SP ENERGY NETWORKS

Flexible Networks for a Low Carbon Future

Methodology & Learning Report

Work package 2.3: Energy Efficiency

September 2015

Contents

1 Background

Large scale rollout of energy efficiency measures can simultaneously provide customer benefits (e.g. lower operating costs), network benefits (e.g. easing network constraints, increasing capacity headroom, etc.) and other societal benefits (e.g. reduced carbon emissions). DNOs clearly benefit from such a movement and thus they have an important role to play in facilitating the uptake of energy efficiency measures, be this in conjunction with energy suppliers or via other relevant vehicles.

The objective of this work package was to engage with customers (predominately Industrial & Commercial), develop knowledge regarding their position on energy efficiency and gain their buy-in to progress the identification, development and roll-out of practicable energy efficiency measures within their premises.

The development of effective engagement strategies (with customers, energy efficiency product suppliers and energy retailers) to support large-scale implementation of energy efficiency measures was a key learning outcome. The adoption of these measures in both specific, highly constrained network locations, and across the network for a representative range of customer groups has potential to provide an incremental increase in capacity headroom.

A key dependency of delivering this work package was the engagement, education and provision of support to customers to explore the opportunities and tackle the barriers of deploying energy efficiency measures. It was therefore necessary for this work to be subsidised by the project. We engaged the Building Research Establishment limited (BRE) to lead the stakeholder engagement activities and opportunity identification process. BRE, who are owned by the BRE Trust (a research and education charity for the public benefit), is an independent research based organisation free from vested interests. BRE's objectives are to share their comprehensive knowledge and experience in built environment sustainability, energy performance and environmental impact to clients, and undertake activities in pursuit of the public good.

A key risk to the development and successful delivery of this work package was deemed to be an unwillingness of customers to change behaviours or seek to implement identified solutions. This risk was mitigated by using BRE as an independent and trusted 3rd party, as well as through offering incentives to customers for the trialling of agreed technologies.

The project sought to identify, develop and realise energy efficiency opportunities in conjunction with the customers and establish which solutions could simultaneously benefit them and the needs of the project. It was recognised that some solutions were likely to be economically prohibitive and so consideration would be given to subsidising an element of identified solutions in order to aid learning and development.

2 Details of the work carried out

The work package consisted of three interlinked activities noted below, and as explained in the following sections:

- Electricity demand modelling
- Stakeholder engagement and
- Intervention development

2.1 Electricity Demand Modelling

The electricity distribution network in each of the three trial areas (Whitchurch, Wrexham and St Andrews) is stressed for several reasons including different combinations of: lack of capacity; general load increases; urban expansion; and the introduction of small and large scale renewable energy systems. Preliminary energy models were prepared by BRE in order to understand the anticipated electricity demands, load profiles and customer/building make-up in each of the areas. This data was needed to understand the network areas in question (in advance of any detailed network monitoring) and to assist the development of an appropriate project delivery plan. The modelling exercise helped identify a number of gaps in knowledge which were further investigated to help improve the model thereby enabling a better understanding of electricity use in each area. The models were developed to provide typical peak winter profiles for a typical year and, whilst not undertaken during the project, the model could be further developed to model the impact of varying weather or extremes. The models allowed a comparison of the modelled electricity demand with actual patterns monitored to assess its accuracy and also included functionality to model the impact of development in an area where information about proposed changes is known i.e. changes in quantity, building type, floor areas (of non-domestic properties) and changes in dwelling numbers, etc. In addition, the models were also used to help identify potential interventions that could reduce (or modify) electricity demand patterns as well as a means of visualising and estimating both the energy saving and peak load saving potential of groups of interventions. The BRE models worked on a bottom-up approach i.e. the performance of each of the network areas was estimated by initially considering the number, type and nature of customer loads connected to the network in question. Thereafter the typical loads for each building type were derived from national norms or other relevant industry accepted methods. To enable an early assessment of performance the models were initially based on publically available data (which included data from census data (for dwellings), and the Scottish Assessors Association or the Valuation Office Agency (for non-domestic buildings)). This assessment was only of limited accuracy and so later revisions refined the models by basing them on the actual number of connected loads using data derived from SPEN's existing databases. This led to significantly improved predictions.

The model contains several parameters that can be adjusted by the user to test the sensitivity of the results to the assumptions that have been made to establish electricity use and peak load profiles. BRE prepared a series of reports that describes the model methodology, findings, conclusions and recommendations, so that the learning can be used by SPEN or other stakeholders.

