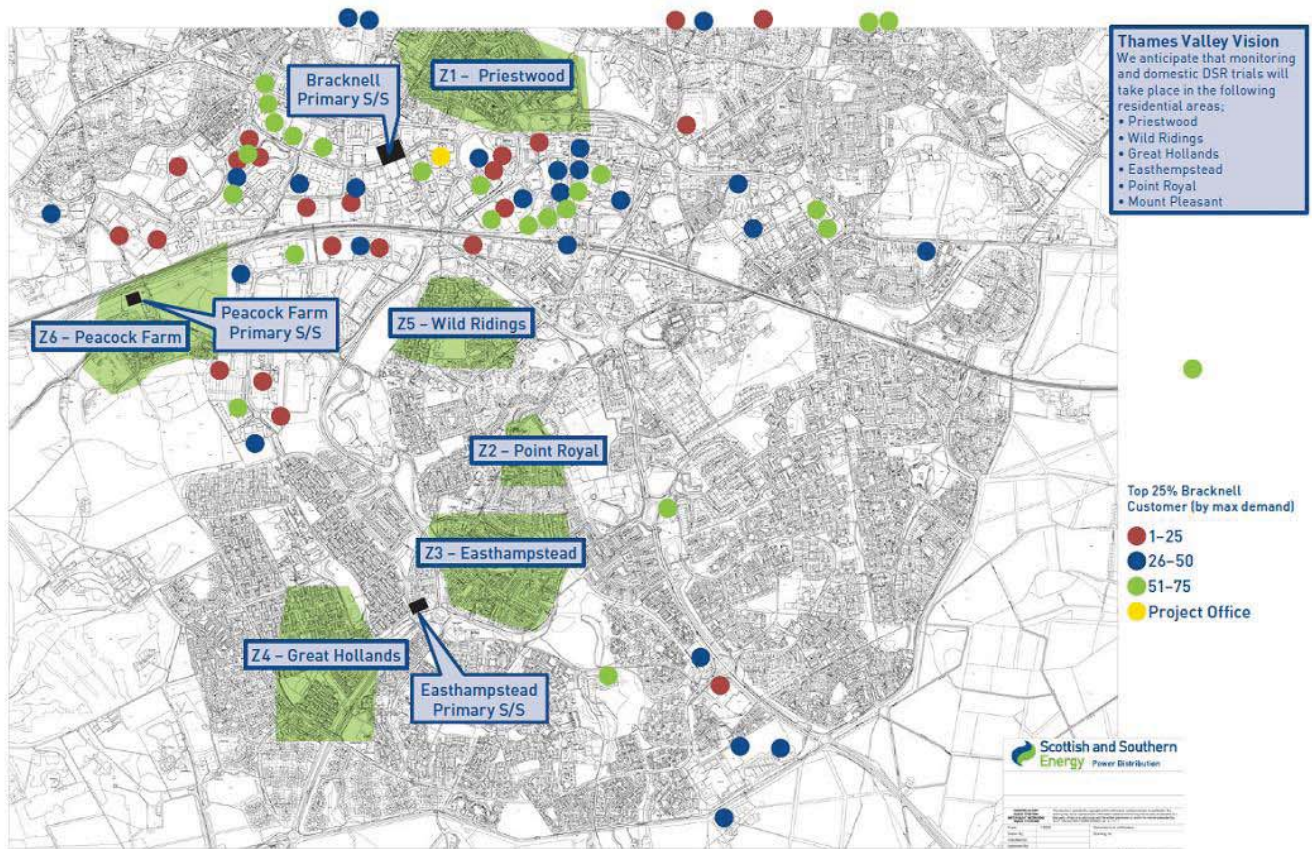


Figure 14 – Potential ADR Load Reductions, Bracknell

Customer Type	Voltage	Number of Customers	Authorised Capacity (kW)	Maximum Demand (kW)	Potential Load Reduction (kW)
Large Commercial	HV	48	42,615	34,426	6885
SME	LV HH (>100kW)	113	45,735	32,023	6405
	LV Domestic (<100kW)	228	24,265	9,750	975
Domestic	Domestic	1,000	N/A	N/A	
Totals	N/A	1,389	112,715	76,199	14,265

Section 9: Successful Delivery Reward Criteria

Criterion (9.1)

Focus: Method 2 (demand response)

Related learning: LO1, LO2, LO4 & LO5 - Understand, Anticipating and Supporting Change. L04 - Supporting Change: Implement Technologies to support the transition to LC Economy. L05 - New Commercial Models with customers and how will they be delivered.

- a) March 2012** - First Automatic Demand Response (ADR) Agreement negotiated and signed with Commercial Customer;
- b) May 2012** - Install the Honeywell/SSEPD interface equipment, programme the Building Management System (BMS) and implement a manual Peak Load Shedding event, via the Demand Response Aggregation Server (DRAS) and track the actual kW shift in Peak Load;
- c) April 2015** - 30 Customers signed up to Automatic Demand Response (ADR) programme and host customer event-renew new arrangements.

Evidence (9.1)

- a)** First Signed Agreement documentation presented to Ofgem. Initial review of engagement process and commercial models used/trialled
- b)** Prepare and present report on learning's and track kW shift in peak loads. Visit to site to physically see, photographic evidence
- c.i)** Provide electronic copies of 30 signed agreements.
- c.ii)** Prepare a sample of new commercial agreement to facilitate optimal use of the network, and provide written overview of technologies deployed in demand side response. Event, produce report including, list of attendees, speakers, feedback and successes of the event.

Criterion (9.2)

Focus: Method 3 (optimised deployment of network monitoring)

Related learning: LO1 & LO4 - Understanding and Supporting Change with improved monitoring & information for network operators

- a) January 2013** - 250 In house end point monitors installed & learnings presented;
- b) April 2013** - 100 Substation monitoring installations installed;
- c) January 2014** - Install and commission the Network Management component of the Distributed Solutions Integrator System (DSI)
- d) April 2014** - Develop and trial method of optimising network monitoring based on installation of first 100 substation monitors

Evidence (9.2)

- a)** Prepare documentation and present work, commissioning reports, sample of data capture/transfer and provide photographic evidence of active operation of systems. Reports to include information regarding unit/installations costs and reliability to inform RIIO. Photographic evidence of installations. Viewings can also be arranged as proof
- b)** Prepare documentation and present work, commissioning reports, sample of data capture/transfer and provide photographic evidence of active operation of systems. Reports to include information regarding unit/installations costs and reliability to inform RIIO. Photographic evidence of installations. Viewings can also be arranged as proof
- c)** Presentation of commissioning report to Ofgem. System tour and overview will be offered. Photographs can also be provided as a back up
- d)** Prepare report reviewing optimal deployment of monitors based on installation of first 100 substation monitors

9: Successful delivery reward criteria contd.

Criterion (9.3)

Focus: Method 2 (demand response) and 3 (optimised deployment of network monitoring)
Related learning: LO1 & LO2 Understanding and Supporting Change - to explore practical and commercial measures required to enrol network monitoring and demand response participation.

- a) **February 2012** - Start Consumer Consortia element of customer engagement programme,
- b) **February 2012** - Arrange and hold the first "Energy Efficiency" focus group.
- c) **February 2013** - Produce customer engagement lessons learnt Report.

Evidence (9.3)

- a) Present minutes and summary of the event. Review feedback forms to assess degree of success. Document methods and effectiveness of customer engagement in relation network monitoring and demand response participation and explore future opportunities.
- b) Present minutes and summary of the event. Review feedback forms to assess degree of success. Document methods and effectiveness of customer engagement in relation network monitoring and demand response participation and explore future opportunities.
- c) Prepare and present first report on level of consumer engagement and formation of consortia. Establish unit/installation costs of engagement to inform RIIO

Criterion (9.4)

Focus: Method 4 (network based energy storage and power electronics)
Related learning: LO1, LO3, LO4 - Understanding, Optimising and Supporting Change through new technologies including energy storage and advanced ICT systems

- a) **July 2012** - Develop problem statement, hypothesis and test deployment programme for coordinated energy storage and power electronics on the Low Voltage distribution network - building on previous and current battery installation tests.
- b) **March 2014** - Install 30 thermal energy storage devices as defined in (a).
- c) **March 2014** - Install 25 LV connected batteries as defined in (a).
- d) **March 2015** - Produce learnings from energy storage and power electronic deployment to assess the hypothesis as defined in (a).

Evidence (9.4)

- a) Produce discussion document and deployment plan for energy storage and power electronics - include an assessment of the management of network losses and power quality.
- b) Photographic evidence of installs. Site visit will also be offered
- c) Photographic evidence of installs. Site visit will also be offered
- d) Produce report which discusses validity of deployment plan and lessons learnt in relation to (a). Report to review hypothesis of (a) drawing conclusions for variation and recommendations for future application.

9: Successful delivery reward criteria contd.

Criterion (9.5)

Focus: Method 1 (Understanding and forecasting customer requirements)

Related learning: LO1 & LO2 - Understanding and Anticipating through Demand Forecasting & Modelling for Smarter Networks

- a) November 2013** - Establish a unique, reliable method for customer segmentation based on individual behavioural energy consumption. Produce first version of the universal customer categorisation vocabulary for DNOs.
- b) April 2014** - Produce first report on the testing of the various mathematically rigorous methods used, develop and produce accurate half hour resolution short, medium and long term rolling forecasts of domestic energy loads.
- c) April 2014** - Aggregate and integrate the short, medium and long term forecasts and produce first report on the modelling LV load profiles.

Evidence (9.5)

- a)** LV Customer Groups presented. The learning from the methods and techniques employed will be presented to enable third party application of these processes. Provide prototype code and description for open-source (unsupported) release.
- b)** Results will be presented together with analysis, evaluation and tests of the methods including accuracy and error estimates and comparisons of techniques
- c)** Include Examples to illustrate effectiveness of the methods. Early validation will also be presented using data collected prior to this date. We will compare against real data to validate the robustness of the model. Provide prototype code and description for open-source (unsupported) release.

Criterion (9.6)

Focus: Method 1 (Understanding and forecasting customer requirements)

Related learning: LO1 & LO2 - Understanding and Anticipating through Demand Forecasting & Modelling for Smarter Networks

December 2013 - Build, Install and Commission the Low Voltage Modelling Environment component of the Distributed Solutions Integrator System (DSI).

Note: The Low Voltage Modelling Environment and wider Distributed Solutions Integrator System are further described Appendix J

Evidence (9.6)

Photographic evidence of the LV modelling environment and an invitation to see it in operation and an online demo.

Prepare documentation and present work including:

- a)** Commissioning reports
- b)** Sample of data capture/ transfer
- c)** Report on lessons learnt during process
- d)** Provide photographic evidence of active operation of systems

9: Successful delivery reward criteria contd.

Criterion (9.7)

Focus: Public Engagement

Successful establishment of all aspects of the Low Carbon Community Advisory Centre - including display material at various locations, the associated interactive website, and the method and means of capture of stakeholders views on the learning outputs.

The strategy and deployment of the Low Carbon Community Advisory Centre will be matched and respond to customer requirement and coordinate with other stakeholder initiatives including Bracknell Forest Council. The duration of the engagement is need driven and will respond to project and community by connecting customers in the Bracknell area with low carbon initiatives, the opportunities and challenges addressed by the New Thames Valley Vision and way in which customers can participate.

Evidence (9.7)

Photographic evidence of established events, and provision of published information including:

- a) "in-situ" low carbon advice displays
- b) Low carbon advice material provided to local roadshow events;
- c) Bracknell Forest Council and other stakeholder website material
- d) NTVV interactive learning and dissemination website

This will include an initial report on attendance list/volumes, first attendee feedback reports, take up of early initiatives and evidence of the most effective way to encourage community energy involvement taking learning from past projects.

Criterion (9.8)

Focus: Knowledge Sharing of methods 1, 2, 3 and 4

- a, b and c) throughout Project** - Prepare final reports on the trials carried out on the subjects listed in "Evidence 9.8" as well as an end of project report;*
- d) April 2017** - Hold a project review seminar to discuss the learning from the project. Attendees will be invited including Customers, Ofgem, DNO's, product suppliers and other stakeholders to discuss the way forward.*

* Description of proposed report scopes as per Appendix K

Evidence (9.8)

- a) November 2014** - (1) End Use and Network Monitoring Evaluation [Methods 1 and 3], (2) Demand Side Response Evaluation [Method 2], (3) Network controlled Automated Demand Response evaluation & Energy Efficiency [Method 2], (4) LV Network Storage [Method 4], (5) EV Chargers Usage Evaluation and Issues [Methods 2 and 1], (6) Smart Meter performance [Method 1], (7) Integration Solution Control Evaluation [Methods 1, 2 and 4] and (8) Overall Proven Benefits (both financial and customer service) [Method 1]
- b) November 2015** - (1) Low Carbon Fuel Poor Evaluation, (2) Bracknell Forest Homes Low Carbon Promotions [Method 1] and (3) Technical Impact Evaluation [Method 1]
- c) November 2016** - (1) UoR Smart Analytic and Forecasting Evaluation [Methods 1 and 3], (2) Low Carbon Community Advisory Centre Evaluation and (3) DNO Training and Policies Review
- d) April 2017** - Project Close Down Report [Methods 1, 2, 3 and 4]

Section10: List of Appendices

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The full costing spreadsheet is also attached.

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Placing learning at the heart of NTVV

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NEW THAMES VALLEY VISION LCNF PROJECT

Appendix Summary

The following appendices are included with the LCNF Bid Submission to support our New Thames Valley Vision project. They include background papers, detailed trial description, supporting quotations from our project collaborators and others. Therefore, we consider the attached appendices are all relevant and required to support and reinforce the Southern Electric Power Distribution (SEPD) LCNF Bid.

Appendix A: Overview of the Full Submission Spreadsheet

Summary of NTVV Costs

Summary

		Total										
		Cost type										
		Labour	Equipment	Contractors	IT	IPR Costs	Travel & Expenses	Payments to users	Contingency	Decommissioning	Other	Total
Expenditure	DNO	5613	2233	1687	329	0	113	591	0	392	716	11674
	Project Partner 1 - GE Energy	0	1637	6386	2759	0	222	0	0	0	0	11003
	Project Partner 2 - Honeywell	0	896	426	1359	0	0	0	0	0	0	2681
	Project Partner 3 - University of Reading	0	0	2502	0	0	0	0	0	0	0	2502
	Project Partner 4 - Other (EATL, BFC, BCoC)	200	0	973	0	0	0	0	0	0	0	1173
	Project Partner 5 - KEMA	130	0	310	160	0	0	0	0	0	300	900
	Total	5943	4767	12284	4607	0	335	591	0	392	1016	29934
Income	External Funding	10	240	3573	563	0	0	0	0	0	27	4414
	DNO Compulsory Contribution	594	467	946	461	0	34	59	0	39	102	2701
	DNO extra contribution	0	0	0	0	0	0	0	0	0	0	0
	Initial net funding required	5338	4060	7764	3583	0	302	532	0	353	887	22819

Appendix B: Detailed trial description (including Maps and Network Diagrams)

The principle aim of New Thames Valley Vision is to demonstrate that understanding, anticipating and supporting changes in consumer behaviour can help DNOs to develop an efficient network for the low carbon economy.

NTVV has been structured around our five Learning Outcomes (LOs) – Appendix B(ii), page 15. The trial design follows this principle, with technology only being deployed where it will contribute to our key areas of learning. As NTVV progresses, we will take the learning and apply it in real DNO systems – control systems /software /policies. This will significantly narrow and de-risk the activity necessary to transfer outputs into day-to-day DNO operation and practice.

LO-1: Understanding - *What do we need to know about customer behaviour in order to optimise network investment?*

LO-1.1 What is the optimum level and location of network monitoring?

The correct level and location of network monitoring will be identified through the installation of high density monitoring across the trial distribution network, particularly on the low voltage network. The data provided will be analysed and categorised to determine the locations where there is a beneficial outcome and those where no further value can be identified.

Understanding the changes on the network

We will monitor the network by installing sensors at 1790 LV feeders at 325 distribution substations (aggregated to give each overall substation loading, and 11kV feeder loading information) and all HV customer network exit point supplied from Bracknell Primary (33/11kV) substation. This monitoring will be extended to distribution substations and HV customer exit points supplied from all 11kV feeders that interconnect Bracknell Primary substation with Warfield (33/11kV) and Easthampstead (33/11kV) Primary substations.

Whilst the trial will start with the Bracknell area, it will be expanded to the broader Thames Valley region, as necessary to fill in any data gaps as the trial progresses.

It is proposed to install monitors that can provide data on voltage, current, phase angle and harmonics. This level of network monitoring is necessary to understand the interaction between the network and the individual customers (described Section 2, Methods 3, page 7 of bid) utilising buddying and forecasting techniques. This will allow future installations of monitoring on the power networks to be minimised, so reducing cost and overall complexity.

All network monitoring will be deployed with very limited DNO-related supply interruptions. We are confident this can be achieved, as informed by our T1 monitoring project SSET002, where we have worked with a range of equipment suppliers to develop network monitoring that can be safely connected to live cables.

Rather than deploy 100% of monitoring in a scatter-gun approach in the NTVV project, we will start with a representative sample (less than 50% of the target network substations). We will use statistical techniques to underpin a phased deployment; this will ensure technology is only installed where absolutely necessary to draw out the learning. The monitoring funding in the project will be ring-fenced – in the event that 100% of the monitoring is not required, the unspent monies will be returned to Ofgem (and customers).

Understanding the interaction between increased network monitoring and smart metering data

Domestic smart meter data is potentially a rich source of valuable operational data and which may have the potential to give early awareness of operational network issues and may offset investment in network monitoring and reinforcement. Smart meter data is likely to be of value at an aggregated level for DNOs, rather than for individual premises, however this will be evaluated during the course of the project.