A comparison between modelled and measured electricity demand was undertaken, for each area, to provide confidence in the model and the assumptions underpinning it. The comparison with the modelled and measured demand in the three areas varied from a very close match to a reasonable approximation, and where there are differences the likely reasons for these differences have been suggested.

2.1 Electricity Demand Modelling [continued]

The models were further developed to enable assessment of a selection of loads served by an individual sub-station or transformer. The approach to modelling is structured so that it can provide an approximation based on limited information about connected buildings, their size and electricity demand. This can then be refined by replacing some of the default values within the model either local data from publicly available information sources, or specific data for each building (e.g. from site surveys, design information or energy performance certificates) where these may exist, leading to an increasingly accurate model.

The modelling approach could be used either as an intervention planning assessment tool or as a network planning tool to provide early knowledge on the anticipated demand of new, or changing, developments – e.g. assessing the impact of increased take up of heat pumps. Equally it could be applied at a larger scale to help understand the aggregated performance or the impact of large scale rollout of the modelled energy efficiency interventions.

Whilst the model has been specifically adapted for the three geographic areas of concern it could equally be applied to any part of the UK, and at smaller or larger scale than applied within this project. Further information is included in 'BRE Client Report Flexible Networks: Electricity Modelling' (Appendix 1).

2.2 Stakeholder Engagement

When investigating opportunity for increasing network flexibility via energy efficiency it is vitally important to engage with key stakeholders to better understand their current, and future, energy needs, demand profiles and energy use characteristics; as well as stakeholder's attitudes and priorities regarding energy efficiency, distributed generation, investment and funding. Further details of the stakeholder engagement process are included in 'BRE Client Report Flexible Networks: Customer Engagement' (Appendix 2).

BRE's main role within the stakeholder engagement process included undertaking the following tasks in order to help deliver the overall project aim of engaging a range of stakeholders with a view to identifying and trialling suitable, cost effective, energy efficiency interventions at their sites in order to reduce peak demand on the network thereby freeing up network capacity. The approach set out below was deemed necessary as, at the start of the project, very little information was known about the I&C customer's energy requirements or systems and no data was available concerning the demand profiles in the trial areas:

- Develop a stakeholder engagement methodology and interaction plan
- Identify and engage with key stakeholders - predominantly within the Industrial and Commercial (I&C) sector
- Investigate opportunities for undertaking energy efficiency improvements at stakeholder sites that create additional network capacity or flexibility; and undertake selected technical site surveys to investigate the potential
- Gauge stakeholder appetite to taking up the opportunities (via follow up meetings or phone calls)
- Assess the cost effectiveness of the energy efficiency measures
- Investigate/develop processes, in conjunction with SPEN, to support the delivery, future implementation and/or large scale role out of energy efficiency opportunities.

An initial stakeholder interaction plan provided an introduction to each of the three trial areas; an introduction to key stakeholders (as identified via a desk based study) and set out a proposed process for initial engagement with stakeholders. The stakeholder engagement strategy set out below was then put in place and delivered. The methodology was phased, as below, to ensure that the process remained flexible enough to adapt depending on the outcomes of the preceding phase.

2.2 Stakeholder Engagement [continued]

Phase 1: Initial stakeholder identification and engagement

- Research each specific network / geographical area and identify key stakeholders via desk based review.
- Contact identified stakeholders by telephone to obtain contact details of a relevant person.
- Contact stakeholders by telephone to formally introduce project.
- Issue a formal follow up letter by email to relevant contacts. Issue a project questionnaire to stakeholders.
- Contact all stakeholders to enter in to follow up discussions to gauge interest and discuss next steps, where relevant.
- If relevant (e.g. if there were significant numbers of engaged stakeholders), prioritise future stakeholder activity to parties offering the most promising opportunities, those with high cost effectiveness, highly replicable and/or those which enable maximum project learning.

149 potential stakeholders were initially identified via this review, broken down by trial area as per table 1 below.

Table 1: Identified stakeholder (by trial area)

	Potential stakeholders		
	Identified	HH	Non-HH
St Andrews	60	15	45
Whitchurch	45	13	32
Ruabon	44	7	37
Total	**149**	**35**	**114**

2.2 Stakeholder Engagement [continued]

In many instances stakeholders were reluctant to engage for a number of different reasons. Following initial contact 15 stakeholders (10% of the original 149) engaged with the project at this stage. Follow-up activity consisted of either a one-to-one meetings or site surveys by BRE technical experts.