Working with SSE Energy Retail we will target three specific residential areas to deploy a total of 1000 smart meters to ensure modelling undertaken by the University of Reading is representative of real customers. 60% of all customers in the area are (assumed) to be SSE Energy Retail (Southern Electric). We have actively engaged a further four energy retailers in order to expand the trial to gain data from most residential customers in the target areas. We will also seek data from other T2 LCNF projects to fill in any gaps.

Where smart metering data is not available we will source and install a separate monitoring device in place of the customer's existing service cut-out fuse (SSE 2010_13 – Supply Point Monitoring¹). This will provide us with the necessary end-use monitoring capability; demonstrate an alternative communications medium; and may present a DNO specific solution for end-use monitoring and control applications outside any national smart meter design requirements or roll-out. This will allow the identification and modelling of previously unknown and potential future stress points on individual cables and nodal points on the LV network – that will critically impact on very specific localised decisions in relation to low carbon technology deployment, and the necessary network planning and operational actions.

A meter communications and data management service will be emulated, adopting a role similar to the proposed Data Communications Company. As with the above monitoring activity, we are confident this can be achieved, having recently completed the feasibility stages of project SSET1006 – Modelling¹.

Managing high volumes of data in a DNO environment

Data volumes will increase dramatically as monitoring on LV networks become more the norm. Data must be properly managed in the DNO environment, and presented in a way that empowers the DNO to make informed decisions.

Data architectures and structures

Data architecture and principles will need to govern aspects such as appointing authoritative data, processes for pruning/cleaning/verification and data modelling. All of this will be presented as tradeable information annotated as a universal modelling language to facilitate sharing the learning with Ofgem other DNOs.

We will describe data ownership principles for a DNO managing new sources of data. Ownership of data implies responsibility for, control of and management of data. We will describe the required data integration points which will include supply business data gathered from smart meters, internal IT systems data, real time systems (RTS) and SCADA data and third party information stores, such as data contained in modelling tools.

We will provide a description of Data Security Principles and establish policies for privacy, integrity, accessibility at the outset and maintain them throughout the project.

Various data mining methods will be covered and the setup and use of reporting, deduction of information/models from vast data stores will be determined.

¹ An overview of supporting IF1 and T1 projects is given in Appendix G

Service provision for data capture, messaging and monitoring

The application of appropriate communications methodologies will be an important feature in supporting service delivery and in developing long term learning and understanding. Three communications providers will be engaged across the project so that measured judgements can be made between providers regarding technical performance (functionality delivery), cost and reliability.

Each aspect of the service will be thoroughly monitored and tested over the project term, as will the provider's ability to interface seamlessly and reliably with the complex (near real time) delivery requirements of the project:

- **Performance and functionality** will be assessed for each provider to ensure absolute reliability and compliance in relation to data acquisition (and dissemination) and in support of control instructions between key operational interfaces
- Network technology and data transfer methodology will be examined for **long term support capability** (data volume and control messaging) where each element of delivery will be supported by an appropriate communications service level agreement (SLA)
- Issues such as network management, network control and the provider's ability to **securely interface** multi technologies are vitally important and require close inspection when engaging partners
- **System security and data privacy measures**, likely to be especially sensitive, will need to be a pre-requisite of all communications/systems provider selections and included in supporting SLAs

The communications model will be monitored and managed in relation to three key areas; price, technical performance (bandwidth) and pre-defined SLA.

LO-1.2 To what extent can customers be categorised in order to better understand their behaviour?

At the heart of NTVV is a belief that to operate networks effectively and efficiently, DNOs must understand that consumers are different, and need to be grouped to a much finer degree of resolution than have been done in the past.

The Tesco clubcard is the best known success for smart customer analytics in UK retail. At the end of a three month trial period, before the clubcard was first introduced in 1995, Tesco's then chairman, Lord MacLaurin said more had been learnt about Tesco's customers in three months through smart customer analytics than in the past thirty years. The success of the trial succeeded in converting Tesco from a company focused on its supply chain to a company focusing on the customer and what they want. The ability to segment and categorise their customers into groups provided a step-change in Tesco's understanding of their shoppers, helping them to leapfrog Sainsbury's to become the UK's number one retailer. One of the greatest benefits of smart analytics for Tesco is the provision of accurate demand forecasts, made using customer data, which allow informed decisions to be made about supply requirements resulting in substantial cost savings.

NTVV has the great benefit of the close involvement of Professor Peter Grindrod CBE, of Reading University, who could be described as 'the father of smart analytics'. For almost 20 years his research in industry and academia has involved analytics of vast data bases from mass customer-centred industries. After founding the start up company Numbercraft, which applied algorithms to generate value from customer data for companies including Tesco, Sainsbury's and CocaCola, Professor Grindrod pioneered the development of smart analytics in e-commerce and mobile telephony. In addition to his work at Reading's Centre for mathematics of Human Behaviour, he is a director of behavioural analytics companies in the UK and overseas, working across a range of customer facing sectors.

The introduction of smart meters will enable extensive 24/7 monitoring and the potential for more sophisticated dynamic modelling of consumer demand profiles. To fully understand how one consumer might use or alter their demand compared to another requires a detailed understanding of their specific behaviours, usage patterns and an ability to pick out 'one-off' events that could critically mask or distort the overall trends.

Using this, we believe it is possible to more accurately forecast demand in a system design, network planning and pseudo real-time manner to a degree of accuracy sufficient to gain real benefits – thereby optimising investment plans with a more granular and targeted approach to reinforcement..

Importantly, these techniques could be applicable regardless of whether smart meter data is available to the DNO from every household in the country.

Demonstrating the principles: SSEPD established the 'Smart Analytics' IFI project with the University of Reading in 2011 to demonstrate how the techniques could be applied to electricity distribution networks. This technique is highly innovative, having never been used on electricity networks (transmission or distribution), anywhere in the world. To date the project has demonstrated that:

- Classification of customers into a number of types according to energy demand is possible
- A range of forecasting techniques are available to model customer behaviour over the short term
- Agent based modelling techniques can be developed in this field and agents in a desk-top trial environment have successfully interacted to minimise cost functions such as energy flow between two points by deploying smart control

NTVV aims to significantly extend the trials undertaken through the IFI activity. We aim to develop an industry consensus in which there exists a standard vocabulary and segmentation of different usage types. Such user types may then characterise consequent issues for voltage networks with certain distributions of behaviour under various scenarios. Additionally, common vocabulary will enable better communication between DNOs and electricity suppliers and encourage customers to respond to their own energy use.

An important aspect of the project is to assess the limits of the categorisations and to identify the type and frequency of data required in order to effectively categorise customers' energy behaviour. These categorisations will play a key role in identifying the most appropriate methods for managing different customers.

Once proven with domestic customers, we aim to demonstrate how this can be applied to the diverse SME customer base.

LO-2: Anticipating - *How can improved modelling enhance network operational, planning and investment management systems?*

LO-2.1 How could network headroom change as customers react to low carbon stimuli?

In order to address this Learning Outcome, we need to understand: how might individual customers change their behaviour; how would this change manifest itself for clusters of similar customers; how might these affect different topologies of electricity network.

NTVV will achieve this by expanding on SSE's work with the University of Reading to show how data analysis can be used to simulate future network behaviour. This approach will allow different low carbon technologies (EVs, HPs, PV) to be combined in software models with the accurate predictions of customer behaviour to forecast how loads will change. This allows us to decouple NTVV from the deployment of low carbon

technologies (LCTs) in our identified trial areas, whilst still maintaining robust outputs. Datasets on the individual LCTs will be sourced through this project, other SSE projects and (to the extent that it is made available) from other LCNF projects.

Taking the outputs from LO-1 we will aggregate the modelled profiles of individual domestic and SME customers on each feeder via statistical grouping on feeders, into feeder power flow profiles. We will validate this method for predicting feeder power flow against monitoring data from this project and other LCNF projects (to the extent that these data are made available), to identify whether behavioural demand trends of domestic and SME customers can be identified and the extent to which this could be of use to the DNO.

We are looking to understand the blend of customers down a feeder, whether that is different domestic classes, different business types, or indeed a mixture of the two, to more accurately predict network demand. Experiments with real smart meter data show that small groups of households (up to 200) are not able to aggregate in such a way as to cancel out and smooth out (mollify) peaks in demand. Depending on the modelling outcomes based on the characteristics of the properties on the Low Voltage (LV) networks, the aggregation will fall into one of three categories:

- **Red:** Including volatility the demand on the network at peak is expected to be close to or exceeding capacity and needs addressing immediately or near future
- **Amber:** Demand is expected to be moderately high at peak and is volatile enough to require monitoring, or will reach such a state in the near future
- **Green:** Demand is expected to be low and consistent (low volatility) such that monitoring is not required.

One of the project aims is to understand what characteristics and drivers cause a LV network to be green, amber or red under various scenarios (for example, roll out of new technology or changes in demand). Clearly there could be substantial cost savings by avoiding monitoring all LV networks. But, perhaps more importantly, this method provides a much better understanding of consumers than substation monitoring alone and consequently a much smarter grid.

We will create a tracking and inferencing model, similar to those used for forecasting weather, which will enable short, medium and long-term demand forecasts to be derived. It is expected that this will inform DNO long term operational and investment decisions and SSEPD's Business Plan including preparations for RIIO.

LO-2.2 How can modelling outputs be fed into operational systems and processes in a meaningful manner?

The project will develop and implement a shadow control environment which will be situated in the SSEPD's Control Centre for the purpose of providing a secure, isolated and current set of advanced applications to deliver the functionality supporting the proof of concept. The ENMAC system will act as a centralised management system which will integrate with various distributed energy resources to be deployed in the LV network, leading with demand resource and battery storage resources.

NTVV will use the SSEPD's existing ENMAC distribution management system (DMS) to provide the advanced online distribution power flow (DPF) analysis to support network management. The DMS system supports a wide range of industry protocols and GE's ENMAC system will be used to arbitrate, manage and optimise the dispatch of energy resources and demand reduction subject to grid operating constraints and forecasted customer load profiles. ENMAC will interface with:

- Demand reduction: via around 60 of Honeywell's AutoDR solution installations
- Power electronics and electrical energy storage : over 30 Storage Units
- On-site (emergency) generation: A desktop study will gather information related to the capacity, capability and potential use of such stand-by generation on the Bracknell network

- o Supply reduction: A desktop exercise, to understand how the solution could interface with supply (eg ramp-down signalling to merchant generators)

Crucially, GE will support SSEPD by providing the technical solutions required to support the project and by integrating GE and other technologies to create, with SSEPD, a virtual control room environment. This will enable the simulation of scenarios relevant to a live network deployment. This allow a more complete understanding of the operational implications of these scenarios, de-risking live deployments.

LO-2.3 How can modelling outputs be fed into planning systems and processes in a meaningful manner?

GB distribution network operators design and operate their electrical networks to Engineering Recommendation ER P2/6. This standard defines the level of security for the various connections for demand and generation. Additionally, network operators have legal obligation on the quality of the electrical supply delivered to customer connections. The network model needs to provide sufficient resilience and confidence in output to allow network operators to meet their statutory obligations.

In a rapidly changing low carbon world where new technologies will appear as connections to the distribution at short notice it becomes necessary to fully model some sections of the LV network. The output from the modelling and subsequent analysis will inform better design, planning and operational decisions.

The essence of network modelling is to provide an electrical representation of the real network at the right level of detail for the task. There are two aspects to a network model:

- o physical and actual representation of assets as used in geospatial information systems (GIS)
- o equivalent representation of assets with electrical parameters to enable use in power analytical tools

The degree of complexity and accuracy required in the network model has a direct correlation to the use, timeframe, network use and consequences of actions derived from the output results.

The modelling will not conflict with existing planning and management systems, rather it will complement and support them; for example it will dovetail with GIS, ENMAC and PowerOn Fusion.

LO-2.4 How can modelling outputs be fed into investment systems and processes in a meaningful manner?

We will make use of customer consumption data collected and analysed by University of Reading to create new user profiles for use in the development of cost-reflective DUoS charging and incentive schemes. The modelling outputs will also be reviewed together with other components of the project to gain an indication of likely capex and opex investments that would be required for any wide scale deployment under RIIO.

RIIO-ED1 will include a review of appropriate levels of load-related (LR) capex over the eight year price control period. This project will influence the amount of LR capex expected to be included for LV and HV LR capex: the project could allow new low carbon loads to be connected sooner and at lower levels of LR capex, although there may also be a requirement to increase investments in the DNO business, including IT systems, and make changes to operating procedures and processes which may involve recruitment and/or retraining of staff.

RIIO readiness will require relevant Learning Outcomes to be available by end 2013 – this is a challenging timescale and the project has been structured with the intention of achieving this.

LO-2.5 How can network modelling outputs be fed into town planning systems and processes and vice-versa?

Local government has an important role to play in helping to meet UK energy and climate change policies: by reducing carbon emissions from their own estate and operations; by encouraging and enabling residents, businesses and visitors to reduce their carbon emissions; by protecting the most vulnerable from fuel poverty; and by achieving national priorities such as the Green Deal, smart metering and renewable energy deployment in a locally appropriate way.

Local planning policy is already driving low carbon and renewable energy installation in new developments and local authorities are conducting low carbon and renewable energy studies to inform local plans. These studies can help in predicting elements of future energy demand (e.g. based on planning applications including the effects of future building standards). There are mutual benefits to local government, in aligning network capacity to develop planning policies to encourage the installation of appropriate technologies to suit local circumstances.

Local government could therefore be a key stakeholder to the DNO, in gauging both where reinforcement may be required, and also the types of customers, and therefore the possible suitability in providing demand response support.

Through the course of NTVV we will work with Bracknell Forest Council to:

- Understand how the DNO can most effectively integrate with local planners, integrating planning policy into network demand forecasting and scenario models, and assisting developers in understanding network constraints and of the reinforcement options available
- Understand how the DNO can most effectively work with commercial developers to develop demand models, highlight network capacity and promote connection options for retail and business parks
- Understand how the DNO can most effectively work with property developers to develop demand forecast models, and highlight network capacity for the development of domestic housing estates. Network modelling will enable property developers to understand how consumers react to different technologies and encourage the specification of appropriate technologies in new developments.
- Understand the best way for a DNO to engage with landlords, particularly registered social landlords to support larger scale demand response. Network modelling will enable landlords to understand how consumers react to different technologies and to target the specification of appropriate technologies when buildings are refurbished.

The initial stages of the project will focus on liaison between Bracknell Forest Council and SSEPD. As the project progresses, we will look to work with other councils in the Thames Valley area, before looking to the broader SSEPD areas. This approach will demonstrate the replicability throughout the UK. Subject to cost, this secondary activity may be the subject of future Tier 1 projects.

LO-2.6 What changes are required to industry governance and documentation to facilitate a modelling based approach to network monitoring?

The Learning Outcomes will include a review of network planning documents such as (but not limited to) P2/6 and ETR 130 (Application Guide for Assessing the Capacity of Networks Containing Distributed Generation). Without prejudice to any project outcome, it is possible that that ETR130 is either duplicated in part or amended/expanded to provide guidance for assessing capacity of networks containing dispatchable demand.

Further to this will include a review of the Load Managed Area designation practice, included under Section 8 (Demand Control) of DCUSA, as Load Managed Areas may no longer be necessary when DNOs can constrain demand without frustrating the general availability of demand in any area as a Supplier-traded resource.

LO-3: Optimising - *To what extent can modelling reduce the need for monitoring and enhance the information provided by monitoring?*

Taking the outputs of LO-1 and LO-2, we will understand the extent to which modelling can replace network-wide monitoring, and what data is required for effective modelling.

LO-3.1 To what extent can modelling be used in place of full network monitoring?

As modelling becomes more accurate, it will be possible to better target the placement of network monitoring devices – only deploying them around problematic circuits or for unpredictable customers. We aim to test this.

Demands will be predicted from conditioned simulations which use an agent based modelling (ABM) approach. This technology is used in many areas such as climatology, the financial sector, and the services sectors, where future behaviour of individual consumers (“agents”, conditioned on their own past behaviour) is required. The volatility of customers (and their variability) has already been observed from analysis of EDRP smart meter data. The ABM approach naturally allows us to “buddy” non-metered households with metered ones or surrogates based on the metered users, and for users to influence each other: users/agents may change behaviour and acquire new technology in clusters (not independently). There are a number of forecasting tasks at different time scales, of increasing complexity and uncertainty. As smart meters are rolled out this “buddying” step may become much less necessary. For the purpose of this project the intensively monitored LV networks give us an early view of the future smart meter – smart grid world. Our modelling will deal seamlessly with both the here and now and this future situation.

This is a very novel approach for the energy sector and LV network demands, but it is widely used in other consumer sectors. The University of Reading has worked with disaggregated user data for retailers, their suppliers, the mobile telephone sector, and online monitoring. Behavioural segmentations (data driven) and simulations (not just trend forecasting) have been used for a variety of customer and supplier benefits, reducing costs, improving understanding and relationships and modelling uptake of new propositions.

LO-3.2 How might modelling assumptions change over time?

As more and more data is obtained, the model continually updates and refines itself providing better and better estimates. But there could still be certain events or scenarios that need to be added to the model. For example, if a person sells their home and new residents move in (or a small business changes from a hairdresser to a sandwich shop), then a new adaptive behaviour will be required. The methods built into the algorithm will quickly learn to adapt to the new occupants and adjust forecasts accordingly.

The agent based modelling approach adopted here also lends itself neatly to the ability to input various scenarios, such as the uptake of EVs. Over time one might expect this uptake to have a substantial effect on any LV network. But this will not be in a uniform way. Rather, it is likely to be clustered with a high penetration in some streets and much lower in others. Such scenarios can be fed into the model with, for example, a medium forecast, and high and low forecasts for the uptake for any given LV network.