The table below provides a summary of discussions and meetings with key stakeholders that engaged with the project during phase 1.

Table 2: Engaged stakeholders & activity (by trial area)

	Category	HH site	Mtg	Survey
St Andrews	Public (LA)	y – multiple	y	y – multiple
	Public (other)			y – multiple
	Educational	y – multiple	y	y – multiple
	I&C (transport – depot)			y
	I&C (hotel/accom)	y	y	y
	I&C (sports)	y		y
	I&C (utility)	y – multiple	y	
Whitchurch	I&C (food manuf & distr)	y	y	y
	I&C (cold storage & distr)	y	y	y
	I&C (utility)	y		y
	Public (LA)		y	
	I&C (alloy production)	y	y	
Ruabon	Public (LA)	y – multiple	y	y – multiple
	I&C (utility)	y		y
Total	**14**	**11**	**9**	**11**

2.2 Stakeholder Engagement [continued]

Phase 2: Conduct one to one meeting with key stakeholders.

Phase 3: Targeted site surveys at selected stakeholders:

This phase included undertaking a number of technical surveys at the sites of engaged stakeholders. The primary purpose of the surveys was to identify energy efficiency measures which could result in a reduction in peak electricity demand for the electricity distribution network. The measures were reviewed for cost effectiveness and assessed if suitable for project investment (and at what level).

Phase 4: Develop an appropriate delivery mechanism for implementation:

This phase included considering appropriate delivery mechanism and procurement routes for realising the energy efficiency interventions identified during the earlier phase. This was developed depending on the engaged stakeholders, their building types, energy efficiency opportunities available and the stakeholder's attitudes to energy efficiency investment.

We believed that it was important to cooperate with energy retailers to assist in the implementation of energy efficiency measures. Therefore we engaged with the following energy retailers:-

- EDF Energy (Current holders of the public sector electricity supply contract in Fife)
- Scottish Power Retail (The historic regional supplier)

To focus resources in areas likely to yield the most cost effective energy reduction measures, targeted surveys by installer/contractor and provision of design and costed works proposal were undertaken with a small number of stakeholders with large energy consumptions.

This resulted in a number of offers being prepared for stakeholder review. Following stakeholder review, interventions at the University of St Andrews and Wrexham Borough Council were taken forward for implementation.

- I&C organisations welcomed the surveys and provision of authoritative and independent advice regarding energy efficiency although such an approach is clearly not a sustainable approach.
- A cooperative approach with energy retailers in the implementation of customer energy efficiency measures was found to work well.

2.3 Interventions

A number of potential energy efficiency interventions which can save energy and reduce peak demand have been identified through a series of concise energy surveys undertaken by BRE and a selection of in-depth feasibility studies completed by energy management specialists. The interventions offering the best opportunities for both reducing operational costs for the customer and offering peak demand reductions for SPEN were found to include the following technologies:

- Voltage optimisation
- Heating, Ventilation and Air-conditioning (HVAC) controls including variable speed drives
- Lighting
- Lighting controls

The characteristics of the buildings where each measure could be adopted was examined to identify other types of buildings where such measures are also likely to be suitable.The cost and potential impact (kVA reduction in peak demand) of each intervention was investigated to develop a list of measures that could be implemented to reduce electricity demand. These have been put in a hierarchal order based on the estimated level of investment required per kVA reduction in demand. This analysis presented a clear distinction between reducing the supply voltage by 'tapping down' transformers (the measure deemed most cost effective) and carrying out traditional energy efficiency interventions within buildings.

In addition to the categories of measures listed above PV to domestic hot water "energy diverting" devices (which can divert energy to a hot water cylinder rather than being exporting to the network) were also investigated and found to be a relatively cost effective way of helping facilitate more distributed generation.

2.3.1 Modelling of Interventions

The previously developed computer models were further developed to model a selection of feasible energy efficiency interventions which, in turn, enabled the production of predicted load profiles when the effect of a range of interventions were applied, as well as estimate of peak demand reductions.

One of the outputs of the model is an assessment of peak electricity demand before one or more energy efficiency interventions are applied. This is accompanied by a budget estimate of the capital cost required to achieve that level of reduction so that comparisons can be made between the relative cost and performance of different interventions or combinations of interventions.