In addition, the uptake of micro-generation technologies, such as PVs, micro CHP, heat pumps, etc is not expected to be uniform. Once again the agent based modelling methodology allows various scenarios with, for example, high, medium and low uptake.

LO-4: Supporting Change - How might a DNO implement technologies to support the transition to a Low Carbon Economy?

NTVV will focus on the integrated application of two key solutions, one on the network side and one on the customer side, in a range of scenarios.

LO-4.1 How could distributed solutions be configured into the DNO environment

The distributed technology solutions we are concentrating on for NTVV are:

- o Use of power electronic converters (with and without electrical energy storage): a **network-side solution** that can be applied to LV networks, and in some instances rolled out to customers' premises
- o Building management systems (BMS): a **customer-side solution** for large and (potentially) light commercial customers. This will also include the use of two variants of thermal storage.

Use of power electronic converters

The power electronic converters typically used with electrical energy storage provide a platform to provide reactive power injection to the LV network, allowing the network to be used more effectively without reinforcement. Acting as a form of Static VAR Compensation (SVC), they have the ability to:

- Reduce losses to gain maximum network benefit from embedded generation
- Improve power quality and harmonics management
- Control voltage along a circuit
- Potentially balance phases
- Add energy storage

We intend to deploy over 30 power electronic converters in NTVV. These will all be installed on the LV network, and may or may not be associated with the connection of the electrical energy storage described below.

Use of energy storage

NTVV will deploy LV-connected electrical energy storage, in statistically relevant quantities. This will provide a robust understanding of how a DNO can effectively deploy and operate this technology to support customer choice.

A total of 15 single-phase (10kW/10kWh) domestic storage units and 16 three-phase (25kW/25kWh) street storage units are planned in the NTVV project. This will build on learning acquired from three single-phase units installed as part of the 'LV Connected Batteries' IFI project (Appendix G) where such storage is connected at the midpoint of a LV feeder circuit supplying SSE's 'Low Carbon Homes' project. The primary objective of the IFI project is to prove the functionality of the battery units, to gain experience of the technology and hence de-risk the larger deployment for NTVV.

The battery units will be used to peak lop both demand and generation under theoretical cable limits thereby demonstrating the effectiveness of the technology without affecting the security of supply. The devices also have the capability of four quadrant operation (provides comprehensive balancing of the network) meaning it is possible to provide voltage support to keep the supply within the given standards.

In the initial stage of NTVV we intend to use the smaller domestic storage facilities to simulate the effect of low carbon technologies - 'stress-testing' the LV network.

The primary objectives of this element of the project are to:

- o Reduce peak demand on the LV network
- o Negate the need for traditional network reinforcement

The secondary objectives of this element of the project are to:

- o Quantify the effect on the high voltage network of reducing the peak demand at low voltage level

- o Stop network constraints limiting the connection of low carbon technologies to customers on the low voltage network
- o Understand the economic case for energy storage over traditional reinforcement
- o Appreciate the technical implications of installing a large array of inter-connected energy storage units

Further to locating electrical energy storage on LV feeders, we aim to introduce micro storage facilities – small batteries - on the low voltage network to simulate the effect of low carbon technologies and 'stress-test' the facilities' ability to help balance networks.

Use of building management systems

Internationally, AutoDR is going through a development process with utilities and system operators. The primary role for AutoDR is as a peaking power plant; in many circumstances AutoDR is proving to be a more economic source of generation capacity.

More recently (past 2-3 years) AutoDR (because it is so reliable and fast) is being used for ancillary services support, and increasingly global utilities, are applying AutoDR on a more geographically-specific basis, such as distribution support. Honeywell have found that utilities and regulators are approving AutoDR programs to avoid building peaking power plants, and utilities are finding additional value streams from this resource.

We aim in the NTVV project to trial the BMS solution for the following situations:

- o **Demand:** traditional load in a building – including lighting circuits, electric space heating /cooling
- o **Generation:** Use of standby generation in buildings to support the network
- o **Energy storage:** Use of energy storage (electrical and thermal) in buildings to support the network

Thermal storage will introduced along with some of the Building Management Systems. This is described in more detail with LO4.4

LO-4.2 How could a network management solution integrate with building management systems

NTVV will ensure the building management solutions deployed by Honeywell will integrate into the DNO's distribution management system in the following manner:

- The DNO's distribution management system (GE's ENMAC) will provide a web services 'event' call to the Demand Response Automation Server (DRAS) to reduce electric demand when it senses upcoming constraint at a sub-station level.
- A Honeywell AutoDR controller is located in each building connected to each sub-station, which is enrolled on the NTVV demand response programme. Once-a -minute, each controller reaches out to the DRAS to check whether a load curtailment event signal has been initiated. The controllers action pre-programmed load reduction within each building only when a signal has been sent from the DRAS for them to do so.
- The event signal will specify which building participants should participate and for how long. Data is generated dynamically for each building that participates only for the duration of the load curtailment event.
- Run in a secure closed network, a web portal is provided for the DNO to initiate, manage and record (audit) the load curtailment events.
- Each representative of the buildings enrolled in the AutoDR programme will have access to a portal to manage their participation, to view their performance during curtailment events and generate custom reports.

LO-4.3 How can the DNO best engage with customers to encourage demand reduction, and where on the network is each most effective

Within the scope of NTVV we intend to only focus on demand response with commercial customers. This will start with the large, then move to smaller (kWh usage) consumers.

Honeywell is one of the largest implementers of AutoDR solutions in the world. Coupled with over 100 years experience in providing end-to-end energy and demand management solutions for buildings and facilities across the globe, they are able to deliver a fully functioning system to prove the AutoDR concept and demonstrate the mutual benefits it can deliver for DNOs and buildings enrolled on the programme.

For this element NTVV aims to:

- Demonstrate at scale how demand management can be achieved for large commercial customers via a building management system
- Explore the extent to which something similar to this building management system could be applied to SME customers

LO-4.4 How would network storage be used in conjunction with demand response

NTVV will understand the effectiveness of combinations of embedded thermal energy storage and demand reduction effectively raising the proportion of controllable load. We will use the outcomes of categorisation and modelling of customer behaviour to inform and target deployment where it would be most effective to the DNO.

Two variants of thermal energy storage will be deployed throughout the course of NTVV: Hot water storage to manage excess PV and ice energy storage to manage air conditioning load.

Hot water energy storage from excess PV generation

There has been significant work done in recent years on storing energy in the form of hot water and in particular utilising domestic hot water tanks to store excess renewable generation. SEPD seeks to build on the recent learning, including the knowledge gained from the SSEPD Tier 1 project 'Domestic Demand Management Solutions', and understand to what extent hot water can be used to absorb excess solar generation.

NTVV seeks to install **100 devices** in conjunction with solar PV in a concentrated area.

The large array will allow the investigation of the cost benefit of installing these control devices over traditional upgrades and additionally against the energy storage and demand management techniques employed in the NTVV project. SSEPD has valuable experience in this area and has initiated discussions with the 'Coolpower' equipment supplier.

Ice Energy Storage to offset air conditioning load

As part of the focus on peak load reduction SEPD has recognised that a significant percentage of this demand is from air conditioning requirements. The peak demand day of the year at Bracknell primary substation is at the height of summer when the cooling requirements are high. NTVV seeks to investigate potential options for reducing the need to run air conditioning units at peak times.

There has been significant work in this area particularly in the U.S. with off peak compressors which effectively store energy during the night in the form of ice and use that stored energy through the day to offset the load requirements at peak times. The system functions in a similar manner to a traditional storage heater in reverse. There is currently no documented experience of this technology deployed at scale in the UK.

There are currently multiple supplier providing this type of technology; an example of this is the Ice Bear from the company Ice Energy. We have made initial enquiries in this area and believe there are no fundamental barriers to installing the technology in GB.

SEPD proposes to initially install three units in conjunction with the building management system Tier 1 project. The system will be trialled on a small scale to prove the functionality and understand the associated cost savings. The devices are simply retro

fitted to existing air conditioning units thereby making the installation quick, simple and low cost.

The devices will then be rolled out to **50 commercial premises** connected to Bracknell primary substation as part of NTVV. As the storage devices provide a saving in energy costs to the customer and a benefit to the network, the procurement and installation costs will be part funded by the building owner. The large deployment will provide significant benefit to the network in terms of peak demand shifting and will prolong reinforcement requirements

LO-5: Supporting Change - Which commercial models attract which customers and how will they be delivered?

This LO is focused on clarifying which commercial models (and operating price points) attract different customers within our target groups: large commercial, SME and domestic. It will heavily link to LO-4, but with a real focus on which commercial offerings work for each customer types.

LO-5.1 Large commercial

Within the context of NTVV we are treating large commercial as being any customer with an average maximum demand above 200kW. We will develop Customer Engagement for DNO through AutoDR led by Honeywell. The key activities are to:

- Define 'best fit' selection profile for those end users
- Initiate discussions between DNO, Honeywell and end users
- AutoDR site audits, to identify potential Load Shedding Strategy (LSS)
- Gain end users approval for LSS to be implemented
- Agree participation process for AutoDR activation
- Identify key criteria and Incentives for end users participation
- Select 'best fit' Incentives for end users
- Maintain DNO relationship through forums i.e. User Groups
- DNO to provide feedback to end users' on local participation and LSS impact
- DNO to develop impact tables to encourage greater participation

LO-5.2 Light commercial (SMEs)

Honeywell's international experience of applying demand response to small customers has been brought into NTVV. In California, USA, small commercial buildings make up 20 to 25 per cent of peak electric demand, with small offices, restaurants and retail buildings the major contributors making up over one third of the small commercial peak demand. A 10 per cent reduction in only these three types of buildings can yield up to 0.5 to 0.7 percent of peak demand in California.

Despite a number of barriers to the involvement of small commercial customers, we and our partners believe there to be sufficient opportunity to target this customer group. We will therefore be looking to use these outputs with a focus on different types of light commercial customers as part of NTVV.

LO-5.3 Domestic

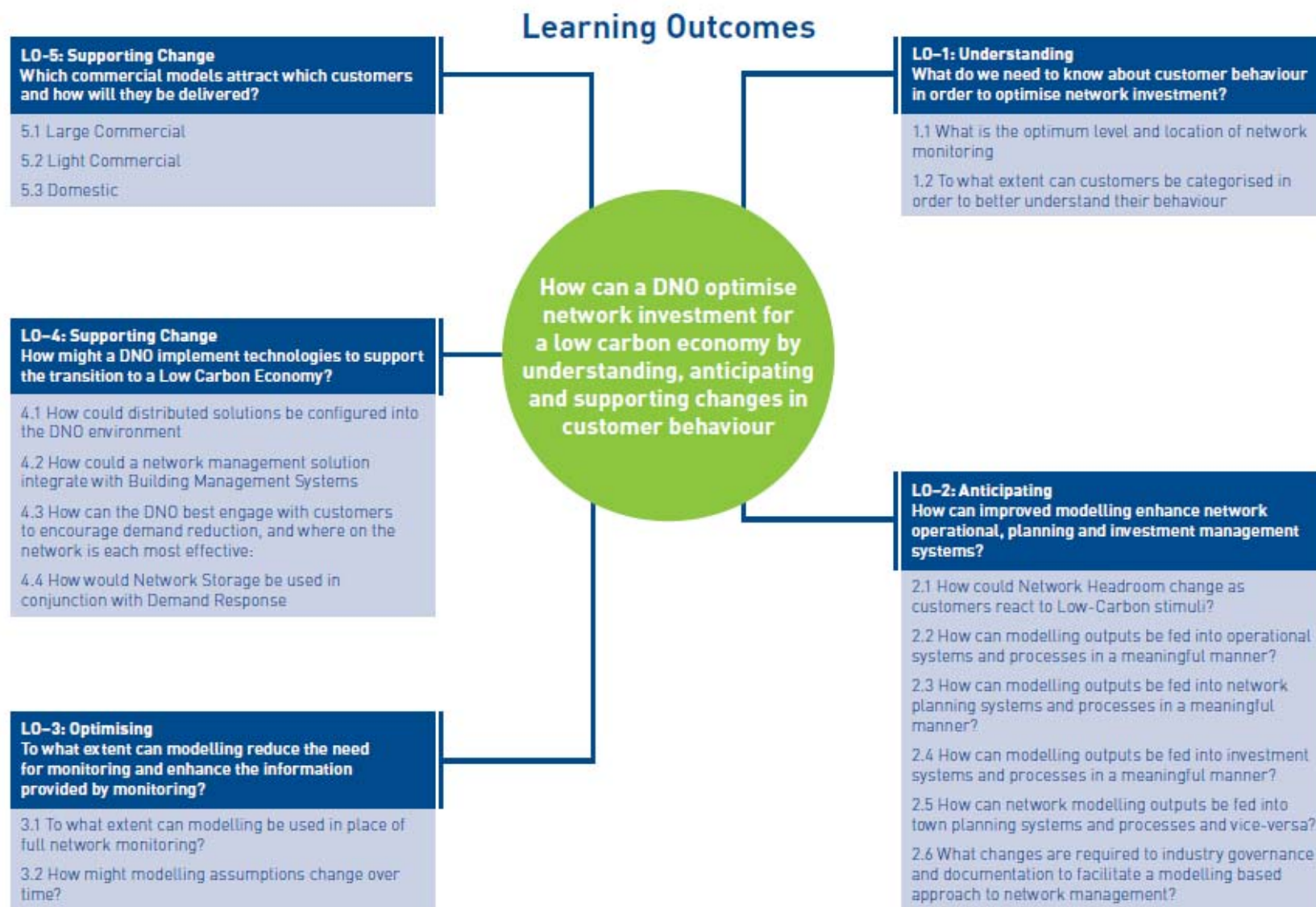
To avoid significant overlap with other existing LCNF Tier 2 projects funded in 2010, the application of management signals to domestic customers will be done as a desktop exercise only for NTVV. It will focus specifically on management may be achieved using outputs of the monitoring /modelling of specific customer types. If sufficient promise is shown throughout the course of the NTVV project SSEPD will aim to establish a relevant T1 project to run in parallel.

The cost of deploying these solutions will be compared to the cost of conventional reinforcement to understand where the boundaries between the solutions lie.

Appendix B(i) - Overview of the Thames Valley region



Appendix B(ii) -Learning Outcomes: Placing learning at the heart of NTVV



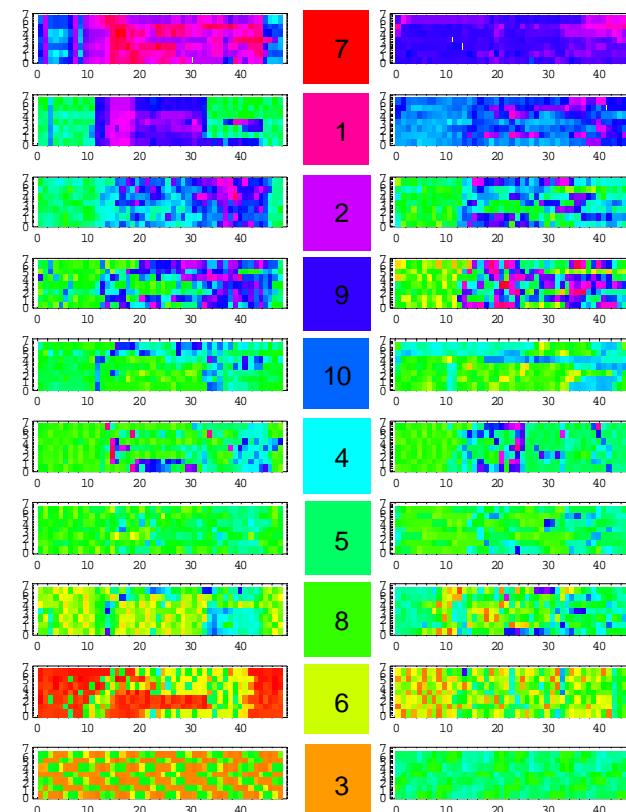
Appendix B(iii) – Classifying consumer demand

Below are ten “clusters” (or “types”) of customers that were initially identified from EDRP data as developed by the University of Reading. The table describes:

- Typical demand of customers in each type in kWh
- Typical inter-day variance - the amount by which a customer's demand is likely to change from one day to the next.
- Typical smoothness - a measure of the correlation from one half-hour to the next within a given day, with a higher figure indicating that the profile remains fairly constant (smooth) and a lower figure indicating that demand can vary significantly from one half-hour to the next (an uneven profile).
- A brief synopsis of the type of profile exhibited re. demand level and variability.