Additional information about the cost-effectiveness of energy efficiency interventions has been provided through the delivery of Scottish Power Energy Solutions surveys. These provided recommendations for interventions at several buildings and provided estimates of capital cost, energy cost savings and anticipated reduction in peak electricity demand for a number of interventions. The Scottish Power estimates of costs were based on nameplate ratings of equipment, spot readings of consumption and information prepared by the site and supplied to Scottish Power; the estimated load reduction was based on the assumption that constant power is used throughout the peak demand period on an annual basis, and the reduction during peak hours is obtained by applying the ratio fraction of peak hours (1,092 hours p.a.) to overall plant operation time to the estimated annual electrical savings.

A list of priority interventions was then prepared based on both a set of default assumptions for modelled interventions, and the information contained within Scottish Power Energy Solutions surveys.

2.3.1 Modelling of Interventions [continued]

The cost and potential impact (kW reduction in peak demand) of each intervention was investigated to develop a priority list of measures that could be applied to reduce electricity demand. The research showed a clear distinction between reducing the supply voltage by 'tapping down' transformers (where the cost per kW reduction is estimated to be £38 or less) and energy efficiency interventions within buildings (where the cost per kW reduction is estimated to range from £750 to more than £2,000).

It was therefore possible to estimate the budget costs (and feasible intervention mix based on the number and types of building in each area) for a variety of feasible approaches required to achieve a 2% reduction in peak demand. The investment required to achieve this was estimated as being in the order of £800k. Whilst this may be a prohibitively expensive investment when considered in terms of conventional reinforcement, it should be noted that each intervention will achieve energy cost savings for each building as well as providing network demand reduction. The project analysed payback periods for the interventions based on their energy cost savings and these were found to ranges from 1-8 years. This means that there is likely to be significant scope to implement interventions in partnership with the end-users e.g. with capital costs being split between the network operator and the building owner or other beneficiaries.

The model was supplemented by a simple software tool to allow users the potential to explore different levels of investment across a mixture of energy efficiency interventions. This tool allows the user to vary the overall level of investment in energy efficiency interventions and to explore the overall impact on demand by varying: the proportion of investment in each of the three geographic areas and the relative spend for each potential intervention. An example screenshot of the tool is presented below.