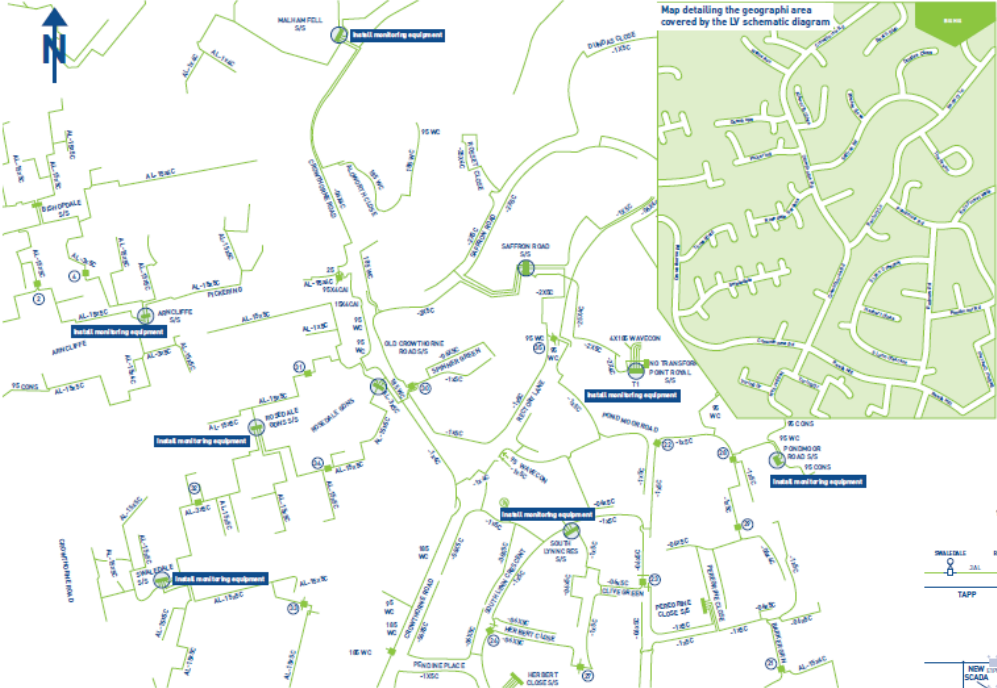
Table B1: Sample of customer types from initial data

Cluster	Typical Population (%)	Typical Demand (kWh)	Typical inter-day variance (kWh ²)	Typical Smoothness	Description
7	1.6	46.3	3.3	0.95	High, steady day to day and smooth during day
1	5.6	26.5	3.1	0.89	Medium, variable day to day and smooth during day
2	12.5	16.3	2.0	0.87	Above average and smooth during day
9	9.5	15.9	2.4	0.75	Above average and uneven during day
10	24.6	10.6	1.3	0.81	Below average and smooth during day
4	9.1	9.2	1.1	0.64	Below average and uneven during day
5	8.2	7.3	-0.6	0.87	Modest and smooth during day
8	16.3	6.6	0.2	0.74	Modest and uneven during day
6	10.4	4.2	-1.1	0.71	Low and uneven during day
3	2.2	2.8	-4.7	0.86	Very low

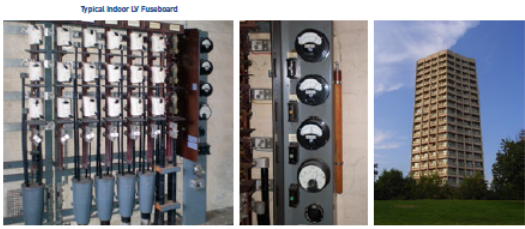
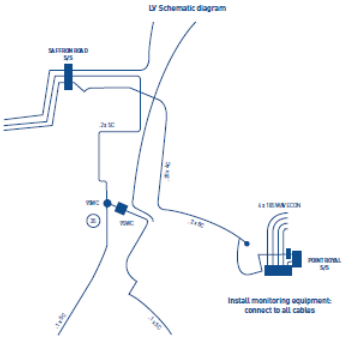
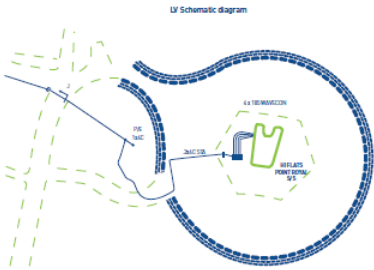
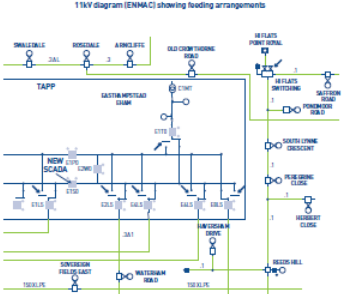


Looking at the same ten types of customers, the graphical representations above illustrate some sample profiles. The numbers in the centre of the plot correspond to the “cluster” number in Table B1. To the left and right of the central numbers are two plots representing two customers who fall into that cluster or type. Each of these two plots is made up of a grid of 7 rows and 48 columns. This grid represents the demand over the course of a week, divided into half-hourly periods, such that each row is the demand over the course of one day. Each square within the plot is coloured according to the demand level with pink/red being the highest levels of demand, decreasing through blue and green to yellow and orange.

Appendix B(iv) - Typical LV Networks - Knowledge of consumer behaviour, will inform network performance, planning and investment



Typical Substation and HV LV Network

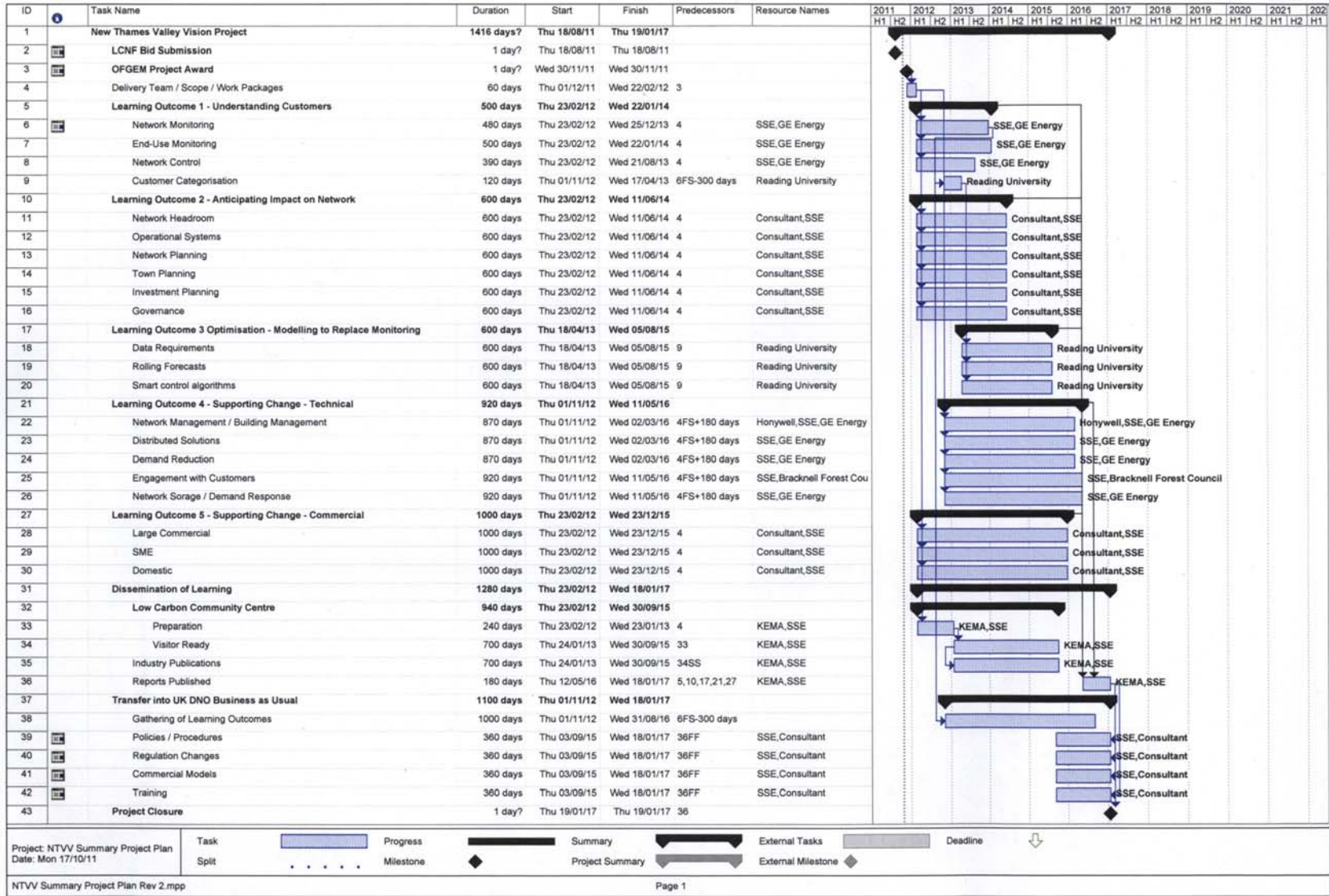


Existing monitoring: Current and Voltage recorded manually



Typical LV Current Sensor
Fit around each phase of every LV cable

Appendix C(i) : NTVV Summary Project Plan



Appendix C(ii): NTVV Project risk register

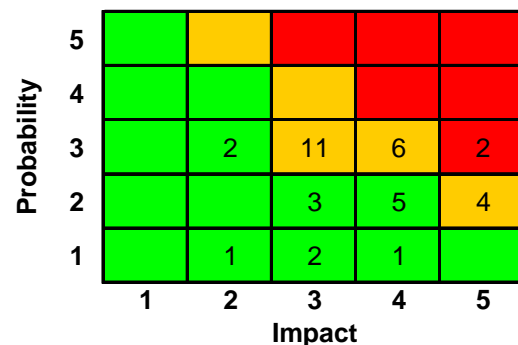
Below is an extract of the top 15 risks for NTVV

Ref.	Date Raised	Status	Risk		Description	Inherent Risk			Category	Owner	Type	Plan	Target Date	Date Closed	Residual Risk			Category	Inherent	Residual	Impact of Control
			Class	Title		Prob	Impact	Score							Prob	Impact	Score				
R005	13/06/2011	OPEN	Project Management	Failure of Bid	NTVV not awarded LCNF tier 2 funding	3	5	15	HIGH	BS/SR	TOLERATE	Develop business plan to allow reduced scope of works as necessary	01/12/2012		3	4	12	MEDIUM	3-5	3-4	3
R001	13/06/2011	OPEN	Project Management	Resources for Project Management/Delivery	Unavailable skills, training and locations impact on project management and delivery of ILOs	3	5	15	HIGH	GS	TREAT	Resource plan and gap analysis. Recruit/second appropriate staff	01/12/2011		2	5	10	MEDIUM	3-5	2-5	5
R012	13/06/2011	OPEN	Project Management	Loss of critical staff	Loss of critical staff within SSE or partners organisation	3	4	12	MEDIUM	ML	TOLERATE	Work carried out by a team rather than a single person. BAU process to maintain contingency/succession planning	N/A		3	3	9	MEDIUM	3-4	3-3	3
R030	13/06/2011	OPEN	End Point Monitoring	Cut-out monitor delay	Cut-out monitor devices delayed	3	4	12	MEDIUM	BS	TOLERATE	Prepare to model remaining endpoints from known substation and monitored end points to determine potential network issues.	02/02/2012		3	3	9	MEDIUM	3-4	3-3	3
R035	13/06/2011	OPEN	Domestic and SME DSR	Domestic DSR technology	Unproven Domestic DSR technology does not deliver	3	3	9	MEDIUM	MS/BS	TOLERATE	Will be proven as part of the trial	N/A		3	3	9	MEDIUM	3-3	3-3	
R043	13/06/2011	OPEN	Learning and Dissemination	Learning and Dissemination	Insufficient uptake or support from stakeholders and project partners	3	4	12	MEDIUM	BS	TREAT	Develop consumer and domestic consortium groups, communications programme	01/12/2013		2	4	8	LOW	3-4	2-4	4
R022	13/06/2011	OPEN	Network Management	Network Management	Lack and Quality of SEPD Network Information	3	3	9	MEDIUM	DH	TREAT	Investigate Quality and prepare correction plan	01/02/2012		2	3	6	LOW	3-3	2-3	3
R023	13/06/2011	OPEN	Network Management	Network Management	Lack of suitable planning tools	3	3	9	MEDIUM	DH	TREAT	Scope new software and algorithms	01/02/2012		2	3	6	LOW	3-3	2-3	3
R008	13/06/2011	OPEN	Monitoring Devices	Monitoring Device Performance	Monitoring equipment does not perform as expected	3	4	12	MEDIUM	DH	TREAT	Review performance and assess likely failure modes	01/02/2012		2	3	6	LOW	3-4	2-3	6
R042	13/06/2011	OPEN	Learning and Dissemination	Site location	No site available for learning and dissemination centre	3	3	9	MEDIUM	BS	TREAT	Discuss with BFC, SEEDA and Corp Support	01/02/2012		2	3	6	LOW	3-3	2-3	3
R041	13/06/2011	OPEN	Large Business Enterprise	Consumer Consortium	Consumer Consortium Lack of interest	3	3	9	MEDIUM	MS	TREAT	Letter of Intent being signed	01/02/2012		2	3	6	LOW	3-3	2-3	3
R006	13/06/2011	OPEN	ICT and Communications	DCC proxy communications & DA	DCC Proxy Communications and Data aggregator service not in place	3	4	12	MEDIUM	IF	TREAT	Prepare Scoping and Tender Document - prepare to tender comms service	01/11/2012		3	2	6	LOW	3-4	3-2	6
R027	13/06/2011	OPEN	Energy Storage and Generation	Energy Storage Efficacy	Battery efficiency or reliability does not meet required standards.	3	3	9	MEDIUM	GM	TREAT	Utilise experience of previous battery projects during tender assessment. Utilise penalty clauses in contracts if appropriate.	01/11/2012		2	3	6	LOW	3-3	2-3	3
R028	13/06/2011	OPEN	Energy Storage and Generation	Energy Storage Power Quality	Issues with power quality / protection systems on local network.	3	3	9	MEDIUM	GM	TREAT	Programme includes modelling to identify possible issues with networks and power quality. System operation to be tested and verified.	01/11/2012		2	3	6	LOW	3-3	2-3	3
R029	13/06/2011	OPEN	End Point Monitoring	Smart Meters	None delivery of smart meters	2	4	8	LOW	BS	TREAT	Prepare alternative to install smart meter functionality at cut out	01/02/2012		2	3	6	LOW	2-4	2-3	2

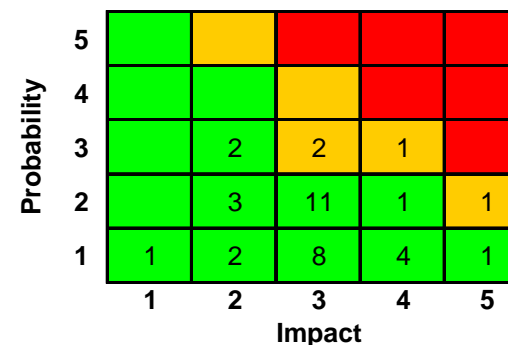
Appendix C(iii): NTVV contingency plan

In line with SSE's Large Capital Project Governance Framework the NTVV project risks have been identified and assessed in terms of probability and impact. All risks are managed by identifying a risk owner and developing a series of controls designed to maintain risks within the accepted appetite for NTVV. The distribution of NTVV project risks is plotted below:

Inherent Risks



Residual Risks



In addition to the control measures specified in the risk register and managed by the respective risk owners, key project risks have been specifically considered in order to develop contingency plans should management controls fail.

It should be noted that contingency planning is inherent to the risk management process adopted by NTVV. Specifically – as all risks are continually reviewed the relevant mitigating actions are modified to meet any change in severity or need. The contingencies identified below are updated during the risk register review process to keep both documents aligned.

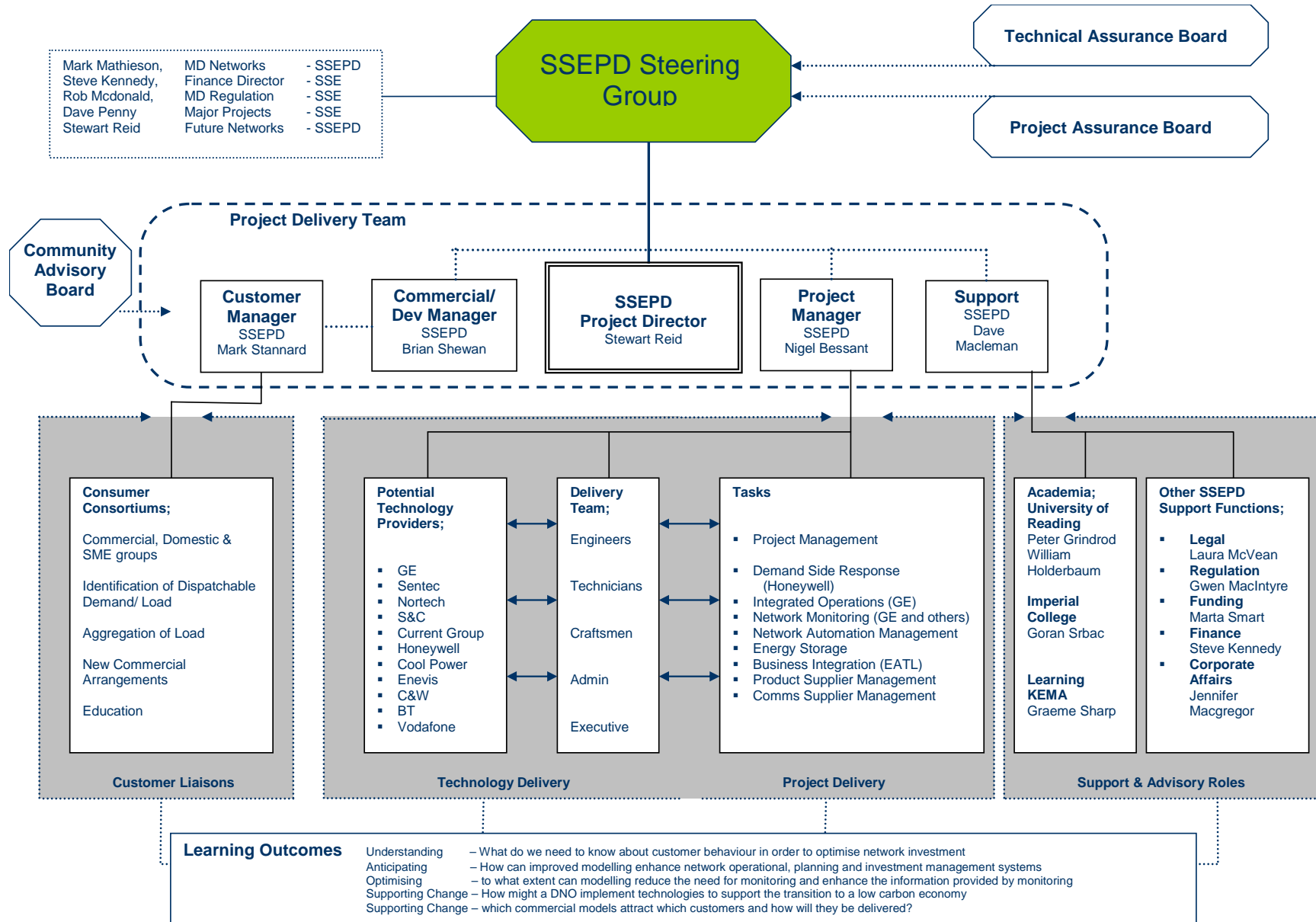
Specific contingency plans have been adopted for all risks with MEDIUM or HIGH residual risk, with HIGH inherent risk, with inherent or residual impacts of category 5 and all risks where the control reduces the score by 30% or more of the maximum. Contingency planning considers three timescales: 1) immediate actions, 2) interim measures and 3) long term recovery.