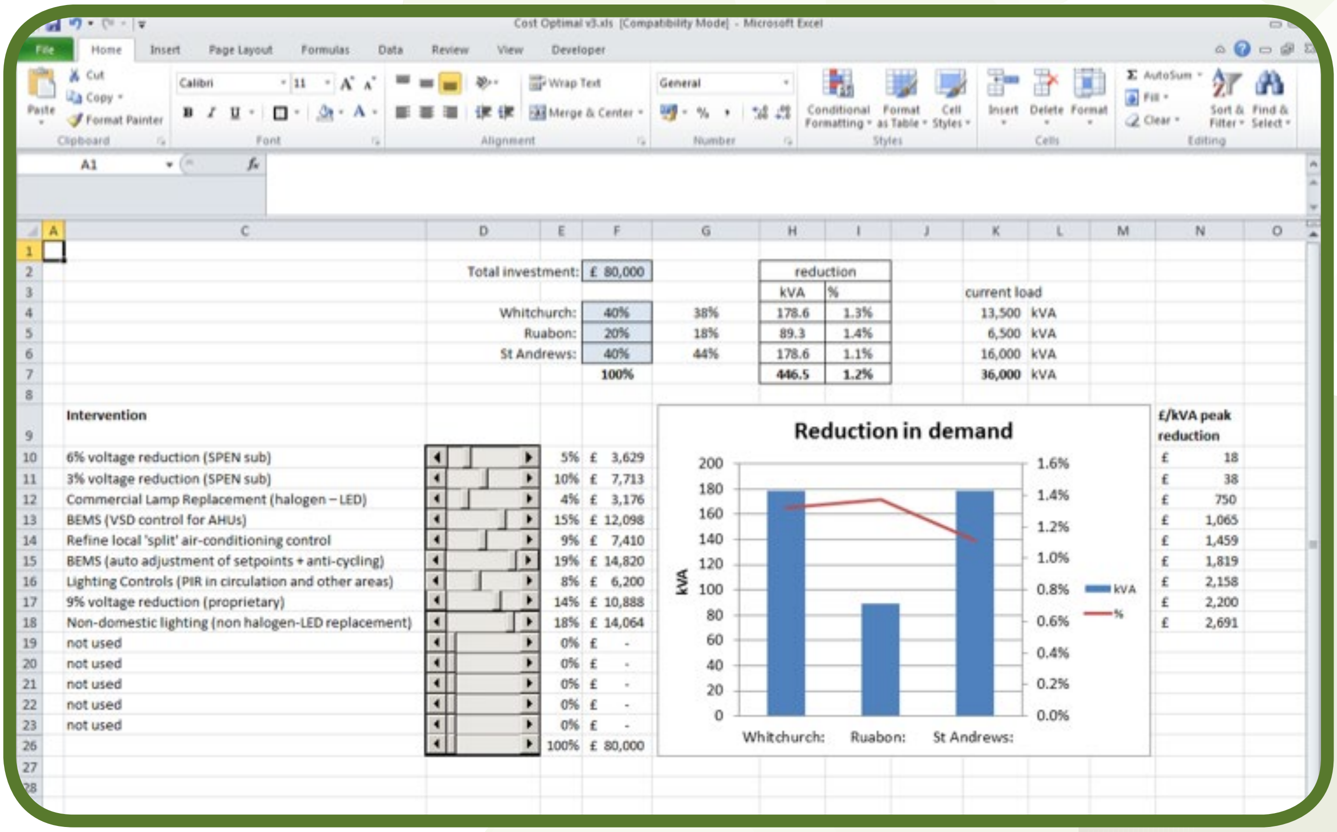

Figure 1: Example screenshot of the intervention investment tool

3 The outcomes of the work

The energy efficiency trial has provided some degree of peak load reduction, customer annual energy savings and facilitation of additional distributed generation. Whilst the savings target for this was 2% of the peak demand within the trial sites, the achieved saving was somewhat less, however shortfall in capacity gains through energy efficiency have been achieved by other elements of the project (as reported elsewhere). The conclusions and key learnings of the work, as well as a summary of the challenges that prevented expected energy savings to be achieved, are set out in the sections below.

3.1 Bottom-up modelling

The bottom-up modelling approach applied within the project was developed to serve multiple functions, more specifically: to help understand customer / building make-up in each area (to assist in the identification of suitable interventions); to estimate anticipated electricity demands; and to enable a means of modelling the "impact assessment" of various intervention strategies. Key conclusions and learning were as follows:

- The models successfully delivered on the above requirements. In addition, they were found to be of particular value when analysing intervention scenarios and modelling their estimated impact and cost.
- As the intervention analysis was a key focus for the model development the model was not developed with the aim of being a precisely accurate load prediction model e.g. the models represented typical winter demand profiles for a typical year and so incorporating accurate weather correction (in order to more accurately analyse demand under varying weather effects) was not deemed essential. As a result, when compared with the measured demand in the three areas the modelled results varied from a very close match to a reasonable approximation (and where there were differences the likely reasons for these differences have been discussed in detail).
- It is worth noting that the accuracy of the model could be improved if customer's estimated floor area information was available to DNOs.
- Moreover, with additional development, refinement and calibration; the bottom-up modelling approach used in the project may offer an alternative to current, data-based, modelling approaches.
- Regarding applications:
    - the modelling approach could be used either as an intervention planning assessment tool or as a network planning tool to provide early knowledge on the anticipated demand of new, or changing, developments, as well as the impact of changes to the energy systems within buildings e.g. providing a before and after assessment of the impact of increased take up of heat pumps, or the wide scale roll-out of efficient lighting, etc.
    - Equally, the models could be applied at a larger scale to help understand the aggregated performance or the impact of large scale rollout of the modelled energy efficiency interventions and whilst the model has been specifically adapted for the three geographic areas of concern it could equally be applied to any part of the UK, and at smaller or larger scale than applied within this project.

3.2 Stakeholder Engagement

The exercise concludes that I&C energy efficiency presents significant opportunity for peak load reductions however there are a significant number of barriers to ensuring successful engagement to realise the potential in practice within the sector. Key conclusions and learning were as follows:

Engagement:

- The engagement approach adopted in the project was relatively time consuming and resource intensive. If completing the project today a different approach would be recommended i.e. to make use of the learning from this project and take advantage of emerging programmes which includes the Energy Saving Opportunity Scheme[1] (ESOS) (a mandatory energy assessment and energy saving identification scheme for large undertakings[2] in the UK that meet the qualification criteria) and DECC's Electricity Demand Reduction (EDR) pilot (a competition providing financial support to organisations that deliver electricity savings at peak times by installing more efficient equipment or increasing the efficiency of selected existing electrical systems. EDR is testing whether projects that deliver lasting electricity savings at peak times could in future compete with generation, demand side response and storage in the Capacity Market).
- Project engagement was low with only approximately 10% (15 out of 149) of the targeted I&C stakeholders initially engaging with the project and progressing to follow-up meetings / opportunity identification stage. The research suggests the following key contributing reasons:
    - Stakeholders are generally unaware of DNO's and their role and responsibilities e.g. when contacted, many stakeholders believed BRE researchers where trying to sell them electricity despite BRE generating a concise opening statement.
    - Barriers to getting to speak with suitable individuals. This was particularly an issue with medium to large organisations or national chains.
    - Difficulties in trying to sell the project to customers owing to the fact that at the early stages of the project (i.e. at initial engagement / pre-survey) it was not possible to:
        - Identify what energy efficiency opportunities were likely to exist,
        - Clearly define what the SPEN offer to customers could be, or
        - Define how the SPEN offer would work in practice i.e. what the terms and conditions of any contributory funding offer may look like at such an early stage.
- It is recommended that any future DNO strategy for energy efficiency interventions should include clearly defined options to aid the engagement process and achieve increased stakeholder buy-in.
- Energy efficiency was unfortunately not high on the agenda for some organisations, particularly small businesses and in particular those who rented their premises and therefore saw may energy efficiency interventions as a landlord's responsibility / benefit.

[1]The Energy Savings Opportunity Scheme Regulations 2014 – see http://www.legislation.gov.uk/uksi/2014/1643/contents/made

[2]i.e. organisations which employ 250 or more people and which have an annual turnover in excess of 50 million euro (£38,937,777), and an annual balance sheet total in excess of 43 million euro (£33,486,489).

3.2 Stakeholder Engagement [continued]

- Some I&C customers were highly motivated by energy efficiency (this was particularly true for those that were largely process driven) and so were already well progressed in terms of energy efficiency at their sites. These stakeholders were amenable to engaging with the project although this was predominantly only if they could see a significant direct benefit. As a result, whilst this type of stakeholder had significant energy use and was the easiest to initially engage with, they are unlikely to offer maximum potential for interventions as they. Many smaller commercial organisations were less progressed in terms of energy efficiency but unfortunately offer smaller opportunities and are more difficult to engage.
- Lack of knowledge, lack of resource and disruption to business activities were highlighted by stakeholders as significant internal barriers to progressing opportunities.
- I&C organisations generally demanded a payback of circa two to five years on energy related projects although it should be noted that this is for projects funded in-house. Longer payback are likely to be suitable where external funding contributes to project cost; although clearly defined terms and conditions are needed.
- Interestingly, whilst some public or charitable bodies with large estates were also very positive towards energy efficiency and reasonably well progressed in terms of having identified opportunities; staff resourcing appeared to the biggest issue (i.e. more of an issue than non-availability of funds) restricting increased delivery of energy efficiency projects. Project opportunities identified and/or being progressed by these types of organisations typically included a wide range of electrical and thermal energy efficiency projects which despite presenting annual energy savings to the client may not necessarily present significant reductions in demand.
- I&C organisations welcomed the surveys and provision of authoritative and independent advice regarding energy efficiency although such an approach is clearly not a sustainable approach.
- A cooperative approach with energy retailers in the implementation of customer energy efficiency measures was found to work well.

Opportunity Identification:

- All of the organisations welcomed the engagement, surveys and provision of authoritative and independent advice provided via the project although such an approach is clearly not sustainable in the longer term. The introduction of the ESOS Regulations requiring large companies to identify energy saving opportunities for all of their significant energy uses by December 2015 (and every four years thereafter); will help to overcome this barrier and will ensure that organisations bound by the new regulation are significantly better informed as to cost effective energy opportunities at their site. This presents an opportunities for DNOs to deliver cost effective demand reduction project.
- In many cases measures to reduce peak demand will also result in a reduction in overall energy use, bringing benefits to both the DNO and electricity consumers. It is however important to appreciate that these benefits are likely to be at different scales and times. Stakeholders were generally interested in interventions that provided highest energy reduction for lowest cost. DNOs are generally interested in interventions that provide the highest load reduction during peak periods for the lowest cost. It was therefore critically important to identify opportunities that are “win-win”.