Naturally, the project plan, risk register and contingency plan are live documents and will continue to evolve as the project progresses. The contingency plan at the time of the bid submission is shown on pages 21-22.

Ref	Risk	Immediate Actions	Interim Measures	Long Term Recovery
R001	<ul style="list-style-type: none"> • PROJECT MANAGEMENT – Resources for Project Management/Delivery • Unavailable of skills, training and locations impact on project management and delivery of ILOs • Residual Impact: 5 Probability: 2 	<ul style="list-style-type: none"> • Obtain short term support via internal secondment; or • Obtain short term support specialist contractor 	<ul style="list-style-type: none"> • Continue short-term support from internal secondment or specialist contractor • Bring less experienced team member in to work along side and begin training process • Identify appropriate training/up-skilling required 	<ul style="list-style-type: none"> • Bring required resource into team by recruitment or by up-skilling existing team
R005	<ul style="list-style-type: none"> • PROJECT MANAGEMENT – Failure of Bid • NTVV not awarded LCNF Tier 2 funding • Residual Impact: 4 Probability: 3 	<ul style="list-style-type: none"> • Inform project partners • Refer to Business Case and review scope of works • Suspend pending orders 	<ul style="list-style-type: none"> • Carry out lessons learnt exercise with project partners • Transfer learning to wider body of DNOs • Modify commercial agreements with project partners 	<ul style="list-style-type: none"> • Continue contribution and assistance with other ongoing LCNF initiatives as appropriate (both within SSEPD and other DNOs) • Identify new opportunities for application of LCNF
R012	<ul style="list-style-type: none"> • PROJECT MANAGEMENT – Loss of critical staff • Loss of critical staff within SSEPD or project partners • Impact: 3 Probability: 3 	<ul style="list-style-type: none"> • Discuss impact and escalate with affected partner organisation and with other partners as appropriate. • Identify tasks which could be placed at risk 	<ul style="list-style-type: none"> • Identify alternative partners if impact is sustained • Assess if task or specific role within task can be supported by SSEPD directly or by other partner • If impact is sustained consider if task can be cancelled without affecting overall deliverable. 	<ul style="list-style-type: none"> • Completion or cancellation of specific tasks - cancellation only with consent from relevant stakeholders
R030	<ul style="list-style-type: none"> • END POINT MONITORING – Cut-out monitor delay • Cut-out monitor devices delayed impacted delivery of subsequent tasks • Residual Impact: 3 Probability: 3 	<ul style="list-style-type: none"> • Assess significance of delay to task delivery and discuss alternative programme phasing with project partners • Trial other tasks using simulated data whilst delay is worked-through 	<ul style="list-style-type: none"> • Review alternative suppliers • Review alternative technologies • confirm hardware specification is appropriate – identify where specification can be widened • Begin redesign of task to consider alternative technologies. 	<ul style="list-style-type: none"> • Implement task to achieve deliverables – though, this may require an alternative technology/design strategy.
R002	<ul style="list-style-type: none"> • PROJECT MANAGEMENT – Technical Rigour • Lack of rigour in approval of technical solutions. • Residual Impact: 5 Probability: 1 	<ul style="list-style-type: none"> • Identify relevant Design Authority and confirm Design Authority has appropriate competency (Where competency is the combination of experience, knowledge and training) • If technical solution cannot be verified or is not forthcoming assess impact on overall delivery of task 	<ul style="list-style-type: none"> • Identify alternative technology vendors/seek specialist support as required • Identify appropriate training/up-skilling required • Assess comparable projects to identify any synergies or crossover 	<ul style="list-style-type: none"> • Implement task to achieve deliverables – though, this may require an alternative technology/design strategy.
R002a	<ul style="list-style-type: none"> • PROJECT MANAGEMENT – Insufficient technical skill • Insufficient skill within SSEPD or project partner. • Residual Impact: 4 Probability: 1 	<ul style="list-style-type: none"> • Triggered by SSEPD or project partner discussion, technical authority sign-off or by defect • Immediately review all work delivered by the affected resource. 	<ul style="list-style-type: none"> • Establish extent of design risks • Identify alternative resource • Develop remedial plan 	<ul style="list-style-type: none"> • Implement task to achieve deliverables

		<ul style="list-style-type: none"> • Suspend all operations with potential safety implication 		
R003	<ul style="list-style-type: none"> • PROJECT MANAGEMENT – Breakup of Partnership • Disagreement, lack of project clarity leads to failure in project partnership • Residual Impact: 4 Probability: 1 	<ul style="list-style-type: none"> • Secure confidential and/or commercial data. Enforce Intellectual Property arrangements • Inform stakeholders and other project partners • Identify remaining common ground and seek continued engagement as appropriate 	<ul style="list-style-type: none"> • Assess impact on specific task and on wider project deliverables. • If appropriate, complete debrief/lessons learnt process with exiting partner • Identify alternative partners as appropriate and required • Assess impact on specific task and on wider project deliverables. 	<ul style="list-style-type: none"> • Completion or cancellation of specific tasks - cancellation only with consent from relevant stakeholders
R035	<ul style="list-style-type: none"> • DOMESTIC AND SME DSR – Domestic DSR Technology • Unproven Domestic DSR technology does not deliver • Residual Impact: 3 Probability: 3 	<ul style="list-style-type: none"> • Triggered by performance trials • Escalate to project partners • Simulate effects of DSR using other deployed battery technology 	<ul style="list-style-type: none"> • Complete peer review of technology to identify potential solutions • Review alternative technologies • Explore long-term application of other simulated technologies (i.e. batteries) 	<ul style="list-style-type: none"> • Record findings for learning outcomes • Mitigate impact on other tasks by implementing DSR simulation
R003a	<ul style="list-style-type: none"> • PROJECT MANAGEMENT – Loss of Technical integration Partner • Partner decides to leave NTVV project and ceases involvement • Residual Impact: 3 Probability: 1 	<ul style="list-style-type: none"> • Agree exit strategy • Secure confidential and/or commercial data. Enforce Intellectual Property arrangements • Inform stakeholders and other project partners 	<ul style="list-style-type: none"> • Revise assessment of alternative suppliers • Assess impact on specific task and on wider project deliverables. • Assess impact on specific task and on wider project deliverables. 	<ul style="list-style-type: none"> • Completion or cancellation of specific tasks - cancellation only with consent from relevant stakeholders
R003c	<ul style="list-style-type: none"> • PROJECT MANAGEMENT – Loss of Modelling Partner • Partner decides to leave NTVV project and ceases involvement • Residual Impact: 3 Probability: 1 			

Appendix C(iv): NTVV Organogram



Appendix C(v): NTVV Roles and Responsibilities

ROLE	RESPONSIBILITY AND ACCOUNTABILITY
SSEPD LCNF STEERING GROUP	<ul style="list-style-type: none"> • Overall responsibility for the delivery of the New Thames Valley Vision Project and other successful bids • Approve and review bids • Approve funding • Regularly review progress • Major problem resolution • Responsibility for project authorisation and approval, achieving the financial model targets
PROJECT BOARD (SEPD, GE, Honeywell, BFC, KEMA EATL, UoR)	<ul style="list-style-type: none"> • Overall accountability for the successful delivery of NTVV • Provision of leadership and direction for the individual project and feedback to the SSEPD LCNF steering group and overall delivery manager • Responsibility for the day to day running of the project • Accountable for project authorisation and approval, achieving the financial model targets • Responsibility for risk management and mitigation • Primary external customer and partner company contact point
PROJECT MANAGER	<ul style="list-style-type: none"> • Provision of leadership and direction for the delivery and partnership teams, GE, Honeywell and sub contractor teams • Delivery of legal documentation for asset transfer, wayleaves and leases for the infrastructure • COST: Responsible for delivering the agreed project scope to or better than budget • PROGRAMME: Monitor performance against programme and achieve key milestones and handover dates • SAFETY: Act as ambassador for the project, promoting a proactive culture at site level. Ensure all documentation is in place and to the requisite standard • QUALITY: Handover of the agreed scope of works, completed to a high standard of workmanship. Monitor and maintain customer satisfaction
CUSTOMER MANAGER	<ul style="list-style-type: none"> • Responsibility for the corporate, SME and domestic consortiums • Responsibility for the project communications strategy • Contact with Bracknell Forest Council, Thames Valley Consumer Consortium and other customer Groups • Contact with energy suppliers • Responsibility for all school and educational events • Responsibility for all media releases
COMMERCIAL/ DEV MANAGER incl Legal and Regulation	<ul style="list-style-type: none"> • Accountable for project authorisation and approval, and achieving the financial model targets • Responsibility for new commercial agreements and incentive payments to customers • Responsibility for communicating and negotiating with the energy suppliers • Providing Legal and Commercial Support to the Delivery Team • Responsibility for Regulation Support to the Delivery Team and Project Board
SUPPORT MANAGER	<ul style="list-style-type: none"> • Learning from trials • Manage Low Carbon Community Advisory Centre • Support services <ul style="list-style-type: none"> ◦ Legal, Regulation, Finance, Corporate Affairs • Academia support • Communications support
DESIGN/ TECHNOLOGY TEAM	<ul style="list-style-type: none"> • Incorporate best practices and new solutions in the design to achieve most economical solutions • Ensure design complies with all relevant statutory and regulatory standards
DELIVERY TEAM	<ul style="list-style-type: none"> • Procurement and coordination of services and interfaces, including resources and documentation to achieve programme delivery • Secure necessary way leaves and consents for project • Manage new connection connections to local utility networks • Provide all testing and commissioning resources • Management of installation of multi utility trench • Customer communication and progress feedback to overall Project Manager

Appendix D: Project partners - Partner Quotes

"The Council was pleased to support Scottish and Southern Energy's original bid to the Low carbon Network Fund and was disappointed that this was not successful. The Council is even more enthusiastic about the even stronger bid that will be submitted in August 2011.

The Council recognises that the Thames Valley Vision's monitor, model and manage methodology will benefit local residents and businesses, while developing "smart grid" solutions for the UK."

– Councillor Chris Turrel, BFC Mayor's Office

"The Honeywell approach is to fully understand the problem before implementing the solution. Technology is simply a means of helping resolve the issues and our focus is to help our Customers reduce their energy consumption, which corresponds with a reduction in their operational costs and has the added benefit of reducing their Carbon Footprint. ADR has the ability to achieve these objectives, without human intervention, once fully operational. Therefore, we are totally focused on supporting the NTVV initiative with SSE and we now have it scheduled as one of our top 5 Projects in the UK"

- Jeremy Eaton, Vice President of Global Energy HBS

"GE is proud to be associated with Scottish and Southern Energy's New Thames Valley Vision project and to be in a position to deploy its products and services and build on our global experience of low carbon and smart grid projects. We believe the project will deliver learning outcomes which are of universal value and which will contribute towards a low carbon future for Great Britain"

- GE Energy, Magued Eldaief, GE Energy, Managing Director, UK

"EA Technology is fully committed to the New Thames Valley Vision project and are proud to support SSEPD with their bid for Low Carbon Networks Funding. We consider the NewTVV project is at the forefront of finding innovative solutions for the future Low Carbon Networks challenges."

– Robert Davis, CEO, EA Technology

"KEMA is proud to be part of the NTVV project as it embodies leading edge solutions that will deliver customer value and facilitate the expedient adoption of low carbon technologies. As such, it is key element of our global innovation activity."

- Thijs Aarten, CEO, KEMA Consulting

"The University of Reading is very proud to be part of this exciting NTVV proposal. We are fully committed to bringing our world class research and enterprise and outreach expertise to the team's efforts, and together we will deliver both radical and innovative outcomes for Ofgem."

- Professor Christine Williams, Pro-Vice-Chancellor (Research and Innovation), University of Reading.

Partner Overview Tables

Organisation Name	General Electric (GE) Digital Energy
Relationship to DNO	None. GE is an existing, legally arms-length supplier to DNO.
Type of Organisation	A diversified infrastructure, finance and media company operating in more than 100 countries. GE products and services provide approximately 18% of UK base power generation and manage the UK's Transmission network and 90% of Distribution networks. GE are included as a technological and global leader in their field and to bring global experience to UK learning.
Role in Project	Lead integration partner, solution designer, and as a provider of products and services. As the leading provider of network management systems and distributed products and services in the UK, GE is uniquely placed to provide expertise to DNO regarding future technologies and future needs of the DNO control room to manage the diverse challenges of a low carbon network. Collaborator will provide some of the products and services required to implement NTVV and will have responsibility to integrate these technologies to deliver the desired learning outcomes.
Prior experience brought to Project	GE has successfully developed and deployed a range of network installed equipment and management systems which currently control the UK's transmission network and 13 of 14 UK distribution networks. Therefore, they have a unique insight into the challenges of all UK DNOs and are proactively addressing these by participating in the project. Collaborators' intellectual capital and global experience will leverage lessons from outside the UK and ensure UK's continued leadership in the sector moving forward.
Funding	GE will contribute £2.7m as benefit in kind to the project, comprising labour, facilities, marketing and discounted products and services.
Contractual relationship	SSEPD & GE have agreed, in principal, high level heads of terms/ terms & conditions contract. This ensures there will be no delay in the start of the project. In addition, SSEPD have contracted the following T1 projects; 1 - SSET1002 - Chalvey Monitoring 2 - SSET1005 - Modelling Environment
External Collaborator benefits from the Project	GE will benefit from the project as: (i) LCNF projects are integral to UK's Smart Grid roadmap and accelerated technology adoption, (ii) learning outcomes will drive national adoption of technologies, (iii) LCNF is leveraged as an exemplar of regulatory incentives across Europe, and (iv) LCNF positions UK as the thought leader in the low carbon networks domain.

Organisation Name	Honeywell Control Systems
Relationship to DNO	None. Ultimate owner: Honeywell Inc.
Type of Organisation	A \$31bn turnover, 122,000 employee, Fortune 100 company that invents and manufactures technologies and deliver related services to address tough energy challenges across the globe. An expert in improving energy efficiency in building, servicing electricity network operators by its unique DR and BMS technologies to design and implement programmes to support them with their peak load reduction efforts across all customer segments: industrial, commercial and residential
Role in Project	This capability will be a key element in NTVV by providing the technology link between the network operator and the commercial customers. To defer network reinforcement investment and manage capacity Honeywell will tie the building management systems across a range of commercial buildings connected to the network, to demand response technology. On notification that the network is approaching peak (an 'event') Honeywell's technology will dynamically reduce electricity demand by adjusting settings on equipment in the buildings such as air conditioning and lighting. Honeywell will also work with the building owners to devise suitable shedding strategies that will not impact productivity.
Prior experience brought to Project	Honeywell has designed and implemented demand response programmes with US Network operators to support them with their peak load reduction efforts. Recently the US Department of Energy selected only one company, Honeywell, to implement Automated Demand Response as part of the highly competitive Smart Grid Investment Grant evaluation in 2009. This programme is running with Southern California Edison (SCE).
Funding	To include sales support (labour) to encourage customers to connect their buildings to the smart grid, technical support to audit buildings and devise suitable load shedding strategies and provision of DR software to control and manage the DR programme. Honeywell will also provide the labour to implement, test and pilot the system. Funding £682k.
Contractual relationship	SSEPD & GE have agreed, in principal, high level heads of terms/ terms & conditions contract. This ensures there will be no delay in the start of the project. In addition, SSEPD have contracted the following T1 projects; 1 - SSET1004 - I&C ADR Trial
External Collaborator benefits from the Project	The Project will enable Honeywell to establish an operating demand response reference from which to expand its business in the UK and Europe.

Organisation Name	University of Reading
Relationship to DNO	None
Type of Organisation	Academic Organisation. The NTVV project is engaging the Department of Mathematics and Statistics, an internationally renowned faculty for both teaching and research in mathematics, statistics and their applications. The department is part of the larger School of Mathematical and Physical Sciences, which includes a world leading meteorology department and several national research centres.
Role in Project	The University will be involved in three tasks for the project: Task 1: Individual household demand characterisation typology. Task 2: Aggregation and integration of short term, medium term and long term demand forecasts Task 3: Smart control algorithms for storage and flexible demand that can utilise the forecasting data from Task 2 to optimise performance. Feedback into the forecasting models to incorporate the consequences of deploying different storage or demand response options under smart control
Prior experience brought to Project	The University has already performed preliminary analysis in its collaboration with SSEPD in the EDRP trials. The research will be headed by Professor Peter Grindrod CBE who has substantial experience working with and providing modelling solutions to many industrial partners.
Funding	Reading University will be providing funding for administration support and for a post-doctoral researcher summing to £575k (£115K each year for 5 years).
Contractual relationship	SSEPD & GE have agreed, in principal, high level heads of terms/ terms & conditions contract. This ensures there will be no delay in the start of the project. In addition, SSEPD have contracted the following IFI project; - Smart Analytics IFI - 2011_01
External Collaborator benefits from the Project	The project will help to develop industrial contacts for the University and will enhance the research and status of the University. In particular the project will improve research in the area of industrial applications which is a current priority for the University.