3.2 Stakeholder Engagement [continued]

- Stakeholders were more interested in reducing energy than simply shifting load out with the peak period as this is typically a cost neutral solution (i.e. stakeholders get no significant cost benefit – except potentially in instances where they are on multi-rate tariffs). In addition, in most cases shifting or limiting load is likely to be detrimental to stakeholders in terms of a reduced service level, reduced output capacity, manufacturing capability, etc.
- It should be appreciated that energy savings (accumulated over the year) often do not directly correspond to the load reduction over the peak period in which the DNO is predominantly interested in. As a result there is often no synchronous, or mutually significant, benefit to both parties during peak periods. The research suggests that careful consideration must therefore be given to understanding the nature and magnitude of the customer benefits so that mutually beneficial solutions can be developed.

The research identified the following issues and barriers restricting customers progressing in-house energy efficiency projects:

- A lack of in-house funding to undertake feasibility studies into energy efficiency opportunities and/or to implement measures, is a key barrier to many stakeholders. Furthermore, project feasibility needs to be undertaken to an appropriately detailed stage before stakeholders can give serious consideration or approval to proceed i.e. proposals need to be developed to a point whereby there is high certainty over the capital cost of works and the likely energy savings. This means that design and installation considerations must be significantly detailed and fully costed. Progressing projects to this stage is both time consuming, costly and can also be relatively high risk e.g. if the project economics no longer stack up after paying for a detailed investigation.
- A lack of awareness of external or grant aid funding, or other financial incentives, for energy related projects – information on available support, funding and incentive schemes was subsequently provided to all identified parties.
- A lack of in-house technical expertise with the technologies being investigated
- Projects need to be low risk (to the customer) and present a relatively quick payback. I&C stakeholders typically required a payback on internal investment of between 2 and 5 years.
- Consideration needs to be given to the specific financial policies of individual stakeholders.
- There may only be selected time windows of opportunity for installing measures. This is particularly the case for industrial and large scale commercial operations.

As a result, there is a need to provide clear and independent advice to customer whilst keepings roles and responsibilities clearly defined and terms and conditions relatively straightforward for any projects that proceed to installation.

Delivery Mechanisms

The research identified a number of barriers restricting stakeholders from delivering energy efficiency projects in-house and so the project considered a number delivery mechanism options in order to deliver detailed site surveys and costed work proposals for a range of energy efficiency interventions. An energy retailer with "design and build" capability was engaged during the project and used to undertake detailed survey, outline system design and cost detailed works proposals. This party also had the capability to undertake installation works, a factor which was deemed beneficial in providing a simplified and expedient customer journey.

To focus resources in areas likely to yield the most cost effective energy reduction measures, targeted surveys by installer/contractor and provision of design and costed works proposal were undertaken with a small number of stakeholders with large energy consumptions.

3.3 Interventions

- Common measures typically offering the best "£/kVA reduction" were identified as:
  - (Non-essential) load shedding
  - Voltage reduction (at sub-station level)
  - Low energy lamp replacements
  - Energy system controls upgrades e.g. improved controls, occupancy linked ventilation controls, air conditioning/chiller plant controls, comfort cooling controls, etc.
  - Variable Speed Drives
  - Lighting controls upgrades and light fitting and lamp replacements

The potential interventions offering the most cost-effective opportunities for both reducing operational costs for the customer and offering peak demand reductions were found to include the following technologies:

- Voltage optimisation
- Heating, Ventilation and Air-conditioning (HVAC) controls including variable speed drives
- Lighting
- Lighting controls

This intervention hierarchy provides direction for targeting specific energy efficiency works at stakeholders or specific building types where opportunities have been identified as most likely to exist. Alternatively, the hierarchy could be used to inform the development of a customer energy efficiency incentive scheme, or similar, to drive implementation of specific measures for maximum network benefit.

In terms of electricity demand reduction, interventions (excluding voltage optimisation at substations) were found to be very costly on a £/kVA basis however each intervention will achieve energy cost savings for each end-user with payback periods in the range 1-8 years. This suggests that there is opportunity to implement these interventions in greater partnership with the end-users. Owing to time restrictions within the project it was not possible to carry out any detailed research as to maximum payback terms when projects were part funded although our limited research suggests that customers are amenable to investigating this approach further.

3.4 Business Case

In our Cost Benefit Analysis (Appendix 3) we have compared the cost of traditional network reinforcement with the cost of energy efficiency interventions.

A generic base cost of £262.50/kVA has been estimated for 33kV and 11kV reinforcement.

There are a range of costs associated with energy efficiency interventions. For the purpose of our analysis we used the costs for interventions identified at a large customer premises in the St Andrews trial area. These are calculated as £842/kVA, significantly greater than the business as usual techniques

When non network derived benefits are taken into account (calculated in accordance with the OFGEM approved ENA methodology), the energy efficiency interventions are much more competitive with traditional methods; £280/kVA for the St Andrews scenario considered.

Given that all of the above measures result in annual energy savings for customers, as well as peak load reduction, this offers scope to reduce the £/kVA peak reduction costs though implementing the interventions in partnership with the end-users thereby enabling a stakeholder contribution toward the cost. This would enable the interventions to be considerably more attractive to SPEN and potentially bring them in line with alternative network focussed solutions.

An additional benefit that energy efficiency can bring is that it is likely to be a cost effective solution in instances where low headroom (e.g. kVA reductions in low hundreds) may be beneficial e.g. providing additional short term capacity to help align with a longer term strategic plan or to help defer the significant spend associated with upgrading of transformers.

Towards the end of the project there were two significant external factors that offer significant potential to further inform and steer the development of any, DNO led, energy efficiency for peak load reduction strategy, namely (i) DECCs **Electricity Demand Reduction (EDR) pilot**, and (ii) the **Energy Saving Opportunities Scheme (ESOS)**.

The recently introduced ESOS Regulations[3] require large undertakings[4] to identify energy saving opportunities for all of their significant energy uses by December 2015. So, over the coming months, large undertakings are required to identify measures that they can take to cost-effectively reduce their energy demand, and central government will understand how some energy saving measures impact on winter peak demand. For future projects, this legislation could potentially help deliver many of the tasks that were undertaken during the 'stakeholder engagement' and the 'energy survey' stages of this pilot, and identify energy saving opportunities, some of which could reduce peak electricity.

[3]The Energy Savings Opportunity Scheme Regulations 2014 – see http://www.legislation.gov.uk/uksi/2014/1643/contents/made

[4]i.e. organisations which employ 250 or more people and which have an annual turnover in excess of 50 million euro (£38,937,777), and an annual balance sheet total in excess of 43 million euro (£33,486,489).

3.4 Business Case [continued]

DECC's Electricity Demand Reduction (EDR) pilot[5] is a competition providing financial support to organisations that deliver electricity savings at peak times by installing more efficient equipment or increasing the efficiency of selected existing electrical systems.

EDR is testing whether projects that deliver lasting electricity savings at peak times could in future compete with generation, demand side response (DSR) and storage in the Capacity Market.

DECC's Electricity Demand Reduction's (EDR) impact assessment suggests there is approximately 26.2TWh of EDR potential in the non-domestic and industrial sectors (after accounting for the impact of existing policy), and that, even under conservative assumptions, there remains considerable potential for cost effective electricity demand reduction.

There could be potential for DNO's to undertake a bidding process for customers who would be prepared to implement measures providing peak load reductions through energy efficiency interventions. This would be in line with the proposals that a number of DNO's are developing to obtain DSR services. Learning from the EDR pilot could be incorporated in the process.

During our stakeholder engagement we received some anecdotal evidence that surveys themselves have acted as a catalyst for stakeholders to progress interventions on their own behalf in order to benefit from attractive payback periods predicted.

Any future DNO led customer energy efficiency strategy should look to capitalise on both the learning's from EDR and the outputs from ESOS.

The intervention hierarchy can also provide direction for targeting specific energy efficiency works that offer best and most cost effective network benefit. These measures can in turn be targeted at stakeholders or specific building types where opportunities have been identified as most likely to exist (see table 2). Alternatively, the hierarchy could be used to inform the development of a SPEN or Ofgem customer energy efficiency incentive scheme, or similar, developed to drive implementation of specific measures for maximum network benefit.

[5] *https://www.gov.uk/electricity-demand-reduction-pilot*