Organisation Name	KEMA Consulting
Relationship to DNO	None
Type of Organisation	KEMA is a global company specialising in strategic and technical energy consulting, operational support, measurements and inspection, and testing and certification. Keeping a close eye on innovation and industry trends, KEMA is actively involved in helping clients address climate change issues through innovative technologies, strategies and solutions.
Role in Project	KEMA will provide the key role of independent technical assurance of the vendor-provided solutions to be utilised in the project. KEMA will also provide technical assistance to the consideration of the deployment of new technologies in clusters and volumes not previously conducted on the network. KEMA will also provide strategic insight and knowledge of technical developments from around the world to inform the project; and utilise their global networks to disseminate the learning from the project.
Prior experience brought to Project	KEMA is actively engaged in smart grid technology development and deployment projects around the world. Recent examples include the Power Matching City project in The Netherlands, the EU ADDRESS project, and smart grid analysis and development for New York Smart Grid Consortium. KEMA has already partnered in the USA with Duke Power to establish a smart grids 'Envision' Centre in Cincinnati.
Funding	KEMA is providing a financial commitment to the project in the order of £60,000
Contractual relationship	SSEPD & GE have agreed, in principal, high level heads of terms/ terms & conditions contract. This ensures there will be no delay in the start of the project.
External Collaborator benefits from the Project	KEMA expects to take learning from the project which KEMA will be able to utilise and promote to other KEMA clients – both in the UK (where we are engaged on national developments) and across Europe and internationally where KEMA is also active.

Organisation Name	EA Technology Ltd
Relationship to DNO	None
Type of Organisation	<p>An employee-owned SME, offering end-to-end technical services and products to meet the needs of operators of power networks around the world.</p> <p>Established in the 1960s to focus on electricity distribution and use, today they work with clients in the electricity, utilities, infrastructure and associated sectors, delivering responses to the challenges they face. EA Technology's strategy for sustainable growth is centred on contributing real value to our customers, shareholders and wider society.</p>
Role in Project	<p>Knowledge transfer into UK DNO business as usual including the delivery of new policy documents and supporting strategies for DNOs – potentially inputting to National or International Standards, and the development of training materials.</p> <p>A supporting role in the management and oversight of the project reviewing live projects to maximise the learning opportunities of these or future projects; supporting the dissemination of results across the electricity distribution sector.</p>
Prior experience brought to Project	<p>Extensive knowledge of distribution networks, micro-generation, heat pumps and demand-side management. It has broad experience of practical trials and experience including: facilitation and co-ordination of technology trials, demand side management, integration of system studies, provision of monitoring, communicating, policy writing, provision of training.</p> <p>EA Technology is a strategic partner to CE Electric UK in the development and delivery of the Customer-led Network Revolution.</p>
Funding	In line with actual in-kind support provided to CE Electric UK in the CLNR, EA Technology will provide in-kind support valued up to £150k over the duration of NTVV.
Contractual relationship	SSEPD & GE have agreed, in principal, high level heads of terms/ terms & conditions contract. This ensures there will be no delay in the start of the project.
External Collaborator benefits from the Project	EA Technology's involvement in the project will primarily be a contractual relationship. However, it is recognised that this is likely to deliver other secondary benefits such as new product development: Identifying market opportunities in areas of instrument or service development; Delivery of skills: identifying and developing new areas of vocational and higher education training courses; Relationships: building on the activity with SSEPD and looking to new opportunities and projects with collaborative partners.

Organisation Name	Bracknell Forest Council
Relationship to DNO	None
Type of Organisation	Local Government Authority responsible for the delivery of the vast majority of public services for the borough of Bracknell Forest.
Role in Project	<p>The Council will champion the merits of the project in its role as a community leader to businesses, residents and voluntary organisations within the borough. It will also act as a facilitator to ensure constructive dialogue between the DNO and key stakeholders.</p> <p>The Council also directly operates and commissions services which consume large quantities of energy and there is the potential for it to lead by example in how it generates and manages its energy consumption.</p>
Prior experience brought to Project	<p>The Council has significant and proven experience in communicating with the various communities within Bracknell Forest and as the recognised community leader it is able to influence the actions of significant stakeholders. The Council is required to report to Central Government on various indicators relating to a low carbon economy and is expected to take action to create a low carbon community. Consequently, it can be expected to put measures in place which encourage a change in consumer behaviour as well as developing appropriate regulation which could support the project objectives.</p> <p>As a major consumer of energy, any relevant changes to the Council's own behaviour will serve to promote NTVV's objectives.</p>
Funding	The project will benefit from the intellectual and practical contribution from Council senior officers and elected Members. These include the Director of Environment, Culture and Communities, the Mayor of the Borough of Bracknell Forest and the Executive Member for the Environment. A nominal value would be c£10k /annum (totalling £50k).
Contractual relationship	<p>Confidentiality Agreement signed along letter of support for the NTVV project.</p> <p>In addition BFC are actively participating in a number of projects.</p>
External Collaborator benefits from the Project	<p>Inclusion in the project enables the Council to further its own objectives for itself as an organisation and its community, described in its climate change action plan which include objectives related to reducing CO₂ emissions, fuel poverty, engagement with stakeholders and community leadership.</p> <p>It is anticipated that NTVV will inform the Council about how to best plan for its future energy production and consumption.</p>

Appendix E: Detail on the Project Business Case

Below are the key elements that have been used in developing the project business case, as used for the Evaluation Criteria (Sections 4(a) and 4(b)) and the SSEPD business case (Section 3). Further information in our NTVV Project Document – available to Ofgem and its agents on request.

E.1 Predicting the installed capacity of the LCTs

The starting point for the data is the numbers quoted by CE Electric UK in the Customer Led Network Revolution bid document Appendix 6: Business Case (which describes the carbon emission savings from that project). These are conservative estimates, based where possible on more than one published data from DECC, the Environment Agency, DEFRA and the Office for National Statistics (data used by permission of CE Electric UK).

Since CE Electric UK produced these figures, data has been published on the number of connections reported under the Feed in Tariff scheme. Also the Committee on Climate Change has published a report on 'Achieving deployment of renewable heat'². This study considered the effect of the delay in the Renewable Heat incentive and supply-side growth constraints for heat pumps.

The CE Electric UK predictions for PV did not show any installations prior to 2015. The number of actual reported PV connections to date and the current rate of growth of connections suggest that the number of installations in 2015 predicted in that model will be reached in 2013. We believe that this effect is due to the initial high rate of FiT and that the rate of installation will fall back to the predicted rates once the rate is reduced. Therefore we have moved forward by two years the number of connections predicted for each year and estimated the number of connections in 2011 and 2012 but have not otherwise changed the rate of uptake.

BISRA has reported the installed base of heat pumps as at 2009. This number is slightly higher than the figure given by CE Electric UK for 2009. The report on 'Achieving deployment of renewable heat'² gives maximum achievable growth rates for sales of heat pumps. Using these data and working from the BISRA figure, results in a slower growth in installed numbers of heat pumps between 2011 and 2018 but a faster growth after 2020 than the figures provided by CE Electric UK. In addition, the report provides an assessment of the impact of the delay in the renewable heat incentive. The conclusions state that 'each years delay leads to a 17% reduction in the amount of renewable heat generated by 2020'. We have therefore delayed the growth rates in the sales of heat pumps by one year but assumed a growth of 20% in 2011. This gives a 23% reduction in the predicted amount of renewable heat generated in 2020. In view of the level of uncertainty in these predictions we believe that it is unnecessary to increase the time resolution of our model to months rather than years in order to get closer to the 17% figure quoted in the report.

The installed numbers of Photovoltaic Generators, Heat Pumps and Electric Vehicles that are predicted using these assumptions are detailed in our Project Document.

E.2 Relevance to UK – scaling factors

This project focuses on networks in Urban, Sub-urban and Semi-rural areas, therefore the findings of this project will be applicable these types of areas across GB. We will not be including interconnected urban LV networks and networks in fully rural areas in the project, therefore the findings might not be directly relevant to these networks, although the techniques probably could be applied, albeit with different network modelling. We have scaled the results of our analysis to all of GB using the number of publically

²hmccc.s3.amazonaws.com/Renewables%20Review/CCC%20Renewable%20Heat%20-%20final%20report_06.05.11.pdf

available information on UK DNO LV feeders in the areas across GB where the learning is applicable.

We estimated the applicability of this project to GB using scaling factors based on LV feeder length:

- o We calculated the length of the representative LV network by assuming that on average 10% of the Rural network is Underground.
- o The length of the LV network in Urban, Sub-urban and Semi-rural networks for each licence area is therefore given by $L = L_{uglv} - L_{ohlv} \times (1 / 90\% - 1)$
- o Where L_{uglv} is the published length of the underground LV network for the licence area and L_{ohlv} is the published length of the overhead LV network for the licence area
- o We have estimated the percentage of LV network of each licence which is comparable to the LV networks which are explored in this project as follows:
 - o LPN: 0% (interconnected network)
 - o SP Manweb: 30% (70% interconnected, 30% radial)
 - o Others (including Southern Electric): 90% (there will be a relatively small number of unusual configurations)
- o This technique gives a weighted average of **65.195%** applicable to UK networks

E.3 Potential carbon contribution from roll-out of each method

The total potential carbon contribution from roll-out of the methods in this project is calculated to be **34,000,000 tonnes CO_{2e}**.

We have used a similar methodology to estimating potential carbon contribution to that followed by CE Electric in their 2010 Customer Led Network Revolution project bid. In essence this approach assumes that project success alone cannot bring about acceptance and use of LCTs. Rather the project can remove barriers that would delay the projected uptake of the LCTs that are considered by the project. Therefore the carbon case is based on the change in overall carbon emitted as a consequence of the project outcomes removing a delay in the implementation of PV, HP and EVs.

For each technology a comparison is made of for the number of installations across the UK based on current predictions against the number which would be made if network constraints delay the roll-out of these technologies. The difference in installed base for each year gives a carbon benefit in each year as a result of this project. This is scaled by 65%, representing the applicability of our project's outcomes to GB (as described in E.2). Aggregating across all of the technologies considered, over all of the years considered, yields a total carbon benefit for each method. For the CO₂ impact of a PV generator we have used the electricity emission factors for 2009³ and assumed a heat pump produces 700 kWh/kW pa⁴. We have assumed the carbon saving per LCT per year shown in the table below.

Low carbon technology	kgCO₂ per LCT per annum
Electric Vehicle ⁵	637
Heat Pump ⁵	506
PV generator ⁶	784

³ 2011 Guidelines to Defra/DECC's GHG Conversion Factors for Company Reporting

⁴ Strategic Technology Programme Report S5198_3

⁵ LCNF Tier2 bid document 'Customer Led Network Revolution' optional appendix 6.

⁶ For the CO₂ impact of a PV generator we have used the electricity emission factors for 2009³ and assumed a heat pump produces 700 kWh /kW pa⁴

Better understanding of customers and management of the LV network will reduce barriers created by the LV network and will help to reduce barriers created by the HV network, whilst demand management of commercial customers will further reduce barriers created by the HV network. These methods are therefore complementary and will lead to the achievement of the same level of carbon saving.

We have conservatively assumed that the learning from this project, if applied across GB, would bring the roll-out of the LCTs forward by one year. We have applied the same factor of applicability as has been applied to the financial benefits. The projected figures for roll-out and the CO₂ savings that would be made if this occurred are available in our Project Document. This results in an overall carbon benefit from these methods of **34,000,000 tonnes CO_{2e}**.

We have calculated the carbon benefits from the tactical deployment of energy storage as follows:

- o Estimated the aggregate time that generators connected to the part of the feeder which is above voltage limits (close to the feeder source) are tripped out, during a three month period.
- o Multiplied this time by the power output and number of affected generators connected to the feeder to obtain an estimate of the energy production which would be enabled by the deployment of energy storage
- o Multiplied this energy by the electricity emission factors for 2009 to obtain the carbon benefit for each generator
- o Estimated the number of generators that are likely to be affected per feeder

Our modelling indicates that 0.72% of feeders will require an intervention to avoid tripping of PV generators within 10 years. We assume that the proportion of feeders requiring this approach will fall over time, as planning processes improve. We have represented this by a straight line decrease in benefit to zero over time. This results in a carbon benefit of **2,504 tonnes CO_{2e}**. We recognise that such a benefit is marginal at a GB scale; the real benefit of this method is in improved customer service and public opinion of LC technologies by reducing / avoiding unnecessary generator tripping.

Summary of GB financial benefits

Item	Costs £m			Benefit £m	Comment
	Novel Method	Novel Reinforced	Conventional		
Total	£ 580	£ 8,699	£ 14,058	£ 4,952	
Method 1 Better Understanding of Customers	£ 529	£ 7,498	£ 12,572	£ 4,545	
Deferred & Avoided LV reinforcement to accommodate PV	£ 138	£1,571	£1,775	£66	40% of applicable networks
Deferred & Avoided LV reinforcement to accommodate HP & EV	£ 391	£4,569	£8,578	£3,617	60% of applicable networks
Total deferred & avoided LV reinforcement	£ 529	£ 6,140	£ 10,353	£ 3,684	
Deferred & Avoided Primary Substation Replacement	£ -	£ 1,358	£ 2,219	£ 861	
Method 2 Demand Management of Commercial Customers					
Deferred & Avoided Primary Substation Replacement	£ 51	£ 1,199	£ 1,486	£ 237	Assumed that method 1 has
Method 3 Reduced Monitoring of LV feeders					
Monitoring of LV feeders	£ 112		£ 280	£ 168	Note that the cost of monitoring is included in the costs of r
Method 4 Tactical deployment of battery storage					
Value of avoiding lost FiT payments		£ 2.31		£ 2.31	Note that the cost of battery costs of method 1

E.4 Methodology used to estimate the capital cost savings for deferred or avoided LV feeder reinforcement by managing the network with a better understanding of electricity consumers (related to Method 1)

The network capital cost savings that will be delivered to the consumer across GB have been calculated by comparing the cost of conventional reinforcement with the cost of employing monitoring and modelling to create a more accurate view of true network capacity. This will enable a more rapid roll-out of Low-Carbon technologies (Photo-voltaic

generators, heat pumps and electric vehicles) (hereafter referred to as PV, HP and EV; collectively as LCT).

Estimates have been made of the headroom of the population of LV feeders, in terms of:

- o The difference between statutory upper voltage limits and voltage on the LV side of secondary substations without PV connections (such headroom available to accommodate the connection of PV);
- o The remaining thermal headroom on LV feeders (as this is the limiting factor for connection of HP and EV).

The range of voltage headroom of LV feeders, using conventional wisdom, has been expressed in terms of the numbers of PV that can be accommodated on the population of LV feeders. The remaining thermal headroom has similarly been estimated in terms of the numbers of HP and EV using conventional wisdom.

We have estimated the numbers of connections of PV, HP and EV between 2017 and 2050 from authoritative published sources (see section E.1). We have assumed that clustering of these technologies will occur, because those who purchase the technologies will be influenced by their friends and neighbours, and different social groups will adopt the technologies at different rates. This clustering causes problems on the network significantly earlier than if the LCTs were distributed evenly. The extent to which installations cluster has been estimated using the 'Feed-in Tariff Installation Report 30 June 2011' provided by Ofgem. This provides the first few digits of post code for each installation. This data has been used to calculate how rapidly five different groups will adopt the LCTs. We believe that our model understates the extent of clustering because even within areas of high penetration some feeders will have few LCTs and some above average. It is also known that voltage limits are being reached in places while the model does not predict it happening for some years indicating that this method is conservative.

Where the numbers of PV/amount of additional load that could be expected to be installed on a feeder exceed the numbers of the LCT/additional load that can be accommodated on the feeder, using conventional wisdom, then intervention is indicated. We have considered two types of intervention:

- 1) Conventional reinforcement
- 2) Application of the true network capacity, as indicated by the understanding and forecasting of consumer demand and management methods which will be demonstrated in this project. In essence, the monitoring and modelling method reveals the capacity of the installed network that is not visible using conventional planning rules. In addition increasing network headroom by use of electrical and thermal energy storage and by using targeted marketing messages to influence specific customer groups to alter demand patterns to provide additional headroom.

The cost of these interventions have been calculated and expressed as a cost per feeder. These costs have been extrapolated to GB as described in section E.2.

We have modelled the impact of PV separately from the impact of HP and EV. This is justified because of differences in the coincidence of the technologies: PV tend to cause problems of increased voltage around midday; whereas HP and EVs tend to cause increases in feeder currents around the time of the existing system peak.

We have assumed clustering of PV, HP and EV is the same as has been experienced for PVs in the first year of the FiT. To model this clustering we have divided the customers into 5 broad types by propensity to install a LCT. The voltage or thermal headroom of LV feeders is reached earlier than it will be if the relevant novel method is applied. The financial benefit of the project therefore mostly results from deferral of reinforcement, although in some cases the modelling indicates that the methods remove the need for reinforcement in the period to 2050.

It is likely that a significant number of LV feeders will have HP and EV connections in addition to PV connections. Our modelling shows that for 60% of the network, assuming

the projected rates of installation of PV, HP and EV. These LV feeders can benefit for some time from a novel intervention to manage power, but a conventional reinforcement is required before the voltage headroom is reached.

These feeders will benefit from methods to facilitate the connection of HP and EV by changing the load profile of these loads. Our modelling has shown that, assuming 50% of EV customers and 75% of HP customers can be engaged and deliver profiles given in the report on the Network benefit of Smart Meters⁷, the cost of applying the method to 60% of applicable GB LV feeders is £4.96bn compared with a conventional reinforcement cost for the feeders of £8.58bn.

We have not assumed any benefit from this project resulting from the novel methods to facilitate the connection of PV to 60% of the network where significant clustering of HP and EV occurs. However, our modelling shows that LV feeders, which supply customers in the group that is slowest to take up PV, HP and EV, can benefit from novel methods to manage voltage limits before conventional reinforcement is required. These feeders do contribute to the financial benefits of this project. They comprise some 40% of applicable GB LV feeders in urban, sub-urban and semi-rural areas. Our modelling reveals that the cost of applying the method to these feeders is £1.71bn compared with a conventional reinforcement cost of £1.78bn providing a net financial benefit to GB of £66m. There is a larger benefit associated with these feeders because the penetration rates of HP and EV are lower than PV and therefore fewer feeder reinforcements are required.

Hence the total cost of applying this method to applicable LV feeders across GB would be £6.67bn = £4.96bn + £1.7bn compared to a the cost of conventional reinforcement of the feeders of £10.35bn = £8.58bn + £1.78bn, resulting in a financial benefit of **£3.68bn**

There will also benefit from the reduction in peak load on primary transformers, with a cost of £1.36bn compared to the cost of conventional reinforcement of £2.22bn resulting in a net financial benefit of **£0.86bn**.

Hence the aggregate benefit is £3.68bn + £0.86bn = **£4.55bn**.

This project does not aim to directly interact with customers of HP and EV, however the customer analysis will reveal the characteristics of customers that would be more likely to accept influence and control of their HP and EV in order to reduce the network cost of supply of their electricity. We are aware that other LCNF projects aim to have wide scale customer engagement. We hope to transfer this element of learning from this project to these projects, in order to test the extent to which this method can deliver benefits. The financial benefit from this project which relates to HP and EV is therefore dependent on transfer of learning to these projects.

⁷ <http://www.cts.cv.ic.ac.uk/documents/publications/iccts01392.pdf>

E.5 Financial benefit associated with demand management of commercial customers (related to Method 2)

We have calculated the financial benefit of increased headroom on Primary transformers by this method as follows:

- o A three-year average of electricity consumptions for the years 2007-2010 shows industrial 32%; commercial 32%; domestic 36%⁸
- o Assuming that all industrial load is fed at EHV, the commercial load is 47% of combined domestic and commercial load of 11kV and below
- o 75% of HP loads and 50% of EV loads are controlled using the method considered above
- o Typically 10% of commercial load (of those organisations with Building Management Systems) is controllable on demand⁹
- o Assume that 60% of commercial customers can be effectively engaged

We have drawn on the experience of Honeywell to estimate the cost per commercial customer.

For comparison of both this method and the previous method with conventional reinforcement costs for primary substations our modelling assumed upgrade of a primary substation would include replacement of both transformers, two 33kV circuit breakers, and 11kV circuit breakers for each HV feeder plus three. Assuming 10 feeders is typical this represents a cost (using DPCR5 unit costs) of £1,647,200 per Primary substation.

Our modelling shows an additional financial benefit (above that which is created by the reduction in peak load at LV considered above) of **£237m** resulting from the difference between conventional reinforcement of £1.49bn and the cost of the method of £1.25bn.

E.6 Tripping of PV (related to Method 4)

G83 requires that a generator must stay off until the voltage and frequency have remained within the limits for a minimum of three minutes. There will be some diversity (probably of the order of seconds) in this time, but shortly after the three minute period there would be another overvoltage event and generation would trip. We have assumed that the connected period is very small compared to the disconnected period and can be ignored.

Tripping is likely to occur around midday when the output from the generators is greatest and the load is lowest. We have assumed that the PV generators do not generate for a period of 2 hours per day for 50% of the days in a three month period.

Using the same assumptions as we used for calculating the carbon benefit of this method, our analysis shows a benefit to consumers from avoiding loss of Feed in Tariff earnings of **£2.3m**. The cost to DNOs is likely to be higher than this, but our modelling shows that there would be no net cost to GB if the installed cost of feeder storage units for this purpose can be reduced to £4,500. The power and energy requirements for this purpose is a small fraction of typical LV network values and we aim to assess in this project the extent to which this value can be approached.

⁸ DUKES 2010, DECC website July 2011

⁹ This would be increased if customers had thermal energy storage (hence its inclusion in NTVV)

Appendix F: Detail on the Changes to the Distribution Charging Methodology & International Learning (including customer engagement)

User cases and budget for NTVV Incentive Fund

Demand-side response from HV half hourly demand (HV customer(s))

An office building where it is sensible to install or upgrade an intelligent building management system. The natural consumption pattern involves substantial consumption with something like 70 per cent of capacity during the red time band.

The effect of installing a new building management system will be to reduce consumption in red, at least in the winter, to avoid high energy prices. Therefore there will be a significant reduction in DUoS income from the site, even if no demand-side response for distribution;

Demand-side response for local distribution will take the form of:

- (a) A planned request, somewhere between a few minutes and a few days in advance, to reduce consumption at the time where the primary substation is close to its peak load. This could avoid reinforcement of the primary substation and of the 33kV network feeding it, whilst maintaining N-1 resilience;
- (b) The CDCM's time of day charging structure might already reflect the benefits to the network of reduced consumption at the time where higher-level substations are close to their peak load. If the red time band corresponded precisely to times where the primary station is near its peak load, and if primary substation costs were charged on unit rates, then there would be no need to pay any rewards;
- (c) In the case of an HV demand customer, primary substation costs are not charged on unit rates: they are taken on capacity charges. In SEPD CDCM model, the contribution of the primary substation and the 33kV feeders to the HV HH tariff is about 1.8 p/kVA/day (out of a total capacity charge of 4.8p/kVA/day);

The reward structure we will test is as follows:

- (a) Rebate the 1.8p/kVA/day on capacity that is declared to be capable of being removed on request.
- (b) Charge a premium unit rate in the event that there is consumption above the requested level at times where SEPD expects the substation to be close to its maximum load. The premium rate would have to be based on the number of hours in which such exceedances might be considered acceptable — for example 6 hours of non compliance in a year would imply a premium unit rate for non-compliant consumption of 110p/kWh.
- (c) For a 1 MVA customer, such a rebate would be worth £6,600 a year. For about 5 MVA of HV demand (an estimate of the maximum that might participate in a scheme as outlined above) it will amount to approximately £33,000 a year;
- (d) While there may be some customers who will fail to act and incur the premium rate, for budget purposes it seems prudent to assume compliance;
- (e) In addition to this, a further benefit of demand-side response might be the ability to influence load in cases where the time of peak on 33kV and above networks does not coincide with the red time band. Given the nature of loads in Bracknell, this is not likely to be a major consideration, and therefore not included to the HV budget.

Demand-side response from LV half hourly demand

For LV half hourly demand, the two factors we will consider are:

- (a) In respect of the HV/LV transformation and 20 per cent of the costs of HV circuits and in some rare cases some LV circuit costs, when consumption by a large LV customer is contributing a voltage drop on a shared LV feeder, the same logic as for HV demand and primary substation will be used. Coincidentally, this is worth about 1.8p/kVA/day (£6.6/kVA/year), as with HV.
- (b) In respect of the primary substation level and above, there might be a benefit of demand-side response in influence loads in cases where the time of peak at the relevant primary substation and above does not coincide with the red time band.

The HV/LV transformation benefit only applies if the HV/LV transformer is properly shared between the half-hourly user and other users, rather than dominated by one side or the other. An estimate of 5 MVA of LV half hourly demand might participate in a scheme as outlined above, which amounts to approximately £33,300 a year for the HV/LV transformation and associated costs.

The ability to retime LV half hourly demand to suit the primary substation and above network levels is a more significant factor than the HV equivalent, since primary substations have more varied load patterns than bulk supply points (especially if you expect new electric car or electric heating loads to develop). So perhaps for a fraction of the LV half hourly customers there is a further reward equivalent to a further £8/kW/year for primary substation load management, the figure is higher than for HV because it is based on simultaneous demand rather than the aggregate maximum demand that underpins HV capacity charges. It is difficult to ascertain much load shedding at that level can be achieved from LV half hourly demand in Bracknell but we have assumed 2 MVA, giving about £13,300 a year.

Demand-side response from small LV demand

A domestic customer with a lot of teleswitched electric load (e.g. electric heating and car charging) might perhaps offer 2kVA of demand reduction on average. That would assume an annual consumption of the order of 20,000 kWh (2.3 kW average — some of the loads are not teleswitchable). On profile class 1 SEPD's CDCM annual distribution use of system charge for such a property is about £400. We believe a £300 annual reward for demand-side response in these circumstances appears a reasonably strong incentive to encourage active customer participation.

Out of 1,000 customers with smart meters in the project, only some will be able to offer this level of teleswitched load. Let's assume 350 of the 1,000 customers. This gives £105,000 a year.

Total budget

The above estimates for HV and LV demand amounts to some £229,000 a year. We believe that incentive payments will build up to the above sum over the lifetime of this project. We have therefore budgeted £503,000 to fund the incentive and reward for this project.

Customer	2012/13	2013/14	2014/15	2015/16	2016/17	Total
HV £	6,600	9,900	13,200	19,800	33,000	82,500
LV £	6,600	20,000	33,300	40,000	46,000	149,900
Domestic (£'s)	6,000	45,000	52,000	66,000	105,000	274,000
Reward (£s)	19,200	74,900	98,500	125,800	184,000	502,400

International Demand Response Experience

North American Demand Response Programs;

The United States Office of Electricity Delivery and Energy Reliability's (OE) mission includes assisting states and regions throughout the US to develop policies that decrease demand on existing energy infrastructure. Appropriate cost-effective demand response programs are included in achieving that goal and appropriate demand response programs have been developed over the last 11 years.

Demand response programs have been established for many years in North America to motivate changes in electricity use by end-use customers in response to changes in the price of electricity over time, or to give incentive payments designed to induce lower electricity use at times of high-market prices or when grid reliability is jeopardized.

Price-based demand response programs such as real-time pricing (RTP), critical peak pricing (CPP) and time-of-use (TOU) tariffs, charge customers time-varying rates that reflect the value and cost of electricity in different time periods. Consumers who have access to the electricity rates they are paying, tend to use less electricity when electricity prices are high.

Incentive-based demand response programs pay participating customers to reduce their loads at times requested by the program sponsor, triggered either by a grid reliability problem or high electricity rates.

The table below provides an overview of the most commonly deployed demand response programs in the United States. Typically, utilities offer their customers a variety of options based on their consumption patterns.

Demand Response Options	
Price-Based Options	Incentive-Based Programs
<p>Time of Use (TOU): a rate with different unit prices for usage during different blocks of time, usually defined for a 24 hour day. TOU rates reflect the average cost of generating and delivering power during those time periods.</p> <p>Real-time Pricing (RTP): a rate in which the price for electricity typically fluctuates hourly reflecting changes in the wholesale price of electricity. Customers are typically notified of RTP prices on a day-ahead or hour-ahead basis.</p> <p>Critical Peak Pricing (CPP): CPP rates are a hybrid of the TOU and RTP design. The basis rate structure is TOU. However, provision is made for replacing the normal peak price with a much higher CPP event price under specified trigger conditions <i>(e.g. when system reliability is compromised or supply prices are very high)</i></p>	<p>Direct Load Control: a program by which the program operator remotely shuts down or cycles a customer's electrical equipment (e.g. air conditioner, water heater) on short notice. Direct load control programs are primarily offered to residential or small commercial customers</p> <p>Interruptible/Curtailable (I/C) Service: curtailment options integrated into retail tariffs that provide a rate discount or bill credit for agreeing to reduce load during system contingencies. Penalties may be assessed for failure to curtail. Interruptible programs have traditionally been offered only to the largest industrial (or commercial) customers</p> <p>Demand Bidding/Buyback Programs: customers offer bids to curtail based on wholesale electricity market prices or an equivalent. Mainly offered to large customers (1MW and over)</p> <p>Emergency Demand Response Programs: programs that provide incentive payments to customers for load reductions during periods when reserve shortfalls arise.</p> <p>Capacity Market Programs: customers offer load curtailments as system capacity to replace conventional generation or delivery resources. Customers typically receive day-of notice of events. Incentives usually consist of up-front reservation payments, and face penalties for failure to curtail when called upon to do so.</p> <p>Ancillary Services Market Programs: customers bid load curtailments in ISO/RTO markets as operating reserves. If their bids are accepted, they are paid the market price for committing to be on standby. If their load curtailments are needed, they are called by the ISO/RTO, and may be paid the spot market energy price.</p>

Source: U.S. Department of Energy

US Congress Support for Demand Response

A reason Demand Response programs have developed in the US is due to Congress passing the American Recovery and Reinvestment Act of 2009 (Recovery Act) under which DOE awarded \$4 billion to stimulate development of the smart grid, including a substantial number of projects deploying some type of demand response.

Appendix G: Key learning from Relevant T1 and IFI Projects

NTVV is a key in realising the benefits of SSEPD's portfolio of Tier 1 and IFI projects. Below are the projects that are in progress (or in planning) that will feed into NTVV.

IFI Projects

SSE 2011_10 - Smart Analytics (with University of Reading)

Linkage to NTVV

- A reduction in the level of risk in the project as the concepts of customer classification and forecasting will have been proven
- No lead time required detailed research in this area

Key learning to date

- It is possible to classify customers into types according to energy demand
- Forecasting techniques to model customer behaviour over the short term

SSE 2010_13 - Supply Point Monitoring (with Senecal)

Linkage to NTVV

- The provision of a temporary device, an alternative to smart meters, for measuring domestic consumption

Key learning to date

- A prototype monitor will be produced by the end of 2011 and ready for deployment by middle of 2012.

SSE 2011_03 LV Connected Batteries (with S&C)

Linkage to NTVV

- Demonstrates an initial installation of three, single-phase battery units, focussing on technical functionality; the physical site installation requirements and; the extent to which battery units can reduce both peak demand and peak generation.
- This will significantly de-risk the larger rollout of electrical energy storage planned for NTVV.

Key learning to date

- Insight of how the battery units could provide volt / VAr support to the network
- An understanding of the site installation works and the connection arrangement, including communications and control systems requirements
- Learning from the Tier 1 monitoring project on the re-active power flows which will inform the operation of the volt / VAr support

LCNF Tier 1 Projects

SSET002 - Chalvey Slough Monitoring Project (with GE Digital Electric /Current Group /Sentec /Nortech)

Linkage to NTVV

Demonstration that accurate network monitoring devices can be deployed without having to disconnect customers.

Key learning to date

Four companies have a product to fit to distribution substation and cable cores without requiring customer interruptions:

- GE Digital Electric – already fitted, now awaiting for first results;
- Current Group - already fitted and results are now showing unexpected concerns to the network operators, including very poor power factor due to PV arrays feeding generation onto the network cables. This has led SSEPD to carry out further studies with battery storage to balance the reactive power flow (non-productive power);

- Sentec - sensors available and waiting to be fitted
- Nortech - equipment available and waiting to be fitted.

SSET1004 - Automated Demand Response (with Honeywell)

Linkage to NTVV

De-risks the deployment of the building management solutions with commercial customers

Key learning to date

- The load control systems are functional and have acted upon a load shedding 'event'.
- On the 15th August 2011 @ 7:15, the project team initiated a load shedding event at Honeywell's Bracknell Head Office, for 1 hour.
- First, the Auto DR system gave advanced notification to test the 'opt out' facility.
- As soon as the Load Shedding Programme was initiated, the kW load decreased, as the HVAC systems are switched off.
- Once the Building was put back into Normal status, the load starts to increase, as the Building HVAC systems start to pick up the load.

SSET1005 - LV Network Modelling Environment (with GE Digital Energy)

Linkage to NTVV

This will provide a foundation for NTVV, including identifying substations where LV monitoring is or will be required and identifying the customers (by MPAN) who will most likely cause LV network load related reinforcement and/or demand management..

Key learning to date

- Identification of available systems and tools (Digisilent, Windebut and Cymdist);
- GE confirm that the equipment will be integrated into standard GE product and thus providing the most cost effective solution.

SSET1006 – SMOS Manage (with GE Digital Energy)

Linkage to NTVV

Demonstrates a low carbon LV network management environment for a selected sub-set of SSEPD territory. Provides the opportunity to demonstrate an architecture which will support DSO functionality down to LV operational management.

Key learning to date

A smart metering operating system has been identified for use in the study.

SSET1003 - Domestic Demand Management Solutions (with Glen Dimplex Heating, Smarter Grid Solutions)

Linkage to NTVV

Help to inform the demand side response deployment and in particular the thermal storage rollout, with information on customer engagement and telecommunications and data monitoring and historical logging.

Key learning to date

- An understanding of the engagement and incentives required to sign up customers
- In depth knowledge of the hot water and heating requirements for domestic users and an understanding of the potential flexibility for demand side response

- Experience of multiple communications mediums with relevant data logging and monitoring

Appendix H: Differentiators from other LCNF projects

This project addresses issues that are not covered by any of the Tier2 projects that are approved or which are being assessed this year; or any registered Tier1 LCNF projects (except those of SSEPD which will feed into this project). These issues are:

- **Categorising the behaviour of domestic customers and their electricity usage patterns.** Understanding customers will be key to predicting network requirements over operational, planning and investment timescales. Current methods for segmenting electricity customers are very crude. This project will test the extent to which the sophisticated customer analysis techniques that large retail organisations use so successfully can be applied to electricity networks. The key differentiators of our project are:
 - the concepts of customer classification and forecasting have already been proven using EDRP data from SSE retail
 - our IFI project 'Smart Analytics' has shown that classification using energy demand is possible
 - we are partnering with the University of Reading Department of Mathematics and Statistics, which not only has expertise in the use of loyalty card data to target retail offerings but also is part of the School of Mathematical and Physical Sciences, which develops forecasting techniques for the UK Met Office.
- **Categorising the behaviour of SME customers and their electricity usage patterns.** It was noted by many of the delegates at this year's ENA LCNF conference that SME customers are important both as sources of challenge for the network and potentially as partners to address these challenges; however it was proving difficult to engage SMEs. This project potentially provides a means to understand the challenges that different SMEs will bring to the network, to identify those that could help to provide solutions and identify the type of approach that is likely to be attractive to each SME.
- **Demand management via building management systems.** We note that a number of other projects are addressing demand management. We are not aware of any that propose to directly link building management systems to network control systems. Building Management Systems are purchased by organisations because they produce benefits of reduced energy demand. The business case for procurement and installation is strong and providing remote control functionality is a marginal cost. Therefore the cost of providing this solution should be low compared to other demand management approaches. We are working with a leading building management system provider that has global experience. Our partner Honeywell is currently trialling Building Management Systems for SMEs in the USA and will deploy these SME BMS in this project.
- **Use of the outcomes of categorisation and modelling of customer behaviour within operational systems and to produce investment and planning tools.** Although other projects are exploring how new technology can be used for network operation and a number of projects intend to produce tools, we can see no evidence that any of the other projects intends to explore the use of such sophisticated customer approaches for operating the network, or for planning and/or investment. We expect that this project will produce robust tools for forecasting the requirements of individual feeders in short, medium and long timescales.

The following features of the NTVV project might be considered similar to features of other LCNF projects. In the following we have endeavoured to draw out the differences in approach and learning.

- Use of smart meters
 - Three of the approved tier 2 projects are using smart meters to obtain customer profiles of 'vanilla' customers and those which have Low Carbon Technologies. We have had discussions with UKPN and CEE who have

- shown interest is sharing data. We hope to gain an agreement to share data with these projects.
- PV and Heat Pumps in domestic properties
 - Three of the approved tier 2 projects are exploring the impacts of Heat Pumps and PV on the network and BRISTOL aims to engage 30 domestic PV . Only this project aims to use statistical techniques from the retail sector to understand how different customer behaviour will affect these impacts, enabling design tools to better model the network.
 - Monitoring and interaction with SME /Small Commercial /Schools and Community Centres
 - Three of the approved tier 2 projects are intending to interact with schools, community centres and SMEs (and BRISTOL with 10 schools). Only this project aims to use statistical and mathematical techniques from retail and finance sectors to understand and categorise the behaviour of different types of small organisation, enabling design tools to better model the network. We believe that this project alone is aiming to have direct load management of SME customers.
 - Load Management
 - A number of projects intend to manage customers' load. We believe that this project is alone in using a leading building management system directly interfaced to the industry standard network management system.
 - Monitoring of HV and LV feeders, Primary and Secondary substations
 - Monitoring is a pre-requisite for assessing the actual impact of new technologies on the network and of the efficacy of the novel techniques that are being explored, therefore all projects are deploying monitoring. This project has a phased roll-out to demonstrate that a proportion of feeder monitoring can be replaced by modelling of customers using statistical and 'buddy' techniques, hence to identify the optimal level of monitoring.
 - Electrical energy storage
 - A number of Tier 2 and Tier 1 projects aim to demonstrate 'first use' of various storage technologies. In contrast this project aims to build on this learning by developing use cases for the distributed use of a statistically valid population of storage, to learn the synergistic benefits of distributed electrical and thermal energy storage and to explore the benefits of short-term tactical deployment of storage at LV to alleviate short-term network constraints.
 - Commercial arrangements
 - Most of the Tier2 projects are exploring some form of commercial arrangement with established players in electricity supply. We believe that our project is unique in using an organisation that is not currently active in the electricity value chain (Honeywell) to arrange commercial demand management as part of contractual relationships to supply and manage building management systems
 - Design tools
 - A number of projects are intending to deliver learning in the form of design tools. A key differentiator of the tools that will be produced by this project is the embodiment of customer characterisation learning in the design tools that will result from the project. This is a ground breaking change in design approach.

Appendix I: Glossary

AutoDR	Automatic Demand Response
BAU	Business as usual
BMS	Building Management System
CDCM	Common Distribution Charging Methodology
Consumers	Anyone who uses electricity (customers are those who pay the bills)
DECC	Department for Energy and Climate Change
DNO	Distribution Network Operator
DUoS	Distribution Use of System
EDRP	Energy Demand Reduction Project
ENMAC	Electricity Network Management and Control
EV	Electric Vehicle
DPCR5	Distribution Price Control Review number 5 (2010-2015)
DSR	Demand Side Response
FiT	Feed-in Tariff
Headroom	The difference between the actual power flows, voltages and power quality metrics and limits set by: network design, equipment ratings or legal / licence requirements
HP	Heat Pump
HV	High Voltage: typically distribution networks of 11,000 Volts
IFI	Innovation Funding Incentive
LCTs	Low Carbon Technologies (the collective name for PV, HPs, EVs, PHEVs)
LCNF	Low Carbon Network Fund
LCTP	Low Carbon Transition Plan
LI	Load Indices
LO	Learning Outcome
LV	Low Voltage: the network feeding domestic properties and small businesses – 400V three-phase /230V single-phase
NTVV	New Thames Valley Vision
PHEV	Plug-in Hybrid Electric Vehicle
PV	Photo-Voltaic
RIIO-ED1	Revenue = Incentives + Innovation + Outputs (Electricity Distribution 1) – the new Regulatory model led by Ofgem for networks. RIIO-ED1 will be an eight year price control period from 2015-2023.
RRP	Regulatory Reporting Pack
RTS	Real Time System
SCADA	Supervisory Control and Data Acquisition
SME	Small to medium sized enterprise
SSEPD	Scottish and Southern Energy Power Distribution
T1 /T2	Low Carbon Network Fund Tier 1 and Tier 2 projects

Appendix J:

Components of Distributed Solutions Integrator System (DSI)

The New Thames Valley Vision implements Network Management and Network Modelling components to create a Distributed Solutions Integrator (DSI) for the Bracknell area.

The project uses a network management solution directly descendant from GE Energy's ENMAC (as presently used by most UK DNOs including SSEPD). This most recent descendant extends the SCADA capability of ENMAC with more advanced network management tools onto which the NTVV will develop additional modules to communicate with and coordinate with the energy management solutions deployed in the project. The NTVV will extend Network Management and SCADA functionality down to the low voltage level.

In addition to management and SCADA functionality, the NTVV will implement a geospatial network model to integrate network data, modelling and forecasting. The modelling environment will be enabled through substation and endpoint monitors, smart analytics and forecasting to develop a load-flow model including the low voltage network.

The NTVV project application of the Low Voltage Modelling Environment is considered in more detail below.

Low Voltage Modelling Environment

An up-to-date model of the LV network (in the Bracknell area) is required for reasons identified in Appendix B (LO-2. Anticipating – How can improved modelling enhance network operational, planning and investment management systems, pages 6 to 9) summarised as follows:

- 1) To allow existing power flows based on monitoring data to be analysed so that network headroom can be understood;
- 2) To allow the predicted power flows to be compared with actual power flows, and consideration given to the predicted effect of the take up of low carbon technologies;
- 3) The above will result in the categorisation of every feeder (Red / Amber / Green) to allow the optimisation of network investment and subsequent monitoring installations;
- 4) To better inform the choices to be made with regard to design, planning and operations of the network; these in turn will improve investment decisions, and will influence RIIO and network governance.

It is a requirement of the NTVV project to build the network model for the Bracknell area. The foundation for this network modelling environment (power analysis tool, data model, load profiles) is being established in the Tier 1 project SSET1005, and this will be fully built for NTVV. Full consideration is to be given to:

- a) Data Management including the identification of actual data requirements and input interfaces to existing systems (GIS (geographic information), SIMS (shared information management system linked to MPAN data), PLACAR (transformer data) and distributed generation data.
- b) Integration of output interfaces to a historian (for data management and analysis), a data management system (HV power flow analysis) and other Ofgem reporting requirements.
- c) Usability including the visualisation of the LV network and functionality within the network modelling environment.
- d) Provision has been made for the training of the core users.

Appendix K:
Description of proposed report scopes as per Successful Delivery Reward
Criteria (SDRC) 9.8

(a) November 2014

(1) End Use and Network Monitoring Evaluation

(Methods 1 and 3, Learning Outcome 1.1)

- Installation (cost, timescales, ability to connect live to minimise effect on customers)
- Operation (reliability, accuracy & communications)
- Application (data use & location selection)
- Standardisation (variations, options for universal designs, standard protocols)

(2) Demand Side Response Evaluation

(Method 2, Learning Outcome 4.2)

- Function (installation, operation, communication)
- Predictability (reliability, variability, aggregated response)
- Customer engagement (installation, participate, customer propositions)
- Regulatory considerations

(3) Network controlled Automated Demand Response evaluation & Energy Efficiency

(Method 2, Learning Outcome 4.3)

- Customer engagement (uptake, decision and justification, ability to respond)
- Regulatory considerations
- Focus Groups (engagement methods, customer feedback)

(4) LV Network Energy Storage

(Method 4, Learning Outcome 4.1)

- Installation (requirements, permissions, unit costs, safety considerations, timescales)
- Benchmark the battery and thermal storage methods.
- Battery Storage (demand shifting from individual and aggregated operation, management of network voltage, thermal. power quality and losses)
- Ice Energy Storage (demand shifting from individual and aggregated operation, commercial arrangements and customer feedback)
- Thermal Energy storage (assess additional generation permitted within existing network, management of network voltage, thermal)

(5) EV Chargers Usage Evaluation and Issues

(Methods 1 and 2, Learning Outcome 4.1)

- Network effect (individual and aggregated demand, power quality, thermal and voltage limits)
- Impact assessment (assessed using network modelling and forecasting tools)

(6) Smart Meter performance

(Method 1, Learning Outcome 1.1.2)

- Customer and supplier engagement
- Technical Issues (communications, standards, protocols)
- Data Issues (volume, accuracy, integration with other systems)

(7) Integration Solution Control Evaluation

(Methods 1, 2 and 4, Learning Outcome 1.1.3)

- Data availability (preparation of data, works required, indirect costs)
- Functionality (assess against business and functional requirements)
- Integration (communications, interfaces with other systems)
- Scalability (consequences of applying to a larger network)

(8) Overall Proven Benefits (both financial and customer service)

(Method 1, Learning Outcomes 2.4 and 2.6)

- Use of modelling to support DNO investment decisions
- Use of modelling to support others (customers, industry, local government)

(b) November 2015

(1) Low Carbon Fuel Poor Evaluation

(Learning Dissemination)

- Fuel Poor (low carbon choices,
- Economic consequences

(2) Bracknell Forest Homes Low Carbon Promotions

(Method 1, Learning Dissemination)

- Funding Issues (vested interests)
- Strategy / Objectives (influence of DNO)
- Community benefits (energy and cost savings)

(3) Technical Impact Evaluation

(Method 1, Learning Dissemination)

- Impact on DNO network from Low Carbon Promotions

(c) November 2016

(1) University of Reading Smart Analytic and Forecasting Evaluation

(Methods 1 and 3, Learning Outcomes 1.2, 2.1 and 3.0)

- Categorisation of customers by energy demand (accuracy, repeatability, scalability beyond Bracknell)
- Forecasting (comparison with monitored data, RAG categorisation of network, tracking and inferencing model, scalability)
- Optimising (optimum level of monitoring required, evidence, adapting to change)

(2) Low Carbon Community Advisory Centre Evaluation

(Learning Dissemination)

- Effectiveness at conveying the message
- Community engagement achieved
- Requirement for scalability

(3) DNO Training and Policies Review

(Learning Dissemination)

- Training (areas where training required, effectiveness of training, scalability)
- Policies (areas where new policies are required, implementation issues, scalability)

(d) April 2017

(1) Close Down Report

(All Methods, All Learning Outcomes)

- Review key learning outcomes
- Recommendations for application Learning Outcomes including priorities
- Review of Project Costs
- Review of project compliance to Ofgem expectations
- Lessons Learning relating to project implementation

NTVV Bid Submission - Change Log

Page/ Box/ App No.	What has Changed?	Why has the change been made?	Other Comments
Project Summary -Page 1	The project summary has changed to reflect the omission of the EN2050 learning centre	Verbal feedback received at the Expert panel bilateral session to reduce the costs of the Learning Centre - 3rd October 2011	
Project Costs - Page 1	We have updated both the LCN funding requirements and External funding boxes to reflect changes in the learning & dissemination activities	Verbal feedback received at the Expert panel bilateral session to reduce the costs of the Learning Centre - 3rd October 2011	There are changes to external funding as a percentage of the overall project due to the omission of the EN2050 Learning Centre
Page 2 & 3 - Project Description	We have removed reference to the EN2050 Learning Centre.	Verbal feedback received at the Expert panel bilateral session to reduce the costs of the Learning Centre - 3rd October 2011	Even with the EN2050 Learning Centre removed from our Bid, we still feel that we have strong L&D and Customer Engagement package.
Page 24 - Evaluation Criteria	Changes to the Gross and Net costs for Kema	Verbal feedback received at the Expert panel bilateral session to reduce the costs of the Learning Centre - 3rd October 2011	Since the Bilateral meeting we have carried out a review of the L&D costs and we changed the figures accordingly.
Page 24 - Evaluation Criteria	Removed reference to the EN2050 Learning Centre	To reflect the withdrawal of the EN2050 Learning Centre from the project	
Pages 29 - 31- Learning & Dissemination	As we have removed the EN2050 learning centre from our project, we have had to make some changes to this section. The main changes include the deletion of all references to the EN2050 Learning Centre and highlighted the increased importance of the "high street" presence, advisory centre, the web site (a new section), consumer consortia and the focus groups to maintain the l&d and customer engagement at the forefront of the NTVV.	Verbal feedback received at the Expert panel bilateral session to reduce the costs of the Learning Centre - 3rd October 2011	We still feel that although we have a significantly reduced the scope of this section, we still have a strong L&D package.
Page 32 - Learning & Dissemination	The top image of has been changed to the 'mock up' of the NTVV website instead of the omitted EN2050 Learning Centre drawings.	Verbal feedback received at the Expert panel bilateral session to reduce the costs of the Learning Centre - 3rd October 2011	With the changes explained, the website will take on even more importance to ensure that customers are engaged effectively
Page 33 & 34	References to agreements signed in principal have been changed to agreements have been signed	In the time since our initial bid submission, we have now reach signed agreements from all project partners	These agreements can be presented to Ofgem if required
Page 35 - Project Readiness	Since the original bid submission, the 'Manage' project has changed from a Tier 1 project to IF1.	Factual update	The fundamental learning that we will get from this project is unchanged with the change in funding mechanism
Page 35 - Project Readiness	Added a sentence to highlight that the figures shown are gross rather than net.	To provide greater clarity	
Page 36 - Project Readiness	The learning and dissemination costs have changed	Verbal feedback received at the Expert panel bilateral session to reduce the costs of the Learning Centre - 3rd October 2011	External funding has reduced slightly as the EN2050 Learning Centre had attracted investment
Page 45 - Customer Impacts	Removed reference to the '.....flagship Low Carbon Smarter Networks Centre'	Verbal feedback received at the Expert panel bilateral session to reduce the costs of the Learning Centre - 3rd October 2011	
Page 47 - Customer Impacts	Removed reference to learning Centres	There will now only be the Low Carbon Advisory Centre	
Page 49 - 52 - Successful delivery reward criteria	As a response to question 37, we were asked to further evaluate and resubmit our Successful Delivery Reward Criteria (SDRC). As part of this exercise we responded with a spreadsheet that clarified our initial responses resulting in many changes. In the resubmitted pro-forma we have made the responses the same as those that were submitted as Question 37	Due to a request to do so in Question 37	In our spreadsheet, the evidence was split into input and output. Due to space in this pro-forma we have listed the evidence as one.
Page 52 - Successful delivery reward criteria	9.7 b has been removed as it referred to the EN2050 Learning Centre. Reference to this SDRC has also been removed in the Evidence section as well		
Page 52 - Successful delivery reward criteria	The evidence in 9.8 has been changed. (I) now reads "Advisory Centre Evaluation"	Due to omission of the EN2050 Learning Centre	
Appendix 2	Costings will be amended to reflect the changes in the bid submission		
Appendix D	Changes to the project partner roles will be made		
Cost Spreadsheet	Items have been removed from the section <i>KEMA Dissemination and Learning</i> : EN2050 Learning Centre specification, build, operation, evaluation, maintenance and decommissioning	These costs have been removed directly to reflect the removal of the EN2050 Learning Centre from the project.	
Cost Spreadsheet	Items have been included into the section <i>KEMA Dissemination and Learning</i> : To support development of the website and low carbon promotions independant of the Learning Centre. The costs linked to learning outcome presentations by some of the partners (also in the section <i>KEMA Dissemination and Learning</i>) have been reduced.	The Low Carbon Advisory Centre will now be used in a wider context than originally planned. The development of the website and low carbon promotion costs were kept low as they shared development benefit with the Learning Centre; the costs now need to stand alone in the absence of the learning centre.	
Cost Spreadsheet	A total value of £60k of funding by KEMA has been factored into a number of lines in the section <i>KEMA Dissemination and Learning</i> . These lines represent the tasks to be carried out directly by KEMA.	The funding available from KEMA was previously linked to the Learning Centre. In the absence of the learning centre KEMA remain willing to provide some funding by means of discounting other tasks carried out by them.	
Appendix Page 25	Remove reference to the EN2050 Learning Centre		
Appendix Page 30	Removed reference to the EN2050 Learning Centre		